



**INSTRUMENT AIR & PLANT AIR SYSTEM  
FOR TALCHER FERTILIZERS LTD. (TFL) AT TALCHER, ODISHA**



Date: 05.07.2021

**AMENDMENT – I**

**NIT, No. PNMM/PC-183/E-4008/NCB Dated 24.05.2021**

**Sub.: Instrument Air & Plant Air System for Talcher Fertilizers Ltd. (TFL) at Talcher, Odisha**

This is for information to all Bidders who are willing to participate in the subject NIT, that Amendment-I date 05.07.2021 is being issued and shall be read in conjunction to the NIT and subsequent Amendments issued till date.

**\*All other terms & conditions of NIT shall be as per original NIT and subsequent Amendment(s).**

For & on behalf of  
Talcher Fertilizers Limited

P. R. Sahu  
Addl. G.M (M.M)  
Projects & Development India Ltd.

SL. NO.	REFERENCE OF BIDDING DOCUMENT				AMENDMENT TYPE	MODIFICATION/ AMENDMENT
	Part/Sec.	Page No.	Clause No.	Description as per NIT	M/D/A	
1.	SECTION –VI 1.0: (PART-A) DESIGN BASIS /PC183/E/4004/ SEC-VI- 1.0	2 of 13 &	1.1,	<p>GENERAL DESCRIPTION OF PACKAGE: Instrument/plant air system shall comprise of following items for each location:</p> <ul style="list-style-type: none"> <li>➤ 2 Working +1Stand by Centrifugal Air Compressors</li> <li>➤ 1 No Moisture Separator Knock Out Drum</li> <li>➤ 1Working +1 Stand by Electric Heater with standby dryer/regeneration vessel with no purge loss)</li> <li>➤ 1 No. Dried Air After Cooler</li> <li>➤ 2 No. Dry Air Receiver vessel</li> <li>➤ 1working +1stand by Set of Instrument Air dryers</li> <li>➤ 2 No. Low Pressure Wet Air Receiver</li> <li>➤ 1 No. High pressure compressor @ 40 kg/cm<sup>2</sup>g discharge pressure for back up receiver.</li> <li>➤ 1 No. Back up Instrument Air receiver for 30 min emergency storage @ 36.5Kg/cm<sup>2</sup>g pressure</li> </ul>	A	<p>GENERAL DESCRIPTION OF PACKAGE: Instrument/plant air system shall comprise of following items for each location:</p> <ul style="list-style-type: none"> <li>➤ Air Filter for Air Compressor: 3 Nos.</li> <li>➤ Air Compressor: 3(2W+1S) Nos.</li> <li>➤ Air Comp after Cooler: 3 Nos.</li> <li>➤ Wet air receiver K. O. Drum: 1 No</li> <li>➤ Air dryer Pre-Filter for each dryer:2No(1W+1S)</li> <li>➤ Adsorber:2 Set (1W+1S)</li> <li>➤ Air dryer After Filter for each dryer:2 Set.(1W+1S)</li> <li>➤ Instrument Air Receiver @ 8.8 kg/cm<sup>2</sup>g:1 No.</li> <li>➤ Dried Air after Cooler: 1 No.</li> <li>➤ Electric Heater: 2 No.</li> <li>➤ Regeneration after Cooler: 2 No.</li> <li>➤ Regeneration Air Moisture Separator: 2 No.</li> <li>➤ <del>Dry air Receiver For Emergency:2 No.</del></li> <li>➤ HP Compressor: 1 No.</li> <li>➤ Low Pressure Wet Air Receiver: 1 No.</li> <li>➤ HP IA Emergency <a href="#">receiver@36.5</a> Kg/cm<sup>2</sup>g for 30 Min backup- 1 No.</li> </ul> <p><b>HOC dryer or heater type ( No-purge split flow type Dryer) both can be used, Subjected to guarantee parameters are met as per cl 3.3 (Process guarantee)</b>  <b>After cooler is integral part of compressor</b>  <b>Capacity of High pressure Compressor - 250 Nm<sup>3</sup>/hr</b></p>

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2.	/PC183/E/4004/ SEC-VI- 2.0	6 of 10		<p><b>2.5.12 Instrument Air Receiver</b>            No. 1            Capacity By Bidder            Hold up time each receiver 30 min each            Max Pressure 36.5 kg/cm2g            Min Pressure 8 Kg/cm2g</p> <p><b>2.5.13 HP Compressor :No 1</b>            Type Reciprocating            Discharge Pressure 40 Kg/cm2g            Capacity By Vendor</p>	A	<p><del>2.5.12 Instrument Air Receiver</del> <b>HP Instrument Air emergency Receiver: 1No.</b>            Capacity By Bidder            Hold up time: 30 min            Max Pressure 36.5 kg/cm2g            Min Pressure 8 Kg/cm2g</p> <p><b>2.5.13 HP Compressor: 1 No</b>            Type Reciprocating            Discharge Pressure 40 Kg/cm2g            Capacity: 250 Nm3/hr</p> <p><b>2.5.14 Low pressure wet air receiver: 1 No</b>            Hold up time both receiver 8 seconds            Max Pressure 9.5 kg/cm2g            Min Pressure 8 Kg/cm2g</p> <p><b>2.5.15 Instrument Air Receiver: 1 No.</b>            Capacity By Bidder            Hold up time: 5 seconds            Max Pressure 8.8 kg/cm2g            Min Pressure 8 Kg/cm2g</p>																																																																																																						
3.	PC183/E/4008/SEC-VI/PART-3.2.1 (SOW)	3 of 3	1.1	SURFACE PREPARATION	A	<b>Painting chapter (6.0) is provided</b>																																																																																																						

4.	Design Specification Rotating (PC183/E/4008/SEC-VI/PART-3.2.2)	9 of 10	3.5 HVAC System:	Design Specification Rotating (PC183/E/4008/SEC-VI/PART-3.2.2)	A	Instrument Air/Plant Air control room shall be inside the CCR-2, which is located adjacent to Urea-Ammonia Plant electrical substation..  HVAC is not in bidder's scope.
5.	Section-VI-3.4  Design Philosophy- Instrumentation  INSTRUMENT AIR/PLANT AIR SYSTEM	547 of 959 of NIT  or Sheet 8 of 87 Design philosophy - Instrumentation	3.4	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  ✓ Statutory requirements and codes & standards	M	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:  ✓ .Design philosophy –Instrumentation  ✓ General specification  ✓ Licensor recommendation  ✓ Statutory requirements and codes & standards
6.	<b>DOCUMENT NO PC183/E/4008/SEC-VI/PART-3.1</b>	page 3 of 8	3.1	1.0GENERAL: The plants shall be designed to operate safely and satisfactorily at a capacity of 50 to 110% of Design Capacity	A	The plants shall be designed to operate safely and satisfactorily at a capacity of 50 to 105% of Design Capacity
7.		page 7 of 8	3.1	7.0 COMPRESSORS: In general, compressors shall be designed to a minimum of 110 % of their maximum required flow.	A	The plants shall be designed to operate safely and satisfactorily at maximum capacity of 105% of Design Capacity
8.	2.5 Equipment Specifications 2.5.1 Air Compressor	page 3 of 10	2.5.1	Capacity Control 0-100%	A	Capacity control for centrifugal compressor shall be in the range of 80-100%
9.	Scope of Work(PC183/E/4008 /SEC -VI/PART-1.0)	10 of 13	<b>1.1 GENERAL DESCRIPTION OF PACKAGE</b>	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.	D	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.
10.	Technical Specification (PC183/E/4008/SEC -VI/PART-2.0)	5 of 10	2.5.4 Adsorber	Desiccant: Molecular sieves.	A	Desiccant Alumina is used in place of molecular sieve for instrument air dryer system.



**INSTRUMENT AIR & PLANT AIR SYSTEM AT TALCHER, ODISHA (INDIA)**  
**NIT No. PNMM/PC-183/E/4008/NCB Dated 24.05.2021**  
**AMENDMENT- 1 Technical, Date : 05-07-2021**



11.	Technical Specification (PC183/E/4008/SEC - VI/PART-2.0)	8 of 10	3.2 Performance guarantee and trial run:	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.		Sustained load test shall be as per as per NIT as stipulated in clause no -3.2 sec-vi/part-2.0																																								
12.	Technical Specification (PC183/E/4008/SEC - VI/PART-2.0)	9 of 10 & 10 of 10	Clause No 3.4	<p><b>Guarantee of Utilities:</b></p> <p><b>Bidder shall guarantee performance of Instrument air/plant air system for the following:</b></p> <ul style="list-style-type: none"> <li>➤ Capacity of Instrument air/plant air system.</li> <li>➤ Total Power consumption</li> <li>➤ Cooling water consumption</li> <li>➤ Operating cost</li> </ul> <table border="1" data-bbox="759 995 1359 1205"> <thead> <tr> <th>Sl.No</th> <th>Raw Material/ Utilities</th> <th>Unit Price in Rs.</th> <th>Consumption per day for required capacity as per Specification</th> <th>Cost Rs. per day</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Cooling water,m<sup>3</sup></td> <td>37.75/m<sup>3</sup></td> <td></td> <td></td> </tr> <tr> <td>2.</td> <td>Power for Air Compressor, kWh</td> <td>5.915/Kwh</td> <td></td> <td></td> </tr> <tr> <td colspan="5"><b>Guaranteed operating Cost</b></td> </tr> </tbody> </table> <p>Note:</p> <ol style="list-style-type: none"> <li>1. All Guaranteed Consumptions including power &amp; chemicals if any and Cost shall be indicated in price schedule and indicate figures to be furnished in technical bid.</li> <li>2. Performance guarantee test run of Air Compressor shall be performed at rated capacity.</li> <li>3. The power consumption (power at motor input) at full Load of one compressor including auxiliaries (8000 Nm<sup>3</sup>/hr at 9.5.0Kg/cm<sup>2</sup> g).</li> <li>4. Total cooling water requirement for complete instrument air system at full Load with one compressor &amp; dryer working.</li> <li>5. The power consumption at full Load of one Air Dryer (8000 Nm<sup>3</sup>/hr for TFL).</li> <li>6. Bidder shall submit following separately in hard copy, which shall be evaluated by TFL/PDIL before price bid opening:</li> </ol>	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 <sup>3</sup>	37.75/m <sup>3</sup>			2.	Power for Air Compressor, kWh	5.915/Kwh			<b>Guaranteed operating Cost</b>					A	<p><b>Guarantee of Utilities:</b></p> <p><b>Bidder shall guarantee performance of Instrument air/plant air system for the following utilities:</b></p> <ul style="list-style-type: none"> <li>➤ <del>Capacity of Instrument air/plant air system. To be deleted</del></li> <li>➤ Total Power consumption</li> <li>➤ Total Cooling water consumption</li> <li>➤ <del>Operating cost</del> Guarantee work cost shall be calculated on the basis of total consumptions figure as furnished by bidder in the price bid:</li> </ul> <table border="1" data-bbox="1857 995 2487 1205"> <thead> <tr> <th>Sl.No</th> <th>Raw Material/ Utilities</th> <th>Unit Price in Rs.</th> <th>Consumption per day for required capacity as per Specification</th> <th>Cost Rs. per day</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Cooling water,m<sup>3</sup></td> <td>37.75/m<sup>3</sup></td> <td></td> <td></td> </tr> <tr> <td>2.</td> <td>Power for Air Compressor, kWh</td> <td>5.915/Kwh</td> <td></td> <td></td> </tr> <tr> <td colspan="5"><b>Guaranteed work Cost</b></td> </tr> </tbody> </table> <p>Note:</p> <ol style="list-style-type: none"> <li>1. All Guaranteed Consumptions including power &amp; cooling water Cost shall be indicated in price schedule and indicate figures to be furnished in technical bid.</li> <li>2. Performance guarantee test run of Air Compressor shall be performed at rated capacity for two running centrifugal air compressors, one air dryer in line and one regeneration heater in line.</li> <li>3. The power consumption (power at motor input) at full Load of two air compressors including auxiliaries (8000 Nm<sup>3</sup>/hr at 9.5 Kg/cm<sup>2</sup> g).</li> <li>4. Total cooling water requirement for complete instrument air system at full Load with all three centrifugal compressors (2 working and one stand by) &amp; two dryers (one working and one stand by).</li> <li>5. The power consumption at full Load of one Air Dryer and one regeneration heater in line (at 8000 Nm<sup>3</sup>/hr instrument air flow).</li> <li><del>6. Bidder shall submit following separately in hard copy, which shall be evaluated by</del></li> </ol>	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 <sup>3</sup>	37.75/m <sup>3</sup>			2.	Power for Air Compressor, kWh	5.915/Kwh			<b>Guaranteed work Cost</b>				
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13.	Technical Specification (PC183/E/4008/SEC - VI/PART-2.0)	3 of 10	2.4	Hazardous Area Classification: In general Area classification shall be in accordance with IS 5572 along with latest update.	M	IA/PA plant is located in SAFE AREA i.e. Non Hazardous area, however bidder to note that area Classification class for instrumentation shall be per NIT.
14.	<b>WORKDOCUMENT NOPC183/E/4008/ SEC-VI/PART-1.0</b>	6 OF 13, 8 of 13	Point O, 2.5.3	<ul style="list-style-type: none"> <li>➤ Supply of mandatory (spare parts for two year operation) and commissioning spares attached elsewhere in bid package.</li> <li>• Mandatory spare parts list (Separate lump sum price to be quoted).</li> <li>• List of 2 (two) years recommended normal operating spares. (As per commercial part of tender)</li> </ul>	A	<ul style="list-style-type: none"> <li>➤ Supply of mandatory (spare parts for two year operation &amp; maintenance) <del>and commissioning spares attached elsewhere in bid package.</del></li> <li>To be deleted</li> <li>• Mandatory spare parts (for two year operation &amp; maintenance) are included in bid document.</li> <li><del>• List of 2 (two) years recommended normal operating spares. (As per commercial part of tender)</del></li> <li>To be deleted</li> <li>• Erection and commissioning spare shall be included in the base price of the bid document</li> <li>• Recommended spare parts (only list not spare parts) with unit price shall be provided by bidder with a validity of two years as per the past experience for smooth operation of package system</li> </ul>
15.	PC183/E/4008/SEC-VI/PART-3.2.1 (SOW)	Page 3 of 3	1.1	<ul style="list-style-type: none"> <li>• Supply of mandatory (spare parts for two year operation) and commissioning spares attached elsewhere in bid package.</li> </ul>	A	<ul style="list-style-type: none"> <li>• Supply of mandatory spare parts (for two year operation &amp; maintenance) by bidder</li> <li>• Erection and commissioning spare shall be included in the base price of the bid document</li> <li>• Recommended spare parts (only list not spare parts) with unit price shall be provided by bidder with a validity of two years as per the past experience for smooth operation of package system</li> </ul>
16.		Page 21 of 39	9.0	<p><b>9.0 Spares (Erection &amp; commissioning, 2 years operation &amp; Special Spares etc.)</b></p> <p><b>9.1 COMMISSIONING SPARES</b></p> <p>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.</p> <p><b>9.2 SPARES FOR 2 YEARS OPERATION</b></p> <p>9.2.1 2 years operation spares shall be supplied by the contractor as per Section-5 of Bid.</p>	A	<p><del>9.0 Spares (Erection &amp; commissioning, 2 years operation &amp; Special Spares etc.)</del></p> <p><del>9.1 COMMISSIONING SPARES</del></p> <p><del>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.</del></p> <p><del>9.2 SPARES FOR 2 YEARS OPERATION</del></p> <p><del>9.2.1 2 years operation spares shall be supplied by the contractor as per Section-5 of Bid.</del></p> <p><b>To be deleted</b></p> <p><b>To be followed as per amended Sl. no 15</b></p>

