

# **PATRATU VIDYUT UTPADAN NIGAM LIMITED**

(A Subsidiary of NTPC Ltd. in Joint Venture with Jharkhand Bijli Vitran Nigam Ltd)

**PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I  
(3 x 800 MW)**

## **TECHNICAL SPECIFICATION**

**FOR**

## **GYP SUM DEWATERING EQUIPMENT**

**SPECIFICATION NO.: PE-TS-434-571-A901, Rev 00**



**BHARAT HEAVY ELECTRICALS LIMITED  
POWER SECTOR  
PROJECT ENGINEERING MANAGEMENT  
PROJECT ENGINEERING INSTITUTE BUILDING  
SECTOR-16A, PLOT NO. 25, NOIDA, UTTAR PRADESH, INDIA**



**3x800 MW PATRATU TPS**  
**GYPSUM DEWATERING EQUIPMENT**  
**TECHNICAL SPECIFICATION**

SPECIFICATION No: PE-TS-434-571-A901

SECTION

REV. 00

SHEET : 1 OF 2

**CONTENTS****SECTION - I**

SUB- SECTIONS	TITLE	Page No.	
<b>Sub-Section-A</b>	INTENT OF SPECIFICATION	5 - 7	
<b>Sub-Section-B</b>	PROJECT INFORMATION	8 - 25	
<b>Sub-Section-C</b>	TECHNICAL SPECIFICATION	26	
	<b>Sub Section-C1</b> SPECIFIC TECHNICAL REQUIREMENT	27 - 45	
	<b>Sub Section-C2</b> CUSTOMER SPECIFICATION	46 - 143	
	<b>C2 - A</b> PROJECT SPECIFIC GENERAL REQUIREMENTS INCLUDING: GENERAL TECHNICAL REQUIREMENT QUALITY ASSURANCE DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE PACKING PROCEDURE		
	<b>C2 - B</b> PAINTING SPECIFICATION (INCLUDING APPROVED DOCUMENT)		
	<b>Sub Section-C3</b> TECHNICAL SPECIFICATION (ELECTRICAL PORTION)		144 - 212
	<b>Sub Section-C4</b> TECHNICAL SPECIFICATION (C&I PORTION)		213 - 367
<b>Sub Section-D</b>	<b>ANNEXURE-I</b> LIST OF MAKES OF SUB-VENDOR ITEMS	368	
	<b>ANNEXURE-II</b> MANDATORY SPARE LIST	369 - 372	
	<b>ANNEXURE-III</b> INSPECTION AND TESTING, STANDARD QUALITY PLAN	373 - 389	
	<b>ANNEXURE-IV</b> INPUT DRAWINGS (P&ID/ MECHANICAL LAYOUT DRAWINGS SHOWING LOCATION OF EQUIPMENT/ PLOT PLAN)	390 - 409	
	<b>ANNEXURE-V</b> MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	410 - 415	
	<b>ANNEXURE-VI</b> PACKING PROCEDURE	416 - 419	
	<b>ANNEXURE-VII</b> SEA-WORTHY PACKING PROCEDURE	420 - 472	
	<b>ANNEXURE-VIII</b> PIPE & VALVE MATERIAL SPECIFICATION	473 - 478	

**SECTION - II**

SUB SECTIONS	TITLE	Page No.
<b>Sub Section-1</b>	STANDARD TECHNICAL SPECIFICATION	479 - 484



3x800 MW PATRATU TPS

SPECIFICATION No: PE-TS-434-571-A901

**GYPSUM DEWATERING EQUIPMENT  
TECHNICAL SPECIFICATION**


SECTION

REV. 00

SHEET : 2 OF 2

**SECTION - III**

<b>SUB SECTIONS</b>	<b>TITLE</b>	<b>Page No.</b>
<b>Annexure-1</b>	LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	485
<b>Annexure-2</b>	COMPLIANCE CUM CONFIRMATION CERTIFICATE	486 - 487
<b>Annexure-3</b>	PRE-BID CLARIFICATION SCHEDULE	488
<b>Annexure-4</b>	DEVIATION SHEET (COST OF WITHDRAWAL)	489
<b>Annexure-5</b>	SCHEDULE OF GUARANTEES	490 - 491
<b>Annexure-6</b>	LIST OF MAKES OF SUB VENDOR ITEMS	492
<b>Annexure-7</b>	LIST OF TOOLS & TACKLES	493
<b>Annexure-8</b>	EQUIPMENT DATA SHEET/ SCHEDULE (TO BE FILLED BY BIDDER)	494 - 501
<b>Annexure-9</b>	LIST OF COMMISSIONING SPARES	502

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
		<b>SECTION: I</b>	
	<b>GYPHUM DEWATERING EQUIPMENT</b>	<b>REV. 00</b>	


## SECTION - I

**3x800 MW PATRATU TPS****SPECIFICATION No: PE-TS-434-571-A901****TECHNICAL SPECIFICATION  
GYPSUM DEWATERING EQUIPMENT****SECTION : I****Sub Section: A****REV. 00****INTENT OF SPECIFICATION****SHEET 1 OF 3**

## **SECTION-I**


### **SUB-SECTION-A**

#### **INTENT OF SPECIFICATION**


	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION</b>	<b>SECTION : I</b>	
	<b>GYPSUM DEWATERING EQUIPMENT</b>	<b>Sub Section: A</b>	
	<b>INTENT OF SPECIFICATION</b>	<b>REV. 00</b>	
		<b>SHEET 2 OF 3</b>	

