NOTICE INVITING TENDER

FOR

INSTRUMENT AIR & PLANT AIR SYSTEM

(OPEN DOMESTIC COMPETETIVE BIDDING)

(NIT NO : PNMM/PC-183/E- 4008/NCB)

TALCHER FERTILIZERS LIMITED

[A JOINT VENTURE OF M/s GAIL (INDIA) LIMITED (GAIL), M/s RASHTRIYA CHEMICALS & FERTILIZERS LTD. (RCF), M/s COAL INDIA LTD. (CIL), & M/s FERTILIZER CORPORATION OF INDIA LTD (FCIL)]

ISSUED BY

PROJECTS & DEVELOPMENT INDIA LTD.
(A Govt. Of India Enterprise)
PDIL BHAWAN, A-14, Sector-1,
NOIDA U.P. (India)

24.05.2021

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INVITATION FOR BID (IFB)

SECTION-I
"INVITATION FOR BID (IFB)"

Ref No: PNMM/PC183/E-4008/NCB Dated: 24.05.2021

To,

PROSPECTIVE BIDDERS

SUB: INSTRUMENT AIR & PLANT AIR SYSTEM
Dear Sir/Madam,

1.0 **INTRODUCTION:**

1.1 GAIL (India) Limited (GAIL), Rashtriya Chemicals & Fertilizers Limited (RCF), Coal India Limited (CIL) and Fertilizer Corporation of India Limited (FCIL) have formed a Joint Venture company in the name of Talcher Fertilizers Limited (TFL) hereinafter also referred to as "Owner", intends to set up INSTRUMENT AIR & PLANT AIR SYSTEM for its Coal gasification and Ammonia Urea Plant, an integrated fertilizer and chemical complex comprising of Coal Gasification and Gas Purification Unit, Ammonia Synthesis Unit, Urea Plant, along with necessary offsite and utility facilities, within the premises of Coal based Ammonia-Urea Complex of Fertilizer Corporation of India Limited (FCIL) at Talcher Unit, Angul district, in the state of Odisha, India.

1.2 GAIL (India) Limited is a Public Sector Unit under the Ministry of Petroleum & Natural Gas and Rashtriya Chemicals & Fertilizers Limited (RCF) & Fertilizer Corporation of India Limited (FCIL) are two Public Sector Units under the Ministry of Chemicals & Fertilizers and Coal India Limited (CIL) is a Public Sector Unit under the Ministry of Coal, Govt. of India.

1.3 Projects and Development India Limited (PDIL), hereinafter referred to as CONSULTANT on behalf of M/s Talcher Fertilizers Ltd. (TFL), hereinafter referred as OWNER, has the pleasure of inviting bids from eligible domestic bidders to submit Bid ONLINE through Central Public Procurement (CPP) Portal under Single Stage Two Bid System, for the subject works.

2.0 The brief details of the tender are as under:

(A)	NAME OF WORK / BRIEF SCOPE OF SERVICE/JOB	**INSTRUMENT AIR & PLANT AIR SYSTEM**
(B)	TENDER NO. & DATE	PNMM/PC183/E-4008/NCB DATED 24.05.2021
(B1)	TYPE OF TENDER	OPEN DOMESTIC COMPETITIVE BIDDING
(C)	TYPE OF BIDDING SYSTEM	SINGLE BID SYSTEM: ☐ TWO BID SYSTEM: ✓

(D)	TYPE OF TENDER	E-TENDER (CPP PORTAL) ✓ MANUAL
(E)	COMPLETION PERIOD	Please Refer Clause 20.0 of SPECIAL CONDITIONS OF CONTRACT.
(F)	BID SECURITY / EARNEST MONEY DEPOSIT (EMD)	APPLICABLE NOT APPLICABLE ✓ Bidders are required to submit declaration for Bid security as per Form F-2 (Refer clause no.16 of ITB)
(G)	AVAILABILITY OF TENDER DOCUMENT ON WEBSITE(S)	CPP Portal(https://eprocure.gov.in/eprocure/app) TFL (http://tflonline.co.in)
(H)	LAST DATE OF RECEIPT OF BIDDER'S PRE-BID QUERIES	04.06.2021
(I)	DATE, TIME OF PRE-BID MEETING (Through Video Conferencing)	08.06.2021 at 11:00 Hrs. (IST)
(J)	BID SUBMISSION START DATE	23.06.2021 at 15:00 Hrs. (IST)
(K)	BID CLOSING DATE	08.07.2021 at 15:00 Hrs. (IST)
(L)	BID OPENING DATE	09.07.2021 at 15:00 Hrs. (IST)
(M)	**Address for Communication**	
(i)	PDIL	M/s Projects & Development India Limited, P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. Gautam Budh Nagar (UP). (India) Kind Attention: Mr. P.R.Sahu, Addl. General Manager (M.M) Fax no. : +91-120-2529801 Tel no. : +91-120-2544063 E-mail : prsahu@pdilin.com anjali@pdilin.com alam@pdilin.com
(ii)	TFL	M/s Talcher Fertilizers Ltd. (TFL), C/O GAIL Training Institute, PARC Building, Plot No. 24, Sector-16A, Film City, Noida District – G.B. Nagar, U.P. - 201301

		Kind Attention : Mr. Amit Kumar Singh (General Manager) Tel No. : +91-120-2518349 +91-120-4097150/199 E-mail : ak.singh@gail.co.in sdasgupta@gail.co.in balasubramanian@gail.co.in
(N)	Original Documents to be submitted at	Projects & Development India Limited, (Materials Management Department) P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. Gautam Budh Nagar (UP). (India) Kind Attention: Mr. P.R. Sahu, Addl. General Manager (M.M) Fax no. : +91-120-2529801 Tel no. : +91-120-2544063. E-mail : prsahu@pdilin.com
(O)	Contact Person for Site visit	M/s Talcher Fertilizers Ltd. (TFL), Administrative Building, Talcher, Post: Vikrampur, Dist: Angul, Pincode-759106, Odisha Kind Attention: Mr. Panchanan Halder, General Manager (PE) Tel No. : +91-9999692275 E-mail : phaldar@gail.co.in

In case the days specified above happens to be a holiday in TFL/PDIL, the next working day shall be implied.

3.0 Bids must be submitted strictly in accordance with Clause No. 11 of ITB depending upon Type of Tender as mentioned at Clause no. 2.0 (D) of IFB. The IFB is an integral and inseparable part of the bidding document.

4.0 The following documents in addition to uploading the bid on CPP Portal (https://eprocure.gov.in/eprocure/app) shall also be submitted in Original (in physical form) within 7 (seven) days from the bid due date provided the scanned copies of the same have been uploaded on CPP Portal (https://eprocure.gov.in/eprocure/app) by the bidder along with e-bid within the due date and time to the address mentioned in Clause no. 2.0 (M) of IFB:-

i) Declaration for Bid Security
ii) Power of Attorney
iii) Pre-Signed Integrity Pact
iv) Original Letter of TPI as per Appendix-I at Section-II

5.0 Bidder(s) are advised to quote strictly as per terms and conditions of the tender documents and not to stipulate any deviations/exceptions.

6.0 Any bidder, who meets the Bid Evaluation Criteria (BEC) and wishes to quote against this Tender Document, may download the complete Tender Document along with its amendment(s) if any from websites as mentioned at 2.0 (G) of IFB and submit their Bid complete in all respect as per terms & conditions of Tender Document on or before the Due Date & Time of Bid Submission.

7.0 Bid(s) received from bidders to whom tender/information regarding this Tender Document has been issued as well as offers received from the bidder(s) by downloading Tender Document from above mentioned website(s) shall be taken into consideration for evaluation & award provided that the Bidder is found responsive subject to provisions contained in Clause No. 2 of ITB.

8.0 Bidder(s) are advised to quote strictly as per terms and conditions of the tender documents and not to stipulate any deviations/exceptions.

The Tender Document calls for offers on single point "Sole Bidder" responsibility basis and in total compliance of Scope of Works as specified in Tender Document.

9.0 Any revision, clarification, corrigendum, time extension, etc. to this Tender Document will be hosted on the above mentioned website(s) only as per Clause No. 2.0 (G) of IFB. Bidders are requested to visit the website regularly to keep themselves updated.

10.0 All the bidders who are willing to submit their bid are required to submit F-6 (Acknowledgement cum Consent letter) duly filled within 7 days from receipt of tender information.

11.0 The bidder shall submit the bid ONLINE through Central Public Procurement (CPP) Portal. Bids complete in all respects should be uploaded in the CPP portal on or before the Bid Due Date and time mentioned in at Sl No. 2(K) above. Bids through Post/ Fax / E-mail /CD/ any other mode other than that specified in ITB will not be accepted

12.0 TFL/PDIL reserves the right to reject any or all the bids received at its discretion without assigning any reason whatsoever.

13.0 Considering the present pandemic situation, relaxation towards submission of bids attached as Appendix-I

This is not an Order.

Thanking You,

(P.R.Sahu)
Addl. General Manager (M.M)
Projects & Development India Limited
Tel No. : +91-120-2544063
E-mail : prsahu@pdilin.com

PHYSICAL DOCUMENTS (Declaration for Bid Security, POA, IP & Original Letter of TPI)

Tender Document No. : PNMM/PC183/E-4008/NCB dated 24.05.2021

***Description* : INSTRUMENT AIR & PLANT AIR SYSTEM**

Due Date & Time : 05.07.2021 at 15:00 hrs.

From:	***To:***
…… ***……*** ***……*** ***……***	M/s Projects & Development India Limited, P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. Gautam Budh Nagar (UP). (India) Kind Attention: Mr. P.R.Sahu, Addl. General Manager (M.M)

i) (To be pasted on the envelope containing Physical Document i.e. Declaration for Bid Security, Power of Attorney & Integrity Pact)

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SECTION-II

BID EVALUATION CRITERIA

&

EVALUATION METHODOLOGY

SECTION-II

A. BID EVALUATION CRITERIA (BEC)

Bids are hereby invited from competent Domestic Bidders meeting the technical and financial criteria of respective BEC stated hereunder. Evaluation of Techno-Commercial offers shall be carried out for only those bidders who shall meet the BEC

1.0 Technical Criteria:

1.1. The bidder should possess experience of having successfully completed One "**Similar work**" during the last Seven (07) years reckoned from the bid opening date.

"**Similar Work**" means Design Engineering, Supply, Installation and Testing & Commissioning of at least One Instrument Air & Plant Air System of Design capacity of minimum 8000 Nm^3/hr under single stream (or multiple streams of minimum 4000 Nm^3/hr capacity each) including supply of Integrally Geared centrifugal Air compressor with capacity of at least 4000 Nm^3/hr.

To meet the Technical Criteria 1.1 above, only single contract is acceptable.

1.2. The said "**Similar Work**" referred at 1.1 above must have been in operation for at least one (01) year from the Date of Acceptance/Commissioning of the works.

Notes for 1.1 above:

i. Job Completed by a Bidder for its own plant / project cannot be considered as experience for the purpose of meeting BEC of the tender. However, jobs completed for Subsidiary / Fellow subsidiary / Holding company will be considered as experience for the purpose of meeting BEC subject to submission of tax paid invoice(s) duly certified by Statutory Auditor of the Bidder towards payments of statutory tax in support of the job completed for Subsidiary / Fellow subsidiary / Holding company. Such Bidders to submit these documents in addition to the documents specified to meet BEC.

ii. The bidder must submit the completion certificate / acceptance certificate issued by end user/ owner (or their consultant who has been duly authorized by them to issue such certificate) only after completion of work/ supply in all aspects.

iii. Only documents (Work order, completion certificate, execution certificate etc.) which have been referred / specified in the bid shall be considered in reply to the queries during evaluation of bids.

iv. In case more than one contract/order/agreement/DLOA are emanating against same tender, these contracts are to be considered as single contract for evaluation of credentials of a bidder for meeting their experience criteria.

v. Experience of bidder acquired as a sub-contractor is acceptable against submission of certificate from end user by such bidder along with other specified documents.

2.0 Financial Criteria:

2.1 The Annual Turnover of the bidder in any one of the last three (03) preceding financial years should be at least INR 7.18 Crore.

2.2 Net Worth of the bidder should be positive as per last audited financial year.

2.3 The Bidder should have minimum working capital equal to INR 1.44 Crore as per last audited financial year. However, if the bidder's working capital is negative or inadequate, the bidder shall submit a letter from their Bank having Net Worth of the bank not less than Rs. 100.0 Crore (or equivalent USD, confirming the availability of line of credit for INR 1.44 Crore. The line of credit from bank shall be submitted strictly as per prescribed format.

"Notes for 2.1, 2.2 & 2.3"

Annual Turnover: In case of tenders having the due date for submission of bid up 30th September of the relevant financial year, and, if audited financial results of the immediate three (03) preceding financial years are not available, the bidder has an option to submit the audited financial results of the 3 years immediately prior to that. Wherever the closing date of the bid is after 30th September of the relevant financial year, bidder has to compulsorily submit the audited financial results for any of the immediate three (3) preceding financial Years.

Net Worth & Working Capital: In case of tenders having due date for submission of bid up to 30th September of the relevant financial year and, if audited financial results of the immediate preceding financial years is not available, in such case the audited financial results of the year immediately prior to that year will be considered as last financial year for Net Worth / Working capital calculation. Wherever the closing date of the bid is after 30th September of the relevant financial year, Bidder has to compulsorily submit the audited financial result for the immediate preceding financial year.

3.0 General Notes (for both Technical BEC and Financial BEC):

Exchange rate for conversion of currency for evaluation of documents relating to BEC:

Exchange rate for Conversion of Currency for evaluation of documents submitted by bidders for BEC which are in a currency other than INR, shall be as follows:

a) **BEC (Technical):** Bill Selling (foreign exchange) Rate of State Bank of India as prevailing on the date award of order / contract submitted by bidder.

b) **BEC (Financial)**

(i) **For Annual Turnover**: The average of Bill Selling (Foreign Exchange) Rate of State Bank of India as prevailing on the First date and Last date of the respective Financial Year.

(ii) **For Net Worth & Working Capital**: The Bill Selling (Foreign Exchange) Rate of State Bank of India as prevailing on the Last date of the respective Financial Year.

c) In case, the SBI Selling rate is not available as on the date of conversion as specified above for respective cases, the exchange rate for conversion of currency shall be taken from the internet, such as

https://economictimes.indiatimes.com/markets/forex/currency-converter
https://www.oanda.com/currency/converter

4.0 BEC for START – UPS:

The Technical and Financial BEC as stipulated above shall also be applicable for start-ups.

5.0 Documents to be submitted for compliance to BEC

(i) Technical criteria of BEC:

To meet the criteria 1.1 above, Bidder must submit Copy of Detailed Letter of Acceptance (DLOA) / Work Order / relevant extract of work Order / Contract Agreement along with detailed scope of work and Completion / Acceptance Certificate reckoned from date of Acceptance / Commissioning of Works.

To meet the criteria 1.2 above a certificate in respect of minimum one year successful operation of the Plant / System from the date of acceptance / commissioning of work issued by the Owner/End user shall be submitted.

The Detailed Letter of Acceptance (DLOA) / Work Order / Contract Agreement must clearly indicate nature of Work, Period and contract value. Similarly, the Completion Certificate / Acceptance Certificate must clearly indicate reference of relevant work order/DLOA/Contract Agreement, Name of Work, Contract Value, Completed order value and date of completion.

(ii) Financial criteria of BEC:

(a) To meet the criteria for Sr. No. 2.1, Bidder shall submit the Audited Financial Statements of the company for any one of the preceding three (03) financial years whichever meets the annual turnover criteria.

(b) To meet the criteria for Sr. No. 2.2, Bidder shall submit the last Audited Financial Statement alongwith "Details of Financial Capability of the Bidder" in prescribed format duly signed and stamped by Chartered Accountant.

(c) To meet the criteria for Sr. No. 2.3, Bidder shall submit the last Audited Financial Statements along with (i) Bank's Letter (if applicable) and (ii) "Details of Financial Capability of the Bidder" in prescribed format duly signed and stamped by Chartered Accountant along - with Bank's letter for 2.3 (if applicable).

(d) If the bidder's working capital is negative or inadequate, the bidder shall submit a letter from their bank having net worth not less than Rs. 100 Crores (or equivalent USD), confirming the availability of line of credit for working capital amount mentioned herein above. The line of credit letter from bank to be submitted strictly as per prescribed format.

For 5 (ii) above, the <u>"Notes for 2.1, 2.2 & 2.3"</u> under 2.0 (Financial Criteria of BEC) Shall apply

(iii) Bidder shall submit Checklist as per prescribed fromat (F-30) in respect of documents to be submitted by bidder towards BEC

6.0 Authentication of documents submitted against BEC:

i. All documents in support of Sl. No. 1.1 of Technical Criteria of BEC to be furnished by the Bidder shall necessarily by duly certified / attested by Chartered Engineer as well as Notary Public with legible stamp.

ii. For authentication of document submitted in support of Financial Criteria of Bid Evaluation criteria (BEC), copy of audited annual financial statements submitted with bid shall be duly certified / attested by Notary Public with legible stamp. Further, bidder shall submit “Details of financial capability of Bidder” in prescribed format duly signed and stamped by a Chartered Accountant / Certified Public Accountant (CPA)

B. EVALUATION METHODOLOGY

The subject work is indivisible and complete works shall be awarded to successful overall lowest bidder as per evaluation methodology described below. In other words, evaluation of bids shall be done on overall L-1 basis considering all applicable taxes & duties including GST as under.

The Evaluation methodology shall be arrived as per following

a) **TOTAL CONTRACT PRICE** - :

The TOTAL CONTRACT PRICE (Including all taxes, duties, levies and GST) as derived from the SCHEDULE OF PRICES as quoted by the Bidder.

b) **NPV OF TOTAL WORKS COST**

Bidder shall furnish the Guaranteed Consumption Figures as per prescribed format (Annexure B). The differential Works cost (in comparison to Bidder quoting the lowest Works Cost) considering 330 stream days per year will be calculated for System and will be discounted at discount rate of 10.0% p.a. for a period of 25 years of operation starting from Preliminary Acceptance.

The NPV of differential works cost so obtained on achieving Preliminary Acceptance (15 months) shall be further discounted at the rate of 10.0% p.a. to arrive at present value i.e. month zero

Total works Cost loading for entire System (to be considered in evaluation) shall be derived by summing up all the separate Works Cost Loading values for entire system.

To summarize the above, the evaluated cost shall be ascertained as per following:

(a) TOTAL CONTRACT PRICE:

Plus (+)

(b) NPV of Total Works cost

Appendix-I

Format for Undertaking from TPIA
(on TPIA letter head duly stamped & signed)

Ref.: Date :

To,

Talcher Fertilizers Limited.
……
……..
……

Dear Sir,

Subject: Verification and certification of documents pertaining to Technical Bid Evaluation Criteria (BEC)

Ref : Tender no. …….. for …….

M/s. ……having Registered office at……intend to participate in above referred tender of Talcher Fertilizers Limited having its registered office at Plot 2/H, Kalpana Area, BJB Nagar, Khordha, Bhubaneswar-751014.

The tender conditions stipulates that the BIDDER shall submit Documents pertaining to Technical Bid Evaluation Criteria (BEC) duly verified and certified by designated independent Third Party Inspection Agency.

In this regard, this is to certify that copies of documents pertaining to Technical Bid Evaluation Criteria (BEC) submitted to us by the bidder have been verified and certified by us with the originals and found to be genuine. We have signed and stamped on the copies of all the verified and certified documents.

(Signature of a person duly authorized to
Sign on behalf of the TPIA)
(Seal of the Company)
Name: ……..
Contact No……

SECTION-III

INSTRUCTION TO BIDDERS

[TO BE READ IN CONJUNCTION WITH BIDDING DATA SHEET (BDS)]

SECTION-III

INSTRUCTION TO BIDDERS

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INSTRUCTION TO BIDDERS [ITB]
(TO BE READ IN CONJUNCTION WITH BIDDING DATA SHEET (BDS)

[A] – GENERAL

1 SCOPE OF BID

1.1 The Employer as defined in the "General Conditions of Contract [GCC]", wishes to receive Bids as described in the Tender document issued by Employer. Employer/Owner/TFL occurring herein under shall be considered synonymous.

1.2 SCOPE OF BID: The scope of work/ Services shall be as defined in Section-VI-3.0 of the Tender documents.

1.3 The successful bidder will be expected to complete the scope of Bid within the period stated in Special Conditions of Contract.

1.4 Throughout the Tender documents, the terms 'Bid', 'Tender' & 'Offer' and their derivatives [Bidder/Tenderer, Bid/Tender/Offer etc.] are synonymous. Further, 'Day' means 'Calendar Day' and 'Singular' also means 'Plural'.

2 ELIGIBLE BIDDERS

2.1 Provision for procurement from a bidder which shares a land border with India has been attached as **Annexure-VII** herewith.

2.2 The Bidder shall not be under a declaration of ineligibility by Employer for Corrupt/ Fraudulent/ Collusive/ Coercive practices, as defined in "Instructions to Bidders [ITB], Clause No. 39" (Action in case Corrupt/ Fraudulent/ Collusive/ Coercive Practices).

2.3 The Bidder is not put on 'Holiday' by TFL or any of the JV partner of OWNER (viz. GAIL, RCF, CIL, FCIL) or Public-Sector Project Management Consultant (like PDIL only due to "poor performance" or "corrupt and fraudulent practices") or banned/blacklisted by Government department/ Public Sector on due date of submission of bid or during the process of evaluation of bids. Further, neither bidder nor their allied agency/(ies) (as defined in the Procedure for Action in case of Corrupt/Fraudulent/Collusive/ Coercive Practices)are on banning list of TFL or any of the JV partner of OWNER viz. GAIL, RCF, CIL, FCIL.

If the Tender documents were issued inadvertently/ downloaded from website, offers submitted by such bidders shall not be considered for opening/ evaluation/Award and will be returned immediately to such bidders.

In case there is any change in status of the declaration prior to award of contract, the same has to be promptly informed to TFL/PDIL by the bidder.

It shall be the sole responsibility of the bidder to inform about their status regarding para 1 of clause 2.2 herein above on due date of submission of bid and during the course of finalization of the tender. Concealment of the facts shall tantamount to misrepresentation of facts and shall lead to action against such Bidders as per clause 39 of ITB.

2.4 The Bidder should not be under any liquidation court receivership or similar proceedings on due date of submission of bid. In case there is any change in status of the declaration prior to award of contract, the same has to be promptly informed to TFL/PDIL by the bidder.

It shall be the sole responsibility of the bidder to inform TFL there status on above on due date of submission of bid and during the course of finalization of the tender. Concealment of the facts shall tantamount to misrepresentation of facts and shall lead to action against such Bidders as per clause no. 39 of ITB.

2.5 Bidder shall not be affiliated with a firm or entity:

(i) that has provided consulting services related to the work to the Employer during the preparatory stages of the work or of the project of which the works/services forms a part of or
(ii) that has been hired (proposed to be hired) by the Employer as an Engineer/ Consultant for the contract.

2.6 Deleted.

2.7 Pursuant to qualification criteria set forth in the Tender document, the Bidder shall furnish all necessary supporting documentary evidence to establish Bidder's claim of meeting qualification criteria.

2.8 **Power of Attorney:**

Power of Attorney to be issued by the bidder in favour of the authorised employee(s),in respect of the particular tender, for purpose of signing the documents including bid, all subsequent communications, agreements, documents etc. pertaining to the tender and act and take any and all decision on behalf of the bidder (including Consortium). Any consequence resulting due to such signing shall be binding on the Bidder (including Consortium).

(I) In case of a single Bidder, the power of Attorney shall be issued as per the constitution of the bidder as below:

a) **In case of Proprietorship**: By Proprietor
b) **In case of Partnership**: by all Partners or Managing Partner.
c) **In case of Limited Liability Partnership**: by any bidder's employee authorized in terms of Deed of LLP.
d) **In case of Public /Limited Company**: POA in favour of authorized employee(s) by Board of Directors through Board Resolution or by the designated officer authorized by Board to do so. Such Board Resolution should be duly countersigned by Company Secretary / MD / CMD / CEO.

The Power of Attorney should be valid till award of contract/order to successful bidder.

3 <u>BIDS FROM "JOINT VENTURE"/"CONSORTIUM</u>"

NOT APPLICABLE.

4 ONE BID PER BIDDER

4.1 A Bidder shall submit only 'one [01] Bid' in the same Bidding Process either as single entity or as a member of any consortium (wherever consortium bid is allowed). A Bidder who submits or participates in more than 'one [01] Bid' will cause all the proposals in which the Bidder has participated to be disqualified.

4.2 More than one bid means bid(s) by bidder(s) having same Proprietor / Partners / Limited Liability Partner in any other Bidder (s). Further, more than one bids shall also include two or more bidders having common power of attorney holder.

Failure to comply this clause during tendering process will disqualify all such bidders from process of evaluation of bids.

4.3 Alternative Bids shall not be considered.

4.4 The provisions mentioned at sl. no. 4.1 and 4.2 shall not be applicable wherein bidders are quoting for different Items / Sections / Parts / Groups/ SOR items of the same tender which specifies evaluation on Items / Sections / Parts / Groups/ SOR items basis.

5 COST OF BIDDING

The Bidder shall bear all costs associated with the preparation and submission of the Bid including but not limited to Bank charges all courier charges including taxes & duties etc. incurred thereof. Further, TFL/PDIL will in no case, be responsible or liable for these costs, regardless of the outcome of the bidding process.

6 SITE VISIT

6.1 The Bidder is advised to visit and examine the site of works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the Bid and entering into a Contract for the required job. The costs of visiting the site shall be borne by the Bidder.

6.2 The Bidder or any of its personnel or agents shall be granted permission by the Employer to enter upon its premises and land for the purpose of such visits, but only upon the express conditions that the Bidder, its personnel and agents will release and indemnify the Employer and its personnel, agents from and against all liabilities in respect thereof, and will be responsible for death or injury, loss or damage to property, and any other loss, damage, costs, and expenses incurred as a result of inspection.

6.3 The Bidder shall not be entitled to hold any claim against TALCHER FERTILIZERS LIMITED for non-compliance due to lack of any kind of pre-requisite information as it is the sole responsibility of the Bidder to obtain all the necessary information with regard to site, surrounding, working conditions, weather etc. on its own before submission of the bid.

[B] – TENDER DOCUMENTS

7 CONTENTS OF TENDER DOCUMENTS

7.1 The contents of Tender documents / Tender Documents are those stated below, and should be read in conjunction with any 'Addendum / Corrigendum' issued in accordance with "ITB: Clause-9":

- Section-I : Invitation for Bid [IFB]
- Section-II : Bid Evaluation Criteria [BEC] & Evaluation Methodology
- Section-III : Instructions to Bidders [ITB], Annexures, Forms & Formats

- Section-IV : General Conditions of Contract [GCC]
- Section-V : Special Conditions of Contract [SCC]
- Section-VI : Scope of Work & Technical Specifications
- Section-VII : Price Schedule/ Schedule of Rates

*'Request for Quotation', wherever applicable, shall also form part of the Tender document.

7.2 The Bidder is expected to examine all instructions, forms, terms & conditions in the Tender documents. The "Request for Quotation [RFQ] and/or Invitation for Bid (IFB)" with all its attachments thereto, shall be considered to be read, understood and accepted by the Bidders. Failure to furnish all information required by the Tender documents or submission of a Bid not substantially responsive to the Tender documents in every respect will be at Bidder's risk and may result in the rejection of his Bid.

8 CLARIFICATION OF TENDER DOCUMENTS

8.1 A prospective Bidder requiring any clarification(s) of the Tender documents may notify TFL in writing or through CPP Portal (https://eprocure.gov.in/eprocure/app)or email at PDIL's mailing address indicated in the BDS no later than 02 (two) days prior to pre-bid meeting (in cases where pre-bid meeting is scheduled) or 05 (five) days prior to the due date of submission of bid in cases where pre-bid meeting is not scheduled. TFL/PDIL reserves the right to ignore the bidders request for clarification if received after the aforesaid period. TFL/PDIL may respond in writing to the request for clarification. TFL/PDIL's response including an explanation of the query, but without identifying the source of the query will be uploaded on the websites at Clause No. 2.0 (G) of IFB and communicated to prospective bidders by e-mail.

8.2 Any clarification or information required by the Bidder but same not received by the Employer at clause 8.1 (refer BDS for address) above is liable to be considered as "no clarification / information required".

9 AMENDMENT OF TENDER DOCUMENTS

9.1 At any time prior to the 'Bid Due Date', Owner may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective Bidder, modify the Tender documents by amendment / corrigendum.

9.2 Any corrigendum thus issued shall be integral part of the Tender Document and shall be hosted on the websites as provided at clause no. 2.0 (G) of IFB. Bidders, in their own interest, are advised to regularly check the websites for any amendment/Corrigendum/Addendum. Bidders have to take into account all such amendment / corrigendum before submitting their Bid.

9.3 The Employer, if it considers necessary, may extend the date of submissions of Bid in order to allow the Bidders a reasonable time to furnish their most competitive bid taking into account the amendment / corrigendum issued thereof.

[C] – PREPARATION OF BIDS

10 LANGUAGE OF BID:

The bid prepared by the Bidder and all correspondence, document(s), certificate(s) etc. relating to the Bid exchanged by Bidder and TFL shall be written in English language only. In case a document, certificate, printed literature etc. furnished by the Bidder in in a language other than English, the same should be accompanied by an English translation duly authenticated by the Chamber of Commerce of Bidders Country, in which case, for the purpose of interpretation of the Bid, the English translation shall govern.

11. DOCUMENTS COMPRISING THE BID

11.1 Bidders are requested to refer instructions for participating in E-Tendering and the ready reckoner for bidders available in https://eprocure.gov.in/eprocure/app. Bids submitted manually shall be rejected.

The bids must be submitted on E-tendering website of CPP portal (https://eprocure.gov.in/eprocure/app) comprising following documents:-

11.1.1 **PART-I: "TECHNO-COMMERCIAL / UN-PRICED BID"** shall contain the following:

(a) 'Covering Letter' on Bidder's 'Letterhead' clearly specifying the enclosed contents.
(b) Duly attested documents in accordance with the "BID EVALUATION CRITERIA [BEC]" establishing the qualification.
(c) 'Bidder's General Information', as per 'Form F-1'.
(d) Copies of documents, as specified in tender document
(e) As a confirmation that the prices are quoted in requisite format complying with the requirements copy of Schedule of Rate (SOR) with prices blanked out mentioning quoted / not quoted (as applicable) written against each item.
(f) 'Letter of Authority' on the Letter Head, as per 'Form F-3'
(g) 'Agreed Terms and Conditions', as per 'Form F-5'
(h) 'Acknowledgement cum Consent Letter', as per 'Form F-6'
(i) Copy of Power of Attorney as per 'F-13'/copy of Board Resolution, in favour of the authorized signatory of the Bid, as per clause no.2.8 of ITB(Original to be submitted physically).
(j) Copy of Declaration for Bid security in original as per Clause 16 of ITB (Original to be submitted physically)
(k) All forms and Formats including Annexures
(l) 'Integrity Pact' as per 'Form F-15'
(m) 'Indemnity Bond' as per 'Form F-16'
(n) Declaration by bidder towards Minimum Local Content as per 'Form-I of Annexure-V'
(o) Undertaking regarding Provisions for Procurement from a bidder which shares a land border with India as per 'Form 1 and Form-2 attached with Annexure VII
(p) Tender Document along with all Amendments/Corrigendum/Addendum, if any, duly signed/ digitally signed by the Authorized Signatory.
(q) Additional document specified in Bidding Data Sheet (BDS).
(r) Any other information/details required as per Tender Document

Note:

1. All the pages of the Bid must be signed/ digitally signed by the "Authorized Signatory" of the Bidder.

2. Forms F-4 and F-14 are not to be filled up at this stage as these will be executed only with successful bidder. However, bidders to be participated in this tender shall produce an acknowledgement regarding acceptance of prescribed format without any deviations at Sr. No. 22 of 'Agreed Terms & Conditions as per F-5' & same shall be produced in case they emerge as successful bidder.

11.1.2 PART-II: Price Bid

i) The Prices are to be submitted strictly as per the Schedule of Rate of the Tender documents. TFL/PDIL shall not be responsible for any failure on the part of the bidder to follow the instructions.

ii) Bidders are advised NOT to mention Rebate/Discount separately, either in the SOR format or anywhere else in the offer. In case Bidder(s) intend to offer any Rebate/Discount, they should include the same in the item rate(s) itself under the "Schedule of Rates (SOR)" and indicate the discounted unit rate(s) only.

iii) If any unconditional rebate has been offered in the quoted rate the same shall be considered in arriving at evaluated price. However no cognizance shall be taken for any conditional discount for the purpose of evaluation of the bids.

iv) In case, it is observed that any of the bidder(s) has/have offered suo-moto Discount/Rebate after opening of unpriced bid but before opening of price bids such discount /rebate(s) shall not be considered for evaluation. However, in the event of the bidder emerging as the lowest evaluated bidder without considering the discount/rebate(s), then such discount/rebate(s) offered by the bidder shall be considered for Award of Work and the same will be conclusive and binding on the bidder.

v) In the event as a result of techno-commercial discussions or pursuant to seeking clarifications / confirmations from bidders, while evaluating the un-priced part of the bid, any of the bidders submits a sealed envelope stating that it contains revised prices; such bidder(s) will be requested to withdraw the revised prices failing which the bid will not be considered for further evaluation.

11.2 Bidders must submit the original "Declaration for Bid security, Power of Attorney, Integrity Pact and TPI letter as specified in the Tender Document to the address mentioned in IFB, in a sealed envelope, superscribing the details of Tender Document (i.e. tender number & tender for) within 7 days from the date of un-priced bid opening.

11.3 The Prices are to be filled strictly in the Schedule of Rate of the bidding documents and provision mentioned at para 11.1.2 hereinabove and to be uploaded in CPP portal.

12 SCHEDULE OF RATES / BID PRICES

12.1 Unless stated otherwise in the Tender documents, the Contract shall be for the whole works as described in Tender documents, based on the rates and prices submitted by the Bidder and accepted by the Employer.

12.2 Prices must be filled in format for "Schedule of Rates [SOR]"/"BOQ" enclosed as part of Tender document. If there is any variation in item description, unit or quantity vis-à-vis SOR format of Tender Document; the Bid is liable to be rejected.

12.3 Bidder shall quote for all the items of "SOR" after careful analysis of cost involved for the performance of the completed item considering all parts of the Tender document. In case any activity though specifically not covered in description of item under "SOR" but is required to complete the works as per Specifications, Scope of Work / Service, Standards, General Conditions of Contract ("GCC"), Special Conditions of Contract ("SCC") or any other part of Tender document, the prices quoted shall deemed to be inclusive of cost incurred for such activity.

12.4 All duties, taxes and other levies [if any] payable by the Contractor under the Contract, or for any other cause except final **GST (CGST & SGST/ UTGST or IGST)** shall be included in the rates / prices and the total bid-price submitted by the Bidder. Applicable rate of **GST (CGST & SGST/ UTGST or IGST)** on the contract value shall be indicated in SOR under column for GST.

12.5 Prices quoted by the Bidder, shall remain firm and fixed and valid until completion of the Contract and will not be subject to variation on any account. Any new taxes & Duties, if imposed by the State/ Govt. of India after due date of bid submission but before the expiry of contract period, shall be reimbursed to the contractor on submission of documentary evidence for proof of payment to State/ Govt. Authorities and after ascertaining it's applicability with respect to the contract.

12.6 Further, Bidder shall also mention the **Service Accounting Codes** (SAC) / **Harmonized System of Nomenclature (HSN)** at the designated place in SOR.

13 GST (CGST & SGST/ UTGST or IGST)

13.1 Bidders are required to mention the GST Registration number in bids wherever **GST (CGST & SGST/UTGST or IGST)** is applicable

13.2 Please note that the responsibility of payment of **GST (CGST & SGST or IGST or UTGST)** lies with the Service Provider only. Service Provider providing taxable service shall issue tax Invoice/ Bill, as the case may be as per rules/ regulation of GST. Further, returns and details required to be filled under GST laws & rules should be timely filed by Service Provider with requisite details.

Payments to Service Provider for claiming **GST (CGST & SGST/UTGST or IGST)** amount will be made provided the above formalities are fulfilled. Further, TFL may seek copies of challan and certificate from Chartered Accountant for deposit of **GST (CGST & SGST/UTGST or IGST)** collected from Owner.

13.3 In case CBIC (Central Board of Indirect Taxes and Customs)/ any equivalent Central Government agency/ State Government agency brings to the notice of TFL that the Supplier of Goods / Services (Service Provider) has not remitted the amount towards **GST (CGST & SGST/UTGST or IGST)** collected from TFL to the government exchequer, then, that Contractor shall be put under Holiday list of TFL for a period of six months after following the due procedure. This action will be in addition to the right of recovery of financial implication arising on TFL.

13.4 For statutory variation in **GST (CGST & SGST/UTGST or IGST), please refer clause no. 13.0 of SCC (Section V of NIT)**

13.5 TFL will reimburse **GST (CGST & SGST/UTGST or IGST)** to the Contractor at actuals against submission of Tax Invoices as per format specified in rules/ regulation of GST, subject to any statutory variations, except variations arising due to change in turnover.

13.6 TFL will prefer to deal with registered contractors under GST. Therefore, bidders are requested to get themselves registered under GST, if not registered yet.

However, in case any unregistered bidder is submitting their bid, their prices will be loaded with applicable GST **(CGST & SGST/UTGST or IGST)** while evaluation of bid (if applicable as per Govt. Act/ Law in vogue).

13.7 In case TFL is required to pay entire/certain portion of applicable **GST (CGST & SGST/UTGST or IGST)** and remaining portion, if any, is to be deposited by Bidder directly as per **GST (CGST & SGST/UTGST or IGST)** laws, entire applicable rate/amount of **GST (CGST & SGST/UTGST or IGST)** to be indicated by bidder in the SOR.

Where TFL has the obligation to discharge **GST (CGST & SGST/UTGST or IGST)** liability under reverse charge mechanism and TFL has paid or is /liable to pay **GST (CGST & SGST/UTGST or IGST)** to the Government on which interest or penalties becomes payable as per GST laws for any reason which is not attributable to TFL or ITC with respect to such payments is not available to TFL for any reason which is not attributable to TFL, then TFL shall be entitled to deduct/ setoff / recover such amounts against any amounts paid or payable by TFL to Contractor.

13.8 <u>RECONCILIATION BETWEEN GSTR2A AND INPUT TAX CREDIT</u>

Supplier shall ensure timely submission of correct e-Inovice(s)/invoice(s), as per GST rules/ regulation, with all required supporting document(s) within a period specified in Contract to enable TFL to avail input credit of GST (CGST & SGST/UTGST or IGST). Further, returns and details required to be filled under GST laws & rules should be timely filed by Bidder with requisite details.

If input Tax credit is not available to TFL for any reason not attributable to TFL, then TFL shall not be obligated or liable to pay or reimburse GST (CGST & SGSTIUTGST or IGST) claimed in the invoice(s) and shall be entitled to deduct/ setoff/ recover such GST amount (CGST & SGSTIUTGST or IGST) or Input Tax Credit amount together with penalties and interest, if any, against any amounts paid or becomes payable by TFL in future to the Bidder under this contract or under any other contract.

In case CBIC (Central Board of Indirect Taxes and Customs)/ any tax authority/ any equivalent government agency brings to the notice of TFL that the Bidder has not remitted the amount towards GST (CGST & SGSTIUTGST or IGST) collected from TFL to the government exchequer, then, that Bidder shall be put under Holiday list of OWNER for period of six months as mentioned in Procedure for Evaluation of Performance of Vendors/ Suppliers/ Contractors/ Bidders. This action will be in addition to the right of recovery of financial implication arising on TFL.

13.9 The amount of statutory levies like, CGST, SGST & IGST will be released when the same will appear in the GSTR-2A of OWNER, in the common portal of GST and Bidder has filed the valid return in accordance with the provisions of the GST act and the rules made thereunder. If, input tax credit is not available to OWNER for any reason attributable to the bidder, then OWNER shall not be obligatory or liable to pay or reimburse GST claimed in invoice and shall be entitled to deduct /setoff/ recover such GST together with all the penalty and interest if any, against any amount paid or payable to bidder. Further in this case, OWNER reserves the right to upload the name of such defaulter on the Company website and may also consider for putting under Holiday list of OWNER for period of six months as mentioned in Procedure for Evaluation of Performance of Vendors/ Suppliers/ Contractors/ Bidders.

13.10 **Anti-profiteering clause**

As per Clause 171 of GST Act it is mandatory to pass on the benefit due to reduction in rate of tax or from input tax credit to the consumer by way of commensurate reduction in prices. The Contractor may note the above and quote their prices accordingly.

13.11 In case the GST rating of vendor on the GST portal / Govt. official website is negative / black listed, then the bids may be rejected by TFL. Further, in case rating of bidder is negative / black listed after award of work, then TFL shall not be obligated or liable to pay or reimburse GST to such vendor and shall also be entitled to deduct / recover such GST along with all penalties / interest, if any, incurred by TFL.

13.12 The Contractor shall mention the particulars of Talcher Fertilizers Limited, (place specified in BDS) on the Invoice. Besides, if any other particulars of Talcher Fertilizers Limited are required to be mentioned, under GST rules/ regulations, the same shall also be mentioned on the Invoice.

13.13 GST, as quoted by the bidder, shall be deemed as final and binding for the purpose of bid evaluation (applicable for tenders where bidder quotes the GST rates). In case a bidder enters zero GST or an erroneous GST, the bid evaluation for finalizing the L1 bidder will be done considering the quoted GST rate. No request for change in GST will be entertained after submission of bids. In case GST column is left blank in the SOR, the quoted prices shall be considered as "Inclusive of GST" and evaluation shall be done accordingly.

In cases where the successful bidder quotes a wrong GST rate, for releasing the order, the following methodology will be followed:

- In case the actual GST rate applicable is lower than the quoted GST rate, the actual GST rate will be added to the quoted basic prices. The final cash outflow will be based on actual GST rate.

- In case the actual GST rate applicable is more than the quoted GST rate, the basic prices quoted will be reduced proportionately, keeping the final cash outflow the same as the overall quoted amount.

Based on the Total Cash Outflow calculated as above, TFL shall place orders.

13.14 The CONTRACTOR confirms that it has included all taxes, duties, levies etc., as applicable at prevailing rates, in its SCHEDULE OF RATES. In case, CONTRACTOR has not included any such taxes, duties, levies etc., at all and/or at prevailing rates and CONTRACTOR has to pay such taxes, duties, levies etc., OWNER shall not be liable for payment of such liabilities and/or OWNER shall not reimburse such taxes, duties, levies etc. to CONTRACTOR.

13.15 Wherever TDS under GST Laws has been deducted from the Tax invoices raised / payments made to the vendors, as per the provisions of the GST law / Rules, Vendors should accept the corresponding GST-TDS amount populated in the relevant screen on GST common portal (www.gst.gov.in). Further, Vendors should also download the GST TDS certificate from GST common portal (reference path: Services>User Services> View/Download Certificates option).

13.16 **Provision w.r.t. E- Invoicing requirement as per GST laws**

Contractor(s) who is required to comply with the requirements of E-invoice for B2B transactions as per the requirement of GST Law will ensure the compliance of requirement of E Invoicing under GST law. If the invoice issued without following this process, such invoice can-not be processed for payment by TFL as no ITC is allowed on such invoices.

Therefore, all the payments to such contractor who is liable to comply with e-invoice as per GST Laws shall be made against the proper e-invoice(s) only. Further, returns and details required to be filled under GST laws & rules against such e-invoices should be timely filed by Contractor with requisite details.

If input tax credit is not available to TFL for any reason attributable to contractor (both for E-invoicing cases and non-E-invoicing cases), then TFL shall not be obligated or liable to pay or reimburse GST (CGST & SGST/UTGST or IGST) claimed in the invoice(s) and shall be entitled to deduct / setoff / recover such GST amount (CGST & SGST/UTGST or IGST) or Input Tax Credit amount together with penalties and interest, if any, by adjusting against any amounts paid or becomes payable in future to the contractor under this contract or under any other contract.

To ensure compliance, undertaking in requisite format is to be submitted by Contractor as per format enclosed at Form F-29 along with documents for release of payment.

13.17 **Provision w.r.t. TCS on Sale of Goods under section 206 C (1H) of Income Tax Act (Applicable only in case of procurement of Goods)**

As per section 206C(1H) of the Income Tax Act, 1961 inserted by Finance Act 2020, a seller (as defined under the said section), who receives any amount as consideration for sale of any goods to a buyer (as defined under the provision)of the value or aggregate of such value exceeding fifty lakh rupees in any previous year, shall levy at the time of sale, TCS for a sum equal to % as defined (Presently 0.1 per cent) of the sale consideration exceeding fifty lakh rupees (or limit as specified in the Act) and deposit the same with Government on receipt/collection of consideration from TFL.

TFL will avail TCS credit and adjust such TCS credit against its income tax liability on the basis of TCS certificate to be issued by seller to TFL.

14 BID CURRENCIES:

Bidders must submit bid in Indian Rupees only.

15 BID VALIDITY

15.1 Bids shall be kept valid for period specified in BDS from the final due date of submission of bid'. A Bid valid for a shorter period may be rejected by TFL as 'non-responsive'.

15.2 In exceptional circumstances, prior to expiry of the original 'Bid Validity Period', the Employer may request the Bidders to extend the 'Period of Bid Validity' for a specified additional period. The request and the responses thereto shall be made in writing or by email. A Bidder may refuse the request. A Bidder agreeing to the request will not be required or permitted to modify his Bid

16 DECLARATION FOR BID SECURITY

16.1 Bid must be accompanied with Declaration for Bid Security, as per Form (F-2(Rev.1)).
Bid not accompanied with Declaration for Bid Security or Declaration for Bid Security not in requisite format shall be liable for rejection.

16.2 Notwithstanding anything contained herein, the Bidder will be put on watch list/holiday/ banning list (as per polices of TALCHER FERTILIZERS LIMITED in this regard) in any of the following cases:

(a) If a Bidder withdraws his Bid during the 'Period of Bid Validity'
(b) If a Bidder has indulged in corrupt/fraudulent /collusive/coercive practice
(c) If the Bidder modifies Bid during the period of bid validity (after Due Date and Time for Bid Submission).

(d) Violates any other condition, mentioned elsewhere in the Tender Document, which may lead the Bidder to be put on watch list/holiday/ banning list(as per polices of TALCHER FERTILIZERS LIMITED in this regard).

(e) In case of Cartelization of bid

(f) In the case of a successful Bidder, if the Bidder fails to:

(i) to acknowledge receipt of the “Notification of Award” / Fax of Acceptance[FOA] / Detailed Letter of Acceptance [DLOA]”,

(ii) to furnish “Contract Performance Security / Security Deposit”, in accordance with “ITB: Clause-38”

17. PRE-BID MEETING

17.1 The Bidder(s) or his designated representative are invited to attend a "Pre-Bid Meeting" which will be held through video conferencing only. The bidder shall send the list of representatives (not more than two) with their email IDs (on which meeting link will be sent) who wishes to attend the Pre Bid meeting to PDIL, at least two days before the scheduled Pre-bid meeting.

17.2 Purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage and give hands-on e-tendering.

17.3 Text of the questions raised and the responses given, together with any responses prepared after the meeting, will be uploaded on websites as mentioned at Clause No. 2.0 (G) of IFB. Any modification of the Contents of Tender documents listed in "ITB: Clause-7.1", that may become necessary as a result of the Pre-Bid Meeting shall be made by the Employer exclusively through the issue of a Corrigendum pursuant to "ITB: Clause-9", and not through the minutes of the Pre-Bid Meeting.

17.4 Non-attendance of the Pre-Bid Meeting will not be a cause for disqualification of Bidder.

16 FORMAT AND SIGNING OF BID

18.1 The original and all copies of the Bid shall be typed or written in indelible ink [in the case of copies, photocopies are also acceptable] and shall be signed by a person or persons duly authorized to sign on behalf of the Bidder (as per POA). The name and position held by each person signing, must be typed or printed below the signature. All pages of the Bid except for unamended printed literature where entry(s) or amendment(s) have been made shall be initialed by the person or persons signing the Bid.

18.2 The Bid shall contain no alterations, omissions, or additions, unless such corrections are initialed by the person or persons signing the Bid.

18.3 Digitally signed documents to be uploaded as detailed in addendum to ITB.

17 ZERO DEVIATION AND REJECTION CRITERIA

19.1 ZERO DEVIATION: Deviation to terms and conditions of "Tender documents" may lead to rejection of bid. TFL will accept bids based on terms & conditions of "Tender documents" only. Bidder may note TFL will determine the substantial responsiveness of each bid to the Tender documents pursuant to provision contained in clause 29 of ITB. For purpose of this, a substantially responsive bid is one which conforms to all terms and conditions of the Tender documents without deviations or reservations. TFL's determination of a bid's responsiveness is based on the content of the bid itself without recourse to extrinsic

evidence. TFL reserves the right to raise technical and/or commercial query(s), if required, may be raised on the bidder(s). The response(s) to the same shall be in writing, and no change in the price(s) or substance of the bids shall be sought, offered or permitted. The substance of the bid includes but not limited to prices, completion, scope, technical specifications, etc. Bidders are requested to not to take any deviation/exception to the terms and conditions laid down in this "Tender Documents", and submit all requisite documents as mentioned in this "Tender Documents", failing which their offer will be liable for rejection. If a bidder does not reply to the queries in the permitted time frame, then its bid shall be evaluated based on the documents available in the bid.

19.2 **REJECTION CRITERIA:** Notwithstanding the above, deviation to the following clauses of Tender document shall lead to summarily rejection of Bid:

a) Bidder not meeting Bid Evaluation Criteria as per Tender Document
b) Firm Price
c) Declaration for Bid Security
d) Specifications &Scope of Work
e) Schedule of Rates / Price Schedule / Price Basis
f) Duration / Period of Contract/ Completion Period
g) Payment Terms
h) Period of Validity of Bid
i) Integrity Pact
j) Mutually Agreed Damages
k) Overall ceiling on total liability
l) Contract Performance Security
m) Guarantee / Defect Liability Period
n) Arbitration / Settlement of Dispute
o) Governing laws, language & measures
p) Force Majeure
q) Undertaking forms, Form I & II of Annexure VII for provision for procurement from a bidder which shares a land border with India
r) Bidder quoting less than 20% as minimum Local content (as per make in India PPLC policy)
s) Any other condition specifically mentioned in the tender document elsewhere that non-compliance of the clause lead to rejection of bid

Note: Further, it is once again reminded not to mention any condition in the Bid which is contradictory to the terms and conditions of Tender document.

18 E-PAYMENT

OWNER has initiated payments to Suppliers and Contractors through RTGS / NEFT. The successful bidder should give the details of his bank account as per the E-Banking Mandate Form (F-12).

[D] – SUBMISSION OF BIDS

19 SUBMISSION, SEALING AND MARKING OF BIDS

21.1 Bids shall be submitted through e-tender mode on CPP portal (https://eprocure.gov.in/eprocure/app) in the manner specified elsewhere in tender document.

21.2 All the original/hard/physical copy of bids shall be addressed to the Consultant at address specified in IFB.

21.3 Bids submitted under the name of AGENT/ CONSULTANT/ REPRESENTATIVE /RETAINER/ ASSOCIATE etc. on behalf of a bidder/affiliate shall not be accepted.

20 DEADLINE FOR SUBMISSION OF BIDS

22.1 Bids must be submitted through e-tender mode on CPP portal not later than the date and time specified in the BDS (Bidding Data Sheet).

22.2 OWNER may, in exceptional circumstances and at its discretion, extend the deadline for submission of Bids (clause 9 of ITB refers). In which case all rights and obligations of OWNER and the Bidders, previously subject to the original deadline will thereafter be subject to the deadline as extended. Notice for extension of due date of submission of bid will be uploaded on website as mentioned in Clause No. 2.0(G) of IFB / communicated to the bidders.

21 LATE BIDS

CPP Portal (eprocure.gov.in) shall close immediately after the due date for submission of bid and no bids can be submitted thereafter until unless the due date extended further. E-mail offers or offers submitted in physical/hard copy sent directly will not be considered and shall be rejected.

In case Bid bond/physical documents have been received but the bid itself has not been uploaded in CPP portal (https://eprocure.gov.in/eprocure/app), such bid bond/ physical documents shall be returned immediately to the address of sender appearing on the envelope.

24 MODIFICATION AND WITHDRAWAL OF BIDS

24.1 The bidder may withdraw or modify its bid after bid submission but before the due date and time for submission as per tender document.

24.2 No bid shall be modified/ withdrawn after the Due Date & Time for Bid submission.

24.3 Any withdrawal/ modification/substitution of Bid in the interval between the Due Date & Time for Bid submission and the expiration of the period of bid validity specified by the Bidder in their Bid shall result in rejection of Bid.

21.4 The latest Bid submitted by the Bidder shall be considered for evaluation and all other Bid(s) shall be considered to be unconditionally withdrawn.

21.5 In case after price bid opening the lowest evaluated bidder (L1) is not awarded the job for any mistake committed by him in bidding or withdrawal of bid or modification of bid or varying any term in regard thereof leading to re-tendering, such bidders shall be debarred from participation in re-tendering of the same job(s)/item(s). Further, such bidder will be put on holiday for a period of six months after following the due procedure.

25 EMPLOYER'S RIGHT TO ACCEPT ANY BID AND TO REJECT ANY OR ALL BIDS

TFL reserves the right to accept or reject any Bid, and to annul the Bidding process and reject all Bids, at any time prior to award of Contract, without thereby incurring any liability to the affected Bidder or Bidders or any obligations to inform the affected Bidder or Bidders of the ground for TFL's action. However, Bidder if so desire may seek the reason (in writing) for rejection of their Bid to which TFL shall respond quickly.

[E] – BID OPENING AND EVALUATION

26 BID OPENING

26.1 **Unpriced Bid Opening:**

PMC/TFL will open bids, in the presence of bidder's designated representatives who choose to attend, at date, time and location stipulated in the BDS. The bidder's representatives, who are present, shall sign a bid opening register evidencing their attendance.

26.2 **Priced Bid Opening**:

26.2.1 PMC/TFL will open the price bids of those bidders who meet the qualification requirement and whose bids are determined to be technically and commercially responsive. Bidders selected for opening of their price bids shall be informed about the date of price bid opening. Bidders may depute their authorized representative to attend the bid opening. Bidders may depute their authorized representative to attend the bid opening. The bidder's representative who is present shall sign a register evidencing their attendance and may be required to be present on short notice. However, bidders can log onto CPP portal at the designated date & time to view the status of price bids.

26.2.2 The price bids of those Bidders who were not found to be techno-commercially responsive shall not be opened. The Price bids for acceptable bidder shall be opened by OWNER/PMC.

26.3 **Deleted**

27 CONFIDENTIALITY

Information relating to the examination, clarification, evaluation and comparison of Bids, and recommendations for the award of a Contract, shall not be disclosed to Bidder(s) or any other persons not officially concerned with such process.

28 CONTACTING THE EMPLOYER

28.1 From the time of Bid opening to the time of award of Contract, if any Bidder wishes to contact the Employer on any matter related to the Bid, it should do so in writing. Information relating to the examination, clarification, evaluation & recommendation for award shall not be disclosed.

28.2 Any effort by the Bidder to influence the Employer in the Employer's 'Bid Evaluation', 'Bid Comparison', or 'Contract Award' decisions may result in the rejection of the Bidder's Bid and action shall be initiated as per procedure in this regard.

29 EXAMINATION OF BIDS AND DETERMINATION OF RESPONSIVENESS

29.1 The owner's determination of a bid's responsiveness is based on the content of the bid only. Prior to the detailed evaluation of Bids, the Employer will determine whether each Bid:

(a) Meets the "Bid Evaluation Criteria" of the Tender documents;
(b) Has been properly signed;
(c) Is accompanied by the required 'Declaration for Bid Security';
(d) Is substantially responsive to the requirements of the Tender documents; and
(e) Provides any clarification and/or substantiation that the Employer may require to determine responsiveness pursuant to "ITB: Clause-29.2"

29.2 A substantially responsive Bid is one which conforms to all the terms, conditions and specifications of the Tender documents without material deviations or reservations or omissions for this purpose employer defines the foregoing terms below:

a) "Deviation" is departure from the requirement specified in the tender documents.
b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirement in the tender documents.
c) "Omission" is the failure to submit part or all of the information or documentation required in the tender document.

29.3 A material deviation, reservation or omission is one that,

a) If accepted would,
   i) Affect in any substantial way the scope, quality, or performance of the job as specified in tender documents.
   ii) Limit, in any substantial way, inconsistent with the Tender Document, the Employer's rights or the tenderer's obligations under the proposed Contract.
b) If rectified, would unfairly affect the competitive position of other bidders presenting substantially responsive bids.

29.4 The employer shall examine all aspects of the bid to confirm that all requirements have been met without any material deviation, reservation or omission.

29.5 If a Bid is not substantially responsive, it may be rejected by the Employer and may not subsequently be made responsive by correction or withdrawal of the of material deviation, reservation or omission.

30 DELETED.

31 CONVERSION TO SINGLE CURRENCY FOR COMPARISON OF BIDS

Not Applicable. All bids submitted must be in the currency specified at clause 14 of ITB.

32 EVALUATION AND COMPARISON OF BIDS

Bid shall be evaluated as per Evaluation Methodology mentioned under Section-II of Tender documents.

33 DELETED

34 PURCHASE PREFERENCE

Purchase preference to Central government public sector Undertaking, Local Content (PP-LC) bidders and Micro and Small Enterprises (MSEs) shall be allowed as per Government instructions in vogue.

[F] – AWARD OF CONTRACT

35 AWARD

Subject to "ITB: Clause-29", Owner will award the Contract to the successful Bidder whose Bid has been determined to be substantially responsive and has been determined as the lowest provided that bidder, is determined to be qualified to satisfactorily perform the Contract.

TFL intends to place the order/contract directly on the address from where Goods are produced / dispatched or Services are rendered. In case, bidder wants order/ contract at some other address or supply of Goods/ Services from multiple locations, bidder is required to provide in their bid address on which order is to be placed.

36 NOTIFICATION OF AWARD / FAX OF ACCEPTANCE

36.1 Prior to the expiry of 'Period of Bid Validity', Notification of Award for acceptance of the Bid will be intimated to the successful Bidder by OWNER either by E-mail /Letter or like means defined as the "Fax of Acceptance (FOA)". The Contract shall enter into force on the date of FOA and the same shall be binding on OWNER and successful Bidder (i.e. Contractor/Service Provider). The Notification of Award/FOA will constitute the formation of a Contract. The Detailed Letter of Acceptance shall be issued thereafter incorporating terms & conditions of Tender Document, Corrigendum, Clarification(s), Bid and agreed variation(s)/acceptable deviation(s), if any. OWNER may choose to issue Notification of Award in form of Detailed Letter of Acceptance without issuing FOA and in such case the Contract shall enter into force on the date of Detailed Letter of Acceptance only.

36.2 The "Notification of Award" will constitute the formation of a Contract, until the Contract has been affected pursuant to signing of Contract as per "ITB: Clause-37".
Upon the successful Bidder's / Contractor's furnishing of 'Contract Performance Security / Security Deposit', pursuant to "ITB: Clause-38".

36.3 The Order/ contract value mentioned above is subject to Mutually Agreed Damages clause.

37 SIGNING OF AGREEMENT

37.1 OWNER will award the Contract to the successful Bidder, who, within 'fifteen [15] days' of issuance of the same, shall sign and return the acknowledged copy to OWNER.

37.2 The successful Bidder/Contractor shall be required to execute 'Contract Agreement' in the prescribed format given in this Tender Document (Form F-11) on a 'non-judicial stamp paper' of appropriate value [cost of the 'stamp-paper' shall be borne by the successful Bidder/Contractor] and of 'state' specified in Bidding Data Sheet (BDS) only, within 'fifteen [15] days' of issuance of "Notification of Award i.e. Fax of Acceptance (FOA)" of the Tender by the successful Bidder/Contractor. Failure on the part of the successful Bidder/Contractor to sign the 'Agreement' within the above stipulated period, shall constitute sufficient grounds for forfeiture of Security Deposit and putting the bidder on watch list/holiday/ banning list (as per polices of TALCHER FERTILIZERS LIMITED in this regard).

38 CONTRACT PERFORMANCE SECURITY (CPS) / SECURITY DEPOSIT (SD)

38.1 Within 30 days of the issuance of Notification of Award i.e. Fax of Acceptance (FOA) by OWNER, the successful bidder shall furnish the Contract Performance Security (CPS). The CPS shall be in the form of either Banker's Cheque or Demand Draft or Bank Guarantee as per Format "F-4"and shall be in the currency of the Contract.

38.2 The CONTRACT PERFORMANCE SECURITY shall be for an amount equal to 3% of total contract value towards faithful performance of the contractual obligations and performance of equipment. For the purpose of CPS, Contract/order value shall be exclusive of **GST (CGST & SGST/UTGST or IGST)** to be reimbursed by the Owner.

Bank Guarantee towards CPS shall be from any Indian scheduled bank or a branch of an International bank situated in India and registered with Reserve Bank of India as scheduled foreign bank in case of Indian bidder as well as foreign bidder. However, in case of bank guarantees from banks other than the Nationalized Indian banks, the bank must be a commercial bank having net worth in excess of Rs 100 crores and a declaration to this effect should be made by such commercial bank either in the Bank Guarantee itself or separately on its letterhead.

38.3 Failure of the successful bidder to comply with the requirements of this article shall constitute sufficient grounds for the annulment of the award and shall be put on watch list/holiday/ banning list (as per polices of TALCHER FERTILIZERS LIMITED).

38.4 CPS/Security Deposit will not be accepted in case the same has reference of 'remitter' / 'financer' other than bidder on the aforementioned financial instrument of CPBG/ Security.

38.5 The CPS has to cover the entire contract value including extra works also. As long as the CPS submitted at the time of award take care of the extra works executed and total executed value is within the awarded contract price, there is no need for additional CPS. As soon as the total executed value is likely to burst the ceiling of awarded contract price, the contractor should furnish additional CPS.

38.6 In case of forfeiture of Contract Performance Security/ Security Deposit, the forfeited amount will be considered inclusive of tax and tax invoice will be issued by TFL. The forfeiture amount will be subject to final decision of TFL based on other terms and conditions of order/ contract.

38.7 The Contractor will also submit covering letter along with CPS as per format at F-4.

38.8 Please also refer 8.0 of GCC of NIT.

38.9 The Bidder shall submit the "Undertaking regarding submission of Contract Performance Security within stipulated time line" as per Form F-28 with their bid.

39 PROCEDURE FOR ACTION IN CASE CORRUPT/FRAUDULENT/COLLUSIVE/ COERCIVE PRACTICES

39.1 Procedure for action in case Corrupt/ Fraudulent/Collusive/Coercive Practices is provided at Annexure-I

39.2 **NON-APPLICABILITY OF ARBITRATION CLAUSE IN CASE OF BANNING OF VENDORS/ SUPPLIERS / CONTRACTORS/ BIDDERS/ CONSULTANTS INDULGED IN FRAUDULENT/ COERCIVE PRACTICES**

Notwithstanding anything contained contrary in GCC and other "CONTRACT DOCUMENTS", in case it is found that the Vendors/ Suppliers / Contractors/Bidders/ Consultants indulged in fraudulent/ coercive practices at the time of bidding, during execution of the contract etc. and/or on other grounds as mentioned in OWNER's "Procedure for action in case Corrupt/Fraudulent/Collusive/Coercive Practices" (Annexure-I), the contractor/bidder shall be banned (in terms of aforesaid procedure) from the date of issuance of such order by OWNER, to such Vendors/ Suppliers / Contractors/Bidders/ Consultants.

The Vendor/ Supplier / Contractor/ Bidder/Consultant understands and agrees that in such cases where Vendor/ Supplier / Contractor/ Bidder/Consultant has been banned (in terms of aforesaid procedure) from the date of issuance of such order by OWNER, such decision of OWNER shall be final and binding on such Vendor/ Supplier / Contractor/ Bidder/Consultant and the 'Arbitration clause' in the GCC and other "CONTRACT DOCUMENTS" shall not be applicable for any consequential issue /dispute arising in the matter.

40 PUBLIC PROCUREMENT POLICY FOR MICRO AND SMALL ENTERPRISES

40.1 Following provision has been incorporated in tender for MSEs, in line with notification of Government of India, vide Gazette of India No. 503 dated 26.03.2012 proclaiming the Public Procurement Policy on procurement of goods and services from Micro and Small Enterprises (MSEs)

i) Issue of tender document to MSEs free of cost.
ii) Deleted.

40.2 In case bidder is a Micro or Small Enterprise under the Micro, Small and Medium Enterprises Development Act, 2006, the bidder shall submit the following:

i. Ministry of MSME vide Gazette notification no. CG-DL-E-26062020-220191 dated 26.06.2020 has notified certain criteria for classifying the enterprises as Micro, Small and Medium Enterprises and specified, form and procedure for filing the memorandum (Udyam Registration) w.e.f. 01.07.2020 (for complete details of policy refer website of Ministry of MSME i.e. https://msme.gov.in)

   Accordingly, Micro and Small Enterprises (MSEs) shall be required to submit Udyam Registration Certificate for availing benefit under Public Procurement Policy for MSEs-2012

The above documents submitted by the bidder shall be duly certified by the Chartered Accountant (not being an employee or a Director or not having any interest in the bidder's company/firm) and notary public with legible stamp.

If the bidder does not provide the above confirmation or appropriate document or any evidence, then it will be presumed that they do not qualify for any preference admissible in the Public Procurement Policy (PPP) 2012.

Further, MSEs who are availing the benefits of the Public Procurement Policy (PPP) 2012 get themselves registered with MSME Data Bank being operated by NSIC, under SME Division, M/o MSME, in order to create proper data base of MSEs which are making supplies to CPSUs.

40.3 If against an order placed by OWNER, successful bidder(s) (other than Micro/Small Enterprise) is procuring material/services from their sub-vendor who is a Micro or Small Enterprise registered with District Industries Centers or Khadi and Village Industries Commission or Khadi and Village Industries Board or Coir Board or National Small Industries Corporation or Directorate of Handicrafts and Handloom or any other body specified by Ministry of Micro, Small and Medium Enterprises with prior consent in writing of the purchasing authority/Engineer-in-charge, the details like Name, Registration No., Address, Contact No. details of material & value of procurement made, etc. of such Enterprises shall be furnished by the successful bidder at the time of submission of invoice/Bill.

40.4 The benefit of policy are not extended to the traders/dealers/ Distributors /Stockiest/Wholesalers.

40.5 NSIC has initiated a scheme of “Consortia and Tender Marketing Scheme” under which they are assisting the Micro & Small enterprises to market their products and services through tender participation on behalf of the individual unit or through consortia.

Accordingly, if the MSEs or the consortia, on whose behalf the bid is submitted by NSIC, is meeting the BEC and other terms and conditions of tender their bid will be considered for further evaluation. Further, in such cases a declaration is to be submitted by MSE/ consortia on their letter head (s) that all the terms and conditions of tender document shall be acceptable to them.

41 DELETED

42 VENDOR PERFORMANCE EVALUATION

Shall be as stipulated Annexure II to ITB herewith.

43 INCOME TAX & CORPORATE TAX

43.1 Income tax deduction shall be made from all payments made to the contractor as per the rules and regulations in force and in accordance with the Income Tax Act prevailing from time to time.

43.2 Corporate Tax liability, if any, shall be to the contractor’s account.

43.3 TDS, wherever applicable, shall be deducted as per applicable act/law/rule.

43.4 **MENTIONING OF PAN NO. IN INVOICE/BILL**

As per CBDT Notification No. 95/2015 dated 30.12.2015, mentioning of PAN no. is mandatory for procurement of goods / services/works/consultancy services exceeding Rs. 2 Lacs per transaction.

Accordingly, supplier/ contractor/ service provider/ consultant should mention their PAN no. in their invoice/ bill for any transaction exceeding Rs. 2 lakhs. As provided in the notification, in case supplier/ contractor/ service provider/ consultant do not have PAN no., they have to submit declaration in Form 60 along with invoice/ bill for each transaction.

Payment of supplier/ contractor / service provider/ consultant shall be processed only after fulfillment of above requirement

44. **UNIQUE DOCUMENT IDENTIFICATION NUMBER BY PRACTICING CHARTERED ACCOUNTANTS**

Practicing Chartered Accountants shall generate Unique Document Identification Number (UDIN) for all certificates issued by them as per provisions of Tender Document.

However, UDIN may not be required for documents being attested by Chartered Accountants in terms of provisions of Tender Document.

45. **DISPUTE RESOLUTION MECHANISM**

1.0 CONCILIATION

Where invitation for Conciliation has been accepted by the other party, the Parties shall attempt to settle such dispute(s) amicably under Part-III of the Arbitration and Conciliation Act, 1996. It would be only after exhausting the option of Conciliation as an Alternate Dispute Resolution Mechanism that the Parties hereto shall invoke Arbitration Clause. For the purpose of this clause, the option of 'Conciliation' shall be deemed to have been exhausted, even in case of rejection of 'Conciliation' by any of the Parties.

2.0 ARBITRATION

All issue(s)/dispute(s) excluding the matters that have been specified as excepted matters and listed at clause no. 2.6 and which cannot be resolved through Conciliation, such issue(s)/dispute(s) shall be referred to arbitration for adjudication by Sole Arbitrator.

The party invoking the Arbitration shall have the option to either opt for Ad-hoc Arbitration as provided at Clause 2.1 below or Institutionalized Arbitration as provided at Clause 2.2 below, the remaining clauses from 2.3 to 2.7 shall apply to both Ad-hoc and Institutional Arbitration:-

2.1 On invocation of the Arbitration clause by either party, TFL shall suggest a panel of three independent and distinguished persons (Retd Supreme Court & High Court Judges only) to the other party from the Panel of Arbitrators maintained by 'Delhi International Arbitration Centre (DIAC) to select any one among them to act as the Sole Arbitrator. In the event of failure of the other party to select the Sole Arbitrator within 30 days from the receipt of the communication from TFL suggesting the panel of arbitrators, the right of selection of the sole arbitrator by the other party shall stand forfeited and TFL shall appoint the Sole Arbitrator from the suggested panel of three Arbitrators for adjudication of dispute(s). The decision of TFL on the appointment of the sole arbitrator shall be final and binding on the other party. The fees payable to Sole Arbitrator shall be governed by the fee Schedule of ''Delhi International Arbitration Centre'.

OR

2.2 If a dispute arises out of or in connection with this contract, the party invoking the Arbitration shall submit that dispute to any one of the Arbitral Institutions i.e ICADR/ICA/DIAC/SFCA and that dispute shall be adjudicated in accordance with their respective Arbitration Rules. The matter shall be adjudicated by a Sole Arbitrator who shall necessarily be a Retd. Supreme Court/High Court Judge to be appointed/nominated by the respective institution. The cost/expenses pertaining to the said Arbitration shall also be governed in accordance with the Rules of the respective Arbitral Institution. The decision of the party invoking the Arbitration for reference of dispute to a specific Arbitral institution for adjudication of that dispute shall be final and binding on both the parties and shall not be subject to any change thereafter. The institution once selected at the time of invocation of dispute shall remain unchanged.

2.3 The cost of arbitration proceedings shall be shared equally by the parties.

2.4 The Arbitration proceedings shall be in English language and the seat, venue and place of Arbitration shall be New Delhi, India only.

2.5 Subject to the above, the provisions of Arbitration & Conciliation Act 1996 and any amendment thereof shall be applicable. All matter relating to this Contract and arising out of invocation of Arbitration clause are subject to the exclusive jurisdiction of the Court(s) situated at New Delhi.

2.6 List of Excepted matters:

a) Dispute(s)/issue(s) involving claims below Rs 25 lakhs and above Rs 25 crores.
b) Dispute(s)/issue(s) relating to indulgence of Contractor/Vendor/Bidder in corrupt/fraudulent/collusive/coercive practices and/or the same is under investigation by CBI or Vigilance or any other investigating agency or Government.
c) Dispute(s)/issue(s) wherein the decision of Engineer-In-Charge/owner/TFL has been made final and binding in terms of the Contract.

2.7. Disputes involving claims below Rs 25 Lakhs and above Rs. 25 crores:- Parties mutually agree that dispute(s)/issue(s) involving claims below Rs 25 Lakhs and above Rs 25 crores shall not be subject matter of Arbitration and are subject to the exclusive jurisdiction of the Court(s) situated at New Delhi.

3.0 GOVERNING LAW AND JURISDICTION:

The Contract shall be governed by and construed in accordance with the laws in force in India. The Parties hereby submit to the exclusive jurisdiction of the Courts situated at New Delhi for adjudication of disputes, injunctive reliefs, actions and proceedings, if any, arising out of this Contract.

4.0 DISPUTES BETWEEN CPSE'S/ GOVERNMENT DEPARTMENT'S/ ORGANIZATIONS

Subject to conciliation as provided above, in the event of any dispute (other than those related to taxation matters) or difference relating to the interpretation and application of the provisions of commercial contract(s) between Central Public Sector Enterprises (CPSEs)/ Port Trusts inter se and also between CPSEs and Government Departments /Organizations , such dispute or difference shall be taken up by either party for resolution through AMRCD as mentioned in OPE OM No. 4(1)/2013-DPE(GM)/FTS-1835 dated 22-05-2018.

Any party aggrieved with the decision of the Committee at the First level (tier) may prefer an appeal before the Cabinet Secretary at the Second level (tier) within 15 days from the date of receipt of decision of the Committee at First level, through it's administrative Ministry/Department, whose decision will be final and binding on all concerned.

The above provisions mentioned at clause no. 45 shall supersede provisions relating to Conciliation, Arbitration, Governing Law & Jurisdiction and Disputes between CPSE's/ Government Department's/ Organizations mentioned in General Conditions of Contract (GCC) and elsewhere in tender document.

46 **DELETED**

47 **PROMOTION OF PAYMENT THROUGH CARDS AND DIGITAL MEANS**

To promote cashless transactions, the onward payments by Contractors to their employees, service providers, sub-contractors and suppliers may be made through Cards and Digital means to the extent possible

48 **CONTRACTOR TO ENGAGE CONTRACT MANPOWER BELONGING TO SCHEDULED CASTES AND WEAKER SECTIONS OF THE SOCIETY**

While engaging the contractual manpower, Contractors are required to make efforts to provide opportunity of employment to the people belonging to Scheduled Castes and weaker sections of the society also in order to have a fair representation of these sections.

49. **QUARTERLY CLOSURE OF THE CONTRACT *[FOR APPLICABILITY OFTHIS CLAUSE REFER BDS]*:-**

During execution of contracts/orders, various issues may arise. In order to timely detect and to address the contractual issue (s) during the execution of contracts, OWNER has introduced a mechanism of quarterly closure of the contract, under which all the issues related to the contract execution will be monitored on quarterly basis for resolution.

Vendors/Contractors are required to co-operate with EIC for proper implementation of this mechanism for smooth execution of the contract."

50 **PROVISIONS FOR STARTPUS (AS DEFINED IN GAZETTE NOTIFICATION NO. D.L-33004/99 DATED 18.02.2016 AND 23.05.2017 OF MINISTRY OF COMMERCE AND INDUSTRY AND AS AMENDED FROM TIME TO TIME) [FOR APPLICABLITY REFER BDS]**

As mentioned in Section-II, Technical and Financial BEC shall be applicable for all Startups [whether Micro & Small Enterprises (MSEs) or otherwise].

For availing the relaxation in EMD, bidder is required to submit requisite certificate towards Startup enterprise registration issued by Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce & Industry specifying the goods/ job domain wherein they are registered for. Further, the certificate should be certified by the Chartered Accountant (not being an employee or a Director or not having any interest in the bidder's company/ firm) and notary public with legible stamp.

In case the certificate of DPIIT towards recognition does not specify the goods/ job domain, startups are required to submit the documents for the same including the application submitted to DPIIT

Further, above document should also be certified by the Chartered Accountant (not being an employee or a Director or not having any interest in the bidder's company/firm) and notary public with legible stamp.

If a Startup emerge lowest bidder, the DLOA on such Startup shall be placed for entire tendered quantity quantity/group/item/part (as the case may be). However, during the Kick of Meeting monthly milestones/ check points would be drawn. Further, the performance of such contractor/ service provider will be reviewed more carefully and action to be taken as per provision of contract in case of failure/ poor performance.

51 **PROVISION REGARDING INVOICE FOR REDUCED VALUE OR CREDIT NOTE TOWARDS MAD (MUTUALLY AGREED DAMAGES)**

As mentioned in GCC, MAD is the reduction in the consideration / contract value for the goods / services covered under this contract. In case of delay in supply/ execution of contract, supplier/ contractor/ service provider should raise invoice for reduced value as per MAD clause. If supplier/ contractor/ service provider has raised the invoice for full value, then supplier/ contractor/ service provider should issue Credit Note towards the applicable MAD amount with applicable taxes.

In such cases if supplier/ contractor/ service provider fails to submit the invoice with reduced value or does not issue credit note as mentioned above, OWNER will release the payment to supplier/ contractor/ service provider after giving effect of the MAD clause with corresponding reduction of taxes charged on vendor's invoice, to avoid delay in delivery/collection of material."

In case any financial implication arises on OWNER due to issuance of invoice without reduction in price or non-issuance of Credit Note, the same shall be to the account of supplier/ contractor/ service provider. OWNER shall be entitled to deduct / setoff / recover such GST amount (CGST & SGST/UTGST or IGST) together with penalties and interest, if any, against any amounts paid or becomes payable by OWNER in future to the Supplier/Contractor under this contract or under any other contract.

52 POLICY TO PROVIDE PURCHASE PREFERENCE (LINKED WITH LOCAL CONTENT) (PP-LC).

The policy for providing purchase preference (linked with Local content) is enclosed as Annexure V to ITB herewith.

53 PROVISION FOR PROCUREMENT FROM A BIDDER WHICH SHARES A LAND BORDER WITH INDIA.

The clause regarding provision for procurement from a bidder which shares a land border with India is enclosed as Annexure-VII to ITB herewith.

54 Deleted

Annexure-I

PROCEDURE FOR ACTION IN CASE CORRUPT/FRAUDULENT/COLLUSIVE/COERCIVE PRACTICES

A Definitions:

A.1 "Corrupt Practice" means the offering, giving, receiving or soliciting, directly or indirectly, anything of value to improperly influence the actions in selection process or in contract execution.

"Corrupt Practice" also includes any omission for misrepresentation that may mislead or attempt to mislead so that financial or other benefit may be obtained or an obligation avoided.

A2 "Fraudulent Practice" means and include any act or omission committed by a agency or with his connivance or by his agent by misrepresenting/ submitting false documents and/ or false information or concealment of facts or to deceive in order to influence a selection process or during execution of contract/ order.

A3 "Collusive Practice amongst bidders (prior to or after bid submission)" means a scheme or arrangement designed to establish bid prices at artificial non-competitive levels and to deprive the Employer of the benefits of free and open competition.

A.4 "Coercive practice" means impairing or harming or threatening to impair or harm directly or indirectly, any agency or its property to influence the improperly actions of an agency, obstruction of any investigation or auditing of a procurement process.

A.5 "Vendor/Supplier/Contractor/Consultant/Bidder" is herein after referred as "Agency"

A.6 "Appellate Authority" shall mean Committee of Directors consisting of Director (Finance) and Director (BD) for works centers under Director (Projects). For all other cases committee of Directors shall consist of Director (Finance) & Director (Projects).

A.7 "Competent Authority" shall mean the authority, who is competent to take final decision for Suspension of business dealing with an Agency/ (ies) and Banning of business dealings with Agency/ (ies) and shall be the "Director" concerned.

A.8 "Allied Agency" shall mean all the concerns within the sphere of effective influence of banned/ suspended agencies. In determining this, the following factors may be taken into consideration:

(a) Whether the management is common;
(b) Majority interest in the management is held by the partners or directors of banned/ suspended firm.
(c) substantial or majority shares are owned by banned/ suspended agency and by virtue of this it has a controlling voice.

A.9 "Investigating Agency" shall mean any department or unit of TFL investigating into the conduct of Agency/ party and shall include the Vigilance Department of the TFL, Central Bureau of Investigation, State Police or any other agency set up by the Central or state government having power to investigate.

B Actions against bidder(s) indulging in corrupt /fraudulent/ collusive/ coercive practice

B.1 Irregularities noticed during the evaluation of the bids :

If it is observed during bidding process/ bids evaluation stage that a bidder has indulged in corrupt/fraudulent /collusive/coercive practice, the bid of such Bidder (s) shall be rejected and its Earnest Money Deposit (EMD) shall be forfeited.

Further, such agency shall be banned for future business with TFL for a period specified in para B 2.2 below from the date of issue of banning order.

B.2 Irregularities noticed after award of contract

(i) **During execution of contract:**

If an agency, is found to have indulged in corrupt/fraudulent/ collusive /coercive practices, action shall be initiated as per procedure mentioned at Clause no. E for putting the agency on banning list.

After conclusion of process and issuance of Speaking order for putting party on banning list as per process defined in para E, the order (s)/ contract (s) where it is concluded that such irregularities have been committed shall be terminated and Contract cum Performance Bank Guarantee (CPBG) submitted by agency against such order (s)/ contract (s) shall also be forfeited. Further such order/ contract will be closed following the due procedure in this regard.

The amount that may have become due to the contractor on account of work already executed by him shall be payable to the contractor and this amount shall be subject to adjustment against any amounts due from the contractor under the terms of the contract. No risk and cost provision will be enforced in such cases.

Suspension of order/ contract:

Further, only in the following situations, the concerned order (s)/ contract(s) (where Corrupt/Fraudulent/ Collusive/ Coercive Practices are observed) and payment shall be suspended after issuance of Suspension cum Show Cause Notice:

(i) Head of Corporate Vigilance Department/CVO based on the investigation by them, recommend for specific immediate action against the agency.
(ii) Head of Corporate Vigilance Department/CVO based on the input from investigating agency, forward for specific immediate action against the agency.

Suspension cum Show Cause Notice being issued in above cases after approval of the competent authority (as per provisions mentioned under Clause no. D) shall also include the provision for suspension of Order (s)/ Contract (s) and payment. Accordingly, after issuance of Suspension cum Show Cause Notice by Corporate C&P Department, the formal communication for suspension of Order (s)/ Contract (s) and payment with immediate effect will be issued by the following with copy to concerned F&A:

(i) <u>For Projects cases:</u> concerned Project Managers in case of Purchase Orders and concerned Construction-in Charge (where PMC is EIC)/ Engineer-in-Charge (EIC) in case of Contracts
(ii) <u>For other than Projects cases:</u> concerned Dealing officer in case of Purchase Orders and concerned Engineer-in-Charge (EIC) in case of Contracts.

During suspension, Contractor/ Service Providers will be allowed to visit the plant/ site for upkeep of their items/ equipment, TFL's issued materials (in case custody of same is not taken over), demobilizing the site on confirmation of EIC, etc.

However, no suspension of contract/ order will be initiated in Exceptional Cases mentioned at Clause no. B.2.3.

(ii) After execution of contract and during Defect liability period (DLP)/ Warranty/Guarantee Period:

If an agency is found to have indulged in corrupt/fraudulent/ collusive/coercive practices, after execution of contract and during DLP/ Warranty/Guarantee Period, the agency shall be banned for future business with TFL for a period specified in para B 2.2 below from the date of issue of banning order.

Further, the Contract cum Performance Bank Guarantee (CPBG)/Contract Performance Security (CPS) submitted by agency against such order (s)/ contract (s) shall be forfeited.

(iii) After expiry of Defect liability period (DLP)/ Warranty/Guarantee Period

If an agency is found to have indulged in corrupt/fraudulent/ collusive/coercive practices, after expiry of Defect liability period (DLP)/ Warranty/Guarantee Period, the agency shall be banned for future business with TFL for a period specified in para B 2.2 below from the date of issue of banning order.

B.2.2 Period of Banning

The period of banning of agencies indulged in Corrupt/ Fraudulent/ Collusive/Coercive Practices shall be as under and to be reckoned from the date of banning order:

S. No.	Description	Period of banning from the date of issuance of Banning order
1	Misrepresentation/False information other than pertaining to BEC of tender but having impact on the selection process. For example, if an agency confirms not being in holiday in TFL/PSU's PMC or banned by PSUs/ Govt. Dept., liquidation, bankruptcy & etc. and subsequently it is found otherwise, such acts shall be considered in this category.	02 years
2	Corrupt/Fraudulent (pertaining to BEC of tender) /Collusive/Coercive Practices	03 years
2.1	If an agency again commits Corrupt/Fraudulent (pertaining to BEC of tender) /Collusive/ Coercive Practices in subsequent cases after their banning, such situation of repeated offense to be dealt with more severity and following shall be the period of banning: (i) Repeated once	7 years (in addition to the period already served)

	(ii) Repeated twice or more	15 years (in addition to the period already served)
3	Indulged in unauthorized disposal of materials provided by TFL	7 years
4	If act of vendor/ contractor is a threat to the National Security	15 years

C Effect of banning on other ongoing contracts/ tenders

C.1 If an agency is put on Banning, such agency should not be considered in ongoing tenders/future tenders.

C.2 However, if such an agency is already executing other order (s)/ contract (s) where no corrupt/fraudulent/ collusive/coercive practice is found, the agency should be allowed to continue till its completion without any further increase in scope except those incidental to original scope mentioned in the contract.

C.3 If an agency is put on the Banning List during tendering and no irregularity is found in the case under process:

C.3.1 after issue of the enquiry /bid/tender but before opening of Technical bid, the bid submitted by the agency shall be ignored.

C.3.2 after opening Technical bid but before opening the Price bid, the Price bid of the agency shall not be opened and BG/EMD submitted by the agency shall be returned to the agency.

C.3.3 after opening of price, BG/EMD made by the agency shall be returned; the offer of the agency shall be ignored & will not be further evaluated. If the agency is put on banning list for fraud/ mis-appropriation of facts committed in the same tender/other tender where errant agency emerges as the lowest (L1), then such tender shall also be cancelled and re-invited.

D. Procedure for Suspension of Bidder

D.1 Initiation of Suspension

Action for suspension business dealing with any agency/(ies) shall be initiated by Corporate C&P Department when

(i) Corporate Vigilance Department based on the fact of the case gathered during investigation by them recommend for specific immediate action against the agency.

(ii) Corporate Vigilance Department based on the input from Investigating agency, forward for specific immediate action against the agency.

(iii) Non performance of Vendor/Supplier/Contractor/Consultant leading to termination of Contract/ Order.

D.2 Suspension Procedure:

D.2.1 The order of suspension would operate initially for a period not more than six months and is to be communicated to the agency and also to Corporate Vigilance Department. Period of suspension can be extended with the approval of the Competent Authority by one month at a time with a ceiling of six months pending a conclusive decision to put the agency on banning list.

D.2.2 During the period of suspension, no new business dealing may be held with the agency.

D.2.3 Period of suspension shall be accounted for in the final order passed for banning of business with the agency.

D.2.4 The decision regarding suspension of business dealings should also be communicated to the agency.

D.2.5 If a prima-facie, case is made out that the agency is guilty on the grounds which can result in banning of business dealings, proposal for issuance of suspension order and show cause notice shall be put up to the Competent Authority. The suspension order and show cause notice must include that (i) the agency is put on suspension list and (ii) why action should not be taken for banning the agency for future business from TFL.

The competent authority to approve the suspension will be same as that for according approval for banning.

D 3 Effect of Suspension of business:

Effect of suspension on other on-going/future tenders will be as under:

D.3.1 No enquiry/bid/tender shall be entertained from an agency as long as the name of agency appears in the Suspension List.

D.3.2 If an agency is put on the Suspension List during tendering:

D.3.2.1 after issue of the enquiry /bid/tender but before opening of Technical bid, the bid submitted by the agency shall be ignored.

D.3.2.2 after opening Technical bid but before opening the Price bid, the Price bid of the agency shall not be opened and BG/EMD submitted by the agency shall be returned to the agency.

D.3.2.3 after opening of price, BG/EMD made by the agency shall be returned; the offer of the agency shall be ignored & will not be further evaluated. If the agency is put on Suspension list for fraud/ mis-appropriation of facts conducted in the same tender/other tender where errant agency emerges as the lowest (L1), then such tender shall also be cancelled and re-invited.

D.3.3 The existing contract (s)/ order (s) under execution shall continue.

D.3.4 Tenders invited for procurement of goods, works and services shall have provision that the bidder shall submit a undertaking to the effect that (i) neither the bidder themselves nor their allied agency/(ies) are on banning list of TFL and (ii) bidder is not banned by any Government department/ Public Sector.

F. Appeal against the Decision of the Competent Authority:

F.1 The agency may file an appeal against the order of the Competent Authority for putting the agency on banning list. The appeal shall be filed to Appellate Authority. Such an appeal shall be preferred within one month from the of receipt of banning order.

F.2 Appellate Authority would consider the appeal and pass appropriate order which shall be communicated to the party as well as the Competent Authority.

F.3 Appeal process may be completed within 45 days of filing of appeal with the Appellate Authority.

G. Wherever there is contradiction with respect to terms of ‘Integrity pact’ , GCC and ‘Procedure for action in case of Corrupt/Fraudulent/ Collusive/Coercive Practice’, the provisions of ‘Procedure for action in case of Corrupt/Fraudulent/ Collusive/Coercive Practice’ shall prevail.

Annexure-II

PROCEDURE FOR EVALUATION OF PERFORMANCE OF VENDORS/ SUPPLIERS/ CONTRACTORS/ CONSULTANTS

1.0 OBJECTIVE

The objective of Evaluation of Performance aims to recognize, and develop reliable Vendors/ Suppliers/Contractors/ Consultants so that they consistently meet or exceed expectations and requirements.

The purpose of this procedure is to put in place a system to monitor performance of Vendors/ Suppliers/Contractors/ Consultants to ensure timely completion of various projects, timely receipt of supplies including completion of works & services for operation and maintenance of operating plants and quality standards in all respects.

2.0 METHODOLOGY

i) Preparation of Performance Rating Data Sheet

Performance rating data Sheet for each and every Vendor/ Supplier/Contractor/Consultant for all orders/Contracts with a value of Rs. 50 Lakhs and above is recommended to be drawn up. Further, Performance rating data Sheet for orders/contracts of Vendor/Supplier/Contractor/ Consultant who are on watch list/holiday list/ banning list shall be prepared irrespective of order/ contract value. These data sheets are to be separately prepared for orders/ contracts related to Projects and O&M. Format, Parameters, Process, responsibility for preparation of Performance Rating Data Sheet are separately mentioned.

ii) Measurement of Performance

Based on the parameters defined in Data Sheet, Performance of concerned Vendor/ Supplier/Contractor/ Consultant would be computed and graded accordingly. The measurement of the performance of the Party would be its ability to achieve the minimum scoring of 60% points in the given parameters.

iii) Initiation of Measures:

Depending upon the Grading of Performance, corrective measures would be initiated by taking up the matter with concerned Vendor/ Supplier/Contractor/ Consultant. Response of Vendor/ Supplier/Contractor/ Consultant would be considered before deciding further course of action.

iv) Implementation of Corrective Measures:

Based on the response of Vendor/ Supplier/Contractor/ Consultant, concerned Engineer-in-Charge would recommend for continuation or discontinuation of such party from the business of TFL.

v) Orders/contracts placed on Proprietary/OEM basis for O&M will be evaluated and, if required, corrective action will be taken for improvement in future.

3.0 PROCESS OF EVALUATION OF PERFORMANCE OF VENDORS/ SUPPLIERS/ CONTRACTORS/ CONSULTANTS

3.1 FOR PROJECTS

i) Evaluation of performance of Vendors/ Suppliers/Contractors/ Consultants in case of PROJECTS shall be done immediately with commissioning of any Project.

ii) On commissioning of any Project, EIC (Engineer-in-charge)/ Project-in-charge shall prepare a Performance Rating Data Sheet (Format at Annexure-1) for all Orders and Contracts.

iii) Depending upon the Performance Rating, following action need to be initiated by Engineer-in-charge/Project-in-charge:

Sl.No.	Performance Rating	Action
1	POOR	Seek explanation for Poor performance
2	FAIR	Seek explanation for Fair performance
3	GOOD	Letter to the concerned for improving performance in future
4	VERY GOOD	No further action

iv) Reply from concerned Vendor/ Supplier/Contractor/ Consultant shall be examined. In case of satisfactory reply, Performance Rating data Sheet to be closed with a letter to the concerned for improving performance in future.

v) When no reply is received or reasons indicated are unsatisfactory, the following actions need to be taken:

A) Where performance rating is “POOR” (as per Performance Rating carried out after execution of Order/ Contract and where no reply/ unsatisfactory reply is received from party against the letter seeking the explanation from Vendor/Supplier/Contractor/ Consultant along with sharing the performance rating)

Recommend such defaulting Vendor/Supplier/Contractor/ Consultant for the following action:

(a) **First such instance: Advisory notice (Yellow Card)** shall be issued and Vendor/Supplier/Contractor/ Consultant shall be put on watch list for a period of Three (3) Years.
Such vendor will be allowed to participate in all other tenders and to execute other ongoing order/ contract (s) or new contract/ order (s).

The Yellow card will be automatically revoked after a period of three years unless the same is converted into Red Card due to subsequence instances of poor/ non-performance in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant.

(b) **Second such instance in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant.**

(i) Poor Performance due to reasons other than Quality: **Putting on Holiday for a period of One Year**

(ii) Poor Performance on account of Quality (if any mark obtained against Quality parameter is less than 30): **Putting on Holiday for a period of Two Years**

(c) Subsequent instances **(more than two)** in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant: **Putting on Holiday for a period of Three Years**

B) Where Poor/Non-Performance leading to termination of contract or Offloading of contract due to poor performance attributable to Vendor/Supplier/ Contractor/Consultant (under Clause no.3.16.1 of GCC-Consultancy)

(a) **First instance**: **Advisory notice (Yellow Card)** shall be issued and Vendor/Supplier/Contractor /Consultant shall be put on watch list for a period of Three (3) Years.

Further such vendor will not be allowed to participate in the re-tender of the same supply/work/services of that location which has terminated / offloaded. Moreover, it will be ensured that all other action as per provision of contract including forfeiture of Contract Performance Security (CPS) etc. are undertaken.

However, such vendor will be allowed to participate in all other tenders and to execute other ongoing order/ contract (s) or new contract/ order (s).

The Yellow card will be automatically revoked after a period of three years unless the same is converted into Red Card due to subsequence instances of poor/ non-performance in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant.

(b) **Second instances** in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant: **Holiday (Red Card)** for period of One Year and they shall also to be considered for Suspension.

(c) **Subsequent instances (more than two)** in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant: **Holiday (Red Card) for period of Three Years and they shall also to be considered for Suspension.**

(C) Where Performance rating is "FAIR":

Issuance of warning to such defaulting Vendor/ Supplier/Contractor/ Consultant to improve their performance.

3.2 FOR CONSULTANCY JOBS

Monitoring and Evaluation of consultancy jobs will be carried out in the same way as described in para 3.1 for Projects.

3.3 FOR OPERATION & MAINTENANCE

i) Evaluation of performance of Vendors/ Suppliers/Contractors/ Consultants in case of Operation and Maintenance shall be done immediately after execution of order/ contract.

ii) After execution of orders a Performance Rating Data Sheet (Format at Annexure-2) shall be prepared for Orders by C&P and for Contracts/Services by respective Engineer-In-Charge.

iii) Depending upon Performance Rating, following action need to be initiated by C&P:

Sl. No.	Performance Rating	Action
1	**POOR**	Seek explanation for Poor performance
2.	**FAIR**	Seek explanation for Fair performance
3	**GOOD**	Letter to the concerned for improving performance in future.
4	**VERY GOOD**	No further action

iv) Reply from concerned Vendor/ Supplier/Contractor/ Consultant shall be examined. In case of satisfactory reply, Performance Rating data Sheet to be closed with a letter to the concerned for improving performance in future.

v) When no reply is received or reasons indicated are unsatisfactory, the following actions need to be taken:

A) Where performance rating is "POOR" (as per Performance Rating carried out after execution of Order/ Contract and where no reply/ unsatisfactory reply is received from party against the letter seeking the explanation from Vendor/Supplier/Contractor/ Consultant along with sharing the performance rating)

Recommend such defaulting Vendor/Supplier/Contractor/ Consultant for the following action:

(b) **First such instance: Advisory notice (Yellow Card)** shall be issued and Vendor/Supplier/Contractor/ Consultant shall be put on watch list for a period of Three (3) Years.
Such vendor will be allowed to participate in all other tenders and to execute other ongoing order/ contract (s) or new contract/ order (s).

The Yellow card will be automatically revoked after a period of three years unless the same is converted into Red Card due to subsequence instances of poor/ non-performance in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant.

(b) Second such instance in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant

(i) Poor Performance due to reasons other than Quality: **Putting on Holiday for a period of One Year**

(ii) Poor Performance on account of Quality (if any mark obtained against Quality parameter is less than 30): **Putting on Holiday for a period of Two Years**

(c) Subsequent instances **(more than two)** in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant: **Putting on Holiday for a period of Three Years**

B) Where Poor/Non-Performance leading to termination of contract or Offloading of contract due to poor performance attributable to Vendor/Supplier/ Contractor/Consultant (under Clause no.3.16.1 of GCC-Consultancy)

(d) **First instance**: **Advisory notice (Yellow Card)** shall be issued and Vendor/Supplier/Contractor /Consultant shall be put on watch list for a period of Three (3) Years.

Further such vendor will not be allowed to participate in the re-tender of the same supply/work/services of that location which has terminated / offloaded. Moreover, it will be ensured that all other action as per provision of contract including forfeiture of Contract Performance Security (CPS) etc. are undertaken.

However, such vendor will be allowed to participate in all other tenders and to execute other ongoing order/ contract (s) or new contract/ order (s).

The Yellow card will be automatically revoked after a period of three years unless the same is converted into Red Card due to subsequence instances of poor/ non-performance in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant.

(e) **Second instances** in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant: **Holiday (Red Card)** for period of One Year and they shall also to be considered for Suspension.

(f) **Subsequent instances (more than two)** in other ongoing order (s)/ contract (s) or new order (s) /contact (s) on such Vendor/ Supplier/ Contractor/ Consultant: **Holiday (Red Card) for period of Three Years and they shall also to be considered for Suspension.**

(C) Where Performance rating is "FAIR":

Issuance of warning to such defaulting Vendor/ Supplier/Contractor/ Consultant to improve their performance.

4.0 **EXCLUSIONS:**

The following would be excluded from the scope of evaluation of performance of Vendors/ Suppliers/Contractors/ Consultants:

i) Orders/Contracts below the value of Rs. 50 Lakhs if Vendor/ Supplier/Contractor/ Consultant is not on watch list/ holiday list/ banning list.

ii) Orders for Misc./Administrative items/ Non stock Non valuated items (PO with material code ending with 9).

However, concerned Engineer-in-Charge /OICs will continue to monitor such cases so as to minimize the impact on Projects/O&M plants due to non performance of Vendors/ Suppliers/Contractors/ Consultants in all such cases.

5.0 REVIEW & RESTORATION OF PARITES PUT ON HOLIDAY

5.1 An order for Holiday passed for a certain specified period shall deemed to have been automatically revoked on the expiry of that specified period and it will not be necessary to issue a specific formal order of revocation.

Further, in case Vendor/ Supplier/Contractor/ Consultant is put on holiday due to quality, and new order is placed on bidder after restoration of Vendor/ Supplier/Contractor/ Consultant, such order will be properly monitored during execution stage by the concerned site.

6.0 EFFECT OF HOLIDAY

6.1 If a Vendor/ Supplier/Contractor/ Consultant is put on Holiday, such Vendor/ Supplier/Contractor/ Consultant should not be considered in ongoing tenders/future tenders.

6.2 However, if such Vendor/ Supplier/Contractor/ Consultant is already executing any other order/ contract and their performance is satisfactory in terms of the relevant contract, should be allowed to continue till its completion without any further increase in scope except those incidental to original scope mentioned in the contract. In such a case CPBG will not be forfeited and payment will be made as per provisions of concerned contract. However, this would be without prejudice to other terms and conditions of the contract.

6.3. Effect on other ongoing tendering:

6.3.1 After issue of the enquiry /bid/tender but before opening of Technical bid, the bid submitted by the party shall be ignored.

6.3.2 After opening Technical bid but before opening the Price bid, the Price bid of the party shall not be opened

6.3.3 After opening of price, the offer of the party shall be ignored & will not be further evaluated. If errant party emerges as the lowest (L1), then such tender shall also be cancelled and re-invited.

7.0 While putting the Vendor/ Supplier/Contractor/ Consultant on holiday as per the procedure, the holding company, subsidiary, joint venture, sister concerns, group division of the errant Vendor/ Supplier/Contractor/ Consultant shall not be considered for putting on holiday list.

Any bidder, put on holiday, will not be allowed to bid through consortium route also in new tender during the period of holiday.

8.0 If an unsuccessful bidder makes any vexatious, frivolous or malicious complaint against the tender process with the intention of delaying or defeating any procurement or causing loss to TFL or any other bidder, such bidder will be put on holiday for a period of six months, if such complaint is proved to be vexatious, frivolous or malicious, after following the due procedure.

9. APPEAL AGAINST THE DECISION OF THE COMPETENT AUTHORITY:

(a) The party may file an appeal against the order of the Competent Authority for putting the party on Holiday list. The appeal shall be filed to Appellate Authority. Such an appeal shall be preferred within one month from the receipt of Holiday order.

(b) Appellate Authority would consider the appeal and pass appropriate order which shall be communicated to the party as well as the Competent Authority.

(c) Appeal process may be completed within 45 days of filing of appeal with the Appellate Authority.

(d) "Appellate Authority" shall mean Committee of Directors consisting of Director (Finance) and Director (BD) for works centers under Director (Projects). For all other cases committee of Directors shall consist of Director (Finance) & Director (Projects).

10. **ERRANT BIDDER**

In case after price bid opening the overall lowest evaluated bidder is not awarded the job for any mistake committed by him in bidding or withdrawal of bid or modification of bid or varying any term in regard thereof leading to re-tendering, such bidders shall be debarred from participation in re-tendering of the same job(s)/item(s).

Further, such bidder will be put on holiday for a period of six months after following the due procedure.

11. In case CBIC (Central Board of Indirect Taxes and Customs)/ any tax authority / any equivalent government agency brings to the notice of TFL that the Consultant has not remitted the amount towards GST (CGST & SGST/UTGST or IGST) collected from TFL to the government exchequer, then, that Contactor shall be put under Holiday list of TFL for period of six months after following the due procedure. This action will be in addition to the right of recovery of financial implication arising on TFL.

ANNEXURE-1

TALCHER FERTILIZERS LIMITED
PERFORMANCE RATING DATA SHEET
(FOR PROJECTS/ CONSULTANCY JOBS)

i) Project/Work Centre :

ii) Order/ Contract No. & date :

iii) Brief description of Items Works/Assignment :

iv) Order/Contract value (Rs.) :

v) Name of Vendor/Supplier/ Contractor/ Consultant :

vi) Contracted delivery/ Completion Schedule :

vii) Actual delivery/ Completion date :

Performance Parameter	Delivery/ Completion Performance	Quality Performance	Reliability Performance#	Total
Maximum Marks	40	40	20	100
Marks Allocated				

Note:
Remarks (if any)

PERFORMANCE RATING (**)

Note :
(#) Vendor/Supplier/Contractor/Consultant who seek repeated financial assistance or deviation beyond contract payment term or seeking direct payment to the sub-vendor/sub-contractor due to financial constraints, then '0' marks should be allotted against Reliability Performance.
(*) Allocation of marks should be as per enclosed instructions
(**) Performance rating shall be classified as under :

Sl. No.	Range (Marks)	Rating
1	60 & below	POOR
2	61-75	FAIR
3	76-90	GOOD
4	More than 90	VERY GOOD

Signature of
Authorised Signatory:

Name:

Designation:

Instructions for allocation of marks

1. Marks are to be allocated as under :

1.1 DELIVERY/ COMPLETION PERFORMANCE **40 Marks**

Delivery Period/ Completion Schedule	**Delay in Weeks**	**Marks**
a) Upto 3 months	Before CDD	40
	Delay upto 4 weeks	35
	" 8 weeks	30
	" 10 weeks	25
	" 12 weeks	20
	" 16 weeks	15
	More than 16 weeks	0
b) Above 3 months	Before CDD	40
	Delay upto 4 weeks	35
	" 8 weeks	30
	" 10 weeks	25
	" 16 weeks	20
	" 20 weeks	15
	" 24 weeks	10
	More than 24 weeks	0

1.2 QUALITY PERFORMANCE **40 Marks**

For Normal Cases : No Defects/ No Deviation/ No failure:		40 marks
i) Rejection/Defects	Marks to be allocated on prorata basis for acceptable quantity as compared to total quantity for normal cases	10 marks
ii) When quality failure endanger system integration and safety of the system	Failure of severe nature	0 marks
	- Moderate nature	5 marks
	- low severe nature	10-25 marks
iii) Number of deviations	1. No deviation	5 marks
	2. No. of deviations $\leq$ 2	2 marks
	3. No. of deviations > 2	0 marks

1.3 RELIABILITY PERFORMANCE 20 Marks

A.	**FOR WORKS/CONTRACTS**	
i)	Submission of order acceptance, agreement, PBG, Drawings and other documents within time	4 marks
ii)	Mobilization of resources as per Contract and in time	4 marks
iii)	Liquidation of Check-list points	4 marks
iv)	Compliance to statutory and HS&E requirements or Reliability of Estimates/Design/Drawing etc. in case of Consultancy jobs	4 marks
v)	Timely submission of estimates and other documents for Extra, Substituted & AHR items	4 marks
B.	**FOR SUPPLIES**	
i)	Submission of order acceptance, PBG, Drawings and other documents within time	5 marks
ii)	Attending complaints and requests for after sales service/ warranty repairs and/ or query/ advice (upto the evaluation period).	5 marks
iii)	Response to various correspondence and conformance to standards like ISO	5 marks
iv)	Submission of all required documents including Test Certificates at the time of supply	5 marks

ANNEXURE-2

TALCHER FERTILIZERS LIMITED

PERFORMANCE RATING DATA SHEET [PRDS]
(FOR O&M)

i) Location :

ii) Order/ Contract No. & date :

iii) Brief description of Items Works/Assignment :

iv) Order/Contract value (Rs.) :

v) Name of Vendor/Supplier/ Contractor/ Consultant :

vi) Contracted delivery/ Completion Schedule :

vii) Actual delivery/ Completion date :

Performance Parameter	Delivery Performance	Quality Performance	Reliability Performance#	Total
Maximum Marks	40	40	20	100
Marks Allocated (*)				

Remarks (if any)

PERFORMANCE RATING (**)

Note :

(#) Vendor/Supplier/Contractor/Consultant who seek repeated financial assistance or deviation beyond contract payment term or seeking direct payment to the sub-vendor/sub-contractor due to financial constraints, then '0' marks should be allotted against Reliability Performance

(*) Allocation of marks should be as per enclosed instructions

(**) Performance rating shall be classified as under :

Sl. No.	Range (Marks)	Rating
1	60 & below	POOR
2	61-75	FAIR
3	76-90	GOOD
4	More than 90	VERY GOOD

Signature of
Authorised Signatory:

Name:

Designation:

Instructions for allocation of marks (For O&M)

1. Marks are to be allocated as under:

1.1 DELIVERY/ COMPLETION PERFORMANCE **40 Marks**

Delivery Period/ Completion Schedule	Delay in Weeks	Marks
a) Upto 3 months	Before CDD	40
	Delay upto 4 weeks	35
	" 8 weeks	30
	" 10 weeks	25
	" 12 weeks	20
	" 16 weeks	15
	More than 16 weeks	0
b) Above 3 months	Before CDD	40
	Delay upto 4 weeks	35
	" 8 weeks	30
	" 10 weeks	25
	" 16 weeks	20
	" 20 weeks	15
	" 24 weeks	10
	More than 24 weeks	0

1.2 QUALITY PERFORMANCE **40 Marks**

For Normal Cases : No Defects/ No Deviation/ No failure: 40 marks

i) Rejection/Defects	Marks to be allocated on prorata basis for acceptable quantity as compared to total quantity for normal cases	10 marks
ii) When quality failure endanger system integration and safety of the system	Failure of severe nature	0 marks
	- Moderate nature	5 marks
	- low severe nature	10-25 marks
iii) Number of deviations	1. No deviation	5 marks
	2. No. of deviations $\leq$ 2	2 marks
	3. No. of deviations > 2	0 marks

1.3 RELIABILITY PERFORMANCE **20 Marks**

A.	FOR WORKS/CONTRACTS	
i)	Submission of order acceptance, agreement, CPS/PBG, Drawings and other documents within time	4 marks

ii)	Mobilization of resources as per Contract and in time	4 marks
iii)	Liquidation of Check-list points	4 marks
iv)	Compliance to statutory and HS&E requirements or Reliability of Estimates/Design/Drawing etc. in case of Consultancy jobs	4 marks
v)	Timely submission of estimates and other documents for Extra, Substituted & AHR items	4 marks
B.	**FOR SUPPLIES**	
i)	Submission of order acceptance, CPS/PBG, Drawings and other documents within time	5 marks
ii)	Attending complaints and requests for after sales service/ warranty repairs and/ or query/ advice (upto the evaluation period).	5 marks
iii)	Response to various correspondence and conformance to standards like ISO	5 marks
iv)	Submission of all required documents including Test Certificates at the time of supply	5 marks

Annexure-III

INSTRUCTIONS FOR SUBMISSION OF BID ONLINE THROUGH CPP PORTAL

1. The bidders are required to submit soft copies of their bids electronically on the CPP Portal, using valid Digital Signature Certificates. The instructions given below are meant to assist the bidders in registering on the CPP Portal, prepare their bids in accordance with the requirements and submitting their bids online on the CPP Portal.
   More information useful for submitting online bids on the CPP Portal may be obtained at: https://eprocure.gov.in/eprocure/app.

2. REGISTRATION
   i. Bidders are required to enroll on the e-Procurement module of the Central Public Procurement Portal (URL: https://eprocure.gov.in/eprocure/app) by clicking on the link "Online bidder Enrollment" on the CPP Portal which is free of charge.
   ii. As part of the enrollment process, the bidders will be required to choose a unique username and assign a password for their accounts.
   iii. Bidders are advised to register their valid email address and mobile numbers as part of the registration process. These would be used for any communication from the CPP Portal.
   iv. Bidders are advised to make ensure the accessibility & availability of java software in their system (PC) either download & install the latest version of java software or click on the below link to install the java in their system prior to proceed further.
   https://www.oracle.com/technetwork/java/javase/downloads/index.html
   v. Upon enrollment, the bidders will be required to register their valid Digital Signature Certificate (Class III Certificates with signing key usage) issued by any Certifying Authority recognized by CCA India (e.g. Sify / nCode / eMudhra etc.), with their profile.
   vi. Only one valid DSC should be registered by a bidder. Please note that the bidders are responsible to ensure that they do not lend their DSC's to others which may lead to misuse.
   vii. Bidder then logs in to the site through the secured log-in by entering their user ID / password and the password of the DSC / e-Token.

3. SEARCHING FOR TENDER DOCUMENTS
   i. There are various search options built in the CPP Portal, to facilitate bidders to search active tenders by several parameters. These parameters could include Tender ID, Organization Name, Location, Date, Value, etc. There is also an option of advanced search for tenders, wherein the bidders may combine a number of search parameters such as Organization Name, Form of Contract, Location, Date, Other keywords etc. to search for a tender published on the CPP Portal.
   ii. Once the bidders have selected the tenders they are interested in, they may download the required documents / tender schedules. These tenders can be moved to the respective 'My Tenders' folder. This would enable the CPP Portal to intimate the bidders through SMS / email in case there is any corrigendum issued to the tender document.

iii. The bidder should make a note of the unique Tender ID assigned to each tender, in case they want to obtain any clarification / help from the Helpdesk.

4. PREPARATION OF BIDS
   i. Bidder should take into account any corrigendum published on the tender document before submitting their bids.
   ii. Please go through the tender advertisement and the tender document carefully to understand the documents required to be submitted as part of the bid. Please note the number of covers in which the bid documents have to be submitted, the number of documents - including the names and content of each of the document that need to be submitted. Any deviations from these may lead to rejection of the bid.
   iii. Bidder, in advance, should get ready the bid documents to be submitted as indicated in the tender document / schedule and generally, they can be in PDF / XLS / RAR / DWF/JPG formats. Bid documents may be scanned with 100 dpi with black and white option which helps in reducing size of the scanned document.
   iv. To avoid the time and effort required in uploading the same set of standard documents which are required to be submitted as a part of every bid, a provision of uploading such standard documents (e.g. PAN card copy, annual reports, auditor certificates etc.) has been provided to the bidders. Bidders can use “My Space” or ‘’Other Important Documents’’ area available to them to upload such documents. These documents may be directly submitted from the “My Space” area while submitting a bid, and need not be uploaded again and again. This will lead to a reduction in the time required for bid submission process.

   Note: My Documents space is only a repository given to the Bidders to ease the uploading process. If Bidder has uploaded his Documents in My Documents space, this does not automatically ensure these Documents being part of Technical Bid.

5. SUBMISSION OF BIDS
   i. Bidder should log into the site well in advance for bid submission so that they can upload the bid in time i.e. on or before the bid submission time. Bidder will be responsible for any delay due to other issues.
   ii. The bidder has to digitally sign and upload the required bid documents one by one as indicated in the tender document.
   iii. Bidder should submit Declaration for Bid security strictly as per format Form F-2 provided in the NIT. Otherwise the uploaded bid will be rejected.
   iv. Bidders are requested to note that they should necessarily submit their financial bids in the format provided and no other format is acceptable. If the price bid has been given as a standard SOR format with the tender document, then the same is to be downloaded and to be filled by all the bidders. Bidders are required to download the SOR file, open it and complete the white coloured (unprotected) cells with their respective financial quotes and other details (such as name of the bidder). No other cells should be changed. Once the details have been completed, the bidder should save it and submit it online, without changing the filename. If the SOR file is found to be modified by the bidder, the bid will be rejected.
   v. The server time (which is displayed on the bidders’ dashboard) will be considered as the standard time for referencing the deadlines for submission of the bids by the bidders, opening of bids etc. The bidders should follow this time during bid submission.

vi. All the documents being submitted by the bidders would be encrypted using PKI encryption techniques to ensure the secrecy of the data. The data entered cannot be viewed by unauthorized persons until the time of bid opening. The confidentiality of the bids is maintained using the secured Socket Layer 128 bit encryption technology. Data storage encryption of sensitive fields is done. Any bid document that is uploaded to the server is subjected to symmetric encryption using a system generated symmetric key. Further this key is subjected to asymmetric encryption using buyers/bid opener's public keys. Overall, the uploaded tender documents become readable only after the tender opening by the authorized bid openers.

vii. The uploaded tender documents become readable only after the tender opening by the authorized bid openers.

viii. Upon the successful and timely submission of bids (i.e. after Clicking "Freeze Bid Submission" in the portal), the portal will give a successful bid submission message & a bid summary will be displayed with the bid no. and the date & time of submission of the bid with all other relevant details.

ix. The bid summary has to be printed and kept as an acknowledgement of the submission of the bid. This acknowledgement may be used as an entry pass for any bid opening meetings.

6. ASSISTANCE TO BIDDERS

i. Any queries relating to the tender document and the terms and conditions contained therein should be addressed to the Tender Inviting Authority for a tender or the relevant contact person indicated in the tender.

ii. Any queries relating to the process of online bid submission or queries relating to CPP Portal in general may be directed to the 24x7 CPP Portal Helpdesk.

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ANNEXURE-IV

BIDDING DATA SHEET (BDS)

ITB TO BE READ IN CONJUNCTION WITH THE FOLLOWING:

ITB clause	Description
	A. GENERAL
1.0	The Invitation for Bid/ Tender is for INSTRUMENT AIR & PLANT AIR SYSTEM AT TALCHER, ODISHA (INDIA) The Employer/Owner is: Talcher Fertilizers Limited
3	BIDS FROM CONSORTIUM / JOINT VENTURE APPLICABLE ✗ NOT APPLICABLE ✓
	B. TENDER DOCUMENT
8.1	For **clarification purposes** only, the communication address is: M/s Projects & Development India Limited, P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. GautamBudh Nagar (UP). (India) Kind Attention: Mr. P.R.Sahu, Addl. General Manager (M.M) Fax no. : +91-120-2529801 Tel no. : +91-120-2544063 E-mail : prsahu@pdilin.com anjali@pdilin.com alam@pdilin.com
	C. PREPARATION OF BID
11.1.1	The Bidder shall submit with its Part-I (Techno-commercial/ Unpriced bid) as detailed in 11.1.1 of ITB
14	The currency of the Bid shall be INR
15	The bid validity period shall be 06 (Six) months from final 'Bid Due Date'.
16.1	Declaration for Bid Security
	D. SUBMISSION AND OPENING OF BIDS
22.3 and 4.0 of IFB	For submission of physical document as per clause no. 4.0 of IFB, the Owner's address is : M/s Projects & Development India Limited, P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. GautamBudh Nagar (UP). (India)

<table>
<tr><td>26</td><td>The bid opening shall take place at:
M/s Projects & Development India Limited,
P.D.I.L Bhawan, A-14, Sector-1,
Noida, (PIN 201301)
Dist. GautamBudh Nagar (UP). (India)</td></tr>
<tr><td colspan="2">E. EVALUATION, AND COMPARISON OF BIDS</td></tr>
<tr><td>32</td><td>Evaluation Methodology is mentioned in Section-II.</td></tr>
<tr><td>33</td><td>Compensation for Extended Stay
<table><tr><td>APPLICABLE</td><td>✗</td></tr><tr><td>NOT APPLICABLE</td><td>✓</td></tr></table></td></tr>
<tr><td colspan="2">F. AWARD OF CONTRACT</td></tr>
<tr><td>37</td><td>State of which stamp paper is required for Contract Agreement :
Uttar Pradesh (U.P.) / State where Bidder’s Corporate or Registered Office is located.</td></tr>
<tr><td>38</td><td>Contract Performance Security (CPS)/ Security Deposit
<table><tr><td>APPLICABLE</td><td>✓</td></tr><tr><td>NOT APPLICABLE</td><td>✗</td></tr></table>
The value/ amount of Contract Performance Security/ Security Deposit shall be @ 3% of TOTAL LSTK PRICE/TOTAL CONTRACT PRICE (exclusive of GST).</td></tr>
<tr><td>40</td><td>Whether tendered item is non-split able or not-divisible :
<table><tr><td>YES</td><td>✓</td></tr><tr><td>NO</td><td>✗</td></tr></table></td></tr>
<tr><td>41</td><td>Provision of AHR item:
<table><tr><td>APPLICABLE</td><td>✗</td></tr><tr><td>NOT APPLICABLE</td><td>✓</td></tr></table></td></tr>
<tr><td>49</td><td>Quarterly Closure of Contract
<table><tr><td>APPLICABLE</td><td>✓</td></tr><tr><td>NOT APPLICABLE</td><td>✗</td></tr></table></td></tr>
</table>

<table>
<tr><td>Clause no. 31.1.4 of GCC</td><td>Bonus for Early Completion
<table><tr><td>APPLICABLE</td><td>✗</td></tr><tr><td>NOT APPLICABLE</td><td>✓</td></tr></table></td></tr>
<tr><td>50</td><td>Applicability of BEC relaxation relating to Startups:
<table><tr><td>APPLICABLE</td><td>✗</td></tr><tr><td>NOT APPLICABLE</td><td>✓</td></tr></table></td></tr>
</table>

Annexure-V

PUBLIC PROCUREMENT

(PREFERENCE TO MAKE IN INDIA), ORDER 2017

Annexure - V

No. P-45021/2/2017-PP (BE-II)
Government of India
Ministry of Commerce and Industry
Department for Promotion of Industry and Internal Trade
(Public Procurement Section)

Udyog Bhawan, New Delhi
Dated: 16th September, 2020

To

All Central Ministries/Departments/CPSUs/All concerned

ORDER

Subject: Public Procurement (Preference to Make in India), Order 2017– Revision; regarding.

Department for Promotion of Industry and Internal Trade, in partial modification [Paras 2, 3, 5, 10 & 13] of Order No.P-45021/2/2017-B.E.-II dated 15.6.2017 as amended by Order No.P-45021/2/2017-B.E.-II dated 28.05.2018, Order No.P-45021/2/2017-B.E.-II dated 29.05.2019 and Order No.P-45021/2/2017-B.E.-II dated 04.06.2020, hereby issues the revised 'Public Procurement (Preference to Make in India), Order 2017" dated 16.09.2020 effective with immediate effect.

Whereas it is the policy of the Government of India to encourage 'Make in India' and promote manufacturing and production of goods and services in India with a view to enhancing income and employment, and

Whereas procurement by the Government is substantial in amount and can contribute towards this policy objective, and

Whereas local content can be increased through partnerships, cooperation with local companies, establishing production units in India or Joint Ventures (JV) with Indian suppliers, increasing the participation of local employees in services and training them,

Now therefore the following Order is issued:

1. This Order is issued pursuant to Rule 153 (iii) of the General Financial Rules 2017.

2. **Definitions**: For the purposes of this Order:

   'Local content' means the amount of value added in India which shall, unless otherwise prescribed by the Nodal Ministry, be the total value of the item procured (excluding net domestic indirect taxes) minus the value of imported content in the item (including all customs duties) as a proportion of the total value, in percent.

   'Class-I local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, meets the minimum local content as prescribed for 'Class-I local supplier' under this Order.

.....Contd. p/2

'Class-II local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, meets the minimum local content as prescribed for 'Class-II local supplier' but less than that prescribed for 'Class-I local supplier' under this Order.

'Non - Local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, has local content less than that prescribed for 'Class-II local supplier' under this Order.

'L1' means the lowest tender or lowest bid or the lowest quotation received in a tender, bidding process or other procurement solicitation as adjudged in the evaluation process as per the tender or other procurement solicitation.

'Margin of purchase preference' means the maximum extent to which the price quoted by a "Class-I local supplier" may be above the L1 for the purpose of purchase preference.

'Nodal Ministry' means the Ministry or Department identified pursuant to this order in respect of a particular item of goods or services or works.

'Procuring entity' means a Ministry or department or attached or subordinate office of, or autonomous body controlled by, the Government of India and includes Government companies as defined in the Companies Act.

'Works' means all works as per Rule 130 of GFR- 2017, and will also include *'turnkey works'*.

3. Eligibility of 'Class-I local supplier'/ 'Class-II local supplier'/ 'Non-local suppliers' for different types of procurement

(a) In procurement of all goods, services or works in respect of which the Nodal Ministry / Department has communicated that there is sufficient local capacity and local competition, only 'Class-I local supplier', as defined under the Order, shall be eligible to bid irrespective of purchase value.

(b) Only 'Class-I local supplier' and 'Class-II local supplier', as defined under the Order, shall be eligible to bid in procurements undertaken by procuring entities, except when Global tender enquiry has been issued. In global tender enquiries, 'Non-local suppliers' shall also be eligible to bid along with 'Class-I local suppliers' and 'Class-II local suppliers'. In procurement of all goods, services or works, not covered by sub-para 3(a) above, and with estimated value of purchases less than Rs. 200 Crore, in accordance with Rule 161(iv) of GFR, 2017, Global tender enquiry shall not be issued except with the approval of competent authority as designated by Department of Expenditure.

(c) For the purpose of this Order, works includes Engineering, Procurement and Construction (EPC) contracts and services include System Integrator (SI) contracts.

.....Contd. p/3

3A. Purchase Preference

(a) Subject to the provisions of this Order and to any specific instructions issued by the Nodal Ministry or in pursuance of this Order, purchase preference shall be given to 'Class-I local supplier' in procurements undertaken by procuring entities in the manner specified here under.

(b) In the procurements of goods or works, which are covered by para 3(b) above and which are divisible in nature, the 'Class-I local supplier' shall get purchase preference over 'Class-II local supplier' as well as 'Non-local supplier', as per following procedure:

i. Among all qualified bids, the lowest bid will be termed as L1. If L1 is 'Class-I local supplier', the contract for full quantity will be awarded to L1.

ii. If L1 bid is not a 'Class-I local supplier', 50% of the order quantity shall be awarded to L1. Thereafter, the lowest bidder among the 'Class-I local supplier' will be invited to match the L1 price for the remaining 50% quantity subject to the Class-I local supplier's quoted price falling within the margin of purchase preference, and contract for that quantity shall be awarded to such 'Class-I local supplier' subject to matching the L1 price. In case such lowest eligible 'Class-I local supplier' fails to match the L1 price or accepts less than the offered quantity, the next higher 'Class-I local supplier' within the margin of purchase preference shall be invited to match the L1 price for remaining quantity and so on, and contract shall be awarded accordingly. In case some quantity is still left uncovered on Class-I local suppliers, then such balance quantity may also be ordered on the L1 bidder.

(c) In the procurements of goods or works, which are covered by para 3(b) above and which are not divisible in nature, and in procurement of services where the bid is evaluated on price alone, the 'Class-I local supplier' shall get purchase preference over 'Class-II local supplier' as well as 'Non-local supplier', as per following procedure:

i. Among all qualified bids, the lowest bid will be termed as L1. If L1 is 'Class-I local supplier', the contract will be awarded to L1.

ii. If L1 is not 'Class-I local supplier', the lowest bidder among the 'Class-I local supplier', will be invited to match the L1 price subject to Class-I local supplier's quoted price falling within the margin of purchase preference, and the contract shall be awarded to such 'Class-I local supplier' subject to matching the L1 price.

iii. In case such lowest eligible 'Class-I local supplier' fails to match the L1 price, the 'Class-I local supplier' with the next higher bid within the margin of purchase preference shall be invited to match the L1 price and so on and contract shall be awarded accordingly. In case none of the 'Class-I local supplier' within the margin of purchase preference matches the L1 price, the contract may be awarded to the L1 bidder.

.....Contd. p/4

(d) "Class-II local supplier" will not get purchase preference in any procurement, undertaken by procuring entities.

3B. Applicability in tenders where contract is to be awarded to multiple bidders - In tenders where contract is awarded to multiple bidders subject to matching of L1 rates or otherwise, the 'Class-I local supplier' shall get purchase preference over 'Class-II local supplier' as well as 'Non-local supplier', as per following procedure:

a) In case there is sufficient local capacity and competition for the item to be procured, as notified by the nodal Ministry, only Class I local suppliers shall be eligible to bid. As such, the multiple suppliers, who would be awarded the contract, should be all and only 'Class I Local suppliers'.

b) In other cases, 'Class II local suppliers' and 'Non local suppliers' may also participate in the bidding process along with 'Class I Local suppliers' as per provisions of this Order.

c) If 'Class I Local suppliers' qualify for award of contract for at least 50% of the tendered quantity in any tender, the contract may be awarded to all the qualified bidders as per award criteria stipulated in the bid documents. However, in case 'Class I Local suppliers' do not qualify for award of contract for at least 50% of the tendered quantity, purchase preference should be given to the 'Class I local supplier' over 'Class II local suppliers'/ 'Non local suppliers' provided that their quoted rate falls within 20% margin of purchase preference of the highest quoted bidder considered for award of contract so as to ensure that the 'Class I Local suppliers' taken in totality are considered for award of contract for at least 50% of the tendered quantity.

d) First purchase preference has to be given to the lowest quoting 'Class-I local supplier', whose quoted rates fall within 20% margin of purchase preference, subject to its meeting the prescribed criteria for award of contract as also the constraint of maximum quantity that can be sourced from any single supplier. If the lowest quoting 'Class-I local supplier', does not qualify for purchase preference because of aforesaid constraints or does not accept the offered quantity, an opportunity may be given to next higher 'Class-I local supplier', falling within 20% margin of purchase preference, and so on.

e) To avoid any ambiguity during bid evaluation process, the procuring entities may stipulate its own tender specific criteria for award of contract amongst different bidders including the procedure for purchase preference to 'Class-I local supplier' within the broad policy guidelines stipulated in sub-paras above.

4. **Exemption of small purchases**: Notwithstanding anything contained in paragraph 3, procurements where the estimated value to be procured is less than Rs. 5 lakhs shall be exempt from this Order. However, it shall be ensured by procuring entities that procurement is not split for the purpose of avoiding the provisions of this Order.

5. **Minimum local content**: The 'local content' requirement to categorize a supplier as 'Class-I local supplier' is minimum 50%. For 'Class-II local supplier', the 'local content' requirement is minimum 20%. Nodal Ministry/ Department may prescribe only a higher

.....Contd. p/5

percentage of minimum local content requirement to categorize a supplier as 'Class-I local supplier'/ 'Class-II local supplier'. For the items, for which Nodal Ministry/ Department has not prescribed higher minimum local content notification under the Order, it shall be 50% and 20% for 'Class-I local supplier'/ 'Class-II local supplier' respectively.

6. **Margin of Purchase Preference**: The margin of purchase preference shall be 20%.

7. **Requirement for specification in advance**: The minimum local content, the margin of purchase preference and the procedure for preference to Make in India shall be specified in the notice inviting tenders or other form of procurement solicitation and shall not be varied during a particular procurement transaction.

8. **Government E-marketplace**: In respect of procurement through the Government E-marketplace (GeM) shall, as far as possible, specifically mark the items which meet the minimum local content while registering the item for display, and shall, wherever feasible, make provision for automated comparison with purchase preference and without purchase preference and for obtaining consent of the local supplier in those cases where purchase preference is to be exercised.

9. **Verification of local content**:

   a. The 'Class-I local supplier'/ 'Class-II local supplier' at the time of tender, bidding or solicitation shall be required to indicate percentage of local content and provide self-certification that the item offered meets the local content requirement for 'Class-I local supplier'/ 'Class-II local supplier', as the case may be. They shall also give details of the location(s) at which the local value addition is made.

   b. In cases of procurement for a value in excess of Rs. 10 crores, the 'Class-I local supplier'/ 'Class-II local supplier' shall be required to provide a certificate from the statutory auditor or cost auditor of the company (in the case of companies) or from a practicing cost accountant or practicing chartered accountant (in respect of suppliers other than companies) giving the percentage of local content.

   c. Decisions on complaints relating to implementation of this Order shall be taken by the competent authority which is empowered to look into procurement-related complaints relating to the procuring entity.

   d. Nodal Ministries may constitute committees with internal and external experts for independent verification of self-declarations and auditor's/ accountant's certificates on random basis and in the case of complaints.

   e. Nodal Ministries and procuring entities may prescribe fees for such complaints.

   f. False declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for up to two years as per Rule 151 (iii) of the General Financial Rules along with such other actions as may be permissible under law.

.....Contd. p/6

g. A supplier who has been debarred by any procuring entity for violation of this Order shall not be eligible for preference under this Order for procurement by any other procuring entity for the duration of the debarment. The debarment for such other procuring entities shall take effect prospectively from the date on which it comes to the notice of other procurement entities, in the manner prescribed under paragraph 9h below.

h. The Department of Expenditure shall issue suitable instructions for the effective and smooth operation of this process, so that:

   i. The fact and duration of debarment for violation of this Order by any procuring entity are promptly brought to the notice of the Member-Convenor of the Standing Committee and the Department of Expenditure through the concerned Ministry /Department or in some other manner;

   ii. on a periodical basis such cases are consolidated and a centralized list or decentralized lists of such suppliers with the period of debarment is maintained and displayed on website(s);

   iii. in respect of procuring entities other than the one which has carried out the debarment, the debarment takes effect prospectively from the date of uploading on the website(s) in the such a manner that ongoing procurements are not disrupted.

10. **Specifications in Tenders and other procurement solicitations**:

a. Every procuring entity shall ensure that the eligibility conditions in respect of previous experience fixed in any tender or solicitation do not require proof of supply in other countries or proof of exports.

b. Procuring entities shall endeavour to see that eligibility conditions, including on matters like turnover, production capability and financial strength do not result in unreasonable exclusion of 'Class-I local supplier'/ 'Class-II local supplier' who would otherwise be eligible, beyond what is essential for ensuring quality or creditworthiness of the supplier.

c. Procuring entities shall, within 2 months of the issue of this Order review all existing eligibility norms and conditions with reference to sub-paragraphs 'a' and 'b' above.

d. **Reciprocity Clause**

   i. When a Nodal Ministry/Department identifies that Indian suppliers of an item are not allowed to participate and/ or compete in procurement by any foreign government, due to restrictive tender conditions which have direct or indirect effect of barring Indian companies such as registration in the procuring country, execution of projects of specific value in the procuring country etc., it shall provide such details to all its procuring entities including CMDs/CEOs of PSEs/PSUs, State Governments and other procurement agencies under their administrative control and GeM for appropriate reciprocal action.

.....Contd. p/7

ii. Entities of countries which have been identified by the nodal Ministry/Department as not allowing Indian companies to participate in their Government procurement for any item related to that nodal Ministry shall not be allowed to participate in Government procurement in India for all items related to that nodal Ministry/ Department, except for the list of items published by the Ministry/ Department permitting their participation.

iii. The stipulation in (ii) above shall be part of all tenders invited by the Central Government procuring entities stated in (i) above. All purchases on GeM shall also necessarily have the above provisions for items identified by nodal Ministry/ Department.

iv. State Governments should be encouraged to incorporate similar provisions in their respective tenders.

v. The term 'entity' of a country shall have the same meaning as under the FDI Policy of DPIIT as amended from time to time.

e. Specifying foreign certifications/ unreasonable technical specifications/ brands/ models in the bid document is restrictive and discriminatory practice against local suppliers. If foreign certification is required to be stipulated because of non-availability of Indian Standards and/or for any other reason, the same shall be done only after written approval of Secretary of the Department concerned or any other Authority having been designated such power by the Secretary of the Department concerned.

f. "All administrative Ministries/Departments whose procurement exceeds *Rs.* 1000 Crore per annum shall notify/ update their procurement projections every year, including those of the PSEs/PSUs, for the next 5 years on their respective website."

10A. Action for non-compliance of the Provisions of the Order: In case restrictive or discriminatory conditions against domestic suppliers are included in bid documents, an inquiry shall be conducted by the Administrative Department undertaking the procurement (including procurement by any entity under its administrative control) to fix responsibility for the same. Thereafter, appropriate action, administrative or otherwise, shall be taken against erring officials of procurement entities under relevant provisions. Intimation on all such actions shall be sent to the Standing Committee.

11. **Assessment of supply base by Nodal Ministries**: The Nodal Ministry shall keep in view the domestic manufacturing / supply base and assess the available capacity and the extent of local competition while identifying items and prescribing the higher minimum local content or the manner of its calculation, with a view to avoiding cost increase from the operation of this Order.

12. **Increase in minimum local content**: The Nodal Ministry may annually review the local content requirements with a view to increasing them, subject to availability of sufficient local competition with adequate quality.

.....Contd. p/8

13. **Manufacture under license/ technology collaboration agreements with phased indigenization**: While notifying the minimum local content, Nodal Ministries may make special provisions for exempting suppliers from meeting the stipulated local content if the product is being manufactured in India under a license from a foreign manufacturer who holds intellectual property rights and where there is a technology collaboration agreement / transfer of technology agreement for indigenous manufacture of a product developed abroad with clear phasing of increase in local content.

13A. In procurement of all goods, services or works in respect of which there is substantial quantity of public procurement and for which the nodal ministry has not notified that there is sufficient local capacity and local competition, the concerned nodal ministry shall notify an upper threshold value of procurement beyond which foreign companies shall enter into a joint venture with an Indian company to participate in the tender. Procuring entities, while procuring such items beyond the notified threshold value, shall prescribe in their respective tenders that foreign companies may enter into a joint venture with an Indian company to participate in the tender. The procuring Ministries/Departments shall also make special provisions for exempting such joint ventures from meeting the stipulated minimum local content requirement, which shall be increased in a phased manner.

14. **Powers to grant exemption and to reduce minimum local content**: The administrative Department undertaking the procurement (including procurement by any entity under its administrative control), with the approval of their Minister-in-charge, may by written order, for reasons to be recorded in writing,

a. reduce the minimum local content below the prescribed level; or
b. reduce the margin of purchase preference below 20%; or
c. exempt any particular item or supplying entities from the operation of this Order or any part of the Order.

A copy of every such order shall be provided to the Standing Committee and concerned Nodal Ministry / Department. The Nodal Ministry / Department concerned will continue to have the power to vary its notification on Minimum Local Content.

15. **Directions to Government companies**: In respect of Government companies and other procuring entities not governed by the General Financial Rules, the administrative Ministry or Department shall issue policy directions requiring compliance with this Order.

16. **Standing Committee**: A standing committee is hereby constituted with the following membership:

Secretary, Department for Promotion of Industry and Internal Trade—Chairman
Secretary, Commerce—Member
Secretary, Ministry of Electronics and Information Technology—Member
Joint Secretary (Public Procurement), Department of Expenditure—Member
Joint Secretary (DPIIT)—Member-Convenor

.....Contd. p/9

The Secretary of the Department concerned with a particular item shall be a member in respect of issues relating to such item. The Chairman of the Committee may co-opt technical experts as relevant to any issue or class of issues under its consideration.

17. **Functions of the Standing Committee**: The Standing Committee shall meet as often as necessary, but not less than once in six months. The Committee

    a. shall oversee the implementation of this order and issues arising therefrom, and make recommendations to Nodal Ministries and procuring entities.
    b. shall annually assess and periodically monitor compliance with this Order
    c. shall identify Nodal Ministries and the allocation of items among them for issue of notifications on minimum local content
    d. may require furnishing of details or returns regarding compliance with this Order and related matters
    e. may, during the annual review or otherwise, assess issues, if any, where it is felt that the manner of implementation of the order results in any restrictive practices, cartelization or increase in public expenditure and suggest remedial measures
    f. may examine cases covered by paragraph 13 above relating to manufacture under license/ technology transfer agreements with a view to satisfying itself that adequate mechanisms exist for enforcement of such agreements and for attaining the underlying objective of progressive indigenization
    g. may consider any other issue relating to this Order which may arise.

18. **Removal of difficulties**: Ministries /Departments and the Boards of Directors of Government companies may issue such clarifications and instructions as may be necessary for the removal of any difficulties arising in the implementation of this Order.

19. **Ministries having existing policies**: Where any Ministry or Department has its own policy for preference to local content approved by the Cabinet after 1st January 2015, such policies will prevail over the provisions of this Order. All other existing orders on preference to local content shall be reviewed by the Nodal Ministries and revised as needed to conform to this Order, within two months of the issue of this Order.

20. **Transitional provision**: This Order shall not apply to any tender or procurement for which notice inviting tender or other form of procurement solicitation has been issued before the issue of this Order.

(Rajesh Gupta)
Director
Tel: 23063211
rajesh.gupta66@gov.in

Annexure-VI

PREAMBLE TO SCHEDULE OF RATES

1. The “Schedule of Rates (SOR)” will be in Excel format (password protected) and will be uploaded during tender creation. This will be downloaded by the bidder and bidder will quote price on this Excel file for entire scope of work as per NIT. Thereafter, the bidder will upload the same Excel file during bid submission.

2. The SOR format is provided in a spread sheet file (BoQ_xxxx.xls). The rates offered should be entered in the allotted space only and uploaded after filling the relevant columns. The SOR template must not be modified / replaced by the bidder; else the bid submitted shall be rejected.

3. Bidder shall quote all Prices in INR only.

4. SOR consists of following three sheets:

   - Annexure A: Schedule of Rates containing Total Lumpsump Turnkey Price & GST
   - Annexure-B: Guaranteed Consumption Figures

5. It is mandatory to quote prices in SOR and fill up figures in Annexure-A & Annexure-B listed in Para 4.

   It will be the responsibility of the contractor to quote for all Materials/ Equipments/Services/Civil & Structural Works etc. as per scope of work defined in NIT.

6. CONTRACTOR shall be responsible for payment of all taxes, duties and levies as applicable on performance of WORK under CONTRACT and shall be included in the quoted TOTAL LSTK PRICE/TOTAL CONTRACT PRICE.

7. A copy of SOR, with prices/figures completely blanked out but with the word “QUOTED” in all columns is to be uploaded along with the unpriced bid, as a confirmation of price/data quoted against each head.

Annexure-VII

CLAUSE REGARDING PROVISION FOR PROCUREMENT FROM A BIDDER WHICH SHARES A LAND BORDER WITH INDIA

1. Order (Public Procurement No. 1) dated 23.07.2020, Order (Public Procurement No.2) dated 23.07.2020 and Order (Public Procurement No. 3) dated 24.07.2020, Department of Expenditure, Ministry of Finance, Govt. of India refers. The same are available at website https://doe.gov.in/procurement-policy-divisions.

2. Any bidder from a country which shares a land border with India will be eligible to bid in this tender only if the bidder is registered with the Competent Authority. For details of competent authority refer to Annexure I of Order (Public Procurement No. 1) dated 23.07.2020.

   Further the above will not apply to bidders from those countries (even if sharing a land border with India) to which the Government of India has extended lines of credit or in which the Government of India is engaged in development projects. Updated lists of countries to which lines of credit have been extended or in which development projects are undertaken are given in the website of the Ministry of External Affairs, Govt. of India

3. "Bidder" (including the term 'tenderer', 'consultant' 'vendor' or 'service provider' in certain contexts) for purpose of this provision means any person or firm or company, including any member of a consortium or joint venture (that is an association of several persons, or firms or companies), every artificial juridical person not falling in any of the descriptions of bidders stated hereinbefore, including any agency, branch or office controlled by such person, participating in a procurement process.

4. "Bidder from a country which shares a land border with India" for the purpose of this:

   a) An entity incorporated, established or registered in such a country; or
   b) A subsidiary of an entity incorporated, established or registered in such a country; or
   c) An entity substantially controlled through entities incorporated, established or registered in such a country; or
   d) An entity whose beneficial owner is situated in such a country; or
   e) An Indian (or other) agent of such an entity; or
   f) A natural person who is a citizen of such a country; or
   g) A consortium or joint venture where any member of the consortium or joint venture falls under any of the above

5. "Beneficial owner" for the purpose of above (4) will be as under:

i) In case of a company or Limited Liability Partnership, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person(s), has a controlling ownership interest or who exercises control through other means.

Explanation-

a) "Controlling ownership interest" means ownership of, or entitlement to, more than twenty-five per cent of shares or capital or profits of the company;

b) "Control" shall include the right to appoint the majority of the directors or to control the management or policy decisions, including by virtue of their shareholding or management rights or shareholders agreements or voting agreements;

ii) In case of a partnership firm, the beneficial owner is the natural person(s) who, whether acting alone or together, or through one or more juridical person, has ownership of entitlement to more than fifteen percent of capital or profits of the partnership;

iii) In case of an unincorporated association or body of individuals, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person, has ownership of or entitlement to more than fifteen percent of the property or capital or profits of such association or body of individuals;

iv) Where no natural person is identified under (i) or (ii) or (iii) above, the beneficial owner is the relevant natural person who holds the position of senior managing official;

v) In case of a trust; the identification of beneficial owner(s) shall include identification of the author of the trust, the trustee, the beneficiaries with fifteen percent or more interest in the trust and any other natural person exercising ultimate effective control over the trust through a chain of control or ownership.

6. **"Agent"** for the purpose of this Order is a person employed to do any act for another, or to represent another in dealings with third persons

7. **SUBMISSION OF CERTIFICATE IN BIDS:**

Bidder shall submit a certificate in this regard as Form-I.

If such certificate given by a bidder whose bid is accepted is found to be false, this would be a ground for immediate rejection of the bid/termination and further action as per "Procedure for Action in case of Corrupt/Fraudulent/ Collusive / Coercive Practices" of tender document.

8. The registration, wherever applicable, should be valid at the time of submission of bids and at the time of acceptance of bids. In respect of supply otherwise than by tender, registration should be valid at the time of placement of order. If the bidder was validly registered at the time of acceptance / placement of order, registration shall not be a relevant consideration during contract execution.

9. PROVISION TO BE IN WORKS CONTRACTS, INCLUDING TURNKEY CONTRACTS:

The successful bidder shall not be allowed to sub-contract works to any contractor from a country which shares a land border with India unless such contractor is registered with the Competent Authority. The definition of "contractor from a country which shares a land border with India" shall be as in Para 4 herein above. A Certificate to this regard is to be submitted by bidder is placed at Form-II

Annexure-VIII

Deleted

Appendix-I

The corresponding clauses/provisions/guidelines in the existing tender document stand superseded by below mentioned clauses.

1. Authentication of documents pertaining to BEC, etc: Bids shall be evaluated based on the self-certified documents submitted by Bidders. The authenticated documents will be submitted by bidder, on whom order/ contract is placed, after normalization of situation. An undertaking (as per modified proforma attached Annexure-1) to this effect shall be submitted by bidder in Bid.

2. Submission of original Integrity Pact (IP) and Power of Attorney (POA): Bidder(s) shall upload/submit scanned copy of Integrity Pact (IP) and Power of Attorney (POA) in their bids. The same shall be considered for evaluation of bid. The original Integrity Pact (IP) and Power of Attorney (POA) will be submitted by successful bidder(s) after normalization of situation.

3. Affidavit / certified documents regarding Domestic Value Addition as per extant Policy to provide Preference to Domestically Manufactured Iron and Steel Products and other Preference Policies (i.e. PPP for MSEs, PP-LC, DMEP, etc.), if applicable:

   Bidder will submit self-certified document as per prescribed proforma / provision of policy and undertaking (as per modified proforma attached Annexure-1) along with bid.

   The Affidavit of Self Certification in original and / or the certification from statutory auditor / cost auditor/ practising cost accountant/ practising chartered accountant regarding Domestic Value Addition as per extant Policy to provide Preference to Domestically Manufactured Iron and Steel Products and other Preference Policies (i.e, PPP for MSEs, PP-LC, DMEP, etc.) in vogue will be submitted by bidder, on whom order/ contract is placed, after normalization of situation.

4. Security Deposit/Contract Performance Guarantee

   In case due date for submission of Security Deposit/Contract Performance Guarantee against the awarded order/ contract is within the restricted/ lockdown / curfew period, the same shall be extended upto 31st July 2021. During the aforesaid period, in case any payment is to be made against such order/ contract, the payment to supplier/ contractor/ consultant/ service provider may be released after deduction of Security deposit/ Initial Security Deposit from due payment after getting confirmation from supplier/ contractor/ consultant/ service provider.

All other terms and conditions of the tender document and Amendments thereof shall remain unchanged.

Annexure-1 to Appendix-I

UNDERTAKING REGARDING SUBMISSION OF AUTHENTICATED DOCUMENTS RELATING TO BEC, AFFIDAVIT / CERTIFIED DOCUMENTS FOR PURCHASE PREFERENCE POLICY(IES), ETC.

1.1.1

To,

M/s Talcher Fertilizers Limited,

Noida, Uttar Pradesh

SUB:

TENDER NO:

Dear Sir,

We hereby confirm that due to COVID-19 situation, we are unable to submit the Authenticated documents relating to BEC and Affidavit / Certified Documents for Purchase Preference Policy(s), etc. (wherever applicable) as specified in tender document. Hence, we are submitting the self-certified documents relating to BEC and Affidavit / Certified Documents for Purchase Preference Policy(s), etc (wherever applicable).

We hereby confirm that in case of award of contract/order, we will submit Authenticated documents relating to BEC and Affidavit / Certified Documents for Purchase Preference Policy(s), etc. (wherever applicable) as per tender provisions after normalization of situation.

Place: [Signature of Authorized Signatory of Bidder]

Date: Name:

Designation:

Name of Bidder:

Seal:

FORMS & FORMATS

LIST OF FORMS & FORMATS

Form No.	Description
F-1	BIDDER'S GENERAL INFORMATION
F-2	PROFORMA OF "DECLARATION FOR BID SECURITY"
F-3	LETTER OF AUTHORITY
F-4	PROFORMA OF "BANK GUARANTEE" FOR "CONTRACT PERFORMANCE SECURITY / SECURITY DEPOSIT"
F-5	AGREED TERMS & CONDITIONS
F-6	ACKNOWLEDGEMENT CUM CONSENT LETTER
F-7	BIDDER'S EXPERIENCE
F-8	CHECKLIST
F-9	FORMAT FOR CERTIFICATE FROM BANKIF BIDDER'S WORKING CAPITAL IS INADEQUATE
F-10	FORMAT FOR CHARTERED ACCOUNTANT CERTIFICATE FOR FINANCIAL CAPABILITY OF THE BIDDER
F-11	BIDDER'S QUERIES FOR PRE BID MEETING
F-12	E-BANKING FORMAT
F-13	FORMAT FOR POWER OF ATTORNEY
F-14	PROFORMA FOR CONTRACT AGREEMENT
F-15	INTEGRITY PACT
F-16	INDEMNITY BOND
F-17	DELETED
F-18	PROFORMA FOR BANK GUARANTEE FOR ADVANCE PAYMENTS
F-19	FORMAT OF LETTER OF NO DEVIATIONS
F-20	DELETED
F-21	DELETED
F-22	DELETED
F-23	DELETED
F-24	DELETED
F-25	DELETED
F-26	DELETED
F-27	DELETED
F-28	UNDERTAKING REGARDING SUBMISSION CONTRACT PERFORMANCE SECURITY (CPS) / SECURITY DEPOSIT (SD) WITHIN STIPULATED TIME LINE
F-29	UNDERTAKING REGARDING SUBMISSION OF ELECTRONIC INVOICE (E-INVOICE AS PER GST LAWS)
F-30	CHECKLIST FOR BID EVALUATION CRITERIA (BEC) QUALIFYING DOCUMENTS FOR BIDDER

	FORMS FOR PUBLIC PROCUREMENT (PREFERENCE TO MAKE IN INDIA) POLICY
FORM – I of Annexure V	CERTIFICATE FROM STATUTORY AUDITOR OR COST AUDITOR OF THE COMPANY (IN THE CASE OF COMPANIES) OR FROM A PRACTICING COST ACCOUNTANT OR PRACTICING CHARTERED ACCOUNTANT (IN RESPECT OF SUPPLIERS OTHER THAN COMPANIES) TOWARDS MINIMUM LOCAL CONTENT
FORM-II of Annexure-V	SALIENT POINTS OF PUBLIC PROCUREMENT (PREFERENCE TO MAKE IN INDIA) POLICY
	FORMS RELATED TO ANNEXURE-VII
Form-I of Annexure-VII	UNDERTAKING ON LETTERHEAD
Form-II of Annexure-VII	CERTIFICATE FOR SUB-CONTRACTING
	FORMS RELATED TO ANNEXURE-VIII-Deleted

F-1

BIDDER'S GENERAL INFORMATION

To,
M/s TALCHER FERTILIZERS LIMITED,
NOIDA

TENDER NO:

1	Bidder Name:	M/s…..
2	Status of Firm	Proprietorship Firm/Partnership firm/ Public Limited/ Pvt. Limited/ Govt. Dept. / PSU/ Others If Others Specify:_____ [Enclose relevant certificates / partnership deed/certificate of Registration, as applicable]
3	Name of Proprietor/ Partners/ Directors of the firm/company	1. 2. 3.
4	Name of Power of Attorney holders of bidder	
5	Number of Years in Operation	
6	Address of Registered Office	_____ City: _____ District: _____ State: _____ PIN/ZIP :_____
7	Bidder's address where order/contract is to be placed	_____ City: _____ District: _____ State: _____ PIN/ZIP :_____
8	Office responsible for executing the contract with GST no.(In case supply of works are from multiple locations, addresses and GST no. of all such locations are to be provided)	City: District: State: PIN/ZIP: GST No.:
9	Telephone Number & Contact Information of address where order is	_____

	to be placed	(Country Code) (Area Code) (Telephone Number) FAX No. : …… e-mail ID: ……
10	E-mail Address	
11	ISO Certification, if any {If yes, please furnish details}	
12	PAN No	[Enclose copy of relevant document]
13	GST No. (refer sl. no. 8 above)	[Enclose copy of relevant document]
14	EPF Registration No.	[Enclose copy of relevant document]
15	ESI code No.	[Enclose copy of relevant document]
16	Whether Micro or Small Enterprise	Yes / No (*If Yes, Bidder to submit requisite documents as specified it ITB: Clause No. 40*)
	Whether MSE is owned by SC/ST Entrepreneur(s)	Yes / No (*If Yes, Bidder to submit requisite documents as specified it ITB: Clause No. 40*)
	Whether MSE is owned by Women	Yes / No (*If Yes, Bidder to submit requisite documents as specified it ITB: Clause No. 40*)
17	Whether Bidder is Startups or not	Yes / No (*If Yes, Bidder to submit requisite documents as specified it ITB: Clause No. 50*)
18	In case of Start-up confirm the following: (i) Date of its incorporation/ registration (ii) Whether turnover for any financial years since incorporation/ registration has exceeded Rs.100 Crores.	

Place:
Date:

[Signature of Authorized Signatory of Bidder]
Name:
Designation:
Seal:

F-2

DECLARATION FOR BID SECURITY
(To be submitted on Letter head of Bidder)

To,

M/s TALCHER FERTILIZERS LIMITED

_____

SUB:

TENDER NO:

Dear Sir,

After examining / reviewing provisions of above referred tender documents (including all corrigendum/ Addenda), we M/s_____ (Name of Bidder) have submitted our offer/ bid no._____.

We, M/s_____ (Name of Bidder) hereby understand that, according to your conditions, we are submitting this Declaration for Bid Security.

We understand that we will be put on watch list/holiday/ banning list (as per polices of TALCHER FERTILIZERS LIMITED in this regard), if we are in breach of our obligation(s) as per following:

(a) have withdrawn/modified/amended, impairs or derogates from the tender, my/our Bid during the period of bid validity specified in the form of Bid; or

(b) having been notified of the acceptance of our Bid by the TALCHER FERTILIZERS LIMITED during the period of bid validity:

(i) fail or refuse to execute the Contract, if required, or
(ii) fail or refuse to furnish the Contract Performance Security, in accordance provisions of tender document.
(iii) fail or refuse to accept 'arithmetical corrections' as per provision of tender document.

(c) having indulged in corrupt/fraudulent /collusive/coercive practice as per procedure.

Place:
Date:

[Signature of Authorized Signatory of Bidder]
Name:
Designation:
Seal:

F-3

LETTER OF AUTHORITY

[Pro forma for Letter of Authority for Attending Subsequent 'Negotiations' / 'Pre-Bid Meetings' /'Un-priced Bid Opening' / 'Price Bid Opening']

Ref: Date:

To,
M/s TALCHER FERTILIZERS LIMITED,
NOIDA

SUB:
TENDER NO:

Dear Sir,
I/We, _____ hereby authorize the following representative(s) for attending any 'Negotiations' / 'Meetings [Pre-Bid Meeting]', 'Un-priced Bid Opening', 'Price Bid Opening' and for any subsequent correspondence / communication against the above Bidding Documents:

[1] Name & Designation _____ Signature _____
Phone/Cell:
Fax:
E-mail: …….. @ ……

[2] Name & Designation _____ Signature _____
Phone/Cell:
Fax:
E-mail: …….. @ ……

We confirm that we shall be bound by all commitments made by aforementioned authorised representative(s).

Place: [Signature of Authorized Signatory of Bidder]
Date: Name:
Designation:
Seal:

Note: This "Letter of Authority" should be on the **"letterhead"** of the Firm / Bidder and should be signed by a person competent and having the 'Power of Attorney' to bind the Bidder. Not more than 'two [02] persons per Bidder' are permitted to attend "Techno-commercial / Un-priced" & "Price Bid" Openings (if applicable). Bidder's authorized representative is required to carry a copy of this authority letter while attending the un-priced and priced bid opening, the same shall be submitted (if applicable).

FORMAT F-4

PROFORMA OF "BANK GUARANTEE" FOR "CONTRACT PERFORMANCE SECURITY / SECURITY DEPOSIT"

(ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)

To, M/s Talcher Fertilizers Limited, Noida	**Bank Guarantee No.**	
	Date of BG	
	BG Valid up to	
	Claim period up to (There should be three months gap between expiry date of BG & Claim period)	
	Stamp Sl. No./e-Stamp Certificate No.	

Dear Sir(s),

M/s. _____ having registered office at _____ (herein after called the "contractor/supplier" which expression shall wherever the context so require include its successors and assignees) have been placed/ awarded the job/work of _____ vide PO/ DLOA /FOA No. _____dated_____ for Talcher Fertilizers LImited having registered office at Plot 2/H, Kalpana Area, BJB Nagar, Khorda, Bhubaneswar-751014, Odisha (herein after called the "TFL" which expression shall wherever the context so require include its successors and assignees).

The Contract conditions provide that the SUPPLIER/CONTRACTOR shall pay a sum of Rs. _____ (Rupees _____) as full Contract Performance Guarantee in the form therein mentioned. The form of payment of Contract Performance Guarantee includes guarantee executed by Nationalized Bank/Scheduled Commercial Bank, undertaking full responsibility to indemnify Talcher Fertilizers Limited, in case of default.

The said M/s._____ has approached us and at their request and in consideration of the premises we having our office at _____ have agreed to give such guarantee as hereinafter mentioned.

1. We_____ hereby undertake to give the irrevocable & unconditional guarantee to you that if default shall be made by M/s. _____ in performing any of the terms and conditions of the tender/order/contract or in payment of any money payable to Talcher Fertilizers Limited we shall on first demand pay without demur, contest, protest and/ or without any recourse to the contractor to TFL in such manner as TFL may direct the said amount of Rupees _____ only or such portion thereof not exceeding the said sum as you may require from time to time.

2. You will have the full liberty without reference to us and without affecting this guarantee, postpone for any time or from time to time the exercise of any of the powers and rights conferred on you under the order/contract with the said M/s. _____ and to enforce or to forbear from endorsing any powers or rights or by reason of time being given to the said M/s._____ and such postponement forbearance would not have the effect of releasing the bank from its obligation under this debt.

3. Your right to recover the said sum of Rs. _____ (Rupees_____) from us in manner aforesaid is absolute & unequivocal and will not be affected or suspended by reason of the fact that any dispute or disputes have been raised by the said M/s. _____ and/or that any dispute or disputes are pending before any officer, tribunal or court or arbitrator or any other authority/forum and any demand made by you in the bank shall be conclusive and binding. The bank shall not be released of its obligations under these presents by any exercise by you of its liberty with reference to matter aforesaid or any of their or by reason or any other act of omission or commission on your part or any other indulgence shown by you or by any other matter or changed what so ever which under law would, but for this provision, have the effect of releasing the bank.

4. The guarantee herein contained shall not be determined or affected by the liquidation or winding up dissolution or changes of constitution or insolvency of the said supplier/contractor but shall in all respects and for all purposes be binding and operative until payment of all money due to you in respect of such liabilities is paid.

5. The bank undertakes not to revoke this guarantee during its currency without your previous consent and further agrees that the guarantee shall continue to be enforceable until it is discharged by TFL in writing. However, if for any reason, the supplier/contractor is unable to complete the supply/work within the period stipulated in the order/contract and in case of extension of the date of delivery/completion resulting extension of defect liability period/guarantee period of the supplier/contractor fails to perform the supply/work fully, the bank hereby agrees to further extend this guarantee at the instance of the supplier/contractor till such time as may be determined by TFL. If any further extension of this guarantee is required, the same shall be extended to such required period on receiving instruction from M/s. _____ (contractor) on whose behalf this guarantee is issued.

6. Bank also agrees that TFL at its option shall be entitled to enforce this Guarantee against the bank (as principal debtor) in the first instant, without proceeding against the supplier/contractor and notwithstanding any security or other guarantee that TFL may have in relation to the supplier's/contractor's liabilities.

7. The amount under the Bank Guarantee is payable forthwith without any delay by Bank upon the written demand raised by TFL. Any dispute arising out of or in relation to the said Bank Guarantee shall be subject to the exclusive jurisdiction of courts at New Delhi.

8. Therefore, we hereby affirm that we are guarantors and responsible to you on behalf of the Supplier/Contractor up to a total amount of _____(amount of guarantees in words and figures) and we undertake to pay you, upon your first written demand declaring the Supplier/Contractor to be in default under the order/contract and without caveat or argument, any sum or sums within the limits of (amounts of guarantee) as aforesaid, without your needing to prove or show grounds or reasons for your demand or the sum specified therein.

9. We have power to issue this guarantee in your favor under Memorandum and Articles of Association and the undersigned has full power to do under the Power of Attorney, dated _____ granted to him / her by the Bank.

10. Notwithstanding anything contained herein:

a) The Bank's liability under this Guarantee shall not exceed (currency in figures) _____ (currency in words only) _____
b) This Guarantee shall remain in force upto _____ (this date should be expiry date of defect liability period of the Contract) and any extension(s) thereof; and
c) The Bank shall be released and discharged from all liability under this Guarantee unless a written claim or demand is issued to the Bank on or before the midnight of _____ (indicate date of expiry of claim period which includes minimum three months from the expiry of this Bank Guarantee) and if extended, the date of expiry of the last extension of this Guarantee. If a claim has been received by us within the said date, all the rights of TFL under this Guarantee shall be valid and shall not cease until we have satisfied that claim.

Yours faithfully,

_____
Bank by its Constituted Attorney

Signature of a person duly
Authorized to sign on behalf of the
Bank

INSTRUCTIONS FOR FURNISHING "CONTRACT PERFORMANCE SECURITY / SECURITY DEPOSIT" BY "BANK GUARANTEE"

1. The Bank Guarantee by successful Bidder(s) will be given on non-judicial stamp paper as per 'stamp duty' applicable. The non-judicial stamp paper should be in name of the issuing bank. In case of foreign bank, the said Bank Guarantee to be issued by its correspondent bank in India on requisite non-judicial stamp paper and place of Bid to be considered as Delhi.

2. The Bank Guarantee by Bidders will be given from bank as specified in Tender.

3. A letter from the issuing bank of the requisite Bank Guarantee confirming that said Bank Guarantee and all future communication relating to the Bank Guarantee shall be forwarded to Employer.

4. If a Bank Guarantee is issued by a commercial bank, then a letter to Employer and copy to Consultant (if applicable) confirming its net worth is more than Rs. 100,00,00,000.00 [Rupees One Hundred Crores] or its equivalent in foreign currency alongwith documentary evidence.

Form-4 (a)

MATTER TO BE MENTIONED IN COVERING LETTER TO BE SUBMITTED BY VENDOR ALONG WITH BANK GUARANTEE (BG)

1. Bank Guarantee No.	
2. Vendor Name	
14 Nature of Bank Guarantee [Please Tick (✓) whichever is applicable]	Contract Performance Security (CPS) / Earnest Money Deposit (EMD) / Advance
15 Purchase Order (PO) / Fax of Acceptance (FOA) / Detailed Letter of Acceptance (DLOA) No.	
16 Details of Bank issuing Bank Guarantee (BG)	
(A) Name of Contact Person	
(B) E-mail ID	
(C) Address	
(D) Phone No. / Mobile No.	

F-5

AGREED TERMS & CONDITIONS

To,
M/s TALCHER FERTILIZERS LIMITED
NOIDA

SUB:
TENDER NO:

This Questionnaire duly filled in, signed & stamped must form part of Bidder's Bid and should be returned along with Un-priced Bid. Clauses confirmed hereunder need not be repeated in the Bid.

Sl.	DESCRIPTION	BIDDER'S CONFIRMATION
1	Bidder's name and address	
2.	Bidder confirms currency of quoted prices is in Indian Rupees	
3.	Bidder confirms quoted prices will remain firm and fixed till complete execution of the order.	
4.1	Bidder confirms that they have quoted rate of **GST (CGST & SGST/ UTGST or IGST)** in Price Schedule / Schedule of Rates (SOR)	Confirmed
4.2	Service Accounting Codes (SAC)/ Harmonized System of Nomenclature (HSN)	
	Bidder hereby confirms that the quoted prices are in compliance with the Section 171 of CGST Act/ SGST Act as mentioned as clause no. 13.10 of ITB	
4.4	a. Whether bidder is liable to raise E-Invoice as per GST Act. b. If yes, bidder will raise E-Invoice and confirm compliance to provision of tender in this regard.	a. _____ _____
4.5	i. Whether bidder as a seller is liable to levy TCS on sale of goods as defined under the said provision of Income Tax. ii. If yes, bidder as a seller will raise proper tax invoice on sale of goods to TFL showing TCS component. iii. Bidder as a seller will comply with all the statutory requirements of TCS regarding deposit of TCS with Government on receipt/collection of consideration from TFL and issue of TCS certificate to TFL timely. iv. If TFL is unable to avail the benefit of TCS Credit on such amount collected by the Supplier, for any reason attributable to Supplier, then TFL shall be entitled to deduct / recover such amount together with penalties and interest, if any, by adjusting any amounts to be paid or becomes payable in future to the Supplier under this contract or under any other contract.	i. _____ ii. _____ iii. _____ _____
5.	Bidder confirms acceptance of relevant Terms of Payment specified in the Bid Document.	
5.1	Deleted	YES/NO

Sl.	DESCRIPTION	BIDDER'S CONFIRMATION
6.	Bidder confirms that Contract Performance Security will be furnished as per Bid Document.	
7.	Bidder confirms that Contract Performance Security shall be from any Indian scheduled bank or a branch of an International bank situated in India and registered with Reserve bank of India as scheduled foreign bank. However, in case of bank guarantees from banks other than the Nationalised Indian banks, the bank must be a commercial bank having net worth in excess of Rs 100 crores and a declaration to this effect shall be made by such commercial bank either in the Bank Guarantee itself or separately on its letterhead.	
8.	Bidder confirms compliance to Completion Schedule as specified in Bid document. Confirm contract period shall be reckoned from the date of Fax of Acceptance.	
9.	(i) Bidder confirms acceptance of Mutually Agreed Damages for delay in completion schedule specified in Bid document. (ii) In case of delay, the bills shall be submitted after deducting the mutually agreed damages due to delay (refer MAD Clause).	
10.	a) Bidder confirms acceptance of all terms and conditions of Bid Document (all sections). b) Bidder confirms that printed terms and conditions of bidder are not applicable.	
11.	Bidder confirms that their offer is valid for period specified in BDS from Final/Extended due date of opening of Techno-commercial Bids.	
12.	a) Deleted	
13.	As per requirement of tender, bidder (having status as Pvt. Ltd. or Limited company) must upload bid duly digitally signed on e-portal through class-3B digital signature (DS). In case, class of DS or name of employee or name of employer is not visible in the digitally signed documents, the bid digitally signed as submitted by the person shall be binding on the bidder.	
14.	Bidder confirms that (i) none of Directors (in Board of Director) of bidder is a relative of any Director (in Board of Director) of Owner or (ii) the bidder is not a firm in which any Director (in Board of Director) of Owner or their relative is not a partner.	Confirmed ☐ Not confirmed ☐
15.	All correspondence must be in ENGLISH language only	
16.	Bidder confirms the contents of this Tender Document have not been modified or altered by them. In case, it is found that the tender document has been modified / altered by the bidder, the bid submitted by them shall be liable for rejection.	
17.	Bidder confirms that all Bank charges associated with Bidder's Bank shall be borne by Bidder.	
18.	No Deviation Confirmation: It may be note that any 'deviation / exception' in any form may result in rejection of Bid. Therefore, Bidder confirms that they have not taken any 'exception / deviation' anywhere in the Bid. In case any 'deviation / exception' is mentioned or noticed, Bidder's Bid may be rejected.	

Sl.	DESCRIPTION	BIDDER'S CONFIRMATION
19.	If Bidder becomes a successful Bidder and pursuant to the provisions of the Tender Document, award is given to them against subject Tender Document, the following Confirmation shall be automatically enforceable: "We agree and acknowledge that the Employer is entering into the Contract/Agreement solely on its own behalf and not on behalf of any other person or entity. In particular, it is expressly understood & agreed that the Government of India is not a party to the Contract/Agreement and has no liabilities, obligations or rights there under. It is expressly understood and agreed that the Purchaser is authorized to enter into Contract/Agreement, solely on its own behalf under the applicable laws of India. We expressly agree, acknowledge and understand that the Purchaser is not an agent, representative or delegate of the Government of India. It is further understood and agreed that the Government of India is not and shall not be liable for any acts, omissions, commissions, breaches or other wrongs arising out of the Agreement. Accordingly, we hereby expressly waive, release and forego any and all actions or claims, including cross claims, VIP claims or counter claims against the Government of India arising out of the Agreement and covenants not to sue to Government of India as to any manner, claim, cause of action or things whatsoever arising of or under the Agreement."	
20.	Bidder to ensure all documents as per tender including clause 11 of Section III and all Formats are included in their bid.	
21.	Bidder understands that Tender Document is not exhaustive. In case any activity though specifically not covered in description of 'Schedule of Rates' but is required to complete the work as per Scope of Work, Conditions of Contract, or any other part of Bidding document, the quoted rates will deemed to be inclusive of cost incurred for such activities unless otherwise specifically excluded. Bidder confirms to perform for fulfillment of the contract and completeness of the supplies in all respect within the scheduled time frame and quoted price.	
22.	Bidder hereby confirms that they are not on 'Holiday' by OWNER or any of the JV partners of OWNER (viz. GAIL, RCF, CIL, FCIL) or Public Sector Project Management Consultant (like PDIL, EIL, Mecon only due to "poor performance" or "corrupt and fraudulent practices") or banned by Government department/ Public Sector on due date of submission of bid. Further, neither bidder nor their allied agency/(ies) (as defined in the Procedure for Action in case of Corrupt/Fraudulent/Collusive/ Coercive Practices) are on banning list of TFL or any of the JV partner of OWNER viz. GAIL, RCF, CIL, FCIL. Bidder also confirms that they are not under any liquidation, court receivership or similar proceedings or 'bankruptcy'. In case it comes to the notice of TFL/PDIL that the bidder has given wrong declaration in this regard, the same shall be dealt as	

Sl.	DESCRIPTION	BIDDER'S CONFIRMATION
	'fraudulent practices' and action shall be initiated as per the Procedure for action in case of Corrupt/Fraudulent/Collusive/Coercive Practices. Further, Bidder also confirms that in case there is any change in status of the declaration prior to award of contract, the same will be promptly informed to TFL/PDIL by them.	
23.	Bidder confirms that, in case of contradiction between the confirmations provided in this format and terms & conditions mentioned elsewhere in the offer, the confirmations given in this format shall prevail.	

Place:
Date:

[Signature of Authorized Signatory of Bidder]
Name:
Designation:
Seal:

F-6

ACKNOWLEDGEMENT CUM CONSENT LETTER

(On receipt of tender document/information regarding the tender, Bidder shall acknowledge the receipt and confirm his intention to bid or reason for non-participation against the enquiry /tender through e-mail to concerned executive in TFL/PDIL issued the tender, by filling up the Format)

To,
M/s TALCHER FERTILIZERS LIMITED
NOIDA

SUB:
TENDER NO:

Dear Sir,

We hereby acknowledge receipt of a complete set of tender documents along with enclosures for subject item/job and/or the information regarding the subject tender.

- We intend to bid as requested for the subject item/job and furnish following details with respect to our quoting office:

  Postal Address with Pin Code : .....
  Telephone Number : .....
  Contact Person : .....
  E-mail Address : .....
  Mobile No. : .....
  Date : .....
  Seal/Stamp : .....

- We are unable to bid for the reason given below:

  Reasons for non-submission of bid:

Agency's Name : .....
Signature : .....
Name : .....
Designation : .....
Date : .....
Seal/Stamp : .....

F-7
BIDDER'S EXPERIENCE

To,

M/s TALCHER FERTILIZERS LIMITED
NOIDA

SUB:
TENDER NO:

Sl. No	Detailed Description of Job	LOA /WO No. and date	Full Postal Address & phone nos. of Client. *Name, designation and address of Engineer/ Officer-in-Charge*	Capacity	Value of Contract/Order (*Specify* Currency Amount)	Date of Commencement	Scheduled Completion Time (Months)	Date of Actual Completion	Reasons for delay in execution, if any	Details of satisfactory operation from the date of Acceptance
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

Place:
Date:

[Signature of Authorized Signatory of Bidder]

Name:
Designation:

Seal:

Note:

1. **The documents (Work Order/DLOA/FOA, Completion certificate, Execution Certificate etc.) which have been referred/ specified/indicated/submitted in above tabulation format and/or along with bid shall be taken into consideration in reply to queries (if any) during evaluation of Bids. Hence, bidder in his own interest should invariably fill-up this format.**

F-8

CHECK LIST

Bidders are requested to duly fill in the checklist. This checklist gives only certain important items to facilitate the bidder to make sure that the necessary data/information as called for in the bid document has been submitted by them along with their offer. This, however, does not relieve the bidder of his responsibilities to make sure that his offer is otherwise complete in all respects.

Please ensure compliance and tick (√) against following points:

S. No.	DESCRIPTION	CHECK BOX
1.0	Digitally Signing (in case of e-bidding)/ Signing and Stamping (in case of manual bidding) on each sheet of offer, original bidding document including Corrigendum / Addendum / Amendment (if any)	
2.0	Confirm that the following details have been submitted in the Un-priced part of the bid	
i	Covering Letter, Letter of Submission	
ii	Declaration for Bid Security as per provisions of Tender	
iii	Power of Attorney in the name of person signing the bid.	
iv	Details and documentary proof required against BEC Criteria of Tender Document	
3.0	Confirm that all format duly filled in are enclosed with the bid duly Digitally Signed / Signed and Stamped by authorised person(s)	
4.0	Confirm that the price part as per Price Schedule has been uploaded.	
5.0	Confirm that annual reports, duly filled in Form F-10 & Form F-9, if applicable are enclosed in the offer for financial assessment	
6.0	Confirm that statutory auditor certificate as per Form 1 have been submitted (applicable for PP-LC bidder).	

Place:
Date:

[Signature of Authorized Signatory of Bidder]

Name:
Designation:

F-9

FORMAT FOR CERTIFICATE FROM BANK
IF BIDDER'S WORKING CAPITAL IS INADEQUATE/NEGATIVE

(To be provided on Bank's letter head)

Date:

To,
M/s. TALCHER FERTILIZERS LIMITED
NOIDA

Dear Sir,

This is to certify that M/s …….. (name of the bidder with address) (hereinafter referred to as Customer) is an existing customer of our Bank.

The Customer has informed that they wish to bid for TFL's RFQ/Tender no. ..... dated …… for ……..(Name of the supply/work/services/consultancy) and as per the terms of the said RFQ/Tender they have to furnish a certificate from their Bank confirming the availability of line of credit.

Accordingly M/s …….. (name of the Bank with address) confirms availability of line of credit to M/s …….. (name of the bidder) for at least an amount of Rs./USD _____

It is also confirmed that the net worth of the Bank is more than Rs. 100 Crores (or Equivalent USD) and the undersigned is authorized to issue this certificate.

Yours truly

for …… (Name & address of Bank)

(Authorized signatory)
Name of the signatory:
Designation :
Stamp

F-10

FORMAT FOR CHARTERED ACCOUNTANT CERTIFICATE/ CERTIFIED PUBLIC ACCOUNTANT (CPA) FOR FINANCIAL CAPABILITY OF THE BIDDER

We have verified the Audited Financial Statements and other relevant records of M/s…… (Name of the bidder) and certify the following:

A. AUDITED ANNUAL TURNOVER* OF PRECEDING THREE FINANCIAL YEARS:

Year	Amount (Currency)
Year 1:	
Year 2:	
Year 3:	

B. NETWORTH* AS PER AUDITED FINANCIAL STATEMENT OF PRECEDING FINANCIAL YEAR:

Description	**Year** _____
	Amount (Currency)
1. Net Worth	

C. WORKING CAPITAL* AS PER AUDITED FINANCIAL STATEMENT OF PRECEDING FINANCIAL YEAR:

Description	**Year** _____
	Amount (Currency)
1. Current Assets	
2. Current Liabilities	
3. Working Capital (Current Assets-Current liabilities)	

Refer Instructions

Notes:

(i) It is further certified that the above mentioned applicable figures are matching with the returns filed with Registrar of Companies (ROC) [Applicable only in case of Indian Companies]

(ii) We confirm the above figures after referring instructions at page 2 of 2 of Format F-10.

(iii) Practicing Chartered Accountants shall generate Unique Document Identification Number (UDIN) for all certificates issued by them.

Name of Audit Firm:
Chartered Accountant/CPA
Date:

[Signature of Authorized Signatory]
Name:
Designation:
Seal:
Membership No.:
UDIN

(Page 1 of 2)

Instructions for Format F-10:

1. The financial year would be the same as one normally followed by the bidder for its Annual Report.

2. The bidder shall provide the audited annual financial statements as required for this Tender document. Failure to do so would result in the Proposal being considered as non-responsive.

3. For the purpose of this Tender document:
   (i) **Annual Turnover** shall be "Sale Value/ Operating Income"
   (ii) **Working Capital** shall be "Current Assets less Current liabilities" and
   (iii) **Net Worth** shall be Paid up share capital plus Free Reserves & Surplus less accumulated losses, deferred expenditure and miscellaneous expenditure not written off, if any.

4. Above figures shall be calculated after considering the qualification, if any, made by the statutory auditor on the audited financial statements of the bidder including quantified financial implication.

5. This certificate is to be submitted on the letter head of Chartered Accountant/CPA.

F-11

BIDDER'S QUERIES FOR PRE BID MEETING

To,

M/s TALCHER FERTILIZERS LIMITED
NOIDA

SUB:

TENDER NO:

Sl. NO.	REFERENCE OF TENDER DOCUMENT				BIDDER'S QUERY	OWNER'S REPLY
	SEC. NO.	Page No.	Clause No	Subject		

NOTE: The Pre-Bid Queries may be sent by e-mail before due date for receipt of Bidder's queries.

SIGNATURE OF BIDDER: _____

NAME OF BIDDER**:** _____

F-12
E-Banking Mandate Form

1. Vendor/Customer Name :

2. Vendor/Customer Code:

3. Vendor /Customer Address:

4. Vendor/Customer e-mail id:

5. Particulars of bank account
   a) Name of Bank
   b) Name of branch
   c) Branch code:
   d) Address:
   e) Telephone number:
   f) Type of account (current/saving etc.)
   g) Account Number:
   h) RTGS IFSC code of the bank branch
   i) NEFT IFSC code of the bank branch
   j) 9 digit MICR code

I/We hereby authorize Talcher Fertilizers Limited to release any amount due to me/us in the bank account as mentioned above. I/We hereby declare that the particulars given above are correct and complete. If the transaction is delayed or lost because of incomplete or incorrect information, we would not hold the Talcher Fertilizers Limited responsible.

(Signature of vendor/customer)

BANK CERTIFICATE

We certify that ---------- has an Account no. ---------- with us and we confirm that the details given above are correct as per our records.

Bank stamp

Date (Signature of authorized officer of bank)

F-13

POWER OF ATTORNEY (POA)

(To be submitted on the Non-Judicial stamp paper / Company's Letter Head)

TENDER NO:

Description of work:

Name of Bidder:_____

"The undersigned _____ (Name of LEGAL PERSON, i.e. CEO/C&MD/Company Secretary/Partners) is lawfully authorized to issue this POA* on behalf of the company M/s _____ (Name of bidder) whose registered address is _____ and does hereby appoint Mr./Ms _____ (name of authorized person signing the bid document) _____ (Designation) of M/s _____ (Name of bidder) whose signature appears below to be the true and lawful attorney/(s) and authorize him/her to sign the bid (both physically & digitally on CPP Portal), conduct negotiation, sign contracts and execute all the necessary matter related thereto, in the name and on behalf of the company in connection with the tender no. _____.

The signature of the authorized person/(s) herein constitutes unconditional obligations of M/s _____ (Name of bidder).

This Power of Attorney (POA) shall remain valid and in full force and effect before we withdraw it in writing (by fax, or mail or post). All the documents signed (within the period of validity of the Power of Attorney) by the authorized person herein shall not be invalid because of such withdrawal.

(*) In case of a single Bidder, the Power of Attorney shall be issued as per the constitution of the bidder as below.

a) **In case of Proprietorship**: By Proprietor
b) **In case of Partnership**: by all Partners or Managing Partner.
c) **In case of Limited Liability Partnership**: by any bidder's employee authorized in terms of Deed of LLP.
d) **In case of Public /Limited Company**: POA in favour of authorized employee(s) by Board of Directors through Board Resolution or by the designated officer authorized by Board to do so. Such Board Resolution should be duly countersigned by Company Secretary / MD / CMD / CEO.

SIGNATURE OF THE LEGAL PERSON

_____
(Name of person with Company seal)

SIGNATURE OF THE AUTHORIZED PERSON
(FOR SIGNING THE BID)

_____
(Signature)
Name of person: _____
E-mail id: _____
DSC (Digital Signature Certificate) No.: _____

F-14

PROFORMA FOR CONTRACT AGREEMENT

(To be executed on non-judicial stamp paper of appropriate value)

DLOA No. ……. dated ……..

TFL's PAN No. …….

Contract Agreement for the work of ---------- of TALCHER FERTILIZERS LIMITED made on ---------- between (Name and Address)---------- , hereinafter called the "CONTRACTOR" (which term shall unless excluded by or repugnant to the subject or context include its successors and permitted assignees) of the one part and TALCHER FERTILIZERS LIMITED hereinafter called the "EMPLOYER" (which term shall, unless excluded by or repugnant to the subject or context include its successors and assignees) of the other part.

WHEREAS

A. The EMPLOYER being desirous of having provided and executed certain work mentioned, enumerated or referred to in the Tender Documents including Letter Inviting Tender, General Tender Notice, General Conditions of Contract, Special Conditions of Contract, Specifications, Drawings, Plans, Time Schedule of completion of jobs, Schedule of Rates, Agreed Variations, other documents has called for Tender.

B. The CONTRACTOR has inspected the SITE and surroundings of WORK specified in the Tender Documents and has satisfied himself by careful examination before submitting his tender as to the nature of the surface, strata, soil, sub-soil and ground, the form and nature of site and local conditions, the quantities, nature and magnitude of the work, the availability of labour and materials necessary for the execution of work, the means of access to SITE, the supply of power and water thereto and the accommodation he may require and has made local and independent enquiries and obtained complete information as to the matters and thing referred to, or implied in the tender documents or having any connection therewith and has considered the nature and extent of all probable and possible situations, delays, hindrances or interferences to or with the execution and completion of the work to be carried out under the CONTRACT, and has examined and considered all other matters, conditions and things and probable and possible contingencies, and generally all matters incidental thereto and ancillary thereof affecting the execution and completion of the WORK and which might have influenced him in making his tender.

C. The Tender Documents including the Notice Letter Inviting Tender, General Conditions of Contract, Special Conditions of Contract, Schedule of Rates, General Obligations, SPECIFICATIONS, DRAWINGS, PLANS, Time Schedule for completion of Jobs, Letter of Acceptance of Tender and any statement of agreed variations with its enclosures copies of which are hereto annexed form part of this CONTRACT though separately set out herein and are included in the expression "CONTRACT" wherever herein used.

AND WHEREAS

The EMPLOYER accepted the Tender of the CONTRACTOR for the provision and the execution of the said WORK at the rates stated in the schedule of quantities of the work and finally approved by EMPLOYER (hereinafter called the "Schedule of Rates") upon the terms and subject to the conditions of CONTRACT.

NOW THIS AGREEMENT WITNESSETH AND IT IS HEREBY AGREED AND DECLARED AS FOLLOWS:-

1. In consideration of the payment to be made to the CONTRACTOR for the WORK to be executed by him, the CONTRACTOR hereby covenants with EMPLOYER that the CONTRACTOR shall and will duly provide, execute and complete the said work and shall do and perform all other acts and things in the CONTRACT mentioned or described or which are to be implied there from or may be reasonably necessary for the completion of the said WORK and at the said times and in the manner and subject to the terms and conditions or stipulations mentioned in the contract.
2. In consideration of the due provision execution and completion of the said WORK, EMPLOYER does hereby agree with the CONTRACTOR that the EMPLOYER will pay to the CONTRACTOR the respective amounts for the WORK actually done by him and approved by the EMPLOYER at the Schedule of Rates and such other sum payable to the CONTRACTOR under provision of CONTRACT, such payment to be made at such time in such manner as provided for in the CONTRACT.

AND

3. In consideration of the due provision, execution and completion of the said WORK the CONTRACTOR does hereby agree to pay such sums as may be due to the EMPLOYER for the services rendered by the EMPLOYER to the CONTRACTOR, such as power supply, water supply and others as set for in the said CONTRACT and such other sums as may become payable to the EMPLOYER towards the controlled items of consumable materials or towards loss, damage to the EMPLOYER'S equipment, materials construction plant and machinery, such payments to be made at such time and in such manner as is provided in the CONTRACT.

   It is specifically and distinctly understood and agreed between the EMPLOYER and the CONTRACTOR that the CONTRACTOR shall have no right, title or interest in the SITE made available by the EMPLOYER for execution of the works or in the building, structures or work executed on the said SITE by the CONTRACTOR or in the goods, articles, materials etc., brought on the said SITE (unless the same specifically belongs to the CONTRACTOR) and the CONTRACTOR shall not have or deemed to have any lien whatsoever charge for unpaid bills will not be entitled to assume or retain possession or control of the SITE or structures and the EMPLOYER shall have an absolute and unfettered right to take full possession of SITE and to remove the CONTRACTOR, their servants, agents and materials belonging to the CONTRACTOR and lying on the SITE.

   The CONTRACTOR shall be allowed to enter upon the SITE for execution of the WORK only as a licensee simpliciter and shall not have any claim, right, title or interest in the SITE or the structures erected thereon and the EMPLOYER shall be entitled to terminate such license at any time without assigning any reason.

   The materials including sand, gravel, stone, loose, earth, rock etc., dug up or excavated from the said SITE shall, unless otherwise expressly agreed under this CONTRACT, exclusively belong to the EMPLOYER and the CONTRACTOR shall have no right to claim over the same and such excavation and materials should be disposed off on account of the EMPLOYER according to the instruction in writing issued from time to time by the ENGINEER-IN-CHARGE.

In Witness whereof the parties have executed these presents in the day and the year first above written.

Signed and Delivered for and on on behalf of EMPLOYER	Signed and Delivered for and on behalf of the CONTRACTOR.
TALCHER FERTILIZERS LIMITED	NAME OF CONTRACTOR

_____ _____

Date :_____ Date :_____

Place:_____ Place:_____

IN PRESENCE OF TWO WITNESSES

1._____ 1. _____

2._____ 2. _____
_____ _____
_____ _____

F-15

INTEGRITY PACT

INTEGRITY PACT

INTEGRITY PACT

INTRODUCTION:

TFL as one of its endeavour to maintain and foster most ethical and corruption free business environment, have decided to adopt the Integrity Pact, a tool developed by the Transparency International, to ensure that all activities and transactions between the Company (TFL) and its Counterparties (Bidders, Contractors, Vendors, Suppliers, Service Providers/Consultants etc.) are handled in a fair and transparent manner, completely free of corruption.

Considering the above, the details mentioned at attached Annexure-1 are applicable as stated in Instruction to Bidders of Bid Document in addition to the existing stipulation regarding Corrupt and Fraudulent Practices.

The attached copy of the Integrity Pact at Annexure - 2 shall be included in the Bid submitted by the bidder (to be executed by the bidder for all tenders of value Rs. 1 (One) crore and above). In case a bidder does not sign the Integrity Pact, his bid shall be liable for rejection.

ANNEXURE-1

Bidder is required to sign the Integrity Pact with TFL as per format & terms and conditions enclosed with tender. In case a bidder does not sign the Integrity Pact, his bid shall be liable for rejection.

I COMMITMENTS AND OBLIGATIONS OF THE "COUNTERPARTY"

a) The Counterparty, directly or indirectly (through agent, consultant, advisor, etc.), shall not pay any bribe/ influence or give undue/ unlawful benefit to anyone to gain undue advantage in dealing with TFL.

b) The Counterparty will not engage in collusion of any kind including price fixation etc. with other Counterparts.

c) The counterparty will not pass TFL's confidential information to any third party unless specifically authorized by TFL in writing.

d) The Counterparties shall promote and observe best ethical practices within their respective organizations.

e) The Counterparty shall inform the Independent External Monitor.
   i) If it received any demand, directly or indirectly, for a bribe/ favour or any illegal gratification/ payment / benefit;
   ii) If it comes to know of any unethical or illegal payment / benefit;
   iii) If it makes any payment to any TFL associate.

f) The Counterparty shall not make any false or misleading allegations against TFL or its associates.

II VIOLATIONS & CONSEQUENCES:

a) If a Counterparty commits a violation of its Commitments and Obligations under the Integrity Pact Programme during bidding process, their entire Earnest Money Deposit/ Bid Security, would be forfeited and in addition, action shall be taken as per "Procedure for action in case Corrupt /Fraudulent/ Collusive/Coercive Practices"

b) In case of violation of the Integrity pact by Counterparty after award of the Contract, TFL shall be entitled to terminate the Contract. Further, TFL would forfeit the security deposits/ Contract Performance Bank Guarantee and in addition, action shall be taken as per "Procedure for action in case Corrupt /Fraudulent/ Collusive/Coercive Practices"

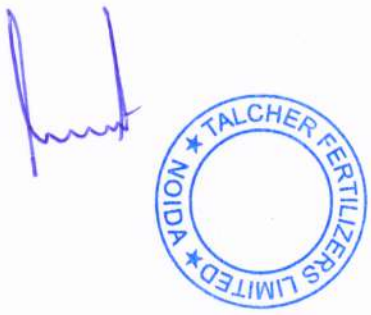
TALCHER FERTILIZERS LIMITED * NOIDA *

INDEPENDENT EXTERNAL MONITORS (IEMS)

Presently the panel consisting of the following Independent External Monitors (IEMs) have been appointed by TFL, in terms of Integrity Pact (IP) which forms part of TFL Tenders / Contracts.

i) Shri Anjan Kumar Banerjee (Email ID: banerjeeanjan@gmail.com)
ii) Shri Atul Sobti (Email ID: sobtiatul@gmail.com)

This panel is authorised to examine / consider all references made to it under this tender. The bidder(s), in case of any dispute(s) / complaint(s) pertaining to this tender may raise the issue either with the designated tender issuing officer or Nodal Officer (presently Sh. S. Dasgupta, DGM (C&P) – Email: sdasgupta@gail.co.in) in TFL or directly with the IEMs on the panel or IEM c/o Chief Vigilance Officer, Rashtriya Chemicals and Fertilizers Ltd., Priyadarshini Building, Eastern Express Highway, Sion, Mumbai Maharashtra, 400022.



ANNEXURE-2

INTEGRITY PACT

(To be executed on plain paper)

Between TFL (India) Limited, a Government of India Public Sector, (here-in-after referred to as "Principal").

AND

_____(here-in-after referred to as "The Bidder/ Contractor").

(Principal and the Bidder / Contractor are here-in-after are referred to individually as "Party" or collectively as "Parties").

PREAMBLE

The Principal intends to award under laid down organizational procedures, contract/s for_____. The Principal values full compliance with all relevant laws of land rules, regulations, and economic use of resources and of fairness /transparency in its relations with its Bidder (s) and/or Contractor (s).

In order to achieve these goals, the Principal will appoint Independent External Monitors (IEMs) who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 – Commitments of the Principal

1. The Principal commits itself to take all measures necessary to prevent corruption and to observe the following Principles:-

   i) No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or for a third person, any material or immaterial benefit which the person is not legally entitled to.

   ii) The Principal will, during the tender process treat all Bidder(s) with equity and reasons. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

TALCHER FERTILIZERS LIMITED * NOIDA *

iii) The Principal will exclude from the process all known prejudiced persons.

2. If the Principal obtains information on the conduct of any of its employees which is a criminal offence under the Indian Penal Code (IPC) / Prevention of Corruption Act (PC Act), or if there be a substantive suspicion in this regard, the Principal will inform the Chief Vigilance Officers and in addition can initiate disciplinary actions.

Section 2 – Commitments of the Bidder (s)/Contractor (s)

1. The Bidder(s) / Contractor(s) commits themselves to take all measures necessary to prevent corruption. The Bidder(s) / Contractor(s) commits themselves to observe the following principles during participation in the tender process and during the contract execution:

i) The Bidder (s) / Contractor (s) will not, directly or through any other person or firm, offer, promise or give to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material or other benefit which he / she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

ii) The Bidder (s) / Contractor (s) will not enter with other Bidders into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other action to restrict competitiveness or to introduce cartelisation in the bidding process.

iii) The Bidder (s) / Contractor (s) will not commit any offence under the relevant IPC/PC Act; further, the Bidder (s) / Contractor (s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

iv) The Bidder (s)/ Contractor (s) of foreign origin shall disclose the name and address of the Agents/ representatives in India, if any. Similarly, the Bidder (s)/ Contractor (s) of Indian Nationality shall furnish the name and address of the foreign principals, if any. Further, all the payments made to the Indian agent/ representative have to be in India Rupees only.

v) The Bidder (s) / Contractor (s) will, when presenting their bid, disclose any and all payments made, is committed to or intends to make to agents,

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brokers or any other intermediaries in connection with the award of the contract.

vi) Bidder(s) / Contractor(s) who have signed the Integrity Pact shall not approach the Courts while representing the matter to IEMs and shall wait for their decision in the matter.

2. The Bidder(s)/ Contractor(s) shall not instigate third person to commit offences outlined above or be an accessory to such offences.

Section 3 – Disqualification from tender process and exclusion from future contracts

If the Bidder (s) / Contractor (s), before award or during execution has committed a transgression through a violation of Section 2, above or in any other form such as to put their reliability or credibility in question, the Principal is entitled to disqualify the Bidder (s) / Contractor (s) from the tender process or take action as per provisions of "Procedure for action in case Corrupt /Fraudulent/ Collusive/Coercive Practices".

Section 4 – Compensation for Damages

1. If the Principal has disqualified the Bidder (s) from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit / Bid Security.

2. If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to Section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages equal to the Contract Value or the amount equivalent to Performance Bank Guarantee.

Section 5 – Previous transgression

1. The Bidder declares that no previous transgression occurred in the last three years, with any other Company in any country conforming to the anti-corruption approach or with any Public Sector Enterprise in India that could justify his exclusion from the tender process.

2. If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or actions can be taken as per provisions of "Procedure for action in case Corrupt /Fraudulent/ Collusive/Coercive Practices"

TALCHER FERTILIZERS LIMITED * NOIDA *

Section 6 – Equal treatment to all Bidders / Contractors / Subcontractors

1. In case of Sub-Contracting, the Principal Contractor shall take the responsibility of the adoption of Integrity Pact by the Sub-contractor.

2. The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors.

3. The Principal will disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

Section 7 – Criminal charges against violating Bidder (s) / Contractor (s) / Sub-contractor (s)

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the same to the Chief Vigilance Officer.

Section 8 –Independent External Monitor / Monitors

1. The Principal appoints competent and credible Independent External Monitor for this Pact after approval by Central Vigilance Commission. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

2. The Monitor is not subject to instructions by the representatives of the parties and performs his/her functions neutrally and independently. The Monitor would have access to all Contract documents, whenever required. It will be obligatory for him/ her to treat the information and documents of the Bidders/ Contractors as confidential. He/she reports to the MD, TFL.

3. The Bidder (s)/ Contractor (s) accepts that the Monitor has the right to access without restriction to all Project documentation of the Principal including that provided by the Contractor. The Contractor will also grant the Monitor, upon his/her request and demonstration of a valid interest, unrestricted and unconditional access to their project documentation. The same is applicable to Sub-contractors.

4. The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.

5. As soon as the Monitor notices, or believes to notice, a violation of this agreement, he/she will so inform the Management of the Principal and request

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the Management to discontinue or to take corrective action, or to take other relevant action. The monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action.

6. The Monitor will submit a written report to the MD, TFL within 10 days as far as possible from the date of reference or intimation to him by the 'Principal' and, should the occasion arise, submit proposals for correcting problematic situations.

7. If the Monitor has reported to the MD, TFL, a substantiated suspicion of an offence under relevant IPC/PC Act, and the MD, TFL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Chief Vigilance Officer, the Monitor may also transmit this information directly to the Central Vigilance Commissioner.

8. The word 'Monitor' would include both singular and plural.

9. In case of any complaints referred under IP Program, the role of IEMs is advisory and would not be legally binding and it is restricted to resolving the issues raised by an intending bidder regarding any aspect of the tender which allegedly restricts competition or bias towards some bidder.

Section 9 – Pact Duration

This Pact begins when both parties have legally signed it. It expires for the Contractor 12 months after the last payment under the respective contract, and for all other Bidders 6 months after the contract has been awarded. Any violation to the same would entail disqualification of the bidders and exclusion from future business dealing.

If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged/determined by the MD, TFL.

Section 10 – Miscelleneous provisions

1. This agreement is subject to Indian Law. Place of performance and exclusive jurisdiction is the Registered Office of the Principal, i.e. New Delhi.

2. Changes and supplements as well as termination notices, if any, need to be made in writing. Side agreements have not been made.

3. If the Contractor / Bidder is a partnership concern or a consortium, this agreement must be signed by all partners or consortium members.

TALCHER FERTILIZERS LIMITED * NOIDA *

4. Should one or several of the provisions of this agreement turn out to be invalid, the remainder of this agreement shall remain valid. In this case, the parties will strive to come to an agreement to their original intentions in such a case.

5. Issues like warranty / guarantee, etc. shall be outside the purview of IEMs.

6. In the event of any contradiction between the Integrity Pact and its Annexure, the Clause in Integrity Pact will prevail.

(For & on Behalf of Principal)

(Office Seal)

एस. दासगुप्ता / S. DASGUPTA
उप महाप्रबंधक (संविदा एवं क्रय)/Dy. General Manager (C&P)
तलचेर फर्टिलाइज़र्स लिमिटेड/Talcher Fertilizers Ltd.
जीटीआई पीएआरसी बिल्डिंग/GTI PARC Building
प्लॉट नं० 24, सैक्टर-16ए, नोएडा-201301(उ.प्र.)
Plot No. 24, Sec.-16A, Noida-201 301(U.P.)

(For & on Behalf of Bidder/Contractor)

(Office Seal)

Place ----------
Date ----------

Witness 1:
(Sign, Name & Address)
[FOR PRINCIPAL]

Geogam (Sura Deogam)
Talcher Fertilizers Limited (TFL), Plot No. 24,
Sector-16A, Film City, Noida (U.P.) - 201301

Witness 2:
(Sign, Name & Address)
[FOR BIDDER / CONTRACTOR]

.....
.....
.....

F-16
INDEMNITY BOND

WHEREAS TALCHER FERTILIZERS LIMITED (hereinafter referred to as "**TFL**") which expression shall, unless repugnant to the context include its successors and assigns, having its registered office at Plot 2/H, Kalpana Area, BJB Nagar, Khorda, Bhubaneswar – 751014 has entered into a contract with M/s*……. (hereinafter referred to as the "**Contractor"**) which expression shall unless repugnant to the context include its representatives, successors and assigns, having its registered office at *…….. and on the terms and conditions as set out, inter-alia in the ……. **[*mention the work order/LOA/Tender No*.]** and various documents forming part thereof, hereinafter collectively referred to as the '**CONTRACT'** which expression shall include all amendments, modifications and / or variations thereto.

TFL has also advised the Contractor to execute an Indemnity Bond in general in favour of TFL indemnifying TFL and its employees and Directors including Independent Directors from all consequences which may arise out of any prospective litigation or proceedings filed or may be initiated by any third party, including any Banker / financial institution / worker(s) /vendor(s)/ subcontractor(s) etc. who may have been associated or engaged by the Contractor directly or indirectly with or without consent of TFL for above works.

NOW, THEREFORE, in consideration of the promises aforesaid, the Contractor hereby irrevocably and unconditionally undertakes to indemnify and keep indemnified TFL and all its employees, Directors, including Independent Directors, from and against all/any claim(s), damages, loss, which may arise out of any litigations/ liabilities that may be raised by the Contractor or any third party against TFL under or in relation to this contract. The Contractor undertakes to compensate and pay to TFL and/or any of its employees, Directors including Independent Directors, forth with on demand without any protest the amount claimed by TFL for itself and for and on behalf of its employees, Directors including Independent Directors together with direct/indirect expenses including all legal expenses incurred by them or any of them on account of such litigation or proceedings.

AND THE CONTRACTOR hereby further agrees with TFL that:

(i) This Indemnity shall remain valid and irrevocable for all claims of TFL and/or any of its employees and Directors including Independent Directors arising out of said contract with respect to any such litigation / court case for which TFL and/or its employees and Directors including Independent Directors has been made party until now or here-in-after.

(ii) This Indemnity shall not be discharged/ revoked by any change/ modification/ amendment/ assignment of the contract or any merger of the Contractor with other entity or any change in the constitution/structure of the Contractor's firm/ Company or any conditions thereof including insolvency etc. of the Contractor, but shall be in all respects and for all purposes binding and operative until any/ all claims for payment of TFL are settled by the Contractor and/or TFL discharges the Contractor in writing from this Indemnity.

The undersigned has full power to execute this Indemnity Bond for and on behalf of the Contractor and the same stands valid.

SIGNED BY :

For *[Contractor]*

Authorised Representative

Place:
Dated:
Witnesses:1.
2.

F-17

DELETED

F-18

Deleted

F-19
FORMAT OF LETTER OF NO DEVIATIONS

(ON BIDDER'S LETTERHEAD)

(NIT NO : PNMM/PC183/E-4008./NCB DATED 24.05.2021)

We * hereby agree to fully comply with, abide by and accept without variation, deviation or reservation all technical, commercial and other condition whatsoever of the Bidding Documents and all Addenda / Corrigenda / Amendment/ Clarifications issued by OWNER.

We further hereby confirm that the bid is submitted in accordance of Tender Document and contains no deviation and the price bid submitted may be treated to conform to, in all respects, with the terms and conditions of the said tender documents including all Addenda / Corrigenda/ Amendment /Clarifications.

For and on behalf of* : …….....……

Stamp & Signature** : ……

Name : ……

Designation : ……

Date **: ……**

* Here fill in the name of bidder.

** The Letter of *No Deviation* must be signed by the person (s) authorized to sign as per POA.

F-20

DELETED

F-21

DELETED

F-22

DELETED

F-23

DELETED

F-24

DELETED

F-25

DELETED

F-26

DELETED

F-27

DELETED

Form F-28.

UNDERTAKING REGARDING SUBMISSION CONTRACT PERFORMANCE SECURITY (CPS)/ SECURITY DEPOSIT (SD) WITHIN STIPULATED TIME LINE

(to be submitted on letter head of bidder)

To,

M/s Talcher Fertilizers Limited

_____

SUB:

TENDER NO:

Dear Sir,

We hereby confirm that we have clearly understood the requirement of Contract Performance Security (CPS) / Security Deposit (SD) specified in the tender document.

We also hereby confirm that in case of award of contract / order, we will submit Contract Performance Security (CPS) / Security Deposit (SD) within 30 days from the date of issuance of Fax of Acceptance.

Place: [Signature of Authorized Signatory of Bidder]

Date: Name:

Designation:

Bidder Name:

Seal:

Form F-29.

UNDERTAKING REGARDING SUBMISSION OF ELECTRONIC INVOICE (E-INVOICE AS PER GST LAWS)

(to be submitted on letter head along with documents for release of payment)

To,

M/s TALCHER FERTILIZERS LIMITED

_____

SUB:
LOA NO:

Dear Sir,

We _____ (Name of the Supplier/Contractor/Service Provider/ Consultant) hereby confirm that E-Invoice provision as per the GST Law is

(i)	Applicable to us	[ ]
(ii)	Not Applicable to us	[ ]

(Supplier/Contractor/Service Provider/ Consultant is to tick appropriate option (✓ or X) above).

In case, same is applicable to us, we confirm that we will submit E-Invoice after complying with all the requirements of GST Laws. If the invoice issued without following this process, such invoice can-not be processed for payment by TFL as no ITC is allowed on such invoices. We also confirm that If input tax credit is not available to TFL for any reason attributable to Supplier/Contractor/Service Provider/ Consultant (both for E-invoicing cases and non-E-invoicing cases), then TFL shall not be obligated or liable to pay or reimburse GST (CGST & SGST/UTGST or IGST) claimed in the invoice(s) and shall be entitled to deduct / setoff / recover such GST amount (CGST & SGST/UTGST or IGST) or Input Tax Credit amount together with penalties and interest, if any, by adjusting against any amounts paid or becomes payable in future to the Supplier/Contractor/Service Provider/ Consultant under this contract or under any other contract.

Place:
Date:

[Signature of Authorized Signatory of Bidder]
Name:
Designation:
Bidder Name:
Seal:

F-30

CHECKLIST FOR BID EVALUATION CRITERIA (BEC) QUALIFYING DOCUMENTS FOR BIDDER

BEC Clause No.	Description	Documents required for qualification	Documents Submitted by Bidder
Technical BEC			
1.	**Experience**	a) Copy of Detailed Letter of Acceptance (DLOA)/ Work Order/ relevant extract of work Order/ Contract Agreement along with detailed scope of work. b) The Detailed Letter of Acceptance (DLOA) / Work Order / Contract Agreement must clearly indicate nature of Work, period and contract value. Similarly, the Completion Certificate must clearly indicate reference of relevant work order/DLOA/Contract Agreement, Name of Work, Contract Value, Completed order value and date of completion. c) Documents in support of Technical Criteria of BEC to be furnished by the Bidder, shall necessarily be duly certified/ attested by Chartered Engineer and Notary Public with legible stamp.	
2.	**Job executed for Subsidiary / Fellow subsidiary/ Holding company.**	Tax paid invoice(s) duly certified by statutory auditor of the bidder towards payment of statutory tax in support of the job executed for Subsidiary / Fellow subsidiary/ Holding company.	
Financial BEC			
1.	**Annual Turn Over**	Audited Financial Statements [including Auditor's Report, Balance sheet, Profit & Loss Accounts statements, Notes & schedules etc.] for any of the last three preceding financial years, whichever meets the Annual Turnover Criteria	Submitted *(for any one of the preceding three (03) financial years/Calendar years whichever meets the annual turnover criteria*.)

2.	**Net Worth**	Audited Financial Statements [including Auditor's Report, Balance sheet, Profit & Loss Accounts statements, Notes & schedules etc.] for last Audited Financial Year.	Submitted (*last Audited Financial Statements)*
3.	**Working Capital**	Audited Financial Statements [including Auditor's Report, Balance sheet, Profit & Loss Accounts statements, Notes & schedules etc.] for last Audited Financial Year. If the bidder's working capital is negative or inadequate, the bidder shall submit a letter (in prescribed format) from their bank having net worth not less than Rs.100 Crores, confirming the availability of line of credit for at least working capital requirement as stated above.	Submitted (*last Audited Financial Statements*) Submitted/ Not Applicable *(Bidder to tick appropriate option)*
4.	**Format for Details of financial capability of Bidder**	Bidder shall submit "Details of financial capability of Bidder" in prescribed format duly signed and stamped by a chartered accountant / Certified Public Accountant (CPA).	Submitted

Place: [Signature of Authorized Signatory of Bidder]

Date: Name:

Designation:

Seal:

FORM – I of ANNEXURE V

CERTIFICATE FROM STATUTORY AUDITOR OR COST AUDITOR OF THE COMPANY (IN THE CASE OF COMPANIES) OR FROM A PRACTICING COST ACCOUNTANT OR PRACTICING CHARTERED ACCOUNTANT (IN RESPECT OF SUPPLIERS OTHER THAN COMPANIES) TOWARDS MINIMUM LOCAL CONTENT

(FOR SUPPLY OF GOODS/ SERVICES / WORKS / EPC / LSTK)

To,
M/s Talcher Fertilizers Limited

SUB:

TENDER NO:

Dear Sir

A. We……. the Statutory Auditor / Cost Auditor / Practicing Cost Accountant / Practicing Chartered Accountant) have verified relevant records of M/s ……. **(Name of the bidder)** and certify that M/s …… **(Name of the bidder)** meets the following:

Sl. No.	Description	Confirmation
a	Bidder meets the mandatory minimum Local content requirement of 20% for participating in the Bidding process under Public Procurement (Preference to Make in India) Policy. (In case bidder does not meet the minimum Local content requirement of 20%, such bidders are not allowed to participate in the Bidding process)	Confirmed.
b	The bidder meets mandatory minimum Local content requirement of 50% for claiming purchase preference under Public Procurement (Preference to Make in India) Policy	Confirmed / Not Confirmed

B. The **details of the location** at which the local value addition is made as follows:

Sl. No.	Item Description	Details of the Location(s) where the local value addition is made
1.		
2.		
3.		

Name of Audit Firm / Chartered Accountant: [Signature of Authorized Signatory]
Name:
Date: Designation:
Seal:

Membership No.:
UDIN:

FORM-II of ANNEXURE-V

Salient Points of Public Procurement (Preference to Make in India) Policy

Sr. No.	Description	Parameter / Document
1	**Minimum Local Content (LC) for Availing Preference under this Policy**	50%
2	**Margin of Purchase Preference**	20%
3	**Local Content (LC) % declared by bidder** (Documents to be submitted as per Sr. No. 4 below)	[Tick **(✓)** whichever is applicable] a) LC Equal to or more than 50% ☐ b) LC More than 20% but less than 50% ☐
4	**Documents to be submitted by bidder under this Policy**	Certificate from the statutory auditor or cost auditor of the company (in case of companies) or from a practicing cost accountant or practicing chartered accountant as per Form-I to be submitted by bidder.
5	**Whether tender is divisible or not divisible**	Not Divisible; Clause No. 3A (c) of revised Policy dated 16.09.2020 shall be applicable

Form-I of Annexure-VII

UNDERTAKING ON LETTERHEAD

To,

M/s Talcher Fertilizers Limited

_____

SUB:
TENDER NO:

Dear Sir,

We have read the Provisions for Procurement from a Bidder which shares a land border with India as per Annexure VII of Section-III. We certify that M/s .....(Name of Bidder) is:

(i)	Not from such a country	[ ]
(ii)	If from such a country, has been registered with the Competent Authority. (Evidence of valid registration by the Competent Authority shall be attached)	[ ]

(Bidder is to tick appropriate option (√ or X) above).

We hereby further certify that bidder M/s…….*(Name of Bidder)* fulfills all requirements in this regard and is eligible to be considered against the tender.

Place:

Date:

[Signature of Authorized Signatory of Bidder]
Name:

Designation:
Seal:

Form-II of Annexure-VII

CERTIFICATE FOR SUB-CONTRACTING OF WORKS

To,

M/s Talcher Fertilizers Limited

_____

SUB:
TENDER NO:

Dear Sir,

We have read the Provisions for Procurement from a Bidder which shares a land border with India as per Annexure VII of Section-III. We certify that bidder M/s .....(Name of Bidder) will not sub-contract any work to a contractor from such countries unless such contractor is registered with the Competent Authority.

Place: [Signature of Authorized Signatory of Bidder]
Name:

Date: Designation:
Seal:

SECTION – IV

GENERAL CONDITIONS OF CONTRACT

CONTENT

SL. NO.	DESCRIPTION
1.0	DEFINITION OF TERMS
2.0	CONTRACT CONFIRMATION
3.0	MODIFICATIONS IN CONTRACT
4.0	USE OF CONTRACT DOCUMENTS AND INFORMATION
5.0	PRICES, TAXES & DUTIES AND OTHER LEVIES
6.0	INCOME TAX
7.0	PATENT INFRINGEMENT AND INDEMNIFICATION
8.0	CONTRACT PERFORMANCE SECURITY (CPS)
9.0	DELETED
10.0	SIGINING OF CONTRACT
11.0	DELETED
12.0	ASSIGNMENT OR SUBLETTING OF CONTRACT AND SUB-CONTRACTING
13.0	STANDARDS
14.0	INSTRUCTIONS, DIRECTIONS
15.0	DELETED
16.0	TIME SCHEDULE, AND PROGRESS REPORTING
17.0	CONTRACTOR TO INFORM HIMSELF FULLY
18.0	SUITABILITY OF PLANT FOR INTENDED PURPOSES
19.0	FEES FOR ROYALTIES AND PATENT RIGHTS
20.0	ACTS OF PARLIAMENT, LOCAL AND OTHER AUTHORITIES REGULATIONS AND BYELAWS
21.0	TIME - PROJECT SCHEDULE
22.0	CONTRACT PRICE
23.0	DEDUCTIONS FROM CONTRACT PRICE
24.0	DELETED
25.0	DELETED
26.0	TAXES APPLICABLE TO CONTRACTOR'S MANPOWER, TURNOVER, EQUIPMENT, ETC
27.0	PACKING, FORWARDING AND SHIPMENT
28.0	INSURANCE
29.0	DELETED
30.0	LIABILITY FOR ACCIDENTS AND DAMAGES
31.0	DELETED
32.0	DELETED
33.0	TIME EXTENSION OF CONTRACT
34.0	TERMINATION OF CONTRACT
35.0	FORCE MAJEURE
36.0	NO WAIVER OF RIGHTS
37.0	BANKRUPTCY AND LIQUIDATION OF CONTRACTOR OR BUSINESS UNDER RECEIVERSHIP
38.0	CERTIFICATE NOT TO AFFECT RIGHT OF OWNER AND LIABILITY OF CONTRACTOR
39.0	SETTLEMENT OF DISPUTES
40.0	ARBITRATION
41.0	GOVERNING LAWS , LANGUAGE AND MEASURES

SL. NO.	DESCRIPTION
42.0	RELEASE OF INFORMATION
43.0	COMPLETION OF CONTRACT
44.0	ENFORCEMENT OF TERMS
45.0	OWNER'S DECISION
46.0	CO-OPERATION
47.0	SUSPENSION OF WORK.
48.0	REPLACEMENT OF PARTS AND MATERIALS (DEFECTIVE/ DAMAGED/ LOST DURING TRANSIT/ERECTION AND COMMISSIONING)
49.0	DEFENCE OF SUITS
50.0	CONTRACTOR'S RESPONSIBILITIES
51.0	PROGRESS REPORTS AND PHOTOGRAPHS
52.0	DELETED
53.0	SECRECY
54.0	CORRESPONDENCE
55.0	MATERIALS AND EQUIPMENTS
56.0	MEASUREMENT, CERTIFYING INSPECTION & PAYMENTS
57.0	UNDER GROUND OBSTRUCTIONS
58.0	REGISTRATION TO THE CONTRACTOR WITH STATUARY AUTHORITIES
59.0	STATUARY OBLIGATIONS
60.0	UTILISATION OF LOCAL RESOURCES
61.0	FUEL REQUIREMENT OF WORKERS
62.0	SURPLUS MATERIAL
63.0	CO-ORDINATION WITH OTHER AGENCIES
64.0	ERECTION OF EQUIPMENT
65.0	ELECTRICAL CONTRACTOR LICENCE
66.0	RENT & ROYALTIES
67.0	GOVT. OF INDIA NOT LIABLE
68.0	SITE CLEANING
69.0	ACCESS TO SITE
70.0	INDEPENDENT CONTRACTOR
71.0	PAYMENT TO THE SUB – CONTRACTOR
72.0	ORDER OF WORKS / PERMISSION / RIGHT OF ENTRY / CARE OF EXISTING SERVICES
73.0	GIFTS, COMMISSIONS,ETC
74.0	LABOUR LAWS-PF, EPF AND ESI
75.0	GENERAL PROVISIONS
76.0	IMPLEMENTATION OF APPRENTICES ACT 1961
77.0	CHANGE IN CONSTITUTION
78.0	ACCESS BY ROAD
79.0	MEMBERS OF THE OWNER NOT INDIVIDUALLY LIABLE
80.0	OWNER NOT BOUND BY PERSONAL REPRESENTATIONS
81.0	LAND FOR CONTRACTOR'S FIELD OFFICE, GODOWN AND WORKSHOP
82.0	ROUNDING-OFF OF AMOUNTS
83.0	DELETED

SL. NO.	DESCRIPTION
84.0	WORK IN MONSOON AND DEWATERING
85.0	GENERAL CONDITIONS FOR CONSTRUCTION AND ERECTION WORK
86.0	ACTION WHERE NO SPECIFICATION IS ISSUED
87.0	DELETED
88.0	DELETED
89.0	CARE OF WORKS
90.0	FIELD MANAGEMENT & CONTROLLING/COORDINATING AUTHORITY
91.0	LOCAL CONDITIONS
92.0	SPECIAL CONDITIONS OF CONTRACT
93.0	POWER OF ENTRY
94.0	LIENS

1.0 DEFINITION OF TERMS AND INTERPRETATION

In the **CONTRACT**, unless the context otherwise requires, the following expressions shall have the following meanings. The singular shall include the plural and the plural include the singular except where the context otherwise requires and the words 'he', 'him', and 'his' shall be taken to mean 'she', 'her' and 'hers' where appropriate.