17.	PC183/E/4008/SEC-VI/PART-3.2.2	Page 10 of 10	5.0	<p><b>5.0 SPARES</b></p> <p>5.1 All erection &amp; commissioning spares shall be supplied by Bidder &amp; cost shall be included in the cost of main equipment.</p> <p>5.2 2 years operation spares / recommended spares, Mandatory spares etc shall be supplied by the contractor as per NIT.</p>	A	<p><del>5.0 SPARES</del></p> <p><del>5.1 All erection &amp; commissioning spares shall be supplied by Bidder &amp; cost shall be included in the cost of main equipment.</del></p> <p><del>5.2 2 years operation spares / recommended spares, Mandatory spares etc shall be supplied by the contractor as per NIT.</del></p> <p><b>To be deleted</b></p> <p><b>To be followed as per amended Sl. no 15</b></p>
18.	PC183/E/4008/SEC-VI/PART-3.3	Page 7 of 9	11.0	<p><b>11.0 SPARES</b></p> <p>11.1 Spares for operation and maintenance Item wise unit prices of spare parts shall be quoted.</p> <p>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.</p> <p>11.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.</p> <p>11.4 All spare parts shall be identical to the parts used in the equipment.</p>	A	<p><del>11.0 SPARES</del></p> <p><del>11.1 Spares for operation and maintenance Item wise unit prices of spare parts shall be quoted.</del></p> <p><del>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.</del></p> <p><b>To be deleted</b></p> <p>11.3 Any other spare parts not specified, but required, shall also be quoted along with the recommended spares list with price for two years validity.</p> <p>11.4 All spare parts shall be identical to the parts used in the equipment.</p> <p><b>To be followed as per amended Sl. no 15</b></p>
19.		Page 11 of 12	14.0	<p><b>14.0 SPARES</b></p> <p>14.1 Spares for operation and maintenance Item wise unit prices of spare parts shall be quoted.</p> <p>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.</p> <p>14.3 Any other spare parts not specified, but required, shall also be quoted along with the offer.</p> <p>14.4 All spare parts shall be identical to the parts used in the motors.</p>	A	<p><del>14.0 SPARES</del></p> <p><del>14.1 Spares for operation and maintenance Item wise unit prices of spare parts shall be quoted.</del></p> <p><del>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.</del></p> <p><b>To be deleted</b></p> <p>14.3 Any other spare parts not specified, but required, shall also be quoted along with the recommended spares list with price for two years validity..</p> <p>14.4 All spare parts shall be identical to the parts used in the motors.</p> <p><b>To be followed as per amended Sl. no 15</b></p>
20.	PC183/E/4008/SEC-VI/PART-3.3  ES:8028  ELECTRICAL ERECTION, TESTING & COMMISSIONING	Page 7 of 50	3.4	<p>3.4 Spares as specified / recommended spares for 2 years operation and Commissioning shall be supplied for all equipments.</p>	A	<p>3.4 Spares as specified / recommended spares for 2 years operation and Commissioning shall be supplied for all equipments.</p> <p><b>To be deleted</b></p> <p><b>To be followed as per amended Sl. no 15</b></p>
21.	PC183/E/4008/SEC-VI/PART-3.3	Page 23 of 34 & 24 of 34	8.0	<p><b>8.0 SPARES</b></p> <p>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</p>	A	<p>8.0 SPARES</p> <p>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.</p> <p>8.2 Mandatory/Insurance spares Contractor shall supply Mandatory / Insurance spares</p>

				<p>be Part of Quoted Price.</p> <p>8.2 Mandatory/Insurance spares 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.</p> <p>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.</p> <p>17.1 All spare parts shall be identical to the parts used in the equipments.</p> <p>17.2 Any other spare parts or special tools not specified, but required, shall also be quoted along with the offer.</p>		<p>for all equipments as per Section 5.0: Spare Parts of this bid package. The same shall be Part Quoted Price.</p> <p><del>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.</del></p> <p>8.4 All spare parts shall be identical to the parts used in the equipments.</p> <p><del>8.5 Any other spare parts or special tools not specified, but required, shall also be quoted along with the offer.</del></p> <p><b>To be deleted</b>  <b>To be followed as per amended Sl. no 15</b></p>
22.	PC183/E/4008/SEC-VI/PART-3.4  2.0 Documentation	Page 10 of 87	2.0	<p>Sl No 5 of the table List of spares (item wise and quantity) for Commissioning and 2 years of operation</p>	A	<p>Sl No 5 of the table <del>List of spares (item wise and quantity) for Commissioning and 2 years of operation</del></p> <p><b>To be deleted</b></p> <p><b>To be followed as per amended Sl. no 15</b></p>
23.	PC183/E/4008/SEC-VI/PART-5.0	Page 3 of 20	1.0, 2.0	<p><b>1.0 SPARES PARTS FOR COMMISSIONING:</b> 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 &amp; Commissioning of the plants till the plant is handed over to the Owner after Performance Test. O&amp;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.</p> <p><b>2.0 SPARE PARTS FOR TWO YEARS OPERATION (MANDATORY SPARES):</b> LSTK Contractor shall supply spare parts as per list of spares for 2 years operation of the plant as detailed below:</p>	A	<p><b>1.0 SPARES PARTS FOR COMMISSIONING:</b> 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 &amp; Commissioning of the plants till the plant is handed over to the Owner after Performance Test. <del>O&amp;M spares for two years to be included in bidder's scope.</del> <del>Bidder shall also provide Pre-Commissioning and Commissioning Spare List along with their Bid.</del></p> <p><b>To be deleted</b></p> <p><del><b>2.0 SPARE PARTS FOR TWO YEARS OPERATION (MANDATORY SPARES):</b></del>  <b>MANDATORY SPARES LIST:</b>  <del>LSTK Contractor shall supply spare parts as per list of spares for 2 years operation of the plant as detailed below:</del></p>
24.	General Notes:  Spares				A	<ul style="list-style-type: none"> <li>Supply of mandatory spare parts (for two year operation &amp; maintenance) by bidder.</li> <li>Erection and commissioning spare shall be included in the base price of the bid document</li> <li>Recommended spare parts (only list not spare parts) with unit price shall be provided by bidder with a validity of two years as per the past experience for smooth operation of package system</li> </ul>
25.	PC183E/4008/SEC-VI/ PART-8.0	8 of 53	Vessel	VENDOR LIST(Static Equipments)	A	<p>Bidder shall select sub vendors from the vendor list as specified below except package Item*. Bidder shall ensure that sub vendor for the specified item has supplied item for the specified service &amp; the supplied item is in satisfactory service.</p> <p>Vendor shall have well proven record for the specified services and shall be subjected to</p>





**INSTRUMENT AIR & PLANT AIR SYSTEM AT TALCHER, ODISHA (INDIA)**  
**NIT No. PNMM/PC-183/E/4008/NCB Dated 24.05.2021**  
**AMENDMENT- 1 Technical, Date : 05-07-2021**



						<p>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 &amp; reliable record of performance for similar or Comparable plant design capacity by LSTK contractor.</p> <p>* LSTK bidder to furnish list of proven sub-suppliers for static equipment within the package Item with PTR (proven track record) &amp; requisite documents subject to owner's/consultant approval during detail engg. Documents &amp; PTR shall be in English language only.</p> <p>Integral static equipment in a package shall be fabricated by package vendor/ proven sub-suppliers.</p>
26.	DOCUMENT NOPC183/E/4008/SE C-VI/PART-3.2.1	6 of 39	1.24 & 1.25	Design criteria	D	1.24 & 1.25 -IBR is not applicable.
27.	DOCUMENT NOPC183/E/4008/SE C-VI/PART- 3.2.1(SOW)	2 of 3	1.0	<p><b>Scope of work</b></p> <p>a) Complete mechanical design &amp; thermal design (For heat exchanger).  b) Detailed engineering of equipment including all mountings, accessories &amp; bought-out items.  c) Procurement of all materials &amp; bought out items.  d) Shop/site fabrication ( as applicable) &amp; 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 &amp; 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.</p>	M	<p><b>Scope of work</b></p> <p>Bidder scope of Work (For Static Equipment) shall include but shall not be limited to following:  a) Complete mechanical design &amp; thermal design (For heat exchanger).  b) Detailed engineering of equipment including all mountings, accessories &amp; bought-out items.  c) Procurement of all materials &amp; bought out items.  d) Shop/site fabrication ( as applicable) &amp; assembly  e) Route survey, if required  f) Design and supply of Anchor bolt  g) Inspection, testing (including hydro testing)  h) <del>Surface preparation, painting , insulation, pickling and Passivation (for SS equipments);</del>  Surface preparation, painting, insulation shall be required.  Equipment will be dispatched with primer painting, surface preparation e.t.c from shop and internal &amp; external coating if required shall be provided by bidder. Equipment and material for blast cleaning, chemical cleaning, pickling, Passivation is not required.  i) Packing (seaworthy when sea transportation) forwarding, transportation to site etc.  j) N2 filling of equipment (Point No 14 to be followed)  K) Storage and preservation at site is under bidder's scope  l) Support for Statutory approvals (PESO e.t.c), for high pressure vessels code/standards shall be applicable along with PESO approval if required.  m) Stage wise and final inspection by appointed TPIA/Owner  n) <del>Fire proofing as per requirement of the bid package</del>  o) Any other requirement for safe and smooth operation shall be provided by bidder  p) Submission of engineering drawing &amp; 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" .</p> <p>The above mentioned activities shall be carried out in accordance with applicable code and all technical requirements covered in the bid package.</p>
28.	WORKDOCUMENT NOPC183/E/4008/SE	6 of 13		<p><b>Scope of work</b></p> <p>j) N2 filling of equipment</p>	M	J) All process equipments shall be supplied with Nitrogen filled. In case of equipment

	C-VI/PART-1.0			<p>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:</p> <ul style="list-style-type: none"> <li>➤ Supply of static equipment ( Vessels, heat exchanger, Tanks, PHE etc) including their accessories</li> <li>➤ Supply of all fabricated and proprietary internals for all equipment as applicable.</li> <li>➤ Supply of mandatory (spare parts for two year operation) and commissioning spares attached elsewhere in bid package.</li> <li>➤ Insulating material, primer paints, fire proofing material etc.</li> <li>➤ Supply of material &amp; equipment required for blast cleaning, chemical cleaning, pickling, Passivation, surface preparation &amp; polishing &amp; coating of internal surface, epoxy coating, rubber lining, and FRP lining e.t.c. for equipment as applicable.</li> <li>➤ Supply of all equipments , tool &amp; 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)</li> <li>➤ Supply of all tools and tackles, template for foundation for heavy lift equipment and for the erection for all equipment.</li> <li>➤ Eye bolts, jack screws, dowel pins and lifting lugs etc. as required</li> <li>➤ Lifting lugs / erection lugs</li> <li>➤ Cleats for earthing connections</li> <li>➤ Cover flanges for manholes, handholes, inspection openings etc. with bolting and gaskets.</li> <li>➤ Supply of all other materials whether specifically mentioned or not but required for</li> <li>➤ completion of the job in all respect as per bid package.</li> <li>➤ Name plate with bracket</li> </ul> <p>The above mentioned activities shall be carried out in accordance with applicable code and all technical requirements covered in the bid package</p>		<p>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.  As per Page No 5 of 39 , PC183/E/4008/SEC-VI/PART-3.2.1</p> <p>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:</p> <ul style="list-style-type: none"> <li>➤ Supply of static equipment ( Vessels, heat exchanger, Tanks, PHE etc) including their accessories</li> <li>➤ Supply of all fabricated and proprietary internals for all equipment as applicable.</li> <li>➤ Supply of mandatory (spare parts for two year operation) and commissioning spares attached elsewhere in bid package.</li> <li>➤ <b>Insulating material, primer paints etc. if any</b></li> <li>➤ <del>Supply of material &amp; equipment required for blast cleaning, chemical cleaning, pickling, Passivation, surface preparation &amp; polishing &amp; coating of internal surface, epoxy coating, rubber lining, and FRP lining e.t.c. for equipment as applicable.</del>  Equipment will be dispatched with primer painting, surface preparation e.t.c from shop and internal &amp; external coating, FRP lining e.t.c. if required shall be provided by bidder. Equipment and material for blast cleaning, chemical cleaning, pickling, Passivation is not required.</li> <li>➤ Supply of all equipments , tool &amp; tackles including torque wrench, bolt tensioned etc. as per specification. <del>and all material required for inspection and testing ( i.e. NDT, Hydro testing, performance testing e.t.c)</del></li> <li>➤ <del>Supply of all tools and tackles, template for foundation for heavy lift equipment and for the erection for all equipment.</del> Supply of template for foundation for heavy lift equipment.</li> <li>➤ Eye bolts, jack screws, dowel pins and lifting lugs etc. as required</li> <li>➤ Lifting lugs / erection lugs</li> <li>➤ Cleats for earthing connections</li> <li>➤ Cover flanges for manholes, hand holes, inspection openings etc. with bolting and gaskets.</li> <li>➤ Supply of all other materials whether specifically mentioned or not but required for completion of the job in all respect as per bid package.</li> <li>➤ Name plate with bracket</li> </ul> <p>The above mentioned activities shall be carried out in accordance with applicable code and all technical requirements covered in the bid package</p>
29.	PC150/E/4004/P-VI-3.3  Design Specification- Electrical	3 of 34			A	Following Attachment has been added : PC183-TS-0820A Technical Specification – High Voltage Variable Frequency Drives
30.	PC150/E/4004/P-VI-3.3	4 of 34	1.3		M	HV Motor Soft starter