## 1.0 INTENT OF SPECIFICATION

- 1.1 The specification covers Supply part, Services part and Mandatory spares comprising of design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site, assembly AND services part covers **supervision services for** erection & commissioning, trial run at site and carrying out Performance guarantee tests at site, training of customer/ client O&M staff covering all aspects of the GDS- Operation & Maintenance, Troubleshooting etc., training of customer at manufacturer's works (3 persons for 2 days including lodging and boarding) & handover in flawless condition of the package to the customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order for the **Gypsum Dewatering Equipment**, a sub-assembly of the Flue Gas Desulphurization (FGD) package of **3x800 MW Patratu TPS, Ramgarh, Jharkhand** of M/s Patratu Vidyut Utpadan Nigam Limited (PVUNL), a Joint Venture amongst Govt. of Jharkhand, JUVNL, JBVNL and NTPC Ltd.
- 1.2 There are three (3) units each of 800 MW rating. Two (02) Sets of Gypsum Dewatering Equipment (1 working + 1 standby) common for all three FGD absorber units shall be provided.
- 1.3 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **GYPSUM DEWATERING EQUIPMENT**.
- 1.4 The Bidder shall offer only proven design, which meets the Provenness criteria indicated in the NIT. Necessary document evidences shall be submitted along with the bid. If bidder doesn't meet the specified provenness criteria, their bid may not be considered for further evaluation.
- 1.5 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to the highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to the purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance.
- 1.6 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the equipment for its safe, efficient, reliable and trouble free operation and maintenance shall also be in supplier's scope unless specifically excluded and notwithstanding that they may have been omitted in drawings / specifications or schedules.

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION</b>	<b>SECTION : I</b>	
	<b>GYPSUM DEWATERING EQUIPMENT</b>	<b>Sub Section: A</b>	
	<b>INTENT OF SPECIFICATION</b>	<b>REV. 00</b>	
		<b>SHEET 3 OF 3</b>	

- 1.7 The general term and conditions, instructions to tenderers and other attachment(s) referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to the compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.8 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Section-III of the specification **within 10 days of receipt of tender documents**. In absence of any such clarification(s), in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further, in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.
- 1.9 The bidder's offer shall not carry any section like clarification, interpretations and /or assumptions.
- 1.10 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Section -III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/it's customer.
- 1.11 In the event of any conflict between the requirements of two clauses of this specification & requirements of different codes/standards and between respective clauses of sub-section C & sub-section D, more stringent clause as per the interpretation of the owner shall apply.
- 1.12 In case, all the above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.13 For definition of words like Contractor, bidder, supplier, vendor, Customer/ Purchaser/ Employer, consultant, please refer relevant clause of General Conditions of Contract (GCC).

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>Sub Section : B</b>	
		<b>REV. 00</b>	
<b>PROJECT INFORMATION</b>			

**SECTION: I**

**SUB-SECTION: B**

**PROJECT INFORMATION**





# **SUB-SECTION-I-B**


## **PROJECT INFORMATION**

**EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER STATION  
EXPANSION PHASE-1 (3x800 MW)**

**TECHNICAL SPECIFICATION  
SECTION-VI, PART-A  
BID DOC NO: CS-9585-001-2**

CLAUSE NO.	PROJECT INFORMATION																
<p><b>1.00.00</b></p> <p><b>2.00.00</b></p> <p><b>3.00.00</b></p> <p><b>4.00.00</b></p> <p>4.01.00</p> <p>4.02.00</p> <p>4.03.00</p>	<p style="text-align: center;"><b>PATRATU STPS EXPANSION PHASE-I (3X800 MW)</b></p> <p><b>BACKGROUND</b></p> <p>A Memorandum of Agreement (MOA) has been entered on 29.07.2015 amongst Govt. of Jharkhand (GoJ), Jharkhand Urja Vikash Nigam Limited (JUVNL), Jharkhand UrjaUtpadan Nigam Limited (JUUNL), Jharkhand BijliVitaran Nigam Limited (JBVNL) and NTPC Limited to form a Joint Venture Company of NTPC Limited &amp; JBVNL for transfer of Patratu Thermal Power Station (PTPS) located in Ramgarh District of Jharkhand State to the proposed JV Company for Performance Improvement of existing capacity &amp; 4000 MW Capacity expansion of PTPS.</p> <p>Further to signing of JV agreement on 29.07.2015, a Joint Venture Company namely Patratu Vidyut Utpadan Nigam Limited (PVUNL) has been incorporated amongst GoJ, JUVNL, JBVNL and NTPC Ltd. on 15.10.2015. The Performance Improvement of existing capacity and 4000 MW Capacity expansion of Patratu STPS will be implemented by the JV Company (JVC). The configuration of expansion of 4000 MW shall consist of 5 units of 800 MW to be implemented in two phases; Phase-I: 3x800 MW and Phase-II: 2x800 MW.</p> <p>The present proposal is for Patratu STPS Phase-I (3x800 MW). The project is envisaged to be commissioned during XIII Plan period.</p> <p><b>CAPACITY</b></p> <p>Patratu STPS Phase-I: 3x800 MW - Present proposal</p> <p><b>MODE OF OPERATION</b></p> <p>Base Load</p> <p><b>LOCATION AND APPROACH</b></p> <p>Patratu Thermal Power station (PTPS) is located just outside the coal belt of South Karanpura in Ramgarh District of Jharkhand State. The nearest Railway Station is Patratu which is at a distance of about 4 km on Barkakhana-Barwadih Railway line.</p> <p><b>The latitudes and longitudes of the site are as follows:</b></p> <table border="1"> <thead> <tr> <th>Corner name</th> <th>Latitude</th> <th>Longitude</th> </tr> </thead> <tbody> <tr> <td>Top Corner</td> <td>23° 38 ' 60'' N</td> <td>85° 17' 51.5" E</td> </tr> <tr> <td>Bottom Corner</td> <td>23° 38 ' 12.5'' N</td> <td>85° 17' 27" E</td> </tr> <tr> <td>Left Corner</td> <td>23° 38 ' 22.5'' N</td> <td>85° 17' 10.6'' E</td> </tr> <tr> <td>Right Corner</td> <td>23° 38 ' 40'' N</td> <td>85° 17' 57'' E</td> </tr> </tbody> </table> <p><b>Airport</b></p> <p>The nearest commercial airport is Ranchi at about 45 km by road.</p>	Corner name	Latitude	Longitude	Top Corner	23° 38 ' 60'' N	85° 17' 51.5" E	Bottom Corner	23° 38 ' 12.5'' N	85° 17' 27" E	Left Corner	23° 38 ' 22.5'' N	85° 17' 10.6'' E	Right Corner	23° 38 ' 40'' N	85° 17' 57'' E	
Corner name	Latitude	Longitude															
Top Corner	23° 38 ' 60'' N	85° 17' 51.5" E															
Bottom Corner	23° 38 ' 12.5'' N	85° 17' 27" E															
Left Corner	23° 38 ' 22.5'' N	85° 17' 10.6'' E															
Right Corner	23° 38 ' 40'' N	85° 17' 57'' E															
<p style="text-align: center;"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800 MW)</b></p>	<p style="text-align: center;"><b>TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC. NO CS-9585-001-02</b></p>	<p style="text-align: center;"><b>SUB-SECTION-IB PROJECT INFORMATION</b></p>	<p style="text-align: center;"><b>PAGE 1 OF 15</b></p>														