1. 'APPROVAL' shall mean and include the written approval by the OWNER of documents, drawing or other particulars in relation to this CONTRACT.

2. 'BATTERY LIMIT' shall mean the outer limits of boundaries of the areas within which the Plants and associated facilities shall be located.

3. 'BID' shall mean the proposal/document that the BIDDER submits in the requested and specified form in response to this NIT.

4. 'BIDDER' shall mean the Sole Bidder who shall submit or who have submitted the Bid.

5. 'CHANGE ORDER / AMENDMENT TO ORDER' means an order given in writing by the OWNER to effect additions to or deletion or alteration to the original CONTRACT.

6. 'CODES' shall mean the following, including the latest amendments, and/or replacements, if any:
   a) All relevant Indian Acts, and Rules and Regulations made there under;
   b) ASME Codes
   c) IBR Codes
   d) AIEE Codes
   e) American Society of Testing of Materials (ASTM) Codes
   f) Other internationally applicable standards and/or Regulations the subject matter of the CONTRACT.
   g) Indian Employees Provident Fund Act,
   h) Pollution Control norms of INDIA
   i) Contract Labour
   j) Minimum Wages Act
   k) Any other labour laws of INDIA applicable during execution of contract.
   l) Any other codes/standards specified in the contract documents.

7. 'COMMERCIAL USE' shall mean that use of the PLANT which the CONTRACT contemplates or of which it is commercially capable.

8. 'COMMISSIONING' shall be as defined in Section-VI of Technical Part.

9. 'CONSULTANT/PROJECT MANAGEMENT CONSULTANT (PMC)' shall mean PROJECTS & DEVELOPMENT INDIA LIMITED, who are the consulting engineer to the OWNER for this project and having registered office at PDIL Bhawan, A-14, Sector-1, Noida – 201301, Uttar Pradesh.

10. 'CONTRACT' shall mean the Agreement between the OWNER and the CONTRACTOR for the execution of the works including therein all contract documents.

11. 'CONTRACTOR' shall mean the successful Bidder whose bid has been accepted by the OWNER and who has been selected by the OWNER for the award of Works and shall include his heirs, legal representatives, successors and permitted assigns.

12. 'SCHEDULED/CONTRACTUAL COMPLETION PERIOD' shall mean the time period mentioned in the tender document by which CONTRACT shall be completed, including any time extension granted in writing by OWNER through a CHANGE ORDER/AMENDMENT. Time extensions, if any, shall be without prejudice to other terms and conditions of tender, unless as otherwise stated in CHANGE ORDER/AMENDMENT.

13. 'CONTRACTOR'S EQUIPMENT' means all equipment, construction plant, vehicles, temporary facilities, material, tools or things brought on to the Site by or on behalf of the Contractor for carrying out the Works but not for permanent incorporation in the Plant.

14. 'CONTRACTOR'S SOFTWARE' means standard Software owned by the CONTRACTOR.

15. 'CONTRACTOR'S WORKS' OR 'MANUFACTURER'S WORKS' shall mean the place or places of work used by the CONTRACTOR/SUB-CONTRACTOR/SUB-VENDOR or their collaborator(s) for the manufacture of EQUIPMENT or performance of WORKS.

16. 'COST' means the cost incurred by the Contractor in carrying out any of his obligations under the Contract, and 'Costs' shall be construed accordingly.

17. 'DAY' shall mean a day of 24 hours from midnight to midnight irrespective of the number of hours worked in that day.

    "WORKING DAY" means any day which is not declared to be holiday or rest day by the OWNER.

18. 'DEEMED ACCEPTANCE' shall be as defined in SPECIAL CONDITIONS OF CONTRACT.

19. 'DEFECT' means any work done or any Material or the Plant or any part of it which does not comply with the CONTRACT.

20. 'DEFECT LIABILITY PERIOD' shall be as defined in SPECIAL CONDITIONS OF CONTRACT.

21. 'DOCUMENT(S)/DOCUMENTATION' means any relevant documents in paper or electronic form, including drawings, technical software, images, designs, manuals or records.

22. 'DRAWINGS' or 'PLAN' shall mean all
    a) Drawings furnished by the OWNER as a basis for proposals;
    b) Supplementary drawings furnished by the OWNER to clarify and to define in greater detail the intent of the CONTRACT;
    c) DRAWINGS submitted by the CONTRACTOR with his proposal provided such drawings are acceptable to the OWNER.
    d) DRAWING furnished by the OWNER to the CONTRACTOR during the progress of the works; and
    e) Engineering data and DRAWINGS submitted by the CONTRACTOR during the progress of the work provided such drawings are acceptable to the OWNER.

23. DLOA shall mean DETAILED LETTER OF ACCEPTANCE which shall be issued to successful bidder.

24. 'ENGINEER'S INSTRUCTIONS' shall mean any drawings and/or instructions in writing, details, directions and explanations issued by the OWNER from time to time to the CONTRACTOR/ SUB-CONTRACTOR for carrying out the WORK during the COMPLETION PERIOD

25. ENGINEER IN CHARGE" shall mean the person designated from time to time by the OWNER and shall include those who are expressly authorized by him to act for and on his behalf for operation of this CONTRACT.

26. 'EQUIPMENT' OR 'STORES' shall mean the equipment, machinery and structure of any kind which the CONTRACTOR is obliged to design, supply, deliver, unload, store at site, erect, set to work and test under the CONTRACT.

27. 'FINAL ACCEPTANCE' shall mean that date when all of the conditions set forth in Clause 19 of SPECIAL CONDITIONS OF CONTRACT have been satisfied, all liabilities and obligations under this CONTRACT have been discharged, except those specially to be continued or performed after FINAL ACCEPTANCE. .

28. 'FINAL ACCEPTANCE CERTIFICATE' shall mean that certificate issued by the ENGINEER-IN-CHARGE or OWNER to the CONTRACTOR subject to clause 19 of SPECIAL CONDITIONS OF CONTRACT at the end of the DEFECTS LIABILITY PERIOD.

29. 'FINAL COMPLETION' shall mean the completion of guarantee tests and handing over of the PLANTS and facilities to OWNER.

30. FINAL PROPOSAL means the Offer/Bid submitted by the Bidder against this tender including it's Amendments/Corrigendum/Addendum/etc.

31. 'FORCE MAJEURE' has the meaning stated in Sub-clause 35.0 of GCC.

32. 'FOA' means FAX OF ACCEPTANCE, which shall be issued to successful bidder.

33. GCC' or GENERAL CONDITIONS OF THE CONTRACT shall mean all the

terms and conditions forming part of this agreement as defined in this Section.

34. 'INSPECTOR' shall mean the duly authorised representative of the OWNER for stage wise or final inspection of WORKS or of EQUIPMENT or MATERIALS to be supplied under the CONTRACT.

35. 'LEGISLATION' means all applicable laws, directives, codes, statutes, rules, ordinances, approvals, licences, decrees, authorizations, by-laws, regulations, standards and any other requirement of any governmental authority or agency whether international national, state, municipal, local or other government subdivision, having the force of law in any place where the WORKS or any part of the WORKS are being carried out.

36. 'MANUFACTURER' shall mean a person or firm who is the producer and supplier of material and/ or designer and/or fabricator of equipment to either the OWNER, the CONTRACTOR or both under the CONTRACT.

37. 'MATERIALS' means machinery, plant and other items of equipment and materials intended to form part of the PLANT and other things needed for its operation, to be supplied by the CONTRACTOR.

38. "MECHANICAL COMPLETION" shall be as defined in SPECIAL CONDITIONS OF CONTRACT.

39. 'MONTH' shall mean the calendar month.

40. 'NOTICE IN WRITING', 'WRITTEN NOTICE' shall mean a notice in written, typed or printed characters sent (unless delivered personally or otherwise proved to have been received) by registered post/ Speed Post to the last known private or business address or registered office of the addressee and shall be deemed to have been received when in the ordinary course of post it would have been delivered. Fax with Post copy confirmation.

41. 'OTHER CONTRACTOR/OTHERS' shall mean any person(s) having a contract with the OWNER to design, supply, erect, set to work, or do any other thing to or in connection with any other plant and shall include their, heirs, legal representatives, successors and permitted assigns.

42. 'OWNER' shall mean M/s TALCHER FERTILIZERS LIMITED having its registered office at Plot 2/H, Kalpana Area Nagar, Khordha, Bhubaneshwar and Project office at GAIL Training Institute, PARC Building, Sector 16A, Film City, Noida – 201301 Uttar Pradesh and shall include their, heirs, legal representatives, successors and permitted assigns.

43. 'PERFORMANCE & GUARANTEE TESTS RUN (PGTR)' shall be as defined in SPECIAL CONDITIONS OF CONTRACT.

44. 'PLANT' shall be as defined in the SPECIAL CONDITIONS OF CONTRACT.

45. 'PRELIMINARY ACCEPTANCE' shall be as defined in the SPECIAL CONDITIONS OF CONTRACT.

46. 'PRELIMINARY ACCEPTANCE CERTIFICATE' shall be as defined in the SPECIAL CONDITIONS OF CONTRACT.

47. "PRE-COMMISSIONING" shall be as defined in the SPECIAL CONDITIONS OF CONTRACT.

48. 'PROJECT' shall mean the Project specified in the Technical specification.

49. 'SCC' or SPECIAL CONDITIONS OF THE CONTRACT shall mean all the terms and conditions forming part of the CONTRACT as stipulated elsewhere in the tender document.

50. 'SITE' shall mean and include the land and other places on, into or through which the EQUIPMENT and related facilities shall be erected and any adjacent land, paths, streets or reservoirs which may be allocated or used by the OWNER or CONTRACTOR in the performance of the CONTRACT.

51. 'SOFTWARE' means all forms of software and firmware and their documentation.

52. 'SPECIFICATION' shall mean collectively all the terms and stipulations in the Technical Specifications, schedules, detailed descriptions, statement of Technical Data, performance characteristics, standards & codes etc., and subsequent addenda issued thereto before the date of closing of bid and all written agreements made or to be made pertaining to the method and manner of performing the Work or to the quantities and the qualities of the materials to be furnished under this CONTRACT.

53. 'SUB-CONTRACTOR/SUB-VENDOR' shall mean any person or persons, or firm(s) including his/their, heirs, legal representatives, successors and permitted assigns selected by the CONTRACTOR with prior written approval of the OWNER for undertaking any part of the Works under the CONTRACT or to whom any part of the CONTRACT is sublet by the CONTRACTOR with the consent in writing of the OWNER.

54. 'TAKING OVER' AND 'TAKEN OVER' shall mean OWNER taking possession of and use of the PLANT.

55. 'TEMPORARY WORKS' means all temporary works and structures of every kind constructed at the Site and required for the provision and construction of the PLANT.

56. 'THIRD PARTY SOFTWARE' means standard Software which is owned by a third party.

57. 'TOTAL LSTK PRICE/TOTAL CONTRACT PRICE" shall mean the sum accepted or the sum calculated in accordance with the prices accepted in tender and/or the CONTRACT rates as payable to the CONTRACTOR for the entire execution and full completion of the work, including CHANGE ORDER, if any.

58. 'WEEK' shall mean continuous period of 7 (Seven) DAYS.

59. 'WORK' OR 'WORKS' means the design, engineering and other services to be

provided by the Contractor including, but not limited to, the provision and construction of the PLANT and any Temporary Works and the subsequent dismantling or removal of the Temporary Works when no longer required, and any other works to be carried out by the CONTRACTOR in accordance with the CONTRACT.

60. 'WRITING' shall include any manuscript, typewritten or printed statement, under or over signature and/or seal as the case may be.

61. 'NOTICE INVITING TENDER (NIT)/ BIDDING DOCUMENT' means Complete Bidding Document as originally issued and any Addendum /Corrigendum/ Amendment(s) issued thereafter.

62. 'MUTUALLY AGREED DAMAGES' (MAD) shall be as defined in SPECIAL CONDITIONS OF CONTRACT.

2.0 CONTRACT DOCUMENTS

The term 'Contract Documents' shall mean and include the following documents which shall constitute the Contract and shall be deemed to form an integral part of the Contract:

a) Contract Agreement
b) Detailed Letter of Acceptance (DLOA) and all Annexures
c) FAX of Acceptance (FOA)
d) Agreed variations , if any
e) Schedule of Rates
f) Corrigendum/Addendum/Amendment to tender
g) Complete Original Tender Document with all enclosures
h) Integrity Pact (IP) signed between the Owner and the Bidder/Contractor

The above documents are intended to be correlative, complementary and mutually explanatory. The Contract shall be read as a whole.

2.1 INTERPRETATION OF CONTRACT DOCUMENTS

2.1.1 Notwithstanding the sub-division of the CONTRACT document into these separate documents and/or volumes and/or heads, every part of each separate section/volume/head shall be deemed to be supplementary of every other part and shall be read with and into the CONTRACT so far as it may be practicable to do so.

2.1.2 If in respect of any commercial term or condition, if any provision in the GENERAL CONDITIONS OF CONTRACT is repugnant to or at variance with any provision(s) of the SPECIAL CONDITIONS OF CONTRACT, the provision(s) of the SPECIAL CONDITIONS OF CONTRACT shall be deemed to override the provision(s) of GENERAL CONDITIONS OF CONTRACT, but only to the extent that such repugnancy in the GENERAL CONDITIONS OF CONTRACT cannot be reconciled with the SPECIAL CONDITIONS OF CONTRACT.

2.1.3 Without prejudice to the provisions of the GENERAL CONDITIONS OF CONTRACT, whenever in the Bidding documents it is mentioned or stated that the CONTRACTOR shall perform certain work or provide certain facilities, it is understood that the CONTRACTOR shall do so at his own cost and the TOTAL CONTRACT PRICE shall be deemed to have included the cost of such performance and/or provision, as the case may be.

2.1.4 The MATERIALS, design and workmanship shall satisfy the applicable relevant Indian standards, the job specifications contained herein and the codes referred to by expression or implication. Where the job specifications stipulate requirements in addition to those contained in the standard codes and specifications, these additional requirements shall also be satisfied. In the absence of any standard/specification/code of practice for detailed specifications covering any part of the work covered in this tender, the instructions/directions agreed between OWNER and CONTRACTOR based on good international engineering practice shall be binding on the CONTRACTOR.

2.1.5 The documents forming the Contract are to be read together and interpreted as mutually explanatory of one another. If there is a direct inconsistency in specific obligation(s), then for the purposes of interpretation, and unless otherwise provided in the Contract, the priority of the Contract Documents shall be in accordance with following sequence:

i. The Contract Agreement
ii. Detailed Letter of Acceptance (DLOA) along with its enclosures
iii. Fax of Acceptance (FOA)
iv. Schedule of Rates (SOR)
v. Scope of Works/ Job Specifications (specific to particular job only, wherever provided)
vi. Drawings
vii. Special Conditions of Contract (SCC)
viii. Technical Specifications (wherever applicable)
ix. Instructions to Bidders (ITB)
x. General Conditions of Contract (GCC)
xi. Other Documents

Any amendment / Corrigendum / Addendum to tender issued by PMC/Owner shall take precedence over respective clauses of the original tender document and its annexures.

Similarly, any amendment / change order issued by Owner upon signing of formal Contract shall take precedence over respective clauses of the formal Contract and its annexures

2.1.6 Should there be any doubt or ambiguity in the interpretation of the CONTRACT documents or contradiction therein or should there be any discernable error or omission in any CONTRACT document, the CONTRACTOR shall, prior to commencing the relative work or supply, as the case may be, apply in writing to the Engineer-In-Charge for his decision for resolution of the doubt, ambiguity or contradiction or correction of the error or making good the omission, as the case may be. Should the CONTRACTOR fail to apply to the ENGINEER-IN-CHARGE for his decision as aforesaid prior to commencing the relative work or supply, the CONTRACTOR shall perform the said work or make the said

supply, as the case may be, at his own risk, and the provisions of NIT shall apply to any such work performed or supply made by the CONTRACTOR.

2.1.7 Notwithstanding anything provided in Clause 2.1.6 hereof above, either the CONTRACTOR or any representative of the OWNER or CONSULTANT may, at any time prior to or during the execution of the work or supply of any material or any part thereof (if the CONTRACTOR has failed to make an application as provided for in Clause 2.1.6), apply to the ENGINEER-IN-CHARGE in writing for his decision in resolution of any doubt, ambiguity or contradiction or for the correction of any error or for making good the omission as the case may be.

2.1.8 The decision of the ENGINEER-IN-CHARGE on any application under Clause 2.1.6 or Clause 2.1.7 hereof shall be in writing and shall be final and binding upon the CONTRACTOR and shall form part of the CONTRACT documents, with the intent that the CONTRACT documents shall be read as though the said decision is and was at all times incorporated therein. It is clarified that in case the Contractor disagrees with the decision of the ENGINEER-IN-CHARGE, the dispute shall be settled as per the provisions of Clause 39.0 of GCC.

2.2 Any work or supply shown, indicated or included in any description of the work, plans, drawings, Specifications and/or Price Schedule or other Contract or Bid documents shall be deemed to form part of the WORK and/or supply contracted for, as the case may be, notwithstanding failure to show, indicate or include such work or supply in any other or others among the documents aforesaid with the intent that the indication or inclusion of the work or supply within any one of the said documents shall be deemed to be a sufficient indication or inclusion of the work or supply, as the case may be, within the work and supply covered by the CONTRACT.

2.3 No verbal agreement, assurance, representation or understanding given by any employee or officer of the OWNER or so understood by the CONTRACTOR, whether given or understood before or after the execution of the contract, shall any-wise bind the OWNER or alter the CONTRACT documents unless specifically given in writing and signed by the OWNER or by the ENGINEER-IN-CHARGE on behalf of the OWNER and issue the amendment of the relative term(s).

2.4 Clause headings given in this or any other contract documents are intended only as a general guide for convenience in reading and segregating the general subject of the various Clauses, but do not form part of the contract documents, with the intent that the Clause headings shall not govern the meaning or import of the Clauses there under appearing or confine or otherwise affect the interpretation thereof.

3.0 MODIFICATIONS IN CONTRACT

3.1 All modifications leading to changes in the CONTRACT with respect to technical or commercial aspects including terms of completion period shall be considered valid only when accepted in writing by OWNER and CONTRACTOR by issuing amendment to the CONTRACT. Issuance of acceptance or otherwise in such cases shall not be any ground for extension of agreed completion date (except in cases where completion period itself is revised by OWNER) and also shall not affect the performance of CONTRACT in any manner except to the extent mutually agreed to, through a modification to CONTRACT. The PARTIES shall have the right to modify or amend the CONTRACT subject to an

adjustment in the CONTRACT PRICE and/ or COMPLETION DATE in accordance with the applicable provision of the CONTRACT, if any, and subject to mutual agreement.

3.2 OWNER shall not be bound by any printed conditions or provisions in the CONTRACT-OR's bid forms or acknowledgement of CONTRACT, packing list and other documents which support to impose any condition at variance with or supplemental to CONTRACT

4.0 USE OF CONTRACT DOCUMENTS AND INFORMATION

4.1 The CONTRACTOR shall not, without the OWNER's prior written consent, disclose the CONTRACT or any provision thereof, or any specification, plan, drawing, pattern, sample or information furnished by or on behalf of the OWNER in connection therewith, to any person other than a person employed by the CONTRACTOR in the performance of the CONTRACT. Disclosure to any such employed person shall be made in confidence and shall extend only so far as may be necessary for purpose of such performance.

4.2 The CONTRACTOR shall not without the OWNER's prior written consent, make use of any document or information enumerated in Clause 6.1 except for purpose of performing the CONTRACT.

4.3 Any document other than CONTRACT, itself, enumerated in Clause 6.1 shall remain the property of the OWNER and shall be returned (all copies) to the OWNER on completion of the CONTRACTOR's performance under the CONTRACT if so required by the OWNER.

5.0 PRICES, TAXES AND DUTIES AND OTHER LEVIES

The following provisions are in addition to Clause 13 of “Instruction to Bidders” (Section-III)

The prices shall include all duties, taxes and levies etc. including but not limited to customs duty, GST on imports, any tax / duty/ levy as per applicable GST laws, personnel and corporate tax as applicable.

The Bidders are to quote firm prices. In respect of both direct transaction between OWNER and the Bidder and Bought Out Items to be dispatched directly from the sub-vendor’s works to Owner’s site, the payment towards all applicable Indian Taxes and duties like Custom Duty, GST and other tax/duty/levy, will be made by OWNER in Indian rupees at actuals limited to the amount indicated in the Bid.

In case of Bought out items to be dispatched directly from sub-vendor’s works to Owner’s site, the CONTRACTOR shall ensure that his sub-vendors raise tax invoice under the provisions of GST Law, billed to the CONTRACTOR and shipped to Owner’s site. The CONTRACTOR shall further ensure that he raises his corresponding tax invoices under the provision of GST Law in the name of OWNER during transit of the Material before the delivery of Material is taken by OWNER.

5.1 Except as specifically provided to the contrary in the SPECIAL CONDITIONS OF CONTRACT:

(i) The CONTRACTOR shall, within the price of materials and scope of supply, be liable to pay and bear any and all duties, taxes, levies and cesses lawfully

payable on any goods, equipment or materials imported into India or within any local limits for permanent incorporation in the work(s), and on materials sold and supplied to the OWNER pursuant to the CONTRACT.

(ii) The CONTRACTOR shall within the price of services and scope of services be responsible to pay on behalf of the OWNER any and all duties, taxes, levies and cesses including education cess etc. lawfully payable on any goods or equipment imported into India or within any local limits for use in the performance of the work(s), and on services performed pursuant to the CONTRACT.

(iii) The CONTRACTOR shall be liable for and shall pay any and all Indian fees, taxes, duties, levies and cesses including education cess etc., assessable against CONTRACTOR in respect of or pursuance to the CONTRACT. However, GST payment by the CONTRACTOR to the Tax Authority shall be made by the Owner to the CONTRACTOR at actual limited to the Amount indicated in the Bid.

(iii) In addition, the CONTRACTOR shall be responsible for payment of all Indian duties, levies, and taxes etc., assessable against the CONTRACTOR or CONTRACTOR's employees or SUB-CONTRACTOR'S whether corporate or personal or applicable in respect of property.

(iv) CONTRACTOR should comply with the provisions of e-way bill notified by appropriate authorities from time to time. The existing provisions of road permit will continue till such time if applicable.

(v) There will be no materials under the scope of Contract which will be consigned to Owner, unless otherwise specifically mentioned elsewhere in the tender. The Owner will not issue / provide Road permits/e-way bill to the Contactor except in respect of material directly purchased by the Owner.

5.2 **TAX INDEMNITY**

It will be the duty of the CONTRACTOR to duly observe and perform all laws, rules, regulations, orders and formalities applicable under GST and Customs Duty on the manufacture, sale, import and/or supply of any material to OWNER and/or applicable on the services performed by the CONTRACTOR pursuant hereto. The CONTRACTOR shall keep the OWNER indemnified for and against any and all claims, demands, prosecutions, penalties, damages, demurrages and/or other levies whatsoever made or levied by the Court or Customs Authorities with respect to any alleged breach, evasion or infraction of such duties, taxes, charges or levies or any breach or infraction of such laws, rules, regulations, orders or formalities concerning the same and from the consequence thereof.

5.3 The CONTRACTOR confirms that, it has included all taxes, duties, levies etc., as applicable at prevailing rates, in its TOTAL CONTRACT PRICE as quoted in Schedule of Rate. In case, CONTRACTOR has not included any such taxes, duties, levies etc., at all and/or at prevailing rates and CONTRACTOR has to pay such taxes, duties, levies etc., OWNER shall not be liable for payment of such liabilities and/or OWNER shall not reimburse such taxes, duties, levies etc. to CONTRACTOR.

5.4 **The award of work shall be on 'Work Contract Service' basis**.

The contractor shall be responsible for payment of any tax levied on the transfer of property and goods involved with relevant GST act and rules made there under including amendments, if any. The contractor shall be liable to ensure to have registered with the respective tax authorities and to submit self-attested copy of such registration certificate(s) and any taxes/ duties/ levies being charged by the Contractor would be claimed by issuing proper tax invoice/challan indicating details/ elements of all taxes charged and necessary requirements as prescribed under the respective tax laws and also to mention correct and valid registration number(s) on all tax invoices raised to TFL.

5.5 Any other taxes / duties in relation to this CONTRACT, which in terms of relevant legislation is the liability of CONTRACTOR, is discharged by OWNER, would be recovered from the CONTRACTOR from any subsequent payment due to the CONTRACTOR.

5.6 Applicable BOCW shall be included in the quoted TOTAL CONTRACT PRICE. The contractor shall pay the cess under BOCW Act for subject works and submit proof of submission of cess to owner before submitting the next R.A. bill. In case, contractor does not submit the said proof, applicable BOCW shall be deducted at source by the OWNER from the contractor's invoice and deposit the deducted amount to the concerned authority. OWNER does not undertake any further responsibility in this regard.

6.0 **INCOME TAX**

6.1 CONTRACT PRICE shall be inclusive of any and all Indian Income Tax payable in India. OWNER shall deduct Indian Income Tax as per rates prescribed for such contracts from time to time, from the payments due to CONTRACTOR and issue Tax Deducted at Source (TDS) certificate to CONTRACTOR. It will the responsibility of the CONTRACTOR to file proper income tax return and pay taxes thereon if any, or claim refund thereof if any. The CONTRACTOR shall give OWNER all necessary documents relating to its income tax assessments and to keep the OWNER informed about their assessments.

6.2 Personal income tax payable, if any, in respect of salary and perquisites of CONTRACTOR's personnel / SUB-CONTRACTOR's personnel in India shall be payable by the individual so deputed by CONTRACTOR or SUB-CONTRACTOR. It is the responsibility of the individual or CONTRACTOR to file proper income tax return and pay taxes thereon if any, or claim refund thereof if any. The CONTRACTOR shall give OWNER all necessary documents relating to income tax assessments of its personnel and to keep the OWNER informed about their assessments.

7.0 PATENT INFRINGEMENT AND INDEMNIFICATION (WHEREVER APPLICABLE)

7.1 **PATENT INFRINGEMENT**

7.1.1 CONTRACTOR shall at all times, indemnify and keep indemnified OWNER against all claims or suits and defend, at its own cost, any suit or action brought against OWNER and hold OWNER free and harmless against all costs of such claims or suits which may be made against OWNER in respect of any infringement of any rights protected by patent, copyright, trademarks, and trade secrets to the extent that such claim, suit, or action is a result of the use of CONTRACTOR's Technical Information for the construction, maintenance, and operation of PLANT and the use of CONTRACTOR's

and/or any other process licenser's processes used in PLANT. OWNER shall pass on all claims made against it to CONTRACTOR for settlement.

7.1.2 CONTRACTOR declares that to the best of its knowledge and belief the use of CONTRACTOR's Technical Information for the construction, maintenance, and operation of PLANT and the use of CONTRACTOR's processes used in PLANT will not infringe any valid patent rights of a third party. However, if at any time such infringement arises, CONTRACTOR agrees to keep OWNER indemnified and harmless against such claims and costs thereof and make arrangements that will allow OWNER to continue the operation of PLANT.

7.1.3 OWNER shall promptly advise CONTRACTOR in writing of any claim of infringement or any action for infringement of patents brought against it by a third party and based upon the use of CONTRACTOR's Technical Information. If such use is in accordance with instructions given in writing by CONTRACTOR, CONTRACTOR shall undertake the defence, or assist OWNER in the defence, of the claim or suit up to final judgment or settlement.

7.1.4 CONTRACTOR shall undertake the defence on behalf of OWNER and shall have sole charge and direction of the defence, and shall bear all costs related thereto. CONTRACTOR shall further hold OWNER harmless from any damages or other sums that may become payable by OWNER under a final judgment or settlement. However, OWNER shall render to CONTRACTOR all reasonable assistance that may be required by CONTRACTOR in the defence, and shall have the right to be represented therein by advisory counsel of its own selection and at its own expense.

7.1.5 In addition to the measures specified in Clause7.1.4, CONTRACTOR may further, at its option, however, in reasonable consultation with OWNER, seek to abate the alleged infringement by modification of PLANT or its operation without adversely affecting the performance and/or secure for OWNER immunity from suit for infringement. In such case, CONTRACTOR shall bear/ reimburse OWNER for all costs related to said modification and to said immunity.

7.1.6 In the event that OWNER is legally restrained from operating PLANT on account of any infringement action or suit, CONTRACTOR shall take all possible actions to allow OWNER to operate and use PLANT.

7.1.7 Neither CONTRACTOR nor OWNER shall settle or compromise any suit or action without the written consent of the other if settlement or compromise obliges the other to make any payment or part with any property or assume any obligations or surrender any rights or to be subjected to any injunction by reason of such settlement or compromise.

7.2 INDEMNITIES

7.2.1 INDEMNIFICATION FOR LIABILITIES

7.2.1. CONTRACTOR Indemnification for Liabilities

To the fullest extent permitted by Law, CONTRACTOR assumes liability for and agrees to indemnify, protect, save and hold harmless OWNER from and against any and all Liabilities (including, any strict liability), arising out of acts or omissions of CONTRACTOR

or its personnel or its agents in the performance of its obligations under the CONTRACT causing bodily injury, sickness, disease or death, damage to or loss of any property, and whether or not involving damage to WORKS or SITE that may be imposed on, suffered or incurred by or asserted against OWNER and in any way relating to or arising out of (i) WORK, any EQUIPMENT (ii) the presence, discharge, treatment, storage, transportation, disposal, escape or release of any Hazardous Substance, or the threat thereof, at, to or from SITE after commencement of work (any hazardous substance already existing at SITE before commencement of WORK excluded)(iii) The performance of WORK, or as a result of personal injuries (including wrongful death); (iv) the violation by CONTRACTOR or any SUB-CONTRACTOR/VENDOR of any Government Approval or applicable Law relating to WORK (v) any breach of CONTRACT with any SUB-CONTRACTOR/VENDOR, provided, however, that CONTRACTOR shall not be required under this Clause to indemnify OWNER for any liability arising out of or resulting from events or circumstances occurring or existing after PRELIMINARY ACCEPTANCE OF PLANT except where the liability arises from an act or omission of CONTRACTOR or any SUB-CONTRACTOR/VENDOR or any other Person directly or indirectly employed by either of them or anyone for whose acts either of them may be liable that was a contributory cause of such liability.

7.2.2 **CONTRACTOR Indemnification for Taxes**

It is specifically understood that CONTRACTOR hereby accepts and assumes exclusive liability for and save and hold OWNER harmless from and against of all Taxes arising from the performance of WORK, and all such Taxes shall be deemed to be included in CONTRACT PRICE.

7.2.3 **Indemnification by SUB-CONTRACTOR/VENDOR**

CONTRACTOR shall obtain from each SUB-CONTRACTOR/VENDOR, which is an affiliate, and shall use all reasonable efforts to obtain from each SUB-CONTRACTOR/VENDOR, an indemnification materially similar in form and substance to Clause-7.1 and Clause-7.2.2 of which the OWNER shall be named as beneficiary.

7.2.4 **Payment of Amounts under this Clause**

Except to the extent covered by insurance, all amounts payable and due by CONTRACTOR to OWNER under this Clause shall be deducted from CONTRACT PRICE or any other amounts owed by OWNER to CONTRACTOR here under. If such amounts payable by OWNER to CONTRACTOR are less than the amounts payable and due by CONTRACTOR under this Clause, CONTRACTOR shall be liable to OWNER for such excess and shall pay such amount to OWNER immediately upon demand.

7.2.5 **Permits and Certificates**

CONTRACTOR shall procure, at its expense, all necessary permits, certificates and licences required by virtue of all applicable laws, regulations, ordinances and other rules in force at the place where any of the works is to be performed, and CONTRACTOR further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of any asserted or established violation of such laws, regulations, ordinances or other rule. OWNER shall provide the necessary permits for CONTRACTOR's personnel to undertake any work in India in connection with CONTRACT.

7.2.6 **Mechanics Lien**

CONTRACTOR agrees to indemnify and hold harmless OWNER against all labourer's material, man's and/or mechanic's liens arising from its work, and shall keep the premises of OWNER free from all such claims, liens and encumbrances.

8.0 CONTRACT PERFORMANCE SECURITY (CPS)

8.1 The proceeds of **CPS** shall be appropriated by the OWNER as compensation for any loss resulting from the CONTRACTOR's failure to complete their obligations under the CONTRACT without prejudice to any of the rights or remedies the OWNER may be entitled to as per terms and conditions of the CONTRACT.

8.2 The CONTRACTOR shall extend the validity of the **CPS** suitably if it is required due to delay in COMPLETION of the PLANT at it's own cost. The CPS shall be suitably extended in event of repair/replacement of equipment or any part thereof during DEFECT LIABILITY PERIOD to take care of extended warranty period of repair/ replacement. The CPS will be discharged by the OWNER after the CONTRACTOR's performance obligation including any warranty obligation under the CONTRACT. For any component replaced during DEFECT LIABILITY PERIOD, the component should work satisfactorily for a period of 12 months from the date of replacement

The CPS shall be retained by OWNER during the currency of CONTRACT as indicated above or till settlement of all the accounts thereof, whichever is later. In case of any dispute or differences not settled within the validity of CPS, contractor shall arrange to get the CPS extended for the period asked for by OWNER. In case CPS is not extended as asked, OWNER shall have the sole discretion to 'call in' the bank to pay the whole or part of the amount of bank guarantee/CPS. The above deposit shall be deemed to be security for the faithful performance of the CONTRACT and for the purpose of section 74 of the Indian Contract Act, 1872 and for the extension of that section , the CPS shall deemed to be the bond given by the CONTRACTOR for the performance of essential duty. In the event of breach of any of the terms and conditions of the contract, OWNER shall have the right to draw from the CPS whole or part of the value of CPS. The amount so drawn shall not in any way affect any remedy to which OWNER may otherwise be entitled or any liability incurred by contractor under the contract or any law for the time being in force relating thereto or bearing here upon. This CPS shall be refunded 3 months after expiry of Defect Liability Period. It shall be lawful for OWNER if any differences or dispute is likely to arise to defer payment of the CPS or any portion thereof which may be due for release until such differences and dispute has been finally settled or adjusted. CPS amount shall not bear any interest.

NOTE:

In case CPS is submitted by way of Bank Guarantee, the non-judicial Stamp paper of appropriate value only or equivalent document value shall have to be purchased in the name of the bank executing the bank guarantee and not in the name of the CONTRACTOR.

8.3 **Rights of the OWNER to forfeit CPS:**

i) Whenever any claim against the CONTRACTOR for the payment of a sum of money arises out or under the CONTRACT, the OWNER shall be entitled to recover such sum by appropriating in part or whole the CPS of the CONTRACTOR. In the event of the security being insufficient or if no security has been taken from the CONTRACTOR, then the balance or the total sum recoverable, as the case may be shall be deducted from any sum then due or which at any time thereafter may become due to the CONTRACTOR. The CONTRACTOR shall pay to the OWNER on demand any balance remaining due.

ii) All compensation or other sums of money payable by the CONTRACTOR to the OWNER under terms of this CONTRACT may be deducted from or paid by the encashment or sale of a sufficient part of his CPS or from any sums which may be due or may become due to the CONTRACTOR by the OWNER of any account whatsoever and in the event of his Rights of the OWNER to forfeit CPS.

9.0 DELETED

10.0 SIGNING OF CONTRACT

10.1 All documents as per Clause 2.0 of GCC shall be included in the DLOA.

10.2 Every page of the DLOA &CONTRACT agreement shall be initialled by the authorised representatives of OWNER and CONTRACTOR under the Seal of their respective Companies.

10.3 The CONTRACTOR shall present the above CONTRACT AGREEMENT so prepared in two Sets alongwith proper Power of Attorney and other requisite material on the day of signing the agreement.

10.4 Notwithstanding anything mentioned in any other clause, any conditions imposed from time to time by Government of India shall be followed by the CONTRACTOR.

11.0 Deleted

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12.0 ASSIGNMENT OR SUBLETTING OF CONTRACT AND SUB-CONTRACTING

12.1 No part of the CONTRACT nor any share or interest therein shall in any manner or degree be transferred, assigned or sublet by the CONTRACTOR directly or indirectly to any person, firm or corporation whatsoever without the consent in writing, of the ENGINEER/EMPLOYER except as provided for in the succeeding sub-clause.

i. SUB-CONTRACTS FOR TEMPORARY WORKS ETC.:

The EMPLOYER may give written consent to Sub- contract for the execution of any part of the WORK at the site, being entered in to by CONTRACTOR provided each individual Sub- contract is submitted to the ENGINEER-IN-CHARGE before being entered into and is approved by him.

ii. LIST OF SUB-CONTRACTORS TO BE SUPPLIED

At the commencement of every month the CONTRACTOR shall furnish to the ENGINEER-IN-CHARGE list of all SUB-CONTRACTORS or other persons or firms engaged by the CONTRACTOR and working at the SITE during the previous month with particulars of the general nature of the Sub-contract or works done by them

iii. CONTRACTOR'S LIABILITY NOT LIMITED BY SUB- CONTRACTORS

Notwithstanding any sub-letting with such approval as aforesaid and notwithstanding that the ENGINEER-IN-CHARGE shall have received copies of any Sub-contracts, the contractor shall be and shall remain solely responsible for the quality, proper and expeditious execution of the Contract in all respects as if such sub-letting or Subcontracting had not taken place, and as if such work had been done directly by the CONTRACTOR. The CONTRACTOR shall bear all responsibility for any act or omission on the part of sub-contractors in regard to work to be performed under the CONTRACT.

iv. EMPLOYER MAY TERMINATE SUB-CONTRACTS

If any SUB-CONTRACTOR engaged upon the works at the site executes any works which in the opinion of the ENGINEER-IN-CHARGE is not in accordance with the CONTRACT documents, the EMPLOYER may by written notice to the CONTRACTOR request him to terminate such subcontract and the CONTRACTOR upon the receipt of such notice shall terminate such Subcontract and dismiss the SUB-CONTRACTOR(S) and the later shall forthwith leave the works, failing which the EMPLOYER shall have the right to remove such SUB- CONTRACTOR(S) from the site.

v. NO REMEDY FOR ACTION TAKEN UNDER THIS CLAUSE

No action taken by the EMPLOYER under the clause shall relieve the CONTRACTOR of any of his liabilities under the CONTRACT or give rise to any right or compensation, extension of time or otherwise failing which the EMPLOYER shall have the right to remove such SUB-CONTRACTOR(S) from the site

12.2 DELETED

12.3 **Sub-Contracting for WORKS (to be read in conjunction with clause regarding sub-contractors/Sub-vendors sharing land border with India as per Annexure-VII of tender document).**

12.3.1 **General**

All vendors, suppliers, consultants and SUB-CONTRACTORS/SUB-VENDORS providing equipment, materials, construction equipment, or services to CONTRACTOR under a SUBCONTRACT, purchase order or similar purchase form or arrangement with CONTRACTOR for the performance of the WORK under this CONTRACT are herein referred as "SUB-CONTRACTORS"/ “SUB-VENDORS”, and any such SUB-CONTRACTS, purchase orders or similar purchase forms or arrangement entered into by or on behalf of CONTRACTOR with SUB CONTRACTORS/SUB-VENDORS are herein

referred to as "SUB-CONTRACTS" provided that none of OWNER's CONTRACTOR'S or SUB-CONTRACTOR'S/ SUB-VENDOR'S shall be deemed to be a SUB-CONTRACTOR/ SUB-VENDOR under the CONTRACTOR. The CONTRACTOR shall be obligated to select SUB-CONTRACTORS/ SUB-VENDORS it retains in connection with the performance by CONTRACTOR of the WORK from the SUB-CONTRACTOR'S/ SUB-VENDOR'S list which would be finalised and approved by the OWNER. OWNER and CONTRACTOR may by mutual agreement add to or delete from such list from time to time and approve any successor or replacement of any person listed on such list or any other vendor, supplier, material-man, consultant or SUB-CONTRACTOR/SUB-VENDOR.

12.3.2 **Approval of SUB-CONTRACTOR/SUB-VENDOR**

12.3.2.1 The vendor list for procurement of EQUIPMENT and the list of SUB-CONTRACTOR/SUB-VENDOR shall be as attached in the Section VI of NIT. Any changes to such list of SUB-CONTRACTOR/SUB-VENDOR shall require the prior approval of OWNER. CONTRACTOR shall provide name, address, fax number and name of contact person of major SUB-CONTRACTORS/SUB-VENDORS for use in future, to OWNER.SUB-CONTRACTOR/SUB-VENDOR as per agreed Vendor list are not subject to approval.

12.3.2.1.1 Under normal circumstance a CONTRACTOR shall not be allowed to source any equipment/machinery from the vendors other than the Owner's approved vendor list. However, in exceptional circumstance the CONTRACTOR may suggest additional vendors meeting the following requirement for the approval of Owner.

a. The CONTRACTOR should specify, while pre-qualifying the Vendors, that during the past 7 years the Vendor should have supplied at least two similar plant equipments or machinery. The CONTRACTOR should satisfy themselves that sufficient documentary proof is submitted by the Vendors in support of this criterion. However, in case of critical equipment, in addition to above criterion, the Vendor should also be prequalified by Process Licensor.

b. The CONTRACTOR would be ultimately responsible for verifying the credentials, the quality of the equipment, machinery and timely supply.

12.3.2.2 The review, approval and consent by OWNER as to the agreed SUB-CONTRACTOR's/VENDOR List or as to CONTRACTOR's entering into any SUB-CONTRACT / PURCHASE ORDER shall not relieve CONTRACTOR of any of its duties, liabilities or obligations under this CONTRACT and CONTRACTOR shall be liable hereunder to the same extent as if any such Subcontract had not been entered into.

12.3.2.3 (a) CONTRACTOR shall provide to OWNER such information concerning the SUB-CONTRACTORS as OWNER may from time to time reasonably request and shall ensure that each SUB-CONTRACT contains provisions in all material respects not less stringent than the provisions of the CONTRACT and shall include terms and provisions required to be included pursuant to the CONTRACT. In the event of termination of the CONTRACT under Clause 34.0 herein, CONTRACTOR shall forthwith deliver to OWNER a copy of each SUBCONTRACT.

(b) CONTRACTOR shall supervise and direct the work of all SUB-CONTRACTORS/SUB-VENDORS and shall be responsible for all design,

engineering, procurement, manufacturing, transportation, delivery, fabrication, construction, commissioning, start-up and testing means, erection, operation, maintenance, repair, methods, techniques, sequences and procedures of, and for co-coordinating the work of SUB-CONTRACTORS/ SUB-VENDORS.

(c) If CONTRACTOR fails to correct, or commence to correct and execute the correction with due diligence of deficient or defective work performed by any SUB-CONTRACTOR/SUB-VENDORS within reasonable time (provided it doesn't materially impact safe operation of plant), after receipt by CONTRACTOR of a notice from OWNER with respect thereto, OWNER may (but shall not be obligated to), after seven days following receipt by CONTRACTOR of an additional notice, and without prejudice to any other right or remedy take all reasonable steps to remedy such defective or deficient work at risk and cost of CONTRACTOR.

(d) CONTRACTOR shall require all SUB-CONTRACTORS/SUB-VENDORS to perform the SUB-CONTRACTS in accordance with the relevant requirements of the CONTRACT, all APPLICABLE LAWS and APPLICABLE PERMITS, Prudent Utility Practice, Good Engineering Practices, the requirements of the NIT, and all Warranties of SUB-CONTRACTORS/SUB-VENDORS and Manufacturers and all insurance policies relating to the PLANT or the WORK.

(e) CONTRACTOR shall be solely responsible for paying each SUB-CONTRACTOR/SUB-VENDOR and any other person to whom any amount is due from CONTRACTOR for services, equipment, construction equipment, materials or supplies otherwise related to the PLANT or the WORK. CONTRACTOR shall take all reasonable steps and actions to ensure that such services, equipment, construction equipment materials and supplies and the like have been or will be received, inspected and approved and that such services have been or will be properly performed.

(f) In performing the duties incidental to its responsibilities hereunder, CONTRACTOR shall issue to the SUB-CONTRACTORS/SUB-VENDORS such directives and impose such restrictions as may be required to obtain such compliance herewith and with the terms of the SUB-CONTRACTS.

12.3.2.4 **SUB-CONTRACTOR/VENDOR AND MANUFACTURER WARRANTIES**

(a) CONTRACTOR shall ensure that all equipment and other items used in connection with the performance of the WORK or incorporated in the PLANT (other than minor items) will be purchased in compliance with CONTRACT Technical Specifications and requirements in order to allow the Plant to achieve the Guarantee and Warrantee as provided for in the CONTRACT, unless otherwise agreed with OWNER.Any residual warranty from sub-contractor/vendor shall be passed to the OWNER after expiry of DEFECT LIABILITY PERIOD.

(b) Neither CONTRACTOR nor its SUB-CONTRACTORS/SUB-VENDORS nor any person under the control of either thereof, shall take any action which could release, void, impair or waive any Guarantee or Warranty on EQUIPMENT or services relating to the PROJECT or the WORK. Any residual warranty from sub-contractor/sub-vendor shall be passed to the OWNER after expiry of DEFECT LIABILITY PERIOD.

(c) Nothing in this clause shall derogate from the obligations of CONTRACTOR to provide the Guarantees and Warranties described in and to comply with the provisions hereinabove.

(d) CONTRACTOR shall, based on its past professional judgement enforce all guarantees and warranties provided hereunder to the fullest extent thereof till such time they are transferred to the OWNER pursuant to sub-clause (g) below.

(e) Upon the expiration or termination of any of the guarantees or warranties provided by CONTRACTOR pursuant to the CONTRACT, the CONTRACTOR shall assign, and hereby assigns, effective as of such date, or otherwise make available, to OWNER all of CONTRACTOR's rights under all such SUBCONTRACTOR's residual Guarantees and warrantee as per 12.3.2.4(a) & (b)(except to the extent CONTRACTOR has thereof provided warranty services to OWNER and is enforcing CONTRACTOR's rights with respect to such services under the applicable guarantee or warranty) and shall deliver to OWNER copies of all contracts providing for such guarantees and warranties.

(f) CONTRACTOR, in accordance with the CONTRACT, shall require all SUB-CONTRACTORS/SUB-VENDORS to be covered by the insurance covers specified in the CONTRACT, during the time in which they are engaged in performing WORK.

(g) CONTRACTOR shall require all SUB-CONTRACTORS/SUB-VENDORS to release and waive any and all rights of recovery against OWNER including its affiliates, subsidiaries, employees, successors, permitted assigns, insurers and underwriters) and against CONTRACTOR and all other SUB-CONTRACTORS/VENDORS which the releasing SUB-CONTRACTOR/VENDOR may otherwise have or acquire, in or from or in any way connected with any loss covered by policies of insurance maintained or required to be maintained pursuant to this the CONTRACT (other than third party liability insurance policies) or because of deductible clauses in or inadequacy of limits of any such policies of insurance. CONTRACTOR shall further require all SUB-CONTRACTORS/VENDORS to include in all policies of insurance maintained by the SUB-CONTRACTORS/VENDORS clauses providing that each underwriter shall release and waive all of its rights of recovery, under subrogation or otherwise, against OWNER, its promoters, affiliates, subsidiaries, employees, successors, permitted assigns, insurers and underwriters, and against CONTRACTOR and all other SUB-CONTRACTORS/VENDORS.

(h) OWNER shall not be deemed by virtue of the CONTRACT to have any contractual obligation to or relationship with any SUB-CONTRACTOR/VENDOR.

12.3.2.5 **CONTRACTOR's LIABILITY FOR APPROVED SUB CONTRACTOR :**

The review by and approval and consent of OWNER as to the approved SUB-CONTRACTORS list or as to CONTRACTOR entering into any SUB-CONTRACT with any approved SUB-CONTRACTOR or as to any WORK done or supply made or services provided by any such approved SUB-CONTRACTOR/SUB-VENDOR shall not relieve CONTRACTOR of any of his duties, liabilities or obligations under this CONTRACT, and CONTRACTOR shall be liable hereunder to the same extent as if any such SUB-CONTRACT had not been entered into. Any inspection review or approval by OWNER permitted under this CONTRACT of any portion of the work or of any work in progress by CONTRACTOR or SUB-CONTRACTORS/SUB-VENDORS shall not relieve CONTRACTOR of any duties, liabilities or obligations under this CONTRACT.

12.3.3 All WORK performed or EQUIPMENT supplied by SUB-CONTRACTOR/ SUB-VENDOR shall be pursuant to an appropriate SUB-CONTRACT, PURCHASE ORDER or similar agreement which shall, as appropriate, contain provisions that:

12.3.3.1 Preserve and protect all the rights of OWNER here under for WORK to be performed or EQUIPMENT to be supplied under PURCHASE ORDER or SUB-CONTRACT.

12.3.3.2 Require that such WORK be performed or EQUIPMENT be fabricated, supplied and installed in strict accordance with the applicable requirements of this CONTRACT.

12.3.3.3 Obligate such SUB-CONTRACTOR/SUB-VENDOR to consent to and be bound by those obligations under this CONTRACT which by their terms are intended to also obligate such SUB-CONTRACTOR/VENDOR, including the provisions of this Clause.

12.3.3.4 Require such SUB-CONTRACTOR/SUB-VENDOR to provide and maintain adequate insurance consistent with requirements for companies of similar size and performing similar services. Permit the assignment of such SUB-CONTRACT/PURCHASE ORDER by CONTRACTOR to OWNER.

12.3.3 **CONTRACTOR RESPONSIBLE FOR WORK**

12.3.4.1 CONTRACTOR is responsible for WORK, and that the performance thereof conforms in all respects to the requirements of this CONTRACT, regardless of any failure of any SUB-CONTRACTOR/VENDOR to perform or any disagreement between any SUB-CONTRACTOR/VENDOR or between any SUB-CONTRACTOR/VENDOR and CONTRACTOR. CONTRACTOR shall furnish such information relative to its SUB-CONTRACTOR/VENDOR (including copies of unpaid SUB-CONTRACT or PURCHASE ORDER) as OWNER may request.

12.3.5 **DAMAGES**

It is within the discretion of Contractor, that CONTRACTOR shall agree to hold all SUB-CONTRACTOR/VENDOR, including all persons directly or indirectly employed by them, responsible for any damages due to breach of CONTRACT caused by them or any negligent act and to diligently endeavour to effect recoveries in such damages..

13.0 STANDARDS

The goods and services supplied under this CONTRACT shall conform to the standards mentioned in the technical specifications and when no applicable standard is mentioned, CONTRACTOR to follow best engineering practices.

14.0 INSTRUCTIONS, DIRECTIONS

14.1 The materials described in CONTRACT are to be supplied according to the standards, data sheets, tables, specifications and drawings attached hereto and/or enclosed with the CONTRACT itself and according to all conditions both general and specific enclosed with the CONTRACT, unless any or all of them shall have been modified or cancelled in writing as a whole or in part.

A) All instructions and orders to CONTRACTOR shall, except what is herein provided, be given by OWNER/ CONSULTANT.

B) All the work shall be carried out under the direction of OWNER and according to the CONTRACT requirements.

C) All communications including technical/ commercial clarifications and/ or comments shall bear reference to the CONTRACT.

D) Invoice for payment against CONTRACT shall be addressed to OWNER.

E) The CONTRACT/DLOA number shall be shown on all invoices, communications, packing lists, containers and bills of lading etc.

15.0 DELETED

16.0 TIME SCHEDULE AND PROGRESS REPORTING

16.1 Time Schedule Network/Bar Chart

16.1.1 Together with the CONTRACT confirmation, CONTRACTOR shall submit to OWNER, his time schedule regarding the documentation, supply and manufacture of equipment and materials as well as information of his SUBCONTRACTS to be placed with third parties, including the dates on which CONTRACTOR intends to issue such SUB CONTRACTS. A complete activity-wise time schedule shall be furnished by the CONTRACTOR within 30 days from the date of issuance of FOA.

16.1.2 The time schedule will be in the form of a network or a bar chart clearly indicating all main or key events regarding documentation, supply of raw materials, manufacturing, testing, delivery, erection & commissioning.

16.1.3 The original issue and subsequent revisions of CONTRACTOR's time schedule and/or SUB-CONTRACTORS' time schedules shall be sent in two copies to OWNER.

16.1.4 The time schedule network/bar chart shall be updated at least every month using the latest 'Project Management software', i.e. Primavera (latest version), acceptable to the OWNER.

16.2 PROGRESS TREND CHART/MONTHLY REPORT

16.2.1 CONTRACTOR shall report monthly to OWNER of the execution of CONTRACT and achievement of targets set out in time bar chart, in a monthly progress report on 7th working *day* of every Month.

16.2.2 The progress will be expressed in percentages shown in the progress trend chart.

16.2.3 The first issue of the progress trend chart will be forwarded together with the time bar chart along with CONTRACT confirmation.

16.2.4 The monthly reporting will bear the updating of the progress trend chart.

16.2.5 OWNER or his representatives shall have the right to inspect CONTRACTOR's premises to evaluate the actual progress of work on the basis of CONTRACTOR's time schedule documentation.

16.2.6 Irrespective of such inspection, CONTRACTOR shall advise OWNER at the earliest possible date of any anticipated delay in the programme indicating the reasons thereof and corrective measures proposed thereto.

16.2.7 The time for completion and phased time schedule shall be subject to and in accordance with the provision of Sub-Clauses 16.2.8 and 16.2.9 below.

16.2.8 Neither OWNER nor CONTRACTOR shall be considered in default in performance of their obligations if such performance is prevented or delayed by FORCE MAJEURE conditions as stated in Clause 35.0.

16.2.9 Should the CONTRACTOR's preparation for the commencement of the work or any portion of it or its subsequent rate of progress be from any cause whatsoever, so slow and reasons for delay solely attributed to the contractor, the CONTRACTOR will not be able to complete the work or any portion thereof within the stipulated time for completion, the provisions of Clause 34 of GCC shall apply.

16.2.10 In the event that the delay is caused by a delay in the delivery of a sub-contracted EQUIPMENT, CONTRACTOR shall be responsible for such delay and submit details together with copies of the appropriate orders and agreements with SUB-CONTRACTOR/vendor.

17.0 CONTRACTOR TO INFORM HIMSELF FULLY

The CONTRACTOR in fixing his rate shall for all purpose whatsoever reason may be, deemed to have himself independently obtained all necessary information for the purpose of preparing his offer and his offer as accepted shall be deemed to have taken into account all contingencies as may arise due to such information or lack of same. The correctness of the details, given in the Tender Document to help the CONTRACTOR to make up the tender is not guaranteed.

The CONTRACTOR shall be deemed to have examined the CONTRACT DOCUMENTS, to have generally obtained his own information in all matters whatsoever that might affect the carrying out of the works at the schedules rates and to have satisfied himself to the sufficiency of his offer. Any error in description of quantity or omission there from shall not vitiate the CONTRACT or release the CONTRACTOR from executing the work comprised in the CONTRACT according to DRAWINGS and SPECIFICATIONS at the scheduled rates. CONTRACTOR is deemed to have known the scope, nature and magnitude of the WORKS and the requirements of materials and labour involved etc., and as to what all works he has to complete in accordance with the CONTRACT documents whatever be the defects, omissions or errors that may be found in the DOCUMENTS. The CONTRACTOR shall be deemed to have visited surroundings, to have satisfied himself to the nature of all existing structures, if any, and also as to the nature and the conditions of the Railways, Roads, Bridges and Culverts, means of transport and communication, whether by land, water or air, and as to possible interruptions thereto and the access and egress from the site, to have made enquiries, examined and satisfied himself as to the sites for obtaining sand, stones, bricks and other materials, the sites for disposal of surplus materials, the available accommodation as to whatever required, depots and such other buildings as may be necessary for executing and completing the works, to have made local independent enquiries as to the sub-soil, subsoil water and variations thereof, storms, prevailing winds, climatic conditions and all other similar matters effecting these works. He is deemed to have acquainted himself as to his liability of payment of Government Taxes, Customs duty and other charges, levies etc.

Any neglect or omission or failure on the part of the CONTRACTOR in obtaining necessary and reliable information upon the foregoing or any other matters affecting the CONTRACT shall not relieve him from any risks or liabilities or the entire responsibility from completion of the works at the scheduled rates and times in strict accordance with the CONTRACT.

It is, therefore, expected that should the CONTRACTOR have any doubt as to the meaning of any portion of the CONTRACT DOCUMENT he shall set forth the particulars thereof in writing to OWNER in duplicate, before submission of tender. The

OWNER may provide such clarification as may be necessary in writing to CONTRACT, such clarifications as provided by OWNER shall form part of CONTRACT DOCUMENTS.

No verbal agreement or inference from conversation with any effect or employee of the OWNER before, during or after the execution of the CONTRACT agreement shall in any way affect or modify and of the terms or obligations herein contained.

Any change in layout due to site conditions or technological requirement shall be binding on the CONTRACTOR and no extra claim on this account shall be entertained

18.0 SUITABILITY OF PLANT FOR INTENDED PURPOSE

18.1 The CONTRACTOR warrants that the PLANT will be suitable in all respects for the purpose mentioned or inherent in the specification and as defined in the CONTRACT.

18.2 Without limiting the generality of the foregoing clause, the CONTRACTOR shall ensure before complying with any direction, that compliance by the CONTRACTOR with that direction will not render the plant unsuitable in any respect for the aforesaid purposes or otherwise prevent the CONTRACTOR from carrying out the CONTRACT in accordance with the terms thereof.

18.3 The CONTRACTOR shall give notice to the OWNER within Twenty one (21) days after receipt of any requirement or direction which he considers will render the plant unsuitable in any respect or is not in accordance with the meaning and intent of the CONTRACT OR otherwise prevent the CONTRACTOR from carrying out the CONTRACT or as aforesaid and submit to the OWNER a proposal or proposals for modifying the requirement or direction. Failure to file an objection within the allotted time will be considered as acceptance of the OWNER's decision and the decision shall become final and binding.

19.0 FEES FOR ROYALITIES AND PATENT RIGHTS (WHEREVER APPLICABLE)

19.1 **Payment Due to be Included in CONTRACT PRICE**

19.1.1 All payments for royalties, patent rights and fees due to or payable for or in connection with any matter or thing used or required to be used in performance of the CONTRACT or to be supplied under the CONTRACT, whether payable in one sum or by instalments or otherwise, shall be included by the CONTRACTOR in the prices named in the CONTRACT and shall be paid by CONTRACTOR to whom such payments may be due or payable.

19.1.2 The CONTRACTOR, if licensed under any patent covering equipment, machinery, materials or compositions of matter to be used or supplied or methods and process to be practiced or employed in the performance of this CONTRACT, agrees to pay all royalties and license fees which may be due with respect thereto. If any equipment, machinery, materials, composition of matters, be used or supplied or methods and processes to be practiced or employed in the performance of this CONTRACT, is covered by a patent under which the CONTRACTOR is not licensed then the CONTRACTOR before supplying or using the equipment, machinery materials,

composition method or processes shall obtain such licenses and pay such royalties and license fees as may be necessary for performance of this CONTRACT. In the event the CONTRACTOR fails to pay any such royalty or obtain any such license, any suit for infringement of such patents which is brought against the CONTRACTOR or the OWNER as a result such failure will be defended by the CONTRACTOR at his own expense and the CONTRACTOR will pay any damages and costs awarded in such suit. The CONTRACTOR shall promptly notify the OWNER if the CONTRACTOR has acquired the knowledge of any plant under which a suit for infringement could be reasonably brought because of the use by the OWNER of any equipment, machinery, materials, process, methods to be supplied hereunder. The CONTRACTOR agrees to and does hereby grant to OWNER, together with the right to extend the same to any of the subsidiaries of the OWNER as irrevocable, royalty free license to use in any country, any invention made by the CONTRACTOR or his employee in or as result of the performance of the WORK under the CONTRACT.

19.2 **Payment to the CONTRACTOR by OWNER**

19.2.1 Final payment to the CONTRACTOR by the OWNER will not be made while any such suit or claim remains unsettled. In the event any apparatus or equipment or any part thereof furnished by the CONTRACTOR is in such suit or proceedings, held to constitute infringement, and its use is enjoined, the CONTRACTOR shall, at his option, and at his own expense, either procure for the OWNER the right to continue use of the said apparatus, equipment or part thereof, replace it with non-infringing apparatus or equipment or modify it, so that it becomes non-infringing.

20.0 ACTS OF PARLIAMENT, LOCAL AND OTHER AUTHORITIES REGULATIONS AND BYE-LAWS

20.1 **Complying With Regulations**

20.1.1 Throughout the execution of the WORK, the CONTRACTOR shall comply with the requirements of all applicable laws and regulations, bye-laws or orders made there under and to the requirements of public, municipal and other authorities in any way affecting or applicable to the work. The OWNER shall, when requested by the CONTRACTOR, give all reasonable assistance to the CONTRACTOR in obtaining information concerning local conditions.

20.1.2 Before making any departure from the specification or drawings which may be necessary to conform to such requirements, the CONTRACTOR shall give the OWNER written notice specifying the departure proposed to be made and the reason for making it and applying for instructions thereon. If the CONTRACTOR does not receive such instructions within thirty (30) days, he shall conform to those requirements and inform the OWNER accordingly.

20.2 **Notices and Fees**

The CONTRACTOR shall give all notices required to be given by the Acts, regulations, bye-laws, orders and requirements referred to in sub-clause 20.1 of this clause and shall pay all fees payable in connection herewith.

Any additional fee becoming applicable due to any change of Acts, regulations, by-laws, orders and requirements after date of submission of FINAL PROPOSAL shall be borne by OWNER in accordance with SCC clause 3.0.

21.0 TIME- PROJECT SCHEDULE

21.1 Without prejudice to anything contained in the CONTRACT, the time and the date of completion of the works as stipulated in the CONTRACT shall be deemed to be of the utmost importance. The CONTRACTOR shall so organise his resources and perform his work so as to complete it within the completion period.

21.2 The contractor shall submit the Primavera Level 4 schedule within thirty (30) days from date of issuance of FOA.

The Primavera Level 4 schedule shall be for OWNER´s review and be based on a level 2 schedule as attachment to the CONTRACT. Such level 2 schedule shall show the execution periods for (i) engineering, (ii) procurement & delivery of equipment and materials, (iii) & erection (iv) Mechanical Completion and (v) commissioning, testing.

CONTRACTOR shall be contractually obliged to issue a Primavera Level 4 schedule provided that such schedule shall not (i) accelerate the OWNER obligations (to be agreed upon prior to Contract award) (ii) change the GUARANTEED COMPLETION DATE.

21.3 The above Primavera Level 4 schedule shall be periodically reviewed and reports shall be submitted by the CONTRACTOR as directed by the OWNER.

22.0 CONTRACT PRICE

22.1 CONTRACT PRICE is inclusive of the cost/fees of CONTRACTOR's obligations as given below briefly but not limited to the following:

a. Detailed Engineering
b. Basic Engineering
c. Supply of all ~~Plant~~, Equipment, Bulk Materials, Chemicals & Lubricants and consumables
d. 2 months vendor supervision assistance.
e. Supply of spares
f. All applicable taxes and duties including GST, Indian Income Tax, etc.
g. Forwarding charges, if applicable
h. Freight up to SITE including taxes
i. Unloading, storage at Site, Site Assembly, Erection, Pre-Commissioning and Commissioning until Preliminary Acceptance of Plant.
j. Insurance
k. Inspection and expediting charges
l. Project management and overheads,
m. Guarantee test runs and handing over of PLANT to OWNER.
n. All other costs, expenses and outgoings of the CONTRACTOR not otherwise expressly set forth herein necessary, required or incidental to the full, complete and proper performance and discharge of the CONTRACTOR's obligations under and in accordance with the CONTRACT including completion of the PLANT in all respects and overheads of the CONTRACTOR.

22.2 OWNER shall pay to CONTRACTOR a lump-sum fixed CONTRACT PRICE for the due and faithful performance of CONTRACTOR's obligations under the CONTRACT. CONTRACT PRICE provided for in this Clause covers entire consideration payable to CONTRACTOR for all obligations of CONTRACTOR.

22.3 CONTRACT PRICE is inclusive of cost of all travel, accommodation, living costs and all other expenses of management and personnel of CONTRACTOR, SUB-CONTRACTOR, VENDOR for travelling to and from plant SITE and other places/countries as may be necessary for the proper performance of CONTRACTOR's responsibilities under CONTRACT and shall also include all costs and expenses incurred in attending such meetings in connection with CONTRACT as OWNER may reasonably require.

22.4 CONTRACT PRICE is inclusive of cost of all CONTRACTOR's EQUIPMENT, materials, services, etc. required to complete WORK under CONTRACT.

22.5 All taxes, duties, licence fees and other such levies as may be applied to the CONTRACT, including Custom Duty, all applicable taxes & duties under GST, Corporate income tax in respect of the performance of the CONTRACT as well as income tax on the personnel deputed by the CONTRACTOR to India in connection with the CONTRACT shall be to the account of the CONTRACTOR.

23.0 DEDUCTIONS FROM CONTRACT PRICE

All costs, damages or expenses which the OWNER may have paid for which, under the CONTRACT, the CONTRACTOR is liable, will be claimed by the OWNER. All such claims shall be billed by the OWNER to the CONTRACTOR regularly as and when they fall due. Such claims shall be paid by the CONTRACTOR within fifteen days of the receipt of the corresponding bills and if not paid by the CONTRACTOR within the said period, the OWNER may then deduct the amount from any bill due or becoming due by him to the CONTRACTOR under the CONTRACT or may be recovered by action of law or otherwise, if the CONTRACTOR fails to satisfy the OWNER of such claims.

24.0 Deleted

25.0 Deleted

26.0 TAXES APPLICABLE TO CONTRACTOR'S MANPOWER, TURNOVER, EQUIPMENT, ETC.

26.1 The CONTRACTOR shall be liable and pay all taxes, duties, levies, lawfully assessed against the OWNER or the CONTRACTOR in pursuance of the CONTRACT. The CONTRACTOR shall be solely responsible for all taxes that may be levied on the CONTRACTOR's turnover & profit or on the earnings of any of his employees or personnel engaged by him and shall hold the OWNER indemnified and harmless against any claims that may be made against the OWNER in this behalf. The OWNER does not undertake any responsibility whatsoever regarding any taxes levied on CONTRACTOR and/or his personnel by Centre/State/Local Authorities. The Taxes shall be deducted where the said provisions shall be applicable and/or obligatory on the part of the OWNER.

26.2 For CONTRACTORS who have to bring equipment and material from outside Odisha, will have to obtain necessary registrations and take appropriate steps as required under Odisha State Laws. Further, form 38 / E-Waybill / Road Permit shall be issued by the

CONTRACTOR in such cases, wherever applicable. Necessary statutory registrations as required shall be done by CONTRACTOR in this regard.

26.3 CONTRACTOR is responsible for obtaining Customs clearance permit for temporary importation on re-export basis of CONTRACTOR'S EQUIPMENT, tools and tackles etc. If any duties, taxes and expenses are payable on this, the same will be to CONTRACTOR'S account.

27.0 PACKING, FORWARDING AND SHIPMENT

27.1 The CONTRACTOR shall give complete despatch information concerning the weight, size, content of each package including any other information the OWNER may require.

27.2 The CONTRACTOR, wherever applicable shall after proper painting, pack and crate all equipment in such a manner as to protect it from deterioration and damage during rail and road transportation to the site and storage at the site till the time of erection. The CONTRACTOR shall be held responsible for all damages due to improper packing.

27.3 The CONTRACTOR shall notify the OWNER of the date of each shipment from his works, and the expected date for arrival at the site for the information of the OWNER. The CONTRACTOR will be responsible for arranging any requirement of over-dimensional, special rail/road wagon/trailer for transporting.

27.4 The CONTRACTOR shall also give all shipping information concerning the weight, size and content of each package including any other information the OWNER may require. The size of the largest packages being considered as over dimensional consignments shall be as per the latest guidelines.

27.5 The CONTRACTOR shall prepare detailed packing lists of all packages and containers, bundles and loose materials forming each and every consignment despatched to the site. The CONTRACTOR shall further be responsible for making all necessary arrangements for loading, unloading and other handling, right from works till the SITE and also till the EQUIPMENT is erected, tested and commissioned. The CONTRACTOR shall be solely responsible for proper storage and preservation of all equipments& machineries etc.

28.0 INSURANCE

28.1 CONTRACTOR shall take in the joint name of CONTRACTOR and OWNER comprehensive transit insurance for imported and indigenous goods. Transit-cum-Storage-Erection insurance or its equivalents and third party liability insurance policies shall be taken with reputed underwriters to cover ALL RISK whatsoever during the whole period starting with dispatch of GOODS from CONTRACTOR's warehouses/ Exworks in foreign country to CIF port of shipment for imported GOODS and EXW at Contractor's works for indigenous GOODS and shall further cover for performing services in India for transportation, loading, unloading, assembly, erection, testing COMMISSIONING of PLANT till care and custody is transferred to OWNER.

28.1.1 Contractor shall take Public Liability (Third Party) Insurance cover of 10% of TOTAL CONTRACT PRICE.

28.1.2 Contractor shall ensure that in addition to "Erection All risk policy", the coverage in respect of workmen compensation, ESI/Health Insurance, Professional Indemnity (with the amount of minimum excess) has been appropriately taken.

28.2 CONTRACTOR shall be fully responsible for pursuing and settling all claims under the underwriters. In the event of accident, injury, damage or loss likely to form a claim under the above insurance policies, CONTRACTOR shall, as quickly as possible submit the insurance claims by underwriters under intimation to OWNER. CONTRACTOR shall also keep OWNER fully informed about progress of each such case. CONTRACTOR shall undertake immediate repair and replacement of the equipment lost in transit, storage, assembly, erection and COMMISSIONING of PLANT pending settlement of claim thereafter by the underwriters.

28.3 The CONTRACTOR at his cost shall arrange, secure and maintain all insurance as may be pertinent to the works and obligatory in terms of law to protect his interest and interest of OWNER in the project, against all perils detailed herein. The Form and the limit of such insurance as defined herein together with the under-writer in each case shall be acceptable to the OWNER andOWNER´s acceptance shall not be unreasonably withheld. However, irrespective of such acceptance, the responsibility to maintain adequate insurance coverage at all times including third party liability during the period of contract shall be as of CONTRACTOR alone. The contractor's failure in this regard shall not relieve him of any of his contractual responsibilities and obligations. The insurance covers to be taken by the CONTRACTOR shall be in the joint names of OWNER and the CONTRACTOR. The CONTRACTOR shall, however, be authorised to deal directly with insurance company or companies and shall be responsible in regard to maintenance of all insurance covers.

28.4 All insurance other than marine insurance for transportation outside India is to be covered from IRDA approved insurance company registered in India. There should be a single cover for marine cum inland transit, storage and erection upto PRELIMINARY ACCEPTANCE OF PLANT.

However adequacy, credibility and maintenance of Insurance policies is sole responsibility of CONTRACTOR and CONTRACTOR shall keep the OWNER indemnified against any such failure.

All insurance covers shall be taken by CONTRACTOR in joint name of CONTRACTOR and OWNER.

Alternatively, the CONTRACTOR has the option to take separate Insurances as

1. Marine Cargo Insurance for transit of all imported and indigenous goods from Ex -Works at CONTRACTOR'S/SUB-CONTRACTOR's works to Site.
2. Erection and All Risk (EAR) Insurance
3. Third Party Liability Insurance

Marine Cargo Insurance and Third Party Liability Insurance can be a part of Global Policy of the CONTRACTOR. However certificate of endorsement in favour of OWNER shall be provided by the CONTRACTOR from the insurance company. These two global policies of Marine Cargo Insurance and Third Party Liability Insurance shall be counter guaranteed by Indian Insurance Company. However, Erection and All Risk (EAR) is to be covered from Insurance Company registered in India and shall be separate dedicated policies for OWNER.

28.5 Any loss or damage to the equipment during handling, transportation, storage, erection, putting the equipment into satisfactory operation and all activities to be performed till the successful completion of trial operation of the plant shall be to the account of the CONTRACTOR. The CONTRACTOR shall be responsible for reference of all claims and

make good the damages or loss by way of repairs and/or replacement of the equipment, damaged or lost. The CONTRACTOR shall provide the OWNER with copies of all insurance policies and documents taken out by him in pursuance of the CONTRACT. Such copies of documents shall be submitted to the OWNER immediately after such insurance coverage. However, if Marine cargo insurance or Third party liability Insurance is a part of their global policies; insurer certificate (including the main terms of policy) shall be submitted by CONTRACTOR. The CONTRACTOR shall also inform the OWNER in the writing at least thirty (30) days in advance regarding the expiry/ cancellation and/or change in any of such documents and ensure revalidation, renewal etc. as may be necessary well in time. However adequacy, credibility and maintenance of Insurance policies is the sole responsibility of CONTRACTOR and CONTRACTOR shall keep the OWNER indemnified against any such failure.

28.6 The perils required to be covered under the insurance shall include, but not be limited to fire and allied risks, miscellaneous accidents (erection risks) workman compensation risks, loss or damage in transit, theft, pilferage, riot and strikes and malicious damages, civil commotion, weather conditions, accidents of all kinds, war risks (during ocean transportation only) etc. The scope of such insurance shall be adequate to cover the replacement/reinstatement cost of the equipment for all risks till the equipment is taken over by the OWNER. The insurance policies to be taken should be on replacement value basis and/or incorporating escalation clause. Notwithstanding the extent of insurance cover and the amount of claim available from the underwriters, the CONTRACTOR shall be liable to make good the full replacement/rectification of all equipment/materials and to ensure their availability as per project requirements without additional financial liability to the OWNER.

The workman compensation policy taken by the SUB-CONTRACTOR of the CONTRACTOR shall be passed on to the OWNER.

28.7 CONTRACTOR shall at its own cost and initiative at all times upto the successful completion of PRELIMINARY ACCEPTANCE, take out and maintain all insurable liability, including but not limited to third Party insurance and liabilities under the Motor Vehicles Act, Worker's Compensation Act, Fatal Accidents Act, Personal Injuries Insurance Act, Emergency Risk Insurance Act and/or other Industrial Legislation from time to time in force in India with Insurance Company(ies), such policy(ies) shall not be of lesser limits hereunder specified with reference to the matters hereunder specified, namely:

- Workmen's Compensation Insurance to the limit to which compensation may be payable under Indian laws.

28.8 All cost on account of insurance liabilities covered under the CONTRACT will be to the CONTRACTOR'S account and will be included in the CONTRACT PRICE. The CONTRACTOR, while arranging the insurance, shall ensure to obtain all discounts on premium, which may be available for higher volume or for reason of financing arrangement of the project.

28.9 Irrespective of single or separate insurances, the CONTRACTOR shall take the same in the joint name of OWNER and CONTRACTOR, with OWNER as Primary Beneficiary and CONTRACTOR as Joint Beneficiary, to cover all risk including marine cum erection insurance (MCE), workmen compensation / Employees State Insurance (ESI) under ESI Act 1948 for Contractor's personnel, fire risk policy etc. till handing over of PLANT to OWNER duly commissioned and tested. However, for CONTRACTOR"s EQUIPMENT, CONTRACTOR can be the sole beneficiary.

Further, OWNER shall have the first right over the claim amount for all insurance claims, where owner has made part or full payment to the contractor.

However, OWNER should have first right over the claim amount in case payment for the "equipment damaged" has already been paid to the CONTRACTOR

28.10 The CONTRACTOR shall be fully responsible for pursuing and settling all claims with the underwriters within stipulated timelines. In the event of accident, injury, damage or loss likely to form a claim under the above insurance policies, the CONTRACTOR shall as quickly as possible but not later than the claim period submit such details as are necessary for settling such claims by underwriters and shall also provide information and assistance necessary to settle the claim. The CONTRACTOR shall also keep OWNER fully informed about progress of each such case.

28.11 All charges on account of insurance shall be included in TOTAL LSTK PRICE/TOTAL CONTRACT PRICE.

29.0 Deleted

30.0 LIABILITY FOR ACCIDENTS AND DAMAGES

30.1 Under the CONTRACT, the CONTRACTOR shall be responsible for loss or damage to the PLANT and provide new equipment and machineries in lieu of equipment/machineries lost/damaged beyond repairs, free of cost until the PLANT is handed over after successful completion of performance guarantee test run.

Notwithstanding the provisions in the CONTRACT, the CONTRACTOR shall not be responsible for any loss or damage to the PLANT or any part thereof if and to the extent that such loss or damage is not covered by insurance coverage such as War risk, provided the same is general exclusion of the policy of the EAR insurance. War Risks shall mean any of the following events occurring within India:
War , hostilities, warlike operations (whether a state of war be declared or not), invasion, act of foreign enemy, civil war, rebellion, terrorism, revolution, insurrection, mutiny, usurpation of civil or military government, conspiracy, riot, civil commotion, mine, bomb, shell, grenade or other projectile, missile, munitions or explosive of war.

30.2 The CONTRACTOR shall indemnify the OWNER in respect of all damage or injury to any person or to any property (other than property forming part of the Work) and against all actions, suits, claims, demands, costs, charges and expenses arising in connection therewith which shall have been occasioned by the negligence of the CONTRACTOR or any SUB-CONTRACTOR, or by defective design (other than a design made, furnished or specified by the OWNER and which the CONTRACTOR has disclaimed responsibility in writing within a reasonable time after receipt of the OWNER's instructions) material or workmanship, any breach of the CONTRACTOR's obligations.

31.0 Deleted

32.0 Deleted

33.0 TIME EXTENSION OF CONTRACT

33.1 The CONTRACTOR shall promptly notify the ENGINEER-IN-CHARGE any event or conditions which might delay the completion of erection work in accordance with the approved schedule and the steps being taken to remedy such situation.

33.2 If the Work is delayed at any time in the commencement or during the progress of the WORK by any act, delay or neglect solely attributable to OWNER or his employees, or by any other contractor utilised by the OWNER or by FORCE MAJEURE conditions, the time of completion shall be extended by OWNER (without levy of Mutually Agreed Damages) in writing for a reasonable period as may be mutually agreed upon, at the time of closure of contract. The CONTRACTOR shall, immediately on occurrence of such special circumstances but not later than 14 working days, bring to the knowledge of OWNER through written application for any such delay as mentioned above.

33.3 OWNER shall have the right to suspend the WORK in whole or in part for such time as may be necessary in order that WORKS shall be well and properly executed. In such events, suitable extension of time shall be granted to CONTRACTOR. However, should the cumulative period of suspension exceed 45 days during the scheduled duration of CONTRACT, the CONTRACTOR shall be compensated as mutually agreed in addition to extension of time, provided the suspension is caused due to reasons not attributable to CONTRACTOR.

34.0 TERMINATION OF CONTRACT

34.1 **Termination due to Legal Incapacity**

If the CONTRACTOR goes into liquidation or has an administrator order made against him or carries on his business or any part of it under an administrator or receiver or manager for the benefit of the creditors or any of them, without prejudice to any other rights or remedies, the OWNER may forthwith by notice in writing terminate the CONTRACT.

34.2 **Termination due to Default by CONTRACTOR**

34.2.1 If the CONTRACTOR is in default in that he:

(a) Neglects to execute the work or part of the work; or

(b) without reasonable cause, suspends or abandons the carrying out the works, either partly or wholly, before their completion; or

(c) Fails to proceed regularly and diligently with the works; or

(d) Defaults in the performance or observance of any conditions or terms of the CONTRACT or neglects to carry out any order, instruction, direction or determination which the OWNER is empowered to give or make under the CONTRACT and which is given or made in writing to the CONTRACTOR,

then, without prejudice to any other rights or remedies which the OWNER may possess, the OWNER may, by notice in writing (which shall specify with reasonable particularity the neglect, default or refusal on the part of the CONTRACTOR) require the CONTRACTOR:

i) to put forward his proposals for

a) Rectifying such neglect, default or refusal as the case may be and

b) Commence and diligently pursue the rectification of the default.

34.2.2 If within 30 days after the posting of the notice addressed to the CONTRACTOR, the CONTRACTOR fails to comply with the notice or if in the opinion of the OWNER, the CONTRACTOR's reasons or proposals are not satisfactory, then the OWNER, without prejudice to any other rights that he may have under the CONTRACT against the CONTRACTOR, may either:

a) DETERMINE THE CONTRACT in which event the CONTRACT shall stand terminated and shall cease to be in force and effect on and from the date appointed by the OWNER on that behalf, whereupon the CONTRACTOR shall stop forthwith any of the CONTRACTOR's work then in progress, except such WORK as the OWNER may, in writing, require to be done to safeguard any property or WORK, or installations from damage, and the OWNER, for its part, may take over the work remaining unfinished by the CONTRACTOR and complete the same through a fresh contractor or by other means, at the risk and cost of the CONTRACTOR, and any of his sureties if any, shall be liable to the OWNER for any excess cost occasioned by such work having to be so taken over and completed by the OWNER over and above the cost at the rates specified in the schedule of quantities and rate/prices.

b) WITHOUT DETERMINING THE CONTRACT, take over the work of the CONTRACTOR or any part thereof and complete the same through a fresh contractor or by other means at the risk and cost of the CONTRACTOR. The CONTRACTOR and any of his sureties are liable to the OWNER for any excess cost over and above the cost at the rates specified in the Schedule of Quantities/ rates, occasioned by such works having been taken over and completed by the OWNER.

In such events of Clause 34.2.2 (a) or (b) above.

(i) The whole or part of the Contract Performance Security furnished by the CONTRACTOR is liable to be forfeited without prejudice to the right of the OWNER to recover from the CONTRACTOR the excess cost referred to in the sub-clause aforesaid, the OWNER shall also have the right of taking possession and utilising in completing the works or any part thereof, such as materials equipment and plants available at work site belonging to the CONTRACTOR as may be necessary and the CONTRACTOR shall not be entitled for any compensation for use or damage to such materials, equipment and plant.

(ii) The amount that may have become due to the CONTRACTOR on account of work already executed by him shall not be payable to him until after the expiry of Six (6) calendar months reckoned from the date of termination of CONTRACT or from the taking over of the WORK or part thereof by the OWNER as the case may be, during which period the responsibility for faulty materials or workmanship in respect of such work shall, under the CONTRACT, rest exclusively with the CONTRACTOR. This amount shall be subject to deduction of any amounts due from the CONTRACT to the OWNER under the terms of the CONTRACT authorised or required to be reserved or retained by the OWNER.

(iii) Before determining the CONTRACT as per Clause 34.2.2 (a) or (b) provided in the judgement of the OWNER, the default or defaults committed by the CONTRACTOR is/are curable and can be cured by the CONTRACTOR if an opportunity given to him, then the OWNER may issue Notice in writing calling the CONTRACTOR to cure the default within such time specified in the Notice.

(iv) The OWNER shall also have the right to proceed or take action as per 34.2.2 (a) or (b) above, in the event that the CONTRACTOR becomes bankrupt, insolvent, compounds with his creditors, assigns the CONTRACT in favour of his creditors or any other person or persons, or being a company or a corporation goes into voluntary liquidation, provided that in the said events it shall not be necessary for the OWNER to give any prior notice to the CONTRACTOR.

(v) Termination of the CONTRACT as provided for in sub- clause 34.2.2(a) above shall not prejudice or affect their rights of the OWNER which may have accrued upto the date of such termination.

34.2.3 In case of termination of CONTRACT herein set forth (under clause 34.2) except under conditions of Force Majeure and termination after expiry of contract, the CONTRACTOR shall be put under holiday [i.e. neither any enquiry will be issued to the party by Talcher Fertilizers Limited (TFL) or any of it's JV partners against any type of tender nor their offer will be considered by TFL or any of it's JV partners against any ongoing tender (s) where contract between TFL/it's JV partners and that particular CONTRACTOR (as a bidder) has not been finalized],for a period of three years from the date of termination by TFL to such CONTRACTOR.

34.3 **Duration of suspension of payment due to CONTRACTOR:**

34.3.1 Owner shall have right to suspend making any payments to the contractor for the portion of WORK having a bearing with CONTRACTOR's default during the period of rectification of the defaults.

34.4 **Work taken out of the hands of the CONTRACTOR**

34.4.1 Employment of other contractors:

If the OWNER takes action under sub-clause 34.2.2, he may complete the work or any part of it by contracting with or employing any other contractor to execute further and complete work or any part of it and to provide all equipment, materials and labour as may be necessary for such further execution and completion. If practicable the further execution and completion shall be carried out in accordance with the specification and at prices obtained under competitive conditions.

The OWNER may also take possession of and permit such person or persons to use for the purposes of the CONTRACT only such materials, tools and equipment and all other things on or about the SITE which are the property of the CONTRACTOR as are requisite and necessary for such further execution and completion, and the CONTRACTOR shall have no right to any compensation or allowance in respect thereof.

On the completion of such work, all tools and equipment and the surplus of the materials so taken possession of shall be handed over to the CONTRACTOR but without payment or allowance for the fair wear and tear they may have sustained in the meantime, provided that if there by a deficiency as referred to in sub clause 34.4.2 of this clause, and if the CONTRACTOR fails to make good such deficiency such of the tools, equipment and materials as are necessary to make good the deficiency may be sold and a sufficient part of the monies received retained by the OWNER and applied in payment of such deficiency.

In addition the OWNER shall be entitled:

a) To take possession of and remove from the CONTRACTOR's premises within a reasonable period anything (including but without limiting the generality thereof any design, drawings, specification, material or other goods) the property which is vested in the OWNER pursuant to the CONTRACT;

b) To full particulars of any sub-contract made by the CONTRACTOR with any person for the execution of any portion of the WORKS and to peruse and copy any instrument (including but without limiting the generality thereof any agreement, letter or other paper) relating to any such SUB-CONTRACT made by the CONTRACTOR with any person for the execution of any portion of the WORKS.

c) To pursue and copy any standard working drawing or other drawing or data necessary in the opinion of the OWNER for completion of the WORKS and the property which is not vested to the OWNER pursuant to the CONTRACT provided that the OWNER shall in no case make use of any copy made pursuant to sub paragraphs (b) or (c) hereof other than for the purpose of completing the WORKS and that on the fulfilment of the whole of the obligations of the CONTRACTOR under the CONTRACT the OWNER shall return to the CONTRACTOR any such copy.

The CONTRACTOR shall offer to the OWNER all rights of access and all reasonable facilities to enable the OWNER to remove any such thing or pursue or copy any such instrument, drawing or data and shall supply such particulars on request by the OWNER in that behalf.

For the purposes of sub-clause 34.4.2the cost incurred by the OWNER in and about for such removal, perusal or copying or obtaining such particulars shall be deemed to be part of the cost of carrying out that portion of the work taken out of the CONTRACTOR's hands.

34.4.2 **Extra cost to the OWNER of completing work for deduction**:

On completing the terminated portion of WORK as provided under Article 34.4.1 the OWNER shall ascertain the reasonable and direct costs based on the documentary evidence of the cost incurred but such amount shall not include any extra cost due to departures from the specification unless such departures were necessitated by the CONTRACTOR's default. Should the amount so ascertained be greater than the CONTRACT PRICE which would have been paid to the CONTRACTOR, if the whole of the Work had been carried out by him, the difference between the two amounts shall be deducted from any monies which may then be or thereafter become due to the CONTRACTOR or which may have been deposited by him as security under the CONTRACT, and if such monies be less than the amounts to be deducted the deficiency shall be paid by the CONTRACTOR to the OWNER and which may be recovered as provided in sub clause 34.4.1 of this clause or by way of arbitration, jurisdiction or both, such payment of excess amount shall be independent of penalty for delay if the completion of work is delayed.

34.5 **Preservation of rights of the OWNER**

No action taken by the OWNER under sub clause 34.3 and 34.4 of this clause shall vitiate the CONTRACT or shall operate to the prejudice of the right of the OWNER to recover from the CONTRACTOR or to deduct from any monies which may be or may become due to the CONTRACTOR all sums of money which may be or may become due to the OWNER under the CONTRACT as damages, penalties or otherwise.

34.6 Should the OWNER decide to terminate the CONTRACT under sub clause 34.2.2(b) of this clause, he may do so under notice in writing as from the date of such notice, and the termination shall be without prejudice to any right that may have occurred to the OWNER or to the CONTRACTOR under the CONTRACT.

34.7 **Termination of Contract on Account of OWNER's Convenience**

34.7.1 The OWNER, may, by 30 days written notice send to the CONTRACTOR, terminate the CONTRACT, in whole or in part, at any time for his convenience. The notice of termination shall specify that termination is for the OWNER's convenience, the extent to which performance of work under the CONTRACT is terminated and the date upon which such termination becomes effective.

34.7.2. Upon receipt of the notice of termination under GCC Clause 34.7.1, the CONTRACTOR shall either immediately or upon the date specified in the notice of termination.

(a) cease all further work, except for such work as the OWNER may specify in the notice of termination for the sole purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition.

(b) terminate all subcontracts, except those to be assigned to the OWNER pursuant to paragraph (d)(ii) below.

(c) remove all CONTRACTOR's Equipment from the Site, repatriate the CONTRACTOR's and its SUB-CONTRACTORs' personnel from the Site, remove from the Site any wreckage, rubbish and debris of any kind, and leave the whole of the Site in a clean and safe condition.

(d) In addition, the CONTRACTOR, subject to the payment specified in GCC Clause 34.7.2.1, shall

(i) deliver to the OWNER the parts of the PLANT executed by the CONTRACTOR up to the date of Termination.

(ii) to the extent legally possible, assign to the OWNER all right, title and benefit of the CONTRACTOR to the PLANT and Equipment as at the date of termination, and, as may be required by the OWNER, in any subcontracts concluded between the CONTRACTOR and its SUB-CONTRACTORs.

(iii) deliver to the OWNER all non-proprietary drawings, specifications and other documents prepared by the CONTRACTOR or its Sub-CONTRACTORs as at the date of termination in connection with the PLANT.

34.7.2.1 In the event of termination of the Contract under GCC Clause 34.7.1, the OWNER shall pay to the CONTRACTOR the following amounts:

(a) the Contract Price, properly attributable to the parts of the PLANT executed by the CONTRACTOR as of the date of termination

(b) the costs reasonably incurred by the CONTRACTOR in the removal of the CONTRACTOR's Equipment from the Site and in the repatriation of the CONTRACTOR's and its SUB-CONTRACTOR's personnel

(c) any amounts to be paid by the CONTRACTOR to its SUB-CONTRACTORs or Vendors in connection with the termination of any subcontracts or supply agreement, including any cancellation charges

(d) costs incurred by the CONTRACTOR in protecting the PLANT and leaving the Site in a clean and safe condition pursuant to paragraph (a) of GCC Clause 34.7.2

34.7.3 **Termination for Insolvency**

OWNER may at any time terminate CONTRACT giving written notice to CONTRACTOR, if CONTRACTOR becomes bankrupt or otherwise insolvent, provided that such termination will not prejudice or affect any right of action or remedy which has occurred or will accrue thereafter to OWNER.

If the Contract is terminated under GCC Sub-Clauses 34.7.3, the OWNER shall pay to the CONTRACTOR all payments specified in GCC Sub-Clause 34.7.2 as reasonable compensation for all loss or damage sustained by the CONTRACTOR arising out of, in connection with or in consequence of such termination.

34.7.4 **Termination by CONTRACTOR due to default of OWNER**

If the OWNER has failed to pay the CONTRACTOR any sum due under the Contract within the specified period or commits a substantial breach of the CONTRACT, the CONTRACTOR may give a notice to the OWNER that requires payment of such sum or specifies the breach and requires the OWNER to remedy the same, as the case may be. If the OWNER fails to pay such sum or fails to remedy the breach or take steps to remedy the breach within thirty (30) days after receipt of the CONTRACTOR's notice then the CONTRACTOR may give a notice to the OWNER thereof, and if the OWNER has failed to pay the outstanding sum or to remedy the breach within thirty (30) days of such notice, the CONTRACTOR may by a further notice to the OWNER, terminate the CONTRACT.

If the CONTRACT is terminated under GCC Clause 34.7.4, the OWNER shall pay to the CONTRACTOR all payments specified in GCC Clause 34.7.2 as reasonable compensation for all loss or damage sustained by the CONTRACTOR arising out of, in connection with or in consequence of such termination.

34.8 **Surviving Obligations**

Termination of this CONTRACT (a) shall not relieve CONTRACTOR of its obligations with respect to the confidentiality as set forth in this CONTRACT, (b) shall not relieve CONTRACTOR of any obligation hereunder which expressly or by implication survives termination hereof, and (c) except as otherwise provided in any provision of this CONTRACT expressly limiting the liability of CONTRACTOR, shall not relieve CONTRACTOR of any obligations or liabilities for loss or damage to the other Party arising out of or caused by acts or omissions of CONTRACTOR prior to the effectiveness of such termination or arising out of such termination, and shall not relieve CONTRACTOR of its obligations as to portions of SERVICES already performed or of obligations assumed by CONTRACTOR prior to the date of termination, except as otherwise agreed by OWNER in writing.

34.8.1 Termination of this CONTRACT (a) shall not relieve OWNER of its obligations with respect to the confidentiality as set forth in this CONTRACT, (b) shall not relieve OWNER of any obligation hereunder which expressly or by implication survives termination hereof, and (c) shall not relieve OWNER of any obligations or liabilities for loss or damage to the other Party arising out of or caused by acts or omissions of OWNER prior to the effectiveness of such termination or arising out of such termination.

35.0 **FORCE MAJEURE**

35.1 CONDITIONS FOR FORCE MAJEURE: In the event of either party being rendered unable by Force Majeure to perform any obligations required to be performed by them under the CONTRACT the relative obligation of the party affected by such Force Majeure shall upon notification to the other party be suspended for the period during which Force Majeure conditions lasts. The cost and loss sustained by the either party shall be borne by the respective parties. The term "Force Majeure" as employed herein shall mean acts of God, earthquake, war (declared or undeclared), revolts, riots, fires, floods, rebellions, explosions, hurricane, sabotage, civil commotions and acts and regulations of respective Government of the two parties, namely the OWNER and the CONTRACTOR. Upon the occurrence of such cause(s) and upon its termination, the party alleging that it has been rendered unable as aforesaid thereby, shall notify the other party in writing immediately but not later than 120 (one hundred and twenty) hours of the alleged beginning and ending thereof giving full particulars and satisfactory evidence in support of its claim. Time for performance of the relative obligation suspended by the Force Majeure shall then stand extended by the period for which such conditions lasts..

OUTBREAK OF WAR

(i) If during the currency of the CONTRACT there shall be an out-break of war whether declared or not, in that part of the World which whether financially or otherwise materially affect the execution of the WORK the CONTRACTOR shall unless and until the CONTRACT is terminated under the provisions in this clause continue to use his best endeavour to complete the execution of the WORK, provided always that the OWNER shall be entitled, at any time after such out-break of war to terminate or re-negotiate the CONTRACT by giving notice in writing to the CONTRACTOR and upon such notice being given the CONTRACT shall, save as to the rights of the parties under this clause and to the operation of the clauses entitled settlement of Disputes and Arbitration hereof, be terminated but without prejudice to the right of either party in respect of any antecedent breach thereof.

(ii) If the CONTRACT shall be terminated under the provisions of the above clause, the CONTRACTOR shall with all reasonable diligence remove from the SITE all the CONTRACTOR's equipment and shall give similar facilities to his SUB-CONTRACTORS to do so

35.2 If the CONTRACTOR suffers delay in the due execution of the contractual obligations due to delays caused by Force Majeure as defined above, the agreed time of completion of job covered by this CONTRACT or the obligation of the CONTRACTOR shall be extended by a period of time on account of force majeure conditions, provided that on the occurrence of any such contingency, the CONTRACTOR within120 hours reports to the OWNER in writing, the cause of delay and likely duration of cause of delay with requisite documentary evidence.

35.3 If the works to be executed by the CONTRACTOR are suspended by Force Majeure conditions lasting for more than 2 (two) months, the OWNER shall have the option to terminate the CONTRACT or re-negotiate the contract provisions.

35.4 CONTRACTOR and OWNER shall endeavour to prevent, overcome or remove the causes of FORCE MAJEURE.

35.5 No ground for exemption can be invoked if CONTRACTOR has failed to give timely notice by registered letter/ Speed-Post/Courier/Email/Hand Delivery and subsequently supported it by documentary evidence.

35.6 Delay or non-performance by a party hereto caused by the occurrence of any event of FORCE MAJEURE shall not:

(a) Constitute a default or breach of the CONTRACT,

Or

(b) Give rise to any claim for damages or additional cost or expense occasioned thereby, if such delay or non-performance is caused by the occurrence of any event of FORCE MAJEURE. FORCE MAJEURE conditions are not payable under any circumstances.

35.7 Force Majeure is no one's fault, therefore each party should bear its own cost and a provision to terminate the CONTRACT in case of Force Majeure extending beyond six (06) months is provided. Should OWNER wish the CONTRACTOR to continue further, both parties may sit together and mutually agree on the future course failing which Parties will have the right to terminate. Such termination shall not be considered as Termination for Owner's Convenience. However, outstanding invoices, payment for supplies made and payment to the work already performed will be paid by OWNER on such termination.

Contractor shall have the right to take action to mitigate the impact of the prolonged Force Majeure event in mutual consent with Owner. For instance, Contractor shall have the right to demobilize Contractor's equipment and personnel from the Plant.

36.0 NO WAIVER OF RIGHTS

Neither the inspection by the OWNER or any of their officials, employees, or agents nor any order by the OWNER for payment of money or any payment for or acceptance of, the whole or any part of the WORKS by the OWNER nor any extension of time, nor any possession taken by the OWNER shall operate as a waiver of any provision of the CONTRACT, or of any power herein reserved to the owner or any right to damages herein provided, nor shall any waiver of any breach in the CONTRACT be held to be a waiver of any other subsequent breach.

37.0 BANKRUPTCY AND LIQUIDATION OF CONTRACTOR OR BUSINESS UNDER RECEIVERSHIP

If the CONTRACTOR becomes insolvent or bankrupt, or has a receiving order made against him, or compound with his creditors, or being a corporation commence to be wound up not being a member's voluntary winding up for the purpose of reconstruction or carry on his business under a receiver for the benefit of his credit, the CONTRACTOR shall within fourteen (14) days notify the OWNER accordingly. On the occurrence of any of the happenings stated in the first sentence of this clause, the OWNER shall be at liberty to:

a) Determine the CONTRACT forthwith by notice in writing to the CONTRACTOR or to the receiver or liquidator or to any person in whom the CONTRACT may have become vested, and act in the manner provided in clause 34.1 (proceedings or default) or,

b) Give to such receiver liquidator or other person in writing the option for a period of one month of carrying out the WORK subject to his providing a guarantee for the due and faithful performance of the CONTRACT upto the CONTRACT value of the work for the time being remaining unexecuted and subject to his taking all reasonable steps to prevent stoppage of the work. In the event of stoppage of the work, the period of the option under this clause shall be fourteen (14) days only.

38.0 CERTIFICATE NOT TO AFFECT RIGHT OF OWNER AND LIABILITY OF CONTRACTOR

No interim payment certificate of the OWNER nor any sum paid on account by the OWNER nor any extension of time for execution of the WORKS granted by the OWNER shall affect or prejudice the rights of the OWNER against the CONTRACTOR or relieve the CONTRACTOR of his obligations for the due performance of the CONTRACT or be interpreted as approval of the WORK done or of the equipment furnished and no certificate shall create liability on the OWNER to pay for alterations, amendments, variations, or additional works not ordered, in writing, by the OWNER or discharge the liability of the CONTRACTOR for the payment of damages whether due certified or not or any sum against the payment of which he is bound to indemnify the OWNER and the Consultant nor shall any such certificate nor the acceptance by him of any sum paid on account or otherwise affect or prejudice the rights of the CONTRACTOR against the OWNER.

39.0 SETTLEMENT OF DISPUTES

39.1 Except as otherwise specifically provided in the CONTRACT, all disputes concerning questions of fact arising under the CONTRACT shall be considered by the OWNER subject to a written appeal by CONTRACTOR to the OWNER.

39.2 Any disputes or differences including those considered as such by only of the parties arising out of or in connection with the CONTRACT shall be to be extent possible settled amicably between the parties.

39.3 If, after 60DAYs from the commencement of such informal negotiations, OWNER and CONTRACTOR are unable to resolve amicably the dispute, either party may require that the dispute be referred for resolution to the arbitration as described under clause 40 below.

40.0 ARBITRATION

40.1 Refer clause no. 45 of Section-III of NIT.

40.2 Continuation of Work and payments during Arbitration

WORK shall be continued by CONTRACTOR during the arbitration proceedings unless the matter itself is the subject of Arbitration or unless the matter itself is such that WORK cannot practically be continued until the decision of the arbitrator is obtained and CONTRACTOR shall remain liable and bound in all respects under the Contract. Except as otherwise expressly provided in CONTRACT, no payment due and payable by

OWNER shall be withheld on account of such arbitration proceedings unless it is the subject matter or one of the subject matters.

41.0 GOVERNING LAWS, LANGUAGE AND MEASURES

41.1 CONTRACT shall be governed and construed according to the Indian Law as in force and shall be subject to the jurisdiction of the Court in Delhi.All disputes arising during the execution of the CONTRACT shall be resolved as per Clause no. 39.0 (Settlement of Dispute) & 40.0 (Arbitration) of GCC and thereafter in accordance with said law.

41.2 The governing language for all communication, notices, Technical Information, etc. pertaining to CONTRACT shall be English. Any literature, correspondence, documents, etc., shall be considered only if its accompanied by English translation. For the purpose of interpretation English translation shall govern and be binding on all parties.

41.3 The metric system of measurement shall be used exclusively in the CONTRACT.

42.0 RELEASE OF INFORMATION

The CONTRACTOR shall not communicate or use in advertising, publicity, sales releases or in any other medium, photographs or other reproduction of the WORKS under this CONTRACT or descriptions of the SITE, dimensions, quantity, quality or other information, concerning the work unless prior written permission has been obtained from the OWNER. Notwithstanding the above, CONTRACTOR is entitled, under intimation to OWNER, to make such public Announcements, as it may be bound to in compliance with the Law, the Rules and any Governmental Agency or Stock Exchange Regulation the CONTRACTOR is subjected to.

43.0 COMPLETION OF CONTRACT

Unless otherwise terminated under the provisions of any other relevant clause, this CONTRACT shall be deemed to have been completed at the expiry of the DEFECT LIABILITY PERIOD.

44.0 ENFORCEMENT OF TERMS

The failure of either party to enforce at any time any of the provisions of this CONTRACT or any rights in respect thereto or to exercise any option herein provided, shall in no way be construed to be a waiver of such provisions, rights or options or in any way affect the validity of the CONTRACT. The exercise by either party of any of its rights herein shall not preclude or prejudice either party from exercising the same or any other right provided in the contract.

45.0 OWNER'S DECISION

45.1 In respect of all matters which are left to the decision of the OWNER/ENGINEER-IN-CHARGE including the granting or withholding of the certificates, the OWNER/ ENGINEER-IN-CHARGE shall, if required to do so, by the CONTRACTOR, give in writing a decision thereon.

45.2 In each case involving a financial commitment, the written APPROVAL of the owner alone shall be binding.

45.3 In matters of difference of opinion on a decision passed by the OWNER/ENGINEER-IN-CHARGE to the CONTRACTOR, stipulations of Clause 39.0 of GCC shall govern.

46.0 CO-OPERATION

46.1 CO-OPERATION WITH OWNER

The CONTRACTOR and OWNER shall co-operate with each other in the discharge of their respective obligation under the CONTRACT with the aim of satisfactory completing the PLANT and the WORKS in accordance with the CONTRACT.

46.1.1 The parties shall deal fairly, openly and in good faith with each other. Subject to Clause 53 (Secrecy) of GCC, each party shall disclose information which the other might reasonably need in order to exercise its rights and to perform its obligations under the CONTRACT. In particular, each party shall promptly disclose full information to the other concerning any matter which will or may prevent the Plant and Works being completed in accordance with the CONTRACT. The parties shall work together in a manner consistent with their respective obligations under the CONTRACT to resolve or mitigate any such problem.

46.1.2 OWNER shall be at liberty to object with reasonably valid reasons to employment of any person at SITE and the objection shall be communicated in writing and CONTRACTOR shall make immediate arrangements for removal of such person.

46.2 COOPERATION WITH OTHER CONTRACTORS

The CONTRACTOR shall not object to the execution of the work by other contractors or tradesmen engaged by OWNER and offer them every facility for the execution of their several works simultaneously with CONTRACTOR's work, provided however that CONTRACTOR'S WORK is not hampered by such co-operation. CONTRACTOR shall at all times provide sufficient fencing, notice boards, lighting and watchmen to protect and warn the public and guard the works and in default thereof, OWNER may provide such facilities at CONTRACTOR's cost, if such failure is attributable to CONTRACTOR.

The CONTRACTOR shall agree to cooperate with the OWNER and OTHERCONTRACTORs and exchange with them such technical information, provided that such CONTRACTOR is bound towards CONTRACTOR on confidentiality and limited use obligations not less stringent than those accepted by OWNER under the CONTRACT and shall not be a competitor of CONTRACTOR as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The OWNER shall be provided with three (3) copies of all correspondence addressed by the CONTRACTOR to other SUB-CONTRACTORS in respect of such exchange of technical information.

47.0 SUSPENSION OF WORKS

(i) Subject to the provisions of sub-para (ii) of this clause, the CONTRACTOR shall, if ordered in writing by the ENGINEER-IN-CHARGE, or his representative, temporarily suspend the WORKS or any part thereof for such written order, proceed with the WORK therein ordered to be suspended until, he shall have received a written order to proceed therewith. The CONTRACTOR shall not be entitled to claim compensation for any loss or damage sustained by him by

reason of temporary suspension of the WORKS aforesaid. An extension of time for completion, corresponding with the delay caused by any such suspension of the WORKS as aforesaid will be granted to the ONTRACTOR should he apply for the same provided that the suspension was not consequent to any default or failure on the part of the CONTRACTOR.

(ii) In case of suspensions of entire WORK, ordered in writing by ENGINEER-IN-CHARGE, for a period of more than two months, the CONTRACTOR shall have the option to terminate the CONTRACT.

48.0 REPLACEMENT OF PARTS AND MATERIALS (DEFECTIVE/DAMAGED/LOST DURING TRANSIT/ERECTION AND COMMISSIONING)

48.1 If during the progress of the WORK, the OWNER shall decide and inform in writing to the CONTRACTOR that the CONTRACTOR has manufactured any plant or part of the plant in an unsound or imperfect manner or has furnished any plant inferior to the quality specified, the CONTRACTOR on receiving details of such defects or deficiencies shall at his own expense, within seven (7) days of his receiving the notice or otherwise within such time as may be reasonably necessary for making it good, proceed to alter, reconstruct or remove such work and furnish fresh equipment upto the standards of the specifications. In case the CONTRACTOR fails to do so, the OWNER may, on giving the CONTRACTOR seven (7) days notice in writing of his intentions to do so, proceed to remove the portion of the works so complained of and at the risk &cost of the CONTRACTOR, perform all such work or furnish all such equipment provided that nothing in this clause shall be deemed to deprive the OWNER of or affect any rights under the CONTRACT which the OWNER may otherwise have in respect of such defects and deficiencies.

48.2 The CONTRACTOR's full and extreme liability under this clause shall be satisfied by the payments to the OWNER of the extra cost, of such replacement procured including erection as provided for in the CONTRACT, such extra cost being the ascertained difference between the price paid by the OWNER for such replacements and the CONTRACT price portion for such defective plants and repayments of any sum/ paid by the OWNER to the CONTRACTOR in respect of such defective plant.

48.3 If the material/ equipment or any portion thereof is damaged or lost during transit and handling, storage, erection, commissioning at site, the replacements of such material / equipment shall be effected by the CONTRACTOR within a reasonable time to avoid unnecessary delays and without waiting for realisation of cost of damages from the insurance company, appointed by him for this purpose. This will not alter the time schedule in any way.

49.0 DEFENCE OF SUITS

49.1 If any action in Court is brought against the OWNER or an officer or agent of the OWNER for the failure omission or neglect on the part of the CONTRACTOR to perform any acts, matters, covenants or things under the CONTRACT, or for damage or injury caused by the alleged omission or negligence on the part of the CONTRACTOR, his agents representatives or his SUB-CONTRACTORS or in connection with any claim based on lawful demands of SUB-CONTRACTORs, workmen, suppliers or employees, the CONTRACTOR shall in all such cases indemnify and keep the owner and/ or his

representative harmless from all losses damages, expenses or decrees arising out of such action.

49.2 If any action in court referred to in Clause 49.1 of GCC above is brought against OWNER or an officer or agent of OWNER, OWNER shall promptly give the CONTRACTOR notice thereof and CONTRACTOR may at its own expense and in OWNER's name, conduct such proceedings or claim for the settlement of any such proceedings or claim. If CONTRACTOR fails to notify OWNER within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then the OWNER shall have full power and right at his discretion to defend or comprise any suit or pay claim or demand brought or made against him as aforesaid whether pending or threatened as he may consider necessary or desirable and shall be entitled to recover from the CONTRACTOR all sums of money including the amount of damages and compensation and all legal costs, charges and expenses in connection with any compromise or award which shall not be called into question by the CONTRACTOR and shall be final and binding upon him provided however that, unless CONTRACTOR has so failed to notify OWNER within the twenty-eight (28) days period, OWNER shall make no admission which may be prejudicial to the defence of any such proceedings or claim.

50.0 CONTRACTOR'S RESPONSIBILITIES

50.1 In consideration of payment by the OWNER, the CONTRACTOR shall regularly and diligently carry out and complete the WORKS in accordance with the CONTRACT.

50.2 All work carried out by the CONTRACTOR shall be carried out with sound workmanship and materials, safety and in accordance with the Contract requirements.

50.3 The CONTRACTOR shall set out the PLANT by reference to points, lines and levels of reference as defined in the approved SPECIFICATION.

50.4 The PLANT/WORKS as completed by the CONTRACTOR shall in every respect comply with the requirements defined in the Specification or any other provision of the CONTRACT.

50.5 If at any time during the performance of the CONTRACT, the CONTRACTOR is of the opinion that a change to the WORKS or the design or method of operation of the PLANT

a. is necessary to eliminate a potential defect in the PLANT or a specific hazard to any person or party in the performance of the WORKS or in the operation of the PLANT which has occurred or would otherwise occur' or

b. would improve operating or life cycle costs of the PLANT; or

c. would otherwise be beneficial to the OWNER;

the CONTRACTOR shall bring the matter to the attention of the ENGINEER-IN-CHARGE stating the reasons for his opinion and where appropriate, submit his proposals for a Variation in accordance with Clause 3 of SPECIAL CONDITIONSOF CONTRACT.

50.6 The CONTRACTOR shall at all times have and maintain adequate resources available for the proper and timely execution of the WORKS, including financial resources, and

competent, appropriately experienced and physically capable staff and labour whether employed by the CONTRACTOR, any SUB-CONTRACTOR or third parties.

50.7 The CONTRACTOR shall provide and maintain records as specified in the CONTRACT.

Unless otherwise agreed, the CONTRACTOR shall, at intervals of not more than one calendar month, report to the ENGINEER-IN-CHARGE on the progress of the WORKS, supporting his reports with appropriate documentation including any revisions to the approved programme.

50.8 The CONTRACTOR shall maintain and cause SUB-CONTRACTORs to maintain, a quality assurance system as specified in the CONTRACT. The existence of such a quality assurance system shall not relieve the CONTRACTOR from any of his other duties, obligations or liabilities under the CONTRACT. The CONTRACTOR shall also prepare and implement a validation plan, if such a requirement is specified in the CONTRACT.

51.0 PROGRESS REPORTS AND PHOTOGRAPHS

51.1 The CONTRACTOR shall furnish soft copy of progress photographs of the work done in his shop/site. Photographs shall be taken when and where indicated by the ENGINEER-IN-CHARGE. Photographs, if required shall be approximately 8 inches by 10 inches in size, including a margin on one 10 inch side for binding. Each photograph shall contain the date, the name of the CONTRACTOR and the title of the view taken. (technical to check, whether to be shifted to SCC)

51.2 Required number of monthly progress reports, in prescribed proforma, shall be submitted by the CONTRACTOR to the ENGINEER-IN-CHARGE for review. These shall detail the status of design, procurement of raw materials and bought outs, approval of the CONTRACTOR's drawings, manufacture of the equipment, statutory approvals taken, inspection of equipment/material, completed despatches, materials received at site, damages, if any, during transit, actions taken or replacement of damaged equipment, progress of erection work and programme of work for succeeding month and statement showing position of payment.

52.0 DELETED

53.0 SECRECY

53.1 The technical information, drawings, specifications and other related documents forming part of the NIT or the CONTRACT or such of those materials prepared during the execution of the project including photographs, micro-films, design, calculations etc. are the property of the OWNER and shall not be used for any other purpose, except for execution of contract. All rights, including rights in the event of grant of a patent and registration of designs are reserved. The technical information, drawings, specifications, records and other documents shall not be copied, transcribed, traced or reproduced in any other form or otherwise in whole and/or duplicated, modified, divulged and/or disclosed to a third party nor misused in any other form whatsoever, without the OWNER's previous consent in writing except to the extent required for the execution of this CONTRACT. Such technical information, drawings specifications and other related documents furnished shall be returned to the OWNER with all approved copies and duplicates, if any, immediately after they have been used for the agreed purposes.

For avoidance of any doubt it may be clarified that this clause relate to documents prepared by OWNER or is a property of OWNER.

In the event of any breach of this provision, the CONTRACTOR shall indemnify the OWNER from any loss, cost or damage or any other claim whatsoever from any parties claiming from or through them in respect of such breach.

All intellectual property rights in documents and calculations prepared by CONTRACTOR shall at all times exclusively vest with CONTRACTOR and be used by OWNER in accordance with the CONTRACT.

53.2 **Records of Contract Documents**

53.2.1 The CONTRACTOR shall at all times make and keep sufficient copies of the DRAWINGS, Specifications and CONTRACT documents for him to fulfil his duties under the CONTRACT.

53.2.2 The CONTRACTOR shall keep at site atleast three copies of each and every Drawing, Specification and CONTRACT document and these copies shall be available at all times for use by the OWNER and EIC and by any other person authorized by the OWNER who needs to know about the PROJECT.

54.0 CORRESPONDENCE

54.1 All correspondences from the CONTRACTOR to the OWNER shall be as per the correspondence distribution schedule. All communications including clarifications and/or comments shall be addressed to OWNER/PMC and shall always bear reference of DLOA No.

54.2 Any notice to the CONTRACTOR under the terms of the CONTRACT shall be served by registered e-mail, Speed Post or courier.

54.3 Any notice to the OWNER shall be served from the CONTRACTOR's Principal office in the same manner.

54.4 Any written order or instruction of OWNER or his duly authorised representative, communicated to authorised representative of the CONTRACTOR at site office shall be deemed to have been communicated to the CONTRACTOR at his legal address.

54.5 A notice shall be effective when delivered or on date of the notice, whichever is later.

55.0 MATERIALS AND EQUIPMENT

55.1 **Materials**

55.1.1 CONTRACTOR shall supply all materials required for incorporation in the works, within the scope of work, necessary to establish, commission and operate the PLANT.

55.1.2 **INVOICES**

CONTRACTOR’s invoices shall be raised as per approved Billing Schedule.

(a) The CONTRACTOR's invoice shall be in the format with all the requisite information as prescribed under GST Laws.

(b) Before raising GST invoices, CONTRACTOR shall coordinate with the OWNER with respect to address and GSTIN number on which such invoices have to be raised

55.1.3 The CONTRACTOR shall be responsible at his own cost and initiative within the scope of WORK, to take delivery of the materials from the port of delivery in India in respect of imported materials and from the factory or ware-house or other place(s) of delivery in respect of indigenous materials and to transport these to the CONTRACTOR's stockpiles, godowns or other places of storage approved by the ENGINEER-IN-CHARGE, and to transport the same from said godowns or place(s) of storage to the work site for installation in the permanent WORKS.

55.1.4 The work of delivery and transportation of materials shall include (but not be limited to) the following:

i) Clearance of the goods through custom and port clearance including filling and/or filing of all custom manifests, bills of entry, and custom declarations and other documents as may be required for the clearance of the goods from customs or port authorities.

ii) Stevedoring, clearing, forwarding and handling services as required for clearing, forwarding and handling imported and indigenous materials and consignments including payment at CONTRACTOR's cost of any demurrage, wharfage, port charges, siding charges, retention charges, detention charges or other charges whatsoever and howsoever designated or levied by any railway, air-port, ship and/or other authorities for or in connection with the loading, unloading or detention of any materials or vessels or other means of transport beyond the free period or unloading, clearance, retention or detention or loading, as the case may be, provided by the relevant authority(ies) or carrier(s) in this behalf.

iii) All works and operations necessary to lift and to remove the material from port, ware-house, railway or other siding, factory or other places of delivery, loading, handling, transporting and unloading and safely stacking, placing or storing the same at approved godowns, yards or other place(s) of storage including lashing or other-wise securing or protecting the same in transit and during and in storage.

iv) Supply, procurement, mobilization, and deployment of all labour thereof, equipment & machinery necessary for lifting, loading, handling, removing, transporting, unloading, stacking or securing the materials.

v) Transit and storage insurance of all materials for the full replacement value thereof delivered at site.

vi) All acts, deeds, matters or things required to fulfil all local, municipal and other statutory authorities with respect to the transportation of any materials through or into any State, municipal, local or other barriers or limits or for the import of the materials or any of them within the limits of such barrier, including payment of octroi or other local toll, terminal and/or entry or other taxes payable on the passage or entry of the materials through or within any local limits, for which purpose the OWNER shall give the CONTRACTOR and/or CONTRACTOR's designate(s) any and all authority(ies) as may be reasonably required in this behalf.

vii) All other acts, deeds, matters and things whatsoever ancillary, auxiliary or incidental to the above including but not limited to the grading of the site and/or creation of temporary approaches and ramps etc. as may be required.

55.2 **GENERAL PROVISION WITH REGARD TO MATERIALS**

55.2.1 The CONTRACTOR shall, within the scope of work, undertake the following activities and responsibilities with respect to and in addition and without prejudice to the activities and responsibilities under Clause 55.1 and associated clauses thereunder in respect of materials:

i) The CONTRACTOR shall be taking delivery, ensure compliance of any condition applicable for delivery from the concerned authority or carrier, and shall be exclusively responsible to pay and bear any detention, demurrage or penalty or other charges payable by virtue of any delay or failure by the CONTRACTOR in lifting the materials or in observing any of the conditions aforesaid, and shall keep the OWNER indemnified from and against all consequences thereof

ii) The CONTRACTOR shall maintain a day-to-day account of all materials indicating the daily receipt(s), consumption(s) and balance of each material and category thereof. Such account shall be in the format, if any, prescribed by the ENGINEER-IN-CHARGE and shall be supported by all documents necessary to verify the correctness of the entries in the account. Such account shall be maintained at the CONTRACTOR office and site(s) and shall be open for inspection and verification (by verification of documents in support of the entry as also by feasible verification of the stock) at all times by the ENGINEER-IN-CHARGE with authority at all times without obstruction to enter into or upon any godown or other place(s) or premise(s) where the materials or any part of them are lying or stored and to inspect the same himself and or through his representative(s).

iii) All materials shall be taken delivery of, held, stored and utilised by the CONTRACTOR as Trustee of the OWNER, and delivery of the material to the CONTRACTOR shall constitute an entrustment thereof to the CONTRACTOR, with the intent that any utilization, application or disposal thereof by the CONTRACTOR otherwise than for permanent incorporation in the contractual works in terms of the contract shall constitute a breach of trust by the CONTRACTOR.

iv) The CONTRACTOR shall at all times be exclusively responsible for any and all losses, damages, deterioration, misuse, wastage, theft, or other application or misapplication or disposal of the materials or any of them contrary to the provisions hereof and shall keep the OWNER indemnified from and against the same and shall forthwith at its own cost and expenses replace any such material, lost, damaged, deteriorated, misused, wasted, stolen, applied, mis-applied and/or disposed as aforesaid with other material of equivalent quality and quantity delivered to site at the CONTRACTOR's risks and costs in all respects.

v) The CONTRACTOR shall take out, at his own cost and keep in force at all times, during transit, handling, storage and erection, till the period as defined in the SPECIAL CONDITIONS OF CONTRACT (SCC),all the Insurance policy(ies) with Insurance Company(ies) for the full replacement value of the materials at site against the risks specified in the CONTRACT. Such policies shall be in the joint names of the OWNER and the CONTRACTOR, with exclusive right in the OWNER to receive all monies due in respect of such policy(ies) and with right in the OWNER (but without obligation to do so) to take out and pay the premia for any such policy(ies) and deduct the premia and any other costs and expense in this behalf from the monies for the time being due or in future becoming due to the

CONTRACTOR. In case of any Insurance claim, the GST leviable on the transfer of the claim money from OWNER to CONTRACTOR shall be over and above the GST cap indicated in the CONTRACT and shall be borne by OWNER.

vi) If the CONTRACTOR shall default in replacing any material lost, damaged, deteriorated, misused, wasted, short, stolen, misapplied or disposed of within the provisions hereof above, the CONTRACTOR shall be liable to pay to the OWNER the cost of such materials.

a) Notwithstanding anything herein provided, the CONTRACTOR shall be and remain solely and exclusively liable to repair, restore or replace, as the case may be, the materials damaged or destroyed as a result of any act or omission, notwithstanding the existence or otherwise of any policy(ies) of insurance aforesaid, with the intent that any policy(ies) of insurance aforesaid taken out by the CONTRACTOR or by the OWNER, on default by the CONTRACTOR, shall not anywise absolve the CONTRACTOR from his full liability up to and until expiry of Defect Liability Period defined in the contract. Further, as provided in respect of the works, the work(s) and all materials incorporated therein shall be and remain at the risk of the CONTRACTOR in all respects, including (but not limited to) accident, lightning, earth-quake, fire, storm, flood, tempest, riot, civil commotion and/or war or otherwise with respect to the materials. The insurance policies for above risks shall constitute merely an additional security and not a substitution of liability.

b) It shall be the exclusive responsibility of the CONTRACTOR to lodge and pursue any or all claims in respect of the insurance covers as above.

c) The CONTRACTOR shall, as a condition to the certification of any Running Account Bill, satisfy the OWNER/ Engineer-In-Charge of the existence of one or more policy(ies) of insurance, covering the materials as specified herein. The policy(ies) of insurance aforesaid shall cover all insurable risks, including but not limited to, any loss or damage commencing from the supplier's ware house in handling, transit, storage and during erection, theft, pilferage, riot, civil commotion, force majeure (including earth quake, flood, storm, cyclone, tidal wave, lightening and other adverse weather conditions), accidents of kinds, fire, war risks and explosion.

55.3.0 BILL OF MATERIALS

55.3.1 The CONTRACTOR shall furnish to the OWNER a detailed "Bill of Materials (BOM)" specifying the materials, which on preliminary determination made by the CONTRACTOR, will be required to be incorporated in the permanent works in order to establish the WORK/ Unit and to operate the PLANT/Unit, including construction materials.

55.3.2 Each item entered in the Bill of Materials shall be priced. The Bill of Materials and said price break–up therein are intended only to form a basis for the purpose of calculating on account payments and for calculating payments due to the CONTRACTOR under Clause 34.0 of GCC upon cancellation of contract, and for no other purpose.

55.3.3 The OWNER shall review or cause to be reviewed the prima facie adequacy, sufficiency, validity and/or suitability of the materials listed in the Bill of Materials for the works for which they are intended and of the prices indicated in the Bill of Materials in respect thereof. Such review shall be performed in conjunction with the design, engineering, specification and other technical reviews to be done by the OWNER and all provisions applicable thereto with reference to critical drawings shall be applicable to the review of the Bill of Materials.

55.3.4 The priced Bill of Materials shall constitute the Bill of Materials envisaged in the contract documents. However, the CONTRACTOR shall have full responsibility under the CONTRACT to sell and supply to the OWNER all materials required for the permanent incorporation in the works and which are required to establish, commission and operate the PLANT/ Unit in accordance with the CONTRACT and the specifications, complete in all respects including spares, tools, tackles and testing equipment, so far as included within the scope of supply, whether or not any particular material is actually included within or omitted in the Bill of Materials and whether or not the price thereof is included in the price indicated in the Bill of Materials and whether or not the price thereof is in conformity with the price thereof indicated in the Bill of Materials. The review and approval of the Bill of Materials and the prices therein are intended only for the satisfaction of the OWNER that the priced Bill of Materials, prima-facie covers the materials required to be supplied by the CONTRACTOR within the scope of supply.

55.4 SUPPLY OF MATERIALS

55.4.1 The CONTRACTOR shall supply the materials required to be supplied within the Contractor's scope of supply for incorporation in the permanent works in accordance with and to meet the requirements in quality, quantity and other particulars of the descriptions, specifications, plans, drawings, designs and other documents applicable thereto, and the CONTRACTOR shall be deemed to have undertaken that all materials selected, procured and supplied by the CONTRACTOR within the scope of supply shall be of the best quality and workmanship and shall be capable of producing the designed desired results and to perform the designed and desired functions to meet the contractual requirements in all respects for the project.

55.4.2 The CONTRACTOR shall undertake and complete the supply of materials within the scope of supply to meet the scheduled progress and requirements of the WORK within the scope of work.

55.4.3 All materials shall be deemed to have been accepted only when the material is received at the project SITE and accepted by the ENGINEER-IN-CHARGE. Such acceptance shall however be subject to the terms and conditions of CONTRACT, including the right of rejection and/or replacement as elsewhere herein specified.

55.4.4 Without prejudice to any other terms of the contract, it is clarified that the mere agreement, acceptance or prescription of a Delivery or other Schedule containing an extended time of commencement or completion in respect of the entire delivery(ies) or any of them shall not anywise constitute an extension of time in a terms of the CONTRACT so as to bind the OWNER or relieve the CONTRACTOR of all or any of his liabilities under CONTRACT, nor shall constitute a promise on behalf of the OWNER or a waiver by the OWNER of any of its rights in terms of the contract relative to the performance of the CONTRACT within the time specified or otherwise, but shall be deemed only (at the most) to be a guidance to the CONTRACTOR for better organising his work on a recognition that the CONTRACTOR has failed to organise his supplies and/or make the same within the time specified in the Delivery Schedule.

55.4.5 If the CONTRACTOR fails to supply the materials in accordance with the dates in this behalf specified in the Delivery Schedule which has an impact on the critical path of the schedule, the CONTRACTOR shall provide the OWNER with a suitable plan to recover the delay, but without prejudice to any other rights, discount or remedy available to the OWNER in respect of such delay or failure.

55.4.6 **MAKE OF MATERIALS**

i) All equipment and materials to be supplied under this CONTRACT shall be from approved vendors as indicated in the Bidding Document or as otherwise approved by the ENGINEER-IN-CHARGE / OWNER.

ii) Where the makes of materials are not indicated in the Bidding document, the CONTRACTOR shall furnish details of proposed makes and supplies and supply the same after obtaining the OWNER's/ ENGINEER-IN-CHARGE's approval.

55.5.0 **CERTIFICATE OF VERIFICATION AND GOOD CONDITION**

55.5.1 The CONTRACTOR shall, before supply of material covered within the scope of supply, at his own risks, costs and initiative, undertake or cause to be undertaken all tests, analysis and inspections as shall be required to be undertaken with regard to the materials under the specifications and any codes, practices, orders and instructions with respect thereto and shall cause the results thereof to be recorded, reported or certified, as the case may be, and shall not offer for delivery or deliver any material(s) which has/have not passed such tests/analysis or inspection and which are not accompanied by the tests results, reports and/or certificates in this behalf provided in the applicable specifications, code(s) and/or practices.

55.5.2 On arrival of the material at site the CONTRACTOR shall give written notice thereof to the ENGINEER-IN-CHARGE or Inspection Agency notified by the OWNER in this behalf, to inspect the materials, and shall keep in readiness for inspection, the materials and the relevant tests results, reports and certificates hereto.

55.5.3 Notwithstanding any other provisions in the contract documents for analysis or tests of materials and in addition thereto, the CONTRACTOR shall, if so required by the ENGINEER-IN-CHARGE or Inspection Agency in writing at his own risks and costs, analyse, test, prove and weigh all materials (including materials incorporated in the works) required to be analysed, tested, proved and/or weighed by the ENGINEER-IN-CHARGE or Inspection Agency in this behalf and shall have such analysis or tests conducted by the agency(ies), or authority(ies) if any specified by the ENGINEER-IN-CHARGE or Inspection Agency. The CONTRACTOR shall provide all equipment, labour, materials and other things whatsoever required for testing, preparation of the samples, measurement of work and/or proof of weighment of the materials as directed by the ENGINEER-IN-CHARGE or Inspection Agency.

55.5.4 If on Inspection or proof, analysis or tests as aforesaid the ENGINEER-IN-CHARGE or Inspection Agency nominated by the OWNER in this behalf is prima facie satisfied that the material received is in conformity with the material requirements of the Bill of Materials and description given in the shipping documents and in the CONTRACTOR's invoices in this behalf and that the test reports/results/certificates given in respect thereof are prima facie in conformity with the relevant result/reports/certificates required in respect thereof in terms of the specifications and/or relevant codes and practices, and that the material appears to be prima facie in good order and condition, the ENGINEER-IN-CHARGE shall issue to CONTRACTOR, a Certificate of Verification and Good Condition in respect of such material, and this shall constitute the Certificate of Verification and Good Condition elsewhere envisaged in the CONTRACT documents. Should the ENGINEER-IN-CHARGE not issue said Certificate within 5 working days following the conformity of the aforementioned requirements, the Certificate of Verification and Good Condition shall be deemed issued.

55.5.5 Such certificate is only intended to satisfy the OWNER that prima facie the material supplied by the CONTRACTOR is in order and shall not anywise absolve the

CONTRACTOR of his/its full responsibility under the CONTRACT in relation thereto, including in relation to,–fulfilment and/or performance of works or other guarantees envisaged in the CONTRACT.

55.5.6 Notwithstanding that any area(s) or source(s) has/have been suggested by the OWNER to the CONTRACTOR from which any material for incorporation in the WORKS can be obtained, the CONTRACTOR shall independently satisfy himself of the suitability, accessibility and sufficiency of the source(s) of supply suggested by the OWNER and suitability of the material available from such source(s) with the intent that any suggestion as aforesaid shall not anywise relieve the CONTRACTOR of his full liability in respect of the suitability and quality of the material(s) obtained from said source(s) and the CONTRACTOR shall obtain material(s) there from and incorporate the same within the permanent works entirely at his own risks and costs in all respects, with the intent that any such suggestion by the OWNER shall only be by way of assistance to the CONTRACTOR and shall not entail any legal responsibility or liability upon the OWNER.

55.6.0 **MATERIALS WITHIN THE CONTRACTOR'S SCOPE OF SUPPLY**

The OWNER does not warrant or undertake the provisions of any materials and the CONTRACTOR shall not imply, by conduct, expression or assurance or by any other means, any promise or obligation on the part of the OWNER in his respect understood by the CONTRACTOR.

55.7.0 **Deleted**

55.8 **PACKING AND FORWARDING**

- The CONTRACTOR shall, wherever applicable, after proper painting, pack and crate all items in such a manner so as to protect them from deterioration and damage during rail and road transportation to the site and during storage at the site till the time of erection. Without prejudice to any other liabilities or obligations of the CONTRACTOR, the CONTRACTOR shall be responsible for all damage(s) due to improper packing.
- The CONTRACTOR shall notify OWNER/ ENGINEER-IN-CHARGE the expected date of arrival materials at the site for the information of OWNER/ ENGINEER-IN-CHARGE.
- The CONTRACTOR's notification shall also give all shipping information concerning the weight, size and content of each packing and such other information as the OWNER/ ENGINEER-IN-CHARGE EIC may require.
- The following documents shall be sent to the OWNER/ EIC in three copies:

a) Signed Invoice(s)
b) Delivery Challan
c) Packing list.
d) Manufacturer's certificate of inspection for shipment duly approved by the CONTRACTOR in one original and one photocopy
e) Third Party Inspection Release Note clearly indicating that material has been inspected and accepted as per QAP approved by OWNER or TPI waiver certificate issued by OWNER.
f) Railway Receipt/LR
g) Intimation to Insurance Company for arranging Transit Insurance
h) Guarantee certificate (wherever applicable)

i) Operation & Maintenance manual (wherever applicable)

55.9 Assembly Marks and Name Plates

55.9.1 All component/parts of EQUIPMENT shall be indelibly hard marked with identification marks, comprising EQUIPMENT, part numbers, and CONTRACT number/PO number which shall also be shown on drawing to facilitate speedy identification, assembling or dismantling.

55.9.2 On each EQUIPMENT, a nameplate indicating basic details, pressure rating, wherever applicable, code number of EQUIPMENT, electrical characteristics in case of electrical EQUIPMENT, name of instrument with tag no., manufacturer's name shall be fixed at proper place.

55.9.3 For packages where marking is not possible at least two metallic nameplates must be affixed. Marking on the plates will be by means of engraving or indelible paint and will include the information listed above.

55.10 **Despatch/Shipping notice**

CONTRACTOR shall notify OWNER by E-mail for its information the expected date of delivery of a consignment, date of readiness of EQUIPMENT for shipment, total gross weight and total volume with dimensions.

55.11 **Heavy Lift Consignment (HLC) or Over Dimensional Consignments (ODC).**

55.11.1 CONTRACTOR shall follow the guidelines of Ministry of Road transport and Highways (MORTH) India, for the shipping/transportation of all packages/consignments. The CONTRACTOR shall be responsible to comply with rules relating to E-way Bills and other related provisions under the GST laws for movement of packages/consignments.

55.11.2 CONTRACTOR shall make his own arrangements for movement of all consignments including ODC/HLC.

55.11.3 CONTRACTOR confirms that it has surveyed the route for transportation of ODC/HLC items of EQUIPMENT and CONTRACTOR further confirms that it has included all cost of repairs of road, civil works, strengthening of bridges, culverts, widening of roads, etc. as required for transportation of ODC/HLC items of EQUIPMENT in its CONTRACT PRICE. OWNER shall not be responsible for repairs of road, civil works, strengthening of bridges, culverts, widening of roads, etc. as required for the transportation of ODC/HLC items of EQUIPMENT and shall not be liable to reimburse the cost of such repairs of road, civil works, strengthening of bridges, culverts, widening of roads, etc. to CONTRACTOR.

55.12 **Marking**

55.12.1 CONTRACTOR shall mark the following on packing three sides i.e. two sides faced and cover (Top) EQUIPMENT with indelible paint in conspicuous printed letters not less than 5 cm. in size in English:

A. For Imported EQUIPMENT

Government of India
A/c TALCHER PROJECT, ODISHA, INDIA.

a) CONTRACT /PO NO. : _____
b) Equipment Description and Item Nos.: _____
c) Package : _____ of _____
d) Gross / Net Weight (Kgs.) : _____
e) Dimension L x W x H cms. : _____
f) WARNING MARKS (FRAGILE, ATTENTION, TOP, KEEP DRY ETC.)
g) Forwarding No. : _____
h) Part shipment/full shipment/final shipment : _____
i) Each package shall bear a symbol contained in the package as follows:

'A' Storage in a closed storehouse.

'B' Storage under a shed.

'C' Storage in the open.

55.12.2 Depending on the characteristics of the contents in the packages, the packages have to be marked with appropriate international marking ("HANDLE WITH CARE"; "THIS SIDE UP"; "SLING MARK"; ETC.) and other indications necessary for correct handling such as Centre of Gravity and points of slinging (in case of heavy loads).

55.12.3 For packages where marking is not possible, at least two metallic nameplates must be affixed. Marking on the plates will be by means of engraving or indelible paint and will include the information listed above.

55.12.4 All corners of the packages shall be painted with indelible 'Blue' paint at least 125 mm in depth for easy identification/location of the packages for clearance and handling at the port.

55.13 **Packing List**

55.13.1 CONTRACTOR will include in each package an item-wise packing List, Invoice No. and associated drawings.

55.13.2 The packing list and any other documents shall be put in a closed polyethylene envelope and included in each package.

55.13.3 A second copy of the packing list shall be placed in a polyethylene envelope on the outside of the each package by means of metallic plate marked "Documents". As regards columns, exchangers and similar equipment, the envelope shall be placed in a nozzle being identified by an arrow, in indelible paint, followed by the word "Document".

55.13.4 Shipping documents must always be presented in the number of copies indicated in this CONTRACT.

55.14 **Shipping Arrangements and Forwarding of Documents**

CONTRACTOR shall avoid the use of over aged vessels for the shipment of the imported EQUIPMENT under this CONTRACT and if so used, the cost of additional insurance, if any, shall be borne by CONTRACTOR.

55.15 **Despatch/Shipment Notice for Insurance.**

55.15.1 CONTRACTOR shall send intimations of despatches indicating items despatched, quantity, value, weight and carrier particulars directly through fax to the insurance company fixed by CONTRACTOR.

55.15.2 Insurance for transit risks and other risks shall be covered by CONTRACTOR.

55.16 UTILITIES AND CONSUMABLES ETC.

Subject to any other provision to the contrary in the CONTRACT, the CONTRACTOR shall be and remain at all times exclusively responsible within the scope of work to provide all utilities, consumables, permits, licenses, easementsand facilities and other items and things whatsoever required for or in connection with the WORK, including but not limited to those indicated by expression or implication in the bid documents and/or other CONTRACT documents or howsoever otherwise as shall be or may from time to time be necessary for or in connection with the WORK.

56.0 MEASUREMENTS, CERTIFYING INSPECTIONS AND PAYMENTS

56.1 Final Measurements:

56.1.1 Within 15 (fifteen) days from the date of certification of works completed /milestone achieved in respect of the WORKS or of any portion of the WORKS, section, group or job site, as the case may be, measurements for the works covered by such certification shall be jointly taken by the ENGINEER-IN-CHARGE and the CONTRACTOR as herein provided.

56.1.2 If the CONTRACTOR fails to apply to the ENGINEER-IN-CHARGE for measurements within15 (fifteen) days from the date of certification of works completed/ milestone achieved as specified in Clause 56.1.1, the ENGINEER-IN-CHARGE shall notify the CONTRACTOR in writing of the date(s) for measurements, and require the CONTRACTOR to be present on date(s) so notified.

56.2 Mode of Measurement

56.2.1 All measurements shall be recorded in the metric system, and shall be taken in accordance with the procedures set forth or provided for in the Schedule of Rates, Specifications and other CONTRACT Documents.

56.2.2 Where the mode of measurement is not provided for in the Contract Documents in respect of any item of work, it shall be measured in accordance with the Indian Standard Specification No. 1200 (latest edition) and in the event of such item not being covered by Indian Standard Specifications, it shall be measured in accordance with the method of measurement in this behalf specified by the ENGINEER-IN-CHARGE, whose decision in this regard shall be final and binding upon the CONTRACTOR. If the Contractor disagrees with the decision of the ENGINEER-IN-CHARGE, the dispute shall be settled as per the provisions of Clause 39.0 of GCC.

56.2.3 All measurements shall be taken jointly by the ENGINEER-IN-CHARGE and the CONTRACTOR or their respective representatives. The CONTRACTOR or his authorized representative shall be entitled to remain present at all times when joint measurements are being taken.

56.2.4 Despite due intimation, if the CONTRACTOR omits or fails to be present to witness joint measurements, the measurements shall be taken in the presence of the ENGINEER-IN-CHARGE and the measurements so recorded and signed by the ENGINEER-IN-CHARGE as correct, shall be final and binding upon the Parties.

56.2.5 Except in cases covered by Clause 56.2.4, in all other cases measurements shall be signed and dated on each page by the CONTRACTOR / CONTRACT MANAGER and ENGINEER-IN-CHARGE or his representative. If the CONTRACTOR objects to any of the measurements recorded, including the mode of measurement, such objection shall be noted in the measurement book against the item objected to and such note shall be dated and authenticated by the CONTRACTOR / CONTRACT MANAGER and ENGINEER-IN-CHARGE or his representative. In the absence of any objection noted as aforesaid, the CONTRACTOR shall be deemed to have accepted the relative measurements as entered in the Measurement Book / Sheets and shall be barred from raising any objection at a later date in respect of any measurements recorded in the Measurement Book.

56.2.6 All objections noted in the Measurement Book in terms of Clause 56.2.5 shall be considered and decided within 15 days by the ENGINEER-IN-CHARGE. The decision of the ENGINEER-IN-CHARGE relative thereto (whether on the correct measurement to be adopted or on the mode of measurement to be adopted)shall be final and binding upon the Parties. If the Contractor disagrees with the decision of the ENGINEER-IN-CHARGE, the dispute shall be settled as per the provisions of Clause 39.0 of GCC.

56.2.7 The measurement as finally recorded in terms of Clause 56.2.4 or Clause 56.2.5 or 56.2.6, as applicable, shall be the Final Measurement.

56.3 CERTIFYING INSPECTIONS

All provisions referred to in Clauses 56.1 to 56.2, in respect of Mode of Measurement, shall apply to all inspections required to be made in order to qualify the CONTRACTOR for any payment(s) under the CONTRACT and any reference in the said clauses to measurements shall, for the purpose of this clause, be deemed to be a reference to certifying inspections and any reference therein to the measurement book shall, for the purpose of this clause, be deemed to be a reference to the certifying inspection book.

56.4.0 Deleted

56.5.0 PRICE SCHEDULE

56.5.1 The remuneration determined due to the CONTRACTOR as provided for in Clause 56.4.1 hereof shall constitute the entirety of the remuneration and entitlement of the CONTRACTOR in respect of the WORK under the CONTRACT, and no further or other payment whatsoever shall be or become due or payable to the CONTRACTOR under the CONTRACT.

56.5.2 Without prejudice to the generality of the provisions of Clause 56.5.1 hereof, the TOTAL LSTK PRICE shall be deemed to include and cover (unless otherwise expressly specified to the contrary in any CONTRACT document(s)):

(i) All costs, expenses, outgoings and liabilities of every nature and description whatsoever and all risks whatsoever (foreseen or unforeseen, including force majeure) to be taken or which may occur in or relative to execution, completion, testing, commissioning and/or handling over the WORKS to the OWNER and/or in or relative to acquisition, loading, unloading, transportation, storing, working

upon, using, converting fabricating, or erecting any item, equipment, system, material or component in or relative to the WORKS, and the CONTRACTOR shall be deemed to have known the nature, scope, magnitude and the extent of the works and items, MATERIALS, EQUIPMENT, and components required for the proper and complete execution of the Works though the CONTRACT documents may not fully and precisely set out, describe or specify them, and the generality hereof shall not be deemed to be anywise limited, restricted or abridged because in certain cases the CONTRACT documents or any of them shall or may and/or in other cases they shall or may not expressly state that the CONTRACTOR shall do or perform any particular labour or service or because in certain cases the CONTRACT documents state that a particular work, operation, supply, labour or service shall be performed/made by the CONTRACTOR at his own cost or without additional payment, compensation or charge or without entitlement of claim against the OWNER or words to similar effect, and in other cases they do not, or because in certain cases it is stated that the same are included in or covered by the Price Schedule and in other cases it is not so stated.

(ii) The cost of all construction and related vessels, craft, vehicles, movements, plant, equipment, distribution of water and power, construction of temporary roads and access, temporary works, pumps, wiring, pipes, scaffolding, piling, shuttering and other materials, supervision, labour, insurance, fuel, stores, spares, supplies, appliances and materials, items, articles and things whatsoever (foreseen of unforeseen) by expression or implication to be supplied, provided or arranged in or relative to or in connection with the performance and/or execution of the WORKS and/or related or incidental thereto, complete in every respect in accordance with the CONTRACT document, and the plans, drawing, designs, orders and/or instructions;

(iii) The cost of mobilisation including but not limited to mobilisation of vehicles, movements, machinery, equipment, gear, tools, tackle, consumables and other items and goods and personnel necessary for or to perform the WORKS contemplated under the CONTRACT, preparation and erection of work yards and other work places and facilities necessary for or to perform the WORKS contemplated under the CONTRACT and/or to supply the material included within the scope of supplies including all work, labour, inputs, goods, EQUIPMENT, and other items and things whatsoever necessary for the performance of the WORKS, dismantling and/or removal of the same and restoration of the site, lifting the materials and transporting them to CONTRACTOR's stock piles/work yard, job sites and loading, stacking and/or storing the same.

(iv) The costs and risks of all rents, royalties, licenses, permits, permission and other fees, duties, penalties, levies, and damages whatsoever payable for or in respect of any protected or patented goods, materials, equipment or processes employed in or relative to the works and of all rents, royalties, licenses, permits, permissions and any other fee, duty, penalty, levy, loss or damages payable on the excavation, removal or transportation of any material or acquisition or use of any right of way or other right, licenses, permit, privilege, permission or uses required for or relative to the performance of the WORK.

(v) The cost of all taxes and duties within the scope of work, all customs and import duties, Indian Income Tax, applicable GST, quay, warfare, demurrage, detention and landing charges and all other duties, taxes, fees, charges, levies, and/or cesses whatsoever imposed or to be imposed by the Central Government or State Government or Municipal or Local Bodies or other Authorities whatsoever and payable on any materials supplied and/or on works performed without any

entitlement to the CONTRACTOR for any exemption, remission, refund or reduction thereof

(vi) The cost of all indemnities under the CONTRACT, and insurance premia on insurance required in terms of the CONTRACT documents or otherwise under any law, rule or regulation, and the cost of all risks whatsoever (foreseen and unforeseen) including but not limited to risks of delay or extension of time or reduction or increase in the work or scope of work and/or cancellation of CONTRACT, and/or accident, strike, civil commotion, war, strike, labour trouble, third party breach, fire, lighting, inclement weather, storm, tempest, flood, earthquake and other acts of God, Government regulation or imposition or restriction, dislocation of road, rail, sea, air and other transport, access or facility, flooding of site and/or access roads and approaches thereto, suspension of work, sabotage and other cause whatsoever.

(vii) The cost of all inspections, tests and certificates relative thereto including third party tests and/or inspections where necessary, and of items, instruments, plant and/or tools and appliances required to conduct such inspection and tests.

(viii) The cost of all materials supplied and/or intended for incorporation in the WORKS supplied within the scope of work, delivery thereof to the job site, loading, transportation and unloading thereof, waste on materials, and return of empties and surpluses.

(ix) The cost of all escalations (foreseen and unforeseen) including but not limited to increase in Government taxes and duties (beyond contractual completion period and any extension hereof due to reasons attributable to CONTRACTOR), labor costs and material costs and other inputs whatsoever..

(x) All supervision charges, establishment's overheads, finance charges and other costs and expenses and charges to the CONTRACTOR, and the CONTRACTOR's profit of and relative to the WORK and/or supply.

(xi) The cost of all deductions, reductions, discounts, adjustments and withholdings whatsoever under or in connection with the CONTRACT.

(xii) The cost shall be deemed to include and cover the risk of all possibilities of delay and interference with the CONTRACTOR's conduct of WORK which occur from any causes including orders of the OWNER in the exercise of his power and on account of extension of time granted due to various reasons and for all other possible or probable causes of delay.

56.6.0 Deleted

56.7.0 Deleted

56.8.0 CLAIMS BY THE CONTRACTOR

56.8.1 No claim(s) shall on any account be made by the CONTRACTOR after submission of the Final Bill, with the intent that the Final Bill prepared by the CONTRACTOR shall reflect any and all claims whatsoever of the CONTRACTOR against the OWNER arising out of or in connection with the CONTRACT or any supply made or work performed by the CONTRACTOR there under or in relation thereto, and notwithstanding any enabling provision in any law or CONTRACT and notwithstanding any claim that the CONTRACTOR could have with respect thereto, the CONTRACTOR hereby waives and relinquishes any and all such claims not included in the Final Bill and absolves and discharges the OWNER from and against the same, even if in not including the same as aforesaid, the CONTRACTOR shall have acted under a mistake of law or of fact, or shall claim to have acted under economic compulsion or necessity.

56.8.2 If required by the OWNER, the ENGINEER-IN-CHARGE shall be authorised to require the CONTRACTOR to furnish, and the CONTRACTOR shall, upon the request of the ENGINEER-IN-CHARGE/OWNER, furnish all invoices, vouchers and accounting records as may be deemed necessary by the ENGINEER-IN-CHARGE/OWNER for the purpose of verifying any CONTRACTOR's claim.

56.9 DISCHARGE OF OWNER'S LIABILITY

56.9.1 The acceptance by the CONTRACTOR of any amount paid by the OWNER to CONTRACTOR in respect of the Final Bill of the CONTRACTOR in settlement of all said dues to the CONTRACTOR under the Final Bill shall, without prejudice to the claims of the CONTRACTOR included in the Final Bill in accordance with the provisions of clause 56.4.2 of GCC, be deemed to be in full and final settlement of all such dues to the CONTRACTOR notwithstanding any qualifying remarks, protest or condition imposed or purported to be imposed by the CONTRACTOR related to the acceptance of such payment, with the intent that upon acceptance by the CONTRACTOR of any payment made as aforesaid, the CONTRACT (including the arbitration clause) shall stand discharged and extinguished insofar as relates to and/or concerns the entitlements of the CONTRACTOR under the CONTRACT except for the CONTRACTOR's right, if any, to receive payment in respect of his notified claims included in his Final Bill and the right to receive payment of the unadjusted balance of the Contract Performance Security in accordance with the provisions of Clause 56.10.3 on successful completion of the DEFECT LIABILITY PERIOD. However, nothing herein stated shall affect the CONTRACTOR's undischarged liabilities and obligations under the CONTRACT.

56.9.2 The acceptance by the CONTRACTOR of any amount paid by the OWNER to the CONTRACTOR in respect of the notified claims of the CONTRACTOR included in the Final Bill, in settlement of the claims of the CONTRACTOR, shall be deemed to be in full and final settlement of all claims of the CONTRACTOR and, the CONTRACT shall stand discharged and extinguished insofar as relates to and/or concerns the claims of the CONTRACTOR except for the CONTRACTOR's rights to receive payments of the unadjusted balance, if any, of the Contract Performance Security in accordance with clause 56.10.3.0 hereof on successful completion of the DEFECT LIABILITY PERIOD. However, nothing herein stated shall affect the CONTRACTOR's undischarged liabilities and obligations under the CONTRACT.

56.9.3 Notwithstanding anything provided in Clause 56.9.1 and/or Clause 56.9.2, the CONTRACTOR shall be and remain liable for defects in terms of DEFECT LIABILITY PERIOD and associated clause thereunder and for any indemnity to the OWNER in terms of Clause 56.10.2 and shall be and remain entitled to receive the unadjusted balance of the Contract Performance Security remaining in the hands of the OWNER in terms of Clause 56.10.3 and associated clauses thereunder.

56.10.0 Deleted

56.11 CLAIMS OF OWNER

56.11.1 The release/payment of any unadjusted balance of the Contract Performance Security (furnished in the form of a Bank Guarantee or otherwise) by the OWNER to the CONTRACTOR as aforesaid or otherwise shall not be deemed or treated as a waiver of any right(s) or claim(s) of the OWNER existing before the issuance of the FINAL ACCEPTANCE CERTIFICATE or shall not stop or prevent the OWNER from thereafter making or enforcing any claim or any rights existing before the issuance of the FINAL

ACCEPTANCE CERTIFICATE against the CONTRACTOR with the intent that the claims of the OWNER, against the CONTRACTOR shall continue to survive and shall not get extinguished notwithstanding the issue of FINAL ACCEPTANCE CERTIFICATE and/or the release of Contract Performance Security to the CONTRACTOR.

57.0 UNDERGROUND OBSTRUCTIONS

The soil investigation report furnished in the NIT is indicative only and is enclosed purely for information/guidance purpose to the bidders. The contractor shall carry out its own detailed soil investigation for the proposed plant. Design of the foundation system of the plant shall be based, only on the site specific report. Nothing extra shall be paid in case of any variation arising out of the soil report conducted by the bidders and the data given in the tender. In the event, CONTRACTOR encounters any underground obstructions, the same shall be removed by CONTRACTOR without any extra cost implications to the OWNER.

In the event, CONTRACTOR encounters any underground obstruction which entails cost implication to the CONTRACTOR, the OWNER shall consider to compensate the CONTRACTOR reasonable cost compensation and/or time extension, depending on merit of the case after mutual discussion. The decision of the ENGINEER-IN-CHARGE in this regard shall be in writing and shall be final and binding upon the CONTRACTOR. It is clarified that in case the CONTRACTOR disagrees with the decision of ENGINEER-IN-CHARGE, the dispute shall be settled as per the provision of clause 39 of GCC.

57.1 ARTICLES OF VALUE FOUND:

All gold, silver and other minerals of any description and all precious stones, coins, treasure relics, antiquities and other similar things which shall be found in, under or upon the SITE, shall be the property of the OWNER and the CONTRACTOR shall duly preserve the same to the satisfaction of the ENGINEER-IN-CHARGE and shall from time to time deliver the same to such person or persons indicated by the OWNER.

58.0 REGISTRATION OF THE CONTRACTOR WITH STATUTORY AUTHORITIES

Within 30 days of execution of the CONTRACT, the CONTRACTOR shall, insofar as necessary, register itself at their own cost with the applicable statutory authorities as required under the rules and regulations governing in India. The CONTRACT PRICE shall be deemed to include all costs towards the same. A copy of all documents related to all such registration shall be submitted to OWNER for record.

59.0 STATUTORY OBLIGATIONS

59.1 CONTRACTOR shall comply with the requirements of statutory provisions and shall be solely responsible for fulfilment of all legal obligations under Contract Labour (Regulation and Abolition) Act, Inter-state Migrant Workmen (Registration of Employment and Condition of Service) Act, Payment of Wages Act, Workmen Compensation Act, Factories Act, Employees Provident Fund and Misc. Provisions Act, Payment of Bonus Act, Payment of Gratuity Act, Industrial Disputes Act and all other applicable Industrial/Labour enactment and Rules made there under as applicable from time to time. In case OWNER incurs any liability towards payment of any kind whatsoever, due to non-fulfilment of statutory provisions under any industrial/labour law by CONTRACTOR, the same shall be made good by CONTRACTOR.

59.2 SUB-CONTRACTOR engaged by CONTRACTOR for performing civil and erection work/other jobs at SITE shall have PF Code No. in its name issued by Regional Provident Fund Commissioner (RPFC).

59.3 The CONTRACTOR shall ensure that the SUB-CONTRACTOR shall comply with the Statutory Requirements, as applicable, for the execution of this CONTRACT.

60.0 UTILISATION OF LOCAL RESOURCES

60.1 The CONTRACTOR shall ascertain the availability of local SUB-CONTRACTORS and skilled/unskilled manpower and engage them to the extent possible for performance of the WORKS.

60.2 The CONTRACTOR shall not recruit personnel of any category from among those who are already employed by the other agencies working at the site, but shall make maximum use of local labour available.

61.0 FUEL REQUIREMENT OF WORKERS

The CONTRACTOR shall be responsible to arrange for the fuel requirement of his workers and staff without resorting to cutting of trees and shrubs. Cutting of trees and shrubs is strictly prohibited for this purpose. The CONTRACTOR shall abide by the conditions put forth by the Environmental Clearance for the SITE as regards to construction workers.

62.0 SURPLUS MATERIAL

Notwithstanding anything provided elsewhere, all surplus materials shall be dealt as follows:

62.1 Any balance Indigenous/imported surplus MATERIALS including scrap shall belong to the CONTRACTOR upon completion of the WORKS and will be allowed to be taken back by CONTRACTOR after compliance of statutory formalities.

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62.2 For taking out balance indigenous/imported surplus MATERIALS as mentioned above upon the completion of the project, the CONTRACTOR shall have to furnish proof of entry and ownership of such MATERIALS inside the SITE, certification of ENGINEER-IN-CHARGE and OWNER in this regard.

62.3 Following clause will apply only in case of applicability of concessional custom duty (presently, there is no applicability of concessional custom duty):

All imported surplus materials other than CONSTRUCTION EQUIPMENT which is brought to the SITE shall be the OWNER's property and shall be returned by the CONTRACTOR to the OWNER's designated stores. All such materials shall be subject to reconciliation and a proper accounting procedure shall be developed and strictly followed by the CONTRACTOR recorded in the inspection reports, proforma of which will be approved by the ENGINEER-IN-CHARGE. These reports shall form part of the completion DOCUMENTS. Inspection and acceptance of the WORK shall not relieve the CONTRACTOR from any of his responsibilities under this CONTRACT. However, indigenous Surplus Material as certified by the OWNER will be allowed to be taken back by Contractor after compliance of statutory formalities.

63.0 COORDINATION WITH OTHER AGENCIES

63.1 CONTRACTOR shall be responsible for proper coordination with other agencies operating at the site so that WORK may be carried out concurrently, without any hindrance to others. The ENGINEER-IN-CHARGE shall resolve disputes, if any, in this regard, and his decision shall be final and binding on the CONTRACTOR.

63.2 If and when required for the coordination of the WORKS with other agencies involved at SITE, the CONTRACTOR shall within the scope of work, re-route and/or prepare approaches and working areas as may be necessary.

64.0 ERECTION OF EQUIPMENT

All erection shall be carried out by deploying a crane(s) of suitable capacity. Erection by derrick shall not be permissible. The CONTRACTOR shall submit erection schemes for erection of critical equipment to ENGINEER-IN-CHARGE for his APPROVAL. No EQUIPMENT shall be erected in the absence of an approved erection scheme for such EQUIPMENT.

The quoted rates of the CONTRACTOR shall be deemed to include load testing of the crane as required to establish the lifting capacity of the crane.

65.0 ELECTRICAL CONTRACTOR'S LICENCE

65.1 The CONTRACTOR or its nominated SUB-CONTRACTOR(s), as the case may be, shall have a valid electrical contractor's license for working in the State in which the job site is located. The CONTRACTOR shall furnish a copy of the same to ENGINEER-IN-CHARGE before commencement of any electrical work or work pertaining to Electrical System.

65.2 No electrical work or work pertaining to electrical system(s) shall be permitted to be executed without a valid Electrical Contractors License being produced by the CONTRACTOR or SUB-CONTRACTOR, as the case may be, intending to execute the WORK.

66.0 RENTS & ROYALTIES

Unless otherwise specified, the CONTRACTOR shall pay all tonnage and other royalties, rents and other payments or compensation (if any) for getting stone, sand, gravel, clay, bricks or other materials required for the WORKS or any temporary works.

67.0 GOVERNMENT OF INDIA NOT LIABLE

It is expressly understood and agreed by and between the CONTRACTOR and the OWNER that the OWNER is entering into this agreement solely on its own behalf and not on behalf of any other person or entity. In particular, it is expressly understood and agreed that the Government of India is not a party to this agreement and has no liabilities, obligations or rights thereunder. It is expressly understood and agreed that the OWNER is an independent legal entity with power and authority to enter into contracts, solely in its own behalf under the applicable laws of India and general principles of Contract. The CONTRACTOR expressly agrees, acknowledges and understands that the OWNER is not an agent, representative or delegate of the Government of India. It is further understood and agreed that the Government of India is not and shall not be liable for any acts, omissions commissions, breaches or other wrongs arising out of the CONTRACT. Accordingly, CONTRACTOR hereby expressly waives, releases and foregoes any and all actions or claims, including cross claims or counter claims against the Government of India arising out of this CONTRACT and covenants not to sue the Government of India on

any matter, claim, and cause of action or thing whatsoever arising of or under this CONTRACT.

68.0 SITE CLEANING

The CONTRACTOR shall take care to keep clean the job site at all times for easy access to the job site and also from the safety point of view in accordance with the CONTRACT requirements.

69.0 ACCESS TO SITE

69.1 The CONTRACTOR shall at his own cost and initiative arrange for and provide any access to the work area and stringing or other yards for labour, EQUIPMENT and MATERIAL as may be necessary for any cause in addition to the ingress and egress available. Any arrangements in respect thereof as may be entered into by the CONTRACTOR with any person interested in the land through which access is sought, shall be in writing and a copy of the writing (certified by or on behalf of the CONTRACTOR to be true copy thereof) shall forthwith be lodged with the OWNER. Such a writing shall specifically stipulate that the OWNER shall not be responsible for any claims under the CONTRACT or for any damage, loss or injury to the land or any material, item or thing thereon or in, and the CONTRACTOR shall keep the OWNER indemnified from and against any claim, action or proceedings in respect thereof.

69.2 The CONTRACTOR shall at his own cost and initiative arrange for and obtain all necessary permissions, permits, consents and licenses as may be necessary to transport the MATERIALS, tools, EQUIPMENT, machinery and labour along or across any highway, roadway, or other way, or railway, tramway, bridge, dyke, dam or embankment, or lake, pond, canal, river, state terminal toll octroi, or other line, border or barrier. Traffic study if required, shall be carried out by CONTRACTOR independently without any liability on OWNER.

70.0 INDEPENDENT CONTRACTOR

70.1 Neither CONTRACTOR nor any SUB-CONTRACTOR nor the employees, agents or representative of either shall be deemed to be employees, agents or representative of the OWNER in the performance of the CONTRACT.

71.0 PAYEMENT TO THE SUB-CONTRACTOR

CONTRACTOR shall indemnify and hold harmless OWNER for any claim brought by SUBCONTRACTOR against OWNER in relation to CONTRACTOR’s payment obligations for the relevant purchase orders and sub-contracts.

71.1 CONTRACTOR agrees that he shall furnish to OWNER, if requested, satisfactory evidence that all SUB-CONTRACTORS, including vendor to CONTRACTOR have been paid on the time and in full for work done or goods supplied, in connection with the performance of the WORK.

71.2 If evidence is not supplied, then the OWNER shall not be bound to make any further payment to CONTRACTOR for that part of work until it is paid by CONTRACTOR.

71.3 CONTRACTOR shall notify OWNER of any dispute of any kind between CONTRACTOR and any of his SUB-CONTRACTOR or vendors stating the nature of dispute, the amount of any payment which is being withheld by CONTRACTOR, the reasons thereof and the CONTRACTOR’s plan to settle the dispute.

72.0 ORDER OF WORKS / PERMISSION / RIGHT OF ENTRY / CARE OF EXISTING SERVICES

CONTRACTOR is required to submit to OWNER the various details with respect to their personnel(s) to be deputed for the execution of WORK such as name(s), nationality and passport details in case of Foreign Nationals (Passport No., Date of Issue, Date of Expiry etc.). These details are required for granting permission to enter and work in the existing fertilizer complex. The OWNER reserves the right to declare any person(s) as non grata. No claim whatsoever shall be entertained by OWNER on this account.

OWNER shall have the right to object to any Representative or personnel deputed to India by CONTRACTOR for execution of WORK or in connection with WORK, due to their misconduct or breach of law and regulation or who are found to be incompetent or negligent. CONTRACTOR shall remove such persons from SITE forthwith and take immediate action for replacement at no cost to OWNER.

73.0 GIFTS, COMMISSIONS, ETC.

Any gift, commission or advantage given, promised or offered by or on behalf of the CONTRACTOR or his partner, agent, officers, directors, employee or servant or anyone on his or their behalf in relation to the obtaining or to the execution of this or any other contract with the OWNER, shall in addition to any criminal liability which it may incur, subject the CONTRACTOR to the cancellation of this and all other contracts and also the payment of any loss or damage to the OWNER resulting from any cancellation. The OWNER shall then be entitled to deduct the amounts so payable from any monies otherwise due to the CONTRACTOR under the CONTRACT.

74.0 LABOUR LAWS- PF, EPF AND ESI

74.1 The CONTRACTOR shall obtain necessary license from the Licensing Authority under the Contract Labour (Regulation & Abolition) Act 1970 and the Central Rules framed there under and produce the same to the ENGINEER-IN-CHARGE before start of WORK.

74.2 The CONTRACTOR shall not undertake or execute or permit any other agency or SUB-CONTRACTOR to undertake or execute any work on the CONTRACTOR'S behalf through contract labour except under and in accordance with the license issued in that behalf by the Licensing Officer or other authority prescribed under the Factories Act or the contract labour (Regulation & Abolition) Act 1970 or their applicable lay, rule or regulation, if applicable.

74.3 The provision of EPF & MP Act, 1952 and Rules scheme there under shall be applicable to the CONTRACTOR and the employees engaged by him for the WORK. The CONTRACTOR shall furnish the code number allotted by the RPFC Authority, to the ENGINEER-IN-CHARGE before commencing the WORK.

74.4 The CONTRACTOR shall be exclusively responsible for any delay in commencing the work on account of delay in obtaining a license under clause 74.1 above or in obtaining the code number under clause 74.3 above and the same shall not constitute a ground for extension of time for any purpose.

74.5 The CONTRACTOR shall enforce the provisions of ESI Act and Scheme framed from time to time there under with regard to all his employees involved in the performance of the CONTRACT and shall deduct employee's contribution from the wages of each of the employees and shall deposit the same together with employer's contribution of such total wages payable to the employees in the appropriate account.

74.6 All liabilities like salaries, wages and other statutory obligations in respect of the persons engaged by the CONTRACTOR shall be borne by the CONTRACTOR during the period

of agreement. In view of the provisions of the ESI Act, PF and EPF Act and other Acts, as may be applicable to OWNER, the CONTRACTOR shall take necessary steps to cover its employees under the said enactments and shall submit proof of such compliance to ENGINEER-IN-CHARGE periodically or at any date upon such request, as may be made by ENGINEER-IN-CHARGE to the CONTRACTOR. In the event of non-compliance with the statute or the provisions thereof, referred to above, it shall be open to OWNER to withhold such amount as in its opinion is due and payable by the CONTRACTOR in respect of its employees from and out of dues, payable by OWNER to the CONTRACTOR and such due shall be held by OWNER with it until proof is submitted by the CONTRACTOR to OWNER indicating compliance with such statutes within reasonable time, failing which OWNER shall deposit such amounts with the authorities concerned on behalf of the CONTRACTOR and inform the CONTRACTOR of such deposit or deposits.

75.0 GENERAL PROVISIONS

75.1 Confidential Information

75.1.1 **Non-disclosure**

Each party agrees to hold in confidence any information imparted to it or in the case of CONTRACTOR, to any of its SUB- CONTRACTOR / VENDOR, by the other Party which pertains to that other party's business activity in any manner, and which is not be subject of general public knowledge, including, without limitation, proprietary processes, technical information and know-how, information concerning other projects, management policies, economic policies, financial and other data and the like. The preceding non-disclosure requirements shall not apply to:

i) Information furnished without restriction by the other Party prior to the date hereof
ii) Information in the public domain; or
iii) Information obtained by a Party from a third Person not under obligation of non-disclosure to the other party.
(iv) Information required to be disclosed in pursuance of an order, judgement, decree of the Court, Tribunal or Statutory Authority.

75.1.2 **Disclosure to Govt. Agency**

Either Party may disclose any such information to the extent that such Party is required by any Government Agency to make such disclosure. In addition, OWNER may disclose such information to the extent that such disclosure is required by any Lender / Lender's Representative, etc. provided that such Lenders signed a confidentiality agreement containing confidentiality and limited use obligations not less stringent than those accepted by OWNER under the CONTRACT and License Agreement, if any and such parties are not competitor of CONTRACTOR or its Licensors.

75.1.3 Upon completion of the Works or in the event of termination pursuant to the provisions of the CONTRACT, CONTRACTOR shall immediately return to the OWNER all drawings, plans, specifications and other documents supplied to the CONTRACTOR by or on behalf of the OWNER or prepared by the CONTRACTOR solely for the purpose of the performance of the WORKS, including all copies made thereof by the CONTRACTOR.

75.1.4 This clause shall survive and remain in full force for a period of ten years following the issue of FINAL ACCEPTANCE CERTIFICATE.

75.2 **Cut-Off Dates**

No claims or correspondence on claims on this CONTRACT shall be entertained by either parties after 6 months after expiry of the Contract Performance Security unless specified otherwise in CONTRACT.

75.3 **Recovery of Sums / Dues**

75.3.1 All costs, damages or expenses which OWNER may have incurred, for which CONTRACTOR is liable under CONTRACT, shall be notified to CONTRACTOR and shall be recovered by OWNER from any payment due to or becoming due to CONTRACTOR under this CONTRACT or other CONTRACT and/or shall be recovered by action at law or otherwise. If the payment due to CONTRACTOR is not sufficient for recovery of the said sums/dues, CONTRACTOR shall pay immediately to OWNER such sums/dues or the balance sums/dues on demand.

75.3.2 All MUTUALLY AGREED DAMAGES applicable and to be recovered from CONTRACTOR under CONTRACT, shall be recovered by OWNER from any payment due to or becoming due to CONTRACTOR under this CONTRACT or other CONTRACT and/or shall be recovered by action at law or otherwise. If the payment due to CONTRACTOR is not sufficient for recovery of the said MUTUALLY AGREED DAMAGES, CONTRACTOR shall pay immediately to OWNER such MUTUALLY AGREED DAMAGES. or the balance MAD on demand.

75.3.3 For avoidance of doubt all the rights and remedies of OWNER/CONTRACTOR and liabilities of the CONTRACTOR/OWNER as set out in the CONTRACT shall be to the exclusion of any other rights, remedies or liabilities available at law.

75.4 **Payments etc. not to affect rights of OWNER**

No sum paid on account by OWNER nor any extension of the date for completion granted by OWNER shall affect or prejudice the rights of OWNER against CONTRACTOR or relieve CONTRACTOR of its obligation for the faithful performance of CONTRACT.

75.5 **Site Working and Safety Conditions**

CONTRACTOR shall follow the SITE working and safety conditions enclosed as Section VI-13.

75.6 **Miscellaneous**

75.6.1 No CONTRACT or understanding in any way modifying the conditions of CONTRACT shall be binding upon either parties hereto unless made in writing and approved by both parties.

75.6.2 Without prejudice to FORCE MAJEURE, CONTRACTOR shall, during inclement weather, carry out WORK in accordance with CONTRACT and CONTRACTOR shall not be entitled to any additional payment over and above the CONTRACT PRICE payable under CONTRACT by reason of its being unable to carry out WORK owing to inclement weather.

76.0 Implementation of Apprentices act 1961:

The CONTRACTOR shall comply with the provisions of the Apprentices Act, 1961 and the Rules and Orders issued thereunder from time to time. If he fails to do so, his failure will be a breach of the CONTRACT and the ENGINEER-IN-CHARGE may, at his discretion, cancel the CONTRACT. The CONTRACTOR shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions, of the Act.

77.0 Change in constitution

Where the CONTRACTOR is a partnership firm, the prior approval of the OWNER shall be obtained in writing, before any change is made in the constitution of the firm. Where the CONTRACTOR is an individual or a Hindu undivided family business concern, such approval as aforesaid shall, likewise be obtained before such CONTRACTOR enters into any agreement with other parties, where under, the reconstituted firm would have the right to carry out the work hereby undertaken by the CONTRACTOR. In either case if prior approval as aforesaid is not obtained, the CONTRACT shall be deemed to have been allotted in contravention of clause 12 of GCC and the same action may be taken and the same consequence shall ensure as provided in the said clause.

78.0 Access by Road:

CONTRACTOR, if necessary, shall build other temporary access roads to the actual site of construction for his own work at his own cost. The CONTRACTOR shall be required to permit the use of the roads so constructed by him for vehicles of any other parties who may be engaged on the project site. The CONTRACTOR shall also facilitate the construction of the permanent roads should the construction there of start while he is engaged on this work. He shall make allowance in his tender for any inconvenience he anticipates on such account. Non-availability of access roads, railway siding and railway wagons for the use of the CONTRACTOR shall in no case condone any delay in the execution of WORK nor be the cause for any claim for compensation against the OWNER.

79.0 Members of the OWNER not individually liable:

No Director, or official or employee of the OWNER/ PMC shall in any way be personally bound or liable for the acts or obligations of the OWNER under the CONTRACT or answerable for any default or omission in the observance or performance of any of the acts, matters or things which are herein contained.

80.0 OWNER not bound by personal representations:

The CONTRACTOR shall not be entitled to any increase on the scheduled rates or any other right or claim whatsoever by reason of any representation, explanation statement or alleged representation, promise or guarantees given or alleged to have been given to him by any person.

81.0 Land for Contractor's Field Office, Godown and Workshop:

The OWNER will, at his own discretion and convenience and for the duration of the execution of the work make available near the site, land for construction of CONTRACTOR's Temporary Field Office, godowns workshops and assembly yard required for the execution of the CONTRACT. The CONTRACTOR shall at his own cost construct all these temporary buildings and provide suitable water supply and sanitary arrangement and get the same approved by the ENGINEER-IN-CHARGE. On completion of the works undertaken by the CONTRACTOR, he shall remove all temporary works erected by him and have the SITE cleaned as directed by ENGINEER-IN-CHARGE. If the CONTRACTOR shall fail to comply with these requirements, the ENGINEER-IN-

CHARGE may at the expenses of the CONTRACTOR remove such surplus, and rubbish materials and dispose-off the same as he deems fit and get the site cleared as aforesaid; and CONTRACTOR shall forthwith pay the amount of all expenses so incurred and shall have no claim in respect of any such surplus materials disposed off as aforesaid. But the OWNER reserves the right to ask the CONTRACTOR any time during the pendency of the CONTRACT to vacate the land by giving 7 days' notice on security reasons or on national interest or otherwise. Rent may be charged for the land so occupied from contractor by the OWNER. The CONTRACTOR shall put up temporary structures as required by them for their office, fabrication shop and construction stores only in the area allocated to them on the project site by the OWNER or his authorized representative. No tea stalls/canteens should be put up or allowed to be put up by any CONTRACTOR in the allotted land or complex area without written permission of the OWNER. Un-authorized buildings, constructions or structures should not be put up by the CONTRACTOR anywhere on the project site. For uninterrupted fabrication work, the CONTRACTOR shall put up temporary covered structures at his cost within Area in the location allocated to them in the project site by the OWNER or his authorized representative. No person except for authorized watchman shall be allowed to stay in the plant area/CONTRACTOR's area after completion of the day's job without prior written permission from ENGINEER-IN-CHARGE.

82.0 Rounding-Off of Amounts:

In calculating the amount of each item due to the CONTRACTOR in every certificate prepared for payment, sum of less than 50 paise shall be omitted and the total amount on each certificate shall be rounded off to the nearest rupees, i.e., sum of less than 50 paise shall be omitted and sums of 50 paise and more upto one rupee shall be reckoned as one rupee.

83.0 Deleted

84.0 Work In Monsoon and Dewatering

(i) Unless otherwise specified elsewhere in the tender, the execution of the WORK may entail working in the monsoon also. The CONTRACTOR must maintain a minimum labour force as may be required for the job and plan and execute the construction and erection according to the prescribed schedule. No extra rate will be considered for such work in monsoon.

(ii) During monsoon and other period, it shall be the responsibility of the CONTRACTOR to keep the construction work site free from water at his own cost.

85.0 General conditions for construction and erection work:

(i) The working time at the site of work is 48 hours per week. Overtime work is permitted in cases of need and the OWNER will not compensate the same. Shift working at 2 or 3 shifts per day will become necessary and the CONTRACTOR should take this aspect into consideration for formulating his rates for quotation. No extra claims will be entertained by the OWNER on this account. No extra claims will be entertained by the OWNER on this account. For carrying out work beyond working hours the CONTRACTOR will approach the ENGINEER-IN-CHARGE or his authorized representative and obtain his prior written permission.

(ii) The CONTRACTOR must arrange for the placement of workers in such a way that the delayed completion of the WORK or any part thereof for any reason whatsoever will not affect their proper employment. The OWNER will not entertain any claim for idle time payment whatsoever.

(iii) The CONTRACTOR shall submit to the OWNER/ENGINEER-IN-CHARGE reports at regular intervals regarding the state and progress of WORK. The details and proforma of the report will mutually be agreed after the award of CONTRACT. The CONTRACTOR shall provide display boards showing progress and labour strengths at worksite, as directed by the ENGINEER-IN-CHARGE.

86.0 Action where no specification is issued:

In case of any class of WORK for which there is no SPECIFICATION supplied by the OWNER as mentioned in the Tender Documents such WORK shall be carried out in accordance with Indian Standard Specifications and if the Indian Standard Specifications do not cover the same, the WORK should be carried out as per standard Engineering Practice subject to the approval of the ENGINEER-IN-CHARGE.

87.0 Care of Works:

i) From the commencement to completion of the WORK, the CONTRACTOR shall take full responsibility for the care for all works including all temporary works and in case any damages, loss or injury shall happen to the WORK or to any part thereof or to any temporary works from any cause whatsoever, shall at his own cost repair and make good the same so that at completion the WORK shall be in good order and in conformity in every respects with the requirement of the CONTRACT and the ENGINEER-IN-CHARGE's instructions**.**

ii) **Defects Prior To Taking Over**: If at any time, before the WORK is taken over, the ENGINEER-IN-CHARGE shall: a) Claim that any works done or materials used by the CONTRACTOR or by any SUB-CONTRACTOR is defective or not in accordance with the CONTRACT, or that the works or any portion thereof are defective, or do not fulfill the requirements of CONTRACT (all such matters being hereinafter, called `Defects' in this clause), and b) As soon as reasonably practicable, gives to the CONTRACTOR notice in writing of the said decision, specifying particulars of the defects alleged to exist or to have occurred, then the CONTRACTOR shall at his own expenses and with all speed make good the defects so specified. In case CONTRACTOR shall fail to do so, the OWNER may take, at the cost of the CONTRACTOR, such steps as may in all circumstances, be reasonable to make good such defects. The expenditure so incurred by the OWNER will be recovered from the amount due to the CONTRACTOR. The decision of the ENGINEER-IN-CHARGE with regard to the amount to be recovered from the CONTRACTOR will be final and binding on the CONTRACTOR. As soon as the WORK has been completed in accordance with the CONTRACT (except in minor respects that do not affect their use for the purpose for which they are intended and except for maintenance thereof provided in clause 3.0 (22) of General Conditions of Contract) and have passed the tests on completion, the ENGINEER-IN-CHARGE shall issue a certificate (hereinafter called Completion Certificate) in which he shall certify the date on which the WORK have been so completed and have passed the said tests and the OWNER shall be deemed to have taken over the WORK on the date so certified. If the WORK has been divided into various groups in the CONTRACT, the OWNER shall be entitled to take over any group or groups before the other or others and there upon the ENGINEER-IN-CHARGE shall issue a Completion Certificate which will, however, be for such group or groups so taken over only. In such an event if the group /section/ part so taken over is related, to the integrated system of the work, notwithstanding date of grant of Completion Certificate for group/ section/ part.

iii) **Defects After Taking Over**: In order that the CONTRACTOR could obtain a COMPLETION CERTIFICATE he shall make good, with all possible speed, any

defect arising from the defective materials supplied by the CONTRACTOR or workmanship or any act or omission of the CONTRACT or that may have been noticed or developed, after the works or groups of the works has been taken over, the period allowed for carrying out such WORK will be normally one month. If any defect is not remedied within a reasonable time, the OWNER may proceed to do the WORK at CONTRACTOR's risk and expense and deduct from the final bill such amount as may be decided by the OWNER. If by reason of any default on the part of the CONTRACTOR a COMPLETION CERTIFICATE has not been issued in respect of any portion of the WORK within one month after the date fixed by the CONTRACT for the completion of the WORK, the OWNER shall be at liberty to use the WORK or any portion thereof in respect of which a completion certificate has not been issued, provided that the WORK or the portion thereof so used as aforesaid shall be afforded reasonable opportunity for completing these works for the issue of Completion Certificate.

iv) COMPLETION CERTIFICATE' where ever mentioned shall be read as 'PRELIMINARY ACCEPTANCE CERTIFICATE'

88.0 Field Management & Controlling / Coordinating Authority:

i) The field management will be the responsibility of the ENGINEER-IN-CHARGE, who will be nominated by the OWNER. The ENGINEER-IN-CHARGE may also authorize his representatives to assist in performing his duties and functions.

ii) The ENGINEER-IN-CHARGE shall coordinate the works of various agencies engaged at site to ensure minimum disruption of work carried out by different agencies. It shall be the responsibility of the CONTRACTOR to plan and execute the work strictly in accordance with site instructions to avoid hindrance to the work being executed by other agencies.

89.0 Local Conditions:

i) It will be imperative on each tenderer to inform himself of all local conditions and factors which may have any effect on the execution of WORK covered under the Tender Document. In their own interest, the tenderer are requested to familiarize themselves with the Indian Income Tax Act 1961, Indian Companies Act 1956/2013, Indian Customs Act 1962 and other related Acts and Laws and Regulations of India with their latest amendments, as applicable. TFL shall not entertain any requests for clarifications from the tenderer regarding such local conditions.

ii) It must be understood and agreed that such factors have properly been investigated and considered while submitting the tender. No claim for financial or any other adjustments to VALUE OF CONTRACT, on lack of clarity of such factors shall be entertained.

90.0 Special Conditions of Contract:

i) Special Conditions of Contract (SCC) shall be read in conjunction with the General Conditions of Contract (GCC), specification of Work, Drawings and any other documents forming part of this CONTRACT wherever the context so requires.

ii) Notwithstanding the sub-division of the documents into these separate sections and volumes every part of each shall be deemed to be supplementary to and complementary of every other part and shall be read with and into the CONTRACT so far as it may be practicable to do so.

iii) Where any portion of the General Condition of Contract is repugnant to or at variance with any provisions of the Special Conditions of Contract, unless a different intention

appears the provisions of the Special Conditions of Contract shall be deemed to over-ride the provisions of the General Conditions of Contract and shall to the extent of such repugnancy, or variations, prevail.

iv) Wherever it is mentioned in the specifications that the CONTRACTOR shall perform certain WORK or provide certain facilities, it is understood that the CONTRACTOR shall do so at his cost and the VALUE OF CONTRACT shall be deemed to have included cost of such performance and provisions, so mentioned.

v) The materials, design and workmanship shall satisfy the relevant INDIAN STANDARDS, the JOB SPECIFICATIONS contained herein and CODES referred to. Where the job specification stipulate requirements in addition to those contained in the standard codes and specifications, these additional requirements shall also be satisfied.

91.0 POWER OF ENTRY:

1) If the CONTRACTOR shall not commence the WORK in the manner previously described in the CONTRACT documents or if he shall at any time in the opinion of the ENGINEER-IN-CHARGE -

   i) fail to carry out the WORK in conformity with the CONTRACT documents, or

   ii) fail to carry out the WORK in accordance with the Time Schedule, or

   iii) substantially suspend work or the WORK for a period of fourteen days without authority from the ENGINEER-IN-CHARGE, or

   iv) fail to carry out and execute the WORK to the satisfaction of the ENGINEER-IN-CHARGE, or

   v) fail to supply sufficient or suitable construction plant, temporary works, labour, materials or things, or

   vi) Commit, suffer, or permit any other breach of any of the provisions of the CONTRACT on his part to be performed or observed or persist in any of the above mentioned breaches of the CONTRACT for fourteen days, after notice in writing shall have been given to the CONTRACTOR by the ENGINEER-IN-CHARGE requiring such breach to be remedied, or

   vii) if the CONTRACTOR shall abandon the WORK , or

   viii) If the CONTRACTOR during the continuance of the CONTRACT shall become bankrupt, make any arrangement or composition with his creditors, or permit any execution to be levied or go into liquidation whether compulsory or voluntary not being merely a voluntary liquidation for the purpose of amalgamation or reconstruction

then in any such case, the OWNER shall have the power to enter upon the WORK and take possession thereof and of the materials, temporary WORK, construction plant, and stock thereon, and to revoke the CONTRACTOR's license to use the same, and to complete the WORK by his agents, other CONTRACTORS or workmen or to relate the same upon any terms and to such other person, firm or corporation as the OWNER in his absolute discretion may think proper to employ and for the purpose aforesaid to use or authorize the use of any materials, temporary work, CONSTRUCTION PLANT, and stock as aforesaid, without making payment or allowance to the CONTRACTOR for the said materials other than such as may be certified in writing by the ENGINEER-IN-CHARGE to be reasonable, and without making any payment or allowance to the CONTRACTOR for the use of the temporary said works, construction plant and stock or being liable for any loss or damage thereto, and if the OWNER shall by reason of his taking possession of the WORK or of the WORK being completed by other CONTRACTOR (due account being taken of any such extra work or works which may or be omitted) then the amount of such

excess as certified by the ENGINEER-IN-CHARGE shall be deducted from any money which may be due for work done by the CONTRACTOR under the CONTRACT and not paid for. Any deficiency shall forthwith be made good and paid to the OWNER by the CONTRACTOR and the OWNER shall have power to sell in such manner and for such price as he may think fit all or any of the construction plant, materials etc. constructed by or belonging to and to recoup and retain the said deficiency or any part thereof out of proceeds of the sale.

92.0 LIENS:

1) If, at any time there should be evidence or any lien or claim for which the OWNER might have become liable and which is chargeable to the CONTRACTOR, the OWNER shall have the right to retain out of any payment then due or thereafter to become due an amount sufficient to completely indemnify the OWNER against such lien or claim and if such lien or claim be valid, the OWNER may pay and discharge the same and deduct the amount so paid from any money which may be or may become due and payable to the CONTRACTOR. If any lien or claim remain unsettled after all payments are made, the CONTRACTOR shall refund or pay to the OWNER all money that the latter may be compelled to pay in discharging such lien or claim including all costs and reasonable expenses. OWNER reserves the right to do the same.

2) The OWNER shall have lien on all materials, equipments including those brought by the CONTRACTOR for the purpose of erection, testing and commissioning of the WORK.

3) The final payment shall not become due until the CONTRACTOR delivers to the ENGINEER-IN-CHARGE a complete release or waiver of all liens arising or which may arise out of his agreement or receipt in full or certification by the CONTRACTOR in a form approved by ENGINEER-IN-CHARGE that all invoices for labour, materials, services have been paid in lien thereof and if required by the ENGINEER-IN-CHARGE in any case an affidavit that so far as the CONTRACTOR has knowledge or information the releases and receipts include all the labour and material for which a lien could be filled.

4) CONTRACTOR will indemnify and hold the OWNER harmless, for a period of two years after the issue of FINAL ACCEPTANCE CERTIFICATE, from all liens and other encumbrances against the OWNER on account of debts or claims alleged to be due from the CONTRACTOR or his SUB-CONTRACTOR to any person including SUB-CONTRACTOR and on behalf of OWNER will defend at his own expense, any claim or litigation brought against the OWNER or the CONTRACTOR in connection therewith. CONTRACTOR shall defend or contest at his own expense any fresh claim or litigation by any person including his SUB-CONTRACTOR, till its satisfactory settlement even after the expiry of two years from the date of issue of FINAL CERTIFICATE.

SECTION – V

SPECIAL CONDITIONS OF CONTRACT

CONTENT

SL.NO.	DESCRIPTION
	GENERAL
1.0	CONTRACTOR'S OBLIGATIONS
2.0	OWNER'S OBLIGATIONS
3.0	CHANGE IN WORK/CHANGE ORDER
4.0	ACCEPTANCE OF PLANTS AND FACILITIES
5.0	PLANT ACCEPTANCE CRITERIA
6.0	ISSUANCE OF PRELIMINARY ACCEPTANCE CERTIFICATE
7.0	LABOUR AND STAFF
8.0	TRAINING OF OWNER'S PERSONNEL
9.0	MODE OF CONTRACTING
10.0	FINAL BILL
11.0	DELETED
12.0	DELETED
13.0	STATUTORY VARIATION IN TAXES AND DUTIES
14.0	PAYMENT TERMS
15.0	BILLING SCHEDULE
16.0	DEEMED ACCEPTANCE
17.0	LIABILITY FOR DEFECTS
18.0	PERFORMANCE TESTS
19.0	FINAL ACCEPTANCE CERTIFICATE

GENERAL

The SPECIAL CONDITIONS OF CONTRACT shall be read in conjunction with the GENERAL CONDITIONS OF CONTRACT, specifications of work, DRAWINGS and any other document forming part of this CONTRACT wherever the context so requires.

Where any portion of the GENERAL CONDITIONS OF CONTRACT is repugnant to or at variance with any other provisions of the SPECIAL CONDITIONS OF CONTRACT, then unless a different intension appears, the SPECIAL CONDITIONS OF CONTRACT shall be deemed to over-ride the provisions of GENERAL CONDITIONS OF CONTRACT and shall prevail to the extent of such repugnancy or variations.

1.0 CONTRACTOR'S OBLIGATIONS

1.1.0 General Responsibility

1.1.1 The CONTRACTOR acknowledges that this CONTRACT is a Lumpsum turnkey contract and CONTRACTOR'S obligation hereunder, notwithstanding anything to the contrary contained herein, is to provide OWNER with fully operational PLANT, complete in all respects under and in accordance with the provision of CONTRACT, within the stipulated time and for the purpose designated herein by OWNER, and to do, furnish and provide everything necessary in connection therewith.

Without prejudice to the foregoing and except as otherwise expressly set forth in the CONTRACT as within the scope of OWNER's obligations under the CONTRACT, the CONTRACTOR shall perform or cause to be performed all WORK and services required in connection with the detailed design, engineering, manufacturing, ~~supply of equipment,~~ procurement (including, without limitation, all transportation services in connection therewith), Third Party Inspection (TPI) as applicable, testing, painting, Expediting, Site Survey and Condition Assessment, Insurance, Construction and Erection of Mechanical, Electrical and Instrumentation Works, Assembly and Installation of Equipments, obtaining all necessary Statutory Approvals, Pre-Commissioning, Commissioning including conducting of Sustained Load test and Performance Guarantee Test Run (PGTR), demonstration of guarantees & calibration and other work and services up to the PRELIMINARY ACCEPTANCE OF PLANT by the OWNER and in connection therewith provide all materials, equipment, machinery, tools, labour, transportation, administration and other services and items required to complete the PLANT in all respects up to the PRELIMINARY ACCEPTANCE OF PLANT and having the performance as guaranteed under the CONTRACT by the CONTRACTOR on a total, fixed price basis in accordance with this CONTRACT.

PLANT' for this NIT shall mean the 'INSTRUMENT AIR & PLANT AIR SYSTEM' as detailed below and in the Technical Section of NIT:

- (2W+1SB), Air Compressors
- 1 No wet Air receiver Knock Out Drum
- 1+1 No. Electric Heater with standby dryer/regeneration vessel(no purge loss)
- 1 No. Dried After Cooler

- 1 No. Dry Air Receiver
- (1working+1SB) Set of IA dryers
- 1 No. Low Pressure Wet Air Receiver
- 1 No. High pressure compressor for Back up receiver.
- 1 No. Back up IA receiver for 30 min storage @ 36.5 Kg/cm2g

The WORK shall, without prejudice to the generality of the foregoing or those enumerated in Clause 1.2.0 include but not be limited to the following:

(a) All engineering and design services including necessary investigation required for a completely engineered PLANT including necessary documentation;

(b) Provision of all equipment, systems, materials, processes, CONTRACTOR's EQUIPMENT, temporary works and all other items, whether of a temporary or permanent nature including those required for the design, erection, Pre-commissioning, commissioning, conducting of PERFORMANCE GUARANTEE TEST RUN and remedying of DEFECTS during DEFECT LIABILITY PERIOD.

(c) Transportation from works, port of entry and import clearance and handling services in and into India and inland transportation from the relevant points of delivery of EQUIPMENT required in connection with the completion of the PLANT, and the performance of the other WORK

(d) Project management.

(e) Receipt of EQUIPMENT at SITE including stores management.

(f) Construction infrastructure services,; mechanical, electrical and instruments erection and installation services, inspection, testing and commissioning, and PERFORMANCE GUARANTEE TEST RUN before PRELIMINARY ACCEPTANCE of PLANT including all relevant applicable permits, with CONTRACTOR having responsibility for overall co-ordination of permits required by the OWNER and all training activities;

(g) Provision of all necessary superintendence, labour, construction fuels and construction chemicals, tools, supplies and other consumables and services;

Construction water (at one point within factory premises and CONTRACTOR to arrange the line upto their Battery Limit) and Construction Power (1 No. 415V feeder of 63A at Existing Substation Near 132 kV Switchyard and CONTRACTOR to arrange tap off Power from this feeder) shall be provided within 3 months of issuance of FOA on chargeable basis (presently @ of Rs 4.50/m^3 for Construction Water and Rs 5.915/KWH for Construction Power. In case of any escalation by statutory authorities in the unit rates during execution of Contract, the same shall be borne by Contractor)

Utilities as defined in Technical part of Section VI-2.0 of NIT and shall be made available to the LSTK CONTRACTOR at one point of battery limit 2 months before

scheduled Completion Period. However required utilities prior to this will be arranged by LSTK CONTRACTOR.

(h) Rectification of defects during DEFECT LIABILITY PERIOD.

1.1.2 CONTRACTOR shall provide services, for PLANT, in accordance with good engineering practice. CONTRACTOR shall provide services of engineers, designers, draftsmen, buyers, inspectors, expediters and other persons required for the performance of WORK pursuant to CONTRACT.

1.1.3 In the event that there is any item of EQUIPMENT or WORK of the type provided for in CONTRACT, which is not specifically mentioned in the specifications or drawings set out in FINAL PROPOSAL, but which is necessary (even though not mentioned in CONTRACT) for normal, safe and continuous operation of PLANT, CONTRACTOR shall include such item of EQUIPMENT in the design and perform such items of WORK, for such EQUIPMENT or WORK free of cost to OWNER as if the same had been originally included in its Scope of Work/FINAL PROPOSAL.

1.1.4 Subject to prior consent of OWNER/PMC, CONTRACTOR may make use of the services of SUB-CONTRACTOR/ VENDOR (approved in writing by the OWNER) in accordance with the provisions in CONTRACT provided, however, the CONTRACTOR shall remain responsible and liable for the work done by such SUB-CONTRACTOR/vendor.

1.1.5 The CONTRACTOR shall be responsible for obtaining necessary approvals which are to be issued in the CONTRACTOR's name from the various statutory authorities. All approvals/permissions other than Environment Clearance and Consent to Establish/Operate shall be obtained by the CONTRACTOR.

1.1.6 The CONTRACTOR shall provide necessary full technical assistance to OWNER including follow-up for obtaining the necessary approvals to be issued in the name of OWNER from the various statutory authorities.

1.1.7 The CONTRACTOR shall furnish CONTRACT PERFORMANCE SECURITY as per the enclosed format in line with the provisions of bidding document.

1.1.8 The enumeration in subsequent Clauses of SPECIAL CONDITIONS OF CONTRACT, in GENERAL CONDITIONS OF CONTRACT and other documents of CONTRACT shall not in any manner limit the general scope of obligations and responsibilities of designing, engineering, procurement, supply, construction, commissioning and proving the performance guarantees of PLANT within the scope of CONTRACT.

1.2.0 CONTRACTOR's Scope of Work

1.2.1 CONTRACTOR shall provide and be responsible for the tasks specified in this Clause under the following heads:

1.2.2 Deleted

1.2.3 Design & Engineering

1.2.3.1 CONTRACTOR shall provide all design and engineering services necessary for completion of the PLANTS in conformity with the CONTRACT and Good Engineering Practices and the NIT including but not limited to:

(a) Preparation of

- Project design book which shall form the basis of PLANT design;
- The conceptual design; and
- The engineering and design necessary to describe and detail the PLANT and the Project.

(b) Provision of criteria for the detailed design by other suppliers of equipment/system/structures for incorporation into the PLANTS.

(c) Preparation of design, engineering, drawings, plans, bill of material, schedule and estimates for the PLANT and the project and the performance by CONTRACTOR of its obligations hereunder so that the PLANT constructed and commissioned by the CONTRACTOR is capable of meeting the performance guarantees and will be such as could be legally, safely and reliably placed in commercial operation by the OWNER.

(d) CONTRACTOR shall perform the design and engineering for PLANT so that when constructed and commissioned, PLANT shall be capable of meeting the guarantees with respect to quality and quantity of products, consumption of raw materials and utilities, and Pollution Level as guaranteed under CONTRACT and shall be reliable and safe and operable in accordance with the sound engineering practice. CONTRACTOR shall ensure design capacity of all sections of PLANT in accordance with CONTRACTOR's experience vis-a-vis as indicated in this NIT and expertise for obtaining a full throughput under varying conditions within the limits specified in CONTRACT. PLANT shall be designed so as to be capable of producing at full plant capacity when operated as specified in CONTRACT. CONTRACTOR shall review the basic design conditions and other conditions furnished by OWNER/PMC in NIT. If CONTRACTOR observes any inconsistency or insufficiency in these data, CONTRACTOR shall bring to the notice of OWNER/PMC the same, before its use.

1.2.4 Deleted

1.2.5 Codes and Standards

1.2.5.1 The engineering shall be performed and EQUIPMENT shall be manufactured and supplied according to acceptable international standards, as specified in the Technical Specification/FINAL PROPOSAL, meeting safety and other requirements of various national/international Codes and Regulations being in force as on submission of the FINAL PROPOSAL. The design of PLANT shall be based on the criteria enumerated in

CONTRACT. However, it shall be CONTRACTOR's responsibility to follow all Indian Rules and Regulations as applicable.

CONTRACT shall comply with and shall cause the WORK and all components thereof (including, without limitation, the design and engineering of the PLANT) to comply with all APPLICABLE LAWS and APPLICABLE PERMITS as they may be in effect at the time of CONTRACTOR's performance under the CONTRACT.

The CONTRACTOR shall ensure that all actions on its behalf in connection with the WORKS shall be in compliance with applicable laws of India. The CONTRACTOR agrees to take all reasonable steps to ensure that Persons appointed by it in connection with the WORK shall comply with the applicable laws/ regulations/ guidelines and obligations.

1.2.6 **Drawings and Documents**

1.2.6.1 CONTRACTOR shall prepare or secure and furnish to OWNER all data, specifications, drawings, plans and other documents as required/used for WORK as specified in Technical Specifications.

1.2.7 **Owner's/PMC Review**

1.2.7.1 ENGINEER-IN-CHARGE shall review all documents and give its comments to CONTRACTOR within 14 (Fourteen) working days from the date of receipt of the same. Review as aforesaid by OWNER/PMC and furnishing of comments by OWNER/PMC or the failure of OWNER/PMC to review or comment as aforesaid shall not relieve CONTRACTOR in any manner of its obligations including performance guarantees under this CONTRACT.

1.2.8 **Procurement Services**

1.2.8.1.1 As part of the WORK, CONTRACTOR shall procure and pay in CONTRACTOR's name as an independent contractor and not as agent for OWNER, all CONTRACTOR and SUB-CONTRACTOR's labour, materials, equipment, supplies, soil, gravel and similar materials and manufacturing, fabrication and related services (whether on or off the PLANT Site) for construction and incorporation in the PLANT or which are otherwise required for completion of the WORK in accordance with the Specification and the CONTRACT and are not explicitly specified to be furnished by OWNER pursuant to the terms and provisions of the CONTRACT including FINAL PROPOSAL.

1.2.8.1.2 CONTRACTOR shall procure and provide all EQUIPMENT required for PLANT. EQUIPMENT procured shall be according to specifications as set forth in the CONTRACT, proven record of performance and with suitable delivery time to meet the Contractual COMPLETION PERIOD. EQUIPMENT shall be procured from the vendor list agreed between CONTRACTOR and OWNER/PMC.

In connection with its procurement work, CONTRACTOR shall be responsible for the shipping, transportation and delivery of all items fabricated, manufactured, constructed or procured as set forth in the FINAL PROPOSAL and the CONTRACT. All such items and

equipment, materials and supplies to be provided by the CONTRACTOR pursuant to the CONTRACT shall be new and of required quality, free from improper workmanship or defects and properly warranted or guaranteed in accordance with the CONTRACT. Any apparent omission or error in the equipment specifications will be corrected by the CONTRACTOR to the extent required by the CONTRACT.

1.2.8.2 **Equipment**

1.2.8.2.1 CONTRACTOR agrees that EQUIPMENT procured shall be strictly in accordance with the specifications as provided, however, that any apparent omission or error in the specifications will be corrected by CONTRACTOR if it is necessary for the functioning of EQUIPMENT. CONTRACTOR shall inform OWNER/PMC for such omission or error or ambiguity in the specifications and corrections made for the same.

1.2.8.2.2 Completeness of EQUIPMENT shall be the responsibility of CONTRACTOR. Any fittings, accessories, etc. which may not be specifically mentioned in Technical Specifications but which is required for the satisfactory functioning of EQUIPMENT and realization of PERFORMANCE GUARANTEES shall be provided by CONTRACTOR without any extra cost.

1.2.8.2.3 CONTRACTOR shall ensure that the modern practices in the manufacture of high grade EQUIPMENT are followed notwithstanding any omission in the specifications.

1.2.8.2.4 The supplies including fittings, accessories, etc. shall be in strict compliance to the applicable specifications/codes/standards. Components for which no relevant standards exist, the same shall be designed and manufactured as per good engineering practices.

1.2.8.2.5 The true intent and meaning of this Clause is that CONTRACTOR shall in all respects design, engineer, ensure quality of manufacture and supply EQUIPMENT in a thorough workman like manner, within prescribed time and in accordance with good engineering practice in order to enable proper operation of EQUIPMENT and PLANT.

1.2.8.2.6 CONTRACTOR shall furnish drawings and documents of EQUIPMENT as described in Technical part, Section VI. These documents shall include but not limited to technical documents, final drawings, preservation instructions, operation and maintenance manuals, test certificates, spare parts catalogues, etc. in a bound book for all rotating EQUIPMENT and in a folder for other EQUIPMENT, before despatch of EQUIPMENT under intimation to OWNER.

1.2.8.2.7 The documents, required for statutory approvals once submitted during construction period by CONTRACTOR shall be firm and final and not subject to subsequent changes unless such subsequent changes are approved by statutory agencies. CONTRACTOR shall be responsible for any payment of penalty as imposed by the Statutory Agencies consequent to furnishing of any in correct data/drawings.

1.2.8.2.8 All dimensions and weights shall be in metric system.

1.2.8.2.9 EQUIPMENT to be supplied and WORK to be carried out under CONTRACT shall conform to and comply with the provision of relevant Regulations/Acts (or both) as may be applicable in the State of ODISHA and in India to the type of EQUIPMENT/ WORK carried out and necessary certificates shall be furnished.

1.2.8.2.10 CONTRACTOR shall provide cross sectional drawings wherever applicable to identify the spare part numbers and their location, e.g. the size of bearings/ seals, their make and number shall be furnished.

1.2.8.3 CONTRACTOR shall furnish unpriced copy of Purchase Orders/Work Order/Contract for equipments and major items as per the list to be mutually agreed (including Priced copy of Purchase Orders/Work Order/Contract as required by the statutory authority) together with spares and special maintenance tools covering accurately all terms and conditions such as specifications requirements for quality, inspection, and test, warranties and guarantees, erection and commissioning assistance by vendor, delivery schedule, packing, transportation and insurance, and documentation.

1.2.8.4 CONTRACTOR shall arrange & furnish/provide to OWNER/PMC,

a) Lubrication schedule from VENDOR, if required ,

b) Mechanical specifications and equipment data sheets for review by OWNER for CRITICAL EQUIPMENT before manufacture is started,

c) Shop fabrication drawings as made available by vendor,

d) Characteristic curves for pumps and compressors, etc. as made available by vendor,

e) Certified drawings including civil scope drawing and loading data, pertinent bulletin, installation, operation and maintenance manuals and test certificates as received from vendor,

f) Final revised vendor's drawings, as described in Technical Specifications, before PRELIMINARY ACCEPTANCE.

g) Any other information as may be sought by OWNER/PMC.

Any changes necessary during commissioning period can be incorporated in the as- built drawing and will be submitted after PAC as per the mutually agreed schedule.

1.2.8.5 CONTRACTOR shall provide services of vendor's specialist for installation and commissioning of EQUIPMENT whenever necessary.

1.2.8.6 Deleted

1.2.8.7 **Inspection, Expediting & Testing**

1.2.8.7.1 CONTRACTOR shall establish an inspection and expediting system and use its services for obtaining EQUIPMENT which conforms to the required technical and quality specifications and delivery schedule according to Purchase Order. CONTRACTOR shall send copies of expediting and inspection reports regularly to OWNER/PMC. CONTRACTOR shall arrange Third Party Inspection and quality certification of EQUIPMENT, as described in CONTRACT. Copies of all test results/report of the tests shall be furnished promptly by the CONTRACTOR to the OWNER/PMC.

Third party Inspection shall be carried by LLyods/BV/TUV/DNV.

1.2.8.7.2 OWNER/PMC or its INSPECTOR shall have the right to inspect and/or to test EQUIPMENT to check its conformity to the specifications laid down in the CONTRACT and as per approved QAP (Quality Assurance Plan). CONTRACTOR shall specify the inspections and tests to be carried out giving reference of applicable codes/standards and the location of inspection/test to OWNER/PMC. OWNER shall notify CONTRACTOR in writing the name of INSPECTOR retained for this purpose. Expediting by OWNER's representative in no way relieves the CONTRACTOR of his obligation under the terms and conditions of this CONTRACT.

1.2.8.7.3 The inspection and tests may be conducted at the premises of CONTRACTOR or SUB-CONTRACTOR/vendor before delivery and/or at SITE. All reasonable facilities and assistance including access to all drawings and production data shall be furnished to INSPECTOR at no charge to OWNER.

1.2.8.7.4 Should any inspected or tested EQUIPMENT fail to conform to the specifications, OWNER/PMC may reject it and CONTRACTOR shall either replace the rejected EQUIPMENT or make all alterations necessary to meet specification requirements free of cost.

1.2.8.7.5 OWNER's right to inspect and wherever necessary, comment about EQUIPMENT after its arrival at SITE or its participation in tests in respect of any EQUIPMENT shall in no way be limited or waived by reason of EQUIPMENT having previously been inspected, tested and passed by OWNER/PMC or INSPECTOR/representative prior to its shipment/despatch.

1.2.8.7.6 INSPECTOR shall follow the progress of the manufacture of EQUIPMENT under CONTRACT to ensure that the requirements outlined in CONTRACT are not being deviated from with respect to Schedule and Quality.

1.2.8.7.7 CONTRACTOR shall allow INSPECTOR to visit, during working hours, the workshops relevant to execution of CONTRACT during the contractual period and INSPECTOR will have the right to inspect EQUIPMENT at all stages of manufacture right from identification of material up to its shipment/despatch, to the extent that the delivery schedule shall not be delayed, with prior notice to CONTRACTOR in writing.

1.2.8.7.8 In order to enable INSPECTOR to obtain entry visa in time, CONTRACTOR shall notify OWNER/PMC two months before assembly, testing and packing of main EQUIPMENT and if requested assist INSPECTOR in getting visa in the shortest possible time.

1.2.8.7.9 CONTRACTOR shall place at the disposal of INSPECTOR free of charge all tools, instruments and other apparatus necessary for the inspection and/or testing of EQUIPMENT. INSPECTOR is entitled to prohibit the use and despatch of EQUIPMENT that has failed to comply with the characteristics/specifications of EQUIPMENT during test and inspection.

1.2.8.7.10 CONTRACTOR shall ensure that the permission for inspection/test is granted by its SUB-CONTRACTOR/VENDOR.

1.2.8.7.11 In respect of the inspection, CONTRACTOR shall advise in writing of any delay in the programme at the earliest possible date, describing in detail what has caused the delay and the proposed corrective action.

1.2.8.7.12 All tests and trials in general of EQUIPMENT shall be witnessed by INSPECTOR. Therefore, CONTRACTOR shall confirm to OWNER/PMC by E-mail about the exact date of inspection at least 15 DAYS in advance. CONTRACTOR shall specify the items and quantities ready for testing and indicate whether a Preliminary or Final Test is to be carried out. On receipt of this notice, if OWNER decides to waive the right to witness the test, information shall be given to CONTRACTOR within 15 DAYS of receipt of the notice from CONTRACTOR and CONTRACTOR then shall have right to proceed with the inspection

1.2.8.7.13 CONTRACTOR shall be held responsible for any possible delay in the approval or testing phase as well as for any possible delay in the remittance of necessary certificates. Delay on the part of the Inspection institutions will not be considered a case of 'Force Majeure'.

1.2.8.7.14 Any and all expenses incurred in connection with tests, preparation of reports and analysis made by qualified laboratories, necessary technical documents, testing documents and drawings shall be at CONTRACTOR's cost. Technical documents shall include the references and numbers of the standard used in the fabrication/construction and, wherever deemed practical by INSPECTOR. INSPECTOR shall attach importance to the views given by CONTRACTOR or its SUB-CONTRACTOR/VENDOR. Any and all expenses for boarding, lodging and airfare/rail fare incurred in connection with Owner's INSPECTOR shall be borne by OWNER.

1.2.8.7.15 Participation or presence of OWNER/PMC or their representatives at any tests or their failure to be present at or to witness any tests to be undertaken pursuant here to shall not in any way or manner relieve or release the CONTRACTOR from any of its warranties, guarantees or other obligations under the CONTRACT.

1.2.8.7.16 Nothing in Clause -1.2.8.7.2 to 1.2.8.7.15 shall in any way relieve CONTRACTOR from any warranty or other obligations under this CONTRACT.

Not performing or failing to perform the inspection by OWNER hereunder shall not be a waiver of any of CONTRACTOR's obligations hereunder nor it be construed as an approval or acceptance of any of the WORK hereunder nor it shall absolve the CONTRACTOR in any way or manner of its liabilities, responsibilities and obligations under the CONTRACT.

1.2.8.7.17 Arrangements for all inspections required by Statutory Authorities and as specified in Technical Specifications shall be made by CONTRACTOR. If certain category of EQUIPMENT/piping fall under the jurisdiction of Indian Boiler Regulations (IBR), irrespective of the fact whether these are proprietary in nature or not, certification from an internationally recognised agency approved by IBR is considered necessary to enable local IBR authorities to allow their installation and operation. In such cases, inspection and certification from such authorities will also have to be arranged by CONTRACTOR. CONTRACTOR shall also submit, as may be required by IBR authorities, necessary design calculations from respective fabricators and/or manufacturers of such EQUIPMENT.

1.2.8.7.17 **Rejections, Removal of Rejected EQUIPMENT and Replacement**

1.2.8.7.17.1 Preliminary inspection at SUB-CONTRACTOR's / vendor's works by INSPECTOR shall not prejudice OWNER/PMC for commenting on EQUIPMENT including its specifications on final inspection at SITE or claim under warranty provisions.

1.2.8.7.17.2 If EQUIPMENT is not of specification or fail to perform specified duties, OWNER/PMC shall be entitled to reject EQUIPMENT or part thereof and ask for modification, repair or free replacement within reasonable time subject to the relevant provisions in the CONTRACT.

1.2.8.7.17.3 In the event of such rejection, OWNER shall be entitled to use EQUIPMENT in a reasonable and proper manner for a time reasonably sufficient to enable it to obtain replacement, without any liability to CONTRACTOR. After free replacement of such rejected EQUIPMENT, the rejected equipment shall become the property of CONTRACTOR.

1.2.8.7.17.4 Nothing in this Clause shall be deemed to deprive OWNER and/or affect any of its rights under CONTRACT which it may otherwise have in respect of such defects or deficiencies or in any way relieve CONTRACTOR of its obligation under CONTRACT.

1.2.8.7.17.5 EQUIPMENT rejected by OWNER/PMC shall be removed by CONTRACTOR, within reasonable time, at its own cost after replacement of the said EQUIPMENT. OWNER shall in no way be responsible for any deterioration or damage to rejected EQUIPMENT under any circumstances whatsoever.

1.2.8.7.17.6 In case, the rejected EQUIPMENT is to be taken out of OWNER's premises for repair, Owner shall have the right to withhold the payment for such cost of equipment to the extent of payment made by Owner towards the equipment until the equipment is returned / replaced.

1.2.8.8 **Packing**

1.2.8.8.1 CONTRACTOR shall ensure that packing of EQUIPMENT is as required to prevent their damage or deterioration during transit to its final destination.

1.2.8.8.2 The packing, markings and documentation within and outside the packages shall comply strictly with the provisions of CONTRACT.

1.2.8.8.3 CONTRACTOR shall be responsible for any eventual consequence occurred to EQUIPMENT due to improper packing of the same.

1.2.8.9 **Delivery/Time Schedule and Documents**

1.2.8.9.1 Time schedule shall include time for submission of documents/drawings for review/approval, incorporation of comments, if any, and final review of drawings by ENGINEER-IN-CHARGE. Within 14 (Fourteen) working days after receipt by ENGINEER-IN- CHARGE of any document requiring OWNER/PMC's review, ENGINEER-IN-CHARGE shall either return one copy thereof to CONTRACTOR as it is, if ENGINEER-IN-CHARGE has no comments or with its comments and reasons thereof.

1.2.8.9.2 Special care shall be taken by CONTRACTOR to furnish Manufacturer's Test Certificates, material of construction, make, type, pressure ratings wherever applicable and included in the scope of supply of EQUIPMENT.

1.2.8.9.3 In case of delay beyond the stipulated COMPLETION PERIOD, for reasons not attributable to OWNER, except FORCE MAJEURE and suspension of WORK by OWNER, even though provisional extension of COMPLETION PERIOD time is allowed by OWNER, all extra costs on account of changes of statutory regulations/Acts or increase in price on any other account, shall not apply to CONTRACT PRICE and the same shall be borne by CONTRACTOR.

1.2.8.10 **Despatch, Transportation/Shipping**

1.2.8.10.1 CONTRACTOR shall be responsible for despatch of EQUIPMENT by sea/ rail/ road/air after proper packing and protection. The consignment shall be despatched after inspection by OWNER unless otherwise agreed to in writing however such inspection shall not constitute waiver of the CONTRACTOR's obligations, responsibilities for the EQUIPMENT including care, safety and preservation in any way and manner and the CONTRACTOR's responsibility and obligation in this behalf shall continue till PRELIMINARY ACCEPTANCE OF PLANT.

1.2.8.10.2 Generally, on-Deck shipment shall not be made without prior permission of OWNER. However, in case of towers, reactors, vessels and other large-sized EQUIPMENT, CONTRACTOR may, at its own discretion, make on-deck shipment, without OWNER's

prior permission. In case of damage to such EQUIPMENT, during delivery or at any stage before PRELIMINARY ACCEPTANCE OF PLANT, CONTRACTOR shall be responsible for repair/replacement of EQUIPMENT.

1.2.8.10.3 Clean onboard bill of lading for all offshore supplies shall be drawn as under:

For CIF/FOB/FAS/FCA shipments

Shipper = CONTRACTOR/Supplier
Consignee = CONTRACTOR

1.2.8.10.4 **Property in EQUIPMENT**

1.2.8.10.4.1 In case of all EQUIPMENTS/MATERIALS, the title of Ownership shall pass on to OWNER on PRELIMINARY ACCEPTANCE of Plant. However, the OWNER shall have Lien on all EQUIPMENTS/MATERIALS including those brought by the Contractor for the purpose of Erection, testing and commissioning of the WORK. However, in case of Termination of Contract the Transfer of Title shall pass automatically to OWNER.