	Design Specification- Electrical					To be read as.....  HV Motor VFD  Remaining part of clause shall remain unchanged
31.	PC150/E/4004/P-VI- 3.3  Design Specification- Electrical	16 to 18 of 34	5.6	HV Motor Starter	D	Complete clause 5.6 and 5.7 deleted.
32.	PC150/E/4004/P-VI- 3.3  Design Specification- Electrical				A	<p>New Clause 5.11</p> <p>5.11 Variable Speed Drives (VSD/VFD)</p> <p>5.11.1 Microprocessor based variable speed drive shall be communicable type and shall be able to communicate with ECMS/DCS. It shall be possible to set speed from process DCS for optimum performance through 4-20 mA signal. Speed/current/status feedback to DCS shall be provided. Drive will run at preset speed in the event of loss of signal from DCS.</p> <p>5.11.2 System shall be highly reliable, efficient and shall provide high power factor, low harmonic distortion, low noise level etc.</p> <p>5.11.3 System shall be provided with complete by pass circuit to ensure the power supply reliability in case of VSD/VFD failure. It shall be possible to start the motor in DOL mode through by-pass system in case there is any problem/fault in the VFD. The Electrical system and the process should be capable to operate the Motor in fixed speed (without VFD).</p> <p>5.11.4 The system shall be suitable for load characteristics, continuous speed control. Drive shall be able to accelerate the load over the full speed range (0 – 100 %) with incoming line voltage regulation of 10%.</p> <p>5.11.5 The system shall be designed for 150% over current withstand for 1 minute. The system shall be equipped with an automatic restart facility which will restart the system in case of voltage dip over 20% or power interruptions less than 4 seconds and recovery of voltage to 95% with a facility to block the automatic restart.</p> <p>5.11.6 The system shall be suitably designed with due care for long length of cables,</p>

						<p>output filters, chokes, motor insulation, cable voltage grades etc.</p> <p>5.11.7 The VSD panel shall be located in the clean air conditioned room in the substation. Required local control equipment shall have start, stop speed raise and lower push buttons, ammeter, speed indicator, ON/OFF/READY status selector switches as required and shall be installed near the motor.</p> <p>5.11.8 The VFD shall be provided with Input and Output transformer. To prevent harmonics in the station supply 12 pulse rectifier shall be deployed at Input of the VFD.</p> <p>5.11.9 "Auto Restart" facility for drive system within preset time, typically 0-15 seconds, in case of supply system dip or complete loss of power shall be provided.</p> <p>5.11.10 Preferably screened type cables or cables as recommended by VSD/VFD vendors shall be used for VSD/VFD systems.</p> <p>5.11.11 The VSD/VFD panels to be supplied shall be of proven model.</p> <p>5.11.12 Training of VSD/VFD shall be provided to owner personnel.</p> <p>5.11.13 For all other specifications, refer PC183-TS-0820A.</p>																																																
33.	PC183/E/4008/SEC-VI/ PART-5.0  Spare Parts	8 & 9 of 20	5.0		M	<table border="1"> <tr> <td>5.0</td> <td>SOFT STARTER</td> <td></td> </tr> <tr> <td>A.</td> <td>PCMU</td> <td>1 Set</td> </tr> <tr> <td>B.</td> <td>Control cards (10% or minimum 1 set of each type &amp; model)</td> <td>1 Lot</td> </tr> <tr> <td>C.</td> <td>Auxiliary Contactor (20% or minimum 1 set of each type &amp; rating)</td> <td>1 Lot</td> </tr> <tr> <td>D.</td> <td>Vacuum contactor</td> <td>1 Set</td> </tr> <tr> <td>E.</td> <td>Dynamic Compensator Contactor</td> <td>1 Set</td> </tr> <tr> <td>F.</td> <td>Surge Supressor</td> <td>1 Set</td> </tr> <tr> <td>G.</td> <td>MCB (20% or minimum 1 set of each type &amp; rating)</td> <td>1 Lot</td> </tr> <tr> <td>H.</td> <td>Space Heater</td> <td>1 No.</td> </tr> <tr> <td>I.</td> <td>VCB coil set (closing &amp; tripping)</td> <td>1 Set</td> </tr> <tr> <td>J.</td> <td>Spring charging motor of VCB</td> <td>1 No.</td> </tr> <tr> <td>K.</td> <td>Temperature Transducer</td> <td>1 Set</td> </tr> </table> <p><b>To be read as.....</b></p> <table border="1"> <tr> <td>5.0</td> <td>VARIABLE FREQUENCY DRIVES</td> <td></td> </tr> <tr> <td>A</td> <td>Complete unit of each type</td> <td>1 No.</td> </tr> <tr> <td>B</td> <td>Set of fuses of all types &amp; sizes used in system</td> <td>5 Sets</td> </tr> <tr> <td>C</td> <td>Software for parameter setting each type</td> <td>1 Set</td> </tr> </table>	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.	I.	VCB coil set (closing & tripping)	1 Set	J.	Spring charging motor of VCB	1 No.	K.	Temperature Transducer	1 Set	5.0	VARIABLE FREQUENCY DRIVES		A	Complete unit of each type	1 No.	B	Set of fuses of all types & sizes used in system	5 Sets	C	Software for parameter setting each type	1 Set
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**INSTRUMENT AIR & PLANT AIR SYSTEM AT TALCHER, ODISHA (INDIA)**  
**NIT No. PNMM/PC-183/E/4008/NCB Dated 24.05.2021**  
**AMENDMENT- 1 Technical, Date : 05-07-2021**



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M: MODIFICATION, A: ADDITION, D: DELETION

Note: - The clauses in Amendment shall take precedence/superseded over all other pre bid replies against the respective clause.

	<b>INSTRUMENT AIR/PLANT AIR SYSTEM TALCHER FERTILIZERS LIMITED</b>  <b>PAINTING SPECIFICATION (TS-2001)</b>	PC183/E/4008/VI/6.0	0	
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**PAINTING SPECIFICATION (TS-2001)**  
**FOR**  
**INSTRUMENT AIR/PLANT AIR SYSTEM**  
**AT**  
**TALCHER FERTILIZERS LIMITED**

0	03.11.2020	FOR ISSUANCE	JKY	JKY/GC	GC
REV	REV ATE	PURPOSE	PREPD	REVWD	APPD

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## 1.0 GENERAL

### 1.1 Scope

This specification covers the technical requirements for shop and site application of paint and protective coatings and includes; the surface preparation, priming, application, testing and quality assurance for protective coatings of mechanical equipment, structural steelwork, plate work, tankage, guards, pipe work, handrails and associated metal surfaces, which will be exposed to atmospheric for the Project.

### 1.2 Definitions

C.S	-	Carbon steel and low chrome (1- <sup>1</sup> / <sub>4</sub> Cr through 9 Cr) alloys
S.S	-	Stainless steel, such as 304,316, 321, 347,
Non-ferrous	-	copper, aluminium and their alloys.
High Alloy	-	Monel, Inconel, Incoloy, Alloy 20, Hastelloy, etc.
DFT	-	Dry Film thickness, the thickness of the dried or cured paint or coating film.

### 1.3 Safety Regulations

Protective coatings and their application shall comply with all national, state, and local codes and regulations on surface preparation, coating application, storage, handling, safety, and environmental recommendations.

Sand or other materials producing silica dust shall NOT be used for any open-air blasting operations.

### 1.4 Material Safety Data Sheets

The latest issue of the coating manufacturer's product datasheet, application instructions, and Material safety data Sheets shall be available prior to starting the work and shall be complied with during all preparation and painting / coating operations.

### 1.5 Materials

All paints and paint materials shall be obtained from the company's approved manufacturer's list. All materials shall be supplied in the manufacturer's containers, durably and legibly marked as follows.

- Specification number
- Colour reference number
- Method of application
- Batch number
- Date of Manufacture
- Shelf life expiry date
- Manufacturer's name or recognised trade mark.

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## 2.0 CODE AND STANDARDS:

Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, the following codes & standards shall be followed. Wherever reference to any code is made, it shall correspond to the latest edition of the code.

### 2.1 Indian Standards:

IS-5: 1994	Colors for ready mixed paints and enamels.
IS-2379: 1990	Color codes for identification of pipe lines.
IS-2629: 1985	Recommended practice for hot-dip galvanizing on iron and steel.
IS-2633: 1986	Methods for testing uniformity of coating of zinc-coated articles.
IS-8629: 1977	Code of practice for protection of iron and steel structures from atmospheric corrosion.
IS:110	Specification for Ready Mixed Paint, Brushing, Grey Filler, for Enamels, for Over Primers
IS:101	Methods of test for ready mixed paints & enamels.

### 2.2 Other Standards:

2.2.1 Swedish Standard: SIS-05 5900-1967 / ISO-8501-1-1988  
(Surface preparations standards for Painting Steel Surface).

This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-charge.

2.2.1 DIN: 53151 Standards for Adhesion test.

**2.3** The paint manufacturer's, instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

- a) Instructions for storage to avoid exposure as well as extremes of temperature.
- b) Surface preparation prior to painting.
- c) Mixing and thinning.
- d) Application of paints and the recommended limit on time intervals between coats.

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### 3.0 SURFACE PREPARATION

#### 3.1 Metal Surface Preparation

##### 3.1.1 Safety

All work in adjacent areas, which may negatively affect the quality of blast cleaning, and/or impose safety hazards, must be completed or stopped before the blasting operation starts.

##### 3.1.2 Pre-cleaning

Prior to surface preparation all weld spatter shall be removed from the surface, all sharp edges ground down and all surfaces cleaned free of contaminants including chalked paint, dust, grease, oil, chemicals and salt. All shop primed surfaces shall be water washed by means of suitable solvent, by steam cleaning, with an alkaline cleaning agent if necessary or by high-pressure water, to remove contaminants prior to top-coating

##### 3.1.3 Surface Decontamination

Surface decontamination shall be performed prior to paint application when uncoated surface is exposed to a corrosive environment or existing paint work is to be repaired.

Existing coatings shall be removed by abrasive blast cleaning, and then high pressure potable water shall be used to clean steel surfaces.

Prior to application of coatings, the surface shall be chemically checked for the presence of contaminants. A surface contamination analysis test kit shall be used to measure the levels of chlorides, iron salts and pH in accordance with the kit manufacturer's recommendations.

Swabs taken from the steel surface, using cotton wool test swabs soaked in distilled water shall not be less than one swab for every 25m<sup>2</sup> of surface area to be painted.

Maximum allowable contaminant levels and pH range is as follows:

Sodium chloride, less than 50 microgram / cm<sup>2</sup>;

Soluble iron salts, less than 7 microgram / cm<sup>2</sup>; and

If the results of the contamination test fall outside the acceptable limits, then the wash water process shall be repeated over the entire surface to be painted, until the contaminant test is within the specified levels.

##### 3.1.4 Abrasive Blasting

All C.S. materials shall be abrasive blast cleaned in accordance with Codes (Ref. Clause 2.0). To reduce the possibility of contaminating S.S., blasting is not usually specified. However, for coatings which require a blast-cleaned surface for proper adhesion, S.S. may be blast cleaned using clean aluminium oxide or garnet abrasives (Free from any chloride or Iron / Steel contamination). When hand or power tool cleaning is required on S.S., only S.S. wire-brushes (including 410 S.S.) which have not been previously used on C.S. surfaces may be used.

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The surface profile of steel surfaces after blasting shall be of preparation grade Sa 2-1/2 of Swedish Standards SIS-05-5900 (Latest Revision) or better according to ISO 8501-1 and shall be measured using the replica tape method or the comparator method.

The roughness (profile) of blast-cleaned surfaces shall be Medium (G) according to ISO 8503-2: 1988 (appendix 1) unless otherwise specified. Medium defines a surface profile with a maximum peak-to-valley height of 60-100 microns, and G indicates that the surface profile is obtained by grit blasting. For the evaluation of surface roughness Comparator G shall be used.

Abrasive blast cleaning shall NOT be performed when the ambient or the substrate temperatures are less than 3° C above the dew point temperature. The relative humidity should preferably be below 50% during cold weather and shall never be higher than 60% in any case.

Abrasive blast cleaning shall be performed with a clean, sharp grade of abrasive. Grain size shall be suitable for producing the specified roughness. Abrasives shall be free from oil, grease, moisture and salts, and shall contain no more than 50ppm chloride. The use of silica sand, copper slag and other potentially silica containing materials shall not be allowed

The blasting compressor shall be capable of maintaining a minimum air pressure of 7 kPa at the nozzle to obtain the acceptable surface cleanliness and profile.

The blast cleaning air compressor shall be equipped with adequately sized and properly maintained oil and water separators. The air supply shall be checked to ensure no oil and water contamination at the beginning of each work shift.

Blast cleaning abrasive shall be stored in a clean, dry environment at all times. Recycling of used abrasive is prohibited.