CLAUSE NO.	PROJECT INFORMATION			
<p><b>5.00.00</b></p> <p><b>LAND</b></p> <p><b>6.00.00</b></p> <p><b>WATER</b></p>	<p>A copy of Vicinity plan of the project site is placed at <b>Annexure - I</b>.</p> <p>The total land to be transferred to JV Company is 1859 acres. Out of 1859 acre, about 1234 acres of land has been envisaged for Plant, Ash pond and Land on railway track of the for Phase-I (3x800 MW). The balance 625 acre of land shall be transferred during commencement of Phase-II (2x800 MW).</p> <p>The make-up water for PSTPS is to be met from Patratu Dam on Nalkari River (capacity 99 MCM i.e. 110 Cusecs). About 52.34 Cusecs of water will be available at 90% dependable monsoon flow after considering evaporation loss.</p> <p>GoJ/JUVNL owns and controls water of Patratu Dam. GoJ/JUUNL supplies water to PTPS and to the other entities in the vicinity from this water reservoir. JUVNL had entered into agreements with these other entities for supply of water from water reservoir. JUVNL shall revisit these agreements to meet the requirement of water for expansion projects, if required.</p> <p>Make up water requirement of PSTPS, Phase-I (3x800 MW) would be about 27 Cusecs with "Air Cooled Condenser" based power plant. GoJ shall provide the required water from the existing reservoir to the JV Company.</p> <p>The JVC shall be responsible for the water supply arrangement starting at the downstream of intake chamber from where water supply commences for the Station. Ownership of the entire water supply system and related plant and equipment, including the water treatment plant, shall be that of the JVC and after the asset transfer, the JVC shall maintain, take care and use the same. The additional facility including addition of plant, equipment etc. for enhanced requirement (if any) and drawl of water shall be the responsibility of JVC and to be arranged by the JVC at their own cost.</p>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800 MW)</p>	<p>TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC. NO CS-9585-001-02</p>	<p>SUB-SECTION-IB PROJECT INFORMATION</p>	<p>PAGE 2 OF 15</p>	

CLAUSE NO.	PROJECT INFORMATION		
<p><b>7.00.00</b></p> <p>7.01.00</p> <p>7.02.00</p> <p>7.03.00</p> <p>7.04.00</p>	<p><b>COAL</b></p> <p><b>Coal Requirement, Availability and Linkage</b></p> <p>About 12 MTPA of coal will be required to meet coal requirement of the Phase-I (3x800 MW) of the project.</p> <p>The Banhardih captive coal block at a distance of about 155 km from plant is allocated to JUVNL for end use of Patratu expansion. The coal from Banhardih captive coal block shall be transferred to the JVC for the usage of PSTPS with the approval of Ministry of Coal, GOI. MOC (11.09.15) has accorded in-principle approval of the Central Govt. to assign Banhardih Coal Block allocated to JUVNL to the JV Company.</p> <p><b>Coal Transportation</b></p> <p>The envisaged mode of coal transportation from the coal mines to the power plant is by Indian Railways through BOBR / BOX- N wagons.</p> <p><b>Coal Quality</b></p> <p>The primary fuel for the main steam generator shall be coal. The domestic coal quality parameters are indicated in <b>Annexure-IV-2</b> and imported coal parameters are indicated in <b>Annexure-IV-4</b> are to be considered for steam generator design.</p> <p><b>Fuel Oil</b></p> <p>The fuel oils to be used for start-up, coal flame stabilization and low load operation of the steam generator shall be Heavy Fuel Oils having the characteristics given at <b>Annexure-IV-3</b> and Light Diesel Oil having the characteristics given at <b>Annexure-IV-1</b>.</p>		
<p><b>8.00.00</b></p>	<p><b>NOT USED</b></p>		
<p><b>9.00.00</b></p>	<p><b>STEAM GENERATOR TECHNOLOGY</b></p> <p>The steam generators shall be super critical once through type, water tube, direct pulverized coal fired, top supported, balanced draft furnace, single reheat, radiant, dry bottom type, suitable for outdoor installation. The gas path arrangement shall be single pass (Tower type) or two pass type.</p>		
<p><b>10.00.00</b></p>	<p><b>FLUE GAS DESULPHURIZATION SYSTEM (FGD) &amp; SCR:</b></p> <p>The project is envisaged with Flue Gas Desulfurization (FGD) system and SCR meeting Ministry of Environment, Forest &amp; Climate Change notification dated 07.12.2015. Limestone to be used for design of FGD system shall be as per the characteristic given at Annexure-IV-5.</p>		
<p><b>11.00.00</b></p>	<p><b>POWER EVACUATION SYSTEM</b></p> <p>85% of power from the project is envisaged to be allocated to Jharkhand State subject to approval of Ministry of Power, while balance 15% would be as unallocated portion and Project is envisaged as regional project. Since major power (85%) is proposed to be absorbed by Jharkhand, the issue of Associated Transmission</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800 MW)</p>	<p>TECHNICAL SPECIFICATION SECTION – VI, PART-A BID DOC. NO CS-9585-001-02</p>	<p>SUB-SECTION-IB PROJECT INFORMATION</p>	<p>PAGE 3 OF 15</p>