1.2.8.10.4.2 CONSTRUCTION EQUIPMENT used by the CONTRACTOR and its SUB-CONTRACTORS in connection with the execution of works shall remain the property of CONTRACTOR or its SUB-CONTRACTORS. All duties, levies, taxes etc payable on account of CONSTRUCTION EQUIPMENT shall be borne by the CONTRACTOR. CONTRACTOR shall indemnify the OWNER on this count.

1.2.9 **Spares, Special Maintenance Tools, Lubricants, Chemicals and Consumable**

1.2.9.1 CONTRACTOR shall procure and supply commissioning spares, special maintenance tools and fixtures for EQUIPMENT, lubricants, chemicals and consumable in sufficient quantity for COMMISSIONING and maintenance of PLANT, as described in FINAL PROPOSAL. The commissioning spares, special maintenance tools, lubricants, chemicals and consumable procured and supply shall be optimum, so as not to fall short during COMMISSIONING, and PGTR. CONTRACTOR shall obtain for these items the appropriate guarantees and warranties. CONTRACTOR shall also ensure that the commissioning spares and special maintenance tools and fixtures are procured along with the related items of EQUIPMENT and form part of PURCHASE ORDER for the related items of EQUIPMENT.

1.2.9.2 **Lubricants, Chemicals, Consumable etc.**

CONTRACTOR shall supply Consumables, lubricants and chemicals, as required for 100% full load run for 6 months operation after successful commissioning (and include the cost in CONTRACT PRICE). Consumables, lubricants and chemicals to be supplied in phased manner and shall be mutually agreed between OWNER and CONTRACTOR considering the consumption and storage capacity.

1.2.9.3 **Special Maintenance Tools**

CONTRACTOR shall supply special devices or tools required for normal maintenance, special handling and lifting of EQUIPMENT with main EQUIPMENT. The cost of such special maintenance tools shall be included in CONTRACT PRICE.

1.2.9.4 **Bidder's Recommended Operational Spares**

CONTRACTOR shall provide Itemised Price List for Bidder's Recommended operational spares 6 months prior to Mechanical Completion with validity of 2 Years. The recommended spares shall be optimum so as not to cause any short fall or excessive inventory. The price of above shall NOT be included in CONTRACT PRICE.

1.2.9.5 **Special Tools & Tackles**

CONTRACTOR shall supply special tools, tackles and fixture, required during normal operation & maintenance of PLANT. The cost of such special tools & tackles shall be included in CONTRACT PRICE.

1.2.9.6 **Chemicals**

CONTRACTOR shall supply all chemicals, if required for first filling and make-up, if required as indicated in Technical Section of NIT. The cost of these chemicals shall be included in the CONTRACT PRICE.

1.2.9.7 **Lubricants**

1.2.9.7.1 CONTRACTOR shall supply lubricants in sufficient quantity for the first filling and make-up required as indicated in Technical Section of NIT. The cost of lubricants shall be included in the CONTRACT PRICE.

1.2.9.7.2 CONTRACTOR shall furnish the name of recommended lubricants indicating their commercial/trade name, quality and grade and equivalent quality lubricants (in case of imported lubricants) available in India to OWNER.

1.2.9.8 **Commissioning spares and Consumables**

CONTRACTOR shall supply spares and consumables required for construction, PRE COMMISSIONING, COMMISSIONING, start-up and testing of PLANT. The cost of such spares and consumables shall be included in TOTAL CONTRACT PRICE.

1.2.9.9 **Mandatory Spares**

CONTRACTOR shall provide Mandatory Spares as per Section VI-5.0, of Technical Document. Notwithstanding anything contained in this CONTRACT, the Prices for Mandatory Spares/Insurance Spares shall be included in TOTAL CONTRACT PRICE.

The price for "Mandatory Spares/Insurance Spares" shall be included in the supply portion of TOTAL CONTRACT PRICE. However, details along with breakup for the above shall be submitted by successful bidder during execution.

1.2.9.10 **General**

1.2.9.10.1 CONTRACTOR shall furnish to OWNER, the blue prints, drawings and specifications of the spare parts.

1.2.9.10.2 CONTRACTOR shall provide to OWNER all addresses and particulars of its SUB-CONTRACTOR/VENDOR on whom PURCHASE ORDER for EQUIPMENT covered under CONTRACT has been placed and will further ensure with its SUB-CONTRACTOR/VENDOR that, OWNER if so desires, shall have the right to place order for two years spare parts directly on them on mutually agreed terms based on offers of such SUB-CONTRACTOR/ VENDOR.

1.2.9.10.3 Spare parts shall be new and as per engineering standards/codes, free of any defects (even concealed), deficiency in Design, Materials and Workmanship and also shall be completely interchangeable with the corresponding parts.

1.2.9.10.4 Type and sizes of bearing/seals and bearing number with make shall be clearly indicated.

1.2.9.10.5 Spare parts shall be packed for long storage under tropical climatic conditions in suitable cases, clearly marked as to their intended purpose.

1.2.10 **Warrantees and Guarantees**

1.2.10.1 Materials and Workmanship Warranty

1.2.10.1.1 CONTRACTOR warrants that EQUIPMENT supplied under CONTRACT are new, unused, of the recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in CONTRACT. CONTRACTOR further warrants that EQUIPMENT supplied under this CONTRACT shall be according to specifications, have no defect (even concealed) arising from design, materials or workmanship or form any act or omission of CONTRACT that may develop under normal use of the supplied EQUIPMENT in the conditions prevailing in the country of final destination.

1.2.10.1.2 The warranty period for the EQUIPMENT supplied by CONTRACTOR shall be valid for minimum 12 months for all EQUIPMENT from the date of PRELIMINARY ACCEPTANCE.

1.2.10.1.3 The warranty shall be valid for the period as described under Clause -1.2.10.1.2 from the date of PRELIMINARY ACCEPTANCE and shall be governed by Clause 17 of SPECIAL CONDITIONS OF CONTRACT. Should any DEFECTS be noticed in design, material and/or workmanship within the said warranty period, ENGINEER-IN-CHARGE shall inform CONTRACTOR and CONTRACTOR shall immediately on receipt of such intimation depute their personnel within 10 DAYS to investigate the causes of DEFECTS and arrange rectification / replacement / modification of the defective EQUIPMENT at SITE without any cost to OWNER, within a reasonable period. If CONTRACTOR fails to

take proper corrective action to replace/ repair defective Equipment satisfactorily within a

1.2.11 **Performance Guarantee of PLANT(S)/ EQUIPMENT**

1.2.11.1 CONTRACTOR guarantees that the performance of PLANTS supplied under CONTRACT shall be strictly in conformity with the specifications and shall perform the duties and have consumption, production and other guarantees set forth in CONTRACT.

1.2.11.2 If the performance of PLANTS and/or any of EQUIPMENT fails as guaranteed and set forth in CONTRACT, CONTRACTOR shall investigate the causes and provide free of cost to OWNER, design, engineering, MATERIALS and services and EQUIPMENT within a reasonable period to prove guarantees. CONTRACTOR's liability in this respect shall be limited as per the provisions of 22.0 of SCC except that the Works Cost Guarantee shall be governed by the provisions of Cl.No.21.2. of GCC.

1.2.12 **STATUTORY APPROVALS**

1.2.12.1 Unless otherwise specified in Bidding Documents, it shall be the CONTRACTOR's sole responsibility to obtain all approvals from any authority (except for environment clearance and Consent to Establish/Operate, however the data and information required for the same shall be made available by the LSTK contractor) required under any statute, rule or regulation of the Central or State Government concerned with the performance of the CONTRACT and/or the contractual Work. The application on behalf of the OWNER for submission to relevant authorities' along with copies of required certificates complete in all respects shall be prepared and submitted by the CONTRACTOR well ahead of time so that the actual execution of the WORKS is not delayed for want of the APPROVAL/inspection by the concerned authorities. The CONTRACTOR shall arrange for the inspection of the works by the authorities and will undertake necessary coordination and liaison required and shall not be entitled to any extension of time for any delay in obtaining such approval. All statutory fees shall be paid by the CONTRACTOR and the same shall be reimbursed by the OWNER upon production of documentary evidence by the CONTRACTOR.

1.2.12.2 Any deficiency (ies) as pointed out by any such authority shall be rectified by the CONTRACTOR within the scope of relative supply and/or WORK at no extra cost to the OWNER. The inspection and acceptance of the WORKS by such authorities shall, however, not absolve the CONTRACTOR from any of its responsibilities under this CONTRACT.

1.2.12.3 No extension of time shall be granted for meeting the requirement and/or obtaining APPROVAL of statutory authorities.

1.2.12.4 **Government Clearances, Permits and Certificates**

CONTRACTOR shall procure at its expenses, all necessary APPLICABLE PERMITS, certificates and licenses required by virtue of all APPLICABLE LAWS, regulations, ordinances and other rules in effect at the place where any of WORK is to be performed, and CONTRACTOR shall further hold OWNER harmless from liability or penalty which

might be imposed by reason of any asserted or established violation of such laws, regulations, ordinances or other rules. OWNER will provide the necessary assistance to CONTRACTOR for obtaining PERMITS for CONTRACTOR's personnel to undertake WORK in India in connection with CONTRACT.

1.2.12.5 CONTRACTOR shall furnish necessary technical information, data, drawing, etc. as and when required by OWNER for submission to Government/Statutory Agencies.

1.2.13 **Network Schedule**

1.2.13.1 OWNER would be using a computerized time and cost monitoring system and CONTRACTOR shall provide necessary input data for the same. CONTRACTOR shall prepare within 30 (thirty) days from date of FOA and provide to OWNER a PROJECT MASTER SCHEDULE indicating the important milestones of activities relating to WORK from date of FOA to the date of PRELIMINARY ACCEPTANCE. This PROJECT MASTER SCHEDULE shall be discussed with and approved by OWNER. Based on the approved PROJECT MASTER SCHEDULE, CONTRACTOR shall also prepare network schedules for activities relating to WORK. CONTRACTOR shall obtain the details of progress of various activities of WORK from SUB-CONTRACTOR and vendor wherever required and update the network schedules and PROJECT MASTER SCHEDULE incorporating the progress achieved by CONTRACTOR, SUB-CONTRACTOR and vendor and submit the same to ENGINEER-IN-CHARGE on monthly basis.

1.2.13.2 CONTRACTOR shall clearly indicate any delay in WORK in the above schedules and shall inform ENGINEER-IN-CHARGE the action taken to achieve the COMPLETION PERIOD.

1.2.14 **Transportation and Storing of EQUIPMENT**

1.2.14.1 CONTRACTOR shall be responsible for proper packing, transportation from vendor's workshop to port or railway station (whether by road, rail, ship or aircraft), handling and clearances at port or railway station including loading and unloading, customs clearance, carriage to SITE, unloading at SITE, warehousing, coding and tagging, storage including proper preservation, etc. of EQUIPMENT. Any special clearance, lifting, handling, loading/unloading, and transport arrangements for over dimensional consignments shall also be done by CONTRACTOR. CONTRACTOR shall ensure timely delivery of EQUIPMENT. CONTRACTOR shall endeavor to have the consignments in the upper part of the hold to enable early discharge at the Port of disembarkment. The above arrangement shall be in accordance with the guidelines set forth in the Co-ordination Procedure which shall be finalised mutually after issuance of FOA. CONTRACTOR shall be responsible for inspection of EQUIPMENT on receipt at SITE and for maintenance and management of stores and warehousing of EQUIPMENT at SITE including all activities connected with the issue of EQUIPMENT, accounting and final reconciliation and handing over of stores to OWNER.

1.2.14.2 OWNER shall provide area at SITE for making shed/covered stores etc. for storing EQUIPMENT. CONTRACTOR shall be responsible for making shed/covered stores etc. for safe storage of EQUIPMENT.

1.2.15 **Construction**

1.2.15.1 CONTRACTOR shall be responsible for erection, insulation & painting works, , site fabrication, piping, instrumentation, electrical installation, and other miscellaneous construction jobs of PLANT leading to MECHANICAL COMPLETION and PRELIMINARY ACCEPTANCE of PLANT. CONTRACTOR shall organise these activities in appropriate sequence and use proper methods giving due regard to the requirements of safety, quality, sound engineering practice, compliance with relevant Codes and Regulations, and for achieving COMMISSIONING of PLANT on or before COMPLETION PERIOD.

The CONTRACTOR shall within the scope of work observe in addition to specifications, all national and local laws, ordinances, rules and regulation and requirements pertaining to the WORK.

Various procedures and methods to be adopted by CONTRACTOR during the construction as required in the respective specifications shall be submitted to OWNER in due time and well in advance of the specific work for approval.

The CONTRACTOR shall carry out required supervision as per Quality Assurance Plan and furnish all assistance required by the OWNER in carrying out inspection work. The OWNER will have authorized representatives present who shall have free access to the work at all times. If an OWNER's representative notifies the CONTRACTOR's representative of any deficiency in any work or in the supervision thereof, the CONTRACTOR shall make every effort to carry out such instructions consistent with best industry practice.

The CONTRACTOR shall so far as reasonably feasible employ skilled workers who are Certified Tradesmen in the field(s) of their relative activities(s).

1.2.15.2 CONTRACTOR shall submit and adhere to the completion schedule of construction/erection leading to PRELIMINARY ACCEPTANCE.

1.2.15.3 In case of delay in completion beyond the stipulated completion period as specified in Invitation For Bid (IFB) under clause 2 (E) for reasons attributable to Contractor, all extra costs on account of changes of statutory regulations / Acts, shall not apply to Contract price and the same shall be borne by Contractor.

1.2.15.4 **Deleted**

1.2.16 **Safety and Plant Security**

1.2.16.1 CONTRACTOR shall observe and also use its best efforts to ensure that all parts of WORK carried out at SITE is being done in a safe and satisfactory manner conforming to the applicable Safety Rules and Regulations. Further, CONTRACTOR shall observe and make provisions in SUB-CONTRACT that employees working for PLANT observe all the Safety Rules as required under the Factories Act and Regulations and other Local Laws and SUB-CONTRACTOR to provide safety apparel and equipment to its employees.

OWNER shall have the right to object to any unsafe practice followed by SUB-CONTRACTOR's employees or any CONTRACTOR's personnel and direct them to carry out the job in a manner considered safe by OWNER. CONTRACTOR shall further abide by all the Security Regulations imposed by OWNER.

1.2.16.2 CONTRACTOR shall observe all safety rules so that no harm is done to OWNER's employees or property. If on account of CONTRACTOR, OWNER's property or personnel are likely to suffer any damage, in such cases any directions issued by OWNER shall be carried out by CONTRACTOR.

1.2.17 **PRE-COMMISSIONING**

1.2.17.1 CONTRACTOR shall render and be responsible for pre-commissioning activities leading to MECHANICAL COMPLETION. These activities will include relevant checking, adjustment, testing, calibration, running in and trial runs of individual items of EQUIPMENT, and other similar jobs.

1.2.17.2 CONTRACTOR shall provide experienced personnel as required for carrying out the PRE-COMMISSIONING activities with OWNER's personnel.

1.2.17.3 CONTRACTOR shall provide SUB-CONTRACTOR's/VENDOR's specialists wherever required. Suitable provision for such services shall be made by CONTRACTOR in PURCHASE ORDER/CONTRACT with their Sub-Vendor/Sub-Contractor.

1.2.17.4 "PRE-COMMISSIONING" shall mean preparation of PLANT so that it is capable of operating on a continuous basis at or near rated capacity for carrying out COMMISSIONING activities

1.2.18 **MECHANICAL COMPLETION**

1.2.18.1 CONTRACTOR shall be responsible for completing the design, engineering, procurement, inspection and expediting, arranging for transportation of EQUIPMENT, construction and erection & testing for making PLANT ready for MECHANICAL COMPLETION.

MECHANICAL COMPLETION" shall mean completion of erection to such an extent that PLANT is ready for commissioning. This shall happen when:

A. The EQUIPMENT capable of producing to rated capacities are installed, aligned and grouted (wherever applicable) in accordance with drawings, specifications as per finally approved P&I Diagrams in accordance with all applicable codes, and laws.

B. All pressure EQUIPMENT are hydrostatically or pneumatically tested once either in CONTRACTOR'S shop or in the field in accordance with Technical Specifications.

C. Deleted

D. Compressor, Pumps, Machinery etc. are cold aligned. Couplings are assembled and guards installed as applicable.

E. Instruments, control system, instrument cable, safety interlock are installed, inspected and such non-operating checks are made as to ensure operability in the manner required for the process application. Instrument air lines are checked for correct hook up. Airlines are leak tested.

F. Relief valves are installed prior to this, and have been checked by the CONTRACTOR in the CONTRACTOR's shop.

G. Piping is hydrostatically or pneumatically tested in accordance with the specifications. Special treatment such as chemical cleaning is done as required by drawing or specifications. Suction screens are installed and test blinds are removed. Spring support anchors and guide are checked for removal of all shipping locks.

H. The electric system is installed and tested in accordance with and to the extent required by electrical specifications. All wiring is checked for correct hook up. Motor rotation is checked. All power system protective devices are set.

I. Insulation and drying out are completed to the extent necessary to permit start of commissioning.

J. Pipe support system installed as per drawings.

K. Painting is completed. EQUIPMENT /MACHINERY, piping duly marked and labelled.

L. Safety equipments, systems are installed and checked for operations. Effluent management and treatment systems are installed and operational.

M. All Emergency & Instrument power system are checked and operating.

N. All chemical & lubricants are charged into the system.

O. PRECOMMISSIONING has been completed.

P. The PLANT is ready for Commissioning

Q. All packing and bed support materials are installed.

R. Liquidation of all punch list applicable for achieving MECHANICAL COMPLETION. Balance items of punch list, if any, shall be liquidated as mutually agreed

S. Temporary constructions facilities are removed to extent necessary to permit start of commissioning of Plant

1.2.19 **COMMISSIONING**

1.2.19.1 CONTRACTOR shall be responsible for COMMISSIONING after Mechanical Completion have been completed giving due regard to safety of EQUIPMENT in accordance with the procedures as per the requirement of Contract document after successful testing, pre-commissioning & trial run and per sound engineering practices. LSTK CONTRACTOR shall provide operating and maintenance personnel for the same. The COMMISSIONING activities shall be conducted as detailed in Section VI-2.0 of NIT)

1.2.19.2 CONTRACTOR shall provide engineers as required to commission the PLANT. CONTRACTOR shall be responsible to provide supervision personnel for operation of PLANT for a period of 2 months from date of successful commissioning and OWNER will operate the PLANT under the supervision and instructions of CONTRACTOR.

1.2.20 **Performance Guarantee Test Run (PGTR)**

'PERFORMANCE & GUARANTEE TESTS RUN (PGTR)' shall mean all operational checks and tests required to determine and demonstrate capacity, efficiency and operating characteristics and proving guarantees for work cost as specified in the CONTRACT documents.

CONTRACTOR shall successfully complete PERFORMANCE TEST as specified in Technical Section-VI, 2.0 of NIT.

1.2.21 Deleted

1.2.22 **2 months Supervisory Assistance.**

Owner requires two months supervisory assistance after successful Commissioning with designated selected manpower defined by Owner as per the requirement specified in Technical Section VI-2.0, of NIT. LSTK Contractor shall include the cost of above services in TOTAL CONTRACT PRICE.

1.2.23 **Laws and Regulations**

1.2.23.1 CONTRACTOR shall abide, while fulfilling its obligations, by all applicable codes and APPLICABLE LAWS from time to time in force in the State of ODISHA and in India.

FINAL PROPOSAL shall be based on the codes, and regulations applicable on the date of submission of the FINAL PROPOSAL.

In the event of change in any codes, legislation, laws or regulation applicable to PLANT WORK or any part thereof after date of submission of FINAL PROPOSAL, which alters the scope of CONTRACTOR's obligations under CONTRACT, CONTRACTOR shall agree to make the necessary changes in scope of WORK. Such changes shall be governed by CHANGE IN WORK as per the provisions of Clause -3 of SCC. Any additional fee becoming applicable due to any change of Acts, regulations, by-laws, orders and requirements after date of submission of FINAL PROPOSAL shall be borne by OWNER in accordance with SCC clause 3.0.

1.2.24 Deleted

1.2.25 **Progress Monitoring and Reporting**

1.2.25.1 CONTRACTOR shall develop a suitable system for monitoring and reporting progress on the various activities up to PRELIMINARY ACCEPTANCE. CONTRACTOR shall submit PROJECT MASTER SCHEDULE and detailed Network Schedule covering the activities and milestones starting from date of FOA until PRELIMINARY ACCEPTANCE, as described under Clause -1.2.13 above. These schedules shall include the activities of CONTRACTOR, SUB-CONTRACTOR/Sub-Vendor. CONTRACTOR shall monitor progress continuously and submit to EIC monthly progress reports giving the status of the activities, indicating those delayed and action being taken, or required to be taken, to bring back those activities on schedule. These reports will also include progress at vendor's workshops and shall be supplemented with photographs, wherever necessary. The Network Schedule shall be updated once in a month. CONTRACTOR shall also furnish information to ENGINEER-IN-CHARGE as may be required by any other Government Authority or any other agency such as Financing Institution etc.

1.2.26 **Technical Information**

1.2.26.1 CONTRACTOR shall furnish to OWNER, CONTRACTOR's Technical Information and know-how as may be necessary for the operation of PLANT and relating to its process according to the provisions of Article 53 of General Conditions of Contract. CONTRACTOR shall grant or cause to be granted to OWNER an irrevocable right to use all such above technical information for PLANT and shall further advise OWNER for a period of five (5) years from date of COMMISSIONING of any improvements in process, know-how, engineering, operation methods, and other conditions which will result in more efficient operation of PLANT that are developed by CONTRACTOR or process licensor or have come to the knowledge of CONTRACTOR, at no extra cost to OWNER. OWNER shall also grant to CONTRACTOR, at no extra cost to CONTRACTOR, to the benefit of process licensor the same right on OWNER's improvements as per the provisions of this Clause. Notwithstanding the generality of the foregoing, ownership of data, technical information processes, technology or software proprietary to CONTRACTOR and/or SUBCONTRACTORS shall remain with CONTRACTOR and/or SUBCONTRACTOR. CONTRACTOR and/or SUBCONTRACTOR shall ensure that OWNER is legally entitled to use of such data, processes, technology and software in the form of a perpetual, non-

terminable, non-exclusive, royalty-free License for the purpose of the operation and maintenance of the PLANT.

1.2.27 **Work of SUB-CONTRACTOR and vendor**

1.2.27.1 CONTRACTOR shall remain responsible for proper execution of such part of WORK as are carried out by its SUB-CONTRACTOR and vendor and any failure of SUB-CONTRACTOR/vendor shall not relieve CONTRACTOR of its obligations under CONTRACT. Furthermore, in the event of any default by SUB-CONTRACTOR/vendor, CONTRACTOR shall either take over SUB-CONTRACTOR/vendor's part of WORK on mutually agreed terms or take remedial action as may be necessary in order to comply with COMPLETION PERIOD and any other activities leading to PRELIMINARY ACCEPTANCE.

1.2.28 **Co-ordination**

1.2.28.1 CONTRACTOR shall render all necessary assistance to ENGINEER-IN-CHARGE required for overall co-ordination of all activities connected with WORKS. For this purpose, CONTRACTOR and ENGINEER-IN-CHARGE shall agree on a meeting as soon as practicable after issuance of FOA, with SUBCONTRACTOR/vendor's and such other parties as are necessary to settle the following:

a) Review the basic design conditions set forth in FINAL PROPOSAL and where appropriate, review possibilities of standardisation.
b) Assess the priorities and key dates required to be included in CONTRACTOR's PROJECT MASTER SCHEDULE.
c) Make an assessment of all items requiring co-ordination.
d) Fix up a date and agenda of any subsequent meeting as may be required in association with OWNER.
e) Discuss with ENGINEER-IN-CHARGE and furnish all technical information.

In the event, ENGINEER-IN-CHARGE pursuant to its responsibilities of overall co-ordination requests CONTRACTOR to make any alteration to the programme, scope of responsibility under CONTRACT, CONTRACTOR shall do the same, subject to the provisions of Clause 3.0.

1.2.29 Notices and Reports

1.2.29.1. CONTRACTOR shall submit the following copies of notices to ENGINEER-IN-CHARGE as part of the Scope of Work:

a) Immediate notification of safety incidents and accidents, including near misses, of any kind or type followed as soon as possible after such event by a full report.

b) Notices from any Government / Statutory Agency or any other Person for a violation of any Law or Government Approval, immediately upon receipt by CONTRACTOR and no later than twenty-four (24) hours after its receipt.

c) Inspection reports by any inspector whether relating to any accident, accepting any test reports or otherwise immediately upon receipt by CONTRACTOR and no later than two (2) working DAYs after its receipt.

d) Any other matter/issue that involves OWNER's interest.

1.2.30 CONTRACTOR's Representative and Key Personnel

1.2.30.1 CONTRACTOR shall with prior consent of ENGINEER-IN-CHARGE, appoint a CONTRACT MANAGER to manage the execution of WORK and to be nominated as CONTRACTOR's Representative. CONTRACTOR's personnel stationed at SITE for providing services during the execution of WORK shall work under the supervision and guidance of CONTRACT MANAGER. The CONTRACT MANAGER shall have the full authority to make binding and enforceable decisions in the name of CONTRACTOR and shall receive all notices/correspondence that OWNER serves on CONTRACTOR.

1.2.30.2 CONTRACTOR shall be responsible for the work performed by CONTRACT MANAGER and CONTRACTOR's personnel and shall under no circumstances be relieved of its responsibilities and obligations under CONTRACT on account of acts or omissions of CONTRACT MANAGER and personnel.

1.2. 30.3 The Key Personnel shall hold the staff positions as indicated in CONTRACT. CONTRACTOR shall use reasonable efforts to ensure that such Key Personnel will be engaged in the execution of WORK continuously until their role is completed unless prior release is approved by OWNER, such approval not to be unreasonably withheld or delayed. Replacement of or addition to Key Personnel shall only be made with persons having qualifications and experience equal to or better than those replaced or added to, and shall be similarly subject to OWNER's prior approval. In the event, any person identified in CONTRACT decides to leave the employment of CONTRACTOR, CONTRACTOR shall use reasonable efforts to retain the services of such person until his portion of WORK is complete. CONTRACTOR further agrees not to remove from WORK Key Personnel, which OWNER considers to be necessary for the proper performance of WORK without the prior written approval of OWNER.

1.2.31 General Warranties

a) CONTRACTOR shall perform WORK in full compliance with its FINAL PROPOSAL and all other terms and conditions set forth herein.

b) WORK shall be performed, in a good and workmanlike manner and in accordance with the FINAL PROPOSAL, all other terms and conditions of this CONTRACT, all DOCUMENTS, all Government Approvals, all APPLICABLE LAWS, and Good Industry Practices.

c) All EQUIPMENT, installed as part of PLANT, (i) shall be free from any encumbrance or lien and shall conform to the specifications and descriptions set forth in CONTRACT and (ii) shall be new and unused, free from DEFECTS and Deficiencies of any kind and shall meet the requirements of the Scope of Work.

d) The completed PLANT shall be free of DEFECTS and Deficiencies and shall be designed, constructed and engineered, in compliance with the Scope of Work.

e) PLANT shall be designed, engineered, constructed, tested, completed and delivered based on Good Industry Practices, CONTRACTOR's specifications and guidelines for operation and maintenance in accordance with the Scope of Work, for CONTRACT PRICE and no later than the COMPLETION PERIOD.

f) All SUB-CONTRACTOR/vendor shall perform their portion of the Scope of Work or supply or install EQUIPMENT in accordance with the applicable terms set forth herein.

g) Adherence to the Operations Manual shall allow safe start-up, operation, maintenance and shut-downs of the completed PLANT, in accordance with CONTRACTOR's guidelines and will not impair any warranty or guarantee of EQUIPMENT incorporated or to be incorporated into PLANT.

1.2.32 General

1.2.32.1 CONTRACTOR shall incorporate during design stage maximum utilization of goods manufactured and/or available in India and also avail shipping, insurance, banking, catering and any other services available from India-owned companies for installation of plant, if quality, delivery and overall cost characteristics are equivalent.

1.2.32.2 CONTRACTOR shall arrange insurance pursuant to Clause 28.0 of GCC, at its own cost.

1.2.32.3 CONTRACTOR shall provide necessary information, documentation, and assistance for obtaining any approvals from Financial Institutions or any other agencies or authorities.

2.0 OWNER'S OBLIGATIONS

OWNER shall be responsible for fulfilling all obligations as specified under the following heads:

2.1 Deleted

2.2 Overall Co-Ordination

The objective of overall co-ordination is to organise orderly execution of WORK, bring about requisite integration amongst the various project activities of executing agencies, to avoid interference between the various activities of the parties in order to achieve the earliest possible completion of WORK. The aim will be to integrate, have compatibility between plants and uniform standardisation of design, engineering, layout, etc.

2.3.0 Review and Approval of Work

2.3.1 CONTRACTOR shall associate OWNER's representatives with WORK as carried out by CONTRACTOR's personnel. For this purpose, OWNER shall associate with WORK at all stages. Specifically, OWNER shall undertake the following tasks:

a) Review/APPROVAL of drawings as per Technical Section and other documents connected with basic and detailed engineering.

b) Review of specifications for EQUIPMENT, lists of spare parts and special maintenance tools, and lists of special construction aids, tools, tackles, and fixtures.

c) Participation in inspection, expediting and testing of EQUIPMENT at SUB-CONTRACTOR's / vendor's works and at SITE, wherever considered necessary by OWNER.

2.3.2 For the smooth functioning, OWNER will nominate an individual who will act as EIC under the CONTRACT. The EIC will have full authority to act on behalf of the OWNER in connection with the CONTRACT. Except as otherwise provided in the CONTRACT, all communications between the OWNER and the CONTRACTOR relating to the WORKS shall be between the ENGINEER-IN-CHARGE and the CONTRACT MANAGER.

2.4 Deleted

2.5 Facilities for CONTRACTOR's Personnel

OWNER shall assist CONTRACTOR in obtaining Visas and other PERMITS from the appropriate authorities for CONTRACTOR's and SUB-CONTRACTOR's / vendor's expatriates to enter and stay in India as necessary for performance of WORK. OWNER shall also provide facilities to CONTRACTOR's expatriates in accordance with the provisions described in Clause-2.8.

2.6 Operating and Maintenance Personnel

OWNER may associate its personnel with the construction and erection of PLANT to familiarise the personnel with WORK, and generally to prepare for proper operation and maintenance of PLANT.

2.7 Utilities

OWNER shall make available the utilities as specified in Section VI-2.0 of bid document for commissioning and PGTR.

2.8 Site Facilities

OWNER shall provide the following SITE facilities:

a) Land for Construction Activities
b) General safety and security without prejudice to Contractor's obligations.
c) Construction Power & Construction Water shall be provided as per clause 1.1.1 (g) above
d) Free and unrestricted access to SITE for CONTRACTOR's Authorized Personnel
e) OWNER shall NOT provide any accommodation and facilities for travelling to and from SITE to the place of residence to the personnel of CONTRACTOR/ SUB-CONTRACTOR, deputed at SITE for performing WORK under CONTRACT.
f) Area for making shed/covered storage for storing EQUIPMENT, as available.

3.0 CHANGES IN WORK/CHANGE ORDER

3.1 OWNER may at any time order change in work scope. OWNER shall have the right to request in writing changes in WORK within the scope of CONTRACT. When the request for a change in WORK by OWNER has been agreed and complied by CONTRACTOR, CONTRACTOR's obligations under CONTRACT shall remain unaffected unless otherwise agreed.

Changes may consist of additions, deletions or revisions of the Scope of Work, and may cause the CONTRACT PRICE, the work schedule or the COMPLETION PERIOD or any other CONTRACTOR's WARRANTEES to be adjusted.

CONTRACTOR shall be entitled to an extension of time to COMPLETION PERIOD suffered and/or payment of additional costs incurred as a result of any change in law or legislation, by way of a CHANGE ORDER, in case it is necessitated or if it becomes applicable.

3.2 The ENGINEER IN CHARGE shall have the right to make any alterations in, omission from, additions to or substitutions for in the scope of work, the original specifications, drawings, designs and instructions that may appear to him to be necessary or advisable during the progress of the WORK and the CONTRACTOR shall be bound to carry out the such altered/ extra/ new items of WORK in accordance with any instructions which may be given to him in writing signed by the ENGINEER IN CHARGE, and such alterations, omissions, additions or substitutions shall not invalidate the CONTRACT and any altered, additional or substituted work which the CONTRACTOR may be directed to do in the manner above specified as part of the WORK shall be carried out by the CONTRACTOR on the same conditions in all respects on which he agreed to do the main WORK. The time of completion of WORK may be extended for the part of the particular job at the discretion of the ENGINEER IN CHARGE, for only such alterations, additions or substitutions of the WORK, as he may consider as just and reasonable. The rates for such additional, altered or substituted WORK under this clause shall be worked out in accordance with the following:-

CONTRACTOR shall, within 7 days of the date of receipt of order to carry out the WORK, inform the ENGINEER IN CHARGE of the rates which it is his intention to charge for such class of WORK, supported by analysis of the rate or rates claimed, and the ENGINEER IN CHARGE shall determine the rate or rates on the basis of the prevailing market rates, labour cost at schedule of labour rates plus 10% to cover contractor's supervision, overheads and profit and pay the CONTRACTOR accordingly. The opinion of the ENGINEER IN CHARGE as to current market rates of materials and the quantum of labour involved per unit of measurement will be final and binding on the CONTRACTOR.

3.3. If it is established that a request for Change in Work asked by Owner does not fall under original Scope of Contract, then CONTRACTOR shall promptly submit cost estimate, and / or time extension and / or terms of payment (as applicable) for making the requested change in WORK together with the details of any variation required to be made to any of CONTRACTOR's or OWNER's obligations and/or guarantees as per clause 3.2 above.

3.4 If in CONTRACTOR's opinion fulfillment of any of its obligations under CONTRACT would be jeopardized by a CHANGE IN WORK requested by OWNER, then CONTRACTOR shall explain in writing to OWNER the reasons for not accepting these changes within fifteen (15) days of receipt of OWNER's written request.

3.5 OWNER and CONTRACTOR shall agree upon the basis and terms of the CHANGE IN WORK in writing.

3.6 It is understood that no change shall become effective and no change will alter the scope of WORK until all of the matters referred to in this *Clause 3* have been mutually agreed upon in writing by OWNER and CONTRACTOR.

3.7 It is agreed by both parties that the following changes shall not be considered a CHANGE IN WORK in the meaning in this Clause:

a) Minor changes requested by OWNER and accepted by CONTRACTOR which do not involve any substantial additional cost or man-hour effort, and have no effect on contractual completion period, and/or

b) Any change necessitated due to requirements of prevalent laws in India upto the time of submission of FINAL PROPOSAL.

3.8 This clause is to be read in conjunction with Clause No. 5.0 of GCC.

4.0 ACCEPTANCE OF PLANTS AND FACILITIES

CONTRACTOR's liabilities for the Performance Guarantees given for the PLANTS and Facilities in respect of capacity, consumption, product quality and pollution level shall be discharged only when the PERFORMANCE AND GUARANTEE TESTS as stipulated in Technical, Section VI-2 of NIT have been successfully carried out as per Plant Acceptance criteria specified at Clause 5.0 below and OWNER has issued PRELIMINARY ACCEPTANCE CERTIFICATE.

5.0 PLANT ACCEPTANCE CRITERIA

Subject to fulfilling PERFORMANCE AND GUARANTEE TESTS as per Section VI-2.0 of NIT and Clause 18.0 of SCC, OWNER shall be in readiness to accept the PLANT. CONTRACTOR shall take all steps to fulfil the provisions of the CONTRACT for OWNER to issue PRELIMINARY ACCEPTANCE CERTIFICATE**.** The care and custody of the PLANT shall be passed on to OWNER on COMMISSIONING of all the PLANT.

6.0 PRELIMINARY ACCEPTANCE

PRELIMINARY ACCEPTANCE shall mean that following milestones have been achieved for each PLANT (i) MECHANICAL COMPLETION has occurred, (ii) PRE-COMMISSIONING and COMMISSIONING of the PLANT have been accomplished, (iii) the Sustained Load Test has been passed successfully, (iv) PGTR has been conducted by LSTK Contractor and accepted by OWNER (v) All statutory approvals in the scope of Contractor, required to operate and maintain the PLANT have been obtained (vi) OWNER has received all DOCUMENTS required hereunder to start up, operate and maintain the PLANT(vii) OWNER has received all operations, maintenance, and spare parts manuals and instruction book necessary to operate and maintain the PLANT in a safe, efficient and effective manner (viii) all special tools and spare parts purchased by CONTRACTOR as provided herein have been delivered to OWNER.; and (ix) Deleted (x) All demonstration runs have successfully completed

6.1 ISSUANCE OF PRELIMINARY ACCEPTANCE CERTIFICATE

Within 30 (thirty) DAYs from completing successfully all activities as defined at clause 6.0 above by the CONTRACTOR and CONTRACTOR fulfilling all the obligations under the provision of the CONTRACT, OWNER shall issue PRELIMINARY ACCEPTANCE CERTIFICATE to CONTRACTOR . On issue of this Certificate by OWNER, CONTRACTOR shall become entitled to receive all associated payment as per provisions of the CONTRACT due to CONTRACTOR subject to CONTRACTOR's fulfilling the obligations stipulated under CONTRACT.

7.0 LABOUR AND STAFF

7.1 The CONTRACTOR shall make his own arrangement for labour, erection and COMMISSIONING engineers and all other staff required for carrying out the WORK. The necessary permissions from Government of India regarding work permit and visa requirement shall be obtained by the CONTRACTOR.

7.2 The CONTRACTOR shall make his own arrangements for providing canteen service to his labour and staff. Open space for this purpose may be provided by OWNER.

7.3 The CONTRACTOR shall at his own cost provide office and other accommodation for his staff and workmen. The CONTRACTOR shall also provide communication, transport and medical facilities to his staff and workmen.

7.4 The CONTRACTOR shall be responsible for all statutory obligations and any other laws in this regard in force from time to time regarding the employment or conditions of service of CONTRACTOR's labour, workman or employees.

7.5 The CONTRACTOR shall observe all safety rules as required under various rules, regulations and laws in India and shall also strictly adhere to safety regulations of OWNER.

8.0 Deleted

9.0 MODE OF CONTRACTING

9.1 Notwithstanding anything stated elsewhere in the CONTRACT documents, the CONTRACT is awarded on Lumpsum turnkey basis with single point responsibility.

9.2 The CONTRACT shall be in all respect being construed and governed in accordance with the Indian laws.

9.3 The Contract shall be treated as a "WORK CONTRACT SERVICE".

10.0 FINAL BILL

10.1 On the basis of the LUMPSUM PRICE provided in the CONTRACT and subsequent Change Order(s)/Amendment(s), if any and the approved billing schedule, the CONTRACTOR shall prepare a Final Bill in the prescribed form. Additions claimed to the LUMPSUM PRICE or reductions thereof on account of CHANGE ORDER(s) shall be separately indicated in the Final Bill with reference to the relative CHANGE ORDERS(s).

10.2 The Final Bill shall, in addition to the payment entitlements arrived at according to the provisions of Clause 10.1 hereof shall separately state and include therein all claims of the CONTRACTOR, if any, with full particulars of the nature of such claim and grounds on which it is based and the amount claimed.

10.3 The Final Bill drawn in accordance with Clause 10.1 shall be submitted together with the PRELIMINARY ACCEPTANCE CERTIFICATE to the ENGINEER-IN-CHARGE for certification, who shall certify the Final Bill, if drawn in accordance with Clause 10.1 After certification of the ENGINEER-IN-CHARGE, the Final Bill shall be submitted in quadruplicate (or in such other number of copies as the OWNER may prescribe) accompanied by the PRELIMINARY ACCEPTANCE CERTIFICATE to the OWNER for payment.

10.4 All monies payable under the CONTRACT for WORKS to be performed and MATERIALS to be supplied up to and including successful completion and final tests and commissioning of the system and performance tests shall become due and payable to the CONTRACTOR only after submission to the OWNER of the Final Bill prepared in accordance with the provisions of Clause 10.1 hereof and associated provisions there under accompanied by the PRELIMINARY ACCEPTANCE CERTIFICATE in respect of the WORKS.

10.5 Payments of the amount(s) due on the Final Bill to the extent certified by the ENGINEER-IN-CHARGE, shall be made within 84 (Eighty Four) days from the due date as specified in Clause 10.4 hereof, subject to the deductions provided in Clause 10.6.

10.6 All payments due to the CONTRACTOR on the Final Bill shall be subject to, tax deductions as provided for in Clause 11.0 and associated clauses there under and any other deduction provided in the CONTRACT or required to be made under any law, rule or regulation having the force of law for the time being applicable, or elsewhere provided for in the CONTRACT documents.

11.0 **Deleted**

12.0 **Deleted**

13.0 **STATUTORY VARIATION IN TAXES AND DUTIES**

13.1 No variation on account of taxes and duties, statutory or otherwise, (other than due to change in turnover) shall be payable by OWNER to CONTRACTOR, except for GST. Any statutory variation in GST, shall be payable up to COMPLETION PERIOD against documentary evidence. Any reduction in the amount of GST resulting from a reduction in the rate of GST or remission or exemption from GST with respect to Goods and Services provided to the OWNER shall be refundable to the OWNER at actuals within the COMPLETION PERIOD and also during the delayed contractual Project completion, if any. The CONTRACTOR shall submit a copy of the 'Government Notification' to evidence the rate as applicable on the Bid due date and on the date of revision.

13.2 Any new taxes, duties, cess, levies notified or imposed after the submission of Price Bid but before COMPLETION PERIOD shall be to OWNER's Account.

13.3 In case of delayed completion beyond the COMPLETION PERIOD, even though extension of completion time is allowed by OWNER, for reasons solely attributable to Contractor, all extra costs on account of changes of statutory regulations/ acts, or shall not apply to the Contract price and shall be borne by the CONTRACTOR.

However, any decrease in taxes and duties during the delayed period shall be passed on to the OWNER.

In case the COMPLETION PERIOD is extended for reasons solely attributable to OWNER, then any increase on account of statutory changes in GST until the extended period shall be borne by OWNER. Further, any new taxes, duties, cess, levies notified or imposed after the submission of Price Bid during such extended COMPLETION PERIOD shall be to OWNER's Account.

13.4 Claim for payment of GST (CGST & SGST/UTGST or IGST)/ Statutory variation, should be raised within two [02] months from the date of issue of 'Government Notification' for payment of differential (in %) GST (CGST & SGST/UTGST or IGST), otherwise claim in respect of above shall not be entertained for payment of

arrears.

The base date for the purpose of applying statutory variation shall be the Bid Due Date.

14.0 TERMS OF PAYMENT

14.1 Payments shall be made by OWNER to the CONTRACTOR through RTGS / NEFT.

14.2 **Deleted**

14.3 Subject to the other provisions of the Contract documents, payments shall be made as follows:

14.3.1 Deleted

14.3.2 A FOR SUPPLIES INCLUDING SPARES, LUBRICANTS, CHEMICALS, ETC:

i) Deleted.

ii) **AGAINST PROOF OF SHIPMENT / DESPATCH OF MATERIALS:**

40% (Forty percent) on pro-rata basis as indicated in the approved Billing schedule (refer clause 15.0 below). Stage payment against "Proof of despatch of Materials" shall be released on submission of the following documents:

a) Signed Invoice(s)
b) Delivery Challan
c) Packing list.
d) Manufacturer's certificate of inspection for shipment duly approved by the CONTRACTOR in one original and one photocopy
e) Third Party Inspection Release Note clearly indicating that material has been inspected and accepted as per QAP approved by OWNER/PMC, or waiver certificate issued by OWNER/PMC.
f) Railway Receipt/LR
g) Certificate of Insurance Policy
h) Guarantee certificate (wherever applicable)
i) Operation & Maintenance manual (wherever applicable)

iii) **AGAINST RECEIPT OF MATERIAL AT SITE** :

45% (Forty Five Percent) on pro-rata basis as indicated in the approved Billing schedule on submission of:

(a) Signed Invoices.

(b) Photocopy of Third Party Inspection certificate as per QAP approved by OWNER along with Test Certificate.

(c) Entry gate pass duly endorsed by OWNER's security for verification of physical entry of material to SITE.

(d) Certificate of Verification and Good Condition after receipt of material at site by Owner.

iv) 5% (Five percent) as indicated in the approved Billing schedule on issue of MECHANICAL COMPLETION Certificate against CONTRACTOR's certified running Accounts Bill(s).

v) 8% (Eight percent) as indicated in the approved Billing schedule on issue of PRELIMINARY ACCEPTANCE CERTIFICATE against the CONTRACTOR's certified Running Account Bills.

vi) 2% (Two percent) as indicated in the approved Billing schedule on completion of balance jobs, if any, against the CONTRACTOR's Certified Final Bill.

B Deleted

14.3.3 FOR SERVICES (including transportation, insurance, installation Erection & Commissioning)

i) 85% (Eighty Five Percent) of the Services Price component shall be paid on pro-rata basis against progress of Service duly certified by the Owner for the quantum of work completed and field quality billed as per the approved Billing Schedule/monthly progress report.

ii) 5% (Five percent) on issue of MECHANICAL COMPLETION Certificate against CONTRACTOR's certified running Accounts Bill(s).

iii) 8% (Eight percent) as indicated in the approved Billing schedule on issue of PRELIMINARY ACCEPTANCE CERTIFICATE against the CONTRACTOR's certified Running Account Bills.

iv) 2% (Two percent) on completion of balance jobs, if any, against the CONTRACTOR's Certified Final Bill.

14.3.4 Deleted

14.3.5 2 MONTHS SUPERVISORY ASSISTANCE

100% (Hundred percent) on monthly basis as indicated in the approved Billing schedule.

14.4 All payments shall be released only after finalization of the planning and monitoring documents and Progress Schedule.

All invoices shall be submitted in quadruplicate to EIC by the Bidder. The payment shall be released within 30 days of submission of invoice.

14.5 **Payment Methodology**

CONTRACTOR shall enclose all documents as per check list issued by PMC/OWNER. After receipt of complete RA Bill as per terms and conditions of the contract and duly certified by Engineer-in-Charge (EIC) / PMC, on-account payment equivalent to seventy percent (70%) of the net payable certified amount of the RA Bill will be released to the Contractor within a period of seven (07) working days from submission of certified bill by PMC to TFL.

14.6 All invoices shall be submitted in quadruplicate to EIC by the Bidder.

15.0 **BILLING SCHEDULE**

The CONTRACTOR shall submit all invoices for a particular month under a single covering letter (once in a month) based on the billing schedule duly certified by OWNER with related documents.

The Billing Schedule shall consist of the following Heads:

1.0	**SUPPLIES (Break-up in line with the Material Control Index-MCI)**
a.	Total of Supplies (excluding Spares , Chemicals, Lubricants)
b.	Mandatory/Insurance Spares as per list enclosed in Section VI-10
c.	Lubricants & Consumables
d.	Others
2.0	**SERVICES**
a.	Basic Engineering (Break-up In line with the Document Control Index-DCI)
b.	Detailed Engineering (Break-up In line with the Document Control Index-DCI)
c.	Installation

d.	Erection
e.	Mechanical completion
f.	Commissioning
g.	PGTR
h.	Insurance
i	Others
j	Transportation Charges
k	2 months supervisory assistance after successful commissioning

The CONTRACTOR shall raise “Tax Invoices” on the OWNER against the GST to enable OWNER to reimburse the same

The GST paid on the local procurements by the CONTRACTOR have to be shown separately with all the supporting documents to enable the owner to reimburse the same.

The Bill of Entry shall have to be filed by the CONTRACTOR within the stipulated time with the appropriate authorities.

Note:

1. Bidder shall indicate all Prices in INR only

2. Spares for Start-up/ Commissioning and Mandatory Spares/Insurance Spares are in CONTRACTOR’s scope of supplies and are to be included in the quoted TOTAL CONTRACT PRICE.

3. It will be the responsibility of the contractor to include prices of all materials/equipments/Services/Civil & Structural Works required for completion of work as per the CONTRACT.

4. The total price payable under the CONTRACT shall be restricted to TOTAL CONTRACT PRICE.

5. The Civil & Structural Works shall include but not limited to the Price of Piling, Equipment Foundation, Buildings, Structural Works, etc.

6. The SUPPLIES shall include but not limited to the Price of all materials complete in all respect including Commissioning and Mandatory Spares, etc.

7. The supply of Services shall include but not limited to the Price of all services complete in all respect including Basic Engineering, Detailed Engineering, installation/Erection Services

including site fabrication, Transportation, Insurance, Pre- Commissioning, Commissioning, Performance Guarantee Test Run (PGTR), etc.

8. CONTRACTOR shall be entirely responsible for all taxes, cess, stamp duties, and other such levies applicable, on performance of WORK under CONTRACT, outside OWNER's country. CONTRACTOR and shall also be responsible for payment of all taxes, duties and levies such as custom duty, GST, income tax, etc. as applicable on performance of WORK under CONTRACT, in India. All such taxes, stamp duties, cess, licence fees, and other such levies applicable shall be included in the quoted TOTAL CONTRACT PRICE.

16.0 DEEMED ACCEPTANCE

In case COMMISSIONING & PGTR of a PLANT is delayed by 12 months from successful MECHANICAL COMPLETION of the PLANT due to reasons solely attributable to the OWNER, the PLANT shall be considered as DEEMED ACCEPTED with a DEFECT LIABILITY PERIOD of another 12 months from DEEMED ACCEPTANCE.

In case of DEEMED ACCEPTANCE, a reasonable cost for conductance of Performance Guarantee Tests shall be worked out mutually and shall be retained by OWNER. Payment against PRELIMNARY ACCEPTANCE, less the aforesaid retention amount shall be released upon DEEMED ACCEPTANCE of the PLANT. The CONTRACT PERFORMANCE SECURITY shall be extended by the CONTRACTOR so as to ensure validity of three (03) months beyond the date of completion of DEFECT LIABILITY PERIOD.

This provision of DEEMED ACCEPTANCE shall not be applicable in case reasons for delay solely attributable to the OWNER are resolved before the completion of 12 months from successful MECHANICAL COMPLETION. In that case, remaining activities including PERFORMANCE GUARANTEE TEST RUN shall be completed as per the terms & conditions of the CONTRACT and CONTRACT PERFORMANCE SECURITY shall be extended, accordingly, by the CONTRACTOR so as to ensure minimum validity of 3 months beyond the expiry of DEFECT LIABILITY PERIOD.

Even after the DEEMED ACCEPTANCE, CONTRACTOR shall not be absolved from his obligations of carrying out COMMISSIONING including PGTR. However, in such case, the CONTRACTOR shall have no obligation to prove the Performance Guarantee Parameters.

The CONTRACTOR may, in consultation with the OWNER, demobilise the team from the Site. It shall remobilise at the time of conductance of COMMISSIONING & PGTR by OWNER which shall be within DEFECT LIABILITY PERIOD. The OWNER shall reimburse the reasonable cost to be incurred by the CONTRACTOR for remobilization.

In case of DEEMED ACCEPTANCE, OWNER shall be responsible for care, custody and proper maintenance of the PLANT. However, OWNER, at its option, may retain the CONTRACTOR's services for watch, ward and preservation of the PLANT and reimburse the CONTRACTOR a mutually agreed reasonable cost incurred to do so.

After Deemed Acceptance, on performance of PGTR by the CONTRACTOR, if the Guaranteed parameters are not achieved, then the CONTRACTOR shall furnish the

Recommendation/Report for corrective action to be implemented by OWNER to achieve the desired Guaranteed parameters.

17.0 DEFECT LIABILITY PERIOD AND LIABILITY FOR DEFECT

17.1 The DEFECT LIABILITY PERIOD shall be for a period of 12 (Twelve) months from the date of PRELIMINARY ACCEPTANCE/DEEMED ACCEPTANCE

If at any time before the PRELIMINARY ACCEPTANCE or during the DEFECT LIABILITY PERIOD stated below, the OWNER:

(a) Claims that any matter is a DEFECT; and

(b) as soon as reasonably practicable gives to the CONTRACTOR notice of the particulars of the DEFECT; the CONTRACTOR shall as soon as possible make good the DEFECT so notified and the OWNER shall so far as may be necessary place the PLANT at the CONTRACTOR's disposal for this purpose. The CONTRACTOR shall, if so required by the EIC, submit his proposals for making good any DEFECT to the EIC for his approval.

17.2 If any DEFECT arises from any breach of the CONTRACT by the CONTRACTOR, the CONTRACTOR shall bear his own cost of making good the DEFECT. In the case of any other matter made good by the CONTRACTOR, the work done by the CONTRACTOR shall be the subject of CHANGE ORDER.

17.3 The performance guarantees are demonstrated only through the performance tests carried out before the achievement of the PRELIMINARY ACCEPTANCE CERTIFICATE.

CONTRACTOR shall carry out further test(s) on the repaired/replaced item during the DEFECT LIABILITY PERIOD having the sole purpose to verify that said item is capable of working in compliance with contractual requirements. Such test(s) shall not be intended as a repetition of the performance tests already performed.

If DEFECT is made good after the issue of a PRELIMINARY ACCEPTANCE CERTIFICATE, the EIC may require the CONTRACTOR to repeat any appropriate performance test for the purpose of establishing that the DEFECT has been made good. The CONTRACTOR shall be responsible for the cost of any repeat inspection or test in the event of an inspection or test failure.

17.4 If in the course of making good any DEFECT which arises during the DEFECT LIABILITIES PERIOD and CONTRACTOR repairs, replaces or renew any part of the PLANT, this Clause 17 shall apply to the repair or to that part of the PLANT so replaced or renewed and shall further apply until the expiry of a period of 12 months from the date of such repair, replacement or renewal (the extended DEFECT LIABILITY PERIOD). However, extended DEFECT LIABILITY PERIOD shall have an upper limit of 24 months, starting from the date of Commissioning. .

17.5 If the CONTRACTOR does not make good with a reasonable time any DEFECT which he is liable to make good under Sub-Clause 17.1 then the OWNER may, in addition to any other

remedies or relief available to him under the CONTRACT, proceed to do the work, provided that the OWNER gives at least fourteen DAYS notice of his intention.

17.6 If the OWNER reasonably requires that any DEFECT notified to the CONTRACTOR under Sub-clause 17.1 which arises during the DEFECT LIABILITY PERIOD be made good urgently and the CONTRACTOR is unable or refuses to comply within a reasonable time, the OWNER may, in addition to any other remedies or relief available to him under the CONTRACT, proceed to do the work in such a manner as the ENGINEER-IN-CHARGE may decide, including the employment of a third party.

17.7 If the OWNER has made good a DEFECT in accordance with Sub-clause 17.5 or 17.6, the CONTRACTOR shall reimburse the OWNER his reasonable cost of so doing provided that the OWNER gives a notice to the CONTRACTOR of his intention and submits a claim supported by DOCUMENTS. The ENGINEER-IN-CHARGE and the CONTRACTOR may agree the amount to be paid by the CONTRACTOR, or in the absence of agreement the ENGINEER-IN-CHARGE shall decide such amount as may be reasonable. Such amount shall be:

a) deducted from any money that would otherwise be payable under the CONTRACT; or

b) paid by the CONTRACTOR to the OWNER

17.8 If the PLANT cannot be used because of a DEFECT to which this Clause 17 applies, the DEFECT LIABILITY PERIOD, or if applicable the extended DEFECT LIABILITY PERIOD, shall be extended by a period equal to the period during which it cannot be used. Similarly the DEFECT LIABILITY PERIOD, or if applicable the extended DEFECT LIABILITY PERIOD shall be extended by any period wherein the PLANT cannot be used by reason of the CONTRACTOR putting the PLANT into such condition that it passes any relevant performance test or attempting to do so.

18.0 PERFORMANCE TESTS

18.1 The performance tests to be carried out on the PLANT shall be as specified in Technical, Section VI-2.0 of NIT.

18.2 The performance test shall be carried out by the CONTRACTOR in the presence of OWNER/PMC.

The CONTRACTOR shall give a notice to the EIC/OWNER about his readiness to carry out the performance tests, including a proposal for the time at which the tests would commence. The CONTRACTOR shall then confirm, at least fifteen (15) DAYS before the commencement of the performance tests.

18.3 Every performance test shall be carried out to completion unless the EIC or the CONTRACTOR shall order it to be stopped because its continuance would be unsafe or unacceptable to either party.

18.4 If PGTR fails due to any reason, CONTRACTOR has to make necessary adjustments and modifications and take all remedial measures at his own cost and demonstrate PGTR.

The OWNER shall permit to CONTRACTOR to make adjustments and modifications to any part of the Plant before the repetition of any performance test.

The CONTRACTOR shall submit details of the adjustments and modifications which he proposes to make.

18.5 If any performance test is stopped before its completion, due to reasons attributable to OWNER, such test shall be repeated as soon as practicable thereafter. However, the OWNER shall have the option to operate the plant in accordance with the Operating Manuals provided by CONTRACTOR, whereupon care and custody of the PLANT shall pass on to the OWNER and DEFECT LIABILITY PERIOD shall start. The OWNER shall exercise the option to allow CONTRACTOR to carry out the Performance Tests with grant of extension of time by such number of days of deferment. Such deferment shall not exceed more than 90 days. In case the deferment exceeds 90 days, the Owner shall reimburse the additional cost of remobilisation incurred due to such deferment. However, the outer limit of such deferment shall be 12 months from COMMISSIONING and the provisions of Clause 16 shall apply thereafter. If the PLANT fails to pass any performance test, such test shall, subject to Sub-clause 18.7, be repeated as soon as practicable thereafter. The OWNER shall permit to CONTRACTOR to make adjustments and modifications to any part of the Plant before the repetition of any performance test and shall, if the CONTRACTOR reasonably requires, shut down any part of the PLANT for such purpose and restart it after completion of the adjustments and modifications, which shall be made by the CONTRACTOR with all reasonable speed.

The timing of such shutdown shall be agreed between the CONTRACTOR and the EIC, provided that if any or both i.e. the timing of shutdown or repetition of Performance Test, is required to be deferred, the agreed period of Performance Test Period shall be accordingly extended.

The CONTRACTOR shall, if so required by the EIC, submit to the EIC for his information details of the adjustments and modifications which he proposes to make.

The CONTRACTOR shall make such adjustment and modifications at his own cost.

18.6 The result of the performance tests shall be compiled by the CONTRACTOR and to be submitted to OWNER/PMC for evaluation.

18.7 If the PLANT passes performance tests towards meeting all Performance Guarantees specified at Section VI-2.0 of NIT, but does not pass the performance test towards meeting Works Guaranteed cost for reasons which are the responsibility of the CONTRACTOR, then

i) If, the results of the performance tests towards meeting Guaranteed Works Cost are within the limits for the application of MUTUALLY AGREED DAMAGES, CONTRACTOR shall at its option either:

(a) may carry out remedial measures necessary to attain the Guaranteed Works Cost and repeat the performance test; or

(b) pay the applicable MUTUALLY AGREED DAMAGES in terms of clause 31 GCC.

Upon payment or allowance of such sum the CONTRACTOR shall become entitled to PRELIMINARY ACCEPTANCE CERTIFICATE which shall inter alia state that applicable MUTUALLY AGREED DAMAGES have been paid in respect of shortfall in performance and CONTRACTOR shall be released from all liability with respect to PGTR.

Further, in case of a) above, the CONTRACTOR will be allowed only one more chance to pass the performance test towards meeting Guarantee Works Cost.

ii) If the results of the performance tests towards Guaranteed Works Cost are outside the limits for application of MUTUALLY AGREED DAMAGES specified in the CONTRACT, OWNER may at his option:

a) instruct the CONTRACTOR to investigate or to co-operate with the EIC or others in the investigation of the reasons in its WORK for the shortfall in the performance;

b) instruct the CONTRACTOR to propose remedial measure and work necessary to correct the shortfall whether as the result of any such investigation or not;

and/or

c) Recommend the CONTRACTOR to carry out, at CONTRACTOR'S option, whatever remedial measures and work within its scope of WORK may be necessary to correct the shortfall.

Thereafter the EIC or CONTRACTOR may require that the PERFORMANCE GUARANTEE TEST RUN be repeated, the result of which shall be subject to this Sub-clause 18.7 (i).

The CONTRACTOR shall bear his own cost of work undertaken in accordance with (a), (b) or (c) above.

iii. After 3 (three) failed Performance Tests as specified at Section VI-2.0 of NIT for reasons attributable to the CONTRACTOR, the OWNER shall have right to proceed with the encashment of Contract Performance Security and other provisions also take all action as per Clause 34 of GCC shall further apply.

19.0 FINAL ACCEPTANCE CERTIFICATE

19.1 As soon as DEFECT LIABILITIES PERIOD for the PLANT has expired or the CONTRACTOR has made good all DEFECTS that have within such period appeared in the PLANT in accordance with Clause 17 (Liability for Defects), whichever is later, the EIC shall issue a FINAL ACCEPTANCE CERTIFICATE to the CONTRACTOR certifying that the CONTRACTOR has performed his obligations in respect of the DEFECT LIABILITY PERIOD and associated clauses thereunder, and until issue of such FINAL ACCEPTANCE CERTIFICATE, the CONTRACTOR shall be deemed not to have performed such liabilities notwithstanding issue of the PRELIMINARY ACCEPTANCE CERTIFICATE or payment of the Final Bill by the OWNER.

19.2 The FINAL ACCEPTANCE CERTIFICATE shall constitute conclusive evidence for all purposes and in any proceedings whatsoever between the OWNER and the CONTRACTOR that the CONTRACTOR has completed the PLANT and made good all DEFECTS therein in all respects in accordance with his obligations under the CONTRACT.

No FINAL ACCEPTANCE CERTIFICATE shall be conclusive as stated above if FINAL ACCEPTANCE CERTIFICATE was issued in reliance upon any fraudulent act, misrepresentation or concealment.

19.3 In the event that OWNER fails to issue the FINAL ACCEPTANCE CERTIFICATE, or fails to notify CONTRACTOR the reason for not issuing said certificate of acceptance, within a period of 60 days from CONTRACTOR's application, the FINAL ACCEPTANCE CERTIFICATE shall be deemed as issued by OWNER for all contractual purposes.

19.4 Upon application for the FINAL ACCEPTANCE CERTIFICATE, the CONTRACTOR shall:

(i) Be deemed to have warranted that it had been fully paid and satisfied all claims for or arising out of the WORK, labour, MATERIALS, supplies and EQUIPMENT used in or connected with the CONTRACT and all other liabilities whatsoever touching or affecting the CONTRACT, or its performance, including in relation to SUB-CONTRACTORS and suppliers, and

(ii) To have undertaken to indemnify and keep indemnified the OWNER from and against all claims, demands, debts, liens, obligations and liabilities whatsoever arising there from or relating thereto.

19.5 Upon issue of the FINAL ACCEPTANCE CERTIFICATE, the CONTRACTOR shall be deemed to have released, acquitted and discharged the OWNER from and against all claims (known or unknown), liens, demands or causes of action of any kind whatsoever arising out of or relating to the CONTRACT or otherwise howsoever touching or affecting the same.

19.6 Forthwith on application made by the CONTRACTOR in this behalf accompanied by the FINAL ACCEPTANCE CERTIFICATE, or within 84 (Eighty Four) days of the OWNER passing the CONTRACTOR's Final Bill, whichever shall be later, the OWNER shall cancel and return to the CONTRACTOR all previous Bank Guarantees remaining unutilised in the hands of the OWNER, and upon such cancellation and return, the OWNER shall stand discharged of all obligations/ liabilities under the CONTRACT provided that the cancellation

and return of any Bank Guarantee(s) furnished by the CONTRACTOR as and by way of Contract Performance Security shall be subject to the CONTRACTOR replacing such Bank Guarantee(s) covering 3% (three percent) of the value (or as determined by the OWNER) of equipments/works replaced or repaired during the DEFECT LIABILITY PERIOD for the unexpired term of extended defect liability period in respect thereof plus a 6 (six) months period. The claims or demands made during such additional 6 months period shall refer to events which has occurred before the expiry of the DEFECT LIABILITY PERIOD.

20.0 **COMPLETION PERIOD:**

Completion period for the entire package shall be 15 (Fifteen) months from the date of issuance of FOA.

21.0 MUTUALLY AGREED DAMAGES (MAD)

21.1 **For Delay in Completion**

21.1.1 The CONTRACTOR agrees that the work shall be commenced and carried on at such points, and in the order of precedence and at such times and seasons as may be directed by the OWNER in accordance with the schedule for the completion of work as outlined in the CONTRACT. The CONTRACTOR declares that he has familiarised himself with the site and rights of way, ground conditions, with all the local conditions, and with all the circumstances which may or are likely to affect the performance and completion of the work and that he has allowed for such conditions in the preparation of this schedule. The progress of work shall be checked at regular monthly intervals and the percentage progress achieved shall be commensurate with the time elapsed after the award of the CONTRACT.

21.1.2 However, it is not incumbent upon the ENGINEER-IN-CHARGE to notify the CONTRACTOR when to begin or to cease or to resume work, nor to give early notice of the rejection of a faulty work, nor in any way to superintend so as to relieve the CONTRACTOR of responsibility of any consequence of neglect or carelessness by him or his subordinates.

21.1.3 The time stipulated in the CONTRACT for the execution and completion of the works shall be deemed to be of utmost importance of the CONTRACT. In the event the CONTRACTOR fails to attain the PRELIMINARY ACCEPTANCE of PLANT within the CONTRACTUAL COMPLETION SCHEDULE due to the reasons not attributable to OWNER, then the CONTRACTOR shall pay to the OWNER as MAD at the rate of 0.5% of the TOTAL CONTRACT PRICE (excluding taxes) per week of delay or part thereof. The total deductions under this head shall not exceed 5% of the TOTAL CONTRACT PRICE (excluding taxes).

The OWNER may, without prejudice to any method of recovery, deduct the amount for such damages from any amount due or which may become due to the CONTRACTOR. In the event of extension of time being granted by the OWNER in writing for completion of the WORKS without levy of MAD (Mutually Agreed Damages), this clause will be applicable after expiry of such extended period. GST at the prevailing rate, if applicable on

"MUTUALLY AGREED DAMAGES" shall be recovered extra from the CONTRACTOR on the amount of such MUTUALLY AGREED DAMAGES levied as per the Contractual terms.

OWNER shall raise separate Tax Invoice for recovery of MAD along with applicable GST.

Mutually Agreed Damages represent, without prejudice to the respect of the contractual obligation under the CONTRACT by CONTRACTOR, the sole and exclusive remedy of OWNER for such delay.

The decision of the OWNER on the applicability of MAD shall be final and binding on the CONTRACTOR.

21.2 **For Failing to Meet Guaranteed Works Cost**

LSTK bidder shall guarantee overall consumption of Utilities so as to guarantee the works cost for all the facilities provided by the CONTRACTOR as detailed in Technical Section VI-2.0.

In the event works cost is more than 100% but upto 102.5% of the Guaranteed Works Cost for each PLANT, then the CONTRACTOR will pay to OWNER Mutually Agreed Damages for the applicable PLANT as under:

For every 0.50% increase in Works cost above the Guaranteed Works Cost or part thereof, CONTRACTOR will pay Mutually Agreed Damages equal to 1.0% of the TOTAL CONTRACT PRICE (excluding taxes).

If the Guaranteed Works Cost as demonstrated during the performance test is more than /102.5% of the Guaranteed Works Cost , then CONTRACTOR at their own cost shall take corrective action irrespective of the cost involved. In case the Guaranteed Works Cost is more than 102.5% even after taking the corrective action, the same shall be considered as breach of Contract and necessary action as per clause 34 of GCC shall be taken by OWNER.

22.0 **OVERALL CEILING ON TOTAL LIABILITY**

22.1 The Maximum Overall Liability under the CONTRACT on account of (a) Delay in execution of project (b) Contractor failing to meet the Guaranteed Works Cost up to 102.5 % (c) Termination of CONTRACT (d) Carrying out balance work at the risk and cost of the CONTRACTOR, re-engineering, make good, mechanical warranty (e) Patent infringement and (f) any other liabilities (if any) defined in the NIT shall be capped to 100% of the TOTAL CONTRACT PRICE.

22.2 Except for criminal negligence or wilful misconduct, the Contractor shall not be liable to the Owner, whether in contract, tort, or otherwise, or any indirect or consequential loss or damage, loss of use, loss of production, or loss of profit or interest cost, provided that this exclusion shall not apply to any obligation of the Contactor to pay liabilities to the Owner, as defined in clause 22.1 above.

23.0 STANDARD CONDITIONS OF SCC: PART I TO PART III

The Contractor has to fully comply with all applicable Labour Laws and Regulations passed, modified and notified from time to time by the Central, State and Local Government agencies/authorities. Brief guidelines and Annexures related to labour laws/Acts for Workmen/labour are enclosed as STANDARD CONDITIONS OF SCC: PART I to PART IV.

STANDARD CONDITIONS OF SCC: PART I

Compliances under various Labour Laws

The Contractor has to fully comply with all applicable Labour Laws and Regulations passed, modified and notified from time to time by the Central, State and Local Government agencies/authorities. Specific attention of the Contractor is drawn to the following obligations amongst others:

1. **The Minimum Wages Act, 1948, Payment of Wages Act, 1936 and Payment of Bonus Act 1965** or **The Code on Wages, 2019 (after it comes into force)**

1.1. **Minimum Wages:**

a. During the tenure of the contract, the Contractor must ensure the payment of minimum wages, as notified by the Central Government or State Government whichever is higher, as per the provisions of the Minimum Wages Act, 1948 / Code on Wages, 2019 (after it comes into force).

b. **Wage period and monthly wages**: Wage period shall be monthly and wages for a month shall be calculated by multiplying daily rate of Minimum Wages by 26. The monthly wages include the wages of the weekly days of rest as applicable to the office/establishment of TFL. Deduction in case of any days of absence other than weekly days of rest shall be calculated using the following formula:

Deduction for absence = days of absence x (monthly wages / number of days in the relevant month)

However, in case the resource has worked for less than 7 working days in a particular month, the payment of wages is to be made as per the actual number of days worked based on notified wage rate per day.

Illustration I (05 days per week working pattern):

Sl. No.	Month	Nos. of days in the month	Nos. of weekly off	Nos. of days absence	Nos. of days present	Daily wage as notified	Monthly wage	Deduction	Wage to paid
1	Feb.	28	8	2	18	603	15678	1119.86	14558.14
2	March	31	10	5	16	603	15678	2528.71	13149.29
3	April	30	8	10	12	603	15678	5226	10452.00
4	May	31	10	-	4	603	2412	0	2412.00

Illustration II (06 days per week working pattern):

Sl. No.	Month	Nos. of days in the month	Nos. of weekly off	Nos. of days absence	Nos. of days present	Daily wage as notified	Monthly wage	Deduction	Wage to paid
1	Feb.	28	4	2	22	603	15678	1119.86	14558.14
2	March	31	5	5	21	603	15678	2528.71	13149.29
3	April	30	4	10	16	603	15678	5226	10452.00
4	May	31	5	-	4	603	2412	0	2412.00

1.2. **Payment of Wages:**

The Contractor shall disburse monthly wages **through e-banking / digital mode through cashless transaction only**, and avoid illegitimate deductions and maintain records /returns as prescribed. The Contractor shall be solely responsible for the payment of wages and other dues to the resources, if any, deployed by him latest by 7th day of the subsequent month as per the provisions of the Payment of Wages Act, 1936 / as applicable under Code on Wages, 2019 (after it comes into force) in the presence of Engineer In-charge (EIC) or authorized representative of TFL. After disbursement of wages, the representative of the Contractor and EIC/ authorised representative of TFL have to certify the payment of wages to the resources and sign the Wage Register - Form B (under The Ease of Compliance to Maintain Registers under various Labour Laws Rules, 2017) / FORM-I of Code on Wages, 2019 (after it comes into force) with specific seal detailing name/designation/Company.

1.3. **Payment of Bonus:**

Contractor shall ensure payment of bonus as per the provisions of the Payment of Bonus Act, 1965 / Code on Wages, 2019 (after it comes into force). Present minimum rate of payment of Bonus as per the Payment of Bonus Act, 1965 is 8.33% of minimum wages per month or 8.33% of Rs.7,000/- per month whichever is higher. The rate shall be subject to amendments made from time to time to the legislation.

Payment of Bonus / ex-gratia (if Bonus is not applicable) shall be made preferably before Deepawali festival falling after the end of relevant financial year(s) and the balance payment at the time of closure of contract.

The amount towards the payment of bonus/ex-gratia shall be released / reimbursed to the contractor, after submission of proof of payment.

2. Leaves/ Leave with wages/ Holiday:

The Contractor shall comply with all the applicable leave Rules including leave with wages in terms of applicable labour legislations i.e. Factories Act, 1948 / Shops & Establishment Act/ Industrial Establishment (national & festival holidays, casual & sick leave) Act, 1965.

The Contractor shall extend the leave with wages and maintain the Register of Leave pertaining to the resource deployed. The payment towards un-availed leave, as per the Factories Act, 1948

/ Shops & Establishment Act, shall be settled with the resource at the time of closure of the contract or separation of resource from the contract by the contractor.

i. As per the **Factories Act, 1948 (if applicable)**:-Annual Leave with Wages @ 01 day for every 20 days of work performed by him in the previous calendar year becomes due.

ii. As per the **Shops & Establishment Act (if applicable)** : Privilege Leave not less than 15 days and Sickness/Casual Leave not less than 12 days (this provision may vary from state to state).

iii. As per the **Industrial Establishment (national & festival holidays, casual & sick leave) Act, 1965 (if applicable)**: (a) three national holidays of one whole day each on the 26th January, 15th August and 2nd October (b) five other holidays on any of the festivals specified in the - Schedule appended to this Act. (c) Every worker shall in each calendar year, be allowed by the employer 07 casual leave and 14 sick leave in such manner and on such conditions as may be prescribed (This provision may vary from state to state).

3. The Employees' Provident Fund & Miscellaneous Provisions Act 1952

a) The Contractor shall have independent PF code no. with the RPFC as required under the Employees' PF & Misc. Provisions Act, 1952.

b) The Contractor has to ensure compliance (as per prevailing rates) and extend benefits under the Employees' Provident Fund Scheme 1952, the Employees' Pension Scheme 1995 & the Employees' Deposit Linked Insurance Scheme, 1976 to the resources deployed by him.

c) The Contractor is required to submit copies of ***separate e-Challans / ECR alongwith proof of payment/receipt*** in respect of resources engaged through this contract only, on monthly basis. **Common challans would not be acceptable in TFL**. The Contractor should submit copies of previous months EPF e-Challans / ECR alongwith current month's bill. The TRRN. No. of the ECR would be verified online from EPFO portal by the Engineer-in-charge to confirm the status of payment and names of the resources deployed.

d) **PF is mandatory irrespective of the number of resources deployed** by the Contractor under this contract. PF membership and deposit of PF contribution is also mandatory even if the wage payment to the resource is exceeding the prescribed monthly wage ceiling (i.e. Rs. 15,000/-) under the Employees' PF & Misc. Provisions Act, 1952 and in such case the liability of the Contractor towards PF contribution shall be limited to the prescribed monthly wage ceiling notified from time to time (i.e. Rs. 15,000/- currently).

e) In case, the Contractor deploys any "**International Worker**", the Contractor should also make compliance under para 83 of EPF Scheme, 1952 i.r.o the "International Workers" and must register on the ***International Worker Portal of EPFO***.

4. The Employees' State Insurance Act, 1948 (If applicable and as per prevailing rates)

a) The Contractor shall have his own ESI code No. allotted by Employees' State Insurance Corporation (ESIC) as required under the Employees' State Insurance Act, 1948.

b) The Contractor has to arrange **Smart Cards (i.e. ESI Identity Card) /e-Pehchan Card** for the resource(s) engaged by him from the Corporation.

5. The Employees' Compensation Act 1923 (wherever applicable)

In case, the work place is out of the notified coverage area under ESIC i.e. ESIC is not implemented in the area **or** in case of excluded employees under ESIC, the Contractor is required to take Employee Compensation / Workmen Compensation Policy from IRDAI approved Insurance Company taking into consideration the **maximum compensation liability** as per provisions of Employees' Compensation Act, 1923. It must be ensured that the contractor/contracting firm should extend coverage to the contract workers through Employee Compensation Policy, to meet the **Compensation Liability** under **Employee's Compensation Act, 1923** along with **Medi-claim Policy** within the overall premium @ 3.25 % of Minimum wages (i.e. employer contribution towards ESI).

6. Group Personal Accident Insurance Policy

The Contractor is required to take a Group Personal Accident Insurance Policy with coverage of **Rs. 3 Lakhs** per resource for the entire period of contract covering all resources deployed under the contract.

7. **The Payment of Gratuity Act, 1972**

In case of Death or permanent disablement of a resource during execution of work under the contract, the Contractor has to pay the Gratuity as per the provision under the Payment of Gratuity Act, 1972 to the nominee(s) of the resource as per the details maintained in the duly signed Nomination Form maintained by the Contractor. The proof of disbursement may be submitted to the EIC for claiming reimbursement of amount paid towards death Gratuity from TFL.

8. **The Contract Labour (R&A) Act, 1970**

a) The Contractor is required to obtain Labour license under the provisions of the Contract Labour (R&A) Act, 1970 from the office of Licensing Officer, Central Labour Authority, Ministry of Labour and Employment, Govt. of India having jurisdiction of the Region.

b) The Contractor shall discharge obligations as provided under the Contract Labour (R&A) Act, 1970 rules and regulations framed under the same and enforced from time to time.

c) The Contractor shall ensure regular and effective supervision and control over the resources deployed for which a supervisor / representative of the Contractor should be available at all the times for giving suitable direction for undertaking the Contractual Obligations.

d) The Contractor is solely responsible for payment of wages to each resource deployed by him and such wages shall be paid before the expiry of such period as may be prescribed.

e) It shall be the duty of the Contractor to ensure the disbursement of wages to resource(s) through e-banking/digital mode. In case the resource does not have a bank account, the disbursement of wages may be made in cash in the presence of the Engineer-in-charge /

authorized representative of TFL initially and Contractor shall simultaneously arrange for opening the bank account of each contract labour deployed by him.

f) In case, the Contractor fails to make payment of wages and deposit of PF contribution within the prescribed period or makes short payment of wages / short deposit of PF contribution, then TFL, as Principal Employer, will make payment of wages in full or the unpaid balance due, as the case may be, to the resource(s) deployed by the Contractor and deposit the PF contribution with PF authorities. Such amounts will be recovered from the Contractor either by deduction from any amount payable to the Contractor under any contract or as a debt payable by the Contractor.

9. The contractor is required to comply with all applicable labour laws and regulations including, but not limited to the following:

a) The Factories Act, 1948 / The Shops & Establishment Act, 1948 (which ever applicable)
b) The Maternity Benefit Act, 1961
c) The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1979 & Building and Other Construction Workers Welfare Cess Act, 1996
d) The Inter State Migrant Workmen (RECS) Act 1979 (if applicable)
e) Contract Labour (R&A) Act-1970
f) Employees' Provident Fund & Misc. Provisions Act- 1952
g) Employees' State Insurance Act-1948
h) Employees' Compensation Act, 1923
i) Payment of Gratuity Act, 1972
j) Minimum of Wages Act,1948
k) The Payment of Wages Act,1936
l) The Payment of Bonus Act,1965

STANDARD CONDITIONS OF SCC: PART II

Responsibilities of the Contractor

1. The Contractor shall be solely responsible and indemnify TFL against all charges, dues, claim etc. arising out of the disputes relating to the dues and employment of resources, if any, deployed by him.

2. The Contractor shall indemnify TFL against all losses or damages, if any, caused to it on account of acts of the resource(s) deployed by him.

3. The Contractor shall indemnify TFL from all claims, demands, actions, cost and charges etc. brought by any court, competent authority / statutory authorities against TFL.

4. The Contractor shall also indemnify TFL for any action brought against him for violation, non-compliance of any act, rules & regulation of center / state / local statutory authorities.

5. All resources deployed by the Contractor are deemed to be on the rolls of the Contractor.

6. **Age**: No resource below the age of **18 years** and above age of **58 years** shall be deployed by the contractor for the execution of the contract.

7. **Appointment/Nomination of supervisor:**
   As a part of the contract, the Contractor is required to appoint/nominate a supervisor (s) who will supervise, control and give directions to the resource(s) for discharging the contractual obligations. Accordingly, the Contractor has to give in writing the name and contact details of the supervisor (s) to the EIC. A copy of the same is also to be sent to HR In-charge and Security In-charge for records.

8. A copy of the Letter of Acceptance (LOA) should be submitted to the Security Department by the Contractor / his representative or supervisor for facilitating the movement of resource(s) including machine & materials involved in the contract.

9. The resources to be deputed/ deployed by the Contractor shall observe all security, fire and safety rules of TFL while at the site/work. All existing and amended safety / fire rules of TFL are to be followed at the work site by the Contractor and his deployed resource(s).

10. **Personal Protective Equipment / Safety Kit and Liveries**: Contractor shall ensure adequate supply of personal protective equipment / Safety Kit and Liveries as mentioned in the Scope of Work to all such resources deployed.

11. In case of accident, injury or death caused to the resource(s) while executing the Work under the contract, the Contractor shall be solely responsible for payment of adequate compensation, insurance money etc. to the next kith & kin of injured / diseased. Contractor shall indemnify TFL from such liabilities.

12. The Contractor shall not deploy any resource suffering from any contagious or infectious disease. The Contractor shall get the deployed resource(s) examined from a civil Govt. Doctor / TFL's Doctor.

13. No resource(s) or representatives of Contractor (including Contractor) are allowed to consume alcoholic drinks or any narcotics within the premises of TFL (including Plant, Office and Residential etc.). If found under the influence of above, the Contractor shall immediately replace that resource(s) with intimation to the EIC.

14. While engaging / deploying the resources, the Contractor is required to make efforts to provide opportunity of employment to resources belonging to **Schedule Caste, Schedule Tribe** and **Other Backward Class** in order to have a fair representation of these sections of the society.

15. While engaging the resources, the Contractor is required to make efforts to provide an **opportunity to** candidates with experience of **apprentice training in TFL** under the provisions of the Apprentices Act, 1961.

16. The Contractor is required to maintain all Registers and other records in an **office** within the premises of TFL or at a place **within a radius of three kilometers**.

17. Contractor shall provide proper **Employment cards (FORM XII)** for the resource to be deployed by him, duly signed by the Contractor or authorized person on behalf of Contractor.

18. **Gate/ Entry Pass or Authorization:**
    Entry to the premises of TFL is restricted and is subject to appropriate entry authorization in the prescribed format of a Gate Pass or any other entry authorization w.r.t police verification as per instruction of Security department from time to time. Similarly, entry for material/ equipment's/ tools/ tackles etc. is restricted & subject to entry authorization by security department.

19. The Contractor shall issue **Identity cards** in his firm's name to the resource deployed.

20. Discipline of the resource(s) during discharge of duties must be regulated by the Contractor himself or by his representative.

21. **Police verification**
    a) The Contractor (including his sub-Contractors/Petty Contractors etc, if allowed) will undertake police verification in respect of the resource(s) engaged by him in TFL's premises. Such verification will have to be carried out from concerned police station of their permanent place of residence/present place of residence.
    b) Further, the Contractor is advised not to deploy any resource having past criminal record in the establishment/premises of TFL under this contract awarded to him.
    c) In the event of violation of above clauses at (a) and (b), the Contractor will be solely responsible for the same.
    d) If any such resource(s) having criminal record is deployed by the Contractor in the premises of TFL and has come to the notice of TFL at any point of time, the Contractor shall immediately replace that resource(s), failing which that particular resource(s) of the Contractor will not be allowed to enter into the premises of TFL.

22. While confirming to any of these conditions, the Contractor must ensure that all applicable Laws of State regarding labour, their welfare, conduct etc. are complied.

STANDARD CONDITIONS OF SCC: PART III

Compliance of Government of India Directives

1. Pradhan Mantri Suraksha Bima Yojna (PMSBY) and Pradhan Mantri Jeevan Jyoti Bima Yojna (PMJJBY)

Contractor shall, ensure that all its resources deployed under this contract have obtained additional insurance coverage under the Pradhan Mantri Suraksha Bima Yojana (PMSBY) and Pradhan Mantri Jeevan Jyoti Bima Yojana (PMJJBY) through the participating banks and submit the proof of such insurance coverage to the satisfaction of TFL. The cost has been included in the estimate mentioned in SOR and the Contractor shall submit evidence / proof to TFL in this respect. Both the schemes are to be regulated continuously on yearly basis and the same should be renewed on each successive relevant date in subsequent years during the period of the contract.

2. Labour Identification Number (i.e. LIN) Registration (Mandatory)

The Unified Shram Suvidha Protal, developed by Government of India, facilitates reporting of Inspections & submission of Returns and has also been envisaged as a single point of contact between employer, resources and enforcement agencies bringing in transparency in their day-to-day interactions. For integration of data among various enforcement Agencies, the Contractor, as an inspectable unit, is required to register and obtain Labour Identification Number (i.e. LIN) from Shram Suvidha Portal and submit the same in TFL.

3. Pradhan Mantri Rojgar Protsahan Yojna (PMRPY) – if applicable

In order to support the Govt. of India's Initiative on Employment Generation, the Contractor must register for Pradhan Mantri Rojgar Protsahan Yojna (PMRPY) Scheme. The Contractor shall inform TFL/Engineer in Charge about the benefit availed, if any, against the scheme for adjustment against the invoice(s) / bill(s).

Annexure-i

Details in support of RA Bill for the Month of _____, 20__

(1) Name of the Firm/Agency/Contractor _____
(2) Nature of Contract: Job/ Service _____
(3) Period of Contract: From _____to _____
    (a) Extension Period of Contract, if any from _____to _____
    (b) Place where contract workmen are working _____
(4) Postal address of the Contractor: _____
(5) Phone No. of the Contractor: _____
(6) Fax No. and Email of the Contractor: _____
(7) Name and Address of PF office from where EPF Code No. has been allotted: _____
(8) EPF Code No. allotted by PF office: _____
(9) Name and Address of ESIC office from where ESI Code No. has been allotted: _____
(10) ESI Code No. allotted by ESIC office: _____
(11) Labour License No. _____ dated _____
(12) Validity period of Labour License from _____to _____
(13) Detail of Resource engaged by the Contractor:

Category	**No. of Resources**		**Prevailing Minimum Wages**
	Male	**Female**	
Unskilled			
Semi-skilled			
Skilled			
Highly skilled			
Total			

(14) Copy of Wage Register in FORM – B (to be replaced by FORM-I as per Code on Wages-2019, after it comes into force)
(15) Details of deposit of contribution towards EPF:
    a) EPF Challan No. _____Amount _____ Date_____
(16) Details of Deposition of contribution towards ESI
    a) ESI Challan No. _____Amount _____ Date _____
(17) Whether any arrangement / agreement has been entered with any resource for extending benefits under Inter-state Migrant Workmen (RE&CS) Act, 1979: ____ (Yes / No)
    If Yes, No. of such Inter-state Migrant Workers: _____

SIGNATURE OF CONTRACTOR/AUTHORIZED REPRESENTATIVE

Place:
Date:

Annexure- ii

UNDERTAKING

(To be submitted along with un-priced bid)

I/We hereby undertake that I/We have completely understood the terms & conditions of the Tender including minimum resources required to be deployed and the cost involved thereof in deployment of resources.

I/We further undertake to ensure all compliances of the tender conditions. Any non-compliance may be construed as deficiency in the performance of the contract. If such non-compliance is noticed TFL/owner is at liberty to take action in line with the tender conditions including termination of the contract.

Signature of Bidder……..
Name of Bidder……..

Annexure - iii

Summary of Insurance Policies

Contractor is required to cover all resources deployed by him with the following insurances / schemes:

Sl. No.	SCHEME	APPLICABILITY	PREMIUM/ CONTRIBUTION	SUM ASSURED/ BENEFITS	REMARKS
1	The Employees' State Insurance Act, 1948	Applicable to all resources of the Contractor (within ESI wage limit) working in notified area.	3.25% of wages by employer 0.75% of wages by employees	Benefits under the Employees' State Insurance Act, 1948.	
2	The Employees' Compensation Act, 1923 (in lieu of ESI – mentioned at Sl. 1)	Applicable to excluded employees under ESI and those who are working in non-notified area to extend similar benefits as available under ESI Act, 1948	Premium to be calculated considering wage limit under EC Act, 1923 (i.e. Rs. 15,000/- p.m currently)	Maximum **Compensation Liability** under Employee's Compensation Act, 1923 along with **a Mediclaim policy** within overall premium @ 3.25 % of Minimum wages (i.e. employer contribution towards ESI)	Provides compensation and medical facility to resources.
3	Group personal Accident Insurance	Applicable to all resources of the Contractor	Based on the coverage	Insured value: Rs. 3 Lakh to cover expenses associated with any accident.	Death, permanent disablement, temporary total disability or any other medical expenses related to accident.
4	Pradhan Matri Suraksha Bima Yojana (PMSBY)	Eligibility – age group 18 to 70 years	Rs. 12/- per annum	**Accidental** death and permanent disability: (i) Permanent total disability – Rs. 2 lakhs. (ii) Permanent partial disability – Rs. 1 Lakh.	
5	Pradhan Mantri Jeevan Jyoti Bima Yojana(PMJJB)	Eligibility – age group 18 to 50 years. (can continue upto 55 years)	Rs. 330/- per annum.	Risk coverage – Rs. 2 Lakhs- in case of **death due to any reason**	

SECTION - VI: TECHNICAL

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INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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SECTION VI: TECHNICAL

PART – 1.0

SCOPE OF WORK

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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1.0 INTRODUCTION:

Government of India has formed a joint venture company of major Public Sector Units – M/s GAIL (India) Limited (GAIL), M/s Rashtriya Chemicals & Fertilisers Ltd. (RCF), Coal India Limited (CIL) and M/s Fertilizers Corporation of India Ltd. (FCIL) by name M/s Talcher Fertilizers Ltd. (TFL) hereinafter also referred to as "OWNER", for setting up a Coal Gasification based Ammonia Urea Fertilizer Complex along with its associated offsite & utility facilities at Talcher, in the Angul District of Odisha State.

Projects & Development India Ltd. (PDIL) has been retained by TFL as Project Management Consultant for selection of a suitable Contractor for execution of the Instrument Air/Plant Air system for Ammonia & Urea fertilizer complex as detailed in subsequent sections of this NIT.

1.1 GENERAL DESCRIPTION OF PACKAGE:

Instrument/plant air system shall comprise of following items for each location:

- 2 Working +1Stand by Centrifugal Air Compressors
- 1 No Moisture Separator Knock Out Drum
- 1Working +1 Stand by Electric Heater with standby dryer/regeneration vessel with no purge loss)
- 1 No. Dried Air After Cooler
- 2 No. Dry Air Receiver vessel
- 1working +1stand by Set of Instrument Air dryers
- 2 No. Low Pressure Wet Air Receiver
- 1 No. High pressure compressor @ 40 kg/cm2g discharge pressure for back up receiver.
- 1 No. Back up Instrument Air receiver for 30 min emergency storage @ 36.5 Kg/cm2g pressure

The Instrument Air and plant air system, a Package unit shall be provided to supply instrument air and plant air to meet the requirement of normal operation of process plants & at time of plant start-up, shutdown and maintenance work.

Atmospheric air is compressed by air compressor; Compressed air is cooled in after-cooler and through wet air receiver K.O.Drum, sent to various plant facilities as plant air and instrument air drier at a pressure of 9.5 Kg/cm2g. The dried air is sent to instrument air header through instrument air receiver at a pressure of 8.8 Kg/cm2 (g) and temperature of 45 ºC, Instrument Air provided by at battery limit considering design flow rate of 8000

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Nm^3/hr, Dew Point of Instrument Air shall be (-) 40 Deg C at Atmoshperic pressure, from header instrument air is distributed various facilities of plant.ACTIVATED Alumina data sheet is to be provided with these Tender documents to ascertain the quality by vendors.

ACTIVATED Alumina data sheet is to be provided with these Tender documents to ascertain the quality by vendors.

2.0 SCOPE OF WORK

Offered packaged should be an integrally geared centrifugal air compressor (As per API 672). The Bidder's scope of work shall include detailed design, engineering, manufacturing, procurement, inspection, testing, painting, supply, erection, commissioning, performance testing at site and handing over of Compressed air package on turnkey basis, along with associated electrical, instrumentation, structural, architectural, piping and insulation works etc., complete in all respects as detailed in the enquiry document i.e. Design & Engineering, procurement, supply, construction & erection, Testing, pre-commissioning, commissioning including , Mechanical, electrical & Instrumentation works as a single point responsibility Vendor(SPRV), Sustained load test & Performance Guarantee Test Run (PGTR), trial runs and demonstration of guarantees, calibration & supply of complete package along with spares & maintenance tools etc. as per related documents enclosed with enquiry for complete instrument/plant air system package and final acceptance of Plant after successful completion of Performance Guarantee Test Run.

The scope of supply will include the following items but not limited to 3 No. Air Compressor, 2 set of Desiccant, Air Drier package & Dry Air Receiver in line with NIT requirement items as listed below including Interconnecting piping, all fittings, mechanical valves, control valves, motors, cables, supply of field and control room instrumentation etc. as required for completing the systems per enquiry specifications. Any other item not specifically mentioned above but which is essential for good engineering practice for continuous operation and maintenance of the system safely at all times shall be included in scope of supply by Bidder.

Sl. No.	Equipment	Qty.
1.	Air Filter For Air Compressor	3 Nos.
2.	Air Compressor	3(2W+1S) Nos.
3.	Air Comp After Cooler	3 Nos.
4.	Wet air receiver K. O. Drum	1 No
5.	Air dryer Pre-Filter	2No(1W+1S)
6.	Adsorber	2 Set (1W+1S)
7.	Air dryer After Filter	2 Set.

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8.	Instrument Air Receiver	1 No.
9.	Dried Air After Cooler	1 No.
10.	Electric Heater	2 No.
11.	Regeneration after Cooler	2 No.
12.	Regeneration Air Moisture Separator	2 No.
13.	Dry air Receiver For Emergency	2 No.
14.	HP Compressor	1 No.
15.	Low Pressure Wet Air Receiver	2 No.
16.	HP IA Emergency receiver@36.5 Kg/cm2g for 30 Min backup	1 No.

IA Dryer working/regeneration cycle shall be as follows:

Cycle Time for Adsorption: 8 hrs approx

Cycle Time for Regeneration: 8 hrs. (Heating 6 hrs approx. & Cooling 2 hrs approx).

Temporary Construction Facilities:

The Bidder shall arrange following facilities at his own cost for Construction/Erection purpose:

i. **Construction power supply facilities:** 1 No. 11 kV Feeder (rated for 2 MVA) at Existing Substation near 132 KV Switchyard shall be made available. Tapping of Construction Power (**chargeable** on actual basis rate at the time of consumption) from this feeder (including supply & erection of all required materials like structural supports for cable tray, cable trays, power cables, control cables, protection & metering, cable termination etc. as well as underground cabling work) and further distribution shall be in LSTK Contractor's scope.

ii. **Construction Water Supply facilities:** Construction water shall be supplied at one point at plant location, bidder to make arrangement for construction water supply from given plant location to bidder plant battery limit on **chargeable** on actual basis rate at the time of consumption. Bidder to install meter for consumption measurement.

iii. Construction sheds

iv. Material storage

v. Construction offices

vi. Temporary Communication facilities

vii. Office furniture

Bidder shall provide following drawing/documents/data for Civil & Structural Design to Owner":

a. Overall equipment layout with co-ordinates

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b. Static equipment:-

- G.A. drawing of the equipment showing bolt details
- Drawing having following details of weight:-
  - Empty weight of equipment
  - Operating weight of equipment
  - Hydro test of equipment
- Shear force and moment at base plate level due to wind and seismic separately

c. Dynamic equipment:-

- G.A. drawing of equipment with bolt/pocket details and base frame.
- Combined C.G. of the system.
- Maximum permissible amplitude.
- Operating frequency of the system.
- Unbalance forces if any and its point of application.

Civil scope of work has been already taken in bagging building Tender.

2.1 The Bidder's scope of work shall include all activities e.g. engineering, Procurement, Construction, Supplies and Services necessary for turnkey execution of the project from basic design to commissioning and successful performance guarantee Test run at site.

2.2 Bidder shall develop Approved for Construction (AFC) drawings/Documents, Taking into account of detailed requirements of the documents appended to the bid Package:-

- Process Design Basis Package,
- Engineering Design Basis,
- Job Specification,
- Standard specifications,
- Drawings,
- Engineering tables,
- Installation Standards,
- Piping & Instrumentation Diagrams (P&IDs),
- Data sheets of all equipment,
- OWNER/PDIL's review and comment, etc.

2.3 Bidder's scope of Work (For Static Equipment) shall include but shall not be limited to following:

a) Process Design and Engineering comprising preparation of the following documents:-

- Residual basic engineering design,
- PFD with major controls, material & energy balance,
- P&IDs,
- Interlock and logic diagram with full description
- Equipment and line list with sizes,
- Functional loop schematics, etc.

b) Detailed Engineering comprising of:-

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- Process flow diagram,
- Plot plan development,
- Scope of Work

c) Complete mechanical design & thermal design (For heat exchanger).

d) Detailed engineering of equipment including all mountings, accessories & bought-out items.

e) Procurement of all materials & bought out items.

f) Shop/site fabrication (as applicable) & assembly

g) Inspection, testing (including hydro testing)

h) Surface preparation, painting , insulation, pickling and Passivation (for SS equipments), internal and/or external coating, epoxy coating, rubber lining etc

i) Packing (seaworthy when sea transportation) forwarding, transportation to site etc.

j) N2 filling of equipment

k) Stage wise and final inspection by appointed TPIA/Owner

l) Fire proofing as per requirement of the bid package

m) Any other requirement for safe and smooth operation

n) Submission of engineering drawing & document for Owner/PDIL review. All drawing submitted to owner/PDIL shall be thoroughly checked by contractor before submission.

o) Supply of “As Built documentation and QC dossiers”.

Bidder scope of supply for Static equipment shall include but shall not be limited to following:

- Supply of static equipment (Vessels, heat exchanger, Tanks, PHE etc) including their accessories
- Supply of all fabricated and proprietary internals for all equipment as applicable.
- Supply of mandatory (spare parts for two year operation) and commissioning spares attached elsewhere in bid package.
- Insulating material, primer paints, fire proofing material etc.
- Supply of material & equipment required for blast cleaning, chemical cleaning, pickling Passivation, surface preparation & polishing & coating of internal surface, epoxy coating, rubber lining, and FRP lining e.t.c. for equipment as applicable.
- Supply of all equipments , tool & tackles including torque wrench, bolt tensioned etc. as per specification and all material required for inspection and testing (i.e. NDT, Hydro testing, performance testing e.t.c)
- Supply of all tools and tackles, template for foundation for heavy lift equipment and for the erection for all equipment.
- Eye bolts, jack screws, dowel pins and lifting lugs etc. as required

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- Lifting lugs / erection lugs
- Cleats for earthing connections
- Cover flanges for manholes, handholes, inspection openings etc. with bolting and gaskets.
- Supply of all other materials whether specifically mentioned or not but required for completion of the job in all respect as per bid package.
- Name plate with bracket

The above mentioned activities shall be carried out in accordance with applicable code and all technical requirements covered in the bid package

2.4 The bidder's scope of work shall include all activities e.g. engineering, Procurement, Construction, Supplies and Services necessary for turnkey execution of The project from basic design to commissioning and successful performance guarantee Test run at site.

2.5 The Contractor's scope of services shall include but not be limited to the following:-

2.5.1 Process Design and Engineering comprising preparation of the following documents:-

- Residual basic engineering design,
- PFD with major controls, material & energy balance,
- P&ID,Interlock and logic diagram with full description.
- Equipment and line list with sizes,
- Functional loop schematics, etc.

2.5.2 Detailed Engineering comprising of:-

- Process flow diagram,
- Plot plan development,
- All Layouts,
- General arrangement Drawings,
- Fabrication and assembly drawings, etc
- Procurement of material and bought outs items.
- Shop/Site fabrication and testing.
- Assembly of sub-assemblies.
- Stage wise inspection at shop.
- Customs clearances.
- All type of Insulation, cladding, and painting of the plant.
- Supply & Transportation to site.
- Shop/Site fabrication and testing.
- Assembly of sub-assemblies.
- Stage wise inspection at shop.
- Unloading, prolong storage/preservation and security at site.
- Movement of material equipment, consumables etc at site.
- Construction, erection, installation, assembly, hook ups and field testing.
- Filling of lubricants, Oils, consumables, chemicals etc. (for first filling and replacement as required before handing over to owner).
- Clear the work space of all construction aids debris etc. and provide a tidy work place from pre-commissioning stage.
- Pre commissioning and commissioning.
- Satisfactory performance guarantee tests at site.
- Handing over of plant to the owner as per PDIL/Owner's satisfaction.

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• All statutory clearances and permits from local, statutory and other bodies such a Indian Boiler Regulations, Static and mobile pressure vessel rules, Chief controller of explosives, Factory inspector, Labour Inspector, Electrical inspector, pollution controls board etc.
• Contractor shall prepare a comprehensive equipment List showing all items classified on the basis of each Process and utility unit. Equipment list shall also identify Equipment requiring:-
• Approval from Statutory authorities (PESO, IBR, etc.),
• ASME Code Stamping,
• Compliance to Petroleum rules, etc
• Equipment list shall include the following against each item:-
• Equipment/item tag numbers,
• Description,
• Drawing number,
• Vendor,
• Data sheet number,
• Design flow, pressure and temperature,
• Special features if any, etc.
• Contractor shall carry out requisitioning activities and the requisition shall contain the following as a minimum:-

2.5.3 Equipment data sheets including accessories and auxiliaries etc. indicating operating Parameters, performance requirements, construction features, instrumentation & Controls, inspection and testing.

• Scope of Supply of Vendor equipment and supply by others.
• List of applicable specifications as well as Codes and Standards.
• Mechanical and Performance Guarantees.
• Vendor documentation and data requirement.
• Experience record format required to be completed by Vendor.
• Mandatory spare parts list (Separate lump sum price to be quoted).
• Erection and Commissioning spares (part of base price).
• List of 2 (two) years recommended normal operating spares. (As per commercial part
• of tender)
• Special Tools & Tackles (if any) (itemized list to be submitted. Price shall be part of
• base price)
• Supply of first fill of lubricants, chemicals, cleaning fluids, hydraulic oils, refrigerants,
• Desiccants and subsequent filling before handing over to owner.
• Vendors site support services for construction and commissioning
• CONTRACTOR shall prepare stage wise Inspection programmes to ensure the Integrity of all equipment and piping. This programme should include inspection & Testing as per data sheet, design basis, job specs. Standard specifications/standards, And codes etc. but are not limited to the following:-
• Identification of Raw Material including all Non-destructive testing to be mutually Agreed between CONTRACTOR, PDIL and OWNER.
• Co-ordination in design, procurement, Inspection, testing and commissioning of Packaged equipment.
• Technical advisory control on all Mechanical matters, throughout all phases of project Execution i.e. from design through procurement, construction and commissioning/
• Problems resolution.
• Preparation of spare parts interchange ability records
• Specific maintenance instructions, which will minimize the removal of obstacles for Routine maintenance

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Scope of supply by bidders should include: Three (3) numbers electric motor driven integrally geared Centrifugal air compressors, (2W+1S) common for Plant air, Instrument air system

Two (2) numbers of Heat of Compression with No Purge Loss type Instrument Air Dryers, each of 8000 Nm3 /hr capacity.

3. Scope of Supply

Contractor's scope of supply shall include but not be limited to the following on turnkey Basis:-

- All equipment's as per (Equipment / Packages list) of this document.

However, Contractor shall supply all the required equipment/ items as per BEDP to complete the system in all respects.

- **All electrical, instrumentation and controls.**
- **All supports for equipment, piping, ducting etc.**
- **Foundations and Foundation Bolts for all equipment and supports**
- **First fill of all** lubricants, activated **alumina, chemicals, hydraulic oils, and heat transfer media, Desiccants (Activated Alumina) and subsequent filling before handing over to** Owner. Any **special tools and tackles required for operation and maintenance of the Plant and equipment.**
- **Spares for start-up and commissioning.**
- **Mandatory Spares**
- Spares for 2 year's normal operation (only itemized price list with recommended Quantity to be furnished).

3.1 Scope of Services

a) Detailed process design including preparation of P&ID, heat and mass balance diagram, control and logic diagram, interlock schemes, etc.

b) Detailed design of plant and equipment, instrumentation, electrical and control system. Detailed design of civil and structural work.

c) Detailed equipment layout, piping GAD & isometrics, battery limit hook ups and other works as required.

d) Documentation & approvals including approvals from statutory authorities including those required to be taken by Owner.

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e) Procurement of raw materials, bought out components, fabrication and assembly at shop.

f) Inspection & testing, including third party inspection at shop, packing, forwarding & delivery to site.

k) All piping works as per piping specification. All isolation valve at battery limit shall be in bidder's scope.

l) Assistance/supervision in Mechanical Completion.

m) Assistance/supervision in Hydro testing, Pre-commissioning and reliability runs.

n) Assistance/supervision in Commissioning and performance guarantee run and handing over.

o) Arrange all necessary instruments, tools/tackles required to aid pre-commissioning, commissioning and performance guarantee tests.

p) All documents/drawings shall be submitted by the bidders as per documentation schedule.

q) Undertake a HAZOP and Disaster Management studies for the system. The HAZOP will be carried out at PDIL/TFL office. Bidders to incorporate all HAZOP changes into their design and supply without any price and time implication.

r) Two months supervision are in vendor scope of work.

All incoming and outgoing utilities shall be provided with isolation valve along with companion flanges gasket and bolting at the battery limit of the unit. All the utilities shall be supplied at battery limit of the plant at a single point.

All consumable chemicals lubricants etc. are excluded. However first charge of all chemicals, grease and lubricants are to be supplied by the bidder.

Operating staff is excluded but operation supervisors and maintenance personnel shall be arranged by the bidder during commissioning, trial and performance test runs.

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3.2 MECHANICAL

3.2.1 STATIC

For Detailed Scope of work with respect of Static Refer Attached Document No. PC183/E/4008/SEC-VI/PART-3.2.1 (SOW)

3.2.2 Rotary

For Detailed Scope of work with respect of Rotary Refer Attached Document No. PC183/E/4008/SEC-VI/PART-3.2.2

3.2.3 PIPING

For Detailed Scope of work with respect of Piping Refer Attached Document No. PC183/E/4008/SEC-VI /PART-3.2.3

3.3 ELECTRICAL

For Detailed Scope of work with respect of Electrical Refer Attached Document No. PC183/E/4008/SEC-VI/PART-3.3

3.4 INSTRUMENTATION

For Detailed Scope of work with respect of Instrumentation Refer Attached Document No. PC183/E/4008/SEC-VI/PART-3.4

3.5 INSPECTION & TESTING REQUIREMENTS

For detail requirements of Inspection & Testing, please refer Technical Specifications of individual discipline attached.

All equipment covered in this NIT shall be subjected to stage-wise and final inspection by Third party inspection(TPI) agency (here in after called Inspector) during manufacture. The approval of TPI for passing such inspection/test will not however prejudice the right of purchaser to reject equipment if it does not comply specifications when erected or do not give service to complete satisfaction of client. Cost of such tests shall be borne by the Bidder. Particulars of proposed procedures and tests shall meet requirements of the specifications/applicable standards without which Inspector's approval will not be given. Pre-assembled units shall be tested at

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the factory as much as possible to demonstrate their specified/required duty conditions prior to despatch to site.

Shop test shall include various tests to be carried at bidder's or his sub-contractor's works and at works where raw material supplied for equipment is manufactured. Bidder shall carry out comprehensive inspection and testing programme during manufacture in the works. Indicative programme of inspection/tests envisaged by client is given below. However, it is contractor's responsibility to draw up and carry out such a quality assurance plan/programme and submit for approval by TFL/PDIL

Check on control panels for dimensions, wiring, continuity, insulation, tubing leakages etc.

All panel mounted and local instruments and accessories to be checked for performances, over-range protection etc., as per Standard or other approved standards, by client.

Test for control valves for body/seat/diaphragm chamber leakage, lift characteristics, bonnet and material composition.

3.6 FUNCTIONAL TEST OF CONTROL SYSTEM.

All test certificates and reports shall be submitted to TFL for approval. The Inspector or his representative shall be given full access to all tests.

Bidder shall inform the TFL/PDIL well in advance regarding the tests.
After erection at site, all components, equipment shall be tested for satisfactory performance without showing any sign of defect of individual equipment-wise or complete system-wise.

All pipings, fittings and valves after installation will be tested hydraulically for 1.5 times that of maximum attainable system pressure as per applicable standard.
All valves shall be operated and checked for 100% of trouble-free travel.

Visual checks shall be carried out on all structural components, welding, painting etc.

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All the test instruments and equipment shall be furnished by the bidder free of cost.

3.7 QUALITY ASSURANCE & CONTROL:

Quality Assurance (QA) shall mean the organizational set up, procedures as well as test methods and facilities developed by bidder in order to assure that all equipment leaving bidder's shop are of the highest possible quality i.e. either equal to or better than the requirement specified.

Quality Control (QC), shall mean all the tests, measurement, checks and calibration which are to be carried out in bidder's shop in order to compare the actual characteristics of the equipment/unit/system with the specified ones, along with furnishing of the relevant documentation (certificates/records) containing the data or result of these activities.

Bidder shall submit a comprehensive description (manual) of QA/QC measures contemplated by him for implementation with regard to this specification. It is contractual obligation of the bidder to develop and implement adequate QA/QC systems.

QA/QC system shall cover all products and services of the contract i.e. documentation material, shop and site fabrication, transportation and site works, including job sub contracted by the bidder.

3.8 PROGRESS REPORTING

Bidder shall submit monthly progress report and detailed project schedule to Principal.

3.9 INTERCONNECTING PIPING:

Bidder shall provide block valve with spectacle blind for all inlet & outlet lines at the battery limit for complete isolation.

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SECTION –VI: TECHNICAL

PART – 2.0

TECHNICAL SPECIFICATION

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

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CONTENTS

Sr No.	DESCRIPTION
1.0	General Description Of Package
2.0	Design Basis
3.0	Guarantees
4.0	Time Schedule

LIST OF ANNEXURE

Annexure Number	Description	Number of Sheets
Annexure -1	Process Flow Diagram	1

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1.0 GENERAL DESCRIPTION OF PACKAGE

Same as page no 2 of 14 in PC150/E/4004/P-VI/ SEC-1.0

2.0 DESIGN BASIS:

2.1 DESIGN CAPACITY

Instrument Air System

Design Capacity;-	8000Nm3/hr(Dry Air)for TFL
Pressure Kg/cm2 (g),	8.8
Temperature ºC	Ambient
Dew point ºC	-40 C at Atm Pressure

Online Dew point analyser with range of 0 – (-) 60 Degree Celsius at the inlet of IA receiver shall be provided.

Dew Point of Instrument Air shall be (-) 40 Deg C at Atm Pressure.

Plant Air System

Design Capacity; -	8000 Nm3/hr for TFL
Pressure Kg/cm2 (g),	9.5
Temperature ºC	Ambient

2.2 QUALITY (Instrument Air)

Dew Point	-40 DEG C at Atm pressure
Oil	Nil
Temperature ºc	Ambient

2.3 Noise Level

Noise level shall be maximum 85 dBA at one meter from the source

2.4 Hazardous Area Classification:

In general Area classification shall be in accordance with IS 5572 along with latest update.

2.5 Equipment Specifications

2.5.1 Air Compressor

No.	3(2W+1S)
Type	Centrifugal
Capacity	8000 Nm^3/hr each (on Dry Basis)
Suction Pressure	Atmospheric
Discharge Pressure	9.5 Kg/cm2g (g)
Capacity Control	0-100%

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Design Condition of Air Compressor shall be as follows:

Suction pressure is atmospheric pressure. Bidder shall consider margin for pressure drop in suction piping & suction strainer. All compressors must be able to operate in parallel.

2.5.2 Air Compressor after Cooler

No.	2(operating) + 1 (standby)
Fluid (Hot (shell)/Cold (tube))	Instrument Air/Cooling Water
Air outlet temp.	45ºC
Cooling water inlet temp.	33ºC
Cooling water outlet temp.	43ºC
Cooling water inlet pressure	3.5Kg/cm^{2}g (g)
Design Pressure (cooling water)	8Kg/cm^{2}g
Allowed pressure drop (cooling water)	0.5 Kg/cm^2 (between Battery Limit)
Air inlet pressure	By bidder
Allowed pressure drop (air)	By bidder
Design pressure (air)	10.5Kg/cm^{2}g
Air fouling resistance	0.0002 Hrm^2 ºc/kcal
Cooling water fouling resistance	0.0006 m^2 ºc h/kcal
Heat duty	By bidder

NOTE: All heat exchangers MOC shall be as follows:

- SHELL : KCS+3mm CA
- TUBE: SS-304/SS-304L
- Channel : Carbon Steel

2.5.3 Wet Air Receiver K.O. Drum (IF APPLICABLE)

No.	1
Operating/Design Pressure	9.5Kg/cm2g/10.5Kg/cm2g
Capacity	By bidder but not less than (30 m3)
Operating/Design Temperature	45/70 ºC
Height (between tangent lines)	By Bidder
Diameter	By Bidder
Material of Construction	Carbon Steel

2.5.4 Adsorber

No.	2 set (1W+1S)
Capacity	8000 Nm^3/hr for TFL
Operating Temperature	By bidder
Operating Pressure	By bidder
Allowed pressure drop	By bidder
Design Temperature	By bidder
Design Pressure	10.5Kg/cm2g for TFL
Material of Construction	C.S. (internals S.S.)

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Desiccant	Molecular Sieve
Dew point of dried air	-40 ºC at Atm Pressure
Cycle time	maximum 8 hrs
Pressure Drop	0.5 kg/cm2 (Max)

Bidder shall provide 1 No. Low Pressure Wet Air Receiver upstream of Instrument Air Generation package to avoid any fluctuations in operation of Instrument Air Generation package.

2.5.5 Air dryer Pre-Filter

No.	4
Type	Hydrofobic sintered polypropylene
Filtration	5 micron with 99.9% efficiency

2.5.6 Air dryer After Filter

No.	4
Type	Cartridge
Filtration	1 micron with 99.9% efficiency

2.5.7 Dried Air after Cooler

No.	1
Fluid (Hot (shell)/Cold (tube))	Dried Air/Fresh Cooling Water
Flow (Dried Air/Fresh cooling water)	8000Nm3/hr
Air inlet temp.	By bidder
Air outlet temp.	45ºc
Cooling water inlet temp.	33ºc
Max. cooling water outlet temp.	43ºc
Cooling water inlet pressure	3.5Kg/cm2g
Allowed pressure drop (water)	0.5 Kg/cm2 (between battery limit)
Air inlet pressure	By bidder
Allowed pressure drop (air)	By bidder
Design pressure (air/water)	10.5/8Kg/cm2g
Air fouling resistance	0.0002 Hrm^2 ºc/kcal
Cooling water fouling resistance	0.0006 Hrm^2 ºc/kcal
Heat duty	By bidder
Material of Construction:	
Tube/tube sheet	S.S.304
Channel	Carbon Steel
Shell	Carbon Steel
Corrosion Allowance	3 mm

2.5.9 Regeneration after Cooler

No.	2
Fluid (Hot (shell)/Cold (tube))	Regeneration Air/ Cooling Water
Flow (Regen Air/ cooling water)	By bidder
Regen air inlet temp.	By bidder

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Regen air outlet temp.	By bidder
Cooling water inlet temp.	33ºc
Cooling water outlet temp.	43ºc
Cooling water inlet pressure	3.5Kg/cm2g
Design Pressure (cooling water)	8.0Kg/cm2g
Allowed pressure drop (fresh water)	0.5 Kg/cm2 (Between Battery Limit)
Regen air inlet pressure	By bidder
Allowed pressure drop (air)	By bidder
Design pressure (air/water)	10.5/8Kg/cm2g
Air fouling resistance	0.0002 Hrm^2 ºc/kcal
Cooling water fouling resistance	0.0006 Hrm^2 ºc/kcal
Heat duty	By bidder
Material of Construction:	
Tube/tube sheet	S.S.304
Channel	Carbon Steel
Shell	Carbon Steel

2.5.10 Regeneration Air Moisture Separator

No.	2
Capacity	By bidder
Operating/Design Temperature	By bidder/70ºc
Operating/Design Pressure	By bidder/ 10.5 Kg/cm2g
Height	By bidder
Diameter	By bidder
Material of Construction	Carbon Steel

2.5.11 Electric Heater

No.	2
Capacity	By bidder
Operating/Design Temperature	By bidder
Operating/Design Pressure	9.5/10.5
Heat Duty	By Vendor

2.5.12 Instrument Air Receiver

No.	1
Capacity	By Bidder
Hold up time each receiver	30 min each
Max Pressure	36.5 kg/cm2g
Min Pressure	8 Kg/cm2g

2.5.13 HP Compressor

No	1
Type	Reciprocating
Discharge Pressure	40 Kg/cm2g
Capacity	By Vendor

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2.6 SITE METEOROLOGICAL DATA:

2.6.1 TFL

Wind load design as defined in IS: 875 Part 3

Prevailing Wind Direction : W & NW

1	**Atmospheric Pressure**	
	Average	1008 mbar
2	**Ambient Temperature**	
	Maximum Dry Bulb Temperature	46.3°C
	Minimum Dry Bulb Temperature	1°C
	Wet Bulb Temperature	29°C
	Average temperature	31.9^0C
3	**Rainfall**	
	Average Annual rainfall	1329 mm
	Design in 1 hour	116 mm
4	**Relative Humidity**	
	Maximum	100 %
5	Seismic zone	Section 5.5(Civil)

3.0 Guarantees:

3.1 Workmanship guarantee: Bidder shall guarantee all components of package against faulty design, improper material of construction and poor workmanship in addition to performance guarantee. Approval by Principal for design calculation and detailed shop drawing, will not in any way absolve the bidder from his responsibility. Should any repair or replacement be necessary owing to any type of failure on account of design material and workmanship of the item, bidder shall in view of this guarantee be bound to replace the same either in part or whole without additional cost to purchaser. Repaired or replaced part shall also be covered by same guarantee as in case of main supply

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3.2 Performance guarantee and trial run:

The individual equipment shall be tested in accordance with standards prior to commissioning to establish the parameter and performance.

The sustained load test of the composite plant shall be deemed to have been completed, if Plant produces an average of not less than 90% of the daily rated capacity. If, during the sustained load test, there are interruptions due to reasons not attributable to the obligations and responsibilities of LSTK Contractor, periods of such interruptions shall be included and regarded as days of operation at min. 90% of design capacities or actual load prior to interruptions whichever is lower. The cumulative period of such interruptions shall be limited to a maximum of 2 (Two) days. Owner shall have option to reduce the period of sustained load test of 72 hours.

Trial run shall be performed for a period mutually agreed upon, without interruption prior to commissioning to establish the satisfactory working of the accessories, equipment. After the pre-commissioning and testing, each unit shall be commissioned to operate at the parameters specified and performance test run shall be conducted.

In the event of failure of performance test run, bidder shall carry out necessary modification at his own expense to meet the guarantees.

The Performance Test shall comprise a 72 hour performance test run. Vendor shall provide to Principal (for approval) not later than 90 days prior to mechanical Completion, a proposed procedure including dates, arrangements and forms of tests, durations of tests, numbers of readings to be taken, instrument lists and numbers of observers required. The Performance Test must demonstrate the requirements outlined in clause 3.3. If the Performance Test is interrupted or terminated for any reason such test shall be restarted from the beginning. Performance Test to be carried within 3 months of commissioning. Bidders to make adequate allowance for these requirements in their tender.

After 3 (three) failed Performance Tests as specified for reasons attributable to the CONTRACTOR, the OWNER shall have right to proceed with the encashment of Contract Performance Security and other provisions also take all action.

3.3 Process Guarantees:

Performance Guarantee parameters for Instrument air system:

a) Electric Power Consumptions
b) Capacity of air dryer

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c) Outlet pressure of Instrument Air dryer
d) Dew point of outlet Instrument Air
e) Pressure drop across instrument air dryer
f) Outlet air temperature of Instrument air

3.3.1 The rated capacity of each LP air compressor shall be minimum 8000Nm^3/hr (Dry Basis).
Compressor Capacity: Each of 8000Nm3/hr at 9.5Kg/cm2g

3.3.2 The plant air capacity shall be 8000 Nm3/hr at(at vendor B/L)

3.3.3 The plant air header pressure (at vendor B/L) shall be 9.3 Kg/cm2 (g)

3.3.5 Instrument Air Generation Capacity is 8000Nm3/hr at 8.8Kg/cm2g pressure at Dry Air Receiver outlet.

3.3.6 The Dried instrument air at B/L (at dry air receiver outlet) shall be minimum at 8.8Kg/cm2 g.

3.3.7 Dew point of dried air shall be –40 ºC at Atmospheric pressure.

3.3.8 Noise level shall be maximum 85 dBA at one meter from the source

3.3.9 Pressure drop across each Air Instrument dryer & across the system shall not exceed 0.5 Kg/cm².

3.3.10 Temperature of outlet of dried instrument air at 45^{0}C at B/L (at dry air receiver outlet)

3.3.11 The Bidder shall demonstrate following parameters during COMMISSIONING at site:
- Capacity
- Battery limit condition i.e. Pressure, temperature, dew point, switch over time,

3.4 Guarantee of Utilities:

Bidder shall guarantee performance of Instrument air/plant air system for the following:

- Capacity of Instrument air/plant air system.
- Total Power consumption
- Cooling water consumption
- Operating cost

Sl.No	Raw Material/ Utilities	Unit Price in Rs.	Consumption per day for required capacity as per Specification	Cost Rs. per day
1.	Cooling water,m^3	37.75/m3		
2.	Power for Air Compressor, kWh	5.915/Kwh		
	Guaranteed operating Cost			

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Note:
1.All Guaranteed Consumptions including power & chemicals if any and Cost shall be indicated in price schedule and indicate figures to be furnished in technical bid.
2. Performance guarantee test run of Air Compressor shall be performed at rated capacity.
3. The power consumption (power at motor input) at full Load of one compressor including auxiliaries (8000 Nm3/hr at 9.5.0Kg/cm2 g).
4. Total cooling water requirement for complete instrument air system at full Load with one compressor & dryer working.
5. The power consumption at full Load of one Air Dryer (8000 Nm3/hr for TFL).
6. Bidder shall submit following separately in hard copy, which shall be evaluated by TFL/PDIL before price bid opening:
a) Expected cooling water consumption along with calculations.
b) Expected power consumption for Air Compressor with calculations.
c) Expected Balance Power Consumptions with calculations.

4.0 Time Schedule

4.1 Bidder shall furnish programme in form of master network identifying main phases in various areas of total work like design, engineering, procurement of materials and bought out items, manufacture of equipment, delivery and field activities. It shall conform to following schedule:

4.2 Master network shall be prepared in Primavera software, discussed and agreed upon. Engineering drawings and data submission schedule shall also be discussed and finalised before issue of letter of intent. Liquidated damages leviable for delays shall be effective from the dates mentioned above.

4.3 After award of contract, the bidder shall plan sequence of work of manufacture and erection to meet the plant commissioning dates given above and shall ensure that all work/manufacture, shop testing and shipment of equipment is in accordance with required construction/execution sequence.

4.4 Within fifteen days after award of letter of intent bidder shall submit for review and approval of detailed network schedules based on master network as mutually agreed upon, showing logic and duration of activities in following major areas: Detailed engineering, procurement, manufacture, shop, inspection, testing, despatch/shipment and receipt at site.

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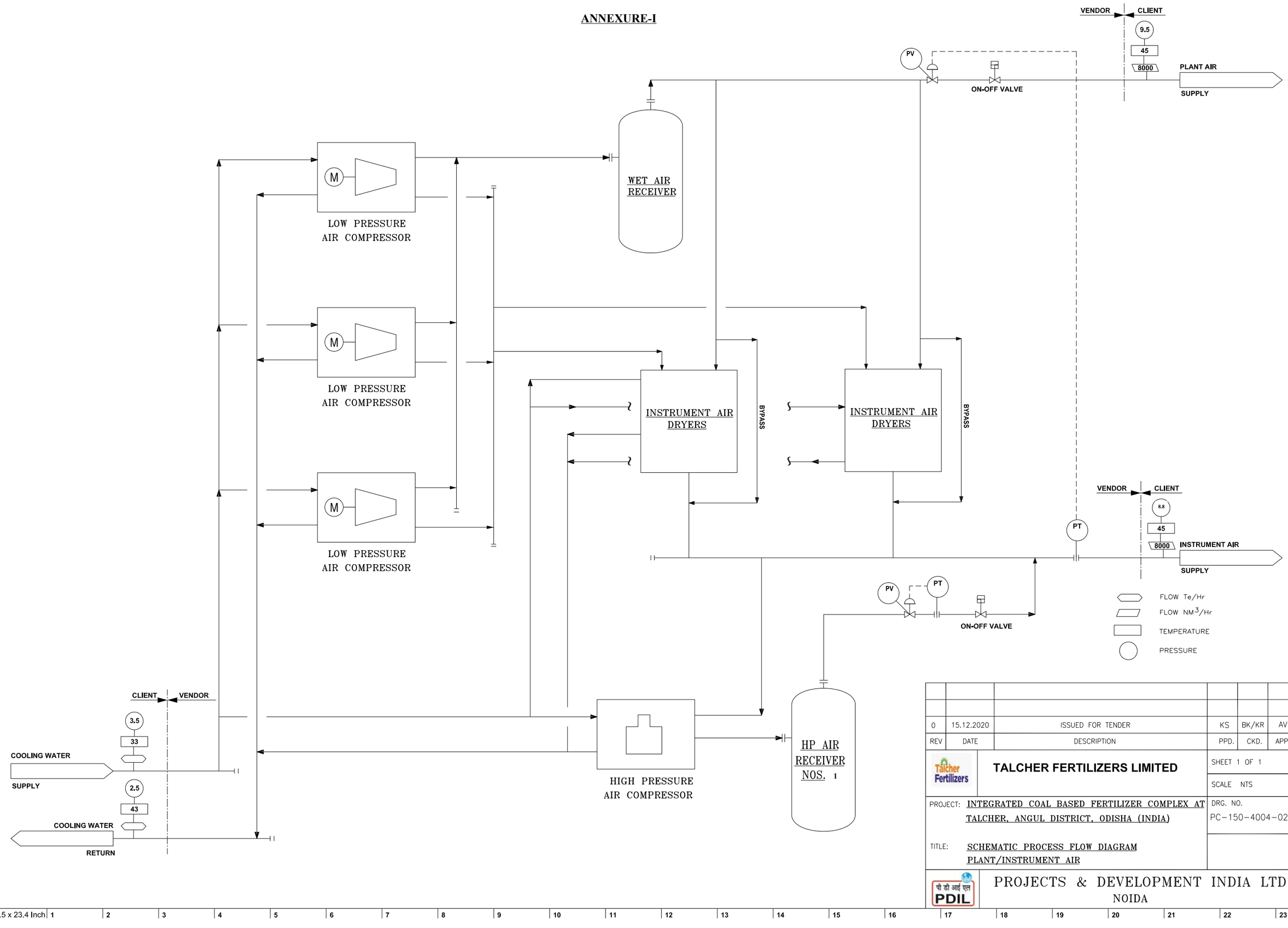
ANNEXURE-I



REV	DATE	DESCRIPTION	PPD.	CKD.	APPD.
0	15.12.2020	ISSUED FOR TENDER	KS	BK/KR	AV

TALCHER FERTILIZERS LIMITED	SHEET 1 OF 1
	SCALE NTS
PROJECT: INTEGRATED COAL BASED FERTILIZER COMPLEX AT TALCHER, ANGUL DISTRICT, ODISHA (INDIA)	DRG. NO. PC-150-4004-021
TITLE: SCHEMATIC PROCESS FLOW DIAGRAM PLANT/INSTRUMENT AIR	
PROJECTS & DEVELOPMENT INDIA LTD. NOIDA	

16.5 x 23.4 Inch

SECTION –VI: TECHNICAL

PART – 3.1

DESIGN SPECIFICATION – PROCESS

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

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CONTENTS

Section Number	Description
1.0	General
2.0	Design Pressure
3.0	Design Temperature
4.0	Corrosion Allowance
5.0	Heat Exchangers
6.0	Pumps
7.0	Compressors
8.0	Pressure Relief Valves
9.0	Columns & Vessels

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1.0 GENERAL:

The plants shall be designed to operate safely and satisfactorily at a capacity of 50 to 110% of Design Capacity. Equipment and machinery shall be provided so that the plants can operate for at least two years without major overhaul or inspection. All design shall conform with the latest edition of the applicable sections of ASME, ASTM, IEEE, NFC, TEMA, AISI, NEMA, AISC, ACI, OSHA, UBE and other governing codes or standard practices. Any other equivalent and acceptable Code of Standard practice may be adopted with the approval of the PMC/Owner. In addition, the following state/local Codes/laws shall supplement:

a)	Pressure Vessels/ Formed ends	ASME, Section VIII, DIV.I / Indian Standard IS 4049.
b)	Buildings & Structural	Relevant Indian Standard (BIS)
c)	Electricity	Indian Electricity Rules.
d)	Sanitary	Relevant Indian Standard (BIS)
e)	Safety	a) Manual of Chief Inspector of Explosives, Govt. of India.
f)	Water Pollution	Relevant Indian Standard (BIS) / Odisa Pollution Board limits

1.1 System of Measurements

The system of measurement shall be Metric as follows:

Parameter	Preferred Units	Alternative Units
Temperature	°C	
Pressure - absolute	kg/cm² abs	
Pressure - gauge	kg/cm² g	
Flow (liquid)	m³/hr	kg/hr
Flow (gas)	Nm³/hr	kg/hr
Flow (steam)	kg/hr	
Length, Level	mm	M
Time	hr	sec, min
Heat	kcal	Gcal
Power	kW	

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Fouling resistance	m² hr °C / kcal	
Pipe size / diameter	Inches (in)	mm
Mass	kg	
Liquid relative density	sp gr T°C/15.6°C	
Liquid density	kg/m^3	
Vapor flowing density	kg/m^3	
Furnace draft	mm of WC	
Storage tank pressure	mm of WC	
Vacuum	mm of Hg, mm WC	
Standard vapor	Nm^3/hr at 0°C & 1.033 kg/cm^2a	
Standard liquid	m^3/hr at 15.6°C	
Thermal conductivity	kcal/hr-m-°C	
Heat Transfer coefficient	kcal/hr-m^2-°C	
Enthalpy, Entropy	kcal/kg	
Heat rate	10^6kcal/hr or MM kcal/hr	Gcal
Viscosity	cP	
Kinematic Viscosity	cSt	
Sound Pressure	dB(A)	
Sound Power	dB(A)	

2.0 DESIGN PRESSURE:

2.1 General Rule:

Design pressure of Process Static Equipment shall be based on the maximum Operating Pressure. Malfunction and Equipment failure shall be taken into consideration by safety devices. Design pressure shall be for process equipment shall be whichever is higher. Alternatively LSTK Contractor shall select the design pressure as standard design.

a) For max operating pressure below 2 kg/cm^2 g use 3.5 kg/cm^2 g

b) For max operating pressure between 2 kg/cm^2g and 15 kg/cm^2g use Max. Operating Pressure + 1.5 kg/cm^2

c) For Max. Operating Pressure between 15 kg/cm^2 g and 100 kg/cm^2 g use Max. Operating pressure x 110 %

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d) For Max. Operating Pressure equal and above 100 kg/cm^2 g use the Maximum Operating Pressure + 10 kg/cm^2 g.

2.2 Equipment under Vacuum:

Equipment normally operated under vacuum is designed for full vacuum and for the highest pressure it can experience in case of vacuum failure. Equipment containing a fluid with a vapour pressure at ambient temperature lower than atmospheric pressure which can be isolated shall be equipped with vacuum breaking device or else be designed for full vacuum. Equipment subject to vacuum due to mal-operation or failure shall be equipped with vacuum breaking devices or else be designed for full vacuum.

2.3 Complete Systems:

Several pieces of Equipment protected by the same relief valve shall have a design pressure of at least the set pressure of the relief valve.

2.4 Equipment on the Discharge of a Pump:

Equipment which may have to bear the shut-off pressure of a pump shall have a design pressure equal to or higher than the shut-off pressure. Pump shut-off pressure shall be estimated according to Clause 7.0.

2.5 Thin Walled Tanks And Vessels:

Atmospheric thin walled tanks and vessels shall have a design pressure equal to the highest pressure imposed upon discharge of the pressure relief device. The design pressure for vacuum shall be equal to the lowest pressure imposed upon suction of the vacuum relief device.

3.0 DESIGN TEMPERATURE:

Design temperature for process equipment shall be whichever is higher:

a) Maximum operating temperature + 15 °C (+25ºC for Feed/Effluent exchanger)
b) Boiling temperature at design pressure of process medium inside, if applicable.
c) Design temperature shall be rounded up to full 5°C steps.
d) Design minimum temperature shall be specified only if the minimum operating temperature is below 0 °C. Design minimum temperature shall be 5 °C less than the minimum operating temperature. Special attention shall be given to low boiling liquids.

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e) For piping, design temperature shall be determined according to ASME B 31.3.

Alternatively LSTK Contractor shall select the design temperature as standard design.

4.0 CORROSION ALLOWANCE:

Materials of construction and corrosion allowance for all Equipment and machinery shall be for a design life of 25 years (except for heat exchanger tubes). However, minimum corrosion allowance for carbon steel (including 0.5 Mo alloy steels) shall be:

Pressure Vessels and other applicable Equipment	3 mm
Storage Tanks	1.5 mm
Piping	1.5 mm
Removable parts or internals (on each side in Contract with operating fluid)	0.75 mm
For stainless steel/titanium	0 mm
Carbon steel with epoxy resin coating	3 mm

5.0 HEAT EXCHANGERS:

In general heat exchangers shall be designed to 110 % of their operating duty/flow.

Columns overhead coolers shall be designed to 120 % of their operating duty/flow.

Large heat exchangers shall be split into two or more shells for easy operation and maintenance.

6.0 PUMPS:

Normally pumps shall be designed to 110 % of their maximum required flow rate in worst case of operation.

The shut-off pressure shall be estimated according to the following criteria whichever is higher:

a) Differential head at rated flow x 120 % + LH (level high) suction static head + max operating pressure suction side.

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b) Differential head of pump at rated flow + LHH (level high high) suction static head + design pressure suction side x 120 %. No over design shall be applied to the rated pressure.

7.0 COMPRESSORS:

In general, compressors shall be designed to a minimum of 110 % of their maximum required flow.

8.0 PRESSURE RELIEF VALVES:

Pressure relief valves shall be supplied with locked open isolating valves. Pressure relief valves for operational failure shall have installed spares. Also PRV on fire case with Hydrocarbon service shall have installed spare. LSTK Contractor shall take care of any additional requirement as per guidelines. The set pressure of pressure relief valves shall be equal to the design pressure of the equipment. All safety valves will have bypass with exception of safety valves which are only for fire cases and if there is more than one safety valve.

All solenoid operated on-off valve 4" and above shall be butterfly valve.

9.0 COLUMNS AND VESSELS:

9.1 Nozzle:

a) Minimum size 3/4" (for S.S shall be 1 inch).

b) Nozzle rating according to once of connected piping for instrument min. Class 150 ANSI rating.

9.2 Manhole:

Manhole size 24" (*)

9.3 Hand hole or Inspection hole:

a) Preferable Size 8 inches

b) Minimum Size 6 inches

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9.4 Vent and Drain:

Vent and drain for vessels will normally be provided at the minimum length on overhead or bottom line in accordance with the following table:

Volume or diameter of vessel (m^3 or mm)	Vent diameter (inches)	Drain diameter (inches)
V < 75 or D <= 4,500	2	2
75 < V <= 220 4,500 < D <= 6,000	3	3
220 < V <= 420 or D > 6,000	4	4
V > 420	6	4

Note: *Vent and drain connections are not necessarily located on vessels.*

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SCOPE OF WORK

(MECHANICAL STATIC EQUIPMENT)

PLANT: INSTRUMENT AIR/PLANT AIR SYSTEM

PROJECT: INTEGRATED COAL BASED FERTILIZER COMPLEX AT TALCHER, ANGUL, DISTRICT- ODISHA, INDIA

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1.0 Scope

This specification covers the requirements for the complete design (Mechanical), procurement, fabrication, construction/erection , insulation, painting ,Pickling & Passivation (for SS equipments), inspection and testing of static equipment (Pressure Vessels, Heat Exchangers, Storage Tanks, and Vessel Internals e.t.c) for INSTRUMENT AIR/PLANT AIR SYSTEM of the M/s TALCHER FERTILISER LIMITED, ODISHA in accordance with this specification, standards specification, codes and other attachment etc. listed in bid document.

Bidder scope of Work (For Static Equipment) shall include but shall not be limited to following :

a) Complete mechanical design & thermal design (For heat exchanger).
b) Detailed engineering of equipment including all mountings, accessories & bought-out items.
c) Procurement of all materials & bought out items.
d) Shop/site fabrication (as applicable) & assembly
e) Route survey, if required
f) Design and supply of Anchor bolt
g) Inspection, testing (including hydro testing)
h) Surface preparation, painting , insulation, pickling and Passivation (for SS equipments), internal and/or external coating, epoxy coating, rubber lining e.t.c
i) Packing (seaworthy when sea transportation) forwarding, transportation to site etc.
j) N2 filling of equipment
k) Storage and preservation at site
l) Statutory approvals (IBR,PESO, e.t.c)
m) Stage wise and final inspection by appointed TPIA/Owner
n) Fire proofing as per requirement of the bid package
o) Any other requirement for safe and smooth operation
p) Submission of engineering drawing & document for Owner/PDIL review. All drawing submitted to owner/PDIL shall be thoroughly checked by contractor before submission.
q) Supply of “As Built documentation and QC dossiers”.

The above mentioned activities shall be carried out in accordance with applicable code and all technical requirements covered in the bid package.

1.1 Scope of supply (For Static Equipment)

Bidder scope of supply shall include but shall not be limited to following:

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- Supply of static equipment (Vessels, heat exchanger , Tanks, PHE e.t.c) including their accessories
- Supply of all fabricated and proprietary internals for all equipment as applicable.
- Supply of mandatory (spare parts for two year operation) and commissioning spares attached elsewhere in bid package.
- Insulating material, primer paints, fire proofing material e.t.c.
- Supply of material & equipment required for blast cleaning, chemical cleaning, pickling Passivation, surface preparation & polishing & coating of internal surface, epoxy coating, rubber lining, and FRP lining e.t.c. for equipment as applicable.
- Supply of all equipments , tool & tackles including torque wrench, bolt tensioner e.t.c. as per specification and all material required for inspection and testing (i.e. NDT, Hydro testing, performance testing e.t.c) erection & Hydro testing including all site re-hydro tested equipment.
- Supply of all tools and tackles, Anchor bolt, template for foundation for heavy lift equipment and for the erection for all equipment.
- Eye bolts, jack screws, dowel pins and lifting lugs etc. as required
- Lifting lugs / erection lugs
- Cleats for earthing connections
- Name plate with bracket
- Cover flanges for manholes, hand holes, inspection openings etc. with bolting and gaskets.
- Supply of all other materials whether specifically mentioned or not but required for completion of the job in all respect as per bid package.

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SECTION – VI
PART- 3.2.1

DESIGN PHILOSOPHY-STATIC EQUIPMENT

PLANT: INSTRUMENT AIR/PLANT AIR SYSTEM

PROJECT: INTEGRATED COAL BASED FERTILIZER COMPLEX AT TALCHER, ANGUL, DISTRICT- ODISHA, INDIA

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LIST OF ATTACHMENTS

SL. NO.	DESCRIPTION	DOCUMENT NO.
1.	VESSEL TOLERANCE	PDS:PV-001
2.	PROJECTION OF NOZZLES	PDS:PV-002
3.	NAME PLATE FOR VESSEL & TOWER	PDS:PV-003
4.	SKIRT SUPPORT FOR VERTICAL VESSEL	PDS:PV-301
5.	LIFTING LUG	PDS:PV-302
6.	PIPE DAVIT	PDS:PV-303
7.	NAME PLATE FOR HEAT EXCHANGER	HE 321
8.	LUG SUPPORT FOR VERTICAL VESSEL	PDS:SR-300
9.	SUPPORT SADDLE FOR HORIZONTAL VESSEL	PDS:SR-302
10.	BRACKET SUPPORT FOR VERTICAL VESSEL	PDS:SR-304

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1. 0 **Design Criteria**

1.1 This specification covers the requirements for the complete design (Mechanical), procurement, fabrication, construction/erection, insulation, painting ,Pickling & Passivation (for SS equipments),inspection and testing, of static equipment (Pressure Vessels, Heat Exchangers, and Vessel Internals etc.) for INSTRUMENT AIR/PLANT AIR SYSTEM of the M/s Talcher Fertilisers Limited (TFL) in accordance with this specification, standards specification, codes and other attachment etc. listed in bid document.

1.2 The equipment shall be designed & constructed as per the latest edition of the following codes and standards:

Code	Description
ASME Section VIII Div 1	Rules for construction of Unfired Pressure Vessels
TEMA 'R' / API 660	Standards of Tubular Exchangers Manufacturer's Association / For Shell & Tube Heat Exchanger
HEI	Heat Exchanger Institute standards for steam surface condensers and steam jet ejectors
API 661	Air Cooled Heat Exchangers
API 662	Plate type Heat Exchangers
IBR	Indian Boiler regulations
API 650	Welded Steel Tanks for Oil Storage
ASME RTP-1	Reinforced Thermo set Plastic Corrosion Resistant Equipment
API RP 2000	Venting Atmospheric and Low pressure storage Tanks
ASME Section II A&B/ ASTM	Materials Specifications
ASME Section II PART C	Specification for welding rod, electrode & filler metal
ASME SEC II PART D	Properties
ASME Section V	Non-destructive Examination
ASME Section IX	Welding Qualification
ASME SEC X	Fiber-Reinforced Plastic Pressure Vessels
EN-13121	For Fiber-Reinforced Plastic Pressure Vessels
ASME B 16.5	For Flanges
ASME B 16.47	For large diameter flanges
ASME B 16.20	For Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral Wound, and Jacketed
ANSI	Pipes, Flanges, Fittings and Valves
IS: 875/SITE DATA	For wind load consideration
IS: 1893 (Part 4) & IS: 1893 (Part	For seismic design consideration

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1) / SITE DATA	
IS:4682 (Part-1) with Amendment No. 3	Code of Practice for Rubber Lining of Vessels & Equipment for Chemical Process
Factory Act, 1948 BS CP 3003 (Part 1)	Factory Act & State Govt factory rules Code of Practice on lining of Vessels and equipment for Chemical Process.
PESO	Petroleum &Explosives Safety organization

1.3 Complete mechanical design of Equipment as per latest code /standard of construction shall be the responsibility of the LSTK Contractor. Strict compliance with the requirement of codes/equipment specification & any other referred document shall be ensured. In addition, all statutory rules & regulations shall also be complied with.

1.4 Design conditions for all equipment shall be as per technical Specification and Material specification. Minimum required thickness is calculated based on design parameters considering different types of loadings including effect of static head of liquid column. Equipment shall also be designed for hydrostatic condition. Final thickness is decided giving due consideration for corrosion allowance.

1.5 Design pressure shall be at the top of vertical vessel or at the highest point of horizontal vessel. The design pressure at any lower point shall be determined by adding the maximum operating liquid head and any pressure gradient within the vessel.

1.6 Wind analysis shall be performed as per IS-875 (Latest Edition).Wind forces shall be increased by 20% (over & above design code requirement) to cater the effect of piping system, platforms and ladders etc.

1.7 Seismic analysis shall be performed by Response spectrum method (RSM) considering seismic zone-IV as per IS-1893 part-1 & IS-1893 Part 4 (Latest edition).

1.8 All carbon steel (CS) & low alloy steel (LAS) pressure parts shall have 3 mm corrosion allowance unless specified otherwise.

1.9 All internals CS/ LAS parts including low temperature materials shall have at least 1.5 mm corrosion allowance on either side unless otherwise specified.

1.10 Design of supports and anchor bolts shall be performed for compressive and tensile loading. In no case shall diameter of anchor bolts be less than M24 for skirt support and M16 for other type of support. Supply of anchor bolt required as per design for equipment shall be in bidder scope.

1.11 Each Lifting lug shall be designed with shock factor 2. Lifting lugs and tailing lugs shall be designed taking account of vessel weight and lifting method, etc. Supplier shall decide location of lifting lug/tailing lugs in order to avoid interferences between lifting wires and external attachments (such as platform, ladder, and nozzles) during erection. Materials, procedures of welding them to the shell and inspection method shall also be carefully checked.

1.12 Hydro testing of equipment shall be as per UG-99b of ASME Sec VIII Div-1. In order to safeguard against the risk of brittle fracture during hydrostatic test metal temperature during hydrostatic test be maintained at least 30°F (17°C) above the minimum design metal temperature, but need not

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exceed 120°F (48°C). Design pressure for each nozzle shall be sum of maximum allowable working pressure and static head of corresponding nozzles.

1.12.1 Maximum Allowable Working Pressure (MAWP) is the maximum gauge pressure at the top of a completed vessel, which is obtained from the calculations for every element of the vessel based on the actual thickness inthe corroded condition. Supplier shall calculate the MAWP of each vessel, and the calculation shall be included in design calculations. MAWP shall not be assumed to be the same as the design pressure except for cases where MAWP cannot be determined by calculation to the applicable code. Accordingly calculate hydro test pressure as per UG-99b.

1.13 Bolt of size M 48 and above shall be designed and spaced so as to permit tightening with a hydraulic stud-tensioner. The bolts shall have an extra threaded length at one end of approximately 1 bolt diameter, and shall be provided with threaded protection caps. Hex nuts shall have suitable holes for manual tightening. The requisite no. of hydraulic stud-tensioner device with necessary adopters/insertions based on varying sizes of studs shall be supplied by bidder as per mechanical design of the equipment.

1.14 Orientation of longitudinal seams and position of circumferential seams shall be clearly marked in the fabrication drawing. Nozzles, support and other attachments shall be located clear of welded joints.

1.15 All process equipments shall be supplied with Nitrogen filled. In case of equipment assembled and welded at site, it shall be filled with N2 after testing at site. Dry Nitrogen shall be filled at a pressure of 0.5 Kg/cm2g and equipment shall be fitted with a pressure gauge and valve.

1.16 Contractor shall guarantee the equipment & their components against faulty design with regard to their mechanical adequacy, improper material of construction & poor workmanship for the period specified in contract.

1.17 Contractors shall stand Performance Guarantee of equipment as per respective technical specifications/Process Data sheets.

1.18 Design conditions for all equipment shall be in accordance with the process data Sheets/specification .However, in any case design pressure shall not be lower than 10% over the maximum anticipated operating pressure and design temperature should be 25°C higher than the maximum anticipated operating temperature for all equipment unless otherwise specified.

1.19 Basic allowable stresses for shell, heads and other components etc.of vessels and shell, roof, etc. of tanks shall be the values specified in the design code.
Maximum allowable “tensile stress” and “compressive stress” shall be as per UG-23 of ASME Sec VIII Div -1. These stresses may be increased by 20% for earthquake & wind combination case in line with UG-23 (d).

1.20 All blind flanges and man way covers weighing 35 kgs or more shall be fitted with handling Facilities such as davits.

1.21 As a General rule all nozzle attachment to shell/head shall be set in type.

1.22 Units

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-Unless otherwise specified, SI unit shall be applied as the measurement system for the drawing and documents to be submitted.

1.23 When post weld heat treatment is required for pressure vessels, all material for pressure holding components shall be simulation tested with minimum additional two (2) heat treatment cycles. Additional two heat treatments are; one for PWHT after shop repairing and the other for future PWHT at site.

1.24 For equipment designed as per IBR, materials/design/inspection e.t.c shall strictly comply with the requirement of the IBR code.

1.25 IBR Approval for Design Calculations drawings, documents. Testing as per IBR requirements & Certification shall be in the scope of Contractor. All vendors, sub-vendors, fabricators & welders etc should be IBR approved.

1.26 PESO Approval for Design Calculations, drawings, documents, testing e.t.c as per PESO requirements & Certification shall be in the scope of Contractor.

1.27 In case of conflict between this specification and other specification, codes and data sheets. It shall be referred to PDIL/ Owner for clarification and the decision of PDIL/Owner shall be final & binding on contractor without any cost & delivery implications. However, it shall be resolved considering the most stringent in the following order

- Statutory requirement
- Requirement specified in this specification
- Process data sheet/ P&ID
- Applicable codes & standards

1.25 REGULATIONS

Besides codes & standards, LSTK Contractor shall follow National Laws and Regulations such as Indian Boiler Regulation and Department of Explosives, Nagpur, India together with Local by Laws for the state including statutory requirements as applicable. Static and Mobile Pressure Vessel (SMPV) rules as applicable shall also be complied with.

PUBLICATIONS:

WRC Bulletin # 107	Local Stresses in Spherical & Cylindrical Shells due to External Loadings.
WRC Bulletin # 297	Local Stresses in Cylindrical Shells due to External Loadings on Nozzles

1.26 DESIGN DOCUMENTATION

1.26.1 Detailed design calculations considering different loadings shall be made as per code/standards and the additional requirements as mentioned below:-

1.26.2 Design of equipment inside the offsite plant complex shall be in accordance with the process licensor's data sheets and specifications.

1.26.3 LSTK Contractor shall consider the interfaces with other engineering disciplines w.r.t.

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- Piping Layout/Location Drawings
- Civil / Structural Drawings
- P & ID's
- Materials
- 3D PDS Model for Piping and Equipment Layout
- Hazardous Area Classification

1.26.4 Design philosophy of other disciplines shall be observed and shall be relevant to the extent applicable.

- Civil/Structural Design Criteria

- Piping Design Criteria
- Process Design Criteria
- Electrical and Instrumentation Design Criteria

1.27 QUALITY ASSURANCE & CONTROL

1.27 1 The quality assurance shall be as per the approved procedures, test methods & facilities to be developed by the LSTK Contractor to ensure that the supplied equipment shall be of highest quality. The quality control shall mean that all the tests , measurements, checks & calibration which are to be carried out may be compared with the actual specified characteristics of the equipments/unit /system.

1.27.2 Quality Assurance (QA) shall mean the organizational set up, procedures as well as test methods and facilities developed by LSTK Contractor in order to assure that Equipment leaving LSTK Contractor's shop are of the highest possible quality i.e. either equal to or better than the requirement specified.

1.27.3 Quality Control (QC), shall mean all the tests, measurement, checks and calibration which are to be carried out in LSTK Contractor's shop in order to compare the actual characteristics of the equipment/unit/system with the specified ones, along with furnishing of the relevant documentation (certificates/records) containing the data or result of these activities.

1.27.4 LSTK Contractor shall submit a comprehensive description (manual) of QA/QC measures contemplated by him for implementation with regard to this specification. It is contractual obligation of the LSTK Contractor to develop and implement adequate QA/QC systems.
QA/QC system shall cover all products and services required for the equipment as per scope of work including job sub contracted by the LSTK Contractor.

2.0 Material of Construction

2.1 Material of construction for various equipment shall be as selected as follows for general Condition/service unless specified otherwise in respective process data sheet.

a) **Pressure Vessel (KCS/CS)**

Shell /Head plates	SA 516 Gr. 60/70 & SA 516 Gr 60 for caustic, amine , hydrogen, sour (Wet H2S) or lethal service
Nozzle Flange	SA 105
Nozzle Neck (Pipe/Plate)	SA 106 Gr. B (Nozzle size < 10"); SA 516 Gr. 60/70 (Nozzle size > 10")

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Non standard forging	SA 266 Gr 2

b) Pressure Vessel (SS)

Shell /Head plates	: SA240 Gr*
Nozzle Flange	: SA 182 Gr*
Nozzle Neck (Pipe/Plate)	: SA 312 Gr* (Nozzle size < 10"); SA 240 Gr * (Nozzle size > 10")
*SS grade as specified in datasheet	
c) Heat exchangers (KCS/CS)	
Shell /Channel plates	: SA 516 Gr. 60/70 & SA 516 Gr 60 for caustic, amine , hydrogen, sour (Wet H2S) or lethal service tanks, vessel and heat exchangers :Tube sheet : SA266 Cl2 (Forged) :Tubes : SA179 (Seamless)
Nozzle Flange	: SA 105
Nozzle Neck (Pipe/Plate)	: SA 106 Gr. B (Nozzle size < 10"); SA 516 Gr. 60/70 (Nozzle size > 10")
d) Heat exchangers (SS)	
Shell /Channel plates	: SA240 Gr *
Tube sheet	: SA336 Gr*(Forged)
Tubes	: SA213 Gr* (Seamless)
Nozzle Flange	: SA 182 Gr*
Nozzle Neck (Pipe/Plate)	: SA 312 Gr* (Nozzle size < 10"); SA 240 Gr * (Nozzle size > 10")
Non standard forging	: SA336 Gr * / SA 965 Gr *
*SS grade as specified in datasheet	
e) SS Tanks/ Non- Coded Vessel	
Shell/ Roof /Bottom Plates	: SA240 Gr *
Nozzle Flange	: SA 182 Gr*
Nozzle Neck (Pipe/Plate)	: SA 312 Gr* (Nozzle size < 10"); SA 240 Gr * (Nozzle size > 10")
Non standard forging	: SA336 Gr *
*SS grade as specified in datasheet	

2.2 The Additional material requirements as indicated below shall be considered by Bidder.

2.2.1 All raw materials including bought -out items, whatsoever required, to complete the supplies shall be procured and supplied with due identifiable mill material test certificates & inspection reports duly certified by third party inspection agency

2.2.2 For coarse grained and high tensile materials in carbon steel (UTS > 45 Kg/mm2) and low alloy steel, guaranteed impact strength shall be ensured at a temperature 15 degree C below envisaged hydraulic test temperature as a precaution against brittle fracture during hydraulic test.

2.2.3 Carbon steel plates shall be procured in fully killed & normalized condition. All plates above 50mm thickness shall be vacuum-degassed and examined by Ultrasonic Testing (UT) as per applicable material specification code/standard.

2.2.4 All Stainless Steel (SS) plates shall be hot rolled & solution annealed and pickled as per SA-480.

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2.2.5 All forgings except for flanges as per ANSI shall be UT tested as per ASTM A 388 for the thickness greater than 50mm and shall be procured in normalized / annealed condition acceptance standards shall be as per AM 203.2 of ASME Section VIII Div. 2. In case any defect is found, no repair by welding shall be allowed.

2.2.6 All forgings including nozzle flanges shall be examined for surface defects by MP/PT testing after matching as per applicable material specification code & standard.

2.2.7 All external / internal attachments, pads/cleats for support directly welded to the equipment shall be of same materials grade as that of equipment, unless specified otherwise.

2.2.8 All nozzles up to DN 10" size shall be made of seamless pipe. For sizes above DN 10" nozzle connection shall be rolled from plates with full radiography of plates.

2.2.9 Unless otherwise specified girth flanges shall be of forged quality and ultrasonically tested.

2.2.10 Unless more restrictive prescription given by material specification the max. Content for carbon steel used for fabrication as shown by ladle analysis shall be 0.23% for plates, pipes & tubes 0.25% for forging.

2.2.11 In order to minimise the effect of temper embrittlement for material to 2¼ Cr 1 Mo specifications in the temperature range of 375-575°C, the embrittlement factors 'X' & 'J' shall be limited to:

$X = (10P + 5Sb + 4Sn + AS) / 100 \leq 15$
The elements above are expressed as ppm

$J = (Si + Mn)(P + Sn) \times 10^4 < 160$
The elements above are expressed as percentages

A stimulated PWHT followed by step cooling shall be performed on a sample of material. Acceptable toughness shall be demonstrated by means of a Charpy V Impact Test.

2.2.12 Top portion of skirt (min. 500 mm height) welded to the bottom dished head shall be of same material as that of shell /head for LAS & SS materials.

2.2.13 Heat treatment of formed parts shall be carried out as per following:

For Carbon Steel:

a. Cold formed dished ends or knuckles up to 16 mm nominal thickness shall be stress relieved.

b. Cold formed dished ends or knuckles above 16 mm nominal thickness shall be normalised.

c. For Low alloy Steel: - Cold Formed Dish ends or Knuckles shall be stress relieved.

d. Hot formed dished ends or similar parts, which have not been uniformly heated in the normalising range in the final stages of manufacture shall be normalised.

e. When the completed vessel involves post weld heat treatment, heat treatment recommended in (a) above shall not be applicable.

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f. Vessels in caustic service, Amine or Sour gas service shall be stress relieved.

g. All internal and external attachments, clips, insulation studs, name plate bracket, and the like shall be welded to the vessel before post weld heat treatment.

2.2.14 PWHT of complete vessel shall be carried out in one go in a furnace. Local stress relieving of Weld joint in piece meal shall be avoided as far as possible.

2.2.15 All Nozzle Flanges & Gaskets size, rating & type etc. shall be as per applicable piping Specifications & instrument specification as applicable enclosed with the enquiry and Selected bolting shall match with corresponding companion flanges.

2.2.16 Equipment under Caustic service shall essentially be PWHT with 100 % radiography. The hardness of the parent weld, weld & HAZ shall be Limited to 200 BHN.

2.2.17 Pressure part plates having thickness 16 mm to 50 mm (both inclusive) shall be ultrasonically Tested (UST) as per ASTM A-435. Pressure part plates having thickness above 50 mm and all Plates to be used shall be UST as per ASTM A-578 Level B. No laminations or inclusions shall be permitted.

2.2.18 Steel for Hydrogen service at elevated Temperature & pressure shall be selected as per API 941 & API 934 .The following special requirements shall be met with for Hydrogen/Sour gas as per NACE standard.

a) All pressure parts shall be post weld heat treated.
b) All pressure retaining welds shall be 100% radiographed after final weld. However Root run shall be liquid Penetrant tested.
c) Hardness of base metals, weld and HAZ shall not exceed 22 HRC

2.2.19 Cladded plates shall be supplied as per ASTM A264 material specification. All clad plate shall be UT examined at the steel works in accordance with ASTM A578 level S8.

2.2.20 The minimum thickness of weld overlay material shall be 1/8 inch (3 mm) except clad or weld Overlay tube sheets and gasket surfaces.

2.2.21 Tube sheets shall have a nominal clad or weld overlay thickness of 3/8 inch (10 mm) but not Less than 5/16 inches (8 mm) regardless of shell side or tube side face. The minimum thickness of clad or weld overlay at a pass partition groove shall be 1/8 inch (3 mm) minimum

2.2.22 Unless otherwise specified Copper & Copper alloys shall not be used. Copper content up to 0.4% are acceptable in carbon steel & 0.6% in stainless steel.

2.2.23 The extent of radiographic examination of the shell and head seams shall be spot examination, as Minimum.

3.0 Technical Requirements

3.1 PLATE TYPE HEAT EXCHANGER

3.1.1 The plate type exchanger shall be designed in accordance with “API 662"

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3.1.2 All plates shall be pressed from a homogeneous single metal sheet in one placing and normal thickness of plate being pressed shall not be less than 0.5 mm

3.1.3 Nozzle neck attachments shall be with full penetration weld. Set on nozzles are not permitted.

3.1.4 Lock washers shall be provided for all rotated nuts.

3.1.5 SS plate shall be of SA 240 specification.

3.1.6 For gasket type PHE, vendor shall be responsible for the compatibility of gasket material & Glue, selected for specified fluids and design conditions.

3.1.7 All components in contact with process fluids shall be as per Process data sheets (PDS).

3.1.8 Equipment shall be hydro tested at test pressure limits (as differential pressure) for 30 Minutes minimum. Also mechanical strength of the frame shall be tested by raising the Pressure on both side equivalents to test pressure (i.e. 1.3 times design pressure) for 90 Minutes minimum.

3.1.9 All nozzles of Heat exchanger shall be of extended type. Studs connections are not acceptable.

3.1.10 The plate shall be fully supported by carrying bar and only guided by the guide bar.

3.1.11 The carrying bar shall be designed to support at least 1.5 times the total weight of movable cover and plate pack filled with water or process fluid whichever is having greater density.

3.1.12 Bidder shall furnish the complete details of the offered system like features, properties of the Descalant, system description, operating details etc.

3.1.13 Vendor to develop methodology or device to get the entrapped gases escaped during welding and also to ensure that no processed fluid should get entrapped during operation in such area otherwise it may lead to crevice Corrosion.

3.2 Shell and Tube Heat Exchangers

3.2.1 Process Shell and Tube Exchangers will comply with the requirements TEMA (Latest) Class ‘R’. The tube sheet shall be analysis by Appendix “UHX” of ASME Section VIII, Div. 1 & TEMA whichever is more stringent.
(TEMA Class ‘C’ may be used for auxiliary heat exchangers for rotating and packaged equipment exchangers.)

3.2.2 ASME Section VIII, Div. 1, Appendix “S” shall be considered mandatory for bolted flange connections. All mandatory requirements are covered under Appendix 2 for different loading condition.

3.2.3 Mean metal temperature of tube & shell be considered in the design of fixed tube sheet exchangers.

3.2.4 Parts such as tubes, tube sheets, floating heads etc. which simultaneously come in contact with both shell side and tube side fluids, shall be designed considering pressure acting on one side only or the combination of pressures, whichever results in higher thickness of parts.

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3.2.5 Exchanger saddle and foundation design shall include additional loadings generated from bundle pulling. The saddle and foundation design for all exchanger for which tube bundle pulling is foreseen during maintenance, shall be designed for longitudinal force acting at the exchanger axis. Pulling force shall be 1.5 times the bundle weights:
Further wind load and piping load shall also considered on the exchanger supports and foundation.

3.2.6 Tube sheets in vertical exchangers shall be provided with drain and vent arrangement with threaded plug seal welded.

3.2.7 Shell side “hot” nozzles shall be located at the top of the shell at the channel end whenever possible.

3.2.8 Lifting lug for heads or bonnets shall be provided wherever frequent dismantling is required.

3.2.9 Bundle weights shall be limited to 10 tonnes. In case the bundle weight increases by 10 Tones, Bidder shall take care necessary precaution in the design and fabrication of exchanger e.g. by Providing rollers arrangement, support plates etc. to avoid excessive loading on shell while Pulling of tube bundle, proper reinforcement in equipment support etc.

3.2.10 Saddle wear plate material shall be the same as the shell material.

3.2.11 Tube sheets and Girth Flanges shall be shall be of Forged Quality & Ultrasonically tested. It shall not have any segmental joint.

3.2.12 All heat exchanger tubes shall be seamless, cold drawn and formed from single length. CS tubes shall be normalized. LAS tubes shall be normalized and tempered.

3.2.13 The minimum radius of U tubes shall be not less than 2xOD of tube. Thickness of 2 inner most rows will be higher than other rows with minimum difference of 2 gauges.

3.2.14 For U tube bundle, the following requirements shall also be met:

i) Each U tube shall be formed from a single straight length
ii) All U tubes shall be cold bent
iii) All C.S, C-Mo, Cr-Mo tubes shall be heat treated after bending
iv) Bent portion of all U tubes shall be examined by PT and hardness check on four opposite points of bent portion shall be carried out
v) Unless otherwise specified, after bending each tube shall be tested hydraulically

3.2.15 Where fixed tube sheet heat exchangers are specified, thermal stress shall be checked in accordance with the TEMA standard to determine if an expansion joint is necessary.

3.2.16 Tube to tube sheets joints shall be leak tested with air & soap solution at pressure of 2.0 kg/cm2 g wherever specified leak testing with halogen shall be carried out.

3.2.17 Pass partitions shall be provided with a weep hole of about 6 to 12 mm in diameter at low points of pass partitions.

3.2.18 Minimum SS 304 as MOC for tubes shall be used for Heat Exchangers having Cooling Water. All tubes shall be seamless only.

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3.2.19 After testing, all exchangers shall be completely dried.

3.2.20 Gaskets used during testing shall be same as specified for operating conditions. However all Joint gaskets shall be replaced by new gasket which will be opened after Hydro testing.

3.2.21 Bidder shall check adequacy of tube bundle against flow induced vibration.

3.2.22 While deciding the location of heat exchanger in the equipment layout it should be ensured that there is no restriction in complete opening of the channel, shell and floating head cover, bundle removal e.t.c. sufficient unobstructed space shall be provided in between two exchangers so as to allow a man to pass through for maintenance.

3.2.23 Unless otherwise stated inlet nozzles on shell side shall be provided with impingement plate in Compliance with TEMA requirement. The flow area around solid impingement plate shall be at least equal to the inlet nozzle cross-section. In case of two phase flow impingement baffle shall be perforated. Impingement baffle plate shall extent at least 25 mm beyond the projection of the nozzle bore. The clear distance from the nozzle (at the inner surface) to the impingement plate shall be at least 0.25 x nozzle diameters. The nominal thickness of the impingement baffle shall be at least 6 mm.

3.2.24 Where heat treatment of U-bends is required, the heat treated portion shall extend at least 150 mm beyond the point of tangency.

3.2.25 All heat exchanger tubes shall be 100% eddy current tested in supplement to hydro test.

3.2.26 Tubes shall be flush with or extend by 3 mm beyond the face of each tube sheet, except that tubes shall be flush with the top tube sheet in vertical exchangers unless otherwise specified.

3.3 Vessel

3.3.1 Design, materials, fabrication and inspection of welded pressure vessels shall comply with ASME Code Section VIII, Division 1 (latest edition) and Technical Specifications.

3.3.1.1 a) Tori spherical heads shall be used for Pressures up to 6.86 bar (g). For tori spherical heads, ratio of Knuckle to Inside Crown Radius shall not be less than 6%.

b) Beyond 6.86 bar g, heads shall be of ellipsoidal type having a ratio of major axis to minor axis 2:1 or hemispherical type. Alternatively, Hemispherical Heads with minimum weld joints may also be used.

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3.3.2 For vessels the minimum thickness of shell & heads, including corrosion allowance shall be as indicated below:

Sr. No	**Shell Diameter(mm)**	**Thickness (Min.) mm**	
		CS / LAS	**HAS**
1.	ID < 500	5	3
2.	501 < ID < 1200	5	4
3.	1201 < ID <2000	6	5
4.	2001 < ID < 2600	8	6
5.	ID > 2600	10	8
CS = Carbon Steel, LAS = Low-Alloy Steel, HAS = High-Alloy Steel			

3.3.3. All nozzles above 24" NB shall comply with ASME B16.47 Series B (API 605).

3.3.4. Minimum branch nozzle thicknesses shall be Schedule Extra Strong above 2" NPS, and Schedule 160 for 2" NPS and below.

3.3.5 Stress calculations due to Local loads on vessel for external structural attachments, such as platform clips, pipe support clips and lifting lugs shall be performed.

3.3.6 Design of vessel skirt shall be based on seismic/wind/thermal considerations and fire proofing/insulation requirements.

3.3.7 Vessel skirts for carbon steel vessels shall be designed from the same material as the shell or the head. Vessel skirts for other than carbon steel vessels shall be the same material as the shell or the head for the top 500 mm.

3.3.8 Vessels with skirt support having eight or more anchor bolts shall be required to be supplied with an anchor bolt template. The template shall be an annulus 10 mm (minimum) thickness and 150 mm (minimum) wide, with bolt holes equal to bolt diameter plus 3 mm, stacked drilled with skirt base plate.

3.3.9 Maximum permissible deflection for columns when subjected to design wind loadings shall not exceed 0.005 x Vessel height.

3.3.10 Minimum man way size shall be equal to 24" nominal pipe size.

3.3.11 Manhole/hand hole/blind holes covers shall be equipped with davits or hinges to facilitate handling.

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3.3.12 Horizontal vessels of large size and thin wall shell on saddle supports shall be investigated for buckling, local circumferential bending and shear stress. The method of L. P. Zick (Supplement to Welding Research, 1971) may be used for this investigation.

3.3.13 Use of structural steel shall be limited to non-pressure parts only.

3.3.14 Local vessel stress calculations for external structural attachments, such as platform clips, pipe support clips and lifting lugs shall be performed.

3.3.15 Dimensional tolerances shall be in accordance with the design codes or standards, whichever is more stringent.

3.3.16 For vessel with diameter less than 900 mm and having removal internals, shell flange shall be provided.

3.4 FRP/GRP TANKS

Codes

Construction

- ASME X Rule for Construction
- EN-13121-For Fiber-Reinforced Plastic Pressure Vessels

Materials and material testing

- ASTM C-581 Chemical resistance of Resins
- ASTM D-2150 Woven roving Laminated FRP
- ASTM D-2583 FRP hardness test
- ASTM D-2584 Ignition loss of cured FRP
- ASTM D-2990 Flexural creep and Creep-rupture
- ASTM D-2997 Machine made FRP pipe
- ASTM D-3299 Filament-wound reinforcing
- ASTM D-3892 Resin and FRP packaging
- ASTM D-4024 Machine made FRP flanges
- ASTM D-4097 Contact-molded FRP tanks
- ASTM D-5421 Contact-molded FRP flanges
- ASTM D-618 Plastics testing conditions
- ASTM D-638 Plastics tensile properties testing.
- ASTM D-695 Plastics compressive testing
- ASTM D-883 Plastics terminology
- ASTM F-412 Plastics piping terminology

Equipment testing

- ASME V Non-destructive examination

Flange Drilling and bolting

- ASME/ ANSI B 16.5 Flanges and flange fittings
- ASME/ANSI B 16.47 Large diameter steel flanges

3.4.1 Graphite powder/ Resin paste shall be applied behind all welds to provide a permanent earth Path for spark testing. Permanent metal foil strips shall not be permitted.

3.4.2 Flange face (Front & back) shall be smooth & flat. If the flange faces are machined, the full Chemical liner shall be reinstated.

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3.4.3 The Barcol Hardness of FRP/GRP wall shall be tested according to ASTM D2583.

3.4.4 The difference in the glass content of FRP/GRP between the samples shall not be more then 5% wt.

3.4.5 All items shall be cured in accordance with the resin supplier's instruction s. wherever possible curing shall be done at Manufacturers works.

3.4.6 High frequency spark testing

All production thermoplastic welds shall be examined visually & by high frequency spark test Equipment at the following stages:

- Completion of first weld run
- Completion of external run
- After pressure or static head test
- After any boil out test

3.4.7 Reinforcing materials used on the inner surface shall be in compliance with the latest edition of ASTM D3299.

3.4.8 For FRP/GRP tanks, thickness of Corrosion barrier of the thermoplastic lining shall not be included in the thickness calculation, to withstand design condition.

3.5 RUBBER LINING

3.5.1 The type of rubber (i.e. Natural, Butyl, Nitride, Ebonite, and Hypalon etc.), its minimum Thickness shall be 4.5 mm & hardness shall be decided as per design code/specification.

3.5.2 For vacuum service, the Triplex lining shall be adopted. It shall consist of 3 layers:

1st layer	:	60 ±5 shore A
2nd layer	:	35 ±5 shore B
3rd layer	:	60 ±5 shore

3.5.3 In general for all other services the preferred hardness of rubber shall be 65 ±5 shore A.

3.5.4 Lining up to 6 mm may be applied in single layer. Above this thickness it shall be applied in 2 or more layers. Except when the sheets shall be prepared by calendaring as follows:

Thickness of Lining (mm)	Minimum no. of Plies
Up to 3	2
3 to 5	3
6	4

3.5.5 The surfaces which are to be covered with rubber shall be easily accessible & free from pitting or other physical imperfection.

3.5.6 Spark testing shall be done for Lining.

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3.5.7 The internal surfaces requiring rubber lining shall be prepared by Tank Fabricator to suit rubber lining. All welds shall be ground smooth and radiused to min. rubber lining thickness. All welds shall be free from pin holes, pits, pockets and nipples. Porous welds are to be peened until tight. Since the internal surface preparation of the tank including roof (like grinding of the weld ments etc.) is to be done by the tank contractor, the same surfaces will also be inspected and approved by the rubber lining contractor during tank fabrication and/or on handing over of the tank to him for rubber lining.

In the event of any surfaces found unsuitable, the tank contractor shall carry out necessary rectifications and make all surfaces suitable as per instructions of the rubber lining contractor or his authorised representative.

3.5.8 Rubber Lining shall be designed as per IS 4682 (Part 1) Latest Edition (Code of Practice for Lining of Vessels and Equipment for Chemical Processes).

3.5.9 For critical service or when required the supplier shall furnish rubber sheets to be used for checking up its suitability by concerned inspector/ owner for the service conditions specified.

3.6 **Safety**

3.6.1 Safety standards and features which are inherent in the specific mechanical equipment design codes, standards and regulations are applicable.

3.6.2 Safety features to be incorporated into the design include, but are not limited to, the following features for equipment:

i) Ladder cages
ii) Safety chain across platform access
iii) Step-off platforms where necessary
iv) Platform grating
v) Toe plates

4.0 **Fabrication**

4.1 The Bidder shall comply in all respects with the provision of the applicable codes, standards and specification during fabrication with respect to tolerances, welding, fabrication, forming of heads, radiography, heat treatment, inspection, testing and quality control etc. unless & otherwise specified.

4.2 Plates of different thicknesses shall be made flush with the inner surfaces of equipment unless otherwise stated.

4.3 Larger heads which cannot be formed in one piece shall be fabricated as follows with prior approval from Principle.

a) In two pieces, with the welding seam included in the middle third and preferably on the centre line

b) In petal construction, with meridianal seams and a central cap of diameter not larger than 0.75 times the vessel outside diameter

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4.4 Due provisions must be kept for venting out entrapped gases during welding of pads, flanges and liner plates etc.

4.5 All welding shall be carried out by qualified welders using approved procedures in compliance with the requirements of codes, standards & specifications and shall be duly certified by the concerned inspecting authority. All welding procedures must be got approved from authorised inspecting authority before starting any fabrication job. Welding of all parts must be completed before heat treatment.

4.6 All welds shall be full penetration welds with back chipping and re-welding from the second side. For those joints which are inaccessible for back chipping the root run shall be carried out with TIG process. Single side welding with backing strips shall are not permitted.

4.7 All parts shall be fabricated in accordance with good shop practice and in uniformity so that all corresponding parts will be inter-changeable.

4.8 All sharp corners shall be rounded off with smooth radius. Inside edge of manhole and hand hole at the internal surface shall be rounded to minimum radius 5 mm.

4.9 All flange bolts & skirt-bolts shall straddle centre line unless otherwise stated.

4.10 In case of nozzle with butt-end construction, extra length shall be provided to facilitate hydraulic testing and subsequently cutting and edge preparation to suit piping welding at site.

4.11 All nozzles less than or equal to NB 65 mm shall be stiffened with three equispaced plate ribs of the same material as that of shell.

4.12 Flange facing and thread connection shall be protected against oxidation during HT.

4.13 Longitudinal and circumferential welded seams shall not interfere with nozzle openings, reinforcement plates, saddle pads, and other attachments as far as possible.

4.14 Welding wherever specified, is to be done by qualified and approved welders using the suitable fillers and fluxes recommended for the materials in the fabrication drawings.

5.0 Inspection & Testing

5.1 Equipment shall be inspected and tested in accordance with the relevant codes, standards and specifications by TPIA. All equipment shall be inspected during various stages of manufacturing starting from identification of raw materials to final completion as per agreed Quality Assurance Plan (QAP) which shall be prepared by Successful Bidder after award of contract. In case of site fabricated/assembled equipment same inspection agency shall be responsible for inspection and testing at site. However all the bought-out items must be supplied with test certificate and inspection reports.

5.1.2 The equipment shall be inspected by Third party inspection agency (TPIA)(approved by owner) as defined elsewhere as inspection agency. It shall be the responsibility of the Bidder to make available to the inspector all the drawings, calculations and other documents. However the Principal shall have free access for inspection at vendor's/sub-vendor's shop and at site during project execution.

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5.2. The equipment shall be considered acceptable for despatch only after final certification for acceptance is issued by concerned inspector.

5.2.1 All parent material (Primary & Secondary Components), welds and HAZ shall be impact tested at Minimum Design Metal Temperature (i.e. minimum service temperature or the temperature to be computed as per applicable codes, standards & specifications) by Bidder and shall have impact energy values as per the applicable codes, standards & specifications.

5.2.2 Production control coupons, when required as per codes & standards shall be subjected to impact test, corrosion test etc. in addition to mechanical tests as required. In case of heat treated equipment test coupons shall be given similar heat treatment as for the equipment.

5.2.3 Formed heads when fabricated in pieces shall be normalised and weld seams fully radiographed after forming.

5.2.4 Vessel containing lethal, toxic and highly inflammable substance shall be fully radiographed and stress relieved.

5.2.5 Tube to tube sheet joints in heat exchanger shall be leak tested with air & soap solution at 2 kg/cm2 g. Helium testing shall be carried out wherever required.

5.2.6 All nozzle reinforcing pads shall be tested pneumatically at 0.5 Kg/cm2g pressure with soap solution on attachment welds. Vent holes shall be plugged with non hardening mastic to prevent ingress of water.

5.2.7 All completed equipment shall be tested hydraulically as per the requirements of codes, standards & specifications in presence of the inspecting authority. Pneumatic test of completed equipment shall be carried out only when specially mentioned in the specification sheets. Chloride content in water used for testing shall not exceed 30 ppm for SS equipment and 40 ppm for CS and low alloy steel equipment. Duration of test shall be as per applicable codes& standards.

5.2.8 The temperature of test water shall comply with requirement of Fabrication code.

5.2.9 Unless otherwise stated gaskets used during testing shall be same as specified for operating conditions. However all joint gaskets shall be replaced by new gasket which will be opened after Hydro testing.

5.3 The following NDT requirements are mandatory in addition to codes, standards & specification requirements:

A) UT examination

i) All butt - welds in thickness greater than 50mm as supplement to radiograph
ii) FPW of nozzle attachments of thickness above 50mm as supplement to radiography
iii) Clad Plates and formed heads from clad plates in all thicknesses
iv) All forgings
v) Weld overlay on tube sheet

B) MP / PT examination

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i) All edges of plates and opening in shell of CS having thickness equal to & above 40mm and LAS / SS having thickness more than 25mm
ii) Root and final layer of all butt welds
iii) Fillet welds of SS
iv) All weld surfaces after PWHT
v) Each layer of weld deposit in SS overlay
vi) Knuckle surfaces of dished ends, expansion bellows and pipe bends
vii) All forgings after machining
viii) Skirt to head joint
ix) Each pass of tube to tube sheet joint
x) Bent portion of all U-tubes

C) Radiography:

i) All weld seams of formed head, if made in more than one segment shall be full radiographed after forming
ii) When spot radiography is specified, all T – Joints & minimum 5% of total weld length excluding T joints shall be radiographed
iii) All nozzles fabricated from plates shall be 100% radiographed
iv) Radiography of welds in C - 1/2 Mo & Cr - Mo - Steel preferably be carried out after

Note : If a vessel is not 100% radiographed and/or UT tested, then a minimum examination of butt, corner & T-joints shall be made.

D) Rubber lining Inspection & Testing as per IS: 4682 (part 1)

6.0 **Pickling and Passivation**

6.1 All SS material shall be Pickled & Passivated as per following procedures:

6.1.1 Pickling

Aqueous pickling solution shall be as follows:

Nitric acid (Tech. grade) 10 to 25% plus Hydrofluoric acid 1 to 8% (to be used only for stabilised SS grades). Temperature 50 to 60° C for 10% Nitric acid and 20° C for 25% Nitric acid. When size and shape of product permit, total immersion in the pickling solution is preferred. Where immersion is impractical, pickling may be accomplished by wetting the surface by

i) Swabbing or spraying

ii) Partial filling the item with pickling solution and rotating or rocking so that all the surface receives the required chemical treatment.

The maximum period for which the pickling solution shall be allowed to remain on the surface is 30 minute. During pickling removal of oxides may be hastened by brushing with a hard fibre or SS wire brush. Over pickling shall be avoided.
The pickling agent shall be washed off with plenty of water so as to leave no trace behind.

6.1.2 **Passivation**

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After pickling and water rinsing, an aqueous caustic permanganate solution containing NaOH 10 weight % and KMnO4 4 weight % shall be used for neutralising pickling solution. This shall be followed by thorough water rinsing.
Water used for pickling and washing shall not have chloride contents exceeding 30 ppm.

7.0 Painting

7.1 All CS external surfaces of shop fabricated equipment shall be primer and final painted as defined elsewhere Listed in bid document.

8.0 Insulation

8.1 The equipment shall be insulated as defined elsewhere Listed in bid document.

9.0 Spares (Erection & commissioning, 2 years operation & Special Spares etc.)

9.1 COMMISSIONING SPARES

9.1.1 All commissioning spares shall be included by LSTK Contractor in their scope of supply and shall be part of the main equipment.

9.2 SPARES FOR 2 YEARS OPERATION

9.2.1 2 years operation spares shall be supplied by the contractor as per Section-5 of Bid.

10.0 Documentation

Documents shall be submitted as per “Documentation schedule” in Section-4 of Bid.

11.0 Vendor List

All equipment shall be procured/fabricated as per approved vendor list (Section-8). Any equipment for which vendor list is not enclosed, the LSTK Contractor may furnish a list of their proposed vendors along with their references for supply of similar type of equipment along with bid. However all the additional proposed vendors shall have well proven track record and shall be subjected to consultant/owner’s approval

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SECTION : TECHNICAL

PART – 3.2.2

DESIGN SPECIFICATION – ROTATING EQUIPMENTS

INSTRUMENT AIR / PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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1.0 SCOPE

1.1 General

1.1.1 This Philosophy states that scope of work shall include basic & detailed engineering, procurement, supply, manufacturing, fabrication, transportation, loading, insurance during transit of all Mechanical Rotating Equipment with allied electrical, instrumentation and civil scope, obtaining all necessary statutory approvals from concerned government authorities as applicable, testing , mechanical completion , supervision/assistance in erection, Mechanical Completion, Pre-Commissioning, Commissioning, performance guarantee test runs of INSTRUMENT AIR / PLANT AIR SYSTEM for M/s TFL ODISHA.

1.1.2 In addition, all statutory rules & regulations shall also be complied with.

2.0 DESIGN PHILOSOPHY FOR MACHINERY

2.1 Codes and Standards

The ***Latest Edition*** of codes and standards as listed below shall be followed for design and manufacturing of different machinery items. Generally, the manufacturer will comply with these codes and standards as indicated therein with minor deviations that are normally adopted by manufacturer and are reasonably accepted as per good engineering practice.

A list of such deviations, if any, may be furnished by the Bidder along with offer. Deviations / exceptions against codes & standards requirement/ guidelines, if any, furnished by successful bidder are subject to owner's review and approval during detail engineering.

Code	Description
API-672, 4th Edition	Integrally-Geared Centrifugal Compressors for Industrial purpose
API 618	Reciprocating Compressors for Petroleum, Chemical and Gas Industry Services

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2.2 Design Life

All equipment shall be designed for a minimum service life of 20 years and at least 2 years of uninterrupted operation under normal operating conditions. This requirement excludes specialised components requiring periodic maintenance and replacement.

2.3 Essential Project Reference Documents

The following documents shall be observed, and relevant aspects incorporated into specifications and datasheets:

- Process Description, Specifications and Data Sheets from Licensor
- Hazardous Area Classification
- Electrical and Instrumentation Design Criteria

2.4 Regulations

Besides codes & standards, Bidder shall follow National Laws and Regulations together with Local by Laws for the state including statutory requirements as applicable.

2.5 Site Conditions

Site conditions shall be as defined elsewhere.

2.6 Material of Construction

Generally Materials of construction shall be as per the process licensor's recommendation. However, relevant API guideline may be adopted to the extent applicable.

Use of equivalent & superior material may be selected & shall be furnished with the offer along with chemical composition.

2.7 Quality Assurance & Control

2.7.1 The quality assurance shall be as per the approved procedures, test methods & facilities to be developed by the Bidder to ensure that the supplied equipment shall be of highest quality. The quality control shall mean that all the tests , measurements, checks & calibration which are to be carried out may be compared with the actual specified characteristics of the equipments/unit /system.

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2.7.2 Quality Assurance (QA) shall mean the organizational set up, procedures as well as test methods and facilities developed by Bidder in order to assure that the machines & associated auxiliaries leaving Bidder's shop are of the highest possible quality i.e. either equal to or better than the requirement specified.

2.7.3 Quality Control (QC), shall mean all the tests, measurement, checks and calibration which are to be carried out in Bidder's shop in order to compare the actual characteristics of the equipment/unit/system with the specified ones, along with furnishing of the relevant documentation (certificates/records) containing the data or result of these activities.

2.7.4 Bidder shall submit a comprehensive description (manual) of QA/QC measures contemplated by him for implementation with regard to this specification. It is contractual obligation of the Bidder to develop and implement adequate QA/QC systems.

2.7.5 QA/QC system shall cover all products and services required for the complete machine unit as per scope of work including job sub contracted by the Bidder.

3.0 DESIGN REQUIREMENTS

3.1 General

3.1.1 All machines shall be directly coupled to their prime movers. Drivers shall have rated output at least 10% greater than the power requirement at design operating condition of the driven equipment.

3.1.2 Copper (Cu) or Cu-alloy shall not be used for any components in Ammonia Plant & in other plant for ammonia services.

3.1.3 Special tools and wrenches required for installation and maintenance shall be provided.

3.1.4 Bidder have to submit the reference list for similar equipment's models (minimum 2 nos.) supplied in past for similar duty conditions. Reference list must contain at least the following: Fluid handled Capacity, Suction Pressure, Discharge Pressure, Model No., Power consumption, Client Name, Address, and Year of supply.

3.1.5 Noise level for all rotating equipment shall be limited to 85 dBA measured at 1meter distance from the equipment. Statutory guideline shall also be followed by contractor.

3.2 Centrifugal Compressors (for Air services)

3.2.1 All compressors shall be oil-free type and shall be supplied as per 'Special Duty Packages' meeting the requirements of API 672 4th Ed. & Addendum to API 672 4th Ed.

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3.2.2 Compressor filtration hood and suction piping including internals shall be SS material only. Air compressor suction to be provided with suitable measures to avoid moisture ingress during rainy season.

3.2.3 All machines shall have stable operating characteristics. The head generated shall rise continuously from choke point to surge point.

Vendor shall provide maximum range of capacity control without air venting. However a surge control shall also be provided so that the operation at low capacity is not limited.

Compressor shall be designed to deliver the rated head (i.e. rated discharge pressure) @ rated capacity without negative tolerance. Vendor to consider pressure losses in the air intake system & compressor discharge up to after cooler while performing compressor sizing.

The BKW at rated conditions shall be guaranteed with zero positive tolerance including all transmission losses in the bull gear.

Driver rating shall be at least 110% of Compressor rated BKW at rated condition or BKW at unthrottled min. ambient temp. & maximum Atm. Pressure whichever is higher.

Extra/ Over-design margin in Compressor capacity shall be as per process design philosophy of NIT.

3.2.4 Compressor package shall be provided with Hydrodynamic Radial & Thrust bearings and **Pressurized lubrication system** meeting requirements of API 672 & and API 614.

3.2.5 Couplings shall be non-lubricated, all metallic flexible type with spacer with a non-sparking coupling guard. The coupling shall conform to API-671 4th Ed. The coupling shall have min service factor of 1.5 over the maximum capability of compressor.

3.2.6 Following performance characteristics shall be furnished for compressor:

a. Discharge pressure vs Inlet capacity (i.e.actual inlet volume)
b. Polytropic head vs Inlet capacity (i.e.actual inlet volume)
c. Compressor BKW vs Inlet capacity (i.e.actual inlet volume)
d. Polytropic efficiency vs Inlet capacity (i.e.actual inlet volume)

The performance shall be shown from surge limits to choke limits.

Expected surge line and surge control line shall be shown on each performance map.

3.2.7 Torsional and lateral critical speed analysis shall be carried out and it shall be ensured that no critical speed (Torsional or lateral) shall be within 15% of any operating speed.

3.2.8 Casings shall be preferably centre line supported.

3.2.9 Compressors shall have such casing designed for easy withdrawal from the shells and easy reassembly for inspection or replacement of parts.

3.2.10 Impellers shall be welded or electrochemically eroded. Tip speed of the impeller preferably shall not exceed 310 m/s.

3.2.11 Labyrinths preferably made of stainless steel or manufacturer's well proven material shall be used. Reference documentation to be furnished by bidder for the same.

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3.2.12 Combined Force lubrication and seal oil system (as applicable) shall be provided for compressor and motor assembly. API-614 standards to be complied for lube oil system.

3.2.13 Shaft vibration monitoring instruments (both radial and axial) shall be provided to trip the machine in case of high radial vibration or axial movement. Complete vibration monitoring system to be provided by the bidder. Bidder to also refer instrumentation philosophy of NIT in this regard.

Machine health monitoring for each compressor package shall be done through PLC / DCS. Each compressor shall be provided with probes/detector for measuring vibration. Set points for Alarm (alert) and shutdown (danger) shall be provided for each of the monitored variables.

3.2.14 All the trip interlock shall be two out of three voting logic. Instrumentation design philosophy of NIT to also to be referred.

3.2.15 All the transmitters shall be smart type and suitable for communication with DCS.

3.2.16 Supply of first fill of lubricants, sealing fluid & other consumables for machines is also included in the vendor's scope of supply.

3.3 Reciprocating Compressors

The reciprocating compressors shall conform to API-618, latest edition. In addition to the above, the following shall be applicable:

3.3.1 Lateral and torsional critical speed analysis shall be carried out to ensure the elimination of any lateral and torsional vibration that may hinder the operating speed range.

3.3.2 Machine shall be balanced to minimise lateral loads.

3.3.3 The piston speed for lubricated cylinder shall not exceed 4 m/s and for non-lubricated cylinders it shall be limited to 3 m/s.

3.3.4 Distance piece of non-lubricated compressor shall of sufficient length to ensure that no oil is in contact with gland packing.

3.3.5 The design of compressor valve shall be such that the valve assembly cannot be inadvertently reversed e.g. Suction valve cannot be fitted into the discharge port.

3.3.6 Valve plates and springs shall be made of stainless steel. PEEK may be used for valve plates in case the vendor has experience of using it for similar service and duty conditions.

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3.3.7 Cylinders shall be water cooled.

3.3.8 The maximum piston rod loading shall be calculated considering safety valve set pressure.

3.3.9 Non-lubricated compressors shall be provided with piston rings, packing made of carbon filled PTFE or equivalent.

3.3.10 The packing boxes shall be provided with atmospheric vents to minimize gas leakage.

3.3.11 Pulsation dampeners shall be provided for meeting the residual pulsation requirements as per API.

3.3.12 For API compressors the requirements for acoustic study shall be in accordance with the API recommendation.

3.3.13 To minimise the need for heavy overhead pipe structures, suction and discharge piping to and from the knockout drums should run close to grade, supported on sleepers.

3.3.14 Frame lubrication system shall be provided with auxiliary pump driven by electric motor for initial lubrication.

3.3.15 Cylinder lubrication, if required, shall be provided by a separate forced feed mechanical lubricator complete with necessary tubing/piping, check valve and sight flow indicator.

3.3.16 Manufacturer's standard can also be accepted for special duty like passivation Air Compressor and other Non-Critical smaller machines. However Bidder to follow the Vendor list attached with the ITB for the selection of Vendors.

3.3.17 Full flow twin oil filter shall be provided.

3.4 EOT Cranes

Bidder to provide EOT Cranes of adequate capacity in Compressor House and other location wherever required for ease in operation and maintenance activities . Cranes to be provided in nearest multiple of 5 Metric Tonnes considering maximum weight to be lifted. Relevant Indian/ ISO Standards to be applicable for EOT Crane. All statutory guidelines to be complied by the contractor/ sub-contractor.

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3.5 HVAC System:

Air conditioning system & air flow ventilation rate should be sufficient to satisfy not only air removal specification, but also to maintain over pressure and temperature specification. It should be also capable to avoid wind penetration in order to meet the requirements of a conditioned space, simultaneous control of temperature, humidity, cleanliness, contamination and air distribution should be considered in design & selection of HVAC equipment. Eco-friendly refrigerant to be used in HVAC equipment. All related civil buildings, Control room / Sub-stations etc to be equipped with suitable HVAC system with 100 % redundancy. ISHARAE / ASHRAE standards to be followed.

4.0 INSPECTION & TESTING

Machines shall be inspected by Third Party Inspection Agency (Lloyds/BV/TUV/PDIL). The Inspection and testing shall be in accordance with the all relevant codes, standards, specifications.

4.1 All testing accessories, measuring instruments including NDT testing equipment, etc. shall be arranged by Bidder. DM water shall be used for hydro testing of the equipment.

4.2 In general, following tests shall be conducted for all rotating equipments:

- Material test
- Non-destructive test
- Hydrostatic test for all the pressure containing parts
- Dynamic balancing of rotor
- Over speed test of impeller (only for compressors)
- Helium leak test of compressor casing (if required)
- Mechanical running test of compressor
- Barring over check (for reciprocating compressor, if any)
- NPSHR test (for pumps , if any)
- Performance Test
- Disassembly Test

The tests required to be conducted and witnessed shall be specified in the equipment data sheet. Disassembly test for small Pumps (if any, in the package) can be waived –off in case no problem occurs during mechanical / performance Test.

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5.0 SPARES

5.1 All erection & commissioning spares shall be supplied by Bidder & cost shall be included in the cost of main equipment.

5.2 2 years operation spares / recommended spares, Mandatory spares etc shall be supplied by the contractor as per NIT.

6.0 PAINTING

6.1 All exterior non-stainless steel surfaces subject to atmospheric corrosion with the exception of machined surfaces shall be epoxy painted.

6.2 All exterior machined surfaces shall be coated with suitable rust preventives.

7.0 VENDORS LIST

All equipment shall be procured / fabricated as per approved vendor list. However, Bidder may have to furnish Proven track record / reference record of any vendor opted for specified services / equipment, if, owner desires.

Any equipment for which vendor list is not enclosed, Bidder may furnish a list of proposed vendors along with their references for supply of similar type of equipment along with bid. However all proposed additional sub-vendors shall have well proven track record and shall be subjected to owner's / consultant approval during detail engg.

8.0 DRAWING & DOCUMENTATION:

Drawings & Documents of machinery items/ rotating equipment shall be as mentioned elsewhere in the NIT.

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SECTION –VI: TECHNICAL

PART – 3.2.3

DESIGN SPEFICICATION – PIPING

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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SECTION NUMBER	DESCRIPTION
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LIST OF ATTACHMENTS

DOCUMENT/ANNEXURE NUMBER	DESCRIPTION
1	Table Of Basic Span
2	Accessibility For Valves & Instruments
3	Vertical And Horizontal Guides Spacing
4	Clearances
5	Design Philosophy For Stress Analysis
PNMP-TS-6000	Engineering Specification–Piping (For Package Units)

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1.0 SCOPE

The scope of this document is pertaining to the design philosophy, norms .and specific requirements which shall be adhered to by contractor or his associates and representatives during the course of the project in designing, procurement & construction of piping material.

1.1 APPLICABLE STANDARD & CODES

Standard No.	Title
ASME/ANSI B16.5	Steel Pipe Flanges and Flanged Fittings
ASME/ANSI B16.9	Steel Butt-Welding Fittings
ASME/ANSI B16.10	Face to Face and End to End Dimensions of Valves
ASME/ANSI B16.11	Forged Fittings Socket Welded and Threaded -
ASME/ANSI B16.20	Metallic Gaskets for Pipe Flanges – Ring Joint, Spiral Wound, and Jacketed.
ASME/ANSI B16.21	Non-Metallic Flat Gaskets for Pipe Flanges
ASME/ANSI B16.25	Butt-Welding Ends
ASME/ANSI B16.34	Valves – Flanged, Threaded Welding End.
ASME/ANSI B16.47	Large Diameter Steel Flanges
ASME/ANSI B31.1	Power Piping
ASME/ANSI B31.3	Process Piping.
ASME/ANSI B31.5	Refrigeration Piping
ASME/ANSI B36.10M	Welded and Seamless Wrought Steel Pipe.
ASME/ANSI B36.19M	Stainless Steel Pipe
API 6D	Specification for Pipe Line Valves (Gate, Plug, Ball and Check Valves).
API 6FA	Fire Test for Valves.
API 501	Specifications for Metallic Gaskets for Refinery Piping.
API 594	Check Valves:, Wafer-Lug and double flanged type
API 598	Valve Inspections and Testing.
API 599	Steel Plug Valves Flanged and Butt-weld ends
API 600	Steel Gate Valves Flanged and Butt-welding ends, Bolted Bonnets
API 602	Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries
API 603	Class 150 – Corrosion Resistant Flanged End gate valves.
API 604	Ductile Iron gate valves – flanged ends.
API 606	Compact C.S. Gate Valve extended body.
API 607	Fire Test for soft seated Ball Valve.
API-608	Metal Ball Valves, Flanged, Threaded & BW Ends.
API 609	Butterfly Valves, Lug type & Wafer type.
API 623	Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets
IBR	Indian Boiler Regulations
AWWA C207-D	Large Dia. Steel Flanges (Ring Type).
EJMA	Expansion Joints Manufacture Association.
MSS SP 6	Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings.
MSS SP 25	Standard Marking System for Valves, Fittings, Flanges & Unions
MSS SP 43	Wrought Stainless Steel Butt-weld Fitting

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MSS SP 45	By-pass and Drain Connection.
NACE MR0175-94	Sulphide Stress Cracking resistant Metallic Material
NFPA	National Fire Protection Association.
EN 10204	Metallic Products - Types of Inspection documents
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

2.0 DESIGN PHILOSOPHY

2.1 Piping systems shall be in accordance with Clause 1.1, which permits the use of the following specifications:

ASME B31.1 Power Piping
ASME B31.3 Process Piping
Materials, design, construction, testing and inspection shall be fully in accordance with the selected specification.

2.2 The dimensions, manufacturing tolerances and marking of ferrous and non ferrous piping components shall conform to the applicable standards .The design shall comply with all applicable codes, laws and statutory regulations. The Contractor shall optimize the layout with the approval of the owner and include any changes resulting from HAZOP studies and taking into consideration the following :

i) General site layout taking into account the topographical geo-technical aspect of the site.
ii) Access for maintenance and fire appliances.
iii) The interdependency of units and buildings with each other within the complex.
iv) Safety escape routes for personnel based on emergency or disaster management plans in the event of environmental upset or fire.
v) Suitable drainage system of Project site.

2.3 Material of construction shall be suitable for specified process duty (both normal and abnormal operations) and have a projected life and corrosion/ erosion allowance in excess of minimum life of the project. Piping materials specified in piping materials specification shall be used for selection of material of construction of major services.
All materials under steam service shall be supplied with proper certificates in prescribed forms.

3.0 CODES, STANDARDS AND SUPPLEMENTARY SPECIFICATIONS:

3.1 The latest edition of codes shall be applicable for piping system design, materials, fabrication, manufacture, erection, construction and inspection etc. For any item not covered in the list of codes and standards / International Standards / proven design may be finalized based on discussion with OWNER/Consultant.

3.2 Where conflict occurs, the order of precedence shall be:

a) Statutory Regulations
b) National, International and Industry Standards and Codes of Practice.
c) Technical Specifications

3.3 Standards, Codes and Supplementary Specifications for piping design shall be applied as follows:

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i) Process and utility piping to ASME B31.3 Process Piping
ii) Power Plant piping to ASME B 31.1
Fire protection system shall be designed and installed in accordance with applicable NFPA (National Fire Protections Associations) Codes.

4.0 GENERAL DESIGN

4.1 Flanges for process and utility piping shall be in accordance with ANSI B16.5 and ANSI B16.47.

4.2 Wherever possible all purchased equipment shall be supplied with flanges that comply with ANSI B16.5/B16.47.

4.3 The minimum size of piping to be used in pipe-racks shall be 2" NB.

4.4 With the exception of equipment connections the minimum size of piping shall be ½" NPS.

4.5 Pipe sizes 1 ¼", 2 ½", 3 ½" 5" and 22" NPS shall not be used except as connections to purchased equipment.

4.6 Threaded pipe nipples between headers and vent, drain and instrument isolation valves shall be Schedule 160 for CS and Schedule 80S for SS in the size range ½" to 2" NPS.

4.7 Piping 2" NPS and above shall be butt-welded. All weld joints in piping 1½" NPS and below shall be socket welded using socket weld fittings.

4.8 In Class 600 and higher pressure rating double block valves shall be used for systems open to atmosphere, such as vents and drains. Piping in hazardous service shall have vents, drains and bleeds routed to a safe location. Category 'M' substances shall be vented to the flare system.

4.9 When a line of one material specification is connected to a line of higher material specification, the connecting line shall be constructed of the higher material specification or pressure rating up to & including the first block valve.

4.10 As a minimum, piping systems shall have isolation facilities as follows:

ASME B31.3 Category 'M' service and Normal service (Class 900 and above) shall have double block isolation valves with a downstream drop-out spool.

ASME B31.3 Normal service (Class 150 and 600) shall have a valve and downstream spectacle blind.

ASME B31.3 Category 'D' service shall have a valve and downstream spectacle blind.

Generally, equipment shall have provision for isolation of piping to each equipment connection by means of valving and /or blinds as determined by service conditions.

5.0 DESIGN PHILOSOPHY / GENERAL CRITERIA

5.1 Equipment Layout

5.1.1 Basis of Equipment Layout

Equipment Layout shall be finalised based on the following data:
a) Overall Plot Plan
b) P&I Ds
c) Equipment Data Sheets

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d) Wind Direction

e) Safety Distance and Specific Distance mentioned in Piping Design Basis and as per statutory requirements.

5.1.2 **Development of Equipment Layout**

The following aspects shall be considered during development of equipment layout.

a) Process Requirement -Proper interconnection between equipment as per P&I Ds to achieve the intended process parameters.

b) Economy of piping material- Minimize the quantity of costly piping.

c) Erection & Construction requirements:

Erection scheme and schedule of all equipment must be considered during equipment layout to have smooth erection mainly in case of tall columns, heavy equipments like thick walled reactors, space for laying tall columns, approach roads for cranes / derricks for lifting the column or reactors and requirement of special foundation / pile etc.

d) Operation and Maintenance Requirement

- Overhead and side clearances for exchangers and pumps
- Horizontal & overhead clearances for easy movement of working personnel.
- Crane approaches for air coolers/fired heaters.
- Provision of monorail for pumps and exchangers

e) Similar equipment grouping - All columns, exchangers, pumps etc. should be grouped together for convenience of maintenance and safety wherever feasible.

f) The technological structures should be interconnected for easy movement of operational personnel.

g) U/G piping corridors for main headers should be marked in equipment layout for all under ground piping.

5.1.3 **Plant Layout & Design guidelines**

5.1.3.1 **General**

The plant layout shall be based on ensuring adequate access, to allow construction, inspection, maintenance and operation to be performed in a safe and efficient manner. The alignment of equipment and pipe shall offer an organised appearance. The layout shall be in accordance with, but not limited to the design practices described in this criteria.

Where dynamic loading, limited pressure drop or other severe service condition applies, particular care shall be taken in routing pipe lines.

Flushing connections shall be provided on all lines containing flammable or toxic material, slurries, and materials which solidify- when the line is dead. Sufficient Nitrogen purging points shall also be provided. Supply piping of fuel gas shall be arranged for equal flow distribution.

Trolley beams, pipe davits, shall be provided with appropriate removable hoists mechanism for charging and discharging catalysts, chemicals, packing rings etc.

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Piping and all other services shall be arranged so as to permit ready access of Cranes for removal of Equipment for inspection and servicing.

All utility and process piping shall be located above ground, and major lines shall be located in overhead pipe ways.

Lines that must be run below grade, and must be periodically inspected or replaced, shall be identified on the P & ID's; these lines must be placed in covered concrete trenches. Sleeper-ways shall not be used in process areas where they may block access for personnel and equipment.

Drip legs and dead ends shall be avoided, especially for piping where solids or fluids may congeal from corrosive condensate.

Where sleeper ways are used the elevations shall be staggered to permit ease of crossing or change of direction at intersections. Flat turns may be used when entire sleeper ways change direction. Flat turns must not be used within pipe racks.

Spacing and routing of piping shall be such that expanding/contracting lines (including insulation) will not clash with adjacent lines, structures, instruments and electrical equipment during warm up and cool down.

Piping to be sloped shall be indicated on the P&I D's.

5.1.3.2 **Pipe-Rack/T-Post/Small Portals**

In general, equipment layout shall be prepared considering straight pipe rack, however other shapes like L / T / U / H / Z etc can also be considered based on area available.
The width of the rack shall be 4M, 6M, 8M, 10M or 12M for single bay having four (4) tiers maximum. In general, the spacing between pipe rack portals (span) shall be taken as 8 M for main rack. However it can be decreased to 6 M depending on the size/number of the pumps to be housed below pipe rack. Intermediate Beams between two portals shall be provided to support smaller pipes <= 2". 20% extra space shall be provided on the pipe rack and portals on each tier for future expansion/modifications.

-Clearance beneath pipe rack shall be 3.8 M minimum.
-Height between two pipe rack tiers shall be 2.0M minimum.
-Road clearance shall be 9 M minimum wherever heavy duty crane movement is required during construction and future maintenance.
-Road clearance shall be 7.5 M minimum for main roads.
-Road clearance shall be 5 M minimum for secondary roads.
-T-Portal's width shall not be more than 2.5 M and height shall not be less than.3.0 M

5.1.3.3 **Pumps**

Wherever practicable pumps shall be arranged in rows with the centre line of the discharge on a common line. In general, pumps shall be kept inside the pipe rack. However in case of smaller racks, pumps shall be kept on one side or outside the pipe rack to provide clear access under the rack as per clause applicable.

Pump foundation height shall be 300 mm above H.P.P.

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Gap between each pump foundation / and foundation of technical structure should be sufficient for easy removal of equipment after piping. Clearance between two adjacent pumps shall be such that clear 900 mm aisle is available.

All pumps not open to sky with motor rating >= 45 KW shall be provided with monorail. No monorail should normally be provided for pumps outside rack and sufficient space below rack shall be available for pump maintenance.

5.1.3.4 **Clearance and Accessibility**

5.1.3.4.1 **Access to Pumps**

Clear access of 3.8M vertically and 4.5M horizontally shall be provided centrally under main pipe rack for small mobile equipment to service pumps, wherever these are put under pipe ways with prior specific approval. Pumps outside rack shall be approachable by small cranes etc. from under the pipe rack.

5.1.3.4.2 **Access to lower items to grade (Lowering Area)**

Clear access shall be provided at grade on the access side for lowering external and internal fittings from tall elevated equipment by providing pipe davits.

5.1.3.4.3 **Layout & Access Requirements for Platforms ladders and Stairs**

For providing platform ladder & staircase following guidelines shall be followed.

- Two means of access (i.e. two ladders or one ladder and one stair case) shall be provided at any elevated platform which serves three or more vessels & for B/L valves operating platform.
- Platforms, ladders and stairways shall be the minimum, consistent with access and safety requirements.
- Stairway for tanks to be provided on upstream of predominant wind direction.

i) Platform at elevated structure

a) Dual access (i.e. one staircase and one ladder) shall be provided at large elevated structure if any part of platform has more than 22.65M (75 ft) of travel.

ii) Platforms with stair access shall be provided for:

a) Location at which normal monitoring (once a day or more) is required or where samples are taken.

b) Locations where vessels or equipment items need operator attention "such as compressors, heaters, boilers etc.

iii) Platforms with ladder access shall be provided for:

a) Points which require occasional operating access including valves, spectacle blind and motor operated valves, heater stack sampling points.

b) Man ways above grade on equipment.

iv) Ladder location

a) Wherever practicable, ladder shall be so arranged that users face equipment or platform rather than facing open space.

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b) Landings shall be staggered. No ladder shall be more than 6 M in one flight.

5.1.3.5 **Clearances**

Minimum clearances shall be as indicated in Annexure.

5.2 **Unit Piping**

5.2.1 **Basis of Unit Piping**

- Piping & Instrument Diagram
- Equipment layout
- Equipment Data sheet & Setting plan
- Line list
- Instrument Data sheet
- Structural & building drawings
- Topography of the plant
- Piping material specification
- Overall plot plan
- Tie in point drawing.

The following objective shall be ascertained during piping layout.

- Proper access to all operating points including valves, and for all orifice tapping points and instruments in particular.
- Proper access to interrelated operating points for specific purpose and for maintenance.

5.2.2 **Pipe Ways/Rack piping**

5.2.2.1 Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.

5.2.2.2 Predominantly process lines are to be kept at lower tier and, utility & hot process lines on upper tier.

5.2.2.3 Generally the top tier is to' be kept for Electrical (if not provided in underground trench as per electrical design basis) and Instrument cable trays. Cable tray laying to take care of necessary clearances for the fire proofing of structure.

5.2.2.4 Generally the hot lines and cold lines shall be kept apart in different groups on a tier. .

5.2.2.5 Generally the bigger size lines shall be kept nearer to the column.

5.2.2.6 Minimum spacing between adjacent lines shall be decided based on O.D of bigger size flange'(minimum rating 300# to be considered), O.D of the smaller pipe, individual insulation thickness and additional 25 mm clearance, preferably. Wherever even if flange is not appearing the minimum spacing shall be based on above basis only. '

5.2.2.7 Actual line spacing, especially at 'L' bend and loop locations, shall take care of thermal expansion / thermal contraction / non expansion of adjacent line. Non expansion / thermal contraction may stop the free expansion of the adjacent line at "L' bend location.

5.2.2.8 Anchors on the racks are to be provided on the anchor bay, if the concept of anchor bay is adopted. Otherwise anchors shall be distributed over two to three consecutive bays.

5.2.2.9 Anchors shall be provided within unit on all hot lines leaving the unit.

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5.2.2.10 Process lines crossing units (within units or from unit to main pipe way) are normally provided with a block valve, spectacle blind and drain valve. Block valves are to be grouped and locations of block valves in vertical run of pipe are preferred. If the block valves have to be located in an overhead pipe way, staircase access to platform above the lines shall have to be provided.

5.2.2.11 Provision of block valves, blinds etc. shall be as per Process Design Basis and P & IDs.

5.2.2.12 All small bore piping shall be designed in a way so as to ensure adequate space for maintenance and operation. For small bore piping intermediate support shall be provided in between portals.

5.2.2.13 Stubs on saline water (if applicable) service shall be from top of main header.

Minimum branch size for tapping including for instruments e.g PG/ *PTI* TE etc. shall be of 3" NPD and 150 mm height on internal cement lined pipes.

5.2.2.14 Aboveground lines shall be grouped to run on pipe racks or sleepers in so far as practicable.

5.2.2.15 Hot lines on pipe racks or sleepers shall be grouped and expansion loops shall be nested together. The number of expansion loops shall be kept to a minimum.

5.2.2.16 Piping handling corrosive fluids shall be run under piping handling non corrosive fluids, and shall not, where possible, be run overhead across walkways or normal passages for personnel.

5.2.2.17 All process and utility piping will be located aboveground within the plant battery limit, except water mains.

5.2.2.18 All piping shall be arranged in horizontal banks, where possible, to facilitate supporting.

Banks running north-south shall be at different elevations from banks running east-west. Exceptions are permitted to avoid unnecessary change in elevation at change of direction or where essential to avoid pockets.

5.2.2.19 All piping shall be routed for the shortest possible run and have the minimum number of fittings consistent with provision for expansion and flexibility. All piping shall be arranged in a neat manner, providing free access around all operating equipment.

5.2.2.20 Vertical lines at vessels shall run close to the vessel shell to facilitate supporting. The line shall be arranged and grouped to allow the use of single support.

5.2.2.21 Lines carrying molten solids, slurries or highly viscous liquids shall have a sufficient

slope for each gravity flow.

5.2.2.22 The shortest and most direct layout possible shall be provided for gravity flow lines, especially when the fluid is subject to solidification and when the differential pressure is

small.

5.2.2.23 Piping shall be arranged to facilitate handling of equipment for inspection or maintenance.

5.2.2.24 Vapor collecting system shall be routed so that the vapor rises continuously from the vessel being vented to a higher point without pocketing.

5.2.2.25 Pockets shall be avoided in lines, particularly those carrying corrosive chemicals, slurries, vents, blow down lines, etc.

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5.2.3 Column / Vessel Piping Control Valves

5.2.3.1 Piping shall be supported from cleats welded on the vessel as far as possible.

5.2.3.2 Proper guides at intervals shall be provided for long vertical lines.

5.2.3.3 Access platforms/ladders shall be provided along the column for valves and instruments.

5.2.3.4 For ease of operation and maintenance, column and vessels which are grouped together, shall have their platforms at the same elevation interconnected by walkways wherever feasible. However each column \ vessel shall have an independent access also. Column vessel platforms should be designed in such a way so that all the nozzles should be approachable from platforms.

5.2.3.5 Unless specifically indicated in P&ID's control valves shall preferably be kept at grade instead of platform.

5.2.3.6 Piping intended for vacuum services shall be routed as short as possible, with minimum bends and flanged joints.

5.2.3.7 Piping support cleats shall be designed for safety valves considering impact loading during popping off.

5.2.4 **Pump Piping**

5.2.4.1 Pump drives shall have clear access.

5.2.4.2 Pump suction piping shall be as short as possible and shall be arranged with particular care to avoid vapor pockets.

5.2.4.3 Reducers immediately connected to the pump suction shall be eccentric type flat side up to avoid the accumulation of gas pocket. For end suction pumps, elbows shall not be directly connected to the suction flange. A straight piece minimum 3 times the line size shall have to be provided at the suction nozzle.

5.2.4.4 Pump discharge check valve if installed in vertical lines shall be fitted with a drain connection as close as possible downstream of the valve.

When a suction vessel operates under vacuum, the vent connection of the pump has to be permanently connected to vapour space of the suction vessel to allow possible filling of the pump with liquid before it is started.

5.2.4.5 Unless otherwise specified T -type strainers shall be used on pump suction piping for sizes 2" and above.

5.2.4.6 Y-type strainers to be used for all sizes in steam services and for pump suction lines 1½ and below.

5.2.4.7 All small bore piping connected to pump (drain to OWS & CBD, seat and gland leak drain) shall have provision for break up flanges for removal of pumps.

5.2.4.8 Piping shall be so arranged that forces and moments imposed on the pump nozzle do not exceed the allowable values as per API 610.

5.2.4.9 Pump discharge should preferably be routed away from the pump rather than towards the motor side.

5.2.4.10 Pump cooling water connection shall be taken from the top of circulating cooling water header.

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5.2.5 **Steam Header & Supply Lines / Steam and Condensate Systems**

5.2.5.1 Steam piping shall be designed to have complete condensate removal. Drip legs shall be provided with steam traps at low points in the system.

5.2.5.2 All steam branch connections shall be taken from the top of the header.

5.2.5.3 Return exhaust steam / condensate lines shall connect to the top of the exhaust steam Condensate header.

5.2.5.4 Where block valves have been installed in the main steam header such that condensate can collect either side of the valve when closed, a safe means of draining the condensate prior to opening the valve shall be provided.