After blast cleaning, the surfaces shall be cleaned by washing with clean water (Pressure 7kg/Cm<sup>2</sup> using suitable nozzles. During washing broom corn brushes shall be used to remove foreign matter.

Assessment of the blast cleaned surfaces shall be carried out in accordance with reference code.

Blast cleaned surfaces which show evidence of rust bloom or that have been left uncoated overnight shall be re-cleaned to the specified degree of cleanliness prior to coating.

All grit and dust shall be removed after blasting and before coating application. Removal shall be by a combination of blowing clean with compressed air, followed by a thorough vacuum cleaning with an industrial grade, heavy duty vacuum cleaner.

All cleaned surfaces shall have protection from atmospheric corrosion as per IS8629:1977

### 3.1.5 Alternate Methods of Surface Preparation

When open air blasting is not permitted on site, or when space limitations or surface configurations preclude blasting, the alternate cleaning methods listed below may be used with prior approval. Alternate cleaning methods shall consider the degree of surface cleanliness and roughness profile required by the specified coating system.

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- Vacuum or suction head abrasive blast-cleaning,
- Wet jet abrasive blast-cleaning,
- Compressed-air wet abrasive blast cleaning,
- Pressurized liquid blast-cleaning,
- Power tool cleaning,
- Hand or power tool cleaning,

Hand and/or power tool cleaning shall only be used for spot repair where abrasive blasting is not permitted or is impractical, and on items which could be damaged by abrasive blasting. Power tool cleaning shall not be carried out with tools which polish the surface, e.g. power wire brushes.

The surfaces of equipments and prefabricated piping etc. which are received at site Primerised or with finish paints, depending upon their conditions, shall be touched up and painted at site. For these surfaces sand blasting is not envisaged and these surfaces shall be prepared using power brushes, buffing or scraping, so as to achieve a surface finish to St-3 as per SIS-05-5900 . After wash-up the area to be touched up shall be jointly marked, measured and recorded for payment purposes. The type of system & nos. of coat (primer and/or finish paint) to be applied after touch up, which shall be decided by OWNER/CONSULTANT in writing before taking up the job.

When paint is to be applied on damaged painted surfaces of equipments all loose and flaking paint work should be removed to a firm feathered edge. Rusted spots should be cleaned by one of the methods specified in the clauses 4.4.1 & 4.4.2 above. In case the previous paint work is not compatible to the specified one the entire coating must be removed.

It shall be ensured that sand blasted surface/machine cleaned surface is not contaminated with oil and grease. Water shall also not be allowed to come in contact with sand blasted surface.

#### **4.0 APPLICATION**

##### **4.1 General**

The final specification of paint systems to be used to suit the exposure conditions of equipment and steelwork, shall be as specified on the scope of work, equipment data sheets or the drawings.

All coatings shall be in accordance with Indian / International Standards, the coating manufacturer's product data sheets and application instructions and the requirements contained in this specification.

##### **4.1.1 General Requirements for Shop Application**

All work areas which facilitates shop paint application shall be surface prepared for painting and have the paint system applied before installation.

Equipments assembled at site shall only receive primer coat in the shop and finish coatings will be applied at site.

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In all cases, where surfaces will be inaccessible after shop assembly, they shall be prepared and have the paint system applied before assembly is carried out. Drying times between successive coats shall be at least those recommended by the manufacturer.

All known field weld areas shall be given the specified abrasive blast surface preparation but left uncoated for a distance of 50mm from the weld line. Such areas shall be given the appropriate touch-up treatment after installation.

The manufacturer's directions for preparation and application of coatings shall be followed to ensure that the durability of the coating system is not impaired.

The Contractor shall submit the full details of the proposed surface preparation and paint systems prior to the commencement of any surface preparation.

#### 4.1.2 General Requirements for Site Application

Paint shall be stored only in accordance with the manufacturer's instructions.

All materials used for the specific system being applied shall be products supplied by one manufacturer and details of such product shall be submitted for approval before commencement of work.

The contents of cans shall be thoroughly stirred before being poured into paint pots and shall be thinned only in the specified proportions in accordance with the manufacturer's instructions.

Finish coats may be applied by spraying except where any over spray is likely to affect finished surfaces or where spraying constitutes a health hazard to workmen in the other areas. Brush and roller application will require multiple coats to achieve the specified dry film thickness.

Brush application may be used only with the approval of the company.

Roller application shall only be used on relatively large surface areas ( i.e. > 50m<sup>2</sup>) and only if spraying is not an option.

The Contractor shall complete the application of any one type of paint or each coat thereof, before beginning the next coat on that section.

In cases nominated as critical, the application of each coat shall be approved before application of the next coat can proceed, in accordance with 'hold' points nominated in the Inspection and Test Plans (ITPs)

All fittings within any given area are to be painted with the same system as the area unless otherwise specified.

Where 2 coat of finish paint are indicated they shall be applied in two different shades to ensure that two coat are applied.

Paint shall not be applied in rain, snow, fog or mist or when the relative humidity is such as to cause condensation on metal surface.

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The CONTRACTOR must ensure the availability of a specialist from the paint manufacturer, at SITE during pendency of CONTRACT within his quoted rates to ensure the quality of painting & procedure. Addition of drying agents, pigments or other substances is not allowed unless specifically prescribed or approved by paint manufacturer's specialist.

Name plates/tags attached to the equipments/machineries shall not be painted or removed during painting job. Failing to comply with above, the CONTRACTOR may be required to replace name plates/tags at his cost.

#### **4.1.3 Qualifications and Materials**

All surface preparation, coatings application and inspection, shall be carried out by personnel experienced in that particular field. Contractors shall submit the names of subcontractors to be employed for the specific work together with the brand names of coating materials for approval prior to commencement of application.

#### **4.1.4 Handling and Transport**

All pipe work, steelwork and equipment that have been finish coated shall be handled with care to preserve the coating in the best practical condition.

Painted materials shall not be handled until the coating has completely cured and dried hard Supports in contact with coated steel during transport and storage shall be covered with a soft material to prevent damage to the coating. Appropriate materials shall be used during transportation between coated steelwork and holding down chains to prevent damage to the coating.

### **4.2 Application of Coatings**

#### **4.2.1 General**

The application method and type of equipment to be used shall be suitable for the paint specified and the surface being painted.

Paints and thinners shall be brought to the point of usage in unopened original containers bearing the manufacturer's brand name and colour designation and ready-mixed unless otherwise specified. Two-pack systems shall be mixed at the site of application to the paint manufacturer's recommendations. The mixed amount prepared shall be no more than the amount that can be applied during the stated pot life.

Paint shall be applied so that an even film of uniform thickness, tint and consistency covers the entire surface and is free of pin holes, runs, sags or excessive brush marks. Film finish shall be equal to that of first class brushwork.

Unless it is practical to do so colour shades for primer, intermediate coat and finish coat must be different to identify each coat without any ambiguity

Paint ingredients shall be kept properly mixed during paint application.

Equipment shall be kept clean to ensure dirt, dried paint and other foreign materials are not deposited in the paint film. Any cleaning solvents left in the equipment shall be completely removed before painting.

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To ensure the required film thickness is achieved on angles, welds, sharp external edges, nuts and bolts, a coat shall be applied to such items/locations immediately prior to the application of each coating to the whole area.

Care shall be taken to ensure paint application into all joints and crevices.

The contact surfaces between steelwork to be fastened by means of friction grip bolting shall be abrasive blast cleaned and prime coated only, prior to erection.

#### 4.2.2 Atmospheric conditions

Surface preparation and coating shall not be carried out in inclement weather and shall be carried out such that the surface being coated is free of moisture, wind-borne or blast cleaning dust.

Coatings shall not be applied if:

- The relative humidity exceeds 85%.
- The ambient temperature is less than 5<sup>0</sup>C (depending on local condition)
- The metal temperature is less than 3<sup>0</sup>C above the dew point.
- There is likely hood of an unfavourable change in weather conditions within two hours after painting.

As a general rule, sufficient ventilation, dehumidification and heating capacity to cope with local climatic conditions must be secured before any coating – related work is started.

In any case, humidity, ambient and surface temperature conditions at the time of paint application, and curing and drying time before application of the next coat, shall be in accordance with the paint manufacturer's recommendations. These conditions shall be recorded in the Inspection Test Record (ITR) by the Contractor and be available for review.

#### 4.2.3 Conventional or Airless Spray

Spray equipment shall be equipped with accurate pressure regulators and gauges. Spray gun nozzles and needles shall be those recommended by the paint manufacturer.

Air from the spray gun shall be clean and dry with no traces of oil or moisture.

Coatings shall be wet on contacting the painted surface. Areas of dry spray shall be removed and the correct system re-applied.

#### 4.2.4 Brush Application

The method of "laying-off" shall be suited to the paint specified and shall ensure minimum brush marking.



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#### 4.2.5 Roller Application

A uniform method of application shall be adopted when painting large areas. The rolling direction shall minimise paint joint build up. Edges and areas subject to possible roller damage shall be brush-painted prior to rolling.

#### 4.2.6 Thickness of Coatings

The maximum thickness DFT in any one application shall not exceed that specified in Technical specifications/ recommended by the paint manufacturer.

Wet film thickness gauges shall be used to make frequent checks on the applied wet film. The Contractor shall maintain at the site of painting operations, a dry film thickness tester of an approved type with a valid current calibration.

Coating thickness checks in accordance with reference code shall be performed, and the Contractor shall undertake remedial action if the measured thickness is less than specified.

Build up of each material to required thickness shall be made prior to the application of the subsequent coat; final film build shall be the minimum specified.

#### 4.2.7 Multiple Coat Applications (Except Wet-On-Wet)

Before successive paint coats are applied, intermediate coats shall be inspected for surface contamination. The presence of any grease or oil, shall be removed by a suitable solvent, and any salt and dirt adhering to the surface shall be removed by scrubbing with a solution of non-toxic detergent (except those prescribed by the manufacturer as "wet-on-wet"). Removal of contaminants shall only be performed after an intermediate coat has had sufficient time to cure.

The surface shall then be pressure hosed or dusted down by brush to disturb and remove deposits not apparent on visual inspection.

Coatings shall be applied only under the following conditions:

- The surface has been cleaned and is dry;
- The manufacturer's stated minimum time for re-coat has elapsed;
- The manufacturer's stated maximum time for re-coat has not elapsed. If the maximum time has elapsed then pre-treatment shall be in accordance with the paint manufacturer's recommendations; and

Damaged areas in preceding coat have been made good in accordance with this Specification.

When multiple coat of finish paint are indicated, they shall be applied in different shades to ensure that multiple coats have been applied.

#### 4.2.8 Protective Coatings for Fasteners

Black and galvanised erection bolts/nuts and galvanised holding down bolts/nuts shall be prepared and painted in accordance with Section 4.4 of this Specification.

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Black high tensile bolts/nuts shall be painted after erection to the same paint system specification as the surrounding structural steel.

### 4.3 Hot Dip Galvanising

All galvanising shall be carried out by the hot dipping process and conform to the requirements of IS-2629:1985 and uniformity of coating shall conform to IS 2633:1986.

All welding slag shall be removed by chipping, wire brushing, flame cleaning or abrasive blast cleaning where necessary prior to galvanising

For temporary identification, either water-soluble marking paints or detachable metal labels shall be used. For permanent identification, figures/labels shall be heavily punched or embossed by the fabricator.

For galvanised items after pickling, the work shall be inspected and any defects that render the work unsuitable for galvanising shall be repaired. After such repairs, the work shall again be cleaned by pickling.

The coating mass of zinc shall be as specified on equipment data sheets and the Drawings. Galvanised coatings shall be tested by the methods described in referred code.

After galvanising all material shall be cooled to air temperature in such a manner that no embrittlement occurs.

Galvanised coatings shall be smooth, uniform, adherent and free from stains, surface imperfections and inclusions.

All gratings and fixtures including nuts, bolts and washers that are required to be galvanised, shall be hot dipped galvanised and all nut threads shall be re-tapped after galvanising and a lubricant applied on Cold working of galvanised steelwork shall be avoided.

### 4.4 Damaged or Inaccessible Surfaces

#### 4.4.1 Damaged Paint Surface

Repair of damaged painted surfaces, as well as painting of galvanised and black bolts, and galvanised holding down bolts after erection shall comply with this Clause. The treatment shall be:

- Pre-clean the damaged or unpainted areas in accordance with Section 4.2.1 of this Specification;
- Disc or hand sand to clean bright metal;
- Inorganic zinc primers subject to mechanical damage or weld etc shall be power tool cleaned
- Feather backs by sandpapering or whip blasting the original coatings surrounding the damaged area over a 50mm distance. A rough surface shall be obtained on epoxy coatings;
- Clean surface to remove all dust;

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- Conduct surface contaminant test in accordance with Section 4.2.2 of this document; and

Build up a new paint system over the affected area with paints equal to those originally used and having the same dry film thickness for each coat. As an exception, damaged inorganic zinc primers shall be repaired with epoxy organic zinc rich paint and shall be applied within four hours of blast cleaning.

The new coatings shall overlap the original coating over the 50mm prepared distance and shall be colour matched to the specified colour of the original coating.

#### 4.4.2 Damaged Galvanised Surfaces

Damaged areas caused by oxy-cutting, welding or physical impact shall be treated as follows:

- Prepare the surface by removing any weld slag followed by vigorous power wire brushing of the coating surrounding the damaged area over a 50mm distance;
- Clean surface to remove all dust; and
- Apply two coats of organic zinc-rich primer to a minimum DFT of 100 microns.

The area to be reinstated shall be colour matched to the surrounding finish colour with 40 microns of aluminium paint to the manufacturer's **written instructions**.

#### 4.4.3 Inaccessible Surfaces

Surfaces that will be inaccessible after erection of other elements of the structure, shall be fully painted prior to the installation of the obstructing item.

#### 4.5 Surfaces Not To Be Coated

The following surfaces shall not be blasted or coated unless specifically directed:

Machined surfaces, bearings, seals, grease fittings, adjusting screws and name plates, and identification tags.