<p>CLAUSE NO.</p>	<p>PROJECT INFORMATION</p>		
		<p>ANNEXURE-I</p>	
			

EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER  
STATION EXPANSION PHASE-I (3X800 MW)


TECHNICAL SPECIFICATION  
SECTION – VI, PART-A  
BID DOC. NO CS-9585-001-02


SUB-SECTION-IB  
PROJECT INFORMATION


PAGE  
6 OF 15

CLAUSE NO.	PROJECT INFORMATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
C	<b>जलवायवी सारणी</b> <b>CLIMATOLOGICAL TABLE</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	1953 से 1960 तक के जलवायवी BASED ON OBSERVATIONS FROM 1953 TO 1960																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
स्टेशन : रात्रास STATION : Rastras अक्षांश : 23°30' N LONG: 85°30' E उचाई : 335 METRES एलिट्यूट : 335 METRES																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<b>वायु तापमान</b> <b>AIR TEMPERATURE</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th rowspan="2">MONTH</th> <th colspan="2">DAILY</th> <th colspan="2">MEAN</th> <th colspan="2">EXTREMES</th> <th colspan="2">HUMIDITY</th> <th colspan="2">CLOUD AMOUNT</th> <th rowspan="2">WIND VELOCITY</th> <th rowspan="2">WIND DIRECTION</th> <th rowspan="2">WIND FORCE</th> <th rowspan="2">WIND PERCENTAGE</th> <th rowspan="2">WIND PERIOD</th> <th rowspan="2">WIND DIRECTION</th> <th rowspan="2">WIND FORCE</th> <th rowspan="2">WIND PERCENTAGE</th> <th rowspan="2">WIND PERIOD</th> </tr> <tr> <th>MAX</th> <th>MIN</th> <th>MAX</th> <th>MIN</th> <th>HIGHEST</th> <th>LOWEST</th> <th>DATE AND YEAR</th> <th>DATE AND YEAR</th> <th>RELATIVE HUMIDITY</th> <th>LOW CLOUDS</th> </tr> </thead> <tbody> <tr><td>JAN</td><td>14.6</td><td>13.2</td><td>24.5</td><td>22</td><td>28.5</td><td>3.7</td><td>33.1</td><td>31</td><td>1.2</td><td>05</td><td>1978</td><td>08</td><td>11.8</td><td>1.2</td><td>0.6</td><td>0.6</td><td>16.7</td><td>1.7</td><td>22.3</td><td>0.0</td><td>42.0</td><td>01</td><td>1956</td><td>2.0</td></tr> <tr><td>FEB</td><td>15.2</td><td>13.2</td><td>27.6</td><td>14.5</td><td>32.7</td><td>5.5</td><td>37.3</td><td>28</td><td>3.0</td><td>10</td><td>1978</td><td>02</td><td>12.4</td><td>1.0</td><td>0.5</td><td>0.5</td><td>10.3</td><td>1.2</td><td>24.0</td><td>0.0</td><td>54.6</td><td>04</td><td>1961</td><td>2.8</td></tr> <tr><td>MAR</td><td>15.5</td><td>13.2</td><td>30.0</td><td>15.1</td><td>37.3</td><td>10.4</td><td>41.1</td><td>26</td><td>7.9</td><td>11</td><td>1979</td><td>05</td><td>14.6</td><td>1.3</td><td>0.4</td><td>0.4</td><td>11.4</td><td>1.2</td><td>26.4</td><td>0.0</td><td>23.2</td><td>04</td><td>1962</td><td>3.3</td></tr> <tr><td>APR</td><td>19.3</td><td>16.7</td><td>38.4</td><td>21.0</td><td>42.3</td><td>15.6</td><td>45.2</td><td>16</td><td>13.5</td><td>27</td><td>1979</td><td>12</td><td>11.5</td><td>1.2</td><td>0.4</td><td>0.4</td><td>16.0</td><td>1.4</td><td>25.2</td><td>0.0</td><td>41.6</td><td>01</td><td>1959</td><td>4.3</td></tr> <tr><td>MAY</td><td>20.2</td><td>17.3</td><td>40.8</td><td>24.5</td><td>44.5</td><td>20.0</td><td>48.0</td><td>11</td><td>17.0</td><td>06</td><td>1979</td><td>07</td><td>22.2</td><td>1.6</td><td>0.6</td><td>0.6</td><td>23.7</td><td>2.3</td><td>25.6</td><td>0.0</td><td>76.4</td><td>23</td><td>1958</td><td>4.5</td></tr> <tr><td>JUN</td><td>22.8</td><td>24.3</td><td>37.5</td><td>24.5</td><td>43.2</td><td>21.7</td><td>47.6</td><td>12</td><td>19.5</td><td>01</td><td>1979</td><td>08</td><td>20.3</td><td>2.2</td><td>1.5</td><td>1.5</td><td>25.4</td><td>7.4</td><td>23.4</td><td>83.4</td><td>140.0</td><td>01</td><td>1961</td><td>4.9</td></tr> <tr><td>JUL</td><td>22.0</td><td>24.5</td><td>32.3</td><td>24.3</td><td>37.3</td><td>22.1</td><td>46.5</td><td>20</td><td>20.0</td><td>09</td><td>1974</td><td>07</td><td>21.3</td><td>2.4</td><td>2.7</td><td>2.7</td><td>28.9</td><td>8.5</td><td>20.2</td><td>31.9</td><td>205.2</td><td>18</td><td>1958</td><td>4.2</td></tr> <tr><td>AUG</td><td>21.9</td><td>22.7</td><td>31.7</td><td>24.1</td><td>35.3</td><td>22.1</td><td>38.0</td><td>08</td><td>18.2</td><td>22</td><td>1979</td><td>09</td><td>20.5</td><td>2.2</td><td>3.5</td><td>3.5</td><td>28.7</td><td>15.8</td><td>18.0</td><td>58.0</td><td>109.8</td><td>24</td><td>1953</td><td>3.5</td></tr> <tr><td>SEP</td><td>22.5</td><td>22.8</td><td>31.6</td><td>23.0</td><td>35.0</td><td>21.1</td><td>34.0</td><td>05</td><td>18.9</td><td>20</td><td>1974</td><td>08</td><td>23.2</td><td>2.5</td><td>3.4</td><td>3.4</td><td>28.3</td><td>11.4</td><td>17.8</td><td>52.7</td><td>106.1</td><td>01</td><td>1957</td><td>3.1</td></tr> <tr><td>OCT</td><td>21.9</td><td>22.1</td><td>31.4</td><td>19.1</td><td>34.4</td><td>24.4</td><td>38.0</td><td>02</td><td>16.0</td><td>27</td><td>1979</td><td>07</td><td>21.4</td><td>2.4</td><td>1.4</td><td>1.4</td><td>21.3</td><td>4.2</td><td>26.7</td><td>2.6</td><td>134.4</td><td>12</td><td>1973</td><td>2.0</td></tr> <tr><td>NOV</td><td>18.6</td><td>18.3</td><td>28.3</td><td>15.4</td><td>31.5</td><td>9.2</td><td>35.1</td><td>01</td><td>5.4</td><td>22</td><td>1960</td><td>06</td><td>15.5</td><td>0.9</td><td>0.2</td><td>0.2</td><td>3.5</td><td>0.5</td><td>21.5</td><td>9.0</td><td>34.3</td><td>07</td><td>1948</td><td>1.6</td></tr> <tr><td>DEC</td><td>14.2</td><td>15.1</td><td>24.5</td><td>9.3</td><td>28.6</td><td>4.0</td><td>32.0</td><td>01</td><td>0.6</td><td>24</td><td>1961</td><td>08</td><td>12.0</td><td>0.9</td><td>0.4</td><td>0.4</td><td>2.3</td><td>0.1</td><td>24.4</td><td>9.0</td><td>56.4</td><td>24</td><td>1958</td><td>1.7</td></tr> <tr><td>ANNUAL</td><td>19.2</td><td>15.3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>TOTAL OR MEAN</td><td>24.3</td><td>19.0</td><td>31.8</td><td>19.0</td><td>44.9</td><td>3.0</td><td>48.0</td><td></td><td>0.6</td><td></td><td></td><td>65</td><td>22.0</td><td>2.4</td><td>1.4</td><td>1.4</td><td>1108.2</td><td>64.0</td><td>146.1</td><td>196.7</td><td>205.2</td><td></td><td></td><td>3.2</td></tr> <tr><td>WIND VELOCITY</td><td>27.5</td><td>21.4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>56</td><td>21.5</td><td>2.6</td><td>1.7</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>WIND PERCENTAGE</td><td>34</td><td>24</td><td>21</td><td>21</td><td>21</td><td>21</td><td>22</td><td></td><td>22</td><td></td><td></td><td>24</td><td>23</td><td>22</td><td>17</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>WIND PERIOD</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>24</td><td>24</td><td>22</td><td>17</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>			MONTH	DAILY		MEAN		EXTREMES		HUMIDITY		CLOUD AMOUNT		WIND VELOCITY	WIND DIRECTION	WIND FORCE	WIND PERCENTAGE	WIND PERIOD	WIND DIRECTION	WIND FORCE	WIND PERCENTAGE	WIND PERIOD	MAX	MIN	MAX	MIN	HIGHEST	LOWEST	DATE AND YEAR	DATE AND YEAR	RELATIVE HUMIDITY	LOW CLOUDS	JAN	14.6	13.2	24.5	22	28.5	3.7	33.1	31	1.2	05	1978	08	11.8	1.2	0.6	0.6	16.7	1.7	22.3	0.0	42.0	01	1956	2.0	FEB	15.2	13.2	27.6	14.5	32.7	5.5	37.3	28	3.0	10	1978	02	12.4	1.0	0.5	0.5	10.3	1.2	24.0	0.0	54.6	04	1961	2.8	MAR	15.5	13.2	30.0	15.1	37.3	10.4	41.1	26	7.9	11	1979	05	14.6	1.3	0.4	0.4	11.4	1.2	26.4	0.0	23.2	04	1962	3.3	APR	19.3	16.7	38.4	21.0	42.3	15.6	45.2	16	13.5	27	1979	12	11.5	1.2	0.4	0.4	16.0	1.4	25.2	0.0	41.6	01	1959	4.3	MAY	20.2	17.3	40.8	24.5	44.5	20.0	48.0	11	17.0	06	1979	07	22.2	1.6	0.6	0.6	23.7	2.3	25.6	0.0	76.4	23	1958	4.5	JUN	