- Steam header shall be located generally on the upper tier and at one end of the rack adjacent to columns.
- Branch lines from horizontal steam header, except condensate collection points, shall be connected to the top of the pipe header.
- Isolation valves (if provided) on the branch line shall preferably be provided on the horizontal run and outside the pipe rack.
- All branch lines shall be drainable.
- Drip legs & steam traps shall be provided at all low points and dead ends of steam header. Drip legs at low points shall be closer to downstream riser and shall be provided to suit bidirectional flows, if applicable.
- All turbines on automatic control for startup shall be provided with a steam trap in the steam inlet line.
- All traps shall be provided with strainers if integral strainers are not provided.
- Steam traps discharging to atmosphere shall be connected to storm water drain/storm sewer, in case of open system. In case of condensate recovery, traps shall discharge into condensate header.
- Expansion loops are to be provided to take care of the expansions within units.
- Wherever condensate is to be drained, proper condensate draining facility shall be provided.

5.2.6. **Water Piping**

5.2.6.1 Water piping shall be designed to minimize the possibility of water hammer.

5.2.6.2 Water main headers may run underground to prevent freezing.

5.2.6.3 Unless local code or regulation prohibits, firewater lines shall be underground to prevent freezing. Firewater piping system shall conform to egulations of the competent governmental authorities.

5.2.7 **Instrument Air Piping**

5.2.7.1 Instrument air lines shall not be connected to process lines, service lines, and other equipment.

5.2.7.2 Instrument air shall not be used as plant air or service air.

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5.2.7.3 Branch lines form the instrument air header shall be taken from the top of the header and shall be provided with a block valve close to the header. Also in the upstream of Instrument manifold, Gate valve has to be provided.

5.2.8 **Supports and Anchors**

5.2.8 1 Supports and/or anchors shall be provided close to changes in direction of lines, branch lines and, particularly, close to valves to prevent excessive sagging, vibration and strain.

5.2.8 2 Allowable spans between pipe supports shall be determined to keep the maximum deflection within 16 mm.

5.2.8 3 In cases where periodic maintenance requires removal of equipment, such as pumps and relief valves, and where lines must be dismantled for cleaning, piping shall be supported to minimize the necessity of temporary supports.

5.2.8.4 Spring-loaded hangers may be used on piping subject to thermal expansion or contraction. In cases where the movement is very large, or the limitation of reaction and

stress are very severe, constant support spring hangers shall be used.

5.2.8.5 Suction and discharge lines of rotating equipment shall be supported as close as possible to equipment nozzles, and shall be relieved of excessive strains by using proper pipe supports.

5.2.8.6 Supports shall not be directly welded to pipes. Where welding is unavoidable, supports having the same chemical composition as pipe shall be carefully welded.

5.2.8.7 All piping shall be properly supported to minimize vibration.

5.2.8.8 Outlet piping of safety and relief valves shall be supported so that the inlet piping is capable of withstanding the reaction caused by operation of safety and relief valves. Furthermore, the supports shall be designed to minimize the stresses due to thermal expansion and the stresses in the valve body due to the weight of piping.

5.2.8.9 Expansion joints shall be guided and anchored to the extent necessary for their proper operation and alignment.

5.2.8.10 Anchors shall provide sufficient fixation to substantially transmit all load effects into the foundations.

5.2.8.11 Underground piping shall be given special anchoring consideration for differential settlement.

5.2.9 **Utility Stations**

Requisite number of utility stations shall be provided throughout the unit to cater for the utility requirement. Utility stations shall have four connections one for LP steam (SL), one for Plant Air (AP), one for Service Water (WS) and one for nitrogen each of 1.0" with isolation valves unless otherwise specified in P&ID.
Utility connection with nitrogen shall be provided with NRV along with isolation valve kept at a separate location other than this cluster @ 15 M

Air and water lines shall have quick type hose connection and steam line shall have flanged type hose connection. All connections shall be directed downward. All connections shall have globe valve for isolation purpose. An inter connection with valve shall be provided between

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steam and service water lines shall be provided. Inert gas hose, when required, shall have built in non return valve in quick connection coupling of piping end.
Number of utility stations shall be such that all equipments shall be approachable from at least one utility station. The approach of utility station shall be considered 15 M all around the station location.

The Utility stations shall generally be located adjacent to pipe-rack column.

The utility stations shall also be provided on elevated structures like - technological structure, operating platforms of vertical equipments etc.

Operating platforms having manholes must have a utility station. Utility station locations shall be limited to a height of 35 M from H.P.P.

5.3 Offsite & Yard Piping

In general, offsite piping (except tank ages area), electrical cable and instrumentation cable shall also be laid either on pipe rack or pipe sleepers.

Wherever piping is laid on pipe sleepers, it shall have hard surfacing below it keeping a gap of 300 mm from the bottom of the pipes. Hard surfacing should be completed before start of pipe laying. Width of hard surfacing shall be about 1.0 meter more than the piping corridor. This extra hard surfacing shall be for movement of operating personnel along the piping corridor.

Pipes at road crossing shall be under culverts in general. Overhead pipe bridges may be used for areas where pipe racks are provided. Where culverts are not provided, pipe sleeves shall be used for underground road crossing. Culverts / overhead pipe bridges shall be adequately designed to take care of future requirements. Minimum 20% extra width shall be provided in all such structures.

Clearances between lines shall be minimum "C" as given below:

$C=(Do+D_f)/2$ + 25 mm + Insulation thickness(es) where,

Do - outside diameter of smaller pipe (mm)

D_f - outside diameter of flange of bigger pipe (mm)

However this 'C' spacing between the offsite piping on the rack/sleeper can be suitably increased so that the lines should not touch each other after insulation / lateral thermal expansion.

Adequate clearance shall be provided for every long & high temperature lines to avoid clashing at the bends. See 5.2.2 also for line spacing at 'L' bends and loops.

Expansion loops for all lines shall generally be kept at the same location.

Vents shall be provided on all high points & drains shall be provided at all low points. Drain valves at sleeper piping shall be kept outside the sleeper way if the same is not accessible and valves shall be put in horizontal only.

Places where piping is extended to make drain valves accessible - 2 nos. of stiffeners, irrespective of pipe rating, shall be provided as per 5.13.1. Spacing of guides on each line on a pipe bay shall not exceed the value given in clause 5.13.1

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5.4 Flare Piping

Flare header shall be sloped towards flare knock-out drum. Only horizontal loop shall be provided as per requirement to accommodate thermal expansion. The desired slope shall be ensured throughout including flat loop. Flare header shall be supported on shoe of height ranging from 100mm to 300mm.

Proper thermal analysis temperature shall be established including the possibility of temperature gradient along the line before providing expansion loops. Efforts shall be made to minimize the number of loops. Flare line between knock out drum and water seal drum shall be designed for pressure fluctuations and adequately supported to avoid vibrations.

5.5 Underground Piping

5.5.1 Underground steel piping shall be protected from electric corrosion.

5.5.2 Underground piping passing under loaded areas, such as main roads in the plant, shall be protected from heavy traffic by casing pipes or covers extending at least 1 m on either side of the area or having the wall thickness sufficient to bear earth pressure.

5.5.3 Underground piping shall be sloped to all drain points with a downward slope of not less than 1 m in 150 m.

5.5.4 Expansion elbows or joints of underground piping for hot fluids, such as steam or heated heavy oil, shall be enclosed in a conduit from which they are separated to allow free longitudinal expansion.

5.5.5 Where it is impossible to run pipe aboveground or underground, trenches may be used.

5.5.6 Trenches for piping close to process equipment should be avoided, whenever possible.

5.5.7 All underground pipe work shall be provided with following protection:

a) At location where Underground Piping becomes above ground, INSULATING GASKET with material Glass Filled Teflon or equivalent shall be provided.

b) CATHODIC PROTECTION (CP) shall be provided to all underground piping. Specification shall be submitted by the CONTRACTOR & shall be approved by the OWNER.

c) Underground piping shall be wrapped & coated by “PYP KOTE” or equivalent tapes / sheets, 4.00 mm thick & shall be “HOLIDAY TESTED” before Hydro Test.

d) All underground pipes shall have Sand Bed, at least 150 MM all around the pipe.

e) All road crossings by Underground piping shall be through Hume Pipe Sleeves.

5.5.8 **Buried Pipes**

The following points to be considered in designing of buried pipes

i) All underground metallic piping shall be coated and wrapped and provided with cathodic protection system. If sacrificial metal is used, permanent testing arrangement shall be provided.

ii) All cooling water distribution headers 18" and higher shall be laid underground.

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iii) All Sewage lines (oily and chemical) from catch basin to mains and manholes shall be laid underground.

iv) Underground pipe crossing roads, access ways and rails shall have casing pipe (R.C.C or C.S).

v) Valve chamber wherever required shall be made of brick or concrete. Valve chamber should be spacious to attend valves during operation/Maintenance.

vi) All U.G. headers shall clear equipment foundations as far as possible. Under special cases, the C.W. header may be laid over the footing of foundations.

vii) Provide break flange at + 500 MM from floor level connection with cathodic protection to isolate underground pipe from above ground piping with insulating gasket KIT.

viii) Pipes shall be laid below electrical cables if any.

ix) Top of underground piping shall be below grade level at least 1 meter deep in case of open areas and 1.5 meter deep for roads.

5.5.9 Piping in Trenches

The following points to be considered in designing of trench pipes

i) Piping located below grade, requiring inspection, servicing or provided with protective heating.

ii) Fire water lines/Process lines.

iii) Drain lines requiring gravity flow trenches.

iv) Sump for valves and trenches shall be provided.

v) Suitable draining scheme for trenches shall be provided.

5.6 **Air Systems**

5.6.1 Branch connections shall be taken from the top of the header.

5.6.2 Low points shall be fitted with drains.

5.7 **In-Line Instruments**

5.7.1 Liquid level controllers and level glasses shall be located so as to be accessible from grade, platform or permanent ladder. The level glass shall be readable from grade wherever possible.

5.7.2 Relief valves shall be accessible. Relief valves with a centre line elevation over 4.5 M above grade (expect in pipe racks) shall be accessible from a platform or permanent ladder.

5.7.3 Relief valves that discharge to a closed system shall be installed higher than the collection header, with no pockets in the discharge line.

5.7.4 Relief valves that discharge to atmosphere shall have tail-pipes extended to a minimum of 3.0 M above the nearest operating platform that is within a radius of 8 M.

5.7.5 Provide steam traps at pocketed low points and at dead ends of steam headers. Provide steam traps on excessively long runs of steam piping to ensure dry quality steam at destination. Steam traps located more than 4.5 M above grade, except in pipe racks, shall be accessible from a platform.

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5.7.6 Control valves shall be accessible from grade or platforms. In general, the instruments or indicators showing the process variables shall be visible from the control valve.

5.7.7 Orifice runs shall be located in the horizontal. Orifice flanges with a centre line elevation over 4.5m above grade, except in pipe racks, shall be accessible from a platform or permanent ladder.

5.7.8 Orifice taps shall be located as follows:

i) Air, Gas and steam
Top vertical centreline (preferred)
45 degrees above horizontal centreline (alternate)

ii) Liquid
Horizontal centreline (preferred)
45 degrees below horizontal centreline (alternate)

iii) Tap orientation shall be shown on piping isometrics.

5.8 **Sample Connections**

Sample connections shall be accessible from grade or platforms. In general, where liquid samples are taken in a bottle, locate the sample outlet above a drain funnel to permit free running of the liquid before sampling.

5.9 **Vents and Drains**

5.9.1 The minimum size of vent and drain connections shall be as follows:

For process & utilities lines :

4" & Below	NPS ¾"
6" & 10"	NPS 1"
12" & above	NPS 11/2"

Vent & Drain shall be provided with the valve & blind flange. For all vents / drains of process lines / utilities lines, double valves shall be required for 600 # & more rating.

Process vents and drains shall be indicated on the P&ID's

5.9.2 Vent, drain and sampling valves on process lines, not connected to a piping system, shall be provided with appropriate end closures.

5.9.3 Vents shall be located at high points of pipelines when necessary.

5.9.4 Drains shall be located at low points to empty pipelines or equipment after testing or during maintenance (i.e for every loop).

5.9.5 All drains and vents shall be provided with valve, except that vents for test purpose for flare liens (header), may be plugged. Exposed threads shall generally be seal welded.

Low-point hydrostatic drains and high-point hydrostatic vents shall be added as required; locations to be determined during the design review.

5.9.6 Vent valves shall be the globe or gate type and drain valves the gate type.

5.9.7 Valved bleeds shall be provided at control valve stations, level switches, level controllers, and gauge glasses.

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5.10 Line Strainers

5.10.1 Provide temporary conical type strainers in 2” NB and above butt weld pump suction lines for use during start-up. Arrange piping to facilitate removal.

5.10.2 Provide permanent Y-type strainers for pump suction piping below 2” NB Thd or SW.

5.10.3 Provide temporary basket type strainers located at the suction pulsation device inlet for start-up of reciprocating compressors. Arrange piping to facilitate removal of the filter.

5.10.4 Provide temporary basket type strainers and locate them as close as possible to the compressor inlet flange for start-up of centrifugal compressors. Arrange piping to facilitate removal of the filter.

5.10.5 Allowable pressure drop when specified shall be certified by vendor along with the offer. If asked specifically, vendor shall furnish pressure drop calculations

5.10.6 All 2" & higher sized Y type strainers shall be provided with 3/4" threaded, tap and solid threaded plug as drain connection. For less than 2", this shall be ½ " size.

5.10.7 Bottom flange of Y-type strainer shall not have tapped hole. Full length standard size studs shall be used for joining blind flange.

5.10.8 For fabricated strainers, all BW joints shall be fully radiographed and fillet welds shall be 100% DP/MP checked.

5.10.9 All the strainers shall be hydrostatically tested at twice the design pressure.

5.11 Spectacle Blinds

5.11.1 Spectacle blinds shall be provided to isolate equipment. In hazardous service flanged drop-out spools shall be provided for safety purposes. Both shall be shown on the P&ID’s.

5.11.2 Spectacle blinds shall be accessible from grade or platforms. Blinds located in a pipe-rack are considered to be accessible. Blinds that weigh over 40kg shall be accessible by mobile equipment. Where this is not possible davits or hitching points shall be provided.

5.12 **Flexibility Analysis and Supporting**

5.12.1 **Pipe Supporting Criteria & General Guidelines.**

Piping system shall be properly supported taking into account the following points:

1. Load of bare pipe + fluid + insulation (if any).
2. Load of bare pipe + water fill.
3. Load of valves and online equipment and instrument.
4. Thermal loads during operation.
5. Steam-out condition, if applicable.
6. Wind loads for piping at higher elevation, e.g. transfer lines, column over head lines, flare headers, etc.
7. Forced vibration due to pulsating flow.
8. Vibration due to two phase flow.
9. Loads due to internal pressure.

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10. Any external loads/concentrated loads and cold load of springs.

Pipe supporting shall preferably follow the minimum basic span as given in Annexure-1 except for flare line in off site on trestles in which case the maximum basic span shall be restricted to 18.0 meters, irrespective of line size.

For sizes not covered in Annexure-1, basic span shall be established based on project requirement. For piping on rack or sleeper, as a minimum, providing resting support on every grid of pipe rack / sleeper is mandatory. Depending on the pipe size, as a rule, guides shall be provided on straight run of pipes at intervals as specified in Annexure-3 unless specifically becomes non-viable due to flexibility problems.

Additional supports, guides, anchors, special supports like spring supports and sway braces shall be provided after detailed analysis of piping system to restrict the forces experienced on nozzles of critical items like pumps, compressors, turbines, exchangers, air fin coolers etc.

For lines which do not need any support otherwise but become unsupported by opening of flange, etc, during maintenance and thereby may transfer the total load on a small branch off, a permanent support shall be suitably provided which may be a spring support also. Bare pipes of size 14" and above on elevated structures shall be supported with pad or shoe. While bare pipes of size 6" and' above, on sleepers, corrosion pads shall be provided.

Pads shall be provided for insulated pipes before welding the shoes for sizes 8" & above.

Adequate stiffening shall be provided for the following:

a) Lines in above 600#,

b) Lines having two phase flow,

c) Lines having Pulsating flow such as discharge of reciprocating compressors & reciprocating pumps,

For pulsating flow lines detailed thermal and vibration analysis by analog study shall be done to decide location of anchor supports and guides etc. Pulsating flow lines shall be as identified by licensor/owner.

Wherever two phase flow in piping is expected, piping design shall be checked by dynamic analysis to prevent vibrations.

Pipe support design shall be such that deflection in piping systems due to sustained loads shall not exceed 15mm, in any case, between two adjacent supports.

As far as possible long trunnion types of supports (more than 0.5 metre) are to be avoided. In case long trunnion support is unavoidable in straight length of pipe, trunnion height to be restricted to 0.5 M and balance height to be made up by providing extended structure.

In the heaters where steam air decoking provision is there, the main lines and decoking lines should be supported in a way so that either of the lines should not be in the hanging position while connected to other one. Same philosophy shall be adopted for similar type of switch over arrangement.

Piping passing through the technology structure or passing near the concrete column etc. should have adequate annular space to avoid restriction of line movement during thermal expansion. The gap should take care the thermal expansion along with insulation thickness.

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High density PUF blocks shall be considered for cold piping supports. Use of wood blocks shall be avoided.

All pipes supports shall be so designed that there is no undue tension on equipment flanges. Flange joints should not move away from each other in case of unbolting of the joint.

5.12.2 **Flexibility Analysis Criteria & General Guidelines**

5.12.2.1 Formal flexibility analysis by computer program of piping system shall be performed on latest version of CAESAR-II software as per Annexure 5, 5A & 5B.

5.12.2.2 The directions of forces and moments shall be in accordance with Welding Research Council Bulletin 107 (WRC 107), with the exception that the radial force (P) shall be away from the vessel. All forces and moments shall be assumed to act simultaneously and apply at the nozzle/vessel interface.

5.12.2.3 Air coolers to API 661 shall be specified with Fx forces and Mz moments increased to 1.2 times the value shown in Figure 8 of API 661 for nozzle sizes 6”NPS and larger to simplify piping flexibility analysis and facilitate piping layout.

5.12.2.4 Piping stress analysis and equipment nozzle loading analysis shall be in accordance with ASME B31.3 and the relevant API, ANSI/ISO and NEMA Codes.

5.12.2.5 API 610 Pumps

The allowable nozzle loads on centrifugal pumps shall meet the load criteria of API 610. Heavy duty base plate shall be specified where the pump design temperature is in excess of 150°C.

ASME or Manufacturer’s Standard Pumps

The allowable nozzle loads on horizontal centrifugal pumps design to ASME B73.1 shall be specified by the manufacturer. For preliminary layout and analysis NEMA SM 23 criteria shall be used for individual nozzles.

Other Horizontal Centrifugal Pumps

The allowable nozzle loads shall meet the load criteria specified by the manufacturer.

Vertical Turbine, Can-Types Pumps

The combined bending and tensional thermal stress in the piping attached to the nozzle shall be limited to 25 percent of the allowable stress range shown in ASME B31.3. The combined stress due to dead load and other sustained loads shall be limited to 25 percent of the allowable hot stress.

5.12.2.6 For piping design purposes, differential settlement between items of major equipment on separate foundations shall be taken as 10 mm.

5.12.2.7 Cold springing in piping shall not be permitted without written permission from the Owner. Cold springing of piping directly connected to rotating equipment is not permitted under any circumstances.

Piping shall be analyzed for expansion, contraction, differential settlement, relief, valve reaction and effects mentioned at Cl. 5.12.1.

The design of piping systems shall take into account the different conditions expected during operation, start-up, shut-down, cold branch in case of standby pump, tracing, etc.

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Hydrocarbon lines shall be designed for steam-out conditions, if specified in line schedule. The use of expansion joints shall be considered only when space oar pressure drop

limitation does not permit pipe bends. Expansion joint of axial type shall be avoided.

Forces and moments due to weight, thermal loads and other imposed loads on the equipment nozzle must not exceed the allowed loads for the equipment.

Minimum analysis temperature shall be the design temperature of the line as per line list.

5.12.3 **Method of Analysis**

Formal computer analysis shall be performed on piping systems as per design philosophy for stress analysis

The package used shall be latest version of CEASER / AUTO PIPE / SIMPLEX / CAEPIPE. Only one of these packages shall be used for the project & not a combination of the above packages.

All lines shall be analyzed at design *I* analysis temperature. In the absence of analysis temperature lines shall be analyzed at design temperature.

However in case of wide difference in design and operating temperature, temperature for analysis shall be established in process documents. (e.g. flare line)

All non-critical lines may be analyzed using other methods.

Special analysis methods shall be followed for lines involving pulsating flow such as those connected to reciprocating pumps & compressors which require acoustical plus analog study by approved agencies and shall require entire system analysis along with piping *I* equipments.

Seismic analysis shall be done for line sizes 12” and above.

5.13 Personnel Protection

5.13.1 Eyewash and emergency safety showers shall be provided in areas where operating personnel are subject to hazardous sprays, emissions or spills.

5.13.2 Personnel protection shall be provided on un-insulated lines and equipment operating above 70 deg C when they constitute a hazard to the operators during normal operation of the facility.

5.13.3 Leakage indicating tape and spray impingement shrouds shall be provided at flanged joints in hazardous service.

5.14 Mechanical Handling

5.14.1 Handling facilities such as davits and monorails shall be provided on vessels over 10m in height where the weight of removable internal and/or external equipment is greater than 35 Kg.

6.0 MATERIALS

6.1 General

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6.1.1 Basic material selection of particular line depending on its service, temperature and corrosivity shall be spelt out in process package. Material specification shall follow the requirements as per process parameters & attached PMS / VMS.

6.1.2 Only piping materials listed in ASME B31.3 shall be used for Category 'M' and Normal Service piping. Unless otherwise specified in PMS, For Category 'D' utility piping, where scaling and impurities are to be avoided (such as instrument air, potable water and deluge water) hot dipped galvanised and threaded fittings may be used in sizes up to and including 4" NB. Galvanised piping shall not be used in environments containing acids or other corrosive commodities. In corrosive environments stainless steel piping material shall be used for such utility systems.

6.1.2 All items/parts of Austenitic Stainless Steel shall be supplied in solution annealed condition.

For all Austenitic Stainless steels, Inter granular Corrosion' (IGC) Test shall be conducted.

6.1.3 In absence of specific requirement, Natural Rubber shall be used for lining in rubber lined piping items, wherever applicable. The Vendor shall confirm the suitability of Rubber Material for specified service. Unless otherwise specified, rubber lining shall be in accordance with IS4682 Part-I.

6.1.4 Unless otherwise specified, HDPE pipes & fittings shall be in accordance to ASTM D3035/ ASTM D3261/ASTM D3350 or equivalent.

6.1.5 **Specification for FRP material**

6.1.5.1 Anticorrosion Barrier of Polymer veil having minimum thickness 2.5 mm shall be provided for chemical resistance. Mechanical resistance to be sustained by FRP.

6.1.5.2 The selected nominal pipe wall thickness will include manufacturers full under tolerance, and the specified corrosion and/or erosion allowance. The pipe thickness will be adequate to resist all external loads from thermal, mechanical and other sources in addition to the process pressure-temperature requirements. However the pipe thickness will be according to vendor's norms and standard calculations but not be lower than indicated in DIN 16965 Part 4. External FRP layer shall be protected against ultra-violet light.

6.2 Pipe

6.2.1 Calculation of pipe thickness and branch reinforcement shall be based on requirements of ASME B31.3. Proper corrosion allowance and mill tolerance shall be considered to achieve the selected thickness.

6.2.2 Unless specifically exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding. 100% radiography for all welds except for pipes for category D service.

6.2.3 Double seam 180˚ apart is allowed for sizes 36" and larger only.

6.2.4 Galvanized Pipes shall be only Hot Dip galv. to ASTM A53.

6.2.5 Hydrostatic tests shall be applied to each length of pipe and be in accordance with the requirements of ASTM A530/A530M, unless otherwise specified.

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6.2.6 Check analysis shall be carried out as per ASTM-A-530 for pipes as per ASTM-A-312 and pipe size > 8" and thickness > Sch.120, Check analysis shall also be carried out as per supplementary requirement S1 of ASTM-A-312.

6.3 **Fittings**

6.3.1 Type of fittings shall be equivalent to pipe type. All fittings shall be seamless similar to pipe specification in construction unless otherwise specified.

6.3.2 Thickness of fittings at ends to match pipe thickness for BW fittings. For reducing BW fittings having different wall thicknesses at each end, the greater one shall be employed and the ends shall be matched to suit respective thickness.

6.3.3 Unless and otherwise specified in the requisition all socket weld and screwed fittings shall be in accordance with ANSI B16.11 to the extent covered in the specification except for unions which shall be in accordance with MSS-SP-83.

6.3.4 Special fittings like Weldolet, Sockolet, Sweepolet etc. which are not covered in ANSI , MSS-SP shall be as per Manufacturer's Std. Contours of these fittings shall meet the requirements of ANSI 31.3. Manufacturer shall submit drawings/catalogues of these items along with the offer & also shall be submitted for approval before manufacturing.

6.3.5 All pipes employed for manufacturing of fittings shall be required to have undergone Hydro test to ASTM A530 to the extent so as to produce wall stress of 75% of SMYS of the material.

6.3.6 All welded fittings shall be 100% Radio-graphed by X-Ray on all welds.

6.4 **Flanges**

6.4.1 All flanges shall be of forged one piece material (seamless), and plate may not be substituted without written approval from the Purchaser.

6.4.2 All flange joints on piping system including flanges on the equipment, manholes, etc shall be tightened using Torque wrench / hydraulic bolt tensioner depending upon service criticality.

6.5 **Gaskets**

Gaskets shall be as per piping material specification/ applicable standard.

6.6 **Stud, Bolts, Nuts and Jack Screws**

6.6.1 All bolting shall be as per ASME/ANSI 818.2.1 for Studs, M/C Bolts and Jack screws, and ASME/ANSI B18.2.2 for nuts. Machine Bolts shall not be used in piping flange joint, except for Butterfly Valves, which shall be lug type, having UNC Threads in lugs facilitating opening of flanges from both sides.

6.6.2 Screw threads of bolting shall be unified coarse threads in accordance with ANSI / ASME B1.1 having Class 2A for bolts and Class2B for nuts. Screw threads in sizel-1/8 and larger shall be 8 threads per inch.

6.7 **Valves**

6.7.1 **General**

All flanged valves (except forged) shall have flanges integral with the valve body.
Valve Castings/Forgings purchased shall be from Local approved foundries/forging shop.

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Yoke material shall be at least equal to body material.
Forgings are acceptable in place of Castings but not vice-versa.
No cast iron material valves to be used in any service.
Valves in saline water (if applicable) service shall be with non ferrous trims and all wetted parts other than trims shall be epoxy coated.
Generic material of valves body, required as per process/service conditions but not specifically mentioned, shall not be lower in chemical composition than the connecting pipe material.

6.7.2 **Ball/Plug/Butterfly Valves**

Use of soft seated ball/plug/butterfly valves shall be suitably selected based on temperatures handled.

Butterfly valves shall be suitable for throttling application.

As a rule, they shall be limited to water services only. Lug type Butterfly valves shall be with threaded lugs only. Each butterfly valve shall be provided with the Bolts to be installed from both sides separately.

PN equivalent rating for Class150# valves shall be minimum PN16.

Ball valves may be used in place of gate or plug valves with the following limitations:

i) Operating conditions are within the permissible pressure - temperature range of seat materials.

ii) Fire safe type to be used for hydrocarbon services.

6.7.3 **Valve Dimensions**

Face-to-Face/End-to-End dimension shall be as per ANSI B16.10. In case the same is not covered under B16.10, the dimension shall be as per BS 2080/manufacturer standard.

Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500 mm on each side. Effort to operate shall not exceed 35 kgf at hand wheel periphery. However, failing to meet the above requirement, vendor shall offer gear operation.

Quarter-turn valves shall have "open" position indicators with limit stops.

6.7.4 **Non Destructive Testing of Valves**

6.7.4.1 Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME/ANSI B16.34.

All valve castings shall be of radiographic quality.

The minimum requirement of radiography shall be as under:

Class	Size	Qty
150	Up to 24”	5%
150	26” & above	100%
300	Up to 16”	10%
300	18” & above	100%
600 & above	All	100%

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6.7.4.2 The welds of body-to-bonnet and body-to-end flange shall be subjected to 100% NDT; both radiographic and magnetic or liquid penetrant examinations.

6.7.4.3 Beveled ends on each butt welding end valve shall be subjected 100% magnetic particle or liquid penetrant examination.

6.7.4.4 Each valve shall be pressure tested in accordance with API 598.

6.7.5 **Criteria for Isolation Valves**

Installation	Process Isolation	Drain/ Vent	Pressure Taping	Level Taping	Flow Element	Safety Valve	Control Valve
150 / 300#	Single	Single	Single	Single	Single	Single	Single
600 #	Single	Double	Double	Single	Double	Single	Single
Above 600#	Double	Double	Double	Double	Double	Double	Single

Note: For S/D & at battery limit, it will be as per process requirements.

6.8 **Traps**

Vendor shall also furnish the performance curve indicating the capacity in mass/hour at various differential pressures across the trap.

Parts subject to wear and tear shall be suitably hardened. Traps shall have integral strainers.

All traps shall be hydrostatically tested to twice the design pressure.

6.9 **Hoses**

Manufacturer shall guarantee suitability of hoses for the service and working conditions specified in the requisition, if the material is not specified in the Material Requisition for any particular service.

All hoses shall be marked with service and working pressure at minimum two ends clearly.

Hoses shall be resistant to ageing, abrasion and suitable for outdoor installations.

Complete Hose assembly shall be tested at two times the design pressure

Steam hoses shall be subject to steam resistance test.

6.10 **Expansion Joints(Metallic)**

The applicable codes are ASME B31.3 and EJMA (Expansion Joint Manufacturer's Association).

Bellows shall be formed from solution annealed sheet conforming to the latest ASTM Spec. Any longitudinal weld shall be 100% radiographed. The finished longitudinal weld must be of the same thickness and same surface finish as the parent material.

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Circumferential welds are not permitted. Bellows are to be hydraulically or expansion (punched) formed. Rolled formed bellows are not acceptable. Noticeable punch or die marks resulting from expansion operation are not acceptable.

No repairs of any kind are allowed on the bellows after forming. Deep scratches and dents are not acceptable.

The out of roundness shall be limited to ± 3mm. This is the max deviation between the max & min diameter.

The actual circumference of the welding end shall be maintained to ± 3mm of the theoretical circumference.

Apart from the usual requirements, the vendor shall also furnish

a) Design calculations to justify stiffness and fatigue life.

b) Axial, lateral stiffness, angular stiffness, effective pressure thrust area.

c) Installation/maintenance manual.

6.11 **Supports & Spring Assemblies**

The Material, Design, Manufacture and Fabrication shall be generally as per MSS-SP-58/ MSS-SP-89 and/or BS 3974.

Testing of springs shall be as per BS1726.

6.12 **Non Destructive Examination**

10% radiography of butt welds and 10%DP/ MP test of fillet welds shall be done for pipe Classes in 150# & 300#.

100% radiography on butt weld joints and 100% DP/MP for fillet welds test shall be done for Pipe Classes in 600# & above.

7.0 **PAINTING**

Painting shall be as per attachment provided elsewhere in NIT.

8.0 **WELDING**

Welding shall be as per ASME BPV- Sec. IX

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ANNEXURE – 1

TABLE OF BASIC SPAN

Pipe Size In.	SCH/Thk (in)	PIPE- VAPOR INSULATION BASIC SPAN (L)M			PIPE- LIQUID INSULATION BASIC SPAN (L)M			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		UPTO 175^{0}C	176^{0}C TO 315^{0}C	316^{0}C TO 400^{0}C	UPTO 175^{0}C	176^{0}C TO 315^{0}C	316^{0}C TO 400^{0}C	SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
3/4"	SCH 40	3.5	3.5	2.5	3.5	3.0	2.0	4.5	1.68	4.0	2.04	*3/4"*
1"	SCH 40	4.5	4.0	3.0	4.5	3.5	3.0	5.0	2.52	4.5	'3.07	1"
1-1/2"	SCH 40	5.0	5.0	4.5	5.0	4.5	3.5	6.0	4.08	5.0	.5.4	*1-1/2"*
2"	SCH 40	5.5	5.0	4.5	5.0	4.5	3.5	8.5	5.47	5.5	7.65	2"
2-112"	SCH 40	6.5	6.0	5.0	6.0	5.5	4.5	7.5	8.7	6.5	11.79	*2-112"*
3"	SCH 40	7.5	6.5	5.5	6.5	6.0	5.0	8.0	11.35	6.5	16.15	3"

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Pipe Size In.	SCH/Thk (in)	PIPE- VAPOR INSULATION BASIC SPAN (L)M			PIPE- LIQUID INSULATION BASIC SPAN (L)M			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		UPTO 175^{0}C	176^{0}C TO 315^{0}C	316^{0}C TO 400^{0}C	UPTO 175^{0}C	176^{0}C TO 315^{0}C	316^{0}C TO 400^{0}C	SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
4"	SCH 40	8.0	7.5	6.5	7.5	7.0	6.0	9.0	16.2	7.5	24.45	4"
6"	SCH 40	10.0	9.5	8.5	9.0	8.0	7.5	10.5	28.3	9.0	46.7	6"
8"	SCH 40	12.0	11.0	10.0	10.0	10.0	9.0	12.0	42.84	10.0	75.22	8"
10"	SCH 40	13.5	13.0	12.0	11.5	10.5	10.5	14.0	60.74	11.5	111.9	10"
12"	*3/8"* w	14.5	13.5	13.0	12.0	11.5	11.0	15.0	74.40	12.0	147.5	12"
14"	*318"*w	15.0-	14.5	13.5	12.0	12.0	11.5	16.0	82.5	12.5	172.05	14"
16"	*318"*w	16.0	15.5	14.5	13.0	12.5	12.0	17.0	94.5	13.0	213.15	16"
18"	*3/8"* w	17.0	16.5	15.0	13..5	13.0	12.0	18.0	106.5	13.5	258.3	18"
20"	*318"* w	18.0	17.5	16.0	14.0	13.5	12.5	19.0	118.5	14.0	307.5	20"
24"	*3/8"*w	20.0	19.0	17.5	14.5	14.5	13.0	21.0	1425	15.0	418.2	24"
3/4"	SCH 80	3.5	3.5	2.5	3.5	3.0	2.0	4..5	2.20	4.0	2.49	*3/4"*
1"	SCH 80	4.5	4.0	3.0	4.5	3.5	3.0	5.0	3.25	4.5	3.72	1"
1-112"	SCH 80	5.0	5.0	4.5	5.0	4.5	4.0	6.0	5.45	5.0	6.60	*1-112"*
2"	SCH 80	6.0	5.0	4.5	5.5	5.0	4.0	6.5	7.53	6.0	9.45	2"
2-112"	SCH 80	6.5	6.0	5.5	6.0	6.0	5.0	7.5	11.49	6.5	14.25	*2-1/2"*
3"	SCH 80	7.5	6.5	6.0	6.5	6.5	6.0	8.0	15.37	7.0	19.66	3"
4"	SCH 80	8.0	8.0	7.0	7.5	7.5	6.5	9.0	22.47	8.0	29.94	4"
6"	SCH 80	10.5	10.0	9.0	9.5	9.0	8.5	10.5	42.90	9.5	59.85	6"
8"	**½" w**	12.0	11.5	10.5	10.5	10.0	10.0	12.0	65.10	11.0	94.8	8"
10"	**½" w**	13.5	13.0	12.0	11.5	11.5	10.5	14.0	82.20	12.0	130.69	10"
12"	**½" w**	14.5	13.5	./, 3.0	12.5	12.0	11.5	15.0	98.13	13.0	168.64	12"
14"	**½" w**	15.0	14.5	13.5	13.0	12.5	12.0	16.0	108.15	13.5	194.4	14"
16"	**½" w**	16.0	15.5	15.0	13.5	13.0	13.0	17.0	124.2	14.0	240.0	16"
18"	**½" w**	17.5	17.0	.16.0	14.5	14.0	13.5	18.0	140.25	14.5	286.64	18"
20"	**½" w**	18.0	17.5	..:.17. 0.	15.0	14.5	14.0	19.0.	157.5	15.0	341.8	20"
24"	**½" w**	20.0	19.0	. 18.5	16.0	15.0	15.0	21.0	188.25	16.0	458.44	24"
1"	10S	4.0	3.5	3.0	4.0	3.0	2.5	4.5	2.08	4.0	2.7	1"
1-112"	10S	5.0	4.5	3.5	4.5	4.0	3.0	5.5	3.12	5.0	4.57	*1-112"*
2"	10S	5.0	4.5	3.5	4.5	4.0	3.0	6.0	3.94	5.5	6.33	2"
2-112"	10S	6.5	5.5	4.5	5.5	5.0	4.5	7.0	5.26	6.0	8.85	*2-1/2"*
3"	10S	7.0	6.0	5.0	6.0	5.5	5.0	7.5	6.45	6.0	11.91	3"

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Pipe Size In.	SCH/Thk (in)	PIPE- VAPOR INSULATION			PIPE- LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		BASIC SPAN (L)M			BASIC SPAN (L)M							
		UPTO 175^0 C	176^0 C TO 315^0C	316^0C TO 400^0C	UPTO 175^0 C	176^0 C TO 315^0C	316^0C TO 400^0C	SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
4"	10S	7.5	7.0	6.0	*6.p*	6.0	6.0	8.0	8.34	7.0	17.87	4"
6"	10S	9.5	9.0	8.0	8.0	7.5	7.5	10.0	13.82	8.5	34.54	6"
8"	10S	11.0	10.5	10.0	9.5	9.5	8.5	11.5	19.94	10.0	55.5	8"
10"	10S	12.5	12.0	11.0	10.5	10.0	9.5	13.0	27.S3	11.0	83.4	10"
12"	10S	14.0	13.0	12.0	11.0	11.0	10.0	14.5	36.00	11.5	114.6	12"
14"	105	14.5	14.0	13.0	11.5	11.0	11.0	15.5	41.18	11.5	132.6	14"
16"	10S	16.5	14.5	14.0	12.0	11.5	11.5	16.5	47.33	12.5	172.2	16"
IS"	10 S	16.5	15.5	14.5	12.5	12.5	11.5	17.5	53.18	13.0	212.1	18"
20"	10 S	17.5	16.5	15.5	13.0	13.0	12.0	18.5	68.50	13.0	264.5	20"
24"	10 S	19.0	18.0	17.0	14.0	13.5	12.5	20.5	94.37	14.0	376.8	24"

ANNEXURE – 2

ACCESSIBILITY FOR VALVES AND INSTRUMENTS

VALVES, INSTRUMENTS, EQUIPMENT TO BE OPERATED	CENTRELINE OF ITEM TO BE OPERATED, LOCATED LESS THAN 3.6m ABOVE GRADE, 2.75 m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM	CENTRELINE OF ITEM TO BE OPERATED, LOCATED MORE THAN 3.6m ABOVE GRADE, 2.75m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM
EXCHANGER HEADS	NIL	PLATFORM

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OPER.VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
OPER. VALVES 3" & ABOVE	PLATFORM	PLATFORM
MOTOR OPERATED VALVES	PLATFORM	PLATFORM
CONTROL VALVES	PLATFORM	PLATFORM
RELIEF VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
RELIEF VALVES 3" & ABOVE	PLATFORM	PLATFORM
BLOCK VALVES 2" & SMALLER	PORTABLE LADDER	PLATFORM
BLOCK VALVES 3" & ABOVE	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)
BATTERY LIMIT VALVES	PLATFORM	PLATFORM
PRESSURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2m HEIGHT	FIXED LADDER
TEMPERATURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2 M Ht	FIXED LADDER
SAMPLE POINTS	PLATFORM	PLATFORM
GAUGE GLASSES	FIXED LADDER	FIXED LADDER
LEVEL CONTROLLERS	PLATFORM	PLATFORM
PROCESS BLINDS AND SPACERS 2" & SMALLER	PORTABLE LADDER / PLATFORM	PLATFORM
PROCESS BLINDS AND SPACERS 3" & ABOVE	PLATFORM	PLATFORM
MANWAYS/MANHOLES	PLATFORM	PLATFORM
HANDHOLES/INSPECTION HOLES	PLATFORM	PLATFORM
NOZZLES (process}	PLATFORM	PLATFORM
VESSEL VENTS	PORTABLE LADDER	FIXED LADDER
LINE DRAINS & VENTS	PORTABLE LADDER	PORTABLE LADDER
ORIFICE FLANGES	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)

NOTE -1:-BLOCK VALVES / ORIFICE FLANGES, IF LOCATED, WITH CENTRE LINES GREATER THAN 2 METER FROM THE OPERATING FLOOR / OPERATING PLATFORM, SHALL BE PROVIDED WITH PORTABLE PLATFORM OR CHAIN FOR OPERATION.

NOTE -2 : PLATFORM SHALL BE PROVIDED FOR THE ORIFICE FLANGES ON PIPE RACK.

ANNEXURE-3

MAXIMUM SPACING OF GUIDES FOR VERTICAL & HORIZONTAL PIPES

NOM PIPE SIZE IN INCHES	VERTICALSPACING METRES	HORIZONTAL SPACING METRES
1	6.0	6.0

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1 ½	6.0	6.0
2	6.0	6.0
3	8.0	12.0
4	8.0	12.0
6	8.0	12.0
8	8.0	12.0
10	12.0	18.0
12	12.0	18.0
14	12.0	18.0
16	12.0	18.0
18	12.0	18.0
20	16.0	18.0
24	16.0	18.0
26 & ABOVE	16.0	18.0

NOTES:-

1. These spacings may be varied to suit column spacing of rack. The above spacing is for straight runs of pipe & does not include guides which are used for control of thermal movements, as decided by stress group.

2. The guide spacings given in the above table are indicative only.

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ANNEXURE – 4

CLEARANCES

Minimum clearances for piping, equipment, structures, platforms, and supports shall be in accordance with the following table:

Item	Description	
Roads	Headroom for primary access roads wherever heavy duty crane movement is required.	9 M
	Headroom for primary access roads	7.5 M
	Width of primary access roads excluding shoulders.	Refer Civil
	Headroom for secondary roads	5 M
	Width of secondary roads excluding shoulders.	Refer Civil
	Clearance from edge of road shoulders to platforms, equipment, pipe associated with equipment, or similar features.	1.5 M**
Maintenance Aisles at Grade	Horizontal clearances for equipment maintenance by hydraulic crane (12t capacity)	3 M
	Vertical clearance for equipment maintenance by hydraulic crane (12t capacity)	3.6 M
	Horizontal clearance for fork lift and similar equipment (2500 kgs capacity)	2.4 M
	Vertical clearance for fork lift and similar equipment (2500 kgs capacity)	2.4 M
	Horizontal clearances for equipment maintenance by portable manual equipment (A-frames, hand trucks, dollies or similar equipment)	1 M
	Vertical clearances for equipment maintenance by portable manual equipment (A-frames, hand trucks, dollies or similar equipment)	2.4 M
Walkways	Horizontal clearance (not necessarily in a straight line)	750 mm
	Headroom (except for hand wheels)	2.2 M
Platforms	Minimum width	1200mm

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Item	Description	
Platforms	Headroom from stairwell treads.	2.2 M
	Minimum clearance around any obstruction on the platform.	500 mm
	Headroom	2.2 M
	Maximum vertical distance between platforms	6 M
	Minimum toe clearance behind a ladder.	210 mm
	Minimum handrail clearance.	100 mm
Equipment	Minimum maintenance space required between flanges of exchangers or other equipment arranged in pairs.	500 mm
	Minimum maintenance space required for structural members or pipe.	300 mm
	Clearance from edge of road shoulder (the extreme projection)	1.5 M
Fired Equipment	Horizontal clearance from hydrocarbon equipment (shell to shell)	15 M
	Exception: Reactors or equipment in alloy systems shall be located for the most economical piping arrangement.	
	Clearance from edge of road to heater shell.	3 M
Valve Hand wheels	Clearance between the outside of the hand wheel and any obstruction.	25 mm*
Pipe (aboveground)	Clearance between the outside diameter of the flange and the outside diameter of pipe insulation.	25 mm*
	Clearance between the outside diameter of the pipe, flange or insulation and a structural member.	50 mm*
	Clearance between the outside diameter of the flange and the outside diameter of bare pipe.	25 mm*
	Minimum distance from underside of pipe to grade or platform.	300 mm
Control Valve Arrangement	Centreline of control valve above grade or platform.	450 mm
	Minimum centreline of control valve from face of column or wall.	600 mm

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Item	Description	
	Where process conditions require steam or hydrocarbon vapours to be discharged to atmosphere at a safe location, the tail pipe shall terminate as below:	
	Distance above nearest operating platform.	3 M
	Within radius of nearest operating platform.	7.5 M
** Verify conformance with local regulations. * With full consideration of thermal movements		

ANNEXURE – 5

DESIGN PHILOSOPHY FOR STRESS ANALYSIS

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1.0 PURPOSE

This design basis deals with the subject of Identification of Stress Critical pipelines and preparation of Critical line list. This procedure also defines the minimum requirements for performing stress analysis, design and location of spring, support and level of system

Analysis with the extent of documentation required for flexibility analysis.

Purpose of piping stress analysis is to ensure:

Safety of piping and piping components

Safety of connected equipment and supporting structure

Piping deflections are within the limits

2.0 SCOPE

This specification covers the supply of engineering services to perform a complete piping and pipe support analysis for piping systems.

3.0 DEFINITIONS

3.1 Critical Lines / Critical Line List

Critical lines or Critical Line List as referred to in this procedure relates to Piping Stress Critical Lines and does not include or refer to process critical lines.

3.2 Stress Analysis Temperature

Stress Analysis Temperature refers to either “Maximum Operating Temperature” or “Steam-out temperature / hot nitrogen purging temperature” of the lines under review whichever is higher. In absence of the above values, it refers to the Design Temperature of the line under review. The Line List should be strictly followed in obtaining the above temperature values.

3.3 Design Pressure

Design Pressure refers to the “Design Pressure” of the line under review as indicated on the Line List. Design Pressure is as defined in clause 301.2 of ASME B 31.3.

3.4 Temperature For Flexibility Analysis

The temperature to be used for the flexibility analysis shall be taken as the maximum / minimum temperature which the pipe will see under any combination of different normal / abnormal operating conditions, as defined in clause 301.3 of ASME B 31.3. Where piping is exposed to direct sunlight, solar radiation temperature of 70 ^{0}C is considered in establishing the maximum temperature of piping. Even, for non-critical piping exposed to direct sunlight on pipe rack or elsewhere, expansion loops, wherever essential, are provided to take care of pipe movements resulting from piping skin temperature due to solar radiation.

In general, unless there is a difference of more than 50 ^{0}C between working Temperature and the design temperature, the design temperature should be taken as Flexibility temperature. Ambient Temperature shall be considered as 21ºC the assumed piping installation temperature. The displacement stress range from this installation temperature to the minimum recorded ambient temperature of 0^{0} C being less than the same from installation temperature to the maximum operating temperature of hot piping in most cases, the later governs as per clause 319.2.3 of ASME B 31.3

The temperature under fire condition is normally not considered for flexibility analysis.

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1.0 SELECTION

A line is selected and listed as a Critical Line provided it falls under any one of the categories defined below and is intended to include the special requirements of Piping Stress Engineer. It is hence defined as any line for which a flexibility review is required or where pipe supporting is deemed to be critical and needs review by a Stress Engineer. Line DN 50 and smaller is inherently flexible and is not normally considered critical unless built from non-metallic or non-ferrous materials. In case of more than one applicable line size, larger line size governs. Lines are classified as Level I, Level II & Level III according to the criteria listed below.

4.1 Level I [Extensive Analysis]

Piping systems or lines that meet Annexure 5A criteria are deemed to be extremely critical. These lines are categorized as Level I and require careful study to ensure that the code compliance is met and the accurate determination of nozzle and support loads have been made. The routing of these lines is very important. They must be analyzed in the early stages of the project during routing studies so that the impact on the location of less critical lines is minimized. Normally, these systems require computer analysis. The general intent of the Level I analysis criteria is to study lines size DN 80 & larger that are affected by thermal expansion and / or a dynamic response, and that can't be evaluated by a weight-only analysis (as per the general intent of Level II analysis). Consideration has to be given to other special situations that augment the Level I general intent guidelines such as for lines that are excessively large and stiff.

4.2 Level II [Normal Analysis]

Piping systems or lines that meet Annexure 5B criteria are moderately critical lines and often do not require such rigorous study to ensure code compliance or accurate determination of nozzle and support loads. These lines are smaller in size and operate at lower temperatures (in general) than the lines to be analyzed using Level I Criteria. Normally, only manual calculations, by use of appropriate monographs are required for analysis of these systems.

4.3 Level III [Minimum Analysis]

All lines that are outside the purview of Level I or Level II criteria will be classified as level III and shall be reviewed by the Piping Engineer during the squad check of the piping drawings and or fabrication Iso's. If more detailed analysis is required, the Piping Engineer may change the level of analysis during the squad check as applicable. Normally, only visual analysis is required for these systems.

4.4 Lines Deemed To Be Support Critical

Lines subjected to two-phase flow.

Cross country pipelines.

Lines with pipe thickness Sch 160 or greater.

Lines DN 400 and above with pipe thickness less than 8 mm.

Lines DN 250 and above with corrosion allowance 3 mm and above.

Lines with high concentrated loads such as heavy valves or fittings etc.

Lines downstream of Relief Valve / letdown Control Valves / bursting (rupture) discs.

Connecting to vent or flare systems or discharging to atmosphere

Liquid Blow down Lines.

Lined pipes

Non-metallic pipes

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4.5 Lines Needing Dynamic Analysis

There are instances where in the frequency of the applied load is comparable to the natural frequency of the piping system. Such systems tend to store the energy and release it according to certain scientific laws. Such a system is dynamic in nature and the study of the response of such a system is referred to as “Dynamic Analysis”. Examples of such kind of systems are Relief Valve discharge lines, water hammer and surge in pipe lines, two phase flow in pipelines, reciprocating pumps and compressor piping, submarine piping etc.

4.6 Special Piping

Special piping forming part of reformer tubes, heater internal piping, etc. are treated as proprietary piping and nozzle loading at the Interface connections are to be co-ordinate with vendor.

5.0 RELATED DOCUMENTATION

5.1 Critical Line List Format.

The critical line list shall be prepared from the project line list document by inserting following relevant fields such as Stress level, stress package no., stress analysis temperature, support critical nature of the line, dynamic loadings, steam out / purge temperature etc.

The list shall reflect analysis status of line that includes its input received date from design & output handover date to design and specific remark if any.

5.2 Lines Affecting the Flexibility of Critical Lines

Non-critical Lines found to affect the flexibility of critical lines which have not been included during the initial review are subsequently added to the Critical Line List.

Non-critical Lines on which advice may be sought by the Lead Piping Engineer are not normally entered into the Critical Line List but covered verbally, or by a memorandum if a record is required.

6.0 PIPE STRESS ANALYSIS AND SUPPORTING

6.1 Piping system shall be properly supported taking in to account of the following points:

Piping stress analysis shall follow ASME B 31.3 and shall be complete to prevent overstressing of the pipe during operating conditions with wind and seismic loadings. During sustained, occasional (wind and seismic) & thermal expansion loading on piping,

The material allowable stresses shall be as per ASME B 31.3 for ASTM materials. For DIN material specifications the allowable stress values shall be calculated as per ASME

B 31.3 clause 302.3.2(d), wherein yield strength and ultimate strength values at temperature shall be taken from DIN material standards. For DIN material specifications, the other material properties viz. elastic modulus, density, coefficient of thermal expansion shall be taken from the respective DIN material standards.

6.2 Analysis shall include, but not be limited to the following; thermal, dead weight, internal pressure, wind and seismic, and a combination of these based on ASME B 31.3.

6.3 Piping shall be designed in accordance with the Indian Standard criteria for earthquake resistance design for structures IS: 1893 for seismic zone-IV (refer project design basis). As a minimum, two (2) orthogonal horizontal components and a vertical component of ground

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motion will be considered in the seismic analysis. For American standard, loading applied to piping would be in accordance with uniform building code (UBC).

The equivalent horizontal static force method shall apply in general .The contractor shall also carry out special designs and provisions as necessary for piping which is considered to be dynamically sensitive to earthquake.

Seismic analysis to be performed for lines equal to and above 12".Seismic load case shall ALGEBRIC combination with operating cases.

Heavy rigid masses like valves shall be restrained in their vicinity to avoid large seismic movements. Guides or snubbers as the case may be used for this purpose.

Horizontal seismic coefficient (Ah) to be considered as 0.26 and Vertical (Av) to be considered as 0.173.

6.4 Wind loads shall be calculated in accordance with IS-875 code of practice for structural safety of building – Loading Standards for Indian code requirement using basic wind speed as mentioned in project design basis. For American standard, wind load in accordance to ASCE 07 shall be calculated. Reduction in velocity pressure due to apparent shielding afforded by buildings and structure or terrain shall not be permitted.

Wind loading shall only be considered for lines larger than 20" OD at elevation higher than 10m above grade. Displacements due to wind and earthquake should be limited to 50 mm.

Both the horizontal directions shall be analyzed independently in two cases

+X, -X, +Z, -Z

Wind and seismic loading will not occur simultaneously.

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6.5 Analysis of all nozzles loading on vessels within the piping boundaries is covered in this specification. Nozzle analysis shall follow the guidelines of ASME Section VIII, Division 1, and WRC 297 & 107 (latest editions). Nozzle stresses shall fall within the allowable per ASME.

6.6 Piping system shall have sufficient flexibility to avoid leakage at joints. Flanged joints imposed by external moments may be analyzed and the stresses evaluated by using the methods of equivalent pressure given in the ASME boiler and pressure code section III. Flange leakage shall be assessed as per “Pressure Equivalent Method”. In case of Failure in Pressure Equivalent Method, the Flanges shall be checked for leakage using Caesar Flange leakage Module. Flange leakage shall be assessed for all PSV flanges, Control valve flanges, High Pressure lines, and all steam lines. Also for equipment flanges where loads are high.

6.7 All forces on connections to equipment shall not exceed maximum allowable as specified by equipment vendor.

6.8 Pipe supports loads shall be based on the maximum loads determined by the piping analysis. Adjustments shall be made to the piping system and model such that the pipe supports loads are within a reasonable uniformity throughout the piping system.

6.9 Various Load cases built in Caesar II to check stress in piping system are listed below.

1	WW+HP	HYD	
2	W+T1+P1	OPE	
3	W+T2+P1	OPE	
4	W+T1+P1+U1	OPE	
5	W+T1+P1+U2	OPE	
6	W+T1+P1+U3	OPE	
7	W+T1+P1-U1	OPE	
8	W+T1+P1-U2	OPE	
9	W+T1+P1-U3	OPE	
10	W+T1+P1+WIN1	OPE	
11	W+T1+P1+WIN2	OPE	
12	W+P1	SUS	
13	W+P2	SUS	
14	L2-L12	EXP	
15	L3-L12	EXP	
16	L4-L2	OCC	
17	L5-L2	OCC	
18	L6-L2	OCC	
19	L7-L2	OCC	
20	L8-L2	OCC	
21	L9-L2	OCC	
22	L10-L2	OCC	
23	L11-L2	OCC	
24	L12+L16	OCC	

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25	L12+L17	OCC	
26	L12+L18	OCC	
27	L12+L19	OCC	
28	L12+L20	OCC	
29	L12+21	OCC	
30	L12+L22	OCC	
31	L12+L23	OCC	

P1- Maximum Operating Pressure W- Dead Weight

T1- Maximum Operating Temperature WW- Water Weight

P2- Design Pressure WIN- Wind Load

T2- Design Temperature U- Uniform Load

HP- Hydro test Pressure L2- Load case

SUS, EXP, OCC, HYD, OPE- Various load types, viz., sustained, occasional, hydro test, operating etc.

7.0 CODES AND STANDARDS

The following codes and standards shall apply in the design and analysis of the piping systems covered under this specification:

Allowable Stress ASME B 31.3

Piping ASME B 31.3

Nozzle Loadings PMC's Standard, WRC297/107(Welding Research Council) /

Allowable Vendor

Wind Analysis ASCE 7 – 98

8.0 SOFTWARE USED

The package used shall be latest version of CEASER-II 5.2. Only one of these packages shall be used for the project & not a combination of the above packages.

9.0 DOCUMENT REQUIREMENT

9.1 A written report shall be submitted on the piping and equipment analysis. The report shall include all pertinent information that shall include but not be limited to the following.

Location and type of pipe supports with loads and movements.

Location of expansion joints and movements.

Vertical and horizontal loads including moments at all support points.

Vertical and horizontal loads including moments on all equipment and

Vessel connections.

Caesar II analysis report, which shall include as a minimum, restraint forces, movements and stresses for all load cases. For flange connection, loaded with high bending moments and/or tensile forces in piping or at equipment connections, Caesar II flange leakage report will be provided. For piping analyzed, if subjected to hydro test, hydro test load case will be made in Caesar II to check for loading under hydro test & the requirement of any additional temporary supports for hydro test.

Detailed nodal model used for the stress analysis

All assumptions and limitations applied to the analysis

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9.2 All dimensions and analysis shall be performed using metric and SI units.

9.3 The final report / stress package folder shall be submitted as follows:

1. Front sheet with Approval status
2. Isometrics with following information
   - Node numbers
   - Type of supports selected by stress engineer
   - Springs / Bellows data required for procurement like spring rate, loads, tide/untied information and SM (special material) identification.
   - Maximum Expansion and sustain stress values with node number
   - Nozzle/Anchors initial movements and piping imposed forces and moments on the same
   - Support loads (anchors, guides or rest) only they are above limit (The limit is defined in the beginning of the project in consultation with civil)
   - Design and maximum operating conditions
   - Coordinate axis system considered for inputs
   - Dimensional details for piping designer to locate supports in piping model/layout.
3. Checklist as per Work instructions.
4. Following outputs
   - Load Cases
   - Restraint summary
   - Spring hanger report, if any
5. Stress critical line list extract for the lines analysed
6. Piping material specifications
7. Equipment drawings with allowable loads, if available
8. PID

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ANNEXURE-5A

CRITERIA FOR IDENTIFING EXTREMELY CRITICAL LINES (LEVEL I)

Temperature T, Degree C	Pipe Diameter DN (mm)	Piping Material	Service and Description
All	All	All	Piping which will undergo hydraulic shock, auto-ignition or is in service.
All	DN≥80	All	Category M (Lethal) fluid service per ASME B31.3 (No cyclic service).
All	DN≥80	All	Piping which is openly exposed to winds> 75 mph.
T<-29	DN≥80	Carbon Steel	All Services.
T<-45	DN≥80	All	All Services
T≥65	DN≥80	Non-Metallic	All Services
T≥65	DN≥80	All	Lines with pressure≥900 psig.
T≥150	DN≥80	All	All Services
ALL	DN≥400	All	All Services.
T≥260	ALL	ALL	ALL Services.
-29≥T≥65 OR -7≥T≥50	DN≥80 DN≥100	All	Piping connected to nozzle load sensitive equipment, air-cooled exchangers and rotating equipment (see note 1).
ALL	ALL	All	Lines requiring expansion joints or flexible connectors.
DELTA T≥27 (NOTE 2)	DN≥80	All	Jacketed piping.
-29≥T≥65	DN≥100	All	Internally lined pipe (except glass).
All	ALL	All	Glass lined piping.
All	DN≥80	All	Differential Tank Settlement (Upto 3 supports from nozzle).
-40≥T≥80 -29≥T≥70	DN≥100 DN≥200	Metallic Metallic	Underground Piping

NOTES:

1) Load sensitive equipment include fired heaters, reformers, lined vessels with lining of brittle material, non-ferrous equipments, graphite heat exchangers, plate & frame heat exchangers, etc.
2) This criterion is not to be applied to auxiliary piping such as seal flush; bearing cooling, etc. delta T refers to the differential temperature between the process piping and jacket.

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ANNEXURE-5B

CRITERIA FOR IDENTIFING MODERATELY CRITICAL LINES (LEVEL II)

Temperature T, Degree C	Pipe Diameter DN (mm)	Piping Material	Service and Description
All	DN<80	All	Lethal fluid service.
T<-29	DN<80	Carbon Steel	All Services.
T<-46	DN<80	All	All Services
95<T<150	80<DN<200	All	All Services
T≥65	DN<80	Non-Metallic	All Services
T≥65	DN<80	All	All Services
T≥65	DN<80	All	Lines with pressure≥900 psig.
T≥150	DN<80	All	All Services
ALL	200<DN<400	All	All Services.
T≥260	ALL	ALL	ALL Services.
ALL	ALL	ALL	Piping connected to nozzle load sensitive equipment, air-cooled exchangers and rotating equipment (see note 1 of Table-1).
DELTA≥27(NOTE 2 of Table-1)	DN<80	All	Jacketed piping.
All	ALL	All	Internally lined pipe (except glass).
All	DN<80	All	Differential Tank Settlement (Upto 3 supports from nozzle).
All	ALL	All	Underground Piping
All	ALL	All	Piping connected to pressure relief
All	ALL	All	Close coupled interconnecting piping between equipment with differential movement greater than 6.0mm.

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DESIGN SPECIFICATION- ELECTRICAL

FOR

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
P1	12.01.21	12.01.21	FOR CLIENT'S REVIEW	RK	SKB	SKB

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CONTENT

SECTION NUMBER	DESCRIPTION
1.0	Scope
2.0	Basis of Design
3.0	Area Classification
4.0	System details & Utilisation Voltage
5.0	Equipment Specification
6.0	Cabling System
7.0	Earthing and Lightning Protection
8.0	Spares
9.0	Testing & Inspection
10.0	Vendor List
11.0	Installation, Testing and Commissioning
12.0	Coordination With Other Bidders
13.0	Deviations
14.0	Bill of Quantity
15.0	Drawing & Documents
	Specification sheets & Technical particulars (Blank) of various Electrical Equipments

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LIST OF ATTACHMENTS

Technical Specification No.	Description
PC183-TS-0810	Induction Motors
PC183-TS-0815	Cables
PC183-TS-0816	Prefabricated Ladder Type Cable Racks
PC183-TS-0817	Local Control Stations
ES: 8028	Electrical Erection Testing & Commissioning

Electrical Sketches	Description
PC183-PDS:E 510	Details of Concrete Cable Trench
PC183-PDS:E 511	Cable Rack Arrangement in Trenches
PC183-PDS:E 516	Typical Arrangement of Cables buried in slit
PC183-PDS:E 530	Pre-Fabricated Cable Tray Straight Run
PC183-PDS:E 531	Pre-Fabricated Cable Tray Horizontal Tee
PC183-PDS:E 532	Pre-Fabricated Cable Tray Horizontal Cross
PC183-PDS:E 533	Pre-Fabricated Cable Tray 900 Horizontal Bends
PC183-PDS:E 534	Pre-Fabricated Cable Tray 900 Vertical Bend Bending Rad. 1000 mm
PC183-PDS:E 535	Pre-Fabricated Cable Tray 900 Vertical Bend Bending Radius 600 mm
PC183-PDS:E 536	Pre-Fabricated Cable Tray Coupling Arrangement
PC183-PDS:E 537	Pre-Fabricated Cable Tray Fixing Arrangement
PC183-PDS:E 601	General Notes on Earthing and Lightning Protection
PC183-PDS:E 603	Arrangement of Connections of Earth Conductors
PC183-PDS:E 604	Typical Details of Connection in Earth Pit
PC183-PDS:E 605	Earth Pit Details
PC183-PDS:E 606	Typical Arrangement of Earthing for Motor and Start Stop Push Button
PC183-PDS:E 610	3.8 M GI Electrode for Earthing
PC183-PDS:E 611	GI/Al Accessories for Earth Electrode
PC183-PDS:E 612	Typical Earthing Arrangement across Pipe Joint/Valves
PC183-PDS:E 613	Earthing of storage tank & vessel
PC183-PDS:E 615	GI Earth Bus
PC183-PDS:E 617	Typical Arrangement for Neutral and Equipment Earthing

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1.0 SCOPE

1.1 This scope of works covers the complete design, engineering, manufacture, testing at works, supply of all electrical equipment, , dispatch, storage, handling, erection, testing and commissioning at site of complete electrical system required for setting up Instrument/Plant air Package for Coal Based Ammonia Urea Fertilizer Plant at Talcher.

1.2 This specification shall be read in conjunction with all drawing and documents, specification sheets attached and other relevant reference as specified therein.

1.3 The minimum scope of work shall include supply, Installation, Testing & commissioning of the following:-

- Motors
- Local control stations for motors
- HV Motor Soft starter
- Earthing & Lightning Protection
- Electric Heater & control panel for Air dryer system
- Cables
- Any other items not specified but required for the safe and complete operation of the system.

1.4 The Owner shall make the following provisions in their respective switch boards/panels for the Instrument/Plant air package bidder: (bidder to indicate power requirement of respective feeders)

- 3 nos. of 11KV ± 10%,50Hz ± 5%, Breaker feeder (Normal/Emergency) for main motor.
- 2 nos. of 415V ± 10%, 50Hz ± 5%, Power Outlets (Normal) for Heater control panel.
- 1 nos. of 415V ± 10%, 50Hz ± 5%, Motor starter feeder for HP Air Compressor
- 3 nos. of 415V ± 10%, 50Hz ± 5%, Motor starter feeder for Lube oil pumps motor, if required.
- One no AC 115V ± 10%, 50 Hz ± 2%, UPS supply

1.5 The owner shall supply & lay all power and control cables from their switchboards to the following load terminals of instrument Air package.

a) Main Compressor Motor
b) Lube oil pump motor
c) Heater Control Panel Incomer only
d) UPS DB incomer

1.6 Heater control panel shall be installed in Offsite & utilities substation of respective plants.

1.7 Bidder shall provide the UPS distribution board with all necessary control & monitoring component

1.8 Bidder to furnish load list, heater rating, maximum power consumption, UPS power requirement and no & rating of feeders required to be provided by owner with bid.

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1.9 This specification contains specifications of the major equipments to indicate the basic requirement and serve as a guideline. However, it shall be the responsibility of the bidder to offer a complete electrical system of superior quality, even if the specifications of certain items are not given. The items for which technical specifications are not indicated herein shall be of IS/IEC standard and specifications of these shall be subject to owner's approval in case of order.

1.10 The bidder shall offer the best and proven most suitable type of energy efficient equipments manufactured by well known reputed manufacturers having proven performance track record of minimum 2 years , as per vendor list appended in this bid package. However for the sake of standardization of the electrical equipment and material used for the electrical installation, the bidder shall supply all items of a particular type or make for whole plant of the same manufacturing company for ease of maintenance and less spares inventory.

1.11 Bidder shall furnish construction power requirement during offer stage.

1.12 Mandatory Electrical spares for operation and maintenance of the electrical system shall be provided by the bidder as listed elsewhere in this bid package.

1.13 The scope shall also include obtaining all required statutory approval from all statutory bodies. Bidder shall carry out all modifications/alterations required by local statutory bodies.

2.0 BASIS OF DESIGN

2.1 General

a) System shall be designed considering following aspects in general :-

- To facilitate inspection, cleaning and maintenance with the care to safety in operation and personnel protection.
- To minimise turnaround times.
- To provide safety, reliability and flexibility of service.
- Adequate provision for future extension and modification.
- Maximum interchangeability of equipment.
- Desired level of operator interface to achieve coordinated efficient and fail-safe operation, data logging and maintenance of the equipment.
- To decide redundancy, stand by, spares and overload capacities to achieve desired reliability and flexibility requirement.
- To get cost effective and techno commercially proven technology. Economic considerations shall cover capital and running costs and an assessment of the reliability and consequent availability of the system.

b) All the electrical consumers in the bidder's scope shall be correctly identified and listed to have complete details of rating, efficiency, power factor, operating duty cycle (continuous, intermittent, standby), category of supply required (emergency, normal, critical) etc.

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c) Bidder while performing design and engineering activities shall adhere to following guidelines.

i) If any equipment is not covered in this specification but required for successful operation of the Plant, Bidder shall prepare additional specifications for equipment or bulk material taking reference of Indian/International Codes and good engineering practices prevalent in fertilizer industry and obtain owner's approval for the same.

ii) The standard drawings attached with this package define the basic system design and distribution philosophy for the package. This is for guidance purpose only. Bidder shall develop detailed drawings and submit for owner's approval.

iii) Bidders shall consider any other requirement which is not covered in this bid package, but required for successful operation of the plants without any extra cost and time implications.

iv) As applicable, Bidder shall obtain approval from all statutory authorities as applicable such as Central Electricity Authority (CEA)/Electrical Inspectorate, CPCB etc.

v) Bidder shall assist in Liaison and in all interface coordination with bidders of other units of project at construction, erection, testing & commissioning phase for any common facility.

vi) Equipment specification sheet/data sheets for all equipment shall be submitted by the bidder based on relevant codes and specifications. Data sheet shall contain all technical data and information which are essential for review and technical acceptability, detailed engineering, installation, testing, repair and maintenance, replacement etc.

vii) Bidder shall clearly specify in their purchase specifications, the requirement of conducting other special tests/type tests, which are envisaged for various electrical equipment, which shall have no impact on cost and time.

viii) Bidder shall visit the site and collect all relevant information required for designing of complete system before quoting.

ix) All the electrical equipments shall be of proven design and technology.

2.2 Statutory requirement Codes and Standards

The design and the installation shall be in accordance with established codes, good engineering practices and shall conform to the statutory regulations applicable in the country. Bidder shall be responsible for obtaining necessary approvals from the statutory authorities e.g. Electrical Inspectorate, PESO as applicable before commissioning of electrical facilities. The CEA clearance for electrical equipment and components as applicable thereof shall be obtained by the bidder.

The relevant Indian Standards are:-

a) IS 13118 - High Voltage Alternating Current Circuit Breakers.

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b) IS 10118 - Selection, Installation, Maintenance of Switch gear and Control gear.

c) IS 3247 - Metal enclosed Switch gear & Control gear for voltage above 1000V but not exceeding 11000V.

d) IS 3156 - Voltage Transformer.

e) IS 2705 - Current Transformer.

f) S 11353 - Marking and arrangement of switch gear bus bars.

g) IS 13947 - Degree of protection provided by enclosures for Switch gear and Control gear.

h) IS 3202 - Climate proofing of electrical equipment.

i) IS 13703 - HRC cartridge fuse links up to 650V.

j) IS 7098 - XLPE FRLS PVC Cable.

k) IS 1248 - Direct acting Electrical indicating instruments.

l) IS 722 - Integrating instruments.

m) IS 3231/IS 3842 - Electrical Relays for Power System Protection.

n) IS 1271, IS 2584 IS 2260 - Insulating materials.

o) IS 2099 - Bushing for alternating voltages above 1000V.

2.3 Latest version of main codes, standards and statutory regulations shall be considered as minimum requirements are as given below:

- Indian Standard Specification
- Indian Electricity Act
- Indian Electricity Rules
- International Electro-Technical Commission
- The Factory Act
- API Standards/IEEE
- Statutory requirement of Govt of Odisha and Govt. of India.
- Guidelines of Insurance Companies Association.
- Any other applicable Rules/Acts/Regulations.

2.4 **Site Conditions**

The equipment shall be designed for the following site conditions:-

A.	Maximum ambient temperature	46°C
B.	Minimum ambient temperature	1°C
C.	Design Reference Temperature	50°C
D.	Relative Humidity	100%
E.	Altitude above mean sea level	< 1000 M
F.	Atmospheric pollution	Dusty due to presence of urea dust & coal

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dust and corrosive due to presence of vapours of Ammonia.

3.0 AREA CLASSIFICATION

3.1 The hazardous zones if applicable, within the project area shall be classified according to the requirement of IS/IEC. The bidder shall furnish area classification drawing.

3.2 All electrical equipments if installed in the areas classified as hazardous shall be certified for such use by a recognized international certifying authority such as CIMFR, Dhanbad /PESO, Nagpur etc.

4.0 SYSTEM DETAILS AND UTILIZATION VOLTAGES

4.1 The various voltage levels for distribution shall be as follows:

Distribution Equipment	a) 11KV ± 10%, 50 Hz ± 5%, 3 Ph, 3 W with resistance earthed neutral b) 3.3KV ± 10%, 50 Hz ± 5%, 3 Ph, 3 W with resistance earthed neutral c) 415V ± 10%, 50 Hz ± 5%, 3Ph, 4W solidly grounded neutral. d) 415V ± 10%, 3 Ph, 4 W/240V ± 10%, 1Ph, 2W, 50Hz± 5% solidly grounded neutral.
Combined variation in voltage & frequency	± 10%
Control Supply for: - HV motors - 415V motors	240V±10%, 50Hz±5%, 1Ph(For contactor controlled motors) DC 110V±5% (For breaker controlled HV/LV motors)
Instrumentation and Automation, DCS & auxiliaries	AC 115V ± 5%, 50 Hz ± 2% 1Ph, 2W
Voltage Ratings	
Motors up to 150 KW Motors above 150 KW up to 1000 KW - Motors above 1000 KW Heaters	415V, 3 Ph AC 3.3 KV, 3 Ph AC 11 KV, 3 Ph AC 415V, 3 Ph AC

4.2 Fault Level:

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11kV : 750 MVA

3.3KV: 150 MVA

415V: 36 MVA

5.0 EQUIPMENT SPECIFICATION

5.1 General Constructional Features

5.1.1 The equipment shall be suitable for tropical climate conditions and corrosive and saline atmosphere.

All electrical equipment accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

Fine mesh screen of corrosion resistant material shall be furnish on all ventilating openings to prevent entry of insects.

5.1.2 The equipment excluding motors to be installed in outdoor plant area shall have IP 65 enclosure. Motors of plant shall have IP 55 enclosure.

5.1.3 4 mm FRP (fire retardant and UV stabilized) canopies shall be provided for all outdoor equipments like motors, starters, LCS, SDBs, sw. sockets etc. PA stations shall have acoustic hood.

5.1.4 All mating surfaces shall be properly machined. Neoprene gaskets shall be used for dust and weather proofing. The gaskets shall be without any discontinuity.

5.1.5 Only non-hygroscopic materials shall be used for insulation. All insulation shall be specially impregnated to withstand ambient conditions and atmospheric pollution.

5.1.6 All live parts shall be adequately protected to prevent inadvertent or accidental contact.

5.1.7 All external hardware's of diameter less than 8mm shall be of stainless steel and those of diameter 8mm and above shall be of mild steel cadmium plated or zinc passivated.

5.1.8 Earthing terminals complete with sockets and identification marks shall be provided on the enclosure of all electrical equipment. The number of terminals shall be two for equipment rated above 250 V and one for those rated 250 V and below.

5.1.9 All equipment shall be provided with stainless steel nameplates containing the particulars as per relevant IS/IEC along with the description and Code Nos. of equipment.

5.1.10 All the electrical equipment shall be provided with weather proof heavy duty double compression type Stainless steel cable glands, proper Cu/Al crimping lugs and terminal blocks suitable for the cable sizes required.

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5.1.11 All detailed drawings, equipment sizing make & type of equipment shall be subject to approval of TFL/PDIL.

5.1.12 The rating of the electrical equipment wherever specified in the bid package are the minimum ratings. The bidder shall check & revise the ratings (up words) if required based on actual load and furnish the calculations for owner's review / approval.

5.1.13 All motors and heaters shall have provisions for control from local as well as owner's PLC/DCS. Cables from local control panel to owner's remote control panel shall be provided by owner. However bidder shall coordinate with owner's other vendor for proper identification & termination of those cables.

5.1.14 The outside surface of all equipment shall be painted after suitable pre-treatment by the application of two coats of anti-rust and corrosion resisting epoxy based paint.

5.2 MOTOR AND DRIVE COORDINATION

Bidder shall be responsible for this drive coordination, in particular to following: -

a. To ensure that main drive motor and Soft starter are both adequately rated and sized for the drive requirements stated and to recommend alternative configurations where appropriate (like separate cooling fan, choice of starting current limit etc.)

b. To arrange where necessary for testing with Soft starter unit to confirm compliance with requirements of load, noise, vibration, temperature rise, etc.

c. To recommend any additional motor protection arrangements, this may be necessary to prevent motor winding damage.

d. Bidder to note that the minimum acceleration time of the induction motor shall meet driven equipment requirements.

e. Bidder to ensure that the main drive electric motor shall be capable of operating continuously at any of the load conditions within the range. Bidder shall state derating factor, if any, for the motor.

f. Bidder to provide Rotor heat withstands calculation during starting and 100% locked rotor condition.

g. Motor shall be suitable for starting on soft starter as well as on DOL.

h. Following data for Motor and Driven equipment shall be informed by motor / driven equipment vendor:

- Super imposed Motor/Load Torque Speed characteristic.
- Motor rated kW - Motor/Load GD2 value.
- Motor current speed curve.
- Motor thermal withstand curve.

5.3 Motors

a) All the motors shall be 3 Phase, squirrel cage induction type.

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b) The rating of motors shall be selected from the sizes as recommended in relevant Indian Standard/IEC.

c) All electric motors shall meet the standard IEC 60034-30-1.

d) The margin between the installed power and absorbed power shall be as recommended by the driven machine supplier but shall not be less than the following:-

Motor Rating	Margin above Driven M/C Absorbed Power
Less than 22 KW	25%
22W to 55 KW	15%
75 KW and above	10%

e) The duty cycle of motors shall match the driven machine requirement.

f) All motors rated for up to 150KW shall be suitable for 415V.

g) The motors shall have maximum rated duty as per relevant Indian Standard/IEC.

h) All LV motors shall be TEFC type as per relevant Indian Standards/IEC while HV motors shall be TEFC/CACA type.. All motors shall be Class-F insulated with temperature rise limited to that of Class-B.

i) Normally the motors shall be suitable for DOL starting.

j) All motors 30 KW and above shall have space heater provision.

k) All HV motors shall have winding, hot air and bearing RTDs. All the temperature signals shall be terminated to DCS as well as LMS.

l) All LV motors shall be energy efficient type having efficiency class of 'IE3' as per IS 12615: 2011 and high power factor type.

m) The starting current i.e. breakaway current of 415V Motors shall not exceed the values indicated in IS: 12615. Also there shall be no further positive tolerance on the values of breakaway current.

n) The starting current of 11 KV & 3.3 KV motors shall not exceed 550% of FLC. No positive tolerance is acceptable over 550% FLC.

o) Type test certificate of similar motor for use in specified hazardous area (if applicable) shall be furnished.

p) The duty cycle of the motor shall meet the process and driven machine requirement.

q) In case of 11 KV & 3.3 KV motor, the terminal box shall be suitably designed for proper termination of XLPE insulated Aluminium cables through heat shrink termination kit.

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r) The mechanical parameters such as duty, mounting type, shaft extension, direction of rotation, starting torque requirements etc. shall be adequate for the application. Sleeve or anti friction type bearings shall be used. Generally, all motors, except for application such as crane, hoist, turbine/engine starting, shall be designed for continuous duty with rated load.

s) Motor rated above 30 KW shall have on line greasing provision and for motor rated above 45 KW, grease outlet feature shall be provided.

t) All HV motors shall have safety factor not less than 1.1.

u) Motors rated 1000 kW and above shall have suitable measures to prevent flow of shaft currents and shall have 2 sets (i.e. 6 nos.) of PS class CTs for differential protection.

v) The motor shall be capable of withstanding the electro dynamic stress and heating imposed if it is started along with the driven equipment at voltage of 110% of the rated value.

w) During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment, while running, shall successfully ride over such period without affecting system performance.

x) The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage. The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.

y) Shaft voltage shall be limited to 200 mV.

z) For all other specifications, refer PC183-TS-0810.

5.4 Heaters

5.4.1 Heater Elements

a) Tubular heater elements (in U-shaped Tubular-type) shall be constructed from 80/20 Ni/Cr resistance wire surrounded by compacted magnesium oxide powder and the outer sheath of the heating elements shall be of Incoloy 800, and of thickness suitable to provide corrosion/erosion resistance suitable for the application with stainless steel nipple of suitable rating to obtain the desired output temperature.

b) The elements shall be designed to minimize peak inrush current. The bidder shall state the inrush current in the specification sheet and technical particulars.

c) Heater elements shall be protected against over-temperature by means of at least two temperature sensing devices. The temperature sensing devices may be either thermocouple elements/ PT 100 devices. The devices shall be clamped or welded to

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the sheaths of different elements and located in an area of highest anticipated sheath temperature. Temperature sensing wiring shall be brought out to a separate terminal box with the same degree of protection as the main terminal box.

d) The heating elements shall be grouped into sections for controlling purpose. The heater controls shall be generally stepped by connecting or disconnecting group of elements to the supply system to maintain constant output temperature with the air flow quantity varying as indicated elsewhere.

5.4.2 **Heater Terminal Box**

a) Suitable terminal box shall be provided with terminals for external connections.

b) The installation of a sun cover/canopy (FRP material) over the terminal box shall be provided to avoid direct rain/ solar radiation on terminal box.

c) The Bidder shall consider the need for a space heater in the terminal box. If installed, the space heater shall be connected between phase and neutral, controlled from the power and control assembly and sized so that the maximum allowable air temperature inside the terminal box does not exceeded.

d) The heater elements shall be star or delta connected depending upon the size of the load and shall be specified by the Bidder. Neutral linking for star connected loads shall be done inside the terminal box.

e) This shall be provided with double compression Stainless steel type cable glands & cable lugs.

f) This shall be dust proof and weather proof and shall be suitable for outdoor use. The box shall be suitably thermal insulated from the shell to avoid the effect of temperature on the terminals. Also to ensure the above air inlet to be kept near the terminal box.

g) Protection against corrosion shall be ensured by using epoxy paints. All nuts and bolts used shall be either cadmium plated or zinc passivated.

h) The terminal box should have adequate space for cabling, tightening etc.

5.5 **Heater Control Panel (Thyristor Controlled)**

a) The control panel shall be suitable for outdoor installation having IP-55 protection and shall be fabricated out of 2.5 mm thick CRCA sheet steel.

b) Thyristors shall have peak inverse voltage rating of approximately 2.5 times the absolute maximum root-mean-square line voltage.

c) Thyristor protection shall include metal-oxide varistor over-voltage limiters suitable for the peak inverse voltage rating of the thyristor, current limiting fuses designed for semiconductor protection, and dv/dt protection networks.

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d) Thyristor power controllers including equipment protection devices for use on 415V, 3ph, 50Hz heaters. The controllers shall operate in the zero-crossover mode (to minimize generation of radio frequency interference) with a controlled output power range down to 3% (single-cycle control). The outlet air temperature shall be use in both the automatic and manual mode.

e) Burst firing control shall not be utilized; single cycling control should be used instead. The load should be configured in either four-wire star or delta, with three-leg control using Thyristor pairs adopted for the star configuration and two-leg control for the delta configuration.

f) In order to enhance reliable operation, the thyristors employed shall be sized so that the maximum current flowing through them shall not exceed 70 % of their continuous rated current.

g) Thyristor protection shall include over-current protection by means of ultra-rapid fuses and voltage transient suppressers. Where deemed necessary by the bidder, di/dt limiting reactors and dv/dt protection networks shall be provided.

h) Manual/auto selection for output power/heat control shall be provided. In auto-mode, power output shall be controlled by the controller and the outlet air temperature shall be user-adjustable. In the manual mode the power output shall be controlled via a keypad/multi-turn potentiometer. The auto/manual mode for power output shall selectable via selector switch. A ramp unit shall prevent the heater being switched directly to full load. This potentiometer and associated switch shall be designed to be tamper-proof.

i) Each heater panel shall have 1 no. incoming voltmeter and ammeter with selector switch and Output voltmeter and current meter with selector switch. KWH meter shall also be provided. A transducer (4-20 mA) for remote current display shall be provided for each phase.

j) The following alarm and protection functions shall be provided as a minimum:

- Heater Earth Leakage Trip (in output side).
- Control Panel Fan Failure Alarm.
- Thyristor Over-Temperature Alarm.
- Thyristor Over-Temperature Trip.
- Heater Element Over-Temperature Alarm.
- Heater Element Over-Temperature Trip.
- A ramp unit shall be provided in order to protect the heater or power system from damage that could occur as a result of Electrical, Mechanical and thermal shocks caused by direct full-load switching.
- Lamp indication shall be provided for heater on/off, alarms (like Heater Over Temperature, fluid Over Temperature, etc). Selector switch shall be provided in panel for selection of fluid temperature RTD input.
- Overload protection by means of ultra rapid fuses.

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k) The control panel shall house the following components for control of electrical items-

- Auto manual switch
- Equipment selection switch
- ON-OFF indicating lamp for different sections of heater bank.

l) Each panel incomer shall comprise of one incoming MCCB/ACB of suitable rating.

m) The incoming MCCB/ACB shall have mechanical interlocking feature with the panel door for preventing the door to open until the MCCB/ACB is in off position.

n) Contactors used shall comply with IS/IEC 60947-4-1 and be rated for uninterrupted duty and intermittent duty of at least Class 1.

o) Ultra-rapid fast acting semiconductor fuse shall be provided for the protection of the thyristors.

p) In the incomer, one voltmeter with selector & one ammeter with selector switch along with suitable CT shall be provided.

q) Different outgoing heater section circuits shall be controlled by using Thyristor, MCCB and contactors.

r) An ammeter with selector switch shall be provided for measuring the current in different outgoing sections.

s) For external cable connections, terminal blocks with 20% spares terminals and suitable number of cable glands shall be provided. At least two nos kick holes shall be provided for future provision of cable glands.

t) The panel wiring shall be made by not less than 2.5 mm^2 copper wire.

u) The design of control panel and cabinet/enclosure should provide sufficient component spacing to allow cooling by natural air circulation. In addition forced draft fans shall be installed with 100% redundancy. The control of the fans shall be such that the fans operate only when the heater is energized.

v) All live terminals of equipments and components mounted within the enclosure having a maximum (peak) voltage of greater than 24V shall be shrouded or otherwise protected by barriers to a degree of protection of at least IP 20. Barriers shall be of rigid insulating material, yet transparent to enable the screened components to be identified.

w) A tinned copper earth bus bar of adequate size, with a suitable number of earthing bolts or screws, shall be provided. The enclosure shall also be fitted with two (02) nos. external earth points for connection to the main earth grid.

x) All components of the panels for example MCCB, thyristor, contactors etc. shall conform to relevant Indian standards and make of the components shall be indicated. Make shall be subject to TFL/PDIL approval.

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y) Two nos of earth terminals with lugs shall be provided on the terminal box and on the control panels.

5.6 HV MOTOR SOFT STARTER

5.6.1 The motor starter shall be Flux compensated magnetic amplifier (FCMA) type with bypass breaker/contactor.

5.6.2 The motor starter shall be designed to restrict starting current upto 2.0 times of motor full load current (inclusive of any tolerance) at Supply bus.

5.6.3 The Soft Starter shall be installed either on the Line side or neutral side of HV Induction Motor.

5.6.4 The Motor Starter shall be so rated as to allow at least three consecutive starts from cold or two hot starts per hour.

5.6.5 Soft Starter shall be air-cooled.

5.6.6 The motor shall be started with the soft starter in line for smooth and stepless acceleration by switching ON the main upstream vacuum circuit breaker (VCB). Bypass breaker shall remain open during this starting operation till the rated speed is achieved. When motor rated speed is reached, the bypass breaker shall be switched ON to bypass the soft Starter. The upstream main breaker will be controlled to start or stop the motor.

5.6.7 Soft starter may be taken in line with the motor, in case of reacceleration of motor due to power interruptions for a period of 1.5 sec.

5.6.8 The actual rating of soft Starter (ampere rating, start duration, no. of consecutive starts etc) to start the motor shall be worked out by vendor based on final motor / driven equipment details

5.6.9 Motor Starter shall be provided with suitably rated ammeter to indicate the motor current during starting. Indicating instruments (96 x 96 mm) shall be switchboard type, with 240o scale, anti-glare glass and accuracy class of ± 2% full scale. Meter shall have zero adjuster on the front.

5.6.10 Soft Starter Vendor shall check for suitability of starter for actual measured test results of Job Motors like Locked rotor test data, values of R1X1, R2X2 & RnXn etc. and revalidate Soft Starting Characteristics for seamless System Integration. Measured values obtained from Motor Vendor and further revalidation of Soft Starter Characteristics shall be submitted to the purchaser for review/approval.

5.6.11 Insulation of FCMA shall be H class insulation with temperature rise limit up to class B.

5.6.12 It shall have Close loop monitoring of temperature and current of FCMA modules.

5.6.13 Soft Starter panel shall have adequate provision for terminating Incoming & Outgoing 3.3KV grade (UE), Aluminum conductor, XLPE insulated, armoured cables with

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Raychem Heat shrinkable termination kit / gland / lugs etc. The preliminary cable size for the Soft Starter is 3C X 300mm2.

5.6.14 Vendor to ensure that the reduced starting voltage is suitable to develop necessary starting torque requirement to start and accerlerate the driven equipment. The motor starter shall be so designed that the minimum possible supply voltage drop shall occur keeping in mind the accelerating torque requirement of the drive motor and the load. Vendor shall suitably co-ordinate with the motor vendor.

5.6.15 All rear panel doors shall be provided with handle for ease of maintenance.

5.6.16 The Flux Compensated Magnetic Amplifier (FCMA) shall work on the principle of unsaturated core in the working zone and shall not lead to generation of harmonics. The Motor Starter shall have Silicon steel core. The windings of the Motor Starters shall be with insulation class F Max. Temperature rise of winding shall be limited to that of class B. The FCMA Motor Starters should be suitable for indoor mounting.

5.6.17 FCMA Motor Starter shall not contain any active electronic components

5.6.18 FCMA starter shall be provided with current dependent ramp up with adjustable bypass time.

5.6.19 Following interlocks and indications shall be provided on FCMA motor starter.

5.6.20 FCMA temperature high

5.6.21 Bypass supervision trip

5.6.22 Analogue voltmeter and Ammeter (input) of 96mmm X 96mm, class 1.0

5.6.23 Indication lamps for Breaker ON/OFF, spring charging, trip and etc…

5.6.24 Remote Indications of above mentioned signals shall be provided.

5.6.25 The soft starter unit shall be provided with inherent self protection like surge suppressors against transient over voltages introduced by input power supply. Short circuits, open circuits, earth fault protection provided by upstream Motor protection relay.

5.6.26 Soft starter (PCMU) shall be provided with RS 485 port to communication with SCADA. DCS interface is not envisaged from soft starter.

5.6.27 FCMA starter shall be provided with appropriate number of taps on FCMA to take care of changes in TS curve of Motor/ Compressor after manufacturing.

5.6.28 Sensing/ isolating Locked rotor condition during starting shall be implemented through Rotor heat monitoring system.

5.7 CONSTRUCTIONAL REQUIREMENTS FOR HV SOFT STARTER

5.6.1 Soft Starter panel shall be totally enclosed, dust proof, vermin proof, floor mounted, self supporting, metal-clad, free standing cubicle type. If necessary louvers with wire

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mesh shall be provided for ventilation. The enclosure shall have complete protection against approach to live parts or contact with internal moving parts as per IS: 3427.

5.6.2 Degree of protection shall not be less than IP 5X.

5.6.3 Soft Starter cubicle shall comprise rigidly welded structural members, partition covers between panels, Rear/side cover, and partition for LT chamber of 2.0mm CRCA. All front doors of LT chambers and front door for VCB chamber shall be of 2.5mm CRCA. All Shutter, Top Cover / explosion cover shall be 2.0mm CRCA. All metal enclosures shall be earthed effectively.

5.6.4 Soft Starter design shall be fully compartmentalized. Access to operating mechanism shall be so arranged as not to expose high voltage circuits. Cubicles shall be provided with hinged doors on the front with facility for padlocking the door handles.

5.6.5 Instruments, meters & control devices shall be flush mounted on the hinged door of the metering compartment located in the front portion of Soft Starter panel.

5.6.6 Main Functioning parts of the Soft Starter shall be accessible for maintenance from the front side.

5.6.7 Soft Starter Panel shall be fitted with a removable gland plate of minimum 4mm thick aluminum sheet at the both of the cubicle for fixing glands for power & control cable termination. Where Single core power cables are used, the gland plate shall be of non-magnetic material.

5.6.8 Soft Starter Panel shall be designed for cable entry from the bottom. Ample space shall be provided to terminate incoming and outgoing power cables at Soft Starter panel. In case standard panel depth cannot accommodate the specified no. of cables, a rear extension panel of uniform height shall be provided.

5.6.9 The Soft Starter panels shall be supplied complete with supports for clamping outgoing and incoming cables. The minimum clearance between cable gland and terminal lugs shall not be less than 600mm.

5.6.10 All insulating material shall be flame resistant, non hygroscopic and anti tracking.

5.6.11 All hardware used inside the panels shall be zinc passivated or cadmium plated.

5.6.12 Independent pressure release flaps shall be provided for each compartment of Soft Starter panel.

5.8 **Following interlocks shall be provided for Soft Starter Cubicle.**

5.6.1 The draw out carriage of Bypass Circuit Breaker/contactor shall have three positions “Service”. “Test” & “Draw out”. Withdrawal or engagement of Bypass Circuit Breaker shall not be possible unless it is in the open position.

5.6.2 Interlock of soft starter with upstream breaker shall be provided.

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5.6.3 Operation of Bypass circuit Breaker/contactor shall not be possible unless it is fully in “service”, “test” or fully drawn out position. It shall not be possible to close the Breaker electrically in service position, unless the auxiliary circuit connection between the fixed and moving portion are made.

5.6.4 Circuit breaker cubicle shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary contacts when the breaker is withdrawn.

5.6.5 Closing and tripping circuits shall be interlocked electrically with equipment and the vendor shall arrange for the necessary wiring terminals.

5.9 **Local Control Stations**

a) Local Control Stations shall be provided for all motors for testing and maintenance purpose when the selection is made is "LOCAL MODE" Operation. The essential features of the LCS shall be as given below:

b) Local control stations for breaker controlled HV and LV motors shall be provided with T-N-C switch, Ready to Start Indication, ON indication, Space Heater ON Indication, Trip Indication, Local-OFF-Remote Control switch and ammeter. Moreover, space heater ON indication lamp, trip indication lamp shall also be provided at the switchgear panel.

c) Local control stations for contactor controlled LV motors shall be provided with start/stop push buttons, ammeters and Space Heater ON Indication (for motor rated 30KW and above), ON indication, Local-Remote switch (as required) for the motors having rating 5.5 KW and above. If required from process point of view, ammeter shall be provided for motors below 5.5 KW also.

d) Provision for pad locking in OFF position shall be provided.

e) The enclosure for LCS shall be of die cast LM-6 Aluminium alloy in weather proof construction with minimum IP65 enclosure. As an alternative to cast Aluminium, Fibre glass enclosure is also acceptable. A rain-hood shall also be offered. It shall be made of 14 gauge Aluminium sheet bent to shape. In case of fibre glass enclosure, these can be made of fibre glass. The enclosure shall be suitable for mounting on wall or on steel structure.4 Nos. holes suitable for 12mm bolts shall be provided outside the enclosure for fixing the control stations.

f) All the components shall be mounted on a base plate inside the enclosure. Necessary actuating system for push buttons/control switches, non yellowing acrylic/glass cover for ammeter and indication lamps shall be provided on the front cover. No wiring shall be carried out on the front cover.

g) Each control station shall be provided with minimum 2 mm thick stainless steel name plates indicating the code number and description of the equipment controlled by it.

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Similar labels shall be provided for all indication lamps, push buttons, control switches. The name plate and label shall be fixed with screws only.

h) The ammeter shall be flush mounting, moving iron spring controlled type, of accuracy class 1.5 with square face of minimum size 72mmx72mm having scale range 0-240^{O}. The ammeter for motor shall be provided with uniform scale up to CT primary current and compressed end scale up to the 6 times the C.T. primary current. Adjustable red pointer shall be provided to indicate the full load current of the motors. Zero adjusters shall be provided for operation from the front of the meter. All ammeters shall be operated through 1 Amp. CTs only.

i) Local/Remote (Lockable) selector switch shall be single pole stay put type having three positions LOCAL-OFF-REMOTE. Provision shall be made to padlock the switch in the OFF position

j) The LCS shall have provisions as indicated in specification sheet of LCS.

k) Emergency stop button shall be provided near compressor which shall be directly connected to switchgear panel.

l) Each element for start and stop shall be provided with 1NO + 1NC contact. The push button construction shall be such to avoid mal-operation due to vibrations.

m) All components shall be completely wired up to terminal block and also provided with earthing terminals.

n) Inscriptions on corrosion resistant metal strips giving drive description, mechanism number and functional requirement shall be provided.

o) All spare hole to be plugged with suitable metal plugs.

p) For all other specifications, refer PC183-TS-0817.

5.10 CABLE TRAYS

a) The cable trays and risers shall be of aluminium alloy / GI prefabricated ladder type as per attached PC183-TS-0816 & drawing nos. PDS: E 530 to 537.

b) Aluminium alloy / GI prefabricated cable trays and its accessories such as coupler plates, risers, bends etc. shall be fabricated from 3.0 mm thick mild steel galvanised sheet. The rung spacing shall be 300 mm. The cable trays accessories shall be hot dip galvanized after fabrication. The galvanizing shall be uniform, clean, smooth, continuous and free from pores. The amount of zinc deposit at any point shall not be less than 610 gm per sq. metre.

c) G.I. prefabricated cable trays and its accessories such as coupler plates, risers, bends etc. shall be fabricated from 3.0 mm thick M.S. sheets. The rung spacing shall be 300 mm. And side channel shall be of 100x15mm. The cable trays and their accessories shall be hot dip galvanized after fabrication. The galvanizing shall be uniform, clean, smooth, continuous and free from pores. The amount of zinc deposit at any point shall not be less than 610 gm per Sq. metre.

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d) The cable trays shall be designed to avoid any sharp bend in the cables. The corners of the cable trays shall have a smooth circular radius, as required.

e) The finished tray and accessories shall be free from sharp edges and corners, burrs and unevenness.

f) Each straight length and bed shall be supplied with two coupling plates fitted at each side channel at one end. The couplings plates shall be complete with bolts, nuts and washers fitted at other four holes for fixing to adjoining member. Coupling plate shall be designed to permit longitudinal adjustment up to ±10 mm and skew up to 10˚.

6.0 CABLING SYSTEM

a) All LT power cables shall be with stranded aluminium/copper conductor with XLPE insulation, PVC inner sheathed, armoured, PVC outer sheathed FRLS type and construction as per IS:7098 (Part 1). Power cables with conductor size up to and including 16 sq. mm shall be with copper conductor, conductor size 35 sq. mm and above shall be aluminium conductor.

b) All control cables shall be with 2.5 sq. mm, stranded copper conductor with XLPE insulation, PVC inner sheathed FRLS type, armoured, PVC outer sheathed FRLS type and construction as per IS: 7098 (Part 1). Control cables shall be twisted pair or shielded wherever electro-magnetic/electrostatic interference is anticipated.

c) All control cables shall have 20 % spare cores. All cores shall be identified with numerical core numbers printed on core in addition to colour coding.

d) All cables shall be armoured and shall have extruded inner and outer sheath.

e) Cables shall be designed to carry the rated current after allowing the temperature and group derating factors.

f) The cables shall generally be laid on overhead cable racks/trays. These racks/trays shall have proper supporting arrangement. Pipe racks, supports where available, shall also be used as cable rack to support the cable trays.

g) The cable trays and risers shall generally be of G.I. prefabricated ladder type of 150/300/450mm wide tray.

h) For multi-tier trays, the minimum gap between the two tiers and above top tier shall be 300 mm.

i) In paved areas near the equipment, if required, the cables may be laid in buried G.I. pipes. Where cables rise up from under-ground, protection by means of G.I. pipe upto a minimum height of 300 mm above grade level shall be provided with open ends sealed.

j) All cables shall have their run No. (as per cable schedule) marked close to their termination as well as intermediate positions for proper identification.

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k) All cables shall be terminated at the equipment by means of double compression type Stainless steel cable glands and crimping lugs. For XLPE cable elongated cable lugs shall be used. All cable entries shall be from bottom only.

l) Cables shall be sized considering the following factors.

- Maximum continuous load current
- Voltage drop
- System voltage
- Laying conditions
- Derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc as applicable, shall be taken into account

7.0 EARTHING AND LIGHTNING PROTECTION

7.1 Earthing

a) Complete earthing installation shall be done as per IS:3043, IEEE-80, IE Rules and IEC recommendations.

b) Complete earthing grid & Earth Pit/Lightning Earth Pit for the package plant area and its connection at two points to Owner's earthing grid shall be in bidder's scope.

c) Earthing grid/ring shall comprise of buried GI earth strips and GI pipes/electrodes.

d) Individual electrical equipment shall be earthed by GI strip / GI wire / Al cable. Earth buses shall be provided in plants for earthing groups of electrical / non- electrical equipment to earthing grid / rings. Minimum size of earth conductor shall be 6mm^2 Al cable.

e) All equipment rated above 250V shall have two external earth connections and those rated up to 250V shall have one external earth connection. However, for lighting fixtures, earthing shall be provided through armouring of cables.

f) Inter-connecting pits having an earth bus in an enclosed brick chamber without earth electrode shall be provided in the common underground earthing grid for convenience of taking earth conductors inside the plants.

g) All steel structures, tanks, vessels, pipes, pipe joints, valves etc. shall be earthed against static charge accumulation by 50x6 mm GI strip. The no. of earth connections shall be as follows :

Equipment having diameter	Hazardous area	Non hazardous area
30 M	2	2
More than 30 M	3	2

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h) Wherever process equipment are mounted on steel structures, the structures shall be earthed instead of earthing the individual equipment.

i) The pipe structures shall be earthed at not more than 25M apart.

j) Minimum sizes of earth conductors to be used shall be as given below. However, vendor to calculate the actual size :-

Sl. No.	Equipment	GI conductor size	Al conductor size
1.	LV switch board, control panels	50mmx6mm	150 sq. mm
2.	Motors rated 75 KW and above	50mmx6mm	150 sq. mm
3.	Motors rated 30 KW to less than 75 KW	35mmx6mm	95 sq. mm
4.	Motors rated 5.5 KW to less than 30 KW	25mmx6mm	25 sq. mm
5.	Motors less than 5.5 KW	8 SWG	6 sq. mm
6.	All minor equipment rated 250V & below	10 SWG	6 sq. mm

All GI conductors shall meet the galvanizing requirement as per IS.

7.2 **Lightning Protection**

a) All structure shall be protected against lightning strokes by suitable lightning protection system to be designed and installed as per latest edition of IS:62305.

b) The number of down conductors shall be minimum two.

c) Bare metallic structures shall not have any air termination rods at the top. The earth connections shall be welded to the bottom of structure at 300 mm above floor level. However, tall metallic columns with insulation at top shall be provided with air termination rods. Separate earth electrodes shall be provided for each down conductor of lightning protection. However, these shall be inter-connected with the other electrodes in main grid.

Down conductor/ earth connection sizes shall be of minimum 50 x 6 mm GI.

8.0 SPARES

8.1 Commissioning Spares:

Bidder to recommend list of commissioning spares as required. The commissioning spares shall form an integral part of the scope of supply. Vendor shall be responsible for the quantification of the commissioning spares for the smooth start up of the plant/package system. Item wise list of commissioning spares with recommended quantity shall be furnished for information. The same shall be Part of Quoted Price.

8.2 Mandatory/Insurance spares

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Contractor shall supply Mandatory / Insurance spares for all equipments as per Section 5.0: Spare Parts of this bid package. The same shall be Part Quoted Price.

8.3 2 Years Bidder's Recommended Operational Spares (Other than Mandatory/ Insurance spare)

Bidder shall recommend 2 years Operational Spares (other than mandatory/ Insurance spare) for all the equipment (item-wise) with recommended quantity and unit price. The item-wise price shall be with validity of 2 Years.

17.1 All spare parts shall be identical to the parts used in the equipments.

17.2 Any other spare parts or special tools not specified, but required, shall also be quoted along with the offer.

9.0 TESTING & INSPECTION

9.1 Testing of electrical equipments shall be done in accordance with relevant IEC/BIS codes.

9.2 The bidder shall submit the certificates of type tests performed on identical equipment as evidence of the compliance of the equipment with the type tests.

9.3 All equipment shall be routine tested as per relevant Indian/ International Standard Specifications.

9.4 All the routine/acceptance tests shall be performed at the manufacturer's works in the presence of owner's representative.

9.5 The owner or their representative shall be allowed to visit the manufacturing works for stage inspection during manufacturing stage.

9.6 The bidder shall intimate the owner 4 weeks in advance of the tests and submit the detailed schedule of tests.

9.7 In addition, the equipment shall be inspected at site for final acceptance.

9.8 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.

9.9 The owner's inspection shall, however, not absolve the bidder from his responsibility for making good any defect which may be noticed subsequently.

10.0 VENDOR LIST

10.1 Make of all electrical equipment shall be as per Section 15.0: Vendor List attached with this bid package.

10.2 Any other vendor shall be subject to Owner/Consultant's approval.

10.3 Bidder shall indicate the make of all the equipments in their offer.

10.4 Any other item for which vendors are not mentioned in NIT, Bidder shall furnish list of proven suppliers with PTR subject to Owner's/ Consultant's approval during detailed engineering. Document(PTR) shall be in English language only.

11.0 INSTALLATION, TESTING AND COMMISSIONING

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11.1 The bidder shall undertake installation of all electrical equipment in accordance with latest code of practices, in conformity with recommendation of the respective equipment manufacturers, drawings approved by the owner or owner's representative, direction of engineer-in-charge, statutory regulations and to the entire satisfaction of the owner.

11.2 The bidder shall arrange all the necessary erection tools and tackles, testing and measuring instruments and shall supply the required erection materials including structural steel.

11.3 Bidder shall furnish field inspection and test data sheets for all equipments for owner's approval.

11.4 The bidder shall obtain the necessary certificate of compliance/completion certificate with test results from statutory authorities as required. All necessary drawings and test certificates as required by them shall be furnished by the vendor.

11.5 At least following tests shall be specifically conducted before commissioning in presence of owner's representative. All the test results shall be recorded and submitted to the owner.

a) Insulation Test

b) Continuity Test

c) High Voltage Test

d) Simulation Test

e) Earth Resistance Test

12.0 COORDINATION WITH OTHER BIDDERS

12.1 The successful vendor shall coordinate with Owner's other vendors and shall freely exchange all technical information required for this purpose.

13.0 DEVIATIONS

Deviations, if any from this standard (clause wise) shall be clearly indicated in the offer with reasons thereof. In the absence of any such deviation the compliance to the clauses shall be deemed automatically.

14.0 BILL OF QUANTITY

The bidder shall furnish the Bill of quantity for all electrical items duly signed and stamped. Bill of quantity shall only be for our information. Actual quantity as required shall be supplied by the bidder

15.0 DRAWING & DOCUMENTS

15.1 The bidder shall submit the documents for electrical equipments as per the drawing and documentation list enclosed with this bid package.

15.2 All drawings and documents shall have the following descriptions written boldly:

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--Name of Client.

--Name of Consultant i.e. PDIL.

--Enquiry / Order Number with Project/Plant name.

--Equipment Code No. and Description.

15.3 At the time of handing over of the installation, the vendor shall supply as built drawings taking into consideration the actual execution carried out at site.

15.4 The vendor shall furnish a Bill of Materials covered in their offer. However, this shall be treated for information only and shall not absolve them from his obligation to supply the required items and quantities for making the plant complete as per intent of the specification.

15.5 Drawings and documents shall be submitted as per Drawing & Document list enclosed with NIT in number of copies as indicated below:

i) With bid: 4

ii) For approval: 4

iii) For information:4

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SPECIFICATION SHEET
INDUCTION MOTOR

PROJECT: Coal Based Fertilizer Plant			**PLANT** : Instrument/Plant air		
ISSUED FOR : PROPOSAL ☐	ENQUIRY ☒	ORDER ☐	FINAL ☐		
GENERAL					
Item No. :			Ref. Stds. : IS ☒	IEC ☒	
Quantity :			Encl. Docs. : ☐		
Description : 3 Phase Induction Motor			Make : As per enclosed vendor list		
Code No. :			Maker's Type. :		
TESTS: Routine ☒	Type ☐	Others ☐			
SERVICE CONDITIONS					
SYSTEM DETAILS			**AMBIENT CONDITION**		
Rated Voltage with ± % : 11/ 3.3KV /415V ± 10%			Temp. Max./Min./Design Ref. 46^0 C / 1^0 C / 50^0 C		
No. of phases : 3			Relative Humidity 100%	Alt. above sea : <1000 M	
Rated Frequency With ± % : 50 Hz ± 5%			**ATMOSPHERIC POLLUTION**	Dusts : Urea / Coal	
Combined V & F variation : ± 10%				Vapour: Ammonia	
Fault Level : 750 MVA (Min) / 150 (Min) /36 MVA (Min)			**Area**	Safe ☐	Hazardous ☐
Space Heater Supply : 240 V AC			**Haz. Area class:** Zone:	Temp. class :	Encl. Gr.
Low Voltage Heating Supply :			**Location** : Indoor ☐	Outdoor ☒	
INSTRUMENT CONTACT RATING	A.C. :		**COOLING WATER**		
	D.C. :		Inlet Press. : Kg/sq.m.	Inlet Temp. ^{O}C	
Aux. Motor Supply :			Fauling Factor :	Outlet Temp. ^{O}C	
BASIC DATA					
RATING & DUTY			**DRIVEN M/C DATA**		
Rated Output :			Type :		
Syn. Speed :			Make :		
Duty :			Absorbed Power :		
Rotor Type : Squirrel Cage			Coupling :		
Starting Method : DOL			Torque-Starting / Max. :		
Max I Start/I Rated : Refer Technical Specification			GD^2 at Motor Speed :		
Min. V Start at Terms : 80% of rated voltage			Thrust - Radial / Axial :		
Min. Starting Torque at V_R :			Addl. Data :		
EXECUTION			**ACCESSORIES**		
Degree of Protection : IP-55			Foundation Bolt ☒	Space Heater ☒	
Addl. Degree of Protection :			Lifting Eye Bolt ☒	Drain Plug ☒	
Mounting Arrangement :			Cable Glands ☒	Cable Lugs ☒	
Direction of Rotation : Bi-directional			Diff. C.T.s ☐	C.W. Flow Indicator ☐	
Insulation Class: 'F' with temp. rise limited to 'B'			**RTDs for HT Motor** Wdgs. ☒	Hot Air ☐	Bearings ☒
Cooling Method : IC411			**Thermometer For HT Motor**	Hot Air ☐	Bearings ☒
Stator Connection : Delta			**Earthing Terminals**	On Body ☒	In T.B. ☒
CABLING DATA			Name Plate : ☒	Addl. name plate : ☒	
Power cable : Shall be indicated ion the receipt of motor rating			Rain Protecting Hood : ☒	Thermistor ☐	
Heater cable :3x2.5 Sq.mm (Cu) subject to Cl.no.7.1 of ES: 8102.			**SPARE PARTS**		
C.T. cable :			Required ☒	For Period of 2 Years	
R.T.D. cable :			Bearings (DE & NDE) : ☒	Cooling Fan ☒	
Alarm cable :			Grease Nipple & Plug : ☒	Fan cover ☒	
CABLE GLAND	Type : Double Compression		RTD for: winding and bearing ☒		
	Material : Stainless Steel		Terminal Plate complete with stud & shorting link : ☒		
			Inner & Outer covers for DE & NDE bearing: ☒		
PAINTING	Type : Epoxy		Terminal Block/Terminal Plate ☒		
	Shade : 631 of IS : 5				

Note: 1) All unfiled data shall be filled by LSTK Contractor and submitted for Owner's review/approval.
2) Space heater shall be provided for all motors rated 30KW & Above.
3) Power cables shall be of 11/3.3KV/1.1KV grade XLPE-A-FRLS and space heater cables shall be of 1.1 KV grade XLPE-A-FRLS PVC.

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TECHNICAL PARTICULARS (INDUCTION MOTOR)

PROJECT: Coal Based Fertilizer Plant			**PLANT** : Instrument/Plant air air
ISSUED FOR : PROPOSAL ☐	ENQUIRY ☒	ORDER ☐	FINAL ☐
GENERAL			
Item No.			
Quantity			
Description			
Code No.			
Ref. Standard			
Make			
Maker's Type			
ELECTRICAL DATA			
Rated Output			
Rated Voltage			
No. of Starts - Hot / Cold			
Torque - Starting / Pull Up / Pull Out			
Starting Time at min. V Start (Hot / Cold)			
Safe Stall Time at V_R / $1.1V_R$			
Stator Time Constant			
Temp. Rise at Full Load - Wdg. / Hot Air / Brg.			
TEMP. RISE OF STATOR / ROTOR AFTER	3 Starts From Cold		
	2 Starts From Hot		
Current at FL / 0.85 FL			
Efficiency at FL / 0.85 FL			
Speed at FL / 0.85 FL			
Power Factor at FL / 0.85 FL / Start			
Push Pull Voltage withstand Capacity			
Max. V dip for 1 sec. / 10 sec. / 60 sec.			
Losses - Fixed / Copper / Total			
Space Heater Rating			
Suitable for Low Voltage Heating			
C.T. Ratio & Accuracy Class			
C.T. V_K & Imag. at V_K / 2			
Heating Time Constant			
Cooling Time Constant			
MECHANICAL DATA			
Frame Size / Ref. Dimensional Drg.			
Weight - Stator / Rotor / Total			
Heaviest Weight to be Lifted			
Rotor GD^2 in Kgm^2			
REACTION AT SUPPORTS FOR	S/C Condition		
	Starting Condition		
	Running Condition		
	Push Pull Condition		
Max. Vibration Limit			
Max. Noise Level			
Suitable for Outdoor Use		Yes ☐	No ☐
Suitable for Bi-directional Rotation		Yes ☐	No ☐
Material of Insulation			
Treatment of Insulation			
Winding Coils Replaceable at Site			
Type & Material of Fan			
Material & Thickness of Cooler Tube			
Cooling Water Required in M^3 / hr			
Lubrication Type			
Lubricant Specn.			
Interval of Lubrication			
BEARING NOS. & TYPE	DE		
	NDE		
	GUIDE		
On Line Lubrication			
Type & Rating of Main Cable Box			
No. of Cable Glands in Control Cable Box			

Note: Technical Particulars shall be filled by the LSTK Contractor and submitted for Approval **after order** in line with NIT/Contract requirement before commencement of manufacturing.

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SPECIFICATION SHEET (LOCAL CONTROL STATION)

PROJECT: Coal Based Fertilizer Plant — **PLANT** : Instrument/Plant air

ISSUED FOR : PROPOSAL ☐ ENQUIRY ☒ ORDER ☐ FINAL ☐

GENERAL		**AMBIENT CONDITION**	
Ref. Stds. :IS / IEC		Temp. Max./Min./Design Ref. 46^0 C / 1^0 C / 50^0 C	
Encl. Docs. : ES-8200		Relative Humidity: 100%	Alt. above Sea : Less than 1000 m
Vendor :		**Atmospheric Pollution**	Dusts : Urea Dust / Coal Dust
Vendor Ref. No. :			Vapours: Ammonia Vapour
		Area	Safe : ☐ Hazardous : ☐
Sample : Reqd. : ☐ Not Reqd. : ☒		**Hazardous Area Class**	Zone : Encl. Gr. :
Tests : Routine : ☒ Type : ☐			Temp. Cl.
Others:		**Location** : Indoor ☒ / Outdoor ☒	

BASIC DATA

Item No.		1 LCS FOR HV/ LV MOTORS (Breaker controlled) TYPE - 1	2 LCS FOR LT MOTORS (above 22KW to 55KW) TYPE – 2	3 LCS FOR LT MOTORS (up to 22KW) TYPE - 3
Quantity				
Rated Control Voltage with + %		220V DC ±5%	240V±10%	240V±10%
Rated Frequency with +		50Hz±5%	50Hz±5%	50Hz±5%
Enclosure for Hazardous Area				
Provisions required in LCS				
PUSH BUTTON	Start		Required	Required
	Stop		Required	Required
	Reverse			
	Forward			
	Emergency stop push	Required		
CONTROL SWITCH	TNC	Required		
	Lock / Service			
	OFF / AUTO / ON			
	Local/Remote	Required	Required	Required
INDICATION LAMP	ON	Required	Required	Required
	OFF	Required	Required	Required
	Ready for Service	Required		
	Space Heater ON	Required	Required	
	C.B. tripped	Required		
METERS	Ammeter	Required	Required	Required*
	Range			
	C.T. Sec. Current	1 Amp.	1 Amp.	1 Amp.
RAIN HOOD	Reqd.	Required	Required	Required
	Not Reqd.			
Control Cable Size PVCAPVC (Cu)				
Painting Type & Shade		Epoxy Shade631of IS 5	Epoxy Shade631of IS 5	Epoxy Shade631of IS 5
Period For which Spares Reqd.				
		2Years	2Years	2Years

MAKE OF COMPONENTS

Push Buttons	L & T / Siemens / Alstom / Teknic / Vaishnav
TNC Switches	L & T / Siemens / Alstom / Teknic
Ammeter	AEP / IMP / Meco / Universal
Indication Lamp	L & T /Teknic / Vaishnav
Cable Gland	Baliga / Flexpro / CEAG FCGPL / FEPL
Terminal Box	Elemex / Siemens/ L& T

Note :- All unfilled data shall be filled in by the bidder.

*Note:-From process point of view, ammeter shall be provided for motors below 5.5 KW .

PROJECT: Coal Based Fertilizer Plant — **PLANT** : Instrument/Plant air air

ISSUED FOR : PROPOSAL ☐ ENQUIRY ☒ ORDER ☐ FINAL ☐

Details Of Local Control Stations

Sl.No.	ITEM NO.	CODE NO.	DESCRIPTION	IFL	C.T. Ratio	Remarks

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TECHNICAL PARTICULARS (LOCAL CONTROL STATIONS)

PROJECT: Coal Based Fertilizer Plant		**PLANT** : Instrument/Plant air
ISSUED FOR : PROPOSAL ☐ ENQUIRY ☒ ORDER ☐ FINAL ☐		
GENERAL		
Maker's Type		
CONSTRUCTIONAL FEATURES		
Material of Construction		
Thickness of Enclosure		
IP Class of Enclosure		
Mounting Arrangement		
Door hinged or not		
Gasketing Material		
External Hardwares		
Rainhood reqd. or not		
Mounting Component	On Door	
	On Base Plate	
Provision of Padlocking provided with		
Dimensions LxBxH / Dimensional Drg. Ref. No.		
Type Test Certificate No.		
WIRING		
Wiring Material & Size		
External Cable Size		
TERMINATION ARRANGEMENT		
Termination Arrangement		
Cable Glands	Material	
	Types	
Terminal	Make	
	Type	
	Rating	
PUSH BUTTONS		
Make & Maker's Type		
Ref. Standards		
Rated Voltage		
No. of Contacts N.O. / N.C.		
Contact Rating (V / A)		
AMMETER		
Make & Maker's Type		
Ref. Standards		
Rated Current / VA		
Accuracy Class		
Scale Band		
Size		
CONTROL SWITCHES		
Make & Maker's Type		
Ref. Standards		
Rated Voltage		
No. of Contacts N.O. / N.C.		
Contact Rating (V / A)		
Utilization Category		
SIGNAL LAMPS		
Make & Maker's Type		
Ref. Standards		
Rated Voltage / Watts		
Type of Holder		
Safety Resistor		

Note: Technical Particulars shall be filled by the LSTK Contractor and submitted for Approval **after order** in line with NIT/Contract requirement before commencement of manufacturing.

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SPECIFICATION SHEET
LT POWER & CONTROL CABLES

PROJECT: Coal Based Fertilizer Plant			**PLANT** : Instrument/Plant air	
ISSUED FOR : PROPOSAL ☐ ENQUIRY ☒ ORDER ☐ FINAL ☐				
GENERAL			**AMBIENT CONDITION**	
Encl. Docs. :			Temp. Max./Min./Design Ref. 46^0 C / 1^0 C / 50^0 C	
Vendor :			Relative Humidity: 100 %	Alt. above Sea Level < 1000M
Vendor Ref. No. :			**Atmospheric Pollution**	Dusts : Urea Dust /Coal Dust
				Vapours: Ammonia Vapour
TESTS TO BE WITNESSED: Routine ☒ Type ☐ Acceptance ☒ Others ☐				
Type Tests Certificate of Similar Cable : Required ☒ Not required ☐				
BASIC DATA				
Item No.				
Ref. Stds.		IS:7098 (PART-1)	IS:7098 (PART-1)	IS:7098 (PART-1)
Voltage Grade		1.1 KV POWER CABLE	1.1 KV CONTROL CABLE	1.1 KV EARTHING CABLE
System Earthing		NEUTRAL SOLIDLY EARTHED	NEUTRAL SOLIDLY EARTHED	NEUTRAL SOLIDLY EARTHED
Type of Cable		POWER	CONTROL	EARTHING
CONDUCTOR	ALUMINIUM/ COPPER	ALUMINIUM / COPPER	COPPER	ALUMINIUM
	STRANDED	STRANDED	STRANDED	STRANDED
Insulation Type		XLPE EXTRUDED	XLPE EXTRUDED	XLPE EXTRUDED
Inner Sheath Type		EXTRUDED PVC (ST2)	EXTRUDED PVC (ST2)	--
CONDUCTOR SCREEN	Required	--	--	--
	Not Required	--	--	--
Material of Conductor Screen		--	--	--
ARMOURING	Required	YES	YES	--
	Material	GALVANISED STEEL STRIP / WIRE	GALVANISED STEEL WIRE	--
	No. of Layer	SINGLE	SINGLE	--
Outer Sheath Type		EXTRUDED FRLS PVC TYPE-ST2	EXTRUDED FRLS PVC TYPE-ST2	EXTRUDED FRLS PVC TYPE-ST2
Special Requirements		--	--	--
Drum Material		WOOD	WOOD	WOOD

BILL OF QUANTITY

Item No.	No. of Core & Cross-Sectional Area in Sq. mm.	Qty. in M.	Preferred Drum Length	Remarks
1.1 KV XLPE insulated, armoured, FRLS PVC outer sheathed, Power, control & earthing cables of following sizes:-				
As required (To be filled by bidder)				

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TECHNICAL PARTICULARS (CABLES)

PROJECT: Coal Based Fertilizer Plant		**PLANT** : Instrument/Plant air
ISSUED FOR : PROPOSAL ☐ ENQUIRY ☒ ORDER ☐ FINAL ☐		
GENERAL		
Make		
Ref. Standard		
Item No.		
Voltage Grade		
Suitable For Earthed / Unearthed System		
No. of Cores & Size of Conductor		
CONSTRUCTIONAL DETAILS		
CONDUCTOR	Material	
	Construction	
	No. & Dia of wires per Core	
CONDUCTOR SCREEN	Material	
	Thickness	
INSULATION	Material	
	Thickness	
	Core Identification Method	
INSULATION SCREEN	Material	
	Thickness	
INNER SHEATH	Type & Material	
	Thickness	
ARMOURING	Type & Material	
	Dia of Wire / Strip Thickness	
OUTER SHEATH	Material	
	Thickness	
ELECTRICAL DATA		
CONTINUOUS CURRENT RATING WHEN LAID IN	Ground At 30^0 C	
	Air At 40^0 C	
Short Circuit Current For 1 sec.		
CONDUCTOR TEMP.	Continuous	
	Short Time	
Resistance At Operating Temp. (Ohm / KM)		
Reactance At 50 C/S (Ohm/KM)		
Capacitance (F/Km)		
Insulation Resistance		
Polarisation Index		
DERATING FACTOR CHART ATTACHED FOR	Temperature	
	Grouping	
	Exposure to Sun	
MECHANICAL DATA		
DIAMETER WITH TOLERANCE	Over Inner Sheath	
	Over Armour	
	Overall	
Weight Of Cables Per KM		
Minimum Bending Radius		
Maximum Pulling Tension		
Standard Drum Length		
Tolerance On Drum Length		

Note: Technical Particulars for each type & size of cable shall be filled by the LSTK Contractor and submitted for Approval **after order** in line with NIT/Contract requirement before commencement of manufacturing.

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SPECIFICATION SHEET FOR ELECTRIC HEATER

PROJECT: Coal Based Fertilizer Plant		**PLANT** : Instrument/Plant air	
ISSUED FOR : PROPOSAL ☐ ENQUIRY ☒ ORDER ☐ FINAL ☐			
GENERAL			
Item No. :		Ref. Stds. : **IS / IEC**	
Quantity :		Encl. Docs. :	
Description : ELECTRIC HEATER		Make :	
Code No. :		Maker's Type. :	
TESTS : Routine ☒ Heat Run ☐ Burn-in ☐ Others :			
SERVICE CONDITIONS			
SYSTEM DETAILS		**AMBIENT CONDITIONS**	
Nom. Voltage with ± % : 415V±10%		Temp. Max./Min./Design Ref. 46^0 C / 1^0 C / 50^0 C	
Highest System Voltage : 456V		Rel. Humidity : 100 %	Alt. above Sea < 1000M
Number of phases : 3PHASE 4WIRE		**Atmospheric Pollution**	Dusts : Urea Dust / Coal Dust
Rated Frequency with ± % : 50Hz ± 3 %			Vapours: Ammonia Vapour
Combined (V & F) Variation : ± 10 %		**Location**	Indoor : ☐ Outdoor : ☒
Fault Level : 36MVA		**Hazardous Area**	
Earthing Mode : Solidly Earthed			
Reference Signal : 4-20 mA			
System Data	A.C. : 240V±10%, 50Hz ±5%		
	A.C. : 115V ±10%, 50Hz ± 2% UPS Supply	**Control Philosophy**	Thyristor control
BASIC DATA			
HEATER RATING		**CONTROL PANEL**	
Rated Capacity :		**Installation**	Indoor & Floor Mounted
Highest Voltage for Eqpt. :		**Degree of Protection**	Minimum IP-4X
Heat Flux Density. : 2.0 W/cm^2 (Max.)		**Cable Entry**	Bottom Side
Max. Allowable Sheath Temperature		**Noise Level**	Less than 75 Db at full load @ 1 meter distance
Design temp. shell side		**Cooling in Panel**	
No. of heating bundle	1 (one) single shell	**Auto/ Manual Control**	Required
Heater Element Material	80Ni-20 Cr and sheath Incoloy-800	**PROTECTION**	Earth Fault Trip Thyristor Over Temperature Trip Heater Element Over Temperature Trip Process Air Over Temperature Trip
Mounting	Horizontal		
Power Rating			
As per design calculations plus 10% positive margin.		**Alarm / Interlock**	
Number Of Heating Elements		Fan failure alarm	Thyristor Over Temperature Alarm
As per power rating plus 10% to be provided as unconnected spares.		Process Air over temperature alarm	Heater Element Over Temperature Trip
Heater terminal Box: As per technical specification		Process trip interlock through PLC	Alarm shall actuate hooter and give lamp indication
Heater Glands & Lugs: double compression Stainless steel cable glands & lugs.		**Indication in Panel**	
		Voltmeter	Ammeter
Process Fluid		KWh Meter	Temperature indicator
Power factor :		PID Controller	Alarm/Trip/Power /On /Off etc. as per Spec.
Spare Parts		**Painting**	
Required as per specification for a period of 2 Years O&M.		Type : EPOXY	
		Shade : RAL – 7032 / IS-631	
		Glands and Lugs	
		Double compression SS cable glands	
		Internal Protection : All Live parts shall be shrouded	
Space Heater: Required in heater as well as control panel.			

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TECHNICAL PARTICULAR FOR ELECTRIC HEATER

PROJECT: Coal Based Fertilizer Plant **PLANT** : Instrument/Plant air

ISSUED FOR : PROPOSAL ☐ ENQUIRY ☒ ORDER ☐ FINAL ☐

Bidder's reference / Model No		
Applicable codes/standards		
Heater Rating		
Heater Full Load Current		
Heating Element & Sheath Material		
No. of elements provided (with calculation)		
No. of heater banks		
Overall Element Length		
Unheated Element Length		
Element Sealing Method		
Overall Dimension (L x W x H) of Heater		
Thyristor Full Load Current		
Thyristor Over Temperature Alarm (in Deg.)		
Thyristor Over Temperature Trip (in Deg.)		
Harmonics Distortion		
Input power supply ratings Basic Design		Voltage :
		Frequency :
Overload capability		
AC Output		Voltage :
		Frequency :
		Voltage accuracy :
		Voltage unbalance :
Transient voltage		
Controls		Heater start :
		Heater stop :
		Auto/Manual Operation : Yes
		Remote trip push button :
Overall efficiency	100 % load	
	75 % load	
	50 % load	
Power converter	Make	
	Type/Model No.	
	Total No. of Thyristor & configuration	
	Efficiency	
	Controls provided at the front of the panel	
	Measuring devices at the front of the panel	
	Status indication and Annunciation on panel	
Cooling System	Type	
	Redundancy in cooling Units	
Make/Rating	Main incomer switch/breaker	
	Main outgoing contactor	
Dimension	Length x Height x Depth	
	Weight of cubicle	
Paint shade		
Heat output of Panel		
Control supply voltage and Aux. Power requirement		
Degree of protection for enclosure		
Size of Power Cable to be supplied		
Size/Type of Control Cable to be supplied		
Any other requirement		

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TECHNICAL SPECIFICATION
INDUCTION MOTOR

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CONTENTS

SECTION NUMBER	DESCRIPTION
1.0	SCOPE
2.0	STANDARDS TO BE FOLLOWED
3.0	SERVICE CONDITIONS
4.0	GENERAL DESIGN FEATURES
5.0	PERFORMANCE
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7.0	ACCESSORIES
8.0	VIBRATIONS
9.0	NOISE LEVEL
10.0	PAINTING
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12.0	PACKING
13.0	DRAWINGS AND DOCUMENTS
14.0	SPARES
15.0	DEVIATIONS
ANNEXURE - I	DOCUMENTATION FOR INDUCTION MOTORS

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1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of medium voltage and high voltage induction motors.

1.2 This standard shall be read in conjunction with relevant part of Design Philosophy - Electrical.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS-325 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the equipment to comply with the above mentioned rules.

2.3 Flame proof motors shall, in addition, comply with the requirements laid down in IS: 2148.

2.4 Increased safety motors shall, in addition, comply with the requirements laid down in IS: 6381.

2.5 Motors with type of protection “n” shall, in addition, comply with the requirements laid down in IS: 9628.

2.6 Wherever any requirement laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

The ambient conditions shall be as indicated in the Design Philosophy - Electrical.

3.2 System Details

3.2.1 The details of power system to which the motors will be connected shall be as indicated in the Design Philosophy - Electrical.

3.2.2 The motors shall be suitable for connection to a power system where transient disturbances are very likely to occur. During the transient disturbances, voltage of the system may completely disappear and return in a short time with the motors still running and connected. Under this condition, the return of voltage may occur at such an instant that the induced e.m.f. in the motor is in phase with the applied voltage giving rise to current surges which may reach a value equal to 1.6 times the starting current and also cause transient torques of large magnitudes.

4.0 GENERAL DESIGN FEATURES

4.1 Enclosure

4.1.1 The enclosure of motors for indoor and outdoor services shall be IP-54 and IPW-55 respectively as per IS/IEC:60529, unless otherwise specified.

4.1.2 Motors for outdoor service shall be provided with special seals for the enclosure, joints, bearing housing, terminal boxes etc. so that no extra protective covering for ingress of water shall be required.

4.1.3 Vertical motors for outdoor installation shall be provided with a rain protective hood.

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4.1.4 All external hardware shall be zinc passivated or cadmium plated.

4.1.5 The enclosure shall be provided with threaded metallic plug to permit drainage of condensed water from the inside.

4.2 **Cooling**

4.2.1 All motors shall be totally enclosed fan cooled conforming to IC-0141 as per IS: 6362 unless otherwise specified.

4.2.2 In case of CACA construction, the same shall conform to IC-0161 as per IS: 6362.

4.2.3 In case of CACW construction, the same shall conform to ICW 37A 91 as per IS: 6362.

4.2.4 Wherever service conditions are such that corrosive agents are present in the surroundings, the following materials of construction for cooling tubes shall be adopted, unless otherwise specified.

For CACA motor - Aluminium tubes having minimum thickness of 1.6 mm

For CACW motor - Low carbon alloy steel

4.2.5 In case of CACW motors, the cooling tubes and flanges shall also be suitable for the cooling water analysis. Trays shall be provided for collection of leaking water with arrangement for its drainage.

4.2.6 The cooling fans shall be suitable for bidirectional rotation of motors. These shall be fastened to the motor shaft by means of compensating rings or will be balanced independent of the motor. Guide key or reference points shall be supplied to prevent wrong assembly. The cooling air shall be sucked from the non-driving end.

4.2.7 The cooling fans shall be made of non-sparking materials such as cast Aluminium (LM-6 alloy) / cast iron.

4.3 **Direction of Rotation**

4.3.1 Motors shall be suitable for both directions of rotation. In case of any design limitation, the same shall be indicated in the offer.

4.3.2 In either case, a plate showing the direction of rotation corresponding to the phase terminal markings shall be fitted at the driving end shield of the motors.

4.4 **Stator**

4.4.1 The stator laminations shall be made from suitable magnetic sheet iron varnished on both sides. Where ventilation is required, these shall be arranged in suitable packs, each pack being separated by spacers to form ventilating ducts for circulation of air.

4.4.2 The slot shall be open type with coils so arranged that the coils can be easily removed for inspection and repair.

4.5 **Rotor**

4.5.1 The rotor shall be of squirrel cage construction, unless otherwise specified.

4.5.2 For small motors, the squirrel cage shall preferably be of pressure die-cast construction. For large motors, the rotor bars and the end rings shall be of copper or copper alloy. The bars shall be firmly placed in slots to prevent vibration during start up / locked rotor condition. Conductor ends shall be securely fixed to the end rings using the latest brazing techniques. Retaining rings shall be provided for high speed machines for the end rings. The rotor cage shall be designed for the required starting and duty cycles.

4.5.3 Wherever wound rotor is specified, the windings shall have the same features as detailed for the stator windings. The rotor voltage shall not exceed the stator voltage.

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4.5.4 The rotor shall be dynamically balanced and shall rotate perfectly with no preferential stop points. The rotor shall be constructed such as to allow the removal or addition of material for balancing.

4.5.5 The rotor shaft shall be electrically and magnetically so balanced that the induced shaft voltage does not exceed 200 millivolt. Otherwise the bearing housing at non-driving end shall be insulated for 2 KV.

4.6 **Windings and Insulation**

4.6.1 The motor coils shall be made out of insulated electrolytic grade copper conductor. Successive coils shall be connected by accessible joints, well brazed and finished smooth to prevent damage to insulation.

4.6.2 The motors shall be insulated assuming the power system neutral as isolated.

4.6.3 All motors shall be insulated with F insulation with tropical and fungicidal treatments.

4.6.4 Wherever class F insulation is specified, the windings shall be easily replaceable type and the temperature rise shall not exceed that of class B insulation.

4.6.5 The winding coils shall be dried, properly impregnated with suitable varnishes to withstand the site conditions and properly baked. At least two additional impregnations and baking shall be applied to the assembled stator coil, making a total of three impregnations and baking. Finally the windings shall be painted with special anti-acid and anti-alkali paints to withstand the site conditions.

4.6.6 The windings shall be well brazed and capable of withstanding thermally and mechanically the transient disturbances specified under clause 3.2.2.

4.6.7 Lead-in wire between the windings and the outside terminals shall be made through bushings in H.V. motors. For M.V. motors, heat resistant insulated conductors shall be used as lead-in wire.

4.6.8 The windings shall be star connected for high voltage motors and delta connected for medium voltage motors.

4.7 **Slip Rings and Brushes**

4.7.1 Slip rings shall be located in the non-driving side. The material of construction shall be copper alloy. The slip rings and the brush gear shall be cooled by the motor cooling fan.

4.7.2 For explosion proof motors, the slip rings and brush gear shall be housed in a flameproof housing. In case this is not possible, the housing shall be pressurised type with flameproof pressure switch for interlocking with the motor. In either case, glass covers shall be provided for inspection.

4.7.3 The starting rheostats shall be designed for intermittent duty and rated for 10 minutes. Where speed regulation is required, the rheostats and the controllers shall be suitable for such duty and be continuously rated. Auxiliary contacts shall be provided on the controllers for connections to the motor supply controls to prevent wrong operations during starting.

4.8 **Bearings**

4.8.1 All motors shall be provided with bearings suitable for the application. The bearings must be guaranteed to ensure a smooth operation and a life not shorter than 30,000 hrs.

4.8.2 Where external thrusts are specified, the motors shall be fitted with special roller thrust bearings capable of withstanding the specified thrust. In such cases, the guaranteed life of the bearings shall not be less than 20,000 hours.

4.8.3 The bearing housing shall be effectively sealed against ingress of dust and water and creep age of lubricants along the shaft.

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4.8.4 The bearing shall be suitable for both directions of rotation of the motor.

4.8.5 All motors shall be provided with on-line grease lubrication arrangement for both DE and NDE side bearings except for motors of frame size 112 and less and flange mounted M.V. motors. The arrangement shall be complete with grease nipple and drain plug located at convenient locations.

4.8.6 All oil lubricated bearings shall be fitted with oil level indicator and resistance temperature detector/dial type thermometer with alarm and trip contacts.

4.8.7 Self cooled bearing system shall be preferred.

4.8.8 The manufacturer shall specify the type of lubricant and the time interval of lubrication for the bearings of each motor.

4.8.9 The bearing temperature shall not exceed 90ºC for grease lubricated bearings and 70ºC for oil lubricated bearings.

4.8.10 Wherever shaft end-play has been specified, the bearings shall be capable of providing the specified end-play.

4.9 **Terminal Box**

4.9.1 All the terminal boxes shall have identical degree of protection as that of the motor.

4.9.2 The power terminal box shall be mounted on the right hand side of the motor as viewed from the coupling end. For M.V. Motors, design of terminal boxes shall be such that it may be possible to arrange top/bottom/side entry of cables at site.

4.9.3 The power terminal boxes shall be as follows:

a) For H.V. motors - Phase segregated type capable of with standing the system fault level for 0.2 Sec. or more.

b) For M.V. motors - Manufacturer's standard box with epoxy or SRBF moulded terminal board.

4.9.4 The mounting arrangement of power and neutral side terminal boxes for HV motors shall be identical so that it shall be possible to interchange the boxes at site.

4.9.5 In case of H.V. motors, all the six leads of the motors shall be taken out, three on one side and three on the other side to separate terminal boxes. However, neutral shorting link shall be provided on the neutral box for star connection.

4.9.6 In case of M.V. motors, all the six leads of the motors shall be taken out to a common terminal box. Shorting links for delta connections shall be provided in the terminal box for motors 112 frame and above.

4.9.7 For increased safety motors and for motors with type of protection "n", the terminals shall be provided with positive locking device so that they do not become loose during normal operation.

4.9.8 The power terminal boxes shall have adequate clearances in between the terminals and also between the terminals and cable gland for proper termination of cables. Where more than one cable is required to be terminated in parallel, the spacing in the box shall be adequate for easy termination.

4.9.9 Separate terminal boxes shall be provided for connection of power, control and space heater cables.

4.9.10 All terminal boxes shall be complete with heavy duty double compression type cable glands and lugs/connectors to receive the external cables.

4.9.11 Where cross linked polyethylene cables are specified, the terminal box shall be suitably designed for proper termination of such cables.

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4.9.12 The cable lugs shall be of tinned copper and suitable for crimping.

4.10 **Geared Motors**

Where geared motors are specified, the gears shall be oil lubricated, heavy duty as per AGMA class III and capable of transmitting the rated motor power continuously. They shall be capable of withstanding moderate shock loads having a service factor of 2 and the starting duties. They shall be silent and smooth in operation. Inspection glass shall be provided to indicate the oil level in the gear box.

5.0 PERFORMANCE

5.1 **Starting**

5.1.1 The motors shall be capable of being started direct-on-line, unless otherwise specified.

5.1.2 The starting torque of each motor shall be higher than the initial resisting torque of the driven load throughout the starting period even at a feeding voltage of 85% of the rated voltage for normal purpose motor and 80% of the rated voltage for special purpose motor.

5.1.3 The starting current of 415 V Motors shall not exceed the values indicated in IS: 12615. Also there shall be no further positive tolerance on the values of starting current.

The starting current of 11 KV & 3.3 KV motors shall not exceed 500% of FLC.

5.1.4 The motors shall be suitable for the following starting cycle:

a) With the motor at ambient temperature - 2 successive starts and 3rd start after 5 minutes.

b) With the motor at steady state load temperature - 1 immediate start and 2nd start after 5 minutes. This sequence shall be repeated in the next hour.

5.1.5 Speed switch shall be provided, wherever required, to fulfil the starting conditions.

5.2 **Locked Rotor Condition**

5.2.1 The locked rotor withstand time (t_E), under hot condition at 110% of rated voltage shall be more than the starting time of the motor coupled to the load even at the lowest stipulated starting voltage by 2 secs. for motors, having starting time up to 10 secs. and by 5 secs. for motors, having starting time more than 10 secs.

5.2.2 For increased safety motors, t_E under hot condition shall not be less than 10 secs. The value of t_E shall be determined in the presence of purchaser's representative unless test certificate from an independent testing authority is submitted for similar motors. The time t_E and the locked rotor current shall be stamped on the name plate as well as indicated in the test certificates.

5.2.3 For deciding the time t_E in all cases, the temperature of the insulated stator and rotor shall not exceed the value stipulated under clause no. 5.4.3.

5.3 **Running**

5.3.1 All motors shall be continuous maximum rated (S1 duty as per IS: 325), unless otherwise specified.

5.3.2 The motors shall be capable of delivering the rated output without exceeding the specified temperature rise under the system voltage and frequency variation conditions.

5.3.3 The motors shall be suitable for running at the rated load for 5 minutes duration at 80% voltage and for 1 Sec. duration at 70% voltage, without exceeding the specified temperature rise.

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5.4 **Temperature Rise**

5.4.1 The total temperature of the stator winding under full load running condition shall not exceed the values permissible for the specified insulation class. For increased safety motors, the total temperature shall be 10ºC less than for normal motors.

5.4.2 For explosion proof motors, the maximum surface temperature shall not exceed the values applicable for temperature class of the hazardous gases / vapours present in the surrounding area. However for type 'n' motors, the maximum allowable temperature shall not exceed 200ºC.

5.4.3 In case of starting and locked rotor conditions stipulated under clause nos. 5.1.4 and 5.2.1 respectively, the maximum temperature in the rotor shall not exceed the following values:

For squirrel cage rotor	-	300ºC
For wound rotor	-	As applicable to the insulation class
For explosion proof motor	-	As per temperature class of the hazardous gases / vapours, without exceeding the above temperature as applicable

6.0 COUPLING DETAILS

6.1 Unless otherwise specified, all motors shall be coupled to the driven equipment through flexible coupling.

6.2 Normally the coupling half for the motor shaft shall be supplied by the driven equipment supplier. The coupling half shall be keyed on the shaft with a tapered joint or shrunk with a straight joint. For this purpose, the motor manufacturer shall coordinate all details of the coupling system with the driven equipment manufacturer, wherever required.

6.3 Where rigid coupling is specified, the motor shaft shall have the desired class of accuracy.

6.4 For all vertical flange mounted motors, the limitations on shaft extension, run out, perpendicularity and eccentricity, as required by the driven machine supplier shall be complied with by the motor supplier.

6.5 i) If the motor is to be coupled to a reciprocating pump or compressor requiring fluctuating torque, the motor supplier shall ensure that the inertia of the driving and driven machine assembly shall be such that the variation in the armature current shall not exceed ±66% of the rated current while delivering full load.

ii) The measurement of armature current shall be done with the oscillograph.

iii) The additional fly wheel, if any, shall be assembled at such a distance from the motor so as to allow easy inspection of the windings.

iv) All necessary coordination with driven equipment manufacturer shall be carried out by the motor manufacturer.

6.6 i) Wherever belt drive is specified, the motor supplier shall ensure that the shaft extension and the bearings are suitable for the duty specified.

ii) Unless otherwise specified, the slide rails for all belt driven motors shall be supplied by the motor manufacturer.

7.0 ACCESSORIES

The motors shall be complete with all the accessories.

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7.1 **Space Heaters**

7.1.1 Space heaters rated for 240 V A.C. shall be provided to keep the winding dry for all high and medium voltage motors, except for motors rated below 30 KW which shall be suitable for space heating by connecting 24 V A.C to any of the two motor winding terminals.

7.1.2 The location of the space heaters shall be such as to allow easy access for inspection, maintenance and replacement.

7.2 **Name Plates**

7.2.1 The name plates shall be of stainless steel with letters embossed on them.

7.2.2 The name plate shall contain all the relevant details as per IS: 325 and in addition shall indicate the following:

i) The description and code no. of motor

ii) Degree of protection of enclosure

iii) Temperature rise of windings under running condition

iv) Designation of bearings

v) Recommended type of lubricant and interval of lubrication

vi) Direction of rotation

vii) Mounting Arrangement

7.2.3 Flameproof motors shall have additional name plate containing relevant particulars as per IS: 2148.

7.2.4 Increased safety motors shall have additional name plate containing relevant particulars as per IS: 6381.

7.2.5 Motors with type of protection “n” shall have additional name plate containing relevant particulars as per IS: 9628.

7.3 **Embedded Temperature Detectors**

7.3.1 All high voltage motors shall be provided with 6 nos. of evenly distributed embedded resistance temperature detectors for measurement of winding temperature. These shall be located in positions at which the highest temperatures are likely to occur.

7.3.2 In addition, the high voltage motors shall be provided with

i) 1 no. RTD for hot air temperature measurement

ii) 2 nos. RTDs (1 on each side) for bearing temperature measurement of oil lubricated bearings. For grease lubricated bearings, RTD shall be provided only where specified

7.3.3 These RTDs shall be of platinum having 100 ohm resistance at 0ºC and temperature coefficient as 3.850×10^{-3}.

7.3.4 The RTDs shall be 3 lead type having power frequency insulation level of 2KV.

7.3.5 The RTDs shall comply with the requirements laid down in IS: 2848.

7.4 **Dial Type Thermometers**

7.4.1 In high voltage motors, the measurement of hot air and bearing temperature (of oil lubricated bearings) by dial type thermometers shall be provided wherever specified.

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7.4.2 The arrangement shall consist of a dial type of mercury-in-steel thermometer so mounted that its stem shall be located in the maximum temperature region.

7.4.3 The thermometer shall have two potential free contacts for alarm and trip.

7.4.4 All contacts shall be rated for 2 Amps. at 110 V D.C.

7.4.5 For bearing temperature measurement, separate thermometers shall be provided for each bearing.

7.4.6 For grease lubricated bearings, temperature measurement arrangement shall be provided only where specified.

7.5 **Oil Supply System**

7.5.1 For large sized motors, where forced oil lubrication system is considered, a common oil supply system for the motor and the driven equipment shall be provided by the driven equipment manufacturer.

7.5.2 However, the motor supplier shall quote separate price for the complete oil system of the motor.

7.5.3 The system shall be suitable for location near the motor.

7.5.4 The oil supply system for each motor shall include:

i) 2 Nos. 100% rated motor driven pumps with motors

ii) 1 No. oil tank complete with oil level gauge and thermometer

iii) 1 No. oil cooler

iv) 1 No. oil filter

v) 1 No. differential pressure switch for filter

vi) 2 Nos. pressure switches

vii) Necessary piping

viii) Necessary control and interlocks

8.0 VIBRATIONS

The motor vibrations measured at the bearings must not exceed the limits specified in IS: 12075.

9.0 NOISE LEVEL

The motor noise level shall not exceed 85 dB measured at a distance of 1 metre from the motor.

10.0 PAINTING

10.1 Enclosures of the motor and its accessories shall be painted with two coats of anti-rust paint and two coats of anti-corrosive paint after suitable pre-treatment.

10.2 Epoxy paint shall be used.

10.3 Unless otherwise specified, the finishing shade shall be light grey having shade No. 631 as per IS: 5.

11.0 TESTS AND INSPECTION

11.1 All motors shall be routine tested as per relevant standards.

11.2 Additional tests, wherever specified, shall be carried out on one motor of each rating.

11.3 For high voltage motors of each rating, polarization index test shall also be carried out.

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11.4 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the motor shall be subject to stage inspection at works and inspection at site for final acceptance.

11.5 These inspections shall, however, not absolve the vendor from their responsibility for making good any defects which may be noticed subsequently.

12.0 PACKING

12.1 The motors shall be properly packed to safeguard against weather conditions and handling during transit.

12.2 The shaft shall be properly clamped / supported.

12.3 Rust inhibiting agents shall be applied to fittings and sliding surfaces.

12.4 All flanges shall be closed with blanking plates to avoid entry of foreign materials.

12.5 The loose pieces of the motor / spare parts / Instruments shall be separately wrapped in moisture resistant paper and marked with identification marks and name plate of the corresponding motors.

12.6 The packing box / crate shall include a copy of installation, operation and maintenance manual.

13.0 DRAWINGS AND DOCUMENTS

13.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

13.2 All drawings and documents shall have the following descriptions written boldly:

- Name of client
- Name of consultant
- Enquiry / order number with plant / project name
- Motor Code No. and Description

14.0 SPARES

14.1 Spares for operation and maintenance

Item wise unit prices of spare parts shall be quoted.

14.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

14.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

14.4 All spare parts shall be identical to the parts used in the motors.

15.0 DEVIATIONS

15.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I

DOCUMENTATION FOR INDUCTION MOTORS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet and Technical Particulars	N	Y	Y
2.	Dimensional Drawings	N	Y	Y
3.	Drawings and data for air / water heat exchangers, if necessary	N	Y	Y
4.	Drawings and data for oil system, if necessary	N	Y	Y
5.	Characteristic curves			
	a) Thermal withstand curve	N	Y	Y
	b) Load Vs FL current	N	Y	Y
	c) Load Vs Efficiency	N	Y	Y
	d) Load Vs Power factor	N	Y	Y
	e) Load Vs Speed	N	Y	Y
	f) Voltage Vs Thermal Withstand time	N	Y	Y
	g) Starting current Vs Time	N	Y	Y
6.	Connection diagram for RTDs, thermometer etc.	N	Y	Y
7.	Terminal Box drawings	N	Y	Y
8.	Illustrative and Descriptive catalogues	N	N	Y
9.	Catalogues of bought out accessories	N	N	Y
10.	Spare parts list	N	N	Y
11.	Installation, Operation and Maintenance manual	N	N	Y
12.	Test certificates			
	a) Routine	N	N	Y
	b) Type	N	N	Y
	c) For enclosure	N	N	Y
13.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
2. 8 hard copies & 2 soft copies in CD shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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TECHNICAL SPECIFICATION

CABLES

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ANNEXURE - I	DOCUMENTATION FOR CABLES

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1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and dispatch in well packed condition of power and control cables.

1.2 The standard shall be read in conjunction with relevant part of Design Philosophy - Electrical and other relevant references as specified therein.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of cables covered by this standard shall comply with the latest issue of following Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

IS: 1554 Part (I)	--	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.
IS: 1554 Part (II)	--	PVC insulated (heavy duty) electric cables for working voltages from 3.3 KV upto and including 11 KV.
IS: 7098 Part (I)	--	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100 volts.
IS: 7098 Part (II)	--	Cross linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 KV upto and including 33 KV
IS: 694	--	PVC insulated cables for working voltages upto and including 1100 volts
IS: 5831	--	PVC insulation and sheath of electric cables

2.2 The design and operational features of the cables offered shall also comply with the provisions of latest issue of the Indian Electricity Rules and other relevant Statutory Rules & Regulations. The supplier shall, whenever necessary, make suitable modification in the cables to comply with the above mentioned rules.

2.3 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated elsewhere in Design Philosophy - Electrical.

3.2 System Details

These shall be as indicated elsewhere in Design Philosophy - Electrical.

4.0 OPERATING REQUIREMENTS

The cables shall be suitable for operating continuously at the rated capacity as specified in relevant I.S. under the ambient conditions without exceeding the permissible temperature rise and without any detrimental effect on any part.

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5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

5.1 The design, manufacture and workmanship of cables shall be in accordance with the latest practice.

5.2 All materials to be used shall be new, unused and of the best quality.

5.3 **Conductors**

The power cables shall be of stranded Aluminium / copper round or shaped conductors and control cables shall be of annealed high conductivity stranded copper round conductors. The conductors shall comply with the requirements of IS: 8130.

5.4 **Insulation**

The conductor insulation shall be XLPE and shall comply with relevant IS.

5.5 **Fillers**

The cables shall have suitable fillers wherever required, laid up with conductors to provide substantially circular cross section before the inner sheath is applied.

5.6 **Inner Sheath**

Inner sheath, wherever applicable shall be ST1/ ST2 type compound applied by extrusion process except for paper cables for which it shall be of lead or lead alloy.

5.7 **Armouring**

All power and control cables shall be armoured. The single core cables shall be armoured with hard drawn Aluminium taps/ wires or any other suitable nonmagnetic material. All other cables shall have galvanized steel wire / strip armouring.

5.8 **Outer Sheath**

The outer sheath shall be ST1/ ST2 type compound applied by extrusion process and suitable to withstand atmospheric pollution, resistance to termites, fire retardant and coloured black.

5.9 **Screening**

Screening over conductor and insulation shall be provided as per relevant standard unless specified otherwise. The screening for control cables if specified shall be of aluminium, mylor or equivalent and provided with tinned drain wire which shall be continuous and permanently connected to the screen.

5.10 **Identification**

The individual cores of cables shall be coloured as per relevant IS. Where it is not possible to distinguish the cores by colour, coloured strip shall be applied on the cores or core nos. shall be marked on each core at regular intervals. All cables shall carry the manufacturer's name or trade mark, the cable size, voltage rating and year of manufacture at intervals not exceeding 100 meters. Running meter markings shall also be provided throughout the length of the cable.

5.11 **Dimension**

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The overall dia. and dia. under armour of the cables shall be indicated by the vendor in the technical particulars. These shall be guaranteed with a tolerance of ± 5% but not exceeding 2 mm.

5.12 The cut ends of the cables shall be sealed by means of non-hygroscopic materials.

6.0 SPECIAL PURPOSE CABLES

6.1 Flame Retardant Low Smoke Cables

Flame retardant low smoke cables shall have outer sheath of PVC having following values.

- Minimum oxygen index - 29%
- Minimum temperature index - 250ºC
- Maximum acid gas generation - 20%
- Maximum smoke density rating - 60%

6.2 Heat Resistant Cables

Heat resistant cables shall be of silicon rubber insulated laid circular with asbestos worming and overall glass fibre braided and varnished. Silicon rubber insulating compound shall conform to IS: 6380 and the constructional features shall conform generally to IS: 9968.

7.0 CABLE DRUM

7.1 The cables shall be supplied in non-returnable wooden drums (or steel drums if specified) of heavy construction. The wood used for construction of the drums shall be properly seasoned, sound and free from defects.

7.2 Cables shall be supplied in specified drum lengths. Where no such indication is given, standard drum lengths may be offered.

7.3 The tolerance on each drum of cable shall not exceed ± 2.5%. However, no negative tolerance on HV cables is acceptable.

7.4 All cable drums shall have stencilled data as per relevant IS as well as the purchaser's order no., item no. & drum no.

8.0 TESTS AND INSPECTION

8.1 The following tests shall be carried out on the cables as per relevant IS.

i) Routine Tests - On all cables
ii) Acceptance tests - On representative length of each size
iii) Type tests - Wherever specified on one cable drum of each size

8.2 In addition, the following tests shall be carried out on all fire retardant low smoke cables as per IS or as per the following standards:

i) Oxygen and temperature index test as per ASTM-D-2863
ii) Acid gas emission test as per IEC-754 Part-I

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iii) Smoke density test as per ASTM-D-2843

iv) Flammability test as per IEC-332 Part-I or IS-10810

8.3 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the cables shall be subjected to stage inspection at works and inspection at site for final acceptance.

8.4 These tests and inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

9.0 DRAWINGS AND DOCUMENTS

9.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

9.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

10.0 DEVIATIONS

10.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I

DOCUMENTATION FOR CABLES

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet	N	Y	Y
2.	Technical Particulars	N	Y	Y
3.	Illustrative and Descriptive catalogues	N	N	Y
4.	Installation, Termination and Jointing Instructions	N	N	Y
5.	Test certificates			
	a) Routine	N	N	Y
	b) Type	N	N	Y
6.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
2. 8 hard copies & 2 soft copies in CD shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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TECHNICAL SPECIFICATION

PREFABRICATED LADDER TYPE CABLE RACKS

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ANNEXURE - I	DOCUMENTATION FOR PREFABRICATED LADDER TYPE CABLE RACKS

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1.0 SCOPE

1.1 This standard covers the technical requirements of design, fabrication, testing at works and delivery in well-packed condition of prefabricated ladder type cable racks.

1.2 The standard shall be read in conjunction with Drawing Nos. PDS: E 530 to 538 (9 Sheets).

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the cable racks covered by this standard shall comply with the latest issue of following and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

IS: 733	--	Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes
IS: 2629	--	Recommended practice for hot dip galvanising on iron and steel
IS: 4759	--	Hot dip zinc coatings on structural steel and other allied products

2.2 Wherever any requirement, laid down in this standard, differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

3.1 Ladder type cable racks shall be fabricated as per attached Drawing Nos. PDS: E 530 to PDS: E 538 (9 Sheets).

3.2 Cable racks and accessories such as coupler plate, tees, bend, elbows etc. shall be fabricated from 3 mm thick mild steel galvanised sheet or 4 mm thick aluminium 19000 H2 alloy sheet extrusion conforming to designation No. 64430 and condition WP as per IS: 733.

3.3 G.I. racks and accessories shall have zinc coating of 800 gm/sq. metre applied by hot dip galvanising process. Galvanising shall be uniform, adherent, smooth and free from defects.

3.4 The finished rack and accessories shall be free from sharp edges and corners, burrs and un-evenness. Stepped arrangement of bending is not acceptable. The channel members in the bending shall have uniform curvature and shall be made out of single piece.

3.5 The racks shall be supplied in minimum length of 2.4 metre.

3.6 Each straight length and bend shall be supplied with two coupling plates fitted at each side channel at one end. The coupling plates shall be supplied with bolts, nuts and washers fitted at the other four holes for fixing to adjoining member.

3.7 Coupling plate shall be designed to permit longitudinal adjustment upto ± 10 mm and skew upto 10º.

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3.8 Clamping arrangement as per attached drawings shall be provided for fixing the rack with the cross support as required.

3.9 All the bends, tees and junctions shall be made sufficiently rigid by providing suitable reinforcement on rungs as required.

3.10 The rungs shall be connected to the side channels by continuous welding alongwith three sides of rung. Aluminium rack shall be welded by TIG welding process.

3.11 All hard wares such as nuts, bolts, washers and crank bolts shall be cadmium plated.

3.12 Tolerances in various dimension shall be follows:

Length	--	± 5 mm
Width	--	± 2 mm
Height	--	± 1 mm
Bend	--	± 1 mm
Thickness	--	± 0.2 mm

Positive tolerance on total quantity upto ± 5% is acceptable. However, negative tolerance on total quantity is not acceptable.

4.0 MARKING

The packing shall be clearly marked on the outside (on top side & ends) in indelible ink with the following minimum details:

-- Part No.
-- Size of Tray (Length x Width x Height)
-- No. of Tray / Section, Total Weight
-- Material Specification
-- Client's Name
-- Purchase Order No.
-- Manufacturer's Name

5.0 TESTS AND INSPECTION

5.1 Following tests shall be carried out on prefabricated cable racks:

Visual inspection and checking for

i) Quality and thickness of raw material
ii) Dimensions as per drawing.
iii) Quality of welding (before galvanising for G.I. racks)
iv) Preparation of metal surfaces (for G.I. racks).

5.2 After galvanising, G.I. cable racks shall be subjected to following tests as per IS:4759.

i) Mass of galvanising coating -- At any location the thickness of zinc coating shall not be less than 90 micron. However, average thickness of zinc coating shall not be less than 113 micron.

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ii) Uniformity of galvanising coating.

iii) Adhesion of galvanising coating.

iv) 3 samples from each lot shall be taken for testing.

v) From each lot and size of rack, measure length of 10 trays and average length to be multiplied by number of trays to arrive for total length.

5.3 All the above tests shall be carried out in the manufacturer's works in the presence of Purchaser's representative. In addition to the above tests, the cable racks and its accessories shall be subjected to stage inspection at works and inspection at site for final acceptance.

5.4 These tests and the Purchaser's inspection shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

6.0 DRAWINGS AND DOCUMENTS

6.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

6.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

7.0 DEVIATIONS

7.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I

DOCUMENTATION FOR PRE-FABRICATED LADDER TYPE CABLE RACKS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Illustrative and Descriptive catalogues	N	N	Y
2.	Installation, Termination and Jointing Instructions	N	N	Y
3.	General Arrangement Drawings, showing details of rack, coupling pieces, fasteners, etc.	N	Y	Y
4.	Test certificates	N	N	Y
5.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
2. 8 hard copies & 2 soft copies in CD shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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TECHNICAL SPECIFICATION

LOCAL CONTROL STATION

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10.0	DRAWINGS AND DOCUMENTS
11.0	SPARES
12.0	PACKING
13.0	DEVIATIONS
ANNEXURE - I	DOCUMENTATION FOR LOCAL CONTROL STATIONS

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1.0 SCOPE

1.1 This standard covers the technical requirements of design, manufacture, testing at works and delivery in well-packed condition of Local Control Stations.

1.2 This standard shall be read in conjunction with relevant part of Design Philosophy - Electrical and other relevant references as specified therein.

2.0 STANDARDS TO BE FOLLOWED

2.1 The design, manufacture and testing of the equipment covered by this standard shall comply with the latest issue of IS/IEC:60947 and other relevant Indian Standards, unless otherwise specified. Equipment complying with equivalent IEC standards shall also be acceptable.

2.2 The design and operational features of the equipment offered shall also comply with the provisions of latest issue of the Indian Electricity rules and other relevant statutory Acts and Regulations. The supplier shall, wherever necessary, make suitable modification in the equipment to comply with the above.

2.3 Wherever any requirement, laid down in this standard differs from that in Indian Standard Specifications, the requirement specified herein shall prevail.

3.0 SERVICE CONDITIONS

3.1 Ambient Conditions

These shall be as indicated elsewhere in Design Philosophy - Electrical.

3.2 System Details

These shall be as indicated elsewhere in Design Philosophy - Electrical.

4.0 OPERATIONAL REQUIREMENTS

This equipment and associated components shall be suitable for operating satisfactorily under the specified ambient and system conditions.

5.0 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES

5.1 The Control Stations shall be suitable for control voltage not exceeding 500V, 50 Hz AC or 220V D.C.

5.2 The enclosure shall be of die cast Aluminium alloy LM-6. As an alternative to cast Aluminium, fibre glass enclosure is also acceptable.

5.3 The equipment shall have dust, hose and weather proof construction equivalent to IPW-55 as per IS/IEC:60947. These shall be suitable for outdoor location without any additional protection or cover.

5.4 A rain-hood shall be offered as an additional item. It shall be made of 14 gauge Aluminium sheet bent to shape. In case of fibre glass enclosure, these can be made of fibre glass.

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5.5 All external hardware of diameter less than 8 mm shall be of stainless steel and those of diameter 8 mm and above shall be of mild steel cadmium plated or zinc passivated. For fibre glass enclosure Nylon PVC bolts of diameter 8 mm may be used.

5.6 The control station shall preferably be with bolted cover. The bolts for retaining the cover in position shall be provided with 10 mm dia. stainless steel and these shall be so arranged that they do not pierce into the door gasket.

5.7 All the components shall be mounted on a base plate inside the enclosure. Necessary actuating system for control switch, push button, non yellowing acrylic/ glass cover for ammeter and indication lamps shall be provided on the front cover. No wiring shall be carried out on the front cover.

5.8 The layout of components in the control station shall be liberal and standardised.

5.9 All mating surfaces shall be smoothly machined and shall be of sufficient width of at least 6 mm. The covers shall be provided with continuous gasket made of neoprene or synthetic rubber to prevent ingress of dust and moisture. The gasket shall be held in position in groove provided in the enclosure and shall be pressed all around uniformly by suitably shaped projection of the door. Gaskets simply glued to the surface are not acceptable.

5.10 The enclosure shall be suitable for mounting on wall or on steel structure. 4 Nos. holes suitable for 12 mm bolts shall be provided outside the enclosure for fixing the control stations.

5.11 The internal wiring shall be carried by means of single core PVC insulated 1.5 sq. mm stranded copper conductor cable. All termination shall be made with crimping type proper size lugs and shall be properly ferruled.

5.12 The control stations shall be completely factory wired and ready for external cable connection.

5.13 For easy identification, numbering ferrules shall be provided on all wiring at both ends i.e. equipment end and terminal block end. Terminals for external wiring shall be numbered

5.14 The enclosure shall be provided with two earthing terminals with studs of 8 mm. dia. projecting outside the enclosure for connection to earth. These terminals shall not pierce through the enclosure and shall be marked with earthing symbol.

5.15 Each control station shall be provided with minimum 2 mm thick stainless steel name plates or consisting of black Perspex with white engraving indicating the code number and description of the equipment controlled by it. Similar labels shall be provided for all indication lamps, push buttons and control switches. The name plate and label shall be fixed with screws only.

6.0 SPECIAL FEATURES FOR FLAME PROOF LOCAL CONTROL STATION

6.1 The enclosure shall be in addition, of flameproof execution as per IS: 2148.

6.2 The control stations shall be suitable for hazardous area of enclosure group and temperature class as indicated in Design Philosophy - Electrical.

6.3 Cables shall enter the terminal box through flame proof cable gland. From the terminal chamber to the main enclosure, the connections shall be made through proper

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bushings. Direct entry of external cables into the main enclosure shall not be accepted. All entries shall be provided with stainless steel inserts.

6.4 An additional earthing terminal inside the terminal chamber shall be provided.

6.5 Local control stations and cable gland must be certified by the Central Mining Research Institute, Dhanbad or any other statutory authority for use in the specified hazardous area.

7.0 COMPONENT DETAILS

7.1 Trip-Neutral-Close Switch

TRIP-NEUTRAL-CLOSE switch shall be double pole, 3 position, pistol grip, rotary type having self spring return feature to neutral position. The contacts shall be of phosphor bronze and shall be provided with two breaks in series. Mechanical sequence device to prevent two successive movements to the same position shall be fitted. The switch shall be capable of being padlocked in the 'TRIP' position.

7.2 'Auto-Manual' Switch

'Auto-Manual' switch shall be single pole stay put type having three positions "AUTO-OFF-MANUAL". Provision shall be made to padlock the switch in the "OFF" position.

7.3 Selector Switch / Lock Service Switch

These shall be single pole stay put type having two position with a pistol grip handle and capable of being padlocked in one of the position.

7.4 All the switches shall be rotary type with snap or wiping action contact and having a set of normally open and closed contacts in each position. All switches shall be provided with pistol grip handle.

7.5 'Off-Auto-On' Switch

7.5.1 'OFF-AUTO-ON' switch shall be in minimum three stack configuration, each stack having three positions with spring return from 'ON' to 'Auto' position and lockable in 'OFF' position by means of padlock.

7.5.2 The switch shall have sliding contact between 'AUTO' and 'ON' position. In 'OFF' position the contact shall be completely broken from 'AUTO' position.

7.6 Push Buttons

These shall be spring loaded, with a set of normally closed and open contacts. The push buttons for 'start' shall be shrouded type and coloured green while 'stop' push buttons shall be un-shrouded type and coloured red. Provision shall be made to padlock the 'stop' push button in 'OFF' position. The fixing ring shall be metallic white. An oil proof rubber cap shall preferably be provided.

7.7 The switches and push buttons shall conform to utilization category AC11/ DC11 as per IS/IEC:60947. The contact shall be rated to make, break and carry inductive current of 5 Amp. at 415 V AC and 1 Amp of 220V DC. The contact arrangement shall be as shown in the terminal drawings. Built in locks instead of padlocking are not acceptable.

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7.8 **Indication Lamps**

7.8.1 LED type indication lamps shall be provided to indicate the various circuit conditions as shown in the terminal drawings.

7.8.2 The LEDs shall provide good illumination through a viewing angle of 180º. The LEDs shall have lumen output of 200 milli Candella in the axial direction.

7.8.3 The colour of the LED indication for various functions shall be as follows:-

RED : For 'ON' Indication
GREEN : For 'OFF' Indication
WHITE : For "Ready for Service" Indication

7.9 **A.C. Ammeters**

The ammeter shall be flush mounting, moving iron spring controlled type, of accuracy class 1.5 as per IS:1248, with square face of minimum size 72 mm x 72 mm having scale range 0-240º. The ammeter shall be provided with uniform scale up to CT primary current and compressed end scale up to 6 times the CT primary current. Adjustable red pointer shall be provided to indicate the full load current of the motors. Zero adjusters shall be provided for operation from the front of the meter. All ammeters shall be operated through 1Amp. CTs only.

7.10 **D.C. Ammeters**

The D.C. ammeter shall be shunt operated. These shall be moving coil or moving iron type of accuracy class 1.5 as per IS: 1248.

7.11 **Terminal Blocks**

All control stations shall be provided with terminal blocks. Terminal blocks shall be located at a minimum distance of 50 mm from the bottom of the enclosure. The terminal blocks for the control station shall be suitable for conductor sizes of 2.5 mm^2. These shall be of pressure clamp type design mounted on the base channel. The minimum rating of terminal block shall be 16 Amp.

7.12 **Cable Glands**

The cables for the external connections, shall enter the terminal chamber through heavy duty double compression type rolled Aluminium cable glands suitable for 2.5 sq. mm PVC insulated, armoured, and PVC sheathed copper conductor 1.1 KV grade cables. The number and cores of control cables shall be as per requirement. The cable gland shall be fitted in a threaded hole.

8.0 PAINTING

8.1 The enclosure after suitable pre-treatment shall be painted with two coats of anti-rust paint followed by two coats of anticorrosive paint.

8.2 Epoxy based paint shall be used.

8.3 All paints shall be carefully selected to withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

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8.4 Unless otherwise specified, the finishing shade shall be of light grey having shade no. 631 as per IS: 5.

9.0 TESTS AND INSPECTION

9.1 All equipment shall be routine tested as per relevant standards.

9.2 Additional tests, wherever specified, shall be carried out.

9.3 All the above mentioned tests shall be carried out in the presence of purchaser's representative. In addition, the equipment shall be subjected to stage inspection at works and inspection at site for final acceptance.

9.4 These inspections shall, however, not absolve the vendor from their responsibility for making good any defect which may be noticed subsequently.

10.0 DRAWINGS AND DOCUMENTS

10.1 Drawings and documents as per Annexure-I shall be supplied, unless otherwise specified.

10.2 All drawings and documents shall have the following descriptions written boldly.

- Name of client
- Name of consultant
- Enquiry / Order Number with plant / project name
- Code No. and Description

11.0 SPARES

11.1 Spares for operation and maintenance

Item wise unit prices of spare parts shall be quoted.

11.2 Commissioning Spares

Commissioning spares, as required, shall be supplied with the main equipment. Item wise list of recommended commissioning spares shall be furnished for approval.

11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.

11.4 All spare parts shall be identical to the parts used in the equipment.

12.0 PACKING

12.1 The local control stations shall be properly packed to safeguard against weather conditions and handling during transit. It shall be wrapped in polythene bags and an additional wrapping of bitumen paper shall also be provided to make it completely water proof before the equipment is packed in wooden crates.

12.2 The packing box shall contain a copy of the installation, operation and maintenance manual.

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13.0 DEVIATIONS

13.1 Deviations, if any, from this standard shall be clearly indicated in the offer with reasoning.

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ANNEXURE - I

DOCUMENTATION FOR LOCAL CONTROL STATIONS

Sl. No.	Document Description	Documents Required (Y / N)		
		With Bid	For Approval	Final
1.	Specification Sheet	N	Y	Y
2.	Technical Particulars	N	Y	Y
3.	General Arrangement Drawings	N	Y	Y
4.	Schematic Diagrams	N	Y	Y
5.	Illustrative and Descriptive catalogues	N	N	Y
6.	Catalogues of bought out accessories	N	N	Y
7.	Spare parts list	N	N	Y
8.	Installation, Operation and Maintenance manual	N	N	Y
9.	Test certificates			
	a) Routine	N	N	Y
	b) Type (only for flameproof equipment)	N	N	Y
	c) For enclosure	N	N	Y
10.	Guarantee Certificates	N	N	Y

Note:

1. 4 hard copies & 1 soft copy shall be supplied for approval after order within 4 weeks from the date of LOI.
2. 8 hard copies & 2 soft copies in CD shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N - No

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ENGINEERING STANDARD

ELECTRICAL ERECTION, TESTING & COMMISSIONING

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
0	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	AV	BKC / SC	BB

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LIST OF ATTACHMENTS

ATTACHMENT NUMBER	DESCRIPTION	NO.OF SHEETS
PDS: E 601	General Notes on Lightning & Earthing protection	2
PDS: E 603	Arrangement of Connections of Earth electrode	6
PDS: E 604	Typical Details of Connections in Earth Pit	1
PDS: E 605	Earth Pit Details	2
PDS: E 606	Typical Details of Earthing of motor & Start Stop Push Button Station	2
PDS: E 610	3.8m long G.I. Earth Electrode for Earthing	1
PDS: E 611	G.I. / Al accessories for Earthing	2
PDS: E 612	Typical Earthing Arrangement across Pipe Joints/ Valves	1
PDS: E 613	Earthing of Storage Tank & Vessel	1
PDS: E 614	Fixing Arrangement of Air termination & Roof / Down Conductors for Lightning Protection	6
PDS: E 615	G.I. Earth Bus	1
PDS: E 212	Typical Installation of Lighting Fixtures at Ground Level	2
PDS: E 208	Installation Arrangement for Area Lighting Fixtures	1
PDS: E 210	Junction box for Street Lighting Pole	1
PDS: E 516	Typical Arrangement of Cables buried in slits	1
PDS: E 530 to E 538	Pre-fabricated Ladder Type Cable Racks	9

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1.0 SCOPE

1.1 This standard covers the technical requirements of erection, testing and commissioning of all Electrical equipments at site.

1.2 This standard shall be read in conjunction with the relevant technical specifications and other references specified therein.

1.3 **Scope of Work**

1.3.1 The scope of work shall generally include supply (wherever specified), handling, transportation, unpacking, checking, reporting of damages/defects, storage, assembling, erection, installation, including fabrication, alignment, levelling, grouting, welding, bolting, painting, etc., testing and commissioning of various electrical equipments and machineries, illumination system, earthing system, lightning protection and fabrication & installation of steel structural etc. required for the complete electrical system as per drawings & documents, specifications, standards & codes, prevalent rules & regulations and best engineering practices.

1.3.2 Detailed Scope of Work (Supply and Erection) shall be as indicated in project specific Technical Specifications.

1.3.3 The entire electrical installation work shall be carried out in accordance with the following:

a) Indian Electricity Rules & all applicable Statutory Acts & Regulations
b) This specification
c) The latest issue of approved drawings of vendors / consultant
d) The recommendation of the manufacturers
e) Latest issue of Relevant IS
f) The direction of the site engineers

Any additional revision made to the drawings at a later stage, which in the opinion of the consultant / owner is necessary, will be binding on the contractor and shall have to be carried out.

1.3.4 The contractor shall be responsible for:

a) Obtaining approval from the Electrical Inspector / Factory inspector or any other Statutory Authority for equipment, plant design / drawings and complete installation work.
b) Carrying out modifications in the equipment & installation as required to comply with the above.
c) Submitting installation certificates on completion of installation to Electrical Inspector & obtaining certificates of approval of the installation.

These jobs shall be carried at the contractor's own cost and the work shall be deemed to have not completed unless the approved certificates mentioned under (c) are submitted to the owner.

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1.3.5 No erection material shall be supplied by the owner. All materials like clamps and tags for cable/ conduit and earthing including hardware material, all tools and tackles required for erection, testing and commissioning such as, but not limited to jacks, welding sets, oxygen/ acetylene gas, cutting set, drilling machines, grinders, pipe bending machine, dies for pipe threading, scaffolding materials, cables, switches for erection power supply and workshops, temporary lightning protection, cable jointing tools, megger, earth tester, primary and secondary injection test sets, substandard meters for calibration of ammeters & voltmeters etc. and any other tools required shall have to be arranged by the contractor.

1.3.6 Consumable materials required for the erection jobs such as, but not limited to kerosene, cotton waste, jute, duster shims for alignment & levelling, cement, concrete, bricks, welding electrodes, paints, carbon tetrachloride, unleaded petrol, solder, flux, raul-plug, phill-plug, nylon-plug, anti corrosive grease for copper, aluminium contacts etc. shall also have to be arranged by the contactor.

1.3.7 Cleaning of site after completion of erection as well as regular clearance of unwanted material from site, returning of all packing materials, & excess of other material supplied by owner back to owner's stores shall also be covered under the scope of work.

1.3.8 All equipments and instruments shall be inscribed with proper number, nomenclature, cautionary signals & other instructions as may be necessary.

1.3.9 The contractor shall supply and touch-up any surface of switchgear and other electrical equipments which are scratched and / or damaged during transportation and erection. The paint used shall match exactly the surface being touched up.

1.3.10 Major civil engineering works pertaining to electrical equipment like foundation and plate inserts etc., if excluded from the scope of work, the contractor shall check their correctness as per latest manufacturer's drawing and carry out minor civil jobs such as, but not to limited to, grouting of base plates, channels, supports and foundation bolts, cutting holes in wall and ceiling, chipping of floor and ceiling, sealing of cable entries and making good the same after installation of the equipment, levelling and any other minor similar civil works advised by site engineer has to be carried out by the contractor with out any extra charges.

1.3.11 The contractor shall furnish all supervision, labour, tools, rigging material and incidental material such as bolts, welding electrodes, anchors etc. required to install, test and adjust the equipment.

1.3.12 The contractor shall employ all skilled, semi-skilled and non-skilled labourers for erection, installation & testing as required. All Electricians, cable jointers, wiremen, welder and other employed shall be suitably qualified possessing valid certificates/ licenses recognized by the complement authorities. The owner at its own discretion, put any electrician, wireman, cable jointer to test about competency of technician concerned and the contractor shall have to replace any such staff found incompetent in the opinion of the owner, to execute the job as per the requirement.

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1.3.13 The contractor shall also furnish a list of Engineers / Supervisors and staff employed by him for erection and installation jobs giving in brief qualification and experience of such staff and indicating whether they hold such competency certificates / licences to supervise the electrical installation jobs as required under Indian Electricity Rules & State Electrical Inspectorate Rules.

1.3.14 The contractor shall set up his own work-shop and other facilities at site allocated place to undertake fabrication jobs, pipe bending, threading etc.

1.3.15 The contractor shall be responsible for recording of all readings and observations during erection, testing and commissioning in registers or on prescribed Performa. These shall be carried out in the presence of owner's representative. All such test data and records shall be duly singed by the contractor's Engineer / Owner's representative and shall be submitted to owner in triplicate.

1.3.16 The contractor shall hand over completed job. Minor details not specifically mentioned in the scope or schedule of quantities but required for completeness of the job shall have to be carried out by the contractor with out any extra cost.

1.3.17 The contractor shall commission all Electrical equipments and carry out all tests inclusive of load test as per the performance guarantee and will be responsible for final adjustment of relays, instruments, meters, breakers etc.

1.3.18 The specifications given under Cl. Nos. 5 & 7 are only guidelines and doesn't give the details entirely. It shall be the responsibility of the contractor to execute the work without any extra cost to owner, in accordance with the standard code of practices, the relevant manufacturer's drawings, owner's drawings, consultant's drawings and as per Site engineer's directions. Further, the stipulations of general conditions of the contract shall prevail over all other conditions stipulated in this specification.

1.4 Exclusion of Work

1.4.1 All major civil engineering works pertaining to electrical equipment like foundation and cable trenches shall generally be excluded. However, minor civil works shall be in contractor's scope. Transportation, handling, assembling, setting, aligning, levelling, plumbing and grouting of all electrical motors and generators shall generally be excluded.

1.4.2 Detailed Exclusion of Work shall be as indicated in project specific Technical Specifications.

2.0 CODES AND STANDARDS

2.1 The erection, testing & commissioning of the equipment shall comply with the latest issues of all relevant Indian Standards and Codes of practices. Design, manufacture, testing & installation of supply items shall also comply with the relevant standards. Equipments complying with equivalent IEC standards shall also be acceptable.

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2.2 Some of the relevant Indian Standards are as follows:

IS: 10028(Part-2)	Code of practice for selection, installation and maintenance of transformers
IS: 6600	Guide for loading of oil immersed transformers.
IS: 10118(Part-3)	Code of practice for selection, installation and maintenance of Switchgear and controlgear
IS: 11039	Requirements for mounting on rails in switchgear and controlgear installations.
IS: 1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS: 14782	Code of practice for maintenance and testing of large lead-acid batteries for generating systems and substations
IS: 2309	Code of practice for protection of buildings and alied structures against lightning
IS: 2551	Danger notice plates
IS: 3043	Code of practice for Earthing
IS: 5216	Recommendations on safety procedures and practices in electrical work
IS: 8437	Guide on effects of current passing through human body
IS: 14786	High voltage / Low voltage prefabricated substations
IS: 900	Code of practice for installation and maintenance of induction motors
IS: 15429	Storage, installation and maintenance of DC motors – Code of practice
IS: 13408	Code of practice for the selection, installation & maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining application or explosive process manufacture)
IS: 14665(Part 2)	Electric Traction Lifts: Code of practice for installation, operation and maintenance

2.3 The contractor shall observe safety rules and take all necessary safety precautions to carry out the work in the plant.

3.0 EQUIPMENT SPECIFICATION

3.1 All equipments shall conform to the relevant specifications indicated in project specific Technical Specifications. They shall be suitable for specified site & climatic conditions.

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3.2 Make of equipments shall be as per project specific requirements. Make of equipment not specified shall be as indicated and shall be subject to Owner / Consultant's approval.

3.3 Drawings and documents for various equipments shall be submitted as per Documentation Schedule indicated in relevant specifications.

3.4 Spares as specified / recommended spares for 2 years operation and commissioning shall be supplied for all equipments.

4.0 GENERAL PROCEDURE FOR ERECTION

The general procedure governing "Transfer of equipment and materials to Contractor", erection and Final acceptance of Owner/ Consultant are given below:

4.1 Drawal of Equipment from Owner's stores

All equipment and materials, excepting, equipment / erection materials included in Contractor's scope of supply, shall be issued from Owner's store. Contractor shall arrange to draw the necessary equipment / material in the sequence required for erection and transports the same to contractor's store or directly to erection point.

4.2 Contractor's inspection at Owner's stores / Site

On receipt of any material (supplied by the owner) at site, before removing any issued item, contractor shall fully unpack and inspect all equipment received for completeness, signs of damages, defect etc. in the presence of owner's representative and shall get all discrepancies (damage / short supply) duly recorded by owner's/ consultant's authorised representative on the issue note, failing which, no claim by the contractor shall be entertained at a later date and he shall be required to make good/replace/repair the defective/ damaged items at no extra cost.

4.3 Handling and cleaning

4.3.1 Contractor shall be responsible for proper handling and cleaning of all materials / equipment drawn / supplied by him until Owner / Consultant finally accepts the erected equipment.

4.3.2 Equipment shall be handled with care by experienced riggers under guidance of competent supervisors and as per rigging marks given on cases. Dragging on floor shall be avoided and crane/suitable rollers shall be used for moving the equipment at any times.

4.3.3 The contractor shall be fully responsible for the safe keeping of equipment issued to him till these are erected, tested, commissioned by him and accepted by owner/ consultant.

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4.4 Transportation

This involves transportation of various electrical equipments / materials from owner's stores / store siding to erection site / Contractor's stores & Contractor's Stores to erection site. When transporting the equipment, it shall be loaded on suitable trailer / trucks as per capacity and size of equipment, and shall be properly supported on the trailers / trucks by means of ropes / stoppers to avoid damage or tilting due to heavy jerks and vibration. Precautions, if any, displayed on equipment shall be strictly observed.

4.5 Storage

Whenever materials are required to be stored by the Contractor in his own stores at site, the contractor shall strictly observe the following requirements: -

4.5.1 The contractor shall keep a proper record of the materials handed over to him by owner / consultant at the initial start of the work and the materials drawn by him and kept in his stores.

4.5.2 All equipment and materials shall be properly stored by the contractor at site in the designated storage area provided by the owner.

4.5.3 The contractor shall ensure that all the materials drawn / supplied by him are stored indoor / under shade. However, if a package is temporarily stocked outdoor due to unavoidable reasons, this shall be ensured that the storage area is dry, hard and well-drained area.

4.5.4 Goods must not be placed directly on the floor / ground but shall be kept on blocks, 60 mm to 120 mm above the floor level such that the bottom is well ventilated.

4.5.5 In case of outdoor storage, the contractor at his own cost shall provide waterproof PVC sheets / tarpaulin to cover all goods so as to protect them from rain etc. These sheets / tarpaulin shall be removed for inspection once in a week and if found moist or mouldy, shall be dried in direct sunlight.

4.5.6 In addition to the above, the equipment manufacturer's storage instructions, if any, shall be strictly followed.

4.6 Erection Requirements

4.6.1 All work shall be carried out as per drawings supplied. Placing of equipment on foundation, aligning, grouting, connecting, fixing danger notice plate / board on equipment shall be done as specified. Meggering, labelling and painting shall form part of erection requirements.

4.6.2 Fixing of supporting frames / pedestals, grouting, cutting and dressing holes in walls / ceiling and any other minor civil work necessary for installation and levelling of electrical equipment are included in electrical erection scope.

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4.6.3 The scope of erection also includes cable dressing/ clamping/ minor rerouting, minor relocation of fittings, internal cleaning of equipment, overhauling and minor repairs.

4.6.4 Fabrication of clamps from the materials specified and clamping of cables on racks, trays etc. fixing of single core cables in tri-foil formation in aluminium clamps, earthing of cable armour and lead sheath, wherever necessary (and as per the details given by Consultant) fall under erection scope of work.

4.6.5 Marking of cables by fixing / grouting the cable marks / number tags for every 25 meters along entire route of cables is included in the scope of work. The tags shall be made of Aluminium Strips.

4.6.6 The contractor shall without any extra cost, touch up with paint all electrical equipment which are damaged / scratched during handling, erection or repair. The paint used shall match exactly the painted surface of the equipment on which touch-up is done, and shall be epoxy based.

4.6.7 The descriptions given above are only to give a preliminary idea about the scope of work and they do not limit the entire scope to these descriptions only. Hence all other parts of the tender document shall be read in conjunction with the referred standards, associated drawings, specification sheets and schedule of materials & services to assess actual scope of work.

4.6.8 The contractor shall undertake erection of all equipment specified herein in accordance with good engineering practices in conformity with statutory regulations and Code of Practice and to the entire satisfaction of the purchaser/ owner.

4.6.9 The contractor shall arrange all the necessary erection tools, tackles, testing and measuring instruments and shall supply all erection materials as required.

4.7 Services of Suppliers' Erectors

For guiding / supervising erection of sophisticated equipment, services of main equipment supplier's engineers / erectors may be made available free of cost to Contractor as per discretion of Owner/ Consultant. However, this will not absolve the contractor from his responsibility nor his obligation to provide his own supervisors or technical personnel.

The contractor shall comply with all the directions, drawings etc. issued to him within the scope of his contract by Supplier's Engineer / Erector.

4.8 Installation Certificate

On completion of work the contractor shall submit installation certificates in prescribed Performa as required under prevailing Electricity Act/ Rules to Electrical Inspector or other competent statutory body and obtain certificates of acceptance/ approval of Electrical Installation carried out by him.

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5.0 SPECIFICATION FOR ELECTRICAL ERECTION

5.1 General

5.1.1 These specifications lay down the erection procedures to be followed for each type of equipment, over and above the general "Erection Requirements".

5.1.2 The contractor shall also follow manufacturer's instructions and any other instructions of consultant / owner / Statutory bodies during erection.

5.1.3 Suggestive Erection Drawings shall be supplied to the successful bidder for Lighting, Earthing, Cable Tray Routing, etc. These drawings may be suitably modified, if required, to suit site requirement with the approval of owner / consultant.

5.1.4 As-Built Drawings shall be prepared by the Erection Contractor and supplied to owner / consultant.

5.2 Prefabricated Sub-Stations

5.2.1 New emerging technologies for Electrical Power Distribution Systems have brought in the concept of Modular / Transportable Sub-Stations instead of conventional RCC Sub-Stations.

5.2.2 Transportable Sub-Stations shall comprise of pre-fabricated transportable modules made of galvanized steel, duly installed with electrical equipment like HV & LV switchboards, distribution boards, lighting transformers, battery, battery chargers, I/O racks, etc. and complete with air conditioning system, illumination, earthing & lightning protection, fire protection & management system, communication system, interconnecting cabling and cable tray support system, etc. within itself.

5.2.3 Most of the work shall be completed and tested at works. After testing, for safe delivery to site, the battery electrolyte shall be removed and all equipments shall be secured.

5.2.4 Due to local transport restrictions, some of the pre-fabricated buildings may be required to be split into units / modules of suitable size for delivery. Splitting shall be done by providing several units placed side by side, each unit complete in itself or a large sub-station split in modules with false walls in between modules for transportation, which shall be removed at the time of assembly at site.

5.2.5 The modules / units shall be assembled at site to complete an Electrical Sub-Station with minimum work required to be done at site. Following work shall be carried out at site:

a) Transportable building shall be put on prepared foundations and anchored.

b) Transportation fixtures and temporary walls shall be removed.

c) Different sections of the transportable buildings shall be joined together.

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d) Staircases shall be assembled and placed in position.

e) Cable Trays shall be fixed.

f) Re-connection of fire protection & internal lighting system.

g) Internal wiring between sections of the transportable buildings shall be connected.

h) Connection to ground & lightning protection system.

i) Installation of panels within transportable building, if supplied by Owner.

j) Re-testing & commissioning of all the installed panels.

5.2.6 The installation works shall be carried out as per manufacturer's instructions.

5.3 Transformers

5.3.1 Contractor's inspection

Particular attention is to be paid to the following while inspecting / examining the transformers for any sign of damage:

a) Tank side and cooling tubes dented

b) Cooling Tubes damaged

c) Any sight glasses broken (including explosion vents)

d) Bushings cracked / broken

e) Bolts loose

f) Oil leakage (particularly along welds)

g) If gas filled, whether gas pressure O.K.

h) Valves leakage

i) Any other damage

5.3.2 Handling

a) Lift the transformers by lugs or shackles provided for the purpose.

b) Use lugs and shackles to avoid unbalance while lifting.

c) Lifting chains not to interfere with any part of the transformer.

d) Check cover bolts for tightness. Tighten fully (if found loose) before handling. Care shall be taken that the bolt does not rotate to avoid damage of the gasket.

e) In case use of jacks is necessary, use jacks only on jacking pads provided for the purpose. (Jacks shall never be used under valves or radiator tubes).

f) Do not keep transformer on bare ground. Where it is not possible, unload transformer directly on the foundation. This can be done with the permission of consultant/ Owner.

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g) Never leave the transformer without putting stoppers of the wheels.

5.3.3 Erection

a) Foundation of the transformer shall be prepared and checked for its level as per Drg. before shifting / transferring the transformers from the stores.

b) Transformer shall be placed on the prepared foundation only.

c) For transformers of high rating (above 1000 KVA) place the transformer on foundation (channels / rails already grouted on the foundation) as per drawing. Proper time shall be given for curing the level of rails. Rails must be checked and adjusted.

d) Wheels shall be fixed before placing of the transformer in position. Wheels of the transformers shall be checked for its proper/ free movement on the rails / plates. Greasing shall also be done on the shaft of wheel before placing the wheels in position. Split pins must be used / placed in position before its rolling. It shall also be levelled & aligned with the bus ducts, if bus ducts are to be connected on the LT side of the transformer.

e) Clamp stoppers to the transformer wheels, immediately after alignment to prevent any movement.

f) Clean all the accessories like radiators, cooling fans, valves, conservator tanks, explosion vent pipe, bushing and other accessories.

g) Flush the radiators with hot oil before assembly.

h) Cloth only shall be used for cleaning purposes (CAUTION: While working on the transformers with hand-holes or bushing holes, take care that no tools or any other foreign matters are dropped into the tanks. All the loose tools shall be properly tied and secured).

i) Assemble all accessories such as radiators, conservator, valves, explosion vents, Buchholz relay, HV and LV bushings, cable-end termination boxes, marshalling kiosk/box, instruments, capillary tubes, silica gel breathers with dried silica gel, fans etc. as per vendor’s drawings and instructions.

j) Prior to topping up of oil, check for proper tightness of all gaskets joints and operation of shut-off valves. Also fix thermometers.

k) Test oil samples from each drum for dielectric strength before topping. (Do not fill oil from the drums, which cannot with stand 40 KV for 1 minute).

l) Filter oil before filling.

m) Oil shall be filled through filtering machine using metallic hose.

n) Fill oil to the transformer tank through bottom drain valve to prevent aeration in oil.

o) Ensure during oil filling operation that no air pockets are left in the tank, and that no dust or moisture enters the oil. Open all air vents. Reduce oil flow rate when oil level is almost up to the bottom of the main cover to prevent internal pressure from rupturing the diaphragm of pressure relief pipe. Allow sufficient time for all air bubbles to escape. Release any air bubble accumulated in Buchholz relay. Close vent plugs.

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p) In case of gas filled transformers, the oil to be filled up under vacuum as per manufacturer's instructions.

q) Connect cables to HV terminals and cables/ bus duct to LV terminals of transformer.

r) Connect control cables / power cables to the marshalling box. Connect Stop push button mounted on the wall of transformer room to trip the transformer.

s) Transformer body, HV cable box and MV / LV cable box to be earthed at 2 separate points to the main earthing grid.

t) Transformer neutral to be earthed to separate and distinct neutral earth pits (through Neutral Earthing Resister, where applicable) as per design and drawings.

u) Provide danger notice board conforming to IS: 2551 and IE Rules 1956 on enclosure or door of the enclosure.

v) Earth Transformer Room's door / enclosures as per IE Rules, 1956.

w) Provide Safety items i.e. fire extinguishers, shock treatment chart, fire buckets with screened sand etc.

5.4 Switch Boards

5.4.1 Handling

a) As far as possible lifting of switchboards is to be done by making use of eyebolts provided. Ensure that before lifting, all eyebolts are fully tightened and that panel supports, nuts and bolts are in tact and tight.

b) If lifting arrangement is not provided / not feasible and final positioning by sliding is unavoidable, retain packing base as long as possible and rolled on suitable pipes. Avoid sliding / dragging panel directly on floor by crowbars.

c) Maximum care shall be taken to avoid any damage to insulator, bushings, meters and protective equipment.

5.4.2 Erection

a) Check the foundation according to the drawings. Ensure that all pockets have been rightly made. Fix the datum level, and level the foundation by chipping in such a way that the prescribed point of cubicle base plate is flush with finished floor.

b) Check the individual cubicle for any deformity and ensure that all faces are straight. Any dent on sheet steel frame is rectified before placing on foundation.

c) Wherever separate base frames are supplied level and the foundation in both directions (lateral and transverse) and ensure that these have been correctly levelled throughout. In case of runner rails, check the rails for level in both the directions and ensure that they are parallel to each other.

Wherever base frame is fixed to cubicle, place the cubicle on foundation ensuring that holding down bolts are directly over the foundation pockets.

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d) Obtain correct level of panel with respect to floor / existing bus-bar by putting shims below base frame (as per drawing). Shims are to be supplied by the contractor. Measure the level of each frame with reference to datum and ensure that level difference between the two ends of the switchboard base frame is within ± 2 mm.

Owner shall provide a level benchmark in each sub-station. All levels shall be checked with this mark by Theodolite and the Contractor shall keep a record.

e) Cubicle shall be so adjusted that front face of all the panels are in one plane, all sides are plumb and corresponding horizontals on all panel faces (e.g. minimum lines, door edges, inter cubicle joints) line up in the same horizontal line(s). Match the cubicles and adjust properly. Provide gasket between edges, if required, so that no inter-panel gaps are seen.

f) Bolt adjacent cubicles and base frame together. (Drill new holes where corresponding holes of cubicles do not match after levelling, if found necessary).

g) Grout the foundation bolts with mortar. Also run grouting mixture under base of the cubicle frame and ram to ensure solidity. After grout has set properly, tighten the foundation bolts.

h) Fix bushing/ insulators of bus-bars as per drawing if these have been despatched loose.

In case of extension panels for existing boards, this must be done before step (d).

5.4.3 Bus Connections and Installation of Loose items

a) Fix bus bar links and inter panel bus-bar connections with coupling bolts/ supporting insulators. Clean the contact surface of bus bars and links and smear with contact grease before bolting.

b) Wherever recommended, fix shroud on the joints and fill compound, or compound may be put on joint to form smooth homogenous & spherical shaped mass and then wrapped with tape. Simple taping of joints may also be done. Recommendation of manufacturer/ consultant/ owner shall be followed in this respect.

c) In case of misalignment of bus bars, adjustments may be necessary. The connecting pieces may have to be re-drilled or re-fabricated.

d) Check tightness of bus bars bolts connections with torque wrench. Follow vendor's recommendations in this regard.

e) Install all loose relays, instruments, cable boxes, metering and protective CTs, PTs etc. Before fixing the relays, make sure that they are cleaned and all packing materials have been removed from them and proper operation. Clean the contacts.

f) Connect all inter-panel bus wiring. Connections of relays and instruments shall be done as per drawings. Check the wiring according to wiring diagram.

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g) Connect all earthing bus bar between the cubicles and it shall be connected at two points by Al/ GI strip or cable to the main earthing ring. Fix all glands for incoming and outgoing and control cable connections on the holes provided for the purpose, as per drawings.

h) Drill holes for fixing cable glands/ cable boxes as per drawings, if such holes are not provided. All spare holes, gaps etc. shall be blanked as per instructions of Owner/ Consultant.

5.4.4 Cleaning

After erection is complete all cubicles, switches, starters, CTs, PT Chambers, Bus Bar Chambers etc. shall be cleaned by blowing air (preferably hot air). Surface of the insulation shall be cleaned with cloth soaked in CTC/ Benzene.

5.4.5 Circuit Breaker installation

5.4.5.1 Air Circuit Breaker

a) Clean the contacts properly with both soaked in CTC/ Benzene etc. Clean and lubricate the operating mechanism, check and rectify the main insulating contacts and bushings and also secondary contact for any damage/ misalignment. Check the locking mechanism.

b) Manually close and trip the breaker several times and check contact alignment and pressure. Adjustment, if required, shall be done according to the manufacturer's instruction. The arc chute if despatched separately shall be fixed properly, only after checking of contact alignment etc. After fixing the Arc Chute, operate manually the breaker and check the contacts make properly. Measure contact resistance with ductor. Check the operation of OFF-ON indicator.

5.4.5.2 Vacuum Circuit Breaker / SF6 Circuit Breaker

a) Check the breaker frame for any damage. In case of vertical isolation type, raise and lower the breaker several times and ensure that breaker moves freely on guide, lubricate the mechanism.

b) Check the operation of locking mechanism. Check the secondary isolating contacts for any deformity. Check HT bushings for any damage and repair if it is minor.

c) Manually close and trip the breaker several times. Adjust the mechanism as per manufacturer's instruction. Measure the contact resistance with ductor. Check the oil level in the chamber. If level is low, due to leakages, rectify and fill up as per manufacturer's instruction. Check the operation of ON-OFF Indicator.

d) Check that safety shutter open and close smoothly. Remove the lock if provided before racking in the circuit breakers. Put the circuit breaker inside the cubicles. If cubicle is aligned properly, the circuit breaker shall go smoothly inside the cubicle.

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e) In case of horizontal isolation type circuit breaker, engage the racking mechanism and put the interlock mechanism operates smoothly and adjustment if required shall be done. Slowly rack in the breaker to service position. While racking in, ensure that safety shutters open smoothly. Check the mechanical interlock mechanism. Also check that the main and secondary isolating contacts mesh properly. Conduct this operation a few times to ensure proper functioning and alignment of all mechanism.

f) For vertical isolation type circuit breaker, put it first at the test position and check interlock mechanism and also the secondary isolating contacts engaged properly. Put it at service position, and slowly raise it to fully raised position. Ensure that main isolating contact bushings enter bush bars spouts smoothly and contacts mesh properly. Conduct the raising/ lowering operation several times to ensure a smooth functioning of all mechanism. Any other allied work thought necessary for completion of the erection will have to be done by the Contractor.

5.4.5.3 Oil Circuit Breaker

a) Check the breaker frame for any damage. In case of vertical isolation type, rise and lower the breaker several times and ensure that breaker moves freely on guide, lubricate the mechanism.

b) Check the operation of locking mechanism; check the secondary isolating contacts for any deformity. Check HT bushings for any damage and repair if it is minor.

c) After detaching tank, slowly close the breaker manually and check that moving and fixed contacts match properly. Adjustments, if required, shall be done according to manufacturer's instruction. Since contact movements and alignment etc. are adjusted at manufacturer's work, any further adjustment shall be done very carefully.

Do not operate the breaker when there is no oil in the tank. Measure the contact resistance with doctor. While operating the CB manually, check the operation of ON-Off indicator.

d) Oil filling-Detach the tank and thoroughly clean tank inside with cloth and then with the insulating oil. Fill the tank with insulating oil upon the level. The dielectric strength of oil shall be as per latest IS. In case of supplied in drum not withstanding the dielectric strength as per IS, filter it before filling in the tank. Secure the tank with bolt the top place to ensure good joint.

5.4.6 General Checks

a) Ensure that all gaskets are in position, replace the same if found damaged.

b) All opening covers and rear doors shall be bolted with required number of bolts. Take care that no bolt/ nut/ washer gets lost during handling and erection.

c) Check inter-changeability of breakers of same rating.

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5.5 Motor Control Centre / Power & Motor Control Centre (MCC / PMCC)

Erection of MCC / PMCC, if required, is to be carried in accordance with Cl. No. 5.4 above. In addition, the following points are to be observed:

a) Cable glands shall be fixed in cable gland plates/ cable alloys (Drilling of holes in gland plates are to be done at site as required).

b) Cable entries are to be made vermin proof.

5.6 Panelled Equipment

These include AC/ DC Distribution Boards, Thyristor Control Panels, Inverters etc. In addition to the procedure laid down in Clause Nos. 4.0 & 5.3, any other instruction given by the manufacturer shall also be followed.

5.7 Storage Batteries

a) Installation work for storage battery cells on steel / wooden racks shall be done strictly as per supplier's drawings and instructions.

b) Steel / wooden racks shall be installed in the battery room on support insulators. The racks shall be plumbed and aligned properly.

c) Each cell shall be inspected for any damage of its positive, negative plates, containers etc. Cell shall be cleaned properly and all packing materials removed as per manufacturer's instructions.

d) The cells after assembling the plates, indicators etc. shall be placed on cell insulators over racks and interconnected to each other so as to avoid strain on cell-terminals.

e) The electrolyte shall be prepared in large glass/ PVC or special jars as per manufacturer's instructions. The jars shall be cleaned with distilled water. The concentrated sulphuric acid shall be added to the distilled water slowly (never add water to sulphuric acid) and electrolyte stirred constantly with PVC rod. Temperature and specific gravity of electrolyte shall be as per manufacturer's instruction.

f) All necessary safety precautions shall be taken while preparing the electrolyte i.e. goggles, rubber apron, and gloves etc. shall be used.

g) No foreign materials, dust or dirt etc. shall be allowed to fall in the electrolyte and it shall be kept duly covered.

h) Connection to the battery charger shall be made.

i) Prepared electrolyte shall be filled in cells up to mark level of at least 10 mm above upper edge of the plates in a manner approved by manufacturer. Electrolyte shall be allowed to cool down.

j) While giving initial charges to the cells, instructions of the manufacturer's regarding rate of charging shall be strictly followed and care taken that charging unit is not over loaded more than the rated capacity. During the period of charging, the cells must be topped up as often as necessary to prevent the electrolyte falling below the required level. Distilled water to be

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used for topping purposes and quantity of distilled water used for topping up of the cells shall be noted.

k) After initial charging battery shall be discharged at specified rate. Thereafter battery shall be recharged.

l) Record all battery voltage of each cell, specific gravity, temperature, charging current during charging/discharging and shall be kept in Performa supplied by the supplier or in a form approved by the consultant/Owner. Discharging and recharging operations shall be done as recommended. After final charging the battery shall be put on float charge.

m) No naked flame or sunlight shall be permitted in battery room and smoking shall be strictly prohibited.

n) During initial charging and discharging battery shall not be left unattended.

o) It is to be assured that battery room is properly ventilated with an exhaust fan / blower.

5.8 Cable Installation

5.8.1 General

a) Fabrication of chequered plates for trench covers, cutting of all types of Al / GI Cable trays to desired length, laying, spacing, fixing etc. of all types of cables, trays, supports, hangars etc. shall be according to the drawings or according to the instructions given by consultant / owner.

b) Contractor shall keep accurate record of cable drums issued to him, the drum nos. and actual length of cable taken out of each drum. Each cable length shall be cut from a specific drum as per approved schedule of cable. Length of cable runs shown in the cable schedules is the calculated length only and the actual lengths shall be measured at site before laying and cutting the cable. The contractor shall take extreme care to adjust cable runs from drums so that joints in the cable are avoided and wastage reduced to minimum.

c) For purpose of measurement of cable run for payment the length of cable between and terminations only will be considered.

5.8.2 Laying

a) The cable drums shall be properly mounted on jack / on a cable wheel. Make sure that the spindle is suitable for carrying weight of the drum without bending. Check that spindle is laying horizontal on the bearing so as to prevent the drum creeping to one side or to the other while rotating.

b) Unroll the cables from the drum in correct direction. Rotate drum only as per arrow mark given in the cable drum. Ensure that the end protection box attached to the flange of the drum is removed and securing rope cut to allow cable and move freely. Rotate the cable drum and simultaneously pull cable steadily and with even pulls and not with unnecessary jerk or strain. In no case the cable shall be allowed to twist or kink since this is likely to spring the armour and fracture the insulation and outer serving of the cable.

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c) Do not drag the cable on floor or hard surface. Use only wooden / steel cable rollers for this purpose.

d) Cable shall not be bent sharply to a small radius. The cable bending radius shall be as large as possible and will not be less than 12 times the outside diameter for paper insulated cables, 8 times for PVC cables and 15 times for XLPE cables. At joint termination, the individual core of cable shall not be bent with bending radius of less than 15 times the diameter over the insulation.

e) Where cables are laid on the MS racks, trays etc. ensure that trays / racks / supports are fixed properly in an approved manner or according to the drawings. Check from drawings that for horizontal runs of cable, bracket, risers, supports and angles are grouted or fixed in formation as required.

f) In sub-station where large no. of cables rise to panels / switchboards, it shall be ensured that these risers and rising cables do not interfere with cables on racks and rising cables do not cross the other cables in horizontal runs. Risers are to be properly supported so that weight of cable does not fall on terminations. All cable crossings shall be avoided. Cable cross section / power layout drawings shall be followed.

g) Cable laid in trenches shall be sealed at the entry to hazardous area/non-hazardous area as per details given by Consultant / Owner / Engineer-in-charge.

h) Openings in substation / MCC rooms and floors for entry of cables shall be sealed after the cables are laid.

i) Cables shall be clamped as shown in the drawings Care to be taken to space clamps to such intervals as to prevent buckling of cables.

j) Cables are laid in concrete trenches built by Consultant / Owner having covers of concrete of slabs or chequered plates. The laying of the cable on the racks shall be done in an approved manner and according to the drawings supplied.

k) Where cables are laid in open concrete trenches / slits, the trench / slits after laying cables shall be filled with sand & lean cement mixture and plastered so that surface flushes with top of trench / slit.

l) Care shall be taken that cables are not laid in waterlogged area as far as practicable. When laid above ground, cables shall be properly supported on rigid poles at least 2M high. At road crossing, minimum head clearance of 6M shall be provided.

5.8.3 Laying of Cables in underground pipes

a) Laying of cables in underground pipes shall include excavation of earth along the cable route, laying of pipes, back-filling, ramming and removing extra earth including supply of bricks and sand.

b) Ground trenches which shall be dug for laying of pipes such as to ensure that depth of the top of the pipe below the ground level shall be 600 mm min. Bottom of the trench shall be properly levelled up and all odd and sharp

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materials removed. HDPVC / GI pipe shall be laid in the trenches. Proper bends & pull boxes wherever required shall be provided.

c) After laying of pipes, fill up earth in trench and ram properly. Remove all extra earth from the sides.

d) Lay the cables as per drawings and instructions of site engineer.

e) Fix cable markers at 100 M apart and at joints on the entire route length of the cables. The cable markers shall be made of pre-cast concrete block of 300 x 350 x 350 mm size with letter HT Cable, LT Cable, depth of the cable, arrow marks etc. inscribed. These shall have to be supplied by contractor at no extra cost and fixed as per the directions of the Consultant / Owner. The top of the above concrete slab shall have a smooth finish with cement only.

f) Laying of cables under road crossing shall be avoided to the extent possible. If required, it shall be done in pipes. When a larger number of pipes are laid across the road, manholes shall be built on either side to terminate the surface of road. Backfilled soil shall be rammed thoroughly to prevent road surface cracking due to settlement of loose soil.

g) Railway Crossing

Where the cable is laid under railway track, it shall be laid through cast iron pipe or spun concrete pipe of suitable diameter and strength. The pipe shall be laid not less than 1 M below the surface of the formation level. Pipes shall be laid with the gradient to facilitate drainage of water. Pipes shall be laid up to a minimum distance of 3 M from the centre of the end tracks on either side. The work shall have to be carried out in accordance with the rules and regulations of railways for cable crossings.

Where number of pipes is to be laid along road / rail crossing, these shall be laid in horizontal formation.

Masonry pipes to be constructed at both ends of road / railway crossing pipe and specified notice to be erected at crossing as per railway rules.

5.8.4 Directly buried Cables

a) Laying of underground cables shall include excavation of earth along the cable route, laying of cables, back-filling, ramming and removing extra earth including supply of bricks and sand.

b) Where cables are laid directly into ground trenches which shall be dug up for laying cables such as to ensure that depth of the top of the entire cable below the ground level shall be 750 mm min. for medium and low voltage, 900 mm min. for cables from 3.3 KV to 11 KV grade, 1050 mm min. for cables from 22 KV to 33 KV grade and 1000 mm min. for cables at road crossing and at railway level crossing respectively.

c) Bottom of the trench shall be properly levelled up and all odd and sharp materials removed. Trench bottom shall then be bedded with a 75 mm thick layer of sand. Before laying the cable over this bed, approval of consultant / owner for preparation of bed shall be taken. Cable shall be laid in the trenches in straight run, care shall be taken that any kinks or bend are not

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formed. After laying the cables, bricks shall be placed lengthwise on both the sides of the cable along the entire length to form through.

d) Fill up space between bricks with sand to height of the bricks.

e) Place bricks closely width wise on the top of the sand filled through. Fill up earth in trench and ram properly. Remove all extra earth from side. Do not use broken bricks. Only Class-I (of relevant IS) bricks shall be used.

f) If new cables are to be laid crossing existing cables, the new cables will be laid under existing cable at depth of not less than 200 mm from the existing cable. Ensure that the approach of the new cable to the crossing is uniform and gradually sloped.

g) Lay the cables as per drawings and instructions of site engineer.

h) Fix cable markers at 100 M apart and at joints on the entire route length of the cables. The cable markers shall be made of pre-cast concrete block of 300 x 350 x 350 mm size with letter HT Cable, LT Cable, depth of the cable, arrow marks etc. inscribed. These shall have to be supplied by contractor at no extra cost and fixed as per the directions of the consultant / owner. The top of the above concrete slab shall have a smooth finish with cement only.

5.8.5 Laying in Trenches

a) RCC slabs and chequered plates lifted from trenches for laying cables shall be put back in position at close of work every day to avoid accident & damage to cables in the trench.

b) When cables pass through pipes, ends shall be sealed by pouring bitumen compound or any other approved compound as required.

c) Pipes shall be provided for protection of the cables entering from the floor, trench etc. in the switchgears, MCCs, and pipes shall be sealed against water ingress.

5.8.6 Laying of single core HT un-armoured cables shall be done in manner stated hereunder. Cables shall be arranged in trefoil formation and clamped with suitable clamps. The clamps shall be fixed on cable hanger, racks etc. The cables shall be laid with extreme care without causing any damage to the sheathing cables in trefoil formation shall be bounded at a regular interval and earthed. Where necessary the bounding on trefoil groups shall be interconnected. The cables shall in no case be drawn through metallic pipe, ducts etc.

5.9 Cable Joining & Termination

5.9.1 General

The scope of work includes:

a) Soldering / crimping of sockets / ferrules and connections at all joints / terminations as per specifications. Sockets shall be provided at all terminations except where pressure clamp type terminals are provided.

b) Glanding of cable and fixing of cable boxes.

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5.9.2 Specifications

a) All PVC cables shall be terminated in conventional type cable boxes, fitted with wiping gland / compression type gland / clamps with rubber bush. For outdoor terminations double compression type gland and for indoor terminations single compression cable gland shall be used. Boxes may be filled with bituminous compound, epoxy M-seal, as and where specified.

b) For XLPE cables, special termination kits (heat shrink type) shall be used.

c) All paper-insulated cables shall be terminated in compound filled type cable boxes using conventional compound filling methods or in special cases resin oil filled or epoxy M-seal cable boxes. Wiping gland / clamp with rubber bush are fitted to the cable box.

d) All LT and control cables shall be terminated through compression type gland.

e) In explosion proof equipment sealing accessories, where provided in cable box, are to be used for sealing the cable entry to the box and termination.

f) All lighting and control cables shall be provided with crimped Al / Cu Sockets before termination in junction boxes.

g) In case of LT cables, armours shall be suitably earthed in compression type glands. For HT cables, this shall be done either in glands or by any other suitable means like bonding the armour with suitable wire and connecting same to the earth terminals inside cable box.

5.9.3 Crimping

All cable lugs for Cu conductor's sizes up to 400 sq. mm shall be of crimped type solder less Cu lugs, which shall be crimped by special hand / hydraulic crimping tools. Cable lugs for conductor sizes exceeding above shall be conventional soldering type, heavy duty. All the control cables, which shall be of copper conductor, shall be terminated without any additional lugs in screwed type terminals provided in various equipments. Before crimping the socket inhibiting grease shall be smeared over the conductor. Conductor shall be shaped properly before sliding the socket over it. Crimping shall be done in an approved manner.

5.9.4 Jointing

a) The jointing shall be done in an approved manner with proper jointing kits. Care shall be taken not to damage the insulation when opening the cable for jointing. Taped / temporary joints shall be avoided.

b) In case of LT PVCA cables, armours shall be suitably earthed in compression type glands. For HT cables, this may be done either in glands or by any other suitable means, like bounding the armour with suitable wire and connecting same to the earth terminals inside cable box.

c) Before commencing soldering of the socket, conductor shall be thoroughly cleaned and insulation protected. The ferrules shall be thoroughly cleaned. Ferrule and each strand of the cable shall be thoroughly sweated with solder to completely tin them and fill the conductor gaps and to remove all air pockets. Soldering materials of approved quality as per IES practice shall

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be used. Taping of the conductors shall be done in an approved manner after crimping / soldering.

d) Filling up compounds and sealing the cable box, shall never be done in one operation. After the first pouring of compound, it shall be topped up again with compound and then sealed.

e) Straight through Joints

Jointing of XLPE & PVC / HRPVC cables shall be done with extreme care and manufacturer's instructions shall be strictly followed. Soldering of ferrules shall be done with extreme care as stated earlier.