- Valve stems;
- Raised faces on pipe and equipment flanges;
- Electrical cabling;
- Instrumentation, gauges and sight glasses;
- Titanium, stainless steel and non-metallic surfaces; and

Field weld margins, 50mm either side of weld, on tankage and piping, prior welding.

The rear face of piping flanges shall be shop prime coated only. Flange holes for fasteners shall be fully coated.

#### 4.6 Wash-Up

All surface of equipments/prefabricated piping etc. Primerised / painted at Vendor shop and received at site if required shall be washed up as follow:

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- a) Washing with clean water (Pressure 7 Kg/cm<sup>2</sup>) using suitable nozzles. During washing, broomcorn brushes shall be used to remove foreign matter.
- b) Solvent washing, if required, to remove traces of wash up as per above procedure of all surfaces of equipment, piping, structure etc. completely painted at contractor's shop shall be included in the quoted rates of oil, grease etc. Wash up as per above procedure of all surfaces of equipment, piping, structure etc. completely painted at contractor's shop shall be included in the quoted rates.

#### 4.7 Touch-Up Painting

Prior to the application of any coat, all damage to the previous coat(s) shall be touched-up. Damage to finished work shall be thoroughly cleaned and re-coated.

Surface preparation shall be done as per clause no. 3.0.....

Items supplied with the manufacturer's standard coating system shall be touched-up with the same generic coating system or recoated.

#### 4.8 Paint Storage

The following must be ensured:

- a) All paints and painting material shall be stored only in such rooms assigned for the purpose. All necessary precaution shall be taken to prevent fire. The Storage building shall preferably be separate from adjacent buildings. A sign-board bearing the Words "PAINT STORAGE- NO NAKED LIGHT" shall be clearly displayed outside. The building shall be properly ventilated and shall be adequately protected with fire fighting equipment.
- b) Storage shall be far away from heated surface open flames, sparks & well protected from sun rays.
- c) Ambient temperature at which paints are stored shall be intimated to paint manufacturer & their advice sought regarding precautions to be taken if any, regarding flammability, explosiveness & toxicity.
- d) Maximum allowed storage time for various paint materials shall be clearly indicated on individual containers. Materials which have passed expiry date shall not be used.
- e) Paints in non-original containers and/or in containers without seals, shall not be used.

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## 5.0 COATING SYSTEM SELECTION

### Coating Systems for Structures Piping and Equipment

The following Table 1 shall be used as a general guide for the selection of a paint system suitable for a particular plant area application. Paint systems specified on equipment data sheets and the Drawings shall take precedence over the general paint system area applications listed in Table 1.

TABLE - 1

Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
01	Structural Steel work with operating temp. Up to 90°C (Steel structures, Piping support, uninsulated CS piping, flanges, valves, stairways, walkways etc. except grating).	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P2</b> : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1  <b>F1</b> : One coat of two packs. Polyamide Cured Epoxy.  <b>F5</b> : One coat of two pack aliphatic acrylic polyurethane	<b>P2</b> : 60 microns  <b>F1</b> : 120 – 200 microns  <b>F5</b> : 60 microns	Total dry film thickness of paint system: 240 microns as per <b>C4 – High durability</b>	Total dry film thickness of paint system: 320 microns as per <b>C5 – High durability</b>
02	Uninsulated CS piping, flanges, valves with operating temp. From Above 90°C to 200°C.	Blast cleaning to near white metal grade Sa-2½, of Swedish Standards SIS-05-5900 (Latest)	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1  <b>F3</b> : Two coats of single pack special Oleo resinous based heat resistant ready mixed Aluminium Paint.	<b>P1</b> : 75 microns  <b>F3</b> : 2 x 25 microns for each coat Total - 125 microns.	Total dry film thickness of paint system: 125 microns.	
03	Uninsulated CS piping, flanges, valves with operating temp. Over 200°C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1  <b>F4</b> : Two coats of Heat Resisting Silicon Aluminium Paint.	<b>P1</b> : 75 microns  <b>F4</b> : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
04	Insulated CS piping flanges, valves with operating temp up to 90°C	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F8</b> : One coat of high temperature epoxy phenolic	<b>F8</b> : 2 x 125 microns	Total dry film thickness of paint system: 250 microns.	



Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
05	Insulated CS piping, flanges, valves with operating temp. From 90° C to 200° C.	Blast cleaning to near white metal grade Sa-2½, of Swedish Standards SIS-05-5900	<b>F8</b> : Two coats of high temperature epoxy phenolic (novolac)	<b>F8</b> : 2 x 125 microns	Total dry film thickness of paint system:250 microns	
06	Insulated CS piping, flanges, valves with operating temp. Over 200° C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F9</b> : Two coats of Inorganic Co-polymer based coating With an Inert Multipolymer Matrix.	<b>F9</b> : 2 x 150 microns	Total dry film thickness of paint system: 300 microns.	
07	Uninsulated CS equipment with operating temp. Up to 90° C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P2</b> : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1  <b>F1</b> : One coat of two packs. Polyamide Cured Epoxy.  <b>F5</b> : One coat of two pack aliphatic acrylic polyurethane	<b>P2</b> : 60 microns  <b>F1</b> : 120 – 200 microns  <b>F5</b> : 60 microns	Total dry film thickness of paint system: 240 microns as per <b>C4 – High Durability</b>	Total dry film thickness of paint system: 320 microns as per <b>C5 – High Durability</b>
08	Uninsulated CS equipment with operating temp. From 91° C to 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 <b>F3</b> : Two coats of single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	<b>P1</b> : 75 microns  <b>F3</b> : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
09	Uninsulated CS equipment with operating temp. Over 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 <b>F4</b> : Two coats of Heat Resisting Silicon Aluminium Paint.	<b>P1</b> : 75 microns  <b>F4</b> : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
10	Insulated CS equipment with operating temp. Up to 90° C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F8</b> : Two coats of high temperature epoxy phenolic (novolac)	<b>F8</b> : 2 x 125 microns	Total dry film thickness of paint system:250 microns	



Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
11	Insulated CS equipment with operating temp. From 91° C to 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F8</b> : Two coats of high temperature epoxy phenolic (novolac)	<b>F8</b> : 2 x 125 microns	Total dry film thickness of paint system:250 microns	
12	Insulated CS equipment with operating temp. Over 200°C, to be treated at Manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F9</b> : Two coats of Inorganic Co-polymer based coating With an Inert Multipolymer Matrix.	<b>F9</b> : 2 x 150 microns	Total dry film thickness of paint system: 300 microns.	
13	Surface of structural steel for furnaces, external surface of furnaces, external surface of flue duct, metal stacks and similar with operating temp. Up to 200°C. (With exclusion of stair ways, walk ways etc.).	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1  <b>F3</b> : Two coats of single pack special Oleo resinous based heat resistant ready mixed Aluminium Paint.	<b>P1</b> : 75 microns  <b>F3</b> : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
14	For external surfaces of flue ducts, metal stacks, and similar with operating temp. Above 200°C.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1  <b>F4</b> : Two coats of Heat Resisting Silicon Aluminium Paint.	<b>P1</b> : 75 microns  <b>F4</b> : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
15	For surfaces of air cooler heads not galvanized with operating temperature up to 90° C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P2</b> : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1  <b>F1</b> : One coat of two packs. Polyamide Cured Epoxy.  <b>F5</b> : One coat of two pack aliphatic acrylic polyurethane	<b>P2</b> : 60 microns  <b>F1</b> : 120 – 200 microns  <b>F5</b> : 60 microns	Total dry film thickness of paint system: 240 microns as per <b>C4 – High Durability</b>	Total dry film thickness of paint system: 320 microns as per <b>C5 – High Durability</b>
		<b>NOTE:</b> All surfaces shall be galvanized at manufacturer's shop with exception of the end header of air cooled heat exchangers that shall be treated as described above at Manufacturer's shop. In case the same surfaces shall not be treated at shop, they shall be treated at site according to environmental and operating conditions.				



Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
16	For surfaces of air cooler heads not galvanized with operating temperature up to 91 <sup>0</sup> C TO 200 <sup>0</sup> C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 <b>F3</b> : Two coats of single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	<b>P1</b> : 75 microns  <b>F3</b> : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
		<b>NOTE:</b> All surfaces shall be galvanized at manufacturer's shop with exception of the end header of air cooled heat exchangers that shall be treated as described above at Manufacturer's shop. In case the same surfaces shall not be treated at shop, they shall be treated at site according to environmental and operating conditions.				
18	<b>STORAGE TANKS</b>					
a)	Acid / Alkali CS Storage Tank (External Surface including all stair ways)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P2</b> : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1  <b>F1</b> : One coat of two packs. Polyamide Cured Epoxy.  <b>F5</b> : One coat of two pack aliphatic acrylic polyurethane	<b>P2</b> : 60 microns  <b>F1</b> : 120 – 200 microns  <b>F5</b> : 60 microns	Total dry film thickness of paint system: 240 microns as per <b>C4 – High Durability</b>	Total dry film thickness of paint system: 320 microns as per <b>C5 – High Durability</b>
b)	CS Storage Tanks, Excluding indicated in Sl. No. (a)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1  <b>F1</b> : One coat of two pack Polyamide Cured Epoxy.  <b>F5</b> : Two-pack aliphatic Isocyanate cured acrylic finish paint	<b>P1</b> : 60 microns  <b>F1</b> : 120 - 200 microns  <b>F5</b> : 60 microns	Total dry film thickness of paint system: 240 microns as per <b>C4 – High Durability</b>	Total dry film thickness of paint system: 320 microns as per <b>C5 – High Durability</b>
19	Cold Insulated Carbon Steel and low alloy Steel (1-1/4 Cr through 9 Cr) Piping and Equipment. (Upto 60 Deg. C)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F7</b> : Two coats of Tar Free Epoxy paint suitably pigmented	<b>F7</b> : 2 x 125 microns	Total dry film thickness of paint system: 250 microns.	
20	Cold Insulated high alloy Steel piping and Equipment (Upto 200 Deg. C)	Lightly Blast cleaned as per Sa 1.0 Swedish Standards SIS-05-5900	<b>F8</b> : Two coats of high temperature epoxy phenolic (novolac)	<b>F8</b> : 2 x 125 microns	Total dry film thickness of paint system:250 microns	





Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks	
		(Latest).				
21	DELETED					
22	Surface (CS) with Equipment with temp. Indicating paint from 220°C to 240°C treated at Manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 <b>F6</b> : Temperature indicating paint	<b>P1</b> : 75 microns <b>F6</b> : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
23	<b>PACKAGE:</b>					
a)	Surface (CS) with operating temperature upto 90°C treated at Manufacturer's shop	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P2</b> : ONE coat of two pack zinc rich epoxy Primer meeting SSPC Paint 20 level 1 <b>F1</b> : One coat of two packs. Polyamide Cured Epoxy. <b>F5</b> : One coat of two pack aliphatic acrylic polyurethane	<b>P2</b> : 60 microns <b>F1</b> : 120 – 200 microns <b>F5</b> : 60 microns	Total dry film thickness of paint system: 240 microns as per <b>C4 – High Durability</b>	Total dry film thickness of paint system: 320 microns as per <b>C5 – High Durability</b>
b)	Surfaces (CS) with operating temperature upto 91 <sup>0</sup> C TO 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 <b>F3</b> : Two coats of single pack special Oleouresinous based heat resistant ready mixed Aluminium Paint.	<b>P1</b> : 75 microns <b>F3</b> : 2 x 25 microns for each coat	Total dry film thickness of paint system: 125 microns.	
c)	Surface (CS) with operating temp. Over 200°C, treated at manufacturer's shop.	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>P1</b> : One coat of Ethyl Silicate zinc rich with solvent Primer meeting SSPC Paint 20 level 1 <b>F4</b> : Two coats of Heat Resisting Silicon Aluminium Paint.	<b>P1</b> : 75 microns <b>F4</b> : 2 x 25 microns for each coat Total - 50 microns.	Total dry film thickness of paint system: 125 microns.	
d)	Package in Carbon Steel and low Alloy Steel (1-¼ Cr through 9 Cr) with cold insulated surface treated at manufacturer's shop (Upto 60 Deg. C)	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F7</b> : Two coats of Tar Free Epoxy paint suitably pigmented	<b>F7</b> : 2 x 125 microns	Total dry film thickness of paint system: 250 microns.	
e)	Package in Cold Insulated high alloy	Lightly Blast cleaned as per	<b>F8</b> : Two coats of high temperature epoxy	<b>F8</b> : 2 x 125	Total dry film thickness of paint system:250	

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Ref No.	Application	Surface Preparation	Generic Coating System	Minimum DFT	Remarks
	Steel. (Upto 200 Deg. C)	Sa 1.0 Swedish Standards SIS-05-5900 (Latest).	phenolic (novolac)	microns	microns
f)	DELETED				
24	For internal surface of shell, roof of CS tanks, with operating temp. Upto 110°C	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F2</b> : Two coats of two pack amine adduct cured Phenolic epoxy (Novolac) (immersion grade)	<b>F2</b> : 2 x 150 microns for each coat	Total dry film thickness of paint system: 300 microns.
25	For underside (soil side) of the tank bottom (CS) below only of the fixed tanks, bottom & shell shall be treated as follows:	Blast cleaning to near white metal grade 2 ½, of Swedish Standards SIS-05-5900 (Latest).	<b>F7</b> : Two coats of Tar Free Epoxy paint suitably pigmented  <b>OR</b> <b>F8</b> : Two coats of high temperature epoxy phenolic (novolac)	<b>F7</b> : 2 x 200 microns  <b>OR</b> <b>F8</b> : 2 x 150 microns	Total dry film thickness of paint system: 400 microns.  <b>OR</b> Total dry film thickness of paint system: 300 microns.
26	CS Equipment and associated piping subject to cyclic, intermittent or regeneration operating condition (e.g. Molecular Sieve Driers) subjected to very severe corrosion with wide operating temperature range.	Blast cleaning to near white metal grade 3, of Swedish Standards SIS-05-5900 (Latest).	Primer: One coat of Thermal spray Aluminium paint and sealed with a Silicon Aluminium seal Finish Coat: One coat of Thermal spray Aluminium paint and sealed with a Silicon Aluminium seal.	Primer: 125 microns  Finish: 125 microns	Total dry film thickness of paint system 250 microns.