22.8	24.3	37.5	24.5	43.2	21.7	47.6	12	19.5	01	1979	08	20.3	2.2	1.5	1.5	25.4	7.4	23.4	83.4	140.0	01	1961	4.9	JUL	22.0	24.5	32.3	24.3	37.3	22.1	46.5	20	20.0	09	1974	07	21.3	2.4	2.7	2.7	28.9	8.5	20.2	31.9	205.2	18	1958	4.2	AUG	21.9	22.7	31.7	24.1	35.3	22.1	38.0	08	18.2	22	1979	09	20.5	2.2	3.5	3.5	28.7	15.8	18.0	58.0	109.8	24	1953	3.5	SEP	22.5	22.8	31.6	23.0	35.0	21.1	34.0	05	18.9	20	1974	08	23.2	2.5	3.4	3.4	28.3	11.4	17.8	52.7	106.1	01	1957	3.1	OCT	21.9	22.1	31.4	19.1	34.4	24.4	38.0	02	16.0	27	1979	07	21.4	2.4	1.4	1.4	21.3	4.2	26.7	2.6	134.4	12	1973	2.0	NOV	18.6	18.3	28.3	15.4	31.5	9.2	35.1	01	5.4	22	1960	06	15.5	0.9	0.2	0.2	3.5	0.5	21.5	9.0	34.3	07	1948	1.6	DEC	14.2	15.1	24.5	9.3	28.6	4.0	32.0	01	0.6	24	1961	08	12.0	0.9	0.4	0.4	2.3	0.1	24.4	9.0	56.4	24	1958	1.7	ANNUAL	19.2	15.3																								TOTAL OR MEAN	24.3	19.0	31.8	19.0	44.9	3.0	48.0		0.6			65	22.0	2.4	1.4	1.4	1108.2	64.0	146.1	196.7	205.2			3.2	WIND VELOCITY	27.5	21.4										56	21.5	2.6	1.7											WIND PERCENTAGE	34	24	21	21	21	21	22		22			24	23	22	17											WIND PERIOD												24	24	22	17										
MONTH	DAILY			MEAN		EXTREMES		HUMIDITY		CLOUD AMOUNT		WIND VELOCITY	WIND DIRECTION										WIND FORCE	WIND PERCENTAGE	WIND PERIOD	WIND DIRECTION	WIND FORCE	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																
	MAX	MIN	MAX	MIN	HIGHEST	LOWEST	DATE AND YEAR	DATE AND YEAR	RELATIVE HUMIDITY	LOW CLOUDS																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
JAN	14.6	13.2	24.5	22	28.5	3.7	33.1	31	1.2	05	1978	08	11.8	1.2	0.6	0.6	16.7	1.7	22.3	0.0	42.0	01	1956	2.0																																																																																																																																																																																																																																																																																																																																																																																																																																																					
FEB	15.2	13.2	27.6	14.5	32.7	5.5	37.3	28	3.0	10	1978	02	12.4	1.0	0.5	0.5	10.3	1.2	24.0	0.0	54.6	04	1961	2.8																																																																																																																																																																																																																																																																																																																																																																																																																																																					
MAR	15.5	13.2	30.0	15.1	37.3	10.4	41.1	26	7.9	11	1979	05	14.6	1.3	0.4	0.4	11.4	1.2	26.4	0.0	23.2	04	1962	3.3																																																																																																																																																																																																																																																																																																																																																																																																																																																					
APR	19.3	16.7	38.4	21.0	42.3	15.6	45.2	16	13.5	27	1979	12	11.5	1.2	0.4	0.4	16.0	1.4	25.2	0.0	41.6	01	1959	4.3																																																																																																																																																																																																																																																																																																																																																																																																																																																					
MAY	20.2	17.3	40.8	24.5	44.5	20.0	48.0	11	17.0	06	1979	07	22.2	1.6	0.6	0.6	23.7	2.3	25.6	0.0	76.4	23	1958	4.5																																																																																																																																																																																																																																																																																																																																																																																																																																																					
JUN	22.8	24.3	37.5	24.5	43.2	21.7	47.6	12	19.5	01	1979	08	20.3	2.2	1.5	1.5	25.4	7.4	23.4	83.4	140.0	01	1961	4.9																																																																																																																																																																																																																																																																																																																																																																																																																																																					
JUL	22.0	24.5	32.3	24.3	37.3	22.1	46.5	20	20.0	09	1974	07	21.3	2.4	2.7	2.7	28.9	8.5	20.2	31.9	205.2	18	1958	4.2																																																																																																																																																																																																																																																																																																																																																																																																																																																					
AUG	21.9	22.7	31.7	24.1	35.3	22.1	38.0	08	18.2	22	1979	09	20.5	2.2	3.5	3.5	28.7	15.8	18.0	58.0	109.8	24	1953	3.5																																																																																																																																																																																																																																																																																																																																																																																																																																																					
SEP	22.5	22.8	31.6	23.0	35.0	21.1	34.0	05	18.9	20	1974	08	23.2	2.5	3.4	3.4	28.3	11.4	17.8	52.7	106.1	01	1957	3.1																																																																																																																																																																																																																																																																																																																																																																																																																																																					
OCT	21.9	22.1	31.4	19.1	34.4	24.4	38.0	02	16.0	27	1979	07	21.4	2.4	1.4	1.4	21.3	4.2	26.7	2.6	134.4	12	1973	2.0																																																																																																																																																																																																																																																																																																																																																																																																																																																					
NOV	18.6	18.3	28.3	15.4	31.5	9.2	35.1	01	5.4	22	1960	06	15.5	0.9	0.2	0.2	3.5	0.5	21.5	9.0	34.3	07	1948	1.6																																																																																																																																																																																																																																																																																																																																																																																																																																																					