Earth continuity wire shall be plumbed and or clamped. Compound shall be filled according to the instruction of manufacturer of terminating kit / cable. Joints made inside trench or racks shall be properly supported. Wherever, joints are made inside the ground, brick masonry work shall be done around the joint box and filled with sand and thereafter covered with earth at no extra cost.

f) A tent shall be used in all circumstances where jointing work is being done outdoor for protection against rain and to prevent dust from being blown into exposed joint and jointing materials. Extreme care shall be taken to maintain proper phase sequence while terminating at equipment ends. Record of connection details shall be maintained. Conductor shall be shaped properly while terminating and no sharp bend shall be given. Where numbers of cables are connected in parallel, proper tests shall be done before connecting so that no cross connection is made. No phase crossing shall be allowed for making the connection.

g) Cables shall be supported adequately at the entry to cable box / equipment so that load of cable does not come on cable gland.

h) All cables shall be meggered (checked for insulation resistance) before and after jointing and insulation resistance values recorded.

i) While terminating at equipment end, each core shall be properly tagged with numbering ferrules as per nomenclature given in the drawings. Wires shall be dressed and clamped neatly. Bolting shall be done properly.

5.10 **Earthing**

5.10.1 General

a) Painting of all earth strip joints with anti-corrosive paint shall be carried out as per details given in the respective drawings / specifications and instructions of owner / Engineer-in-Charge.

b) All electrical equipment rated 415V and above shall be connected to earth bus by two separate and distinct earth connections. All equipment rated 240V and below shall be earthed with single earth conductor.

5.10.2 Specifications

a) Earthing conductor above ground shall be of aluminium / copper wire bare or insulated or strip. Earthing conductor buried in ground shall be of G.I. or

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PVC insulated aluminium / copper cables. Sizes of earthing conductors shall be according to specified drawings. All earthing installations shall conform to IS: 3043 and other relevant standards.

b) The earthing wires or strips shall be laid along the cable racks, cable trenches, risers and supports. Underground conductors shall run at a depth of 600 mm below ground level. Where these conductors run along with cables, they shall be laid at the same depth as cables. Where conductors run on wall, ceilings, they shall be laid on clamps or brackets made out of Al/ GI strips.

c) Wherever earthing conductor is passing through floor, walls etc., the conductor shall be taken through PVC / GI pipes.

d) All paints, enamel etc. shall be removed from point of contact before making connections.

e) Connections between Al/ GI strips shall be done by welding for connecting Al/ Cu/ GI wire. For connecting Al/ Cu/ GI wires, tinned Cu Socket shall be crimped on the wire. At the equipment end, connections shall be done by bolting. However, connections between GI strips shall be done by welding. Connection between Al/ Cu & GI shall be done by bolting. Graphite grease shall be applied on contact surfaces.

f) Epoxy resin paint or bitumen shall be applied on welded or bolted joints to prevent corrosion and taping done as indicated in the drawing. Connections between Al / Cu wires shall be done by crimping weak back Al / Cu ferrules.

g) Earth electrodes shall be provided as per drawings / specifications. Work includes excavation of earth, installation of electrodes and test links etc. supply and filling of charcoal and common salt, back filling of earth and removal of extra earth. It also includes making brick wall around the electrode and cover according to drawings / specifications. The testing links shall be grouted on brick wall and connections with earth electrode and conductors shall be made. Distance between two electrodes shall not be less than 10 meters and may be located 4 M away from building foundation.

h) Earth pits for equipment earthing, transformers neutral earthing and lightning protection shall be separate. However, these pits shall be inter-connected.

5.11 Lightning Protection

5.11.1 Air termination rod shall be installed as indicated in drawings.

5.11.2 Fixing of termination rod on roof with Al sheet shall be done with crank bolt and watertight compound provided.

5.11.3 Laying of down conductors and connection shall be done as per drawings. Lightning Protection installations shall conform to relevant IS.

5.11.4 Earthing of static equipment like vessels, chimneys etc. where no termination rod and down conductor is provided, shall be done by connecting the equipment

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base to earth pit by GI / Al strip or PVC insulated Al / Cu wire. Clamps shall be bolted or welded to the base of the equipment.

5.11.5 Structures for the storage, protection or use of highly inflammable solids, vapour or gases or in which highly inflammable or explosive dusts or vapour may be present shall be protected against lightning. Such protection is to be carried out as per prevailing Indian / IEC Standards. The following shall be taken care of:

a) All major members of metallic structure shall be bonded together and connected to the lightning protective system. Such connections shall be made at least in 2 places.

b) Metallic pipe, electrical cable sheath, steel ropes, rails etc. entering the structure but not in electrical contact with earth, shall be bonded to the lightning protective system.

c) All metal forming part of the structure, its reinforcement or its equipment shall be bonded or welded together and connected in two places with the lightning protective system.

d) The bonding ring conductor shall be run externally about 0.5 M above ground level in order to provide a convenient point for the connection. The ring conductor shall be visible throughout its length. The arrangement of bonding shall be such as to avoid possible sparking.

5.12 Plant Lighting

5.12.1 The electrical installation covered by this specification shall conform to relevant Indian Standards and Codes of practices.

5.12.2 Where a number of cables are run together inside or outside the plant, the wiring shall be supported on GI / Al trays / steel structures.

5.12.3 Erection of light fittings, plug sockets etc. - Fabrication of supports for lighting fittings, sockets, junction boxes shall be done as per the relevant drawings / instructions given by the consultant / owner and same shall be grouted to walls, ceiling or welded to insert plates, steel structures etc. Insert plates on ceilings shall normally be provided. However, if required, the contractor shall, under instruction of the consultant / owner weld such supports to the reinforcement rods after exposing by chipping off concrete at no extra cost. Installation of lighting fittings includes control boxes, where supplied separately, and shall be done as per drawings. Before installation, checking of internal parts, assembly of accessories shall be done as per manufacturer's instruction / drawings.

5.12.4 The explosion-proof fittings shall be earthed through third core of the cable used for wiring. The third pin and body of 15 amps switch sockets shall be earthed similarly.

5.12.5 Installation of explosion proof equipment shall be done strictly following manufacturer's instruction or relevant Standards. Cable termination shall be done as per relevant drawings. No drilling of holes or any change in construction of equipment or part thereof shall be done.

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5.12.6 Wiring for AC supply light and plugs may be fixed in the same brackets but wiring for emergency DC supply lights will be fixed separately. In a circuit controlled by one switch in Group Control Switchboard, there will be a number of points. Drawings for lighting layout give only tentative location of fittings and wiring route shall be decided in consultation with consultant / owner. Wiring of circuit shall be bunched together to the extent possible in the same route.

5.12.7 For wiring and laying of cables, Cl. 5.8 shall be referred. Cable for wiring, light points, socket outlets, shall normally be laid along wall, ceilings and structures on suitable brackets made out of M.S. / Al sheets or strips. Connections to the points in one circuit shall be taken through junction boxes. Junction boxes shall be suitably located for branching off from the circuit to the individual point. Wherever indicated, cables may be laid directly on walls, ceilings etc. by clamping on saddles.

5.12.8 Terminations shall be done in a manner as detailed in Cl. 5.9. Wherever indicated, the wire can be drawn through PVC bushings provided in the fittings. Relevant drawings may also be referred to.

5.12.9 Lamps shall be installed after installation of fittings and wirings.

5.12.10 All light fittings and corresponding control switches shall be numbered in a permanent way as instructed by consultant / owner / engineer-in-charge.

5.13 Street Lighting

In addition to the requirements stated in Clause No. 5.12, the following are also involved:

5.13.1 Excavation of earth, pouring of concrete foundations, erecting, aligning and grouting of poles.

5.13.2 Assembly of arms, fixing of lighting fittings, accessories like fuse carrier, control box etc.

5.13.3 Laying of cables directly underground as per Cl. 5.8 and connecting to Junction boxes and lighting fittings as per Cl. 5.9.

5.14 Installation of Cable Trays / Risers / Supports

5.14.1 The fabrication work shall be done as per drawings / specifications / sketches in an approved manner and to the complete satisfaction of consultant / owner / engineer-in-charge. The contractor shall take necessary care to avoid wastages. Scrap shall never exceed the permissible limit.

5.14.2 Erection of fabricated racks, risers, cable supports etc.

a) Erection of racks and risers for cable supports shall be done along the cable routes as indicated in the drawings. The contractor before erection shall check the route for any obstruction like process pipelines, structures,

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equipment etc. In case obstructions are noticed, the matter shall be brought to the notice of consultant/ Owner in writing and racks shall be re-routed as per his instructions.

b) As and where indicated in the drawings, supports for racks, risers etc. shall be clamped/ welded on the steel structure, such as MS beams, pipe trestles, insert plates provided in the RCC column etc. for erection of racks.

c) Wherever indicated, supports for racks, risers, shall be grouted on walls. Racks & risers shall be installed on such supports and these shall be welded properly.

d) Opening on walls / floors shall be provided where racks / risers are crossing floors / walls.

e) Heavy channels, risers may also be grouted on the floors in addition to supports provided from walls, ceilings and steel structures.

f) As indicated in the drawings, racks and risers shall be erected either in multi-tier or single-tier formation.

5.14.3 Erection of supports in Trench

a) Supports and Hangers shall be grouted with rag bolts on the walls of prepared concrete trench. Insert plates shall be supplied by owner / consultant.

b) Pockets on walls, floors for erection of racks, etc. shall be provided where such racks, risers are crossing floors and walls. In prepared trench wall, pockets shall be provided for grouting rag bolts. But if needed the contractor shall arrange to make suitable pockets or modify pockets already provided for grouting the cable supports and/ or erection of riser, racks etc. at no extra costs.

c) Wherever insert plates are not provided, but required for support of cable rack, the contractor shall weld such plates to the reinforcement MS rods. This shall be done by chipping the concrete for exposing the reinforcement MS rods and thereafter welding the plates and making good the concrete chipping by plastering.

5.14.4 The pipes will have to be bent (wherever required) and fixed / embedded in floor, wall and ground for laying the cables. Neoprene bushes shall have to be fixed at the end of such pipes.

5.14.5 GI / Al trays of different sizes shall be cut in size and fixed on racks and risers. Supports for the main cable racks shall be provided by the owner. However, supports for small branch cable racks & risers may have to be fabricated by the contractor. Fixing of trays shall only be done after erection / welding / painting of the supports as required.

5.14.6 Erection of support frames for miscellaneous equipments, base channels for transformers and switchboards etc. shall be carried out at no extra cost.

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5.14.7 Dismantling of steel fabrication and re-erecting as required by consultant/ owner/ engineer-in-charge shall have to be carried out.

5.14.8 Dismantling of cable racks and re-erecting shall have to be carried out.

6.0 GENERAL PROCEDURE FOR TESTING & COMMISSIONING

6.1 Before proceeding with the work, contractor shall fully inspect all installed Electrical Equipment for completeness, signs of damages, defects etc. and shall get all discrepancies duly recorded by Owner / Consultant, failing which no claims by the contractor shall be entertained at a later date and shall be required to make good / repair / replace the damaged components at no extra cost.

6.2 Cleaning and Regular Maintenance

Till the commissioned equipment is finally accepted by Owner / Consultant / Engineer-in-Charge, Contractor shall be responsible for regular cleaning and maintenance of all electrical equipment. The maintenance job is to be done in consultation with or on advice from the Owner / Consultant.

6.3 Testing & Commissioning Requirements

6.3.1 All works shall be carried out in accordance with the drawings, suppliers' instructions / manuals for equipment and as per relevant standards and codes of practices.

6.3.2 Before conducting test on any equipment, the contractor shall obtain permission from Owner / Consultant / engineer-in-charge and all tests shall be conducted in their presence.

6.3.3 Records / results of each test shall be recorded by the contractor immediately after the test on approved Performa and counter signed by both the contractor and the owner’s authorised representative.

6.3.4 Copies of the record shall be handed over to Owner / Consultant / engineer-in-charge.

6.3.5 The contractor shall commission all electrical equipment and carry out all pre-commissioning / commissioning tests inclusive of no-load and on-load tests on motors / generators and shall be responsible for final adjustments of relays, motors, instruments, starters, breakers etc. as per operational data supplied and as per directions of Engineer-in-Charge.

6.3.6 Painting

The contractor shall without any extra cost, touch up with paint all electrical equipment which are damaged/ scratched during testing and commissioning work. The paint used shall match exactly painted surface of the equipment on which touch up is done.

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6.3.7 All terminations, cable joints, which are opened for testing purposes shall be re-terminated and re-insulated to restore their original state.

7.0 TESTING & COMMISSIONING SPECIFICATIONS

7.1 These specifications lay down the testing and commissioning procedures to be followed for each type of equipment, over and above the general requirements laid down in specifications for erection.

Manufacturer's instructions and any other instructions of consultant / owner / Statutory bodies shall also be followed by the contractor during testing and commissioning.

The contractor shall maintain and furnish the records of all equipments i.e. HT/LT panels, motors, transformers, CT, PT, relays etc. including any special test as per manufacturer's manual.

7.2 Transformers

7.2.1 The final testing shall be done in cold condition after drying out (Disconnect H.V. and L.V. side cables by removing links in disconnecting chamber, bus ducts or cables and also earth connections to neutral).

7.2.2 The insulation between windings and between winding and earth shall be measured with a motorized 2500/1100V megger. Compare the test result with the manufacturer's Test Certificates (for 11 KV windings, polarisation index to be noted). Auxiliary power cables and control wiring shall be tested with 500V megger and values shall be preferably more than 2 MΩ.

Polarization Index shall be recorded as below to determine whether drying is necessary or not:-

$$PI = \frac{IR\ 10\ Min}{IR\ 1\ Min}$$

Evaluation of insulation condition based	Base on PI	Drying on PI
Hazardous	< 1	Mandatory
Bad	1-1.5	Mandatory
Doubtful	1.5 - 2	Recommended
Adequate	2 - 3	No
Good	3 - 4	No
Excellent	> 4	No

7.2.3 Oil Tests

Crackle test: Cleaned Iron piece shall be heated red hot and put in the oil taken in a pot. In case of crackle sound, presence of moisture is indicated.

Dielectric strength test: It shall be carried out as prescribed in Appendix 'C' of IS: 335. The oil should withstand minimum of 40 KV for 1 minute.

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Even if the oil condition after final topping up is found to be satisfactory, it is advisable that as an additional precaution, the transformers shall be dried out as per following procedures.

7.2.4 Drying out

Drying out of the transformers shall be carried out in accordance with IS: 10028 and other relevant standards / manufacturer's recommendation or as advised by consultant / owner.

a) Before drying out, check for the following:

- Any oil leakage through bushings and radiators.
- Transformer tank is connected to earth.
- Temperature indicators are suitably calibrated.
- Capillary tube connections made to respective temperature indicators.
- MOG, if provided, is working properly.

b) Precautions when drying

i) Use only Alcoholic type thermometers for temperature measurement. Mercury Thermometers shall only be used where pockets are provided for this purpose.

ii) Maximum sustained temperature shall not be more than 80^{o}C. Do not leave the transformer unattended during drying out period. Watch the transformer during drying out process and record carefully all observations viz. oil temperature winding temperature and insulation resistance of H.V. and L.V. windings.

iii) Drying out to be continued till the insulation resistance value is steady prescribed in standard code of practice and IS: 10028 Part-II and that the steady value remains constant for 12 hours. Within the above period, several samples of oil are to be tested to ascertain dielectric strength. Record all readings (hourly / half hourly as advised by consultant / owner) of insulation resistance and temperature of oil & winding. Collect samples of oil from transformers from bottom only after the oil has been allowed to settle for at least 24 hours (collection of oil will be done in accordance with code of practice).

iv) It may be desirable that transformer oil shall be filtered by using filtration machine and Breakdown Voltage shall be measured before and after the filtration. The minimum Breakdown Voltage shall be 45KV for one minute.

v) In case the insulation resistance does not improve by the above method, it may be desirable to run the transformer for few hours on short circuit applying low voltage, approximately equal to impedance voltage, to the HV side after short-circuiting the LV side. During this process take regular readings of insulation resistance of the winding to earth, winding to winding and temperature against time and record.

vi) If found necessary/ depending upon the manufacturer's recommendations, a vacuum pressure of 635 mm of mercury shall be applied for the removal of air bubbles.

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vii) After drying out process, release hot air by opening vent cocks / screws. Close vent cocks and screws after release of air.

7.2.5 Ratio Test

Apply 3 phase 415 V supply on H.V. side for every tap position. Measure the voltage at L.V. side at all tap positions. Switch off supply before changing tap in case of off-load tap changer for every tap changing.

7.2.6 Polarity Test

Apply 3 phase 415 V supply to H.V. side. Join one terminal of H.V. side to corresponding terminal of L.V. side, say A-a, Measure voltage across A-a, A-b, A-c, B-a, B-b, B-c, C-a, C-b, C-c, N-a, N-b, N-c. Ascertain vector group from above test.

7.2.7 Magnetizing Current

Apply 3 phase 415 V supply to H.V. side and simultaneously measure the current readings of the three phases using low range A.C. ammeters of the same accuracy class.

7.2.8 Phasing of Transformers (for paralleling)

Connect two transformers in parallel on primary side. Connect secondary terminal ‘a’ to the bus bar which corresponds to the equivalent terminal of second transformer. Ensure that both transformers are at same tap. Then apply 415V 3-phase supply on the primary side. Close circuit breaker of second transformer. Measure voltage between corresponding secondary terminals of two transformers a1-a2, b1-b2, c1-c2. This voltage shall be zero in case both the transformers are of same polarity and phase displacement.

Use voltmeter having range double the reading of secondary voltage under test conditions.

In case of star connected secondary windings having star point earthed, secondary terminals need not be connected as stated earlier.

7.2.9 Buchholz relay testing

Insert air pressure through petcock gently till alarm contacts make. Pressurise further till trip contacts make. Check whether trip contacts make in case of low oil level.

7.2.10 Temperature indicators

Calibrate temperature indicator and test whether alarm contacts make properly.

7.2.11 Checks before commissioning

Before commissioning transformers, the following points shall be checked and ensured for safe energising of the transformer.

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a) General Inspection

i) Check assembly with reference to accessories and mountings according to relevant drawing.

ii) Check tightness of all cover bolts, flange connections etc.

iii) Check oil leakage through bushings, valves etc.

iv) Check shut off/open marking of radiator valves.

b) Oil Level

i) Check for correct level in conservators.

ii) Check for oil level in disconnecting chamber & pockets for thermometers.

c) Buchholz relay

i) Check that floats are at normal position and unlocked.

ii) Check shut off valve between relay and conservator is open.

d) Breather

i) Check that protective cover on air passage removed.

ii) Check oil level in seal chamber and condition of silica gel.

e) Explosion vent

i) Check diaphragm is intact and no oil visible in gauge glass.

ii) Check equaliser pipe valve between vent and conservator open.

f) Radiator

i) Check that all valves between banks and main tank open.

g) Thermometer

i) Check CT and Heater element connection for winding temperature indicator.

h) Wiring

i) Check wiring from instruments to Marshalling Kiosk & to switchboard / control panel.

ii) Check wiring of driving mechanism and control gears for tap-changer.

iii) Check wiring of cooling fans & pump circuits.

i) HV and LV bushing & Connections

i) Clean bushing and check connections with incoming / outgoing lines etc.

ii) Check oil level in bushings (in case oil filled & HV bushings) and release air.

iii) Check & adjust gap of arcing horn (HV bushings).

j) Check & release air through screwed petcocks, cocks etc. from Main tank, Radiator banks, Buchholz relays etc.

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k) Check & release air through screwed petcocks, cocks etc. from Main tank, Radiator banks, Buchholz relays etc.

l) After all checking is found O.K., the breaker for incoming of transformer shall be made ON for charging the transformer. It shall be watched for at 24 hours without load. Then it can be loaded after finding every thing O.K.

7.3 Switch Boards

7.3.1 General Checks

a) Check all auxiliary contacts of breakers for proper make-break operation.

b) If necessary, make minor adjustments to circuit breakers mechanism, auxiliary contacts etc. for proper operation of circuit breakers. Proper greasing and lubrication or mechanism must also be done before final commissioning.

c) Check for termination of control circuit wiring as per drawing and ensure that the terminals at equivalent and panel are mechanically sound.

d) Ensure proper operation of all test operation switches and push button.

e) Check wiring of all space heaters, indication lamps bells, buzzers etc.

7.3.2 Insulation resistance test

a) Measure the insulation resistance of main bus-bars (Phase to phase & Phase to earth) with 5000 V, 2500 V and 1000 V Megger (IR values shall generally be not less than 100 MΩ, 50 MΩ and 10 MΩ respectively in case of 11 KV, 6.6 / 3.3 KV & 415 V).

b) Insulation resistance of circuit breaker shall be measured with 1000 V Megger.

c) Control wiring shall be tested with 500 V Megger (IR values shall not be less than 2 MΩ).

7.3.3 High voltage Test

The test shall be conducted on switchgear rated 3.3 KV and above. Test voltage shall be as per relevant Indian Standard. However, for AC High voltage test, the value shall be twice the working voltage of the switchgear plus 1000 V. This voltage shall be maintained for one minute. Each phase shall be tested in turn, with remaining phases earthed. After high voltage test, a further Megger test shall be made to make sure that insulation resistance to earth has not altered appreciably. The reading of second megger test shall be consistent with that of the first.

AC test voltage for 1 minute duration shall be as follows:
24 KV for 11 KV panel, 15 KV for 6.6 KV panel and 8 KV for 3.3 KV panel

7.3.4 Testing of current transformer

a) Insulation resistance to earth of secondary winding shall be tested with 500V megger (remove earth connection before test).

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b) Check the polarity of C.T. – Connect zero centre voltmeter in the secondary winding, connect 6 V batteries with switch in the primary. Close the switch and from the kick of the voltmeter, ascertain the polarity.

c) Ratio test shall be carried out by injecting current in the primary and subsequently secondary side current shall be checked.

7.3.5 Testing of P.T. Insulation.

Testing of HT & LT side of PT shall be done with 1000 V & 500 V megger respectively (the value shall not be less than 100 MΩ, 50 MΩ & 10 Ω, respectively for the voltage rating 11KV, 6.6KV & 400V).

7.3.6 Testing of Relays

a) Checking of wiring shall be done according to Manufacturer's drawings. Check relay continuity at all taps also ensure plug bridge contact satisfactory.

b) Secondary injection test.

Use secondary injection test set incorporating timer. Testing of all protective relays such as but not limited to over current, earth fault differential, motor protection, directional feeder protection, under voltage relays etc. shall be done as per the procedure set by the manufacturers of the relays. All time delay relays shall be tested to verify their characteristics for IDMT and instantaneous relay pick up and drop off values shall be noted at various taps. Relays shall be tested at all taps. Errors shall be calculated and compared with permissible limits specified by manufacturers. Adjustment, such as in establishing circuit, shall be done as recommended by manufacturer. After testing, relays shall be set at values given by Consultant.

c) Timer relay shall be tested and calibrated and set properly.

d) All auxiliary relays shall be tested for proper operation.

7.3.7 Testing of Instruments

All indicating and recording instruments like Ammeter, Voltage meter, KWh meter etc. shall be calibrated. Zero error of each instrument shall be corrected.

7.3.8 Operational Tests

Conduct the following operational tests after putting the circuit breaker at test and service position. Check that the fuses of proper rating are put in control circuit as per wiring diagram.

a) Close and trip the circuit breaker several times with power or manually. In case of motor operated spring charged closing mechanism, check the operation of charging motor. Ensure that it cuts in / off properly.

b) Check the indication scheme: 'ON', 'OFF', trip circuit healthy, auto-trip indication etc.

c) Trip the breaker by operating the protective relays (operate contact manually).

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d) Check the trip free feature.

e) Check the anti-pumping feature.

f) Check operation of voltage selector relay scheme for supply.

g) Check annunciation scheme for AC/DC power supply failure.

7.4 Motor Control Centres / Power & Motor Control Centres

In addition to checks and tests (wherever applicable) detailed under Clause No. 7.3 above, the following shall also be carried out:

7.4.1 Insulation resistance test of the main bus bars, starter units control wiring etc. shall be done with 500 V megger.

7.4.2 Each motor starter shall be tested for correct operation. All operational tests to verify sequence of operation, inter-locking and alarm indication schemes (by simulating the connection) shall be done.

7.4.3 Bi-metallic type thermal over load relay shall be tested at different settings. Current shall be injected through the thermal elements (three elements can be connected in series) at twice and thrice the set value and tripping time shall be noted. The values shall be compared with the data supplied by manufacturer.

7.4.4 Single-phase prevention relays shall be tested for proper operation.

7.4.5 Check that fuses of specified ratings are put in various outlets.

7.5 Soft Starter Panel

In addition to the procedure laid above in Clause Nos. 7.3 & 7.4, any other instruction given by the manufacturer shall also be followed.

7.6 Panelled Equipments

These include relay and alarm panels, Rectifier panels, Battery charger panels DC / AC distribution boards, conveyors / control cum power supply panels, UPS, inverter static power supply, Variable Frequency Drive and PLC. Details shall be indicated in project specific Schedule of Rates.

7.6.1 Test insulation resistance with 500 V megger.

7.6.2 All operational tests to verify function of each component like relays, switches etc. and sequence of operation, interlock, alarm system as per circuit diagram.

7.6.3 Invertors / Thyristor controlled panels, static power supply system units, Variable Frequency Drive and PLC panels shall be tested as per the instructions of manufacturer.

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7.7 Cables

7.7.1 All HT (11KV, 6.6KV & 3.3KV) cables shall be tested for insulation resistance with 5KV / 2.5KV motorized meggers and LT cables shall be tested for insulation resistance with 1000 V megger before and after termination. IR shall be measured between phases and between phase and earth. The voltage shall be applied for 1 minute.

7.7.2 All the 3.3KV, 6.6 KV and 11 KV cable joints shall be tested on high voltage as per IS: 1255 after making all termination and joints followed by IR test.

7.8 Lighting

7.8.1 Before energising any lighting circuit, the IR values (phase/ phase and phase/ earth) shall be recorded for entire wiring installation. The testing shall be done with 500 V megger. After switching on the power supply, load of each circuit shall be measured.

7.8.2 Illumination levels shall be tested and same shall not be less than the levels mentioned below for specific areas, unless otherwise specified elsewhere:

a)	Control room, Laboratory	:	500 Lux
b)	Office area / operators / UPS room	:	300 Lux
c)	Switchgear room	:	200 Lux
d)	Cable cellar	:	70 Lux
e)	General process area	:	60 Lux
f)	Cooling tower	:	60 Lux
g)	Battery room	:	150 Lux
h)	Compressor area	:	150 Lux
i)	Pump house, sheds	:	100 Lux
j)	Loading areas and staircases	:	60 Lux
k)	Roads and tank farm	:	10 Lux

7.9 Earthing

The continuity of earthing and resistance of each earth pit and grid shall be measured with earth megger. The resistance of grid connecting all earth pits shall be less than one ohm.

7.10 Miscellaneous Equipment

Under this are included, exhaust fans, blowers, limit switches, vibrators, electro-magnets, air pressurisation unit etc. The following tests shall be conducted:

7.10.1 Measurement of insulation resistance

7.10.2 Check up the direction of rotation.

7.10.3 Operational test

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7.11 Motors / Generators

7.11.1 General Checks

a) Check the alignment of motor/generator with the driven equipment/prime mover.

b) Check and calibrate motors/generators, safety switches, bearings/ air temperature indicators, winding temperature indicators, water flow/ air flow pressure meters, lubricating oil pump motors.

c) Check operation of space heaters.

d) For motor/generator standing idle for a long time, carry out overhauling, re greasing and drying.

7.11.2 Check the condition of grease in bearings and if required replace completely with fresh grease after proper cleaning of bearings. This work shall preferably be taken up before final alignment of motor with driven equipment.

7.11.3 In case of oil lubricated bearings, the bearing housing shall be flushed with oil and then filled up to the specified level. Check that oil ring rotates freely along with motor. In case of pedestal type journal bearing, it may be necessary to open the top cover, and check the bearings.

7.11.4 Fix up all accessories like techno-generators, water pressure relay, temperature detectors and any other safety switches after calibration.

7.11.5 Check that the shaft rotates freely. This shall be done after decoupling the motor from driven equipment.

7.11.6 Check air gap between rotor and stator (wherever possible) at three places at 120^{o} apart on both sides of drive and verify with the figures furnished by the manufacturers. The variation shall not exceed 10% of average value.

7.11.7 Check the tightness of foundation bolts. Ensure pins are fitted before commissioning of motor.

7.11.8 Check that power and control cables are properly connected and tightened. All earth connections of the machine shall be checked.

7.11.9 In case of forced ventilated motor, clean the ventilation duct. Ensure that recommended flow and pressure of air is available to produce the required cooling effect. If the motor is provided with air to water heat exchanger, check for the adequate flow of water. If necessary, clean the exchanger to remove any obstruction to water flow. Check that there is no leakage from water cooler, pipe connections.

7.11.10 Check the space heater circuit. Space heaters shall be provided on all HT and special type LT motors. Switch on spare heater supply at least one week before the commissioning of motor. Wherever drain plugs are provided in motor body, open and check for water accumulation inside motor.

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7.11.11 Testing

a) Insulation Resistance Test

The insulation resistance of LT motors shall be measured between the winding of the machine and its frame by means of 500 / 1000V megger. A minimum value of 1 MΩ for 400 V motors shall be considered a safe value.
3.3KV, 6.6KV and 11KV motors / generators shall be tested for insulation by 1000 5000 V megger and its value shall not be less than 1 MΩ for each KV. However, it is desirable that before commissioning the motors, the insulation resistance shall be improved substantially above the lower limits. The contractor shall carry out heating of winding as per the advice of the consultant/Owner. The following methods may be adopted.

b) Drying

i) Blowing hot air

ii) Placing heater or lamps around and inside, in case of small motors after making suitable guarding and covering arrangement so as to conserve that heat.

iii) Heating by injecting low voltage in the winding low voltage output of welding set shall be used. The winding shall be inter-connected so that current flows through each phase, and particular care shall be exercised to prevent local over heating. The voltage applied shall be suitably adjusted. The maximum temperature of winding, while drying, shall be 70^{o} to 80^{o}C by thermometer or 90o to 95^{o}C by resistance method. Heating shall be done slowly first till steady temperature of winding is reached (may be within 4 to 8 hours depending upon size of motor) once the steady temperature is reached, maintain it for some time.

iv) Check the insulation resistance which will drop first and then become steady. Hourly reading of IR shall be taken and temperature shall be recorded 1/2 hourly. If IR is reasonably steady, supply can be switched off. Measure IR under cold condition. Never keep the motor unattended during drying process.

v) For checking polarisation index of HT motor, use electric driven megger. Note IR value after 1 minute and 10 minutes. The ratio shall be compared with data supplied by manufacturer (but shall be not less than 2.5).

7.11.12 Operational Test

a) Check control gear and set the protective relays as per settings supplied by Consultant. It is preferable that before first no-load run, the settings may be kept lower than 100%. However, during load running, settings shall be restored to Normal. Simulation test shall be conducted on motor starter, circuit breaker (main fuses removed on CB at test position). All interlock shall be incorporated in the control system. Testing shall be done from local and remove control station and shall be ensured that the control system works satisfactorily. In case of any defect in the integrated control wiring the contractor shall locate and rectify such defects.

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b) Any other tests recommended by the manufacturer for special type equipment like variable speed motors etc. shall be done.

7.11.13 No-load Test

Finally the motor shall be started on no load after decoupling. Check the direction of rotation and change if required. The motor shall be run for 8 to 10 hours. Voltage, starting current, and starting time shall be noted. Hourly reading of current, winding and bearing temperature, (for small motors body temperature to be measured by thermometer) shall be noted. Note vibration, excessive noise if any.

In case of variable speed motor, variation of speed shall be checked and regulation of speed noted.

7.11.14 After switching off the motor, the insulation resistance shall be measured under hot and cold condition.

7.11.15 If the no-load trial run is found satisfactory, the motor shall be run on load after adjusting the protective relay setting to 100% value. Note the starting time, load current, winding temperature etc. The temperature rise shall not be more than the specified value. Check for any excessive vibration or noise.

7.11.16 Generator shall be tested in the presence of manufacturer's representative only as per their instructions.

8.0 DOCUMENTATION

8.1 For the purpose of completion certificate, the following documents will be deemed to form completion document:

i) The technical documents according to which the work was carried out.

ii) Final check-list and completion report.

8.2 Three sets of construction drawings showing therein the modifications and correction made during the course of execution signed by Owner/ Consultant/ Engineer-in-charge.

8.3 Test certificates for the materials purchased by Contractor.

8.4 Material appropriation statement for the materials issued by Owner for the works and list of surplus materials returned to Owner's stores duly supported by necessary documents.

8.5 No claim certificate by the Contractor certifying that the entire work done by him under the contract has been measured and accepted for the final bill to his satisfaction and that he will have no claim(s) concerning any work(s) or part thereof performed by him under the Contract, to Owner except otherwise indicated in the final bill.

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8.6 The completion certification shall be issued by Owner within 30 days of the Contractor furnishing documents listed in this clause jointly certified by Owner/ Consultant and Contractor's Site Engineer.

9.0 HANDING OVER TO OWNER

9.1 The contractor shall hand over the complete installation as a whole. Minor details not specified or mentioned in the scope or schedule of rates but required to complete the job as a whole will have to be done by the contractor without extra cost. Any equipment/ installation shall not be deemed as handed over to Owner until the same is complete in all respect and is accepted in writing by the Owner/Consultant.

9.2 The final acceptance of the work shall be after the demonstration of guarantees by the Contractor and Owner shall issue the final acceptance/ taking over certificate upon fulfilment of the guarantees.

10.0 OBLIGATIONS & RESPONSIBILITIES OF CONTRACTOR

The contractor's obligations and responsibilities shall include but not limited to the following:

10.1 To deploy skilled, semi skilled and unskilled personnel in requisite numbers and as per scheduled programme so as to complete the WORK as per overall project schedule.

10.2 To deploy suitably qualified supervisors and engineers in requisite numbers to assure execution of good quality job as per best engineering practices and to the full satisfaction of Owner / Consultants / Engineer-in-charge.

10.3 To prepare detailed planning and execution schedule considering the availability of fronts and materials. This shall be reviewed by Owner & consultant and Contractor shall be required to keep updating the same (as per the instructions of Owner / Consultant / Engineer-in-charge) to take care of any changes in the availability of fronts and materials and to complete all jobs as per the overall project schedule. Owner / Consultant / Engineer-in-charge shall in no way be held responsible for such changes because such changes are deemed quite a common feature in any project of this size.

10.4 To check for quantity compliance between bill of materials and drawings for cable, structural, earthing materials etc. and intimate Owner / Consultant / Engineer-in-charge sufficiently in advance regarding discrepancies, if any.

10.5 Construction power shall be made available at one point. Arrangement for distributing the same to various areas for construction shall be the contractor's responsibility.

10.6 To arrange and supply all tools and tackles, consumables, instruments, erection materials & machineries etc. for handling erection, testing & commissioning of

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complete electrical installation. List of major tools and tackles required are as listed below:

i. Cranes, winches, chain pulley blocks etc. in required quantity and of suitable capacity.

ii. Trailers with prime mover/Tractor trailers.

iii. D-Shackles, slings, wire ropes etc.

iv. Transformer welding sets

v. Water level, spirit level etc. for levelling and alignment.

vi. Gas cutting sets

vii. Drilling/Grinding machines

viii. Jacks with spindles (for cable drums)

ix. Pipe bending machine

x. Hydraulic crimping tools set

xi. Hand crimping tools set

xii. Air blower/vacuum cleaner

xiii. Streamline transformer oil filtration machine with temperature and pressure gauges.

xiv. Transformer oil dielectric strength testing machine, portable type.

xv. High voltage testing set.

xvi. Secondary injection testing set

xvii. 5 KV motorised Megger Insulation tester

xviii. 500 V to 2.5 KV each rating hand operated ‘Megger’ Insulation tester

xix. Earth resistance tester with leads and spikes

xx. Clip on ammeters/tong testers

xxi. Tachometers/ Tacho-generators (for RPM checking)

xxii. Phase sequence meter

xxiii. Primary injection set up to 2000 amps., if required

xxiv. Grease gun for greasing of motors

xxv. Wooden sleepers of proper size and in adequate numbers.

xxvi. Scaffolding materials as required.

xxvii. Any other tools and tackles and facilities required completing all the jobs as per ITB to the best engineering practices.

xxviii. Drilling M/C for drilling hole in RCC Roof/ Column for grouting expansion bolts.

xxix. DG set for construction power

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10.7 To arrange and supply all consumables (required for executing the under question) such as but not limited to the following in sufficient quantity, of required quality and in time to meet the schedules:

Electrodes, filler wires, industrial gases, such as oxygen, acetylene, diesel, petrol, kerosene, CTC, standard grease/ lubricant for motor bearings, insulating tapes, compounds, solders, fluxes, rawl plugs, phil plugs, saddles & bars, ferrules, bricks, sand, cement, stone chips, clamps, tags, shims, hard wares, paints, thinners (as required), salt and charcoal (for each electrode pits), copper lugs for GI earth wires, cotton waste, marking cloth, sand papers, emery papers, thread, nylon ropes.

10.8 To arrange and supply storage tanks for drinking water so as to avoid any inconvenience that may be caused due to interruption in water supply at times.

10.9 To provide proper storage and security arrangements for Contractor's tools, tackles, equipments, materials etc. as well as equipment and materials issued by Owner/ Consultant to Contractor. Owner/ Consultant shall not be responsible for any loss or damage to items in the custody of Contractor at site for any reason whatsoever.

10.10 Completion of all repairs arising out of defective work done by Contractor Owner/ Consultant / Engineer-in-charge may at his discretion require the Contractor to rectify certain defects in materials caused due to bad workmanship of supplier and/or during transportation. For such work of course, the payment modalities shall be settled by mutual agreement before starting such rectification jobs.

10.11 To maintain all the records for men, materials and execution of job as required by law as well as Owner / Consultant / Engineer-in-charge.

10.12 To get his work inspected by Owner / Engineer-in-charge and approved from statutory agencies such as but not limited to Electrical Inspector, Factory Inspector etc.

All co-ordination with Statutory Authorities shall be contractor’s responsibility. Only statutory fee required for approval shall be paid by the owner.

10.13 To make arrangements for services such as transport, medical, lighting, canteen etc. for working round the clock.

10.14 In addition to safety regulations indicated in this enquiry Owner / Consultant / Engineer-in-charge may issue certain safety directives, which shall have to be followed meticulously without any reservation.

10.15 To undertake and execute work and supply as per scope of work, scope of supply, to follow Technical Conditions including specification for electrical erection, specification for electrical testing and commissioning and as per schedule of rates. In honour all other obligations listed in other sections and sub-sections of this enquiry.

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10.16 Reconciliation of materials issued to Contractor as directed by Owner / Consultant / Engineer-in-charge.

10.17 Handing over of the completed works to Owner / Consultant / Engineer-in-charge as per procedure laid down by Consultant.

10.18 To submit documentation forming part of request for issue of completion certificate.

10.19 Clearing the site after cleaning the areas where the Contractor executed the job, stored the materials and built his office, fabrication shop etc.

11.0 TERMS AND CONDITIONS

11.1 All the work shall be carried out in accordance with drawings supplied to the contractor and the entire installation shall conform to the Indian Electricity Rules/ Regulations/ Acts and with latest issue of relevant IS, Specifications, drawings & documents supplied by Consultant/ Supplier/ Owner and as per the directions of Owner / Consultant / Engineer-in-charge.

11.2 Contractor's Staff

The contractor shall employ all skilled, semi-skilled, non-skilled labourers necessary for erection, installation testing and commissioning. All electricians, cable jointer, wire man and others employed by the contractor shall be suitably qualified and must possess valid certificates / licences recognised by the competent authorities.

Engineer-in-charge at his own discretion may put any electrician / wireman / wire cable jointer to test for ascertaining the competence of the technician concerned and the contractor shall have to replace any staff found incompetent to execute the jobs as per requirements, in the opinion of the Owner / Consultant / Engineer-in-charge. The contractor shall also furnish a list of such staff and indicating whether he holds such competence certificate to supervise electrical installation jobs as required under Indian Electricity Rules and Regulations, and State Inspectorate Rules.

11.3 Contractor's Workshop

The Contractor shall set up his own workshop having facilities to undertake all jobs connected with, Erection, Testing and Commissioning. He shall provide all facilities at site to undertake steel fabrication work e.g. fabrication of cable racks/ trays, cable supports/brackets/ frameworks/ base frames for electrical equipment etc.

The contractor will be required to provide workshop and other facilities to undertake minor fabrication work, including conduit bending and threading, fixing rawl plugs, welding supports, making brackets, small foundation bolts, protective guards, and such other miscellaneous items as may be necessary for completing the erection, testing and commissioning jobs. The contractor shall also, on his

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own, set up adequate office, stores, godowns etc. for his work in the area / space provided by the Owner / Consultant / Engineer-in-charge.

11.4 **Tools and Tackles**

The contractor shall have to arrange all tools, tackles including various erection machineries and instruments for measuring, testing, calibrating etc. required for erection as well as for Testing and commissioning on his own, such as compressors, cranes, winches, jacks, chain pulley blocks, welding sets, oxygen, acetylene gas cutting set, drilling machines, grinders, pipe bending machines, dies for pipe threading, scaffolding materials, cable jointing/ crimping tools, megger, ductor, filtering machines, earth tester, secondary injection sets, sub-standard meters for calibration of ammeters, voltmeter, oil testing-sets, Multi meters, phase sequence meters, HT test set, primary injection (if required), clip on ammeters (tong testers), techo-generators etc.

11.5 **Materials**

11.5.1 All materials shall be in contractor's scope of supply, unless indicated to be supplied by Owner. The contractor shall have to arrange at his own expenses all consumables required by him for erection as well as for testing and commissioning like Kerosene oil, petrol, CTC, grease, petroleum jelly, rawl plug, phil plug, screws/nails, wires for portable tools, lights, plugs, cotton waste, jute dusters, shims for alignment / levelling, cement, sand, stone chips, bricks, reinforcement rods, welding electrodes paint, insulating taps, compounds, solders fluxes, ferrules, nut bolts, washers, cable clamps, cable tags and such other materials contractor might need to execute the complete job. The contractor might need to execute the complete job. The contractor shall also provide foundation bolts, for all floor/ wall mounting equipment as per requirement at site. All hard wares supplied by the contractor shall be of GI. All GI materials shall have a minimum zinc coating of 800 g/m^2 at any point on the surface.

11.5.2 All equipment and materials including Instruments / meters required for measuring, checking, testing and commissioning are included in the scope of the contractor and shall be arranged and supplied by the contractor himself

11.6 **Inspection**

11.6.1 Electrical Installation work shall be subject to inspection by Owner's/ Consultant's engineers, statutory bodies like Electrical Inspector, Factory Inspector, and wherever applicable by equipment supplier's engineer. The contractor shall carry our without extra cost all damages/rectification/modification desired by the above engineers/ inspectors or to make the installation conform to relevant Electricity Rules etc.

11.6.2 Further the Owner/ Consultant may reject any portion of the work considered defective or of poor workmanship and contractor shall make good these defects without extra cost.

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11.6.3 Owner/ Consultant reserves the right to get such repairs/replacements done from any other agencies in case the contractor fails to do the job within a period of 7 days after the request has been made to him in writing and the cost of such alteration/ repair/ testing shall be recovered from the contractor and will be adjusted against any bill due to the contractor.

11.7 Completion of work

Work shall be deemed to be incomplete until such certificates as required under statutory regulations are obtained and delivered to Owner / Consultant / Engineer-in-charge.

11.8 Clearing of Site

The contractor will be responsible for the final clearing of site after completion of erection works as well as after completion of jobs connected with testing and commissioning. He will return all excess materials such as cables, earthing materials etc. to the Stores under instructions from Owner / Consultant / Engineer-in-charge. All empty cable drums, packing materials, cut-pieces of cables, steel scraps, and other materials, supplied by Owner for the job shall be shifted to a suitable place by contractor as per instruction of Owner / Consultant / Engineer-in-charge. Contractor will also be responsible for demolition and clearance of temporary sheds and structures put up by him.
All clearance of unwanted materials shall regularly be done as per advice of the Owner / Consultant / Engineer-in-charge.

11.9 Materials utilisation statement and permissible wastage

After completion of the erection, the contractor shall submit to the Owner / Consultant a statement giving details of materials drawn from stores and quantity used in erection, balance quantity returned to stores and quantity of scraps for his checking & approval.

The scraps of steel shall not be more than 2% of total quantity used for erection. For cables, the quantity of scrap allowable is as follows:

a) 11 KV and 6.6 KV cables : 1% of actual quantity laid
b) 1000 volts & below grade power and control cables : 2% of actual quantity laid
c) Lighting cables only : 3% of actual quantity laid

Any cable cut piece less than 5 mtrs. and structural steel less than 1 mtr. shall be considered as scrap.

11.10 Civil Foundation

Owner / Consultant will give necessary civil foundations ready complete with location of foundation bolts, sleeves etc. before the contractor is expected to commence his work. Minor rectifications and chipping etc. may, however, have to be carried out by the contractor, if found necessary while grouting the foundation bolts. Contractor shall check the foundations cleared by other agency; Owner /

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Consultant shall not be responsible for any delay. But all concrete cutting and chipping work necessary for fixing and grouting of base channels for switchgear and control panels will have to be done by the contractor.

12.0 MEASUREMENT

12.1 For all payment purposes, the measurement will be based on physical measurement. Wherever it is not possible to take physical measurement, payment shall be made on the basis of drawing. The contractor in the presence of Owner/ Consultant/ Engineer-in-charge will take physical measurement.

12.2 Measurement of weight / length / area / volume will be in metric system corrected to nearest kilogram / centimetre / square centimetre / cubic centimetre.

12.3 For structural steel works measurement and payment will be made on weight basis.

12.4 Measurement for cable laying shall be made on the basis of length actually laid between end terminations including that of loops provided and paid accordingly.

13.0 PRIOR APPROVAL OF THE MATERIAL TO BE SUPPLIED BY CONTRACTOR

All items to be supplied by the contractor shall be of superior quality and shall be of approved make. These shall be as per specifications and conforming to relevant Standards.

14.0 RECOVERY AGAINST OWNER'S UN-RECONCILED MATERIALS

The contractor shall be responsible for material utilisation statement. Any equipments or materials not reconciled shall be charged back to the contractor.

15.0 STATUTORY APPROVALS

All co-ordination at site with statutory authorities (including inspection of completed WORKS from statutory authorities) shall be in the scope of CONTRACTOR. Only statutory fees deposited by CONTRACTOR for approval of installations and works shall be reimbursed to the CONTRACTOR on production of documentary evidence.

16.0 GUIDELINES FOR SAFETY MEASURES

Requirement of electrical power for any construction activity is of prime importance. The utilization of power in any construction site shall be done with utmost care to avoid accidents due to electrical shocks, fire due to electrical short circuits. Electrical installation increase the risk of such accidents, if it is exposed to adverse environmental conditions i.e. presence of hazardous gases. Hence, it is absolutely essential to take extra precaution for such installation to ensure safety of personnel and equipments.

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This standard gives details of required safety measures to be adopted for the electrical installations by all contractors during construction activities. Following are some general guidelines & check points that should be followed:

16.1 All electrical connections for electrical installations shall be carried out as per provisions of the followings latest codes and standards in addition to the requirements of statutory authorities and IE rules:

OISD – STD – 173 : Fire prevention and protection system for electrical installations

IS – 30 : National electric code

16.2 All electrical connections shall be done by a competent electrician having valid license and to the satisfaction of Engineer-in-charge and one competent licensed electrician shall be made available by contractor at site round the clock to attend the normal / emergency jobs.

16.3 All necessary personal protective equipment (PPE), Safety equipment shall be made available to use for persons employed by the contractors on the site and shall be maintained in condition suitable for immediate use. Protective equipment for head protection, body protection, eye protection, hand protection, hearing protection & respiratory protection shall be made available by the contractor. No loose clothing shall be allowed.

16.4 When workers are employed on electrical installations, adequate safety items / charts viz. fire extinguishers, insulating mats, hand gloves, multilingual (English, Hindi & local languages) caution boards, shock treatment charts and instruction plate containing location of isolation point for incoming supply, name and telephone number of contact person in emergency shall be provided in substation and near all distribution boards / local panels. The workers shall not wear any rings, watches & carry keys or other materials, which are good conductors of electricity.

16.5 When work has to be done on elevated places, towers, roofs, pipe racks & other lofty positions where plat-forms & other fall guards are not there, use of SAFETY BELT is compulsory. Safety Nets will prove very helpful in case somebody slipped from height.

16.6 All welding machines and switchboards shall be kept in well-ventilated and covered shed. The shed shall be elevated to avoid water logging. Use of flammable material shall be prohibited for construction shed; also flammable material shall not be stored in and around electrical equipments. Adequate clearance and operational space shall be provided around the equipment.

16.7 No work, however, small should be undertaken / started without obtaining valid work permit from the concerned department. Confined space entry should be done only by valid entry permit from the Engineer-in-charge. Safety permit shall be obtained before taking the temporary electrical equipment inside the hazardous area.

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16.8 No work must be carried out on any live equipment. Electrical equipment should be considered live unless it is ensured that they are isolated & made dead / safe. A 'permit-to-work' shall be issued before any work is carried out. Don't tamper with any type of electric switches / equipments or any other appliances or moving machinery installed in factory area without permission.

16.9 Before the contractor connects any electrical appliance to any plug / socket belonging to the other contractor / owner, he shall:

i) Indicate to the Engineer-in-charge that the appliance is in good working condition.

ii) Inform the Engineer-in-charge of the maximum current rating, voltage and phase of appliance.

iii) Obtain the permission of the owner dealing the sockets to which the appliance may be conducted.

16.10 The Engineer-in-charge shall not grant permission to plug-in until he is satisfied that:

i) The appliance is in good working condition and is fitted with a suitable plug.

ii) The appliance is fitted with a suitable cable having earth conductors.

16.11 All temporary installation shall be tested before energizing to ensure proper earthing, bonding and suitability of protection system and adequacy of feeders / cables.

16.12 Voltage for all portable equipment viz. drilling machine, temporary lighting etc. will not exceed 240 volts.

16.13 Earth leakage device shall be checked for operation regularly by temporarily connecting the series lamps. The operating current of earth leakage device shall not exceed 30mA.

16.14 All the electrical equipments should be properly earthed as per Indian Electricity Rules.

16.15 Use of hoisting machines & tackle including their attachments, anchorage & supports shall be good of mechanical construction, sound materials & adequate strength & free from patent defect & shall be kept in good condition & in good working order.

16.16 No welding / grinding / cutting / soldering or open flare / fire etc. should be done without valid safety permit issued by the Engineer-In-charge. While welding / grinding / cutting make sure that sparks & molten slag etc. don't fly or come into contact with combustible materials surrounding equipments, valves etc. i.e. make provision for collection of sparks by using 'Fire Blankets'.

16.17 Use of SAFETY APPLIANCES like safety goggles, canvas hand gloves, welding helmet, chrome-leather hand gloves, safety shoes, etc. during welding/ chipping/ grinding should be enforced.

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16.18 The following design features shall be ensured for all electrical installation during construction phase:

i) Each installation shall have a main switch with a protective device, installed in enclosure adjacent to the metering point. The operating height of the main switch shall not exceed 1.5M. The main switch shall be connected to the point of supply by means of armoured cables.

ii) The out going feeders shall be double or triple pole switch with fuses / MCB. Loads connected to three phase circuit shall be balanced as far as possible and load on neutral shall not exceed 20% of load in the phase.

iii) The installation shall be provided adequate protection against overload, short circuit and earth leakage by using suitable protective devices. Fuses wherever required, shall be of HRC type only. Use of rewireable fuses shall be strictly prohibited.

iv) Connections to the welding receptacles / hand tools shall be taken through proper switches, sockets and plugs.

v) It shall be ensured that all single phase sockets shall be 3-pin type only and all unused sockets shall be provided with socket caps.

vi) Contractor shall use 3 core (P+N+E) overall sheath flexible cables with minimum conductor size of 1.5 sq. mm. copper for all hand tools.

vii) Metallic distribution boxes with double earthing shall be used only at site. No wooden boxes shall be used.

viii) It shall be ensured that cables to be used for installation purpose shall be free from insulation damage.

ix) An independent earthing facility should preferably be provided within the temporary premises.

x) For local earthing, separate earth electrodes shall be installed near the supply point and earth continuity wire shall be connected to local earth plate for further distribution to various appliances. All insulated wires for earthing shall have insulation of green colour.

xi) It shall be ensured that structures shall not be used as a neutral. Separate core shall be provided for neutral earth.

xii) ON / OFF position of all switches shall be clearly marked / painted for easy isolation in emergency.

16.19 Don’t check gas leaks with lighter, matches or other flame. Always keep gas cylinders away from direct rays of sun, hot place, welding, grinding & cutting sparks. Valves on cylinders should not be lubricated. Gas cylinders should be kept away from work place & Acetylene cylinders should be kept vertical. Cylinder should not be rolled on roads for transportation from stores or one place to another place, use suitable handcart for the purpose. It is prohibited to carry gas cylinder up-stair in the plant or in-side the vessel or confined spaces for cutting / welding job.

16.20 Permission of a supervisor before any excavation is a must. Also the presence of underground electric cables or any pipelines must be taken care of during

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excavation. Excavated earth must not be dumped within five feet. The further the better.

16.21 All the sewers or openings / cut-outs should be kept covered to avoid pit falls. Red illuminated signal should be displayed so that nobody goes near the pit / opening during dark hours. Proper approaches / scaffoldings / ladders etc. must be provided to avoid falls.

16.22 Be careful to keep all aisles, passageways and stairways clean & unobstructed. All discarded metal & other scrap should be collected. Storage area for keeping equipments, machines & other raw materials should be isolated & properly protected. Combustible materials like wooden pieces, cotton waste, bags etc. should be immediately removed to safe places.

16.23 Sitting or walking on rail tracks, crossing between wagons, taking rest under stabled wagons, crossing the rail through the openings underneath the stationary wagons shall be strictly prohibited. Standing under a suspended load is very dangerous. It may slip & fall on you thereby causing serious injury & even death.

16.24 Hands should be thoroughly washed before touching anything that goes in your mouth. All concerned personnel at site should maintain a high standard of 'Cleanliness'. Smoking & carrying matchbox, cigarettes, lighter, bidis etc. shall be prohibited.

16.25 Unauthorized entry into any battery limit of plant shall be strictly prohibited. Reckless driving or other non-observance of traffic safety rules shall result into withdrawal of permission to carry vehicles in side factory.

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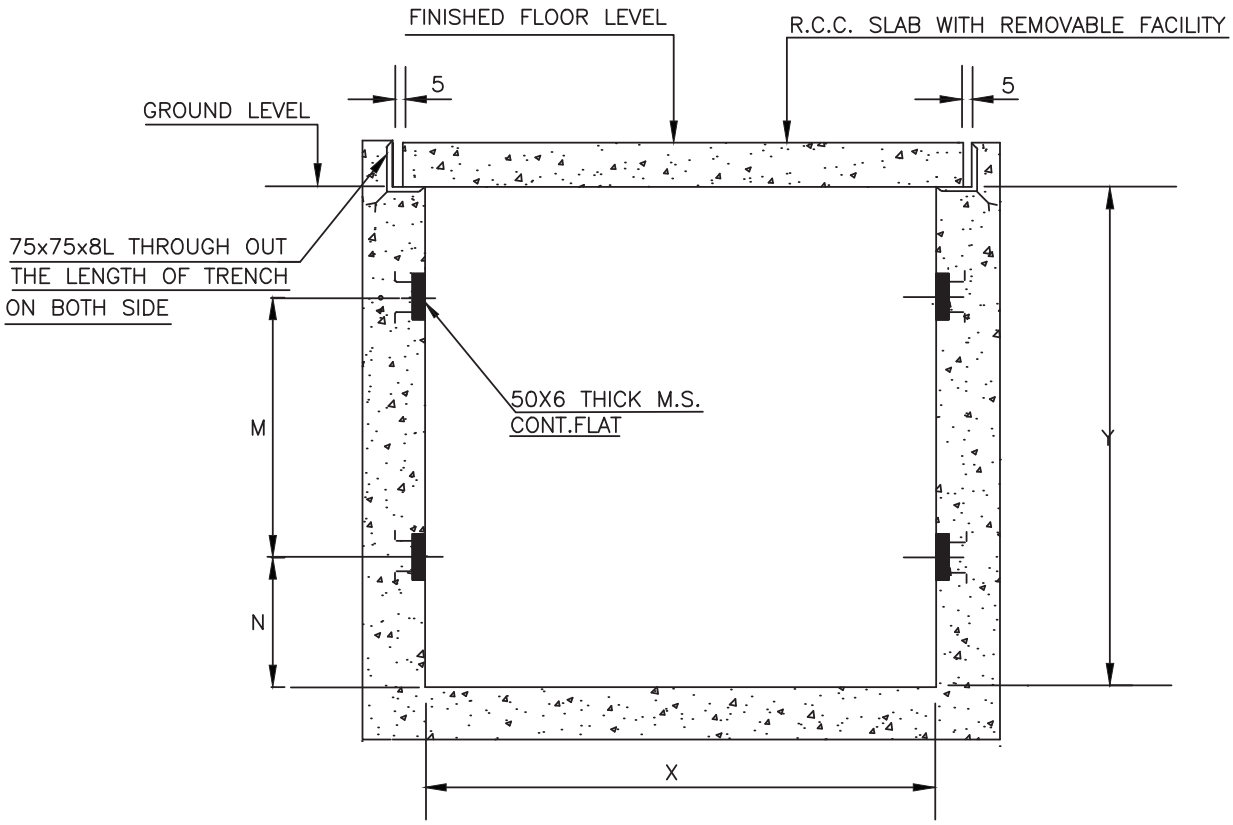
पी डी आई एल PDIL	DETAILS OF CONCRETE CABLE TRENCH	PC183–PDS:E 510	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



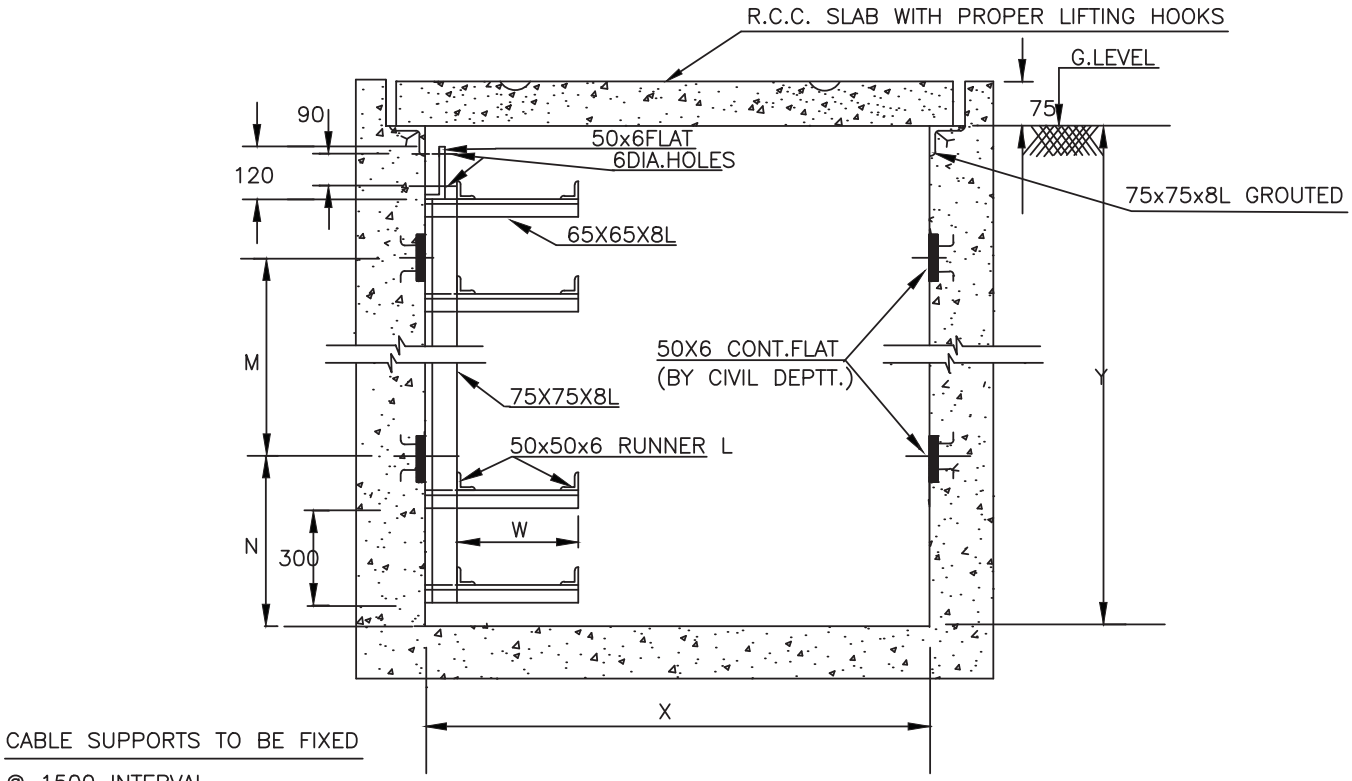
SECTION OF TRENCH

DESIGN TYPE	X	Y	N	M
5T 350DS.	1400	1500	400	650
4T 350DS.	1400	1200	250	650
3T 350DS.	1400	900	250	300
5T 350SS.	1000	1500	400	650
4T 350SS.	1000	1200	250	650
3T 350SS.	1000	900	250	300
5T 250DS.	1200	1500	400	650
4T 250DS.	1200	1200	250	650
3T 250DS.	1200	900	250	300
5T 250SS.	900	1500	400	650
4T 250SS.	900	1200	250	650
3T 250SS.	900	900	250	300

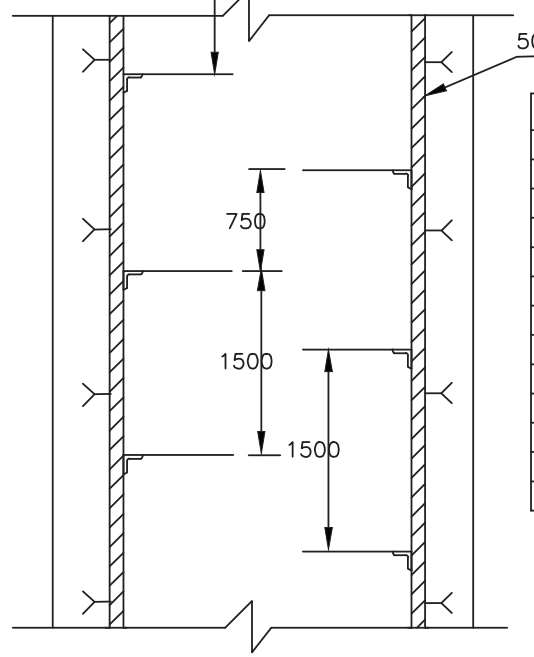
NOTES:–

1. THE TOP OF TRENCH SHALL MATCH THE FLOOR LEVEL IN PLANT AREA.
2. IN INDOORS INSTEAD OF RCC SLAB,20mm.THICK Al. EXTRUDED PLANK OR 10mm.THICK M.S.CHEQUERED PLATE SHALL BE USED AS PER PDS:E 507.
3. PROPER SLOPE TO BE GIVEN IN THE TRENCH FOR NATURAL DRAINAGE.
4. SS–SINGLE SIDE CABLE SUPPORTS.
5. DS–DOUBLE SIDE CABLE SUPPORTS.
6. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	CABLE RACK ARRANGEMENT IN TRENCHES	PC183–PDS:E 511	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION OF TRENCH

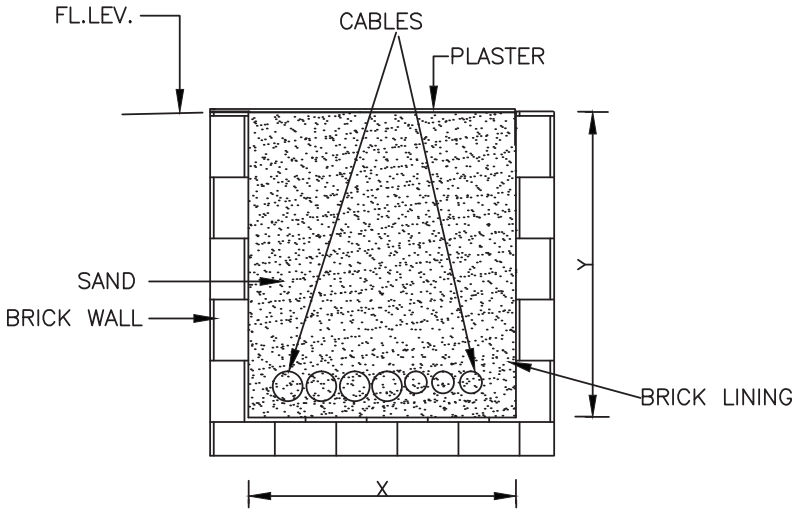


TYPICAL PLAN OF TRENCH

DESIGN TYPE	X	Y	N	M	W
5T–350–DS.	1400	1500	400	650	350
4T–350–DS.	1400	1200	250	650	350
3T–350–DS.	1400	900	250	300	350
5T–350–SS.	1000	1500	400	650	350
4T–350–SS.	1000	1200	250	650	350
3T–350–SS.	1000	900	250	300	350
5T–250–DS.	1200	1500	400	650	250
4T–250–DS.	1200	1200	250	650	250
3T–250–DS.	1200	900	250	300	250
5T–250–SS.	900	1500	400	650	250
4T–250–SS.	900	1200	250	650	250
3T–250–SS.	900	900	250	300	250

NOTES:–
1. SS–SINGLE SIDE CABLE SUPPORT.
2. DS–DOUBLE SIDE CABLE SUPPORT.
3. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF CABLES BURRIED IN SLITS	PC183 –PDS:E 516	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



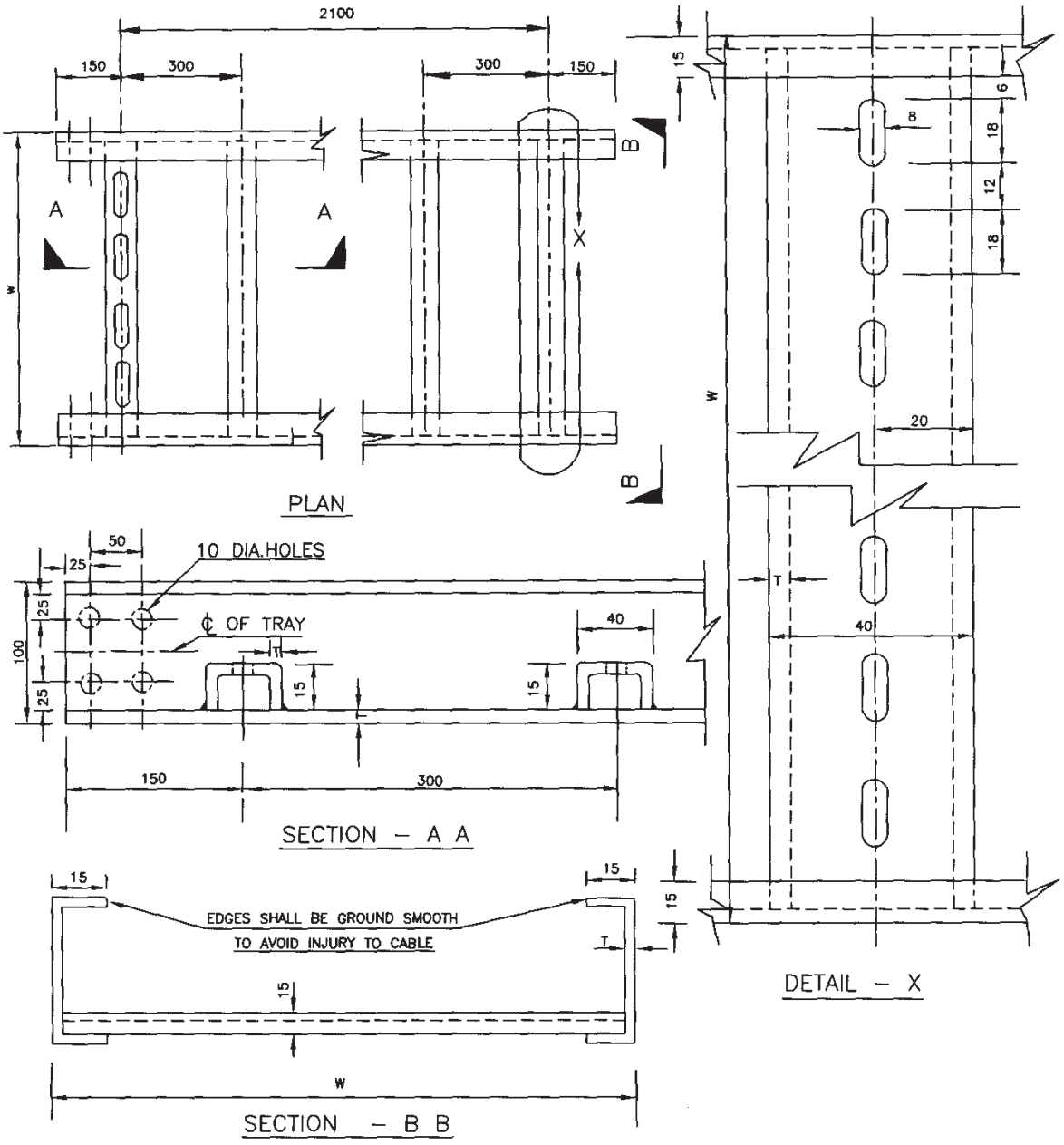
SECTION OF SLIT

DESIGN TYPE	X	Y
S 300	300	300
S 200	200	200

NOTE:–

1. CABLE SLITS SHALL BE FILLED WITH SAND AND PROPERELY PLASTERED WITH LEAN CONCRETE AFTER LAYING OF CABLES.
2. WHEREVER CABLES ARE COMING OUT OF THE SLIT, SUITABLE MECH.PROTECTION TO BE PROVIDED.

	PRE–FABRICATED CABLE TRAY STRAIGHT RUN	PC183 PDS:E 530	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



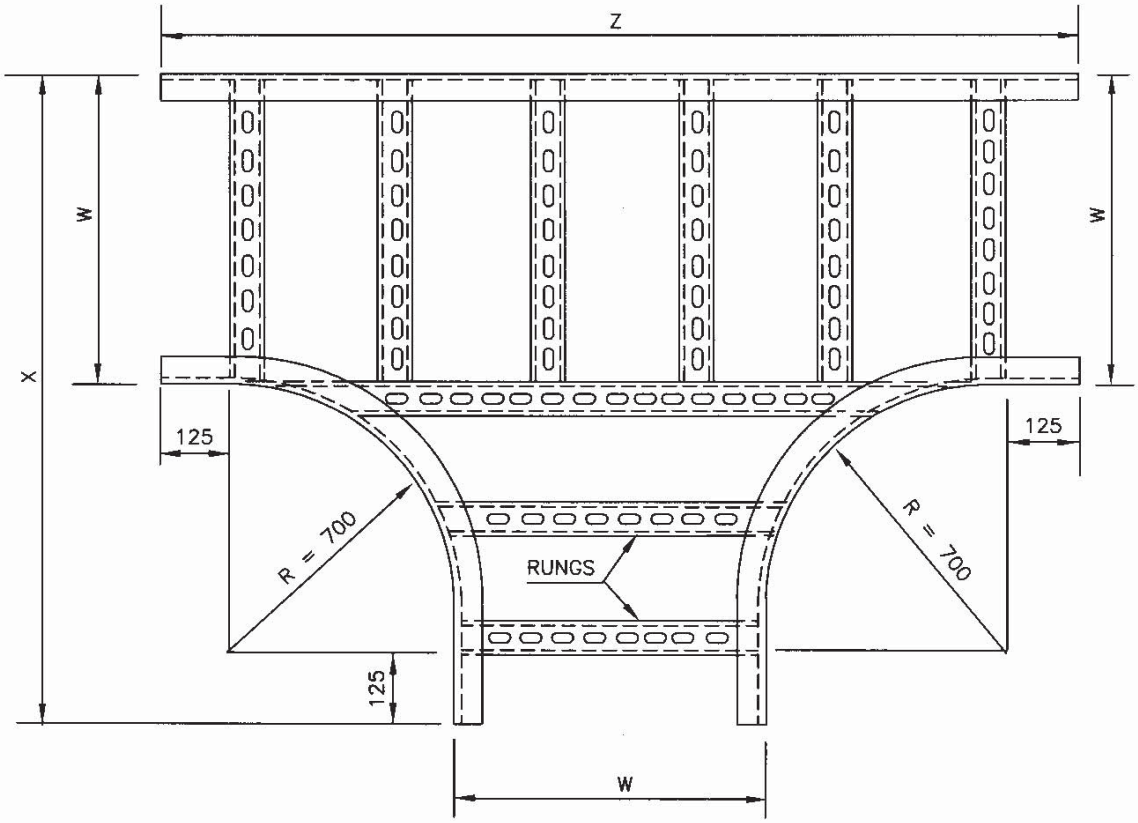
DESIGN TYPE (WIDTH)	MAX.SUPPORTING SPAN		WEIGHT/METER APPROX. IN Kg.	
	G. I.	A. L	G. I.	A. L
SR 900	2000	2000	10.5	3.6
SR 600	2000	2000	8.9	3.05
SR 450	2000	2000	8.0	2.75
SR 300	2000	2000	7.6	2.6
SR 150	2000	2000	6.8	2.33

NOTE:–

THICKNESS " T " SHALL BE 3mm FOR G.I AND 4mm.FOR AL.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

PDIL	PRE–FABRICATED CABLE TRAY HORIZONTAL TEE	PC183 PDS:E 531	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



PLAN

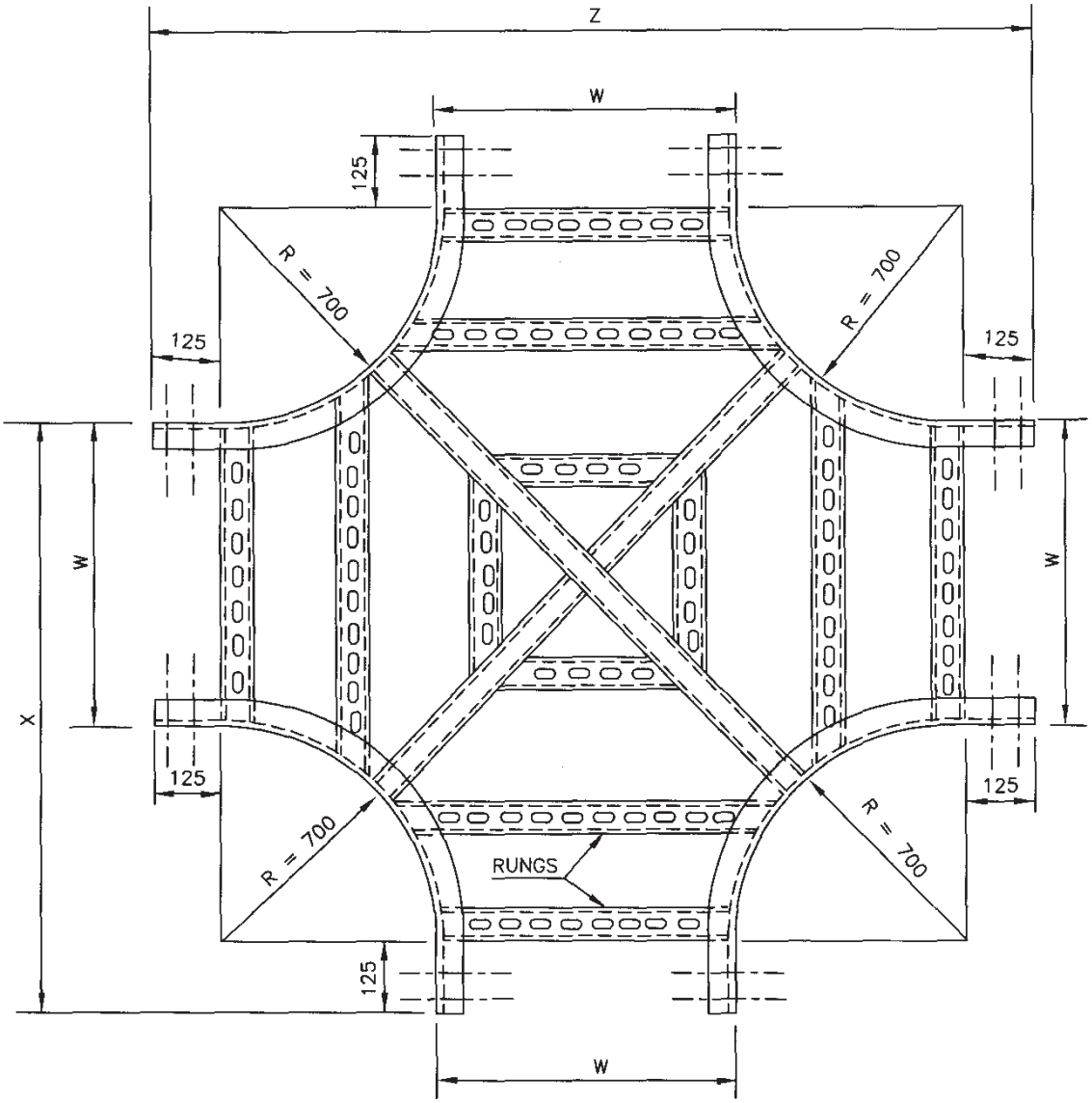
DESIGN TYPE	W	X=R+W+125	Z=2R+W+250
HT 900	900	1725	2550
HT 600	600	1425	2250
HT 450	450	1275	2100
HT 300	300	1125	1950

NOTES :–

1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

PDIL	PRE–FABRICATED CABLE TRAY HORIZONTAL CROSS	PC183 PDS:E 532	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



PLAN

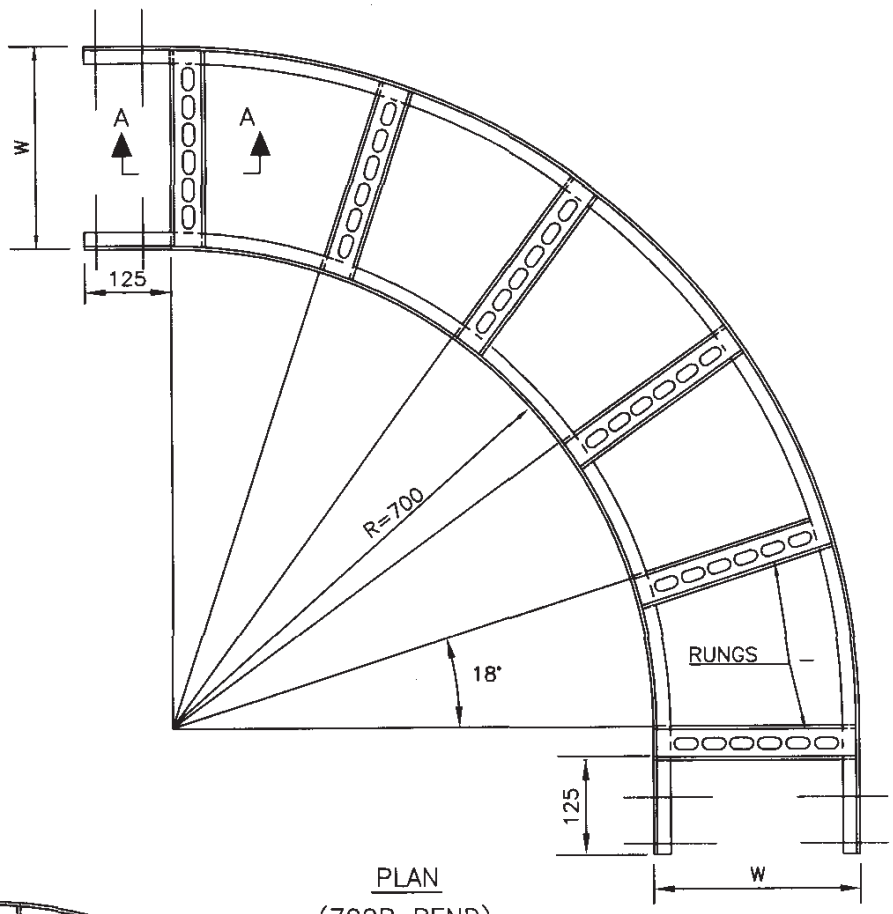
DESIGN TYPE	W	X=R+W+125	Z=2R+W+250
HC 900	900	1725	2550
HC 600	600	1425	2250
HC 450	450	1275	2100
HC 300	300	1125	1950

NOTES :–

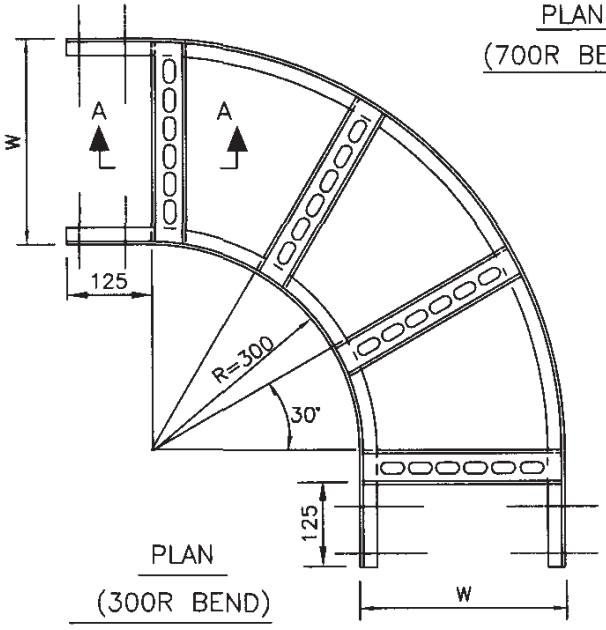
1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

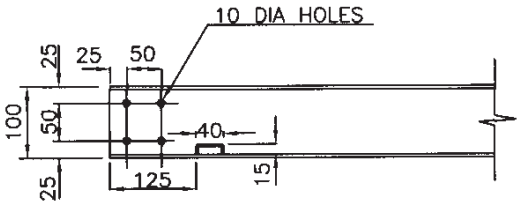
PDIL	PRE–FABRICATED CABLE TRAY 90° HORIZONTAL BENDS	PC183 PDS:E 533	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



PLAN
(700R BEND)



PLAN
(300R BEND)

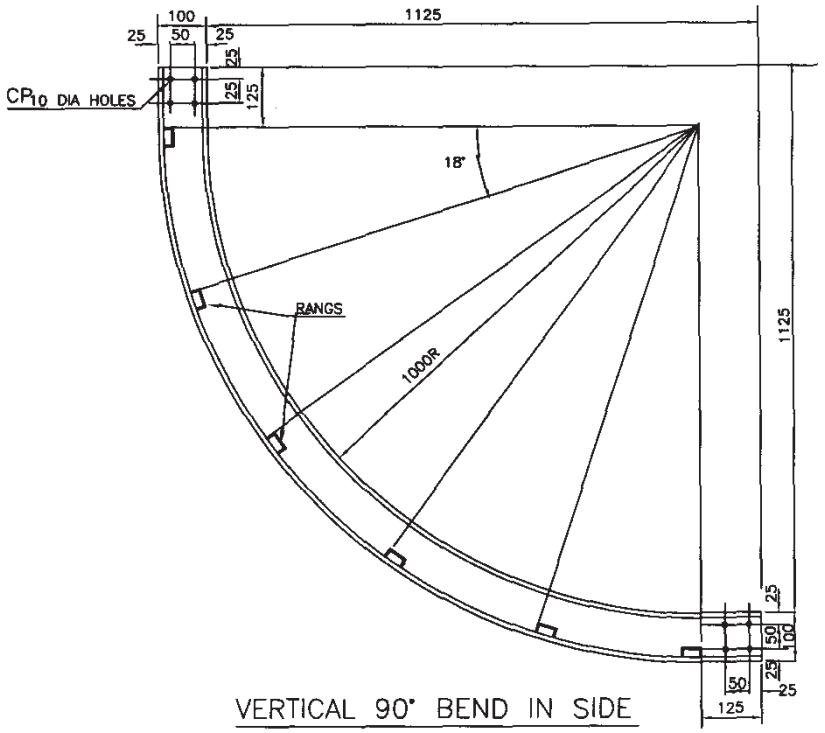


SECTION A–A

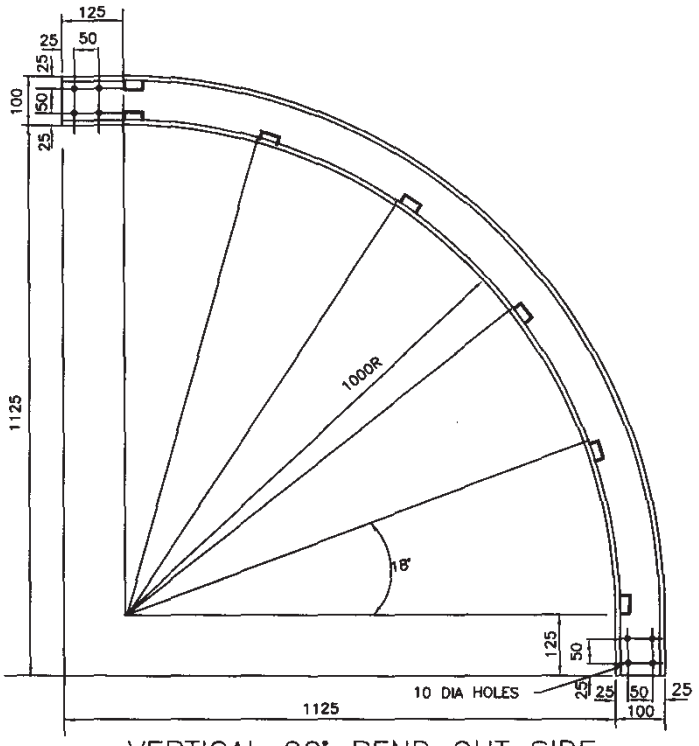
ALL DIMENSIONS ARE IN mm.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

PDIL	PRE–FABRICATED CABLE TRAY 90° VERTICAL BEND BENDING RADIUS 1000 mm	PC183 PDS:E 534	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



VERTICAL 90° BEND IN SIDE

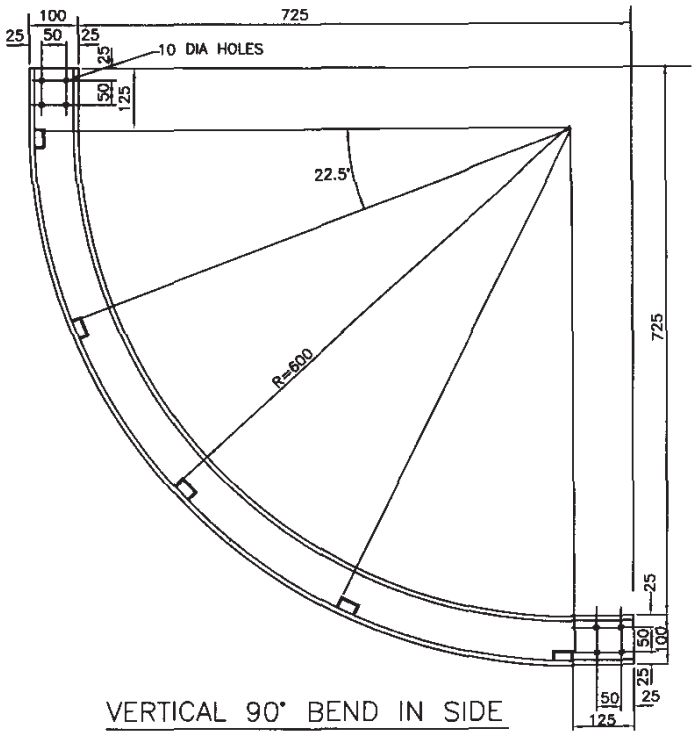


VERTICAL 90° BEND OUT SIDE

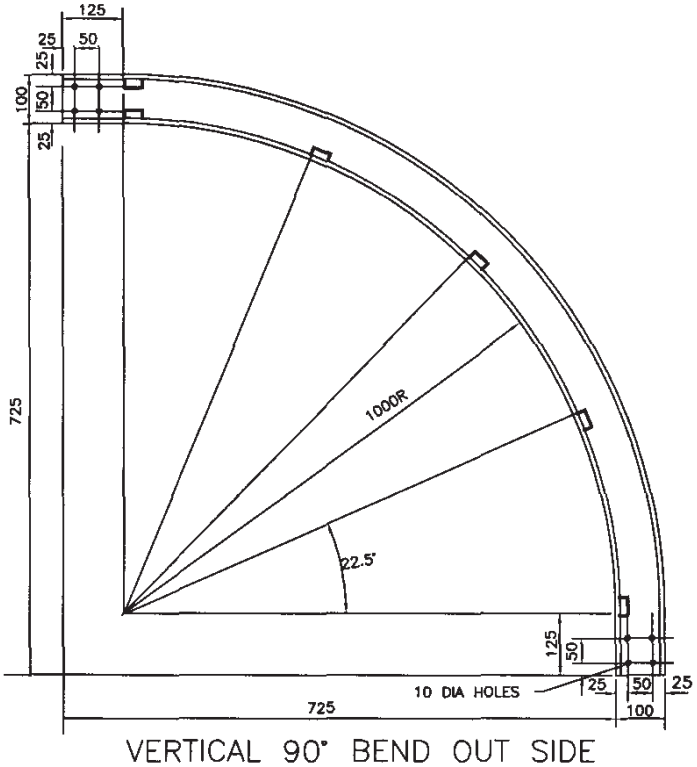
DIMENSIONS ARE IN mm.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

PDIL	PRE–FABRICATED CABLE TRAY 90° VERTICAL BENDS BENDING RADIUS 600 mm	PC183 PDS:E 535	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



VERTICAL 90° BEND IN SIDE

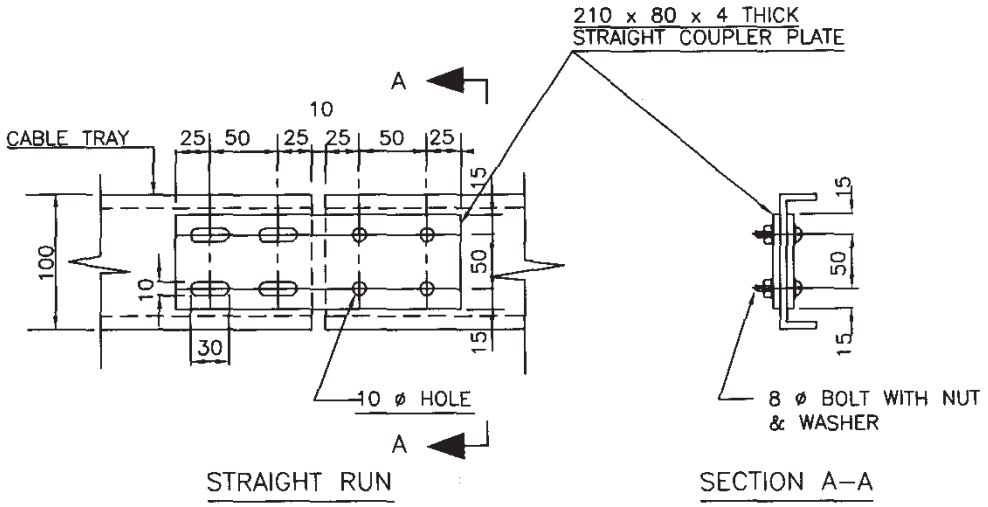


VERTICAL 90° BEND OUT SIDE

ALL DIMENSIONS ARE IN mm.

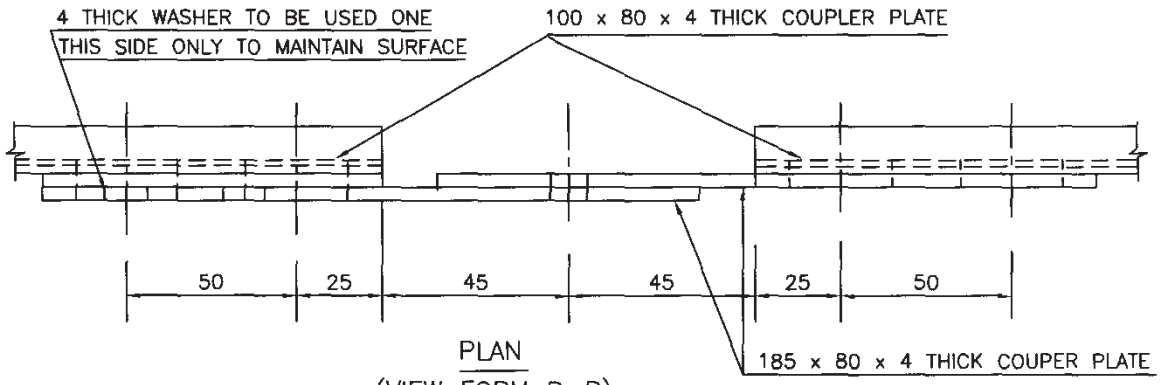
REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

PDIL	PRE–FABRICATED CABLE TRAY COUPLING ARRANGEMENT	PC183 PDS:E 536 / DOCUMENT NO. / SHEET 1 OF 1 — REV 1

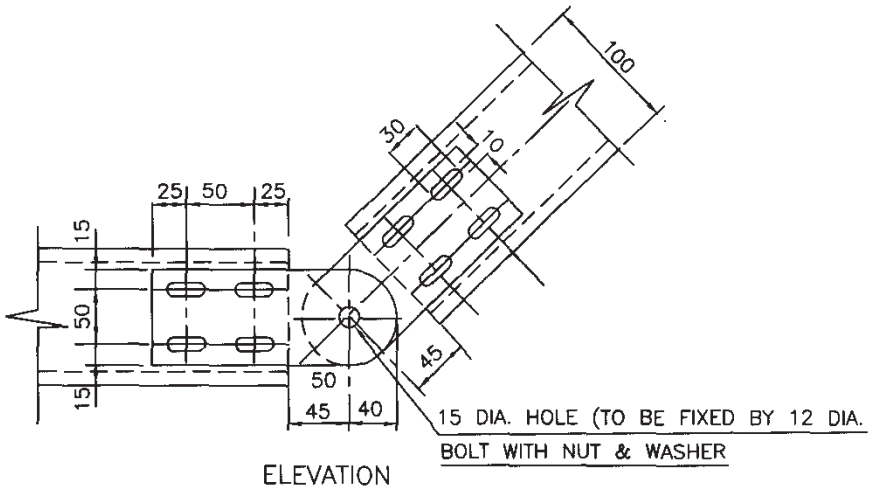


STRAIGHT RUN

SECTION A–A



PLAN
(VIEW FORM B–B)

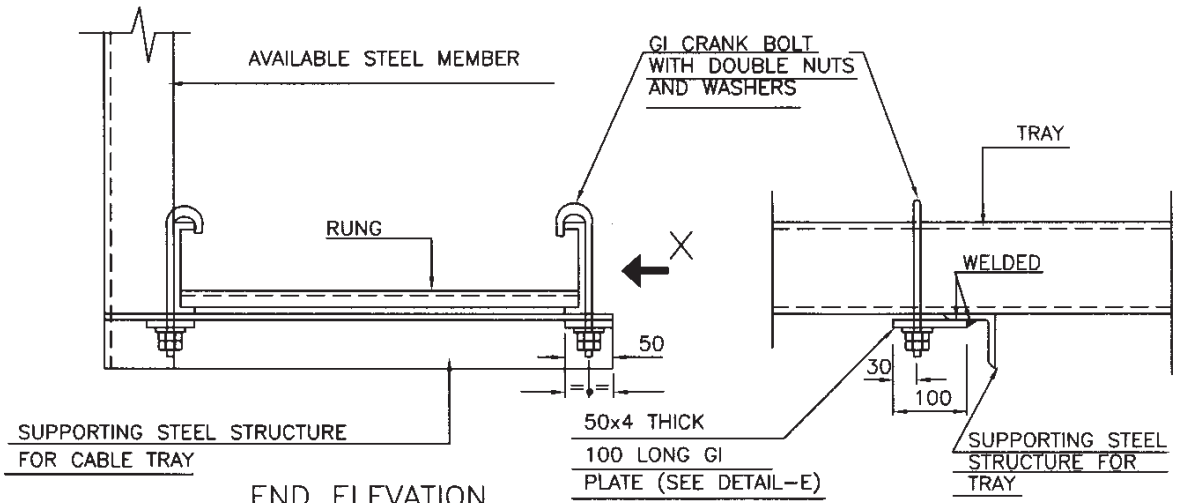


ELEVATION
(ADJUSTABLE BEND)

ALL DIMENSIONS ARE IN mm.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

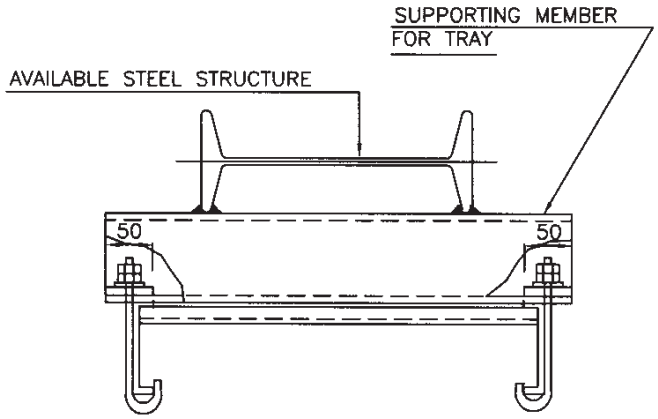
PDIL	PRE-FABRICATED CABLE TRAY FIXING ARRANGEMENT	PC183 PDS:E 537 / 1 DOCUMENT NO. / REV SHEET 1 OF 1



END ELEVATION

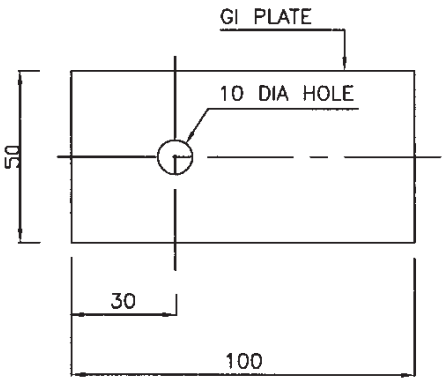
(HORIZONTAL RUN)

VIEW AT -X



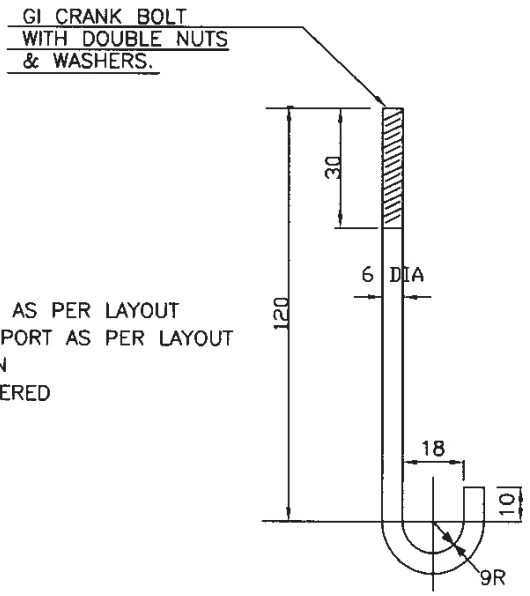
PLAN

VERTICAL RUN (RISER)



PLAN

DETAIL-E



NOTES:-

1. HORIZONTAL RUN TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
2. VERTICAL RUN/ RISER TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
3. EACH CRANK HOOK SHALL BE SUPPLIED WITH ONE PLAIN WASHER, ONE SPRING WASHER AND TWO DOUBLE CHAMFERED HEX NUTS. THESE SHAL BE GALVANISED ITEMS.
4. ALL DIMENSIONS ARE IN mm.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

PDIL	GENERAL NOTES ON EARTHING AND LIGHTNING PROTECTION	PDSE: 601	0
		DOCUMENT NO.	REV
		SHEET 1 OF 2	

A. GENERAL

1. EARTHING AND LIGHTNING PROTECTION SHALL BE CARRIED OUT IN ACCORDANCE WITH IS : 3043 AND IS : 2309 RESPECTIVELY AND SHALL ALSO CONFORM TO THE REQUIREMENTS OF INDIAN ELECTRICITY RULES.
2. THESE NOTES SHALL BE READ IN CONJUCTION WITH EARTHING & LIGHTNING PROTECTION LAYOUT DRGS. AND RELEVENT EARTHING STANDARDS (PDS:E)
3. THE SIZE OF EARTH CONDUCTORS & SYMBOLS SHOWN IN THE LAYOUT DRGS. SHALL AS PER PDSE: 602
4. AS FAR AS POSSIBLE, THE EARTH CONDUCTORS SHALL BE TAKEN ALONG POWER & CONTROL CABLE ROUTES.
5. EARTHING CONDUCTORS BURIED UNDER THE GROUND SHALL BE LAID ATLEAST 500 MM BELOW THE GROUND LEVEL UNLESS REQUIRED OTHERWISE, e.g FOR CROSSING ANY UNDER GROUND PIPE OR TRENCH ETC. WHERE THE EARTHING CONDUCTORS SHALL RUN AT A MINIMUM DEPTH 300 MM BELOW THE BOTTOM OF THE PIPE/TRENCH.
6. BARE ALUMINIUM CONDUCTORS SHALL NOT BE BURIED DIRECTLY UNDER THE GROUND.
7. TAPPING FROM THE UNDER GROUND EARTH GRID SHALL BE TAKEN ONLY FROM EARTH PIT OR A PIT WITHOUT ELECTRODE PROVIDED FOR THIS PURPOSE.
8. JOINTING OF UNDERGROUND EARTHING STRIPS SHALL BE AVOIDED TO THE EXTENT POSSIBLE. HOWEVER, IF JOINTING IS TO BE DONE DUE TO UNAVOIDABLE REASONS, THIS SHALL BE DONE BY ELECTRIC ARC WELDING.
9. TERMINAL JOINTING & CLAMPING ARRANGEMENT SHALL BE AS SHOWN IN PDSE:603. ALL WELDED OR BOLTED JOINTS SHALL BE PAINTED WITH EPOXY RESIN PAINT OR BITUMINOUS PAINT.
10. EARTH BUSES, AS PER CONVENIENCE, SHALL BE PROVIDED IN PLANTS FOR EARTHING GROUPS OF EQUIPMENT TO EARTHING GRID. THESE EARTH BUSES, SHALL BE AS SHOWN IN PDSE: 615.
11. DETAILS OF EARTH PIT CONNECTIONS & ACCESSORIES FOR EARTH ELECTRODES SHALL BE AS SHOWN IN PDSE :604, 605 , 610 AND 611.
12. EARTH PITS FOR EQUIPMENT EARTHING, SYSTEM NEUTRAL EARTHING & LIGHTNING PROTECTION SHALL BE SEPARATE. HOWEVER, THESE PITS SHALL BE INTERCONNECTED.
13. SPACING BETWEEN TWO EARTH PITS SHALL NOT BE LESS THAN 10 M & THESE MAY BE LOCATED ABOUT 4M AWAY FROM THE BUILDING / STRUCTURE.
14. TYPICAL ARRANGEMENT OF NEUTRAL & EQUIPMENT EARTHING SHALL BE AS SHOWN IN PDSE: 617.

B. SYSTEM NEUTRAL EARTHING

1. THE NEUTRALS OF H.T & L.T SYSTEMS SHALL BE EARTHED BY USING 2 NOS. 150 SQ. MM ALUMINIUM CABLE OF RESPECTIVE VOLTAGE GRADE. EACH EARTH CONNECTION SHALL BE TERMINATED ON SEPERATE EARTH PITS. HOWEVER, FOR ECONOMY REASONS, 2 EARTH CONNECTIONS OF 2 DIFFERENT EQUIPMENT CAN BE TERMINATED ON THE SAME EARTH PIT AS SHOWN IN PDSE: 617.
2. THE NEUTRAL OF H.T. SYSTEM SHALL BE CONNECTED TO EARTH PIT AS ABOVE THROUGH THE NEUTRAL EARTHING RESISTOR (N.E.R.) AS REQUIRED, WHERE AS THE NEUTRAL OF L.T. SYSTEM SHALL BE SOLIDLY EARTHED THROUGH RESPECTIVE L.T. SWITCH BOARD.
3. FOR D.C. SYSTEM, POSITIVE POLE SHALL BE EARTHED THROUGH HIGH IMPEDANCE IN BATTERY CHARGER.

C. ELECTRICAL EQUIPMENT EARTHING

1. ALL EQUIPMENT RATED ABOVE 250V SHALL HAVE TWO EXTERNAL EARTH CONNECTIONS & THOSE RATED 250V & BELOW SHALL HAVE ONE EXTERNAL EARTH CONNECTION.

   FLAME PROOF EQUIPMENT, IN ADDITION, SHALL HAVE ONE INTERNAL EARTH CONNECTION THROUGH ADDITIONAL CORE OF POWER / CONTROL CABLE.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
0	03.01.07	15.01.07	ISSUED FOR IMPLEMENTATION	NKR	AV	BB

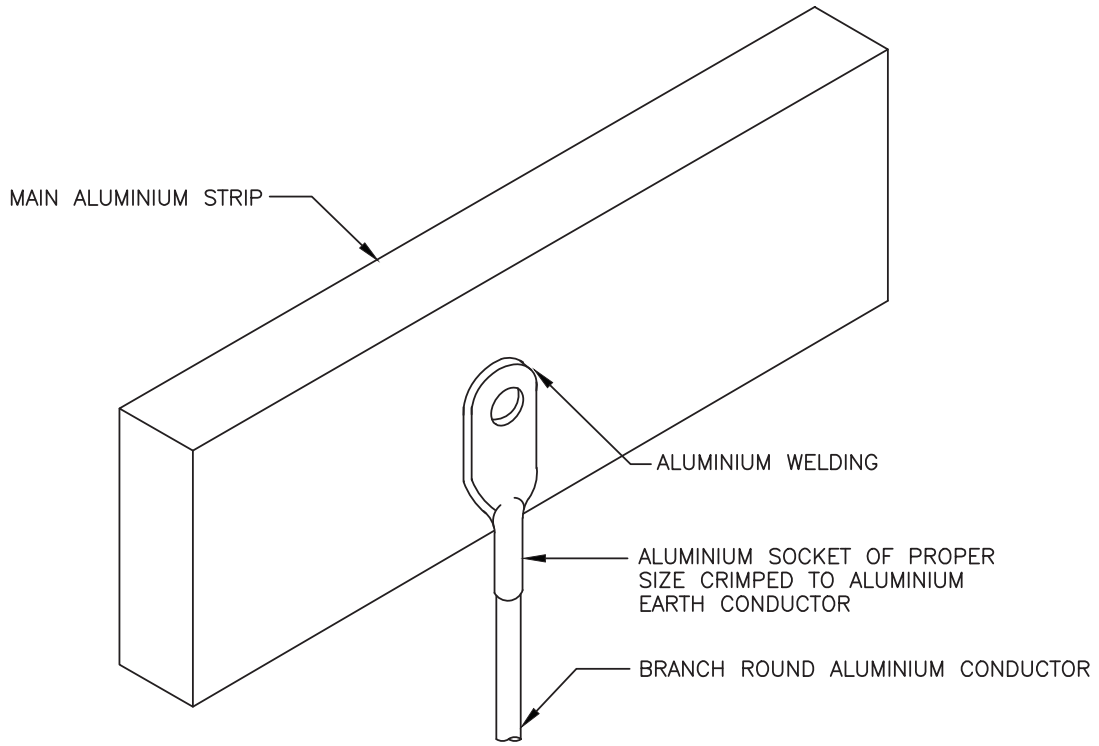
2. EARTHING CONNECTION TO INDIVIDUAL EQUIPMENT SHALL BE TAPPED ONLY FROM THE EARTHING GRID / RING OR EARTH BUS EXCEPT FOR EQUIPMENT RATED 250V & BELOW, FOR WHICH THE CONNECTION MAY BE TAKEN FROM THE NEAR BY EARTH CONDUCTOR OF A LARGER EQUIPMENT OR FROM THE BODY OF THE LARGER EQPT.
3. EARTHING ARRANGEMENT OF MOTOR AND ASSOCIATED LOCAL CONTROL STATION SHALL BE AS SHOWN IN PDSE: 608.
4. EARTHING ARRANGEMENT OF RAILS SHALL BE AS SHOWN IN PDSE: 609 WITH BOTH ENDS EARTHED.
5. CABLES RACKS/RISERS/TRAYS SHALL BE ELECTRICALLY CONTINUOUS BY BONDING THE JOINTS BETWEEN THE RUNNER MEMBERS OF THE ADJACENT SECTIONS. THE CABLE RACKS SHALL BE CONNECTED TO THE EARTHING GRID AT SUITABLE INTERVALS.
6. EARTHING ARRANGEMENT OF LIGHTING FIXTURES & PLUG SOCKETS RATED 250V AND BELOW SHALL NOT BE SHOWN IN THE EARTHING LAYOUT DRGS. HOWEVER, PLUG SOCKETS SHALL BE EARTHED BY 10 SWG SIZE G.I./AL. CONDUCTOR TAKEN FROM THE NEAREST EARTHING GRID/CONDUCTOR AND LIGHTING FIXTURES SHALL BE PROVIDED EARTHING THROUGH CABLE ARMOURS.
7. IN SWITCH YARD AND GENERATING STATIONS SUITABLE EARTHING MAT SHALL BE PROVIDED TO REDUCE THE VALUE OF STEP/TOUCH POTENTIAL TO PERMISSIBLE VALUE.
8. SWITCH YARD FENCE SHALL BE CONNECTED TO EARTH AT A REGULAR INTERVAL, NOT EXCEEDING 10 M.

D. STATIC EARTHING

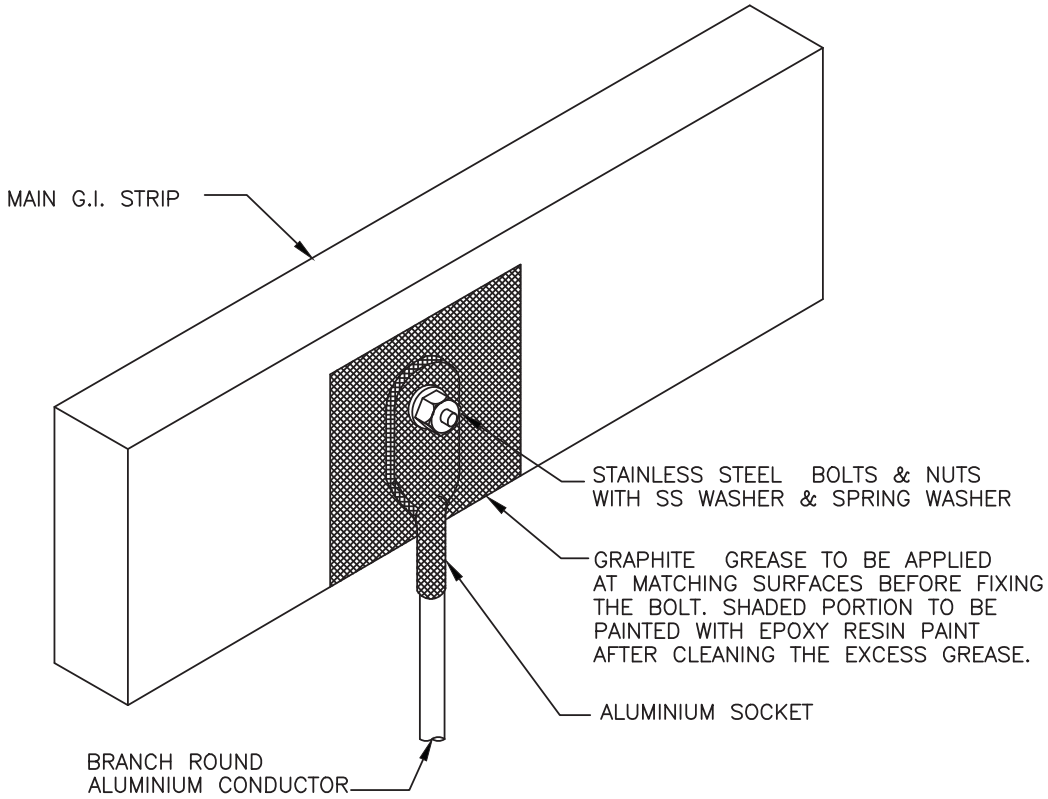
1. ALL PROCESS EQUIPMENT WHICH ARE LIKELY TO GET STATICALLY CHARGED, e.g. STORAGE TANKS, HIGH PRESSURE & MIDIUM PRESSURE VESSELS/PIPES, HIGH PRESSURE COMPRESSORS. HIGH PRESSURE STEAM EJECTORS ETC. SHALL BE EARTHED AGAINST STATIC CHARGE ACCUMULATION.
2. EARTHING ARRANGEMENT ACROSS PIPE JOINTS/VALVES SHALL BE AS SHOWN IN PDSE: 612
3. DETAILS OF EARTHING OF VESSELS SHALL BE AS SHOWN IN PDSE: 613.
4. MOBILE EQUIPMENT, REQUIRING EARTHING AGAINST STATIC CHARGE, SHALL BE TEMPORARILY EARTHED AS SHOWN IN PDSE: 608.
5. PIPE TRESTLE CARRYING PIPES WITH HYDRO CARBONS SHALL BE CONNECTED TO EARTH GRID AT REGULAR INTERVALS, NOT EXCEEDING 25 M.
6. WHEREVER PROCESS EQUIPMENT ARE MOUNTED ON STEEL STRUCTURE, THE BASE OF THE STRUCTURES SHALL BE EARTHED INSTEAD OF EARTHING THE INDIVIDUAL EQUIPMENT.

E. LIGHTNING PROTECTION

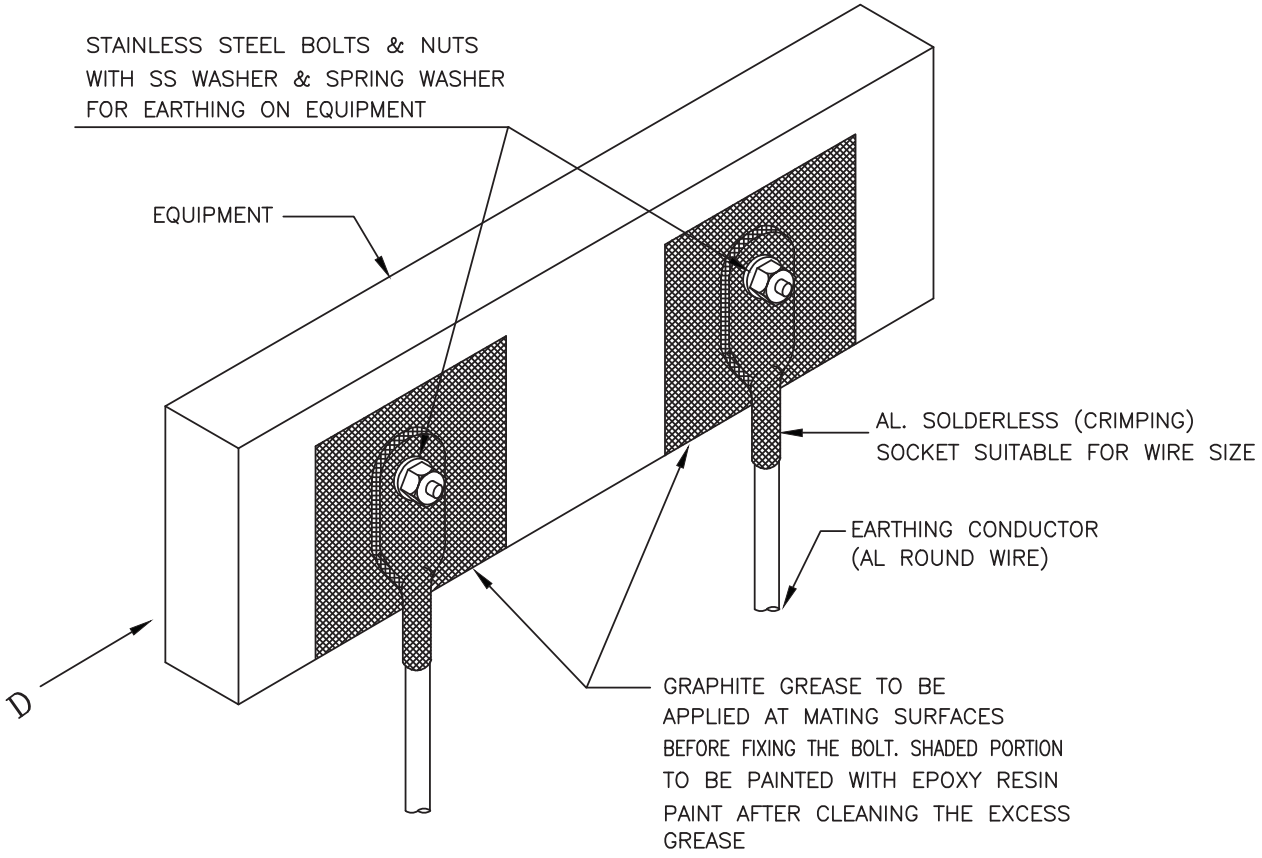
1. FIXING ARRANGEMENT ON AIR TERMINATION AND ROOF/DOWN CONDUCTOR FOR LIGHTNING PROTECTION SYSTEM SHALL BE AS SHOWN IN PDSE: 614.
2. FOR LIGHTNING PROTECTION OF TALL STEEL STRUCTURES/VESSELS/TANKS, DOWN CONDUCTOR SHALL BE TAKEN FROM THE BASE AND CONNECTED TO EARTH PITS. AIR TERMINATION ROD SHALL NOT BE REQUIRED.
3. LIFT SHAFT SHALL NOT BE USED FOR FIXING THE DOWN CONDUCTOR.
4. IN CASE EARTH PITS FOR CONNECTING THE DOWN CONDUCTORS ARE NOT AVAILABLE IN THE BEGINNING OF FABRICATION/ERECTION OF SUCH STRUCTURES/VESSELS / TANKS. THEIR BASES SHALL TEMPORARILY BE CONNECTED TO NEAR BY STEEL COLUMN. ELECTRICAL CONTINUITY OF THE STRUCTURES, HOWEVER, SHALL BE CHECKED AND ENSURED.
5. FOR ALL HIGH RISE CONCRETE STRUCTURES, TEMPORARY LIGHNING PROTECTION NEED BE PROVIDED DURING CONSTRUCTION AND MAINTAINED TILL PERMANENT LIGHTNING PROTECTION IS INSTALLED. FOR THIS PURPOSE THE VERTICAL REINFORCEMENT, PROJECTING OVER EACH LIFT, SHALL BE CONNECTED TO EARTH PITS BY MEANS OF 2 NOS. FLEXIBLE COPPER CONDUCTOR CABLES. EACH OF THE FLEXIBLE CABLE SHALL BE OF 95 Sq. mm SIZE HAVING ONE END PERMANENTLY CONNECTED TO EARTH PIT AND OTHER END PROVIDED WITH A CLAMP FOR CONNECTING TO THE EXPOSED REINFORCEMENT.



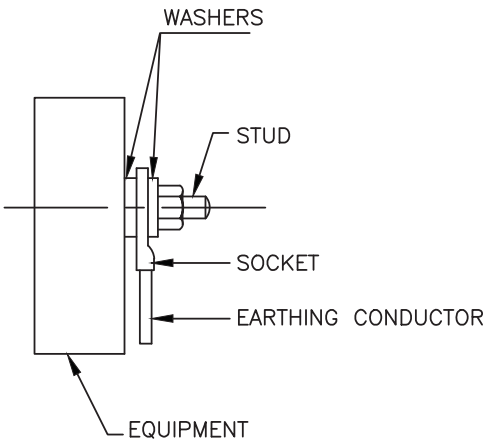
' T ' JOINT ALUMINIUM STRIP TO ROUND ALUMINIUM CONDUCTOR



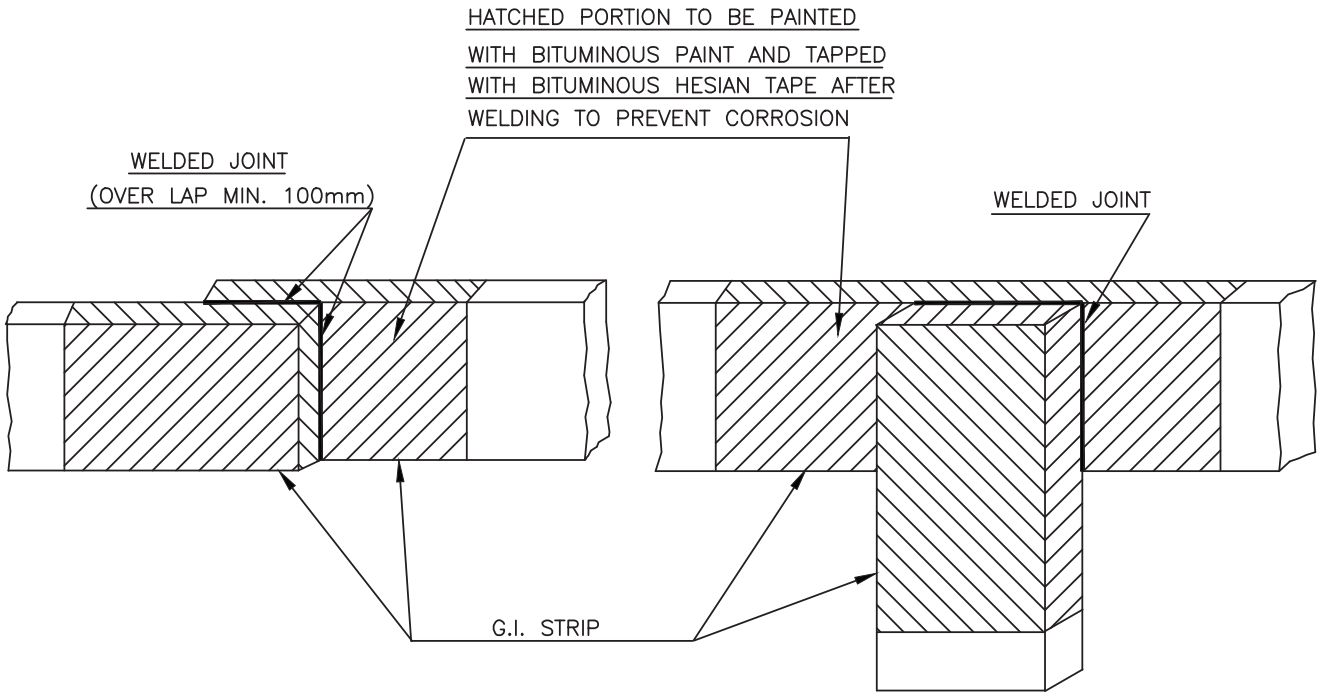
' T ' JOINT G.I. STRIP TO ROUND ALUMINIUM CONDUCTOR



ARRANGEMENT OF DOUBLE EARTH CONNECTIONS TO EQUIPMENT

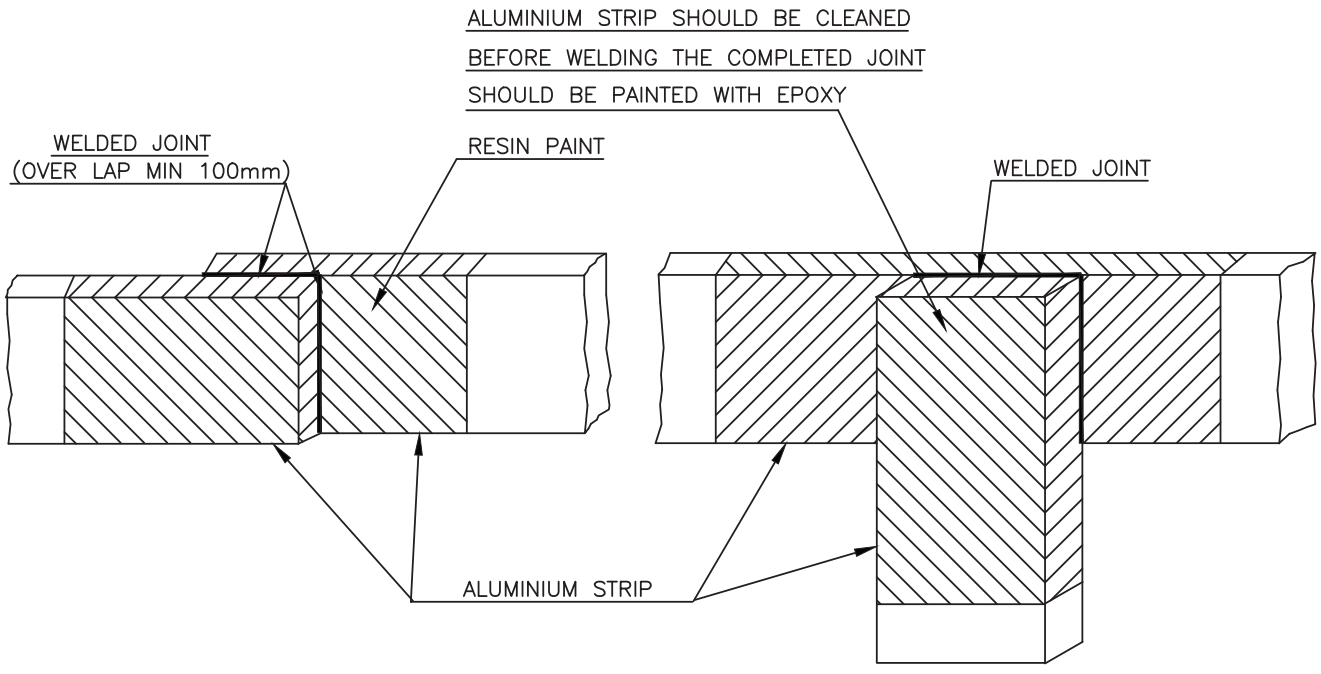


V I E W F R O M – D



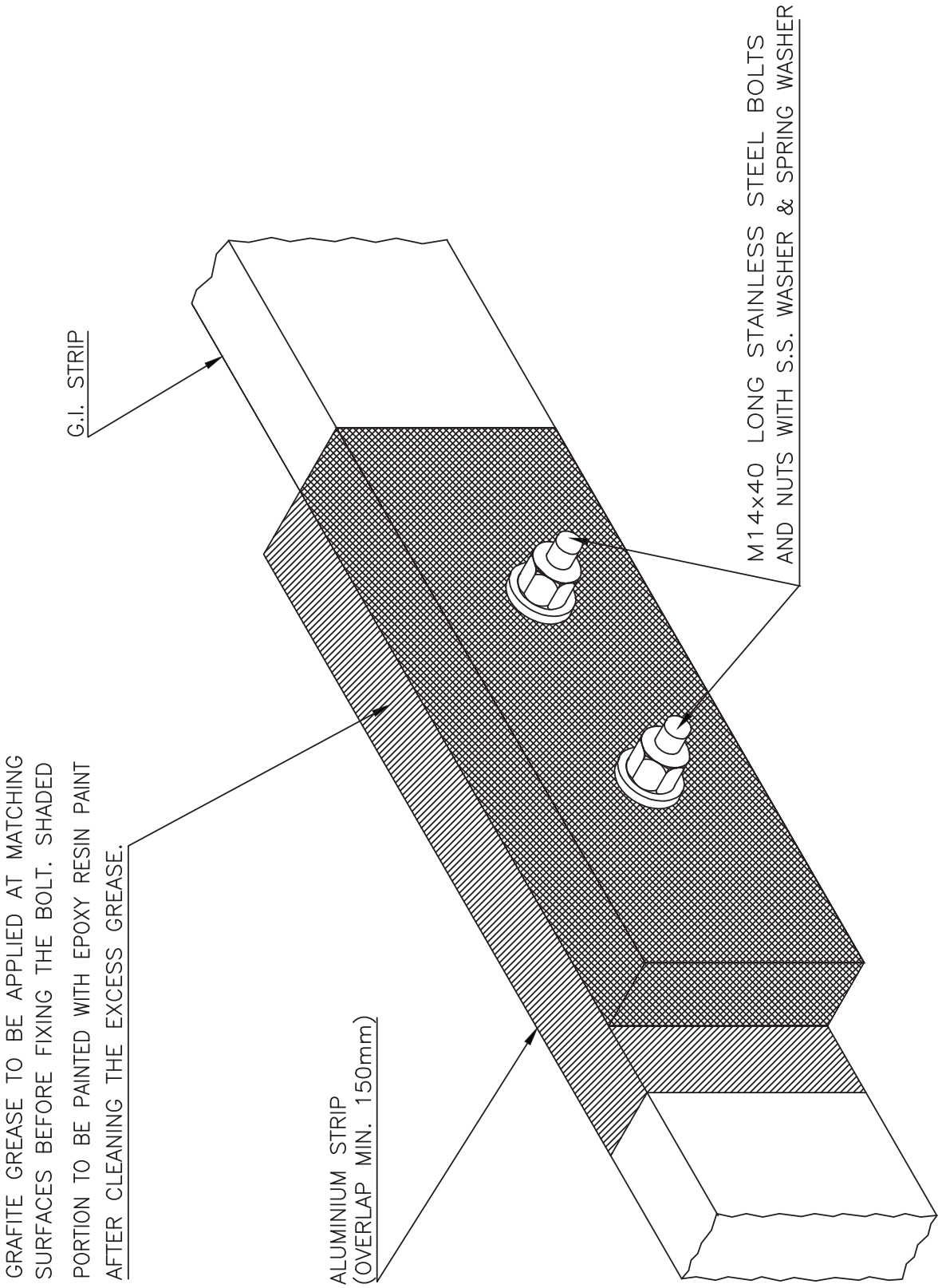
STRAIGHT JOINT G.I TO G.I. STRIP

" T " JOINT G.I. TO G.I. STRIP



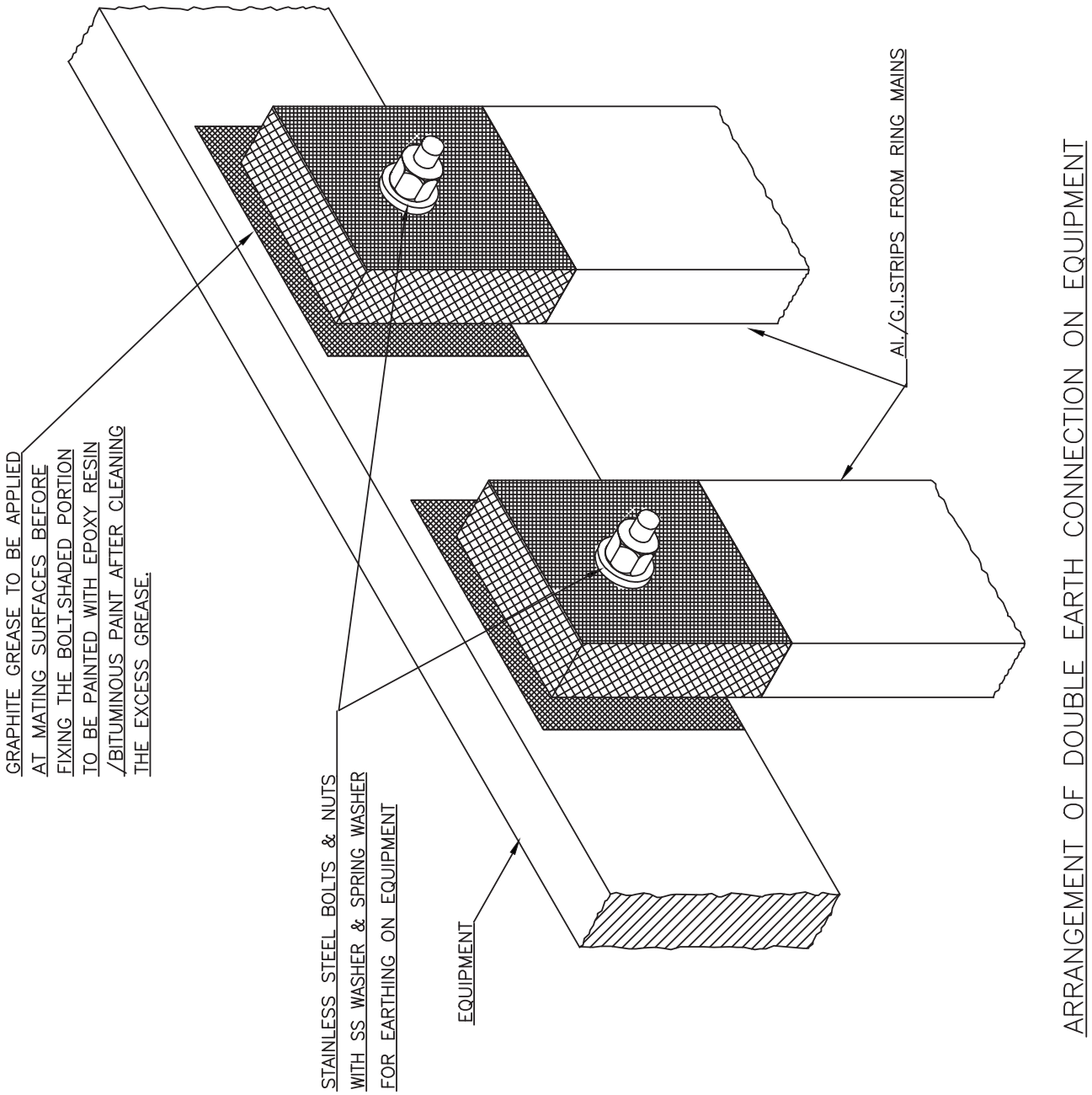
STRAIGHT JOINT AL. TO AL. STRIP

" T " JOINT AL TO AL STRIP



ARRANGEMENT OF LAP JOINT BETWEEN

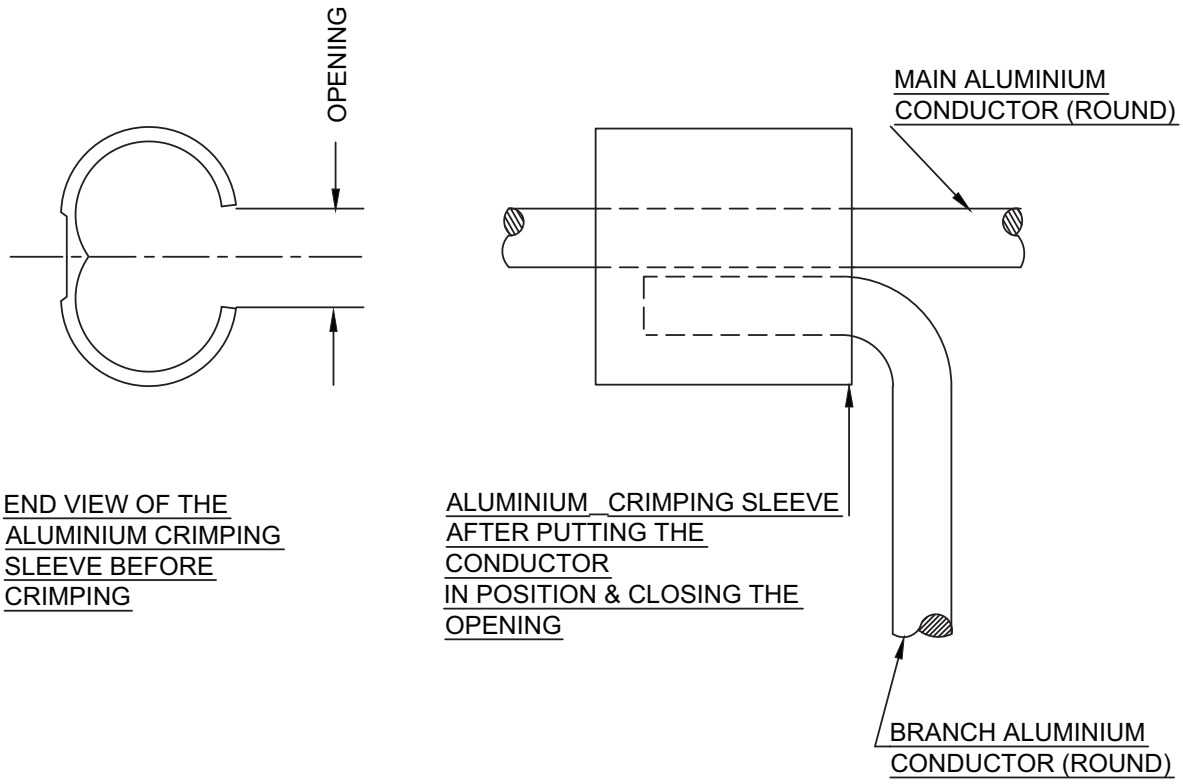
AI. EARTH STRIP TO G.I. EARTH STRIP



ARRANGEMENT OF DOUBLE EARTH CONNECTION ON EQUIPMENT

NOTE:–

EPOXY RESIN PAINT SHALL BE USED FOR AL STRIP AND BITUMINOUS PAINT FOR G.I.STRIP.

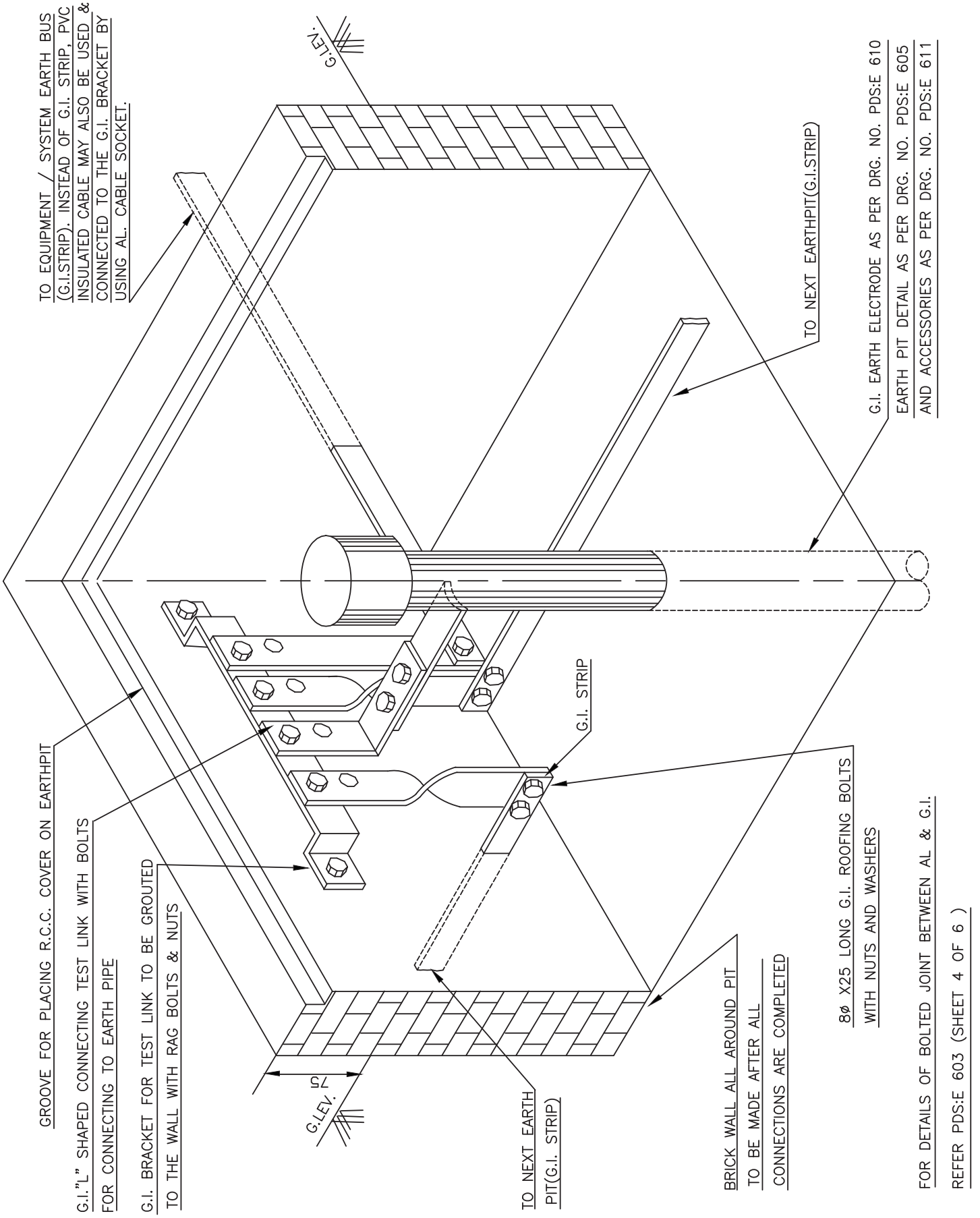


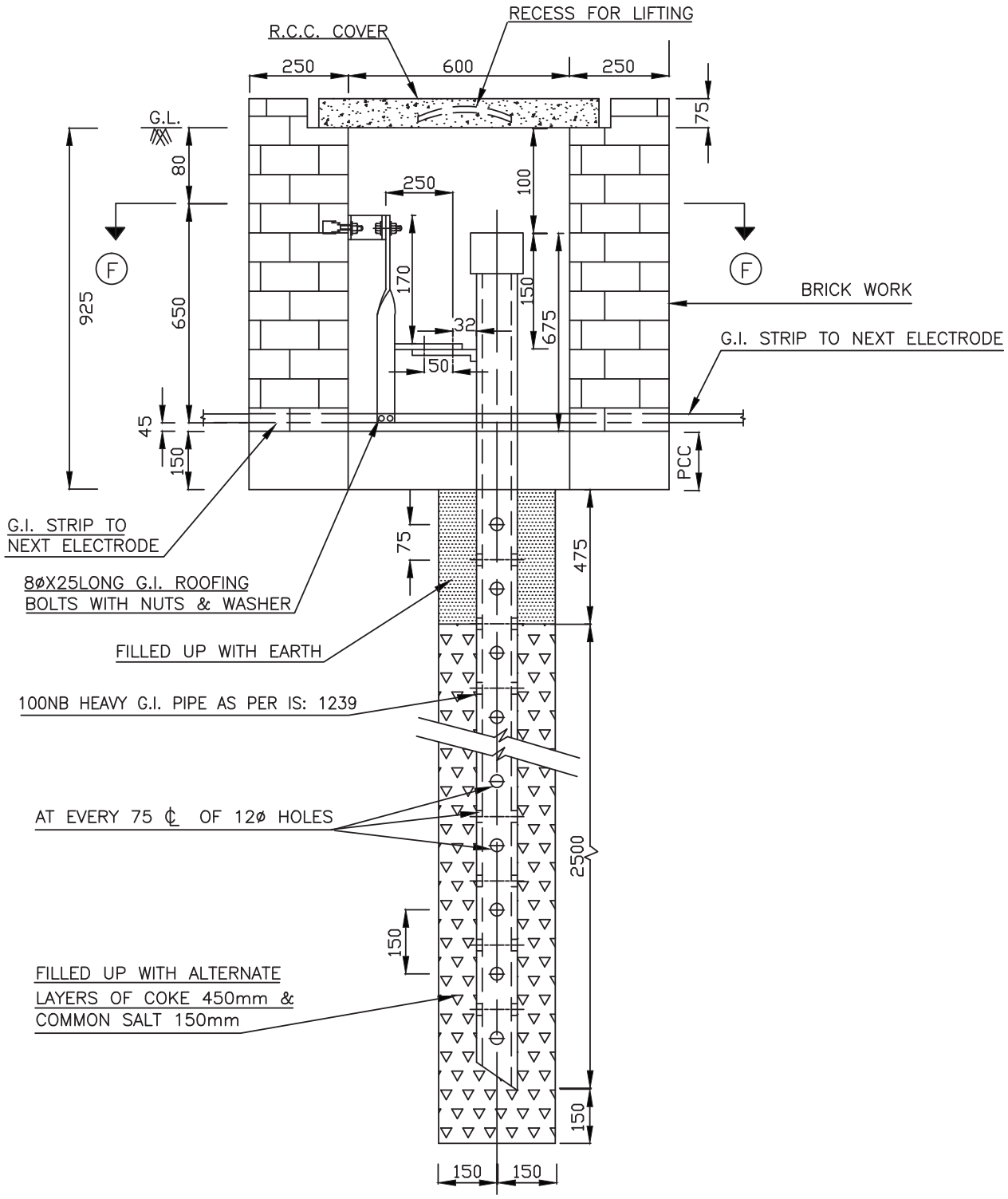
"T" JOINT ROUND ALUMINIUM CONDUCTOR TO ROUND ALUMINIUM CONDUCTOR (CRIMPING TYPE)

NOTE :–

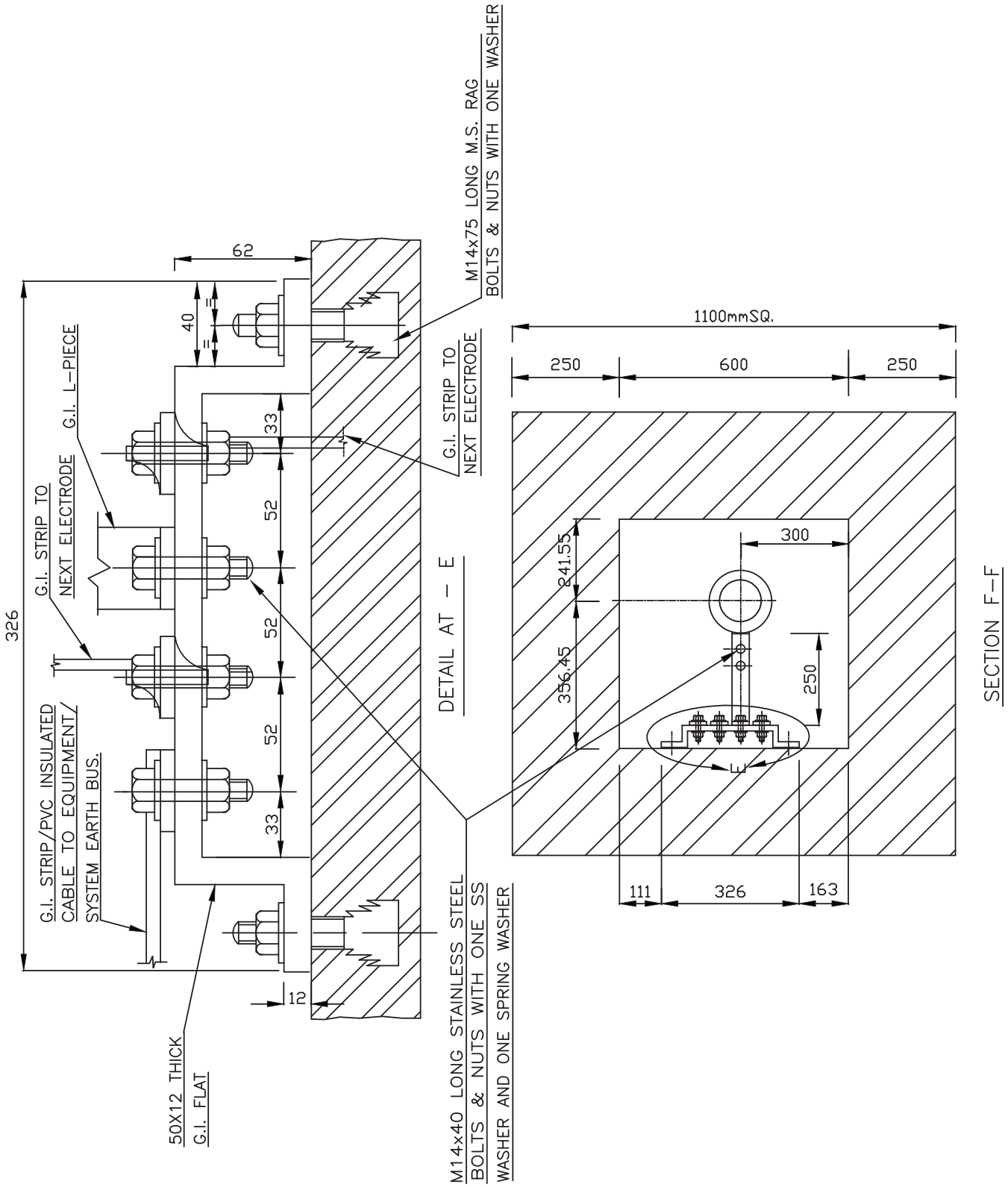
USE CORRECT SIZE OF COMPRESSION DIES.

पी डी आई एल PDIL	TYPICAL DETAILS OF CONNECTIONS IN EARTH PIT	PC183 – PDS:E 604	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

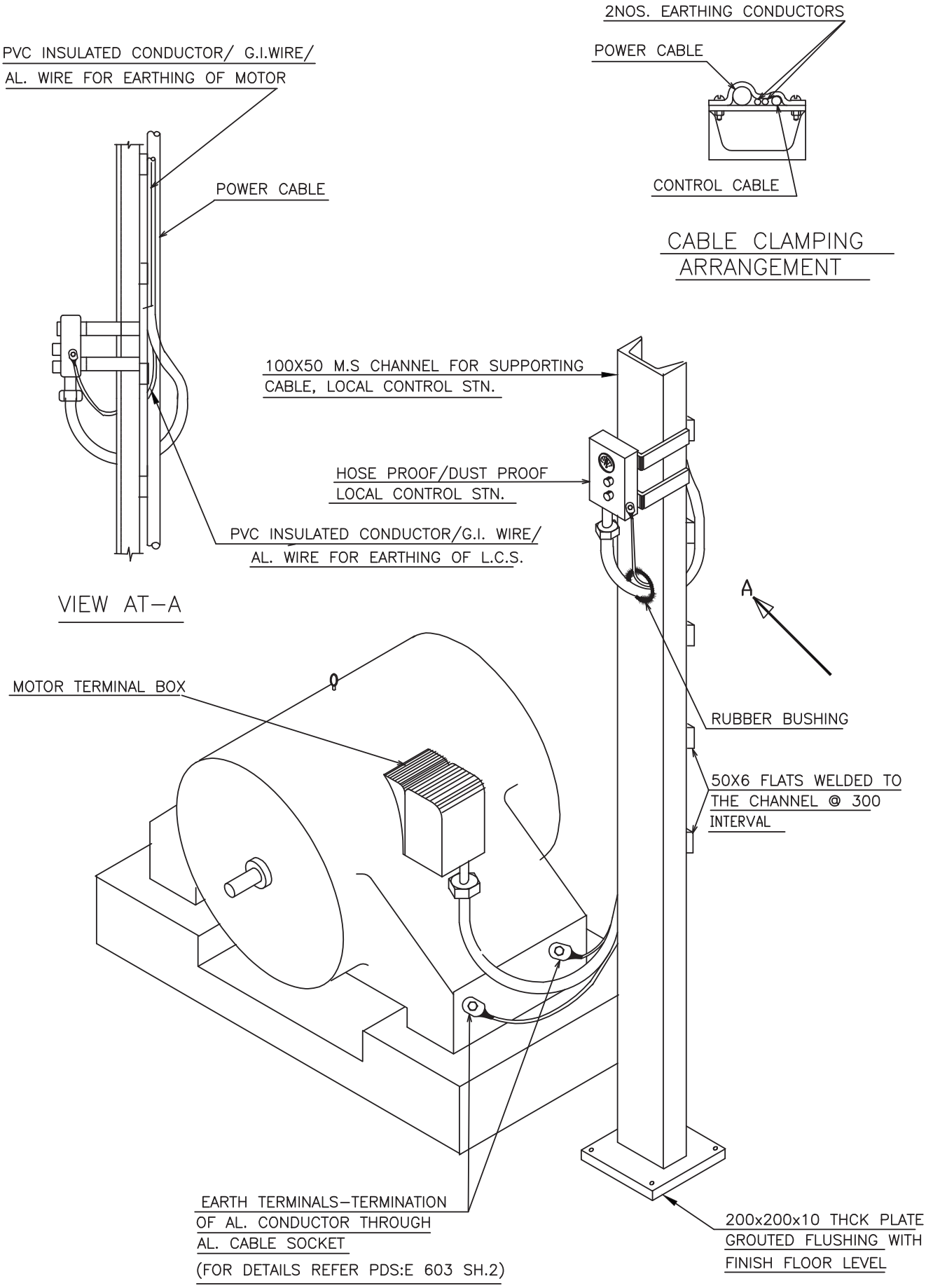




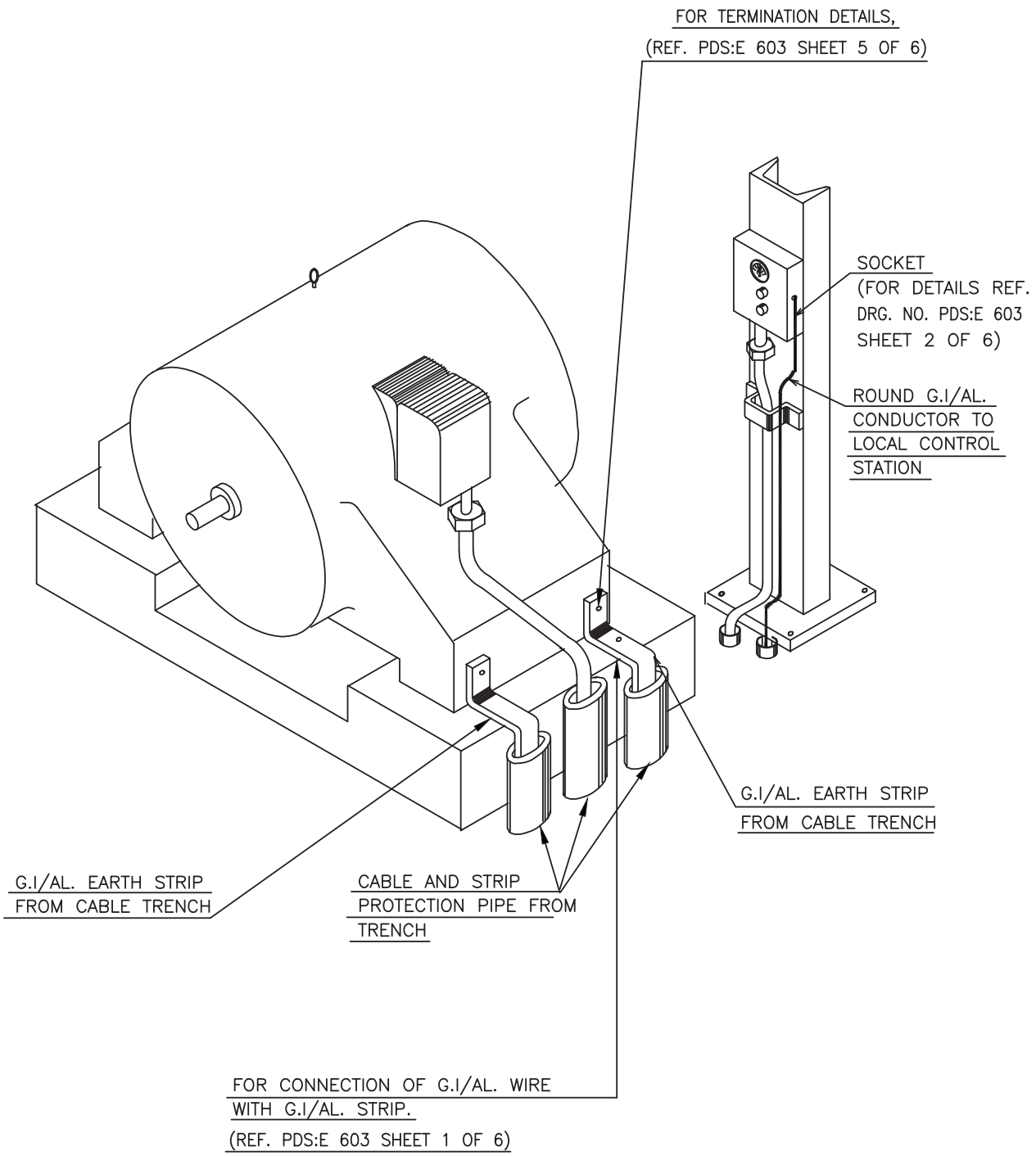
SECTIONAL ELEVATION OF EARTH PIT


M14x75 LONG M.S. RAG
BOLTS & NUTS WITH ONE WASHER
G.I. STRIP TO
NEXT ELECTRODE
62
40
G.I. L–PIECE
G.I. STRIP TO
NEXT ELECTRODE
326
G.I. STRIP/PVC INSULATED
CABLE TO EQUIPMENT/
SYSTEM EARTH BUS.
33
52
52
52
33
12
50X12 THICK
G.I. FLAT
M14x40 LONG STAINLESS STEEL
BOLTS & NUTS WITH ONE SS
WASHER AND ONE SPRING WASHER
DETAIL AT – E
1100mmSQ.
250
600
250
300
241.55
356.45
250
E
111
326
163
SECTION F–F

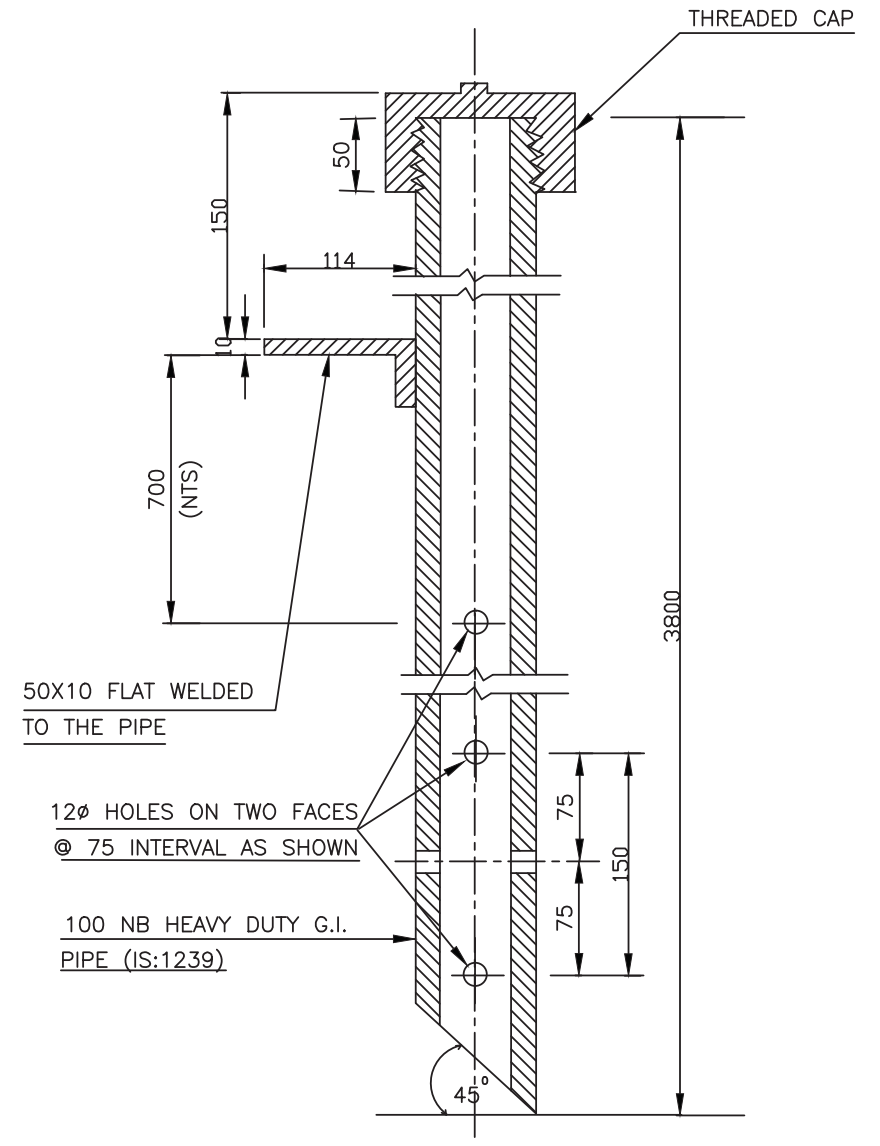
पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF EARTHING FOR MOTOR AND START STOP PUSH BUTTON STATION	PC183–PDS:E 606	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	



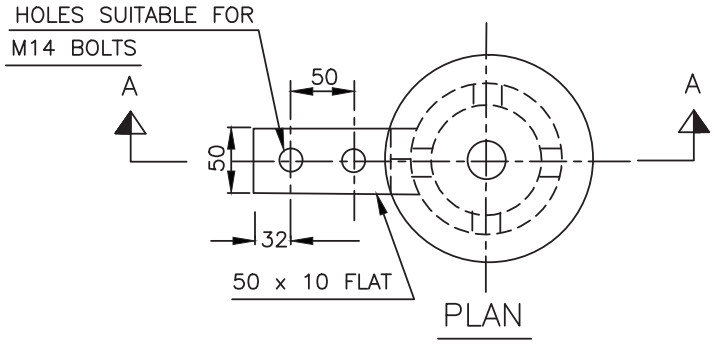
पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF EARTHING FOR MOTOR AND START STOP PUSH BUTTON STATION	PC183 –PDS:E 606	0
		DOCUMENT NO.	REV.
		SHEET 2 OF 2	



पी डी आई एल PDIL	3.8M G.I. ELECTRODE FOR EARTHING	PC183 – PDS:E 610	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION A–A

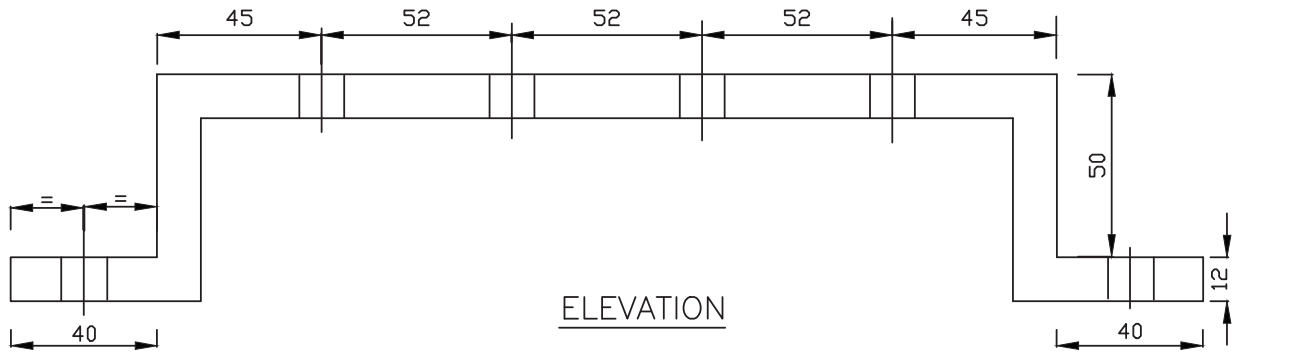


PLAN

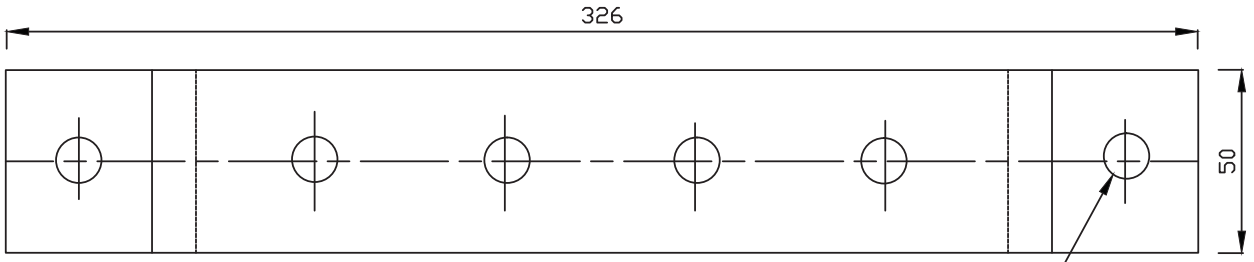
NOTE:–

1. 12ø HOLES WILL BE PROVIDED AT 75mm INTERVAL ON TWO FACES THROUGHOUT THE LENGTH OF PIPE. THE FIRST ONE SHALL START 700mm BELOW THE WELDED FLAT.
2. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	GI / AL ACCESSORIES FOR EARTH PIT	PC183 – PDS:E 611	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	

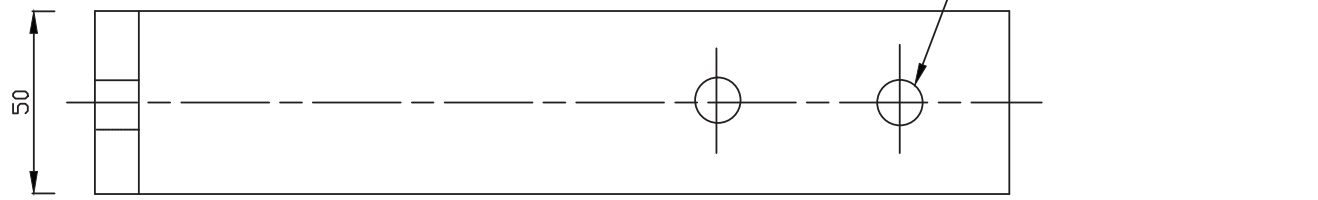


ELEVATION

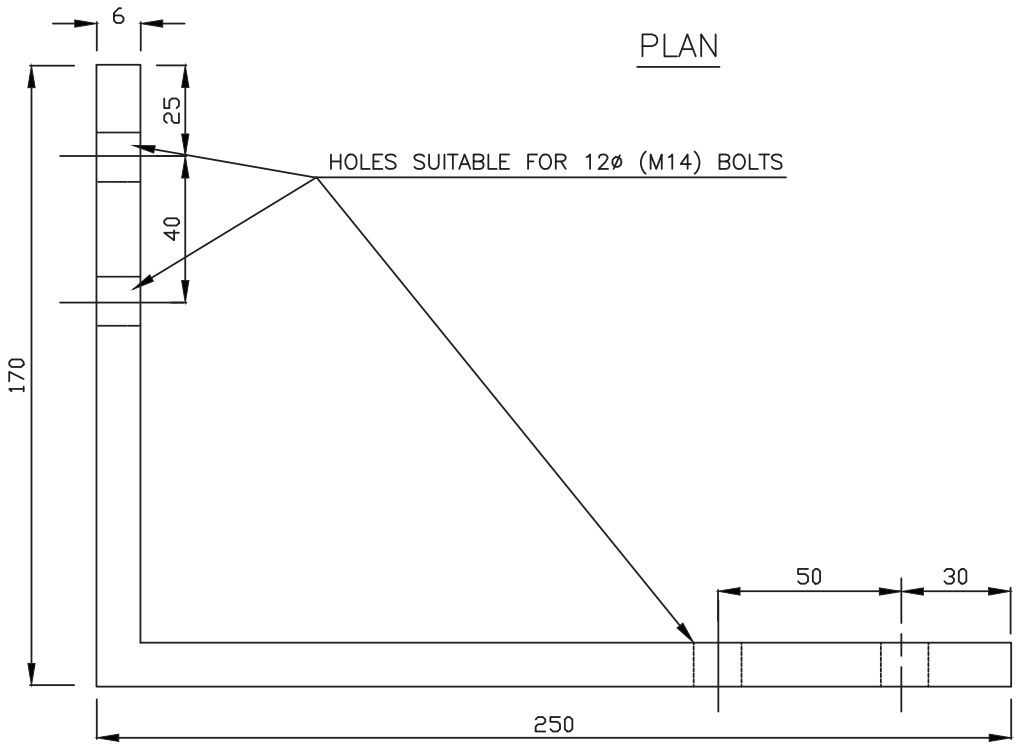


PLAN

G.I. TEST LINK

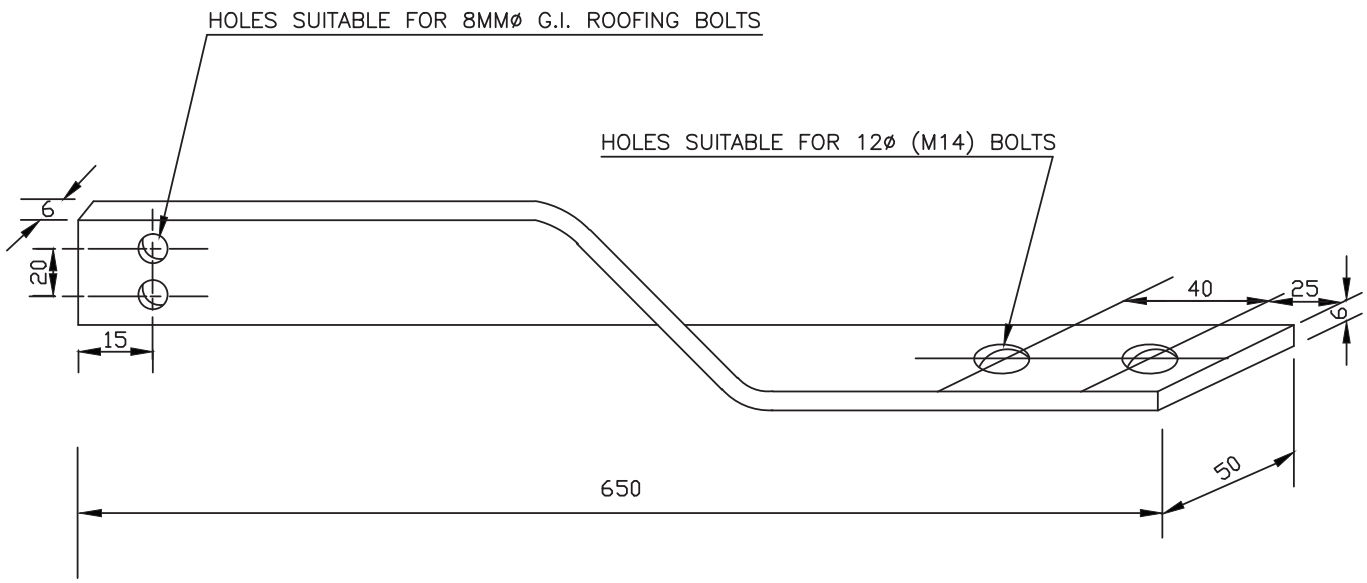


PLAN

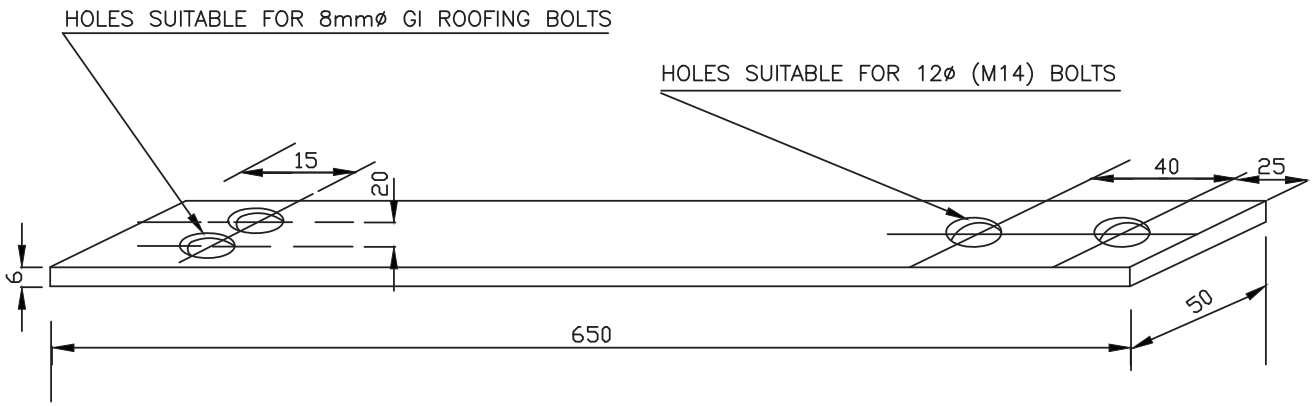


ELEVATION

G.I. 'L' PIECE

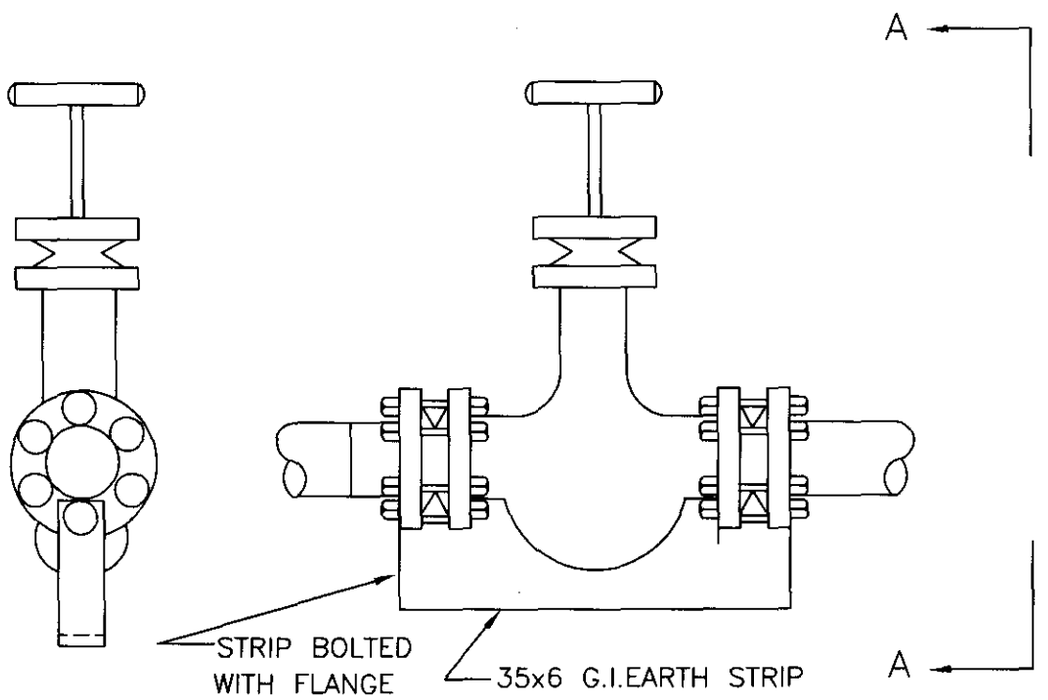


CONNECTING TWISTED ALUMINIUM FLAT PIECE



CONNECTING ALUMINIUM / G.I. FLAT PIECE

PDIL	TYPICAL EARTHING ARRANGEMENT ACROSS PIPE JOINT/VALVES	PDS:E 612	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	

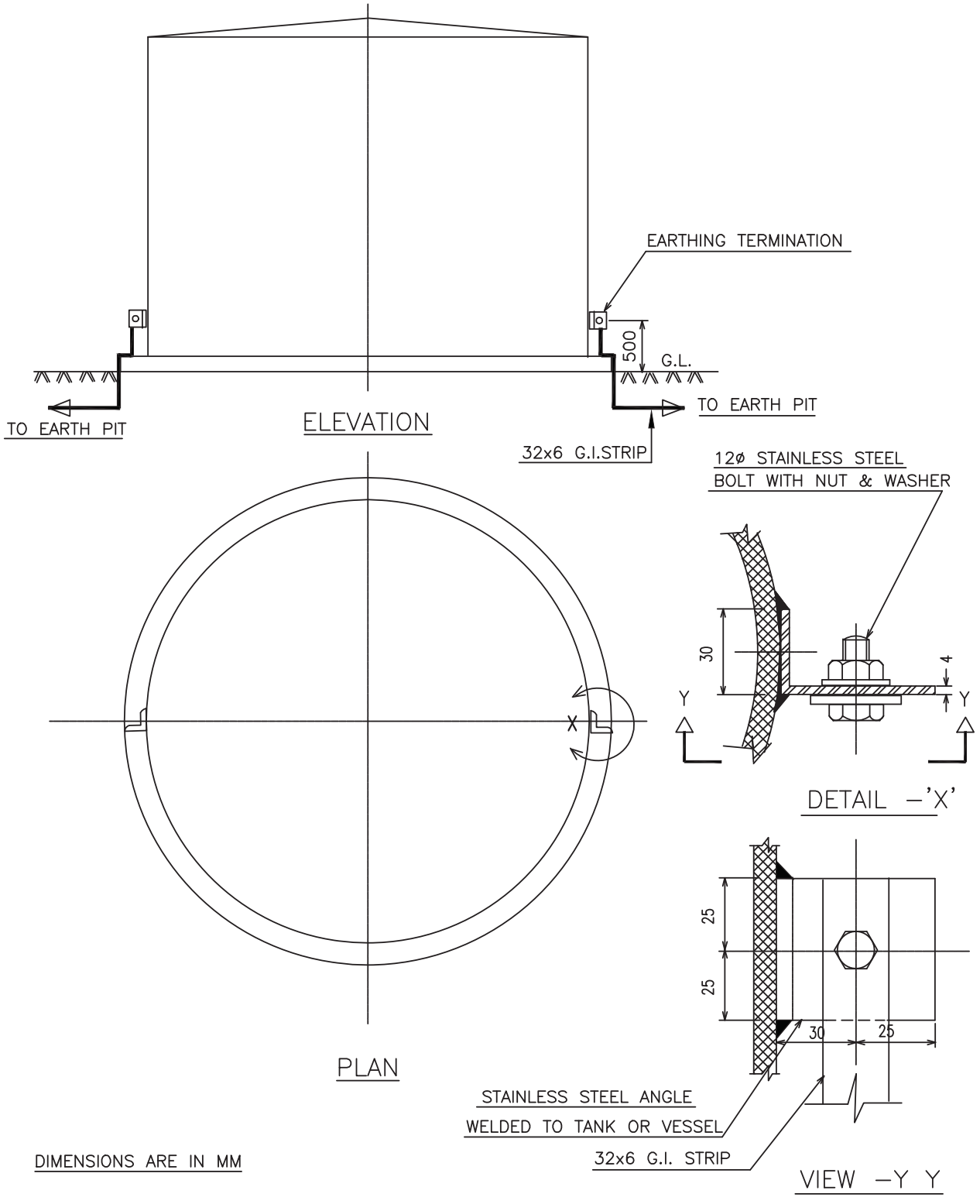


VIEW AT A–A ELEVATION

ALL DIMENSIONS ARE IN mm.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
1	16.01.06	30.01.06	ISSUED FOR IMPLEMENTATION	RUNDA	AV	BB

पी डी आई एल PDIL	EARTHING OF STORAGE TANK & VESSEL	PC183–PDS:E 613	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

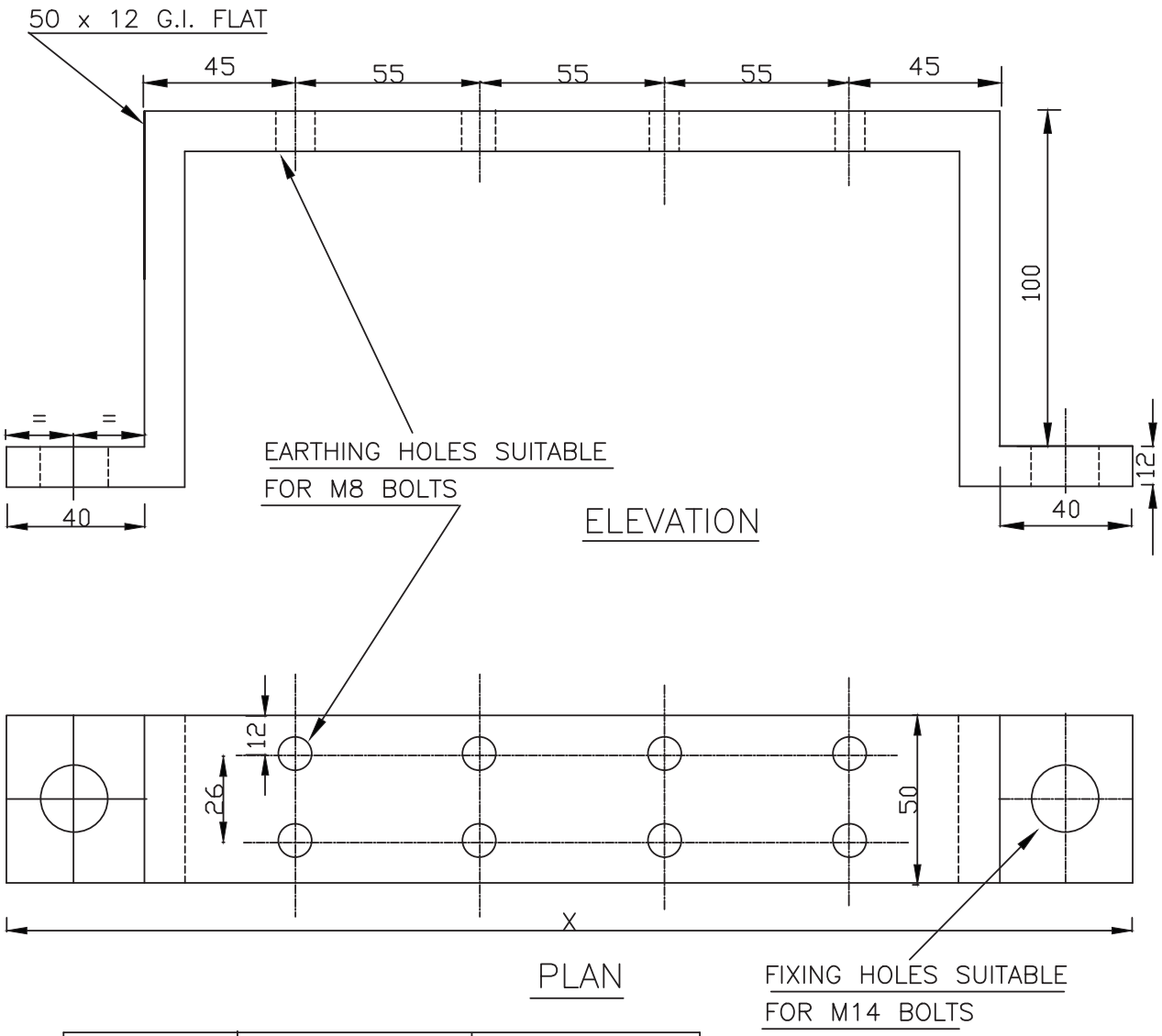


DIMENSIONS ARE IN MM

THE NO. OF EARTH CONDUCTOR SHALL BE AS FOLLOWS

EQUIPMENT WITH ANY DIMENSION	HAZARDOUS AREA	NON–HAZARDOUS AREA
≤ 3 Mts.	1	1
> 3 Mts. ≤ 30 Mts.	2	1
> 30 Mts.	3	2

पी डी आई एल PDIL	G.I. EARTH BUS	PC183 – PDS:E 615	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

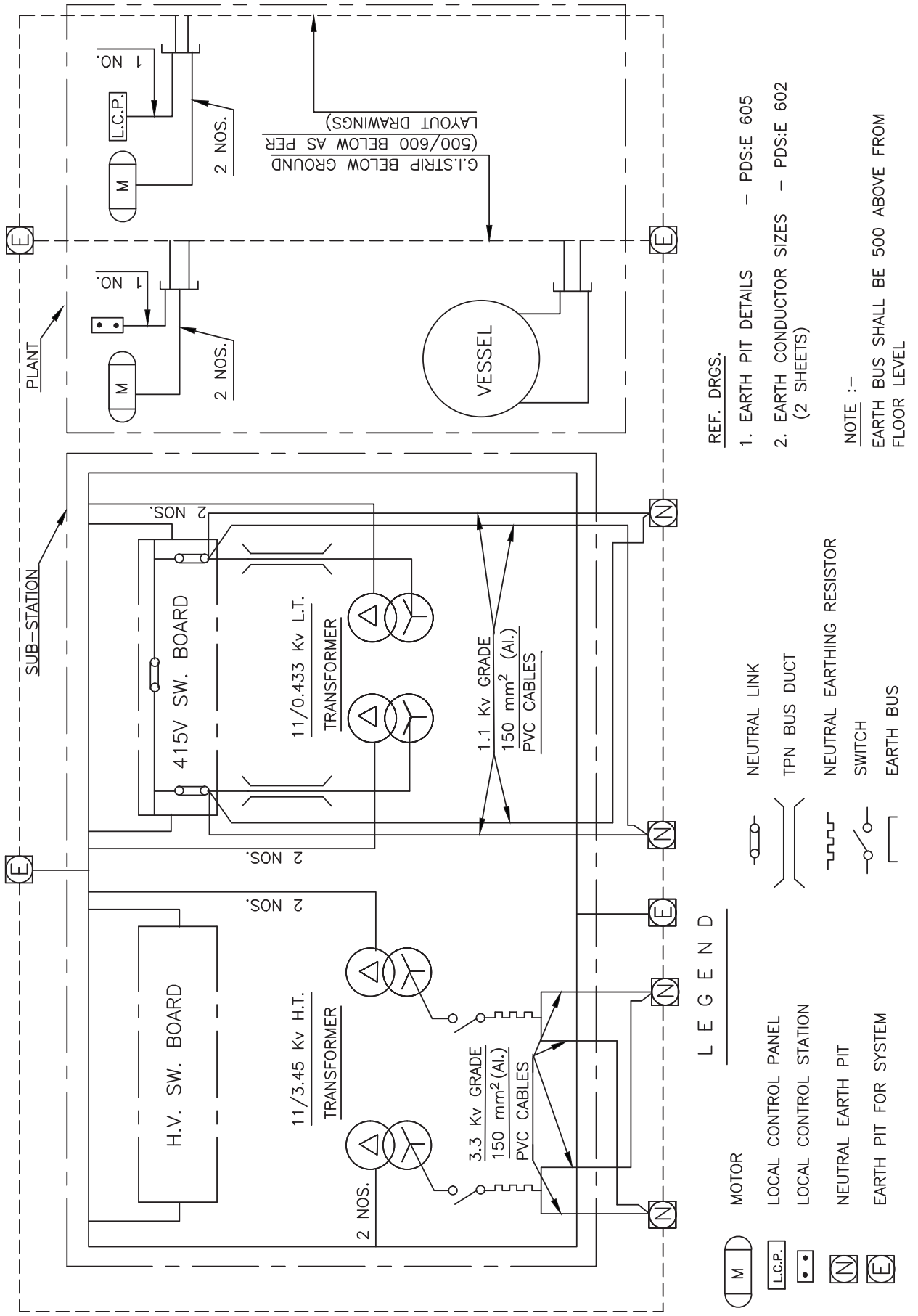


TYPE OF EARTH BUS	NO.OF EARTHING HOLES	OVERALL LENGTH x (mm)
1	8	335
2	10	390

NOTES:–

1. LOCATION OF EARTH BUS TO BE DECIDED AS PER EQUIPMENT POSITION AT SITE.
2. EARTH BUSES SHALL BE LOCATED ON STRUCTURES/COLUMNS WALLS/EQUIPMENT FOUNDATION ETC.
3. MOUNTING HEIGHT OF EARTH BUS SHALL NOT BE LESS THAN 500mm FROM FINISHED FLOOR LEVEL
4. ALL DIMENSIONS ARE IN mm

पी डी आई एल PDIL	TYPICAL ARRANGEMENT FOR NEUTRAL AND EQUIPMENT EARTHING	PC183 – PDS:E 617	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION – VI

PART : 3.4

CONTRACTOR SCOPE OF WORK - INSTRUMENTATION

PLANT : INSTRUMENT AIR/PLANT AIR SYSTEM

PROJECT: INTEGRATED COAL BASED FERTILIZER COMPLEX AT TALCHER, ANGUL, DISTRICT-ODISHA, INDIA

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CONTENTS

SECTION NUMBER	DESCRIPTION
1.0	Instrumentation And Controls Philosophy
2.0	Documentation
3.0	Control Philosophy (General)
4.0	Instrumentation Code And Practices
5.0	Hazardous Area Classification & Electrical Execution
6.0	Electrical Supply
7.0	Field Instruments
8.0	Control system
9.0	Local Control Panel
10.0	Pneumatic transmission
11.0	Installation
12.0	Storage Tank
13.0	Training
14.0	FAT/SAT

ANNEXURE NUMBER	**DESCRIPTION**
ANNEXURE-1	Instrumentation Accuracies
ANNEXURE-2	Instrument Process Connections
ANNEXURE-3	System Configuration
ANNEXURE-4	OS/ES/SOE specification
ANNEXURE-5	Hardwire Console
APPENDIX	Cable Sizes

A. Control System Architecture

B. List of General Specification

ATTACHMENT NUMBER	**DESCRIPTION**
GSTD-0100	General Specification For Instrument Tube Fitting
GSTD-0101	General Specification For Instrument Tubing
GSTD-0102	General Specification For Instrument Valves And Manifold
GSTD-0103	General Specification For Junction Boxes And Cable Gland
GSTD-0201	General Specification For DCS System
GSTD-0202	General Specification For PLC System
GSTD-9998	Inspection And Test Requirements

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1.0 INSTRUMENT AND CONTROL PHILOSOPHY

SCOPE

The description and requirements contained in this specification are concise by necessity and cannot include all details. However, it is the responsibility of the contractor to execute the job on a turnkey basis in accordance with the specifications and internationally recognized good engineering practices for smooth and successful operation of various units of the plant. Any activity specifically not listed in this document, does not absolve the contractor of their responsibility to include such activities in their scope of work and supply, which otherwise is necessary, to complete instrumentation work for the Instrument air/Plant air plant. All such activities shall be carried out by the contractor without any implication.

This section outlines the general requirements and specifications for Instrumentation and Control System for Design, engineering, procurement, fabrications, supply, inspection, testing, painting, transportation, calibration, supervision of erection and commissioning supervision of Instrument Air/plant Air system with associated facilities at TFL.

This section outlines the general requirements and specifications for Instrumentation and Control System for Design, Engineering, Manufacture, Shop test, third party Inspection, Supply, erection and commissioning of Instrument Air/plant Air system along with associated facilities. The Instrumentation and Control System shall consist of but not limited to the following

- Instrument Air/plant Air shall be provide as per below mentioned Control System:

- Instrument Air package plant shall be provided with DCS/PLC based control system. This control system will accommodate all control/trip and monitoring signal/functions for the unit
- Common DCS/PLC has been considered for Instrument package and bidder to ensure segregation of individual plant level signals at AI/AO/DI/DO card level so as to ensure the reliability of the system. The same control system shall be applicable for Drying Unit also.

- 1 no. OS with dual LED monitors and 1 no. OS cum Engineering having the feature of SOE also (placed in console area of engineering room), shall be provided by the bidder.
- One no. Aux. Console with Ann. window, push buttons, switches for critical trip and alarm shall also be provided.

- RIO shall not be considered anywhere in the package.

- All the required protections & interlocks shall be carried out in DCS/PLC. All the features such as graphics, alarms, and process parameters display diagnosis for

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plant equipment shall be displayed in package's operator station installed in the CCR.

- Network securities shall be provided by Vendor in control room as per IEC 62443 for protection of the system from both internal and external threat. The requirement includes all USB port blocking (including all monitors / CPU), provision of sufficient firewalls, and antivirus update for one year, patch update; unauthorized logging recording with events etc. must be addressed by Vendor.

- Bidder to note that all the Operator /Engineering Console & printer table etc. supplied by Bidder shall preferably match with the Client's installed consoles in the Main Plant CCR. Details regarding existing consoles shall be provided to the bidder at later stage.

- Beside this, Bidder to arrange power distribution to additional 4 operator station. Supply of 4 OS not in bidder scope, power supply distribution from PDB to OS is in Bidder scope. Bidder to consider PDB panel to achieve the same.

- The Instrument Air/plant Air syste**m** package shall be provided with complete instrumentation & control system that performs the safety and protection of the packages.

- Package vendor shall be responsible for supply of instruments, controls, local panels, trays, cable, termination to junction boxes and multipair cable termination from junction boxes to Central control room etc.

- All the instruments on skid (if applicable) shall be supplied as installed items, no lose supply of instruments shall be acceptable for any type of skid.

- For important operating data and indications required for surveillance and monitoring, a provision shall be made to repeat the signals in Client's DCS/ ESD from Instrument air/plant air unit Control system, wherever applicable. For this bidder to provide communication redundant port (MODBUS TCP/IP) / OPC server for communication to Client's DCS. Bidder to provide necessary interfacing cards to achieve the purpose. It is preferable to offer Control system of the same make as the existing DCS/ESD in central control room. Existing DCS/ESD make shall be discussed during detail engg. Any Hardware / software required for seamless integration for interfacing from Package Control system to CCR, shall be in the scope of bidder.

- Bidder shall supply, install & commission all field instruments, local cables, junction boxes, cable trays, Air Distribution Pots. All local cabling shall be terminated in Field Junction Boxes/Local Panels by the bidder and the same from JB/Local panel shall be taken to Central Control Room through Multi-core cables by the Bidder. Supervision for erection/commissioning shall also be provided by the bidder at site.

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- Bidders shall provide necessary support for interfacing till the control room.

		Supply	Installation/ Erection/Commissioning	Assistance Erection/Commissioning
1.	Field Instruments	By Bidder	By Bidder	By Bidder
2.	Control system	By Bidder	By Bidder	By Bidder
3.	Package Battery Limit to Central Control Room through multi-pair cables & cable trays	By Bidder	By Bidder	By Bidder
4.	Interface Control system (Hardware/Software)	By Bidder	By Bidder	By Bidder
5.	Earthing/Earthing cables & Earth Pits	By Bidder	By Bidder	By Bidder

- All the required, control function, logic function, protections & interlocks shall be carried out in the control system. All the features such as process Cause and Effect graphics, Logic functions, alarms, and process parameters display diagnosis for plant equipment shall be displayed in package's operator station installed in the Central Control room with local interruption facility.

- All operating conditions including necessary data logging, alarms etc. process Cause and Effect graphics etc. shall be communicated to control system. Changes in 'Operating Modes' (for generating either liquid or gaseous Nitrogen) shall be carried out by control system.

- Planned shut-down and 'Emergency shut-down' caused by plant trips, shall be managed through control system.

- Sequence of Cyclical mode operation of the Absorber Vessels (if applicable), along with temperature, pressure and flow indications, and ON/OFF indication and their push buttons for Compressor and other vessel shall be implemented in control system with their repeat signal in local panel wherever applicable.

- The plant shall be capable of fully automatic operation once started. The control and monitoring of parameters along with over-ride features shall be incorporated for part and full manual operation.

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- The system shall be capable of operating on a continuous or intermittent basis and shall be completely automatic, requiring no operator attention, with all cycle control valves actuated by a control system.
- The operation shall be from control system only, however the complete plant could be started manually from local control panel.
- Emergency stopping shall be possible from control system. & local control panel.
- Analyzers shall be designed for continuous monitoring
- The Instruments in general shall be Electronic Micro processor based type with latest revision of software. The field instrumentation i.e. Flowmeters, Transmitters, Smart Positioner, etc. shall have latest HART protocol as minimum.
- All equipments/instruments/system oriented items (with all its sub-systems) shall be of field proven quality both with respect to design and materials. Prototype instruments or instruments of an experimental nature shall not be offered or supplied. In general, all the supplied items by supplier shall have a well proven performance record of operating satisfactorily in an Acid /Pharmaceuticals /Oil and Gas sector/Power/Chemical/Fertilizer Plants for minimum of one year. No instrument requiring special maintenance or operating facilities shall be offered or supplied as far as possible. PTR for field instruments shall be considered min for 2 years.
- Bidder to carry out :
- Preparation of engineering and construction documents like functional schematics, I/O list, logic diagrams for interlocks as per ISA 5.2 with functional descriptions, configuration diagram, electrical load list, cable schedule, cable tray/trench layout, instrument air requirement, nameplate schedule, JB schedule, instrument location layout, electrical instrument signal interface, instrument index, layout drawings, loop diagrams, primary and secondary sketches and bill of materials.
- Preparation of all engineering documents for control system like graphic schemes, instrument loop data base, log formats and any other documents necessary to carry out the system engineering of control system.
- Co-ordination with Control system vendor for system engineering, implementation, software testing, supply and final commissioning supervision and site acceptance tests.
- Co-ordination with all instrumentation vendors for obtaining sufficient information in the form of documents, drawings for engineering and approval from OWNER.
- Preparation of specification for erection materials like cables (Signal, power, control, Optical fiber etc), cable trays, pipe & pipe fittings, air tubing, junction boxes, air distribution pots etc.

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- Bidder to provide all sufficient information in the form of documents, drawings for engineering and approval from OWNER.

- Bidder to supply complete instrumentation system with all necessary erection material like valves, fittings, tubes/pipes, cables, cable glands and cable trays Junction box and any other erection material for the completeness of the job.

- All system cables/fiber optic cables in the field (including communication between CCR and CR) shall be routed in HDPE Hard pipe. Fillings shall be used for joining the HDPE pipe. HDPE pipes shall be ORANGE in colour with BLACK fillings. All system cables/fiber optic cables shall be routed in the middle 150mm portion of the tray. Wherever it is absolutely necessary to route these cables underground, it should be routed in the RCC Trenches only. Separate route should be followed for redundant system cables. Supply of Cable trays and laying of cables through trenches upto CCR are in bidder scope.

- No copper or copper alloy shall be used for the parts coming either in contact with process fluid or outside atmosphere.

- All instruments and equipments shall be suitable for use for specified site climatic conditions and industrial environment in which corrosive gases and/or chemicals may be present. As a minimum, all instruments and enclosures in field shall be dust proof and weatherproof to IP-67 as per IEC-60529 or equivalent NEMA 4X enclosure rating or better and secure against the ingress of fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive plant atmosphere.

- All Inst. JB's shall be of FRP material with minimum 4 mm thickness with proper support to protect against corrosive environment and cable entry shall be from bottom only.

- The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC 61000-4 "Electromagnetic compatibility for Industrial Process measurement and Control equipment".

- Process switches, shall be realized through field transmitters only. If for some packages, process switches are unavoidable same shall be provided with sealed micro switch contacts rated for the specified application. Contacts shall be 1 no. DPDT preferably. Otherwise 2 nos. SPDT can be considered. All switch contacts except those used in intrinsically safe circuits shall be silver plated. Contacts used in intrinsically safe circuits shall be suitable for the applications. Switches shall be hermetically sealed type. Switches shall be connected through interposing relays.

- All Field transmitter supports should be properly clamped with SS304 accessories to the pipe for pre-fabricated wherever required and closed couple installation. No air gap shall be kept between support clamp and pipe.

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- All Solenoid valves shall be Intrinsically Safe type (24 V DC), SIL3 certified with details inside the design basis. Solenoid valve body material shall be SS316. All critical loops must have redundant SOV's.

- Other specification like panel earthing, instrument earthing, MCT material, temp monitoring inside panels, inside CR the scope of vendor shall still be as per contract, UPS monitoring alarms in Control system, H2 detector in battery room etc. shall be as specified elsewhere in this tender.

Dew point/Moisture Analyzer

For dew point analysis, analyser based on aluminium oxide sensor along with OEM specified sampling probes and sampling system and its accessories shall be considered subject to compatibility with the process sample. The dew point analyser shall be supplied complete with proper calibration apparatus, local indication, any sample conditioning requirement etc. The aluminium oxide cell and sample conditioning unit shall be located as close as possible to the sample point. Twisted pair armoured cable shall be used to connect to the transmitter. Auto calibration facility need to be provided for the analyser, if applicable. The analyser shall be stand alone panel mounted and protection class shall be IP65 or better. Suitable canopy shall be provided for the enclosure. Analyser shall have 4-20 mA transmission output for indication in Central Control Room. Local display shall be digital LED type.

Where the analyser is required to monitor extremely low levels of moisture the quartz-crystal oscillator technique shall be considered.

Connection between the sample point and the conditioning unit / analyser element shall utilise a pre-insulated / electrically heated stainless tube (SS316-in inches only) bundle.

For extremely low moisture concentrations the use of internally polished (Electro-polished and passivated), pre-insulated /electrically traced tube bundles shall be considered.

- ➢ Accuracy shall be ±3 Deg C or better and repeatability must be ±0.5 C' or better.

- In the event of any conflict between this specification, related standards and codes, any other attachment to this package or process packages, the contractor shall follow the following documents in the order of their priority:

  - ✓ General Standard specification attached
  - ✓ Licensor's recommendation

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- ✓ Statutory requirements and codes & standards

Instrument Air Plant shall be provide as per below mentioned Control System

OPTION 1

DCS based control system for Control & ESD function also with applicable redundancy as specified in this tender. This control system will accommodate all control/trip and monitoring signal/ functions. One redundant controller with I/O cards (redundant cards to be considered only for closed loops signals) for control & monitoring application and one separate redundant controller with redundant I/O cards for trip/shutdown functions. Scan time of the controllers shall not be more than 250 msec.

Control system for Instrument Air plant shall be placed in CCR (Central Control Room).

(Detail specification of DCS shall be share with the bidder on later stage.

OPTION 2

PLC based control system (TMR/DMR)

Scan time of the controllers shall not be more than 250 msec. *(Other requirements for PLC system shall be per NIT)*

- o 1 nos. OS, 1 no. ES cum OS with SOE, with dual LED monitors will be used for controlling Instrument Air package out of which 1 nos. OS will be placed on the consoles of CCR, 1 no. ES cum OS and 1 no. SOE station will be placed on the consoles of Engineering room of CCR.
- o One no. Aux. Console with Ann. window, push buttons, switches for critical trip and alarm shall also be provided.

Dedicated SOE work station is not required. Engineering station shall have feature of SOE.

2.00 DOCUMENTATION

SL No	Document Description	Document to be submitted		
		With Bid	After order for approval	Final
1	List of Instruments (tag wise) indicating type of Instrument, make, model no., quantity etc.	Yes	Yes	Yes
2	Instrument mounting and connection details		Yes	Yes
3	Instrument layout drawings			Yes

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4	Catalogue of Instruments & System	Yes		Yes
5	List of spares (item wise and quantity) for Commissioning and 2 years of operation	Yes	Yes	Yes
6	Specification of Instruments	Yes	Yes	Yes
7	Detail wiring/ interconnection diagram		Yes	Yes
8	P and I Diagram	Yes	Yes	Yes
9	I/O list		Yes	Yes
10	Loop Diagram		Yes	Yes
11	Logic Diagram for interlock & safety (if any)	Yes	Yes	Yes
12	J.B. termination drawings		Yes	Yes
13	Instrumentation, operating, maintenance manuals			Yes
14	Instrument Test Certificate			Yes
15	Vendor to indicate power requirement (if any) for the control system	Yes	Yes	Yes
16	Other documents necessary to have a clear understanding of the system	Yes	Yes	Yes
17	List of alarms	Yes	Yes	Yes
18	Schematic drawings for controls	Yes	Yes	Yes
19	Control room layout/System Architecture	Yes	Yes	Yes
20	Field Operator Room layout	Yes	Yes	Yes
21	System Architecture	Yes	Yes	Yes
22	Instrument Air Consumption Requirement	Yes	Yes	Yes
23	UPS power & Heat Load Requirement	Yes	Yes	Yes
24	Bill of Material	Yes	Yes	Yes

3.0 CONTROL PHILOSOPHY (GENERAL)

3.1 Design and installation of instrumentation shall comply with codes and recommendations listed in item 4.0.

3.2 The instrumentation shall be designed to provide stable and accurate plant control ensure safe plant operation and to facilitate plant maintenance, Control and Monitoring. The operating interface to the process shall be colour dual screen 22” LED TFT Color (Minimum) display units with touch facility, presenting overview, group and point displays as well as process graphics with live data. The operator will manipulate all facilities through dedicated operator’s keyboard and using the touch panel. All operating consoles for control system shall be located inside the Central control room.

3.3 I/O units, marshalling cabinets, power distribution cabinets shall be housed in Rack room in the Central control room.

3.4 ES cum OS (Dual Stacked) with SOE feature shall be placed on the console of engineering room.

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3.5 Package Unit Control System :

Bidder to provide Control System with redundancy at all levels and with latest model. It shall have provision to communicate with main plant control system placed in CCR (Central Control room) through Modbus protocol and connected by Serial cable in redundant mode. Control System for the package including marshalling cabinets, relay cabinets, MCC Interface cabinets, power supply distribution cabinets, instrument isolator, alarm cards, terminals, relays with accessories duly mounted, wired & tested to meet specified requirements.

3.6 DIs/DOs from MCC to Control System or from Control System to MCC shall be with relays only. Separate panels for DI/DO and AI/AO. The details will be discussed during detailed engineering.

3.7 Alarm and Annunciation System (LED type only):

Annunciation system is used to indicate and sound alarm for any process abnormality, trip/status change of Electric drive. Annunciation system shall be of modular design & programmable type. Electrical circuit is designed to read the change of state of discrete signal and generate the output to illuminate the window and give the alarm. The alarm can be silenced by acknowledge switch. Window light can be reset after acknowledgement and, when the state of signal returns to the prior alarm state. Annunciation system can be configured for any of sequences of ISA standard. There shall be a provision in circuit design to change the state of signal required to generate alarm (from Open to Close or vice versa) simply by changing the jumper position on circuit board. Lamps in window shall be replaceable from the front.

Hooter in general, shall be solid state type with audibility of the order of 100 dB at the distance of 3 meters. An interruption of power supply up to 20 msec shall not affect the functioning of unit.

3.8 The minimum instrument accuracy shall be as defined in Annexure-1.

3.9 Universal HART Protocol with Latest Revision shall be used in all cases.

3.10 SIL certification rating for all the instruments shall be minimum as per following list :-

- All Smart Positioners - SIL 2
- All Transmitters - SIL2
- All Solenoids - SIL 3

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- All Gas Detectors - SIL 2
- All switches - SIL-3 or maximum SIL rating available

3.11 Card mounted Relays are acceptable but cards must have redundant power facility, with it power healthiness indication in diagnostic graphics.

3.12 Cable entry to control room, analyser shelter, substations shall be through MCT blocks with SS MOC only.

3.13 Entry into the Marshalling Panels in the control room shall be through bottom mounted MCT blocks or SS316, DC, ET glands.

3.14 General Earthing & Instrument Earthing shall be provided separately (Panel and power earthing, Control System earth and Instrument signal earth is minimum envisaged).

3.15 All wetted part materials for all instruments (sensing elements) shall be min SS316L.

3.16 The instrument item like control valve, pressure relief valve, orifice flanges, level instrument, thermowell etc., coming on pipe and vessel under IBR services shall be certified by IBR or IBR authorised representative, even for SS metallurgy.

3.17 Turbine flowmeter shall not be used.

3.18 All Contacts shall be 2 SPDT or 1DPDT.

3.19 No Direct Process Switches (Pressure / Level/ Flow / Temp.) shall be used.

3.20 All field transmitters for pressure, d/p, level and flow shall be microprocessor based (dual compartment) SMART transmitters with “UNIVERSAL HART” protocol with latest revision. The transmitter selection shall be such that the operating maximum upper limit shall be around 70% of the total measurement range of the transmitter. All Field transmitters for pressure, d/p, level and flow shall be provided with 10 years stability with accuracy (0.1%).

3.21 The control system and its software must be of latest version and supplied with latest anti-virus software.

3.22 All equipment/materials supply shall include spares required for 2 years operation and separate consumable for commissioning.

3.23 Motor / electrical equipment control philosophy

a. Field :

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- Ready to START (Lamp)
- START
- STOP
- L/R Switch

b. For Package PLC

- STOP Command
- Discrepancy Alarm
- Running Indication
- Motor Fault Alarm
- Current Indication (All motor > 5KW)
- L/R Switch Indication
- Ready to START F/B

c. For start / stop of all electrical equipments, local/remote selector switch shall be located in field, A/M (Auto/ Manual) and stop push buttons on consoles in Central control room. Local stop push button on LCS (local control station) shall be always effective.

d. In remote mode, motor can be stopped from control system.

e. In LOCAL mode, both START and STOP shall be possible only from LOCAL. Only in REMOTE, stopping is possible from control system.

f. Auto / manual selection shall be in Control System /local.

3.24 For all motors current indication shall be provided in control system for rating more than 5 KW.

3.25 For Auto start/stop signal to pump, 1oo2 philosophy shall be considered.

3.26 All Instruments including volume bottle must be painted with Corrosive resistant epoxy paint.

3.27 Local indicators, start /stop switches, emergency stop switches shall also be provided near package units/rotating machines where local start up of the equipment is advisable.

3.28 For instrumentation electrical interface, input and output contacts shall be in separate multicables (should be signal cables).

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3.29 All trip solenoids shall be dual redundant, and configured and hooked up properly in such a way that failure of one solenoid doesn't initiate a false trip. Trip solenoids shall be normally in energised condition and shall be de-energised to initiate trip.

3.30 All trip interlocks must be designed on 2oo3 philosophy.

3.31 Emergency stop and critical stops must have transparent protective cover.

3.32 PB's , Annunciator , EPB must be available on console placed in Central Control Room.

3.33 Air fails to open, Close or Hold of any control valve shall be as per process requirement , to take care of process, plant and human safety. For Piston actuators necessary air volume chambers and lock up relay shall be provided to achieve the fail-safe condition.

3.34 All Analysers shall be Ex.proof (Minimum IP65 or better) irrespective of area of installation.

3.35 All control valves / On – Off Valves / MOVs shall be flanged type.

3.36 Control valve / on-off valve, pneumatic valve shall be designed for minimum 4 Kg/cm2 air pressure.

3.37 Actuator design shall be of 1.5 times of shut off pressure with guidelines as below:-

Vendor shall ensure that the actuator torque produced at maximum air supply pressure (MAWP) does not exceed the shear torque of the valve stem/shaft. As a guideline, actuator torque values shall be in accordance with the following :

Minimum actuator torque of 1.5 x required highest starting torque to commence movement of the ball in the case of maximum differential across the valve.

Shear torque of stem/shaft greater than 1.5 x maximum torque produced by actuator at maximum air supply pressure

3.38 Valve body MOC in steam service shall be of WCC or better irrespective of pipe class.

3.39 Air distribution pots shall be of stainless steel (SS304). Inst. Impulse pipes for process parameters shall be in accordance with piping specifications.

3.40 Hart Compatible gas-detectors to be provided. Electrochemical type gas detectors shall not be considered. Bidder to submit suitable gas detectors as per OEM recommendation/ as per ITB as specified elsewhere. Bidder to submit gas detectors quantity calculation

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along with layout. Bidder to provided hooters (electric type) & beacon (rotating type with light flash).

3.41 All line mounted instruments like in-line SOVs, Magnetic flow meter, Rotameter, Mass flow meters etc shall be provided with block & bypass arrangement, with their indications in system as per requirement, which will be discussed in detailed engineering.

3.42 Separate Sample handing system shall be used for each analyzer. Multi Channel with stream selector can be used, provided the total system including sample handling system shall be imported. Necessary sequence shall be inbuilt in the analyzer for draining the condensate.

3.43 For double acting valve, air accumulator (with MOC as SS304) shall be used for achieving fail safe operation.

3.44 FRP Canopies (UV stabilized 3 mm thick), 2” Pipe mountable, are required for Transmitter, JBs, LCPs, Control Valve positioner, Temp Elements, Proximity level switch, remote mounted electronics, mass flowmeter, ultrasonic flowmeter etc. FRP Canopy shall be Pre-fabricated type. Canopy for transmitters shall cover top and 3 sides. SS canopy instead of FRP, if offered by package vendor, shall also be acceptable. No separate canopy shall be required for instruments located under shed like compressor shed etc.

3.45 System / Marshalling/ Packages cabinet size shall be 2100 (H) X 1200 / 800 (W) X 800 (D) Rittal make.

3.46 Separate Tapping shall be used for each instrument coming for trip, control & monitoring, local display. No More than 3 set of taps allowed.

3.47 Smart positioner shall be considered for all Control Valves. For high temperature services (Above 200 Deg C) remote feedback shall be used.

3.48 Positioner shall be of valve OEM or as per approved vendor list.

3.49 For all Local panels rain cover to be provided. The gasket of local panels must be acid resistant preferably Silicone/EPDM or better which will be discussed during detailed engineering.

3.50 For Analysers separate feeders to be directly taken from UPS. No sub-branching is allowed at any place.

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3.51 No Switches to be used. If in pump seal plan, if level measurement is requirement, GWR to be used.

3.52 Fibre optic cables shall be armoured, multicore type. All fibre optics cable must be laid through HDPE conduit. The make of fibre optic cables shall be Belden / Leoni.

3.53 All cables inside package battery limit shall be supplied and laid by Package vendor through instrument cable trays supplied by Package vendor. All cables inside skids/modules shall be supplied in pre-wired & pre-tested condition.

3.54 All Instrument Hookups shall be approved by owner/PMC.

3.55 All fittings shall be SS316 and in inch only.

3.56 All tubing shall be SS316 and must be made from hot extrusion process only.

3.57 The manifolds (3 valve/5-valve/2 valve) material shall be SS316L.

3.58 All the soft parts of Local panels/JB/SOVs etc shall be of acid resistance, preferably silicone, EPDM or better which will be discussed during detailed engineering.

3.59 Level measurement in the acids tanks shall be of ultrasonic type.

3.60 Bidder to submit separate 5 years Comprehensive AMC prices (with price break-up for each year) for all Control systems, Dew Point analysers. Bidder to provide breakup for each system (Control systems, Dew Point, O2 and CO2 analyzers). It will NOT be a part of evaluation.

3.61 LO auto start (if applicable) should be designed on 1oo2 principle and if Run feedback is taken as one process input in trip logic then it must be designed on 2oo3 logic using two inputs as other process parameters.

3.62 One emergency push button be placed near the compressor and it must be directly connected to MCC for stopping the compressor i.e. without routing through Control System logic. However, its spare contact must be connected to Control System as DI signal so as to get its actuation feedback in Control System as a SOE event.

3.63 Load and Unload SOV must be of SIL3 and redundant.

3.64 Suitable vibration measurement system shall be considered by the bidder for vibration measurement in the machines. (Detail shall be discussed during DE stage). In case of any

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trip action is required because of machine high vibration; interlocks must be design on 2oo3 philosophy or 2oo4 philosophy. Key phasor for speed measurement shall be provided in compressors.

3.65 All absorber swing valves (if applicable) must be rugged and proven for high frequency cycle operation. They must have both position and limit switch feedback. Logic designing on position feedback will be preferred instead of limit switch feedback.

3.66 All drier change over valves must operate in auto mode and must have both position and limit switch feedback. Logic to be designed on position feedback instead of limit switch feedback.

3.67 The drier operation should be automatic without any manual interventions.

3.68 For all Diaphragm Seal Type DP Transmitters/Gauges on Vessels, min size and rating shall be 3” 300# RF.

3.69 The vessel having two LT’s shall be based on two different principles.

3.70 Flushing ring for remote diaphragm seal shall be provided where extended diaphragm seal cannot be provided for pad type nozzles.

3.71 For LT,PT, DPT, PG proper vent /drain facility using manifold/drip ring shall be provided.

For vent, drain ,1/2” gate isolation valve shall be provided

3.72 For ON/off Valve, open/close indication, SOV(either redundant or 2oo3),PST, feedback of SOV if 2oo3 ,if any signal from switch is going to ESD ,2oo3 shall be provided.

3.73 For control Valve, open/close indication, SOV(either redundant or 2oo3), feedback of SOV if 2oo3 shall be provided.

3.74 For MOV, open signal, close signal,open/close command, position feedback, fault , if any signal is going to ESD ,position feedback 2oo3 shall be provided.