### NOTES:

#### Primers

#### ZINC ETHYL SILICATE PRIMER – P1

The zinc ethyl silicate consists of two packs. One pack contains the ethyl silicate binder with suitable solvents. The other pack contains zinc dust (NOT Paste). Zinc dust shall be ASTM D 520 Type II. They have to be mixed in suitable proportions before application as recommended by manufacturer.

<b>Volume solids</b>	:	Min.64% ±2
<b>DFT Range</b>	:	50 – 75 microns
<b>Theoretical Spreading Rate</b>	:	12.8 – 8.53 sqm/litre
<b>Colour</b>	:	Grey
<b>Application</b>	:	Spray (airless/air)
<b>Drying time ( dry to handle )</b>	:	< 45 mins. @ 30 Deg. C and 65% RH
<b>Curing</b>	:	<16 hrs @ 30 Deg. C and 65% RH



% of total metallic zinc in dry film (As per the ASTM D520 – Spherical size)	:	(SSPC SP 20 Level 1) >85% by wt.
Specific Gravity	:	2.5 Kg/Litre min.
Storage life	:	6 months under sealed conditions

Zinc silicate Material curing shall be checked using ASTM D 4752, minimum Acceptable value is 4.

#### **ZINC RICH EPOXY PRIMER – P2**

The zinc rich epoxy consists of two packs. One pack contains the epoxy binder with suitable solvents. The other pack contains zinc dust as per ASTM D520 Type II. They have to be mixed in suitable proportions before application as recommended by manufacturer.

Volume solids	:	65% min. ±2
DFT	:	50 – 100 microns
Theoretical Spreading Rate	:	13 – 6.5 sqm/litre
Colour	:	Grey
Application	:	Airless spray/air spray/brush
Drying time ( dry to handle )	:	<10 min. @ 30 Deg C
Hared Dry	:	< 1.5 hrs @ 30 Deg C
% of total metallic zinc in dry film (As per the ASTM D520 – Spherical size)	:	(SSPC SP 20 Level 2) 81% by wt. min.
Specific Gravity	:	2.3 Kg/Litre min.
Storage life	:	12 months under sealed conditions

#### **Finish Paints**

##### **HIGH BUILD EPOXY FINISH – F1**

This finish paint is fast drying, high build, Two-pack polyamide cured epoxy resin

Volume solids	:	85% min. ±2
DFT Range	:	100 – 200 microns
Theoretical Spreading Rate	:	7.6 – 3.8 sqm/litre
Colour	:	As per Manufacturer List
Binder	:	Polyamide cured epoxy resin, Lead & Chrome Free
Application	:	Brush or spray
Drying time	:	< 2 hrs @ 30 Deg C
Over coating time	:	< 2 hrs @ 30 Deg C
Storage life	:	24 months under sealed conditions

##### **HIGH BUILD EPOXY FINISH (Immersion Grade) – F2**

This finish paint is high build, Two-pack phenolic (novolac) epoxy

Volume solids	:	68% min. ±2
DFT Range	:	100 – 150 microns
Theoretical Spreading Rate	:	6.8 – 4.5 sqm/litre
Colour	:	As per Manufacturer List



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<b>Binder</b>	:	Amine adduct cured epoxy resin
<b>Application</b>	:	Brush or spray
<b>Drying time</b>	:	< 1.5 hrs @ 30 Deg C
<b>Over coating time</b>	:	< 6.5 hrs @ 30 Deg C
<b>Storage life</b>	:	24 months under sealed conditions

### **HEAT RESISTANT ALUMINIUM FINISH PAINT : F3**

It is a single pack system based on oleo resinous general purpose aluminium paint with good heat resistance upto 250 Deg. C. and light reflection.

<b>Volume solids</b>	:	25% min. $\pm 2$
<b>DFT Range</b>	:	25 microns
<b>Theoretical Spreading Rate</b>	:	10 sqm/litre
<b>Main pigment</b>	:	Aluminium (ASTM 962), Lead & Chrome Free
<b>Colour</b>	:	Metallic Aluminium
<b>Pigment Volume Concentration</b>	:	15 – 20%
<b>Application</b>	:	Brush or spray
<b>Drying time</b>	:	Surface dry <1hr. @ 30 Deg. C Hard dry < 3 hrs. @ 30 Deg. C
<b>Storage life</b>	:	24 months under sealed conditions

### **HEAT RESISTANT SILICON ALUMINIUM FINISH PAINT : F4**

It is a single pack system based on ambient curing silicone aluminium pigmented polysiloxane paint with maximum heat resistance of upto 600 Deg. C.

<b>Volume solids</b>	:	25% min. $\pm 2$
<b>DFT Range</b>	:	25 microns
<b>Theoretical Spreading Rate</b>	:	10 sqm/litre
<b>Main pigment</b>	:	Aluminium (ASTM 962), Lead & Chrome Free
<b>Colour</b>	:	Metallic Aluminium
<b>Pigment Volume Concentration</b>	:	15 – 20%
<b>Application</b>	:	Brush or spray
<b>Drying time</b>	:	Surface dry < 1hr. at 30 Deg. C Hard dry < 3 hrs. at 30 Deg. C
<b>Storage life</b>	:	12 months under sealed conditions

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### **TWO PACK ALIPHATIC ACRYLIC POLYURETHANE FINISH PAINT – F5**

It Consists of Acrylic Resin in Part A. Part B consists of an aliphatic poly-isocyanate with appropriate solvents and additives.

<b>Volume solids</b>	:	51% min. ±2
<b>DFT range</b>	:	50 – 100 microns
<b>Theoretical Spreading Rate</b>	:	10.2 – 5.1 sqm/litre
<b>Main pigment</b>	:	Suitable pigments to get the desired colour, <b>Lead &amp; Chrome Free</b>
<b>Colour</b>	:	Metallic Aluminium
<b>Binder</b>	:	Shall not contain any binder other than acrylic resin; should not contain any <b>alkyd / acrylate alkyds / esters.</b>
<b>Application</b>	:	Brush or spray
<b>Drying time</b>	:	Surface dry < 1hr. @ 30 Deg. C Hard dry < 8 hrs. @ 30 Deg. C
<b>ISO 11507/ASTM G 154, QUV A - Accelerated weathering</b>	:	<b>Gloss retention: approx. 80 % and colour change approx. DE 1.2 after 3000 hours exposure</b>
<b>Storage life</b>	:	24 months under sealed conditions

### **TEMPERATURE INDICATING PAINT : F6**

It is a single pack temperature indicating system based on silicone binder. Pigments change colour by heating. The colour change of the coating is permanent. At approximately 200°C, the colour changes from green to blue, above 310°C, the colour changes from blue to greyish white. Maximum service temperature is 400°C.

<b>Volume solids</b>	:	40% min.
<b>DFT</b>	:	25 microns
<b>Theoretical Spreading Rate</b>	:	16 sqm/litre
<b>Main pigment</b>	:	As per shade requirement, Lead & Chrome free
<b>Colour</b>	:	As per manufacturer
<b>Binder</b>	:	Based in silicone Resins
<b>Application</b>	:	Brush or spray
<b>Drying time</b>	:	Surface dry < 1hr. @ 30 Deg. C

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		Hard dry < 4 hrs. @ 30 Deg. C
<b>Storage life</b>	:	12 months under sealed conditions

### **TAR FREE EPOXY – F7 (Coal Tar is Banned Globally being Carcenogenic)**

A high build two component abrasion resistant, pure epoxy with anti-corrosive properties meant for excellent performance.

<b>Volume solids</b>	:	Minimum 72%
<b>DFT Range</b>	:	150 – 200
<b>Theoretical Spreading Rate</b>	:	4.8 – 3.6 sqm/litre
<b>Application</b>	:	By brush or airless spray
<b>Drying time</b>	:	Touch Dry within 4 hrs. @ 30 Deg C Hard dry < 9 hours @ 30 Deg. C
<b>Storage life</b>	:	12 months under sealed conditions

### **EPOXY PHENOLIC (NOVOLAC) – F8**

Two Pack epoxy-phenolic (novolac) cured with amine adduct used as an External coating for the protection of insulated (CUI) equipment.

<b>Volume solids</b>	:	68% min.
<b>DFT Range</b>	:	100 – 150 microns
<b>Theoretical Spreading Rate</b>	:	6.8 – 4.5 sqm/litre
<b>Binder</b>	:	Epoxy phenolic (novolac)
<b>Dry Temp. Service</b>	:	Min. -196 to max. 205 Deg. C.
<b>Application</b>	:	Airless Spray / Brush Touch up
<b>Drying Time</b>	:	Surface dry < 1.5hr. @ 30 Deg. C Hard dry < 6 hours @ 30 Deg. C
<b>Storage life</b>	:	12 months under sealed conditions

### **INORGANIC CO-POLYMER COATING – F9**

MIO pigmented single component inorganic copolymer coating which cures to form an inert polymer matrix able to resist temperatures up to 650°C/1202°F and thermal shock/cycling in dry or dry/wet service.

<b>Volume solids</b>	:	74% min.
<b>DFT Range</b>	:	150 microns
<b>Theoretical Spreading Rate</b>	:	5 sqm/litre
<b>Binder</b>	:	Inorganic copolymer coating
<b>Dry Temp. Service</b>	:	Min. -196 to max. 650 Deg. C.
<b>Application</b>	:	Airless Spray / Brush Touch up
<b>Drying Time</b>	:	Surface dry < 0.5hr. @ 30 Deg. C Hard dry < 1.5 hours @ 30 Deg. C
<b>Storage life</b>	:	12 months under sealed conditions

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## 6.0 MACHINERY, ELECTRICAL AND INSTRUMENT EQUIPMENT:

### 6.1 Machinery

Steel surfaces shall be treated with complete paint system at Manufacturer's shop. The paint system shall be according to Manufacturer's Std. However, suitable for operating condition and the environmental condition where the machinery will operate. Where necessary machinery shall be restored at site by Contractor with suitable finish.

### 6.2 Electrical and Instrument Equipment

Steel surfaces shall be treated with complete paint system at Manufacturer's shop. The paint system shall be according to Manufacturer's Std., however suitable for operating condition and the environmental condition where the electrical and instrument equipment will operate. Where necessary Electrical and Instrument Equipment shall be restored at site by Contractor with suitable finish.

## 7.0 COLOURS:

These shall be as required by specification and in particular for:

Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
- Piping with temperature less than 90°C	GREY	7035	
- Piping, hot surface, flue gas ducts and stacks with temperature above 90°C	SMOOTH	ALUMINIUM	"
- Cooling Water Piping	SEA GREEN		"
- Fire fighting Piping	Red	3002	"
- Structures upto 2 MT	BLACK	9005	"
- Structures above 2 MT	GREY	7010	"
- Stair cases – ladders	BLACK	9005	"
- Walkways	GREY	7010	"
- Handrails assemblies	YELLOW	1004	"
- Equipment	GREY	7035	"
- Hot equipment	SMOOTH	ALUMINIUM	"
- Fire fighting equipment	RED	3002	"
- Valves in general	GREY	7035	"
- Hot valves	SMOOTH	ALUMINIUM	"
- Safety and Fire fighting valves	RED	3002	"
- Valves handwheels	BLACK	9005	
- Electric Rotary Machines	SKY BLUE	5012	

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Description	Colour	Ra1	Correspond. Asian Paint colors to be defined – See Note-2
- Electric Static Machines	GREY	7035	
- Machinery (compressors & pumps) with operating temperature less than 90°C	GREY	7035	“
- Machinery (compressors & pumps) with operating temperature above 90°C	SMOOTH	ALUMINIUM	“
<b>FURNACES</b>			
- Casing and connected steel works	SMOOTH	ALUMINIUM	“
- Steel work not connected to casing	SMOOTH	ALUMINIUM	“
<b>AIR COOLER</b>			
- High Temperature Surfaces (Temp. > 90°C)	SMOOTH	ALUMINIUM	
- Low Temperature surface (Temp. ≤ 90°C)	GREY	7035	“
- Flare ≤ 90°C	GREY	7035	“
- Flare ≥ 90°C)	SMOOTH	ALUMINIUM	“
<b>TANKS</b>			
- Shell of fixed roof	WHITE	9010	“
- Roof of fixed roof tank	WHITE	9010	
-			“
- T-303	WHITE	9010	“

NOTE-1: The colours shall be according to IS2379:1990/International STD. RAL or BS, proposed by Contractor or Manufacturer

## 8.0 PARTICULAR DESCRIPTION

The abrasive Grit Blasting shall be used for surface preparation. **Sand blasting is prohibited due to environmental regulations.**

Primerized surface shall be faultless and shall not have mud-cracking, dripping over thickness and dry sprays.

Blast cleaning and painting shall not be carried out on wet surfaces.

Blast cleaning shall not be done when surfaces temperatures are less than 3°C above dew point, or temperature is below 5°C.

No acid washes or other cleaning solutions or solvents shall be used on metal surfaces after they have been blasted.

The surface preparation of all steel surfaces to be coated shall be free of all mill scale, rust corrosion product, oxides, paint, oil or other foreign matter



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Only dry abrasive blasting procedures will be allowed. The compressed air supply used for blasting shall be free of detrimental amounts of water and oil. Adequate separator and traps shall be provided and these shall be kept emptied of water and oil. Any blast cleaning set up without functioning moisture separators shall be removed from blast cleaning areas. All welded areas and appurtenances shall be given special attention for removal of welding flux in crevices. Welding splatter, slivers, laminations and underlying mill scale exposed during sand blasting shall be removed or repaired.

The blast-cleaned or power brushing surfaces shall be coated with primer within four hours of surface preparation.

No primer or intermediate or finishing coating shall be applied without prior notification to the Company.

The application of the products shall be carried out in strict compliance with the paint manufacturer's recommendation.

The Contractor shall provide suitable protection for all adjacent plants or equipment from airborne during spraying and sand blasting.

## 9.0 INSPECTION AND TESTING

The inspection and testing requirements outlined in this section shall be performed for shop and site applied coating systems.