DEC	14.2	15.1	24.5	9.3	28.6	4.0	32.0	01	0.6	24	1961	08	12.0	0.9	0.4	0.4	2.3	0.1	24.4	9.0	56.4	24	1958	1.7																																																																																																																																																																																																																																																																																																																																																																																																																																																					
ANNUAL	19.2	15.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
TOTAL OR MEAN	24.3	19.0	31.8	19.0	44.9	3.0	48.0		0.6			65	22.0	2.4	1.4	1.4	1108.2	64.0	146.1	196.7	205.2			3.2																																																																																																																																																																																																																																																																																																																																																																																																																																																					
WIND VELOCITY	27.5	21.4										56	21.5	2.6	1.7																																																																																																																																																																																																																																																																																																																																																																																																																																																														
WIND PERCENTAGE	34	24	21	21	21	21	22		22			24	23	22	17																																																																																																																																																																																																																																																																																																																																																																																																																																																														
WIND PERIOD												24	24	22	17																																																																																																																																																																																																																																																																																																																																																																																																																																																														
<b>वर्ष</b> <b>YEAR</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th>YEAR</th> <th>WIND VELOCITY</th> <th>WIND PERCENTAGE</th> <th>WIND PERIOD</th> </tr> </thead> <tbody> <tr><td>1953</td><td>16.7</td><td>1.7</td><td>22.3</td></tr> <tr><td>1954</td><td>10.3</td><td>1.2</td><td>24.0</td></tr> <tr><td>1955</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1956</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1957</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1958</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1959</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1960</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1961</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1962</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1963</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1964</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1965</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1966</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1967</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1968</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1969</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1970</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1971</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1972</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1973</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1974</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1975</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1976</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1977</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1978</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1979</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1980</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> </tbody> </table>			YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD	1953	16.7	1.7	22.3	1954	10.3	1.2	24.0	1955	11.4	1.2	26.4	1956	16.0	1.4	25.2	1957	23.7	2.3	25.6	1958	25.4	7.4	23.4	1959	16.0	1.4	25.2	1960	3.5	0.5	21.5	1961	2.3	0.1	24.4	1962	11.4	1.2	26.4	1963	16.0	1.4	25.2	1964	23.7	2.3	25.6	1965	25.4	7.4	23.4	1966	16.0	1.4	25.2	1967	3.5	0.5	21.5	1968	2.3	0.1	24.4	1969	11.4	1.2	26.4	1970	16.0	1.4	25.2	1971	23.7	2.3	25.6	1972	25.4	7.4	23.4	1973	16.0	1.4	25.2	1974	3.5	0.5	21.5	1975	2.3	0.1	24.4	1976	11.4	1.2	26.4	1977	16.0	1.4	25.2	1978	23.7	2.3	25.6	1979	25.4	7.4	23.4	1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																							
YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1953	16.7	1.7	22.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1954	10.3	1.2	24.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1955	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1956	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1957	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1958	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1959	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1960	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1961	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1962	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1963	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1964	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1965	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1966	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1967	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1968	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1969	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1970	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1971	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1972	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1973	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1974	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1975	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1976	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1977	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1978	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1979	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<b>वर्ष</b> <b>YEAR</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th>YEAR</th> <th>WIND VELOCITY</th> <th>WIND PERCENTAGE</th> <th>WIND