4.0 INSTRUMENTATION CODE AND PRACTICES

IEC 13	Diagrams, Charts and Tables, Preparation of Logic Diagrams
IEC 534	Industrial - Process Control Valves

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IEC 584	Thermocouples
IEC 605	Equipment Reliability Testing elements
IEC 611-12	Part 12 Graphical Symbols for Diagrams. Binary Logic
IEC 654	Measurement and Control equipment
IEC 751	Industrial Platinum Resistance Thermometer Sensor
IEC 801	Electromagnetic Compatibility for Industrial Process measurement and Control Eqpt.
IEC 848	Preparation of Function Charts for Control Systems
IEC 902	Industrial Measurement and Control Terms and Definitions
ISA S-5 .1	Instrumentation Symbols and Identification
ISA S-5.2	Binary Logic Diagrams for Process Operation
ISA S-5 3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Symbols
ISA-S20	Instrumentation specification formats
ANSI/ISA S 5.1	Process Instrumentation Terminology
ANSI/ ISA S71.04	Environmental conditions
ANSI/ ISA S75.01	Control Valve Equations
ANSI/ ISA S75.02	Control Valve Procedure Capacity Test
ANSI/ ISA S75.03	Face-to-Face Dimensions for Flanged Globe Style Control Valve Bodies
ANSI/	Quality Control Standard for Control Valve Seat
FCI 70.02	Leakage
BS 6020	Instruments for the Detection of Combustible Gases
DIN 43760	Measurement Standard for RTD.
DIN 19243	Measurement and Control Electrical Sensors, Electrical Position Sensors and Signal Converters used for Intrinsically safe two-wire DC System.
EN-50-014/020	Electrical Apparatus for Potentially Explosive Atmospheres
EN 54 Part I	Components of Automatic Fire Detection System Introduction.

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EN 54 Part 5	Heat sensitive Detectors - Point Detectors containing a Static Element.
ISO 3511.1	Process Measurement Control Functions and Instrumentation Representation Part I: Basic requirements.
ISO 3511.2	Process Measurement Control Functions and Instrumentation Representation Part 2: Extension of Basic Requirements.
ISO 3511.4	Process Measurement Control Functions and Instrumentation Representation Part 4: BasicSymbol for Process Computer, Interface and shared Display/Control Systems.
ISO 4200	Plain End Steel Tubes, Welded and Seamless - General Table of Dimensions and Masses per Unit Length.
ISO 5167	Measurement of Fluid by Means of Orifice Plates, Nozzles and Venturi Tubes Inserted in Circular cross-section Conduits Running Full.
API RP 520	Sizing, selection and Installation of Pressure relieving devices in Refineries
API RP 521	Guide for Pressure Relieving and Depressuring System
API RP 2000	Venting Atmospheric and low-pressure storage tanks
API-RP-550	Manual on Installation of refinery Instruments Part I and Control System
ANSI - B 16.104	Control Valve seat leakage
ISA-S 75.01	Control Valve sizing
ISA S 18.1	Specifications and guides for the use of general Annunciators.
IEC 529	Environmental Protection of equipment
ANSI B 2.1	Pipe threads
ANSI B 16.5	Steel pipe flanges, flanged valves and fittings
IEC 79.11/	Intrinsic safety code and practice
IEC-79.14	International Boiler Regulation
IS 2148	Flameproof enclosure of electrical apparatus

5.0 HAZARDOUUS AREA CLASSIFICATION & ELECTRICAL EXECUTION

5.1 Irrespective of area classification, the execution of instrumentation shall be as per area Zone 2, group IIC, T6, Exia ~~and Protection~~.

Electrical / Electronic instruments IP 67

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Sensors; RTD, T/C, etc.	IP 65
Local Gauges; PG, etc.	IP 55
Pneumatic instruments	IP 54
Solenoid valves	IP 67
Local Panel / Skid Mounted Panels	IP 55

EMC compatibility and electrical safety as per latest IEC standard.

5.2 Electrical instrument equipment shall be designed for and supplied as intrinsic safe certified.

Analysers, solenoid valves and other equipment that cannot be classified intrinsic safe shall be ex-proof in accordance with the above mentioned electrical specification.

Certification for installation in hazardous areas in accordance with IEC 60079 series is shown below:

Transmitters, Positioners, Limit Switches , etc.	Ex ia IIA/IIB T6
Field Switches:	Ex de IIA/B T6
Analysers and Panels:	Ex p IIA/B T6
Solenoid Valves:	Ex ia IIA/B T6 (Ex md not allowed)
Junction Boxes and Cable Glands:	Ex e/Ex d

6.0 ELECTRICAL SUPPLY

The electrical supply will be as follows:

S.No.	Description	110 V AC 50Hz UPS	110 V DC	24V DC	110 V AC Non UPS	240V AC 50Hz (Non UPS)	415 V AC-3 phase	Remarks
1	Control System	YES						
2	Package Units	YES				YES		Non UPS for Lighting
3	Alarm Annunciator	YES						
5	Solenoid Valves			YES				
6	Smart Positioners, I/P, Transmitters			YE S				

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7	I/P Interrogation Voltage			YE S				
8	Gas Detectors			YE S				
9	Analyzers and Analyzer System	YES						
11	Level Gauge Illumination					YES		
12	Cabinets Fan					YES		
13	Cabinets Lighting					YES		
14	Control Room					YES		
15	Local Panel	YES		YES		YES		Non UPS for Lighting
16	Analyzer Cabinet Air Conditioning	YES						
17	Analyzer Shelter HVAC						YES	

Where 24V DC is needed, it will be generated by local rectifier units (bulk power supply), which are part of the instrumentation supply. The power supply to these units shall be taken from the UPS.

Where 24V DC are used for Safety Circuits, the rectifier units shall be duplicated and with high reliability and form a part of Control System vendor. The bulk power supply shall be with MOSFET O-ring.

There shall be minimum 4 (two no. Of each type; total 8 nos.) separate earth pits for signal (IS) , Non IS, Panel and chassis (system) grounding for DCS/PLC Earthing system at Central Control Room with different cable colour codes. All earth shall be less than 2 Ohm or OEM specific, if better. The size of Earthing Cable shall be 50 sq.mm minimum and should be routed in proper HDPE conduit, outside the control room building. All above instrument earth pits shall be separate from Electrical earth pits and must have separate colour identification from electrical earths. Minimum 2 nos. Of earth pits of each type (total 8 nos) shall be constructed by the bidder.

Supply of earth electrodes, grounding cables (separate for signal grounding and instrument grounding) and other related accessories required for barrier earth, system earth and installation shall also be in the scope of work Contractor. Copper conductor shall

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be of 1Cx10 Sqmmas minimum. For surge protection devices separate earthing shall be used.

UPS supplies shall not be used for utilities supplies cooling fans, panel/cabinet lighting etc. A separate non-UPS supply shall be used for the same.

A summary of all critical UPS alarms, 24V DC supply, Panel supplies, diode o rings healthiness shall necessarily provided in Control System and hardwired annunciation in control room or any manned location

Only copper cables & tin-plated copper lugs shall be considered for instrumentation power distribution system.

Supply of UPS and its battery is not in the scope of Bidder . Owner shall provide UPS power at OSBL substation or Utility substation, further distribution shall be done by Bidder. Kindly refer area plot plan elsewhere attached with the Tender. Bidder to furnish requirement of UPS load as well as no. of feeders. The power distribution from UPS to UPS load (like Panels, PDB, lights, Field Instruments etc.) to be catered by Bidder. Bidder to note that distance between UPS room to main central control room (where Panels are placed including IRP,IFC panels) is approximately around 500 meter(Bidder to confirm the distance from area plot plan). Necessary PDB in the control room shall be provided by the bidder to distribute power supply.

Protection coordination with respect to fuse/MCB ratings from the supply source ACDB/DCDB to downstream distribution panels shall be thoroughly studied by the system designers/OEM and documented as a part of the system documentation and be implemented accordingly.

MCB's must have DI contact's which must be wired to Control System and available in diagnostic graphics.

7.0 FIELD INSTRUMENTS

7.1 Flow Instruments

7.1.1 Flow Transmitters

D/P cells shall have measuring method on the floating capacitance technology. The signal transmitter shall normally be a 2-wire system and shall be capable of delivering rated current into external load of at least 600 ohms when powered with 24 V d.c. Protection

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against short circuit and reverse voltage shall be provided. Bodies shall normally be in stainless steel with SS316L internals. Integral 3- valve manifold similar to AGCO make model 4A shall be used for mounting transmitters on manifold for ease of maintenance. Material of manifold in general shall be SS316L but may vary depending upon service. Digital output indication shall be preferable on the integral output meter with the transmitter. All flow transmitters shall have sq.root extraction function.

Pressure elements in austenitic stainless steel is a requirement. The transmitter shall be furnished with an output meter or gauge with a sqrt scale. Smart type transmitters will be used with Hart V protocol. Overall accuracy for SMART transmitters shall be +/- 0.050% or better. Process connection size shall be 1/2" NPT.

All field transmitters shall be 2 wire type, 24 Volt DC, SMART with HART protocol, and shall be equipped with Local LCD type digital indicator. 2" pipe mounting, SS304 MOC brackets and other accessories, as applicable, Accuracy 0.050% of Span , Rangebility 1:100, Local Display configurable, SS MOC, Double Compression SS 316 cable glands, Exia IIA/B/T6, IP67, Wetted MOC SS316L, SS316L MOC Manifold, Housing Die-Cast Aluminium Epoxy Painted, Universal Hart Protocol with Latest Revision is required.

7.1.2 Rota meter with Transmitters

Rotameters or variable area meters may be used in pipe sizes from 1 1/2" and smaller. The meter shall be selected for normal flow at 50 to 60% of the span. In applications with toxic or inflammable fluids, glass tubes must not be used except for low pressure analyser sample flows. They may be used for severe corrosive services and of fluid of high viscosity. The metal tube meters shall be of stainless steel, PTFE lined or any other suitable lining for the service. The Indicator assembly shall be magnetically coupled and mounted with rotameter body. Transmitters or Indicators on float extension are not recommended except for cryogenic services. The switch assembly shall be of proximity type. All Rotameters shall be metal tube type with transmitter. The rotameter transmitters shall have 4-20 mA output at 24V d.c. power on two wire system, which must wired to control system.

7.1.3 PRIMARY DIFFERENTIAL PRODUCERS

7.1.3.1 Orifice Plates

Orifice plates of the square edged concentric type shall be specified except where unsatisfactory for the application. Materials of orifice plate shall normally be AISI 316

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unless special materials are required for the service. The maximum ratio of orifice to inside pipe diameter of 0.70 and minimum ratio of 0.30.

Orifice plates dimensions and calculations shall be in accordance with ISO 5167-1980.

The flow range shall be selected such that normal flow rates are between 50% and 70% of the flow upper range value.

Material of construction of orifice plate shall be 316L SS except where this material is unsuitable for the service because of corrosion or erosion considerations, in which case an alloy shall be chosen whose corrosion allowance is equal to or better than line material. Orifice plates dimensions, finishing, flatness, tolerances for dimensions and identification information shall be in accordance with ISO standard. Orifice plate shall be provided with tab handle, which is welded on the orifice plate and engraved with following information on the upstream of the tab handle:

- UPSTREAM or UP
- Instrument tag number
    - Orifice diameter
    - NPS (Nominal Pipe Size) and ANSI flange class
    - Material of the orifice plate
    - DP range & Meter (Flow) range

The tab shall also be in line with the Drain or Vent hole and shall indicate the direction of flow.

BIDDER shall submit the sizing calculations for orifice plates for review.

Pressure drop for orifice sizing shall generally be selected among the following values: 125, 250, 500, 625, 1250, 2500, 5000 and 10000 mm H2O with standard selection at 2500 mmH2O.

Orifice plates shall be installed on horizontal lines when practical. Vertical meter runs may be used for down flow of vapour and up flow of liquids.

Differential ranges for all liquid flow meters shall not exceed 5000 mm water. Typical ranges for gas, steam or vapour meters are as follows:

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Static Pressure	Diff. Range
(in Kg/Cm2g)	(in mmwc)
0.35 to 2.5	500-1200
2.6 to 6	1250-2500
Above 6	2500-5000

Orifice bore with diameter less than 0.125” shall be avoided.

a) Flange taps orifice shall generally be used for line sizes 2” to and including 18”. Above 18”line size, D and D/2 taps shall be used. Integral Orifice assembly with transmitter shall be used for line size 1 1/2 “or below (as per standard BS-1042)

Orifice assembly shall be provided with two sets of “Flange Taps” located in accordance with latest AGA standards. The orifice assembly shall be provided with jack screw for removal of orifice plate. In case of 2 out of 3 logic requirement, three different transmitters shall be used and no two transmitters shall share the common tapping. In such case six set of taps (independent tapping) shall be provided in orifice assembly. Instrument tapping connections shall be 1/2”NPT (F).

b) Orifice flanges shall be in accordance with the ANSI B16.36, ANSI B16.36a and applicable piping specification and shall generally be of weld-neck type only. The minimum pressure rating of flanges shall be ANSI 300 lbs.

Flanges larger than 3" shall have a pair of jack-screws. The mating flanged shall be aligned in such a way that jack-screws will be diametrically opposite.

Orifice flanges used at pressure ratings up to 600 lb. shall be tapped ½” NPT(F) tap for 900 # above ¾” NPT(F). Orifice connections for Vena contracta taps or pipe taps ½” socket with schedule/MOC as per piping specs

c) For line size below 2” Integral orifice with corner taps shall be supplied as an integral assembly consisting of upstream and downstream straight pipes, integral orifice of 316L SS (as a minimum) installed along with H type manifold and SMART, 2 wire 24 V DC, DP transmitters with latest HART protocol (refer 7.2.1 for tx details). End flanges shall be as per piping specifications. Upstream and downstream pipes shall be honed from inside to achieve smooth surface. Integral orifice meters, when used, shall be installed with block and bypass valves.

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d) Upstream and downstream straight length shall be provided based on maximum d/D ratio of 0.70, in general. Where it is difficult to meet this requirement, the actual d/D can be considered for reducing the straight length as permitted by ' recommended practice shall be as per API-MPMS Recommended Practices and AGA Report No.3. The piping layout, where possible, shall be arranged such that straightening vanes are not required.

e) Orifice plates with RTJ flange connections above 2" shall be supplied with Carrier rings.

f) Meter taps shall be horizontal for liquids, condensable vapors and steam. The tap shall be on top for gas, non-condensable vapor, or liquids, which boils at maximum design ambient temperature at operating pressure.

g) The Meter Range flow shall be equal to the 1.5 times of normal flow or 1.3 times of the maximum flow and it shall be nearest higher multiple of 50/100/1000s of units of measure (in Engg. Unit) in round figures. This meter max range criteria specified is applicable to all other type of flow transmitters also.

7.1.3.2 Nozzles

ISA 1932 Nozzles may be used in high and medium pressure steam and BFW piping. Materials for nozzle element shall normally be AISI 316L steel unless special materials are required for the service. Dimensions and calculations shall be in accordance with ISO 5167-1980. Generally, branch pipe is required with the nozzle the same shall be machined from higher schedule pipe than the one used for the service or forged branch pipe shall be used if higher schedule pipe is not available. The branch pipe bore shall be same as that of nozzle ID and shall have mirror finish.

7.1.3.3 Venturi Tubes

Venturi Tubes or nozzles as per ISO 5167-1980 or similar type elements may be used to measure the flow of low pressure gases or liquids where loss of pressure is an important consideration.

7.1.3.4 Averaging pitot tube/Annubar (Not to be used) The vendor may supply thermal mass flowmeter instead.

7.1.3.5 Local Flow Indicator

Motion balance (Barton cell type) type differential pressure indicator shall be used for local flow indication. Body and internals shall be of 316L SS. Process connection shall be

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1/2" NPT(F) . SS316L 5-valve manifold with 1/2" NPT connection shall be used with the meter.

7.1.4 OTHER FLOW METERS

7.1.4.1 Mass Flowmeter

Coriolis type mass flow meter with local digital display of flow shall be used to measure the process flow where high accuracy is required. Normal accuracy for mass flowmeters shall be 0.15% of span. The sensing element shall be straight/U-tube, matl. 316L in general.

7.1.4.2 Vortex Meter

Vortex shedding meters may be used for wide range of flows for gases and liquids. The measured flow shall be temperature compensated.

Insertion type vortex meter may be used in utility services for line size more than 6" inplace of Pitot /Annubar/Pitot venturi tubes.

7.1.4.3 Ultrasonic Flowmeter

Ultrasonic flow meters (non- insertion probes preferred) based on the "time-of-flight" method shall be used. Meters based on the "Doppler" principle are less accurate and shall not be used. Ultrasonic flow meters shall be considered for large turn downs and where pressure drop is not permitted. Upstream and downstream straight lengths shall be as per standard.

7.1.4.4 Electro-Magnetic Flowmeter

Electromagnetic flowmeter with ceramic lining shall be used for the measurement of flow with high accuracy for highly viscous and corrosive services. Instrument shall be suitable for Acid and alkaline measurement.

7.2 LEVEL INSTRUMENTS

Level Instrument shall be suitable for Acid and alkaline measurement. Guided wave radar type instruments (SMART) shall normally be used for level measurement up to 2400 mm, wherever guided wave radar cannot be used then only external displacer type transmitter to be used.. Differential pressure transmitter (Capillary type) shall be used for level measurement above 2400 mm and for services requiring purge or where liquid might boil

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in external portion. Capillary type DPTs shall not be used in vacuum services. Internal displacer type of level transmitters shall be not be used. Remote Seal PT/DPT shall be with min 5 mtr Capillary with SS armoured in PVC sheath of Protection with DRIP RING and with Ball type Isolation Valve. For Vessel/Equipment requiring more than 5 m capillary electronic remote seal shall be provided. Process connections shall normally be 3" flanged. Wherever Differential pressure transmitter is considered for level measurement, the element shall be preferably remote seal type with drip ring provision & with welded joint for vent & drain. Remote diaphragm seal type DP shall be taken for level measurement with min size and rating of 3" 300#RF.

Where ever possible C-C Distance shall be same for ESD and DCS level transmitter. If there is any deviation, same shall be discussed during DE on case to case basis.

7.2.1 External Displacement

Displacer type level instrument shall be avoided and guided wave radar type or remote diaphragm seal DP shall be used in their place if suitable to process condition.

If unavoidable External displacement type instruments shall generally be used (with owner/PMC approval) for small spans only (The standard ranges shall be: 350 mm, 810 mm., 1200 mm). The cage material shall normally be forged material conforming to the service requirements. Where the vessels are of alloy steel construction, the body material shall be equivalent or of a better material. The displacer shall be in stainless steel (SS316L) and the torque tube in inconel. If LVDT type transmitter in place of torque tube is selected then the range spring of such transmitters shall be Inconel and cannot be used for temp. more than 330 degree C. Process connections shall normally be 2" flanged with side-side connections.

For high temperature as well as low temperature and cryogenic services, torque tube heat insulation extension or torque tube extensions shall be applied. Radiation fins or extensions shall be used for temperature above 200 degree C or below 0 degree C.

7.2.2 LEVEL GAUGE GLASS

Gauge Glasses

Glass gauges shall be avoided and magnetic type level gauges shall be used if suitable to process condition. If unavoidable Gauge Glasses shall normally be reflex type for all process services, except for boiler drums bicolour types shall be used, and in corrosive

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services. Where transparent gauges with glass protection and illuminators shall be used, Illuminators shall be explosion-proof in hazardous areas. Gauge glass columns will not exceed 1500 mm. Multiple level gauges shall be used for visible lengths more than 1500 mm.

Transparent type gauge glasses (double glass) will be used for services in which a level may not be distinguishable, such as interface services, between different liquids, where mica shields are required and fluids of high viscosity or high solid content.

For corrosive services, such as strong acids or alkalies, special devices such as magnetic followers or plastic ("KelF") coated glasses shall be used.

Level gauges shall be supplied with a pair of off-set shut off valves with ball check with SS304, or material suitable to process, as its MOC.

For cold services where temperature is below 0 deg C a non-frosting gauge will be used. Glass tube level gauges shall be avoided.

Gauge glass columns will not exceed 1500 mm. Multiple level gauges shall be used for visible lengths more than 1500 mm.

7.2.3 Non Contact Radar/Guided Wave Radar

Displacer type level instrument shall be avoided and guided wave radar type shall be used in their place if suitable to process condition.

Ultrasonic / Radar type Instrument shall be used for large liquid storage tanks. Guided Wave Radar type level instruments, where used, shall be external type with side / side connections and rotatable transmitter head. Vent and drain valves shall be provided. Non-Contact Radar type level shall be used on corrosive, congealing, slurry services where diaphragm seal type transmitter cannot be used. Dip tube can be used in above services where radar cannot be used. In case of heavy congealing service (sticky liquid) rigid single lead type GWR shall be used. All guided wave radar will be coaxial type, where high accuracy or interface level measurement is required. However single rod design to be avoided to extent possible).

Guided Wave Radar Level transmitter shall be applicable for liquids or slurries, hydrocarbons too water- based media. In absence of dielectric constant for the process fluid, Bidder shall confirm the suitability of Guided Wave radar Level Transmitter for such applications and Bidder shall suggest the suitable model for the same. Bidder shall

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suggest the suitable model for Interface applications like oil on water, Hydrocarbon on water, etc. Electronics shall be capable of measuring upper liquid and interface level simultaneously. Selection shall be available for analog output signal from level transmitter corresponding to upper liquid or Interface. Process connections shall normally be 2" flanged with side-side connections.

For sump levels, Guided wave radar for DCS and non- contact type radar level instrument for interlock shall be used within accuracy ±3mm. For servo gauges where used, calibration chamber with access for removing the displacer for maintenance purpose shall be provided.

SS (or other material as per piping spec) Still Well shall be provided for Non Contact/Guided Wave Radar .

7.2.4 Magnetic Level Gauges

Magnetic type level gauges shall be considered for:

- Cryogenic services
- Fluids that attack glass (e.g., strong acids, alkalies, boiler feed water)
- Light ends services
- Toxic services
- Pressures above 500 psig (3450 kPa) special consideration must be given to the design of float for high pressure

Magnetic- type level gauges shall consist of a liquid chamber enclosing a float which is magnetically coupled to a rotary wafer-type indicator. It shall be top or side mounted type. The liquid chamber shall be one- piece construction with a minimum internal diameter of 50 mm, provided with a bottom flange for removal of the float, vent and drain connections. Indicator shall be adjustable around the chamber with provisions to indicate float failure.

The indication shall consist of bi-colour (red/white, silver/black) magnetic rollers mounted on outside the magnet chamber. As the float rises or falls with the liquid level each roller rotates 180 Deg and so presents a contrasting colour.

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Floats shall be designed and manufactured for suitable to the process parameters. It shall be designed to be adequate for hydrostatic test conditions. Floats shall be hermetically sealed, no vented or pressure equalized construction shall be allowed.

7.3 PRESSURE INSTRUMENTS

7.3.1 Pressure Transmitters

Pressure Transmitters and differential pressure transmitters shall be modern inherent motion-free type. Bodies shall normally be in stainless steel with pressure elements in SS316L. Two valve integral manifold of SS316L material in general shall be used with pressure transmitters.

The signal transmission should normally be a 2-wire system and shall be capable of delivering rated current into external load of atleast 600 ohms when powered with 24 V. Protection against short circuit and reverse voltage shall be provided. Pressure transmitters shall normally be electronic type and shall have digital transmitter.. Smart type transmitters will be used with Hart V protocol.Overall accuracy for SMART transmitters shall be +/- 0.050% or better. Process connection size shall be 1/2” NPT.

All field transmitters shall be 2 wire type, 24 Volt DC, SMART with HART protocol, and shall be equipped with Local LED type digital indicator. 2” pipe mounting, SS304 MOC brackets and other accessories, as applicable, Accuracy 0.050% of Span , Rangebility 1:100, Local Display configurable, SS MOC, Double Compression SS316 cable glands, Exib IIA/B/T6, IP67, Wetted MOC SS316L, SS316L MOC Manifold, Housing Die-Cast Aluminium .Epoxy Painted, Universal Hart Protocol with Latest Revision is required

7.3.2 Pressure Gauges

Gauges for process and utility services shall be industrial SS316L Bourdon gauge/diaphragm or spring bellows type as per process requirement with the case in 316L stainless steel. The gauge for 60 kg/cm2 above pressure shall preferably be a safety type with solid front where pointer and glass are partitioned off from the sensor by a solid disc. Pulsation dampeners shall be installed with the gauges where pulsating pressure occurs. Process connection shall be 1/2” NPT (M) bottom in general. Bezel rings shall be screw on pattern. Dial Size minimum 150mm

Blow-out discs are required for all pressure gauges except for instrument air services.

Vibration proof gauges or remote seal type shall be used if the surrounding environment

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is subject to vibration.

Minimum accuracy for pressure gauges shall be +/- 1%,

Pressure gauges for vibrating services and near pump, shall be glycerine filled type or with pulsating dampener device with capillary of suitable length..

7.3.3 Pressure Switch (Not to be used)

7.3.4 Diaphragm seal

Diaphragms or liquid seals shall be inserted between the instrument and the process for corrosive or highly viscous fluids. For all services element material shall be minimum SS316L.

Pulsation dampeners shall be furnished with pressure transmitters on pulsating services.

All catalyst vessel's dP measurement shall be with ERS (electronic remote seal).

Remote Seal PT/DPT shall be with min 5 mtr Capillary with SS armoured in PVC sheath of Protection with DRIP RING and with SS304 Ball type Isolation Valve. For Vessel/Equipment requiring more than 5 m capillary electronic remote seal shall be provided

DP transmitters with diaphragm seals are envisaged, where condensing leg required to be filled in normal DP transmitters or across filters, at all those locations, remote seal type DP transmitters are to be used. Also, wherever there is a control and interlock on level measurement, one transmitter shall be remote diaphragm seal type and one will be guided radar type with Material: Minimum Inconel. Guided Wave radar may be used for non-critical applications. Process connection will be 3" flanged and sealing liquid must be selected as per process requirement.

7.4 TEMPERATURE INSTRUMENTS

7.4.1 Thermocouples

Thermocouples shall normally be the sheathed type with high purity magnesium oxide insulation. The hot junction shall be isolated from ground. Sheath diameter shall normally be 6mm (1/4") Inconel 600 sheath material shall be used for design temperatures above 400 degree C, whereas ordinary SS material can be used below 400 degree C. The nominal wire diameter shall be approximately 0.19 x sheath OD. The casing material

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must be SS316L.

Inputs from thermocouples shall be provided with cold junction compensation and downscale burns out feature for high temperature shut downs and vice versa for low. A passive alarms shall warn about the burn-out.

In general type K thermocouples shall be used according to IEC 584, class-1. All temperature elements shall be duplex type, one connected and the second one shall be used as spare.

Thermocouple head must be of die cast aluminium with epoxy paint to with stand the corrosive environment.

Unless otherwise specified, thermocouples cable color coding shall be in accordance with the latest edition of ANSI-MC 96.1.

The type of thermocouple shall be selected based on the following guidelines as minimum:

Copper-Constantan (ISA-Type-T)	(-) 200 to 200°C
Chromel-Constantan (ISA-Type-E)	(-) 200 to 600°C
Iron-Constantan (ISA-Type-J)	(-) 40 to 750°C
Chromel-Alumel (ISA-Type-K)	(-) 180 to 800 °C
NiCrSil - NiSil (ISA-Type-N)	0 to 1200 °C
Platinum Rhodium-Platinum (ISA-Type-S or B)	600 to 1600°C

7.4.2 Resistance Temperature Probes

Resistance Temperature Probes shall be considered for applications where very narrow spans and high accuracy are required as well as low temperature service. They shall be 6mm (1.4”) stainless steel sheath type similar to the thermocouples and with a Pt 100 ohms (0 degree C) element. The sensors shall be duplex type and shall be spring loaded for vibration proof. The elements shall conform to DIN 43760 or IEC 751. The casing material must be SS316L. RTD head must be of die cast aluminium with epoxy paint to with stand the corrosive environment.

Class 'A' / Class '1’ tolerance as per IEC 751 / 584-2 shall be specified for all RTD and

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thermocouple sensors in complete temperature measurements for all open/closed loops and interlocks/Logic.

7.4.3 Temperature Transmitters

Temperature transmitters shall be Remote mounted type (on 2" Pipe), Smart with latest HART protocol and integral digital output meter, dual compartment type.

Head mounted transmitters shall not be used.

Conventional transmitter shall have universal input for thermocouple / RTD and output 4-20 mA DC for 2 wire system.

Transmitter output signal shall be linear and directly proportional to the measured temperature with overall accuracy of +/- 0.1% FS. TT body must be of die cast aluminium with epoxy paint to with stand the corrosive environment

Thermocouple transmitters shall have cold junction compensation and thermocouple linear characterization. Resistance temperature transmitters shall have resistance element linear characterization.

Burnout protection (selectable Up Scale / Down Scale) must be provided for all temperature transmitters.

No temperature switches are to be used. The same is to be achieved through transmitters which shall be directly connected as analog input to DCS / PLC.

Temperature transmitters are to be provided for all temperature measurement (closed/open/interlock) loops. All process temperature measurements shall be done through Temp. Transmitters. No temp. Input shall be connected directly to ESD/PACKAGE UNITS. MUX is not allowed.

7.4.4 Thermometers

Thermometers shall normally be bi-metallic, heavy duty, weatherproof (IP 65), adjustable angle connected type with 150 mm dial as a minimum, dials of smaller size may be used for auxiliary services on machinery. Casing material shall be SS316L.

Liquid filled indicators will be used only where indication is required to be remote Case

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and stem shall be in stainless steel. Dials shall be of white, non-rusting metal with black figures.

For local temperature control upto a maximum scale range of 530 deg C, liquid filled sensors with capillary extension shall be used.

Filled system instruments when used shall be fully compensated for ambient temperature variations.

Capillary shall be SS armoured and length of which will not generally exceed 3 mtrs.

Range should be selected so that normal operating temperature is approximately 70% of full scale, and the maximum expected temperature is approximately 90% of full scale.

7.4.5 **Thermowells**

Thermowells shall normally be made from bar stock material.

Flanged thermowells shall be used of 1 1/2" size, threaded thermowells shall not be used, except where accepted by piping specifications, in such case they shall be 1" NPT(M) and real welded. Flanges rating, facing and material shall be in accordance with the equipment or piping standard. Thermowell flange rating shall be 11/2" 300# minimum.

Thermowell shall be used for thermocouples, bimetallic thermometers, filled system and for temperature test points (TW).

Thermowells in vapor-liquid applications, inside columns, shall be located in the liquid phase, unless otherwise dictate by process requirements.

Test wells shall be equipped with threaded plugs and chains.

The preferred mounting position of thermowells, in horizontal pipelines, shall be in the upper half ofthe pipe.

For lines up to 2 inch size, the pipe shall be enlarged to 4 inches.

Thermowell material in general shall be of AISI 316L SS.

Immersion length of thermowells for different line sizes shall be as follows:-

Line Size	Immersion length (U)

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4" to 6"	280 mm
8" and above	320 mm
Vessels	400 mm

Immersion length is based on 200 mm length between flange face and inner well of pipe and approx. 60% insertion in the pipeline. In vessels, where fouling with vessel internals is expected, the immersion length shall be suitably modified. Other sizes and immersion lengths may be considered based on special condition/actual requirements.

The design of the wells shall be verified by means of stress analysis, resulting from stream velocity condition. The wake frequency shall not exceed 66% of the thermowell natural frequency. Wake frequency calculation is required for all thermowells. Bidder has to submit Wake frequency calculations for all thermowells as per latest PTC 19.3. Velocity collars not to be used.

7.5 CONTROL VALVES

Valve types shall be selected, pneumatic diaphragm/piston operated globe, ball or butterfly shall be selected taking into account such factors as piping, operating and design conditions, fluid being handled, tangibility required, allowable leakage, noise and other special requirements. The valves shall have smart electropneumatic positioners of same OEM make as the valve. All control valves shall be provided with SMART valve positioner with valve position signal feedback connected to DCS system by 4 to 20 mA analog signal. It shall be HART compatible. Seat Leakage shall be chosen in accordance with process demands and safe operation of the plant and in accordance with AISI B16.104-1976. However, in general, the globe valves used shall be of class IV leakage minimum as per ANSI B6.104 in general. Metal seated valves shall be preferred instead of soft seated valves. Soft seat requirement shall be evaluated by PMC/Client on case to case basis. However, in general, the globe valves used shall be of class IV leakage minimum as per ANSI B6.104 in general. For vent services the leakage class shall be class V or VI depending upon process requirement.

Safety shutoff valves must not be used in throttling service during normal operation.

Noise abating devices shall be provided with valves where noise level at the outlet of valve at a distance of 1 metre all around is more than 85 DBA for valve which have operating times of 5 minutes or more in general and which are only working during start up and in upset conditions. For continuous operation the allowable sound level shall be

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85 dBA. All noise abating plates, expanders, flanges, gaskets, studs & nuts shall be in the scope of valve manufacturer. The noise abating plates shall be of wafer design for easy removal for maintenance. Source treatment for noise shall be preferred over path treatment and for high noise vent applications “DRAG” type trim shall be specified.

All valve bodies shall be cast or forged. Stainless steel bodies shall be acceptable inplace of alloy steel bodies, if not available, for low temperature application.

The valve body, positioner and actuator body material shall be suitable to corrosive environment. Suitable lining shall be provided inside wetted parts as per application.

Flanged bolted type gland packing boxes shall be used, unless other specified. Gland packing shall normally be self-lubricating type. Packing shall be PTFE type up to 200”C. For temperature above 200 “C, grafoil is to be used. Usage of asbestos is not allowed in any part.

Bellows seals shall be used wherever gland leakage is not permissible like toxic / hazardous product like carbon monoxide gas, etc.

As a minimum, trim MOC shall for all control/on-off valves shall be SS316L. By default, all Guide MOC shall be hardened stainless steel like 440 C, 17.4 PH. For erosion service, high pressure drop, cavitating service hard surfacing of plug and seat material, satellite shall be used for all cases as specified in above point 22.1. Special cases valve may require 17.4PH seat and 440C solid plugs or other material like Hastelloy, Monel, Zirconia, duplex steel, etc. for severe services like steam, urea grade, carbamate solution, acid, etc.

Mechanical stopper shall be provided as per process recommendations for min. Flow condition.

On line replaceable trims shall be considered for all high pressure valves of butt-weld or socket weld connections. Trim characteristics shall be equal percentage, unless otherwise specified. For high erosion service or in steam service where, the delta P is higher than 5 Kg/Cm2, hardened trim with stelliting shall be used. When this alone is not sufficient, in such cases, special Anti-cavitating trim or shall be selected. In general, for all trims, hardened full stelliting shall be used, as a minimum.

All on-off valves shall be ball type on-off valves only. The ball valves of up to 4”, 150# size shall be floating ball design with full bore design, unless otherwise specified. Other ball

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valves (higher size and rating) with higher size can be trunnion supported ball type design type.

For all shutdown valves on fire safe applications, air volume tank shall be supplied for the storage of air volume for minimum 3 stroke operation.

Oxygen service valves shall be de-greased completely and certified for oxygen service use. MOC for body shall be Monel and trim shall be Inconel 600 only.

Control / Ball valves bodies used in steam services should be A182 F22/ A217 WC9.

Split body design for ball valves acceptable where top entry ball design has not been considered for economical reasons. Mufflers shall be provided on ball valve vent air lines for noise suppression. Spring loaded seat and hard chrome plated ball shall be a standard feature for ball valves, in general. Wherever springs come into picture, vendor to ensure corrosion resistant spring steels are provided.

All control valves/ Actuators (pneumatic & Motorised) shall be painted with corrosive resistant paint. SS bug screen shall be provided for the exhaust ports.

All valve actuators shall be selected for a minimum operating air pressure of 4.0 kg/cm2g. The actuators shall be diaphragm or piston actuators in general. Diaphragm actuators with single or concentric multi-springs shall be used. volume tank with airlock relay , booster relays shall be avoided as far as possible.

Rotary rack and pinion pneumatic actuators may be used with ball and butterfly valves for on-off services.

In general, if otherwise not specified in the valve data sheet the time for full travel shall not exceed 10 seconds.

Wherever handwheel is required with a valve the same shall be side mounted type.

All split range functions for valve operations shall be carried out in control system and split range provision in valve positioners shall not be necessary.

Butterfly valve bodies shall be of wafer design. Lug type body shall be considered for size above 12”. Face to face dimensions shall conform to ANSI B 16.10 and ANSI B 16.47 wherever applicable. Butterfly valves shall be used for high flow, low pressure drop below 10 kg/cm2g.

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All instrumentation butterfly control valves shall be triple offset type only.

Non destructive test like radiography, ultrasonic, die penetration and magnetic particle shall be carried out for cast and forged bodies conforming to procedures laid down in ANSI B16.34. Radiography or ultrasonic test, if not specifically mentioned in the data sheet, shall be carried out for cast or forged bodied of rating 900 lb. or above.

Valve bonnets shall be in general of bolted bonnet design as per ASME B 13.3 par 307.2 with minimum four bolts.

Smart E/P positioners with position transmitter along with valve signature software to be provided for all control valves. It shall be HART compatible, The software shall be provided for remote configuration and diagnostic analysis too.

Actuator sizing shall be done at 4 Kg/cm^2.

Handwheel (Side-mounted) for All regulating control valves to be provided

By-pass valve provision shall be as per process licensor requirement.

The control valve % opening shall be at minimum flow 10-20%, for normal flow 50 to 70%, for maximum flow 75 to 85%.

All on – off application valve shall be fixed with necessary limit switches.

Valve Sizing shall be used on a maximum flow rate of approx. 1.5 time normal flow or 1.3 times the max. flow, whichever is greater, and the process conditions that exist at the increased flow (Pressure and differential pressure). Valve lift shall be approximately 70 % for equal percentage and 60 % for linear characteristic plug design at normal flow. It shall be checked that the calculated and the selected valve also covers start-up and stop conditions. In cases where over sizing shall not apply, it will be specifically mentioned in the Instrument Data Sheets.

The fluid velocity at outlet flange shall not exceed 6 m/sec for liquids whereas the velocity of gas or vapor shall not normally exceed 0.3 Mach under operating conditions. To meet this, valves shall be selected having reduced trim, labyrinth plug or cage trim as manufacturer standards.

Bidder shall submit the sizing calculations for all control valves.

Face to face dimensions of the control valves shall be as per ANSI/ISA-S75.03.

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Direction of flow indication shall be engraved or embossed on the body.

Stroke time of the antisurge valves shall be 2-3 seconds and for critical services shall be as defined by process licensor or as mentioned in individual data sheet.

7.5.1 **Control Valve Test and Inspections**

Valves shall be tested in accordance to individual specification which shall cover but not limited to:

- Visual Inspection and dimensional check

- Liquid Penetrants examination on stellite coating as per ASME B16.34 ann D.

- Radiographic, ultrasonic, magnetic particle as per ASME B16.34

- Hydrostatic Body Test - Duration 3 min. (including all parts in assembled condition like body, gland, all joints)

- Impact test

- Seat leakage test as per ANSI B16.104/FCI 70.2

- Performance tests and Functional tests

- Leakage test from actuators and seals and packings

- Diaphragm head test

- Complete actuator leak test

- Helium leak test for control valve with bellow seals

- Stroke calibration

- Stroke speed test

7.5.2 Limit switches / Position Switches:

7.6.2.1 All type of limit switches shall be 2 wire, proximity type, intrinsically safe certified. Limit switches shall be provided both for close and open positions for all shutdown valves.

7.6.2.2 The make shall be P+F only. The sensor shall be generally cylindrical NAMUR sensor type proximity switch. The diameter and sensing range shall be selected based on

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application.

The MOC of sensor shall be SS316 or acid resistant body.

All limit switches sensor shall be adjustable with the threaded length and check nut arrangement.

Flying lead type loose connections for NAMUR sensors are not acceptable. All these NAMUR sensors installed on any instruments to sense the position shall be housed in a closed box certified for weatherproof to IP65. The gland size shall be ½" NPT(F).

7.5.2.3 All ON-OFF type application valves taking in part in interlock/shutdown shall be provided with Open and Close type NAMUR sensor as limit switches. The sensors along with enclosure shall be installed in control valve in such a way that it can be removed with ease for maintenance.

7.5.2.4 Limit switches shall not be used for Control Valves.

7.5.3 Actuators

7.5.3.1 Generally, control valve actuator shall be of the spring and diaphragm, pneumatically actuated type. Standard air control signal to positioner shall be 0.2 to 1.0 kg/cm2g. For larger dP shut offs, higher spring range/higher areas shall be considered.

7.5.3.2 Actuators shall be single acting type for all valves.

7.5.3.3 All valve actuators shall be designed with 1.5 times factor of safety.

7.5.3.4 Piston type actuators (spring return type) with or without fail-safe capacity tanks (minimum of 2 strokes to be possible in case of air failure) shall be considered for high-pressure drop services or if actuator force requirements fall beyond the normal range of diaphragm actuators. All actuators shall be adequate to fully stroke the valve under the maximum differential pressure specified by the process requirements.

7.5.3.5 Air filter Regulator filter to be 5 micron. Miniature type, SS316L body & drain assembly etc as parts of air filter regulator are not acceptable.

7.5.3.6 Actuators must be painted with corrosion resistant paints and all its springs must be corrosion resistant spring steels. SS bug screen shall be provided for the exhaust ports.

7.6 PRESSURE RELIEVING DEVICES

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7.6.1 **Pressure Relieving Devices**

All Pressure Relieving Devices shall be sized in accordance with applicable local and national code requirements. Formulas shall be in accordance with API RP 520, 1990 and ASME Codes section I and VIII.

7.6.1.1 Percent Overpressure and Accumulation used in calculation of sizes of relieving devices shall be :

Overpressure

3% - Steam services where ASME Power Boiler Code applies.
10% - Gas or Vapour service.
15% - For liquids and pump discharge lines with 6% system accumulation (Power Boiler Code) and with 10% system accumulation (Pressure Vessel Code)
21% - Fire exposure on unfired pressure vessels.
10% - Liquids for thermal relief of pipelines or vessels Accumulation
10% - Gas , Vapour and liquid where ASME Pressure Vessel Code applies
16% - Gas , Vapour and liquid where ASME Pressure Vessel Code applies and the system is protected by means of multiple valves.

7.8.1.2 **Nomenclature**

Nomenclature used shall be in accordance with API RP 520.

7.6.1.3 **Safety and Relief Valves**

Safety and Relief Valves shall normally be direct spring loaded type. Balanced bellows valves shall normally be furnished for relief into closed flare and slowdown systems, if the developed back-pressure exceeds 10% of the set pressure. Bellows shall also be specified where leakage of gas from the seals are not permitted during normal plant operation. Steam jacketing may be considered necessary to keep some valves and lines warm at all the times to avoid the solidification of the lading fluid.

Full nozzle types of valves shall be specified for sizes 1” or above.

Test gags shall be furnished on all safety and relief valves. Test gags shall be removed and transferred to Owners possession after testing, clearly labelled with the tag number of the valve.

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Lifting levers shall be furnished for exposed spring bonnets on valves on steam and hot water services, on air valves and hot water service valves with closed bonnets.

Bonnet construction shall be plain closed bonnet for toxic and inflammable gases as well as vapour and liquids. Exposed bonnet shall be specified for steam service and in Boiler feed water service above 200°C. Bonnet extension shall be used above 400°C.

Springs shall be of carbon steel for normal process operating temperature of (-) 25°C to 200°C and tungsten alloy or high temp. alloy steel above 200°C. Stainless steel spring may be used for services below (-) 25°C. Carbon steel is permitted above 200°C for open bonnets.

Blowdown shall be between 5% to 7%. For steam services under Power Boiler Code as per ASME the blowdown shall be 3% - 4%

All connections shall be flanged in general with facing and rating in accordance with the piping specification or API 526 whichever is higher.

Centre to Centre dimensions shall be in accordance with API 526

7.6.2 **Rupture Discs**

Rupture discs may be used in lieu of or in combination with safety and relief valves, where applicable or required. For disc rupture trip or alarm disc shall be with bursting sensors.

7.6.3 **Pressure and Vacuum Relief Valves**

Pressure and Vacuum Relief valves for storage tanks shall normally be of the weight loaded or pilot operated type, and sized in accordance with API RP-2000 Tank Venting Code, or Local Codes if they govern.

7.6.4 **Thermal Relief Valves**

For thermal relief of accumulated liquids in pipelines and vessels 1” x 2” size valves shall be used in general.

7.6.5 **Centre-to-Face**

Centre-to-face dimensions shall be in accordance with API 526.

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7.7 SWITCHES AND SOLENOID VALVES

7.9.1 Switches

Process switches, shall be realised through field transmitters only. If for some packages, process switches are unavoidable same shall be provided with sealed micro switch contacts rated for the specified application. Contacts shall be 1 no. DPDT preferably. Otherwise 2 nos. SPDT can be considered. All switch contacts except those used in intrinsically safe circuits shall be silver plated. Contacts used in intrinsically safe circuits shall be suitable for the applications. Switches shall be hermetically sealed type. Switches shall be connected through interposing relays**.**

7.7.2 Solenoid Valves

Solenoid valves shall normally be used to actuate other instruments/valves connected directly to the process. The SOVs shall be SIL3, direct acting type (3/2 external pilot operated, universal type, low power intrinsic safe type, with manual override and LED indication). Protective enclosure shall be IP 67 and the coil insulation H class or better suitable for continuous operation in 85 degree C ambient temperature (max. surface temperature in sun) for outdoor service. Body materials shall normally be stainless steel 316. Solenoid valves will be powered by 24V DC or through barrier, insulation class 'H' and orifice size 9 mm. The D.C. solenoids shall not have in built rectifier to operate with A.C voltage. The d.c. solenoids shall be used as an alternative to A/C solenoids only for low current intrinsic safe operations.

All solenoid valves shall be fitted with 1/2" NPT (F) SS 316 double compression cable gland connection. The cable entry should be from bottom only and solenoid coils must be hermetically sealed. SS bug screen shall be provided for the exhaust ports. The sealing medium of the SOV's will be EPDM or better (will be discussed during the detailed engineering).

8.0 CONTROL SYSTEM

DESIGN CRITERIA

EXPANDABILITY

Systems shall be designed with 20% installed pre-wired spare capacity for all I/O type cards of each category for project development. The sparing supplied shall be for "complete loop"; i.e. corresponding marshalling, power supply, terminals/barriers, interposing relays, pre-fab cables other accessories, etc. and its space, and panel cut

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outs where appropriate, etc.

To allow for future expansion 20% spare capacity shall be allowed & terminated in multi core cables, junction boxes, marshalling racks, etc,

Communication networks and cables shall have a spare load capacity of 50% as a minimum.

Plant wide networks shall have a node connection spare allowance of 50 % as a minimum.

Local networks shall have a node connection spare allowance of 30% as a minimum**.**

Operators' Keyboard

This shall be used by plant operators along with each Operator station display unit for operation of the plant. It will have multiple assignable keys to directly open pre-programmed display as well as few other system typical templates for selected tags including controller group display, trend, configuration display, alarm summary pages, etc. There shall be both numeric and alphabet keys and dedicated function keys on membrane type operator keyboard each of which must be freely programmable. There shall be one no. of operator keyboard with each of the operator stations.

This shall be membrane type fully dust proof and spill proof & corrosion proof.

Key lock switch / password switch shall be provided for operator/supervisor/engineer security levels.

Dummy Consoles/Filler Panels shall be provided to maintain aesthetic and mounting instruments like indicators, annunciators etc. as well as for push buttons, lamps, key switches, paging system hardware.

Entry into the Marshalling Panels shall be through SS316 ET double compression cable glands only.

PLC CONTROL SYSTEM

8.1 **General**

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The operation and control of Plant shall be through Process PLC based Control system. The system shall be microprocessor based programmable logic control (PLC) with fault tolerant redundant processors based on DMR/TMR technology.

The PLC will be used to provide protection and controls for the entire plant.

Following minimum functions are provided on the OS (Operator station).

1. Area wise display of the plant.

2. Operation of the plant from the OS.

3. The schematics will be having dynamic parameters like valve open / close and motor running/ fault indications

The Control system shall perform any of the following functions for safety of the plant from control room.

- Total Shut Down
- Unit Shut Down

It will perform following functions also:

Data Display
Process Control
Process and system alarms
Logging
Real Time trends & Historical trend
Dynamic Graphics
Report Generation (shift, daily, weekly, monthly and on demand)
System diagnostics

The following shall be adhered to while selecting the TMR/DMR system

a) TMR/DMR CPU's shall be applied.

b) If a CPU fails, the other(s) shall continue to operate. Single CPU operation system to be certified to operate without any time limitation of faulty CPU repair.

c) TMR/DMR buses shall be applied.

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d) TMR/DMR analogue inputs and outputs shall be applied.

e) TMR/DMR digital inputs shall be applied.

f) TMR/DMR digital outputs shall be applied.

e) Redundant communication interfaces shall be supplied.

f) Redundant Power supplies (at least three in parallel) shall be supplied.

g) In the event of a failure of a fault tolerant component, power supply or other function, of the system shall change over to "single mode" operation without causing nuisance trips and also generate alarm on Operator and Engineering console.

h) In case of failure of complete processor system, i.e., system outputs shall take fail safe state automatically unless otherwise specified.

Operator interface for critical trips shall be mosaic display with illuminated push button for trip, reset, inactivation etc. and LED indication for each element of trip & actions.

The operator will be informed about a trip situation by a warning sound (to be different from the audible signal from the alarm system), and a LED display will clearly inform about the alarms in trip position. The first up alarm will flash.
Scan time shall be maximum 250 msec. CPU loading shall not exceed 50%, Bus Communication modules, Power Supply and I/O cards shall have 100% redundancy and fail safe certification.

System Redundancy

Following system redundancy shall be available as a minimum.

1.	Controller (CPU for control, I/O communication, network communication)	1:1
2.	Communication Bus	1:1
3.	I/O communication modules with CPU (I/O bus between CPU and I/O with all necessary hardware)	1:1
4.	Main data highway	1:1
5.	Communication Cards	1:1
6.	System Device	1:1

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7. Power supply 1:1
8. (Power supply for all CPUs,
9. I/O power supply modules)
10. History 1:1
11. Modbus/Serial interface 1:1
12. OPC server: OPC server, If applicable shall have RAID-5 configuration with firewall.
13. System server (for server based PLC): Redundant (1:1 redundancy)

However, lamp drive cards, supporting mosaic need not be redundant also. Active isolator/barriers need not be certified for fail safe operation.

The operator can bypass trip alarm inputs, which may be necessary in abnormal situations. A lamp shall indicate that the trip alarm is inactivated. The operator will be warned by sound and fast flash if the inactivated circuit goes in alarm status.

The system shall include an event recording system, and it shall be considered to store about 500 events. The system should have SOE backup facility for 30 days. Sequence event recorder (SOE) of 1 msec, resolution to be envisaged.

Display colours shall be in accordance with the following:

Alarm and Trip (safety operations) : Red
Pre-alarm for trip (safety operations) : Orange
Indication for by pass of trip (safety operations) : Red
Equipment in operation (alarms and pilot lights) : White
Ready (standby of equipment) : Green

The critical trip shall be displayed on a separate graphics available in control system.

All Emergency stop and manual start/stop push buttons shall drive an interposing relay located at IRC. For all critical electrical drives (list will be discussed separately during detailed engineering), the spare contact of final DO command from PLC going to MCC, must be connected as DI into PLC and configured in SOE for confirmation of command to MCC from PLC.

Consumables like printer paper, cartridges, fuses etc shall be supplied along with the PLC control system for a minimum period of one year duration.

8.1.1 PLC requirements

a) All systems' all cards shall be supplied with ISA G3 level or equivalent coating for

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environmental protections.

b) ISOLATIONS

Analog I/Os to Field : Galvanic Isolation through safety barriers

Analog I/Os Module : Channel to Channel Galvanic Isolation

If individual channel to channel isolation is not available with system vendor, then only Isolation shall be provided in a group of 4 channels as per system vendor design. Digital Input to Field : barriers + optical isolators on cards

Digital Output to Field : Interposing relays + smart barriers for monitoring purpose

c) PANELS:

All panels shall be either 1200 mm (wide) x 800 mm (depth) x 2100 mm (height) or as a special case 600 mm(wide) x 800 mm (depth) x 2100 mm (height), RITTAL make, with 100 mm black powder coated metal base frame and with colour shedding of RAL7032 (Siemens Grey) and removable gland plates at bottom only. This applies to all types of instrument panels to be used in the whole project like various PDB, Electrical / Instrument panels, Third party device panels, etc.

d) All A/D converters of system I/O cards shall have resolution of min. 13 bits and all D/A converters of system I/O cards shall have resolution of min. 10 bits

e) There shall be 20% installed spares minimum 1, installed and wired capacity for I/O cards of each category in DCS, including all peripheral termination modules, prefab cables, Relays, Safety barriers, etc

f) All marshalling and system panels shall have minimum 20 % wired spare capacity for future expansion (should be possible with the same wiring philosophy.)

g) I/O cards' Channel density shall not exceed the following limits:

Analog Input	16 Channels
Analog Output	16 Channels
Digital Input	32 Channels
Digital Output	16 Channels

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h) Process override switches (POS) shall be soft type.

i) All interlock and control transmitters shall be separate right from field junction box to marshalling panels

j) Those parameters, which are directly or indirectly tripping the plant or may cause production loss, shall be wired with 2 out of 3 transmitter trip voting interlock in PLC. There shall be three separate analog input channels in three different cards. AI cards shall be used for this purpose in system. Same thing is applicable to Digital inputs also including emergency stop and compressor stop DI's.

8.2 DCS CONTROL SYSTEM

The control system shall be a modern Digital Distributed Control System (DCS) located in the Central Control Room. The system shall be reliable, fault tolerant and build up in modules from the suppliers' standard components and software. The system shall have facilities for plant control monitoring, alarm handling, shutdown & trip functions. It shall be self- diagnostic, self documenting and contain all the functions necessary for advanced regulatory control and trip functions.

Display colours shall be in accordance with the following:

Alarm and Trip (safety operations) : Red
Pre-alarm for trip (safety operations) : Orange
Indication for by pass of trip (safety operations) : Red
Equipment in operation (alarms and pilot lights) : White
Ready (standby of equipment) : Green

The critical trip shall be displayed on a separate graphics available in control system.
All Emergency stop and manual start/stop push buttons shall drive an interposing relay located at IRC. For all critical electrical drives (list will be discussed separately during detailed engineering), the spare contact of final DO command from control system going to MCC, must be connected as DI into control system and configured in SOE for confirmation of command to MCC from control system.

The control system shall comprise racks with I/O devices, control cards, CPU cards, hard disk, system buses, and required number of operator stations with colour video display units (VDU) with dynamic graphic generation capabilities to ensure complete access to the process during normal operation, start-up, and upset conditions. The operator shall

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use dedicated operator keyboards to manipulate the DCS.

The DCS shall have the following main components. Detailed specifications of each of them are given in subsequent sections. The system shall be 100% fault tolerant and dual redundant, except the redundancy at I/O cards levels. This means, all central control processors, all communication processors and all other central rack and individual node's common cards, all the communication cards, networks and cables, etc. shall be 100% fault tolerant and dual redundant, except individual IO cards of the system. All the system hardware of DCS shall have ISA G3 level corrosion protection. Since redundancy at I/O card level is not envisaged, the failure of a single card from complete system shall not affect more than the I/Os supported by that particular I/O card. It means all the hardware except I/O cards shall be 100% fault tolerant. All the hardware including control/communication processors, networks, cables, all type of system cards, all type of I/O cards shall be hot replaceable.

All operating consoles for control system shall be located inside the central control room but their I/O units, marshalling cabinets, power distribution cabinets and engineering station shall be housed in the adjacent room.

DCS Functions

The DCS will perform, as a minimum the following functions:

Data Display
Process Control & Trip/Interlock
Process and system alarms
Logging
Real Time trends & Historical trend

Dynamic Graphics
Report Generation (shift, daily, weekly, monthly and on demand)
System diagnostics

Trend: All the critical parameters (Temperature, flow, pressure, level, speed, vibration etc) as well as the Closed loops (PV,LV, MV etc) the trend shall be recorded for every 1 second with the back up of minimum 4 days. Recording shall be on FIFO basis.

8.2.1 Data Storage and Retrieval

Data storage and retrieval will be provided on hard disc and on DVD or DAT. The trend shall be recorded as follows:

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Analogue signals

Last 3 days	Every 1 second.
Last 7 days	Every 1 minute.
Last 45 days	Every 1 hour
Last 1 year	Shift averages
Last 2 years	Daily averages
Alarms	Last 48 hours (Minimum)

8.2.2 DCS Operator Interface

For Details of OS/ES please refer Annexure -3 System configuration

One Emergency Stop push button station directly wired to MCC, should be provided for all critical drives (if applicable). The spare contact of this emergency push button must be mapped to DCS/PLC as a DI contact for SOE punching. All emergency push buttons and stop push station must be provided with transparent safety covers.

8.2.3 Process Controller Cabinets

The process controllers will contain the microprocessor based system capable of combining continuous, sequential and discrete functions in order to the requisition of analog and discrete signals, sequential and continuous control.

The process controller cabinets shall/may have incoming and outgoing cable marshalling facility. All field cables shall be terminated in marshalling cabinets in single tier WAGO/ Phoenix make cage clamp type terminals. Isolators shall be provided for all intrinsic safe input and outputs. All thermocouple signal wiring from terminal to respective isolator/input card shall be through extension wires corresponding to the type of thermocouple element used. The signal I/O cards may also be installed in Process Controller Cabinets. Some marshalling/I/O racks may be installed in remote safe areas by extending the system bus, especially in MCC rooms where lot of inputs from drives shall directly be terminated in the marshalling /I/O racks.

8.2.4 DCS Redundancy Philosophy

In order to increase the system availability and then the continuity of plant operation, redundancy shall be provided as follows:

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100% fault tolerance and dual redundancy in DCS shall be for Controller cards, all communication cards and buses, all control buses, all type of common cards in the system, all power supply modules, all I/O modules for closed loops and interlock I/Os, buses, Ethernet modules. The failure of any single I/O module for open loop shall not affect more than the channels being catered by that particular I/O card. Dual redundant power supply modules for each dual redundant controller shall be dedicated.

8.2.5 **Multiloop Controllers and Input/Output Cards**

All multi loop shared controllers will be redundant with 1:1 redundancy. The control processors shall be of fault tolerant type and both shall be active with cyclic changeovers. All I/O cards for close loop applications shall be capable of holding the last value in case of open condition of input. Input cards for specific open loop inputs used for calculation functions must also be capable for holding the last value. As otherwise the same function shall be built up in DCS software.

8.2.6 **I/O Segregation:**

The I/O card segregation for DCS shall be as per physical units of the plant.

8.2.7 **Controller Loading**

Each Controller loading shall not exceed more than 50% (hardware and software load of each controller) in any case, after implementation of complete project and running at peak load. In case more controllers are required to meet 50% loading criteria, CONTRACTOR to include additional controllers without any cost implication.

8.2.8 **DCS requirements**

a) All DCS/ESD systems' all cards shall be supplied with ISA G3 level or equivalent coating for environmental protections.

b) All digital output from DCS and ESD shall drive interposing relays of OMRON make, 4 Change over (4 NO/NC) with socket mounted relays with LED indicators and built in surge suppressor. The contact rating shall be minimum 230 V AC/ 5 amps. Any DO Channel from DCS/ESD shall not be directly connected to any devices without interposing relays.

c) DCS shall be a large and expandable type system available with the vendor.

d) The system architecture shall be compliant to IEEE 802.XXX with dual redundant and

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100% fault tolerant BUS/RING topology. System shall be fully open with DDE/OPC&ODBC compliant. System availability shall be better than 99.95%.

e) DCS and ESDS I/O cards channel density shall be as per following:

I/O cards' Channel density shall not exceed the following limits

Analog Input	16 Channels
Analog Output	16 Channels
RTD/T/C Inputs	16 channels
Digital Input	32 Channels
Digital Output	DCS-32 Channels /ESDS-16 Channels

f) All I/O cards in individual category shall be of same type/model/revision only. No diff bulk I/O cards or I/O cards with degraded features shall be accepted in any of the category in a mix mode supply.

g) ISOLATIONS

Analog I/Os to Field : Galvanic Isolation through safety barriers

Analog I/Os Module : Channel to Channel Galvanic Isolation

If individual channel to channel isolation is not available with DCS / ESDS vendor, then only Isolation shall be provided in a group of 4 channels as per DCS / ESDS vendor design.

Digital Input to Field : barriers + optical isolators on cards

Digital Output to Field : Interposing relays + smart barriers for monitoring purpose

h) PANELS:

All panels shall be either 1200 mm (wide) x 800 mm (depth) x 2100 mm (height) or as a special case 600 mm(wide) x 800 mm (depth) x 2100 mm (height), RITTAL make, with 100 mm black powder coated metal base frame and with colour shedding of RAL7032 (Siemens Grey) and removable gland plates at bottom only. This applies to all types of instrument panels to be used in the whole project like various PDB, Electrical / Instrument panels, Third party device panels like wood word digital governors, Bentley Nevada system hardware panels, etc.

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i) All A/D converters of system I/O cards shall have resolution of min. 13 bits and all D/A converters of system I/O cards shall have resolution of min. 10 bits

j) There shall be 20% installed spares minimum 1, installed and wired capacity for I/O cards of each category in DCS, including all peripheral termination modules, prefab cables, Relays, Safety barriers, etc

k) All marshalling and system panels shall have minimum 20 % wired spare capacity for future expansion (should be possible with the same wiring philosophy.)

DCS System Redundancy

Following system redundancy shall be available as a minimum.

a.	Controller (CPU for control, I/O communication, network communication)	1:1
b.	Input / output cards closed loops	redundant
c.	Communication Bus	1:1
d.	I/O communication modules with CPU (I/O bus between CPU and I/O with all necessary hardware)	1:1
e.	Main data highway	1:1
f.	Communication Cards	1:1
g.	System Device	1:1
h.	Power supply (Power supply for all CPUs, I/O power supply modules)	1:1
i.	Serial (RS-485) Modbus (For Interlock PLC)	1:1
j.	In case of client-server system, server shall be redundant (Raid-6 Configuration)	1:1

I/O bus and I/O interface card at controller rack shall be redundant

Connectivity from Upstream redundant device to downstream redundant device shall be through redundant device or cable.

Loading philosophy (with 20% installed spares and 20% future expansion)

Control Processor	50%

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Communication Processor	50%
Communication Bus	50%

8.2.9 **Scanning Time**

not more than 250 msec.

8.2.10 **Other requirements**

Operators' Keyboard

This shall be used by plant operators along with each Operator station display unit for operation of the plant. It will have multiple assignable keys to directly open pre-programmed display as well as few other system typical templates for selected tags including controller group display, trend, configuration display, alarm summary pages, etc. There shall be both numeric and alphabet keys and dedicated function keys on membrane type operator keyboard each of which must be freely programmable. There shall be one no. of operator keyboard with each of the operator stations.

This shall be membrane type fully dust proof and spill proof & corrosion proof.

Key lock switch / password switch shall be provided for operator/supervisor/engineer security levels

Dummy Consoles/Filler Panels shall be provided to maintain aesthetic and mounting instruments like indicators, annunciators etc. as well as for push buttons, lamps, key switches, paging system hardware**.**

Entry into the Marshalling Panels shall be through bottom mounted MCT blocks.

8.2.11 **Consumables**

One No. Spares like printer cartridges with each printer to be provided.

8.3 **System Cabinets**

8..1 **Interlock Marshalling Cabinet**

Marshalling cabinet(s) are foreseen for both incoming to Interlock system and outgoing from Inter ('from' and 'to' field) termination. The interlock marshalling cabinet(s) shall also accommodate the repeater power supplies for the field transmitters, galvanic isolators for all

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inputs, trip amplifiers, output relays etc.

The termination strips shall be arranged or grouped for inputs/outputs 24VDC, 115VAC, etc. both for inputs as well as outputs.

The terminals shall be of the Wago/weidmuller/Phoniex /Klippon make screwless, cage clamp type, single tier design (double tier design shall be avoided). Terminal stack for each unit shall be supplied with approx. 20% extra terminal points as spare/future provision in addition to the existing inputs and outputs.

Physical separation between the terminal stacks/points shall be maintained for the intrinsically safe and normal termination. Also the termination area shall be physically separated from the electronics area there by sealing the latter from dust ingress.

8.4 Sequence of event (SOE)

Bidder shall provide the Sequence of event recorder function, with a time resolution not above the machine scanning time. This information shall be available, for archiving, filtering and visualization operations to the SOE which shall be feature of ES station. (I.e this feature to be provided in Engineering station) located in the Engineering room in, to aid in diagnosis and recognise the first cause of plant or equipment shut-down.

Sizing of the system bulk memory capacity shall be done considering for SOE activities a rate of 500 events/day (or shall be discussed during detail engineering).

The SOE package of the offered system must have facility to generate a separate SOE file for critical event trips that is all important events just before and just after tripping event.

Time stamping of the SOE must be generated directly from the controller and it must be as latest ISA standard.

8.5 System Clock

The DCS/PLC control system clock shall have facility for synchronising with a Main plant DCS through hardwire DI signal. Bidder shall consider Ethernet port/TCIP for synchronising to Master GPS clock. Additional hardwired or communication connections / networks between DCS/PLC control system and Main plant DCS shall be consider by the bidder.

8.6 Power Supply

All instrumentation shall be fed by an Uninterruptible Power Supply (UPS) system.

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An uninterrupted Supply to DCS/PLC system shall be provided to the power distribution cabinet of DCS/PLC system at 115VAC +/- 10%, 50Hz +/- 3%. UPS feeders from ACDB to DCS/PLC loads shall be redundant whereas UPS feeders for Non-Control system loads shall Non-redundant, The Contractor shall prepare a list Non-Control system UPS load requirement.

110 VAC UPS Power supply feeder failure alarm before PDB shall be provided in DCS/PLC by using double pole MCB in PDB. One contact of these MCBs shall be wired to DCS/PLC for alarm purpose

In case rectification to DC is involved, rectifiers shall be dual redundant and both shall be 'hot' (on line) so that failure of one rectifier will not cause a system trip. Provision shall be included in the system to annunciate the rectifier/DC power supply failure.

24V DC power supply

i) 24 VDC power supply required for interrogation voltage, solenoid valve supply, lamp, pushbutton, etc and for other packages shall be supplied by contractor using dual redundant Bulk Power Supply (BPS).

ii) Each redundant bulk power supply shall be sized for maximum50% loading of its capacity in normal time; the maximum loading is to be 70% of its capacity of BPS.

iii) All bulk power supply (BPS) shall be provided with surge protection capability. BPS shall also provide with cooling fans and with fan failure alarm indications in DCS/PLC system.

iv) Each BPS shall be provided with Mosfet based redundancy with auto-current balancing and equal loading on both PS.

v) Power supply & redundancy module shall be same make .

vi) Current output (4 to 20 mA) shall be available from the power supply unit and the same shall be wired to DCS for Power supply health monitoring and indication from all BPS.

Philosophy of power isolation and over load protection (switch fuse units) or only over load protection shall be extended upto individual card level, while designing the system, so that, minor card failures can be localised for easy rectification. Also this will avoid major down time on the system.

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Earthing /Grounding bus bars for terminating shields of the cables shall be provided on the cabinet.

Power supply (For all DCS/PLC and Vendor Packages):

All BPS Failures shall be connected to DCS/PLC as a separate DI signal.

All MOSFET O rings Failures shall be connected to DCS/PLC as a separate DI signal.

All power feed Modules shall be connected to DCS/PLC as a Separate DI signal.

All MCB healthiness feedback shall be connected to the DCS/PLC as a Separate DI signal. Silver/Cu/humidity/temperature monitoring shall be with 2 nos. of C/R with indication in DCS/PLC.

Healthiness of BPS/MOSFET O ring must have LED indications for indicating the healthiness of the module locally. 110 V AC and 24 V DC supplies must have current and voltage transducer wired to DCS/PLC.

8.7 Annunciator

The Annunciator display stations will consists of:

- LED Lamps
- Split type architecture with lamps and electronics separate
- All connections with interlock system cabinet and interlock marshalling cabinet shall be through plug in connectors.
- About 20% spare capacity shall be there
- All switches and status lights indicated below shall be an integral part of Display Modules.
- Supply shall include mounting accessories and about 20% of unassembled extra LED lamps

8.8 Precision & Accuracy

The isolator, repeater modules/trip amplifiers for analog inputs shall have a total accuracy of less than 0.2% of full span for the measurement circuit.

The accuracy and stability for thermocouple trip amplifiers, if applicable, shall be +/- 0.5%.

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8.9 **Control System Spare Philosophy:**

Installed Spares	I/O Level	20%
	Marshalling	20%
Spare Space	I/O Level	20%
	Processor	50%
	Marshalling	20%
	Rack	

9.0 LOCAL CONTROL PANELS

All local panels under the scope of package vendor shall follow the minimum specifications listed below:

9.1 Panels shall be suitable for acidic environment. Sealings of the panel will be Silicone/EPDM or better, which will be freezed during detailed engineering.

9.2 Panel shall be free standing close cabinets, constructed in sections of min. 1000 mm wide. The panel construction shall be welded or bolted frame construction with upright and and additional framing in modular construction. The panel front sheet thickness shall be min. 3 mm. The front of panel shall be stiffened where necessary with profiles tack welded to the rear. Top, sides and doors can be made out of 1.6 mm thick plate.

9.3 The panels shall have environmental protection conforming to IP 55 min.

9.4 Instrument air shall be provided for purging of local panels.

9.5 Panel face, sides and doors shall be sand blasted and cleaned before primer and two coats of paints are applied. The colour of paint shall be bright grey. The final surface shall be semi mat, free from blemishes and paint runs.

9.6 115V A.C. +/- 10%, +/- 3% Hz power at one point to the local panel shall be provided by the client. Any other voltage level if required preferably 24 V, DC, the same shall be arranged by the vendor. Redundant rectifier units shall be provided for the generation of d.c.by the vendor.

9.7 Earthing lugs for both power and system earthing shall be provided by the vendor.

9.8 The wiring shall preferably contained in polymer ducts. Instrument safe wiring shall be laid separately from others. The colour of IS wiring shall be light blue.

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9.9 Cage clamp type terminals shall be used for cable termination and wiring. 20% terminals shall be kept as spares in each terminal strip and box.

9.10 Gland plates shall be provided alongwith cable glands (ex. proof wherever required) in each panel for cable termination.

9.11 A miniature circuit breaker shall be provided for each power supply with DI contact wired to system.

9.12 All panels shall be provided with vibration dampening pads.

9.13 Each panel section shall be provided with illumination level of 300 Lux min.

9.14 Name plate/labels shall be provided for each panel mounted instruments, equipments and accessories mounted in the front or rear of the panel.

9.15 Purged panels shall be provided with purge fail alarm. Purge fail trip shall be provided with a bypass switch

9.16 The panel must have all necessary push buttons, LED displays, field mounted displays for all relevant process parameters (may be mounted separately near panel, if required)

9.17 The compressor status/ Unit operation must be clearly visible from the local panel.

10.0 PNEUMATIC TRANSMISSION

10.1 Output Signal

Output signal from all pneumatic transmitters shall be 0.2-1kg/cm2g.

10.2 Pneumatic Receiver Instruments

Pneumatic receiver instruments shall have receiver elements design for 0.2-1 kg/cm2g input signal.

10.3 Pneumatic Transmission Tubing

Pneumatic transmission tubing for local transmission shall be ½"or ¼" OD stainless steel tubing with SS316 fittings (inch).

10.4 Instrument Air

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Instrument air required is available at 6.5 kg/cm2g and max. 70 degree C. However, the air pressure can be down to 4.5 kg/cm2g for remote consumers. Design pressure is 10 kg/cm2g. Dew point is -40 degree C at line pressure.

Air Distribution Headers shall be as SS 304.

11.0 ERECTION , INSTALLATION & COMMISSIOING

The bidder shall be responsible for the installation, calibration & testing, commissioning of the complete instrumentation and controls as defined in this specification as minimum. All the instruments & systems installed by the bidder as per scope subject to inspection, checking, calibration & testing to prove their operational fitness. Testing & calibration shall be done by the bidder, if required , all the required tools, tackles, calibration instruments, qualified skilled manpower for conducting these tests shall be provided by the bidder.

Testing & calibration may be witnessed by representative Client/PMC and/or manufacturer's representative.

LETTER WRITING: LETTER WRITING FOR ALPHA-NUMERIC TAGGING (WITH SYNTHETIC ENAMEL). :- Letter writing of different sizes on Instrument Panels/misc. Instruments/ Equipments with synthetic enamel paints (Asian/ Jonson & Nicolson/ Berger /Nerolac Make) suitable for a temp. of 100 degree Celsius for writing of letters, figures etc. Job includes cleaning of surface on panels/instruments/misc. instruments etc. All complete with labour and materials as per drawings, specifications, Name plate schedule and directions of Engineer-in-Charge. (Supply of paints is in contractor scope)

11.1 INSTRUMENT LOCATION

11.1.1 The location of instruments, control valves. Including junction boxes shall permit easy access from grade, permanent platforms or stairways for operation, inspection and maintenance.

11.1.2 The use of portable ladder or mobile platform shall be limited to access root valves, thermowells and line mounted flowmeters.

11.1.3 Locations shall be decided to minimize the possibility of damage from passing or falling objects and the possibility of tripping hazard or obstruct on walkway.

11.2 INSTRUMENT CABLE

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11.2.1 Overhead Runs

Instrument main cable tray from field junction boxes to main control building shall generally be laid in aboveground cable tray with protection cover. Tray protection cover shall be provided only for the tray on top of tray layer.

Instrument branched cable runs from junction box or local panel to each instrument in the field shall also be routed aboveground and supported with trays, steel angles and channels.

Aluminium perforated cable trays/cable ducts shall generally be used for main cable trays. Single pair cables from instrument to junction box and branch cable tray shall be through perforated Aluminium cable trays.

The scope of supply includes Aluminium perforated type cable trays, FRP accessories such as Bends, tees, crosses, reducers & connector plates and accessories like bolts, nuts etc.

Aluminium trays shall be vinyl ester resin based and all tray shall be manufactured using the PULTRUSION process.

For Signal 900mm/ 600mm tray and for power 600mm/ 300 mm tray to be considered or shall be discussed during detail Engineering.

Cable tray segregation shall be based on the voltage level. Cable tray shall be supported at every 3M. 20% spare to be considered in the cable tray filling.

Instrumentation cables that form part of intrinsic safe (IS) circuits, if any, Shall be segregated from other instrument signal cables.

Instrument power supply (AC) cables shall not run in the same tray of instrument signal cables. Cable tray shall be dedicated for laying instrument power cables separately from the signal cable tray.

Alternatively, cable ducts of suitable size shall also be considered for main cables. When common cable ducts are used for running both power and signal cables, necessary air gap partition shall be used to segregate the cables

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11.3 CABLES

All cables shall have PVC insulated primary insulation of 85°C PVC as per IS-583. Inner and outer jacket shall be made of extruded flame retardant 90 ac PVC to IS-5831

All cables shall be FRLS as per standard IEC 332-3 Part 3 Cat. A. Fire resistance cables whenever specified shall be as per me 331 Cat. A.

The insulation grade shall be 600 V/11000 V as a minimum arid shall meet insulation resistance, voltage and spark test requirements as per BS-5308 Part-2

All cables shall be armoured. Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 part I / IEC 502. All the cores of single pair or multi-pair shall be twisted and numbers of twist shall not be less than 10 per metre.

For signal and control cables, inner jacket colour shall be black. Outer jacket colour shall be light blue, for intrinsically safe application and black for others. For thermocouple extension cables the inner and outer jacket colour shall be as per IS-8784.

L/R ratio of adjacent cores shall not exceed 40 μH/ohm for cables with 1.5 mm2 conductor Electrical Properties of Cables shall be in line with EN50288-7:2005.

Contractor shall ensure a minimum of 20% of quantity of each type of cables supplied as spare including any special cable and in each multipair cables 20% pairs shall be kept as spare.

11.3.1 Instrument Signal Cable

a) Single pair shielded signal/alarm cables shall be used between all field instruments including switches and junction boxes/local control panels.

b) Triad cable shall be used between GDs/RTDs to JB/Transmitter respectively.

b) Multipair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and control room.

c) The single pair/triad cables shall be 1.5 mm2 conductor size made of annealed electrolytic copper conductor of 7 strands with each strand of 0.53 mm diameter. Multipair cables with 1.5 mm2 conductor size shall have 7 strands of annealed electrolytic grade copper conductor with each strand of 0.3 mm diameter. Multi triad cable or multi pair cable with 1.5 mm2 conductor shall have 7 strand with each strand

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of 0.53 mm diameter. Colour of core insulation shall be black blue in pair and black, blue and brown in a triad.

d) Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/triad and 0.075 mm in case of multipair/triad cable.

e) Drain wire shall be provided for individual pair and overall shield which shall be 0.5 mm2 multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.

f) All multi pair cables shall have 6 pair/12 pairs only while multitriad cable shall have 6 triads/8/12 triads only. Size for multipair cable will be 1.5 mm2 with drain and overlap as above.

11.3.2 Cables and Multicore Cables for Solenoids etc.

Cables and multicore cables for such items as solenoid valves and flame detectors shall normally have a conductor size of 2.5 mm2. However, conductor sizes for power cables shall be co-ordinated with the Electrical Group to avoid too many different cable types.

Signals (4-20 mA or switch 'contact): 6/12 pair individually and over all shielded (screened) and armoured, twisted, 0.75 mm2 conductor.

11.3.3 Thermocouple Extension Wires

a) Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes transmitters/ local control panel mounted instruments.

b) Multipair individually and overall shielded thermocouple extension cables shall be used between junction boxes and main control room mounted devices.

c) The type of thermocouple extension cables shall be compatible with thermocouple used. In addition the colour coding of the primary insulation shall be as per ANSI.

d) The cable shall have 16 AWG and 18 AWG solid conductors for single and multipairs respectively.

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e) All thermocouple extension cable shall be matched and calibrated in accordance with MC-96.1.

f) Shield shall be aluminium backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25% overlap and100 % surface. Minimum shield thickness shall be 0.05 mm for single pair and0.075 mm for multipair cable. Drain wire shall be 0.5-mm2 multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with the aluminium side of the shield.

g) Inductance shall not exceed 4mH/Km.

h) All multi-pair cables shall have 6 pairs/12 pairs only.

11.3.4 Power supply Cables

All power supply cables shall be as per IS-1554 Part I and shall have copper conductors. Minimum conductor size shall be 2.5 mm2. The cables shall be PVC insulated and armoured. The higher size conductors shall be used incase of long distance power cable where voltage drops more than 3 volts than required supply.

Any other special cable required for instruments that should also be supplied as per requirements. CONTRACTOR shall ensure that these cables are armoured type and shall meet all other requirements.

11.3.5 OPTICAL FIBER CABLE

The Optical Fiber Cable (OFC) used shall conform to the following specification as a minimum:

a) The OFC shall be CSTA (corrugated steel tape armored, electrolytically chrome plated low carbon steel) armored cable.

b) The OFC shall have FRP strength member, loose tubes for single mode optical fibers filled with moisture resistant jelly, moisture barrier of polymer coated Aluminum tape or water swellable tape, inner sheath of HDPE and outer sheath of PVC.

c) Optical fibers shall be single mode fibers compliant to ITU-TG.652 and fibers colours shall correspond to IEC 793-2 and 304. Optical fibers shall be coated with UV cured double acrylic resin. It should not have any reaction with cladding or core material. The coating should provide maximum resistance to micro-bending & abrasion and ensure mechanical & optical strength. The coating shall be easily stripped with mechanical tools.

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d) The number of fibers in the OFC shall be decided depending upon the requirement with 8 fibers as a minimum.

e) The cabled fiber attenuation shall be 0.37 dB/km for 1310 nm wavelength range and 0.22 dB/km for 1550 nm wavelength range.

f) The tensile performance shall be as per **. IEC 60794-1-2 E1** and with tensile load of **9.81 x 2.5 W (Where W= mass of 1 km of cable in Kg)**Newton Or 2670 N whichever is higher.

11.4 JUNCTION BOX

a) In all JBs, cable entries shall be from Bottom only. Further after commissioning, all JB's should be covered with Aluminum tapes at its periphery to prevent water ingress.

b) JB MOC shall be FRP and 4 mm thick sheet. Junction boxes shall be for IEC Zone 2 & Gas group IIA/IIB EExe. with acid resistant gasket (will be freezed during detailed engineering).

In general a junction box shall contain only signal of same class. The signal class is categorized as following type:

i) Signal Level

- Analog
- Digital
- T/C
- Solenoid Valve
- Instrument Power
- Gas Detectors

ii) Type of protection

- Non IS, Exd
- IS, Exe

c) All JB extra entries shall be plugged with SS316 plug. Each junction box shall be provided with 2 multi-cable entries from the bottom of the junction box with one plugged. All Cable entry shall be at the bottom only, and not from side or top.

d) All spare cable cores shall be terminated in the Junction box, at the marshalling panel end and wired through spare barriers / isolators or relays (as the case may be) right upto the corresponding spare channel of I/O module.

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e) All spares hole of JBs, T/C head etc to be plugged with metallic plugs. The metallic plugs, Junction box hinges, Handle, DIN rail, Allen screws shall be SS 316 material of construction.

f) For ease of identification shutdown JB's shall be colored should be marked with RED.

g) Cable glands shall be provided with Cables shrouds. 20% spare terminals shall be supplied in each junction box.

11.5 CABLE GLANDS

a) Contractor shall supply all cable glands required for glanding the above mentioned cables both at field instrument and local control panel side, junction boxes side and at control room side.

b) All cables glands shall be of SS316 ex-proof and they shall be double compression type suitable for armoured cables. Glands shall be in line with Area classification

c) Flame proof glands wherever required 'shall be supplied with EX'd' certification.

11.6 INSTRUMENT VALVES AND MANIFOLDS

a) Contractor shall supply instrument valves (miniature type) and valve manifolds wherever required.

b) Body rating shall be as per piping class or better. All valves and manifolds shall be forged type only.

c) Valve body and trim material shall be SS 316L unless otherwise specified. Superior trim material shall be selected as requirement by process conditions. Packing material in general shall be of PTFE

11.7 INSTRUMENT IMPULSE LINES

a) In general ½" OD annealed seamless SS 316 tubing shall be used in preference to piping.

b) Tubing standard shall be used upto 600 # only where the same is required as per job specification. For rating above 600 # and hydrogen/lethal service, only piping standard shall be used. The tubing shall be 1/2" OD tube with all fittings suitable for the same. Valves used shall be threaded. At the first isolation / root valve end suitable

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pipe tag to tubing conversion fittings shall be used. For remote installation suitable unions / couplings shall be used.

c) Piping standard shall be used for all installation where specified in job specification. For rating upto 600#, the connection to the transmitters shall be with a male connector and tubing 1/2" OD. For rating higher than 600 #, no tubing shall be used. The connection to the transmitters shall be with 1/2" piping with flanges in between piping standard, all pipes shall be 1/2" NB unless higher sizes required to meet the "requirements, with all fittings suitable for the piping. All the joints shall be welded or flanged as required. For instrument end connection i.e root valve of orifices and other items, level gauges vent and "drain connection, seal welding shall be provided. For non diaphragm seal instruments and instruments where provided with threaded connection, no welding is required at instrument end

d) All instruments shall be provided with isolation, drain and/ or vent valves with vent/drain end duly capped. This isolation valve shall be SS304 GATE type. It shall be in addition to the first isolation /root valve provided on the pipe or vessel at instrument take off.

f) For diaphragm seal type instruments, spacer ring with vent and drain connection along with vent / drain valve with end capped.

g) Contractor shall supply flareless compression type of tube fitting and of three piece construction with design similar to Swagelok/Parker Hannifen etc.

h) Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 #. Weld neck fittings shall be used where socket weld type are not allowed by piping class.

i) All pipe fittings shall be according to piping material specification as per piping class of the pipe on which instrument is connected. In case of vessel/equipment / reactor, PMS of equivalent piping class shall be considered.

11.8 INSTRUMENT AIR SUPPLY DISTRIBUTION

Instrument air headers, pipes and distributors shall be of S.S 304(min size 2''). Instrument air manifold shall be used for supplying instrument air to control valves and other instruments. These shall be with 10 nos. of tappings and be with ½" NPT (F), SS 304 valves. From the nearby air manifold, instrument air shall be supplied to the control valves. For the purpose, all tubing shall be used shall be of SS316, ¼", 1/2" OD,

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seamless tubes, laid in perforated aluminium trays. All intermediate fittings shall be double compression, SS316 MOC, Swaglok or equivalent make only.

Instrument air shall be provided at one point. Package vendor has to develop air distribution scheme.

11.9 MCT Blocks

Cable entry to main control room shall be through MCT blocks.

Entry into the Panels in the control room shall be through bottom mounted MCT blocks.

Bidder shall provide minimum 8+8x6 MCT frame along with multi-dia blocks with peeling of arrangement and centre plug, with wedge, lubricant, stay plate. Bidder shall provide at least 20% installed spares with mult-dia blocks with peeling of arrangement and centre plug. (Qty of frame shall be submitted by the bidder during bidding stage with typical cable arrangement).

11.10 PROTECTION AND PAINTING

All exposed carbon steel parts to be painted shall be thoroughly cleaned from inside and outside to remove scale rust, dirt and other foreign materials by wire brushing / sand blasting as applicable. Minimum acceptable standard in case of power tool cleaning shall be St. 3 and in case of blast cleaning shall be SA 2. as per Swedish standard SIS 055900-1967.

- Non – ferrous materials. Austenitic stainless steels, plastic or plastic coated materials.
- Insulated surfaces of equipment and pre-painted items shall need not be painted.
- Stainless steel surfaces, both inside and outside. Shall be pickled and passivated.
- Machined and bearing surfaces shall be protected with varnish or thick coat of grease.
- **Depending on the environment the following primer and finish coats shall be applied:**

S. No.	Environment	Description	Minimum Requirements
1	Normal – Industrial	Primer	2 coats of Red oxide
			Zinc phosphate each 30-35 microns thick
		Finish Coat	2 coats of synthetic enamel, each 25 microns (min.) thick.
2	Corrosive – Industrial	Primer	2 coats of epoxy zinc chromate, Each 35 microns (min.) thick.
		Finish Coat	2 coats of epoxy high build paint, each 100 microns (min.) thick.
3	Coastal and	Primer	2 coats of high build chlorinated rubber. Zinc

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S. No.	Environment	Description	Minimum Requirements
	Marine		phosphate, each 50 microns (min.) thick.
		Finish Coat	2 coats of chlorinated rubber coat paint. Each 35 microns (min.) thick.
			(Any values refer to dry film thickness).

Colour Band shall be provided on loading arm as per Product colour code at site.

11.11 PACKAGING AND IDENTIFICATION

All packaging shall be done in such a manner as to reduce the volume. The equipment shall be dismantled into major components suitable for shipment. All assemblies shall be properly match marked for site erection.

Attachments, spare parts of the equipment and small items shall be packed separately in wooden cases. Each item shall be appropriately tagged with identification of main equipment. Item denomination and reference number of the respective assembly drawing.

Detailed packing list in waterproof envelope shall be inserted in the package together with equipment Each equipment shall have an identification plate giving salient equipment data, make, year of manufacture. Equipment number, name of manufacturer, etc.

12.0 Storage Tank

Instrument design Philosophy shall be same as per section above.

2 Nos. of Level measurement of two different principle shall be provided.

13.0 Training

Supplier shall train Clients' maintenance engineers as well as operations staff in his works at Vendors Center of Excellence. The training imparted shall be by qualified and experienced staff available. It shall be exhaustive and aimed at making clients' maintenance & operations staff self reliant for most of the day to day applications. For training, supplier shall make available as close a model of the system with all the representative nodes, as the actual system to be installed. It is envisaged that following be covered in the training:

- **Operating Staff Training**

Operating courses include all aspects involved in operating the Control System from operator interface. This shall include operation under normal and abnormal conditions as

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may result from minor or major system malfunctions such that the trainee can take the appropriate remedial actions. The training shall include but not be limited to the following:

• Overview of the system

• Control philosophy

• User interfaces

• Messages and alarms

• Operator commands

• Generation of reports

• Predictable events and expected operator action

- **Engineering staff training**

Software Design courses shall be provided which would train the Employer's Maintenance and

Design staff to be able to identify and remedy software faults, upgrade and implement data and software changes, generate/develop new software for the purpose of improving the system and production of revised or new displays. The training shall include but not be limited to the following:

• Overview of the system architecture, hardware and software

• Software design and organisation

• Database structure, generation and modification

• Generation and modification of the VDU screen

• Customization of report/chart/graph format

• Assembly, compilation, linking, editing, debugging, distributing, testing and integration of program modules

14.0 FAT/SAT

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Bidder to consider FAT/SAT for the offered system in his scope of supply. FAT/SAT procedure.

FAT – Factory Acceptance Test

FAT is inspection for verification that all equipment and devices function properly with integrity.

Prior to notification of FAT to Client/Purchaser, all the involved contractual documentation shall be completed and all the cabinets, equipment and components of Control system shall be assembled and installed in one area at one time.

Bidder shall demonstrate all the functions of the PLC working properly in FAT. Each test shall be carried out on the procedure reviewed and accepted by Client/PMC/Purchaser after submitting Manufacturing Internal Test Certificate.

FAT certificate shall be issued by bidder at the successful end of the test activities. All the hardware and software failures and problems shall be documented. All the failures and problems shall be resolved before shipment to site, All series of actions shall be taken in accordance with the FAT procedure.

FAT will start with Visual Inspection including the following activities as minimum;

- Quantity of all the cabinets, equipment and components.
- Installation of all the cabinets, equipment and components.
- Tagging of all the cabinets, equipment and components.
- Wiring of all the cabinets, equipment and components.

Once Visual Inspection has been successfully completed, Hardware Testing shall start including the following activities as minimum;

Power-On

- Redundancy of Power Supply on failure
- Diagnostics of the main equipment
- Redundancy of the main equipment on failure
- Redundancy of network on failure

- 100% I/O Accuracy Check at 5 point (0%, 50%,100%,50% and 0%) for all the hardwired points (sample check may be allowed if 100% I/O Accuracy has been checked Manufacturer Internal Test)

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Once Hardware Testing has been successfully completed, Software Testing shall start including the following activities as minimum;

- I/O Database implementation
- Graphic implementation
- Control implementation
- Logic and sequence implementation
- Historian implementation
- SER implementation
- AMS implementation

SITE ACCEPTANCE TEST (SAT)

SAT is inspection for checking that all the conditions are good after installation at site.

Prior to notice of SAT to Client/Purchaser, bidder shall submit all the "As-Shipped" documentation incorporating all the FAT correction.

Prior to start SAT, all the cabinets, equipment and components of PLC shall be installed in proper location as designed.

Bidder shall demonstrate all the function of PLC working properly in SAT. Each test shall be carried out on the procedure and its criteria reviewed and accepted by Client/Purchaser.

Test certificate shall be issued by bidder at the successful end of the test activities. All the hardware and software failures and problems shall be documented.

SAT shall be identical to FAT but at reduced amount to check hardware without any damage, installations completed properly and interface working properly. bidder shall provide special tools and test equipments.

ANNEXURE -1

INSTRUMENT ACCURACIES

The instrument reference accuracies shall be as per the table below. Accuracy of the Instruments shall be minimum as follows.

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Type of Instrument	Accuracy
Belt weighers	+/- 0.5 % of range
Differential pressure & Pressure transmitter - SMART	± 0.050% of span within TD ratio of 1: 100 or better
Diaphragm seal transmitter & Pressure transmitter - SMART	± 0.050% of span within TD ratio of 1: 100 or better
Variable area type flow meter with transmitter	± 2.0% FS Note (1)
Vortex flow meter	± 0.7 % FS
Positive displacement flow meter	
- Raw material and Product	± 0.2% FS
- Others	± 0.5% FS
- Turbine meter or Mass flow meter	
- Raw material and Product	± 0.2% FS
- Others	± 0.5% FS
- Magnetic type flow meter	± 0.5% FS
- Mass flow meter (Coriolis Type)	± 0.1% of reading
- Ultrasonic type flow meter	± 0.5% of reading
- Ultrasonic type flow meter(5 – path)	± 0.1% of reading
Orifice plate : Normal Application	+/- 2% of flow rate
Orifice plate : Special Application	+/- 1.5% of flow rate
Venturi	+/- 1 % of flow rate
- Displacement type level indicator	± 1.0% FS
- Displacement type level transmitter	± 0.2% FS (Smart)
- Tank gauge (Custody Transfer)	± 1 mm with +/- 1 mm resolution
- Servo type tank gauge	± 2 mm (up to 20 m height)
- Radar type tank gauge	± 1 mm or better for custody transfer ± 5 mm or better for normal application
	± 0.2% of span within TD ratio of 1: 100
- Pressure gauge	± 1.0% of span for Bourdon type , 1.5% for diaphragm
- Temperature Transmitter	± 0.15 % of calibrated span for RTD & T/C
- Filled system/Bimetallic	± 1.0% FS
- Small size pressure gauge	± 3.0% FS
- Draft gauge	± 3.0% FS
- Receiver gauge	± 1.5% FS

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- Thermocouple & Resistance Bulb	Applicable Codes/Standards

Note: 1. Vendor's standard accuracy is applied to local indicator type.
2. Accuracy for custody transfer/mass balance instruments shall be ±% of reading and shall be supplied with wet calibration certification.

Remarks: 1. Accuracy of instrument and special articles except for the above mentioned instrument shall be in accordance with the applicable codes/standards, or Vendor's standards as approved by Purchaser.
2. FS: Full scale.
3. Overall rangeability of transmitter except for draft range shall be 1: 100. Draft range transmitter rangeability shall be 1: 30 for the accuracy indicated above.

ANNEXURE -2

Field instrument connections shall be as follows.

Instrument Type	**Process / Vessel Connection**	**Instrumentation Connections**
DP Flow Instruments	½" NPT (M)	½" NPT
External Displacer on Vessel (Min. Rating ANSI 300#)	2" Flanged	2" Flanged
Internal Displacer (Min. Rating ANSI 300#)	4" Flanged	4" Flanged
External Ball Float on Vessel (Min. Rating ANSI 300#)	2" Flanged	2" Flanged
Internal Ball Float (Min. Rating ANSI 300#)	4" Flanged	4" flanged
Magnetic Level Gauge (Min. Rating ANSI 300#)	2" Flanged	2" Flanged
D/P Level	½" NPT (M)	½" NPT
D/P Level with Remote Seal Diaphragm (Min. Rating ANSI 300#)	3" Flanged	3" Flanged
D/P Level Direct Vessel Mounted (Min. Rating ANSI 300#)	3" Flanged	3" Flanged
RADAR – Direct Mount on vessel (Min. Rating ANSI 300#)	3" flanged	3" flanged
GW RADAR – Side/Side Chamber Mounted on vessel (Min. Rating ANSI 300#)	2" flanged	2" flanged
Internal GWR on Equipment (Min. Rating ANSI 300#)	4" Flanged	4" flanged
Special Level Instrument on Equipment (Capacitance/ Ultrasonic/R.F.Probe)	2" flanged	2" flanged

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Tank Level Instruments (Servo) on Atmospheric tank/ Pressurized Equipment	6" flanged	6" flanged
Tank Level Instruments (Radar) on Atmospheric tank clean service / Pressurized Equipment	8" flanged	8" flanged
Tank Level Instruments (Radar) on Atmospheric tank viscous service / Pressurized Equipment	24" flanged	24" flanged
Tank Level Instruments (Capacitance/ Ultrasonic/R.F.Probe) on Atmospheric tank / Pressurized Equipment	2" flanged	2" flanged
Pressure Instruments	½" NPT (M)	½" NPT
Press.Gauge	½" NPT (M)	½" NPT
Pressure with diaphragm seal, (Min. Rating ANSI 300#)	3" Flanged	3" Flanged
Pressure Instruments on Vessel	1 ½" Flanged	½" NPT
Diaphragm Seal pressure Instrument gauge on Vessel	2" Flanged	2" Flanged
Thermowell (Min. Rating ANSI 300#)	1 ½" Flanged	1 ½" Flanged
Multipoint Temperature Element for Tanks	2" Flanged / 3" Flanged	2" Flanged / 3" Flanged
Standpipe	3" Flanged	-

Note:-

a. There shall be a separate tapping for each of the instruments on any pipeline/vessel. No multiple instruments from one tapping is acceptable (for example PG and PT from single pipe line tapping with single or double mechanical isolation valves are not acceptable). However, as an exception to this, three transmitters on clean gas services from one orifice (with two pairs of tapping) is acceptable, where multiple (2 out of 3, etc.) transmitters are to be installed.
b. All type of instrument tapping flange rating shall be minimum ANSI 300#, irrespective of minimum design pressure. However for pressure rating of 600# class and above, RTJ flange shall be used. At few locations, double isolation valves shall be used as per table given below.

INSTALLATION	**PRESSURE TAPPINGS**	**LEVEL TAPPINGS**	**FLOW ELEMENTS**	**CONTROL VALVE**
RATING				
300 #	SINGLE	SINGLE	SINGLE	SINGLE
600 #	DOUBLE	SINGLE	DOUBLE	SINGLE
900 # / 1500 # / 2500 #	DOUBLE	DOUBLE	DOUBLE	SINGLE

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Annexure - 3

SYSTEM CONFIGURATION

Control system package (latest model at the time of supply)

1 No. Operator Stations with, 22" TFT, COLOR, LED type dual monitors to be placed in control room

1 No. ES/OS having the feature of SOE also, dual personality, 22" TFT, COLOR, LED type

1 no. of Membrane Operator's Keyboard and 1 no. of QWERTY engineer's keyboards with mouse with each operator station

All USB ports must be blocked and the system must have latest anti-virus.

Note: All OS and ES shall be of latest configuration which shall be freezed during detail engineering.

Printers

2 No. A4 Heavy duty colour (1 No with SOE and 1 no with OS)	HP make or equivalent Laser printer

Annexure - 4

OPERATOR STATION SUB-SYSTEM

* Model No. _By Vendor__

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A. **General Requirement**

1	Number of Operator Consoles	ONE
2	Inter-changeability between operator consoles	Required
3	On-line system diagnostics on Console Monitor	Required at Module level
4	On-line configuration change	Required
5	Console configuration	Dual

B. **OPERATOR CONSOLE**

1	Console's basic electronics	Individual electronics for each monitor
	µp Type	64 bit
	µp Manufacturer/ model	Note-1
	Memory size /Cache size	16_GB (Vendor to check the suitability of memory size)
2	Type of Database	Functionally Separate

Database Storage Devices:

Sr. No.	ITEM MODEL No.	FUNCTION	REDUNDANCY (Refer Note)	REMARK
1.	HDD	Note-1	REQUIRED	
2.	Combo drive	Note-1	REQUIRED	
3.	Vendor recommended	Note-1	REQUIRED	

(Note: Full Redundancy is required if Centralized global database is provided)

STORAGE DEVICES ARE APPLICABLE IN EACH OPERATOR STATION.

3 Number of Devices (per console)

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S. No	TYPE OF DEVICE	Description OF DEVICES REQUIRED	NO. OF DEVICES	REMARKS
1.	MONITOR	22" TFT, COLOR, LED type dual monitors (Control system architecture)	1 per console	
2.	KEYBOARD SETS	1 no. of Membrane Operator's Keyboard and 1 no. of QWERTY engineer's keyboards with mouse.	1 per console	
3.	ALARM & EVENT, LOG A4 PRINTER	1 Nos A4 Heavy duty Colour –HP or equivalent make	1	
4.	DVD DRIVE		1 per console	
5.	PRINTER	HP make or equivalent Laser printer	1 per console	1 No with SOE & 1 no with OS

4 Inter-changeability between Monitors Required

5 Spare memory requirement Min. 40%

6. Keyboard Set

a) Keyboard Security against unauthorized access Required with Key-lock

Note: Key-lock Password shall be provided for each operator console.

b) Maximum number of keystrokes for accessing views as per standard display hierarchy:

S.No.	TYPE OF VIEW	REQUIRED	OFFERED	REMARKS
1.	GROUP VIEW	TWO		
2.	LOOP VIEW	THREE		
3.	LOOP IN ALARM	TWO		
4.	GRAPHICS VIEW	TWO		

c) Assignable function keys for single keystroke access Required

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	d) Number of Assignable function keys per Monitor			64	
7	a) Number of devices for cursor control			Two/Monitor	
	b) Devices for cursor control	Keyboard	**[X]**	Mouse	**[X]**

8 Monitors and Displays

a) Size of Monitor 22" diagonal

b) Type of Monitor TFT LED

c) Surface Treatment Hard Coating anti Glare

d) Length of tag number (characters) 16 alphanumeric

e) Length of description (characters) 24 alphanumeric

f) Display update rate 2 s

g) Dynamic graphics Required

h) Multi Window Capability Required

i) Control through dynamic graphics Required

j) Screen displays and Call-up time

S.No.	TYPE OF DISPLAY	REQUIRED	CALL-UP TIME(S)*	REMARKS
1.	OVERVIEW	YES		
2.	GROUP DISPLAY	YES		
3.	LOOP DISPLAY	YES		
4.	DYNAMIC GRAPHICS	YES		
5.	REAL-TIME TREND	YES		
6.	HISTORIC TREND	YES		
7.	ALARM SUMMARY	YES		
8.	ALARM HISTORY	YES		
9.	CONFIGURATION	YES		
10.	DIAGNOSTIC	YES		

k) Display Hierarchy

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S. No.	DESCRIPTION	REQUIREMENT	SYSTEM CAPABILITY	REMARKS
1.	NO. OF OVERVIEW PAGES	AS REQD.		
2.	NO. OF GROUPS/OVERVIEW	AS REQD.		
3.	NO. OF LOOPS / GROUP	8		
4.	NO. OF GRAPHIC PAGES	AS REQD.		
5.	NO. OF POINT IN ALARM SUMMARY	AS REQD.		
6.	NO. OF POINTS IN ALARM HISTORY	AS REQD.		
7.	NO. OF TRENDS PER DISPLAYS	AS REQD.		
8.	NO. OF MULTI-TREND DISPLAYS	AS REQD.		
9.	OTHERS	AS REQD.		

l) Multi Windowing facility Required

Note: Opening of more than four windows on the same Monitor shall be restricted by the system .

m) Trending functions: Each Operator Console shall be capable of trending all analog points.

n) Real-time trend

Number of parameters Required for ALL TAGS (AI trip signals tends must be configured in a separate group with 0.5 sec trending)

o) Historical trend

Number of parameters Required for ALL TAGS

Time period 1 year

9) Logging Function

a) Number of tags to be logged Required for ALL TAGS

b) Number of log reports:

Alarm History per shift

Event logging

Hourly logs

Shiftly logs

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Daily logs

Weekly logs

Shutdown report

Trip initiated log

Others (Note)

Note: Other log reports as required shall be furnished during execution stage.

c) Log formats — User definable

10 System boot-up from — Engineer console

11 Auto boot-up on power On — Required

12 Storage disks

a) Type of storage disk — HDD — Optical (DVD)

b) Number of disks and capacity

Sl. No.	TYPE OF DISC	NUMBER (MINIMUM)	MEMORY CAPACITY PER DISK	REMARKS
1	HDD	One Per Monitor	AS per latest configuration	
2.	OPTICAL	One Per Monitor	AS per latest configuration	
3.	Other			

13 Any other feature available as a standard:

a)_____

b) _____

14 CPU Loading — 60 %

15 Memory Utilization — 60 %

16 Operating System — Latest must have validation with the system

17 Antivirus/Network Security — Required as per latest IEC standard

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ENGINEERING Cum OPERATOR STATION with SOE Facility SUB-SYSTEM

- Model No. ____By vendor

1. Number of Engineering cum Operator Station — One
2. Number of Monitors per Engg. Station — One
3. Type of electronics — Individual per Monitor
   - µP type — 64 bit
   - Memory size — NOTE-1
   - Model No. — NOTE-1
4. Number of engineering keyboards — One per Monitor
5. Number of Operation keyboards — One per Monitor
6. Functional Capability — Same as operator station subsystem
7. Basic functions of Engineering Console
   a) System configuration and reconfiguration
   b) Group & multi-groups alarm inhibiting
   c) Plant views with/ without plant operation
   d) Graphic page compilation
   e) Setting/ resetting real-time clock
   f) Loop tuning on selectable basis
   g) System maintenance and diagnostics
8. Monitor specification — As per operator station subsystem
9. Keyboard specification — As per operator station subsystem
10. Data storage Devices and capacity

Sr. No.	TYPE OF DISC	NUMBER (MINIMUM)	MEMORY CAPACITY PER DISK	REMARKS
1	HDD	One	As per Latest configuration	
2.	DVD writer	One		
3.	OPTICAL(DVD)	One	As per Latest configuration	
5.	OTHER			

11. Antivirus/Network SecurityRequired

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ANNEXURE -5

HARDWIRED CONSOLE

- Model No. ____By vendor

1. One no. of Hardwired/Aux. console:
2. Instrument Located on Hardwired consoles: (AS REQUIRED)

INSTRUMENT TYPE	NUMBER REQUIRED ON HARDWIRED CONSOLE WITH	
		CONSIDERED BY VENDOR
ASSIGNABLE RECORDERS	N.A.	
HARDWIRED ANNUNCIATORS	AS REQUIRED	
INDICATING LAMPS	AS REQUIRED	
SWITCHES	AS REQUIRED	
PUSHBUTTONS	AS REQUIRED	
OTHERS	AS REQUIRED	

3 Power supply Alarm/Annunciator 110 V AC, 50 Hz **[X]**

4 Power supply for switches, lamps, pushbuttons etc. 24 V DC **[X]**

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APPENDIX –1

Type of Signal	Inst to JB (1P,1T)		JB to Control Room (6P/12P/6T/8T/12T)		Control Room to MCC/MCC to Control Room (Multi-conductor cable)	
	Size (mm2)	Type	Size (mm2)	Type	Size (mm2)	Signal
AI	1.5	Signal	0.75	Signal	1.5	Signal
AO	1.5	Signal	0.75	Signal	1.5	Signal
DI	1.5	Signal	0.75	Signal	1.5	Signal
DO	1.5	Signal	0.75	Signal	1.5	Signal
RTD	1.5	Signal	0.75	Signal	1.5	Signal
TC	1.5	Signal	0.75	Signal	1.5	Signal
GD	1.5	Signal	1.5	Signal	-	-
SOV	2.5	Signal	2.5	Signal	-	-
POWER	2.5	Power	2.5	Power	2.5	Power
TC Extension cable	Special compensation cable between Element to transmitter					
RTD Extension cable	Triad cable between Element to transmitter of 1.5mm2					
Analysers	1.5	Signal	0.75	Signal or serial communication as the case may be.		

***Note :** Above size is minimum. Further cable size may be increase based on voltage drop calculation .

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GENERAL SPECIFICATION

FOR

INSTRUMENT TUBE FITTINGS

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing and shipping of instrument tube fittings which includes the following type:

Stainless steel compression fittings (for stainless steel tube)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest Editions prior to the date of the purchaser's enquiry: -

ANSIIASME American National Standards Institute/American Society of Mechanical Engineers

B 1.20.1 Pipe Threads General Purpose (Inch).

B 16.11 Forged Steel Fittings - Socket Welding and Threaded.

BS-4368 Carbon and Stainless Steel Compression Couplings for Tubes.

EN 10204 Inspection Documents For Metallic Products.

IS-319 Specification for free cutting Brass Bars, Rods and Sections.

ISA Instrumentation, Systems and Automation Society.

RP 42.1 Nomenclature for Instrument Tube Fittings.

1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations

b) Data Sheets

c) Standard Specification

d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached along with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the Following;

a) Compliance to the specifications.

b) Whenever specifically indicated, detailed specification sheet for each item, which shall provide the information regarding type, size, material of construction etc. of

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the items. The material specifications and units of measurement for various items in vendor's specification sheets shall be to the same standard as those indicated in purchaser's data sheet.

c) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they must include a list of deviations item wise summing up all the deviation from the purchaser's data sheets and other technical specification along with technical reasons for each of these deviations.

d) Catalogues giving detailed technical specifications, model decoding details and other information for each type of instrument tube fitting covered in the bid.

1.2.3 All documentation submitted by vendor including their quotation, catalogues, drawings, Installation, operation and maintenance manuals etc , shall be in English language only.

2.0 DESIGN AND CONSTRUCTION

2.1 Stainless Steel Tube Fittings

2.1.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.

2.1.2 Fittings shall be of flare less compression type having four-piece (for double compression type) construction consisting of two ferrules, nut and body or three piece (compression type construction consisting of single ferrule, nut and body suitable for use on tubes of specified material for example stainless steel tubes conforming to ASTM A269 TP 316 with hardness in the range of HRB 70 to 79.

2.1.3 All parts of the tube fittings shall be of 316 Stainless Steel.

2.1.4 Hardness of the ferrules shall be in the range of HRB 85-90 so as to ensure a hardness difference of the order of 5 to 10 between tube and fittings for better sealing.

2.1.5 Nuts and ferrules of a particular size shall be interchangeable for each type.

2.1.6 Spanner hold shall be metric.

2.1.7 Threaded ends of fittings shall be NPT as per ANSI B 1.20.1.

2.1.8 Specific techniques like silver plating shall be used over threading in order to avoid jamming and galling.

2.1.9 Ferrule finish and fitting finish shall be such that there is no abrasion/galling when the nut is tightened.

2.1.10 All instrument tube fittings in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connection shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

2.2 Copper Tube Fittings (Not applicable for this Project)

2.2.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.

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Fittings shall be of flare less compression type and of three-piece construction consisting of ferrule, nut and body Suitable for use on copper tubes conforming to ASTM B68 *1B68M,* hardness not exceeding HRB 50.

2.2.2 All parts shall be manufactured from brass as per IS 319 bar stock and nickel plated.

2.2.3 For better grip, vendor shall maintain hardness difference between tube and ferrule and indicate the same along with the offer.

2.2.4 Threaded ends of fittings shall be NPT as per ANSI B 1.20.1.

2.2.5 Spanner hold shall be metric.

3.0 NAMEPLATE

No separate nameplates are required on the fittings. However. manufacturer's name/trademark should be punched on a visible place on the body of each fitting for easy identification.

4.0 THIRD PARTY INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all items at vendor's works, inline with the inspection test plan for instrument tube fittings.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

4.2.1 Type test reports for following tests in accordance with BS-4368·Part IV:

a) Hydrostatic proof pressure test.
b) Minimum hydrostatic burst pressure test.
c) Disassembly and reassembly test.
d) Minimum static gas pressure (vacuum) test.
e) Maximum static gas pressure test.
f) Hydraulic impulse and vibration test.

4.2.2 Material test certificates as per clause 3.1 B of EN 10204.

4.2.3 Routine test reports for following tests:

a) Hydrostatic Test
Instrument tube fittings shall be hydrostatically tested at ambient temperature at test pressures given in Annexure I of this specification. During and after the hydrostatic test, the tube fittings shall not show any leakage or rupture.

b) Pneumatic pressure test
The fittings shall be tested at 7 kg/c mg of dry air. There shall not be any visible leakage when immersed in water or coated with a leak detection solution.

c) Disassembly and reassembly test.

d) Hardness verification:
Hardness test shall be carried out on each rod used for machining ferrules. Vendor shall ensure that after machining, the finished ferrules shall meet the required hardness given in the specification.

d) Dimensional test report

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4.3 Third Party Witness Inspection

4.3.1 All fittings shall be offered for pre-dispatch inspection for the following as a minimum:

a) Physical dimensional verification and workmanship on representative samples.
b) Hydrostatic and pneumatic tests as per clause 4.2.3 of this specification on representative samples.
c) Hardness verification as per clause 4.2.3 of this specification.
d) Disassembly and reassembly test on representative samples.
e) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.3.2 In the event when no witness inspection is carried out by purchaser, vendor shall any way complete the tests and test reports for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 All threads/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.2 All the fittings in oxygen and chlorine service shall be separately packed along with a certificate indicating 'SUITABLE FOR OXYGEN/CHLORINE SERVICE', as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to the above requirements, shall be summarily rejected.

Annexure- 1

Sr. No.	Size of Tube Fittings	Material	Line Pressure No. Class	Hydrostatic Test Pressure
1	¼"and ½"	Stainless steel	<600#	153 Kg/cm2 g
2	¼" and ½"	Stainless steel	>=900# to <=1500#	383 Kg/cm2 g
3	¼" and 3/8"	Brass		80Kg/cm2 g

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GENERAL SPECIFICATION

FOR

INSTRUMENT TUBING

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ABBRIVATIONS:

ID	Inner Diameter
OD	Outer Diameter
PVC	Polyvinyl Chloride

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing and shipping of Instrument Tubing which includes the following types: -

Stainless steel tubes

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;

ASTM American Society for Testing and Materials.

A 269 Standard Specification for Seamless and Welded, Austenitic Stainless Steel Tubing for General Services.

A632 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Services.

B 251 Specification for general requirements for wrought seamless copper and copper alloy tube.

B 251M Specification for general requirements for wrought seamless copper and copper alloy tube (Metric)

B 68 Specification for seamless copper tube, bright annealed.

B 68 M Specification for seamless copper tube, bright annealed. (Metric)

E 243 Standard Practice for Electromagnetic (Eddy - Current) Examination of Copper and Copper - Alloy Tubes

EN 10204 Inspection Documents for Metallic Products

1.1.3 In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory regulations
b) Job specification
c) Standard specification
d) Codes and standards,

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following;

a) Compliance to the specifications.

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b) Whenever the requirement of a detailed specification sheet, is specifically indicated, the specification sheet shall provide information regarding size, length, construction, materials etc. of the Items. The material specifications and units of measurement for various items in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheet.

c) Overall dimensions in mm/inch as per purchaser's specification.

d) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, thc)! must include a list of deviations item wise. summing up all the deviations from the purchaser's data sheet and other technical specification along with the technical reasons for each of these deviations.

e) Catalogues giving detailed technical specifications; model decoding details and other related information for each item covered in the bid,

1.2.3 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation and maintenance manuals shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data by the vendor or after placement of purchase order shall include the following as a minimum;

a) Specification sheet for each type of tube.

b) Copy of test certificates of all tests indicated in clause 4.0 of this specification.

2.0 DESIGN AND CONSTRUCTION

2.1 **Stainless Steel Tubes**

2.1.1 The tubes shall be 316 Stainless Steel fully annealed, and seamless and hot extrusion.

2.1.2 The hardness of the tubes shall be limited to HRB 70-79. Equivalent hardness as

Rockwell superficial scale (30T/15T) or Vicker's hardness scale shall also be acceptable.

2.1.3 Tubes shall have good surface finish and shall be free from scratches burrs etc. and suitable for bending.

2.1.4 Maximum working pressure shall be as per Annexure - I attached with this specification.

2.1.5 Tubes shall preferably be supplied in length of 5 to 6 metres without welding in between. Tube length less than 5 meters shall be rejected.

2.1.6 All tubes in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride and tube ends shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

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2.1.7 Stainless Steel Seamless Instrumentation Tubes should be Cold Finished and Bright Annealedas per ASTM A 213 /A 269 / EN 10216-5.
2.1.8 Hot Extruded Mother Pipes must be used for manufacturing Seamless Tubes. It is not acceptable to use Hot Pierced Mother Pipes. It should be followed by Cold Pilgering Process to ensure good quality tubes from Hot Extruded Mother Pipes
2.1.9 With C <0.025% improves Corrosion resistance &Weldability with Special Chemistry
2.1.10 Nickel – 13% Minimum and Molybdenum – 2.50% Minimum
2.1.11 Hardness Controlled to < 80 HRB (It ensures easy Bending &Swaging)
2.1.12 Dual Certified Grades – 316 / 316L
2.1.13 IGC Practice as per ASTM A 262 Practice E
2.1.14 Complies to NACE MR 0175
2.1.15 100% Eddy Current Testing of Tubes as per ASTM A1016
2.1.16 Hydro Testing on Request
2.1.17 End Capped
2.1.18 Wooden Box Packing
2.1.19 Surface Finish Ra < 1.0 Microns on OD and 1.8 Microns on the ID Unpolished surface

2.2 Copper Tubes (Not applicable for this project)

2.2.1 Copper Tubes (PVC Jacketed)

a) The tube shall be soft annealed copper with 6mm OD and a wall thickness of 1.0mm as per ASTM B 68M copper No. C 12200.

b) The tube shall be jacketed with black PVC. The jacket thickness shall be 1.6mm. The PVC jacket shall confirm to ASTM D-I047.

c) The tube ends shall be plugged prior to transportation.

d) The tube shall be continuous length without any brazing in between.

e) The length of single tube shall preferably be100 metres. However any tube length less than 70 meters shall be rejected unless specifically required otherwise in job specification.

f) The dimensional tolerances shall be as per ASTM B 251M.

2.2.2 Bare Copper Tubes (For Steam Tracing)

a) The tube shall be soft annealed copper with 3/8" (10mm) OD with wall thickness of 0.049" or 6mm OD with wall thickness of 1.Omm as per ASTM B6&.copper No.C12200.

b) The tube ends shall be plugged prior to transportation.

c) The tube shall be continuous length without any brazing in between.

d) The length of single tube shall preferably be 100 metres. However any tube length less than 70 meters shall be rejected unless specifically required otherwise in job specification.

e) The dimensional tolerances shall be as per ASTM B 251.

f) Maximum working pressure shall be 53.0 kg/crrr'g at 38°C unless specified otherwise.

3.0 NAME PLATE

3.1 The following information shall he marked on the stainless steel tubes:

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a) Name of manufacturer

b) Type and material grade of tube

c) Tube outer diameter and wall thickness.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at vendor's works, in line with the inspection test plan for instrument tubing.

4.2 Vendor shall submit following test certificates and test reports for purchasers review:

a) Material test certificates as per clause 3.1B of EN 10204.

b) Hydrostatic test for stainless steel tube and bare copper tubes as per clause 4.3 of this specification.

c) Pneumatic test for PVC jacketed copper tubes as per clause 4.4 of this specification.

d) Hardness / tension test for stainless steel tubes as per clause 4.5 of this specification.

e) Ball test for copper tubes as per clause 4.6 of this specification.

I) Eddy current examination of copper tubes as per ASTM E-243

g) Dimensional test report.

4.3 Hydrostatic test

4.3.1 Stainless steel and bare copper tube shall be hydrostatically tested at ambient temperature at test pressures given in Annexure - 1 attached with this specification. During and after the hydraulic test, the tubes shall not show any leaks or rupture.

4.4 Pneumatic test

PVC jacketed copper tubes shall be tested at 7.0 kg/crrr'g of dry air. During and after the test, tubes shall not show any leak or rupture.

4.5 Hardness/Tension Test

All mother tubes shall be hardness tested for each heat prior to drawing for proper quality control. The hardness of the drawn tubes shall be checked by Rockwell Hardness Test.
Following shall apply;

a) For tubing less than 0.6Sin (1.6Smm) in wall thickness, Rockwell superficial hardness test on 30T / 1ST scale or Vicker's scale shall be equivalent to HRB 70 - 79.

b) Hardness test is not required for tubes smal1er than 1/4in (6.4mm) inside diameter or tubes having a wall thickness thinner than 0.020in (O.Slmm). These tubes shall be tension tested in accordance with ASTM A632.

4.6 Ball Test

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4.6.1 Ball test shall be carried on all copper tubes to ensure clear opening of the tube. The OD of the ball shall be minimum 1.0 mm for 6.0mm 00 tube and 2.0 mm for 3/8" (10mm) OD tube.

4.7 'Witness Inspection

4.7.1 All tubes shall be offered for pre-dispatch inspection for the following, as a minimum;

a) Physical dimensional verification and workmanship.

b) Hardness / tension test for stainless steel tubes.

c) Hydrostatic and pneumatic tests on representative samples.

d) Ball test on copper tubes on representative samples.

c) Eddy current examination of copper tubes on representative samples.

f) Review of all certificates and test reports as indicated in c1ause4.2 of this specification.

4.7.2 In the event that the witness inspection is not carried out by purchaser, vendor shall anyway complete the tests and test reports for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 The tube shall be plugged at both ends to prevent entry of foreign matter.
5.2 The tubes shall be packed carefully so as to avoid damage during transport.

5.3 All tubes III oxygen and chlorine service shall be separately packed along with a certificate indicating 'SUITABLE FOR OXYGEN! CHLORINE SERVICE', as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents and information which is specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall summarily be rejected.

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ANNEXURE - 1 : MAXIMUM WORKING PRESSURE AND HYDROSTATIC TEST PRESSURES FOR INSTRUMENT TUBING

Sr. No.	Size of Tube (OD)	Material	Line Pressure Class	Thickness	Maximum Working Pressure	Hydrostatic Test Pressure
1.	½" (12 mm)	Stainless Steel	≤ 600 #	0.049" (1.2 mm)	102 Kg/cm2g	153 kg/cm2g
2.	½" (12 mm)	Stainless Steel	≥ 900 # to ≤ 1500 #	0.065" (1.65 mm)	253 Kg/cm2g	383 kg/cm2g
3.	¼" (6 mm)	Stainless Steel	≤ 600 #	1.00 mm	102 Kg/cm2g	153 kg/cm2g
4.	¼" (6 mm)	Stainless Steel	≥ 900 # to ≤ 1500 #	0.065" (1.65 mm)	253 Kg/cm2g	383 kg/cm2g
5.	¾" (10 mm)	Copper	-	0.049"	53 Kg/cm2g	80 kg/cm2g
6.	¼" (6 mm)	Copper	-	1.00 mm	53 Kg/cm2g	80 kg/cm2g

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GENERAL SPECIFICATION

FOR

INSTRUMENT VALVES AND MANIFOLDS

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Abbreviations

CWP	Cold Working Pressure
NPT	National Pipe Thread
PTFE	Poly Tetra Fluoro Ethylene

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ANNEXURE
ANNEXURE - 1: HYDROSTATIC TEST PRESSURES FOR INSTRUMENT VALVES AND MANIFOLDS.

1.0 General

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This standard specification shall be used for Instrument Valves and Manifolds.

2.0 DESIGN AND CONSTRUCTION

2.0.1 The finishing and tolerances of parts like stem, piston, stem threading etc. of the offered Valves and manifolds shall be properly machined to avoid problems like galling.

2.0.2 The hand wheel material for all valves and manifolds shall be zinc/nickel plated carbon steel. Any other material, if provided as per standard vendor design, shall also be acceptable.

2.1 Instrument Valves (Miniature)

2.1.1 The instrument valves shall be of globe pattern needle valves forged bar stock with inside screwed bonnet, with back-seated blowout proof system.

2.1.2 Body material shall be 316L Stainless Steel unless otherwise specified.

2.1.3 The minimum cold working pressure (CWP) rating of the valve shall be as per Annexure 1 of this specification, unless otherwise specified.

2.1.4 The end connection shall be *1/2" NPTF* to ANSI B1.20.1, unless otherwise specified.

2.1.5 Flow direction shall be marked on the body.

2.1.6 The valve dimensions shall be as follows:
a) End to end dimensions 76mm (approximately).
b) Height in fully open condition - 135mm maximum.
These dimensions are indicative only.

2.2 Valve Manifolds

2.2.1 3-Valve and 5-Valve manifolds:

2.2.1.1 3-Valve manifold

a) 3-Valve manifold shall be designed for direct coupling to differential pressure Transmitters having 2 bolt flanges with 54mm (2-118") centre-to-centre connections and 41.3mm (1-5/8") bolt-to-bolt distance.

b) 3-Valve manifold shall contain two main line block valves and an equalizing by pass valve. The valves shall be needle type. They shall use self-aligning 316LStainless Steel ball seats, unless otherwise specified.

2.2.1.2 5-Valve manifold

a) 5-Valve manifold shall be designed for direct coupling to differential pressure Transmitters having 2 bolt flanges with 54mm (2-1/8") centre-to-centre connections and 41.3mm (1-5/8") bolt-to-bolt distance.

b) 5-Valve manifold shall contain two main line block valves and a combination Double block and bleed for the bypass line The valve shall of needle type or special ball With bleed hole.

2.2.2 The flanges shall be integral part of manifold block.

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2.2.3 The material of construction shall be 316L Stainless Steel, unless otherwise specified.

2.2.4 The minimum cold working pressure (CWP) rating of manifolds shall be as per Annexure 1 of this specification, unless otherwise specified.

2.2.5 The process connection shall be 1/2"NPTF to ANSI B 1.20.1.

2.2.6 Wherever the manifolds are specified for stanchion mounting, these shall be supplied along with mounting accessories. The bolts and nuts MOC shall be ASTM A 193 Gr B7 and ASTM A194 Gr. 2H. Other accessories shall be zinc plated.

2.2.2 3 way 2 valve manifolds for pressure gauges

2.2.2.1 The manifold shall be designed for use with pressure gauges with block and bleed valves. The manifold body shall be either straight or angle type as specified in the data sheet.

2.2.2.2 The valve shall be a needle type.

2.2.2.3 The body material shall be 316L Stainless Steel, unless otherwise-specified.

2.2.2.4 The minimum cold working pressure rating of the manifold shall be as per Annexure 1 of this specification, unless otherwise specified.

2.2.2.5 The manifold shall have the following connections:

a) The inlet connection shall be %" plain ends with a minimum of 100mm nipple Extension suitable for socket weld or butt weld as per B16.11/ B16.9 as Specified in the job specifications

b) The gauge connection shall be with union nut and tail piece threaded to ½" NPTF.

c) The drain connection shall be ½" NPTF.

2.3 Instrument Air Valves

2.3.1 Instrument Air Isolation Valves (Miniature)

2.3.1.1 The valves shall be full-bore ball type with forged body.

2.3.1.2 Body material shall be 304 Stainless Steel

2.3.1.3 The minimum cold working pressure rating of instrument air isolation valves shall be as Per Annexure 1 of this specification, unless specified otherwise.

2.3.1.4 The end connection shall be1/4" NPTF to ANSI B 1.20.1, unless otherwise specified.

2.3.1.5 End to end dimensions shall be as per ASME B16.10.2000 (latest edition)

2.3.2 Instrument Air Needle Valves (Miniature)

2.3.2.1 The instrument valves shall be globe pattern-needle valves forged/bar stock with inside Screwed bonnet.

2.3.2.2 Body material shall be 304 Stainless Steel.

2.3.2.3 The minimum cold working pressure of Instrument Air Needle valves shall be per

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Annexure I of this specification. Unless otherwise specified.

2.3.2.4 The end connection shall be 1/4" NPTF to ANSI B1.20.1, unless otherwise specified.

2.3.2.5 Flow direction shall be marked on the body.

2.3.3 All instrument valves in oxygen and chloride service shall be thoroughly degreased using reagents like trichloroethylene or carbon tetrachloride. End connection shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

3.0 NAME PLATE

Following information shall be punched on the body of each of these items;

a) Material of construction to the same standards as in purchaser's data sheets.
b) Cold working pressure of each item to the same standards as in purchaser's data sheets.
c) Manufacturer's identification and model number.
d) Flow direction (if applicable)
e) Material of construction.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at vendor's works, in line with the inspection test plan for instrument valve and manifolds.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:
a) Material test certificates as per clause 3.1B of EN 10204 for body and bonnet and as per clause 2.2 for other parts.
b) Dimensional test report.
c) Pressure test report as per clause 4.3 of this specification.
d) Hydrostatic proof and burst tests as per MSS-SP-99 for each design and size of valve.

4.3 Pressure Test Requirements

4.3.1 Each valve and manifold shall be subjected to hydrostatic pressure test at ambient temperature for both seat and shell leakage at test pressures given in Annexure-I of this specification. During and after the hydrostatic test there shall not be any visible leakage.

4.3.2 Pneumatic Test

Each valve and manifold shall be subjected to pneumatic test for both shell and seat leakage at 7.0 kg/cm-g with testing medium as air at ambient temperature. There shall not be any visible leakage when immersed in water or coated with a leak detection solution.

4.4 Witness Inspection

4.4.1 All valves and manifolds shall be offered for pre-dispatch inspection for following, as a Minimum:

a) Physical dimensional verification and workmanship.
b) Pressure test as per clause 4.3 of this specification on representative samples.
c) Review of all certificates and test reports as indicated in clause4.2 of this specification.

4.4.2 In the event, when witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

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5.0 SHIPPING

5.1 The threads/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.2 All instrument valves and manifolds in oxygen and chloride service shall be separately packed along with a certificated indicating 'CERTIFED FOR OXYGEN/CHLORINE SERVICE' as applicable

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per this specification and shall attach only those documents and information, which is specifically- indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be summarily rejected.

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Annexure-I

HYDROSTATIC TEST PRESSURES FOR INSTRUMENT VALVES AND MANIFOLDS

Sr. No.	Item	Line Pressure Class	Minimum Cold working pressure(CWP)	Hydrostatic Test Pressure For	
				Seat leakage Test	Shell Leakage Test
1	Instrument valve (Miniature)	≤ 600#	102 kg/cm^2 g	112 kg/cm^2 g	153 kg/cm^2 g
		≥900# to ≤1500#	253 kg/ cm^2 g	278 kg/cm^2 g	383 kg/cm^2 g
2	Instrument valve (Manifolds)	≤ 600#	102 kg/cm^2 g	112 kg/cm^2 g	153 kg/cm^2 g
		≥900# to ≤1500#	253 kg/ cm^2 g	278 kg/cm^2 g	383 kg/cm^2 g
3	Instrument Air Isolation Valve		27 kg/cm^2 g	30 kg/cm^2 g	41 kg/cm^2 g
4	Instrument Air Needle Valves		27 kg/cm^2 g	30 kg/cm^2 g	41 kg/cm^2 g

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GENERAL SPECIFICATION

FOR

JUNCTION BOXES AND CABLE GLANDS

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CONTENTS

1.0 GENERAL

2.0 DESIGNS AND CONSTRUCTION

3.0 NAME PLATE

4.0 INSPECTION AND TESTING

5.0 SHIPPING

6.0 REJECTION

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for design, materials, nameplate marking, testing and shipping of junction boxes and cable glands which include the following types:

a) Electrical junction boxes
b) Pneumatic junction boxes
c) Cable glands (whenever specified)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the purchaser's enquiry;

ANSI/ASME	American National Standards Institute *I* American Society.of Mechanical Engineers.
B 1.20.1	Pipe Threads, General Purpose (Inch).
EN 10204	Inspection Documents for Metallic Products
IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere
IEC-60529	Degrees of Protection Provided by Enclosures. (IP Code)
IS-5	Colours for ready mixed paints and enamels.
IS-13947	Specification for Low Voltage Switchgear and Control gear.
IS-2148	Electrical Apparatus for Explosive Gas Atmospheres – Increased safety Enclosures ‘e'.

1.1.3 In the event of any conflict between this specification, data sheets, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification
d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached along with the material requisition.

1.2.2 Deviation on technical requirements shall not be entertained.

1.2.3 Whenever a detailed technical offer is required, vendor's quotation shall include the following;

a) Compliance to the specifications.

b) Whenever the requirement of a detailed specification sheet for each item is specifically indicated, the specification sheet shall provide information regarding type, construction material. Size and number of cable entries etc. The material specifications and unit of measurement for various parts in vendor's specification sheets shall be to the same standards as those indicated In purchaser's data sheets.

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c) Drawing for each type of junction box with dimensional details (in millimetres) showing the terminal, entries arrangement, mounting details etc.

d) Proven references for each offered model in line with clause 1.2.4 of this specification whenever specifically indicated in purchaser's specification.

e) Copy of certificate for approval of increased safety junction boxes, adapter, plug and cable glands from local statutory authority as applicable such as Chief Controller of Explosive (CCE), Nagpur or Director General Mines Safety in India along with:

i) Test certificate from recognised testing house like CMRI/ERTL etc. as per relevant Indian Standard for all Indian manufactured items or items requiring DGMS approval.

ii) Certificate of conformity from agencies like LICE, BASEEI:.A, PTB, CSA, UL etc. for compliance to ATEX or any recognised standard for items manufactured outside India.

f) Catalogues in English giving detailed technical specifications, model decoding details and other related information for each type of junction box and cable gland covered in the bid.

1.2.4 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.5 All documentation submitted by the vendor including their drawings, installation manual etc shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies, shall be sent to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data and installation manual submitted by the vendor after placement of purchase order shall include the following, as a minimum;

a) Specification sheet for each junction box and its accessories like cable glands etc.

b) Certified drawing sheets for each junction box and its accessories, which shall provide dimensional details, internal constructional details (general arrangement details) and material of construction.

c) Copy of type test certificates.

d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.

e) Installation procedure for junction boxes and its accessories

2.0 DESIGN AND CONSTRUCTION

2.1 Junction Boxes

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2.1.1 Junction boxes shall be either of the following type as specified in data sheets.

a) Weather proof junction boxes.
b) Weather proof and increased safety junction boxes.

No other type of junction boxes shall be offered ,*I* supplied unless specifically indicated otherwise.

2.1.2 Unless otherwise specified, the enclosure shall conform to the following standards:

Weatherproof housing : IP 65 to IEC-60529/IS-13947

Housing : EEx (e) as per IEC-60079/IS-2148.

2.1.3 Number of entries and their location shall be as per data sheets. Junction boxes with top entries shall not be offered. The size of cable entries shall be as per the cable sizes indicated in the data sheet.

2.1.4 Multi-pair junction boxes shall be provided with telephone sockets and plugs for connection of hand-powered telephone set.

2.1.5 Electrical Junction Boxes

a) The material of construction of electrical junction boxes shall be SS316L of minimum 2 mm thick.

a) b) Weather proof junction box shall have hinged type door with Silicon/EPDM or better gasket, which shall be fixed to the box by plated countersunk screws. JB's should be covered with Aluminum tapes at its periphery to prevent water ingress after final commissioning.

c) Increased safety junction box shall have detachable cover, which shall be fixed to the box by means of cadmium plated triangular head/hexagonal head screws.

d) Increased safety junction boxes for signal, alarm and control shall have the following warning engraved/integrally cast on the cover; "Isolate power supply elsewhere before opening"

e) Power junction boxes (junction boxes for power supply cable / distribution) shall have either the warning cast or shall have warning plate with following marking;

"Isolate power supply elsewhere before opening".

Unless otherwise indicated in the job specification, power junction boxes shall be suitable for incoming armoured power cable up to 150 sq.mm conductor size.

f) Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.

g) All terminals used In signal, alarm and control junction boxes shall be suitable for accepting minimum 2.5sq.mm copper conductor, in general.

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h) Terminal used in power junction boxes / power supply distribution box shall be suitable for accepting conductor size of 4 Sq. mm to up to 120 sq. mm. Exact requirement shall be specified in job specification. Higher size of terminals shall be provided when indicated. Bus bar terminals shall be provided for conductor size 50 sq.mm and above. Suitable size of lugs shall be provided to suit conductor size specified.

i) Each junction shall have minimum of 30% spare terminal of those actually required to be utilised. Unless higher number of terminal are specified in the purchaser's data sheet, the number of terminals for various types of junction boxes shall be as follows;

24 Nos for 6 pair junction box.
48 Nos. for 12 pair junction box
36 Nos for 6 triad junction box.
48 Nos. for 8 triad junction box.

j) Terminals shall be identified as per the type of input signal indicated in data sheets e.g all terminals for intrinsically safe inputs shall be blue while others shall be grey in colour.

k) Junction boxes shall be provided with external earthing lugs.

l) Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines;

i) 50 to 60 mm gap between terminals and sides of box parallel to terminal strip for up to 50 terminals and additional 25 mm for each additional 25 terminals.

ii) 100 to 120 mm between two terminal strips for upto 50 terminals and additional 25 mm for each additional 25 terminals.

iii) Bottom/top of terminal shall not be less than 100 mm from bottom / top of the junction box.

2.1.6 Pneumatic Junction Boxes

a) Pneumatic junction boxes shall be made of 3 mm thick hot rolled steel, They shall have necessary Silicon/EPDM or better gasket between door and body. Door shall be flush with the box and shall be hinged type and provided with wing nuts.

b) Single tube entries shall be suitable for 6 mm 0.0 copper tube with bulk head fittings. Multi tube bundle entry shall be suitable for the data furnished in data sheets.

2.1.7 Painting (if applicable)

a) Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

b) Two coats or lead-free base primer and two final coats of lead free epoxy based paint shall be applied both for interior and exterior surfaces.

c) The colour shall be as specified in data sheets. However, following philosophy shall be followed, in general:

(i) Light blue for all intrinsically safe junction boxes.

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(ii) Light grey for all others

2.2 Cable glands, Plugs and Reducers/Adaptors

2.2.1 Cable glands shall be supplied by vendor whenever specified.

2.2.2 Cable glands shall be double compression type for use with armoured cables.

2.2.3 The cable glands shall be of SS316, as a minimum.

2.2.4 The cable glands shall be weatherproof. Whenever specified they shall also be increased safety and certificate for the specified electrical area classification specified in the data sheets.

2.2.5 Cable glands shall be supplied to suit the cable dimensions indicated along with tolerances in data sheets. Various components like rubber ring, metallic ring, metallic cone and the outer / inner nuts etc. shall be capable of adjusting to the indicated tolerances of cable dimensions.

2.2.6 Reducers / adapters shall be supplied as per details indicated in data sheets. They shall be SS316 as a minimum. These shall also be weatherproof and *I* or increased safety wherever specified and certified for the electrical area classification specified in the data sheets.

2.2.7 Plugs shall be provided as specified elsewhere.

2.2.8 Plugs shall be certified increased safety when used with increased safety junction boxes.

3.0 NAMEPLATE

3.1 Each junction box shall have an anodised aluminium nameplate permanently fixed to it at a visible place furnishing the following information;

a) Tag number as per purchaser's data sheet.
b) Manufacturer's serial number and model number.

c) Manufacturer's name *i* trade mark.

d) Stamp of certifying agency with certificate number.

e) Electrical area classification.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works in line with inspection test plan for junction boxes and cable glands.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

a) Material test certificates as per clause 2.2 of EN 10204

b) Pressure test on castings for £1ameproofjunction boxes.

c) Dimensional test report.

d) High voltage and insulation resistance test report.

e) Air leak test report on pneumatic junction boxes.

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f) Certificate from statutory body for suitability to install in specified hazardous area.

4.3 Witness Inspection

4.3.1 All Junction boxes, cable glands and other accessories shall be offered for pre-dispatch inspection for the following. as a minimum:

a) Physical dimensional verification and workmanship on representative samples.

b) High voltage and Insulation resistance test on representative samples.

c) Air leak test report on representative samples of pneumatic junction boxes.

d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.3.2 In the event when witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted for scrutiny of purchaser.

5.0 SHIPPING

5.1 All threaded openings shall he suitably protected to prevent entry of foreign material.

5.2 All threaded components shall be protected with plastic caps to prevent damage of threads.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be-summarily rejected.

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STANDARD SPECIFICATION

FOR

DISTRIBUTED CONTROL SYSTEM & PLC SYSTEM

1	28.04.2021	28.04.2021	**Client's comments incorporated**	**AKS**	**SG**	**RKR**
0	07.09.2020	07.09.2020	**For Tender**	**SG**	**RKR**	**SKT**
REV	**REV DATE**	**EFF DATE**	**PURPOSE**	**PREPD**	**REVWD**	**APPD**

Abbreviations:

AC	Alternating Current
APC	Advanced Process Control
CFF	Common File Format
CPU	Central Processing System
CRT	Cathode Ray Tube
DA	Data Access
DC	Direct Current
DD	Device Description
DCS	Distributed Control System
DVD	Digital Versatile Disc
EDDL	Enhanced Device Descriptive Language
EPROM	Erasable Programmable Memory
EMI	Electromagnetic Interference
ESD	Emergency Shutdown System
FAT	Factory Acceptance Test
FDT / DTM	Field Device Tool / Device Tool Manager
FF	Foundation Fieldbus
FMEDA	Failure modes, Effects and Diagnostic Analysis
GPS	Global Position System
HART	Highly Addressable Remote Transducer
HDA	Historical Data Access
HI	Foundation Fieldbus low speed (31.25kbps) loop powered bus
HSE	High Speed Ethernet
HVAC	Heating, Ventilation and Air Conditioning
HW	Hardware
HWC	Hardware Console
I/O	Input / Output
IAMS	Instrument Asset Management System
LAN	Local Area Network
LAS	Link Active Scheduler
LCD	Liquid Crystal Diode
MCC	Motor Control Centre
MOV	Motor Operated Valve

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MTTF	Mean Time to Failure
MTTR	Mean Time to Repair
OIS	Operator Interface System
OLE	Object Linking and Embedding
OPC	OLE for Process Control
PC	Personnel Computer
P&ID	Piping and Instrumentation Drawing
PID	Proportional, Integral and Derivative
PLC	Programmable Logic Controller
QUAD	Quadruplet
RAID	Redundant array of independent discs
RAM	Random Access Memory
RDBMS	Relational Database Management System
RFI	Radio Frequency Interference
ROM	Read Only Memory
SAT	Site Acceptance Test
SCSI	Small Computer System Interface
SER	Sequence of Event Recorder
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SPD	Surge Protection Device
SQL	Structured Query Language
TCP / IP	Transmission Control Protocol / Internet Protocol
TFT	Thin Film Transistor
UHF	Ultra High Frequency
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus
VDU	Video Display Unit
VFD	Vertical Field Device
VHF	Very High Frequency
WAN	Wide Area Network

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PART – I

GENERAL SPECIFICATIONS OF DISTRIBUTED CONTROL SYSTEM

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GENERAL

1.1 SCOPE

1.1.1 This specification, together with the data sheets attached herewith defines the minimum functional requirements for the design; hardware, software and firmware specifications, nameplate marking, testing and shipping of Distributed Control System designed for reliable effective and optimum control and monitoring of a process plant .

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:-

AG-181	Foundation Fieldbus System Engineering Guidelines	
EN 10204	Inspection Documents for Metallic Products.	
EN 50039	Intrinsically Safe Electrical System	
IEC 60079	Electrical Apparatus for Explosive Gas Atmosphere.	
IEC 60529	Degree of Production Provided by Enclosures.	
IEC 60617	Graphic Symbols for Electronic Diagram	
IEE 4	Guidelines for Documentation of Computer Software for Real time and Interactive Systems	
FF – 569	Foundation Fieldbus Host interoperability support test procedure	
FF – 816	Foundation Fieldbus Specification 31.25 Kbits/s Physical Layer Profile	
FF – 890~894	Foundation Fieldbus Specification Function Block Application process	
ANSI / ISA TR 99.00.01	Security Technologies for Manufacturing and control system	
ANSI / ISA TR 99.00.02	Integrating Electronic Security into the manufacturing and control systems environment	
EEMUA 191	Alarm System, a guide to design, management and procurement	
IS-3043	Code of Practice for Earthing	
IS 13947	Degree of Protection provided by Enclosures for low voltage switchgear and control gear	
IS 13948	Flameproof Enclosures of Electrical Apparatus	
ISA	S 71.01	Environmental Conditions for process Management and Control System : Temperature and Humidity
	S 71.04	Environmental Conditions for Process Measurement and control System: Airborne Contaminants
	S 5.2	Binary Logic Diagrams for Process Operations

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S 5.3 Graphic Symbols for Distributed Control System Display Instrumentation, Logic and Computer System.

S 5.4 Instrument Loop Diagram

S 5.5 Graphic Symbols for Process Display

S 18.1 Annunciator Sequences and Specifications

S 50.2 Fieldbus Standard for use in Industrial Control System

IEC 61000-4-3 Electromagnetic Compatibility (EMC) – Testing and Measurement Techniques – Radiated Radio Frequency, Electromagnetic Field Immunity Test.

IEC-61000-4-4 Electromagnetic Capability (EMC) – Testing and measurement techniques – Electrical fast transients / bust immunity test

IEC-61000-4-5 Electromagnetic Compatibility (EMC) – Testing and Measurement techniques – Surge immunity test

IEC-61000-6-2 Electromagnetic Compatibility (EMC) – Generic Standards – Immunity for Industrial Environments

IEEE 472 Electrical Surge protection

IEC-60584 Thermocouple (Tolerances)

IEC-60751 Industrial Platinum Resistance Temperature Sensors

ANSI MC 96.1 Temperature Measurement Thermocouples

IEEE 802.3 Telecommunication and Information exchange between Systems – Local and Metropolitan Area networks – specific requirements – Part 3 : Carrier Sense Multiple access with collisions Detection (CSMA / CD) Access Method and Physical layer specification.

IEC 61508 Functional Safety of Electrical / Electronic / Programmable Electronic Safety related Systems.

IEC 61131 Programmable Controllers

IEC 61511 Functional Safety – Instrumented System for Process Industry Sector IEC 61158 Fieldbus Standard for use in Industrial Control Systems.

1.1.3 In the event of any conflict existing between this specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Design Basis / Statutory regulations

b) Data Sheets

c) Standard specifications

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d) Codes and standards

1.1.4 In addition to meeting purchaser's specifications in totality, vendor's extent of responsibility shall also include the following:

a) Purchaser's data sheet specify the minimum acceptable functional requirements for the control system. It shall be vendor's responsibility to select proper hardware, software and firmware to meet the specified functional requirements.

b) Purchaser's data sheets specify the scan time / cycle time / response time / macro cycle time and loading requirements. Vendor shall be responsible for sizing and selecting their standard product i.e. hardware, software and firmware to meet the requirements specified in the purchaser's data sheets.

c) Selection of proper and adequate hardware, software and firmware to meet architectural requirements specified in the purchaser's specifications, keeping the integrity of functional blocks specified in the configuration diagram attached with the material requisition.

d) Segment design based on requirements specified in the job specifications and its validation during site testing and pre-commissioning.

e) Adequacy of Bill of material selected to meet purchaser's requirements. Vendor to note that bill of material shall not be verified by the purchaser during evaluation stage. Any hardware, software and firmware required to meet the purchaser's specified requirements shall be provided by the vendor without any implication.

f) Providing adequate mandatory spares including consumable spares as specified in the purchaser's specifications. Vendor shall be responsible to meet mandatory spare requirements specified by the purchaser.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Detailed specification sheets for each sub-system. The specification sheet shall provide information regarding hardware specifications, software specifications, redundancy requirements, capacity, power consumption etc. of the distributed control system and its accessories. The material specifications and unit of measurement for various items in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) System security features and design details

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d) Proven references for each offered model in line with clause 1.2.4 of this specification whenever specifically indicated in the purchaser's specifications.

e) A copy of approval for flameproof enclosure, intrinsic safety etc whenever specified, from local statutory authority, as applicable, like Petroleum and Explosive Safety Organisation (PESO) / Chief Controller of Explosives (CCE), Nagpur or Director General of Mines Safety (DGMS) in India along with;

i) Test certificate from recognised house CIMFR (Central Institute of Mines & Fuel Research) / ERTL (Electronics Research and Test Laboratory) etc. for specified protection class as per relevant Indian Standard for all Indian manufactured equipments or for equipments requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, BASEAFA, PTB, CSA, UL etc., for compliance to ATEX or other recognised standards for all equipments manufactured outside India.

f) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate from the specified requirement, they must include a list of deviations item wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

G) Catalogues giving detailed technical specifications, model decoding details and other related information for each item / sub-system covered in the bid.

1.2.3 Vendor shall offer only their standard proven product i.e. hardware, system software and firmware, which shall be configured to meet the functional requirements specified in the material requisition. Whenever any bought out item is offered to meet the configurational requirements specified in the material requisition, it shall also meet the functional requirements. Moreover, the equipment being offered / supplied shall be of latest proven version available in the current manufacturing range and meeting the requirements specified in clause 1.2.4 of this standard specification.

1.2.4 The system hardware, software and firmware as offered, shall be field proven and should have been operating satisfactorily for a period of minimum 4000 hours continuously on the bid due date in the validly similar size and application specified in the purchaser's data sheet. Items with prototype design or items not meeting provenness criteria specified above shall not be offered or supplied.

1.2.5 The detailed scope of work, specific job requirements, exclusions, deviations, additions etc. shall be indicated in the job specifications which shall be part of material requisition.

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1.2.6 Whenever specified, vendor shall furnish tested values of failure rates, probability of failure on demand and test intervals for safety integrity level analysis.

1.2.7 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals shall be in English language only.

1.2.8 Vendor shall also quote for the following;

a) Two year's operational spares for each sub-system and their accessories which shall include the following as a minimum;

i) All type of electronic modules e.g I/O modules, processor modules, communication modules, memory modules, disc controller module, power supply modules etc.

ii) All type of auxiliary items e.g. barriers / isolators, hardwired instruments, annunciator modules, receiver switches, trip amplifiers, temperature element converters etc.

iii) Switches, lamps, fuses, connectors, terminals, pre-fabricated cables, circuit breaker, relays etc.

iv) Video display units, keyboards, disc drives, PC's, network items (e.g. switches, hubs etc.) etc.

b) Any special tools and test equipments needed for the maintenance of DCS, PLC's and other items being offered by vendor. This shall also include test equipments for fieldbus testing and configuration like fieldbus tester, fieldbus configurator etc. wherever specified in the data sheets. Vendor must confirm in their offer if no special tools or test equipments are needed for maintenance other than those specifically indicated in purchaser's data sheet.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of producibles, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design manuals, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase order shall include the following, as a minimum:

a) Specification sheet for each sub-system, auxiliary instrument and bought out item.

b) Certified drawings for complete system including;

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i) GA drawings for panels, cabinets, marshalling racks, hardwired consoles, operator / engineering console etc with complete dimensions details, internal construction and weight in kilograms.

ii) Control room e.g. console room, rack room and engineering room layout with all dimensions in millimeters.

iii) Channel base drawing for console room, rack room and engineering room.

iv) Input / output assignment

v) Fieldbus segment drawing

vi) Loop wiring diagram

vii) Power supply distribution single line diagram

viii) Dynamic graphic diagrams

ix) System grounding drawing

c) Design manuals and functional design specifications which shall include hardware design manual, software design manual and special software specifications.

d) Copy of type test certificates.

e) Copy of test certificates for all tests indicated in Part II of this specification.

f) Installation manual containing installation procedure for distributed control system and other items covered in the material requisition.

g) Power-on, start-up and internal testing procedures.

h) Software debugging and system configuration procedures

i) Calibration and maintenance manual containing maintenance procedures including replacement of parts, application modification etc.

j) Any other drawings and documents specifically indicated in job vendor data requirement enclosed with the material requisition.

2.0 DEFINITIONS

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The various terms used in this specification are defined as follows:

2.1 Distributed control system

The class of control systems which in addition to maintaining and managing data bases in distributed fashion also executes the stated control functions and permits transmission of control, measurement and operating information to and from a single or a plurality of user specified locations connected via a communication sub-system.

2.2 Programmable Logic Controller

The class of control systems which can be programmed to execute plant shutdown and / or interlock / sequence logics to the specified safety integrity levels.

2.3 Accessible

A system feature that is viewable by and interactive with the operator and allows the operator to perform user permissible control action e.g. set point change, auto-manual transfers or on-off actions.

2.4 Assignable

A system feature that permits an operator to direct a signal from one device to another without the need for change in wiring, either by means of switches or via other data entry devices like key board commands to the system.

2.5 Configurable

A system feature that permits selection through entry of key board commands or commands from other data entry devices of basic structure and characteristics of a device or system, such as control algorithm, display format or I/O termination.

2.6 I/O

Input / Output with respect to process / operator.

2.7 Fieldbus

Fieldbus is a digital two-way multi drop communications link among intelligent measurement and control devices.

2.8 System Size

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System size shall be defined as maximum number of process inputs or tags those can be connected to the system and viewable from any one of the VDUs of an operating console in all hierarchical displays without changing the configuration or without operator interaction considering;

a) all inputs as close loops

b) all inputs as open loops

2.9 Operator console

Operator console is the operator's main plant interface device via which operator can view, monitor and control the plant and can give instructions to peripherals to execute commands, and shall have protective access to configure and maintain the system.

2.10 Engineering console

Engineering console shall be the engineer's main interface device via which engineer can configure and maintain the system, and shall have protective access to monitor and control the plant, give instructions to peripherals to execute commands,.

2.11 Local Level

All those sub-systems, which directly interface with field devices shall be referred to as local level.

2.12 Central Level

Operator consoles and Engineering Console, which present data acquired from local level devices shall be referred as Central Level.

2.13 Data base

Database shall be defined as the information stored temporarily or permanently in the system which can be accessed by various programs to meet all its functional requirements.

2.14 Global Database

Global database is defined as the database that can be accessed by two or more non-nested modules of a program without being explicitly passed as parameters between the modules.

2.15 Loop integrity

A system shall be said to have loop integrity if the failure of one component in the system/ sub-system does not affect more than one loop.

2.16 Interchangeability

System/sub-systems shall be said to have full interchangeability if the functions and information available on one system/sub-system shall also be available on the other in totality.

2.17 System Loading

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System loading for a sub-station is defined as the percentage of time a sub-system spends in carrying out various activities referred to the use of memory, CPU time and communication capacity in the worst case of high sub-system operation out of the designed / designated cycle time of the sub-system.

2.18 Bus-degradation

Bus-degradation shall be defined as a change in the system performance from the specified one measured in terms of display update rate while loading the communication sub-system from 10 through 100 percent.

2.19 Redundancy

A system component shall be termed as redundant if it takes over automatically the operation in the event of the failure of the main component without causing any interruption in the system and upsetting the process. The repaired or replaced device shall be brought in-line only through operator action without upsetting system operation.

2.20 Switchover Time

Time required for a back up instrument / system to come on-line automatically in case of the failure of the main instrument / system.

2.21 Processor Cycle Time (Tpc)

Processor cycle time is the measure of the processing speed of a processor and is user selectable from the pre-defined discrete values. Processor cycle time for a sub-systems shall be defined as follows:-

a) Controller Sub-system

Processor cycle time for controller sub-system shall be defined as the total time taken by the control processor to read inputs supplied by input module, execute control algorithm and write the outputs for the output module.

b) Data acquisition sub-system

Processor cycle time for data acquisition sub system shall be defined as the total time taken by the processor to read inputs supplied by input processor, perform calculations for all the open loops configured within the data acquisition sub-system and make data available to the communication sub-system.

c) Programmable logic controller

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Processor cycle time for programmable logic controller shall be defined as the total time taken by the processor to read input supplied by input module, execute all computations (analog as well as logic as configured) and write the outputs for the output module.

2.22 Scan time (ts)

Scan time is the end-to-end response time of a sub-system and shall be defined as follows:
For fieldbus based system refer clause 2.25 for close loop response time.

a) Close-Loops

Scan time for a close-loop shall be defined as the total time taken by a sub-system e.g. controller and data acquisition sub-system to read inputs from the input terminal, process input, perform control algorithms, update control output and write output at the output terminal for all the loops configured within the sub-system.

b) Open-Loops

Scan time for an open loop shall be defined as the total time taken by a sub-system e.g controller and data acquisition sub-system to read input from input terminal, process input, perform calculations and write output for communication sub-system to pick-up the same for all the open loops configured within the sub-system e.g. controller and data acquisition sub system.

c) Logic Loops

The scan time for a logic loop shall be defined as the total time taken by a sub-system e.g. programmable logic controller to read input from the input terminal, process input, execute logic, updating logic output and write output at the output terminal for all the logics configured within the subsystem.

2.23 Control Cycle time

Control cycle time is defined as the total cycle time taken by the supervisory computer to read data from control system, perform calculations and update the set point of a regulatory loop configured in the control system e.g. controller and data acquisition sub-system.

2.24 Macro Cycle

Macro cycle is defined as a single iteration of a schedule within a fieldbus device.

2.25 Macro Cycle Time

Macro Cycle time or execution time is defined as the amount of time taken by a fieldbus device to complete the macro cycle. Macro cycle time can refer to a single field device, the LAS or a complete segment made up of multiple devices.

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2.26 Loop Response Time

Loop response time for fieldbus based system shall be defined as the total time required to perform the following functions in each of the specified loop configuration;

a) Control function in transmitter

Execute the analog input and control (PID) function block in transmitter, publish the output on the fieldbus, receive the controller out value and perform analog output function block in final control element.

b) Control function in final control element

Execute the analog input function block in the transmitter, publish the process variable on the fieldbus, receive the process variable and execute the control algorithm (PID) and analog output function block in the final control element.

c) Control Function in DCS

Execute the analog input function block in the transmitter, publish the process variable at DCS, execute the control algorithm (PID) in DCS, publish the controller output value on the fieldbus and execute the analog output function block in the final control element.

2.27 Display update rate

Display update rate shall be defined as the time taken by the system to display the information present at the system input terminals updated on the current display on the VDU of an operator console

2.28 Call-up time

Call up time shall be defined as the time taken by the system to display a particular display/data on the VDU after getting the corresponding command from the operator.

2.29 User's memory

Free memory space available after utilisation of memory required for system operation, configuration and implementation of application and other system related functions for implementation of user defined specific programs such as plant calculations, process optimization or MIS (like free formatting of certain logs). The programs shall either be written in high level language or system specific language.

2.30 Event

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An event shall be defined as any action taken by the operator via operator keyboard or switches on hardwired console like change of set point, change of control mode, start/stop of motor, open/close of shut down valves, alarm acknowledge etc.

2.31 Sequence of Event (SOE)

Arranging events in the sequence of their occurrence in time with a specified time resolution by a program is defined as sequence of event.

2.32 Sequence of Event Recorder (SOR)

System of sub-system which presents and / or records the events in the sequence of their occurrence in time with a specified time resolution utilizing its hardware and software capabilities is termed as sequence of event recorder.

2.33 Real time trend

Real time trend shall be defined as a continuously progressing graphical record showing continuously updated parameter with most recent value and a past record of minimum of 10 minutes without depressing any additional key for moving backward in time.

2.34 Windowing

Ability of software program to break the console screen i.e. video display unit into simultaneous or overlapping zones with separate presentations at the same time.

2.35 Interoperability

Interoperability is the capability to substitute a device from one manufacturer with that of another manufacturer as a fieldbus network without loss of any functionality or degree of integration.

2.36 Acyclic Period

Acyclic period is defined as the portion of communication cycle time during which information other than publish / subscribe data is transmitted.

2.37 Capabilities File

A capabilities file describes the communication objects in a fieldbus device. A configuration file can use DD files and capabilities files to configure a fieldbus system without having the fieldbus device active.

2.38 Link Active Scheduler (LAS)

LAS is defined as a deterministic centralised bus scheduler that maintains a list of transmission times for all data buffers in all devices that need to be cyclically transmitted.

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2.39 Link Master

Any device containing the link active scheduler personality that can control communication of a H1 fieldbus segment is designated as link master.

2.40 Segment

Segment is defined as a network or part of network that serves as the primary communication highway for the connected field-bus devices.

2.41 Resource Block (RB)

Resource block describes the characteristics of a fieldbus device such as device name, manufacturer and its serial number. Resource block is unique for a device.

2.42 Vertical Communication Relationship (VCR)

VCR is defined as the pre-configured application layer channels which provide the data transfer between applications. Publisher – subscriber, client – server and report distribution are three VCRs in foundation fieldbus.

2.43 Link Objects

Link object contains information to link function block input / output parameters in the same device and between different devices.

2.44 Plant Control Network

Communication network within a plant that has control information circulating between various plant units or processing locations.

2.45 Plant Information Network

High-level communication network which serves various user's within a plant and transfer information for the purpose of unit / plant monitoring. This network is different than control network and is generally realised using open communication protocol network e.g. OPC etc.

2.46 OPC node

OPC node is any node in the network that provides OPC interfaces consistent with OPC data access, OPC alarm and event and OPC historical data access interface specifications certified against OPC compliance and interoperability test specification.

2.47 Computer Integrated Manufacturing (CIM)

Computer integrated manufacturing shall be defined as the integration of process, plant and business operations made possible through information network.

3.0 SPARES PHILOSOPHY

3.1 The system including programmable logic controller, alarm information management system, sequence of event recorder, hardwired instruments etc. shall meet the following spare philosophy. This

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philosophy shall also be applicable for items like field-bus accessories, barriers, relays, terminals, lamps, push buttons etc.

3.1.1 Mandatory Spares

Vendor shall include following mandatory spares in their scope of supply;

3.1.1.1 Installed Engineering Spares

Installed engineering spares shall be provided in each sub-system for each type of module to enhance the specified system functional requirements by 20%. The basic of offering installed engineering spares shall include;

a) For a system with conventional and / or smart input / output, 20% spare input / output of each type shall be considered for calculating I/O modules and all other related accessories.

b) For a system with fieldbus input / output, 20% spare segments of each type of field-bus type (foundation fieldbus, profibus etc.) shall be considered for calculating I/O modules, power supply modules and all other related accessories. When only input / outputs are indicated instead of field-bus segments, the installed spare philosophy as specified in 3.1.1.1 (a) shall be followed.

c) For all serial input / outputs to the system 20% spare serial I/O channels of each type of serial input / output shall be provided.

d) A minimum of one spare I/O module of each type as offered to meet type of inputs / outputs specified in the material requisition.

e) 20% spare accessories like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals etc.

f) A minimum of one number of input / output module and accessories of, each type such as analog input / output, discrete (contact) input / output, pulse input, serial input / output, foundation fieldbus / profibus PA input / output modules (in case of fieldbus based system) temperature input shall be provided irrespective of those required as per 3.1.1.1(d) as engineering spare.

g) The engineering spares shall be wired up to the field cable interface and shall be in ready-to-operate condition when field cable is connected to spare assigned terminals.

h) Spare pairs of the incoming cables shall be terminated on spare terminals in the marshalling / barrier cabinets as applicable.

i) The system shall be fully engineered considering 20% installed engineering spares

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including processor loading.

3.1.1.2 Spare Space Requirement

In addition to installed engineering spares specified in Clause 3.1.1.1 of this specification, the system shall be provided with following spare space;

a) The controller and data acquisition racks shall have 10% usable spare space for installing additional I/O and field-bus segment modules in future. However, the control and data acquisition processor shall have additional 10% capacity to handle these I/O's and field-bus segment. In addition, internal wiring for the same shall be completed up to I/O terminals.

b) Each operator console shall contain 10% usable spare group and related display capability in addition to as specified in para 3.1.1.1 of this specification.

c) The system shall have capability to extend its historical trending, logging and user's memory by 20% to meet future expansion with/without adding additional memory modules.

d) I/O racks of programmable logic controller shall have 10% usable spare space for installing additional I/O cards of each type in future. However internal wiring for the same shall be connected up to the I/O terminals.

e) Processor system of programmable logic controller shall have capability to execute additional 20% logics.

f) The communication sub-system shall have sufficient capacity to handle additional data contributed by addition of 20% I/O / segments over and above installed engineering spares

g) Usable spare space in panels and cabinets to install 10% spare hardwired items like barriers, trip amplifiers, receiver switches, panel mounted instrument, relays etc. in future.

3.1.1.3 Spare Memory Requirement

a) The system shall be provided with a minimum of 40% spare memory capacity, as required for application program and data base to meet specified functional requirements.

b) For field-bus based system, spare memory capacity (and CPU loading) shall be calculated considering all control algorithms being configured in the system and executed at the scan time equal to the specified control loop response time.

c) It shall be possible to extend the memory by at least 20% over and above the actual requirement at a later date.

3.1.1.4 Spare Software Capability

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a) Sufficient additional software capacity shall be available in the system to take care of spares requirement as specified in para 3.1.1.1 and 3.1.1.2(a) to (f) of this specification to meet all functional requirements as per para 5.0 of this specification.

b) Unless specifically indicated otherwise, the offered system shall have software licenses to cover all the tag numbers indicated in the material requisition, including installed engineering spares and spare space indicated in clause 3.1.1.1 and 3.1.1.2 of this specification.

3.1.1.5 Predefined Mandatory Spares

a) Mandatory spares shall be ware-house spares and shall be supplied as loose items.

b) Mandatory spare module of 5% or one module of each type, whichever is higher, must be supplied for each type of modules being used including in consoles.

c) For items like hardwired instruments, assignable recorders, Personnel computers, VDU / video screens, keyboards, disc drives, RAID controller, lamps, network components, barriers, fuses and circuit breakers complete item limited to 5% or minimum one of each type shall be supplied as predefined mandatory spare. But this shall not include hardware like discs, terminals, switches, telephone sets etc.

d) Items like personnel computers, operator consoles servers, engineering consoles etc. where complete item needs replacement instead of individual modules, complete unit shall be supplied as mandatory spares in line with clause 3.1.1.5(b).

e) Software which need to be separately loaded in the items specified in clause 3.1.1.5(d) above to define the items personality and can't be uploaded from engineering console or any other network device shall be supplied along with additional software.

3.1.1.6 Consumable Spares

Any paper, ribbon, printer heads and ink required for printers, assignable recorders, video copier or any other consumable item shall be supplied along with system required for minimum of six months duration after system acceptance.

3.1.1.7 Commissioning Spares

Unless otherwise specified, vendor shall be responsible to supply all spares which are found necessary to replace failed modules, failed sub-systems, or corrupted / faulty softwares while performing pre-commissioning and commissioning activities.

3.1.2 Two years operational spares

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Two years operational spares shall be as per Clause 1.2.8(a) of this specification and shall be quoted separately.

4.0 SYSTEM CONFIGURATION

The system configuration shall consist of the following major sub-systems:-

4.1 Controller and Data acquisition sub-system

Controller and data acquisition sub-system is the main field interface sub-system and is capable of performing control and data acquisition functions as one integrated sub-system.

Controller and data acquisition sub-system shall interface with field instrumentation like transmitters, process switches and final control elements to monitor and / or control process parameters like flow, temperature, level etc. The sub-system shall include a comprehensive set of control algorithms and auxiliaries to provide close loop control and data monitoring capability of the system.

4.2 Operator interface sub-system

Operator interface sub-system shall consist of one or more operator consoles for monitoring and controlling process parameters and performing other process related functions.

4.3 Communication sub-system

Communication sub-system interconnects various sub-systems over which they can communicate with each other to meet all functional requirements.

4.4 Engineer interface sub-system

Engineer interface sub-system shall consist of an engineering console primarily for tuning, configuring and maintaining the system.

4.5 Supervisory computer sub-system

Supervisory computer, when specified, shall be employed for providing supervisory level plant control, plant and unit optimization and other computer based plant management capabilities. For the Integrated network , each node where history resides should be minimum RAID-5 configuration to ensure maximum availability of history or otherwise separate redundant Servers in RAID-5 configuration and redundant power supply configuration should be provided

4.6 Programmable Logic Controller

Plant start up and safety shutdowns shall be performed by separate programmable logic controller which shall communicate with other sub-systems over the communication sub-system.

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4.7 Foreign Device Interface

Foreign Device like programmable logic controllers, gas chromatographs, analyzer systems, gas turbine systems etc. when specified shall communicate with other subsystems over the communication sub system for plant monitoring and control using foreign device interface. The foreign device interface shall be either dedicated or shall be part of controller data acquisition sub-system as specified in the job requirements.

4.8 OPC Server

OPC Server when specified in this specification is used as synonymous with any server entity on the communication sub-system network which shall allow the user to implement applications, within or outside the system, without providing any special drivers or custom interfaces. OPC server, when specified, shall be used to transfer / receive data to / from applications run in other systems.

4.9 Unit History Node

4.9.1 Unit history node, when specified, shall store the long term historical data of the complete unit and shall interact with central computer system over plant wide network. In addition every history residing node should be minimum RAID-5 configuration.

4.9.2 Unit history modem, when specified shall be a dedicated node and shall be in addition to historical data required for normal plant operation (specified as part of operating interface sub-system).

4.10 Sequence of Event Recorder (SER)

Sequence of event recorder, when specified, shall be a dedicated equipment which shall identify, store and print alarms with the specified time resolution. SER may also transfer data to operator sub-system over communication sub-system.

4.11 Documentation node (DON)

Documentation node, when specified, shall be a node on the information network sub-system and shall store unit documentation.

4.12 Alarm Information and Management Sub-system (AIMS)

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Alarm information and management sub-system when specified, shall be a alarm management package which shall gather alarm information from various sub-systems and shall present the desired meaningful analysed data for information and further analysis.

4.13 Instrument Asset Management System (IAMS)

Instrument asset management sub-system shall acquire store, analysed and present meaningful diagnostic and maintenance related data of field devices for efficient plant maintenance.

4.14 Large Display System (LDS)

Large Display System, when specified, shall consist of one or more large video screens which shall display either operator selected operator console screen or any pre-selected screen on a back projected large video screens as real time basis.

4.15 Hardwired Instrumentation

Hardwired instrumentation shall be provided as a back up to the distributed control system for critical process parameters when specified in the job specification.

4.16 Information Network Sub-system

4.16.1 Information network when specified shall interconnect with various plant wide systems like distributed control system/systems, mainframe computers, personal computers, laboratory information and management system (LIMS) etc over which any information can be exchanged without affecting and disturbing the plant control and operations.

5.0 DESIGN AND CONSTRUCTION

5.1 Design Requirements

5.1.1 The system shall be microprocessor based having functional distribution and data base distribution sub-system wise. The system design shall ensure that;

a) All the functions defined in this specifications are performed in an integrated manner

b) The access to the distributed data base is available system-wide.

This system shall also have networking capability with other systems distributed geographically in the various units of a plant, over a plant wide information network such as Ethernet or other industrially recognised open networks.

5.1.2 The system shall be of modular construction and expandable in future by adding additional modules. The type of modules shall be kept to the minimum possible in order to have interchangeability and low inventory.

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5.1.3 System Availability

a) The system shall be designed 'fault avoidant' as a minimum by selecting high grade components of proven quality and proper design of system electronics.

Redundancy shall be provided, as per this specification as a minimum, to improve the system availability and reliability. Due considerations shall be given to the environmental conditions particularly for field mounted sub- system, if specified in job specifications, during system design.

b) The system shall have a high MTBF value and shall have well proven record of operating in hydrocarbon plants.

c) The system shall be designed with 99.995% or greater availability. The availability shall be defined as follows;

$$\text{Availability} = \frac{\text{Meantime Between Failure (MTTF)}}{\text{MTTF + Mean time to repair (MTTR)}}$$

For the purpose of calculations, consider mean time between repairs as four (4) hours unless the manufacturer recommends higher value for MTTR. It is therefore necessary that;

i) Vendor covers all necessary spare parts in 2 years recommended operational spares which shall be necessary to meet specified MTTR time.

ii) Vendor provides adequate training to owner's personnel and cover all necessary maintenance related topics in their training programmes to ensure specified MTTR time.

5.1.4 Operating Environmental Conditions

5.1.4.1 Environmentally controlled location installation

a) All subsystem of Distributed Control System located in control room, Local Control Room or in Satellite Rack room shall be able to operate satisfactorily from 15°c to 30°c and 20% to 80% non condensing humidity.

b) In addition to above, all such sub-systems shall also be able to operate satisfactorily in case of air conditioning failure with ambient temperature of 50°c and 90% non-condensing humidity until the system safe operating limits are exceeded. The minimum period of continuous operation shall be 48 hours at least once in a month without any damage or degradation of system performance. Vendor, therefore, shall provide continuous temperature monitoring for each enclosed cabinet housing items / equipments generating heat, such as system cabinets, barrier cabinets, relay cabinets etc and also provide alarm for operator

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alert in case the safe operating temperature limits are exceeded. Alarm in the operator consoles shall be available for each cabinet while group alarms shall be provided on hardwired annunciator located on hardware console.

c) Chemical filters have been provided in the incoming air conditioning air to limit the concentration of contaminants below following limits

Contaminants (Corrosive Gases)	Concentration
SOx	<10ppb
Nox	<5ppb
H2S	<5ppb
Cl2	<10ppb
SPM	<0.2gm/m3

All sub-systems and system components shall be suitable for operating continuously in the above mentioned corrosive environments.

d) Vendor shall provide continuous corrosion monitoring system consisting of transmitter with 4 – 20mA output and switch unit with setting as per contaminant level exceeding limits specified in clause 5.1.4.1(c) of this specification. Unless otherwise specified the number of corrosion monitors shall be as follows;

Equipment Type	**Room Type**	**Quantity**
Corrosion Transmitter	Rack Room / Satellite Rack Room	1 No.
Corrosion Switch Unit	Rack Room / Satellite Rack Room	3 Nos.
	Console Room	1 No.
	Engineering Room	1 No.

Continuous corrosion monitoring trend and alarms shall be provided on the operator console while one group alarm shall be provided on the hardwired annunciator located on the hardwired console.

5.1.4.2 Outdoor Installations

a) Sub-systems or system components which are installed outdoor shall be able to continuously operate at ambient temperature of 50°c and non-condensing humidity of 90%.

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b) Unless otherwise specified, all sub-systems or system components installed outdoor shall have corrosive environmental protection coating meeting the environmental classification class G3 as per ISA-S71.04.

5.1.5 Transient, Static and EMI / RFI Protection

5.1.5.1 The system shall be internally protected against system errors and hard ware damage resulting from:

a) Electrical transients on power wiring

b) Electrical transients on signal wiring

c) Connecting and disconnecting devices or removing or inserting printed circuit boards in the Distributed Control System(DCS) and Programmable Logic Controller (PLC) .

5.1.5.2 All sub-systems and system components shall be capable of accepting various signal inputs for its direct use while preventing noise errors due to electromagnetic interference (EMI) or radio frequency interference (RFI) including nearby radio stations, hand held two way radios, electrical storms, solenoids, relays or contactors carrying heavy currents as per levels of Environmental electromagnetic phenomenon defined in IEC-61000-6-2. The system shall have total noise immunity from UHF / VHF radio communication equipments (RFI) and (EMI) noise generating equipments as per IEC-61000-4. The surge withstand capability for input/output modules shall be as per IEEE standard 472.

5.1.5.3 System cables for interplant, inter unit, and others routed in the field, the level of surge immunity required for equipment signal ports shall be increased to level 4 as defined in IEC-61000-4-5 and the system shall operate according to performance criterion B as defined in IEC-61000-6-2.

5.1.6 On-line replacement

5.1.6.1 On-line replacement of electronic module shall be possible in such a way that removal and addition of an I/O module shall be possible and safe without de-energising the system. Furthermore, there shall not be any interruption of the system while replacing a faulty module wherever redundant modules are provided.

5.1.6.2 Apart from system modules, power supply units shall be replaceable on-line without disrupting the process and without effecting the system redundancies.

5.1.7 Electrical Isolation

Galvanic or optical isolation shall be provided for all field signals. The isolation levels shall be as follows;

Analog I/o channel to system ground	:	1500 VAC
Discrete I/o channel to system ground	:	500 VAC

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Isolation shall also be provided between Engineering / operator console/PLC programming terminal and related sub-systems connected to it if there is any possibility of high voltage being transmitted to the sub-systems.

5.1.8 Design Requirements of Equipments in Hazardous Area

5.1.8.1 Unless specifically indicated, the field devices are beyond the scope of this specification. However vendor shall be fully responsible for integrating these devices with their system including compiling and maintaining the engineering data base of these devices and incorporating the data base into the Asset Management System.

5.1.8.2 General Requirements

a) Unless otherwise specified, all instruments in hazardous area shall be intrinsically safe type. Other concepts shall be used when specified.

b) For conventional instrumentation, entity concept shall be used for selecting proper barriers / isolators.

c) Fieldbus segment in classified area may consist only of the type and number of devices which will not cause the segment current draw to exceed the rated barrier / isolator parameters.

5.1.8.3 Fieldbus design in Hazardous Area

The segment design and equipment solution shall be based on the classified area concept used. The functions and entity / safety parameters of power conditioner, safety barriers / isolator, terminators and field devices shall be considered to verify the compliance to the requirements applicable for the specified concept. Following concepts shall be used depending upon the one specified in the job specifications;

a) Entity Concept

Certified entity / safety parameters of each device shall be used to match the entity parameters on entity concept.

b) FISCO

Certified FISCO parameters shall be used and shall be matched like entity parameters. All elements in the hazardous area and their interface module shall be certified FISCO.

c) FNICO

Certified FNICO parameters and equipment shall be used to design loop on the basis of FNICO.

d) Multi barriers

The safety barriers / isolators shall be installed in the field in an increased safety enclosure. The enclosure shall be metallic either of SS or of anodised alluminium. The entity / safety parameters shall be matched as in case of entity concept. Vendor's scope shall include barriers duly installed in the box / junction box.

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5.1.9 Repeat Signals

5.1.9.1 Unless otherwise specified in the job specifications, following philosophy shall be followed for repeat signals;

a) Whenever repeat contact outputs are required as per job specifications following philosophy shall be followed;

i) For intrinsically safe input contacts, isolating barrier with dual contact output shall be utilized.

ii) For all other contact inputs, repeat contact shall be provided using electro magnetic relays.

b) Whenever repeat analogue outputs are required as per job specifications, following philosophy shall be followed;

i) For intrinsically safe analogue inputs, isolating barrier with dual analogue outputs shall be utilized.

ii) For all other analogue inputs, repeat analogue outputs shall be provided using signal isolators with dual output.

5.1.10 System Integration

The distributed control system shall be a fully integrated control system , also the Shut Down System (Safety Instrument system(ESD)) and the Fire and Gas system should be fully integrated with the control system . Shut Down system and Fire and Gas system should not be integrated with the control system as or with serial/Foreign/third party device card , however engineering database and engineering tool of all the above three system should be separate, dedicated and independent of each other Foreign devices like analyser system, third party equipment, (like compressors etc) etc. shall be functionally integrated with the distributed control system. Functionally integrated system shall meet the following requirements, as a minimum;

a) The foreign devices shall either be configurable from DCS engineering consoles or from the dedicated engineering consoles of each foreign device.

b) Unless specifically indicated otherwise, each foreign device shall be integrated with DCS through MODBUS (RTU) protocol using redundant interface unit.

c) Operator console shall display information in the similar fashion irrespective of source of information. Source of information shall be transparent to the operator.

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d) The process alarms and diagnostic alarms shall be presented on the operator console in the similar fashion as DCS alarms.

e) Whenever specifically indicated, the time of all foreign devices shall be synchronized with DCS clock or GPS, as specified in the job specification.

f) The data transfer to and fro from other distributed control systems or supervisory computers through information network shall utilize OPC protocol with adequate security.

5.1.11 Surge Protection

5.1.11.1 Surge protection devices (SPD's) shall be provided on the system to limit the surge voltages reaching beyond the safe limits, under normal, abnormal or lightening strike condition. Unless otherwise specified, SPD's shall be provided at least at the following locations;

a) All serial signal cables (UTP / STP / coaxial and not fibre optical) going from or to control system and from one location to another out side the control building at both ends.

b) All fieldbus segments at control system end.

c) All power incoming cable (220 V AC) UPS or non UPS, at the power supply distribution cabinet.

5.1.11.2 The selection of type and rating of SPD shall be selected such that the introduction of this device shall not change the characteristics or reliability of an application, whether it is for the protection of power system, signal such as fieldbus or analog or communication signal, as applicable.

In case of fieldbus system, the SPR shall be selected such that its inclusion in the segment shall not degrade the fieldbus signal, maximum length of the segment and / or number of devices on a segment significantly.

5.1.12 System Securities

5.1.12.1 The system shall have incorporated a fool proof system security feature in its design which would protect its data base and functioning against viruses, trojans and works through integrated anti virus, fire wall and intrusion detection for the system.

5.1.12.2 All devices and / or servers which interface and interact with external application must be supplied with hardware and software firewalls.

5.1.12.3 All the security protections, hardware or software, as offered shall provide protection against all sort of threats and vulnerabilities which include;

a) Positive user authentication and login privileges.

b) Prevention of importation of viruses.

c) Packet filtering, content filtering, URL filtering protocol filtering and application level filtering to accept only intended data.

d) Strict Access controls like password hash files, cryptographic material used in confidentiality etc.

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e) Hardening of operating system.

f) Firewall proxy.

g) Network sniffers and file integrity checkers

h) Scanning, enumeration and vulnerability scanning tools.

i) Log file analysis tools.

The functionalities indicated above are the indicative security features and shall be provided within and where data import / export utilities apply.

5.1.13 System Software

5.1.13.1 The system software shall be governed by the operating system running in a real time mode and shall be able to meet all functional requirements specified in clause 5.2 of this specification as a minimum. Any other standard/special software package, if available, shall also be offered describing the full capabilities.

5.1.13.2 The operating system and other standard softwares (e.g. OPC foundation fieldbus etc.) shall be of latest version.

5.1.14 The system shall have the capability of detecting the open sensors and short sensor. The sensor status reading on failure either upscale or downscale shall be field configurable.

5.1.15 Emergency Switches (ESD Switches)

5.1.15.1 All Emergency (ESD) switches shall he hardwired and shall preferably pull type with red coloured knob. Control room mounted ESD switches shall be installed on hardwired console.

5.1.15.2 ESD switches shall directly trip the final ESD element without any intermediate device.

5.1.15.3 In addition to utilizing contacts for direct shutdown, the contacts shall also be used in ESD system (PLC etc) for logic implementation and event history.

5.1.16 Alarm by-pass Switches

5.1.16.1 Startup by-pass (SBS) switches

a) Unless otherwise specified, all SBS's shall be configured in the ESD system (i.e. PLC) and shall be operable from DCS operator console and PLC operator console when specified. All such by-pass switches shall be alarmed and shall have audit trail.

5.1.16.2 Maintenance by-pass switches (MBS's)

Unless otherwise specified, following philosophy shall be utilized for MBS's;

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a) All process inputs shall have miniature back lighted MBS (else shall have LED to show by-pass status).

b) MBS shall be installed in a cabinet which can be physically lockable. The by-pass status shall also be available in operator console with a common flashing message always appearing on operator server whenever an MBS is operated. All MBS's shall have audit trail.

c) Logic-wise common alarm shall also be available on the hardwired console.

5.1.17 Interface with Electrical Input / Outputs

5.1.17.1 All contact input and output contacts from electrical switch gear panels (MCC / PCC etc.) shall be terminated in a dedicated 'Electrical Interface marshalling cabinet' located in control room. All such I/O's shall have intermediate relays.

5.1.17.2 Remote I/O rack shall be provided in sub-station for non-shutdown related data, when specifically indicated in the material requisition.

5.1.17.3 All serial I/O cables from sub-station to control room shall be redundant including remote I/O cable.

5.1.18 Automatic Loop Tuning Software Package

5.1.18.1 It shall be possible to tune a control loop or group of control loops on selective basis at a time automatically unless otherwise specified. Tuning parameters computed by the system shall either be loaded automatically or manually by operator.

5.1.18.2 The automatic loop tuning software shall be used to tune PID control loops. The auto tuning technology used shall utilize principles like Ziegler – Nichols, Cohen – coon or Internal Model Control (IMC).

5.1.18.3 The software package for loop tuning may reside / run on any system hardware including controller sub system, console sub system, engineering sub system, supervisory computer etc. The tuning software must ensure that the process is not disturbed whenever a loop is being tuned.

5.1.18.4 Automatic look tuning package shall be able to study the dynamics of control loops and shall be able to compute response time, dead time, lead or lag time etc. directly from Engineering / operator console.

5.1.19 The system shall be suitable for power supply as specified in para 6.2 of this specification. Suitable battery back-up shall be provided for volatile memory protection only.

5.1.20 System Upgrade Capability

5.1.20.1 System shall be scalable and upgradeable by adding additional hardware, over and above the spares specified, without rendering the initial hardware and software investment obsolete within the capability of the system.

5.1.20.2 This is in addition to the system upgrades, hardware and software, available from vendor as standard from time to time.

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5.1.21 Noise Level

5.1.21.1 Noise level generated by any equipment shall not exceed the following limits;

a) Noise level shall not exceed 55dBA for equipments installed in console room, engineering room and computer room.

b) Noise level shall not exceed 65dBA for equipments installed in rack room and satellite rack room (SRR).

c) For control rooms where consoles and cabinets are installed in the same room, the noise level generated by any equipment shall not exceed 55dBA.

5.1.21.2 The noise level shall be measured in dBA at a distance of 1 metre from the equipment generating noise.

5.1.22 Equipment Identification

Unless otherwise specified, all equipments shall be identified by tag numbers indicated in the data sheet / summary sheet attached with the material requisition. The tag number shall be inscribed on a nameplate which shall be fixed with screws.

The nameplate shall be black laminated plastic with core i.e. black with white characters. The size and description shall be subject to purchaser's approval.

5.1.23 System Furniture

All system furniture required for mounting and operation of the system including mounting of tabletop equipments shall be supplied. Furniture for operating personnel shall be as defined in job specifications.

5.2 Functional requirements

5.2.1 The system, as a minimum, shall meet the following requirements without the supervisory computer:

a) Control

b) Data acquisition & monitoring

c) Alarming

d) Logging & report generation

e) Historical data storage

f) Trending

g) System shall have some free memory space available for the user and CPU shall have the additional capability to perform advance control functions, process optimization programs or

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generate management reports as specified in job specification in addition to space requirements as per para 3.0 of this specification. The availability of process control language shall be preferred.

h) System shall support functionalities like remote calibration, remote diagnostics and asset management in case of smart or field-bus based instruments.

5.2.2 In addition to above, following functional requirements shall also be complied, when specifically indicated in the job specifications;

a) Sequence of event function.

b) Alarm management

c) Long term historisation

d) Open system connectivity

5.2.3 The system when specified with Programmable Logic Controller (PLC) either as integral part of system or as separate third party device it shall perform follow functions;

a) Process interlocks

b) Plant safety shutdown

c) Monitoring the sequence control units, when specified

Plant process and safety shutdown shall be independently performed by programmable logic controller. (PLC shall be communicating with other sub-systems via communication sub-system).

5.2.4 The system when specified along with a supervisory computer, shall meet the following requirements in addition to as specified in para 5.2.1 of this specification.

a) Advanced Control

b) Unit and plant optimization

c) Management information service reports.

5.2.5 Whenever information network alongwith plant wide interconnectivity is specified, the system shall meet any or all of the following requirements in addition to those specified in para 5.2.1 of this specification as specified in the material requisition:-

a) Centralised information system

b) Statistical process control/statistical quality control.

c) Plant optimization, data reconciliation, overall mass balance, etc.

d) Plant planning and scheduling.

e) Computer integrated manufacturing with information transfer to achieve functions like production and preventive maintenance scheduling and plant wide coordination etc.

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5.2.6 The system as offered shall be fully and functionally integrated meeting the requirements specified above. In addition, the system shall also have capability and capacity to interact with smart and field-bus instrumentation simultaneously. The system shall also be capable of accepting signals from different type of field-buses in the same controller and data acquisition sub-system.

5.3 Controller and data acquisition sub-system (CDAS)

5.3.1 Controller and data acquisition sub-system shall primarily be used for plant control and data acquisition and shall interface with physical inputs and outputs from the plant and third party devices.

5.3.2 CDAS shall be microprocessor based and fully programmable sub-system which shall be capable of processing the acquired data from input / output devices utilizing a set of algorithms within its defined processing cycle. The microprocessors utilized in controller and data acquisition sub-system shall generally be of latest generation.

5.3.3 CDAS shall have a multi-processor architecture with each processor responsible to carryout predefined functions like Input / Output processing, control processing, internal communication, external interfaces etc.

5.3.4 The hardware and software capability of this sub-system shall primarily be exploited for processing regulatory close loop and open loop control functions only. Sequencing and interlocking capability shall be utilized whenever specified in job specifications.

5.3.5 CDAS shall be capable of accepting signals from various process sensors and devices with linear, non-linear and serial outputs preferably without requiring external or auxiliary signal conditioning devices and processing signals. Typically the inputs shall include 4-20mA DC (both conventional and HART), 1-5VDC, milli volt signal from thermocouples, resistance from resistance temperature detectors (RTD's), pulse input, field-bus (foundation field-bus, profibus PA etc.), serial inputs (MODBUS) and discrete contacts (powered or potential free), as a minimum. System shall also accept other inputs when specified in job specifications.

System shall be able to accept 2-wire, 3-wire and 4-wire signal inputs without any change in the I/O module.

5.3.6 The system shall have capability to generate analog 4-20mA DC (conventional or HART) current signal, 1-5VDC voltage signal, field-bus output signal, potential free contacts for discrete outputs and serial (MODBUS) outputs, as a minimum, apart from others specified in the job specifications.

5.3.7 The output from the system shall be capable of driving following loads;

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a) Analog outputs shall be able to drive loads of output devices such as I/P converters, smart positioners, recorders / indicators etc. In general, it should have load driving capabilities up to 750 ohms.

b) Contact outputs suitable for driving alarm annunications, status lamps, relays, converters, solenoid valves, contactors / breakers of motor control etc. In general, contacts rating shall as follows;

Intrinsically safe load	:	30V 0.5 Ampere
AC powered loads	:	230 V 5 Ampere
DC powered loads	:	110V 0.5 Ampere
DC powered loads	:	220V 0.2 Ampere

5.3.8 The system shall be capable of differentiating between out of range measurement (Bad process value) and a failed transmitter signal. In conventional 4-20mA output transmitter this shall be identified by setting bad quality data flags while for smart (HART) and field-bus transmitters data quality indicator from the device shall be utilized.

The detection of device failure alarm and driving output to a pre-defined value shall be configurable within this sub-system.

5.3.9 It shall be possible to override or force an input measurement or an output in the system while testing or on failure of an input.

5.3.10 Controller and data acquisition sub-system shall have a non-volatile memory for storing configurational data. In case vendor's standard product supports only volatile memory, battery back-up shall be provided to store the data for a period of 72 hours, as a minimum. A battery drain indication along with a potential free contact shall be provided to alert the operator.

5.3.11 The sub-system shall have sufficient memory to store the program instructions, CDAS data base, data required for real time trending and point trend and any other data required to be stored to meet specified functional requirements.

5.3.12 The sub-system shall incorporate a hardware or software based watch dog timer to monitor the healthiness of the CDAS processor-health.

5.3.13 Each controller and data acquisition unit shall have its own dual redundant power supply which can be replaced online. Separate dual redundant power supply unit shall be provided for powering field devices.

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5.3.14 Controller and data acquisition sub-system shall be modular in construction with rack mounted modules in general. Input / Output modules shall be either rack mounted or DIN Rail mounted type.

5.3.15 Input / Output Modules

5.3.15.1 General

a) I/O modules shall communicate with processor modules serially either through back-plane or through I/O communication network. I/O network shall always be redundant. Data transferring through hardwired connections shall not be acceptable.

b) Analog to digit converters for analog 4-20MA / 1-5VDC modules shall meet the following requirements;

A/D Resolution	12 bits
Repeatability	± ½ LSB
Accuracy	± 0.1% of full scale
Common mode Rejection	60dB at 50Hz
Normal mode Rejection	55dB at 50Hz

c) Digital to analog converters for output module shall meet the following requirements;

D/A Resolution	10 bits (min.)
Repeatability	± 1 LSB
Accuracy	± 0.25% of full scale

d) Each output channel must maintain its own – failure mode value, which is automatically executed upon detection of a communication failure between process and output module.

e) Unless I/O module has universal design it shall have unique keyed facility to prevent faulty operation and termination.

In addition I/O modules shall also meet the specific requirements specified in clause 5.3.15.2 through 5.3.15.7.

5.3.15.2 Analogue Input / Output modules (conventional / smart)

The input module shall meet the following requirements;

a) It shall accept 4-20mA isolated input with maximum input resistance of 250 ohms or 1-5VDC isolated input with input resistance more than 500k ohms.

b) The input module shall support field powered transmitter i.e 2-wir, 3-wire or 4 wire system.

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c) Input faults such as open circuit, short circuit and earth fault shall be detected by I/O module.

d) The output module shall provide 4-20mA output driving up to 600ohms of total loop resistance at 24V DC.

e) The system shall provide 24V DC for loop powered 2-wire transmitter and shall also loop power the 2-wire outputs.

f) Input / Output module shall not have more than 16 inputs or outputs.

5.3.15.3 Analogue Input / Output module with HART

a) The Analogue Input / output modules for HART signal shall meet all requirements specified in clause 5.3.15.2 above.

b) Input / Output shall fully support the HART communication signal i.e. the American Bell 202 standard frequency shift keeping signal superimposed at a low level on analogue measurement signal.

5.3.15.4 Foundation Fieldbus (H1) Interface Module

a) Foundation fieldbus HI interface module shall be capable of supporting multiple segments and able to operate in full redundancy mode.

b) Foundation fieldbus H1 interface module shall always be provided in redundant configuration with Link Active Schedulers (LAS) configured in primary and back-up HI interface modules respectively to ensure that failure of primary LAS shall not cause failure of H1 bus communication. Power for H1 segment shall be provided by power conditioner module which shall be separate from H1 interface module to ensure that failure or removal of H1 interface module does not affect the supply of power to the segment.

c) HI interface module shall be supplied with link active scheduler (LAS) capability and running foundation fieldbus (FF) function blocks which include PID, PD, Bias, Gain, calculations etc. These function blocks shall be code identical to FB code provided in the field devices. The manufacturer shall guarantee the interoperability of HI interface module with any function box residing in the field device.

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d) Foundation fieldbus HI interface card shall utilize a fieldbus Foundation Registered mark.

e) The sub-system shall accept all the dynamic variables transmitted by the field-bus-device.

5.3.15.5 Temperature Input Module

a) The thermocouple input module shall accept grounded or ungrounded inputs from various thermocouple types i.e. T, E, J, K, R, S and B. The module shall be capable of linearising the thermocouple inputs and provide cold junction compensation.

b) The module shall have 12 bit resolution with digital accuracy of ±1°c

c) The RTD input module shall accept 100ohm platinum resistance temperature detector (Pt 100) in 3-wire or 4-wire configuration.

d) The module shall be capable of linearising the RTD input.

e) The module shall have 12 bit resolution with digital accuracy of ±0.28°c

5.3.15.6 Serial Interface Modules

a) Serial Interface modules shall be capable of communicating with RS232C, RS422 or RS485 signals.

b) Unless otherwise specified, all serial interface modules shall be configured in redundant configuration.

5.3.15.7 Discrete Digital Input / Output Module

a) Digital input module shall be capable of detecting close or open status of powered or potential free contacts. The interrogation voltage of the contacts shall be 24VDC or as per selected barrier for barrier powered contacts.

b) The input module shall also be suitable to accept inputs from proximity switches or from open collector output from proximity input barrier.

c) The digital output module shall provide output contact rated for 220V AC 10 Ampere 110V AC 5 Ampere or 110V DC *0.3* Ampere.

d) The type of contact output ie. normally open or normally closed shall be user selectable.

e) Maximum number of inputs or outputs shall not exceed 32.

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5.3.16 Fieldbus Segment Power supply and terminators

5.3.16.1 The power supply used for powering fieldbus segment shall have a impedance matching network, preferably part of power supply unit.

5.3.16.2 Short-circuit at spur level shall not lead to failure of any fieldbus segment except the short-circuited spur.

5.3.16.3 Unless otherwise specified, fieldbus power supply / conditioner shall meet the requirement of type selected instruments and shall be as per;

a) Foundation fieldbus power supply Type 131 non – IS power supply intended for feeding IS barriers.

b) Foundation fieldbus type 133 IS power supply compliant with IS parameters.

c) For Non-Intrinsically safe segment, the power conditioner shall be capable of each drawing 20mA current supplying power to at least sixteen field devices including a segment terminator.

d) For intrinsically safe segment, the power conditioner shall comply with FISCO or entity concept requirements as specified in purchaser's specifications.

e) For a segment designed with Non-insendive concept, the power conditioner shall meet the requirements of FNICO.

5.3.16.4 Each foundation fieldbus power supply shall have redundant power conditioners (unless limited by concept design), current limited outputs to all foundation fieldbus segment and surge protection as applicable.

5.3.16.5 Individual power conditioners and input power supplies can be replaced without interrupting power or communication fieldbus segment.

5.3.16.6 Terminators

Terminators shall be provided by vendor at both ends of a foundation fieldbus segment. The terminator at DCS side shall be incorporated into the foundation fieldbus power supply / conditioner while field side terminator shall be installed in the junction box.

5.3.17 Control functions and algorithms

Controller and data acquisition sub-system shall have capability to perform conventional and advanced control algorithms for implementation of regulatory and advanced control strategies. This sub-system shall have real time computational capability and shall be able to perform following algorithms and computations in addition to those specified in job specifications;

a) Control algorithms

Proportional (P), Proportional – Integral (PI), Proportional – integral – derivative (PID), adaptive gain, feed forward, cascade, split-range etc.

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b) Dynamic Functions

Lead-lag, dead time, timers, counters etc.

c) Signal Selector

High selector, low selector, high-low selector.

d) Calculation Blocks

Linearisation, pressure-temperature compensation, polynomial, multiplication / division / addition / subtraction etc.

e) Signal Limiters

Low limiter, high limiter, high-low limiter etc.

f) Logic Blocks

Logic 'GATES' (OR, AND, NOR, NOT NAND etc), Flip-flops etc.

5.3.18 Controller shall be able to operate in either manual, auto, cascade or computer mode. Mode changeover in either direction shall be procedure-less and bump-less. Following functional capability shall necessarily be possible;

a) In cascade loops, the primary controller shall be able to track the set point of the secondary controller when the secondary controller is not operating in cascade mode.

b) In computer mode, controller shall be able to track computer generated set point and shall hold the last generated value in case of computer failure. In such case, controller shall fall back on auto-mode and continue to operate at the last received set point, in general. Other options like pre-defined set point operation and fail safe condition shall also be possible. On the resumption of computer set point again, the controller shall not return to the computer mode automatically. Computer failure indicator shall be provided at central and local level.

5.3.19 Controller shall accept the change in set point command from central level (as operator interface function) and take action accordingly. It shall have facility for slow and fast ramping of set point as well as output. In addition, it shall have anti-reset wind-up feature as standard.

In addition to above, it shall also be possible to change set point, tuning constant, operating mode, controller configuration from the central level i.e. operator's interface keyboard and engineer's interface keyboard.

5.3.20 Loop Integrity

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5.3.20.1 Loop integrity shall be maintained in controller functionality in such a way that the single component failure in the sub-system shall not effect more than one control loop (single loop integrity). This shall be achieved in offered sub-system architecture in one of the following ways;

a) By providing one to one controller back-up. In case failure is detected in the active controller all the loops of the failed controller shall be transferred to the back-up controller.

b) Where single loop controller is specified in the purchase specifications, no controller back-up shall be necessary provided no input other than that required for the specified loop is connected to the controller.

5.3.20.2 Loop integrity shall be maintained for the data acquisition functionality i.e openloop processing including processor such that a single component failure shall not effect more than 16 analog inputs or 32 discrete inputs.

5.3.20.3 Loop integrity shall also be applicable to I/O modules, power supply modules, communication modules and other associated devices as per the philosophy explained in clause 5.3.20.1 and 5.3.20.2 of this specification.

5.3.21 Sub-system Redundancy

5.3.21.1 In case of redundant configuration (where back-up components are provided), the design shall incorporate a fail-safe automatic control transfer switching mechanism which shall transfer the entire configuration, data base and loop control of the failed controller to the back-up controller. Design must also ensure that data integrity is maintained during switchover and no portion of data to be transferred is corrupted or lost before and during switch over to the redundant (back-up) controller. The indication of the failed controller / component shall be displayed at the level as well as on the central level.

5.3.21.2 The switchover from primary to back-up component / device shall be bumpless and transparent to the operator i.e. the outputs shall be held at the last value during switchover to avoid any process upset. The switchover time shall be of the order of one (1) second.

In case of redundant HI modules, the back-up module shall maintain connectivity with all publishers and shall subscribe to all publishers to minimise switchover time.

5.3.22 Sub-system configuration and on-line modifications

5.3.22.1 Controller and data acquisition sub-system shall be configured from the central level i.e. through engineers interface sub-system under password or hardwired key lock protection. Single loop controller when specified shall be configured from the local level.

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5.3.22.2 Sub-system shall allow following configurational functions to be performed for each loop;

a) Control function parameters

b) Processor cycle time for each loop tagwise.

d) Macro-cycle time for foundation fieldbus HI segment as per segment loading.

d) Output status of each control loop in case of processor failure.

5.3.22.3 It shall be possible to carryout online modifications or perform back-up without interrupting the central software of preventing the operator commands. Such modifications shall be possible without any plant upset or process interruption.

5.3.22.4 Downloading of modifications to the respective controller and data acquisition sub-system shall be possible in running condition.

5.3.22.5 Sub-system shall perform saving and back-up of data base as per changes made automatically.

5.3.23 System Diagnostics

5.3.23.1 Each module shall have a board diagnostic with on board LED for indicating status of the module at local level.

5.3.23.2 All diagnostic subroutines shall carryout various diagnostic tests to check the healthiness. The test shall include memory test (RAM and ROM), on-board processor test and back-up module communication healthiness test etc. Failure of any of the tests shall be alarmed as module failure.

5.3.24 Sub-System Performance

The sub-system response time shall be the indicator for the performance of the sub-system. The control system shall be able to perform control algorithm, calculation function etc. for each loop within the specified response time unless specified otherwise in the purchaser's data sheets, the system response time (scan time) and loop response time as defined in clause 2.22 and clause 2.26 (for fieldbus based system) respectively of this specification shall be as follows;

- For flow and pressure close-loops - 500mS
- For temperature and level close-loops - 1000mS
- For analyser close-loops - 1000mS
- For all open loops - 1000mS
- For Interlock related inputs - 500mS

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The processor cycle time shall be set to achieve the scan time and loop response time values specified above.

Scan time of multi-variable advanced control loops when implemented in controller and data acquisition sub-system shall be specified in purchaser's data sheets.

5.3.25 Controller & data acquisition subsystem loading

The system loading for controller and data acquisition subsystem shall not exceed 60%. The loading as indicated here is the worst case of high system activity referred to the use of memory, CPU time and communication capacity for this sub-system.

5.3.26 Sub-system Sizing

5.3.26.1 Sizing of controller and data acquisition sub-system shall be carried out considering the following parameters, as a minimum;

a) Unit-wise segregation of CADS as specified in the job specification.

b) Number and type of inputs / outputs specified in each unit in the job specifications e.g. analogue I/Os (conventional / smart (HART), Fieldbus I/Os, discrete I/Os etc.

c) Intrinsically safe and non-intrinsically safe I/Os.

d) Spares philosophy.

e) Distribution of spare I/O's in I/O modules

f) Scan time (Response time) and loop response time specified for each type of I/O.

g) Segment design criteria

h) Worst-case processor loading specified in the specifications.

i) Calculation blocks specified in the job specification. Following philosophy shall be followed for computing calculation blocks in addition to those indicated;

PID Blocks	-	No of outputs
Calculation Blocks	-	50% of PID Blocks or 130% of specified calculation Blocks whichever is higher.
Logic Blocks	-	150% of specified blocks or 100% of specified Discrete outputs whichever is higher.
Advanced blocks	-	150% of actual numbers specified.

For the purpose of block calculation, consider actual I/O's along with installed engineering spares. Also consider clause 5.3.26.2 (e) for fieldbus based system.

j) Serial interface modules in redundant and single configuration as specified.

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k) Any parameter not specified above but required to be considered for size because of vendors standard sizing methodology.

Processor loading factor / calculation available in standard product guide for sizing shall be utilised else vendor shall reduce the sub-system block handling capability by a factor of loading.

5.3.26.2 In addition to relevant requirements specified in Clause No.5.3.26.1, following process control functionalities and requirement must be considered for fieldbus segment design;

a) The sensor device and the corresponding actuator in a control loop shall be on the same fieldbus segment.

b) Control loop that include a cascade type controller, the primary and secondary loop measurement as well as final control element shall be on the same fieldbus segment.

c) Split range measurement and final control element shall be on the same fieldbus segment.

d) Discrete fieldbus device used in an interlock alongwith a control loop, discrete device shall preferably be on the same fieldbus segment. Discrete device here means fieldbus converter.

e) The default configuration shall be for control (except high level calculations) to reside in fieldbus device. System shall be configured for control to fail over to CDAS

f) Type of hazardous area philosophy i.e entity concept, FISCO, FNICO or high power trunk.

g) Length of each segment with respect to the physical distance between control system (host) and field devices.

h) Loop response time or macro cycle time as specified.

i) Sufficient unscheduled time must be kept in each cycle to transmit a cycle information within defined loop response time. This shall be 50% of the specified loop response time.

5.4 Operator interface sub-system

5.4.1 General

5.4.1.1 The operator interface sub-system shall provide the centralized information to the plant operator/Engineer in the following fields:

a) Indication of all analog and digital process variables of control loops, open loops and all loop related parameters

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b) Manipulation of control loops including changing set point, mode, output, configuration, tuning, and computational constants.

c) Alarm displays and annunciation.

d) Graphic displays and status indication.

e) Logging and trending including historical trend recording.

f) Trend recording on assignable trend recorders.

g) Self diagnostic messages.

5.4.1.2 The operator interface sub-system shall consist of a single or multiple operator consoles (VDU's driven by console electronics) and hardwired consoles. The number of consoles for a unit shall depend upon the size and operating philosophy of the plant. The number of console shall be specified in the job specifications.

5.4.1.3 The operator interface subsystem shall have either single tier construction or stacked construction. The type of construction shall be specified in the material requisition.

5.4.1.4 The operator station shall comply with ISO 9241-5 'Workstation layout and postural requirements' and ISO 9241-7 'Display requirements with reflections'. The layout of the operator interface sub-system shall be as indicated in the material requisition. The consoles required to meet the shape and symmetry indicated shall be supplied by the vendor.

5.4.1.5 Unless otherwise specified in job specifications, each VDU shall be a 459.7mm active matrix TFT type LCD display unit and shall have native resolution of 1280 x 1060 pixels, as a minimum, with a 160° wide viewing angle.

5.4.2 Operator Consoles

5.4.2.1 Each operator console shall consist of the following;

a) Single tier construction shall have three (3) VDU screens with its own dedicated keyboards (a total of three keyboards) each driven by an independent electronics.

b) Stacked construction shall have the two stacks of VDU's with four VDU's (2VDU's / stack) and two sets of keyboards (one keyboard / stack) each stack driven by an independent electronics.

c) Each operator video screen or 2 VDUs of stacked construction shall be driven by a dedicated driver electronics which also keeps the desired data base for various functions defined and termed as

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workstation. All the three operator workstations shall be operationally interchangeable in such a way that all the three workstations have similar data base and functionalities.

d) The operator console shall also have a logging printer, a alarm and event printer and a hard copy unit, unless otherwise specified in job specifications.

5.4.2.2 Hardware Configuration

The operator console shall meet any one of the following configuration options;

5.4.2.2.1 Option I

Each operator video screen shall be driven by a dedicated driver electronics which also keeps the desired data base for various functions defined and termed as workstation in this case each as has data stored in it should be minimum RAID-5 configuration to ensure maximum availability of history/data . All the three operator workstations shall be operationally interchangeable in such a way that all the three workstations have similar data base and functionalities.

5.4.2.2.2 Option II

One or more number of operator console (consisting of three video screens and dedicated keyboards) are driven by a common redundant server machine storing a common database for all the three video screens (three video screens may work like clients to this server).

Server shall be a multifunction higher end server grade machine which may support functionalities such as;

a) Data connectivity between CDAS and other sub-systems (i.e. operator sub-system, engineering sub-system, IAMS etc.)

b) Database storage and engineering functionality as per Clause 5.4.2.3 of this specification.

c) Historisation of data related to associated operator consoles.

This server can also be used for functions like;

a) Plant history (UHN)

b) Connectivity to information network or OPC node.

c) Running specific applications like generating advance controls, MIS reports, IAMS, AIMS etc.

5.4.2.2.3 Option III

a) Two parallel servers (each containing same data base, each driving), two of the operator console VDU's are driven by a server which stores complete data base for the units being assigned. In this case, operator console shall have four operator console VDU's (instead of three specified as operator console). Similar philosophy shall apply in case of stacked VDUs operator console.

b) In case, multiple servers are used to support different functions like data connectivity, data base storage and historian function, similar philosophy as 5.4.2.2.3(a) may be followed.

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5.4.2.3 The system shall have global data available at each operator console electronics and all the functions explained in Clause 5.4 shall be available / executed at operator console. However, in case functionalities are distributed in various intelligent hardwares / softwares or in case of distributed database / console functions is supported by the standard system architecture, each data base electronics / functionality shall be RAID 5 configuration dual redundant. Further any change made in the data base of one operator console shall automatically update the data base of other operator consoles if configured identically. Following shall apply;

a) history function, for the units monitored and controlled from the operator console, shall be RAID 5 configuration dual redundant with each node have dual disc drives dedicated for history storage.
b) Data base storage function for the units being monitored and controlled by the unit shall be RAID 5 dual redundant and shall have dual disc drive configuration.
c) All stations used for data storage and such functionalities shall have RAID5 configuration.

5.4.2.4 The operator, as a minimum, shall have access to the following through the operator key board at all times:

a) Selection of all the displays including the direct selection of loop in alarm, page turning facility, overview, group view and loop view selection etc.
b) Selection of loop for operation.
c) To acknowledge alarms as and when they are annunciated on the operator console.
d) Facility to enter any changed parameter like setpoint, manipulated variable, digital commands and to cancel any wrong entry while making such change.
f) Facility for easy positioning of cursor for the selection of any parameter.
g) Selection of hardcopy printout, logging printout, alarm history printout and assignable trend recorder points.
h) Auto/manual/cascade/computer mode changeover of each controller.

5.4.2.5 In addition the Engineering keyboard shall have the following capabilities for restricted user/engineer through a key-lock or with password protection;

a) Data base configuration including overview, group, loop, multi-loop and multi-variable control configuration.
b) Group or multi-group alarm inhibit from a plant under maintenance.

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c) Reconfiguration of alarm settings and their values, addition and deletion of components in a loop.

d) Tuning of control loops including change of P, I, D and dead-time contacts

e) On-line compilation of graphic displays using standard user defined symbols.

f) Changing of parameters to be logged.

g) Setting of real time clock.

h) Assigning of parameters for historical trending.

i) To call detailed self-diagnostic for maintenance.

Any change made for any parameter for an input from any display shall be automatically updated on all displays configured for that input.

5.4.2.6 Operational Protection

A key-lock switch or software password shall be provided for operational protection. Following minimum level of access and authorisation shall be available;

Operator Level	-	Authorises all commands for plant operation.
Engineers level	-	Authorises all commands for plant operation and system engineering.
Management Level	-	Authorises all operational data and reports to be viewed.

Other levels of key-lock / password protections if available as standard with the system shall also be offered.

5.4.2.7 It shall not be possible to override any process variable or digital status from operator keyboard.

5.4.2.8 Each keyboard either integral or as a separate attachment shall have a set of dual function user configurable keys. These keys shall be configured to access important pages in single keystroke. These keys shall have LEDs which flash on pre-configured alarm conditions. A minimum of 32 number of such keys shall be offered with each keyboard. Systems, which do not support dual function keys with their standard keyboard shall offer either;

i) a dedicated VDU and keyboard with each operator console configured with an intelligent graphic which would replicate the functionality of dual function keys.

ii) a dedicated keyboard with dual function keys alongwith each standard keyboard.

5.4.3 Process displays

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5.4.3.1 Process information and operational aids shall be presented to the operator in the form of display. These displays shall cover all points related to tag numbers built within the system. The process displays shall include different type of displays and the functionalities associated with each of these displays. Various types of process displays, as envisaged, are detailed out in the clauses to follow. The details provided herein are typical and explain only the functional requirements. The systems as offered must provide displays which meet these functional requirements.

5.4.3.2 Overview display

5.4.3.2.1 Overview display shall present the overall status of a unit or large segment of the process plant. The analysed data and alarm conditions are displayed with colour changes.

5.4.3.2.2 Overview display shall incorporate a minimum of 128 analog or discrete inputs which can be monitored simultaneously on the VDU screen (Referred as page). Each page shall be organized into a suitable number of groups. Each group shall be identified separately. Each group shall further incorporate suitable number of inputs (Referred as tags). Suitable identification and description shall be shown for each group on the overview display to relate it to a group or loop display.

5.4.3.2.3 All analog points in the overview shall be represented as variable lengths indicating deviation above or below the normal operating value or set point.

5.4.3.2.4 Alarms shall be displayed in change of colour against each variable if the variable crosses a set value. Control loops operating in manual mode shall be indicated.

5.4.3.2.5 An input in alarm condition shall be identified by flashing.

5.4.3.2.6 In case, any hard wired instrumentation backup is provided, overview pages shall be assigned indicating the tag number and type of hardwired instrument.

5.4.3.2.7 The operator shall be able to call directly any group display or loop display or any predetermined displays covered in the overview display.

5.4.3.2.8 It shall not be possible to acknowledge alarms directly from the overview display.

5.4.3.3 Group Display

5.4.3.3.1 Group display shall be limited to the group of inputs as displayed in the overview display. Each group shall preferably include eight (8) number of inputs.

5.4.3.3.2 Each input in the group shall be identified by the tag number, unit of measurement and process description which shall be displayed on the VDU screen.

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5.4.3.3.3 Display, as a minimum, shall show following degree of details:

a) Process variable in analog form shall show, as a percentage of the transmitter span on a linear scale bar graph of 0- 100% or engineering units and in digital form as alphanumeric display in engineering units.

b) Set point value in analog form as a percentage of the transmitter span on linear scale bar graph of 0-100% engineering units and in digital form as alpha-numeric display in engineering units.

c) Output value in analog form as a percentage of linear scale bar graph of 0-100% and digital form as percentage.

d) Controller mode i.e. auto, manual, cascade, computer.

e) Process alarm on process variable, deviation or velocity.

f) Selected loop within the group shall be identified by cursor marking or similar identification.

g) Control valve failure position.

h) The contact input / output shall be represented by simulated graphic lamps and configurable alphanumeric status description.

5.4.3.3.4 It shall be possible to control the process from group views. Following control actions shall be possible;

a) Increase / decrease of set point value either slow or fast.

b) Change of controller mode i.e. Auto/manual transfer.

c) Changing output to the final control element.

d) For digital points, start/stop or open/close command.

5.4.3.3.5 It shall be possible to repeat any tag number in more than one group/console. However it shall be possible to control or change configuration from only pre-assigned group/console.

5.4.3.4 Loop Display

5.4.3.4.1 Loop display shall provide a separate detailed display for each of the process inputs. The graphic representation of analog and digital points shall be similar to group display. However in addition following information shall also be presented in alphanumeric form as a minimum

a) Controller tuning constants.

b) Process variable zero and span values.

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c) Alarm set point on various parameters.

d) Limits on set point, output, velocity etc.

e) Controller action (direction/reverse).

f) Failure position of final control element.

g) Computational constants like ratio or bias.

h) Integrated value.

i) Output to the final control element.

j) Engineering units.

5.4.3.4.2 It shall be possible to change the following through the keyboard of operator console:

a) Tuning constants.

b) Scale, zero and span.

c) Limits on set point, output, velocity etc.

d) Configuration of any loop.

e) Alarm set points.

f) Control mode.

g) Output to the final control element.

h) For digital points, it shall be possible to issue start/stop or open/close command.

5.4.3.4.3 Loop control parameters changes as specified in para 5.4.3.4.2 (a) to (e) shall be restricted by a key lock control or password.

5.4.3.4.4 The loop display shall also contain a trend displaying process variable, set point and output with a sample interval time of maximum 1 second and full scale time base of minimum 60 seconds for tuning the process control loops.

5.4.3.5 Graphic display

5.4.3.5.1 It shall be possible to display dynamic graphic of different sections of plant on the operator console VDU screens. Graphic displays shall be field configurable only through engineering key-board with standard / user defined graphic symbols. Dynamic graphic displays if different sections of the plant shall be displayed on different pages.

5.4.3.5.2 The system shall have graphic symbol library as per ISA-5.1 and 5.3. In addition standard industrial symbols like distillation columns, heat exchangers, pumps, compressors, tanks etc. shall also be provided as a standard.

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5.4.3.5.3 Graphic displays shall be interactive type through which it shall be possible to control the process. It shall also be possible to send motor start/stop and shutdown valve open/close commands, as specified in job specifications, from this display.