Preference shall be given to manufacturers and applicators that are quality certified to ISO 9001: 2000.

Documentation of coating material manufacturers and applicators shall include daily inspection reports, equipment reports, and shall clearly identify and trace materials supply and testing performed on coated items and areas.

Inspection and Test Plans (ITPs), and quality control procedures used for application of coating systems shall form part of the Method Statement and shall be submitted for approval by the Principal prior to commencement of work.

The applicator shall appoint a certified inspector of coatings for inspection and testing of coating systems.

Tests of coated areas and items shall form part of the ITPs.

- Surface Preparation in accordance to Swedish Standard SIS-05-5900 (Latest).
- Blast cleaning profile shall be checked using a suitable profile meter – Acceptable profile shall be 40 - 60 microns.
- Check of time of top coating and drying in accordance with the direction of the paint manufacturer.
- Check of dry film thickness by suitable non-destructive Instrument such as "MIKROTEST", "DIAMETER" or equivalent.

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- Before any coating work is performed on the site, the contractor shall ensure that any works applied by others is acceptable.

Any defect that are discovered, are to be notified in writing to the owner before proceeding with the contract work. To ensure the good execution of painting work following test shall be performed:

- Surface Preparation
- Surface contaminant tests
- Surface profile tests
- Coating thickness tests
- Tests for cure of coatings
- Adhesion tests
- Continuity testing
- Iron contamination
- Chloride contamination
- Dust Contamination

All Inspection and Test Records (ITRs) shall be submitted with the Manufacturer's Data Report (MDR) at the conclusion of the job.

Defective coated areas shall be suitably marked for rectification work to be performed in compliance with this specification.

Access shall be granted for inspection of all paint work, and witnessing of test work. This shall not however relieve the Contractor of their own QA/QC responsibilities.

### 10.0 ADHESION TEST RESULTS

For all type of primer the Contractor shall guarantee the Classification of Adhesion Test Results as per ASTM D3359. The acceptable Rate Adhesion Test Results shall be for sandblasted and primerized surfaces shall be minimum 3A (or Higher)

For primer plus finishing coat(s) the Contractor shall guarantee the Classification of Adhesion Test Results as per ASTM D 3359. The acceptable Rate Adhesion Test Results shall be for blast cleaned and painted surfaces shall be minimum 3A (or higher).

After test, the surface must be repaired according to the system applied.

### 11.0 SUBMISSION OF DATA

Contractor shall submit in phase of bid the original technical data sheet and system for all material supplied by him to apply for the permanent works and test report for the paint in compliance to IS101. This material shall be subject to Owner's approval. The test certificates of zinc silicate shall provide the specific gravity of mixed paint.

### 12.0 LETTER AND NUMBER INSCRIPTION

Inscriptions letters, as herebelow indicated, shall be made on equipments, piping, storage tanks, machinery etc.

#### 12.1 Geometric forms and dimensions

Letters and numbers dimensions shall be orientatively fixed according to following:

(A – Dimension of side of unitary elements of grid)

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- a) Storage Tanks A – 60 mm
- b) Equipments and piping with O.D. above 600 mm A– 40 mm and
- c) Equipments and pipings with O.D. from 300 to 600 mm and for machinery of great dimensions A – 20 mm
- d) Equipments and pipings with O.D. less than 300 mm and for machinery with small dimensions A – 10 mm

#### 12.2 Inscription's Colours

Inscriptions shall be Black ENI 901 (RAL 9005) on light base

Inscriptions shall be White ENI 101 (RAL 9010) on dark base

#### 12.3 Spaces and Interspaces

Spaces between words and assemblage of numbers shall have dimensions equal to 2A

Interspaces between letters or numbers shall have dimensions equal to A.

#### 13.0 **Colour Band for piping ;-**

As a rule minimum width of colour band shall conform to the following Table:-

Nominal pipe Size	Width L (mm)
3" & below	25
4" NB-6" NB	50
8" NB-12"NB	75
14" OD & above	100

#### 14.0 **LIST OF MANUFACTURERS :**

1. M/s Berger Paints
2. M/s Jensions & Nickolson
3. M/s Asian Paints
4. M/s Grauer & Weil (India) Limited
5. M/s Shalimar paints
6. M/s Garware Paints
7. M/s Goodlass Nerolac Paints Ltd
8. M/s. HEMPEL Paints
9. M/s International Paints (Akzo Nobel Brand)
10. M/s Jotun Paints

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11. M/s Carboline (India) Pvt. Ltd.

12.M/s Mohan Paints

**15.0** The contractor shall obtain prior approval from Engineer-In-Charge for the brands of paint material proposed to be used. The contractor shall submit the following details of paint material either at the time of bidding or soon after award of work for approval of paints.

- a. Technical data sheet
- b. Material safety data sheet
- c. Finger printing of paint products as per ISO 20340

**16.0** Owner reserves the right to take random samples and get it tested through reputed labs. In case the supplied paint material do not meet the specified performance requirements then suitable action shall be taken against the paint supplier. The decision of Engineer-In Charge shall be final and binding on the Contractor in such cases

**17.0 WARRANTY:**

Contractor along with Paint Manufacturer jointly shall develop the paint schemes following the system specification.

They shall jointly provide a performance guarantee for a period 5 years as stipulated below,

After 1 years – Corrosion in 3% of total painted area accepted

After 2 years – Corrosion in 6% of total painted area accepted


After 3 years – Corrosion in 9% of total painted area accepted

After 4 years – Corrosion in 12% of total painted area accepted

After 5 years – Corrosion in 15% of total painted area accepted



**where spontaneous visible corrosion has broken down the paint film to a degree exceeding “Ri 3” (as defined in ISO 4628/3-2003).**

**Note:** Final colour coding of piping is as per IS-2379-1990 ( Reaffirmed 2006 ).

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## TECHNICAL SPECIFICATION

### HIGH VOLTAGE VARIABLE FREQUENCY DRIVE SYSTEM

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## 1.0 SCOPE

- 1.1 The scope of this specification is to define the minimum technical requirements for the design, manufacture, testing and supply of High Voltage, AC Variable Frequency Drive system. The VFD system shall be complete with Squirrel Cage Induction Motor/ Synchronous Motor as specified in data sheet, Converter, Converter input transformer, drive output transformer, DC link reactor with associated auxiliaries, harmonic filters and field mounted local motor control panel.
- 1.2 The Vendor shall be responsible for engineering and functioning of the complete system, meeting the intent and requirement of this specification and data sheets. This shall include but not be limited to inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, motor cable selection and motor sizing/selection.
- 1.3 This specification applies to drive systems having converter input voltage above 1000 V AC and up to and including 11000V AC.

## 2.0 CODES AND STANDARDS

- 2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS, unless otherwise specified:

IS:325 Three-phase Induction Motors

IS:3700 Essential Ratings and Characteristics of Semiconductor Devices

IS:3715 Letter symbols for semi-conducting devices

IS:4411 Code of designation of semi-conducting devices

IS:5001 Guide for preparation of drawings of semiconductor devices and Integrated Circuits

IS:5469 Code of practice for the use of semiconductor Junction Devices

IS:14901 Semi-conductor devices- Discrete devices & Integrated Circuits

IS:15880 Three Phase Cage Induction motors when fed from IGBT Converters Application Guide

IS:8789 Values of Performance characteristics for Three Phase induction motor

IS: 12615 Energy Efficient Induction Motors - Three Phase Squirrel Cage



IS:12729 Common specification for High-Voltage Switchgear and Control gear standards

IEC:60 146-1-3 Semiconductor Convertors general requirements and line commutated convertors-Transformer & reactors

IEC:61800 Adjustable speed electrical power drive systems

IEEE:519 Recommended Practices and requirements for Harmonics Control in Electrical power system

- 2.2 In case of imported equipment, standards of the country of origin shall be applicable, if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

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2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BSNDE/IEEE/NEMA or equivalent agency shall be applicable.

2.5 In case of any contradiction between various referred standards/specifications/data sheet and statutory regulations the following order of priority shall govern:

- Statutory regulations
- Data sheets
- Job specification
- This specification
- Codes and standards

### **3.0 GENERAL REQUIREMENTS**

3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 15 years from the date of supply

3.3 Vendor shall give a notice of at least one year to the end user of equipment before phasing out the product/spares to enable the end user for placement of order for spares and services.

3.4 Vendor shall ensure proper co-ordination with the driven equipment supplier in selection/sizing of offered variable frequency drive system.

### **4.0 SITE CONDITIONS**

4.1 The drive system shall be designed to operate under specified site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 50°C and an altitude not exceeding 1000 metres above mean sea level shall be considered.

4.2 The AC drive shall be installed indoors in a non-hazardous, air-conditioned or pressurized room, as specified in data sheet. Transformer installation (outdoor/ indoor) shall be as indicated in datasheet. Motor shall be installed outdoors in safe or hazardous area as specified in datasheet.

4.3 All the equipment shall be designed for continuous duty as per nameplate rating under the specified ambient conditions.

### **5.0 DESIGN AND FABRICATION REQUIREMENTS**

#### **5.1 Performance Requirement**



5.1.1 The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low harmonic distortion and low vibration/ wear / noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.

5.1.2 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with input supply variation of  $\pm 10\%$  and frequency variation of  $\pm 3\%$ . The system shall be suitable for the load characteristics and the operational duty of the driven equipment. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short-circuit.



5.1.3 The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment or specified in the data sheet:

- a. Variable torque changing as a function of speed i.e. Speed squared
- b. Constant torque over a specific speed range





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- c. Constant power over a specific speed range where the torque decreases when speed increases
- d. Any other as specified in data sheet
- 5.1.4 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable from 0.1 to 20 seconds.
- 5.1.5 The System shall be suitable for single quadrant operation and the speed variation shall be with range 10-100 % unless otherwise specified in data sheet with speed set accuracy of  $\pm 1\%$  of rated maximum speed and steady state regulation of  $\pm 0.5\%$  of rated speed.
- 5.1.6 The total harmonic distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800 and same shall be considered in the design of the motor. The dv/dt limits & Vpeak shall also be as per IEC-61800-2.
- 5.1.7 Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519. The vendor shall perform design calculation for harmonic filter system considering VFD connected to the power system and including the supply of harmonic filters along with all accessories which shall be installed at owner's power system unless otherwise specified. These harmonic studies shall be conducted with maximum and minimum system fault level, cable capacitance, system equipment reactance etc. The studies shall highlight but not be limited to maximum load current, expected resonant frequencies, need of harmonic filters, sequence of switching of filters, voltage wave form, rating of equipments/ feeder for feeding filters from owner's switchgear etc.
- 5.1.8 Unless otherwise specified, the overload capacity of the controller shall be 150% of rated current of motor for one minute for constant torque applications, and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demands exceed the current limit for more than 1 minute, the drive shall shutdown to prevent over heating of the motor and damage to the drive.
- 5.1.9 During operation, the system shall be capable of developing sufficient torque under all load conditions to respond to a 20% alteration in speed set point within a time limit upto 60 seconds.
- 5.1.10 The integrator action of the speed set point alteration shall be independently adjustable for both an upward and a downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 seconds.
- 5.1.11 The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.
- 5.1.12 Maximum noise level from the drive at 1-meter distance, under rated load with all normal cooling fans operating shall not exceed 85 dBA.
- 5.1.13 Variable frequency drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start up adjustments and troubleshooting/ maintenance.
- 5.1.14 Voltage at motor neutral shall be maintained at ground potential for the total operating condition.
- 5.2 Control Requirement**
  - 5.2.1 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.

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- 5.2.2 Short time voltage dips up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.
- 5.2.3 The system shall also be equipped with a momentary powerloss ride through feature which will restart the system in case of voltage dip over 20% or power interruptions for less than 2 seconds, with recovery of the voltage to its nominal value .. The drive shall have the facility to block this feature, if required by the operator. Upon restart, the converter shall be capable of synchronizing onto a rotating motor and develop full acceleration torque within 10 seconds.
- 5.2.4 The system shall be suitable for number of starts as per attached specification for High Voltage Motors.
- 5.2.5 The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.
- 5.2.6 The drive motor shall be speed controlled corresponding to 4-20mA or 0-10 V reference input signal. Unless otherwise specified, upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as at 80-100% of the last speed reference available prior to the loss of signal.
- 5.2.7 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/Manual selection shall be from VFD panel unless otherwise specified.
- With the selector switch in "manual" mode, the operator shall be able to set the speed through key pad (mounted on front of the drive panel) or from speed increase/decrease push buttons (from the field). Motor operated potentiometer shall be provided as a speed set point device.
  - With the selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20 mA signal, from owner's PLC/DCS (Process Control) system. Necessary equipment required for interfacing with PLC/DCS shall also be provided in the VFD panel.
  - Local/Remote selector switch shall be provided in local control station (in Field). With the selector switch in "Local" mode, the operator shall be able to start and set the speed through local control station (in Field). With the selector switch in "Remote" mode, speed of the motor shall be controlled either from VFD panel or from Owner's PLC/DCS as explained in a) and b) above.
- 5.2.8 The required provision for the interface with remote PLC/DCS located at control room shall be either through hardwired connection (with potential free contacts and transducers as described elsewhere in this specification) or through serial communication link as defined in the datasheet.
- 5.2.9 Drive system shall have provision for interface with upper level automation such as Substation monitoring system or electrical control system in case specified in the data sheet/job specification.
- 5.2.10 The closed loop control feed back for the drive system having out put transformer shall be tapped from the secondary side of the output transformer.
- 5.3 Panel Construction**
- 5.3.1 The panel shall include suitable semi conducting power devices (Diodes/IGBT/IGCT/ IEGT/SGCT) modules with protective devices, reactors (if required) , filters, control circuit, control accessories, indication and annunciation etc. The construction of the panel shall provide effective protection against electromagnetic emissions and shall meet the design requirement of relevant standards.
- 5.3.2 Upstream breaker 'ON/OFF/TRIP' indications and remote breaker closing and trip push buttons shall be provided on the front door.