5.4.3.5.4 It shall be possible to view the process variable and alarm points and view and change set point value, manipulated variable, controller mode etc. from the graphic display. Also rotating machinery (i.e. compressor / pump) status and valve status shall be displayed on the graphic display with different colours.

5.4.3.5.5 Various colours used in the generation of graphics like colour of the process lines, utility lines, Instrument signal lines and event modifier conditions shall be finalised during detailed engineering. The colours used to identify event modified conditions shall generally be as follows unless otherwise indicated during detailed engineering.

Red	:	All points alarm
Blue	:	Valve open, pump running.
Green	:	Valve closed, pump stopped.
Flashing green	:	Shut down valve transition state.

5.4.3.5.6 It shall be possible to go from any graphic page to related graphic pages or any group view or alarm summary in single key stroke using soft key function.

5.4.3.6 Trend Display

5.4.3.6.1 The system shall be capable of displaying the following trends:

a) Real time trends for the parameters specified in job specifications displaying current data for a period of minimum one (1) hour as defined in clause 2.33 of this specification. However it shall be possible to assign any parameter for real time trend.

b) Historical trend for number of parameters as specified in the job specification for a period of 30 days with sampling rate of 10 minutes. However, it shall be possible to assign any parameter for historical trending.

5.4.3.6.2 Historical data shall be stored on the nonvolatile memory device like hard disc in such a way that such historical data can be utilized for archival storage and subsequent recall.

5.4.3.6.3 Real time and historical trend shall be possible on any parameter or variable like measured variable, set point, output, calculated variable etc.

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5.4.3.6.4 It shall be possible to sample and store data of instantaneous and average value at the intervals mentioned below. However it shall be possible to display by scrolling or expanding the time base for all the trends.

a) At intervals 1 second or higher for the real time trend.

b) At 1 minute, 10 minute & 1 hour interval for historical trend.
Historical data trends shall be displayed for a period of minimum up to 72 hours for a data sampling rate of 1 minute.

5.4.3.6.5 The requirement of fast trend (trends with sample time faster than Real time trend) if any, shall be specified in the job specification. This shall be in addition to tuning trend requirement specified in this specification.

5.4.3.6.6 Selection of the tag number and sampling time for real time and historical trending shall be possible from operator keyboard.

5.4.3.6.7 The system shall also have a multi trend capability in such a way that it shall be able to display set point, measured variable and output on the same display, the trend of either the same process variable or any other process variable.

5.4.3.6.8 Trend display shall be single line type or bar graph type with additional information like loop tag number, engineering units, span, present value of the trended point, alarm status etc displayed.

5.4.3.7 Closed Circuit Television Window display

It shall be possible to display close circuit television (CCTV) video monitor image on the operator console as a CCTV window. A function key on the operator keyboard shall be assigned to select the desired CCTV monitor window. The CCTV window on the operator console video shall always be on-top.

5.4.3.8 Alarm Monitoring and display

5.4.3.8.1 Alarm Management

a) It shall be possible to display process as well as system alarms on the operator console for operator's attention and action. Alarms shall appear immediately on the operator console as and when they occur on priority basis.

b) It shall be possible to set process alarm limits from the engineering keyboard i.e. alarm limits on absolute value of measured variable; rate of change of measured variable; high and low deviation set points; high, extra-high, low and extra-low points on process variable and output etc. In

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addition, it shall be possible to derive alarm conditions on the basis of few calculations performed by the system.

c) Alarm messages shall be displayed by flashing the page and group number of the input under alarm irrespective of type of display. It shall be possible to access the group or tag in alarm condition with a maximum of two key-strokes of operator's console keyboard. The plant overview display, in addition to display alarm message, shall also be able to provide warning by changing colour of excessive deviation of process variable from their set value.

d) All alarms shall be displayed as and when they occur or generated with change in the colour of display in the following sequence, activating an audio signal:

Continuous flashing : Un-acknowledged alarm
Steady display : Acknowledged alarm

e) The system shall not put off the audio alarm and visual flashing even after the condition returns to normal unless it is acknowledged by the operator.

f) In order to provide immediate attention to critical alarms, alarms shall be classified in the priority of their criticality.

g) In addition to alarms appearing on the different displays as mentioned in para 5.4.3.1 to 5.4.3.5 of this specification, the system shall also be able to display alarm summary and alarm history as per para 5.4.3.8.2 and 5.4.3.8.3 of this specification.

5.4.3.8.2 Alarm summary display

a) It shall be possible to display summary of all alarms in the sequence of their occurrence and shall disappear from display only when they are acknowledged and cleared. The alarm display shall list the following for each alarm as a minimum:-

i) The date and time of occurrence.
ii) Point identification (i.e.Tag number)
iii) Point description.
iv) Type of alarm (absolute value or deviation.)
v) Serial number of alarm in the sequence of its occurrence.

b) The system shall be able to display on alarm summary a minimum of 100 alarms.

c) Alarms shall preferably be listed in the form of alarm list like current, List I, List II etc. The minimum number of alarms per list shall be 25. Alternately system may provide a common list of alarms in the sequence of their occurrence (with respect to time).

5.4.3.8.3 Alarm history

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a) The history of alarm conditions shall be maintained in the database for alarm history display and printed on shift-wise basis for the parameters specified in the job specifications. The alarm display and print out shall list the following for each alarm as a minimum:-

i) The data and time of occurrence.

ii) Point identification (i.e. Tag number)

iii) Point description.

iv) Type of alarm (absolute value or deviation.)

v) Time of acknowledgement.

vi) Time of return to normal.

vii) Serial number of alarm in the sequence of occurrence.

b) The system shall be able to display and print out the alarm history of minimum of 300 alarms.

c) Alarms shall be listed in the form of alarm lists like List I, List II, List III etc. The minimum number of alarm points per list shall be 25. Alternately system may provide a common list of alarm in the sequence of their occurrence.

5.4.3.8.4 System alarm

a) System shall have capability of on-line self diagnostics as mentioned in para 5.4.5 of this specification.

b) Any abnormal conditions in and sub- system or any other functional device shall be displayed as system alarm message on the operator console irrespective of the display selected.

5.4.3.9 Configuration display

5.4.3.9.1 Configuration display shall provide a separate detailed display for each loop indicating the configuration of that loop. When control requires more than one loop, all interrelated loops shall also be displayed. Following information is required to be available on configuration display.

a) Loop configuration giving designation of each block.

b) Control block interconnection showing soft-wiring or hardwiring.

c) Value of each block parameter like P.I.D., ratio, bias, dead-time, lead- time etc.

5.4.3.9.2 It shall be possible to configure & reconfigure the loops from this view using user friendly software.

5.4.4 Logging and Report Generation function

5.4.4.1 It shall be possible to log all real time data, historical data, computed parameters, operator actions, alarms and events etc from operator consoles irrespective of data source connected to communication sub-system. In general, the data type shall include;

a) All measured and manipulated variables (inputs as well as output data)

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b) System calculated variables

c) Historical data values

d) Alarm and event data

e) Operator data entry and operator actions

f) Equipment status data

g) Data through serial links

h) Data through OPC server

i) Batch related data

j) System clock time

k) System diagnostic data

5.4.4.2 The system shall have a report builder and report scheduler which shall have following capabilities;

a) The system shall be able to generate reports on hourly basis, shiftly basis (8 hourly), daily basis and in some cases weekly or monthly basis, as specified in job specifications.

b) The system shall be able to generate reports as per operator command either on-demand or on predefined time.

c) In general, the type of reports shall be;

- On demand report initiated by operator action
- Predefined time initiated report e.g. hourly, shiftly, daily etc.
- Event driven report
- Shutdown driven report
- Equipment runtime status report

d) The generation of on demand report shall not affect any scheduled report.

e) These reports shall be stored in separate files independent from historical and trend data files.

5.4.4.3 All parameters required for logging shall be stored in the system memory as per data base update rate. The system shall be able to perform following functions on all such stored data prior to logging as per the requirement of the report;

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a) Basic arithmetic calculations such as averaging, summing, multiplication, division etc.

b) Advanced calculations like efficiency calculations, conditional calculations etc.

c) Extended log reports such as weekly and monthly reports.

d) Batch Reports

5.4.4.4 The formats used to generate log reports shall be user definable, in general. Typical log formats for hourly, shiftly and daily reports have been attached alongwith (Refer Annexure 1) for reference. System shall have a user friendly structured programming language suitable to generate and access various reports. System may utilize high level language for generating reports with advanced calculations. High level language compiler software shall be supplied as part of standard system function.

5.4.4.5 Number of log reports generated for a project shall be governed by the number and type of log formats defined for a project like hourly report format, daily report format, shutdown report format etc. Number of pages in each log report shall be sufficient to accommodate all the parameters defined in the job specifications.

5.4.4.6 In addition to the real time and historical data, the report builder programme shall incorporate report title, sub-headings, notes and messages.

5.4.4.7 Hourly report shall be printed only as and when initiated on demand by the operator and shall not be printed automatically after the end of the hour. All other reports shall be printed automatically at the end of the pre-defined time as well as on demand by the operator. The maximum storage time for a log information shall be 15 minutes after the pre-defined print out time for a format, within which time log report must be printed. In case report could not be printed within the scheduled defined time, data shall remain stored till the report is finally printed.

5.4.4.8 Logging hardware

Data required to be logged shall be finalised during log report finalisation stage. However, typically following shall apply;

a) All tag numbers, analogs as well as digitals, shall be available for hourly log.

b) All flow tag numbers and other selective tag numbers shall be available for daily log report.

c) Only selective tag numbers shall be available for weekly and monthly report.

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d) Average (over the defined period) for flow and instantaneous shall be used for log printing with maximum and minimum value as defined in log formats.

5.4.4.9 Logging Hardware and Software

5.4.4.9.1 The system shall be supplied with all hardware and software necessary to meet functional requirements specified in Clause 5.4.4.7 of this specification. Log reports shall be generated, compiled and printed using system standard hardware and software. No separate computer / server shall be used.

Separate server, if necessary, may be utilised, to generate extended logs or reports requiring advanced calculation.

5.4.4.9.2 It shall be possible to archive log reports on an external computer. Facility shall also be available to retrieve these reports as a magnetic tape or a disc for future reference.

5.4.4.9.3 In the event of printer failure, the system shall maintain the data in the point buffer memory of the report originating device buffer with a printer failure alarm.

It shall also be possible to print the report at an alternate printer without any data loss, whenever necessary.

5.4.4.9.4 System Printers

a) In addition to configuration and maintenance (C&M) printing, printers shall be used for printing reports like log reports and alarm and event reports.

C&M printers shall be dedicated for each machine whenever such a function is required.

b) All printers shall be low noise industrial type and shall be suitable for continuous duty.

c) Logging printer

Logging printer shall be A3 size colour laser printer and shall be able to meet the following requirements;

i) Logging printer shall be able to print the following reports;

- Printing of hourly, shift-wise, daily and weekly log.
- Shut down report printing.
- Any other report defined in the job specification.

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ii) In addition to above, logging printer shall also be used for printing hard copy of any video screen, whenever necessary.

d) Alarm and event printer

Alarm and event printer shall be low speed dot matrix printers capable of meeting the following requirements;

i) Alarm and Event printer shall be able to print out following reports;

- Log the process and system alarm messages with a time stamp as and when they occur
- Print the alarm history for every shift of operation or on demand from operator console.
- Log events such as operator actions as defined in para 2.30 of this specification, as and when they are initiated.
- System alarms as per self-diagnostic reported alarms.

ii) Alarms and Events shall be clearly distinguishable on the report, preferably by colour.

iii) Print out shall show as a minimum the tag number, description, date and time of occurrence, time of acknowledgement and time of return to normal.

iv) The time stamp shall include month, day, hour and minute.

e) Multifunction printer

Multifunction printer be a colour laser printer which shall be able to print out log reports as well as alarm and event reports. Multifunction shall be specified either common for a unit or a group of units. The functionality of multifunction printer shall be same as (a) through (d) specified in clause 5.4.4.9.4 of this specification.

The command for printing of any report shall be generated from any operator and / or engineering console. The reports shall be generated in the priority of which shall be as per request time for printing report.

f) Hard-copier

i) Hard-copier shall preferably be a coloured heavy duty laser printer. The command for copying shall be initiated from any operator console.

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ii) The screen display may be changed on the console after the copy command is initiated for any screen. This video copier shall have buffer memory storage for at-least two screen pages.

5.4.5 Self diagnostics

5.4.5.1 The self diagnostic message for a subsystem failure shall appear on the operator console irrespective of display selected. The choice of the detailed self diagnostic displays shall be made by a key-lock switch.

5.4.5.2 The system shall have an extensive set of self-diagnostic routines which shall locate and identify the system failure at least up to module level including redundant components.

5.4.5.3 At the local level, failure of a module in a sub-system shall be identified by an individual LED display.

5.4.5.4 Failure of a subsystem shall be annunciated with the change in colour. To aid system maintenance and for effective fault location, following displays shall be provided as a minimum.

5.4.5.4.1 Communication system status display.

The display shall show an over view of different sub-systems connected over the communication sub-system showing status of each sub-system. When a failure is detected by the system self diagnostic routine, the display shall indicate the location and nature of malfunction. Display shall as a minimum have

- Type of sub-system.
- Failure of communication bus/link with the sub-system.

5.4.5.4.2 Sub-system diagnostic display

One display page shall be available for each sub-system on the communication sub-system which can be called on demand.

The display as a minimum shall contain:

- Sub-system number and type
- Error code and description
- Details of failed module

5.4.6 Data Storage, Archival and Retrieval

5.4.6.1 **Historical data shall be stored on a non-volatile memory device like hard disc which can be subsequently recalled by operator on any screen. System must support multiple historical data discs in order to avoid data loss in case of disc crash.**

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5.4.6.2 It shall also be possible to store and retrieve this data on removable mass storage media like floppy disc, cartridge or tape etc.

5.4.7 Assignable Trend Recorder

5.4.7.1 It shall be possible to provide real-time trend on the assignable recorders for any process or calculated variable. The variable shall be assigned through the keyboard of operator console on any point and any recorder connected to that console.

5.4.7.2 Assignable trend recorders shall be located on the hard wired console. Each recorder shall have four pens.

5.4.8 Hard copy unit

5.4.8.1 Hard copy unit shall be used to make permanent copy of any VDU page when demanded through the operator console/Engineer console.

5.4.8.2 VDU page shall not be locked for more than 5 seconds while taking the video-copy.

5.4.8.3 Copies of display shall be in full colour.

5.4.9 System Servers sizing criteria

5.4.9.1 The servers provided as part of standard system architecture shall have fault tolerant architecture with a minimum availability of 99.999%. The design requirements of each server shall be dependent on its functional requirements such as;

a) Guaranteed throughput performance.
b) Continuous and consistent data connectivity even during fault.
c) Continuous and consistent processing of data even during fault.
d) Fault tolerant operating system.

The fault tolerant configuration of server shall include synchronised redundant processors such that failure, if any, is transparent to the user and server applications.

Transparent to the user implies that the data display on the graphic of any VDU shall not be lost for more than three (3) seconds in case of failure of the main server.

5.4.9.2 In case if redundant server configuration, the maximum switchover time shall not exceed ten (20) seconds.

System servers which have switchover time exceed 3 seconds, shall ensure that real time data is available on at least two of the three operator console VDU's even during switch over.

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5.4.9.3 All machines that are used for data is storage shall be high end server garde machine with minimum RAID – 5 configuration. General purpose servers(below RAID 5 Configuration) shall not be acceptable.

5.4.9.4 Server Sizing

5.4.9.4.1 Unless otherwise specified, following criteria shall be considered while sizing the server / servers used for driving operator console(for configurations where data is not stored in the operator station);

a) Number of operator workstation (clients)

Consider 1.2 times the specified number of operator workstations rounded to next higher whole number for each type.

b) Number of Engineering workstations (clients)

Consider 1.2 times the specified number of engineering stations round to next higher whole number.

c) Number of Controller and data acquisition nodes

Consider 1.4 times the specified number of CDAS nodes.

d) Maximum number of nodes / sub-systems on the network should be less than 60% of the system capacity specified in the standard printed catalogues of manufacturers.

e) Maximum history storage tag numbers per second

Consider 1.4 times the specified number of tag points in the material requisition with storage rate of 1 second.

f) Maximum number of trends

Consider 1.4 times the specified number of trend points. Where no separate trend points are indicated consider all analog inputs and outputs as required trend points.

g) Maximum number of Reports

Maximum number of log reports (formats) shall be 50 with 1000 points in each log report.

h) Maximum number of Tag data

Consider 1.4 times the total number of tags and associated parameters i.e. process variable, set point, manipulated variable, auto-manual-computer status, alarm values, diagnostic data from field devices, serial data (process and diagnostics) from third party devices SOE data etc.

i) Maximum number of process alarms, operator events and operator messages

Consider 1.4 times the maximum specified parameters. Where no operator-events or operator messages are indicated in material requisition, consider a total of 1000 points for sizing.

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j) Number of Peripheral devices

Consider 1.4 times the maximum number of peripheral devices specified in the configuration diagram.

k) Maximum number of fieldbus segments

Consider 1.4 times the maximum number of fieldbus segments specified or computed by the vendor, as applicable.

l) Maximum number of data for UHN and OPC node (If applicable)

Consider 1.4 times the maximum number of tag data specified in the job specification. Where no separate data is given in the job specification consider through put requirements specified for UHN and OPC node sizing in this specification. The polling rate shall be considered as 1000 tags per second.

m) Maximum amount of Asset Management data

Consider 1.4 times the maximum data available from field devices for asset management.

5.4.9.4.2 While sizing the server / system consider the following operational features;

a) Number of Operator Console VDU (WS) with over view display. : 33% of 'A'

b) Number of operator console VDU's (WS) with trend displays. : 33% of 'A'

c) Number of operator console VDU's (WS) with graphic displays. : 33% of 'A'

Consider 'A' as number of workstations specified in clause 5.4.9.4.1(a) of this specification.

5.4.10 System Operational Response Time

The system shall meet the following response times beyond which the delay may have detrimental effect on the operator's performance;

System activation or Logging-on of a terminal	:	1 sec.
Display call-up time		
- Simple pages like menu display	:	0.5 sec.
- Graphic page	:	1 sec.
Command execution response	:	4 sec
Data entry error reporting	:	1 sec.
Response to mouse / keyboard commands	:	0.5 sec.

5.5 Engineer interface sub-system

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5.5.1 Engineer interface sub-system shall be primarily an engineer's interface which shall normally be used for configuring, tuning and maintenance of the Distributed Control System. This sub-system shall also be used as operator console whenever necessary (e.g. during start-up etc).

5.5.2 It shall consist of an Engineering console which shall be able to perform all engineering functions related to each operator console and other sub-systems e.g. controller and data acquisition sub-system, interface devices etc (except PLC for which dedicated engineering console shall be provided). It shall also be possible to configure field-bus function blocks on any segment from engineering console.

5.5.3 Each Engineering console shall consist of single or multiple colour 459.7mm active matrix TFT LCD video screens with full integrated audio capability and shall have an integral USB hub. The video screen shall have a native resolution of 1280 x 1024 pixels with wide viewing angle. Each engineering video screen shall be provided with one operator key-board and one engineering keyboard. This, as a minimum shall also have one configuration and maintenance printer.

5.5.4 Engineering console shall also have, the capability of an operator console. However, the operation of the plant shall be restricted from this console. All the operator console displays as specified under clause 5.4.3 of this specification shall also be available on Engineering console.

5.5.5 Engineering console like any other sub-system shall be capable of communicating with all other sub-systems over the communication sub-system.

5.5.6 Engineering console shall have individual dedicated electronics with RAID 5 disk configuration.

5.5.7 It shall be possible to perform all system configuration functions and configuration modification functions from the Engineering console typically;

a) Data base configuration including overview, group view, loop view, trend view, sequential programming, multi-loop multi-variable control configuration for connection, smart and field-bus based inputs.

b) Group or multi group alarm inhibit from the plant under maintenance.

c) Configuration or re-configuration of alarm settings, their values, addition or deletion of any control block or component in a loop.

d) Compilation of graphic displays.

e) Setting of real time clock.

f) Compilation of logs/reports/historical trend points.

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g) To call detailed self diagnostic displays for maintenance aid.

5.5.8 Configuration Requirements

5.5.8.1 It shall be possible to configure conventional, smart (HART) and fieldbus I/O's and control strategies the same way. The device configuration application for HART and fieldbus devices shall utilize EDDL or FDT / DTM as specified in data sheet. It shall include the following;

a) Capability to display all device parameters directly from the device itself.

b) Modify and download device configuration directly to device.

c) Separate display of process values and device alarms.

d) Capability to modify multi-device and download all at the same time.

5.5.8.2 Fieldbus HI interface configuration

a) The configuration software shall have capability to configure all HI fieldbus interfaces such as;

- LAS assignment and management
- LAS scheduling
- Macro cycle time calculations / optimisation

b) Interface configuration software shall support multiple LAS as a segment. Graphical tool shall be provided which shall provide sequence of execution, execution time of each fieldbus device and overall macro-cycle time.

5.5.8.3 Fieldbus Function blocks

a) The configuration software shall be able to configure all fieldbus functional blocks available in fieldbus devices.

b) Function block configuration shall be downloaded from engineering console to field devices on line.

c) Downloads that will result in change in segment macro-cycle shall proceed with a positive confirmation before the download is allowed.

5.5.8.4 Segment Scheduling

a) The engineering software shall have capability to carryout segment scheduling against the scheduling constraints such as number of parameters which LAS can transmit during the single cycle.

b) Response time for an HI segment shall be from 32µ seconds to 2.2milliseconds.

5.5.8.5 Automation configuration tool

5.5.8.5.1 The configuration software shall be capable of auto-detection of following I/O devices;

a) Identification of I/O ports and all types of I/O modules with software configuration defined. If mismatch is detected, an alarm message shall be generated.

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b) Function block configuration tool shall be capable of identifying the installed field devices. An alarm message shall be generated in case of mismatch.

c) Automatic address and tag name assignment for fieldbus devices. These capabilities shall also include handling of any foundation fieldbus registered device using the device DD and CFF files.

5.5.8.5.2 The system shall be pre-configured to identify the attributes of all I/O interface ports and general characteristics of any connected field device, which comply with FDDL (of latest version) or FDT / DTM as specified.

5.5.9 Tuning of a control loop shall be possible from Engineering as well as from operator console, the location for tuning shall be selected by the operator.

5.5.10 On-line Configuration

The system shall have the capability to copy, store, modify and restore the configuration data on-line without shutting the system partly or completely. The system shall be capable of downloading controller configuration from engineering console without taking controller off-line.

5.5.11 Off-line Configuration

5.5.11.1 It shall be possible to generate system configuration i.e. controller and data acquisition sub-system and display configuration including graphics from an independent PC with windows software loaded. System engineering features like continuous control, advanced controls, displays, alarm, historical functions, logging functions etc. shall be configurable from above station. The configuration shall be possible without the availability of actual engineering station. Configuration generated off-line shall be loaded on to engineering station without any limitation.

5.5.11.2 Fieldbus engineering software tool shall be able to perform offline fieldbus engineering by accessing CFF and DD files of field devices without connecting the field devices.

5.5.12 During the normal operation, the Engineering console, in no case, shall interfere with the process operation or system software. However any change in the configuration shall be down loaded into the system with proper knowledge of the operator.

5.5.13 All detailed diagnostics of the system shall appear on the Engineering console with a print out on the Configuration and Maintenance (C & M) printer. A common diagnostic message on the operator console shall indicate the need of the maintenance.

5.5.14 To aid the system maintenance and effective fault identification, following displays shall appear on the engineering console;

a) Communication system status display

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b) Device diagnostic display and System diagnostics upto module level should be possible from the diagnostic software. The details of system diagnostics are described under para 5.4.5 of this specification.

5.5.15 Any special diagnostic package, in addition to as mentioned under para 5.4.5 of this specification, if available with the system shall also be offered. Detailed description and capability of this package shall be supplied.

5.5.16 C&M Printer shall be used for printing the configuration or configuration changes, printing system alarms as and when they appear and to print out any engineers command from Engineering console. Hard copy unit, when specified, shall be used to take hard copy of the engineers console screen.

5.5.17 The system shall have adequate security features to secure plant operation and DCS data base. Engineering console shall have the following security features, as a minimum;

a) Key-lock or password protection for accessing operator functions and engineering functions.
b) Redundant disc and RAID-5 controller configuration
c) Disc interface to enable 'disc down loading' / database or configuration data back-up.
d) Defuncting / inhibiting all functions other than those functions which are required for engineering and operation as defined above.

5.5.18 System Back-up and Re-initialization

a) The entire control software including control database (application program), system software, source code, schematics etc shall be backed up on system hard disc automatically at a regular interval.
b) It shall be possible to have a complete back-up of system including the historical data on-demand without interrupting the system normal function.
c) It shall be possible to have back-ups on remarkable media like CD-RW, DVD-RAM or DVD-RW.
d) The maximum time acceptable for reloading a device like console is five (5) minutes.

5.5.19 Global database Management and Configuration

5.5.19.1 System configuration software shall provide a common database configuration environment and shall support the following data management facilities, as a minimum;

a) System design shall follow the data centric approach and shall manage entire system data in global manner. Paths and connections between data objects shall be automatically maintained when configuration is changed.

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b) Whenever the offered system maintains multiple data bases, the design must ensure a close coordination between these data bases such as management of cross reference table and data reconciliation algorithms.

c) Configuration of operator graphics including management of change tools so that the changes made in graphics are updated uniformly throughout the system.

d) All control historical trend function configuration and interconnection between data elements in the system without any need to maintain user based cross references.

5.6 Communication sub-system

5.6.1 The communication shall be a digital communication network bus, that provides a high speed data transfer rapidly and reliably between the operator consoles, process I/O devices, process computer and other devices connected to it. Each network node shall be capable of communicating with other nodes over the communication network.

5.6.2 The Communication network topology shall preferably be bus structure. Other vendor standard topologies shall also be acceptable provided these meet all the functional requirements specified in this specifications and in the material requisition.

5.6.3 The communication over the communication network shall not be affected even if a node connected to network is powered down or fails to respond. It shall be possible to connect or disconnect a device from the system without disturbing the operation.

5.6.4 The communication sub-system shall be dual redundant, consisting of two separate communication networks and two separate communication system interfaces for each device. The systems requiring traffic directors shall be avoided. However, if unavoidable, dual redundant traffic directors shall be provided

5.6.5 Design shall ensure that there is no cause of common mode failure in communication sub-system.

In general, both the communication networks / devices shall be active at all the times in such a way that either they shall take the communication data load or switch the communication path at regular interval whenever vendor standard data transfer technique allows data transfer to one network while redundant network takes control on the failure of the main network fails. Vendor shall ensure that there shall not be any system degradation or data loss before, during and after the changeover.

Redundant communication network and communication components / modules shall be continuously checked for their availability and healthiness. In case of main bus failure or any communication device failure, the transfer to the back-up device or bus shall be automatic without interrupting the system

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operation and without any operator's intervention. Information about the failed device / bus shall be displayed on the operator console.

5.6.6 Communication network protocol used within the system shall safeguard against false date transfer and allow error detection, recovery failure detection and initiatives of switchover to the redundant network / network component / module.

5.6.7 In addition to automatic switchover of communication network on detection of failure of active / one of the network / network device, it shall be possible to switch over the communication from main bus to the redundant bus manually without disturbing the system operation. Manual switchover shall be effected whenever the network integrity and switchover is to be verified during testing.

5.6.8 The mechanism used by the communication system for error check, parity error, over-run error etc and other advanced codes.

5.6.9 In general, the transmitting message shall identify the transmitting the receiving device. The transmitting device shall receive a reply from the receiving device on the receipt of correct message. Lack of response shall be considered as a receiver failure. These shall be positive acknowledgement of all messages transmitted over the communication network.

5.6.10 Communication speed on the communication bus shall be sufficient to update the operator console data base once in every second. The overall system performance shall not be degraded whether communication sub-system is 10% loaded or 100% loaded. Degradation of communication bus shall be as defined under para 2.18 of this specification. Failure of one or more nodes shall not degrade the communication performance in any way.

5.6.11 Network Diagnostics

5.6.11.1 Network management software shall be resident on all the network modules in order to ensure reporting of node status to other network nodes and reporting node failure alarm within one second.

5.6.11.2 Communication network diagnostics shall run continuously so that the failure of any network / network component / communication module is alarmed without any delay.

The diagnostics sub-routines shall detect and isolate faulty network component and noisy network cables. Communication shall automatically transfer to the redundant component/ module / network whenever the failure is detailed without interruption of system operation and loss of data.

5.6.11.3 Diagnostic sub routines shall be available to monitor the network performance and generate an on-demand report of all the accumulated number of errors over a specified time period.

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5.6.12 Network Components and their Requirements

5.6.12.1 All hardware like network cables, connectors, media converters, network switches and hubs and fibre-optic patch-cards required for completing communication network shall be supplied by the vendor.

5.6.12.2 Network can be either screened twisted pair copper and / or fibre optic cable. All network cables shall be armoured type. Fibre optic cable in addition shall be jelly filled for protection against ingress of moisture.

5.6.12.3 Communication network if routed outside the control room shall be fibre optic type only and shall support the use of media converters for fibre optic network. The system design shall allow the use of unequal network lengths in case of redundant network configuration to make-up for the difference in routing lengths.

5.6.12.4 Type and specifications of the fibre-optic cable shall be decided by vendor based on the distance, band-width required for data transfer and allowable signal attention. Minimum two number of spare fibres shall be provided in fibre optic cable.

5.6.12.5 Fibre optic cable shall always be routed in enclosed HDPE conduit with matching fittings. HDPE conduit shall be as per IS-4984 or as per equivalent IEC code. The outer sheath colour of HDPE conduits shall be orange with black for the fittings throughout the fibre optic cable run.

5.6.12.6 The network devices such as network switches, media converters, connectors etc, utilized in communication sub-system shall be of industrial grade type and of rugged design. These components shall be selected as per the make and model number listed in the vendor standard product guide.

5.6.12.7 The network switches used shall have multiple speed ports (10/100/1000 MBPS) and shall have;

a) Multi-processor design for high performance operation.

b) Routine diagnostics to detect and isolate noisy cables and jabbering nodes.

5.6.13 Network Loading and OPC Server

Worst-case network loading for the systems supporting determinable protocol shall not exceed 50% while for non-determinable protocol shall not exceed 15%.

5.7 **Open System Connectivity**

5.7.1 The system shall be capable of interacting with other plant systems and computers over a well established communication network like ethernet (HSE) conforming to IEEE 802.3. This connectivity with the other systems shall always be made via a firewall.

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5.7.2 The system software shall be support industry standards like Windows, OSF/ MOTIF, TCP/IP etc. as applicable.

5.7.3 The method of data access by any user on this network shall be by I/O Tag name and not by any physical or logical address.

5.7.4 Whenever the communication network is required to connect to any other system network or to plant information network, fire-wall (hardware and software) and routers shall be used.

5.7.5 The system shall be capable of acting as a Dynamic data Exchange (DDE) or OPC client or server to exchange real time data with DDC or OPC compliant application.

5.7.6 When OPC is used for interfacing, system shall exchange the data with any client's application in the standard OPC format. Design shall ensure that OPC connectivity tools are fully integrated within the standard product providing seamless integration. Following shall be ensured;

a) System shall provide alarm and event information with no point building from other OPC alarm and event server directly into DCS system alarm summary.

b) Allows OPC data access clients to view DCS system data, hierarchical area, point and parameter structure.

e) Allows access to historical data from DCS.

f) Allows third party OPC server information to be mapped, displayed, alarmed, get historical data and controller data into the system server.

g) Integrates supervisory monitoring, alarming and control data between two or more OPC servers.

h) All graphic applications and all control function blocks supported by operator console software shall have direct access to data integrated with DCS via OPC.

i) OPC data groups, items and tags shall be viewable in any browser function provided in graphics, devices or control configuration tools as if it were data native to the controller sub-system.

5.7.7 OPC Server

5.7.7.1 Vendor shall offer integrated or dedicated OPC server in a high grade minimum RAID 5 Configuration only This node in no way restricts the data transfer. In any case, the device shall be intelligent with adequate memory and software capabilities.

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5.7.7.2 OPC Data Access (DA) Server

a) OPC data access server functionality shall allow bi-directional data transfer between multiple OPC data access servers for monitoring, alarming and control. DA server shall read and write process data using item ID is identifier.

b) Rate of data transfer in case of DA server is typically 1000 tags per second.

5.7.7.2.2 OPC Historical data access (HDA) Server

a) OPC client shall access DCS data by connecting to HDA server. It shall also automatically save instantaneous data acquired from DA server and A&E server to be a historical database in HDA server.

b) HDA server shall be able to receive and publish data timely and efficiently whether online or from archived source. System shall be able to read raw data at the rate of 1000 tags per second and read manipulated data at the rate of 100 data per second.

5.7.7.2.3 OPC Alarm and Event (A&E) Server

a) OPC A&E server shall publish DCS alarm and events to OPC clients. The server shall support event types such as conditions, tracking and simple events (e.g. component failure). It shall also publish DCS alarm and event such as process alarms, alerts, messages, event, sequence of events and operator changes.

b) OPC A&E server shall write the following messages to DCS, as a minimum;

i) System and process alarm messages

ii) Mode change and status change message

iii) Sequence message

iv) Operator guide message

v) OPC server alarms and errors

vi) Engineering maintenance messages

c) The maximum number of alarms and events received by OPC A&E server shall be of the order of 1 A&E per second.

5.7.7.2.4 OPC Batch Server

OPC batch server shall read and write the batch related data and information of DCS.

5.7.7.3 The OPC server software shall have the following features, as a minimum;

a) It shall meet support standard OPC standard interface functions such as DA, A&E, HDA, Batch and security as specified by OPC foundation.

b) The software shall be able to interact with another OPC compliant software loaded in another Third party server machine associated with different make of DCS or control system without the need of any additional hardware or / and software.

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c) The software shall support automatic data back-up in such a way that process data acquired by DA / A&E server are automatically saved as back-up data on a disc without client having requested to save the data by server.

d) The software shall allow viewing of contents of OPC server from OPC client.

e) The software shall have capability to restrict the access of OPC server to its client to avoid exceeding the maximum accessible data to avoid load concentration which may slow down the data access.

5.7.7.4 System Sizing

Following criteria shall be followed for sizing OPC notes;

a) Number of third party OPC servers / nodes (This shall include UHN connected to other DCS systems) shall be minimum 10. Ten (10) concurrent licenses shall be supplied as part of OPC node.

b) In addition to third party servers, consider the following;

Number of client per OPC node	:	10
Number of third party OPC devices Such as RTU's	:	10 (when specified)

c) Follow up rate of data read / write shall be considered for sizing;

OPC client data read (cache read)	:	1000 per second
OPC client data read access (Device)	:	500 per second
OPC client write	:	500 per second
d) Maximum number read and write data for OPC node	:	2000 data points (unless otherwise specified)

One data point shall include PV, MV, SP for analog control loop.

5.7.7.5 System performance

OPC node shall meet the following performance requirements;

Data read and write on client machine (This includes data display update for real time data)	:	max. 5 seconds
Data read and write on server machine	:	max. 5 seconds
Maximum server loading	:	50%

5.7.7.6 OPC node configuration shall be minimul RAID -5

5.7.7.6.2 OPC node shall be supplied with operating system and other softwares to meet functional requirements specified herein.

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5.7.7.6.3 Whenever OPC node is provided with historisation or dedicated , it shall have RAID 5 configuration.

5.7.7.6.4 The system when specified, shall offer a standalone software application that provides OPC server redundancy by transparently redirecting client requests to secondary OPC server when primary OPC server is unavailable or fails.

5.8 Time Synchronization

5.8.1 The system shall have capability to synchronize the time of all the sub-systems within the system either by internal or external clock as specified in the job specification.

5.8.2 Time Synchronization with Internal clock

Unless specified otherwise, all the sub-system node clocks shall be synchronized with designated system master clock. Master clock shall either be assigned automatically by system or assigned manually during system configuration. In both the above cases, whenever the master clock node fails, an alternate sub-system clock assumes the charge of time synchronization. In no case, the system shall operate without time synchronization.

5.8.3 Time Synchronisation with External Clock

a) When specifically indicated, the time shall be synchronised with external time reference eg GPS. This shall ensure that data acquired by all sub-systems will have the same and common global time reference. All hardware and / or software required to meet this requirement shall be supplied by the vendor.

b) In general, the system shall be provided with an external GPS antenna connected to a master clock server. This server shall synchronise all DCS clocks and also provide time synchronising outputs to synchronise all non DCS sub-system clocks. The node shall not exceed 30 millisecond time difference between GPS and any node clock come.

c) In case of failure of master clock server the time synchronisation shall be carried by the designated DCS master clock.

5.9 Shutdown Sub-system - Programmable logic controller (PLC)

5.9.1 Programmable logic controller shall be microprocessor based system which shall be used to execute all the process and safety shut-down logic of the plant when specified, it shall also execute plant interlock logics as well. Programmable logic controller shall be an independent unit and shall not depend on any of its functionality on any other system including Distributed Control System.

5.9.2 The system shall be designed fault tolerant and shall utilize high quality components of proven quality. Any single system fault shall not degrade the system safety or functionality of effect operation. The

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system shall have certified Safety Integrity Level as per IEC-61508 / 61511 as applicable and specified in job specification. Unless otherwise specified it meet the availability requirement specified in Clause 5.1.3 of this specification.

5.9.3 The system shall have a very high noise immunity in order to ensure safe and reliable operation when subjected to electrical radio frequency interference and Electro-magnetic disturbances expected in a plant.

5.9.4 Unless otherwise specified, the scan time of programmable controller shall be of the order of 250 milliseconds. Scan time for a PLC shall be as defined under para 2.21(c) of this specification.

5.9.5 Operation of PLC shall be completely unaffected by a momentary loss of power of the order of 20 milliseconds.

5.9.6 On line replacement of any module of programmable logic controller shall be governed by Clause 5.1.6 of this specification in general. However, in case of Dual Redundant,Triple redundant, Quadruple Modular Redundant (QMR)configuration, there shall not be any process upset while replacement of failed module.

5.9.7 It shall be possible to Hot swap any faulty system module without degrading the system safety or operation or freezing the output status. The switchover to the healthy module shall be bumpless. The swaped module shall take over the function of the failed module without any manual programming.

5.9.8 The system shall be programmed in principle as per the logic diagrams furnished during detail engineering. Vendor shall prepare their own Logic/Ladder diagrams depending upon the capability of the programmable logic controller offered by them. Owner / Consultant reserves the right to revise or review the logic diagrams even after acceptance of any offer. The programming language of offered PLC shall be as per IEC 61131.

5.9.9 Whenever the requirement of SIL is specified for the, it shall meet the requirements of SIL level specified and shall be certified by an indepedent body (e.g. TUV) for complying requirements of IEC-61508 / 61511 as specified.

5.9.8 Power supplies in the system shall be provided as follows:

5.9.8.1 Each I/O rack shall have a separate independent power supply system. Each power supply shall be sized to take full load of the I/O rack/signal conditioning panel/rack and shall be provided with dual redundant power supply.

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5.9.8.2 Each processor shall be provided with separate power supply. Failure of one power supply shall not affect the system operation in case of dual processor system. Wherever triple redundant system is specified each processor shall preferably be provided with a separate power supply. Also separate power supply must be provided for each multiplied process I/O channel.

5.9.9 System Architecture

5.9.9.1 General

a) PLC system configuration / architecture shall be as specified by Bidder.

b) Regardless the action feature selected (except for single architecture), the failure of single component shall not result in a failure of correctly executed safety function.

c) In general, the PLC system shall comprise of various sub-systems as described in the subsequent clauses of 5.9.9.

5.9.9.2 Input/Output system

5.9.9.2.1 Each I/O module shall have its own processor working asynchronocally w.r.t control processor and other I/O processors. However, I/O modules configured in redundant configuration, shall have their processors properly synchronised.

5.9.9.2.2 Unless otherwise specified, system shall accept analog 4 – 20mA inputs and contact inputs. The maximum number of Input/Output per I/O module shall be limited as per the following table.

Sl. No.	Type of Configuration	Maximum No. of I/Os
1	Single I/O system	8
2	Dual I/O system	16
3	Triple Modular Redundant system (TMR)	40
4	Quadruplicate Modular redundant System (QMR)	16

5.9.9.2.3 Each I/O shall be galvanically isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 1000 volts DC.

5.9.9.2.4 Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.

5.9.9.2.5 Each input shall be provided with filters to filter out any noise in the input line and contact bouncing noise, as applicable.

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5.9.9.2.6 All the inputs shall be double ended i.e. two wires per input and not with common return for all inputs.

5.9.9.2.7 The interrogation voltage to the inputs and power supply for 2-wise instruments shall be powered from separate redundant power supply / supplies and shall not be a part of PLC, unless otherwise specified. This power supply shall be supplied at one point and shall be distributed by the vendor.

5.9.9.2.8 a) Each I/O module shall have a LED per channel to indicate the status of each Input/Output.

b) When specified, input module shall be capable of monitoring the input contacts for any wire open fault (i.e. 4 – 20mA).

5.9.9.2.9 Analog input module

a) Input module shall be capable to accept input from transmitters (.e.g. 4 – 20mA).

b) The module shall have 12 bit A/D resolution accuracy of ±0.25% of full scale over the entire range, unless otherwise specified.

5.9.9.2.10 a) Output contacts from the PLC shall be potential free dry contacts with contact rating as per para 5.9.9.2.10 b) of this specification. Wet contacts/ powered contacts / TTL outputs etc. shall not be acceptable. Vendor must provide arc suppression device for each output contact.

b) The output contact rating shall be as follows:

Sl. No.	APPLICABLE FOR	VOLTAGE RATING	CURRENT RATING
1.	All output cards driving solenoid valve and alarm annunciator system unless otherwise specified.	110 V DC	0.5 A
2	All motors/pumps/compressor output cards unless otherwise specified. Category – I Category - II	240 V AC 220 V DC	5.0 A 0.2 A

The category of contacts shall be specified in the material requisition.

c) Each output shall be short circuit proof and protected by fuse. Visual indication of fuse blown must be provided for each module.

d) When specified contact output module shall have monitored output features like 5.9.9.2.8(b).

5.9.9.2.11 The communication of I/O system with central processor shall be carried out redundant with complete error checking.

5.9.9.2.12 Where inputs or outputs have multiple field devices for the same measurement or device, the outputs shall be configured in separate I/O modules.

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2.9.9.2.13 Where single input signal is available for QMR or DMR/TMR configuration, inputs shall be multiplied to feed independent inputs to each input modules.

5.9.9.3 Processor system

5.9.9.3.1 The processor shall have capability to implement all the control functions required to implement the logic scheme attached alongwith, as logic/ladder diagram.

5.9.9.3.2 The size of the memory shall be sufficient for storage of the program instructions required by the logic schemes and other functional requirements. Offer shall indicate the amount of memory capacity occupied by the actual program and spare capacity available for later program modifications or additions.

5.9.9.3.3 Memory shall be non-volatile. However in case volatile memory is provided, battery back up shall be provided with a minimum of 3 months lifetime to keep the program storage intact. A battery drain indication shall be provided at least one week before the battery gets drained. A potential free contact shall be provided for hardwired annunciation in the central control room.

5.9.9.3.4 Watchdog timer shall be a software device. The healthiness of processors shall be continuously monitored by watchdog timer. Any hardware or software problem in the processor system, which shall include, CPU, memory, power supply, communication interface etc. shall cause the watch dog timer to report processor failure.

5.9.9.3.5 Wherever Qurd redundant processor is specified, redundancy, shall be provided in such a way that in case of failure of the main processor, the standby shall take over automatically. The changeover, shall be bumpless and the system shall be fail proof, unless any other requirement is specified in the job specifications. Redundancy shall be provided for complete processor system including CPU, memory, power supply and communication sub system.

5.9.9.3.6 In case of triple redundant system all the three processors shall execute the same instructions / programs and check their results and majority vote to correct any faulty result. The faulty processor diagnostic shall be made available.

5.9.9.3.7 In case of QMR system, individual processors shall execute the same instructions / programs and check their results within same CPU module and vote to correct any faulty result. The faulty processor diagnostic shall be made available.

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5.9.9.3.8 Failure of a single processor in triple redundant system and two processors in quad system shall not affect the system. In case of failure of complete processor system i.e. both processors in case of dual configuration, two or more in case of triple redundant system and more than two in case of quad system, outputs shall take failsafe state automatically unless otherwise specified in the data sheets.

5.9.9.3.9 In case multiprocessor configuration is offered, the processors must be able to communicate with each other over the interconnecting data link. Vendor must ensure that system performance shall not be degraded by any means when such a system is offered.

5.9.9.3.10 It shall be possible to generate the first out alarm contact by the PLC in case where a group of parameters are likely to trip a system.

5.9.9.4 PLC console (Programming)

5.9.9.4.1 The PLC console shall be used for programming, program storing, fault diagnostics and alarm monitoring and should be completely independent of control system(DCS) network /functionality/hardware/software. Whenever specified, it shall also be possible to use this for plant operation. The functionality to operate as engineering terminal or operator terminal or both shall be specified in the material requisition.

5.9.9.4.2 It shall consist of a at least one coloured 21" size TFT screen and one programming / operating keyboard and printer unless specified otherwise.

5.9.9.4.11 PLC console when used for plant operation shall also meet the following functional requirements.

5.9.9.4.3 The keyboard shall preferably be touch sensitive sealed type, easy to operate with each key clearly identified.

5.9.9.4.4 All illegal entries shall be rejected by the terminal and shall be identified by warning signal on VDU.

5.9.9.4.5 Manual forcing of any input or output contact connected to PLC shall be possible from keyboard. Forced functions shall have an associated audit trail.

5.9.9.4.6 It shall be possible to modify, add or delete the application program on line without affecting the outputs.

5.9.9.4.7 PLC Console shall display logic and/or ladder diagram indicating power flow and shall show description and status of each contact. It shall also be possible to display process alarms and diagnostic messages as and when they appear. Further it shall also be able to display I/O map in a user defined format.

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5.9.9.4.8 It shall be possible to print out the ladder/logic diagram on the dedicated PLC printer. The printer in addition shall also print out;

a) The diagnostic messages as and when generated and diagnostic reports, when called for.

b) Process alarms connected to the programmable logic controller as and when they appear and alarm report whenever initiated. The choice of printing alarms on this printer shall be operator selectable from a key lock switch on PLC console.

c) The I/O maps showing status of all inputs and corresponding outputs in a user defined format.

5.9.9.4.9 The PLC console shall be provided with self diagnostics feature which shall display error messages and initiate an audible alarm if the fault is detected. A potential free contact for diagnostic group alarm shall be provided which shall be connected to the hardwired alarm and annunciator system.

5.9.9.4.10 The system shall be able to identify the failure at least up to the module level including I/O system and redundant processor and report print out.

a) When PLC console is specified, it shall have complete graphic capacity and shall be used for plant operation, process monitoring and control, fault diagnostics, alarm monitoring and report generation.

b) At least three number cursor control devices shall be provided in addition to keyboard which may include touch screen, mouse, track ball etc.

c) PLC operator console shall have complete graphic capability and shall be able to display process dynamic graphics, overview and group view displays. It shall be possible to operate the plant i.e. start and stop of rotating machinery, opening and closing of valves etc. from dynamic graphics and group displays available on PLC operator console.

d) It shall be possible to monitor, historise and print out all process alarms, diagnostic alarms and alarm reports.

e) The time stamping of all alarms shall be as per PLC processor time stamping .

f) The system shall be able to store and display stored data wherever required. The minimum storage capacity shall be for 30 days at 1 minute sample rate for all the inputs specified, diagnostic alarms, process and first out alarms, manipulation data etc.

g) The system shall be able to generate shiftily, hourly, daily, weekly and monthly reports. The log format shall be furnished during configuration.

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h) The system shall be supplied with first out alarm generation capability. The resolution of alarm shall be as per processor cycle time.

5.9.9.5 PLC Communication Subsystem

5.9.9.5.1 The PLC communication subsystem shall be a digital communication bus that provides a high speed data transfer rapidly and reliably between the processor, I/O sub-system, PLC console and other devices connected in the PLC system.

5.9.9.5.2 Redundancy in PLC communication subsystem shall be provided as follows unless otherwise specified.

a) The communication subsystem between PLC processor and I/O subsystem shall be single unless otherwise specified. This shall include single communication bus and single interfaces/buffers.

b) For the triple redundant system, each processor shall have a separate set of PLC communication subsystem.

c) For the QMR systems each I/O subset shall have separate communication interface and bus for connecting to respective CPU module.

d) The communication subsystem between processor subsystem and PLC console shall be dual redundant, consisting of two separate communication interfaces and two buses, each one configured in redundant mode, unless this is only used as programming aid.

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5.9.9.5.3 The mechanism used by the system for error checks and control shall be transparent to the application information / program. Error checking shall be done on all data transfers by suitable codes.

5.9.9.6 Interface with Distributed Digital Control System

5.9.9.6.1 The PLC shall be required to be interfaced to the offered Distributed Digital Control System bus. A suitable interface shall be offered in order to achieve the following functions:

a) Display of all input points under alarm/first out alarm connected to PLC or generated by PLC on the main operator console.

b) Generate shutdown reports on the logging printer of Distributed Digital Control System.

c) To receive certain operational commands from the operator console for the operation of certain output devices connected to PLC.

d) To display diagnostic messages of PLC.

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5.9.9.6.2 In general, PLC shall provide data in a well established protocol format preferably MODBUS protocol.

5.9.9.6.3 The interface shall be dual redundant unless otherwise specified meeting all requirements as specified under para 5.9.9.5.3 and 5.9.9.5.4 of this specification.

5.9.10 System software

5.9.10.1 The system software shall include all programs for the PLC and PLC console which are required to perform all PLC functions including communication and self-diagnostics.

Whenever different functional logics are combined within a common PLC, the safety related I/O's of each functionality shall be kept segregated within the system.

5.9.10.2 Logic program shall be recorded on the CD which shall be delivered in duplicate together with the system.

5.9.10.3 The PLC programming language for implementation of logic operations shall be based on the following representations:

a) Logic diagrams - Binary logic symbols such as AND, OR, NOT Gates, Timers and Flip-Flops.

b) Ladder diagram - Series parallel connection of relay contacts.

c) Combination of (a) & (b) above.

5.9.10.4 It shall be possible to print out the ladder/logic diagram on a dedicated printer. The printer shall also print out all diagnostic reports. Vendor must supply the off line software package to enable the owner to modify/add/delete any part of program and for documentation.

5.9.10.5 Software for the generation of various displays including dynamic graphics, whenever specified, to be provided as per para 5.4.3.5 of this specification.

5.9.10.6 The software for printing alarms, system as well as process and events on the PLC printer must be provided. All alarms must be printed as and when they appear.

5.9.10.7 Software package for displaying I/O map showing status of inputs and corresponding output as per logic shall be offered. The I/O map format shall be users definable.

5.9.10.8 The system shall have an extensive set of self diagnostic routines which shall be able to identify all permanent and transient system faults / failures at least up to module level including redundant

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components and power supplies through detailed VDU displays and report print out. Diagnostic software shall have the capability to provide information about the failed module/system either in the form of a system configuration display or provide information in the form of a statement.

5.9.10.9 System for the following functionalities shall be supplied when specified;

a) Long storage historisation
b) Log report generation
c) First out alarm generation

5.9.10.10 System diagnostics shall be capable of identifying, locating and reporting the following faults, as a minimum;

a) Processor fault
b) Communication fault
c) I/O module fault
d) Power supply fault
e) Over temperature monitoring
f) Permanently close / open (stuck on or off) fault
g) Scan time failure
h) Memory fault
i) Signal redundancy fault

Any other additional diagnostic alarm if available as standard shall also be provided by vendor.

5.9.10.11 Self diagnostic software shall have capability to detect faults which make the system permanently close/open in the I/O modules or I/O signal conditioning modules (incase of triple redundant system, whenever specified in the job specifications, this may be achieved by automatically running the testing software at cyclic intervals) The automatic cyclic testing feature shall also be provided for dual I/O configuration and dual I/O signal conditioning for triple redundant system. The testing software cycle time may be considered one in 30 minutes however this shall be field adjustable by engineer. However, system performance shall not be degraded whenever testing feature is specified.

5.9.10.12 In case of triple redundant system or quadruplicate system, whenever output module testing software detects any faulty channel, the power supply to that particular module in that particular bank is removed automatically and further testing on the corresponding module in the other mirror image bank is stopped. However, the testing continues uninterruptedly in other output modules.

5.9.10.13 Feedback must be provided in case of triple redundant system and quadruplicate system from the output voter system to detect any latest faults of the system in addition to other diagnostic software as per para 5.9.10.9 through 5.9.10.10 of this specification.

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5.9.10.14 Diagnostic package and its related equipment and software shall be supplied. A list of additional diagnostic packages available and the packages provided, including the description and capabilities, shall be provided with separate quote.

5.9.11 Sequence of Event (SOE) Function Requirement

Sequence of Event for analog and digital inputs shall be generated and time stamped in PLC. The maximum resolution between two events shall not exceed specified PLC scan time unless specified otherwise. A separate SOE PC with 21" size TFT screen and laser printer shall be provided for each PLC sub-system unless specified otherwise.

5.10 Foreign Device Interface

5.10.1 Foreign device interface shall be capable to transfer data from the foreign devices like analyser systems, gas chromatographs, gas turbine system etc. to other sub-systems connected to communication sub-system and vice-versa wherever specified in the job specifications.

5.10.2 Each device interface shall be redundant unless otherwise specified in job specifications.

5.10.3 Interface hardware and software shall be suitable to match the foreign device communication requirements like hardware interface, communication protocols etc.

5.10.4 While writing software or mapping the input/output in the interface device it must be ensured that integrity of the data to be transferred like resolution, correctness etc. shall be maintained.

5.10.5 Redundant interface switchover shall be designed based on the type of redundancy available in the foreign devices.

5.10.6 The total responsibility of selection of hardware, writing of software, switchover of redundant interface etc. shall be of distributed control system vendor only. All necessary information, assistance and help shall be rendered by the Foreign device vendor.

5.10.7 The exact requirements of Input/outputs to be transferred shall be as per job specifications.

5.11 **Interface with Smart Transmitters**

5.11.1 System shall be provided with suitable hardware and software to interface with the communication protocol of specified smart transmitters.

5.11.2 In case, smart transmitters are specified with 'HART PROTOCOL', the maintenance data related to these transmitters shall be made available on a separate Personnel Computer. The system shall meet the following requirements as a minimum :-

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a) The system shall allow the maintenance functions like configuration, calibration and monitoring of transmitter's data from the associated personnel computer in addition to Hand held terminal, whenever used.

b) The hardware used shall allow unrestricted transfer of digital signal without degrading the analog data i.e process variable.

c) The software supplied shall be 'CORNER STONE' OR EQUIVALENT compatible with the specified transmitter protocol. The software shall allow the following data to be displayed on the PC:-

(i) Complete configurational data base of all transmitters including data of commissioning, last calibration, next due calibration etc.

(ii) Historical data for calibrations and configuration changes.

(iii) Event and log reports.

(iv) Multiple authorisation levels for carrying out Configuration changes and Calibration adjustments.

(v) Manual editing of data base with Password and /or keylock protection.

5.12 **Hard-wired Instrumentation**

5.12.1 Hardwired instruments shall be stand-alone type and shall meet their functional requirements fully without depending on DCS system. Even power supply and input/output circuits of hardwired instruments shall be totally independent of DCS system.

5.12.2 Hard wired instruments shall be microprocessor based. Each instrument shall have as a minimum the necessary firm-ware to meet its functional and operational requirements.

5.12.3 Each device shall have its own analog to digital/digital to analog converter.

5.12.4 The display of each device shall preferably be bar graph type.

5.12.5 Controller shall be digital type capable of performing automatic control based on the set points given locally or from a remote device like another controller or Distributed Control System or Supervisory computer. The controller as an instrument shall also have provision for manually controlling the process by means of a manual loader and cascade-computer auto-manual transfer switch. The operation of the transfer switch shall be procedure-less and bumpless while changing mode from computer to cascade to manual and from manual to auto to cascade to computer. During such a change the output shall not change by more than 1% of span. Controller shall have a facia giving continuous indication of

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process variable, set value, controller output, and controller mode. It shall be possible to remove an instrument for maintenance without upsetting the process by use of device like service station. Operation of the controller like set point change, manual control, controller mode change shall be possible from the front of the controller. Controller shall be flush panel mounting type on the panel/hard wired console. Configuration and tuning of controller shall be possible through a portable and pluggable configurator.

5.12.6 Recorder shall have independent circuit and pen drive assembly for each channel. Recorder shall have capability of continuous line marking or digitized marking of input value with high resolution. Recorder chart drives shall be of multi-speed type and shall be operator selectable. Recorders shall be flush panel mounting type on the panel/hard wired console.

5.12.7 Manual loader unit shall have continuous display of process variable and manual loader output. It shall be possible to manually change the output to control valve. Manual loaders shall be flush panel mounting type on the panel/hardwired console.

5.12.8 Temperature transducers and trip amplifiers shall accept inputs from standard industrial thermocouple and resistance temperature detector (RTD). Linearization of the thermocouple and RTDs shall be done inside each instrument. Transducers and amplifiers shall be suitable for rack mounting.

5.12.9 Alarm cards shall accept standard outputs and shall produce changeover contact output. Each alarm card shall have one continuously adjustable blind setting device. Alarm cards shall be suitable for rack mounting.

5.12.10 Alarm and annunciator system

5.12.10.1 The alarm logic shall be executed in single input plug-in type logic modules. Where integral logic has been indicated, the logic module shall be accessible from the front of the annunciator after opening the swing door. The design of each module shall be such that by simply jumpering suitable point, it may be changed from normally open mode of operation to a normally closed mode of operation and vice versa.

5.12.10.2 Lamps shall be replaceable from the front. The power consumption of each lamp shall be approximately 10 watts.

5.12.10.3 The initiation of alarm condition in the annunciator shall take place approximately 330 millisecond after the condition sensing contact have assumed the off- normal state.

5.12.10.4 Hooter, in general, shall be solid state type with audibility of the order of 100 dB at a distance of 3 metres.

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5.12.10.5 An interruption of power supply for a duration of 20 milliseconds or less shall not affect the functioning of the annunciator.

5.13 Instrument Asset Management System (IAMS)

5.13.1 Instrument Asset Management System shall facilitate the maintenance management of all smart, field-bus based and conventional field instruments. Unless otherwise specified, the system shall manage the maintenance of following;

a) All smart and field-bus based instruments connected to Distributed Control System or Programmable Logic Controller.

b) Conventional (non-smart / non field-bus) instruments connected to DCS or PLC or any other dedicated instruments.

c) Field Instruments other than (a) and (b) above eg. local gauges etc.

5.13.2 The system shall include all hardware and software to meet specified functional requirements. In general, IAMS shall be an integral part of Distributed Control System and shall acquire the data from the controller and data acquisition sub-system. Inputs, which are connected to programmable logic controller, shall be parallely connected to DCS in such a way that the hardware used shall allow unrestricted transfer of digital signal without degrading the analog signal.

5.13.3 A dedicated IAM console consisting of one video display unit along with a printer shall be provided;

a) Display all data related to device diagnostics.

b) Provide historical data for calibration and device configuration / reconfiguration etc.

c) Generate event and other device reports.

d) Manual data entry with password / key lock.

The VDU shall be 21" colour TFT monitor along with a keyboard and a printer.

5.13.4 The system shall support multiple authorisation levels for carrying out configuration charges and calibration adjustment.

5.13.5 The Instrument Asset Management System shall meet the following requirements:

a) Instrument Configuration

It shall be possible to configure, verify the configured parameters, reconfigure, re-range and calibrate / recalibrate the smart and field-bus devices from IAM console.

b) Device Status Monitoring

The system shall monitor the status of all field devices and shall report any maintenance alarm generated by these devices. In general, following shall apply;

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- Diagnostic alarms from smart and fieldbus devices shall be classified into device failure and device diagnostic categories.
- Out of limit alarm shall be generated to indicate device failure alarm for conventional devices.

The system shall be capable of displaying and generating maintenance report listing all devices currently under alarm. The report may be generated unit-wise / area-wise or for complete plant.

c) Maintenance database

The system shall be able to maintain maintenance database for all the instruments which shall include date of commissioning, last calibration date, next due calibration. The system software shall have capability to manage and track scheduling of all such maintenance related activities.

The software shall also provide data as predictive maintenance such as list of transmitters experiences excessive drift, list of control valves loosing on shipping characteristics etc.

d) Audit Trail

The system shall have capability to provide an audit trail for a complete historical record of all configuration, calibration and device alert data. This shall include tracking of maintenance history for all instruments in the plant, typically recording the type of maintenance work done, smart and compilation times of activity, person responsible for the activity etc.

e) Advanced diagnostics

The system shall be able to provide advanced diagnostics such as device step response, device signature, dynamic error band etc. special device diagnostic software whenever required (like for smart / field-bus position) shall run in the system.

f) Documentation

System shall generate documentation like trend reports, diagnostic reports, pre-detective maintenance report, audit report, historical data and device specification sheet etc. Definition, engineering, configuration, loading and completion of all reports whether specifically indicated are available as standard and shall be supplied as part of vendor scope of supply.

5.14 Alarm Information Management System (AIMS)

5.14.1 The purpose of Alarm Information Management System (AIMS) is to provide a centralised Alarm information over and above the requirements specified in Clause 5.4.3.8 of this specification and shall be used for acquiring, sorting, add value and provide redistribution platform, so as to streamline and transform the raw alarm data into intelligent, add actionable information for plant operation personnel.

5.14.2 The system shall acquire inputs from various systems such as;

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- Distributed Control System / Systems and Programmable Logic Controllers.
- ESD and F&G Systems
- Package unit control systems
- Machine monitoring and Analyser system
- Electrical control system / systems
- Electrical numerical relays
- Any other system defined specifically in the job specifications.

5.14.3 Unless otherwise indicated, the AIMS shall have a high speed data transfer OPC link connectivity with the systems. Where OPC link is not available, the data transfer shall be through dedicated serial links. In addition, AIMS shall also have capability to accept hardwired inputs.

5.14.4 Unless otherwise specified, the following type of data shall be acquired by the AIMS software for further analysis;

- Process and utility alarms
- System diagnostic alarm
- Sub system status alarms
- Operator activities
- Maintenance alarms

The AIMS shall offer a variety of alarm handling feature for processing, and presenting alarms in most efficient way. The package shall be a comprehensive tool with capabilities of;

a) Logical filtration of alarms during normal and special operating conditions such as start-up, process upset and turndown conditions.

b) Logical processing of events and sequence of events for facilitating quick assessment of normal or emergency situation based on pre-defined rule-sets.

c) Generation of different levels of alerts, based on type of alarms, sequence of alarms, logical processing of alarms etc. and propagation of the same to different groups and categories of personnel's, based on pre-defined alarm distribution matrix.

5.14.5 AIMS shall meet the following functional requirements, as a minimum;

5.14.5.1 Data Acquisition

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The data acquired from the various sub-systems and other control systems shall be stored in a dedicated AIMS server. The data shall be stored in a structured format and shall contain tag number, time of occurrence, text information like service description, event type, alarm priority, alarm group priority etc.

5.14.5.2 Alarm Computing

The package shall have capability to generate / compute alarms based on a logical combination of states, conditions and events.

5.14.5.3 Information Analysis

The package shall have capability to analyse and present only the meaningful information. This shall include the following;

a) Analyse the alarm frequency within the predefined period and its repetition period.

b) Analysis of various alarms to identify nuisance, chattering and redundant alarms and eliminate them, if necessary.

c) Analysis of various alarms to identify serious alarms and monitor their frequency of occurrence.

d) Monitoring Operator actions.

5.14.5.4 Expert Alarming

i) The system shall be able to carry out statistical analysis on the alarms data gathered and perform;

- Real-time frequency analysis
- Alarm frequency break-up
- Alarm frequency monitoring
- Standing alarms
- Time elapsed between two alarms / events

ii) The system shall have capability of implementing rule sets to analyse various alarms / data and inform plant operator the probable reason, make recommendations for the action to be taken and provide operational alternatives.

iii) System shall also be capable of analysing and recommending maintenance requirements based on preset rules.

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iv) The system shall have advanced search and sort features to provide quick access of alarm data to operator.

5.14.5.5 Alarm Prioritisation

The system shall have the capability to segregate the alarms as per their criticality and operational importance, which may be defined as per the severity with respect to its;

- Production losses
- Human and equipment safety
- Environmental safety
- Process reaction time like run-down reactions

The alarms shall be differentiated in different displays by allocating different colour codes.

The system shall be able to be configured with different priority levels which shall be defined based on the process criticality and operational requirements. As a minimum following priority levels shall be definable;

Level 1 - Alarms directly related to human safety – leading to heavy casualties

Level 2 - Alarms directly leading to total plant shutdown – personnel, environmental and equipment safety hazard.

Level 3 - Alarms leading to partial plant trip conditions.

Level 4 - Maintenance alarms not leading to immediate plant trip.

Level 5 - Status or low priority alarms for operator information.

Other priorities shall also be user definable. It shall also be possible to set priority for each and every alarm point. Assignment or change of level of priority shall be possible only under password protection.

Number of alarms under each level of priority shall be user definable. However, for the purpose of internal assignment, following numbers may be considered

Priority Level	No. of Alarms
Level 1	10 Nos.
Level 2	70 Nos.
Level 3	5% of Total
Level 4	20% of Total
Level 5	75% of Total

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5.14.5.6 Alarm Display

a) AIMS shall display alarms gathered from all Nodes / subsystems seamlessly and shall be displayed on any display irrespective of source or location.

b) Alarm display shall be sorted out in the form of alarms groups in the following categories;

- Priority level sorting
- Sorting as per type, frequency, unit-wise, area wise and operating area wise.

c) AIMS displays shall be in graphic form with user friendly displays, color modifiers etc.

d) The system shall process alarms using well proven analysis techniques, directly related to specific alarms, which are trendable.

The system shall have advanced Rule-based and latest abnormal condition management tool which shall provide prediction and anticipation of plant deterioration with sufficient lead time for operation action. The system shall also have real time root cause analysis.

5.14.5.7 Operator Actions

The system shall be able to acquire and analyse operation action required during plant operation such as;

- Time to alarm acknowledge
- Controller mode changes
- Controller set point changes
- Analogue output changes (in manual mode)
- Discrete output changes (in manual mode)
- Alarm level of priority changes
- Range changes
- Tuning constant changes
- System configuration changes e.g. control algorithm, cycle time changes etc.
- Manual time adjustment
- Alarm acknowledgement
- ESD switch actuation (full or partial)

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° Any other operator action not specifically indicated above but required during operation. The operator actions shall also be categorised based on their criticality in various levels.

Level – 1 - Most critical operator actions leading to plant shutdown in full eg. ESD switch action.

Level – 2 - Configuration changes or set point changes which may lead to mal Operation or partial plant shutdown eg. set point changes, range Changes, time adjustment etc.

Level – 3 - Changes which may effect control but rarely could lead to plant Shutdown full or partial eg. controller mode change, range changes, tuning constant changes etc.

Level – 4 - Actions which are mere operation but does not lead to plant operation.

The system shall also able to provide information like;

i) Time to acknowledge alarms

ii) Alarm acknowledge time exceeding a pre-set value.

5.14.5.8 Report Generation Printing

The package shall have capability to;

a) Store alarm messages for a period of minimum one year and shall have facility for data archival on portable media.

b) AIMS shall be capable of generating and printing reports in user defined formats. The data in each report shall be either raw, manipulated, calculated, compressed or analysed.

c) The alarm shall be possible to be printed as and when required, as a user defined formats. These formats shall be defined during engineering.

5.14.5.9 System Diagnostics

The AIMS shall have extensive set of diagnostic subroutines running in real time basis and shall provide at least the following diagnostic alarms;

- System software failure
- Disc / Disc drive failure
- Application software failure

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- Network failure
- Communication software failure
- Disc full
- Power supply failure

These diagnostic alarms shall also be made available at DCS operator and engineering consoles.

5.14.5.10 Data Storage and Archival

AIMS shall store alarms and events indicated in Clause 5.4.6 for a period of minimum 1 (one) year in the hard disc. Multiple disc configuration, if required, shall be provided for the purpose of calculating data storage capacity consider occurrence of 30% of alarm and events per day apart from other system defined functionalities.

5.14.5.11 Alarm Notification and Audio Messaging

The system shall be capable of performing following alarm notification and messaging functions;

a) Dial Telephone

In case of predefined alarm or alert condition the system shall automatically dial a telephone number and plays a pre-recorded message. All hardware and software for auto-dialing shall be included.

b) Dial a Cell phone

The system shall have facility to dial up mobile pager or mobile cell phone. When an alarm occurs, the system shall be able to send a test (SMS) message also.

c) E-mail

When a predefined alarm occurs, the system shall be able to send message through an e-mail to the predefined user. This facility shall also be utilised to send e-mails to the manufacturers of various system oriented items like DCS, PLC etc in case of occurrence of a critical system diagnostic alarm.

d) Audio Messages

The system shall be capable to play a pre-recorded message in case of predefined critical alarms on the plant public address system. For example, this shall be useful for alerting plant personnel's on gas / fire alarm in a particular area.

e) Emergency Hooters

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The system shall be capable of generating input such that in case of an emergency condition emergency hooters can be initiated along with audio messages on the public address system.

5.14.6 System Hardware & Software

5.14.6.1 AIMS shall have all the hardware and software to meet the following major functional requirements;

a) Efficient storage and archiving of acquired and manipulated data to allow retrieval of reports or alarm analysis information.

b) Retrieval of important information on-line to a network drive disc or dedicated device.

c) Remote access to more than one clients on the network.

d) Export alarm, events or other information to other applications, Excel or Access.

e) Advanced diagnostic techniques for analysis of acquired data.

f) Log the time between specified alarms / messages.

g) Assignment of various level of pass-ports.

h) Multiple client's displaying different data or data screens simultaneously.

i) Disc mirroring for data storage over the network.

j) Automatic Triggering of alarm reports and messages on devices like mobiles, telephones, computer networks etc.

k) Data search facilities with efficient search engines like SQL.

l) Data sorting facility as per defined rule-set.

m) Time stamping of data as per AIMS clock wherever required.

5.14.6.2 AIMS can be reealised on either the DCS platform or as a stand along system. In either case the offered solution shall meet all the requirements specified in MR without exception.

5.14.6.3 In case AIMS functionality realised on DCS platform a separate dedicated AIMS station shall be provided. This station shall have same hardware and software configuration as operator console and shall have redundant storage disks for bulk data storage.

5.14.6.4 In case stand-alone system is considered, the same shall meet the following requirements;

a) The system shall be capable of interaction with DCS via a serial port or by OPC connectivity.

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b) The system shall have a minimum of one dedicated server with monitor and cursor control devices capable of meeting all functional requirements for AIMS. If the system demands more than one server to meet job requirements, the same shall be supported and provided.

c) The AIMS console shall be server based machine and shall have 21" LCD display screen with keyboard, mouse and read / write DVD drive.

d) The system shall support client server architecture with minimum of 4 clients. Detailed functionalities of these clients shall be finalised during engineering. The clients shall also meet hardware and software requirement specified in Clause 5.14.6.4(c).

e) AIMS server shall have redundancy in storage discs for bulk-data storage.

5.14.6.5 In general, all alarms and events shall be transferred to AIMS with time stamped by the originating devices. AIMS shall maintain this time for further analysis. AIMS shall time stamp the acquired data only when this data is not transferred by the originating device with time stamp.

5.14.6.6 The AIMS connectivity to third party devices and systems shall be either from the control network (i.e. communication sub system) or from the serial ports available in these devices. For third party systems direct connectivity from the station having master database is preferred.

5.14.6.7 When multi drop serial link connectivity, not more than four (4) devices shall be multi-dropped on one serial link to server.

5.14.6.8 AIMS shall have sufficient flexibility in hardware and software to interface a variety of peripheral devices, these include but shall not be limited to;

- Printer to be provided and attached to the server or client for printing reports and alarms.
- Public Address system for automatic broadcasting of alert messages in pre-designated areas. (The package shall be supplied with a voice package, which shall automatically broadcast the message as the occurrences of the particular alarm).
- Fixed line EPBAXs and Mobile telephones
- Horn and / or beacons for Audio / Visual alarming.

5.14.6.9 AIMS server memory shall be sized suitably to display and printout the alarm history of all the tags of all the systems and sub-systems connected to it.

5.15 **Unit History Node (UHN)**

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5.15.1 UHN shall primarily used to carryout the following activities;

a) Store automatically gathered data from control system (DCS, PLC, etc), other DCS systems over OPC and manually entered data.

b) Present data in a meaningful manner for performance enhancements and fault analysis.

c) Long term historisation of data for future reference and decision making.

d) Carryout calculations on the real time and stored data, as necessary.

5.15.2 The UHN shall be a high capacity data storage device where data from various process units shall be stored in a fast access database. The node shall support standard open system interfaces like OPC, SQL, OLE, DDE and shall provide active X facility.

5.15.3 UHN shall collect data from;

a) Distributed Control system of which this UHN is a node.

b) UHN's of other control systems

c) Nodes other than UHN's connected on information network.

d) Manually entered data.

The data collected shall be of various types like process variable, set point, computed variable, manipulated data, outputs, alarms, events, which shall be used for long term storage, trending and report generation.

5.15.4 UHN shall have capability of storing real time data in real time database and shall perform functions like;

a) Identification of bad data (algorithm to run in UHN when necessary)

b) Specify dead band and data sampling rate (or collection rate) as user definable parameter.

c) Calculate maximum, minimum, average, summission, and, integrated values of collected data. The time period of calculating average shall be user definable.

d) Specify high / low, high – high / low – low alarm limits for triggering an event or message or alarm as applicable.

e) Specify damping parameter, delay parameter etc. to reject unwanted data.

f) Specify data storage / sampling rate and period of storage necessary for historical storage of data.

g) Mathematical functions and application program as specified in material requisition which are necessary for report generation. (This does not include advanced control functions but do include MIS reports)

All the parameters indicated or functions performed shall be definable tag number wise.

5.15.5 Data Management and data presentation

5.15.5.1 UHN shall act as a network server and shall support two way data communication between;

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a) DCS and UHN for real time data transfer. UHN shall acquire real time data from DCS and provide derived and calculated data to DCS.

b) UHN and information network to transfer data from other systems on information network to UHN and vice versa.

5.15.5.2 UHN provides the user with current raw and calculated / manipulated data on predefined graphic screens or pre-defined report formats. The graphic screens and report formats are user configurable.

5.15.5.3 UHN perform long-term historization of raw and calculated / manipulated data.

5.15.5.4 The data received or sent from the UHN shall have time stamp associated with it from the originator of the data. The data update is effected in case the data value has changed by more than the configured dead band since the last update.

For manually entered data, the time stamp shall be time of entering data (by default) or the time entered with the data as applicable.

5.15.5.5 UHN time shall be synchronized with DCS time clock. For time synchronization refer clause 5.8 of this specification.

5.15.5.6 UHN shall maintain relational database and shall support oracle ROBMS tool.

5.15.5.7 All data raw, manipulated or manually entered acquired or calculated by UHN shall be stored, as unit-wide historian. Historian can be accessed to retrieve the data from specified period in the past. Historian should have capability to store data for a period of one year (365 days) with a sampling rate of 30 seconds, as a minimum. Other sampling rates such as 1 minute, 5 minutes, 10 minutes and 1 hour shall also be possible. The duration of on-line storage shall be controlled by the archiving facilities which in turn shall be dependent on specified sampling rate.

5.15.5.8 The data shall be presented to the user in a well structured hierarchically configured user displays. User shall be able to navigate down to any detailed data displays without any system configuration knowledge.

The display structure may include;

a) Overview display or main menu display, displaying key process parameters and performance indicators like real time data, swap-shot, calculated variables, real time trend, historical trends, manual data entry, function block, alarm and events, reports etc.

b) The reports generated shall include both tabular and graphical type (i.e. trend and bar graph). The reports as a minimum, shall include shiftily, daily, weekly, monthly and yearly reports. The report formats and specific data shall be finalised during system configuration stage.

5.15.6 System Administration and Security functions

5.15.6.1 The system shall perform the following administration functions;

a) System start-up and shutdown

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b) System configuration and configuration changes

c) System diagnostic alarm management

d) Archiving and storing history data.

e) System back-up and system restoration from back-up.

f) Manning user and security files.

g) Maintenance sub-routines and manipulation of data in the database with Audit.

5.15.6.2 UHN shall provide a full data security guarantee and shall be equipped with proper fire wall security features. For details refer clause 5.1.12 of this specification. Typically firewall shall be CISCO system appliance firewall (PIX) and software (IOS) or equivalent.

5.15.7 System Configuration

5.15.7.1 UHN shall be higher grade RAID 5 server machine with preferably Xeon CPU. The selected UHN hardware platform shall meet system throughput and capacity requirements. As a minimum, the system hardware shall meet the following requirements;

a) VDU shall be 459.7 mm active matrix TFT type coloured LCD screen.

b) QWERTY keyboard with SCSI interfaces

c) Mouse or track-ball control

d) Memory as 1GB RAM and 80GB hard disc (HDD) and shall support DAT and DVD / CD ROM.

e) Clock speed as 2.4 GHZ

f) Coloured laser printer

5.15.7.2 The system shall be supplied with a robust operating system and all supporting softwares necessary to meet functional requirements specified here in including RDBMS such as oracle or SQL with TCP / IP as network protocol.

5.15.8 System Sizing

Following criteria shall be followed for sizing UHN;

a) UHN shall interact concurrently with minimum 10 number of users in addition to DCS (of which UHN is the node) and clients main computer. Unless otherwise specified, ten concurrent user licenses shall be supplied along with UHN node. For the purpose of sizing consider at least 20 concurrent users.

b) The data shall be accessed from remotely located data sources through information network or through auto-dialing with proper ID address and password protection. The rate of data access from / to this network shall be considered as 1000 tags per second.

c) The data access from DCS shall be all 1.4 times the all analog (PV, MV, SV) and digital tags accessed at the rate of 1000 tags per second.

d) UHN historian shall be sized considering following factors;

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Storage data	:	2 times the total analog (PV, MV, SV) and digital data of all DCS connected tag number (through hardwiring, serial ports, fieldbus etc.
Storage time	:	1 year (365 days)
Storage rate	:	30 seconds for all data
Storage interval on RAM:		20 minutes

5.15.9 System Performance

5.15.9.1 The response to all online enquiries and actions from any user shall be complied with 95% confidence level from any client with a maximum of 20 concurrent users as defined in clause 5.15.8(a) of this specification shall be as follows;

a) A data query to display on graphic or report : 5 second

b) Pre-defined trends up to 1hour data : 5 seconds

c) A data query to present a 24 hours report : 10 seconds

5.15.9.2 Average loading shall not exceed 50% when averaged over 15 minutes with peak loading at any time not to exceed 70%.

5.15.9.3 All securities shall be positioned while evaluating system performance.

5.16 Sequence of Event Recorder (SER)

5.16.1 Sequence of event recorder shall be provided for recording sequence of alarms / events for shutdown inputs.

5.16.2 The inputs for sequence of event recording shall be handled as follows;

a) The maximum number of inputs for I/P module shall be 32.

b) The contact inputs (either open or close on alarm) shall be multiplied using dual output contact barrier one of which contact shall be connected to PLC while the other contact is routed to SER. Wherever necessary, fast response multiplying relays may be used (certified by SER manufacturer)

c) For analog input, the signal shall be connected in parallel across the conditioning resistance to PLC or dual output barrier and to a dedicated alarm card, the contact of which shall be routed to SER.

In case analog input are to be routed to different physical locations or more than two devices, analog isolators shall be used.

5.16.3 SER shall be capable of providing demonstrable alarm resolution of 1millisecond between the events and shall also be able to print out the same with similar resolution.

5.16.4 The contacts or alarm may be close or open on failure and must be configurable for close / open on failure.

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5.16.5 The SER system shall be capable of providing alarm monitoring, printing and inputs for management packages. The configuration of inputs and other functions mentioned above shall be carried out using a dedicated terminal, which is also provided with a printer. Once configured, the access to configuration shall be denied except with 3 level of password protection.

5.16.6 All the trip / alarm settings should be same as that of PLC in all respects. The accuracy and resolution of measurements and settings are to be equal or greater than that of PLC.

5.16.6.7 Vendor shall make a provision to connect PLC outputs to SER recorder whenever necessary and decided during engineering with proper isolation.

5.16.8 There must be 20% installed and wired spare input channels up to the marshalling cabinet for each type of input / output of DCS, PLC and other systems.

5.16.9 The system must have facility of keeping at least 96 hours of record at the time with last in and first out facility.

5.16.10 It shall be possible to configure / modify / reconfigure the system online through a dedicated programming unit. Engineering shall be possible to engineer the system using menu driven fashion. Any addition and deletion of inputs should be menu driven only and should be possible to be done during running condition.

5.16.11 It shall be possible to archive data from the SOE recorder on tape drive / CD drivt. CD driver and CD writer along with all necessary software shall be part of system supply by the vendor. The CD driver and CD writer must be with latest hardware and latest software.

5.16.12 The system shall have an extensive set of diagnostic package, which shall be able to provide the fault alarms up to the module level. The same shall be also printable on the laser printer.

The system shall be able to generate an audit report, which can be printed on demand. The audit report shall be able to provide shutdown area, time of shutdown and reason for shutdown.

5.16.13 Sequence of events shall also record PLC shutdown outputs.

5.17 Large Screen

5.17.1 The Giant Screen (Large screen) in the control room, is primarily used for:

a) Display important operational data of the plant /unit for ready reference like daily production, shutdown required /requested etc.

b) Display operational situations like start up or shutdown to enable mangers / operators to discuss without disturbing the unit operator.

c) Display any operator screen on the large screen.

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d) To provide real time clear luminous view of the unit to share information's between operators, unit managers and refinery manager.

e) To hold demonstrations to visitors for ready impressive and effective plant overview and plant highlights.

5.17.2 The giant screen shall be installed in the control room wall. The size of the screen shall be approximately 3200mm(L) X 1300mm(H) as a minimum.

5.17.3 The giant screen system shall have the following specifications:

i) The screen design shall be based on single chip DLP technology.

ii) Optical system shall have a resolution of 1024 pixels X 768 pixels Colour pixels per cubic. Each cube shall have a screen diagonal of 70 inches with 16.7 million colours

The lamp shall be pre-adjusted in lamp module, which shall not require any readjustment after replacement. The minimum operational time of lamp shall be 8000Hrs.

They shall be able to provide uniform brightness of 95% with a contrast 250:1, which shall be able to provide high contrast even in bright ambient light.

iii) The display screen shall be seamless and flicker less. It shall be black or grey in colour. The brightness and contrast shall remain uniform irrespective of the number of cubes used.

iv) The control of screen displays shall be carried out either from the operator console. The signal transfer shall provide guaranteed disturbance free operation, which shall not effect sharpness and colour quality.

v) The giant screen shall be lightweight and low thickness type, which can be supported from the control room wall. Only the front access shall be provided for any maintenance.

vi) The system shall perform satisfactorily in ambient conditions with maximum temperature of +40 degree Celsius and 80% non-condensing humidity.

vii) Provision of automatic switch off of Giant screen if temperature in the console room increases above the maximum permissible limit for Giant screen is required.

viii) VDU shall be provided with the Giant screen Control station.
Ethernet card shall be provided in Giant Screen to connect it with Ethernet port for necessary functionality.

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5.17.5 The Giant screen system shall be interfaced with the system such that any operator display of any screen could be displayed on the Giant screen suitably. It shall meet the following requirements;

i) Any operator console display or all operator console displays shall be able to be displayed or switched as desired.

ii) Screen areas should be protected for each console group.

iii) Priority of displays should be assignable.

iv) The system shall be supplied complete with all hardware and software as necessary for the specified application including interface software for DCS.

6.0 MISCELLANEOUS REQUIREMENTS

6.1 Safety requirements

6.1.1 Unless otherwise specifically indicated in job specification, all the equipment covered in this specification shall be located in general purpose non hazardous area, normally in control room or / and satellite rack room. However, transmitters, process switches and final control elements including smart positioners, solenoid valves etc. I/P converters (not forming part of this specification) shall be located in the field and shall be specified as per the electrical area classifications.

6.1.2 Unless otherwise specified, intrinsically safe certified transmitters, smart positioners, field-bus devices, and I/P converters shall be used when located in hazardous area.

6.1.3 Intrinsic Safety Protection

6.1.3.1 I/O modules of Distributed system shall have either built in intrinsic safety or shall use external barriers for intrinsic safety. Safety barriers shall also be used whenever intrinsic safety is specified for contact inputs and solenoid valves. Barriers shall not be required when protection other than intrinsic safety are specified.

6.1.3.2 The system as a whole shall be intrinsically safe based on entity concept. It may be noted that the field instruments are being bought separately and can be of different make and models by different recognised statutory body. These details shall be furnished during detailed engineering. Safety barriers selection shall be carried out based on the entity (safety) parameters which shall be properly matched. Field-bus segment terminator shall be considered for evaluating intrinsic safety of a segment. Any limitation or special requirements for cables to meet the intrinsic safety requirements shall be brought out in the offer.

6.1.3.3 Conventional or smart Instrumentation

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a) Whenever intrinsic safety is specified for conventional and smart instrumentation entity parameters of the elements in loop shall be matched with the barrier safety description parameters (i.e. loop design as per entity concept).

b) In case of smart transmitter, the entity parameters of the hand held terminals shall also be considered while selecting proper barriers.

c) Unless otherwise specified all intrinsically safe barriers shall be isolating type only providing isolation between;

i) Input and output (non-hazardous to hazardous side of barriers)

ii) Power supply and input

iii) Power supply and output

The minimum isolation level shall be 250V. In case of I/O modules have built in barriers, I/O modules shall also meet the requirements specified in Clause 6.1.3 of this specification.

d) Unless specifically indicated, only single channel barriers shall be selected. Following shall apply;

i) Dual input barriers shall not be selected

ii) Single input and single output barriers shall be selected.

iii) Single input dual output shall be selected when specifically indicated.

6.1.3.4 Field-bus instrumentation

a) Whenever intrinsically safe field-bus system is specified with Entity concept, safety parameters of various items in the segment shall be matched with the selected barrier.

b) Whenever FISCO system is specified, all components in the segment is FISCO complied, segment power supply selected shall also meet FISCO compliance. Segment design shall also meet FISCO requirements.

c) Whenever non-incendive is specified, all components in the segment shall be FINICO complied including segment power supply.

6.1.4 All intrinsically safe barriers shall be of the isolating type only, shunt diode type of safety barriers shall not be used. Only single channel type of barriers shall be used.

6.2 Power supplies and distribution

6.2.1 System Power Supply

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6.2.1.1 Unless specified otherwise, the system shall operate on uninterrupted power supply (UPS). However the system shall be capable of operating satisfactorily at the following power supply specifications :

Voltage	:	220 V AC ±10%
Frequency	:	50 Hz ±3 Hz
Harmonic contents	:	Less than 5%
Power interruption	:	10 millisecond

Various main load centres of distributed control system may be sequentially started whenever the starting current are high. The requirement of sequential starting shall be specified in job specification. The sequential starting circuit shall be designed using hardware timers and contactors of adequate rating.

6.2.1.2 The system shall be supplied with dual DCS feeders each capable of handling 100% of the total power supply load requirements. The system shall be engineered such that;

a) The redundant systems / sub-systems shall be powered such that main and redundant components are powered from separate UPS feeders.

b) The non-redundant components / items shall be powered from either of the feeders, unless otherwise specified in the job specification.

c) In case of failure of one feeders, redundant feeder shall supply the total load.

6.2.1.3 Each power feeder shall be monitored for its voltage and current in DCS, the transducers required for the measurement shall be located in power supply distribution cabinet/cabinets.

In addition to above, following indication / alarms shall also be provided for each feeder;

a) Voltmeter, ammeter and power-on-lamp on the cabinet front of respective power supply distribution cabinet.

b) Power failure Alarm contacts for such feeder for DCS monitoring.

c) One common power failure alarm contact for alarm on hardwired console.

6.2.2 DC Power Supply

6.2.2.1 DC supply shall be generally used for ESD devices and shall be 24V DC as specified in job specifications. In general, DC supply shall have the following specifications;

Voltage	:	24V ±10%

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Harmonic Contacts : ...

6.2.2.2 Each DC power supply feeder shall be monitored for its voltage. The voltage transducer shall be installed in the DC supply distribution cabinet.

6.2.2.3 In addition to above, following indications and alarms shall also be provided for each DC supply feeder;

a) Voltmeter installed on the respective DC power supply distribution cabinet.

b) Power failure alarm contacts for each feeder for DCS monitoring.

c) One common power failure contact for alarm as hardwired console.

6.2.3 Non-UPS Power Supply

6.2.3.1 Non-UPS power supply shall be generally used for panel / cabinet / console lighting, power sockets. The voltage shall be 240V 50Hz power supply. In general, 240V 50Hz Non-UPS power supply shall follow the following specifications;

Voltage : 240V ± 10%

Frequency : 50Hz ± 3%

6.2.3 All cubicles lighting shall be on 240 V, 50 Hz normal power supply.

6.2.4 Power supply shall be made available at one point. Further power distribution network shall be designed such that a single power fault in any instrument branch system shall not cause a trip of the entire system. Each consumer shall be provided with a separate switch and fuse for isolation and protection of the system.

6.2.5 Each transmitter shall preferably be powered with individual power supply. However when several transmitters are powered by a common DC source, each power supply branch shall have a separate switch and fuse. The distribution network shall be designed in such a way that overload in any branch shall not trip the main power supply. Enough redundant power supplies/battery banks shall be provided which shall take over automatically in case of main common power source failure. All power supplies shall have one to one redundancy and shall be sized for full load.

6.3 Equipment assembly

6.3.1 General

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6.3.1.1 All system equipment like instruments, electronic modules, power supplies, barriers, relays etc shall be installed in either of the following enclosures / cubicles as specified in purchaser's job specifications. The layout of these enclosures shall be prepared considering proper accessibility and maintainability;

a) Control Panels

All indicating types of dedicated instruments like single loop controllers, indicators, recorders, alarm annunciators, manual loading station manual switches etc shall be installed on control panel when control panel is the operator interface or when specifically indicated in the job specifications.

b) Hardwired Console

All indicating type of dedicated instruments like single loop controllers, indicators, recorders, alarm annunicators manual switches shall be installed on hardwired console when hardwired cosole is the operator interface or whenever specifically indicated in the job specifications.

Hardwired consoles form the part of main operator console and shall have same design, dimensions, colour, and shape as operator consoles.

c) System cabinets

All system hardware (excluding consoles) shall be installed in system cabinets. This shall include system racks, system modules, communication modules, power supply modules etc.

System cabinets shall be pre-standing type and shall be freely accessible from front and / or back as required. Following system cabinets shall be required, in general;

i) Power distribution cabinet (for AC and DC distribution).

ii) Safety barrier mounting cabinet (when field instrument is intrinsically safe).

iii) Controller and data acquisition sub-system cabinet.

iv) Temperature converter trip amplifier and other auxiliary card mounting cabinet.

v) Shutdown system cabinets (PLC processor and I/O cabinets)

vi) SER Cabinet

vii) Marshalling cabinets

Free issue items mounting cabinet (for mounting items which are free issued to vendor)

6.3.1.2 In general, control panels and hardwired consoles supplement the operator consoles for plant operation. Those instruments which provide direct operating interface to the plant operator are installed on these enclosures / cubicles.

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In contrast, system cabinets generally house back and items / equipments / instruments which are not required by the plant operator for direct operation.

6.3.1.3 Mechanical Design

6.3.1.3.1 As far as possible, panels / cabinets / consoles shall be manufactured using standard modular design and standard equipment. Vendor may follow their standard manufacturing procedures, however following points must be ensured;

a) All nuts, bolts, screws, washers (lock or flat) and hinges shall be of stainless steel. All fastening links shall also be of stainless steel.

b) Document pocket / wallet shall be provided on the inner side of front and rear doors of each cabinet and on the inner side of the door of each panel. Similar arrangement shall also be made on the inner side of doors of console.

6.3.1.3.2 Control Panels

a) Control panels shall have self-supporting free standing cubical construction with back doors made up of sectional steel panels. Two doors shall be provided for each panel, as standard.

b) Each panel section shall have the following dimensional details;

Height : 2000mm

Width : 1200mm

Depth : 1000mm

Panel shall be rigidly mounted on 100mm high channel base.

c) The panel shall be fabricated using angle iron frame section of minimum 50mm x 50mm x 4.0mm size. The control panel front shall be fabricated preferable from 3.0mm cold rolled carbon steel sheet.

d) Unless otherwise specified the panel shall be straight face type. Desk type panel shall be supplied where specified. Case shall be taken to ensure that the face of the panel is truly float and smooth.

e) Panel painting procedure shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high grade lacquer with wet sand blasting between coats. Two coats of paint in the panel colour shall be provided. Final coat shall be given after assembly at site of non-glossy high satin finish when specified in the job specifications. Colour of the panels shall be as per job specifications.

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f) Normal mounting heights of instruments (centre lines of instruments to floor) on panel shall conform to the following, with minor adjustments depending upon instruments selected.

1	Miniature and sub-miniature instruments. (3 rows)	Bottom Row Middle Row Top Row	1100 mm 1350 mm 1600 mm
2	Annunciators		1950 mm
3	Electrical push buttons		700 mm

d) Door locking arrangement

All doors of cabinets / panels / consoles shall have flush mounted handles with key operated mechanical door locking arrangement. The locking arrangement shall be interchangeable and shall have common key for locking / unlocking all locks (master keying arrangement).

e) Internal lighting arrangement

Internal illumination shall be provided for all panels / cabinets / consoles to ensure proper illumination level of 250 lux for performing maintenance activities.

Fluorescent lamps shall be provided in each cabinet / console / panel which shall be activated individually by door operated magnetic switches. The lamps shall activate when door is opened and deactivate when the door is closed. The magnetic switches selected shall have undergone life cycle cyclic test of at lest 10,00000 operations. A manual over-ride switch shall be provided inside the panel / cabinet / console which shall keep the lamp deactivated even when the door is open. Panels / cabinets / consoles housing memories, which are likely to be effected by fluorescent light, shall have incandescent lamps.

The cabinet / panel / console lighting shall operate on 240V AC emergency power supply.

f) Utility Sockets

Each cabinet / panel / console shall have at least one number each of 240V AC (emergency power) and 220V AC, (UPS) power socket. The sockets shall be rated for 10A as a minimum.

g) Ventilation

In order to effectively remove dissipated heat from the cabinets / panels / consoles, ventilation fans along with vent louvers backed by wire fly screen shall be provided as required. Ventilation fans shall be provided in all cabinets / panels / consoles where the temperature rise with all doors closed and all internal and external loads energised shall exceed 10°c above the ambient temperature. A

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temperature element (resistance temperature detector) shall be provided in each cubicle for temperature measurement. Ventilation fans shall be provided in dual configuration, as a minimum.

Each fan shall have a separate dedicated assembly and shall be replaceable on-line without shutting down any equipment / panel / cabinet / console in part or in complete.

Ventilation fan assembly shall operate at 240V AC emergency power supply. Each fan shall have its own dedicated circuit breaker.

Each ventilation fan shall be fitted with a protection type finger guard. Whenever, the number of panels / cabinets / consoles are compacted (supplied in mechanical joined conditions), each panel / cabinet / console shall be provided with separate ventilation fan assembly.

The maximum noise level with all fans operating and cubicle doors open shall not exceed 85dBA. Following signals and alarms shall be provided for each panel, cabinet and console separately;

i) Fan failure alarm for each cubicle in DCS.

ii) Temperature indication of each cabinet or compacted combination, as applicable in DCS.

iii) A common alarm each for high temperature and fan-failure on hardwired console.

h) Earthing

Each cubical (panel / cabinet / console) shall be provided with earth bus bars of at least 15 x 5 square mm cross-section for the following;

i) Electrical earthing (non-isolated earth) where all metal components like all cabinet panels, doors etc shall be connected.

ii) System earthing (isolated earth) where cable shielding of all cables shall be earthed. System earth bus bar shall be isolated from electrical earth and also from metallic doors, panels etc.

iii) DC earth (isolated earth) where cable shielding of all 110V DC shall be earthed. DC earth shall be isolated from electrical earth, system earth and also from metallic doors, panels etc.

i) Lifting lugs

All control panels and system cabinets shall be provided with removable lifting lugs to permit lifting of panels / cabinets. The panel structure / frame shall be designed to permit panel / cabinet

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lifting without deformation. The normal working load of the lifting lugs shall be more than 1.5 time the panel / cabinet load. The eye bolts shall be certified for their normal working load.

Panels / cabinets shall also be supplied with plugs which can be fitted after the lifting lugs are removed after their placement.

j) Name Plates

All panels / consoles / cabinets shall have name plates fixed on the front, back and inside with following details;

Front and Back : Tag number and description

Inside : Manufacturer's name, purchase order number and year of manufacture, port number of manufacture.

All other details shall be as per clause 5.1.22 of this specification.

6.3.1.3.3 System cabinets

a) All the cabinets shall be free standing, enclosed type and shall be designed for bottom entry for cable connection. Cabinets structure shall be sound and rigid.

b) Cabinets shall be equipped with front and rear access doors. Doors shall be equipped with lockable handles and concealed hinges with pull pins for each door removal.

c) Each cabinet shall have the following dimensional details;

Height : 2000mm

Width : 600mm / 1200mm

Depth : 800mm

Cabinets shall be rigidly mounted on 100mm high channel base. Construction shall be modular preferably to accommodate 19" standard electrical racks. All racks shall be of same height. Maximum swing out for doors and drawers shall be limited to 600 mm.

d) Cabinets shall be fabricated from cold rolled steel sheet of minimum 2 mm thickness suitably reinforced to prevent warping and buckling. Doors shall be fabricated from cold rolled steel sheet of minimum 1.6 mm thickness. Cabinets shall be thoroughly deburred and all sharp edges shall be grounded smooth after fabrication.

e) Equipment, within the cabinet, shall be laid out in an accessible and logically segregated manner. All metal parts of the cabinet including doors shall be electrically continuous and shall be provided with a common grounding lug.

f) Cabinet painting procedure shall include sand blasting, grinding, chemical clearing, surface finish by suitable filler and two coats of high grade lacquer with wet sand blasting between the coats. Two coats of paint shall be provided. Colour of the cabinet shall be as per job specifications.

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6.3.1.3.4 Electrical Wiring

All the cabinets, consoles and panels shall be completely wired and/or tubed, as required. Interconnections shall preferably be done with the help of pre-tracked cables. Vebdir may follow their standard wiring practices, however the requirements specified herein must be complied.

6.3.1.4.1 Terminals and Terminal Blocks

a) All terminal / terminal blocks shall be DIN Rail mounted type and shall be easily removable. The size of the terminal blocks / terminals of different types shall be consistent and identical.

b) All terminal blocks shall be mounted on suitable anodised metallic or plastic stand-off.

c) Terminal strips shall be arranged group-wise for incoming and outgoing cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip.

d) Terminal housing shall be strictly sized with considerations for accessibility and maintenance. Minimum distance required between various components are listed below. These distances are clear distances, and are excluding the width of the raceways or any other component / item mentioned herein. Following clearances should be considered;

i) Distance between terminal strip and side of the cabinet parallel to the strip, up to 50 terminals, shall be minimum 50mm.

ii) Distance between terminal strip and, top and bottom of the cabinet shall be minimum 75mm.

iii) Distance between two adjacent terminal strips shall be minimum 100mm.

iv) Additional distance for each additional 25 terminals shall be minimum 25mm.

v) Distance between cable gland plate and the bottom of the strip shall be minimum 300mm.

6.3.1.4.2 Terminals

a) Terminals shall be non-hygroscopic type made up of unbreakable fire-retardant, safe extinguishable, halogen free polyamide compound of VO grade of 960°c. These shall be manufactured as per IEC-60947-7-1.

b) Terminals shall be suitable for wires up to 2.5 sq. mm base solid or standard conductor in general. For power cables, higher size terminals shall be used.

c) The metal parts of terminals shall be of high quality (pure electrolytic) copper and shall be tin or nickel plated (of thickness up to 15 micron). The contact terminal resistance shall be of the order of 0.3 multi ohm.

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d) The spring material for all terminals shall be chrome nickel spring steel of high tensile strength and of excellent corrosion resistance.

e) Voltage withstand capacity of the terminals shall be up to 4KV for 60 seconds as per IEC/EN-60664-1.

f) Field side terminal blocks in marshalling cabinet shall be cage clamp interruptable (i.e. disconnect) terminals providing necessary polarity distribution, protection, test point and earthing.

6.3.1.4.3 Wiring Requirements

a) All wiring shall conform to SPI RP 550 Part-I, Sections 7 and 12. Different signal level cables shall be routed under false flooring with separation distances as recommended by API RP 550 Section 7.

b) All wiring inside racks, cabinets, and back of the panels shall be housed in covered, non-flammable plastic raceways arranged to permit easy assembly to various instruments for maintenance, adjustments, repair and removal.

c) All wiring in the raceways shall be properly clamped. All incoming cable shall be terminated by vendor at marshalling rack with cable glanding including supply of cable glands. Total wiring cross-sectional area shall not exceed 50% of the raceway cross sectional area.

d) Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring, and intrinsically safe wiring. Parallel runs of AC and DC wiring closer than 300mm shall be avoided.

e) Vendor can alternately offer prefabricated cables for interconnection between different cabinets and panels.

f) Wire termination shall be done using self-insulating crimping lugs. More than two wires shall not be terminated on one side of single terminal. The use of shorting links for looping shall be avoided.

g) No splicing is allowed in between wire / cable straight run.

6.3.1.3.5 Hardwired console

a) Hardwired console shall be non-graphic self supporting, free standing cubicle with back doors and shall be designed for batter cable entry for connections. Console structure shall be sound and rigid.

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b) The design and dimensions of hardwired console shall strictly match with the operator consoles. For designing hardwired console, following points must be ensured;

- No instrument or switch shall be installed on the horizontal portion of console.
- Horizontal portion of console shall be spill proof, as well as scratch proof. Materials other than metallics can also be accepted for horizontal portion provided this can provide rigid, hard, flat and smooth surface. This shall require the purchaser's approval prior to deciding the material.
- In order to reduce number of hardwired consoles, vendor may utilize back-lighted switches and miniature instrumentation and annunciator windows.

c) Whenever the operator consoles are specified with table top design instead of console type of design, the hardwired console shall be identical and symmetrical to the operator console design.

d) Panels/hard wired console shall be fabricated preferably from 3 mm thick cold rolled steel sheet. Angle iron frame shall use a minimum section of 50 x 50 x 4 mm angle.

e) Cabinet paint procedure shall include sand blasting, grinding, chemical cleaning, surface finish by suitable filler and two coats of high quality lacquer with wet sand blasting between two coats. Two coats of paint shall be provided. Colour of hardwired console shall be as specified in job specification.

6.4 Earthing

6.4.1 All system equipments such as panels, marshalling cabinets, system cabinets and other powered equipments shall be provided with following type grounding system;

a) Protective Earth / Electrical Earth

b) System earth / signal earth

c) Safety earth / ZB earth (when required)

d) SPD Earth

Both system earth and safety earth shall be totally separate from protective earth.

6.4.2 Protective earth / Electrical earth

a) Earth metallic enclosure / cabinet / panel / console etc shall be provided with electrical earth lug, as a minimum. Door hinges, flexible conduits or self-detachable connectors shall not be considered path for earth connectivity/earth return paths. Separate earth lug or permanent connectivity shall be considered.

b) Unless recommended otherwise by vendor, all earthing lugs of metallic equipments indicated in Clause 6.4.2(a) above shall be connected individually to electrical protective

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earthing system bus-bar / earthing station using a maximum of 10sq mm solid copper conductor PVC installed wires.

c) Where multiple cabinets are multiplexed together, earth looping with permanent shorting link cables shall be acceptable. Two earthing connection wires as indicated in Clause No.6.4.2(b) above shall be used for connecting multiplexed cabinets to protective earth station / bus-bar.

6.4.3 System Earth

a) System earth shall be totally noise free dedicated earthing system and shall be fully isolated from electrical protective earth. This earth must be very high integrity system and shall be used to ground zero volt references and signal cable grounds.

b) System earth shall be less than one (1) ohm grounding system with its own dedicated earthing pits. These earth pits shall be away from any heavy noise plant equipment. Outside the control room building is the most appropriate location.

c) The earth pit design shall be as per IS-3043 code of practice for earthing. A minimum of four (4) number of earth pits shall be provided for grounding system integrity. In case number of pits required to meet 1 ohm resistance are more than (2), the number of earth pits shall be two times the actual number of pits required to meet resistance criteria. All these pits shall be security connected with each other to form a one homogeneous system earth grid.

d) Each marshalling / system cabinet / panels etc shall be provided with system earth bus-bar which shall be insulated from the metallic body frame. This bus-bar shall be used to earth also signal zero volt references and signal cable screens. Terminals used for termination of spare conductor pairs / cores of multi-pair signal / control cables shall be connected to system earth bus-bar. Shorting links shall be used for spare terminal looping.

e) System bus-bars in the multiplexed cabinets can be joined together by permanent shorting links. System bus-bars of other cabinets can also be connected together provided they are permanently joined using 35 sq mm stranded copper conductor cable in a looped both ends except for the following exceptions;

6.4.4 Safety earth / Zener barrier earth

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a) Whenever Zener barriers are selected or used to meet intrinsically safe requirements, the earthing terminal of the zener barriers shall be connected to a separate earth bus bar.

b) This earth shall meet all the requirements specified in Clause 6.4.3 of this specification.

c) Safety earth bus bar shall be directly connected to earth pits using dual insulated cable. Cable conductor size shall be minimum 95 sq. mm (copper).

6.4.5 SPD Earth

a) SPD earthing terminals are connected to separate earthing bus bar in the cabinets.

b) This earth shall meet all the requirements specified in Clause 6.4.3 and 6.4.4(c) of this specification.

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PART - II

TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE OF DISTRIBUTED CONTROL SYSTEM

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1.0 SCOPE

1.1 This specification defines the basic guidelines to Distributed Control System vendor for factory testing and acceptance, installation, commissioning and field acceptance of the fully integrated system.

1.2 These guidelines shall also be applicable to all sub-systems and hardware bought by DCS vendor.

1.3 On the basis of this specification, vendor shall submit detailed testing and acceptance procedures specifically applicable for their system. The procedure shall include both hardware as well as software testing and acceptance methodology covering following details;

a) Hardware Testing;

The procedure shall include;

i) Test name
ii) Purpose of Test
iii) Test equipment
iv) Test set-up (Block diagram)
v) Input definition
vi) Test procedure
vii) Results expected
viii) Acceptance criteria.

b) Software Testing;

The procedure shall include;

i) Test name
ii) Purpose of Test
iii) Test equipment
iv) Test set-up
v) Sequence of Execution
vi) Results expected
vii) Acceptance criteria

The procedure shall not omit any column as indicated above in the procedure submitted. Indicate 'NA' whenever any column is not applicable. Additional requirement, if any may be include, as applicable.

1.4 The testing and acceptance of the system shall be carried out on the approved testing procedures and criterion based on this specification and vendor's standard testing requirements and procedures.

2.0 FACTORY TESTING AND ACCEPTANCE

2.1 General

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2.1.1 Vendor shall test and demonstrate the functional integrity of the system hardware and software. No material or equipment shall be transported until all required tests are successfully completed and certified "Ready for Shipment" by the owner/consultant.

2.1.2 The purchaser reserves the right to be involved and satisfy himself at each and every stage of inspection. The purchaser shall be free to request any specific test on any equipment considered necessary by him although not listed in this specification, as a part of approval of factory testing procedure. The cost of performing all tests shall be borne by the vendor.

2.1.3 Vendor to note that acceptance of any equipment or the exemption of inspection or testing shall in no way absolve the vendor of the responsibility for delivering the equipment meeting all the requirements specified in Material Requisition.

2.1.4 It shall be vendor's responsibility to modify and/or replace any hardware and modify the software if the specified functions are not completely achieved satisfactorily during testing and factory acceptance.

2.1.5 Failure of components/ modules/ sub-systems during Testing

2.1.5.1 Vendor shall not replace any system component/module/sub-system unless it is failed. A log of all failed components/modules in a sub- system shall be maintained which shall give description of the failed component/module, effect of failure on the sub-system, cause of failure and number of hours of operation before it failed.

2.1.5.2 If malfunction of a component/module in a sub-system repeat, the test shall terminate and vendor shall replace the faulty component/module. Thereafter the test shall commence all over again. If even after this replacement, the sub-system fails to meet the requirements, vendor shall replace the full sub-system to the one meeting the requirements and the system shall be tested all over again.

2.1.5.3 If a sub-system fails during the test and is not repaired and made operational within four hours of active repair time after the failure, the test shall be suspended and restarted all over again only after the vendor has replaced the device in the acceptable operation.

2.2 The factory testing and acceptance shall be carried out in two phases i.e. Phase I and Phase II. The schedule for the testing shall be submitted by the vendor for both Phase I and Phase II separately. The minimum requirements for testing during these two phases are as follows:

2.2.1 Phase-I

2.2.1.1 Vendor shall perform tests at his works to ensure that all components function in accordance with their respective specifications. A test report shall be submitted to the owner/consultant for review within one week of completion of testing giving details. Phase II testing (witness inspection) shall start only after.

2.2.1.2 All sub-systems shall undergo a minimum of 30 days (720 hours) burn-in period. The system shall be offered for factory acceptance only after it has completed the specified burn-in period. The requirements shall be as follows;

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a) The burn-in time shall start after the sub-system is fully assembled and is powered up. It may include any such time for which the system has been kept powered on even for system generation and Phase I testing.

b) Burn-in period log report shall be maintained by the vendor clearly recording sub-system (Tag No. / Identification No.), date and time of power-on, date and time of power-off, failed component (if any) with identification, communicative power-on time and sign-off. In case power to the sub-system is switched off because of any reason, the same shall be recorded in this log report.

c) Vendor shall submit burn-in period log report as part of Phase I test report for purchaser's review.

2.2.1.3 All the test results shall be recorded in the test log report. The test logbook shall contain the following information about the tests:

a) Date/time

b) Assembly /loop tag number

c) Test input

d) Test results and sign off with personnel name

e) Action required (if deficiency is detected)

f) Action taken, date of completion and sign off

g) Special test methods (including special equipment requirement, bypasses used etc.)

2.2.1.4 Test details

Following tests shall be performed by the vendor and report shall be forwarded to the owner/consultant.

2.2.1.4.1 Quality control test

a) Quality control tests shall be carried out to assure quality of all components and modules in accordance with vendor’s quality control and assurance procedures. QA / QC test methodology shall be in accordance with relevant international standards and practices. Vendor shall forward the details of these procedures for purchaser’s review.

b) The sampling procedures for all purchased components or components manufactured by the vendor shall be in accordance with the vendor standard quality assurance / quality control procedures.

c) All assemblies shall be aligned and adjusted before conducting tests. All tests shall be carried out as per manufacture's published / established testing methods and shall be recorded in a test logbook. The test logbook shall be duly signed by the QA / QC manager.

2.2.1.4.2 System power-up tests

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All sub-systems shall undergo complete functional testing as part of Phase I power-up testing. Testing shall include, but not limited to, the following;

a) System hardware functional testing including redundancy, wherever applicable, as per vendor standard testing procedures

b) System software testing as per vendor standard testing procedure including builder functionality.

c) System performance on power supply variations as per vendor standard procedures.

d) Application, Software testing;

Complete application programme generated by the vendor specific to the job shall be tested by simulating inputs. This shall include the following, as a minimum;

- Database verification including loop configuration as per approved functional schematics.
- Display verification including dynamic graphics and hierarchical displays.
- Trending, real time and historical, functionality and assignment.
- Logging and report generation
- Serial port assignment and its proving
- Security functionalities, as applicable e.g. password functionalities, fire-wall protection
- Testing of third party equipments (if applicable)
- Verification of logic diagrams
- Alarm management verification
- Any other software verification necessary for the offered system, as per vendor standard.

e) System Diagnostic verification

All the test results shall be recorded as per Clause 2.2.1.3 of this specification.

2.2.2 Phase II (Witness Inspection)

2.2.2.1 During Phase II testing, all the hardware and software shall be systematically, fully and functionally tested in the presence of purchaser representative.

All the sub- systems shall be interconnected to simulate, the totally integrated system as close as possible. Vendor purchased items (third party equipment) e.g. programmable logic controller, sequence of event recorder, alarm information management system etc shall also be integrated with the system. Free issue item, if any supplied by purchaser to the vendor for integrated factory acceptance test, shall also be integrated with the system. Barrier cabinets shall be used as the connecting points for the test inputs and outputs.

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2.2.2.2 The duration of Phase II testing shall be communicated by the vendor along with day wise testing schedule to the purchaser. System shall be shipped to site only after the successful completion of this testing and the system is certified 'ready for shipment' by purchaser.

2.2.2.3 Data review:

Purchaser shall review the following documents before starting the witness Inspection (Phase II));

a) The latest document revisions, based on which vendor has generated the system, to the current data. Any revision or changes required shall be informed to the vendor before starting the witness inspection.

b) Test reports of all bought-out items by their respective manufacturers.

c) The test report/log book forwarded by vendor after Phase-I testing. Owner / consultant has right to witness any test performed in Phase I, if found necessary.

2.2.2.4 Testing record

a) During testing of Phase II, each test carried out shall be recorded. Any deficiency or problem observed during testing shall be clearly recorded and corrected thereafter.

b) Vendor shall prepare a punch list report listing out all the action points. All punch list actions must be completed before system dispatch.

c) Any change in the data or configuration etc informed to the vendor during testing by purchaser shall be recorded and modifications required shall be carried out by the vendor.

2.2.2.5 Visual and mechanical testing.

Visual and mechanical testing shall be carried out in principle to assure correct, proper, good and neat workmanship by the vendor. This testing shall include the following, as a minimum;

i) Dimensional verification
ii) Sheet thickness
iii) Layout verification as per approved GA drawings
iv) Quality of painting (outer and inner)
v) Nameplates, identifiers and tag plates
vi) Adherence to ferruling philosophy.
vii) Dressing of wires / prefabricated cables and clearances
viii) Locks and handles

2.2.2.6 Verification of Bill of Material (BOM)

Hardware and software including bought-out items shall be available for verification with the bill of material (BOM) document submitted by the vendor during engineering. Vendor must obtain

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purchaser's prior approval if any sub-system or bought-out equipment / item can't be made available during Phase II testing i.e. witness inspection. The verification of BOM shall include the following;

a) Hardware verification

The verification shall include verification of all hardware including mandatory spares as per the model numbers and quantities indicated in bill of material document. Items which can't be identified with model numbers, shall be verified with manufacturer's serial numbers. In all such cases, vendor must ensure that the serial number has been indicated against all such items in the BOM document.

b) Software verification

The verification shall include verification of licenses and their numbers for all softwares as listed in bill of material document. All licenses shall be in the client's name. Number of copies of as built application programmes shall be verified at the time of site acceptance test and not during factory acceptance test.

All system hardware including network interfaces and all software including operating system, console software, network software, complete application software etc. shall be installed and tested as part of function testing.

2.2.2.7 Functional testing

All system hardware including network interfaces and all software including operating system, console software, network software, complete application software etc. shall be installed and tested as part of function testing.

Functional testing shall include the simulation of inputs and outputs to verify proper system response for both analog and discrete signals. Unless otherwise specified, at least 20% of I/O's shall be simulated in controller and data acquisition sub-system while all I/O's shall be simulated and corresponding logics shall be verified in case of Programmable logic controllers. The I/O sampling shall be at random and shall be selected by the purchaser during testing. The testing, as a minimum, shall include the following:-

a) Complete system configuration loading.

b) Controller and Data acquisition Sub-system

Demonstration of all controller functionalities verification and data acquisition sub-system functions from local as well as from central level including;

- Changing control algorithms
- Changing control mode and controller action
- Changing alarm limits
- Controller tuning using tuning trend.

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- Controller tuning using auto-tuning package and change in tuning package and change in tuning parameters either automatically or manually.
- Output status on controller failure.
- Setting of macro-cycle time for fieldbus segment.

c) Scan time verification of scan time values for controllers and data acquisition sub-system and PLC testing shall be carried out by simulating the inputs as follows;

i) Open or close the contact input as per logic execution requirements.

ii) Step input or slow ramp input (typical frequency of 4 cycles / second) with amplitude corresponding to 16mA (4mA to 20mA or vice versa) for all conventional analog and smart (HART) inputs from a signal generated.

The processor cycle time setting and the processor loading shall not exceed the specified limits while verifying scan time.

Checking of scan time values for controllers and data acquisition sub-system and PLC;

The inputs to the system shall be;

- Step input i.e. 0 or 1 for all contact inputs.
- Step input or ramp input for all analog inputs

The processor cycle time setting and the processor loading shall not exceed the specified limits while verifying scan time.

Control cycle time shall be measured by simulating a segment with transmitters and positioners in the worst case fieldbus segment (w.r.t number of transmitters and positioners) and scheduled activities.

d) Checking of correct change-over of the back-up units in case of main unit failure. This shall include the following:-

i) Uninterrupted controller operation shall be verified even during and after switchover of back-up device. The failed controller Database, point records, inputs and outputs of the failed main controller shall be transferred to the back up controller without any interruption. The same shall be repeated for transfer back from back up controller to the main controller. Maximum transfer time shall not exceed the specified value. The test shall be repeated for controller all redundant devices including input /output modules.

ii) Uninterrupted data transfer from main communication network and communication interfaces to the redundant ones shall be checked. The transfer back from back-up device or back-up communication network to main network or interface shall not be automatic (automatic transfer from back-up device / network to main device / network shall also be

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acceptable in case the changeover procedure is flawless and smooth). This test shall be repeated for all interface units in the system including foreign device interfaces.

iii) Uninterrupted operation of system shall be checked on failure and resumption of any of the power supplies where redundant power supplies are provided.

iv) Uninterrupted operation of the system incase of redundant H1 module, power supply conditioners and LAS functionality.

e) Checking of controller loading

Controller loading shall be verified as displayed by the system by simulating as many as inputs to simulate worst case data transfer condition.

f) Simulation of fieldbus segment

At least one fieldbus segment of each type (e.g. foundation fieldbus, profibus etc) shall be simulated as applicable. The segment shall include at least one device of each make and model number being used in the project (purchaser shall identify and provide the device to vendor for segment simulation). Following minimum tests shall be carried out;

i) Inter operability test to ensure correct data transfer between devices of different makes and host (i.e. DCS).

ii) Control cycle time verification as per specifications.

iii) Control loop functionality when control algorithm is configured in DCS and in a field device i.e. positioner and in transmitter.

iv) Verification of functionality of control input data transfer along with fieldbus converter by simulating inputs.

g) Functional verification of cursor movement devices

Verification of correct functioning of all keyboards, mouse, touch screens, light pen etc shall be carried which shall include;

i) Smooth functioning of all devices.

ii) Functional commands verification

iii) Dual function key configuration.

The devices shall include those attached to operator console, engineering console, PLC console, personal computers, other sub-systems / accessories.

h) Verification of loop configuration

Data base and the configuration of all the loops shall be verified for their correctness with respect to range, limits, engineering units, alarm set points, software configuration, output status of

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controller / control block failure etc with respect to latest revisions of instrument details and functional schematics / P&ID's supplied by purchaser.

i) Verification of Displays

All types of displays, process as well as system, configured on operator console, engineering console and PLC console shall be verified with respect to correct display configuration, colour scheme, colour modifiers, engineering units, windowing feature, alarms, flags, restricted operation etc.

j) Verification of functionality of accessories

All the accessories like printers and hard copiers shall be verified for their proper operation by printing either test data or actual data.

k) System Diagnostics

System diagnostics shall be thoroughly checked for all sub-systems on local level as well as on operator/engineering console. These shall include diagnostics of failure of main as well as redundant items such as a sub-system, sub-system module, HI module, LAS functionality, power supply, interface unit, network and network module, consoles, third party device interfaced with DCS, printers, hard copier, server failures, key-board / cursor movement devices, disc and disc drives, field-bus devices, field-bus segment, network devices etc. and other detailed diagnostics and their corresponding displays. Diagnostic alarms for any ventilation fan failure, cabinet temperature high and corrosion monitor shall also be verified.

l) Verification of Application programme

Following application programming shall also be verified thoroughly in addition to the complete loop operation by simulation;

i) Verification of trending and trend displays.
ii) Verification of historisation functionalities
iii) Verification of alarm management
iv) Verification of data retrieval functionalities.
v) Verification of all dynamic graphics.
vi) Verification of interchangeability between various video screens of a console.
vii) Synchronisation of system clocks.
viii) Verification of various log formats and log reports including MIS reports as applicable.
ix) Complete (100%) verification of interlock and shutdown logic by simulating inputs and verifying outputs preferably using simulator, other related functions like forcing, first out shall also be verified.

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x) Verification of third party device (like PLC, analyser system, computers, MMS, F&G systems etc) interfaces for complete data transfer between device and DCS and vice versa. Where third party devices are not supplied by vendor (and cannot be provided by purchaser for conducting factory testing), the complete address mapping shall be verified and the link shall be proved using third party device simulation.

xii) Verification of data and reports related to instrument asset management system.

m) Verification of other specific requirements when specified like;

i) Large screen functionality and display solution shall be verified along with large screen controller. Where large screen is not available during factory acceptance test, vendor may utilize a PC in place of display unit for application verification.

ii) Verification of all functionalities of alarm information and management system including report generation.

iii) Verification of functionalities of unit history node and its verification. The verification shall include configuration verification, sample rate versus storage time verification (by extrapolated method for extended time period), throughput, report formats and report generation.

iv) OPC node verification with respect to its configuration, data structure and throughput.

v) Sequence of Event Recorder functionalities verification by verifying identification of events with the specified resolution. The input shall be generated using pulse generator of suitable frequency.

vi) Functionalities of other items when specified shall also be verified.

n) Verification of hardwired console and its functionality. All functions shall be 100% verified such as operation of hardwired instruments, hardwired annunciator, switches, ramps, pushbuttons, instruments like controllers, indicators, recorders etc. Hardwired consoles must be present during factory acceptance test and shall be interconnected for functional verification. All hardwired instruments like alarm cards, barriers and relay shall also be verified for their proper operation.

o) Verification of all system builder functions and engineering console functionalities.

p) Verification of fieldbus simulator functionalities when specified and purchased along with the system.

q) Verification of display update rate and call-up time under worst loading conditions. Network performance shall also be verified by verifying display update rate of an analog tag number when all other inputs in the system are under varying conditions.

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2.2.2.8 The vendor shall notify the owner/consultant at least three weeks prior to final system testing. In the event that representatives arrive and the system is not ready for testing, the vendor will be liable for back charges for any extra time and expenses incurred.

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2.2.2.6.4 Checking of loop configuration for correctness with respect to ranges, limits, alarm points, engineering units etc.

2.2.2.6.5 Checking of all types of VDU displays including process and system displays on operator Engineering and PLC console.

2.2.2.6.6 Checking of correct functioning of key-board operation for operator, Engineering and PLC console.

2.2.2.6.9 Testing of proper functioning of all printers and hard copy units.

2.2.2.6.10 Testing of system features like interchangeability between VDUs of a console, synchronisation of system clocks, selective tuning from Engineering console, key-lock functions etc.

2.2.2.6.11 Checking of various log formats, shut down reports, I/O mapping and other MIS formats printing.

2.2.2.6.12 Checking of shutdown and interlock configuration and proper operation thoroughly.

2.2.2.6.13 Proper system operation at power supply specifications specified in the Material Requisition.

2.2.2.6.14 Checking of proper operation of all interfaces with the system like interface with PLC, computer, analyzer system etc as specified in Material Requisition.

2.2.2.6.15 Checking of bus-degradation while loading the bus from 10% to 100%.

2.2.2.6.16 Simulation of power failure and restarts.

2.2.2.6.17 Checking of all hardwired instrumentation including all alarm cards, alarm annunciator system, switches and other indicating instruments.

3.0 INSTALLATION, TESTING AND COMMISSIONING

3.1 Vendor shall offer the services of the installation team which would install the equipment in the control room, lay the interconnecting cabling inside the control room, check out, test and commission the system.

All technical personnel assigned to the site by the vendor shall be fully conversant with the supplied system and software package, and shall have both hardware and software capability to bring the system on line quickly and efficiently with a minimum of interference with other concurrent construction and commissioning activities.

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3.2 Vendor's responsibility at site shall include all activities necessary to be performed to complete the job as per material Requisition including:

a) Receipt of hardware/software and checking for completeness of supplies.

b) Installation of the system including free supply equipment and field cable termination in the system.

c) Check out of the equipment installation.

d) Checking of interconnection, hardware & software configuration, overall system functioning etc.

e) Loop checking.

f) Liaison with vendor's home office.

g) Field tests

h) Commissioning and on-line debugging of the system.

i) Performance of final acceptance test.

3.3 The only exclusion from vendor's responsibility shall include the following:

a) All civil works in the control room including false flooring, control room lighting and air conditioning ducting.

b) Laying and identification of field cables.

c) Field instrument installation and calibration.

3.4 Field Inspection

3.4.1 All equipments shall be inspected thoroughly by vendor after its receipt at site. The tests, as a minimum, shall include;

(a) Hardware verification as per packing list.

(b) Visual and mechanical checking.

(c) Complete System Configuration loading.

(d) Functioning of all VDUs, keyboards, disc drives, printers, hardcopy units etc.

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(e) Checking of correct change-over of redundant devices.

(f) Checking of hardwired instruments.

(g) Any other checking.

3.4.2 The testing defined in para 3.4.1 shall be carried out to ensure functional integrity of all hardware being supplied. Vendor must initiate the remedial action in case unsatisfactory operation of any equipment or item is observed during this testing with an intimation to Engineer-in charge.

3.4.3 Vendor must document all observations including details of malfunctions observed, if any. Items/ equipments requiring total replacement must document reasons for the same.

3.5 **Loop Checking**

3.5.1 Vendor shall be responsible for loop checking which shall also include checking of the interconnection, at control room end, configuration and ensuring over all system functioning.

3.5.2 Calibration and installation of field instruments, installation of junction boxes, interconnection between instruments and junction boxes, laying of single, multi pair cables upto control room, tagging all field cables, performing continuity/ insulation test of cable, core identification of field cables etc. shall not be in the vendor scope. This work shall be carried out by the field contractor.

3.5.3 Vendor's scope of work, as a part of system installation and loop checking shall include termination of all field cables in control room, checking of interconnection between instrument glanding and equipment, ferruling and tagging of interconnecting cables in control room, ferruling of field cables in control room and performing overall loop performance check.

3.5.4 Loop checking shall be carried out to check the functional performance of all elements comprising the loop and thereby ensuring proper configuration, functioning and interconnection.
For fieldbus devices the loop checking shall include the checking of complete fieldbus segment connectivity with its devices including noise, device configuration, waveform checking. The complete device configuration shall be downloaded to all field devices from DCS prior to the start of loop checking.

3.5.5 Vendor shall co-ordinate with the field contractor for smooth and proper loop checking. Any discrepancy found during checking shall be brought to the notice of Engineer-in-Charge. Complete loop checking shall be performed in the presence of Engineer-in Charge or his authorised repre-

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sentative. All readings shall be recorded on a suitable format which shall be handed over to the vendor by the field contractor after completing calibration record of each field device. On the completion of loop checking, remaining information related to loop checking shall be filled by the vendor. Completely filled format duly signed shall be submitted for approval, to Engineer-in Charge.

3.5.6 a) All the components of the loop shall be checked for proper functioning. All field instruments connected to control room shall be loop checked at 0%, 50% & 100% of FS (for both increasing and decreasing signals). The mode of generating signal from the field by field contractor shall be as follows for different instruments types:-

	Type of Instrument	**Mode of Signal Generation**
a)	Differential pressure/ flow instruments/ DP type level instruments	By applying impulse to the primary by squeeze bulb or regulator at field
b)	Pressure instruments	By applying impulse to the instrument using instrument air, regulator & standard gage or using portable hydraulic pump and standard gage.
c)	External Displacer	Cage shall be filled with water for different levels and specific gravity correction shall be applied
d)	Other type of tank level instruments	By lifting the float of the level instruments for 0% and 100% of range
e)	Temperature loops with thermocouple	Appropriate mV signals shall be fed from thermocouple head
f)	Temperature loops with RTD	Appropriate resistance shall be fed from RTD head
g)	Field switches for Alarm & Shutdown	Abnormality shall be simulated by disconnecting and connecting the wires at field instruments end
h)	Owner supplied items	As per Engineer-in-Charge's Instructions
i)	Special instruments & any other type of instruments	As per Engineer-in-Charge's Instructions

b) Receiver alarm cards shall be checked by the vendor for different settings on both increasing and decreasing signals.

c) Shutdown schemes shall be checked for proper functioning, configuration and actuation.

d) Performance of individual loops may be accepted for an overall accuracy of ± 1.0% unless otherwise specified. Where deviation exists, re-calibration of instruments, based on the scope of work, shall be carried out either by field contractor or by vendor.

e) Signal from controllers/shutdown schemes to control valves/shutdown valves shall be checked at the respective valves. The stroke checking including checking of time of operation of control

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valves/shutdown valves also forms a part of loop checking. Vendor shall coordinate this activity with field contractor and record the same in the loop checking format.

f) For the loop checking of loops connected to substation, vendor shall be responsible to coordinate with the Electrical Contractor.

g) After loop checking is completed, vendor shall connect back any terminals and connections removed for loop checking.

4.0 SYSTEM ACCEPTANCE

4.1 The owner shall provisionally takeover the system from vendor after System acceptance test. System acceptance test shall be started only after the satisfactory performance of loop checking and verification of all loop checking records by Engineer-in-charge.

4.2 The system acceptance test shall be carried out in the presence of owner's representative and Engineer-in-charge or his authorised representative. The tests carried out in System acceptance test shall be fully recorded and duly signed by all representatives participating in the System Acceptance Testing.

4.3 Vendor shall carry out the following functional tests on the fully integrated system as a part of System acceptance test, as a minimum;

a) Hardware verification as per final Bill-of-material.

b) Visual and mechanical checking for proper workmanship, identification, ferruling, nameplates, etc.

c) System configuration as per approved configuration diagram.

d) Checking of correct functioning of all keyboards and dual function keys.

e) Checking of proper operation of hardcopy unit and all printers including printing of Alarms and Events on the Alarm & Event (A&E) printer.

f) Demonstration of all system diagnostics.

g) Checking of correct changeover of redundant devices.

h) Checking of redundancy for LAS functionality for fieldbus segments.

i) Checking of communication between DCS, PLC and other foreign devices.

j) Checking of proper functioning of all disc drives, historical trend-points, alarm summary and alarm history.

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k) Verification of proper functioning of assignable trend recorder

l) Printing of Configuration and Configuration changes on C&M printer.

m) Proper information transfer on the information network by verifying system displays and printouts.

5.0 FINAL ACCEPTANCE TEST

5.1 The owner will take over the system from the vendor after the final acceptance test, which is defined as successful uninterrupted operation of the integrated system for three weeks for all units of the plant. Vendor's personnel shall be present during the test.Any malfunctioning of the system components shall be replaced/repaired as required. Para 2.1.6 of this specification shall be applied for failure of components & readjustments.Once the system failure is detected, the acceptance test shall start all over again from the beginning. The warranty period commences from the day owner takes over the system.

6.0 TESTING/CALIBRATION EQUIPMENTS

6.1 Vendor shall make available all consumable, instruments, and equipments necessary for testing, calibration, maintenance etc. as required by the defined scope of works. All instruments and equipments used for the above purpose shall be of standard make with accuracy better than the accuracy expected from the calibrated/tested instruments, and certified by National Physical Laboratory or other equivalent agencies. These instruments/equipments are necessary only during testing/calibration/maintenance.

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PART - III

GENERAL REQUIREMENTS

OF

DISTRIBUTED CONTROL SYSTEM

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1.0 SCOPE

1.1 This specification defines the general requirements expected to be fully complied by Distributed Control System vendor including logistic sup ports, documentation, warranty, maintenance contract and shipping instructions etc.

1.2 The requirements defined in this specification shall also be applicable for all sub-system and hardware bought and supplied by vendor from manufactures other than his own.

2.0 LOGISTIC SUPPORT SERVICES

2.1 The hardware maintenance engineers shall be trained for module level nd optionally component level diagnostics of the system. Vendor is required to quote separately for these training facilities. It is also necessary to include in the proposal the details of diagnostic software package for isolating the fault at module level for all the sub- system of Distributed Control System.

2.2 Training

2.2.1 The requirements of training for owner/consultant personnel (one group consisting of operators and other group consisting of hardware/software maintenance engineers) in the operational software and diagnostic programs, are set forth herein.

2.2.2 Vendor shall be responsible for furnishing details of course outlines, manuals of training, equipment necessary to conduct the training, exercises to evaluate trainees' progress. Vendor shall also be responsible for any other requirements necessary to train the engineers deputed by owner within a time limit so that they acquire the necessary expertise to operate and maintain the programs and the equipments supplied.

2.2.3 Owner/ consultant or his authorised representatives shall select personnel for training on the basis of his requirements and will review all materials furnished for adequacy of teaching aids and time tables.

2.2.4 Training Personnel.

Each instructor-designate shall have the following minimum qualifications for his area of instructions:

a) Six months of formal class-room instructor experience.

b) Complete and thorough technical knowledge of the equipment and system supplied under the contract and skilled experience in their programming, maintenance and operation.

c) Complete and thorough knowledge of the test and laboratory equipment maintaining, diagnosing, programming, operating and trouble shooting the hardware software system.

2.2.5 Course contents

2.2.5.1 The outline of each course shall give the subject matter, a short resume of the pre-requisite subjects (if applicable), the position of the course in the training programme, the aim and yardsticks for evaluation and other topics which will add to the usefulness of the program. In order that the selected trainees shall have time to participate in the course, sufficient advance notice of minimum 8 weeks shall be given by the vendor. The course outlines shall be submitted 10 weeks ahead for review.

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2.2.5.2 The training exercise shall be designed to be objective in nature and shall include trouble shooting exercises on similar equipments.

2.2.6 **Training manuals**

2.2.6.1 All training manuals shall be prepared by the vendor and submitted for review 10 weeks ahead of the commencement of the course. After course completion, these manuals shall become the property of the owner. Any change in equipment, manuals and other material shall be informed to the owner during the guarantee period. In addition to vendor documentation, the following minimum requirements shall be adhered to for the training manuals:

a) Functional flow-charts, descriptive material, program source listings applicable to all operating and application software and diagnostics programs.

b) Schematic drawings of each assembly of the hardware for the course on maintenance.

c) All manuals pertaining to procedures, specifications and operation for each equipment.

2.2.7 **DCS hardware and software maintenance training**

2.2.7.1 Vendor shall conduct a course in hardware (module level and optional component level) maintenance, software maintenance and diagnostic of the system for owner at vendor's facility. The course shall be conducted prior to the factory system performance tests so that trained personnel can participate effectively in the final testing.

2.2.7.2 The hardware maintenance training course shall cover every equipment item supplied as part of the Distributed Control System. This course shall include:

a) Actual operation, detection and correction of faults in equipments.
b) Familiarisation with maintenance procedures for the system offered.

2.2.7.3 Some of the topics covered in the course shall include:
a) Fundamentals of the system
b) Equipment logic diagrams
c) Diagnostic procedures
d) Peripherals maintenance
e) Preventive maintenance procedures

2.2.7.4 Software maintenance training shall cover all software supplied with the system. The trained personnel shall be able to write and debug the application and system software.

2.2.7.5 The vendor is required to quote for in-house and on-site training separately and manhour rate for additional training, if required by the owner.

2.2.8 **Site training facility and training kit**

2.2.8.1 The training kit shall essentially be used for refresher and training courses for process engineers, operating and instrument maintenance staff. The training kit shall be simple control system with process simulator for a group of loops and shall include:

a) An operator console with a VDU, operator key board and engineering keyboard.

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b) Controller with auto backup facility.
c) One each of the varieties of PCBs used in data acquisition.
d) Signal simulator.

2.2.8.2 Vendor to provide the details of the kit offered alongwith the proposal.

2.2.8.3 Training kit system shall be stand alone with respect to hardware and software and in no way be lined with the main system.

2.3 **Spare parts**

2.3.1 Vendor shall include in the proposal, provisions for special tools, test equipments and initial stock of maintenance spares for a period of two years after commissioning as are essential for proper maintenance and operation of the equipment. In addition, estimated requirements of spares consumption per annum should also be indicated. Full particulars of the tools, test equipments and spare parts shall be provided separately. The list should also include the item wise price.

2.3.2 The successful vendor shall warrant that spare parts for the system would be available for a minimum of fifteen years. After this period, if vendor discontinues the production of spare parts, vendor shall give at least twenty four (24) months notice prior to such discontinuation so that the owner may order his requirements of spares in one lot.

3.0 DOCUMENTATION

Vendor shall furnish all the manuals necessary to test, operate and maintain Distributed Control System hardware and software.

3.1 **Hardware documentation**

3.1.1 The following documentation for all hardware supplied and as built under this contract shall be submitted for review two months before the start of factory acceptance testing.

a) The specifications for all off-the-shelf hardware manufactured by vendor, his sub-contractors or suppliers.
Supplier's name and identification of ordered hardware and expected delivery data to vendor's premises shall also be supplied along with this.

b) Documentation relating to off-the-shelf hard ware and hardware developed by vendor including description, specifications, theory of operation, maintenance procedures, installation information and drawings. This information shall exclude all non-applicable information.

c) Where more than one size, rating or type of construction appears on the submitted catalogue data, those characteristics applicable shall be identified. Non applicable information shall be suppressed.

d) Test plans and test reports as specified in Part II of this specification for each item of hardware, to be supplied.

e) Bill of material listing all hardware to be supplied including manufactures part numbers, name plates data, approximate volume, weight and overall dimensions.

f) Spare parts catalogue for all items (at component level) to be supplied.

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g) Recommended spare parts for two years.

3.2 **Software documentation**

The following documents shall be submitted for review before 90 days of the shipment of the system, for the software packages included in the supply:

a) The specifications for all software to be obtained in-house or from subcontractors or suppliers. The details supplied shall also include the name of the suppliers, software identification including latest modification data.

b) Reference manuals, operating manuals, programming manuals and other software manuals (if any).

c) Description of the function of each program. This shall include the logic, configuration requirements and constraints and sub-programs used,, memory map and special characteristics.

d) Input and output details for each program.

e) Listing of assembled programs with label and symbol tables in assembler/compiler language.

3.3 **System manuals**

3.3.1 Manuals shall be submitted for assuring satisfactory operation and maintenance of the system. Detailed literature for installation and maintenance of all hardware should be provided to the owner.

3.3.2 All system manuals shall be supplied in hard cover loose ring folders in A size i.e. 216 x 279 mm. All drawings and sketches shall be in multiple of 'A' size like 'B' (279 mm x 432 mm) or 'C' type (406 mm x 518 mm) etc. but folded to 'A' size.

3.3.3 Instruction Manual

The information submitted shall preferably be in three parts.

I Part
First part shall give the following information:
a) A general functional description of the whole system.
b) General software description.
c) General Instructions and start up procedures.

II Part
Second part shall describe the system software in detail including its interaction with application programs and other programs used as supporting software.

III Part
The third part shall include detailed maintenance information including all data pertaining to equipment required for maintenance of the system.

3.3.4 Maintenance manuals

3.3.4.1 The maintenance manual shall include details of

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a) Preventive maintenance procedures.
b) Trouble shooting procedures including failure analysis.

3.3.4.2 A section on repairs shall provide enough information on repairs including removal, repairs, adjustment and replacement.

3.3.4.3 The maintenance manuals shall contain a list of all maintenance parts to facilitate quick identification of the parts for replacement and ordering. Standard hardware structural parts, or other parts not requiring maintenance shall not be included here. At the end of the list of parts requiring maintenance, a list of special tools required for the maintenance of each unit shall be given. List of manufacturers of each part shall also be included.

3.3.5 The final system manuals shall be furnished to owner within a month of completion of final satisfactory field testing. All field modifications shall be incorporated and system as built drawings and documents shall be included. Fifteen copies of each manuals shall be submitted to the owner/consultant.

3.3.6 Engineering drawings

3.3.6.1 The vendor shall provide a complete set of drawings covering each art of the supply for the owner/consultant record. The vendor is required to include owner's project number on each of his drawings in order to ease owner/consultant's record keeping.

3.3.6.2 Functional schematics and logic diagrams are furnished by owner/consultant to provide an idea of system hardware and software requirements to the vendor. Functional schematics shall be furnished in two parts.

a) Part-I, containing all system hardware and software requirements is furnished along with Material Requisition.

b) Part-II, containing the field devices details like transmitter, junction box details, final actuating device single and multi cable/core details, shall be furnished later.
Vendor shall develop loop wiring diagrams, containing full information of each loop (one drawing per loop) including field termination, junction box details, cables numbering, rack number, bus address code, device address code, power supply connections, final actuating device details including positioner and air supply etc and furnish these before the installation of system.

3.3.6.3 All field modifications shall be carefully recorded by the vendor's commissioning personnel and change shall be incorporated into final drawings. Fifteen copies of each drawing shall be submitted with one reproducible.

4.0 WARRANTY

4.1 Vendor shall be fully responsible for the manufacture in respect of proper design, quality, workmanship and operation of all the equipment, accessories etc. supplied by the vendor for a period of 18 months from the date of taking over by the owner at the site as mentioned in this specification or 24 months from the shipment date whichever is later.

4.2 It shall be obligatory on the part of vendor to modify and/or replace any hardware and modify the operating, application and diagnostic software free of cost, in case any malfunction is revealed even during on line operation after taking over within the warranty period.

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4.3 Vendor shall also provide the total maintenance of the system during warranty period. The cost for warranty maintenance, if any, shall be included in the proposal separately in 'vendor proposal outline and pricing details'.

5.0 MAINTENANCE CONTRACT

5.1 Vendor shall quote separately for maintenance contract after warranty period for two years based on per day rate for each category of personnel required. The personnel deployed shall have thorough knowledge of the system and atleast two years of experience on the maintenance of similar system. Any other conditions of contract required by vendor shall be explained in the offer.

6.0 PACKING AND SHIPPING INSTRUCTIONS

6.1 All the material used for packing, wrapping, sealers, moisture resistant barriers and corrosion preventers shall be of recognised brands and shall conform to the best standards in the areas for the articles which are packaged.

6.2 Workmanship shall be in accordance with best commercial practice with the requirement of applicable specifications. There shall be no defects, imperfections or omissions which would tend to impair the protection offered by the package as a whole.

6.3 The package shall be suitable for storing in tropicalised climate, the ambient conditions being specified in the job specifications.

6.4 Shipment shall be thoroughly checked for completeness before final packing and shipment.

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GENERAL SPECIFICATION

FOR

PROGRAMMABLE LOGIC CONTOROLLER (PLC)

REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD
1	28.04.2021	28.04.2021	Client's comments incorporated	AKS	SG	RKR
0	05.12.2016	05.12.2016	For Tender	Ritu Agarwal	Sanjay Kr Tripathi	Sanjay Kr Tripathi

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AC	:	Alternating Current
API	:	American Petroleum Institute
BIS	:	Bureau of Indian Standards
CCOE	:	Chief Controller of Explosives
CPU	:	Central Processing System
DC	:	Direct Current
DCS	:	Distributed Control System
DGMS	:	Director General of Mines Safety
DMR	:	Dual Modular Redundant
DVD	:	Digital Versatile Disc
EMI	:	Electromagnetic Interference
ERTL	:	Electronic Regional Testing Laboratory
ESD	:	Emergency Shutdown System
FAT	:	Factory Acceptance Test
FMEDA	:	Failure Modes, Effects and Diagnostic Analysis
HART	:	Highway Addressable Remote Transducer
HW	:	Hardware
HWC	:	Hardwired Console
I/O	:	Input / Output
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronic Engineers
IS	:	Indian Standards
ISA	:	International Society of Automation
ISO	:	International Organization for Standardization
LAN	:	Local Area Network
LCD	:	Liquid Crystal Display
LCIE	:	Laboratorie Central Industries Electriques
LED	:	Light Emitting Diode
MTBF	:	Mean Time Between Failure
MTTR	:	Mean Time to Repair
OPC	:	OLE for Process Control(Open Platform Communication)
P&ID	:	Piping and Instrumentation Diagram
PC	:	Personal Computer
PESO	:	Petroleum and Explosives Safety Organisation
PID	:	Proportional, Integral and Derivative
PLC	:	Programmable Logic Controller
PTB	:	Physlkalisch Technische Bundersanstalt
QMR	:	Quadruple Modular Redundant
RFI	:	Radio Frequency Interference
SAT	:	Site Acceptance Test
SER	:	Sequence of Event Recorder
SIL	:	Safety Integrity Level
SIS	:	Safety Instrumented System
TCP / IP	:	Transmission Control Protocol /Internet Protocol
TFT	:	Thin Film Transistor
TMR	:	Triple Modular Redundant
TUV	:	Technische Uberwachungsvereine

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UHF	:	Ultra High Frequency
UL	:	Underwriter's Laboratories
UPS	:	Uninterrupted Power Supply
VDU	:	Video Display Unit
VHF	:	Very High Frequency

Triple Modular redundant (TMR), Quadruple Modular Redundant (QMR)configuration, Flexible Modular Redundant (FMR) configuration, Virtual Modular Redundant (VMR),Dual Modular Redundant (DMR)

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the Material Requisition defines the minimum functional requirements for the design, hardware, software and firmware specifications, nameplate marking, testing and shipping of Programmable Logic Controllers (PLC) designed for reliable effective and optimum control and monitoring of a process plant .

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

APIRP 552	Transmission Systems
EEMUA 191	Alarm System -A Guide to Design, Management and Procurement
EN 10204	Metallic Products -Types of Inspection Documents
EN 50039	Electrical Apparatus for Potentially Explosive Atmospheres: Intrinsically Safe Electrical System 'I'
IEC 60079	Electrical Apparatus for Explosive Gas Atmosphere
IEC 60529	Degree of Protection Provided by Enclosures
IEC-60584	Thermocouple Part 2: Tolerances
IEC 60617	Graphical Symbols for Diagram
IEC-60751	Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors
IEC 61000-4-3	Electromagnetic Compatibility (EMC) -Testing and Measurement Techniques - Radiated, Radio Frequency, Electromagnetic Field Immunity
IEC-61000-4-4	Electromagnetic Compatibility (EMC) -Testing and Measurement Techniques - Electrical Fast Transients / Bust Immunity Test
IEC-61000-4-5	Electromagnetic Compatibility (EMC) -Testing and Measurement Techniques – Surge Immunity Test
IEC-61000-6-2	Electromagnetic Compatibility (EMC) -Generic Standards -Susceptibility - Industrial
IEC 61508	Functional Safety of Electrical/Electronic / Programmable Electronic Safety-related Systems
IEC 61131	Programmable Logic Controllers
IEC 61511	Functional Safety -Safety Instrumented Systems for the Process Industry Sector

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IEEE 802.3	Telecommunication and Information Exchange between Systems -Local and Metropolitan Area Networks -Specific Requirements -Part 3: Carrier Sense Multiple Access with Collisions Detection (CSMA / CD) Access Method and Physical Layer Specifications
IS 2148	Flameproof Enclosures of Electrical Apparatus
IS-3043	Code of Practice for Earthing
IS 13947	Specifications for Low Voltage Switchgears and Control Gears
ISA 5.1	Instrumentation Symbols and Identification
ISA 5.2	Binary Logic Diagrams for Process Operations
ISA 5.3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer System.
ISA 5.4	Instrument Loop Diagrams
ISA 5.5	Graphic Symbols for Process Displays
ISA 18.1	Annunciator Sequences and Specifications
ISA 71.01	Environmental Conditions for Process Management and Control Systems: Temperature and Humidity
ISA 71.04	Environmental Conditions for Process Measurement and control Systems: Airborne Contaminants
ANSI/ISA	Security Technologies for Industrial Automation and Control Systems TR 99.00.01 Manufacturing and Control System
ISO 216	Writing Paper and Certain Classes of Printer matter-Trimmed Sizes-A & B Series
ISO 9241-5	Workstation Layout and Postural Requirements
ISO 9241-7	Display Requirements with Reflections

1.1.3 In the event of any conflict between this specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Design Philosophy / Statutory regulations

b) Data Sheets

c) Standard Specifications

d) Codes and Standards

1.1.4 In addition to meeting purchaser's specifications in totality, vendor's extent of responsibility shall also include the following:

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a) Purchaser's data sheets specify the minimum acceptable functional requirements for the programmable logic controllers. It shall be vendor's responsibility to select proper hardware, software and firmware to meet the specified functional requirements.

b) Purchaser's data sheets specify the scan time / cycle time / response time and loading requirements. Vendor shall be responsible for sizing and selecting their standard product i.e. hardware, software and firmware to meet the requirements specified in the purchaser's data sheets.

c) Selection of proper and adequate hardware, software and firmware to meet system requirements specified in the purchaser's specifications, keeping the integrity of functional blocks specified in the configuration 'diagram attached with the material requisition.

d) Adequacy of Bill of Material selected to meet purchaser's requirements. Vendor to note that bill of material shall not be verified by the purchaser during evaluation stage. Any hardware, software and firmware required to meet the purchaser's specified requirements shall be provided by the vendor without any implication.

e) Providing adequate mandatory spares including consumable spares as specified in the purchaser's specifications. Vendor shall be responsible to meet mandatory spare requirements specified by the purchaser.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition. Vendor's quotation shall enumerate and include the detailed specification of each subsystem and each module of programmable logic controller, detailed system configuration, hardware and software capabilities, programming aids, display facilities and other relevant information.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Detailed specification sheets for each sub-system. The specification sheet shall provide information regarding hardware specifications, software specifications, redundancy requirements, capacity, power consumption etc. of the programmable logic controllers and its accessories. The material specifications and unit of measurement for various items in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) System security features and design details.

d) Proven references for each offered model in line with clause 1.2.4 of this specification whenever specifically indicated in the purchaser's specifications.

e) A copy of approval for flameproof enclosure, intrinsic safety etc whenever specified, from local statutory authority, as applicable, like Petroleum and

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Explosive Safety Organization (PESO) / Chief Controller of Explosives (CCOE), Nagpur or Director General of Mines Safety (DGMS) in India along with:

i) Test certificate from recognized house CIMFR (Central Institute of Mines & Fuel Research) / ERTL (Electronics Research and Test Laboratory) etc. for specified protection class as per relevant Indian Standard for all Indian manufactured equipments or for equipments requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, Baseefa, PTB, CSA, UL etc., for compliance to ATEX or other recognized standards for all equipments manufactured outside India.

f) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate from the specified requirement, they must include a list of deviations item wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

g) Catalogues giving detailed technical specifications, model decoding details and other related information for each item / sub-system covered in the bid.

1.2.3 Vendor shall offer only their standard proven product i.e. system hardware, system software and firmware, which shall be configured to meet the functional requirements specified in the material requisition. Moreover, the equipment being offered / supplied shall be of latest proven version available in the current manufacturing range and meeting the requirements specified in clause 1.2.4 of this standard specification.

1.2.4 The system hardware, software and firmware as offered, shall be field proven and should have been completed trouble free satisfactory operation for a period of minimum 4000 hours on the bid due date in the similar application with equal or higher than the proposed system size with respect to number of inputs and outputs specified in the purchaser's data sheet. Items with prototype design or items not meeting proneness criteria specified above shall not be offered or supplied.

1.2.5 The detailed scope of work, specific job requirements, exclusions, deviations, additions etc. shall be indicated in the job specifications which shall be part of material requisition.

1.2.6 Whenever specified, vendor shall furnish tested values of failure rates, probability of failure on demand and test intervals for safety integrity level analysis.

1.2.7 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals shall be in English language only.

1.2.8 Vendor shall also quote for the following:

a) Two year's operational spares for each sub-system and their accessories which shall include the following as a minimum:

i) All type of electronic modules e.g. I/O modules, processor modules, communication modules, memory modules, disc controller module, power

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supply modules etc.

ii) All type of auxiliary items e.g. barriers / isolators, hardwired instruments, annunciator modules, receiver switches, trip amplifiers, temperature element converters etc.

iii) Switches, lamps, fuses, connectors, terminals, pre-fabricated cables, circuit breakers, relays etc.

iv) Video display units, keyboards, disc drives, PC's, network items (e.g. switches, hubs etc.) etc. \

b) Any special tools and test equipments needed for the maintenance of PLCs and other items being offered by vendor. Vendor must confirm in their offer if no special tools or test equipments are needed for maintenance other than those specifically indicated in purchaser's data sheet.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from thy vendor are indicated by the purchaser in vendor data requirement sheets. The required number of prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design manuals, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase order shall include the following, as a minimum:

a) Specification sheet for each sub-system, auxiliary instrument and bought out item.

b) Certified drawings for complete system including the following:

i) GA drawings for panels, cabinets, marshalling racks, hardwired consoles, operator console, programming terminal etc with complete dimensional details, internal construction and weight in kilograms.

ii) Control room layouts e.g. console room, rack room and engineering room layout with all dimensions in millimetres.

iii) Channel base frame drawing for console room, rack room and engineering room.

iv) Input / output assignment.

v) Logic / Ladder diagrams.

vi) Loop wiring diagram.

vii) Power supply distribution diagram.

viii) Memory loading calculations/Scan time calculation.

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ix) Protocol/Pin Details.

x) Dynamic graphic diagrams.

xi) System grounding drawing.

c) Design manuals and functional design specifications which shall include hardware design manual, software design manual and special software specifications.

d) Copy of type test certificates.

e) Copy of test certificates for all tests indicated in this specification.

f) Installation manual containing installation procedure for programmable logic controllers and other items covered in the material requisition.

g) Power-on, start-up and internal testing procedures.

h) Software debugging and system configuration procedures.

i) Calibration and maintenance manual containing maintenance procedures including replacement of parts, application modification etc.

j) Any other drawings and documents specifically indicated in job vendor data requirement enclosed with the material requisition.

All system manuals and documentation shall be supplied in hard dover loose ring folders in 'A4' size as per ISO 216 i.e. of size 210mm x 297mm. All drawings and sketches shall be in multiple of'A4' size like 'A3' (297mm x 420mm) or 'A2' type (420mm x 594mm) etc. but folded to 'A4' size.

2.0 DEFINITIONS

The various terms used in this specification are defined as follows:

2.1 Programmable Logic Controller

The class of control systems which can be programmed to execute plant shutdown and / or interlock / sequence logics to the specified safety integrity levels.

2.2 Accessible

A system feature that is viewable by and interactive with the operator and allows the operator to perform user permissible control action e.g. set point change, auto-manual transfers or on-off actions.

2.3 Assignable

A system feature that permits an operator to direct a signal from one device to another without the need for change in wiring, either by means of switches or via other data entry devices like keyboard commands to the system.

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2.4 Configurable

The capability to select and connect standard hardware modules to create a system or the capability to change functionality or sizing of software functions by changing parameters without having to modify or regenerate software.

2.5 I/O

Input / Output with respect to process / operator

2.6 PLC Console (Operator)

PLC console (Operator) is the operator's main plant interface device through which operator can view, monitor and control the plant and can give instructions to peripherals to execute commands, and shall have protective access to configure and maintain the system.

2.7 **PLC Console (Programming Terminal)**

PLC console (Programming Terminal) shall be the engineer's main interface device through which engineer can configure / program and maintain the system, and shall have protective access to monitor and control the plant, give instructions to peripherals to execute commands.

2.8 Local Level

All those sub-systems;' which directly interface with field devices shall be referred to as local level.

2.9 Central Level

Operator Console and Programming Terminal, which present data acquired from local level devices shall be referred as Central Level.

2.10 Database

Database shall be defined as the information stored temporarily or permanently in the system which can be accessed by various programs to meet all its functional requirements.

2.11 Loop Integrity

A system shall be said to have loop integrity if the failure of one component in the system/ sub-system does not affect more than one loop.

2.12 System Loading

System loading for a sub-system is defined as the percentage of time a sub-system spends in carrying out various activities referred to the use of memory, CPU time and communication capacity in the worst case of high sub-system operation out of the designed / designated cycle time of the sub-system.

2.13 Redundancy

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A system component shall be termed as redundant if it takes over automatically the operation in the event of the failure of the main component without causing any interruption in the system and upsetting the process. The repaired or replaced device shall be brought in-line only through operator action without upsetting system operation.

2.14 Switchover Time

Time required for a back up instrument / system to come on-line automatically in case of the failure of the main instrument / system.

2.15 Processor Cycle Time (tpc)

Processor cycle time is the measure of the processing speed of a processor. Processor cycle time for a sub-system ofthe programmable logic controller shall be defined as follows:

Processor cycle time for programmable logic controller shall be defined as the total time taken by the processor to read input supplied by input module, execute all computations (analog as well as logic as configured) and write the outputs for the output module.

2.16 Scan Time (ts)

Scan time of a logic loops is the end-to-end response time of a sub-system and shall be defined as follows:

The scan time for a logic loop shall be defined as the total time taken by a sub-system e.g. programmable logic controller to read input from the input terminal, process input, execute logic, updating logic output and write output at the output terminal for all the logics configured within the subsystem.

2.17 User's Memory

Free memory space available after utilization of memory required for system operation, configuration and implementation of application and other system related functions for implementation of user defined specific programs such as plant calculations, process optimization or MIS (like free formatting of certain logs). The programs shall either be written in high level language or system specific language.

2.18 Event

An event shall be defined as any action taken by the operator via operator keyboard or switches on hardwired console like change of set point, change of control mode, start/stop of motor, open/close of shut down valves, alarm acknowledge etc.

2.19 Sequence of Event (SOE)

Arranging events in the sequence of their occurrence in time with a specified time resolution by a program is defined as sequence of event.

2.20 Sequence of Event Recorder (SER)

System or sub-system which presents and / or records the events in the sequence of their

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occurrence in time with a specified time resolution utilizing its hardware and software capabilities is termed as sequence of event recorder.

2.21 Real Time Trend

Real time trend shall be defined as a continuously progressing graphical record showing updated parameter with most recent value and a past record of minimum of 10 minutes without pressing any additional key for moving backward in time.

2.22 Plant Information Network

High-level communication network which serves various users within a plant and transfer information for the purpose of unit / plant monitoring. This network is different than control network and is generally realised using open communication protocol network e.g. OPC etc.

2.23 Tag

A Tag is a collection of attributes that specify either a control loop or a process variable, or a measured input, or a calculated value, or some combination of these, and all associated control and output algorithms. Each tag is unique.

3.0 SPARES PHILOSOPHY

3.1 The system including sequence of event recorder, hardwired instruments etc. shall meet the following spare philosophy. This philosophy shall also be applicable for items like barriers, relays, terminals, lamps, push buttons etc.

3.1.1 Mandatory Spares

Vendor shall include following mandatory spares in their scope of supply:

3.1.1.1 Installed Engineering Spares

Installed engineering spares shall be provided in each sub-system for each type of module to enhance the specified" system functional requirements by 20%. The basis of offering installed engineering spares shall include:

a) For a system with conventional and / or smart analog input / output, discrete (contact) input / output, 20% spare input / output of each type shall be considered for calculating I/O modules and all other related accessories.

b) For all serial input / outputs to the system, 20% spare serial\I/O ports ofeach type of serial input / output shall be provided.

c) 20% spare accessories like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals etc.

d) The engineering spares shall be wired up to the field cable interface and shall be in ready-to-operate condition when field cable is connected to spare assigned terminals.

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e) Spare pairs of the incoming cables shall be terminated on spare terminals in the marshalling / barrier cabinets as applicable.

f) The system shall be fully engineered considering 20% installed engineering spares including processor loading.

3.1.1.2 Spare Space Requirement

In addition to installed engineering spares specified in Clause 3.1.1.1 of this specification, the system shall be provided with following spare space:

a) I/O racks of programmable logic controller shall have 10% usable spare space for installing additional I/O cards of each type in future. However internal wiring for the same shall be connected up to the I/O terminals.

b) Processor system of programmable logic controller shall have capability to execute additional 20% logics.

c) Each operator console shall contain 20% usable spare group and related display capability in addition to as specified in para 3.1.1.1 of this specification.

d) The system shall have capability to extend its historical trending, logging and user's memory by 20% to meet future expansion with/without adding additional memory modules.

e) The communication sub-system shall have sufficient capacity to handle additional data contributed by addition of 20% I/O over and above installed engineering spares.

f) Usable spare space in panels and cabinets to install 10% spare hardwired items like relays, switches, lamps, fuses, circuit breakers, barriers, isolators, terminals, panel mounted instrument etc. in future.

3.1.1.3 Spare Memory Requirement

a) The system shall be provided with a minimum of 40% spare memory capacity, as required for application program and data base to meet specified functional requirements.

b) It shall be possible to extend the memory by at least 20% over and above the actual requirement at a later date.

3.1.1.4 Spare Software Capability

a) Sufficient additional software capacity shall be available in the system to take care of spares requirement as specified in para 3.1.1.1 and 3.1.1.2 of this specification to meet all functional requirements as per para 4.0 of this specification.

b) Unless specifically indicated otherwise, the offered system shall have software licenses to cover all the tag numbers indicated in the material requisition, including installed engineering spares and spare space indicated in clause 3.1.1.1 and

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3.1.1.2 of this specification.

3.1.1.5 Predefined Mandatory Spares

a) Mandatory spares shall be ware-house spares and shall be supplied as loose items.

b) Mandatory spare module of 5% or one module of each type, whichever is higher, must be supplied for each type of modules being used excluding modules used in consoles, servers, Personal Computers.

c) For items like, Video Display Units, keyboards, disc drives, network components, hardwired instruments like barriers, lamps, fuses and circuit breakers, complete item limited to 5% or minimum one of each type shall be supplied' as predefined mandatory spare. But this shall not include hardware like hard discs, terminals.

3.1.1.6 Consumable Spares

Any paper, ribbon, printer heads, toner and ink required for printers, video copier or any other consumable item shall be supplied along with system required for minimum of six months duration after system acceptance.

3.1.1.7 Commissioning Spares

Unless otherwise specified, vendor shall be responsible to supply all spares which are found necessary to replace failed modules, failed sub-systems, or corrupted / faulty softwares while performing pre-commissioning and commissioning activities.

3.1.2 Two Years Operational Spares

Two years operational spares shall be as per Clause 1.2.8(a) of this specification and shall be quoted separately.

4.0 DESIGN AND CONSTRUCTION

4.1 Design Requirements

4.1.1 Programmable logic controller shall be microprocessor based system which shall be used to execute all the process and safety shut-down logic of the plant. When specified, it shall also execute plant interlock logics and sequence operation. Programmable logic controller shall be an independent unit and shall not depend on any of its functionality on any other system including Distributed Control System.

4.1.2 The system shall be of modular construction and expandable in future by adding additional modules which shall be easily accessible for maintenance and repair. The type of modules shall be kept to the minimum possible in order to have interchangeability and low inventory.

4.1.3 System Availability

a) The system shall be designed 'fault avoidant' as a minimum by selecting high grade components of proven quality and proper design of system electronics.

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Redundancy shall be provided, as a minimum, as per this specification to improve system availability and reliability. Due considerations shall be given to the environmental conditions particularly for field mounted sub-system, if specified in job specifications, during system design.

b) The system shall have a high MTBF value and shall have well proven record of operating in hydrocarbon plants.

c) The system shall be designed with 99.995% or greater availability. The availability shall be defined as follows:

$$\text{Availability} = \frac{\text{Mean Time Between Failure (MTBF)}}{\text{MTBF + Mean time to repair (MTTR)}}$$

For the purpose of calculations, consider mean time to repairs as four (4) hours unless the manufacturer recommends higher value for MTTR. It is therefore necessary that:

i) Vendor covers all necessary spare parts in 2 years recommended operational spares which shall be necessary to meet specified MTTR time.

ii) Vendor provides adequate training to owner's personnel and cover all necessary maintenance related topics in their training programmes to ensure specified MTTR time.

4.1.4 Operating Environmental Conditions

4.1.4.1 Environmentally Controlled Location Installation

a) All subsystem of Programmable Logic Controllers located in Control Room, Local Control Room or in Satellite Rack Room shall be able to operate satisfactorily from 15°C to 30°C and 20% to 80% non condensing humidity.

b) In addition to above, all such sub-systems shall also be able to operate satisfactorily in case of air conditioning failure with ambient temperature of 50°C and 90% no condensing humidity until the system safe operating limits are exceeded. The minimum period of continuous operation in such condition shall be 48 hours at least once in a month without any damage or degradation of system performance. Vendor, therefore, shall provide continuous temperature monitoring for each enclosed cabinet housing items / equipments generating heat, such as system cabinets, barrier cabinets, relay cabinets etc and also provide alarm for operator alert in case the safe operating temperature limits are exceeded.

c) Chemical filters have been provided in the incoming air conditioning air to limit the concentration of contaminants below following limits:

Contaminants (Corrosive Gases)	Concentration
SOx	< 0.01 ppm by volume
NOx	< 0.05 ppm by volume

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H2S	< 0.003 ppm by volume
Cb	< O.OOlppm by volume
NH3	< 0.5 ppm by volume
SPM	< 200 ugm/m'
RSPM	< 100 ugm/nr'

All sub-systems and system components shall be suitable for operating continuously in the above mentioned corrosive environments

4.1.4.2 Outdoor Installations

a) Sub-systems or system components which are installed outdoor shall be suitable to continuously operate at ambient temperature and humidity specified under ambient conditions. The heat generation effect of current carrying for the electronic modules shall also be considered. For this purpose the system shall be\rated for minimum 5 deg C more than the maximum ambient temperature specified. In case the system is not suitable for the above conditions, necessary cooling arrangement shall be provided.

b) Unless otherwise specified, all PLC sub-systems or system components installed outdoor shall have corrosive environmental protection coating meeting the environmental classification class G3 as per ISA-S71.04.

4.1.5 Transient, Static and EMI / RFI Protection

4.1.5.1 The system shall be internally protected against system errors and hardware damage resulting from:

a) Electrical transients on power wiring.

b) Electrical transients on signal wiring.

c) Connecting and disconnecting devices or removing or inserting printed circuit boards in the Programmable Logic Controller (PLC).

4.1.5.2 All sub-systems and system components shall be capable of accepting various signal inputs for its direct use while preventing noise errors due to electromagnetic interference (EMI) or radio frequency interference (RFI) including nearby radio stations, hand held two way radios, solenoids, relays or contactors carrying heavy currents as per levels of Environmental electromagnetic phenomenon defined in IEC-61000-6-2. The system shall have total noise immunity from UHF / VHF radio communication equipments, (RFI) and (EMI) noise generating equipments as per IEC-61000-4.

4.1.5.3 For interplant, inter unit and other system cables routed in the field, the level of surge immunity required for equipment signal ports shall be increased to level 4 as defined in IEC-61000-4-5 and the system shall operate according to performance criterion B as defined in

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IEC-61000-6-2.

4.1.6 On-line Replacement

4.1.6.1 On-line replacement of any module of programmable logic controller shall be possible in such a way that removal and addition of the module shall be possible and safe without de-energising the system. Furthermore, there shall not be any interruption of the system while replacing a faulty module wherever redundant modules are provided.

4.1.6.2 Apart from system modules, power supply units shall be replaceable on-line without disrupting the process and without affecting the system redundancies. It shall be possible to hot swap any faulty system module without degrading the system safety or operation or freezing the output status. The switchover to the healthy module shall be bumpless. The swapped module shall take over the function of the failed module without any manual programming.

4.1.7 Electrical Isolation

Galvanic or optical isolation shall be provided for all field signals. The isolation levels shall be as follows:

Analog I/O channel to system ground 1500V AC

Discrete I/O channel to system ground 500V AC

External isolator shall be provided, if necessary to meet the above.

Isolation shall also be provided between Engineering / operator cbnsole/PLC programming terminal and related sub-systems connected to it if there is any possibility of high voltage being transmitted to the sub-systems.

4.1.8 Design Requirements of Equipments in Hazardous Area

4.1.8.1 Unless specifically indicated, the field devices are beyond the scope of this specification. However vendor shall be fully responsible for integrating these devices with their system.

4.1.8.2 General requirements

a) Unless otherwise specified, all instruments in hazardous area shall be intrinsically safe type. Other concepts shall be used when specified.

b) For conventional instrumentation, entity concept shall be used for selecting proper barriers / isolators.

4.1.9 Repeat Signals

4.1.9.1 Unless otherwise specified in the job specifications, following philosophy shall be followed for repeat signals:

a) Whenever repeat contact outputs are required as per job specifications following philosophy shall be followed:

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i) For intrinsically safe input contacts, isolating barrier with dual contact output shall be utilized.

ii) For all other contact inputs, repeat contact shall be provided using electro-magnetic relays.

4.1.10 The system shall be designed fault tolerant and shall utilize high quality components of proven quality. Any single system fault shall not degrade the system safety or functionality or affect operation. The system shall have certified Safety Integrity Level as per IEC61508/ 61511 as applicable and specified in job specification. Unless otherwise specified, it shall meet the availability requirement specified in Clause 4.1.3 ofthis specification.

4.1.11 Unless otherwise specified, the scan time of programmable controller shall be of the order of 250 milliseconds for PLCs. Scan time for a PLC shall be as defined under para 2.16 of this specification.

4.1.12 Operation of the PLC shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.

1.1.13 The system shall be programmed in principle as per the logic diagrams furnished during detailed engineering. Vendor shall prepare their own Logic/Ladder diagrams depending upon the capability of the programmable logic controller offered by them. Owner / Consultant reserve the right to revise or review the logic diagrams even after acceptance of any offer. The programming language of offered PLC shall be as per IEC 61131.

1.1.14 Whenever the requirement of SIL is specified for the PLC, it shall meet the requirements of SIL level specified and shall be certified by an independent body (e.g. TUV) for complying requirements of IEC-61508 / 61511 as specified.

1.1.15 The system shall have extensive set of self diagnostics hardware and software for easy and fast maintenance of PLC. Routine checks should run automatically at frequent intervals for identifying any fault in software or hardware. Diagnostics shall be required at local as well as console level. \

1.1.16 Safety barriers shall be provided by the vendor for intrinsically safe input/output circuits wherever specified. In such cases, the system shall be designed intrinsically safe based on entity concept. The barriers shall be certified by a statutory authority like Baseefa, LCIE, CSA, UL, PTB, CIMFR etc., for the use in the area classification as specified elsewhere in the job specifications. The proper selection of the safety barriers shall be the vendor's total responsibility. In case of smart transmitter, the entity parameters of the hand held terminals shall also be considered while selecting proper barriers.

1.1.17 Unless otherwise specified all intrinsically safe barriers shall be 3 port isolating type only providing isolation between;

i) Input and output (non-hazardous to hazardous side of barriers)

ii) Power supply and input

iii) Power supply and output

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The minimum isolation level shall be 250V.

4.2 System Configuration

4.2.1 General

a) PLC system configuration / architecture shall be as specified in the job specification. For emergency shutdown system application the system configuration shall be TMR or QMR or DMR or VMR as per the job specification and shall be certified by independent agency e.g. TUV.

b) Regardless of the action feature selected (except for single architecture), the failure of single component shall not result in a failure of correctly executed safety function.

c) In general, the PLC system shall comprise of various sub-systems as described in the subsequent clauses of 4.2.

4.2.2 Input/ Output Subsystem

4.2.2.1 Each I/O module shall have its own processor. I/O modules configured m redundant configuration, shall have their processors properly synchronised.

4.2.2.2 Unless otherwise specified, system shall accept analog 4 -20mA inputs and contact inputs. The maximum number of Input/Output per I/O module shall be limited as per the following table.

Sl No.	Type of Configuration	Maximum No. I/O s
1	Single I/O system	8
2	Dual I/O system	16
3	Triple Modular Redundant system (TMR)	32
4	Quadruple Modular redundant System (QMR), Flexible Modular Redundant (FMR) configuration, Virtual Modular Redundant (VMR)	16

4.2.2.3 Each I/O shall be galvanically isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 1000 volts DC.

4.2.2.4 Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.

4.2.2.5 Each input shall be provided with filters to filter out any noise in the input line and contact bouncing noise, as applicable.

2.2.2.6 All the inputs / outputs shall be double ended i.e. two wires per input / output and not with

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common return for all inputs.

4.2.2.7 The interrogation voltage to the inputs and power supply for 2-wire instruments shall be powered from separate redundant power supply / supplies and shall not be a part of PLC, unless otherwise specified. This power supply shall be supplied at one point and shall be distributed by the vendor.

4.2.2.8

a) Each module shall have a LED per channel to indicate the status of each input output.

b) When specified, input module shall be capable of monitoring the input contacts for any wire open fault and short circuit.

4.2.2.9 Analog Input Module

a) Input module shall be able to accept 4~20 rnA DC input from smart transmitters (e.g. 4 -20mA HART).

b) The module shall have 12 bit Analog to Digital resolution accuracy of ±0.2S% of full scale over the entire range, unless otherwise specified.

4.2.2.10

a) Output contacts from the PLC shall be potential free dry contacts with contact rating as per para 4.2.2.10 b) of this specification. Vendor must provide arc suppression device for each output contact.

b) The output contact rating shall be as follows:

SL.No.	APPLICABLE FOR	VOLTAGE RATING	CURRENT RATING
1	All output cards driving solenoid valve and alarm annunciator system unless otherwise specified Category -I Category -II	 **110 V DC** **24VDC**	 0.5 A 2A
2	All motors/pumps/compressor output cards unless otherwise specified. Category –I Category -II	 **240 V AC** **220 V DC**	 5.0A 0.2 A

c) The category of contacts shall be specified in the material requisition. Each output shall be short circuit proof and protected by fuse. Visual indication of fuse blown must be provided for each module.

d) When specified contact output module shall have monitored\ output features like wire open and short circuit.

4.2.2.11 Where inputs or outputs have multiple field devices for the same measurement or device, the corresponding inputs / outputs shall be configured in separate I/O modules.

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4.2.2.12 Where single input signal is available for QMR or DMR or FMR or VMR configuration, inputs shall be multiplied to feed inputs to each input modules / channels.

4.2.2.13 PLC shall be provided with Auto I/O testing facility as a standard diagnostics features. PLCs which do not have auto I/O testing facility, manual testing facility shall be provided to detect any system fault. For manual testing, manual switches shall be provided to bypass each input at a time and its effect on the output shall be monitored.

4.2.3 Processor System

4.2.3.1 The processor shall have capability to implement all the control functions required to implement the logic scheme as logic/ladder diagram.

4.2.3.2 The size of the memory shall be sufficient for storage of the program instructions required by the logic schemes and other functional requirements. Offer shall indicate the amount of memory capacity occupied by the actual program and spare capacity available for future program modifications or additions.

4.2.3.3 Memory shall be non-volatile. However in case volatile memory is provided, battery backup shall be provided with a minimum of 3 months lifetime to keep the program storage intact. A battery drain indication shall be provided at least one week before the battery gets drained.

4.2.3.4 Watchdog timer shall be a software device. The healthiness of processors shall be continuously monitored by watchdog timer. Any hardware or software problem in the processor system, which shall include, CPU, memory, power supply, communication interface etc. shall cause the watch dog timer to report processor failure.

4.2.3.5 Wherever dual redundant processor is specified, redundancy shall be provided in such a way that in case of failure of the main processor, the standby shall take over automatically. The changeover shall be bump less. Redundancy shall be provided for complete processor system including processor, power supply and communication sub system.

4.2.3.6 In case of triple modular redundant system all the three processors shall execute the same instructions/program and check their results and vote to correct any faulty result. The faulty processor diagnostic shall be made available.

4.2.3.7 In case of QMR system, individual processor shall execute the same instructions/ programs and check their results within same CPU module and majority vote to correct any faulty result. The faulty processor diagnostic shall be made available.

4.2.3.8 Failure of a single processor in dual redundant, triple redundant system and two processors in QMR system shall not affect the system. In case of failure of complete processor system

i.e. both processors in case of dual configuration, two or more in case of triple redundant system and more thah two in case of QMR system, outputs shall take failsafe state automatically unless otherwise specified in the data sheets.

4.2.3.10 It shall be possible to generate the first out alarm contact by the PLC in case where a group of parameters are likely to trip a system.

4.2.4 PLC Console (Programming Terminal)

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4.2.4.10 The PLC console (Programming Terminal) shall be used for programming, program storing, fault diagnostics and alarm monitoring. Whenever specified, it shall also be possible to use this console for plant operation. The functionality to operate as engineering / programming terminal or operator terminal or both shall be as specified in the job specification.

4.2.4.2 It shall consist of at least one coloured 22" LED monitor with TFT technology and one programming / operating keyboard, mouse and printer unless specified otherwise.

4.2.4.3 PLC console when used for plant operation shall also meet the functional requirements as per clause 4.2.5 of this specification

4.2.4.4 The keyboard shall preferably be touch sensitive sealed type, easy to operate with each key clearly identified.

4.2.4.5 All illegal entries shall be rejected by the terminal and shall be identified by warning signal on VDU.

4.2.4.6 Manual forcing of any input or output contact connected to PLC shall be possible from keyboard. Forced functions shall have an associated audit trail.

4.2.4.7 It shall be possible to modify, add or delete the application program on line without affecting the outputs.

4.2.4.8 PLC Console shall display logic and/or ladder diagram indicating power flow and shall show description and status of each contact. It shall also be possible to display process alarms and diagnostic messages as and when they appear. Further it shall also be able to display I/O map in a user defined format.

4.2.4.9 I t shall be possible to print out the ladder/logic diagram on the dedicated PLC printer. The printer in addition shall also print out:

a) The diagnostic messages as and when generated and diagnostic reports, when called for.

b) Process alarms connected to the programmable logic controller as and when they appear and alarm report whenever initiated. The choice of printing alarms on this printer shall be operator selectable from a key lock / password protected switch on PLC console.

c) The I/O maps showing status of all inputs and corresponding outputs in a user defined format.

4.2.4.10 The PLC console shall be provided with self diagnostics feature which shall display error messages and initiate an audible alarm if the fault is detected. Wherever specified, a potential free contact for diagnostic group alarm shall be provided which shall be connected to the hardwired alarm 'annunciator system.

4.2.4.11 The system shall be able to identify the failure at least up to the module level including I/O system and redundant processor and report print out.

4.2.5 PLC Console (Operator)

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4.2.5.1 Where dedicated PLC operator console is specified, it shall be used for operation of plant, fault diagnostics, alarm monitoring and report generation.

4.2.5.2 It shall consist of colored 22" LED monitor with TFT technology, operator keyboard and printer unless specified otherwise.

4.2.5.3 At least two number cursor control devices shall be provided in addition to keyboard which may include touch screen, mouse, track ball etc.

4.2.5.4 PLC operator console shall have complete graphic capability and shall be able to display process dynamic graphics, overview and group view displays. It shall be possible to operate the plant i.e. start and stop of rotating machinery, opening and closing of valves, Pill function etc. from dynamic graphics and group displays available on PLC operator console.

4.2.5.5 It shall be possible to monitor, historise and print out all process alarms, diagnostic alarms and alarm reports.

4.2.5.6 Unless otherwise specified, the time stamping of all alarms shall be as per PLC processor time stamping.

4.2.5.7 The system shall be able to store and display stored data wherever required. The minimum storage capacity shall be for 30 days at 1 minute sample rate for all the inputs specified, diagnostic alarms, process and first out alarms, manipulation data etc.

4.2.5.8 The system shall be able to generate shiftly, hourly, daily, weekly and monthly reports. The log format shall be furnished during detailed engineering.

4.2.5.9 The system shall be supplied with first out alarm generation capability. The resolution of alarm shall be as per processor cycle time, as a minimum.

4.2.6 Communication Subsystem

4.2.6.1 The PLC communication subsystem shall be a digital communication bus that provides a high speed data transfer rapidly and reliably between the processor, I/O sub-system, PLC console and other devices connected in the PLC system.

4.2.6.2 Redundancy in PLC communication subsystem shall be provided as follows unless otherwise specified:

a) For single architecture, the communication subsystem between PLC processor and I/O subsystem shall be single unless otherwise specified. This shall include single communication bus and single interfaces/buffers.

b) For dual I/O configuration, each I/O sub set shall have separate communication interface and bus for connecting to PLC processors.

c) For the triple redundant system, each processor shall have a separate set of PLC communication subsystem.

d) For the QMR systems each I/O subset shall have separate communication interface and bus for connecting to respective CPU module.

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e) The communication subsystem between processor subsystem and PLC console shall be dual redundant, consisting of two separate communication interfaces and two buses, each one configured in redundant mode, unless this is only used as programming aid.

4.2.6.3 In case of redundant PLC communication sub system, on the failure of the active device, the redundant device shall take over automatically without interrupting the system operation. Information about the failed device shall be displayed at local as well as on PLC console. It shall be possible to manually switch over the communication from main bus / device to redundant bus / device without interrupting any system function.

4.2.6.4 The mechanism used by the system for error checks and control shall be transparent to the application information / program. Error checking shall be done on all data transfers by suitable codes.

4.2.6.5 In general, PLC shall provide data m a well established protocol format preferably MODBUS protocol.

4.2.7 System Power Supplies

4.2.7.1 Unless specified otherwise, the programmable logic controller shall operate on uninterrupted power supply (UPS). However the system shall be capable of operating satisfactorily at the following power supply specifications:

Voltage	220 V ±10%
Frequency	50 Hz±3 Hz
Harmonic contents less than	5%
Power interruption	10 millisec

4.2.7.2 The power supply system shall be supplied with dual PLC feeders each capable of handling 100% of the total power supply load requirements. In case of failure of one feeder, redundant feeder shall supply the total load.

4.2.7.3 Each I/O rack shall be provided with separate power supply unless otherwise specified in job specifications. Each power supply shall be sized to take full load of the I/O rack/signal conditioning panel. Each rack shall be provided with dual redundant power supply.

4.2.7.4 Processor subsystem shall be provided with separate power supply, as a minimum, unless otherwise specified in job specification. Failure of one power supply shall not affect the system operation/processor switchover in case of dual processor system. Wherever triple redundant system is specified each processor shall preferably be provided with a separate power supply. Also separate power supply must be provided for each multiplied process I/O channel.

4.2.8 Self Diagnostics

4.2.8.1 The system shall have an extensive set of self diagnostic routines which shall be able to identify all permanent and transient system faults / failures at least up to module level

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including redundant components and power supplies through detailed VDU displays and report print out.

4.2.8.2 At the local level, failure of a module in any subsystem shall be identified by an individual LED.

4.2.8.3 Diagnostic software shall have the capability to provide information about the failed module/system either in the form of a system configuration display or provide information in the form of a "statement".

4.2.8.4 Self diagnostic software shall have capability to detect faults which make the system permanently close/open in the I/O modules or I/O signal conditioning modules (in case of triple redundant system, whenever specified in the job specifications, this may be achieved by automatically running the testing software at cyclic intervals), The automatic cyclic testing feature shall also be provided for dual I/O configuration and dual I/O signal conditioning for triple redundant system. The testing software cycle time may be considered once in 30 minutes however this shall be field adjustable by engineer. However, system performance shall not be degraded whenever testing feature is specified.

4.2.8.5 System for the following functionalities shall be supplied when specified:

a) Long storage historisation

b) Log report generation

c) First out alarm generation

4.2.8.6 System diagnostics shall be capable of identifying, locating and reporting the following faults, as a minimum:

a) Processor fault

b) Communication fault

c) I/O module fault

d) Power supply fault

e) Over temperature monitoring

f) Permanently close / open (stuck on or off) fault

g) Memory fault

h) Signal redundancy fault

Any other additional diagnostic alarm if available as a standard shall also be provided by vendor.

4.2.8.7 Testing software shall be capable of detecting faults in case of normally closed system as well as in normally open system.

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4.2.8.8 Feedback must be provided in case of triple redundant system and QMR system from the output voter system to detect any latest faults of the system in addition to other diagnostic software.

4.2.9 System Software

4.2.9.1 The system software shall include all programs for the PLC and PLC console which are required to perform all the PLC functions including communication and self-diagnostics. Whenever PLC is specified for shutdown application, the system shall be designed and engineered in full compliance with the requirement of IEC-61511. Whenever different functional logics are combined within a common PLC, the safety related I/O's of each functionality shall be kept segregated within the system.

4.2.9.2 Logic program shall also be recorded on the external most reliable electronic media like DVD which shall be delivered in triplicate together with the system.

4.2.9.3 The PLC programming language for implementation of logic operations shall be based on the following representations:

a) Logic diagrams -Binary logic symbols such as AND, OR, NOT Gates, Timers and Flip-Flops.

b) Ladder diagram -Series / parallel connection of relay contacts.

c) Combination of (a) & (b) above.

4.2.9.4 Diagnostic package and its related equipment and software shall be supplied. A list of additional diagnostic packages available and the packages provided, including the description and capabilities, shall be provided with separate quote, wherever asked.

4.2.9.5 It shall be possible to print out the ladder/logic diagram on a dedicated printer. The printer shall also print out all diagnostic reports. Vendor must supply the off line software package to enable the owner to modify/add/delete any part of program and for documentation.

4.2.9.6 Software for the generation of various displays including dynamic graphics wherever specified to be provided as per given below:

4.2.9.6.1 It shall be possible to display dynamic graphic of plant on the operator console VDU screens. Graphic displays shall be field configurable only through PLC Console (Programming terminal) with standard / user defined graphic symbols. Dynamic graphic displays of different sections of the plant shall be displayed on different pages.

4.2.9.6.2 The system shall have graphic symbol library as per ISA-5.! and 5.3. In addition standard industrial symbols like distillation columns, heat exchangers, pumps, compressors, tanks etc. shall also provided as a standard.

4.2.9.6.3 Graphic displays shall be interactive type through which it shall be possible to control the process. It shall also be possible to send motor start/stop and shutdown valve open/close commands, as specified in job specifications, from this display

4.2.9.6.4 It shall be possible to view the process variable and alarm points and view and change set

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point value, manipulated variable, controller mode etc. from the graphic display. Also rotating machinery (i.e. compressor / pump) status and valve status shall be displayed on the graphic display with different colours

4.2.9.6.5 Various colours used in the generation of graphics like colour of the process lines, utility lines, Instrument signal lines and event modifier conditions shall be finalised during detailed engineering. The colours used to identify event modified conditions shall generally be as follows unless otherwise indicated during detailed engineering

Red -	All points alarm
Blue-	Valve open, pump running
Green -	Valve closed, pump stopped
Flashing green -	Shut down valve transition state

4.2.9.6.6 It shall be possible to go from any graphic page to related graphic pages or any group view or alarm summary in single key stroke using soft key function.

4.2.9.7 The software for printing alarms, system as well as process, and events on the PLC printer must be provided. All alarms must be printed as and when they appear.

4.2.9.8 Software package for displaying I/O map showing status of inputs and corresponding output providing tag numbers as per logic diagram shall be offered. The I/O map format shall be user definable.

4.2.10 Power Supply Distribution

4.2.10.1 All type of power supplies shall be made available at one point. Further distribution of power supply shall be in vendor's scope.

4.2.10.2 In general, all output contacts and solenoids shall be powered with 1I0V±10% DC/ 24V±10% DC power supply. However, the actual interrogation voltages shall be as per job specifications and logic diagrams.

4.2.10.3 The distribution network for interrogation voltage shall be designed such that a single fault in any branch shall not cause trip of the logic other than where the fault has occurred.

4.2.10.4 Sequential starting of various load centers shall be provided whenever specified.

4.2.10.5 Power distribution network must use bus bars of adequate capacity with DPDT (Double Pole Double Throw) switches and HRC (High Rupture Capacity) fuses in each branch network. Vendor may select circuit breaker if short circuit characteristics do not match the HRC fuse.

4.2.10.6 All cubicles lighting shall be on 240 V, 50 Hz AC normal power supply.

4.2.11 PLC System Cabinets

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4.2.11.1 All PLC system cabinets shall be completely wired with all modules in place. Inside cabinet wiring shall preferably be done using ribbon type pre-fabricated cables.

4.2.11.2 All the cabinets shall be free standing, enclosed type and shall be designed for bottom entry of cables. Cabinet structure shall be sound and rigid. Cabinet shall be provided with removable lifting lugs to permit lifting of the cabinets.

4.2.11.3 Cabinet shall be fabricated from cold rolled steel sheet of minimum 2 mm thickness suitably reinforced to prevent warping and buckling. Doors shall be fabricated from cold rolled steel sheet of minimum 1.6 mm thickness. Cabinets shall be thoroughly deburred and all sharp edges shall be grounded smooth after fabrication.

4.2.11.4 Cabinet finish shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filter and two coats of high grade lacquer with wet sanding between two coats. Two coats of paint in the cabinet colour shall be given for non-glossy high satin finish. Colour of the cabinets shall be as per job specification. Final coat shall be given after assembly at site when specified in the job specifications.

4.2.11.5 Each cabinet shall be maximum 2100 mm high (excluding 100 mm channel base), 800 mm wide and 800 mm deep, in general. Construction shall be modular preferably to accommodate 19" standard electrical racks. All cabinets shall be of same height.

4.2.11.6 Cabinets shall be equipped with front and rear access doors. Doors shall be equipped with lockable handles and concealed hinges with pull pins for easy door removal.

4.2.11.7 In order to effectively remove dissipated heat from the cabinets, ventilation fans along with vent louvers backed by wire fly screen shall be provided as required. Ventilation fans shall be provided in all cabinets where the temperature rise with all doors closed and all internal and external loads ertergised shall exceed 10° C above the ambient temperature. A temperature element (resistance temperature detector) shall be provided in each cubicle for temperature measurement. Ventilation fans shall be provided in dual configuration, as a mmimum.

Each fan shall have a separate dedicated assembly and shall be replaceable on-line without shutting down any equipment / panel/cabinet / console in part or in complete. \

Ventilation fan assembly shall operate at 240V AC power supply. Each fan shall have its own dedicated circuit breaker.

Each ventilation fan shall be fitted with a protection type finger guard. Whenever, the numbers of cabinets are compacted (supplied in mechanical joined conditions), each cabinet shall be provided with separate ventilation fan assembly.

The maximum noise level with all fans operating and cubicle doors open shall not exceed 85dBA.

Following signals and alarms shall be provided for each cabinet:

i) Fan failure alarm for each cubicle in PLC.

ii) Temperature indication of each cabinet or compacted combination, as applicable in PLC.

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iii) A common alarm each for high temperature and fan-failure shall be made available.

4.2.11.8 Internal illumination shall be provided for cabinets to ensure proper illumination level of250 lux for performing maintenance activities. Illumination shall be provided for all cabinets by incandescent lamps, which shall be activated individually by door operated magnetic switches. The lamps shall activate when door is opened and deactivate when the door is closed. The magnetic switches selected shall have undergone life cycle cyclic test of at least 1000000 operations. A manual over-ride switch shall be provided inside the cabinet which shall keep the lamp deactivated even when the door is open.

4.2.11.9 Equipment within the cabinet shall be laid out in an accessible and logically segregated manner. Cable glands shall be provided and supplied by vendor for incoming and outgoing cables to prevent excessive stress on the individual terminals. All metal parts of the cabinet shall be electrically continuous and shall be provided with a common grounding lug.

4.2.12 Control Panels/ Hardwired Console

4.2.12.1 Control panels, if required, shall be non-graphic self supporting, free standing cubicle with back doors made up of sectional steel panels. Each section shall be maximum 2100 mm high, 1200 mm wide and 1000 mm deep and shall be mounted on 100 mm high channel base. Care shall be taken to ensure that the face of the panel is truly flat and smooth.

4.2.12.2 Panels / hardwired console shall be fabricated from 3.0 mm thick cold rolled steel sheet. Angle iron frame shall use a minimum section of 50x50x4mm angle.

4.2.12.3 Front of panel/console instrument nameplates shall be black laminated plastic with white core. Nameplate shall be provided on the rear of the panel also for each instrument.

4.2.12.4 Document pocket / wallet shall be provided on the inner side of front and rear doors of each cabinet and on the inner side of the door of each panel. Similar arrangement shall also be made on the inner side of doors of console.

4.2.13 Wiring Requirements'!

4.2.13.1 All wiring shall conform to API RP 552-Transmission Systems. Different signal level cables shall be routed with separation distances as recommended by this code.

4.2.13.2 All wiring inside racks, cabinets, and back of the panels shall be housed in covered, non-flammable plastic raceways arranged to permit easy assembly to various instruments for maintenance, adjustments, repair and removal. \

4.2.13.3 All wiring in the raceways shall be properly clamped. All incoming cable and outgoing cables shall be terminated by vendor at marshalling rack. Total wiring cross-sectional area shall not exceed 50% of the raceway cross sectional area.

4.2.13.4 Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring, and intrinsically safe wifing. Parallel runs of AC and DC wiring closer than 300mm shall be avoided.

4.2.13.5 Vendor can alternately offer prefabricated cables for interconnection between different

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cabinets and panels.

4.2.13.6 Wire termination shall be done using self insulating crimping lugs. More than two wires shall not be terminated on one side of single terminal. The use of shorting links for looping shall be avoided.

4.2.13.7 Terminal housing shall be strictly sized with considerations for accessibility and maintenance. Minimum distance required between various components is listed below. These distances are clear distances and are excluding the width of the raceways or any other component / item mentioned herein. Following clearances should be considered:

a) Distance between terminal strip and side of the cabinet parallel to the strip, up to 50 terminals, shall be minimum 50 mm.

b) Distance between terminal strip and, top and bottom of the cabinet shall be minimum 75mm.

c) Distance between two adjacent terminal strips shall be minimum 100 mm.

d) Additional distance for each additional 25 terminals shall be minimum 25 mm.

e) Distance between cable gland plate and the bottom of the strip shall be minimum 300 mm.

4.2.13.8 All terminal/terminal blocks shall be DIN Rail mounted type and shall be easily removable. The size of the terminal blocks / terminals of different types shall be consistent and identical. All terminal blocks shall be mounted on suitable anodised metallic or plastic stand-off.

4.2.13.9 No splicing is allowed in between wire/ cable straight run.

4.2.13.10 Terminal strips shall be arranged group-wise for incoming and outgoing cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip. Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used.

4.2.13.11 Cabinet and rack layout shall be made considering proper accessibility and maintenance.

4.3 Earthing

4.3.1 All system equipments such as panels, marshalling cabinets, system cabinets and other powered equipments shall be provided with following type grounding system:

a) Protective Earth/ Electrical Earth

b) System Earth! Signal Earth

c) Safety Earth! Barrier Earth (when required)

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Both system earth and safety earth shall be totally separate from protective earth.

4.3.2 Protective Earth / Electrical Earth

a) Each metallic enclosure / cabinet / panel/console etc. shall be provided with electrical earth lug, as a minimum.

b) Unless recommended otherwise by vendor, all earthing lugs of metallic equipments indicated in Clause 4.3.2 (a) above shall be connected individually to electrical protective earthing system bus-bar / earthing station using ,a maximum of 10sq mm solid copper conductor PVC insulated wires.

c) Where multiple cabinets are multiplexed together, earth looping with permanent shorting link cables shall be acceptable. Two earthing connection wires as indicated in Clause NoA.3.2 (b) above shall be used for connecting multiplexed cabinets to protective earth station / bus-bar.

4.3.3 System Earth

a) System earth shall be totally noise free dedicated earthing system and shall be fully isolated from electrical protective earth. This earth must be very high integrity system and shall be used to ground zero volt references and signal cable grounds.

b) System earth shall be less than one (l) ohm grounding system with its own dedicated earthing pits. These earth pits shall be away from any heavy noise plant equipment. Outside the control room building is the most appropriate location.

c) Wherever supply of earth pit is kept in vendor's scope in the Material Requisition, the earth pit design shall be as per IS-3043 code of practice for earthing. A minimum of four (4) number of earth pits shall be provided for grounding system integrity. In case number of pits required to meet 1 ohm resistance are more than (2), the number of earth pits shall be two times the actual number of pits required to meet resistance criteria. All these pits shall be securely connected with each other to form a one homogeneous system earth grid.

d) Each marshalling / system cabinet / panels etc shall be provided with system earth bus-bar which shall be insulated from the metallic body frame. This bus-bar shall be used to earth also signal zero volt references and signal cable screens. Terminals used for termination of spare conductor pairs / cores of multi-pair signal/control cables shall be connected to system earth bus-bar. Shorting links shall be used for spare terminal looping.

e) System bus-bars in the multiplexed cabinets can be joined together by permanent shorting links. System bus-bars of other cabinets can also be connected together provided they are permanently joined using 35 sq mm stranded copper conductor cable.

4.3.4 Safety Earth / Zener Barrier Earth

a) Whenever Zener barriers are selected or used to meet intrinsically safe

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requirements, the earthing terni'inal of the zener barriers shall be connected to a separate earth bus bar.

b) This earth shall meet all the requirements specified in Clause 4.3.3 of this specification.

c) Safety earth bus bar shall be directly connected to earth pits using dual insulated cable. Cable conductor size shall be minimum 95 sq. mm (c~pper).

4.4 Interface with DCS

The PLC shall be required to be interfaced to the Distributed Control System bus whenever specified. A suitable interface shall be offered in order to achieve the following functions:

a) Display of all input points under alarm/first out alarm connected to PLC or generated by PLC, continuous indication for analog signal on the main DCS operator console.

b) Generate shutdown reports on the logging printer of Distributed Control system.

c) To receive certain operational commands from the operator console for the operation of certain output devices connected to PLC

d) To display diagnostic message of PLC.

In general, PLC shall provide data in a well established MODBUS protocol format.

The interface shall be dual redundant unless otherwise specified.

The speed of data transfer shall be such that any change in I/O which is to be updated on the operator console shall not exceed 3 second from the time event to update on the operator console screen considering one second standard update rate in DCS operator console.

4.5 Sequence of Event (SOE) Function Requirement

Sequence of Event, whenever specified, for analog and digital inputs shall be generated and time stamped in PLC. The maximum resolution between two events shall not exceed specified PLC scan time unless specified otherwise. A separate SOE PC with 21" size TFT screen and printer shall be provided for PLC sub-system unless specified otherwise.

5.0 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

5.1 General

5.1.1 This specification defines the basic guidelines to vendor for factory testing and acceptance, installation, commissioning and field acceptance of the complete PLC system. On the basis of this specification, vendor shall submit their own detailed testing, installation, commissioning and acceptance procedure. For hardware, the procedure shall include test name, purpose of

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test, test equipment / set up, definition of input, test procedure, results expected and acceptance criteria. Similarly for software, it shall include test name, details of the method, list of tests, sequence of execution, results expected and acceptance criteria.

5.1.2 The testing and acceptance of the system shall be carried out on the approved testing procedures and criteria based on this specification and vendor's standard testing requirements and procedures.

5.2 Factory Acceptance Tests (FAT)

5.2.1 Vendor shall test and demonstrate the functional integrity of the system hardware and software. No material or equipment shall be transported until all required tests are successfully completed and certified "Ready for Shipment" by the owner/consultant.

5.2.2 The purchaser reserves the right to be involved and satisfy himself at each and every stage of inspection. The purchaser shall be free to request any specific test on any equipment considered necessary by him although not listed in this specification, as a part of approval of factory testing procedure. The cost of performing all tests shall be borne by the vendor.

5.2.3 Vendor to note that acceptance of any equipment or the exemption of inspection or testing shall in no way absolve the vendor of the responsibility for delivering the equipment meeting all the requirements specified in Material Requisition.

5.2.4 It shall be vendor's responsibility to modify and/or replace any hardware and modify the software if the specified functions are not completely achieved satisfactorily during testing and factory acceptance.

5.2.5 Schedule of FAT shall be included in the Vendor's proposal.

5.2.6 Vendor shall not replace any system component/module/sub-system unless it is failed. A log of all failed components/modules in a sub-system shall be maintained which shall give description of the failed component/module, effect of failure on the sub-system, cause of failure and number of hours of operation before it failed. If malfunction of a component/ module in a sub-system repeats, the test shall terminate and vendor shall replace the faulty component/ module. Thereafter the test shall commence all over again. If even after this replacement, the sub-system fails to meet the requirements, vendor shall replace the full sub-system by the one meeting the requirements and the system shall be tested all over again. If a sub-system fails during the test, which is not repaired and made operational within four hours of active repair time after the failure, the test shall be suspended and restarted all over again only after the vendor has replaced the device in the acceptable operation.

5.2.7 Testing and FAT shall be carried out in two phases. The minimum requirements for testing during these two phases shall be as follows:

5.2.7.1 Under the first phase, vendor shall perform tests at his works to ensure that all components function in accordance with the specification for each type of test. A test report shall be submitted for purchaser review within one week of completion of this test. Phase II testing (witness inspection) shall start only after this.

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All subsystem shall undergo a minimum of 30 days burn in period. The burn-in time shall start after the sub-system is fully assembled and is powered up. It may include any such time for which the system has been kept powered on even for system generation and Phase I testing.

Following tests shall be performed by the vendor and reports shall be forwarded to purchaser:

a) Quality control test which shall be carried out to assure quality of all components and modules in accordance with vendor's quality control and assurance procedures.

b) System pre-test which shall be physical check of all modules, racks, cabinets etc.

c) System power-up test which shall test functionally all hardware and software. This shall include testing of redundancy, System performance on power supply variations, application software testing and system diagnostic verification.

5.2.7.2 The second phase of testing shall systematically, fully and functionally test all hardware and software in the pre~ence of purchaser representatives. All subsystems shall be interconnected to simulate, as close as possible, the total integrated system. Following minimum tests shall be carried out:

a) Visual and mechanical testing, which shall be carried out in principle to assure correct, proper, good and neat workmanship by the vendor This testing shall include dimensional verification, Layout verification as per approved GA drawings, Verification of Sheet thickness / Quality of painting (outer and inner) / N~meplates, identifiers and tag plates / Adherence to ferruling philosophy / Dressing of wires / prefabricated cables and clearances / Locks and handles as a minimum.

b) Verification of Bill of Material. The Bill of material verification shall include both hardware and software.

c) Functional testing:

This shall include the simulation of each input and output to verify proper system response. The testing as a minimum shall include:

i) Complete system configuration loading.

ii) Demonstration of all PLC system builder functions including addition/deletion of an input/output, addition/ deletion of a rung or an element in a rung, generation of dynamic graphics and other views, report generation etc.

iii) 100% checking of logics configured in the PLC by connecting switch/lamp at input/output, by simulating inputs and verifying outputs preferably using simulator, other related functions like forcing, first out shall also be verified.

iv) Checking of scan time. Scan time verification shall be carried out using high resolution storage oscilloscope during Factory Acceptance Test based on the specified requirements considering discrete input by given step change. The scan time values so observed shall be within 90% confidence

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level. Incase of analog inputs, input shall be ramp or minimal step, however such reading for analog inputs should be noted only for reference.

v) Checking of all PLC console displays, keyboard and touch-screen operation (wherever specified), printer/hard copier functions etc.

vi) System redundancy check including correct change over of the back-up unit in case of failure of main unit.

vii) System diagnostic checking for all subsystems on local level as well as on console, including checking of the testing software for I/O modules/signal conditioning modules, when specified.

viii) Checking of output status on processor failure.

ix) Checking of first-out alarm generation.

x) Simulation of power failure and system restart auto boot-up of system configuration and program after power restoration.

5.2.8 Vendor shall notify the purchaser at least three (3) weeks prior to factory acceptance test. In the event that representative arrives and the system is not ready for testing, vendor shall be liable for back charges for any extra time and expenses incurred.

5.3 Installation, Testing and Commissioning

5.3.1 Vendor shall offer the services of an installation team which would install the equipment in the control room, lay the interconnecting cables inside control room, check-out, test and commission the system.

All technical personnel assigned to the site by the vendor shall be fully conversant with the supplied system and software package, and shall have both hardware and software capability to bring the system on line quickly and efficiently with a minimum of interference with other concurrent construction and commissioning activities

5.3.2 Vendor's responsibility at site shall include all activities necessary to be performed to complete the job as per material requisition including:

a) Receipt of hardware/software and checking for completeness of supplies.

b) Installation of the system including for free supply equipment, if any.

c) Field cable termination and inter-cabinet cabling and termination.

d) Check out equipment installation.

e) Checking of interconnections, hardware and software configuration, overall system

f) Loop checking.

g) Field tests.

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h) Commissioning and on-line debugging of the system.

i) Involvement during plant commissioning and performance of final acceptance test.

j) Co ordination for integration with DCS / other third party system.

5.3.3 Field Inspection

5.3.3.1 All equipments shall be inspected thoroughly by vendor after its receipt at site for completeness and proper functioning. Vendor must initiate the remedial action, in case unsatisfactory operation of any item is observed, with intimation to Engineer-in-charge.

5.3.3.2 Vendor must document all observations including details of any malfunction observed. Items/ equipments requiring total replacement must document the reasons for the same.

5.3.4 Loop Checking

5.3.4.1 Loop checking shall be carried out by vendor including checking the interconnections, configuration and overall system functioning.

5.3.4.2 Vendor's scope of work as a part of system installation and loop checking shall include termination of field cables in the control room, checking of interconnection between instrument/equipment, glanding, ferruling/tagging of interconnecting cables in control room, ferruling of field cables in control room and performing overall loop performance check.

5.3.4.4 The input signals shall be simulated by disconnecting/connecting the field wires for all field switches connected to 'PLC. All field transmitters connected to control room shall be loop checked at 0%, 50% & 100% of full scale (for both increasing and decreasing signals). Wherever receiver cards are used, the set point shall be generated by giving the input signal to receiver card. All outputs shall be checked in field, either for actual operation of solenoid valve or actual pick-up of electrical contractor for rotary equipments. Shutdown schemes shall be checked for proper functioning, configuration and actuation.

5.3.4.5 After loop checking is completed, vendor shall connect back any ~erminals and connections removed for loop checking.

5.4 System Acceptance

5.4.1 The owner shall provisionally takeover the system from vendor after System acceptance test. System acceptance test shall be started only after the satisfactory performance of loop checking and verification of all loop checking records by Engineer-in-charge.

5.4.2 The system acceptance test shall be carried out in the presence of owner's representative and Engineer-in-charge or his authorised representative. The tests carried out in System acceptance test shall be fully recorded and duly signed by all representatives participating in the System Acceptance Testing. .

5.4.3 Vendor shall carry out the following functional tests, as a part of system acceptance test, as a minimum.

a) Hardware verification as per final Bill of Material.

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b) Visual and mechanical check-up for proper workmanship, identification, ferruling, nameplates etc.

c) System configuration as per approved configuration diagram.

d) Demonstration of all system function, display and diagnostics.

e) Checking of correct change-over of redundant devices.

f) Checking of various peripheral devices like printers and printing of all reports.

g) Complete checking of logic system, loading of user's program and checkout of results.

h) Checking of proper functioning of all disc drives, alarm summary, alarm history etc.

i) Proper information transfer on the information network by verifying system displays and printout.

5.5 Final Acceptance Test

The owner will take over the system from the vendor after the final acceptance test, which is defined as successful uninterrupted operation of the integrated system for three weeks. Vendor's personnel shall be present during the test. Any malfunctioning of the system components shall be replaced / repaired as required. Once the system failure is detected, the acceptance test shall start all over again from the beginning. The warranty period commences from the day owner takes over the system.

6.0 GENERAL REQUIREMENTS

6.1 Vendor shall comply fully with the general requirements of PLC system including logistic support services, documentation, warranty, maintenance contract and shipping instructions.

Post Warranty Maintenance Contract

Vendor shall quote separately for post warranty maintenance contract after warranty period for five years for the complete system as per commercial terms and condition of the requisition and the type (i.e. comprehensive or non-comprehensive) of post warranty maintenance shall be as specified in job specification. The personnel deployed during post-warranty maintenance shall have thorough knowledge of the system and at least two years of experience on the maintenance of similar system. Any other conditions of contract required by vendor shall be explained in the offer.

7.0 SHIPPING

7.1 All the materials used for packing, wrapping, sealers, moisture resistant barriers and corrosion preventers shall be of recognised brands and shall conform to the best standards in the areas for the articles which are packed

7.2 Workmanship shall be in accordance with best commercial practices and requirements of

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applicable specification. There shall be no defects, imperfections or omissions which would tend to impair the protection offered by the package as a whole.

7.3 The packing shall be suitable for storing in tropicalised climate, the ambient conditions, being specified injob specifications.

7.4 Shipment shall be thoroughly checked for completeness before final packing and shipment. Vendor shall be responsible for any delay in installation or commissioning schedule because of incomplete supply of equipments.

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INSPECTION AND

TEST REQUIREMENTS

FOR INSTRUMENTATION

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CONTENT

Sl. No.	DESCRIPTION
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1.2	Visual Inspection
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1.12	High-voltage Test

ATTACHMENT

Sl. No.	DESCRIPTION
Table-A	Table-A- Table of Inspection and Test Items

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1. INSPECTION AND TESTS

1.1 General

1.1.1 All instruments and system-oriented items shall undergo factory testing and inspection by authorized Third party representatives / Owner and PMC unless specified otherwise.

1.1.2 Wherever inspection at manufacturer's shop is waived because of any reason, the sub vendor's own testing reports shall be verified before despatch. In no case items shall be released without proper inspection verification.

1.1.3 The inspection and testing shall be carried out as per related specifications, international codes and practices/standards, approved documents and/or any other documents attached along with specifically suggesting testing to be carried out at manufacturer' works.

1.1.4 Items, for which 'Witness Inspection' is specifically exempted, manufacturer shall forward the test certificates as desired for review. The material shall be despatched only after obtaining written despatch clearance.

1.1.5 No system or system oriented item shall be despatched without integrated factory testing witnessed by representatives of / Third party inspector / Owner /PMC. The testing procedures shall be detailed out, based on testing requirements indicated in individual system specifications and shall be approved by Owner/ PMC. It must certify that the system is actually ready before calling the Owner/PMC for FAT. Also all the necessary documents and literature are to be submitted before calling for FAT.

1.1.6 Testing and inspection for all items shall be carried out as per approved factory testing procedures.

1.1.7 Performance specifications must be detailed out on each time which shall be verified by third party agency / by Owner / PMC during factory testing.

1.1.8 Acceptable criteria for Radiography and other NDT requirements for the instruments / instrument castings shall be inline with those specified in 'Piping Specifications' have been attached elsewhere in this package.

1.1.9 IBR certifications shall be provided by in the appropriate format duly signed by IBR authority or their authorised agency.

1.1.10 Verification of setpoint of rupture disc shall be part of witness inspection. Testing shall be carried out on the rupture disc, which are part of the actual rupture disc batch of manufacturer. This shall be in addition to the 3 numbers of spare rupture discs already indicated in the requirements. The testing, in general, shall be as per ASME section VIII.

1.1.11 Inspection and test items, witness inspection items for each kind of instrument at FAT (Factory acceptance test) shall be as shown in Table A.

1.1.12 Inspection and acceptance standards

Inspection and acceptance standards shall be as follows.

1.2 Visual Inspection

1.2.1 Conformation items

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1. Type and model
2. Tag no.
3. Rating
4. Range, Scale and symbol of unit
5. Set pressure and capacity of safety valves
6. Valve characteristics and CV value of control valves
7. Name of materials
8. Nameplate
9. Colour of painting
10. Die Marking (nominal size, material of flange and direction of flow)
11. Accessories
12. Quantity

1.2.2 Harmful defects

- Defect such as cracks, deformation and flaws shall not be found in the casting, forging and machined surface of the pressure rating part.
- Defect such as inside surface weld protrusion; lack of fusion and incomplete penetration shall not be found in welded places of pressure retaining part.

1.2.3 The instrument shall be in rugged design and assembly of all components within the enclosure fixed firmly to avoid loosening or falling-off of any parts.

1.2.4 Painting of instrument's surface shall be such that there is no defect or lack of uniformity.

1.3 Dimensional Inspection

[X] Main parts
[ ]
[ ]

Check and conform to the requirement of Purchaser's Spec, approved drawings or applicable code and standards.

1.4 Material Inspection

1.4.1 Mill test certificates

Manufacturer shall submit the mill test certificates for the following parts.

1. ANSI class 900 or above (ALL material used at the P.T. ratings)

2. The following parts made of steel for :
   - High temperature service (Alloy steel above C-Mo steel used at temperature of 400ºC or over)
   - Low temperature service (Iron and steel material of design temperature bellow minus 11ºC containing Al-killed steel)
   - Corrosion-resistant materials

I.	Temperature detective parts	:	**[X]** Flange and Thermowell
II.	Orifice assembly	:	**[X]** Flange
III.	Venturi tube, Flow nozzle and Low-loss tube	:	**[X]** Body
IV.	Positive displacement flow meter and	:	**[X]** Body, Strainer and

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	Turbine meter		Straightner
V.	Area type flow meter	: **[X]**	Body and Flange
VI.	Displacement type liquid level meter	: **[X]**	Chamber and Flange
VII.	Glass Gauge	: **[X]**	Body and Flange
VIII.	Control valve	: **[X]**	Valve body, Bonnet, Plug, Seat and Vane
IX.	Safety valve	: **[X]**	Valve body, Nozzle and Disc
X.	Condensate pot	: **[X]**	Body
XI.	Gas eliminator	: **[X]**	Body

1.4.2 Material grade 316SS or 316L SS of stainless steel, Purchaser may require Vendor to carry out the qualitative analysis for molybdenum.

1.5 Non-Destructive Examination

1. Control valve and safety valve
   Following Par. 1.5.2 and 1.5.3

2. Other instruments
   Shall be carried out in accordance with manufacture's standards approved by Purchaser

1.5.1 Ultrasonic Examination

1. Forging material on Orifice flange and Flow nozzle
   [X] ANSI class 900 or above

1.5.2 Radiography Examination

[ ] The pressure retaining casting parts

1. Applicable material and quantity (refer table VI)
   - Welded parts : [ ] JIS Z 3104, Z 3106
     [X] ASME VIII Division 1 uw-51 "Radiographic & Radioscopic Examination of Welded Joints"

2. Acceptant standards and grade
   - Casting : [ ] JIS G 0581
     [X] ASTEM E 446-9 or 186-93

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Table VI Radiography Examination

Materials			Quantity
Casting	class 1500 or over	C-steel	One out of total quantity of the same type, size and rating for pressure retaining critical parts(a)
	class 900 or over	C-Mo steel	
	class 600 or over	Cr-Mo steel Stainless steel	
	class 300 or over	Al-killed steel 2.5 Ni steel 3.5 Ni steel	
Pressure retaining welded parts	class 1500 or over	C-steel C-Mo steel	One spot on each welded parts per same material and same welder. All welded crossing parts
	class 300 or over	Cr-Mo steel Stainless steel	
	class 150 or over	Al-killed steel 2.5 Ni steel 3.5 Ni steel	

a. Following parts are Critical parts.
- Groove-welded parts of cast body
- Flange neck and valve seat's vicinity of cast body
- Other welded parts included in pressure retaining parts

Note: 1. In case of practical difficulty to perform Radiography Test, Manufacture shall notify Purchaser in advance, and for such case, magnetic particle or liquid penetrant examination may be used in accordance with Par. 1.5.3 with Purchaser's approval.

2. For the welded parts having nominal size of 1-1/2 in. or below, magnetic particle or liquid penetrant examination in Par. 1.5.3 may be used.

1.5.3 Magnetic Particle or Liquid Penetrant Examination

[X] For the pressure retaining parts

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Table VII Magnetic particle / Liquid penetrant examination

Materials			Quantity
Casting	class 900 or over	C-steel	20% of total quantity of the same type, size and rating for pressure retaining critical parts (a)
	class 600 or over	Cr-Mo steel Cr-Mo steel Stainless steel	
	class 150 or over	Al-killed steel 2.5 Ni steel 3.5 Ni steel	
Pressure retaining welded parts (b)	class 150 or over	All materials	20% of total welded parts

a. Refer to Par. 1.5.2(1).
b. Including butt groove-welded parts at site.

1.6 Pressure Test

1.6.1 Control Valve

1. Body and Bonnets

[X] Hydrostatic test with Applicable codes and standards

2. Body of special type

[X] Hydrostatic test

Test pressure and Hold time

[X] 1.5 times of max. Operating pressure / min. 2 kgcm2g
[X] Minimum 5 minutes.

3. Permanent distortion or Leakage

[X] shall not be found

1.6.2 Safety Valve or Safety Relief Valve

1. Pressure retaining parts

[X] Hydrostatic test before assembling

i. Test pressure and Hold time

[ ] 1.5 times of Max. Operating pressure / min. 2 kgf/cm2g.
[X] 2.2 times of Max. Operating pressure.
[X] Minimum 5 minutes.

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ii Distortion or leakage
[X] shall not be found

2. The out side parts of enclosed type
[X] Hydrostatic test after assembling

i. Test pressure and Hold time
[X] 1.5 times. Nominal pressure of flange
[ ] 2.2 times. Nominal pressure of flange
[X] Minimum 5 minutes.

ii. Defects
[X] Shall not be found

3. Special type valves

[X] Hydrostatic test with the manufacturer's standards approved by purchaser, where Par. 1.6.2(1) and (2) are not applicable

1.6.3 The pressure retaining parts of instrument

[X] Hydrostatic test or Pneumatic test as per applicable codes and standard

I Test pressure and Hold time
[X] 1.5 time of Max. Operating pressure / Min. 2 kg/cm2g
[X] Min. 5 minutes

ii Permanent distortion or Leakage
[X] Shall not be found

If the above mentioned test is technically difficult, the test shall be carried out in accordance with the manufacturer's standards approved by purchaser.

1.7 Pneumatic Test

1.7.1 The pneumatic test for instrument

I Test pressure & Hold time

[X] Max. Operating Pressure. (Design press.)
[X] Minimum 5 minutes

ii Permanent distortion or Leakage

[X] Shall not be found

1.8 Seat Leakage Test

1.8.1 Control Valve

Allowable leakage valve / (code):

[X] ANSI B16.104 (FCI 70-2)

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Unless other wise specified, butterfly valves shall not require the seat leakage test.

1.8.2 Safety valve

Seat leakage test (closing property) as follows.

1. Safety valve for Steam

   i. Test pressure

      [X] 90% of set pressure

   ii. Leakage

      [X] Shall not be found

2. Safety valve for Gas

   i. Test pressure

      [X] 90% of set pressure

   ii. Allowable leakage value (Refer Table – VIII)

Table VIII - Allowable leakage value of Safety valve

Type	Orifice Area (mm)	Number of Bubbles (min)	Leakage Value (cm3/min)
General	16.0 and less 20.5 and over	40 20	11.80 5.90
Balance bellows	16.0 and less 20.5 and over	50 30	14.75 8.85

3. Relief safety valves, Vacuum breakers and atmospheric valve
   [X] Manufacture's standard (approved by Purchaser)

1.9 Performance Test

For each instruments, the performance test shall be carried out in accordance with procedure approved by Client / PMC.
Acceptance standard shall be in accordance with applicable codes & standard, All specification, and manufacture's standard shall be approved by Client / PMC.

1.10 Steam Test

Steam test shall be performed as follows:

[ ] Valves used for steam service Temperature of 450°C or more, and the body ratings of class 600 and above.

[ ] After attaining the steady surface temperature same as temperature of the service with the pressure of service condition.

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In the case, when steam test has been performed and the report is submitted for the valve of same type, same bore size and material from the same lot, the steam test for the other valves may be omitted.

1. Leakage

   i. Body : [ ] Shall not be found
   ii. Seat : [ ] As per specified leakage value

2. Operation

   [ ] To be smooth

   After the steam test, the test of Par. 1.6 and Par. 1.8 shall be carried out.

1.11 Insulation Resistance Test

1. Power supply circuit & alarm circuit : 10M Ω or over (instrument panel: 3 MΩ or over/each panel)

2. Signal circuit : 5M Ω or more (instrument panel: 3 MΩ or More per panel)

The test shall be carried out in accordance with the applicable codes & Standards. Due to any technical constraint to measure, this test can be omitted

1.12 High-voltage Test

1. A-C power supply and alarm circuits

   i. Voltage level less than 250 V : **[X]** A-C 1500 V

   ii. Voltage level 250 V and above : **[X]** A-C 2E + 1000V

   'E' is the rated voltage.

2. D-C power supply circuits : **[X]** A-C 500V

   Test can be omitted in case of any technical constraint.

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Table A : Table of Inspection and Test Items

Kind of Instrument	Inspection and Test Items										
	Visual insp.	Dimensional insp.	Material insp.	Non-destructive exam	Pressure test	Pneumatic test	Seat Leakage test	Performance test	Insulation resistance test	High voltage test	Steam test
1 Thermocouple	○ ●T	○●T	—	—	—	—	—	□●T	□●T	□●T	—
2 Resistance thermometer bulb	●T ○	●T ○	—	—	—	—	—	●T □	□●T	□●T	—
3 Compensating lead wire	○●T	○●T	—	—	—	—	—	□●T	□●T	□●T	—
4 Bimetallic thermometer	○●T	○●T	—	—	—	—	—	□●T	—	—	—
5 Gas or liquid-filled thermometer	○●T	○●T	—	—	—	—	—	●T □	—	—	—
6 Thermowell	○●T	○●T	○ □●T	○ □●T	○ □●T	—	—	—	—	—	—
7 Orifice plate	○●T	○ □●T	○●T	—	—	—	—	—	—	—	—
8 Orifice flange	○●T	○●T	○ □●T	○ □●T	—	—	—	—	—	—	—
9 Restriction orifice	○●T	○ □●T	○●T	—	—	—	—	—	—	—	—
10 Flow nozzle low-loss tube	○●T	○●T	○ □●T	○ □●T	○ □●T	—	—	—	—	—	—
11 Venturi tube	○●T	○●T	○ □●T	○ □●T	○ □●T	—	—	—	—	—	—
12 Positive displacement flow meter	●T ○	●T ○	●T ○ □	●T ○ □	●T ○ □	—	—	●S ○ □	●T ○ □	●T ○ □	—
13 Area type flow meter	○●T	○●T	○ □●T	○ □●T	○ □●T	—	—	○ □●T	○ □●T	○ □●T	—
14 Thermal mass flow meter	●T ○	●T ○	●T ○	—	●T ○ □	—	—	●S ○ □	●T ○ □	●T ○ □	—
15 Turbine meter	●T ○	●T ○	●T ○ □	●T ○ □	●T ○ □	—	—	●S ○ □	●T ○ □	●T ○ □	—
16 Differential pressure flow meter	●T ○	●T ○	—	—	●T ○ □	—	—	●T ○ □	●T ○ □	●T ○ □	—
17 Differential pressure transmitter	●T ○	●T ○	—	—	●T ○ □	—	—	●T ○ □	●T ○ □	●T ○ □	—
18 Magnetic flow meter	●T ○	●T ○	●T ○	●T ○ □	●T ○ □	—	—	●S ○ □	●T ○ □	●T ○ □	—
19 Bourdon gauge	○●T	○●T	—	—	○ □●T	—	—	○ □●T	—	—	—
20 Draft gauge	○●T	○●T	—	—	—	—	—	○ □●T	—	—	—
21 Differential pressure gauge	○●T	○●T	—	—	○ □●T	—	—	○ □●T	—	—	—
22 Pressure transmitter	○●T	○●T	—	—	○ □●T	—	—	○ □●T	○ □●T	○ □●T	—
23 Displacement type level indicator, controller	●T ○	●S ○ □	●T ○	●T ○	●S ○ □	—	—	●S ○ □	●S ○ □	●T ○ □	—
24 Chamber for displacement type level meter	○●T	○ □●T	○ □●T	○ □●T	○ □●T	—	—	—	—	—	—
25 Glass gauge	○●T	○ □●T	○ □●T	○ □●T	○ □	—	—	—	—	—	—

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Kind of Instrument	Inspection and Test Items										
	Visual insp.	Dimensional insp.	Material insp.	Non-destructive exam	Pressure test	Pneumatic test	Seat Leakage test	Performance test	Insulation resistance test	High voltage test	Steam test
26 Float type level meter,	●T ○	●S ○	●T ○ □	●T ○ □	●S ○ □	—	—	●S ○ □	●S ○ □	●T ○ □	—
27 Differential pressure type level meter	○●T	●T ○	●T ○	—	●T ○ □	—	—	●T ○ □	●T ○ □	●T ○ □	—
28 Purge type level meter	○●T	○●T	—	—	—	—	—	○ □●T	—	—	—
29 Capacitance type level meter	○●T	●T ○ □	●T ○	—	—	—	—	●T ○ □	●T ○ □	●T ○ □	—
30 Conductivity type level meter	○●T	●T ○	●T ○	—	—	—	—	●T ○ □	●T ○ □	●T ○ □	—
31 Conductivity type level meter	●T ○	●S ○	—	—	—	—	—	●S ○ □	●S ○ □	●T ○ □	—
32 Weight sounding type level meter	●T ○	●S ○	—	—	—	—	—	●S ○ □	●S ○ □	●T ○ □	—
33 Radiation type level meter	●T ○	●S ○	—	—	—	—	—	●S ○ □	●S ○ □	●T ○ □	—
34 Pneumatic type control valve	●T ○	●S ○	●T ○ □	○ □●T	●S ○ □	—	●S ○ □	●S ○ □	●T ○ □	●T ○ □	
35 Hydraulic type control valve	●T ○	●S ○	●T ○ □	●T ○ □	●S ○ □	—	●S ○ □	●S ○ □	●T ○ □	●T ○ □	
36 Motor-operated control valve	●T ○	●S ○	●T ○ □	●T ○ □	●S ○ □	—	●S ○ □	●S ○ □	●S ○ □	●S ○ □	
37 Self-acting control valve	○●T	○●T	○ □●T	○ □●T	○ □●T	—	—	○ □●T	—	—	—
38 Indicator	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
39 Recorder unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
40 Controller unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
41 Integrator unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
42 Alarm setting unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
43 Computing unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
44 Converter unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
45 Limiter unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
46 Power source unit	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
47 Instrument panel	●T ○	●S ○	—	—	●T ○ □	●S ○ □	—	●S ○ □	●T ○ □	●T ○ □	—
48 Instrument desk	●T ○	●S ○	—	—	—	—	—	●S ○ □	●T ○ □	●T ○ □	—
49 Gauge board	●T ○	●S ○	—	—	●T ○ □	●S ○ □	—	●S ○ □	●T ○ □	●T ○ □	—
50 Safety valve	●T ○	●S ○ □	●T ○ □	●T ○ □	●T ○ □	—	●S ○ □	●S ○ □	—	—	—
51 Pilot operated safety relief	●T	●S	●T	●T	●T	—	●S	●S	—	—	—

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Kind of Instrument	Inspection and Test Items										
	Visual insp.	Dimensional insp.	Material insp.	Non-destructive exam	Pressure test	Pneumatic test	Seat Leakage test	Performance test	Insulation resistance test	High voltage test	Steam test
valve	○	○ □	○ □	○ □	○ □		○ □	○ □			
52 Vacuum breaker	●T ○	●S ○ □	●T ○ □	●T ○ □	●T ○ □	—	●S ○ □	●S ○ □	—	—	—
53 Atmospheric valve	●T ○	●S ○ □	●T ○ □	●T ○ □	●T ○ □	—	●S ○ □	●S ○ □	—	—	—
54 Gas chromato-graph	●T ○	●T ○	—	—	—	●T ○ □	—	●S ○ □	●S ○ □	●T ○ □	—
55 Mass spectro-meter	●T ○	●T ○	—	—	—	●T ○ □	—	●S ○ □	●S ○ □	●T ○ □	—
56 Infrared type gas analyzer	●T ○	●T ○	—	—	—	●T ○ □	—	●S ○ □	●S ○ □	●T ○ □	—
57 Magnetic type gas analyzer	●T ○	●T ○	—	—	—	●T ○ □		●S ○ □	●S ○ □	●T ○ □	—
58 Thermal conductivity type analyzer	●T ○	●T ○	—	—	—	●T ○ □	—	●S ○ □	●S ○ □	●T ○ □	—
59 Combustion type gas analyzer	●T ○	●T ○ □	—	—	—	●T ○ □	—	●S ○ □	●S ○ □	●T ○ □	—
60 Density type gas analyzer	●T ○	●T ○	—	—	—	—	—	●S ○ □	●S ○ □	●T ○ □	—
61 Photo-electric type analyzer	●T ○	●T ○	—	—	—	—	—	●T ○ □	●T ○ □	●T ○ □	—
62 Moisture analyzer	○●T	●T ○	—	—	—	—	—	●T ○ □	●T ○ □	●T ○ □	—
63 pH meter	○●T	○●T	—	—	—	—	—	○ □●T	○ □●T	○ □●T	—
64 Turbidity analyzer Water quality analyzer	●T ○	●T ○	—	—	●T ○ □	—	—	●T ○ □	●T ○ □	●T ○ □	—
65 Density meter	○●T	○●T	—	—	○ □●T	—	—	○ □●T	○ □●T	○ □●T	—
66 Electric conductivity meter	○●T	○●T	—	—	○ □●T	—	—	○ □●T	○ □●T	○ □●T	—
67 Flame detector	●T ○	●T ○	—	—	—	—	—	●S ○ □	●S ○ □	●T ○ □	—
68. Mass Flow meter	●T ○	●T ○	●T ○ □	●T ○ □	●T ○ □	—	—	●S ○ □	●T ○ □	●T ○ □	—
69. Vortex Flow Meter	●T ○	●T ○	●T ○ □	●T ○ □	●T ○ □	—	—	●S ○ □	●T ○ □	●T ○ □	—
70 Gas detector	●T ○	●T ○	—	—	—	—	—	●S ○ □	●S ○ □	●T ○ □	—

○ : Tested by Manufacturer.
● : Tested by manufacturer & witnessed by 3rd party inspector(TPI).
□ : Manufacturer will submit Inspection & test records.
T : Total Inspection by TPI.
S : Sample inspection by TPI.(10% of total quantity of the same type & rating.

Notes: PMC/OWNER may witness any or all testing in stages during manufacturer or at final stage before shipment.

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SECTION –VI: TECHNICAL

PART – 4.0

DRAWINGS & DOCUMENTS

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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CONTENTS

Section Number	Description
1.0	Drawings & Documents
2.0	Category of Documents
3.0	Procedure
4.0	List of Drawings & Documents

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1.0 DRAWINGS & DOCUMENTS:

This chapter details out various drawings and documents to be generated at various stages during the course of execution of the Project by the LSTK Contractor for different project activities. Categorization of the documents/ drawings for review/ information/ records of PMC and the review/ approval requirements of the Owner/ PMC along with routing of the documents/ drawings will be conveyed separately as a philosophy.

The efficient handling of drawings and documents to be prepared by the LSTK Contractor under the contract is the key to the timely completion of the plants. The LSTK Contractor undertakes to ensure that all drawings and documents to be submitted by him to the Owner/ PMC shall be of professional quality and conforming to the contractual requirements. The LSTK Contractor also undertakes to institute a formal drawing control system which will be documented and submitted to the Owner/PMC for review or approval.

Compliance of this chapter on drawings and documents is mandatory and is non-negotiable.

The drawings / documents are to be generated by the LSTK Contractor at various stages of the project covering different activities. The drawings / documents generated will be in the category of Approval/ Review/ Information. The list of drawings and documents required is enclosed; however, the categorisation for the drawings/ documents will be informed separately. However, this will in no way relieve the LSTK Contractor of responsibility to conform to drawings, standards, specification, codes and contractual requirements / obligations.

The LSTK Contractor shall prepare the drawing numbering procedure and submit to Owner/ PMC for approval. Each Drawing submitted by the LSTK Contractor shall be clearly marked with the name of the Owner, PMC with revision number & date. It should contain the minimum following details:

a. Size of Drawing.

b. Discipline of Engineering for which the drawing is issued.

c. Discipline wise segregation of numbering sequence for example:

   100 Series for Process. 200 Series for Mechanical etc.

For drafting of Drawings, Computer aided design and drafting, AutoCAD 2015 shall be used. Further, standard, approved and well established P.C. based computer programmes/software

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packages, available in market shall only be used by the LSTK Contractor/his subcontractors/vendors etc. Every time a computer aided design is submitted for review/ approval to Owner/PMC, it shall accompany with input/output data on Compact disc (CD) along with the name of the software package and operable on any system along with the requisite No. of Hard Copies (specified elsewhere in the Bidding document).

For drawing, data sheet and all graphic works Auto CAD 2015 and for all texts, MS Word Package 2012 shall be used. Hard Copies (4 nos.) and Soft Copies of all calculations & Drawings shall be made available by the Contractor for PMC review. Line List, Data Sheet & spread sheets shall be provided in MS Excel & all text items shall be in MS Word. All other documents like presentations etc. and other data shall be in MS Office; the required operating system for Data Exchange shall be at least Windows.

All documents before forwarding to Owner/PMC will have to be vetted in detail by the LSTK Contractor/duly approved engineering sub-contractor appointed by the LSTK Contractor. Document received without vetting will be returned.

The review by the PMC/Owner shall not be construed by the LSTK Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and drawings.

Each drawing submitted by the LSTK Contractor shall be clearly marked with the name of the Owner, Unit Designation, Specifications, Title, Specification number and the name of the Project with Revision number and date. If standards, catalogue pages are to be submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawings shall be in English.

All the dimensions should be in metric units. Upon receiving comments on Drawings & Documents by the LSTK Contractor, the subsequent submission should give compliance report, separately on each of the comments, document-wise. Comments given by PMC/Owner to be discussed and finalised within agreed schedule.

The schedule of submission of the Drawings & Documents shall be in accordance with project plans only. The detailed list under different category, document-wise, shall be prepared by the LSTK Contractor for approval of Owner/PMC. This activity is to be completed within one month of LOA.

Sequence of submission of drawing is essential for proper review of documents and timely completion of the project is to be adhered. In case sequence is not maintained, the documents

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submitted will not be reviewed by Owner/ PMC and responsibility of timely execution of plant shall be to the LSTK Contractor's account.

2.0 CATEGORY OF DOCUMENTS:

Category	Description	Action by Owner/ PMC
1	Records/ Information	LSTK Contractor can continue to progress with the work. This drawings or documents will be retained with Owner/PMC for information only. Owner/ PMC reserves the right to advise the LSTK Contractor of any comments (deviations from the contract) at any time and the LSTK contractor is liable to respond to satisfy that the work being done is in accordance with the contract; deviations, if any will be bidder's risk and cost.
2	Review/Approval	Owner/PMC will review and advise the LSTK Contractor of any Comments on Contractor's Drawings / documents within specified schedule (ie 2 weeks), from date of receipt in PMC office of LSTK Contractor's drawings/documents. The review period is defined as date of receipt of documents by PMC, to date of issue of comments by PMC. This review period shall be valid only if submission of drawings is done by LSTK Contractor in accordance with approved drawings / documents schedule as indicated in ITB. In case of any non-conformity to the above by LSTK Contractor due to which the period of review extends beyond 2 weeks by the PMC, schedule delay, if any will have to be absorbed by the Contractor. Review of documents / drawings shall be categorized as follows: i) Code-3: Not accepted. New Document / Drawing to be submitted ii) Code-2: Accepted with comments as marked iii) Code-1: Final approval

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The documents falling under Review category will be returned with comments within specified time schedules subject to fulfilling other conditions enumerated. The information category document will be retained for information only but however Owner/PMC reserves the right to comment at any stage of the Project, but not later than two weeks of receipt.

Where clearance of Owner/ PMC is required for ordering of equipment materials, enquiry documents and one technically selected offer is to be submitted for review. The unpriced copies of purchase orders detailing both technical and commercial aspects for all items shall be submitted to PMC/ Owner within 15 days of issue of the same.

Each purchase order forwarded should contain complete technical documents. It is obligatory for the LSTK Contractor to obtain acceptance on all the technical documents and accepted copy only to be forwarded to Owner / PMC. Any inaccuracies /omissions/inconsistencies noticed and brought to the notice of the LSTK Contractor at any stage of the project will be rectified/ replaced by LSTK Contractor without any cost & time implication to the Owner/ PMC.

Detailed manufacturing schedules of fabricated/ manufactured items shall be submitted within one month of ordering, Status report for all the items in detail, will be submitted once in a month.

Documents to Boiler Regulation authorities shall be submitted and getting the documents reviewed by PMC/Owner. To any other agencies, documents shall be submitted under intimation to PMC/Owner.

As built drawings and documents will be generated within one month of completion of activities on respective items of work.

As Built Drawings:

LSTK Contractor will furnish reproducible and electronic files of all the drawings under their scope to Owner / PMC, certified as “As-Built Issue” by Third Party Inspection Agency (TPIA) for Vendor Items coming under Third Party Inspection / LSTK Contractor for all other drawings.

Upon completion of identifiable units or components of the fabrication, construction and installation phase of the project the Contractor will complete all the related plans to the "as built' stage including all Vendor drawings and furnish Owner/PMC with the following:

a. One complete set of all original tracings copies.

b. One complete set of reduced size (A3-297x420 mm) copies of all drawings.

c. One set of CD for all documents/drawings/data

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d. All the as built drawings duly certified should be scanned and converted into electronic files made on magnetic/discs/optical long storage.

e. All other project documents such as operating and maintenance manuals, manufacturers' Catalogues etc. shall also be scanned on magnetic/optical discs for safe storage and retrievals by the Owner when needed.

f. 10 complete sets of full size prints of the drawings and 4 sets of reduced size prints.

g. 10 complete bound sets of Manufacturer's specifications including design calculations.

h. 10 complete sets in hard binders of the Manufacturers data book including certified prints and data for all items including test reports. Data Books shall be complete with index as tag numbers associated with Manufacturer's data shown. Equipment data shall include as a minimum requirement the principal and description of operation, drawings and dimensions, spare parts lists and un-priced purchase orders and bill of material.

i. 10 bound copies each of the Spare Parts data books and the Lubricants inventory Schedule.

j. 10 complete sets of field records shall be signed by both the Contractor's and Owner's Representative at the site.

k. Original approvals and related drawings and documents from the statutory authority.

l. Copies of correspondence with the statutory authorities.

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3.0 PROCEDURE:

The procedure for compilation of final as-built documents / drawings shall be informed later. However the Procedure for routing the final / as built documents/ drawings to PMC / Owner shall be informed during the execution stage.

4.0 LIST OF DRAWINGS & DOCUMENTS:

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Sl.No	Description	With bid Y/N	For Review/ Approval	For Information	Final/ Approved/ As-built
A.	PROCESS				
	Basis of Design		Y		Y
	Process Description		Y		Y
	Process Flow Diagram & Material Balance		Y		Y
	Material Selection diagram		Y		Y
	P&I Diagrams		Y		Y
D	Design calculations for sizing of equipments		Y		Y
	Utility Requirements		Y		Y
	Data sheet of all equipment and machinery		Y		Y
	Logic diagrams		Y		Y
	Safety valve Specifications		Y		Y
	Instrumentation Control philosophy		Y		Y
	HAZOP Study and Compliance report		Y		Y
	Plot Plan (Preliminary)		Y		Y
	Operating Manuals and maintenance manuals		Y		Y
	Analytical Manual		Y		Y

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B	PIPING				
Sl. No.	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved/ As-built
1.0	Equipment layout drawing.	Y	Y	-	Y
2.0	Piping Layout drg.	N	Y	Y	Y
3.0	Quality control plan	N	-	Y	Y
4.0	Filled in Valve Data Sheet.	N	Y	-	Y
5.0	Design data:				
5.1	Design basis	N	Y	-	Y
5.2	Piping material specification	N	Y	-	Y
6.0	Issued for construction (IFC) Drawing.	N	-	Y	Y
6.1	Piping GA DRGS.	N	-	Y	Y
6.2	Isometrics	N	-	Y	Y
6.3	Piping supports, operating platforms drg.	N	-	Y	Y
7.0	Material Take-offs	N	-	Y	-
8.0	Material Requisitions schedule	N	-	Y	-
9.0	Design calculation / Documents.	N	-	Y	-
9.1	Flexibility Analysis of Piping	N	Y	-	-

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9.2	Support and load data	N	-	Y	-
10.0	Vendor Drawings(Valves, Strainers, Traps etc)	N	Y	Y	Y
11.0	All inspection, testing & NDT Records.	N	-	Y	Y
12.0	As Built Drgs/Docs/MTCs	N	-	-	Y
13.0	3D Model	N		Y	Y

C	ELECTRICAL				
SL. No.	Description	With bid Y/N	Documents Required (Y / N)		
			For approval	For Information	Final / Approved/ As built
	Filled in Specification Sheets and Technical Particulars of all equipment.	N	Y	--	Y
	Load List indicating rated and absorbed power of loads and duty type (Continuous / Standby / Intermittent) at different voltages including emergency loads.	Y	-	Y	Y
	Load Data indicating normal, peak, starting and construction power requirement at various voltage levels.	Y	-	Y	Y
	Single line distribution diagram (Normal power, UPS supply) including protection and metering details.	Y	Y	--	Y
	General arrangement and foundation drawings of all equipments	N	Y	--	Y
	Equipment layout in plant area showing location of all electrical equipment	N	-	Y	Y
	Cable rack/ trench layout.	N	-	Y	Y

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	Schematic diagram for all control panel & switch boards	**N**	**Y**	**--**	**Y**
	Design calculations for heater	**N**	**-**	**Y**	**Y**
	Earthing and lightning protection layout	**N**	**-**	**Y**	**Y**
	Drawings and documents asked for each equipment as per respective Technical Specifications	**N**	**Y**	**-**	**Y**
	Catalogues for all bought out items	**N**	**-**	**Y**	**Y**
	Installation operation and maintenance (Manual)	**N**	**-**	**-**	**Y**
	Spare Parts list	**Y**	**-**	**Y**	**Y**
	Characteristic curves for motors etc.	**N**	**-**	**-**	**Y**
	Bill of Materials covering all electrical equipment and installation materials	**Y**	**--**	**--**	**Y**
	Test certificates	**N**	**--**	**Y**	**Y**
	Guarantee Certificates	**N**	**--**	**Y**	**Y**
	Quality Assurance Plan	**N**	**Y**	**--**	**Y**

Note:

4 hard copies & 1 soft copy shall be supplied for approval/information after order within 4 weeks.

8 hard copies & soft copies in Pen drive shall be submitted as final documents prior to despatch of the equipment. These shall be made in sets and supplied in fine plastic coated folder.

Y - Yes, N – No

D	**INSTRUMENTATION**

Sl.No	**Description**	**With Bid (Y/N)**	**For Review/ Approval**	**For Information**	**Final/ Approved/ As-built**

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	INSTRUMENTATION				
1	**Drawing & document schedule**		**Y**		**Y**
2	**Instrument Index**			**Y**	
3	**Instrument sizing calculations (control vales, safety valves & flow elements)**			**Y**	
4	**Utility requirements**			**Y**	
5	**Level sketches**			**Y**	
6	**Material Requisition**		**Y**		**Y**
7	**Purchase Requisition**			**Y**	
8	**Vendor Drawings**			**Y**	
9	**Functional Schematic**			**Y**	
10	**Logic Diagrams as per ISA 75.2**			**Y**	
11	**Instrument loop drawings**			**Y**	
12	**Control room layout**		**Y**		**Y**
13	**Layout of equipment inside control room**		**Y**		**Y**
14	**Power supply distribution**		**Y**		**Y**
15	**Wiring diagram for panels**			**Y**	
16	**Configuration diagram**		**Y**		**Y**
17	**I/O assignment**		**Y**		**Y**
18	**DCS graphics, report/log formats & other DCS docs.**		**Y**		**Y**
19	**Instrument duct / tray layout**			**Y**	
20	**Instrument cable schedule**			**Y**	
21	**Instrument location plans**			**Y**	
22	**Instrument installation drawings**			**Y**	

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23	**Bill of material for installation items**			**Y**	
24	**Spare part list for :**				
	Mandatory Spares			**Y**	
	Start up & commissioning			**Y**	
25	**Inspection & test procedures**			**Y**	
26	**Complete catalogues with part list for all vendor supplied instruments, control etc.**			**Y**	
27	**Installation, operation & maintenance manuals**			**Y**	
28	**As Built Drawings**			**Y**	
29	**System Architecure**	**Y**		**Y**	
30	**Instrument Control Philosophy**	**Y**		**Y**	
	This section is further elaborated in Section 5.4 of Instrumentation and the same shall have precedence in case of conflict.				

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E: STATIC

The following drawings/documents marked "Y" shall be furnished by the bidder.

VESSEL & COLUMN

Sl. No.	Name of Document	With Bid	Post Order		
		Y/N	For review/ Approval	For information	Final / approved/ As-built
1.0	Material Requisition	N		Y	Y
2.0	OUTLINE SKETCHES SHOWING THICKNESS OF MAIN PARTS,MOC, DETAILS OF INTERNAL INCLUDING DEMISTER,WEIGHT (ERECTION & OPERATING) AND ANCHORAGE DETAILS	Y	-	-	-
2.1	GENERAL ARRANGEMENT DRAWINGS INDICATING DESIGN DATA , FABRICATED EQUIPMENT WEIGHT, GENERAL NOTES, NOZZLE SCHEDULE, DETAILS OF SHELL, HEADS SUPPORTING ARRANGEMENT , MAIN WELD SEAMS ,NOZZLE ORIENTATION PLAN ETC	N	Y	-	Y
3.0	DETAIL OF NOZZLES, MANHOLES,ACCESSORIES ETC.	N	-	Y	Y
4.0	DETAIL OF INTERNALS SUCH AS TRAY,TRAY SUPPORT RING, BOLTING BARS ETC.	N	-	Y	Y
5.0	DETAIL OF DEMISTER	N	Y	-	Y
6.0	MECHANICAL DESIGN CALCULATIONS COMPLYING WITH THE SPECIFICATIONS AND CODES.	N	Y	-	Y
7.0	DETAIL OF PACKING SUPPORT,DEMISTER SUPPORT, GRATING & GRATING SUPPORT	N	Y	-	Y
8.0	DETAIL OF INTERNAL DISTRIBUTOR	N	Y	-	Y
9.0	DETAIL OF EXTERNAL CLIPS SUCH AS LADDER, PLATEFORM,PIPE SUPPORT	N	-	Y	Y
10.0	DETAIL OF INSULATION ,FIREPROOFING	N	-	Y	Y
11.0	DETAIL OF PIPE DAVIT	N	-	Y	Y
12.0	DETAIL OF LIFTING LUG, TAILING LUG & TRUNION ETC. INCLUDING DESIGN CALCULATION	N	-	Y	Y
13.0	SHELL DEVELOPMENT DRAWINGS INCORPORATING ALL ATTACHEMENTS AMD WELD SEAMS	N	-	Y	Y
14.0	ALL FINAL AS- BUILT SHOP DRGS. & DESIGN CALCULATIONS DULY CERTIFIED BY THIRD PARTY INSPECTING AUTHORITY (**)	N	-	Y	Y
15.0	DATA FOLDER AS PER SPECIFICATION	N	-	Y	Y
16.0	MATERIALS TEST CERTIFICATES DULY STAMPED BY INSPECTING AUTHORITY (**)	N	-	-	Y
17.0	QAP & INSPECTION AND TEST PLAN (**)	N	Y	-	Y
18.0	WELDING PRCEDURE AND QUALIFICATION TEST REPORTS (**)	N	-	Y	Y
19.0	DESTRUCTIVE AND NON DESTRUCTIVE PROCEDURE & TEST REPORTS (**)	N	-	-	Y
20.0	HEAT TREATMENT PROCEDURE AND TIME TEMPRATURE CHARTS (**)	N	-	Y	Y
21.0	RADIOGRAPHIC EXAMINATION REPORTS & FILMS(**)	N	-	-	Y

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VESSEL & COLUMN					
Sl. No.	**Name of Document**	**With Bid**	**Post Order**		
		Y/N	**For Review/ approval**	**For information**	**Final / approved/ As-built**
22.0	COMPLETION CERTIFICATES (INCLUDING INSPECTION CERTIFICATE, HYDROSTATIC TEST CERTIFICATE , LOCAL CODE REQUIREMENTS)	N	-	-	Y
23.0	PACKING AND FORWARDING INSTRUCTION (**)	N	-	-	Y
24.0	TRANSPORTATION DRAWING SHOWING OVERALL DIMENSION, C.G. WEIGHT AND HANDLING INSTRUCTIONS DULY APPROVED BY APPROPRIATE AUTHORITY	N	-	Y	Y
25.0	FINAL CIVIL LOAD DATA INCLUDING DETAILS OF FOUNDATION/ANCHOR BOLTS	N	-	Y	Y
26.0	LIST OF SPARE PARTS AND DETAILS	N	Y	-	Y

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HEAT EXCHANGERS					
Sl. No.	**Name of Document**	**With Bid**	**Post Order**		
		Y/N	**For Approval/ Review**	**For information**	**Final / approved/ As-built**
1.0	Material Requisition	**N**		Y	Y
2.0	OUTLINE SKETCHES SHOWING THICKNESS OF MAIN PARTS, MOC, WEIGHT (ERECTION & OPERATING) ETC.	Y	-	-	-
2.1	GENERAL ARRANGEMENT DRAWINGS INDICATING DESIGN DATA , FABRICATED EQUIPMENT WEIGHT, GENERAL NOTES, NOZZLE SCHEDULE, DETAILS OF SHELL, HEADS SUPPORTING ARRANGEMENT , MAIN WELD SEAMS ,NOZZLE ORIENTATION PLAN ETC.	N	Y	-	Y
3.0	DETAILS OF TUBE SHEET & TUBE LAYOUT.	N	Y	-	Y
4.0	DETAILS OF NOZZLES AND EXCHANGER SUPPORT	N	-	Y	Y
5.0	DETAILS OF GASKETS	N	Y	-	Y
6.0	LIST OF SPARE PARTS AND DETAILS	N	Y	-	Y
7.0	FINAL CIVIL LOAD DATA INCLUDING DETAILS OF FOUNDATION/ANCHOR BOLTS	N	-	Y	Y
6.0	MECHANICAL DESIGN CALCULATIONS COMPLYING WITH THE SPECIFICATIONS AND CODES.	N	Y	-	Y
8.0	WELDING PRCEDURE AND QUALIFICATION TEST REPORTS (**)	N	-	Y	Y
9.0	TRANSPORTATION DRAWING SHOWING OVERALL DIMENSION, C.G. WEIGHT AND HANDLING INSTRUCTIONS DULY APPROVED BY APPROPRIATE AUTHORITY	N	-	Y	Y
10.0	DESTRUCTIVE AND NON DESTRUCTIVE PROCEDURE & TEST REPORTS (**)	N	-	Y	Y
11.0	PROCEDURE FOR REPAIR OF DAMAGED TUBES (**)	N	-	Y	Y
12.0	QAP & INSPECTION AND TEST PLAN (**)	N	Y	-	Y
13.0	RECORDS OF NDT TESTS E.G. RADIOGRAPHY, ULTRASONIC TESTING(UT), MAGNETIC PARTICAL / PENETRANT TESTING (MP/PT), HARDNESS ETC. (**)	N	-	-	Y
14.0	MATERIALS TEST CERTIFICATES DULY STAMPED BY INSPECTING AUTHORITY (**)	N	-	Y	Y
15.0	PWHT CHARTS (**)	N	-	Y	Y
16.0	TEST ON PRODUCTION TEST COUPONS (**)	N	-	-	Y
17.0	HYDRAULIC/PNEUMATIC TEST REPORTS (**)		-	-	Y
18.0	MOCK-UP TEST FOR TUBE TO TUBESHEET JOINT(**)		-	-	Y
19.0	ALL FINAL AS- BUILT SHOP DRGS. & DESIGN CALCULATIONS DULY CERTIFIED BY THIRD PARTY INSPECTING AUTHORITY (**)	N	-	-	Y
20.0	RADIOGRAPHIC EXAMINATION REPORTS & FILMS (**)	N	-	-	Y
21.0	MECHANICAL GUARANTEE CERTIFICATE (**)	N	-	-	Y
22.0	INSPECTOR'S FINAL CERTIFICATE (**)				y
23.0	PACKING AND FORWARDING INSTRUCTION (**)	N	-	-	Y

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LEGEND: Y – Yes, N – No

Notes :

1. Final documentations shall be supplied in hard copies as well as soft copes in CD Formats. Applicable. Software are MS Office 2000, Word, Access, and Excel.
2. Document marked as (**) are to be approved by authorised Third Party Inspection Agency and Statutory Authorities as applicable.
3. Final documentation shall be supplied in hard copies (6 prints) and soft (two CDs/DVDs) in addition to submission through email.
4. All drawing & documents shall be submitted in A2/A3 or A4 paper size .Documents in higher paper size Shall be submitted in exceptional circumstances or as indicated in MR/Tender.
5. Bill of material (showing part no. MOC, Size, quantity, weight of each part) shall form part of the respective drawing.

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F	ROTATING EQUIPMENTS				
Sl No.	**Description**	**With Bid (Y/N)**	**For Review/ Approval**	**For Information**	**Final/ Approved/ As-built**
a.	**COMPRESSORS**				
1.0	List of drawings / documents including drawing number, revision number, description and approval status	N	Y	-	Y
2.0	Detailed manufacturing programme (Time bar chart)	N	Y	-	Y
3.0	Specification sheet complete filled in PDIL proforma enclosed with enquiry/order.	N	Y	-	Y
4.0	Equipment layout with main overall dimensions including those required for foundations and piping design for compressor and auxiliaries. (This layout shall include the driven equipment and its auxiliaries).	Y	Y	-	Y
5.0	Performance curves for Centrifugal compressor :				
	i) For turbine driven compressor, Discharge pressure, Brake horse power, Polytropic head and Efficiency Vs Inlet capacity (from surge point to 115 % of rated capacity) of the compressor at specified inlet pressure, temp. and mol. wt. of the gas and at 80, 90, 100 and 105 % speed for each stage and for overall compressor	N	Y	-	Y

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	ii) For constant speed motor driven compressors Discharge pressure , Brake horse power , Polytropic head and Efficiency Vs Inlet capacity (from surge point to 115 % of rated capacity) of the compressor at specified inlet pressure, temp. and mol. wt of the gas for each stage and for overall compressor	N	Y	-	Y
	iii) Torque Vs Speed curve for the compressors.	N	-	Y	Y
6.0	Performance Curve	N	Y	-	Y
7.0	i) Calculation of the lateral critical speeds of the compressors. ii) Calculation of the torsional critical speeds. Analytical report for torsional vibration of whole set. iii) Thrust loading curves for each casing / barrel for various operating conditions. iv) Response curve of deflection Vs RPM for varying amount of imbalance. v) Torsional critical response curve	N	-	Y	Y
8.0	Overall dimensional drawing with all main dimensions, size and location of piping connections for compressors and its auxiliaries.	N	Y	-	Y
9.0	Cross sectional drgs. Of the compressor showing details of construction including sealing details, bearing etc. With part no., description and material of construction.	N	Y	-	Y
10.0	Coupling drawings	N	-	Y	Y

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11.0	Seal assembly drawings & Bill of material	N	-	Y	Y
12.0	Lube oil Pumps a) Specification sheet b) Performance curve c) Cross Sectional drawing	 N N N	 Y Y		 Y Y Y
13.0	Certified foundation scope drawing of the compressor with driver and all accessories resting on the foundation and control panel. In the event of motor not in the scope of supply of vendor the motor frame dimensions shall be supplied by the purchaser later). Direction and magnitude of all unbalanced forces, couples and centre of gravity along with direction of rotation shall also be mentioned	N	Y	-	Y
14.0	a) Engineering flow diagram indicating all instruments, valves, etc. marked with battery limit of supply of : - Process Gas lines - Cooling Water lines - Lubricating Oil lines - Condensate drain and vent lines The above drawings shall identify all components by size, pressure rating and material b) Material balance for gas, lube & seal oil.	Y	Y	-	Y
15.0	Piping layout plan and elevation drawings for gas, cooling water and utility lines, lube and seal oil lines etc.	N	Y	-	Y

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16.0	Driver : Selection details a) Speed - torque diagram b) GD2 of the rotating masses of the compressor referred to the motor speed	N	-	Y	Y
17.0	a) Piping isometrics for gas pipes DN>20, piping manifold and all oil lines. b) Flexibility analysis for gas lines.	N	-	-	Y
18.0	Piping support location drgs. With forces, moments and movements for gas pipes and with weights for all lines.	N	Y	-	Y
19.0	Certified allowable forces, moments, movements, stresses for compressor nozzles.	N	Y	-	Y
20.0	Bill of Material for Piping and supports.	N	Y	-	Y
21.0	Bill of Material for insulation for Pipings.	N	Y	-	Y
22.0	Bill of quantity for Painting for piping, equipments and auxiliaries.	N	Y	-	Y
23.0	Thermal calculation for heat exchangers, Mechanical calculation and fabrication drawings for heat exchangers and Pressure vessels.	N	Y	-	Y
24.0	Inspection and Test Procedure.	N	-	-	Y
25.0	Quality Assurance Plan.	N	Y	-	-

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26.0	Inspection and test reports, material test certificates, radiographic reports duly approved by specified inspecting authority, certificates for compressors, heat exchangers, pressure vessels, pipings, valves, instruments and other auxiliaries.	N	-	-	Y
27.0	Lubrication schedule	N	-	-	Y
28.0	Instruction manual for erection, installation, operation and maintenance of compressor and its accessories (important clearances to be maintained should be clearly specified.).	N	-	-	Y
29.0	Recommended list of spares for two years trouble free operation	Y	-	-	-
30.0	List of special tools	Y	-	Y	Y
31.0	Installation list of similar machines shall also include the following : a) Client, location and year of installation b) Drive c) Model No. and type of compressor d) Duty condition of the compressor e) Speed and KW rating	N	-	-	-
b	**EOT Crane & Hoist**				
1	Data sheets – completely filled		Y		**Y**
2	Information to be supplied by manufacturer / Vendor		Y		**Y**
3	General arrangement Drg. showing various details & all principal dimensions of the assembled unit, horizontals and vertical clearances and approaches.		Y		**Y**
4	List of spare parts with individual part Nos. and prices.		Y		**Y**

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5	Descriptive literature / catalogue		Y		**Y**
6	Detailed manufacturing programme Time-Bar Chart.		Y		**Y**
7	Individual structural drgs. For main girders and End-carriages.		Y		**Y**
8	Mechanical calculations (Brakes, Gear boxes, gears, pinions coupling, Bearing, Rope-drum, Wire-rope etc.		Y		**Y**
9	Civil load data drawing, Cross-sectional detailed drawings of sub-assemblies part nos., materials of construction and heat treatment details wherever applicable :		Y		**Y**
10	a) General Assembly Drg. Showing the complete mechanical details.		Y		**Y**
11	Crane rail & end stops fixing arrangement.		Y		**Y**
12	Material test certificates (including the originals) of load bearing parts e.g.		Y		**Y**
13	Crane rail & end stops fixing arrangement.		Y		**Y**
14	Material test certificates (including the originals) of load bearing parts e.g.		Y		**Y**
15	Test certificates of motors (including the originals)		Y		**Y**
16	Certificates of No load, load, over load defection Test duly witnessed by the Inspector		Y		**Y**
17	Operation & Maintenance Manual (including the lubrication schedule also.)		Y		**Y**
18	Drg. Showing the supporting arrangement of flexible cable with main bridge and trolley.		Y		**Y**
c	**HVAC System**				
1	List of drawings / documents including drawing number, revision number and Description & approval status.		Y		**Y**
2	Specification sheets - Completely filled		Y		**Y**
3	General Assembly drawings - with main overall dimensions including those required for accessories and auxiliaries		Y		**Y**

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	and all horizontal & vertical clearances for dismantling, direction of rotation etc.				
4	List of spares for 2 years normal maintenance in PDIL proforma.		Y		**Y**
5	Description of Lubrication and sealing system (if any).		Y		**Y**
6	Manufacturing schedule.		Y		**Y**
7	Cross-Sectional drawing of AC Plant and auxiliaries alongwith Bill of Materials.		Y		**Y**
8	Parts catalogue complete with reference drawing numbers & sketches etc.		Y		**Y**
9	Instruction manuals for erection, installation, operation and maintenance of AC Plant and accessories.		Y		**Y**
10	Material test certificates and Inspection & performance test report alongwith despatch clearance certificates from inspector.		Y		**Y**
11	Reference list for similar types of AC Plant supplied in past for similar duty conditions. Reference list shall contain complete address of user, user's purchase order number, brief specifications and date of commissioning along with operating conditions..		Y		**Y**
12	Lube oil schedule, if any.		Y		**Y**
13	Drivers specification and Drg.		Y		**Y**
G	**GENERAL**				
1.0	Master Time Schedule/Network (PERT Network/ Bar chart) showing all the activities		-	Y	Y
2.0	Reference list for similar packages supplied and executed by the bidder with details.		Y	-	Y
3.0	Detailed Painting & Insulation Specifications		Y	-	Y

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4.0	Complete Spare Part List for the whole package		Y	-	Y
5.0	List of all construction equipments, tool-tackles & man power resources proposed to be used.		-	Y	Y
6.0	Description and Catalogues of Auxiliary items		-	Y	Y

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SECTION – VI : TECHNICAL

PART – 5.0

SPARE PARTS

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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CONTENTS

SECTION NUMBER	DESCRIPTION
1.0	Spare parts for Commissioning
2.0	Mandatory spare parts
3.0	Vendor recommended spare parts

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1.0 SPARES PARTS FOR COMMISSIONING:

Contractor shall supply free of cost (Include in the scope) spare parts and Consumables (except raw materials and Utilities supplied by others) required during Pre-commissioning & Commissioning of the plants till the plant is handed over to the Owner after Performance Test.
O&M spares for two years to be included in bidder's scope.

Bidder shall also provide Pre-Commissioning and Commissioning Spare List along with their Bid.

2.0 SPARE PARTS FOR TWO YEARS OPERATION (MANDATORY SPARES):

LSTK Contractor shall supply spare parts as per list of spares for 2 years operation of the plant as detailed below:

2.1 STATIC EQUIPMENT:

S.no	Spare Items	Quantities
1.0	**Heat Exchangers – Shell & Tube:**	
1.1	Bolts	**10% of for each nozzles with blind/companion flanges (minimum 2 numbers)**
1.2	Gaskets (for all nozzle connections with blind flange)	200 %
1.3	Gaskets(girth flange)	200 %
1.4	Bolts	10% of for Girth Flange (minimum 2 numbers)
1.5	Tube Plug	5 % of tube holes
2.0	**Pressure Vessel ,Tanks, filter**	
2.1	Gaskets (for all nozzle connections with blind flange)	200 %
2.2	Bolts	10% for each nozzles with blind/companion flanges (minimum 2 numbers)
2.3	Gaskets(girth flange)	200 %
2.4	Bolts	10% of for Girth Flange (minimum 2 numbers)
2.5	Bolting for internal flange	10 % (Minimum 2 numbers)
2.6	Gasket for internal flange	200 %
2.7	Spare for internals Clamps Washer Bubble Caps / valve	 2 % excess, min. 5 piece 20 % excess, min. 3 piece 10%
2.8	Sight/light glass assembly complete with bolting and gasket	300% of each installed glass
2.9	Filter Cartridge/Elements	200%
3.0	**Plate type Exchanger**	
3.1	Plate gasket	10 %
3.2	Flow plate	10 %
3.3	Nozzle gasket	200 %
3.4	Glue (1 kg pot)	1
3.5	Special spanner tool	1 for each size/ type

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Notes:

1) The quantities shown are for each equipment.
2) The parts listed are the principal parts only. Other parts shall be considered for recommendation in quantities consistent with the above table.
3) All special tools and tackles required for maintenance for critical items shall be supplied along with equipment.

2.2 ROTATING EQUIPMENT

MANDATORY SPARE PARTS:

Contractor shall supply spare parts as per list of spares detailed below:

a) Centrifugal Compressor
b) EOT Crane

2.1 CENTRIFUGAL COMPRESSOR

S. No.	DESCRIPTION	QUANTITY
1.0	**COMPRESSOR**	
1.1	Completely assembled dynamically balanced spare rotor including clearance check and mechanical run test	1 set
1.2	Complete spare coupling including distance piece and set of coupling bolts & nuts	1 set
1.3	Stator blade carrier with stator blades completely assembled (for axial compressor)	1 set
1.4	Complete set of radial bearing (Both suction & discharge side)	1 set
1.5	Complete set of Pads for radial bearing with built-in temperature elements (Both suction & discharge side)	2 set
1.6	Complete set of thrust bearings (Both active & inactive sides)	1 set
1.7	Complete set of shoes for thrust bearings with built-in temperature elements (Both active & inactive sides)	2 set
1.8	Set of process media seals for each casing including labyrinths for balance piston , oil scraper rings etc.	2 set
1.9	Complete Set of oil seals	200%
1.10	Complete Set of 'O' rings, gaskets, sealing rings for compressor	200%
1.11	Sealing compound	1 charge
1.12	Seal for each casing	1 set
2.0	**LUBE OIL SYSTEM**	
2.1	Complete set of Lube Oil Pumps with drive :	1 set
2.2	Spares for lube oil pump :	
	a) Set of bearings	1 set
	b) Set of seal	200 %
2.3	Lube oil filter cartridges	4 sets

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S. No.	DESCRIPTION	QUANTITY
2.4	Set of Couplings	2 sets
3.0	**ACCESSORIES**	
3.1	Set of spares for all valves (Isolation, control, safety, etc.), in lines, consisting of spindle, seat , disc, flap, packing etc.	1 set
3.2	Spare elements for permanent filters .	200%
3.3	Complete Set of inlet air Filters for Air compressor, as applicable	200 %
3.4	All type of Fasteners	200%
4.0	**INSTRUMENTATION**	
	As per Instrumentation specification enclosed with enquiry / order specification.	

2.2 Reciprocating Compressor:

Sl. No.	DESCRIPTION	QUANTITY
1.0	**Compressor**	
1.1	Main bearings	1 set
1.2	Crankshaft journal bearings	1 set
1.3	Big end bearing	1 set
1.4	Cross head pin bearings	1 set
1.5	Complete Set of Connecting rod with fasteners	1 Set of each size
1.6	Complete Set Cross head body & guide assembly with fasteners	1 set of each size
1.7	Piston assembly complete with piston rod, piston, piston rings & lock nut etc. for each stage	1 set
1.8	Piston rings for each piston	2 sets
1.9	Complete stuffing box internal packing	1 set
1.10	Oil slinger ring	1 set
1.11	Liner for each stage	1 set
1.12	Complete inlet valves assembly with internals for each cylinder	1 set
1.13	Complete discharge valves assembly with internals for each cylinder	1 Set
1.14	Complete Set of all Gasket and O-Ring .	2 sets
2.0	**Gas Coolers**	
2.1	Tubes for gas cooler	1 set
2.2	Tubes for oil cooler (when tube are easily replaceable)	5 % for each cooler
2.3	Complete set of Gaskets for coolers & pressure Vessels	2 sets
3.0	**Lube Oil System**	
3.1	Spares for lube oil pump :	
	a) gears with Shaft	1 set
	b) complete set of bearings	1 set
	c) complete set of seal	2 sets
3.2	Lube oil filter cartridges	4 sets
3.3	Cylinder lubrication system :	
	a) Complete set of Lubricator bearings	1 set
	b) Pumping unit assembly	1set
	c) Check valves of each size	1 set of each size
	d) Sight glass	1 set

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4.0	**Accessories**	1 set
4.1	Set of spares for all valves (Isolation, control, safety, non return etc.) in gas lines consisting of spindle, seat , disc, flap, packing , fasteners etc.	1 set
5.0	**Instrumentation**	
	As per Instrumentation specification enclosed with enquiry / order specification.	

2.3 EOT CRANE

S. No.	DESCRIPTION	QUANTITY
1.	Wire rope for main hoist	1 set
2.	Wire rope for Auxiliary hoist (if applicable)	1 set
3.	Rope guide for main Hoist	1 set
4.	Rope guide for Auxiliary Hoist (if applicable)	1 set
5.	All type of Bearings	1 set
6.	All type of Oil seals, Gaskets , O-Rings	1 set

NOTE:

1. 'Set' means complete replacement of particular part in one machine.
2. Item wise price against each item shall be furnished in the Performa enclosed with the enquiry.
3. The quotation should contain sectional drawing showing location & part no. (For exact identification) & material specification.
4. Part which are not applicable in the supplied equipment, Bidder to clearly explain in the offer.

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2.3 ELECTRICAL ITEMS:

Sr. No.	Item	Quantity
1.0	HV Motor (For each rating)	
A.	Bearings housing (complete with End Shield) both Driving End and Non driving end	1 set
B.	Cooling fan	1 No.
C.	Space heater	2 Nos.
D.	Terminal box	1 No.
E.	Terminal stud with bushing & star links	2 sets
F.	RTDs for HV motors for Bearing/ hot air	2 Nos. each
G.	Dial Type thermometer	2 sets
H.	Grease nipple & Plug (if installed)	2 Nos.
I.	Charge of Lubricating oil (if not centrally lubricated)	1 Charge
2.0	LV Motor (For each rating)	
A.	Bearings housing (complete with End Shield) both Driving End and Non driving end	1 set
B.	Cooling fan	2 No.
C.	Terminal box	1 No.
D.	Terminal stud with bushing & star links	1 No.
E.	Space heater, if installed	2 Nos.
F.	Grease nipple & Plug, if installed	2 Nos.
G.	Cooling fan cover	1 No.
1.0	Lube oil motor	1 No.
2.0	Local Control Station (for each type)	
A.	Trip – neutral – close switch	20%
B.	Auto Manual / Local -Remote switch	20%
C.	Ammeters of different ranges	20%
D.	Terminal block	20%
E.	Indicating Lamps of different type	20%
F.	Push Buttons of different type	20%
G.	Complete LCS of each type	20%
3.0	Heater	
A.	Heater Element	20% of the total requirement in multiples of 3 (rounded off to next higher digit)
B.	Heater Terminal Box	1 no
4.0	Heater Control Panel	
A.	MCCB	20% of each type (rounded off to next

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Sr. No.	Item	Quantity
		higher digit)
B.	Main & auxiliary contactor	20% of each type (rounded off to next higher digit)
C.	Relays	20% of each type (rounded off to next higher digit)
D.	Push Buttons	20% of each type (rounded off to next higher digit)
E.	Indicating lamp with lamp holder	20% of each type (rounded off to next higher digit)
F.	Timer	20% of each type (rounded off to next higher digit)
G.	All electronic cards for thyristor (1 no of each type)	1 set
H.	Semiconductor fuses (1 no of each type)	1 set
I.	Thyristor	1 set
J.	Thyristor stack assembly	1 no.
K.	Contactors	1 no. of each rating
L.	Anti-condensate heater-with Thermostat	1 no
M.	Power supply unit	1 No.
N.	Varying knob for voltage and current used for firing of thyristors	1 no. each
5.0	SOFT STARTER	
A.	PCMU	1 Set
B.	Control cards (10% or minimum 1 set of each type & model)	1 Lot
C.	Auxiliary Contactor (20% or minimum 1 set of each type & rating)	1 Lot
D.	Vacuum contactor	1 Set
E.	Dynamic Compensator Contactor	1 Set
F.	Surge Supressor	1 Set
G.	MCB (20% or minimum 1 set of each type & rating)	1 Lot
H.	Space Heater	1 No.

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Sr. No.	Item	Quantity
I.	VCB coil set (closing & tripping)	1 Set
J.	Spring charging motor of VCB	1 No.
K.	Temperature Transducer	1 Set

Note:-

1) The above spares do not include commissioning spares and shall be purely warehouse spares.
2) Set means complete replacement of particular part in one machine.
3) Item wise unit price against each item shall be furnished.
4) Wherever "Each Type" is specified, it means of the “Type/make/model/size/rating and exactly replaceable"

2.4 INSTRUMENTATION ITEMS

1) Set means complete replacement of particular part in one machine.
2) Wherever "Each Type" is specified, it means "of the Type/make/model/size/rating and exactly replaceable"
3) Wherever "% qty." is specified, Bidder to quote in next higher rounded figure
4) Out of % age spares and minimum qty specified against each item - higher of the two shall be supplied.

Sl. No.	DESCRIPTION	QUANTITY
1.0	Field instruments	
	Pressure Gauges, Differential Pressure Gauge, Draft Gauges, Field Indicators, RTD/T/C with Thermowells, welded thermowell, Skin Thermocuple Sets, Speed Probes with Cables and Fixing Screws and Bolts, Vibration Probes, with Cables (including extension cable) and Fixing Screws and Bolts, Speed Transmitter with Cables and Fixing Screws and Bolts, Proximeters of diff. model and Fixing Screws and Bolts, Gas Sensors with Cables and Fixing Screws and Bolts	10% of each type of instruments, subject to minimum 2 nos. of each type
	Pressure Switches, DP Switches, Purge Rotameters	10% of each type of instruments, subject to minimum 2 nos of each type
	Special thermocouples (like reactors) /multipoint thermocouples,	10% of each length subject to minimum 1 number of each type.

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	Skin Type Thermocouple-	10% of total subject to minimum 1 number Complete Set of each type.
	Float and micro switch assembly for level switch	10% of each length subject to minimum 1 number of each type.
	Transmitters for Flow, Pressure, Temperature, Level, Diff. Pressure application, Remote Seal Transmitter, Transmitter for LEL/GAS Detector System including Sensors .	10% of each type of instruments, subject to minimum 2 nos of each type
	Hydra Step	1 no. Electronic unit or 10% subject to minimum. 20% or Min 3 Nos of Sensor Probes
	Mass flow meter & Mag Flow meter	A) Power fuses 6 nos per set B) Sensor assembly-10% min 1 no C) 10% or minimum one number complete electronic head unit
	Vortex Flow Meter	A) One sensing probe ,one set of gasket and Packing for each type and Size B) 10% or minimum one number complete electronic head unit
	Ultrasonic Flow meter	A) 1 pair probe for each instrument B) 1 number electronic card of each type C) 2 numbers fuses of all Types.
	Glass tube Rota meters	20% or min 2 Nos of glass tubes of each size/rating /make.
	Variable Area Flow meter (Rota meters)	10% or minimum one no. float & set of Packing for each type, size, rating and material
	Averaging Pitot Tube	Set of Gasket, O-ring, Packing for Retract Mechanism and one no. Needle Valve with each Pitot Tube.
	Flame scanners and optical pyrometer a) Electronics b) Detectors / sensors or spares with limited life	a)10% subject to minimum 1 No. of each type. b)As required for 1 year operation

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		or Min 2 Nos Complete flame scanner
2.0	Displacer type Level Transmitters	A) 10% of each type of instruments head with Torque Tube Assembly and Transmitter, subject to minimum 2 nos of each type. 1 No of float of each type. B) 10% Electronic cards and Display module – Minimum 1 no. of each type
2.1a	Ultrasonic / Guided Wave Radar Type – Level Instrument	A) 10% complete Instrument – Minimum 1 No. of each Type / Range / Material B) 10% Electronic – module / Cards /Display module – Minimum 1 no. of each type
2.2	Level gauge- Transparent / Reflex Type	20% subject to minimum 10 numbers of glass along with pair of Gaskets and glands sets for I/V valves of each type, size (Cushion & Wet Gaskets), whichever is higher.
2.2.1	Level Gauge- Magnetic Type	10% subject to minimum 1 set of Float, Magnet/ball follower-ring gaskets of each type.
3.0	Control Valve, Shut Down, On-Off, Butterfly, Ball Valves, Gate Valves, Angle Valves, PCV, MOV, Safety Valve Spares	
3.1	Soft part / actuator spares, including actuator diaphragm, actuator seal kit and spring sets, for each type of actuator	20% of each type of instruments, subject to minimum 1 no. of each type
3.2	Trim Set	Trim set consisting of seat ring / seal ring, plug with stem, cage (wherever applicable), packing material for each make, type , size, reassure rating valve to be provided as spare
3.3	Complete Actuator with Hand Wheel assembly	one complete Actuator for each type and size
3.4	Complete Spare Control Valve for Antisurge Control Valve	One No
3.5	Gland packing, O rings, Packing and Bonnet gasket, seat gasket	100 % for each valve. i.e. one set for each tag.
3.6	Greases and grease guns	5 sets of each type of grease and

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		1 grease gun of each type
3.7	Solenoid valves	10% of each type of instruments, subject to minimum 2 nos of each type
3.8	Proximity switches including enclosure	10% of each type of instruments, including enclosure- subject to minimum 2 nos of each type
3.9	SMART Positioners	10% of each type of instruments, subject to minimum 2 nos of each type
3.11	Other accessories: Quick Exhaust relay, Volume Boosters, Air Filter regulators, position Transmitters, change over relay, NRV, Pilot valves.	10% of each type of instruments, subject to minimum 3 nos of each type. Air filter regulator shall be minimum 20%.
3.12	PRDS & De-super heater unit	a)Same as those of Control Valves
		b) Gaskets for valve and connections per unit (if such gaskets, are special and supplied by PRDS/De-Super heater vendor
3.13	For PCV Repair kit consisting of (orifice, plug, spring, gasket, diaphragm, spring, O-ring for each valve.	20% or minimum 1 no. in each type
3.14	HHT loaded with latest HART configurator software (Emerson make)	1 no. minimum
3.15	Safety Valve:	Set of each type/ size. 1 Set comprising of 1 upper adjusting ring, 1 lower adjusting ring, 1 disk, 1 Nozzle, 1 stem & 1 Gasket set
		20% of each size and rating of Discs, Nozzles, bellows, springs etc. Additionally Minimum 2 Nos of Complete PSV for critical application (Very high pressure PSV's e.g Boiler drum application etc.)
4.0	DCS, ESD, F&G PLC, Storage PLC, Analyser PLC, Any other Control and PLC system.	
4.1	CPU	10% or minimum 1 no. each type.
4.1a	Communication cards, Processor cards (Controller) ,FTA cards	2 nos of each type of cards.
4.2	System Pre-fab cables, I/O Card cables, communication bus cables.	10% or min. 5 sets of each type with all connectors, plugs,
4.3	Racks, Backplane units	2 Nos each type
4.4	Local Panel, Hardwire console & annunciator	10% or minimum 2 no. each type.

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	All items like Push buttons, indicators, hand switches lamps, relays selector switches, IS type indicators / Annunciators, holders etc. mounted in the local panel	
4.5	HDD unit	2 set of each type (normal as well as Raid-5) with all connectors, plugs.
4.6	Various Keyboards (including operator keyboard) /mouse	2 nos. of keyboard each type and 5 Nos. of mouse.
4.7	Relays	5% of each type of relays, including relevant terminal modules/sockets minimum 5 nos of each type
4.8	Pushbuttons, Lamps, Selector switches	10% of each type , including relevant terminal modules/accessories as a complete set
4.10	All type of system/PDB/Marshalling cabinet /console filters	100%
4.11	All type of system/PDB/Marshalling cabinet/console fan	2 Nos of each type including relevant terminal modules/pre-fab system cables.
4.12	All type of system/PDB/Marshalling cabinet/console Tube light	2 Nos of each type.
4.13	All type of various PDBs Voltmeters	2 Nos of each type.
4.14	I/O Cards	20% of each type of card, including relevant terminal modules/pre-fab system cables, etc., subject to minimum of 5 nos. each
4.15	Various System Battery, Terminators	1 no. of each type
4.16	All system Fuses and various glass fuses	100% for imported fuses
4.17	All PDB fuses, like HRC, GSA Fuses	100% of total qty. of each type
4.18	MCBs	5 Nos. of each type
4.19	Terminal Blocks	Spare Terminal Blocks along with DIN rail – 100 nos each type
4.20a	Cables for wiring inside Marshalling Racks of DCS of relevant size	100 mtr of each color and size
4.20b	Cables for wiring inside Marshalling Racks of ESD of relevant size	100 mtr of each color and size
4.21	24 V DC Bulk Power Supply modules	Min. 2 nos of each type
4.22	System DC Power supply for DCS	Min. 2 nos of each type
4.23	System DC Power supply for ESD	Min. 2 nos of each type
4.23 a	Diode-o ring modules	10% or minimum 1 no. each type.
4.24	Safety barriers, active isolators, signal convertors, trip amplifiers, signal multipliers	10% of each type of instruments, subject to minimum 5 nos of each type

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4.25	Hubs, Bus units, Switches, Routers	20% or Min 1 nos of each type
4.26	OPC / Modbus interface Cards	1 No each along with connectors / cables
4.27	DCS operator and engineering subsystem	
	Communication card Operator Station communication bus	1 No.
	Communication card for Engineering Station communication bus	1 No.
	Motherboard for Operator Workstation	1 No.
	Motherboard for Engineering Workstation	1 No.
	SMPS	1 No.
4.28	PLC operator and engineering subsystem	
	Communication card for PLC programming Station communication bus	1 No.
	Communication card for PLC SOE Station communication bus	1 No.
	Communication card for PLC Operating Station communication bus	1 No.
5.0	Special control system modules a) WoodWard Digital Governor, b) WoodWard PROTECH 2oo3/Braun Speed Trip unit, Speed Probes c) Any other Control system module associated with Speed trip and Monitoring system. d) Voith Make E/H Converters.	1 no. of each (Controller, IOs ,cables, barriers Complete unit). Speed Probe - 2 nos of Speed Governing, 2 nos for Over speed Trip. • 1 no of each electronics & sensor • 1 no I/H converter complete set.
6.0	Bentley Nevada 3500 Series Vibration Monitoring System Spares	
6.1	Central Rack cards : Power supply card, Vibration/Thrust Monitoring card, Axial displacement card, Speed monitor card, Key phasor module, Relay module, Display Unit., transducers and transmitters	20% of each type of cards, subject to minimum 2 nos of each type
6.2	Vibration probes with leads, axial displacement probes with leads, Bearing thermo elements, speed probes with leads, I/H converter, E/H Convertor, trip solenoid valves, transducers, barriers for vibration probes/ Proximeter.	10% or minimum 1 no. of each type. Proximeter 20%
7.0	Consumables for DCS	
7.1	Printer papers A3, A4 size	A3- 10 Rims, A4- 50 Rims
7.2	Laser Cartridges (Black and Color)	For 6 month usage, min. 2 sets for each printer
7.3	DATs of HP/ 3-M	25 nos. each
7.4	CDs of HP/Samsung	200 with individual casing
7.5	DVDs of HP/Samsung	200 with individual casing

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8.0	GC Spares	
a	Set of Filters	1 set
b	Detector Assembly	1 set
c	PCB assembly Power Supply	2 nos.
d	PCB assembly Digital temp control	2 nos each type
e	Pressure Regulator	1 no
f	Thermocouple Assembly	1 no
g	Sol Valve	1 no
h	Backplane Assembly	1 no
i	PCB Assembly	1 no
j	Ignitor Assembly	1 no
k	Pressure Sensor	1 no
l	Filament Kit	2 nos
m	Set of Fuses	1 no
n	Set of Fittings	1 no
o	Pressure Gauge	1 no
p	Temperature gauge	1 no
q	Sample flow meter	1 no
r	Bypass flow meter	1 no
9.0	Gas Analyzer Spares applicable for all Gas Analyzers / MassSpectrometer	
a	Sample Flow Meter	1 no
b	By pass Flow meter	1 no
c	Solenoid Valve	1 no
d	Communication board	1 no of each type
e	Display Unit	1 no each type
f	CPU Board	1 no each type
g	Sensor Electronic	1 no each type
h	Modulation Unit	1 no each type
i	Sample Cell	1 no
j	Sensor	1 no each type
k	O Ring	3 sets
l	Thermal fusses	2 sets
m	Heating cartridge	1 set
n	Thermal trip	2 set
o	Analogue module	1 set each type
p	Filter membrane (pack of 25)	1 set
q	Fuse	1 set each type
10.0	pH / Conductivity Analyzer	2 (Two) Complete Analyzer complete with sensor, cables, transmitters etc of each type
11.0	Silica Analyzer/Sodium/chlorine/ moisture /Turbidity /density/O2/CO/NOx/SPM Spares	
a	Sensor board	1 no.

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b	Sensor and Detector	1 no each type
c	Rotameter (if applicable)	1 no.
d	Pressure Control Valve (if applicable)	1 no.
e	Fuses	5. sets.
f	Electronic card	1 no. each type
g	Other Aux. Cards	1 each
h	Probe	1 no. each type
i	Filters, O-rings, Gaskets	2 sets
j	Consumable Kit	2 sets
12.0	Sample Conditioning system applicable for all analyzers / Mass spectrometer	
a	Complete sample kit for sample pumps inclusive of 'O' rings, Seal ring, Diaphragm	1 set
b	Solenoid valve for, more than one stream application	1 no
c	Flow switch	1 no
d	Vaporization system if required, which includes vaporizer, thermostat, electrical tracing cable and heater	1 set
e	Cooling system if required, which includes one cooler, flow conditioning system	1 set
f	Sample handling system fitting, valves, pressure gauges, regulators, solenoid valves, flow meters / flow switches and other components, etc	10% or minimum 1 no. of each type
g	Consumables like filters, membranes, reagents, cal. Gas, carriers	For 1 year of continuous operation
13.0	Flame Scanner	Two complete instrument of each type
14.0	Ferruling machine	1 no along with printer ribbon and sleeves size of 5.0 mm2 and 3.5 mm2 100 meter each
	Other Items	
15.0	Snubber, Syphon, Gauge Saver	10% (subject to minimum of 2) of each item used, whichever is higher
16.0	Loop powered indicators	10% (subject to minimum of 2) of Loop powered indicators used, whichever is higher
17.0	Panel mounted instruments	10% or minimum one no. whichever is higher
25.0	Tools	
25.1	Technician's Tool Kit Set including screw drivers, slide wrench, O & D Spanners Kits	10 nos
25.2	Crimping Tool for RJ-45 Connector, Tapria	5 nos
25.3	Crimping Tool 0.5 to 4.0 mm2 wire, Tapria	5 nos
25.4	Crimping Tool BNC connector for Bentely Neveda	2 nos

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25.5	Torque Wrench (Adjustable)	2 nos
25.6	Insulation Remover	5 nos
25.7	IC Puller	2 nos of each type
25.8	Logic probe	2 nos.
25.9	Screw driver kit (Taparia make)	5 set
25.10	Allen Key Set (1mm to 8 mm)	5 set
25.11	Lamp puller	3 nos.
25.12	Torches (LED) handheld	10 nos
25.13	Torches (Head Lamp)	10 nos
25.14	Battery charger alongwith 1 set of batteries	2 nos of each type
26.0	CCTV camera, camera station, lens with zoom, Pan & Tilt Unit, Receiver Unit, electronic unit, , power supply, etc.	10% or minimum one of each type of module.
27.0	EPABX Unit, Electronic Card each type	10% or minimum one of each type of module.
28.0	Gas Detector system a) Transmitter assembly (including field display) b) Sensors	10% subject to minimum 1 No. of each type. 20% subject to minimum 2 No. of each type
29.0	Smoke Detectors , MCP, Sounders, Hooters	10% or minimum one of each type of module.
30.0	Pressure Relief Valves/Thermal Relief Valves/ Vacuum Relief Valves / Low Pressure Relief Valves / Pilot Operated Valves	10% of minimum one of each type & size for nozzle, disc insert, guide whichever is higher
30.0a	Rupture Disc	2 spare disc for each Tag.
31.0	MOVs Main PCB of each type Local / Remote / off Selector Switch each type Open / close / stop Selector Switch each type	 1 Nos 1 Nos 1 Nos
31.0	Installation Material	
31.1	Instrument valves and	10% subject to minimum 1 no. of each type.
31.1.1	Valve manifolds	10% subject to minimum 3 no. of each type.
31.2	Tube fittings	10% subject to minimum 10 no. of each type.
31.3	Tubes	10% of the total length of each type
31.4	Cables	10% of the total length of each type
31.5	Junction boxes and cable glands	10% subject to minimum 1 no. of each type

2.5 Piping Items:

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Following spares are to be supplied for the Piping Bulk Materials:

Sl. No.	Part Description	Size Range (NB)	Quantity Required (% of as built)	Remark
1	Pipes & Fittings	≤1.5”	5%	min. qty. 6 mtr. / 1 No.
2	Pipes & Fittings	≥ 2”	2%	min. qty. 6 mtr. /1 No.
3	Flanges	≤1.5”	5%	min. qty. 1 No.
4	Flanges	2” to 6”	5%	min. qty. 1 No.
5	Flanges	8” to 36”	2%	min. qty. 1 No.
6	Valves	≤1.5”	5%	min. qty. 1 No.
7	Valves	2” to 14”	5%	min. qty. 1 No.
8	Valves	≥16” with rating ≥900#		Note-5
9	Bolts, Nuts & Gaskets (For each size, rating, material)		10%	min. qty. 1 No.
10	Traps (For each size, rating, material)		2%	min. qty. 1 No.
11	Expansion Bellow (For each size, rating, material)		10%	min. qty. 1 No.
12	Strainer element (For each size, rating, material)		10%	min. qty. 1 No.
13	Complete Gear Box for gear operated Valves		5%	min. qty. 1 No.
14	Seal ring for the Pressure seal type valves		5%	min. qty. 10 Nos.
15	Hose assembly		50%	min. qty. 10 Nos.
16	Bolt torque wrenches (Manual)		1 set	min. qty. 1 set.
17	Bolt torque wrenches (Hydraulic)		1 set	min. qty. 1 set.
18	Bolt tensioning for equipment		1 set	min. qty. 1 set.

Notes(Piping items):

1. Percent of quantity required as mandatory spares is for each and every item/size/material consumed in as built.
2. No substitution in size, rating and material is allowed.
3. Pipe length in meter and other items in No. or Set shall be supplied.
4. Fractional part of quantity shall be converted into nearest upward whole part.
5. For rating ≥900# and sizes ≥16”, minimum one qty. valve spare shall be supplied for each size, rating & material.

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3.0 VENDOR'S RECOMMENDED SPARE PARTS

Contractor shall submit list of recommended spare parts of specialised items not covered mandatory spares, along with itemised price. Owner will review and decide the recommended spares required for the project. However, these spares shall not be considered in Price evaluation.

Notes:

1. The above spares do not include installed spares / commissioning spares. The above shall be 2 years spares.
2. Set means complete replacement of particular part in one machine/equipment/Reformer/Fired heater etc.
3. Item wise price against each item shall be furnished.
4. Wherever "Each Type" is specified, it means "of the Type/make/model/size/rating and exactly replaceable"
5. Wherever "% qty." is specified, LSTK Contractor to quote in next higher rounded figure
6. Out of % age spares and minimum qty specified against each item - higher of the two shall be supplied.
7. Spares mentioned above to be offered as 2 years spares. However, if these spares are not used in the equipments being offered / supplied, the same need not be supplied. Bidder shall clearly indicate against each such spare that these spares / items are not used in their equipments.
8. The above is owner's recommended list of spares. The supplier may add other items as per their recommendations.
9. The quotation should contain sectional drawing showing location & part no. (For exact identification) & material specification.
10. The above nos. of spares are minimum.
11. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
12. Wherever % age is identified, Contractor shall supply next rounded figure.
13. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
14. Mandatory spares shall be applicable for Electrical / Instrumentation items of sub packages also as per above mandatory spares philosophy.

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15. Mandatory spares shall be procured along with the main equipment. These spares include only those spares, which are critical for equipment and require longer delivery periods.
16. The word 'Set' means the quantity required for full replacement of that part in one machine.
17. The Bidder shall quote for all the mandatory spares as defined above & as applicable to the proposed design of the equipment. In case, any spare which is listed above but not applicable due to specific construction/design of the equipment, the same shall be highlighted as 'Not Applicable' against that spare supported with proper technical explanation.
18. Spare parts shall be identical in all respects to the parts fitted on the main equipment, including dimensions, material of construction, testing & heat treatment.

    Mandatory spares as specified elsewhere in the engineering specifications for other items are also to be provided by the contractor before Commissioning of the plant.

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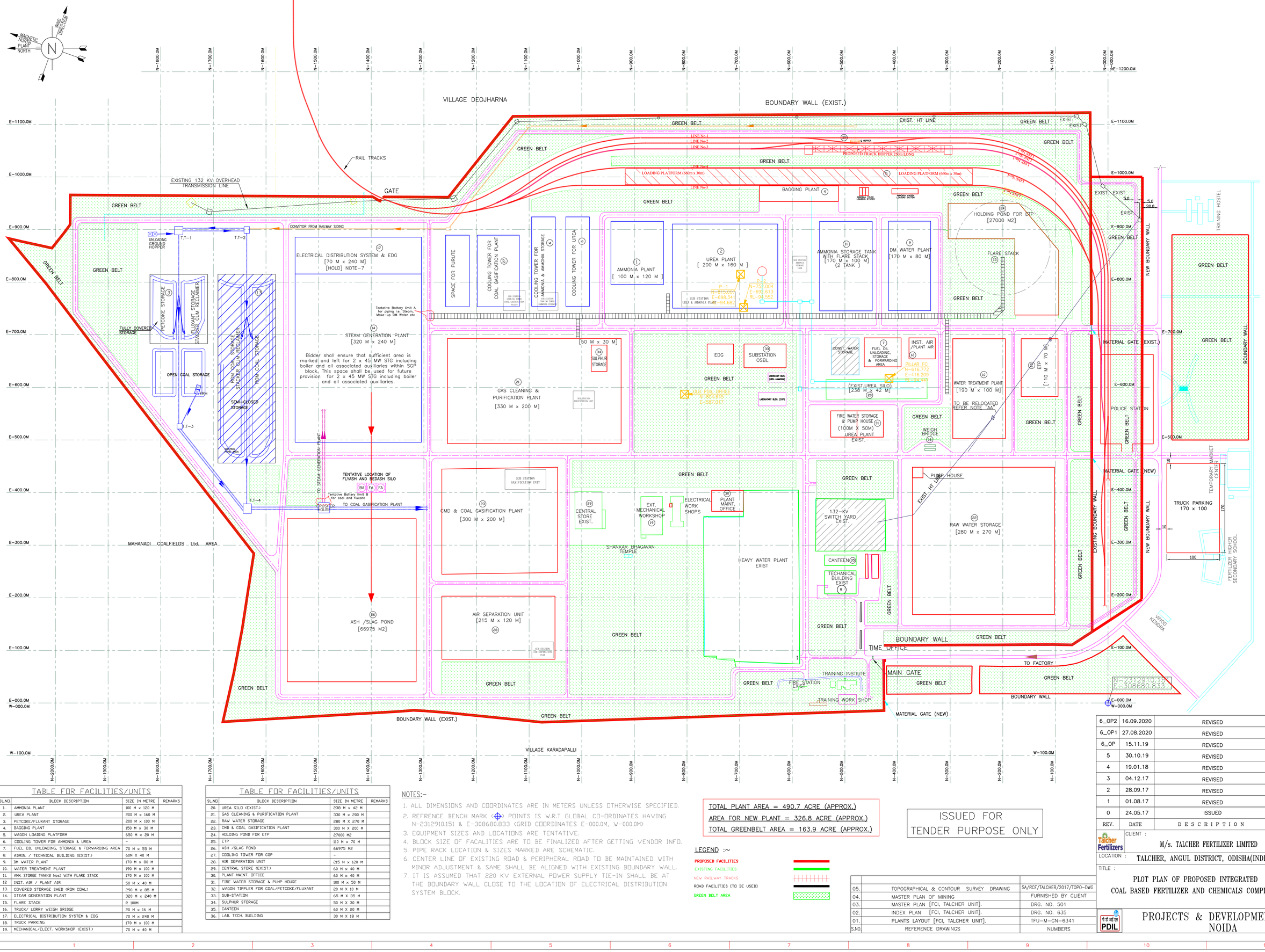

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TABLE FOR FACILITIES/UNITS

SL.NO.	BLOCK DESCRIPTION	SIZE IN METRE	REMARKS
1.	AMMONIA PLANT	100 M x 120 M	
2.	UREA PLANT	200 M x 160 M	
3.	PETCOKE/FLUXANT STORAGE	200 M x 100 M	
4.	BAGGING PLANT	150 M x 30 M	
5.	WAGON LOADING PLATFORM	650 M x 20 M	
6.	COOLING TOWER FOR AMMONIA & UREA	–	
7.	FUEL OIL UNLOADING, STORAGE & FORWARDING AREA	70 M x 55 M	
8.	ADMIN. / TECHNICAL BUILDING (EXIST.)	60M X 40 M	
9.	DM WATER PLANT	170 M x 80 M	
10.	WATER TREATMENT PLANT	190 M x 100 M	
11.	AMM. STORGE TANK(2 Nos) WITH FLARE STACK	170 M x 100 M	
12.	INST. AIR / PLANT AIR	50 M x 40 M	
13.	COVERED STORAGE SHED (ROM COAL)	290 M x 85 M	
14.	STEAM GENERATION PLANT	320 M x 240 M	
15.	FLARE STACK	R 100M	
16.	TRUCK/ LORRY WEIGH BRIDGE	20 M x 16 M	
17.	ELECTRICAL DISTRIBUTION SYSTEM & EDG	70 M x 240 M	
18.	TRUCK PARKING	170 M x 100 M	
19.	MECHANICAL/ELECT. WORKSHOP (EXIST.)	70 M x 40 M	

TABLE FOR FACILITIES/UNITS

SL.NO.	BLOCK DESCRIPTION	SIZE IN METRE	REMARKS
20.	UREA SILO (EXIST.)	238 M x 42 M	
21.	GAS CLEANING & PURIFICATION PLANT	330 M x 200 M	
22.	RAW WATER STORAGE	280 M X 270 M	
23.	CMD & COAL GASIFICATION PLANT	300 M X 200 M	
24.	HOLDING POND FOR ETP	27000 M2	
25.	ETP	110 M x 70 M	
26.	ASH /SLAG POND	66975 M2	
27.	COOLING TOWER FOR CGP	–	
28.	AIR SEPARATION UNIT	215 M x 120 M	
29.	CENTRAL STORE (EXIST.)	60 M x 40 M	
30.	PLANT MAINT. OFFICE	60 M x 40 M	
31.	FIRE WATER STORAGE & PUMP HOUSE	100 M x 50 M	
32.	WAGON TIPPLER FOR COAL/PETCOKE/FLUXANT	20 M X 10 M	
33.	SUB-STATION	65 M X 35 M	
34.	SULPHUR STORAGE	50 M X 30 M	
35.	CANTEEN	60 M X 20 M	
36.	LAB. TECH. BUILDING	30 M X 18 M	

NOTES:-

1. ALL DIMENSIONS AND COORDINATES ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. REFRENCE BENCH MARK (⊕) POINTS IS W.R.T GLOBAL CO-ORDINATES HAVING N-2312910.151 & E-308680.833 (GRID COORDINATES E-000.0M, W-000.0M)
3. EQUIPMENT SIZES AND LOCATIONS ARE TENTATIVE.
4. BLOCK SIZE OF FACALITIES ARE TO BE FINALIZED AFTER GETTING VENDOR INFO.
5. PIPE RACK LOCATION & SIZES MARKED ARE SCHEMATIC.
6. CENTER LINE OF EXISTING ROAD & PERIPHERAL ROAD TO BE MAINTAINED WITH MINOR ADJUSTMENT & SAME SHALL BE ALIGNED WITH EXISTING BOUNDARY WALL.
7. IT IS ASSUMED THAT 220 KV EXTERNAL POWER SUPPLY TIE-IN SHALL BE AT THE BOUNDARY WALL CLOSE TO THE LOCATION OF ELECTRICAL DISTRIBUTION SYSTEM BLOCK.

TOTAL PLANT AREA = 490.7 ACRE (APPROX.)
AREA FOR NEW PLANT = 326.8 ACRE (APPROX.)
TOTAL GREENBELT AREA = 163.9 ACRE (APPROX.)

LEGEND :~
PROPOSED FACILITIES
EXISTING FACILITIES
NEW RAILWAY TRACKS
ROAD FACILITIES (TO BE USED)
GREEN BELT AREA

ISSUED FOR TENDER PURPOSE ONLY

S.NO.	REFERENCE DRAWINGS	NUMBERS
05.	TOPOGRAPHICAL & CONTOUR SURVEY DRAWING	SA/RCF/TALCHER/2017/TOPO-DWG
04.	MASTER PLAN OF MINING	FURNISHED BY CLIENT
03.	MASTER PLAN [FCI, TALCHER UNIT].	DRG. NO. 501
02.	INDEX PLAN [FCI, TALCHER UNIT].	DRG. NO. 635
01.	PLANTS LAYOUT [FCI, TALCHER UNIT].	TFU-M-GN-6341

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
6_OP2	16.09.2020	REVISED	ANIL	NS/DR	AMAR
6_OP1	27.08.2020	REVISED	ANIL	NS/DR	AMAR
6_OP	15.11.19	REVISED	ANIL	NS/DR	AMAR
5	30.10.19	REVISED	ANIL	NS/DR	AMAR
4	19.01.18	REVISED	SAH	NS	AMAR
3	04.12.17	REVISED	SAH	NS	AMAR
2	28.09.17	REVISED	SAH	NS	AMAR
1	01.08.17	REVISED	SAH	NS	AMAR
0	24.05.17	ISSUED	SAH	NS	AMAR

Talcher Fertilizers

CLIENT : M/s. TALCHER FERTILIZER LIMITED

REV. 6_OP | 6_OP1 | 6_OP2

LOCATION : TALCHER, ANGUL DISTRICT, ODISHA(INDIA)

SHEET 1 OF 1

SCALE :~ 1 : 2200

TITLE : PLOT PLAN OF PROPOSED INTEGRATED COAL BASED FERTILIZER AND CHEMICALS COMPLEX

DRG. No.:~ PC009-0000-0001

FILE :~ PC009-0000-0001 Rev.6_OP2

PDIL PROJECTS & DEVELOPMENT INDIA LTD. NOIDA

SECTION –VI: TECHNICAL

PART - 7.0

INFORMATION REQUIRED IN TECHNICAL PROPOSAL

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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CONTENTS

Section Number	Description
1.0	Design Basis
2.0	Detailed Description of the Process
3.0	Process Flow Diagrams/ Material Selection Diagrams
4.0	Design calculations for sizing of exchangers
5.0	Piping & Instrument Diagram (P & ID)
6.0	Details of Equipment & machinery
7.0	Design Philosophy for Electrical system
8.0	Normal & Emergency Power requirement
9.0	Specifications of chemicals
10.0	Plant layout for Battery Limit Plant
11.0	Details of Instrumentation system
12.0	Detailed Technical Specifications
13.0	Comprehensive Engineering Specifications/ Standards & design codes
14.0	Details of Shop & Field Testing & Inspection Procedures
15.0	Implementation plan
16.0	Project Plan
17.0	List of Deviations

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18.0	Time Schedule Network
19.0	List of Vendor's not covered under ITB Vendor List
20.0	Quality Assurance & Quality Control Procedure
21.0	List of Spare Part

INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL:

The Technical proposal of the bid shall include, but not necessarily be limited to the following:

1.0 **Design Basis:** Design basis for all Process, Mechanical, Electrical, Instrumentation, Civil & structural items shall be submitted by the Contractor.

2.0 **A detailed description of the process** offered, including overall process scheme and the specific merits of the process scheme being offered.

3.0 **Process flow diagrams/ Material Selection Diagrams** indicating the major equipment in proper Flow sequence, Flows, Temperatures, Pressures, Compositions, Critical Instrumentation, Control points and the material of construction adopted for the major lines.

4.0 **Design calculations**

Calculation for dosing chemical consumption

Details of Treatment process indicating various chemical reactions & chemicals required for treatment processes.

Design calculations for sizing of the exchangers shall cover all process route, showing input and output utility streams as well as composition, volumetric flow, molecular weight and densities of principal process streams at inlet and outlet of each equipment.

5.0 **Piping & Instrument Diagram (P & ID)** for all plants and package items design case and normal case.

6.0 **Details of Equipment and Machinery** (Mechanical, Electrical, Instrumentation included in the proposal). Data sheets of equipment indicating design code used and sufficient specification such as those used in enquiry documents giving details like, size, overall

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dimensions, thickness, weight, material of construction, lining/cladding (if any), details of internals and packing materials, distributors, design conditions and corrosion allowances used etc.

7.0 Design Philosophy for the Electrical System, List of Electrical Drives with normal & design ratings, a Single Line Electrical Distribution Diagram showing Loads at various voltage levels, Protection/ metering and interlocking scheme, Hazardous area classification drawing for the plant and list of vendors. Specification of all electrical equipments.

8.0 Normal & Emergency Power Requirement and the list of equipments connected to it.

9.0 Specifications of Chemicals and their estimated Initial and yearly requirement.

10.0 Plant Layout for Battery Limit plant showing principal equipment and machinery including detailed floor plans and elevations. The plot plan should show clearances required, roads and all principal pipe racks.

11.0 Details of Instrumentation System including the proposed models etc. as also details of the proposed control systems (DCS) Safety Interlock and Trip system shall be enclosed. A list of all control valves with purchase specifications, material of construction, codes/standards used shall be enclosed. Instrumentation Control Philosophy, Logic Diagrams & Safety valve Specifications shall also be enclosed.

12.0 Detailed Technical Specifications of piping & valves with approximate tonnage/quantities in the form of Bill of Material.

13.0 Comprehensive Engineering Specification/Standards and Design Codes for all types of Equipments/items including Mechanical, Electrical, Instrumentation, Civil & Structural proposed to be adopted by the Contractor.

14.0 Details of Shop & Field Testing and Inspection Procedures proposed to be adopted. Inspection of equipment & machinery should be carried out by a Third Party Inspector. Owner also has the right to inspect any equipment, machinery at any stage.

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15.0 An Implementation Plan showing man-power deployment schedule during various stages of implementation period, including peak requirements. Contractor shall indicate the schedule, category and number of personnel proposed for supervisory services during different phases of work, indicating clearly as to how many of them would be deployed by Contractor. Contractor shall also indicate the correspondence and documentation system to be followed.

16.0 Project Plan showing Project Organisation, Project team, Project services offered by the Contractor at home office and at site. Contractor would also indicate the activities proposed to be carried out.

17.0 List of Deviations. Contractor shall submit list of deviations to technical ITB indicating clearly clause-wise deviation from ITB. Any deviation listed other than in deviation list shall not be considered.

18.0 Time Schedule Network. A time schedule for the complete project in the form of a Bar Chart and Network indicating the time allocated for various activities. Master time schedule/ network (PERT Network/ Bar chart) showing all activities shall be submitted by the Contractor.

19.0 List of Vendor's not covered under ITB Vendor List.

Bidder shall furnish list of vendors for the items not covered under ITB which shall be discussed & finalised with selected contractor.

20.0 Quality Assurance & Quality Control procedure to be followed by Contractor for the implementation of this project.

21.0 List of Spare part. Complete list of itemised commissioning, mandatory & recommended spare (spare parts not covered under mandatory spares list) parts for 2 years operations for all Process, Mechanical, Electrical, and Instrument items considered for this project.

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SECTION – VI: TECHNICAL

PART – 8.0

VENDOR LIST

INSTRUMENT AIR/PLANT AIR SYSTEM

AT

TALCHER FERTILIZERS LIMITED

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Bidder shall select sub vendors from the vendor list as specified below. Bidder shall ensure that sub vendor for the specified item has supplied item for the specified service & the supplied item is in satisfactory service.

Vendor shall have well proven record for the specified services and shall be subjected to owner/consultant approval.

Any addition to vendor list shall be reviewed and approved by Owner/PMC subject to submission of back-up credentials with proven & reliable record of performance for similar or comparable plant design capacity by LSTK contractor.

1.0 STATIC EQUIPMENTS:

S.NO	ITEM DESCRIPTION	COUNTRY
VESSELS IN CS/AS/SS PRESSURE UPTO 10 Kg/cm2g		
1	BTL EPC LIMITED (CS OONLY)	INDIA
2	AERO ENGINEERS	INDIA
3	AIRFRIGE INDUSTRIES	INDIA
4	ARTSON ENGINEERING LIMITED	INDIA
5	B H P V	INDIA
6	BHARAT HEAVY ELECTRICALS LTD.	INDIA
7	FABTECH PROJECTS & ENGINNERS LTD. (For CS Only)	INDIA
8	FLOWLINK INDUSTRIES PVT. LTD. (CS/SS Except Urea Service)	INDIA
9	FURNACE FABRICA (INDIA) LTD. (CS/SS)	INDIA
10	G R ENGINEERING PRIVATE LIMITED	INDIA
11	GANSONS LTD.	INDIA
12	GEMINI ENGI-FAB PVT. LTD. (Excluding AS Mati)	INDIA
13	GHANSHYAM STEEL WORKS LTD. (CS/SS)	INDIA
14	GMM PFAUDLER LIMITED	INDIA
15	GODREJ & BOYCE MFG. CO. LTD	INDIA
16	GRAND PRIX ENGINEERING PVT. LTD. (upto 4m D x 6m L x80mm Thk)	INDIA
17	GRASIM INDUSTRIES	INDIA

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18	HEATEX INDIAN CORPORATION	INDIA
19	HINDUSTAN DORR-OLIVER LTD.	INDIA
20	ICEM ENGG. CO. LTD.	INDIA
21	INDIA TUBE MILLS & METAL INDUSTRIES LTD. (For CS/SS only)	INDIA
22	INDUS PROJECTS LTD (FORMERLY INDUS ENGG)	INDIA
23	ISHAN EQUIPMENTS PVT. LTD. (CS/SS only)	INDIA
24	KINETICS TECHNOLOGY INDIA LTD.	INDIA
25	LARSEN & TOUBRO LTD.	INDIA
26	LLOYDS STEEL INDUSTRIES LIMITD	INDIA
27	LOYAL EQUIPMENTS PVT. LTD. CS/SS and Non IBR only)	INDIA
28	MARS DESIGN PVT. LTD.	INDIA
29	MISTRY PRABHUDAS MANJI ENGG. PVT. LTD.	INDIA
30	MOD FABRICATORS	INDIA
31	MULTI-MAX ENGINEERING WORKS PVT. LTD. (CS and SS Material only)	INDIA
32	NAVA BHARAT FERRO ALLOYS LTD	INDIA
33	NEW FIELD INDUSTRIAL EQUIPMENT PVT. LTD. CS/SS Only)	INDIA
34	NIVITA ENGINEERING WORKS	INDIA
35	NOVATECH PROJECTS INDIA (P) LTD. (CS and SS material only)	INDIA
36	ORIENTAL MANUFACTURERS PROVATE LIMITED (CS/SS only)	INDIA
37	PATELS AIRTEM (INDIA LIMITED	INDIA
38	PRECISION EQUIPMENTS (CHAANAI) PVT LTD	INDIA
39	PROJECT TECHNOLOGISTS PVT. LTD.	INDIA
40	R.D. ENGINEERS (INDIA) PVT. LTD.	INDIA
41	RAJ ENGG. CO.	INDIA
42	RELIANCE FABRICATIONS PVT. LTD.	INDIA

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43	REYNOLDS CHEMEQUIP PRIVATE LIMITED (CS/SS)	INDIA
44	SHRENO LTD. (UNIT 2)	INDIA
45	TAS ENGINEERING CO. (P) LIMITED	INDIA
46	TATA CHEMICALS LTD	INDIA
47	THE ANUP ENGINEERING LIMITED	INDIA
48	THE KCP LIMITED	INDIA
49	ISGEC HEAVY ENGINEERING LIMITED	INDIA
50	TITANIUM EQUIPMENT AND ANODE MFG. CO. LTD.	INDIA
51	TRIVENI STRUCTURALS LTD.	INDIA
52	UNITOP ENGINEERS PVT. LTD. (Max. Shell Dia 4.65, Water vol. 140m3)	INDIA
53	HYOSUNG CORPORATION (CS/SS/LAS only)	KOREA
54	APPARATEBAU SCHWEISS TECHNIK GMBH	AUSTRIA
55	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
56	OLMI SPA	ITALY
57	JAPAN STEEL WORKS LTD	JAPAN
58	DOOSAN MECATEC CO. LTD.	KOREA
59	HANJUNG DCM CO. LTD.	KOREA
60	HUNDAI HEAVY INDUSTRIES	KOREA
61	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD	KOREA
62	CHEM PROCESS SYETEM PVT. LTD. (CS/SS ONLY)	INDIA
63	COPERION IDEAL PVT. LTD.	INDIA
64	ESSAR HEAHY ENGINEERING SERVICES	INDIA
65	PHILS HEAVY ENGINEERIG PVT. LTD.	INDIA
66	PRAJ INDUSTRIES LIMITED	INDIA
67	SPETECH PLANT EQUIPMENT PVT. LTD. (CS ONLY)	INDIA
68	TECHNO PROCESS EQUIPMENT (I) LTD. (CS/AS/SS(AS only for P3 Material))	INDIA

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69	UNIVERSAL HEAT EXCHANGER LIMITED (CS/SS/LTCS only)	INDIA
70	VIJAY TANKS & VESSELS LIMITED (CS/LAS AND SS ONLY)	INDIA
71	CRYOSTAR TANKS AND VESSEL PVT. LTD (CS ONLY)	INDIA
72	VIJAY TANKS & VESSELS LIMITED (KANDLA) (CS/ SS ONLY)	INDIA
73	SUNGJIN GEOTECH CO. LTD. (CS and SS only)	KOREA
VESSELS IN CS/AS/SS PRESSURE 11 TO 60 Kg/cm2g		
1	ALTECH INFRASTRUCTURE (INDIA) PVT. LTD. (Upto 20 Kg/cm2(g)CS Material)	INDIA
2	ARIEN NEW DELHI PRIVATE LIMITED (CS/SS UP TO 11 to 30 kg/cm2(g))	INDIA
3	B H P V	INDIA
4	BHARAT HEAVY ELECTRICALS LTD.	INDIA
5	EXPO GAS CONTAINERS LTD. (Upto 30 Kg/sq cm (g) CS/SS Material.)	INDIA
6	FABTECH PROJECTS & ENGINNERS LTD. (For CS Only)	INDIA
7	FURNACE FABRICA (INDIA) LTD. (CS/SS UP TO 11 to 30 kg/cm2(g))	INDIA
8	G R ENGINEERING PRIVATE LIMITED	INDIA
9	GANSONS LTD.	INDIA
10	GHANSHYAM STEEL WORKS LTD (CS/SS)	INDIA
11	GODREJ & BOYCE MFG. CO. LTD	INDIA
12	GRAND PRIX ENGINEERING PVT. LTD.	INDIA
13	GRASIM INDUSTRIES (upto 30Kg/cm2g)	INDIA
14	HEATEX INDIAN CORPORATION	INDIA
15	HINDUSTAN DORR-OLIVER LTD. (CS/SS Only)	INDIA
16	INDIA TUBE MILLS & METAL INDUSTRIES LTD. (For CS/SS only upto 30 Kg/cm2g)	INDIA
17	INDUS PROJECTS LTD (FORMERLY INDUS ENGG)	INDIA
18	ISHAN EQUIPMENTS PVT. LTD. (CS/SS Upto 30 Kg/Cm2(g) only)	INDIA
19	INDCON PROJECTS &EQUIPMENT LIMITED. (CS/LTCS/SS Upto 30 Kg/Cm2(g) only)	INDIA

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20	KAVERI ENGG. INDUSTRIES LTD.,	INDIA
21	LARSEN & TOUBRO LTD	INDIA
22	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
23	LOYAL EQUIPMENTS PVT. LTD. (Upto 11-30 Kg/cm2, CS/SS and Non IBR only.)	INDIA
24	MULTI-MAX ENGINEERING WORKS PVT. LTD. (Up to 30 Kg/cm2g (CS and SS Materials only)	INDIA
25	NEW FIELD INDUSTRIAL EQUIPMENT PVT. LTD. (Upto 30 Kg/cm2g (CS/SS Only)	INDIA
26	ORIENTAL MANUFACTURERS PRIVATE LIMITED (CS/SS only)	INDIA
27	PATELS AIRTEMP (INDIA LIMITED (CS & SS only)	INDIA
28	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD (upto 44Kg/cm2g)	INDIA
29	NEWTON ENGINEERING & CHEMICALS LIMITED	INDIA
30	RAJ ENGG. CO. (up to 30kg/cm 2 (g) CS/SS/AS (P3 & P4 only)	INDIA
31	THE ANUP ENGINEERING LIMITED	INDIA
32	ISGEC HEAVY ENGINEERING LIMITED	INDIA
33	THE INDIAN SUGAR & GENERAL ENGG. CORPN. (ISGEC), DAHEJ (Except Urea Plant Critical Equipment)	INDIA
34	HYOSUNG CORPORATION (CS/SS/LAS only)	KOREA
35	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
36	BORSING GmbH	GERMANY
37	BELLELI S.P.A	ITALY
38	FBM HUDSON ITALIANA S.p.A	ITALY
39	GE POWER (NUOVO PIGNONE SPA)	ITALY
40	ROLLE S.P.A. (11 TO 60 kg/cm2 pr.)	ITALY
41	WALTER TOSTO SpA	ITALY
42	HITACHI ZOSEN	JAPAN
43	KOBE STEEL LIMITED	JAPAN
44	MITSUBISHI HEAVY INDUSTRIES LTD.	JAPAN

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45	MITSUI ENGINEERING & SHIPBUILDING CO. LTD	JAPAN
46	DOOSAN MECATEC CO. LTD.	KOREA
47	HANJUNG DCM CO. LTD.	KOREA
48	HANTECH LIMITED	KOREA
49	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD	KOREA
50	MECANICA DE LA PENA S.A.	SPAIN
51	BEAIRD INDUSTERIES LOUISIANA	U.S.A
52	CHEM PROCESS SYSTEM PVT. LTD. (CS/SS upto 30 kg/cm^2g only)	INDIA
53	CICB-CHEMICON PVT. LTD. (upto 30 kg/cm^2 only (CS only))	INDIA
54	ESSAR HEAVY ENGINEERING SERVICES	INDIA
55	FAB-TECH WORKS & CONSTRUCTIONS PRIVATE LIMITED	INDIA
56	GMM PFAULER LIMITED (CS/SS only)	INDIA
57	INDCON PROJECTS & EQUIPMENT LIMITED (for CS/LTCS/SS only upto 30 kg/cm^2g)	INDIA
58	MEENAKSHI ASSOCIATED (P) LTD. (CS/LTCS/SS upto 30 kg/cm^2g)	INDIA
59	NUBERG ENGINEERING LIMITED (CS/SS upto 30 kg/cm^2g)	INDIA
60	PHILS HEAVY ENGINEERING PVT. LTD. (upto 30 kg/cm^2g)	INDIA
61	PRAJ INDUSTRIES LIMITED (CS & SS ONLY)	INDIA
62	R.D. ENGINEERS (INDIA) PVT. LTD. (upto 30 kg/cm^2g)	INDIA
63	RELIANCE FABRICATIONS PVT. LTD. (CS/SS upto 30 kg/cm^2g)	INDIA
64	SPETECH PLANT EQUIPMENT PVT. LTD. (CS upto 30 kg/cm^2g)	INDIA
65	TECHNO PROCESS EQUIPMENTS (I) LTD. (CS/AS/SS upto 30 kg/cm^2g (AS only for P3 Material))	INDIA
66	UNIQUE CHEMOPLANT EQUIPMENTS (CS/SS only upto 30 kg/cm^2g)	INDIA
67	UNIVERSAL HEAT EXCHANGERS LIMITED (CS/SS/LTCS upto 30 kg/cm^2g)	INDIA
68	VIJYA TANKS & VESSELS LIMITED (CS/SS and LAS from 11 to 30 kg/cm^2g only)	INDIA

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69	VIJYA TANKS & VESSELS LIMITED (KANDLA)(CS/SS upto 30 kg/cm^2g only)	INDIA
70	THE KCP LIMITED	INDIA
71	AERO ENGINEERS (CS only)	INDIA
72	AVADH INDUSTRIES (Upto 34 kg/cm2g), CS only	INDIA
73	GEMINI ENGI-FAB PVT. LTD. (Upto 40 Kg/cm2g)	INDIA
74	JINDAL STEEL & POWER LTD. (MACHINERY DIVISION) (CS only)	INDIA
75	BTL EPC LIMITED (up to 30 kg/cm2, CS only)	INDIA
76	ALPEC CO. LTD. (CS & AS only)	KOREA
77	SUNGJIN GEOTEC CO., LTD. (CS and SS only)	KOREA
VESSELS IN CS/AS/SS PRESSURE ABOVE 60Kg/cm2g		
1	B H P V	INDIA
2	BHARAT HEAVY ELECTRICALS LTD.	INDIA
3	G R ENGINEERING PRIVATE LIMITED	INDIA
4	GODREJ & BOYCE MFG CO. LTD.	INDIA
5	LARSAN & TOUBRO LTD.	INDIA
6	THE INDIAN SUGAR & GENERAL ENGG. CORPN. (ISGEC), DAHEJ (Except Urea Plant Critical Equipment)	INDIA
7	ISGEC HEAVY ENGINEERING LIMITED ((Except Urea Plant Critical Equipment)	INDIA
8	HYOSUNG CORPORATION (CS/SS/LAS only)	KOREA
9	BORSIG GmbH (upto 1500 Deg. C & upto 35000KPa)	GERMANY
10	FERROSTAAL AKTIENGES ELLSCHAFTG	GERMANY
11	KRUPP INDUSTRIES-TECHNIK	GERMANY
12	THYSSEN RHEINSTAHL TECHNIK GMBH	GERMANY
13	ACCIAI SPECIALI TERNI	ITALY
14	ATB ACCIAIERIA E TUBIFICIO DI BRESCIA SP	ITALY
15	BELLELI S.P.A	ITALY
16	FBM HUDSON ITALIANA S.p.A	ITALY
17	GE POWER (NUOVO PIGNONE SPA)	ITALY
18	OLMI SPA	ITALY
19	WALTER TOSTO SpA	ITALY
20	KAWASAKI HEAVY INDUSTRIES LTD.	JAPAN
21	KOBE STEEL LIMITED	JAPAN
22	MITSUBISHI HEAVY INDUSTRIES LTD.	JAPAN
23	SUMISHO MACHINERY TRADE CORPORATION	JAPAN
24	DOOSAN MECATEC CO. LTD.	KOREA
25	HANJUNG DCM CO. LTD.	KOREA

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26	HUNDAI HEAVY INDUSTRIES	KOREA
27	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD	KOREA
28	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
29	HINDUSTAN DORR-OLIVER LTD. (CS/SS/LAS/LTCS only)	INDIA
30	SUNGJIN GEOTEC CO. LTD. (CS and SS only)	KOREA
31	TECHNO PROCESS EQUIPMENTS (INDIA) PVT. LTD. (NON IBR ONLY)	INDIA
32	ISGEC HITACHI ZOSEN LIMITED	INDIA
33	THE ANUP ENGINEERING LIMITED	INDIA
34	PATEL AIR TEMP INDIA LIMITED (CS ONLY)	INDIA
35	PRAJ INDUSTRIES LIMITED (CS/SS ONLY)	INDIA
36	ALPEC CO. LTD. (CS & AS only)	KOREA
SHOP FABRICATED TANKS & NONCODED VESSELS		
1.	ALTECH INFRASTRUCTURE (INDIA) PVT. LTD.	INDIA
2.	ARTSON ENGINEERING LIMITD	INDIA
3.	BAKSHI CHEMPHARMA EQUIPMENTS PVT. LTD.	INDIA
4.	ESSAR HEAVY ENGINEERING SERVICES	INDIA
5.	FLOWLINK INDUSTRIES PVT. LTD. (CS/SS only)	INDIA
6.	G R ENGINEERING PRIVATE LIMITED	INDIA
7.	GANSONS LTD.	INDIA
8.	GAYATRI TANKS & VESSELS	INDIA
9.	GEMINI ENGI-FAB PVT. LTD.	INDIA
10.	GENERAL MECH & PROCESS EQUIPT. (P) LTD.	INDIA
11.	GODREJ & BOYCE MFG. CO. LTD.	INDIA
12.	GRANDPRIX ENGINEERING PVT. LTD	INDIA
13.	INDIA TUBE MILLS & METAL INDUSTRIES LTD.	INDIA
14.	INDUS ENGG. COMPANY	INDIA
15.	ISHAN EQUIPMENTS PVT. LTD. (CS/SS only)	INDIA
16.	KINETICS TECHNOLOGY INDIA LTD.	INDIA
17.	LAXMI ENGINEERING INDUSTRIES (BHOPAL) PRIVATE LIMITD (CS/SS only)	INDIA

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18.	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
19.	MABEL ENGINEERS PVT. LTD.	INDIA
20.	MULTI-MAX ENGINEERING WORKS PVT. LTD.	INDIA
21.	NEWTON ENGG. & CHEMICALS LTD.	INDIA
22.	NIVITA ENGINEERING WORKS	INDIA
23.	NOVATECH PROJECT INDIA (P) LTD.	INDIA
24.	ORIENTAL MANUFACTURERS PRIVATE LIMITED (CS/SS only)	INDIA
25.	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD.	INDIA
26.	PRECISION TANKS & VESSEL	INDIA
27.	PROJECT TECHNOLOGISTS PVT. LTD.	INDIA
28.	R.D. ENGINEERS (INDIA) PVT. LTD.	INDIA
29.	RAJ ENGG. CO.	INDIA
30.	RELIANCE FABRICATIONS PVT. LTD.	INDIA
31.	SHARP TANKS & STRUCTURALS PVT. LTD.	INDIA
32.	TAS ENGINEERING CO. (P) LIMITED	INDIA
33.	TATA CHEMICALS LTD.	INDIA
34.	UNITOP ENGINEERS PVT. LTD. (Max shell Dia 4.65m. Vol 140m3)	INDIA
35.	VIJAY TANKS & VESSELS LIMITED	INDIA
36.	VIP J INDUSTRIAL ENTERPRISES PVT. LTD.	INDIA
37.	RELIABLE FABRICATION & ENGINEERING INDUSTRIES	INDIA
38.	TITANIUM TANTALUM PRODUCTS LTD.	INDIA
39.	VIJAY TANKS & VESSELS LTD. (KANDLA)	INDIA
40.	OSWAL INFRASTRUCTURE LIMITED	INDIA
41.	BTL EPC LIMITED (CS Only)	INDIA
DEMISTERS		
1	EVERGREEN INDUSTRIES	INDIA
2	GRAND PRIX ENGINEERING PVT. LTD.	INDIA

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3	HAVER STANDARD INDIA PVT. LTD. (Demister pads with grids)	INDIA
4	HEIN LEHMANN (I) LTD.	INDIA
5	MISTER – MESH WIRE PRODUCTS	INDIA
6	COSTACURTA VICO S.P.A	ITALY
7	GLITSH ITALIANA, SPA	ITALY
8	KNITMESH LTD.	U.K.
9	KEVIN ENTERPRISES PVT. LIMITED	INDIA
HEAT EXCHANGERS UPTO 30 Kg/cm2g		
1	ARTSON ENGINEERING LIMITED	INDIA
2	B H P V	INDIA
3	BHARAT HEAVY ELECTRICALS LTD.	INDIA
4	EXPO GAS CONTAINERS LTD.(Upto 30 Kg/sq (g) CS/SS Material.	INDIA
5	FABTECH PROJECTS & ENGINEERS LTD. (For CS Only)	INDIA
6	FLOWLINK INDUSTRIES PVT. LTD. (CS/SS Except Urea service)	INDIA
7	G R ENGINEERING PRIVATE LIMITED	INDIA
8	GANSONS LTD.	INDIA
9	GEMINI ENGI-FAB PVT. LTD.	INDIA
10	GHANSHYAM STEEL WORKS LTD. (CS/SS)	INDIA
11	GODREJ & BOYCE MFG. CO. LTD.	INDIA
12	GRASIM INDUSTRIES	INDIA
13	HEATEX INDIAN CORPORATION	INDIA
14	HINDUSTAN DORR-OLIVER LTD.	INDIA
15	INDIA TUBE MILLS & METAL INDUSTRIES LTD.	INDIA
16	INDUS PROJECTS LTD. (FORMERLY INDUS ENGG.)	INDIA
17	LARSEN & TOUBRO LIMITED	INDIA
18	LAXMI ENGINEERING INDUSTRIES (BHOPAL) PRIVATE LIMITED (CS/SS only Except Urea service)	INDIA
19	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
20	MABEL ENGINEERS PVT. LTD.	INDIA
21	MANISH UDYOG HEAT EXCHANGERS PVT. LTD.	INDIA
22	MISTRY PRABHUDAS MANJI ENGG. PVT. LTD.	INDIA
23	MULTI-MAX ENGINEERING WORKS PVT. LTD. (CS and SS Materials only)	INDIA
24	PATELS AIRTEMP (INDIA LIMITED)	INDIA
25	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD.	INDIA
26	R.D. ENGINEERS (INDIA) PVT. LTD.	INDIA
27	RADIANT HEAT EXCHANGER PVT. LTD. (CS/SS only)	INDIA
28	RAJ ENGG. CO.	INDIA
29	REYNOLDS CHEMQUIP PRIVATE LIMITED (CS/SS)	INDIA

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30	TAS ENGINEERING CO. (P) LIMITED	INDIA
31	TATA CHEMICALS LTD	INDIA
32	TEMA INDIA LIMITED(ACHHAD UNIT-1)	INDIA
33	THE ANUP ENGINEERING LIMITED	INDIA
34	ISGEC HEAVY ENGINEERING LIMITED	INDIA
35	TITANIUM EQUIPMENT AND ANODE MFG. CO. LTD.	INDIA
36	APPARATEBAU SCHWEISSTECHNIK GMBH	AUSTRIA
37	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
38	D'HONDT S.A.	BELGIUM
39	BORSING GmbH	GERMANY
40	BELLELI S.P.A.	ITALY
41	FBM HUDSON ITALIANA S.p.A.	ITALY
42	GE POWER (NUOVO PIGNONE SPA)	ITALY
43	OLMI SPA	ITALY
44	WALTER TOSTO SpA	ITALY
45	HITACHI ZOSEN	JAPAN
46	KAWASAKI HEAVY INDUSTRIES LTD.	JAPAN
47	KOBE STEEL LIMITED	JAPAN
48	MITSUI ENGINEERING & SHIPBUILDING CO. LTD	JAPAN
49	DOOSAN MECATEC CO. LTD.	KOREA
50	HANTECH LIMITED	KOREA
51	HYUNDAI CORPORATION	KOREA
52	KOREA HEAVY INDUSTRIES & CONSTN. CO. LTD.	KOREA
53	HANJUNG DCM CO. LTD	KOREA
54	MECANICA DE LA PENA S.A.	SPAIN
55	MANNING & LEWIS ENGINEERING CO.,	U.S.A
56	CHEM PROCESS SYSTEM PVT. LIMITED (CS/SS only)	INDIA
57	ESSAR HEAVY ENGINEERING SERVICES	INDIA
58	FAB-TECH WORKS & CONSTRUCTIONS PRIVATE LIMITED	INDIA
59	GMM PFAUDLER LIMITES	INDIA
60	NUBERG ENGINEERING LIMITED	INDIA
61	PHILS HEAVY ENGINEERING PVT. LIMITED. (for AS (P3 & P4) only)	INDIA
62	RELIANCE FABRICATIONS PVT. LTD. (CS/SS only)	INDIA
63	TECHNO PROCESS EQUIPMENTS (I) LTD.	INDIA
64	TEMA INDIA LIMITED (PANOLI, ANKLESHWAR-UNIT-III & UNIT-IV) (IN Non ASME Certification LIKE U, U2, R ETC. Category)	INDIA
65	TEMA INDIA LIMITED (SILVASSA, UNIT-II (In Non IBR Category))	INDIA
66	TITANIUM TANTALUM PRODUCTS LTD. (CS & SS Material)	INDIA
67	UNIQUE CHEMOPLANT EQUIPMENTS	INDIA

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68	UNIVERSAL HEAT EXCHANGERS LIMITED (CS/SS/LTCS Only)	INDIA
69	BTL EPC LIMITED (CS ONLY)	INDIA
70	SUNGJIN GEOTEC LTD. (CS and SS Only)	KOREA
HEAT EXCHANGERS 30 TO 60 kg/cm2G		
1	B H P V	INDIA
2	BHARAT HEAVY ELECTRICALS LTD.	INDIA
3	G R ENGINEERING PRIVATE LIMITED	INDIA
4	GODREJ & BOYCE MFG. CO. LTD.	INDIA
5	GRASIM INDUSTRIES	INDIA
6	HINDUSTAN DORR-OLIVER LTD. (CS/SS only)	INDIA
7	LARSEN & TOUBRO LIMITED	INDIA
8	LAXMI ENGINEERING INDUSTRIES (BHOPAL) PRIVATE LIMITED (CS/SS only Except Urea service)	INDIA
9	LLOYDS STEEL INDUSTRIES LIMITED	INDIA
10	PATELS AIRTEMP (INDIA LIMITED)	INDIA
11	PRECISION EQUIPMENTS (CHENNAI) PVT. LTD.	INDIA
12	TEMA INDIA LIMITED (ACHHAD-I)	INDIA
13	THE ANUP ENGINEERING LIMITED	INDIA
14	THE INDIAN SUGAR & GENERAL ENGG. CORPN. (ISGEC), DAHEJ (Except Urea Plant Critical Equipment)	INDIA
15	ISGEC HEAVY ENGINEERING LIMITED	INDIA
16	APPARATEBAU SCHWEISSTECHNIK GMBH	AUSTRIA
17	SCHOELLER-BLECKMANN NITEC GMBH	AUSTRIA
18	BORSING GmbH	GERMANY
19	FBM HUDSON ITALIANA S.p.A.	ITALY
20	OFFICIENCE LUIGI RESTA S.P.A.	ITALY
21	ROLLE S.P.A. (30 to 60 kg/cm2 pr.)	ITALY
22	HITACHI ZOSEN	JAPAN
23	MITSUBISHI HEAVY INDUSTRIES LTD.	JAPAN
24	DOOSAN MECATEC CO. LTD.	KOREA
25	HANJUNG DCM CO. LTD.	KOREA
26	HANTECH LIMITED	KOREA
27	HUNDAI HEAVY INDUSTRIES	KOREA
28	MECANICA DE LA PENA S.A.	SPAIN
29	CICB-CHEMICON PVT. LTD. (CS Only)	INDIA
30	ESSAR HEAVY ENGINEERING SERVICES	INDIA
31	GMM PFAUDLER LIMITED	INDIA
32	INDCON PROJECTS & EQUIPMENT LIMITED (CS/SS Only)	INDIA
33	MEENAKSHI ASSOCIATES (P) LTD. (CS/SS Only)	INDIA
34	TECHNO PROCESS EQUIPMENTS (I) LTD.	INDIA
35	TEMA INDIA LIMITED (SILVASSA, UNIT-II (In Non IBR	INDIA

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	Category))	
36	SUNGJIN GEOTEC CO. LTD. (CS & SS Only)	KOREA
37	ALPEC CO. LTD. (CS & AS only)	KOREA
38	NEWTON ENGG. & CHEMICALS LTD. (Upto 36 Kg/cm2)	INDIA
39	GEMINI ENGI-FAB PVT. LTD.	INDIA
40	FABTECH PROJECTS & ENGINEERS LTD. (For CS only)	INDIA
41	EXPO GAS CONTAINERS LTD. (CS only)	INDIA
42	AVADH INDSTRIES (Upto 44 Kg/cm2g (CS Only))	INDIA
43	AERO ENGINEERS (Upto 46 Kg/cm2g (CS only))	INDIA
44	FAB-TECH WORKS & CONSTRUCTIONS PRIVATE LIMITED	INDIA
45	MULTI MAX ENGINEERING WORKS PVT. LTD (CS & SS ONLY)	INDIA
46	PRAJ INDUSTRIES LIMITED (CS/SS ONLY)	INDIA
PLATE TYPE HEAT EXCHANGERS		
1.	ALFA LAVAL INDIA LIMITED	INDIA
2.	APV (PRAJ)	INDIA
3.	DOVER INDIA LTD (TRANTER PHE DIVN)	INDIA
4.	KELVION INDIA PRIVATE LIMITED (FORMERLY GEA ECOFLEX INDIA PV	INDIA
5.	LARSEN & TOUBRO LIMITED	INDIA
6.	SHRACHI ENGINEERINF & INDUSTRIES LTD.	INDIA
7.	URISAN HEAT EXCHANGERS PVT. LTD.	INDIA
8.	LINDE AG	GERMANY
9.	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
10.	MECANICA DE LA PENA S.A.	SPAIN
11.	MANNING & LEWIS ENGINEERING CO.,	U.S.A
12.	TRANTER PHE, INC.	U.S.A
13.	HRS PROCESS SYSTEM LIMITED	INDIA
14.	TRANTER INDIA PVT. LTD.	INDIA
FRP / PVC TANKS & VESSELS		
1	GANDHI AND ASSOCIATES	INDIA
2	SONAL ENGG. PLASTIC FABRICATOR	INDIA

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3	EPP COMPOSITES PVT. LTD.	INDIA
4	APPARATEBAU SCHWEISSTECHNIK GMBH (acid storage tanks up to 3.8 in dia.)	AUSTRIA
FRP / PVC LINING		
1.	GANDHI AND ASSOCIATES	INDIA
2.	EPP COMPOSITES PVT. LTD.	INDIA

Note: LSTK contractor shall evaluate and decide present financial, performance credential and **Shop** loading conditions of the vendors.

Any addition to vendor list shall be reviewed and approved by Owner subject to submission of back-up credentials with proven & reliable record of performance for similar or comparable plant design capacity by LSTK contractor.

ROTATING EQUIPMENTS:

INSTRUMENT AIR COMPRESSOR (CENTRIFUGAL)		
1.	INGERSOLL RAND INDIA LTD.	INDIA
2.	ATLAS COPCO ENERGAS GMBH	GERMANY
3.	GHH BORSIG TURBOMASCHINEN AG	GERMANY
4.	LINDE AG WERKSGRUPPE	GERMANY
5.	MANNESMAN DEMAG AG	GERMANY
6.	SIEMENS AG PGI	GERMANY
7.	GE POWER (FORMERLY NUOVO PIGNONE SPA)	ITALY
8.	EBARA CORPORATION	JAPAN
9.	HITACHI LTD	JAPAN
10.	KAWASAKI HEAVY INDUSTRIES LTD.	JAPAN
11.	KOBE STEEL LTD.	JAPAN
12.	MITSUBISHI HEAVY INDUSTRIES LTD.	JAPAN
13.	MITSUI ENGINEERING & SHIP BUILDING CO. LTD	JAPAN
14.	SULZER TURBO LIMITED	SWITZERLAND
15.	DRESSER-RAND CO.	SINGAPORE
16.	ELLIOT OVERSEAS CORPORATION	U.S.A
	E.O.T CRANES	
1.	W.H. BRADY & CO. LTD	INDIA
2.	AVON CRANES PVT. LTD.	INDIA
3.	THE ACME MANUFACTURING CO. LTD	INDIA
4.	WMI CRANES	INDIA
5.	SAMCO ENGINEERING PVT. LTD	INDIA
	AIR CONDITIONING SYSTEM	
	MAKE OF CHILLER UNIT / AIR CONDITIONING PACKAGE :	

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1	YORK	INDIA
2	TRANE	INDIA
3	CARRIER	INDIA
	AIR CONDITIONING SYSTEM	
1	BLUE STAR	INDIA
2	VOLTAS LTD.	INDIA
3	SUVIDHA ENGINEERS	INDIA
4	AIR CONDITIONING CORPORATION LTD	INDIA
5	S K SYSTEMS PVT LTD	INDIA
6	ADVANCE VENTILATION PVT LTD	INDIA
7	ROOTS COOLING SYSTEMS PVT LTD	INDIA
8	KIRLOSKAR ELECTRIC COMPANY LTD.	INDIA
9	PATELS AIRTEMP INDIA LIMITED	INDIA
RECIPROCATING COMPRESSOR		
1.	ATLAS COPCO (FOR AIR SERVICE ONLY)	INDIA
2.	DRESSER-RAND INDIA PVT LTD.	INDIA
3.	BURCKHARDT COMPRESSION (INDIA) PVT. LTD.	INDIA
4.	CAMERON COMPRESSION SYSTEM	INDIA
5.	INGERSOLL RAND INDIA LTD. (FOR AIR & N2)	INDIA
6.	KIRLOSKAR PNEUMATIC CO. LTD (FOR AIR SERVICE ONLY)	INDIA
7.	HOWDEN (FORMERLY BURTON CORBLIN)	FRANCE
8.	LINDE AG WERKSGRUPPE	GERMANY
9.	GE POWER (NUOVO PIGNONE SPA)	ITALY
10.	ISHIKAWAJIMA HARIMA HEAVY INDS CO. LTD (IHI)	JAPAN
11.	KOBE STEEL LTD.	JAPAN
12.	MITSUI ENGINEERING & SHIP BUILDING CO. LTD	JAPAN
13.	BURCKHARDT COMPRESSION AG	SWITZERLAND
14.	THOMASSEN TURBINE SYSTEMS B.V	NETHERLANDS
COUPLINGS		
1.	ELECON ENGG. CO. LTD (FOR FLEXIBLE COUPLING)	INDIA
2.	FENNER INDIA LTD. (FOR FLEXIBLE COUPLING)	INDIA
3.	HI-CLIFF (FOR GEAR COUPLING)	INDIA

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4.	RATHI TRANSPOWER PVT. LTD	INDIA
5.	RATHI TURBOFLEX PVT. LTD	INDIA

ELECTRICAL

ITEM	NAME OF THE VENDOR	COUNTRY
Control & Relay Panel		
1.	Alstom Limited (Areva T&D)	India
2.	Asea Brown Boveri Ltd.	India
3.	C & S Electric. Ltd.	India
4.	Elecmech Corporation	India
5.	Larsen & Toubro Ltd. (El. Products Divn)	India
6.	Siemens Ltd.	India
7.	Schneider	India
INDUCTION MOTORS – HV (FOR SAFE / HAZARDOUS AREA)		
1.	BHEL (Electrical Machines Divn.)	India
2.	Jeumont Industrie	France
3.	Fuji Electric Systems Co. Ltd	Japan
4.	Mitsubishi Corporation	Japan
5.	Toshiba Corporation	Japan
6.	Toshiba Mitsubishi Electric Industrial Systems Corporation (Excluding Flame-proof motors of frame size more than 900)	Japan
7.	Peebles Electrical Machines	UK
8.	Siemens	India / Germany
9.	ABB	Finland/Switzerland/India
10.	Jeumont Electric India Private Limited	India
INDUCTION MOTORS – LV (415 V) (SAFE/HAZARDOUS AREA)		
1.	Asea Brown Boveri Ltd	India
2.	Bharat Bijlee Ltd	India
3.	Crompton Greaves Ltd	India
4.	Kirloskar Electric Company Ltd	India
5.	Siemens Ltd	India
6.	Jeumont Industrie	France
7.	Siemens AG, Germany	Germany

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ITEM	NAME OF THE VENDOR	COUNTRY
8.	Fuji Electric Systems Co. Ltd.	Japan
9.	Mitsubishi Corporation	Japan
10.	Toshiba Corporation	Japan
11.	Asea Brown Boveri	Sweden
12.	General Electric Co.	USA
LT POWER & CONTROL CABLES		
1.	Cable Corpn. of India Limited	India
2.	Cords Cable Industries Ltd	India
3.	Delton Cables Ltd	India
4.	Finolex Cables Ltd	India
5.	KEC International Ltd. (Formerly RPG Cables Limited	India
6.	KEI Industries Limited	India
7.	Plaza Cable Industries Limited	India
8.	Ravin Cables Limited	India
9.	Torrent Cables Ltd	India
10.	Universal Cables Ltd.	India
11.	Polycab	India
INDUSTRIAL HEATER		
1.	Alco Heating Co	India
2.	Batliboi & Co Ltd	India
3.	Elpro International Ltd	India
4.	Escorts Ltd	India
5.	Kantilal Chunnilal & Sons Appliances Pvt. Ltd.	India
6.	Macneil & Magor (Kilnburn)	India
7.	Middleton Engg Co	India
8.	Raycold Ltd	India
9.	T.M.I (Transformers Mfg. Industries)	India
10.	Klopper-Therm Gmbh & Co. KG	INDIA
HOSE/FLAME PROOF LOCAL CONTROL STATION/INDUSTRIAL TYPE SWITCH SOCKET & PLUG		
1.	Baliga Lighting Equipments Limited	India
2.	Flameproof Equipments Pvt. Limited	India
3.	Fcg Power Industries Ltd.	India
4.	Fcg Flameproof Control Gears Pvt. Ltd.	India
CABLE TRAYS		
1.	Globe Electrical Industries	India
2.	Metalite Industries	India

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ITEM	NAME OF THE VENDOR	COUNTRY
3.	Stealite Engineering Co.	India
4.	Rukmini Electricals & Components Pvt. Ltd.	India
5.	Parekh Engineering Company	India
6.	Sadhana Engineering Corporation	India
7.	Indiana Engg. Works Pvt. Ltd.	India
8.	Premier Power Products (Calcutta) Pvt. Ltd.	India
EARTHING & LIGHTNING PROTECTION MATERIAL – (GI) WIRE/STRI		
1.	Anand Electric Trading Co.	India
2.	Bharti Exports	India
3.	Controls & Switchgear Co. Ltd.	India
4.	Jayant Metal Mfg. Co.	India
5.	Metalite Industries	India
6.	Premier Power Products (Calcutta) Pvt. Ltd.	India
SOFT STARTER		
1.	Kimo Electronics Pvt. Ltd.	India
2.	Larsen & Toubro Ltd. (El. Products Divn.)	India
3.	Rockwell Automation India Ltd.	India
4.	Hitachi Hi-Rel Power Electronics Pvt. Ltd.	India
5.	Siemens Ltd.	India

NOTE:

1. Make of the equipment not indicated and any other make for the specified equipment shall be subject to TFL/ PDIL approval.

MECHANICAL – PIPING

Bidder shall select sub vendors from the vendor list as specified below. Bidder shall ensure that sub vendor for the specified item has supplied item for the specified service & the supplied item is in satisfactory service since last 3 years as on date of offer.

Vendor shall have well proven record for the specified services and shall be subjected to owner/consultant approval.

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3.1	CS WELDED PIPES TO API 5L SPIRAL LONG. WELDED	
1	HEAVY METAL PIPE CENTRE (UPTO 24" (UPTO SCHXXS)	INDIA
2	JINDAL PIPES LTD. (2” TO 14”)	INDIA
3	JOTINDRA STEEL & TUBES LTD. (½" TO 14")	INDIA
4	KALPESH TUBE(INDIA), (TRADER)	INDIA
5	LALIT PIPES & PIPES LTD.. (16" to 64" thickness upto 20mm)	INDIA
6	MUKAT PIPES LTD.	INDIA
7	P.K.FORGE & FITTING INDUSTRIES	INDIA
8	PRATIBHA INDUSTRIES LTD. (16" to 24" thickness 6mm to 14.27mm)	INDIA
9	RATNAMANI METALS & TUBES LTD.	INDIA
10	SAGAR STEEL CORPORATION (TRADER)	INDIA
11	SAIL	INDIA
12	SURINDRA ENGINEERING CO. PVT. LTD.	INDIA
13	SURYA ROSHINI LTD (GR. A 3” TO 4”, GR. B, 6” TO 14”)	INDIA
14	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
15	WELSPUN GUJARAT STAHL ROHREN LIMITED (FOR ANJAR AND DAHEJ PLANTS) (UPTO 72” 50 MM THK FOR DAHEJ PLANT AND UPTO 100” 30 MM THK. FOR ANJAR PLANT.)	INDIA
16	PHOCEENNE	FRANCE
17	ETS TROUVAY & CAUVIN	FRANCE
18	MANNESMANN HANDEL AG	GERMANY
19	THYSSEN-KRUPP STAHLUNION GMBH	GERMANY
20	DALMINE SPA	ITALY
21	RACCORTUBI SRL	ITALY
22	KOSEI SANGYO LTD	JAPAN
23	MARUBENI ITOCHU STEEL	JAPAN
24	MITSUBISHI CORPORATION	JAPAN
25	NIPPON KOKAN	JAPAN
26	NIPPON STEEL CORPORATION	JAPAN
27	NISHITANI & CO. LTD.	JAPAN
28	NISSHO IWAI CORPORATION	JAPAN
29	OKURA & CO. LTD.	JAPAN
30	SOJITZ CORPORATION	JAPAN
31	SUMITOMO METAL INDUSTRIES LTD.	JAPAN

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32	HYUNDAI CORPORATION	KOREA
33	BRITISH STEEL CORPORATION	U.K.
34	CORUS TUBES LIMITED	U.K.
35	SAW PIPES USA, INC	U.S.A
3.2	**CS/AS LTCS SEAMLESS PIPES**	
1	BHEL	INDIA
2	CHETAN STEELS (Upto 12", SCH80)	INDIA
3	HEAVY METAL & TUBES (Upto 8", thickness upto 18.26mm)	INDIA
4	HEAVY METAL PIPE CENTRE (UPTO 24" (UPTO SCHXXS)	INDIA
5	INDIAN TUBE CO. (TATA DEV. OF TUBES & PIPES)	INDIA
6	ISMT LIMITED	INDIA
7	JINDAL SAW LTD.	INDIA
8	MAHARASHTRA SEAMLESS LTD.	INDIA
9	P.K.FORGE & FITTING INDUSTRIES	INDIA
10	RATNADEEP METAL & TUBES PVT. LTD.	INDIA
11	SAINEST TUBES PVT. LTD. (½ " NB TO 3" UPTO SCH. 160 (ASTM A 106 GR. B, A333 GR. 1 & 6 & A335 GR. P11))	INDIA
12	PHOCEENNE	FRANCE
13	ETS TROUVAY & CAUVIN	FRANCE
14	MANNESMANN HANDEL AG	GERMANY
15	HORST KURVERS GMBH	GERMANY
16	DALMINE SPA	ITALY
17	GAM RACCORDI S.P.A	ITALY
18	IBF SEAMLESS PIPES SPA	ITALY
19	RACCORTUBI SRL	ITALY
20	MARUBENI ITOCHU STEEL	JAPAN
21	MITSUBISHI CORPORATION	JAPAN
22	NIPPON STEEL CORPORATION	JAPAN
23	NISHITANI & CO. LTD.	JAPAN
24	NISSHO IWAI CORPORATION	JAPAN
25	OKURA & CO. LTD.	JAPAN
26	SOJITZ CORPORATION	JAPAN
27	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
28	HYUNDAI CORPORATION	KOREA
29	AB SANDVIK STEEL	SWEDEN
30	VOMAL INTERNATIONAL LIMITED	U.K.
31	CORUS TUBES LIMITED	U.K.

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32	BRITISH STEEL CORPORATION	U.K.
3.3	**SS SEAMLESS/ WELDED PIPES**	
1	APEX TUBES	INDIA
2	BHANDARI FOILS & TUBES LIMITED (SEAMLESS UPTO 4" (SCH. 80) & WELDED UPTO 20" (THK. <= 8	INDIA
3	CHOKSI TUBE COMPANY LTD.	INDIA
4	CHETAN STEELS (UPTO 6” SCH. 40)	INDIA
5	HEAVY METAL & TUBES (UPTO 8" (THICKNESS UPTO 18.26 MM))	INDIA
6	HEAVY METAL PIPE CENTRE (UPTO 8" (UPTO SCH80S) (PDIL APPROVED MANUFACTURER'S MAKE ONLY))	INDIA
7	JINDAL SAW LTD.	INDIA
8	KRYSTAL STEEL MANUFACTURING PVT. LTD. (UPTO 2" (MATERIAL UPTO GRADE SS 321))	INDIA
9	MARDALE PIPES PLUS LTD.	INDIA
10	MODERN TUBE INDUSTRIES LTD. (Upto 2" (upto SS Grade 321))	INDIA
11	NUCLEAR FUEL COMPLEX	INDIA
12	P.K.FORGE & FITTING INDUSTRIES	INDIA
13	PRAKASH STEELAGE LTD. (Seamless: upto 12” & Welded: upto 24”)	INDIA
14	QUALITY STAINLESS PVT. LTD.	INDIA
15	RAJENDRA MECHANICAL INDUSTRIES LTD.	INDIA
16	RATNAMANI METALS & TUBES LTD.	INDIA
17	RATNADEEP METAL & TUBES PVT. LTD. (SMLS. 6” , WELDED 2”)	INDIA
18	SANDVIK ASIA PVT. LTD. (¾" TO 2" (THK: UPTO 8.74 MM))	INDIA
19	SANGHVI METALS (TRADER)	INDIA
20	SCORODITE STAINLESS (INDIA) PVT. LTD. (UPTO 2" (UPTO SS GRADE 321))	INDIA
21	SUBHLAXMI METALS & TUBES PVT. LTD. (Seamless: upto 2” & Welded: upto 8”)	INDIA
22	SURAJ STAINLESS LIMITED	INDIA
23	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
24	ZHEJIANG JIULI STAINLESS STEEL PIPE CO. LTD.	CHINA
25	ETS TROUVAY & CAUVIN	FRANCE
26	PHOCEENNE	FRANCE
27	H. BUTTING GMBH & CO. (SEAMLESS : UPTO 30" (UPTO 16MM THK) & WELDED: UPTO 72" (UPTO 64MM)	GERMANY
28	HORST KURVERS GMBH	GERMANY
29	MANNESMANN HANDEL AG	GERMANY

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30	THYSSEN-KRUPP STAHLUNION GMBH	GERMANY
31	DALMINE SPA	ITALY
32	GAM RACCORDI S.P.A	ITALY
33	IBF SEAMLESS PIPES SPA	ITALY
34	RACCORTUBI SRL	ITALY
35	MARUBENI ITOCHU STEEL	JAPAN
36	MITSUBISHI CORPORATION	JAPAN
37	NIPPON STEEL CORPORATION	JAPAN
38	NISHITANI & CO. LTD.	JAPAN
39	NISSHO IWAI CORPORATION	JAPAN
40	OKURA & CO. LTD.	JAPAN
41	SOJITZ CORPORATION	JAPAN
42	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
43	AB SANDVIK STEEL	SWEDEN
44	T.T.I. – TUBACEX TUBOS INOXIDABLES, S.A.	SPAIN
45	SOSTA BV (UPTO 72" (THICKNESS UPTO 25.4 MM))	NETHERLAND
46	VOMAL INTERNATIONAL LIMITED	U.K.
47	CORUS TUBES LIMITED	U.K.
48	BRITISH STEEL CORPORATION	U.K.
49	HYUNDAI CORPORATION	KOREA
3.4	**SS SEAMLESS TUBES**	
1	ANIL METAL CORPORATION	INDIA
2	APEX TUBES PVT. LIMITED (UPTO 50.8 MM OD (THICKNESS UPTO 4.00 MM))	INDIA
3	BHANDARI FOILS & TUBES LIMITED (UPTO 50MM OD)	INDIA
4	HEAVY METAL & TUBES (UPTO 8" (THICKNESS UPTO 18.26 MM))	INDIA
5	KRYSTAL STEEL MANUFACTURING PVT. LTD. (UPTO 50.8 MM OD (MATERIAL UPTO GRADE SS 321))	INDIA
6	MODERN TUBE INDUSTRIES LIMITED (UPTO 50.80 MM OD (UPTO SS GRADE 321))	INDIA
7	PRAKASH STEELAGE LTD. (Seamless: upto114 mm OD, Thickness upto 6 mm)	INDIA
8	RATNAMANI METALS & TUBES LTD.	INDIA
9	SANDVIK ASIA PVT. LTD. (OD UPTO 60.33 (THK: UPTO 8.74 MM))	INDIA
10	SCORODITE STAINLESS (INDIA) PVT.LTD. (UPTO 50.80 OD (UPTO SS GRADE 321))	INDIA
11	SURAJ STAINLESS LIMITED	INDIA

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12	T.T.I.-TUBACEX TUBOS INOXIDABLES, S.A.(OD 15.8 MM TO 250.0 MM, WALL THK.1.0 MM)	SPAIN
3.5	**FITTINGS: CS/AS/SS SEAMLESS & FORGED**	
1	AMFORGE INDUSTRIES	INDIA
2	ANIL METAL CORPORATION	INDIA
3	CHETAN STEELS (UPTO 6” SCH. 80)	INDIA
4	COMMERCIAL SUPPLYING AGENCY	INDIA
5	CSA FITTINGS (Forged ½” to 2”-upto 900#, Seamless: 2” to 8”- upto SCHXXS)	INDIA
6	EBY FASTENERS	INDIA
7	EBY INDUSTRIES	INDIA
8	FIT-TECH INDUSTRIES (Forged ½” to 1 1/2”-upto 900#, Seamless: 2” to 8”- upto SCHXXS)	INDIA
9	FLASH FORGE(P) LTD.(Forged upto 4”-upto 900#, Seamless/welded: up to 42”)	INDIA
10	GUJARAT INFRAPIPES PVT. LTD.	INDIA
11	KALPESH TUBE(INDIA),(TRADER) (UPTO A MAX ORDER VALUE RS.25.0 LAKH)	INDIA
12	M.S FITTINGS MANUFACTURING CO. PVT LTD.	INDIA
13	MARDALE PIPES PLUS LTD.	INDIA
14	NAVKAR FORGINGS & FITTINGS PVT. LTD	INDIA
15	NL HAZRA (upto SCH80)	INDIA
16	P.K TUBES & FITTINGS PVT. LTD.	INDIA
17	P.K FORGE & FITTING INDUSTRIES	INDIA
18	PARAS FITTINGS PVT. LTD. (Forged: CS ½” to 2” & CS Seamless: 2” to 8”- upto SCHXXS)	INDIA
19	PARMAR TECHNO FORGE (Elbow, Tee, Reducer- ½” to 12” & Cap upto 18”)	INDIA
20	PERFECT MARKETTING PVT. LTD.	INDIA
21	PETROCHEM INDUSTRIES (Seamless: Upto 16" (All Fittings) & upto 36" (caps) SCH : XXS /80S, Forged: upto 3”-6000#)	INDIA
22	RAJENDRA FORGE INDUSTRIES (CS: UPTO 12" SCH 40 & SS: 6" SCH 40S)	INDIA
23	S & G ENGINEERS (P) LTD.	INDIA
24	SAGAR STEEL CORPORATION (TRADER)	INDIA
25	SANGHVI METALS (TRADER)	INDIA
26	SAWAN ENGINEERS	INDIA
27	SHIVANANDA PIPE FITTINGS LTD.,	INDIA
28	STEWARTS AND LLOYDS OF INDIA LIMITED	INDIA

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29	TEEKAY TUBES PRIVATE LIMITED	INDIA
30	THE BENGAL MILL STORES SUPPLY CO.(TRADER)	INDIA
31	TOPAZ PIPING INDUSTRIES	INDIA
32	TUBE BEND (CALCUTTA) PVT. LTD. (CS FITTINGS ONLY)	INDIA
33	TUBE PRODUCTS INCORPORATE	INDIA
34	ZOLOTO INDUSTRIES (upto 6” (only CS Galv.))	INDIA
35	PHOCEENNE	FRANCE
36	ETS TROUVAY & CAUVIN	FRANCE
37	VALLOUREC	FRANCE
38	SEIKMANN ANLAGEN-TECHNIK GMBH.	GERMANY
39	TPS-TECHNITUBE ROHRENWERKE GMBH	GERMANY
40	MANNESMANN HANDEL AG	GERMANY
41	HORST KURVERS GMBH	GERMANY
42	PETROL RACCORD S.P.A. (Seamless: 1” to 42” (Elbow) & 1” to 56” Tee/Reducer/Cap))	ITALY
43	DALMINE SPA	ITALY
44	GAM RACCORDI S.P.A	ITALY
45	IBF SEAMLESS PIPES SPA	ITALY
46	IND MECCANICA BASSI LUIGI & C. SPA	ITALY
47	MANTOVANI SPA	ITALY
48	RACCORTUBI SRL	ITALY
49	TECHNO FORGE SPA	ITALY
58	MARUBENI ITOCHU STEEL	JAPAN
51	NIPPON KOKAN	JAPAN
52	NISHITANI & CO. LTD.	JAPAN
53	NISSHO IWAI CORPORATION	JAPAN
54	OKURA & CO. LTD.	JAPAN
55	SOJITZ CORPORATION	JAPAN
56	SUMITOMO METAL INDUSTRIES LTD.	JAPAN
57	HAITIMA CORPORATION	TAIWAN
58	CORUS TUBES LIMITED	U.K.
59	BRITISH STEEL CORPORATION	U.K.
60	EUROTUBE LIMITED	U.K.
61	VOMAL INTERNATIONAL LIMITED	U.K.
62	BONNEY FORGE	U.S.A.
3.6	**FORGED FLANGES**	
1	AJAY FORGING PVT. LTD	INDIA

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2	AMFORGE INDUSTRIES	INDIA
3	ANANDMAYEE FORGINGS PVT. LTD.	INDIA
4	C D ENGINEERING	INDIA
5	CHAUDHARY HAMMER WORKS (P) LTD.	INDIA
6	CHETAN STEELS (UPTO 6", 150#)	INDIA
7	`ECHJAY INDUSTRIES LTD	INDIA
8	FERROUS ALLOYS FORGING PVT. LTD	INDIA
9	GOOD LUCK ENGINEERING CO. (½"-12" (UPTO 2500#), 14"-16" (UPTO 900#), 18"-32" (UPTO 600#), 34"-48" (UPTO 300#),	INDIA
10	J.K FORGINGS	INDIA
11	KUNJ FORGINGS PVT. LTD.(MATERIAL CS/SS/AS) (upto 60" (upto 300#) & upto 12" (upto 2500#))	INDIA
12	MAHESH INDUSTRIES (Upto 8" -150#, material ASTM A105 only)	INDIA
13	P.K TUBES & FITTINGS PVT. LTD. (Upto 24"(upto1500#) & Upto 12"(upto2500#) Spectacle Blind and Spacer & Blinds only)	INDIA
14	PARAMOUNT FORGE (CS,AS & SS : ½" TO 42" (UPTO 600#), ½" TO 24" (UPTO 900#, ½ " TO 16" (UPTO 1500#), ½" TO 12" (UPTO 2500#)).	INDIA
15	PERFECT MARKETING (P) LTD.	INDIA
16	PUNJAB STEEL	INDIA
17	R D FORGE (A UNIT OF R D CHEMICALS PVT LTD) (Upto 54" (150#), 42" (upto 600#), 20" (upto 1500#) & 12" (2500#))	INDIA
18	RAJENDRA FORGE INDUSTRIES (CS & SS : UPTO 12", 300#)	INDIA
19	S & G ENGINEERS (P) LTD.	INDIA
20	SANGHVI FORGINGS & ENGINEERING LTD	INDIA
21	SANGHVI METALS (TRADER)	INDIA
22	SAWAN ENGINEERS	INDIA
23	TECHNO FORGE LTD. (UPTO 42" (UPTO 300#), UPTO 24" (600#), UPTO 20" (900#), UPTO 16" (1500#),	INDIA
24	TUBE BEND (CALCUTTA) PVT LTD	INDIA
25	PHOCEENNE	FRANCE
26	ETS TROUVAY & CAUVIN	FRANCE
27	HORST KURVERS GMBH	GERMANY
28	I.S. INTERNATIONAL	ITALY
29	MANTOVANI SPA	ITALY
30	OFFICINE NICOLA GALPERTI & FIGLIO S.P.A	ITALY
31	RACCORTUBI SRL	ITALY
32	NICHINAN SANGYO CO. LTD.,	JAPAN
33	NISHITANI & CO. LTD.	JAPAN

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34	SOJITZ CORPORATION	JAPAN
35	VOMAL INTERNATIONAL LIMITED	U.K.
3.7	**GATE/ GLOBE/ CHECK VALVES CS/SS/AS < 900 LBS**	
1	AV VALVES LTD. (CAST UPTO 42" ,150#) 28" 300#, 24" (600#) & FORGE UPTO 2" (800#)	INDIA
2	ADVANCE VALVES (2"-80" (Upto 600#) Dual Plate Check Valves only)	INDIA
3	ASSOCIATED TOOLINGS (I) PVT. LTD.	INDIA
4	AUDCO INDIA LIMITED (L&T VALVES DIVN.)	INDIA
5	AUTOCAP INDUSTRIES (1/2" to 2" 800# (only CS & SS)	INDIA
6	BELL- O-SEAL VALVES LTD.(FOR ZERO LEAKAGE , HAZARDOUS FLUIDS.)	INDIA
7	BHEL (VALVES DIVISION)	INDIA
8	BRIGHTECH VALVES AND CONTROLS PVT. LTD. (Upto 8" x 300#)	INDIA
9	CHEMTECH INDUSTRIAL VALVES PVT. LTD.	INDIA
10	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD. (<=300#, (only CS))	INDIA
11	DATRE CORPORATION LTD. (Upto 300#, 2" to 8" (Gate), 2" to 6" (Globe & Check Valves))	INDIA
12	DEWRANCE MACNEILL & CO. LTD.	INDIA
13	ECONO VALVES PVT. LTD.	INDIA
14	EXPERT ENGINEERING ENTERPRISES	INDIA
15	FLOCON SYSTEMS PVT. LTD. (CS upto 6" – 1500#)	INDIA
16	FLOVEL VALVES PVT. LTD.(SINGLE DISC , DULA PLATE & NOZZLE CHECK VALVES ONLY : UPTO 48" (150#) & 24 (UPTO 600#)	INDIA
17	FLUIDTECH EQUIPMENT PVT. LTD. (CAST # CS & SS 2" TO 12" 150# & 2 " TO 8" 300 # AND FORGED (CS AND SS) ½" TO 2" (800#)	INDIA
18	FORWARD ALLOYS & CASTINGS (UPTO 14")	INDIA
19	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: upto 24"(150#), 20"(300#), 10" (600#) & Forged : upto 2" (800#)	INDIA
20	HAWA ENGINEERS LTD. (Gate Valves: upto 40"(150#), upto 26" (300#), upto 24" (600#), upto 2" (800#); Globe Valves: upto 20"(150#), upto 16" (300#), upto 12" (600#), upto 2" (800#), Check Valves: upto 36"(150#), upto 24" (300#), upto 16" (600#), upto 2" (800#) (Dual Plate: 36" (150#)	INDIA
21	HAWA VALVES INDIA PVT. LTD. (CS upto 6", 150#)	INDIA
22	HI-TECH VALVES PVT. LTD. (CS,<=800 #, SIZE ½-2, <=300# FOR SIZE 2-6")	INDIA
23	INTERVALVE INDIA LTD. (CAST UPTO 24" (UPTO 300#) & UPTO	INDIA

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	12” 600# , FORGED UPTO 2” (800#))	
24	JC VALVES & CONTROLS INDIA PVT. LTD. (CAST UPTO 48” (150#) & 24” (UPTO 600#) & FORGED UPTO 2” (800#))	INDIA
25	KIRLOSKAR BROTHERS LTD.(CS UPTO 12” , 300#)	INDIA
26	KSB PUMPS LIMITED (VALVES DIVN)	INDIA
27	LARSEN & TOUBRO LIMITED (1/2" TO 24")	INDIA
28	LEADER VALVES LTD. (Casting<=20”-600#, 300-150#, Forging<=2”-800#)	INDIA
29	M.H. VALVES PVT. LTD. (1/2” to 1 1/2”-800#, 2” to 6”-600#)	INDIA
30	MICON ENGINEERS (HUBLI) [PVT. LTD.(Cast: Upto 12” (150# & 300#), 6” (600#) & Forged: upto 2” (800#))	INDIA
31	MICROFINISH VALVES LTD.	INDIA
32	NSSL LTD. (UPTO 80” (150#), 56” UPTO 600# & FORGED UPTO 2” (800 #))	INDIA
33	NITON VALVES INDUSTRIES PVT. LTD.	INDIA
34	OSWAL IND. LTD. (UPTO 48” (150#), 32” (300#) & 24” (600#)	INDIA
35	S & M INDUSTRIAL VALVES LTD. (CS Gate & Globe Valves 2” – 24” <=300#)	INDIA
36	SHALIMAR VALVES PVT. LTD. (Cast Upto 24” (Upto 600#), Forged: ½” to 1 ½” (800#))	INDIA
37	SHREERAJ INDUSTRIES (CS upto 150#)	INDIA
38	STEEL STRONGVALVES (I) PVT. LTD. (Upto 42”)	INDIA
39	VENUS PUMP & ENGINEERING WORKS.	INDIA
40	VIBA FLUID CONTROL	INDIA
41	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast UPTO 36" (150#); 24" (300#); 12" (600#) & Forged: Upto 2” (800#))	INDIA
42	ZED VALVES CO. PVT. LTD. (Upto 14” (600#))	INDIA
43	ZOLOTO INDUSTRIES. (40 MM TO 200 MM(ONLY CS & SS))	INDIA
44	VELAN INC. (UPTO 48” , 600#)	CANADA
45	BOTELI VALVE GROUP CO. LTD.(Cast Upto 56” (150#), 36” (300#), 24” (600#) & Forged: Upto2” (800#))	CHINA
46	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
47	PEMTO VALVE	GERMANY
48	CESARE BONETTI SPA (Cast Upto 42” (Upto 300#), 24” (600#) Forged: ½” to 1 ½” (800#))	ITALY
49	FASANI S.P.A.	ITALY
50	FRIULCO SPA (UPTO 48" (150#), 32" (Upto 600#)	ITALY
51	GTC ITALIA, S.R.L.	ITALY
52	MANTOVANI SpA	ITALY

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53	OMB S.P.A.	ITALY
54	PETROL VALVES S.R.L.	ITALY
55	MATSURA H. P MACHINE WORKS CO.LTD.	JAPAN
56	NISHITANI & CO. LTD.	JAPAN
57	SOJITZ CORPORATION	JAPAN
58	REDPOINT ALLOYS BV	NETHERLAND
59	WALTHAN & WEIR	SPAIN
60	POYAM VALVES (AMPO S.CCP.) (Size upto 60” (Rating upto 800#)	SPAIN
61	BABCOCK BORSIG ESPANA , S.A	SPAIN
62	SUFA LIMITED	U.A.E.
63	BEL VALVES	U.K.
3.8	**GATE/ GLOBE/ CHECK VALVES CS/SS/AS > =900 LBS**	
1	A V VALVES LIMITED (Cast Upto 24” (900# & 1500#), 8” (2500#) Forged: Upto 2” (2500#))	INDIA
2	ADVANCE VALVES (2”-36” (900#) 2”-24” (1500#), 2”-12(2500#) Forged: Upto 2” (2500#)) FOR DUAL PLATE CHECK VALVES)	INDIA
3	ASSOCIATED TOOLINGS (I) PVT. LTD. (½” TO 2” (900# & 1500#))	INDIA
4	AUDCO INDIA LIMITED (L&T VALVES DIVN.)	INDIA
5	BHEL (VALVES DIVISION)	INDIA
6	FLOVEL VALVES PVT. LTD. (Dual Plate Check Valves: Upto 24” (900#)	INDIA
	HAWA ENGINEERS LTD. (Gate Valves: upto 20”(900#), upto 10” (1500# & 2500#); Globe Valves: upto 8”(900# & 1500#), upto 1” (2500#); Check Valves: upto 10”(900#), upto 6” (1500#), upto 1” (2500#)	INDIA
7	HAWA VALVES INDIA PVT. LTD. (Forged upto 2”, 1500#)	INDIA
8	INTERVALVES INDIA LTD.(Forged: Upto 2” (1500#))	INDIA
9	JC VALVES & CONTROLS INDIA PVT. LTD. (CAST UPTO 12” (1500#),10” (2500#) & FORGED UPTO 2” (2500#))	INDIA
10	KSB PUMPS LIMITED (VALVES DIVN)	INDIA
11	LARSEN & TOUBRO LIMITED (1/2" TO 2")	INDIA
12	LEADER VALVES LIMITED (1500# & 2500# UPTO 12", FORGING UPTO 2" 2500#)	INDIA
13	METROPOLITAN INDUSTRIES (SIZE=200mm, rating=2500 lb)	INDIA
14	MICON ENGINEERS (HUBLI) PVT. LTD. (FORGED: UPTO 2" (1500#))	INDIA
15	NSSL LIMITED. (CAST: Upto 36"(900#), 24” (upto 2500#) & FORGED: Upto 2” (Upto 2500#))	INDIA
16	OSWAL INDUSTRIES LTD. (Upto 12” (900# & 1500#))	INDIA

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17	SHALIMAR VALVES PVT.LTD.(CAST: UPTO 20"(900#), FORGED: ½" TO 1 ½" (1500#))	INDIA
18	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast UPTO 12" (upto 2500#) & Forged: Upto 2" (1500#), 1" (2500#))	INDIA
19	VELAN INC. (UPTO 24" (Rating upto 2500#))	CANADA
20	BOTELI VALVE GROUP CO. LTD.(Cast Upto 16" (Upto 1500#), 12" (2500#) & Forged: Upto 2" (1500# & 2500#))	CHINA
21	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
22	BFE BONNEY FORGE VALVE LICENSEE	ITALY
23	CESARE BONETTI SPA (Upto 24" (Upto 2500#)	ITALY
24	FASANI S.P.A.	ITALY
25	FRIULCO SPA (UPTO 32" (900#); 24" (1500#); 14" (2500#))	ITALY
26	GTC ITALIA S.R.L.	ITALY
27	OMB S.P.A.	ITALY
28	PETROL VALVES S.R.L.	ITALY
29	VALVITALIA SPA	ITALY
30	MATSURA H. P MACHINE WORKS CO.LTD.	JAPAN
31	NISHITANI & CO. LTD.	JAPAN
32	BABCOCK BORSIG ESPANA, S.A.	SPAIN
33	POYAM VALVES, (AMPO S. COOP.) (SIZE UPTO 30" (RATING UPTO 2500#))	SPAIN
34	SUFA LIMITED	U.A.E.
35	BEL VALVES	U.K.
3.9	**BALL VALVES (SOFT SEATED)**	
1	A V VALVES LIMITED (Upto 12" (Upto 600#))	INDIA
2	AIRA EURO AUTOMATION PVT. LTD. (Upto 6", Rating 150# & 300#),	INDIA
3	AQUA VALVES PVT. LTD.	INDIA
4	BRIGHTECH VALVES & CONTROLS PVT. LTD. (4" x 150# for CS, AS & SS material)	INDIA
5	CHEMTECH INDUSTRIAL VALVES PVT. LTD.	INDIA
6	CRAWLEY & RAY (FOUNDER & ENGINEERS) PVT. LTD. (DN25)	INDIA
7	DELVAL FLOW CONTROLS PVT. LTD. (Upto 12" (Upto 900#))	INDIA
8	FLOCON SYSTEMS PVT. LTD. (CS upto 6", 150#)	INDIA
9	FLOW CONTROL	INDIA
10	FLOWCHEM INDUSTRIES (UPTO 300# and upto 10")	INDIA
11	FLUIDTECH EQUIPMENT PVT. LTD(UPTO 4" (300#))	INDIA
12	FORWARD ALLOYS AND CASTINGS (Upto 900#)	INDIA
13	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12"	INDIA

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	(Upto 300#), 4" (Upto 900#) & Forged: Upto 2" (800#))	
14	HAWA ENGINEERS LTD. (Upto 16" (150# & 300#), Upto 12" (600# & 900#))	INDIA
15	INTERVALVE INDIA LTD. (Forged: Upto 2" (800#), Cast: Upto 12" (Upto 300#))	INDIA
16	JC VALVES & CONTROLS INDIA PVT. LTD. (CAST UPTO 28" (upto 600#),12" (900# , 1500#) & 10" (2500#))	INDIA
17	KSB PUMPS LTD. (VALVES DIVN.) (CS upto 100DN, 20 bar)	INDIA
18	LEADER VALVES LTD. (Casting upto 600#, 6" & forging upto 800#, 2")	INDIA
19	MICON ENGINEERS (HUBLI) PVT. LTD. (Cast: Upto 6" (150# & 300#) & Forged: Upto 2" (800#)	INDIA
20	MICROFINISH VALVES (P) LTD.	INDIA
21	NSSL LTD. (Upto 12" (150# & 300#))	INDIA
22	OSWAL IND. LTD. (Upto 24" (150#, 300# & 600#))	INDIA
23	SHALIMAR VALVES PVT. LTD. (Upto 18" (600#) Material: CS/AS/SS)	INDIA
24	VIBA FLUID CONTROL (Upto 300#)	INDIA
25	VIRGO ENGINEERS LTD. (Upto 16" (upto 600#))	INDIA
26	WEIR BDK VALVES (Cast: Upto 30" (150# & 300#), 20" (600#), 16" (900#), 12" (1500#) & Forged: Upto 2" (800#))	INDIA
27	XOMOX SANMAR LTD.(FISHER XOMOX)	INDIA
28	BHDT GMBH	AUSTRIA
29	BOTELI VALVE GROUP CO. LTD. (Upto 32" (150# & 300#), 30" (600#), 24" (900#)	CHINA
30	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
31	VELAN INC.(UPTO 16", 600#)	CANADA
32	ETS TROUVAY & CAUVIN	FRANCE
33	PERRIN GMBH (2500#, SIZE UPTO 24")	GERMANY
34	FRIULCO SPA (UPTO 48" (150# & 300#); 20" (upto 1500#); 12" (2500#))	ITALY
35	CESARE BONETTI SPA (Cast: Upto 4" (150#) & Forged: Upto 1" (800#) Floating only)	ITALY
36	GTC ITALIA S.R.L	ITALY
37	MANTOVANUI SPA	ITALY
38	PIBIVESSE SRL (UPTO 48" , 600#)	ITALY
39	PETROL VALVES S.R.L	ITALY
40	METSO AUTOMATION	SINGAPORE
41	POYAM VALVES (AMPO S. COOP.) (Size upto 42" (Rating upto 2500#))	SPAIN
42	HATIMA CORPORATION	TAIWAN

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3.10	**BALL VALVES (METAL SEATED)**	
1	AIRA EURO AUTOMATION PVT. LTD. (Upto 6", Rating 150# & 300#),	INDIA
2	BRIGHTECH VALVES & CONTROLS PVT. LTD. (4" x 150# for CS, AS & SS material)	INDIA
3	DELVAL FLOW CONTROLS PVT. LTD. (Upto 12" (Upto 900#))	INDIA
4	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12" (Upto 300#), 4" (Upto 900#) & Forged: Upto 2" (800#))	INDIA
5	HAWA ENGINEERS LTD. (Upto 16" (150# & 300#), Upto 12" (600# & 900#))	INDIA
6	INTERVALVE INDIA LTD.(UPTO 12" , 150#).	INDIA
7	JC VALVES & CONTROLS INDIA PVT. LTD. (CAST UPTO 28" (upto 600#),12" (upto 1500#), 10" (2500#))	INDIA
8	MICON ENGINEERS (HUBLI) PVT. LTD. (Cast: Upto 6" (150# & 300#) & Forged: Upto 2" (800#)	INDIA
9	MICROFINISH VALVES (P) LTD.	INDIA
10	NSSL LIMITED (Upto 12" NB, (150# & 300#))	INDIA
11	OSWAL INDUSTRIES LTD. (UPTO 24" (150#, 300#, & 600#))	INDIA
12	VIRGO ENGINEERS LTD. (UPTO16" (UPTO 600#))	INDIA
13	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Cast: Upto 30" (150# & 300#); 20" (600#), 16" (900#), 12" (1500#) & Forged: Upto 2" (800#)	INDIA
14	VELAN INC. (SIZE UPTO 16" (Rating Upto 600#))	CANADA
15	BOTELI VALVE GROUP CO. LTD. (Upto 32" (150# & 300#), 30" (600#), 24" (900#)	CHINA
16	ALFA VALVOLE SRL	ITALY
17	CESARE BONETTI SPA (UPTO 24" (150#) & 4" (UPTO 1500#) TRUNNION MOUNTED ONLY)	ITALY
18	GE POWER (NUOVO PIGNONE SPA)	ITALY
19	GTC ITALIA, S.R.L.	ITALY
20	PETROL VALVES S.R.L	ITALY
21	PIBIVIESSE (48", 600#)	ITALY
22	VALVITALIA SPA	ITALY
23	PERRIN GMBH (SIZE UPTO 24" (RATING UPTO 2500#))	GERMANY
24	RED POINT ALLOYS BV	NETHERLAND
25	FRIULCO SPA (UPTO 48" (150# & 300#); 20" (UPTO 1500#); 12" (2500#))	ITALY
26	POYAM VALVES, (AMPO S. COOP.) (SIZE UPTO 42" (RATING UPTO 2500#))	SPAIN
27	METSO AUTOMATION	SINGAPORE
28	ORBIT VALVES PLC	SINGAPORE

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3.11	**BUTTERFLY VALVES**	
1	A V VALVES LIMITED (UPTO 48" (150#))	INDIA
2	ADVANCE VALVES (RUBBER LINED AND METAL SEATED)	INDIA
3	AIRA EURO AUTOMATION PVT. LTD. (Upto 48”, Rating upto 300#)	INDIA
4	AUDCO INDIA LIMITED (L&T VALVES DIVN.)	INDIA
5	BDK PROCESS CONTROL PVT LTD. (UPTO 1600MM)	INDIA
6	CHEMTECH INDUSTRIAL VALVES PVT LTD	INDIA
7	CRAWLEY & RAY (FOUNDER & ENGINEERS) PVT. LTD. (40mm-1000mm)	INDIA
8	DELVAL FLOW CONTROLS PVT. LTD. (Upto 24” (Upto 300#))	INDIA
9	FLOCON SYSTEMS PVT. LTD. (CS upto 12”, 150#)	INDIA
10	FLUIDTECH EQUIPMENT PVT. LTD. (CS upto 12” (300#))	INDIA
11	FOURESS ENGINEERING (I) LTD.	INDIA
12	HAWA ENGINEERS LTD. (2" to 48”(PN10/PN16/150#/300#))	INDIA
13	HAWA VALVES INDIA PVT. LTD. (CS UPTO 6", 150#)	INDIA
14	HI-TECH BUTTERFLY VALVES INDIA PVT. LTD (<300#,<30"(TEFLON/RUBBER) ,<72"(METAL))	INDIA
15	INSTRUMENTATION LTD. (PALAKKAD)	INDIA
16	INTERVALVE INDIA LTD. (Upto 72” (150#) & Upto 16” (300#))	INDIA
17	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 20” (150#) & 10” (300#))	INDIA
18	L&T LTD (1/2" TO 24")	INDIA
19	LEADER VALVES LTD.(150#, upto 16”)	INDIA
20	MATHER & PLATT (INDIA) LTD. A SUBSIDIARY OF WILO SE GERMAN (UPTO DN 1600,PN10, Double flange type)	INDIA
21	METROPOLITAN INDUSTRIES (SIZE=2000mm)	INDIA
22	MICON ENGINEERS (HUBLI) [PVT. LTD.(Upto 24” (PN10 & PN16))	INDIA
23	VENUS PUMP & ENGINEERING WORKS (upto 600NB, 150#)	INDIA
24	VIRGO ENGINEERS LTD. ((Triple offset only): 3” to 24”, Upto 600# (CS/SS))	INDIA
25	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (Upto 56” (Upto 250#), 24” (300#))	INDIA
26	XOMOX SANMAR LIMITED (FISHER XOMOX)	INDIA
27	TOMOE VALVE CO. LTD. (Upto 48”(150# & 300#), Upto 24”(600#, 900# & 1500#))	JAPAN
28	BHDT GMBH	AUSTRIA
29	VELAN INC. (Size upto 48”(Rating upto 600#)	CANADA
30	BOTELI VALVE GROUP CO. LTD. (Upto 36” (150# & 300#)	CHINA
31	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA

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32	GRISS SAPAG INDUSTRIAL VALVES	FRANCE
33	ADAMS ARMATUREN	GERMANY
34	GTC ITALIA, S.R.L.	ITALY
35	HAITIMA CORPORATION	TAIWAN
36	WEIR VALVES & CONTROLS DIVISION.	U.K
37	LEEDS VALVE LTD	U.K
38	CURTIS WRIGHT FLOW CONTROL CORPOARATION	U.S.A.
39	LEAR SIEGLER MEAS. CTRLS. CORP	U.S.A.
40	TYCO INTERNATIONAL INC.,U.S.A.	U.S.A.
41	EMERSON PROCESS MGT	U.S.A.
42	SPX VALVES & CONTROLS	U.S.A.
43	XOMOS (CRANE CO.)	U.S.A.
3.12	**PLUG VALVES (NON LUBRICATED)**	
1	A V VALVES LIMITED (UPTO 48" (150#))	INDIA
2	AUDCO INDIA LTD (L&T VALVES DIVN.)	INDIA
3	AZ ARMATUREN GMBH (1/2” TO 20”(150#, 300# & 600#), Matl. CS, AS &SS)	INDIA
4	BDK PROCESS CONTROL PVT LTD.	INDIA
5	CHEMTECH INDUSTRIAL VALVES PVT LTD	INDIA
6	CRAWLEY & RAY (FOUNDERS & ENGINEERS) PVT. LTD (DN 200)	INDIA
7	FLUIDTECH EQUIPMENT PVT. LTD. (Upto 4” (300#))	INDIA
8	GURU INDUSTRIAL VALVES PVT. LTD. (Cast CS only: Upto 12” (Upto 300#), Upto 4” (Upto 900#)) & Forged: Upto 2” (800#))	INDIA
9	HAWA ENGINEERS LTD. (1/2” TO 8” (150#))	INDIA
10	JC VALVES & CONTROLS INDIA PVT. LTD. (Upto 12” (Upto 300#))	INDIA
11	L&T LTD (1/2" TO 24")	INDIA
12	LEADER VALVES LIMITED (Upto 6” (Upto 300#))	INDIA
13	WEIR BDK VALVES (A UNIT OF WEIR INDIA PVT. LTD.) (UPTO 16"(150#), 12" (300#), 3" (600#))	INDIA
14	XOMOX SANMAR LIMITED (FISHER XOMOX)	INDIA
15	ZHEJIANG JIEHUA VALVE CO. LTD.	CHINA
16	O.M.S. SALERI DI SALERI P & FIGLI S.M.C.	ITALY
17	POYAM VALVES, (AMPO S. COOP.) (UPTO 30" (UPTO 900#) FOR LIFT PLUG VALVES ONLY.)	SPAIN
3.13	**FLAT GASKETS**	
1	FERROLITE JOININGS (P) LTD.	INDIA
2	GASKETS (INDIA) PVT. LTD	INDIA
3	GOODRICH GASKET PVT. LTD. (UPTO 24")	INDIA

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4	HINDUSTAN ASBESTOS & ALLIED PRODUCTS	INDIA
5	HINDUSTAN COMPOSITE LTD.	INDIA
6	HINDUSTAN FERREDO LTD.	INDIA
7	IGP ENGINEERS LIMITED	INDIA
8	MADRAS INDUSTRIAL PRODUCTS(UPTO 48")	INDIA
9	MECHANICAL PACKING INDUSTRIES LTD.	INDIA
10	PACKING & JOINTINGS (P) LTD.	INDIA
11	PERFECT MARKETING (P) LTD,	INDIA
12	PRASHANT ENGG STORES	INDIA
13	REIN TALBROS PVT. LTD.	INDIA
14	SPIRALSEAL GASKETS PVT. LTD. (CAF & Teflon)	INDIA
15	STARFLEX SEALING INDIA PVT. LTD.	INDIA
16	THE BENGAL MILL STORES SUPPLY CO. (TRADER)	INDIA
17	UNIQUE INDUSTRIAL PACKINGS PVT. LTD.	INDIA
3.14	**SPIRALLY WOUND GASKETS**	
1	GASKETS (INDIA) PVT. LTD	INDIA
2	GOODRICH GASKET PVT. LTD.	INDIA
3	IGP ENGINEERS LIMITED	INDIA
4	MADRAS INDUSTRIAL PRODUCTS	INDIA
5	PACKINGS & JOINTINGS PVT. LTD	INDIA
6	PERFECT MARKETING (P) LTD,	INDIA
7	PRASHANT ENGG STORES	INDIA
8	SPIRASEAL GASKETS PVT. LTD.	INDIA
9	STARFLEX SEALING INDIA PVT. LTD.	INDIA
10	THE BENGAL MILL STORES SUPPLY CO. (TRADER)	INDIA
11	UNIQUE INDUSTRIAL PACKINGS PVT.LTD. (UPTO 42"(600#) & UPTO 24" (2500#))	INDIA
12	ZHEJIANG JIEHUA VALVE CO. LTD.	INDIA
3.15	**EXPANSION JOINTS & BELLOWS**	
1	CORI ENGINEERS PVT. LTD.	INDIA
2	D.WREN & CO. (For Rubber & Fabric)	INDIA
3	FLEXATHERM EXPANLLOW PVT. LTD. (Circular: Upto 240", Rectangular No bar for size, (Upto 600#))	INDIA
4	FLEXICAN BELLOWS & HOSES PVT. LTD	INDIA
5	FLUIDYNE ENGG. (I) PVT. LTD	INDIA
6	KELD ELLENTOFT INDIA PVT. LTD	INDIA
7	LONESTAR INDUSTRIES	INDIA

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8	MB METALLIC BELLOWS (INDIA) PVT. LTD	INDIA
9	PRASHANT ENGG. STORES	INDIA
10	STANDARD PRECISION BELLOWS	INDIA
11	TUBOFLEX	GERMANY
12	FLEXIDER S.P.A.	ITALY
3.16	**STRAINERS (PERMANENT INCLUDING Y-TYPE)**	
1	CHEMTECH INDUSTRIAL VALVES PVT. LTD	INDIA
2	FLAIR STRAINERS & FILTERS (SIZE UPTO 42" (RATING UPTO 1500#))	INDIA
3	GRAND PRIX ENGINEERING PVT. LTD. (UPTO 60" PIPELINE, UPTO ANSI 1500#)	INDIA
4	GREAVES LIMITED	INDIA
5	GUJARAT OTOFILT	INDIA
6	HAWA ENGINEERS LTD. (1/2” to 24”(150# / 300#)	INDIA
7	KWIKFLO FILTERS PVT. LTD.	INDIA
8	LEADER VALVES LTD. (upto 300# & upto 12” size)	INDIA
9	MULTITEX FILTERATION ENGINEERS LTD	INDIA
10	MOD FABRICATORS	INDIA
11	ZOLOTO INDUSTRIES (15MM TO 100MM)	INDIA
12	BOTELI VALVE GROUP CO. LTD. (Y - TYPE ONLY: 14" (150#) & 3" (300# & 600#))	CHINA
3.17	**STEAM TRAPS**	
1	GREAVES LTD.	INDIA
2	PENNANT ENGINEERING PVT. LTD.	INDIA
3	VIRGO ENGINEERS LTD. (1/2” to 4” (upto 600#) (CS/SS))	INDIA
4	YARWAY CORPORATION	INDIA
5	ZOLOTO INDUSTRIES (15 mm to 25 mm)	INDIA
6	GESTRA AG	GERMANY
7	ARMSTRONG INTERNATIONAL INC.	U.S.A
8	OGONTZ CORPORATION	U.S.A
9	TYCO INTERNATIONAL INC.,U.S.A.	U.S.A
3.18	**SPRING SUPPORTS**	
1	MYRICS PIPING SYSTEM PVT.LTD.	INDIA
2	PIPE SUPPORTS INDIA PVT. LTD.	INDIA
3	PIPING & ENERGY PRODUCTS (P) LTD.	INDIA
4	SARATHI ENGG. ENTERPRISES PVT. LTD.	INDIA
5	SPRING SUPPORTS MFG. CO.	INDIA

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6	FLEXIDER S.P.A.	ITALY
3.19	**FASTENERS**	
1	AEP COMPANY	INDIA
2	CAPITAL INDUSTRIES	INDIA
3	CONSOLE ENGG. & FASTNERS INDUSTRIES	INDIA
4	EBY FASTNERS	INDIA
5	FIT TIGHT NUTS & BOLTS LTD.	INDIA
6	FIX FIT FASTENERS MFG. PVT. LTD.	INDIA
7	INDUSTRIAL ENGINEERING CORPORATION (SIZE UPTO 4" (M100))	INDIA
8	MEGA ENGINEERING PRIVATE LIMITED (½" TO 3" MATERIAL: CS/AS/SS)	INDIA
9	METRO MECHANICAL PVT.LTD.	INDIA
10	NAGBHUSHANAM INDUSTRIES	INDIA
11	NIREKA ENGG. CO. PVT. LTD.	INDIA
12	PACIFIC FORGING & FASTENERS PVT. LTD. (M 10 TO M125)	INDIA
13	PERFECT MARKETING (P) LTD,	INDIA
14	PIONEER NUTS & BOLTS PVT. LTD.	INDIA
15	PRECISION AUTO ENGINEERS	INDIA
16	PRECISION ENGINEERING INDUSTRIES	INDIA
17	PTD FASTNERS PVT. LTD.	INDIA
18	SANGHVI METALS (TRADER)	INDIA
19	SUNDARAM FASTENERS LIMITED	INDIA
20	UDHERA FASTENERS	INDIA
3.20	**FIRE FIGHTING SYSTEM**	
1	AGNICE FIRE PROTECTION LTD.	INDIA
2	BHARTIYA CACCIALANZA FIRE SYSTEMS LTD	INDIA
3	BLUE STAR LTD.	INDIA
4	DE'S TECHNICO	INDIA
5	DE'S TECHNICO PVT. LTD.	INDIA
6	FUTECH CONSULTANTS PVT. LTD.	INDIA
7	GENERAL MECHANICAL WORKS	INDIA
8	HD FIRE PROTECTION COMPANY	INDIA
9	LAL ENTERPRISES	INDIA
10	MATHER & PLATT (INDIA) LTD. (A Subsidiary of WILO SE German)	INDIA
11	MX SYSTEMS INTERNATIONAL PVT. LTD.	INDIA
12	NEWFIRE ENGINEERS SERVICES	INDIA

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13	PRAGATI ENGG. (PVT.) LTD.	INDIA
14	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
15	RADIANT FIRE PROTECTION ENGINEERS	INDIA
16	STEELAGE INDUSTRIES LTD.	INDIA
17	TECHNOFAB ENGG.	INDIA
18	TRI-PARULEX FIRE PROTECTION SYSTEMS	INDIA
19	UNITECH MACHINES LTD	INDIA
20	VIJAY FIRE PROTECTION SYSTEM LTD.	INDIA
3.21	**HOSE PIPE (METALLIC) & CAM LOCK COUPLING**	
1	AEROFLEX INDUSTRIES LIMITED (Size 6mm to 250mm dia. (SS Corrg. Flex. Hose with Braid, Braid & Assembly)	INDIA
2	CHHATARIA RUBBER CHEMICALS INDUSTRIES	INDIA
3	D. WREN & CO.	INDIA
4	FLEXATHERM EXPANLLOW PVT. LTD. (1/2” to 6”)	INDIA
5	GAYATRI INDUSTRIES	INDIA
6	GAYATRI INDUSTRIAL CORPORATION (UPTO 6” ID)	INDIA
7	HELIFEX HYDRAULICS & ENGG CO. LTD.	INDIA
8	SENIOR INDIA PVT. LTD.	INDIA
3.22	**HOSE PIPE (NON-METALLIC) & CAM LOCK COUPLING**	
1	CHHATARIA RUBBER CHEMICALS INDUSTRIES	INDIA
2	D. WREN & CO.	INDIA
3	GAYATRI INDUSTRIES	INDIA
4	GAYATRI INDUSTRIAL CORPORATION (UPTO 8” ID)	INDIA
5	HELIFEX HYDRAULICS & ENGG CO. LTD.	INDIA
6	PADMINI INDUSTRIES LIMITED	INDIA
7	PYROTEK INDUSTRIES (INDIA) PVT. LTD.	INDIA
8	SENIOR INDIA PVT. LTD.	INDIA

NOTE:

1. Make of the equipment not indicated and any other make for the specified equipment shall be subject to owner’s / consultant’s approval.

INSTRUMENTATION:

Sl.No	Vendor’s Name	Country
SODIUM ANALYSER		

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1.	ABB	
2.	HACH	
3	THERMOFISHER	
4	WALTRON	
5	AWA	
6	METTLER TOLEDO	
CHLORINE ANALYSER		
1.	ABB	INDIA
2.	HACH	FRANCE
3.	KROHNE	U.K
4	E&H	
5	WALTRON	
6	THERMOFISHER	
MOISTURE ANALYSERS		
1.	GE PANAMETRICS	ITALY
2.	AMETEK INC	U.S.A
3.	Chemtrols Industries Limited	India
TURBIDITY ANALYSERS		
1.	HACH	
2.	YOKOGAWA	JAPAN
SDI ANALYSERS		
1.	RODI	USA
pH, conductivity & ORP Analyser		
1.	ABB India Limited	India
2.	BELA INSTRUMENTS (For Knick, GmbH make), Mumbai(For ConductivityAnalyser)	India
3	Chemtrols Industries Limited	India
4	Emerson Process Management (I) Pvt. Ltd	India
5	Endress+ Hauser (India) pvt. Ltd. (Liquid Analyser)	India
6	Forbes polymetron Pvt. Ltd.	India
7	POTENCE CONTROLS (for GLI International make), Mumbai.(For ConductivityAnalyser)	India
8	Yokogawa India Ltd.	India
9	Emerson Process Mgt Singapore Ltd.	Singapore
10	Foxbro Far East PTE Ltd.	Singapore
11	Hach Company	U.S.A
12	Yokogawa Electric Corporation	Japan
13	Zellweger SA	France
Gas & Fire Detection System		
1.	Andrew Yule & Company Ltd. (Fire)	India
2.	Chemtrols Industries Limited	India
3.	Honeywell Automation India Limited (Gas)	India
4.	J B Boda And Brothers Pvt. Ltd. (Gas Make-International Sensor Technology)	India
5.	Pollution Protection System Mumbai Pvt Ltd (Gas)	India
6.	General Monitors (Gas)	U.K
7	Teledyne Fluid Systems (Gas)	Thailand
FIRE ALARM SYSTEM		
1	HONEYWELL	INDIA
2	SIEMENS	INDIA
PC / SERVERS		
1.	DELL	India

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Flow Element: Orifice/ Venturi/ Flow Nozzle		
1.	Baliga Lighting (only Orifice)	India
2.	Chemtrol Industries Ltd.	India
3.	Delta Engineering, Pune	India
4.	Eureka Industrial Equipments Pvt. Ltd.	India
5	FORBES MARSHALL	India
6	Flowtech Instruments (Orifice/Venturi)	India
7	General Instruments Consortium	India
8.	Instrumentation Ltd.	India
9.	Micro Precision Products Private Ltd.	India
10.	Micro India Flow Elements Pvt. Ltd.	India
11	Minco(India) Flow Instruments Pvt. Ltd.	India
12	Unicontrols Instrument Pvt. Ltd.	India
13	Bopp & Reuther Messtechnik GMBH	Geramny
14	Daniel Measurement & Control	USA
15	ISA Controls Limited	U.K
16	Technomatic SPA	Italy
Pitot Tube/ Annubar		
1.	ABB India Limited	India
2.	Control Engineers	India
3.	Emerson Process Management (I) Pvt. Ltd.	India
4	Micro Precision Products Private Ltd.	India
5.	Unicontrols Instruments Pvt. Ltd.	India
6.	Daniel Measurement & Control	U.S.A
7.	ISA Controls Limited	U.K
8	Technomatic Spa	Italy
Rotameters		
1.	ABB india Ltd.	India
2.	Chemtrols Industries Ltd.	India
3.	Delta Control	India
4.	Eureka Industrial Equipments Pvt. Ltd.	India
5	Flowtech Instruments services	India
6.	Instrumentation Engineers Pvt. Ltd.	India
7.	Krohne Marshall Pvt. Ltd.	India
8.	Placka Instruments & Controls Pvt. Ltd. (Purge Rotameter Only)	India
9.	Rota Instrumentation	India
10	Yokogawa	India
11	Rota Yokogawa Gmbh& Co. Kg	Germany
12	Tokyo Keiso Co.Ltd.	Japan
13	Azbil Corporation	Japan
14	Emerson Process Mgt	U.S.A
15	Krohne	Germany
Mass Flow Meter (Coriolis Type)		
1.	ABB India Limited	India
2	Chemtrol Industries Ltd	India
3.	Emerson Process Management (I) Pvt. Ltd.	India
5	Endress + Hauser	India
6.	SIEMENS Ltd.	India
7.	Yokogawa	India
8.	Bopp & Reuther Messtechik GMBH	Germany
7	Krohne	Germany

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8	Schlumberger resource management Ltd.	U.S.A
Turbine Flowmeter		
1.	ABB India Ltd.	India
2.	Chemtrol Industries Ltd	India
3.	Krohne	India
4.	Yokogawa	India
5.	Azbil Corporation	Japan
6.	Bopp & Reuther Messtechnik Gmbh	Germany
7.	Barton Instrument System Ltd.	U.K.
8.	Emerson Process Mgt	U.K.
9.	Emerson Process Mgt.	U.S.A
10.	Instromet International N.V.	Holland
11.	Itochu Corporation	Japan
12.	Oval Asea Pacific Pte Ltd.	Singapore
13.	Rockwell International Corporation	U.S.A
Vortex meter		
1.	ABB India Ltd.	India
2.	Emerson Process Management (I) Pvt. Ltd.	India
3.	Krohne Marshall Pvt. Ltd.	India
4	Siemens Ltd.	India
5.	Yokogawa Limited	India
6	Bopp & Reuther MesstechnikGmbh	Germany
7.	Endress + Hauser	Germany
8..	Itochu Corporation	Japan
9.	Krohne	Germany
10.	Schlumberger resource management Ltd.	U.S.A
PD Meter		
1.	Chemtrols Industries Ltd.	India
2.	Rock Flow Meters (i) Pvt. Ltd.	India
3.	Bopp & Reuther MesstechnikGmbh	Germany
4.	Emerson Process Managment	U.S.A
5.	Oval Asea Pacific Pte Ltd.	Singapore
6.	Schlumberger resource management Ltd.	U.S.A
Magnetic Flow meter		
1.	ABB India Ltd.	India
2.	Chemtrol Industries Ltd	India
3.	Emerson Process Management (I) Pvt. Ltd.	India
4.	Endress + Hauser (India) Pvt. Ltd.	India
5.	Krohne Marshall Pvt. Ltd.	India
6	Siemens Ltd.	India
7	SBEM Pvt. Ltd.	India
8	Yokogawa	India
9.	Azbil Corporation	Japan
10.	Bopp & Reuther MesstechnikGmbh	Germany
11	Krohne	Germany
Ultrasonic Flow Meter		
1	Chemtrol Industries Ltd	India
2.	Endress + Hauser (India) Pvt. Ltd.	India
3.	Emerson Process Management	India
4	Siemens Ltd.	India
5	Yokogawa	india

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Orifice Meter		
1	Chemtrol Industries Ltd	India
Pressure Gauges		
1.	Ashcroft India(P) Ltd. (standard normal type)	India
2.	A.N. Instruments Pvt. Ltd.	India
3.	Baumer Technologies India Pvt . Ltd	India
4.	Forbes Marshall	India
5.	General Instruments Consortium,	India
6.	H.Guru Industries	India
7.	Peejee Engg. Works	India
8.	Precision Industries Ltd. (standard normal type)	India
9.	Premium Instrument & Controls Ltd.	India
10.	Manometer (India) Pvt. Ltd.	India
11.	Walchand Nagar Industries Ltd.	India
12.	Wika	India
13.	Budenberg Gauge Co. Ltd	U.K
14.	Dresser Europe S.A	Germany
15.	Nagano keiki Seisakusho	Japan
16.	Rueger Sa	Switzerland
17	Spriano Spa	Italy
18	WikaAlexenderWiegardGmbh& Co.	Germany
Local D/P Indicators		
1.	Precision Mass Products Pvt. Ltd	India
2.	Switzer Instrument Co.	India
3	Wika	India
4	Barton Instrument Systems Limited	U.K
5	Delta Controls Ltd.	U.K
Pressure & D/P Transmitters		
1.	ABB India Ltd.	India
2.	Emerson Process Management (I) Pvt. Ltd.	India
3.	Endress + Hauser (India) Pvt.Ltd.	India
4.	Honeywell Automation India Limited	India
5	Siemens Ltd.	India
6.	Yokogawa Limited	India
7.	Azbil Corporation	Japan
8.	Emerson Process Mgt Singapore Ltd	Singapore
9.	Honeywell Inc.	U.S.A
10	Moore Products Company	U.S.A
11	Siemens Ag, Germany	Germany
12	Smar Singapore Pte. Ltd.	Singapore
13	VEGA Grieshaber KG	Germany
14	Yokogawa Electric Corporation	Japan
Transparent/ Reflex / Bicolor Mag.Level Gauges		
1.	ABB India Ltd.	India
2.	Bliss Anand Private Ltd.	India
3.	Chemtrols Samil(India) Pvt Ltd.	India
4.	Flowtech Instruments services	India
5.	LEVCON INSTRUMENTS PVT. LTD.	INDIA
6	Nisan Scientific Process Equipments Pvt. Ltd	India
7.	Pune Techtrol Pvt. Ltd. (=<300#)	India
8	Technomatic (India) Pvt. Ltd.	India

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9.	V-Automat Instruments Pvt. Ltd. (upto 300#)	India
10	Clark-Reliance Corp.	U.S.A
11	CesareBonetti	Italy
12	Jerugson Gauge & Valve Co.	U.S.A
13	Nihon Klingage Co. Ltd.	Japan
14	Richard Klinger Ag	Austria
15	Technomatic Spa	Italy
Level Switches (Float & Displacer Type)		
1.	ABB India Ltd.	India
2.	Bliss Anand Private Ltd.	India
3.	Chemtrols Samil(India) Pvt Ltd.	India
4.	Pune Techtrol Pvt. Ltd.	India
5.	SBEM Pvt. Ltd.	India
6.	Siemens Ltd.	India
7.	V.Automat & Instruments (P) Ltd.	India
8.	ISA Controls Limited	U.K.
9	KDG. MOBREY Ltd.	U.K.
10	Magnetrol International N.V	Belgium
11	SOR Inc.	U.S.A
12.	Vega Grieshaber KG	Germany
Displacer Type Level Transmitters		
1.	Chemtrols Industries Limited (Eckdart Make Electronics)	India
2.	Dresser Valve India Pvt Ltd (Rating <= 600#)	India
3.	Dresser Masoneilan	France
4.	Foxboro EckardtGmbh	Germany
5.	Magnetrol International N.V. (Lvdt)	Belgium
6.	Parcol Spa (Pneumatic Transmission Only)	Italy
Tank Level Instruments		
1.	ABB India Limited	India
2.	Emerson Process Management (i) Pvt. Ltd.	India
3.	Pune Techtrol Pvt. Ltd.	India
4.	Siemens Ltd. (Radar level Transmitter, guided wave Radar)	India
5.	SBEM Pvt. Ltd.	India
6	EnrafSingaporePte. Ltd.	Singapore
7.	Endress + Hauser Gmbh& Co., (Non-Contact & Servo)	Germany
8.	Krohne (Non-Contact Type)	Germany
9.	L& J Technologies	U.S.A
10.	Toyo Keiso Co. Ltd.	Japan
Ultrasonic Level Transmitter		
1.	Forbes Marshell	India
2.	Siemens Ltd.	India
3	Vega Grieshaber KG	Germany
Radar transmitter (GWR / non Contact type)		
1.	Endress + Hauser (India) Pvt. Ltd	India
2.	Forbes Marshell	India
3	Magnetrol	India
4	Vega Grieshaber KG	Germany
Temperature Elements (Thermocouple, Rtd)		
1.	Altop Industries Ltd.	India
2.	ABB India Ltd.	India
3.	Detriv Instrumentation & Electronics Ltd.	India

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4.	Electrical & Electronics Ltd.	India
5.	Eleind Engineering Pvt. Ltd.	India
6.	Endress + Hauser (India) Pvt. Ltd.	India
7..	Exotherms Instruments	India
8.	General Instruments Consortium	India
9.	Goa Instruments Industries Ltd.	India
10.	Industrial Instrumentation	India
11.	Precision Mass Products Pvt. Ltd.	India
12.	Pyro Electric Instruments Goa Pvt. Ltd.	India
13.	Tempsens Instruments (I) Pvt. Ltd.	India
14	Thermal Instruments India Pvt. Ltd.	India
15	Unicontrols Instruments Pvt. Ltd.	India
16	Azbil Corporation	Japan
17	Okazaki Manufacturing Co.	Japan
18	Sensycon	Germany
19	Thermo Electric Co.Ltd.	Holland
20	W.C.Heraeus GMBH	Germany
Bimetallic Thermometer		
1.	A N Instruments Pvt. Ltd.	India
2.	Ashcroft India(P) Ltd.	India
3.	Baumer Technologies India Pvt. Ltd.	India
4.	General Instruments Consortium	India
5.	Goa Instruments Industries Ltd	India
6.	H.Guru Industries	India
7	Krohne Marshall Pvt. Ltd.	India
8	Precision Mass Products Pvt. Ltd.	India
9	Nagano Keiki Seisakusho	Japan
10	Rueger SA	Swizerland
11	Technomatic SPA	Italy
12	Trend Instrument Inc.	U.S.A
Dial Thermometer (Hg In Steel/Glass)		
1.	A N Instruments Pvt. Ltd.	India
2.	Ashcroft India(P) Ltd.	India
3.	Baumer Technologies India Pvt. Ltd.	India
4.	General Instruments Consortium,	India
5.	Goa Instruments Industries Ltd	India
6.	H.Guru Industries	India
7.	Precision Mass Products Pvt. Ltd	India
8.	Pejee Engg Works	India
9.	Walchand Nagar Industries Ltd.	India
Radiation Pyrometer		
1.	Tempsens Instruments Pvt. Ltd.	India
2.	C.C.R Technico	Italy
3.	Chino Corpn.	Japan
4.	Land Infrared	U.K.
5.	Siemens AG	Germany
6.	Wahal Instruments	U.S.A
Temperature Transmitters		
1.	ABB India Limited	India
2.	Emerson Process	India
3.	Endress+ Hauser (India) Pvt. Ltd.	India

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4.	Siemens Ltd.	India
5	Yokogawa	India
Gate/Plug Valves		
1.	Audco India Limited(L&T Valves Divn.)	India
2.	BHEL(Valves Division)	India
3.	Chemtrols Engineering Limited (Plug Valves)	India
4.	Flowserve India Control Pvt. Ltd.(Plug Valve upto 12"300# upto 6" 600#)	India
5.	Ksb Pumps Limited (Valves Divn)	India
6	NU Tech Controls (MOV Gate :1/2" to 8" 2500#, 10" to 14",300#)	India
7.	Samsons Contols Pvt. Ltd. (Upto 34", 300#)	India
8.	Valve Tech Industries (Mov -8" upto 2500#)	India
9.	Velan Inc.	Canada
10	Weir Bdk Vlaves	India
11	Bel Valves	Japan
12	CesareBonetti	Italy
13	Fasani S.P.A	Italy
14	MalbranqueS.A.	France
15	Matsura H. P Machine works co. Ltd.	Japan
16	Petrol Valves S.R.L	Italy
Globe / Angle Valves		
1.	AST S.P.A (Upto 8"900#)	India
2	Chemtrol Industries Ltd.	India
3	Circor Flow Technologies India Pvt. Ltd.	India
4	Dresser Valve India Pvt. Ltd.(Rating =<600#,size ¾" to 6")	India
	Emerson Process Management India Ltd	India
5	Emet Controls Pvt. Ltd.(Globe Valve up to 4",300# angle valve upto 1-1/2",2500#)	India
6	Flowserve india control pvt. Ltd. (globe valve upto 30" 600# upto 24" 900#, upto 16" 2500# upto 4" 4500#)	India
7	Koso fluids controls pvt. Ltd. (globe valves: upto 8" 2500# 10 to 18" 300# angle valves upto 8" 300#)	India
8	Instrumentation Ltd. (Palakkad)	India
9.	Mil Controls Limited	India
10.	NU Tech Controls	India
11	Pneucon valves Pvt. Ltd. (upto 6" 300#) noncritical)	India
12	Samson Control Pvt Ltd(upto 6'' &=<600#)	India
13	Tecnik valves pvt Ltd. (air & water service upto 4" 150#)	India
14	Valve-Tech Inducstries (non-critical)	India
15	Azbil Corporation (=< 2500#)	Japan
16	Arca Regler GMBH	Germany
17	Dresser Masoneilan	France
18	Flowserve (=<2500#)	U.S.A
19.	Fisher Xomox (=< 2500#)	Singapore
20.	Parcol Spa	Italy
21	Nippon Fisher Co. Ltd. (=<2500#)	Japan
22	Severn Glocon (1 to 12" 600#)	U.K.
Ball Valves		
1.	Tyco Valves & Controls (I) Ltd (=< 150 #)	India
2.	Virgo Engineers Ltd. (=<600# With Maccair Actuators)	India
3.	Anand teknow aids engineering india limited (upto 6",600# (ON-OFF)	India

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4.	Bray Controls India Pvt. Ltd.(upto 4",300#)	India
5.	Emerson	India
6	EMET controls pvt. Ltd.(upto 8",150# for air service)	India
7	Fisher Xomox Sanmar	India
8	Flowserve India controls Pvt. Ltd. (upto 16" 600#)	India
9	Intervalve ponnawalla limited (uptp 10",150#)	India
10	Koso Fluid Controls pvt. Ltd. (upto 8 " ,2500# ,10" to 18" 900#)	India
11	NU Tech Controls (14",600# for non-critical purpose)	India
12	Pentair Valves and controls India Pvt. Ltd. (<=150#)	India
13	Pneucon valves pvt. Ltd. (upto 6",150# non-critical)	India
14	Samson Control Pvt Ltd(upto 24" &=<1500#)	India
15	Valve tech industries ltd. (18",150# non critical)	India
16	Weir Bdk Vlaves (upto 16",150#)	India
17	G.T.C. Italia S.R.L(=<300#)	Italy
18	Metso Automation (=<2500#)	Singapore
19	Orbit Valves PLC (=<2500#)	Singapore
20	Petrol Valves S.R.L	Italy
21	PERRIN Gmbh (size ½" to 12",& rating 150# to 2500#,size 14"to 18", rating 150# to 1500# ,size 20"to 24" rating 150# & 300#)	Germany
22	Pibiviesse S.P.A. (Rating Upto 2500 #)	Italy
23	Rotex manufacturers & Engineers Pvt. Ltd. (upto 6" 600#, 6" to 10" 150#)	India
24	Velan Inc. (ball valves on/off size: ¼" to 6" (rating upto 2500#) size 8"to 16" (rating upto 900#) size 18" to 30 " (rating upto 300#)	Canada
Butterfly Valves		
1	Advance valves pvt. Ltd.(size 2"to 24" upto 600#)	India
2	Bray controls india pvt. Ltd. (upto 300#)	India
3	Dresser Masonelian Valves	India
4	Emet controls pvt. Ltd. (upto 4",900#, 6",150# to 16",150# double eccentric)	India
5	Flowserve india control pvt. Ltd. (upto 30",300# upto 12" 600#)	India
6	Fisher	India
7	Intervalve ponnawaala ltd. (2" to 48",150#)	India
8	Instrumentation Ltd. (Palakkad) (=< 300#)	India
9	Koso fluid controls (pvt.) ltd. (=< 150#)	India
10	Nu tech controls (16",300# for non-critical services)	India
11.	Pneucon valves pvt. Ltd. (upto 8",150# non critical)	India
12.	Samson controls pvt. Ltd.	India
13	Tyco Valves & Controls (I) Ltd (=< 150 #)	India
14	Valve tech industries (non-critical services)	India
15	Virgo Engineers Ltd. (=<300#)	India
16	Weird BDK valves (upto 16",300#0	India
17	Bray Controls(=<300#)	U.S.A
18	Keystone (Upto 2500#)	Singapore
19	Leeds valve ltd.	UK
20	Korea Unicom Valve Co. Ltd.	Korea
21	Parcol Spa (=< 2500# Urea Service Also)	Italy
22	Pentair Valves and controls India Pvt. Ltd. (<=150#)	
23	Metso Automation (Upto 2500#)	Singapore
24	Orton S.r.l. (upto 2500#)	
PRDS & SPRAY NOZZLE,VENT VALVES upto 2500#		
1.	ARCA (Forbes Marshal) (Mech. Spray nozzle type desuperheater only)	India
2.	Chemtrols Industries Ltd. (PRDS Combine &Split)	India

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3.	Circor Flow Technolgies India Pvt. Ltd. (1" to 20",upto 150#, 1 to 10" upto 1500#, 1"to 8",upto 2500#)	India
4	Control components INC	India
5	FisherControls	India
6.	Samson Controls Pvt. Ltd. (upto 6",150#)	India
7.	CCI Valve Technology AB	Sweden
8	SPX Valves & Controls (COPES-VULCAN LTD.)	U.S.A
Electric Actuator		
1.	Cair euromatic Automation Pvt. Ltd. (non-critical)	India
2.	Marsh Automation (for safe area)	India
3.	Biffi Italia S.R.L	Italy
4.	Limitorque, U.S.A	U.S.A
5.	Rotork Control (Deutschland) Gmbh	Germany
Air Filter cum Pressure Regulator		
1.	ABB India Limited	India
2.	Divya Control Elements Pvt. Ltd.	India
3.	Dresser	India
4.	Emerson Process Managenment	india
5.	Mil Controls Limited	India
6.	Placka Instruments & Controls Pvt. Ltd.	India
7.	Shavo Norgren(India) Pvt Ltd.	India
8.	Schrader Duncan Ltd. (1/4" to 2" port size)	India
Valve Actuator (Pneumatic/Rotary)		
1.	Bray Control India Pvt. Ltd.	India
2.	EL-O-Matic India Pvt. Ltd.	India
3	Rotex Manufacturers & Engineers Pvt Ltd	India
4	Schrader Ducan Ltd.	India
Self actuated pressure control valve		
1	FisherControls	India
2	Nirmal Industrial controls private limited (size ½" to 6 " & rating : < =300#)	India
3	Nu tech Controls (upto 10",600#)	India
4	Pneucon Valves Pvt.Ltd. (upto 4",150#)	India
5	Samsons Controls Pvt. Ltd. (upto 2",150#)	India
Electropneumatic Positioner		
1.	FisherControls	India
2	Siemens Ltd.	India
Desuperheaters		
1.	Circor Flow Technologies India Pvt. Ltd (upto 24",300# upto 28",150#, multinozzle 3" to 4",upto 2500#)	India
2.	Chemtrols	India
3	CCI	India
4	EMET Controls Pvt. Ltd.(Desuperheating Control Valves 1-1/2", 600# * 3",2500#)	India
5	Fisher	India
6	Tyco	India
Safety Valves & Thermal Relief Valves Upto 2500#		
1.	AST S.P.A	India
2.	Bliss anand private limited (8" * 10" 300#, 6" * 8 " 600# ,4 * 6" 1500#)	India
3.	FaingerLeser Valves (P) Ltd. (Upto 600#, ½" To 6")	India
4.	Instrumentation Ltd. (Palakkad)	India
5.	Keystone	India
6	Pentair Sanmar Ltd.	India

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7	Nu tech controls (upto 2",300# * 3",150#)	India
8	Valve Tech Industries	India
9	Weir Bdk Valves	India
10	BOPP & Reuther Messtechnic GMBH	Germany
11	Crossby valve & Engg. Company Ltd.	U.K
12	Dresser Industries Incorporated	U.S.A
13	Dresser Valve & Controls	Canada
14	Farris	U.K
15	Itochu Corporation	Japan
16	Parcol Spa (For Urea Service Also)	Italy
17	Sapag Gec Alsthom	France
18	Tai Milano S.P.A	Italy
19	Teledyne Fluid Systems	Thailand
Vaccum Breakers		
1.	Fainger Engineering	India
2.	Potego India Pvt. Ltd.	India
3.	Braunschweiger Flammenfilter	
4.	Itochu Corporation	Japan
5.	Parcol Spa	Italy
6.	Safety Systems UK Ltd.	U.K
7.	Tai Milano S.P.A	Italy
8.	Whessoe Varec Limited	U.K
Rupture Discs		
1.	Bs&B Safety Systems (India) Limited	India
2.	Fainger Engineering	India
3.	Tyco Sanmar	India
4.	Continental Controls Inc.	U.S.A
5.	Fike Europe	Belgium
6.	Sapag GEC Alsthom	France
7.	Teledyne Fluid Systems	Thailand
Pilot relief valves		
1.	AST S.P.A (inlet size upto 3", upto 1500#, outlet size upto 4", upto 300#,inlet size upto 4",upto 300# ,inlet size upto 6", upto 150#,outlet size upto 8", upto 150#)	India
2.	Bliss Anand Private Limited (Size 1"* 2" 2500#)	India
Low pressure relief valve		
1.	Protego India Pvt. Ltd. (less than 1 BAR with flame arrestor)	India
Flame arrestor		
1.	Protego India Pvt. Ltd	India
Control Panel		
1.	Electronics corporation of india ltd.	India
2.	Ex protecta	India
3.	Hulasi metals pvt. Ltd.	India
4.	Industrial control appliances (p) ltd.	India
5.	Jaisun & hutchisun control ltd.	India
6.	Prima automation (india) pvt. Ltd.	India
7.	Pyrotech electronics pvt. Ltd.	India
8	Tan swa technologies INC	India
9	United electric co (delhi) pvt. Ltd,	India
10	Yokogawa india limited	India
11	Instromet international N.V.	Holland
Programable Logic Controller- Package		

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1.	ABB India Limited	India
2.	Emerson Process Management (I) Pvt. Ltd.	India
3.	Ge Fanuc Systems Prvitate Limited	India
4.	Honeywell Automation India Limited	India
5.	Rockwell Automation India Ltd.	India
6	Siemens Ltd.,	India
7.	Yokogawa	India
8	GE fanuc automation north America INC (fault tolerant TMR)	U.S.A
9	Hima paul Hiildebrandt Gmbh +Co KG (fail safe)	Germany
10	Marconi italiana (non fail safe)	Italy
11.	Omron corporation (Relay)	Japan
12	RTP Control system	U.S.A /India
13	Triconex (fault tolerant TMR)	Singapore
14	Triconex (Schenider)	Singapore
Distributed Control System		
1.	ABB India Limited	India
2.	Emerson process management India Pvt. ltd.	India
3.	Foxboro	India/Intl.
4.	Honeywell Automation India Limited	India
5.	Siemens Ltd.	India
6	Yokogawa Limited	India
7	Bailey controls company	U.S.A
8	Emerson process management Singapore ltd.	Singapore
9	Honeywell Inc.	U.S.A
10	Invensys	Holland
11	Siemens AG	Germany
12	Yokogawa Electric Corporation	Japan
Alarm Annunciator		
1.	Industrial Instruments & Controls	India
2.	Shree Electronics	India
3.	M.T.L., U.K.	U.K
4.	Rochester Instrument Systems Ltd.	U.K
5.	Riley Panalarm	U.S.A
6.	Ronan Engg. Co.	U.S.A
Temperature Scanner		
1.	Industrial Instrumentation	India
2.	Protocontrol Instruments (I) Pvt. Ltd.	India
Cctv / Access System		
1.	Honeywell Automation India Limited	India
2.	Yokogawa Limited	India
Surge Protection Devices		
1.	Phoenix Contact (India) Pvt. Ltd.	India
Wiring Ducts		
1.	Trinity touch Pvt.Ltd.	India
DIN Rail		
1.	Trinity touch Pvt.Ltd.	India
Interface Module		
1.	Trinity touch Pvt.Ltd.	India
Cable connector		
1.	Phoenix contact (India) Pvt. Ltd.	India

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Burner Management System		
1.	Siemens (TMR/QMR)	India
2.	Triconex (TMR/QMR)	U.S.A
3.	Honeywell (TMR/QMR)	Japan
4.	Yokogawa (TMR/QMR)	Japan
5.	Rockwell Automation Pvt. Ltd. (TMR/QMR)	Germany
Instrument Power & Control Cables		
1.	Associated Cables Ltd.	India
2.	Associated Flexibles & Wires Pvt. Ltd.	India
3.	Cords Cable Industries Ltd.	India
4.	Delton Cables Ltd	India
5.	Insucon Cables & Conductors (P) Ltd. (For Smaller Non-Critical Projects)	India
6.	J K Cables Limited	India
7.	Kei Industries Limited	India
8.	Leoni cable solutions	India
9.	Paramount Cable Corporation	India
10.	T C Communications Pvt Ltd	India
11.	Thermo Cables Limited	India
12.	Toshniwal Cables	India
13	Udey Pyro Cables Pvt Ltd	India
Extension & Compensating Cables		
1.	Associated Cables Ltd.	India
2.	Associated Flexibles & Wires Pvt. Ltd.	India
3.	Cords Cable Industries Ltd.	India
4.	Delton Cables Ltd	India
5.	General Instruments Consortium,	India
6.	J K Cables Limited	India
7.	Kei Industries Limited	India
8.	Paramount Cable Corporation	India
9.	ThermopadsPvt. Ltd.	India
10.	Toshniwal Cables	India
Cable Trays & Accessories (FRP)		
1.	D-Y Engineers	India
2.	Globe Electrical Industries	India
3.	HOPPES	India
4.	Indiana Engg Works Pvt Ltd	India
5.	Metalite Industries	India
6.	Parekh Engineering Company	India
7	Sadhana Engineering Corporation	India
8	Steelite Engineering Limited	India
Multi Transit Inlet System		
1.	Hawke International	U.K
2.	MctBrattbergAktiebolag	Sweden
3.	RoxtecAb	Sweden
Junction Box (FRP) & Cable Gland		
1.	Baliga Lighting Equipments Limited	India
2.	Ceag Flameproof Control Gears Pvt.Ltd.	India
3.	Ex-protecta	India
4.	Flameproof EquipmentsPvt. Ltd.	India
5.	Flexpro Electicals Pvt. Ltd.	India
6.	TAN SWA technologies Inc (Junction Box)	India

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7.	Trinity Touch Pvt. Ltd. (Only cable Glands upto size 25M)	India
8	Stahl-Und Apparatebau Hans LefferGmbh	Germany
CS Seamless Pipes –As per Piping list		
1	Indian tube Co.(Tata Div of tubes & pipes)	India
2	ISMT limited	India
3	Maharasthra seamless limited	India
4	Dalmine SPA	Italy
5	ETS Trouvay & Cauvin	France
6	Horst kurvers Gmbh	Geramny
7	Hyundai Corporation	Korea
8	IBF seamless pipes SPA	Italy
9	Mannesmann Hnadel AG	Geramny
10	Marubeni Itochu Steel	Japan
11	Nippon steel corporation	Japan
12	Nissho IWAI Corporation	Japan
13	Okura & Co. Ltd.	Japan
14	Sojitz Corporation	Japan
15	Sumitomo metal industries Ltd.	Japan
16	Phoceenne	France
17	Vomal International Limited	UK
SS Seamless Pipes-As per piping list		
1	Choksi tube company limited	India
2	Maxim tubes company pvt. Ltd.	India
3	Nuclear fuel complex	India
4	Ratnamani metals & tubes limited	India
5	Remi edelstahl tubular ltd.	India
6	Dalmine SPA	Italy
7	Phoceenne	France
8	TPS technitube Rohrenwerke	Germany
9	T.T.I tubecex tubos inoxidables S.A. (1/2" NB SS pipe)	Spain
SS Tubes		
1.	Choksi Tube Company Ltd.	India
2.	Matim Tubes Company Pvt. Ltd.	India
3.	Nuclear Fuel Complex	India
4.	Ratnamani Metals & Tubes Limited	India
5.	Sandvik	India
6	Itochu Corporation (Rep.KubotaCorpn.)	Japan
7.	Nishitani& Co. Ltd.	Japan
8	Sumitomo Metal Industries Ltd.	Japan
Pipe Fittings		
1.	Eby industries	India
2.	Excel hydropneumatics pvt. Ltd.	India
3.	Micro precision products pvt. Ltd.	India
4	Precision engineering industries	India
5	Tecnomatic (india) pvt. Ltd.	India
6	Wesmec engineering pvt. Ltd.	India
7	Celleir	France
8	Cesare bonetti SPA	Italy
9	Dewrance & Co. Ltd.	U.K.
10	Hopkinsons Ltd.	U.K.
11	Siemens AG PGI	germany

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12	Sumitomo metal industries ltd.	Japan
13	Thysen krupp stahlunion Gmbh	germany
14	Tecnomatic SPA	Italy
Instrument Miniature Valves		
1.	Audco India Limited(L&T Valves Divn.)	India
2.	Aura Inc	India
3.	Bhel (valves division)	India
4.	Chemtrol Industries Ltd	India
5.	Chemtrols Samil(India) Pvt Ltd	India
6.	Comfit & Valves Pvt. Ltd.	India
7.	Excel Hydro-Pneumatics Pvt Ltd,	India
8.	Excelsior Engg Works	India
9.	Hyd- Air Engineering works Lonavla	India
10.	Ksb Pumps Limited (Valves Divn)	India
11	Panam Engineers	India
12	Tecnomatic (India) Pvt. Ltd.	India
13	Anderson Greenwood & Co.	U.S.A
14	BFE boneey forge valve License	Italy
15	Celleir S.A.	France
16	Crane Company International Sales	U.S.A
17	Dewrance & Co. Ltd.	U.K.
18	Euromisure Cremona	Italy
19	Hopkinsons Ltd.	U.K.
20	Kosei Sanyog Ltd.	Japan
21	Swagelok company/creximco	U.S.A
22	Sumitomo metal industries ltd.	Japan
23	Technomatic SPA	Italy
24	Velan engineering Co. Limited	U.K.
25	Wesmec engineering pvt. Ltd	India
Purge rotameter		
1	Eureka industrial equipments Pvt. Ltd.	India
2	Instrumentation engineers pvt. Ltd.	India
3	Placka instruments & engineers pvt. ltd	India
AIR HEADER/ADPOT		
1	Wesmec engineering pvt. Ltd.	India
Condensate pot		
1	HYDROPNEUMATICS	India
2	MICRO-PRECISION PRODUCTS	India
3	TECHNOMATIC (I) P. LTD.	India
4	Wesmec engineering pvt. Ltd.	India
Valve manifolds		
1	Comfit & Valves Pvt. Ltd.	India
2	EXCEL HYDROPNEUMATICS PVT. LTD.	India
3	HYDER	India
4	INSTRUMENTATION LTD.	India
5	MICRO PRECISION	India
6	NORDIVAL (SWAGELOC)	
7	PARKER	India
8	TECHNOMATIC	India
9	Wesmec engineering pvt. Ltd.	India
Calibration equipment & services		

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1	Tempsens instruments (i) pvt. Ltd.	India
2	Fluke	Singapore
3	Omega Engineering	US
Enclosures		
1	Trinity touch pvt. Ltd. (weatherproof size 80 * 80 mm)	India
Bulk power Supply		
1	WAGO	India
2	Phoenix	India
Instrument contractor for inst. Construction /erection works		
1	Blue star	India
2	Bells control ltd.	India
3	Godrej & Boyce mfg. co. ltd	India
4.	ICB Contractor Pvt. Ltd.	India
5.	Jasubhai Industries	India
6.	Koso india pvt. Ltd. (kent introl control valve divn.)	India
7.	L&T (construction contracts Divn.)	India
8.	Miraj instrumentation service (upto 0.5 crores)	India
9.	Narayan engineering (< Rs. 5 lacs (small project))	India
10.	Pace process control pvt. Ltd.	India
11	Peron engg. Construction ltd.	India
12.	Protect control pvt. Ltd.	India
13	Technimont ICB ltd.	India

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