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- 5.3.3 Safety Interlock shall be provided so that power cabinet can't be opened unless the upstream breaker is disconnected, safety-grounding switch is closed and DC link capacitor is discharged. Power source breaker can only be closed once the earthing switch is open and panel door is closed with lock defeat facility.
- 5.3.4 The drive shall be suitably housed in sheet steel panels and shall be fabricated using cold rolled sheet steel. The sheet steel used for the panel shall be of minimum 2 mm CRCA. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of enclosure protection as IP-31. Maximum and minimum operating height shall be 1900 mm and 300 mm respectively.
- 5.3.5 Bolted un-drilled gland plate shall be provided at bottom. Clamp type terminals shall be used for connection of all wires up to 10 mm<sup>2</sup>, and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 600mm clear from bottom of the cable gland plate.
- 5.3.6 Bus bars shall be of electrolytic copper/aluminium, sleeved, color coded separately for AC and DC system. All the live parts shall be sleeved / shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate.
- 5.3.7 All the switches, component and accessories which are essential for normal and emergency operation shall preferably be mounted on the door and shall be operable externally. All the analogue instruments, where provided, shall be switchboard type, back connected & of size 96x96mm. Scale shall have red mark indicating maximum permissible operating rating.
- 5.3.8 Each panel shall be provided with illuminating lamp/11 W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.
- 5.3.9 Copper earth bus of min. 30x6 sq.mm. upto short circuit withstand capacity of 31.5kA and 50x6 sq.mm. for a short circuit withstand capacity above 31.5kA shall be provided in the panel with provision for connection to owner's plant earth grid. All the non-metallic components/parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system if required shall be provided.
- 5.3.10 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.
- 5.3.11 All the control wiring shall be enclosed in plastic/ metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, low smoke, copper conductor wire 1.5mm<sup>2</sup> size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm<sup>2</sup> size for control fuse rating above 16 A for electrical circuits and 0.5mm<sup>2</sup> for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminals shall be provided.
- 5.3.12 All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipments and power electronic equipments shall be used.
- 5.3.13 Low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.
- 5.3.14 DC link capacitor and pre-charging & discharging circuit shall be preferably mounted in the rear of the panel.
- 5.3.15 Suitable eyebolts/ lifting clamps/ strap & cradle arrangement shall be provided for lifting of the panel/shipping section. The bolts, when removed shall not leave any opening in the panel.
- 5.3.16 Acrylic type transparent insulating material shall be used for covering live components.

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5.3.17 Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.

5.3.18 All equipment shall be complete with cable glands, lugs etc. and cable glands shall be single or double compression type for indoor and outdoor equipment respectively. Cable glands shall also be suitable for the hazardous area application if specified in data sheet.

#### 5.4 Cooling

5.4.1 The drive panel shall be naturally cooled or water cooled type as per manufacturer's standards. However, it is preferred to have natural air cooled system. If unavoidable, forced type-cooling system shall be provided. Cooling system shall include well-dimensioned panel, adequate cooling airflow path, modular cooling fan and if necessary, panel cooling fan or water-cooling system shall be considered. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+ 1) shall be provided. In case redundant cooling fan is not possible to be mounted in the panel, same shall be supplied loose.

5.4.2 For water-cooled drives, entire cooling system including but not limited to heat exchanger, flow and pressure meters and pumps shall be in vendor's scope. The system shall be provided with closed circuit water cooling system, requiring only make up water required for topping up. The cooling water pumps, in case provided, shall have 100% redundancy. Water quality/characteristics shall be as defined in the data sheet and selected cooling water system components/material shall be suitable for the same. Adequate safety measures shall be incorporated in water cooled drives such that no leakage is there which results in malfunctioning of electronic devices. Proper segregation between water cooling system and other equipment shall be provided. It is preferred that cooling cabinet panel shall be separated from the main panels.

5.4.3 Necessary starters shall be provided within the VFD panels for the Ventilation fans, Cooling Water circulation pumps, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shutdown so that safety interlocks such as start permit from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc., are incorporated in the overall sequence logic.



5.4.4 MCB for motor space heater, auxiliary power supply if required for local panel, drive panel space heater etc. shall be included and mounted in easy accessible location.

#### 5.5 Equipment/ Component Specification

##### 5.5.1 Motor

The motor shall be designed, constructed and tested in accordance with the latest revision of Specification /data sheet for High Voltage Induction / Synchronous Motor, in addition to the following requirements:

- The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
- The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- The motor shall be designed to operate continuously at any speed over the range (10-100%) of rated speed unless otherwise specified in data sheet.
- The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.

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- e. Motors required to be transferred to DOL by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL bypass mode shall be limited to value specified in motor specifications, unless otherwise specified in datasheets.
- f. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
- g. The motor insulation shall be designed to accept the applied voltage waveform, within the V<sub>peak</sub> and dv/dt limits as per IEC-61800-4 and necessary co-ordination between the VPD manufacturer & motor manufacturer W.r.t. incorporation of VPD output parameter in the design of motor shall be carried out.
- h. The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.
- i. Motors shall be provided with Resistance Temperature Detectors (RTDs).

### 5.5.2 Converter Transformer/ Output transformer

- a. The converter transformer shall be dry type or oil filled type as specified in the data sheet. In case of the dry type transformer, it shall be mounted in the drive system panel unless specified otherwise in the datasheet. Offered transformer shall be as per enclosed Specifications/data sheet.
- b. The impedances of converter input transformers with more than one secondary windings for 12/18/24/36 pulse systems shall be selected to ensure equal load/current sharing between the secondary windings, the converters and the motor windings under all operational conditions including starting and restarting.
- c. Drive output transformer considered only for the purpose of meeting standard rated motor voltage i.e. 3300, 6600V, 11000V shall not be provided unless otherwise agreed between purchaser and the manufacturer.

### 5.5.3 Power Converter

- a. The static power converter shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
- b. Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
- c. All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
- d. The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the entire speed range.
- e. All power diodes shall be of silicon type with minimum V<sub>BO</sub> rating as 2.5 times the rated operating voltage.
- f. The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise due to harmonic currents generated by the inverter operation.
- g. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.
- h. The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.

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- i. Offered system shall also take into account the distance between Drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 350m unless otherwise specified in the data sheet.

#### 5.5.4 DC Link Reactor

- a. Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit.
- b. Unless otherwise specified, the reactor shall be air-cooled or fan cooled type located within the panel.
- c. Reactor shall be suitable for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.

#### 5.5.5 Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds, with harmonic limits as specified in this specification. Output filter shall be provided, if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 300 seconds after a loss of AC voltage. All capacitor shall be maintenance-free and self-healing type.

The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

#### 5.5.6 Bypass Feature

- a. Bypass feature along with motor protection relay and output side isolator/breaker shall be provided by purchaser unless otherwise specified in the datasheet. All necessary interlocks as required for safe and reliable operation of VFD system along with bypass feeder and output side isolator/breaker provided by Purchaser shall be provided in VFD system.
- b. Bypass starter shall be in separate compartment and switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended independently. Suitable interlock shall be provided such that bypass mode and VFD mode shall not operate simultaneously.



#### 5.5.7 Local Motor Control Station

- a. The local motor control station, to be installed in the field near the motor shall conform to the attached specifications. Components and accessories that are required in the local motor control station may be mounted on the local field mounted panel envisaged for the driven equipment.
- b. Meters in the local control station shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current. Further, for drives with bypass facility, the meters shall be capable of reading bypass mode full load and starting currents as well as the VFD mode drive current.

### 5.6 Protection, Control, Metering, Indication and Annunciation

- 5.6.1 The system vendor shall provide all the necessary system control, protection, alarm and metering equipment for the entire drive system and its auxiliary equipment.
- 5.6.2 Automatic sequence control shall include start-up of cooling system, auxiliary system of the motor, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor-based system.

#### 5.6.3 Operator Control Panel

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- a. Each drive shall be equipped with a front mounted operator control console consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter which shall not be limited to Start/Stop, Local/Remote, Auto/Manual, Increase/Decrease, menu navigation and protection and measurement parameter selection, etc.
- b. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand the display without the use of a manual or cross-reference table. This shall also be used for the modification of all electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self test and diagnostics. Keypad shall be operable with password for changing the protection setting, safety interlock etc. However, the parameters such as measurements, setting, mode of drive etc. shall be allowed to be viewed without any password.
- c. Operator console shall have facility/ port to connect external hardware such as Laptop etc. Console shall have facility to upload and download all parameter settings from one drive to another identical drive for start-up and operation.
- d. Drive system control shall also have facility to receive tripping signal from upstream breaker for tripping and also provision for closing upstream breaker after all required process parameters are achieved.
- e. User-friendly software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.



#### 5.6.4 Protective Features

The system shall incorporate adequate protective features, properly coordinated for the drive control and for the motor but not limited to the following:

- I. Incoming line surge protection
- II. Under / Over voltage protection
- III. Phase loss protection.
- IV. Programmable over current protection and under load protection.
- V. Inverter Fault.
- VI. Over frequency/Over speed of motor
- VII. Ventilation loss (In case same is not provided, drive shall generate an over temperature fault alarm and suitable sensors, as required for same, shall be provided).
- VIII. Over temperature of equipment.
- IX. Specific motor protection, including motor winding, bearing temperatures, over current, overload, negative phase sequence and earth fault protections etc.
- X. System earth fault protection.
- XI. Excitation system protection for synchronous motor
- XII. Over and under frequency, rotor earth fault (if applicable), field failure protection for synchronous motor
- XIII. Additional protection, if any for the drive system

#### 5.6.5 Control

The following controls shall be provided as a part of the Operator Control Panel or through separate switches.

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- I. Start/Stop
- II. Speed control (Raise/Lower)
- III. Forward/Reverse (if specified)
- IV. Auto/Manual /Test mode
- V. Local/Remote
- VI. Emergency stop
- VII. Start/Stop for bypass starter (where specified)
- VIII. Trip-Remote Breaker
- IX. Excitation control system for synchronous motors
- X. Sequential switching of filters

#### 5.6.6 Indications

Vendor shall provide indications as required for normal operation and for ease of maintenance, which shall not be limited to the following indications.

- I. Motor running
- II. Motor stopped
- III. VFD System Fault
- IV. System ready to start
- V. AC mains ON
- VI. Motor over speed
- VII. Rectifier output 'ON'
- VIII. Motor zero speed
- IX. Remote breaker trip
- X. Excitation system healthy for synchronous motors

Above indications may be provided as a part of the operator control panel, i.e. door mounted keypad or through hardwired LEDs. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2 Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm.



Potential free contacts for items i to iv shall be wired separately for remote indications in DCS system.

#### 5.6.7 Metering

Digital display of the following parameters shall be as a part of the Operator Control Panel, selectable by the operator.

- I. Output voltage
- II. Output current-VFD model Bypass mode
- III. Output frequency
- IV. Drive thermal state
- V. Motor speed
- VI. Motor energy meter
- VII. Hour Run



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- VIII. Voltage and current meter for excitation system of synchronous motor
- IX. KVAR, power factor meter for synchronous motors
- X. Necessary transducer shall be provided with 4-20mA output for indicating motor
- XI. speed and motor current in DCS unless otherwise specified for other parameters.

### 5.7 Fault Diagnostic

Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including, shutdown of the system, shall be available for a period of minimum 4 days (96 hours) after a shutdown, even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

### 5.8 External Power supply for auxiliary and Control Circuit

Auxiliary power supply for devices external to VFD module, space heater supply for Motor, VFD panel space heater, auxiliary power supply for transformers, cubicle 11W CFL lamps, indicating lamps, digital meters (Ammeter, Speedometer) etc. shall operate on 240 volts single phase AC supply provided by purchaser.

All control circuit shall operate at maximum voltage of 240V AC or 220V DC unless otherwise specified in the datasheet.

Vendor shall include supply of all control transformers, protective devices, associated accessories etc. and any other control supply voltage required for the system shall be derived by the vendor from the power supply made available by purchaser.

### 5.9 Reliability Features

The expected lifetime of the drive system shall be min. 20 years. The system including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years.

### 5.10 Maintenance features

The controller design shall incorporate the following maintenance features:

- Modular construction

- All components shall be easily accessible.

- Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.



### 5.11 Painting

5.11.1 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL 7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.11.2 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

## 6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the drive shall be subject to inspection by PDIL / Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used.

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**6.2** All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of PDIL/Owner or of an agency authorized by the owner. Prior notice of minimum 4 weeks shall be given to the inspector for witnessing the tests.

**6.3** All Routine & Type Tests shall be conducted as per the NIT for HV variable frequency drive as per IEC 61800-4. Moreover, combined test for VFD and motor at vendor's works shall be carried out.

**6.4** String Test with driven equipment

If a string test with driven equipment is specified in the data sheet of the driven equipment, it shall be carried out with the job equipment.

## **7.0 SPARES**

**7.1** 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.

**7.2** Spares for 2 Years operation (Mandatory), as specified shall be supplied.

**7.3** Recommend 2 years Operational Spares (other than mandatory spare) alongwith recommended quantity & item-wise unit price shall be furnished.

**7.4** All spare parts shall be identical to the parts used in the equipment

## **8.0 DRAWINGS**

**8.1** Vendor shall submit to Purchaser, for approval, before completion of manufacturing and assembly of equipment following drawings and literature.

- (i) Installation and maintenance manual including trouble-shooting chart.
- (ii) Panel drawings and cable schedule
- (iii) Block diagram and control logic.

## **9.0 CERTIFICATION**

The motors and associated Variable frequency drive system equipment shall have test certificates issued by recognized independent test house (CIMFRI BASEEFA/ LCIE/UL/FM or equivalent). All indigenous motors shall conform to Indian Standards and shall be certified by Indian testing agencies. All motors (indigenous and imported) shall also have valid statutory approvals as applicable for the specified hazardous location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

Also the motor nameplate shall clearly indicate that the motor is suitable for operation with variable frequency drive along with VFD make and model number.

## **10.0 PACKING AND DESPATCH**

All the equipment shall be divided in to several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. ship/rail or trailer. The equipment shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchaser for scrutiny. The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains/high ambient temperature.