PERIOD</th> </tr> </thead> <tbody> <tr><td>1953</td><td>16.7</td><td>1.7</td><td>22.3</td></tr> <tr><td>1954</td><td>10.3</td><td>1.2</td><td>24.0</td></tr> <tr><td>1955</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1956</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1957</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1958</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1959</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1960</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1961</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1962</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1963</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1964</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1965</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1966</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1967</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1968</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1969</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1970</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1971</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1972</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1973</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1974</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1975</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1976</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1977</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1978</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1979</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1980</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> </tbody> </table>			YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD	1953	16.7	1.7	22.3	1954	10.3	1.2	24.0	1955	11.4	1.2	26.4	1956	16.0	1.4	25.2	1957	23.7	2.3	25.6	1958	25.4	7.4	23.4	1959	16.0	1.4	25.2	1960	3.5	0.5	21.5	1961	2.3	0.1	24.4	1962	11.4	1.2	26.4	1963	16.0	1.4	25.2	1964	23.7	2.3	25.6	1965	25.4	7.4	23.4	1966	16.0	1.4	25.2	1967	3.5	0.5	21.5	1968	2.3	0.1	24.4	1969	11.4	1.2	26.4	1970	16.0	1.4	25.2	1971	23.7	2.3	25.6	1972	25.4	7.4	23.4	1973	16.0	1.4	25.2	1974	3.5	0.5	21.5	1975	2.3	0.1	24.4	1976	11.4	1.2	26.4	1977	16.0	1.4	25.2	1978	23.7	2.3	25.6	1979	25.4	7.4	23.4	1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																							
YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1953	16.7	1.7	22.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1954	10.3	1.2	24.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1955	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1956	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1957	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1958	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1959	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1960	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1961	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1962	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1963	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1964	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1965	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1966	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1967	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1968	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1969	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1970	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1971	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1972	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1973	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1974	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1975	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1976	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1977	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1978	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1979	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<b>वर्ष</b> <b>YEAR</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th>YEAR</th> <th>WIND VELOCITY</th> <th>WIND PERCENTAGE</th> <th>WIND PERIOD</th> </tr> </thead> <tbody> <tr><td>1953</td><td>16.7</td><td>1.7</td><td>22.3</td></tr> <tr><td>1954</td><td>10.3</td><td>1.2</td><td>24.0</td></tr> <tr><td>1955</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1956</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1957</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1958</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1959</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1960</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1961</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1962</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1963</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1964</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1965</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1966</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1967</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1968</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1969</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1970</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1971</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1972</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1973</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1974</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1975</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1976</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1977</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1978</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1979</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1980</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> </tbody> </table>			YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD	1953	16.7	1.7	22.3	1954	10.3	1.2	24.0	1955	11.4	1.2	26.4	1956	16.0	1.4	25.2	1957	23.7	2.3	25.6	1958	25.4	7.4	23.4	1959	16.0	1.4	25.2	1960	3.5	0.5	21.5	1961	2.3	0.1	24.4	1962	11.4	1.2	26.4	1963	16.0	1.4	25.2	1964	23.7	2.3	25.6	1965	25.4	7.4	23.4	1966	16.0	1.4	25.2	1967	3.5	0.5	21.5	1968	2.3	0.1	24.4	1969	11.4	1.2	26.4	1970	16.0	1.4	25.2	1971	23.7	2.3	25.6	1972	25.4	7.4	23.4	1973	16.0	1.4	25.2	1974	3.5	0.5	21.5	1975	2.3	0.1	24.4	1976	11.4	1.2	26.4	1977	16.0	1.4	25.2	1978	23.7	2.3	25.6	1979	25.4	7.4	23.4	1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																							
YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1953	16.7	1.7	22.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1954	10.3	1.2	24.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1955	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1956	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1957	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1958	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1959	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1960	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1961	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1962	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1963	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1964	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1965	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1966	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1967	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1968	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1969	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1970	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1971	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1972	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1973	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1974	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1975	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1976	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1977	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1978	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1979	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<b>वर्ष</b> <b>YEAR</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th>YEAR</th> <th>WIND VELOCITY</th> <th>WIND PERCENTAGE</th> <th>WIND PERIOD</th> </tr> </thead> <tbody> <tr><td>1953</td><td>16.7</td><td>1.7</td><td>22.3</td></tr> <tr><td>1954</td><td>10.3</td><td>1.2</td><td>24.0</td></tr> <tr><td>1955</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1956</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1957</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1958</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1959</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1960</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1961</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1962</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1963</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1964</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1965</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1966</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1967</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1968</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1969</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1970</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1971</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1972</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1973</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1974</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1975</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1976</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1977</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1978</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1979</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1980</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> </tbody> </table>			YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD	1953	16.7	1.7	22.3	1954	10.3	1.2	24.0	1955	11.4	1.2	26.4	1956	16.0	1.4	25.2	1957	23.7	2.3	25.6	1958	25.4	7.4	23.4	1959	16.0	1.4	25.2	1960	3.5	0.5	21.5	1961	2.3	0.1	24.4	1962	11.4	1.2	26.4	1963	16.0	1.4	25.2	1964	23.7	2.3	25.6	1965	25.4	7.4	23.4	1966	16.0	1.4	25.2	1967	3.5	0.5	21.5	1968	2.3	0.1	24.4	1969	11.4	1.2	26.4	1970	16.0	1.4	25.2	1971	23.7	2.3	25.6	1972	25.4	7.4	23.4	1973	16.0	1.4	25.2	1974	3.5	0.5	21.5	1975	2.3	0.1	24.4	1976	11.4	1.2	26.4	1977	16.0	1.4	25.2	1978	23.7	2.3	25.6	1979	25.4	7.4	23.4	1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																							
YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1953	16.7	1.7	22.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1954	10.3	1.2	24.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1955	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1956	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1957	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1958	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1959	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1960	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1961	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1962	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1963	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1964	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1965	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1966	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1967	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1968	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1969	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1970	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1971	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1972	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1973	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1974	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1975	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1976	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1977	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1978	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1979	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<b>वर्ष</b> <b>YEAR</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th>YEAR</th> <th>WIND VELOCITY</th> <th>WIND PERCENTAGE</th> <th>WIND PERIOD</th> </tr> </thead> <tbody> <tr><td>1953</td><td>16.7</td><td>1.7</td><td>22.3</td></tr> <tr><td>1954</td><td>10.3</td><td>1.2</td><td>24.0</td></tr> <tr><td>1955</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1956</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1957</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1958</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1959</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1960</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1961</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1962</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1963</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1964</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1965</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1966</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1967</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1968</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1969</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1970</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1971</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1972</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1973</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1974</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1975</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1976</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1977</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1978</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1979</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1980</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> </tbody> </table>			YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD	1953	16.7	1.7	22.3	1954	10.3	1.2	24.0	1955	11.4	1.2	26.4	1956	16.0	1.4	25.2	1957	23.7	2.3	25.6	1958	25.4	7.4	23.4	1959	16.0	1.4	25.2	1960	3.5	0.5	21.5	1961	2.3	0.1	24.4	1962	11.4	1.2	26.4	1963	16.0	1.4	25.2	1964	23.7	2.3	25.6	1965	25.4	7.4	23.4	1966	16.0	1.4	25.2	1967	3.5	0.5	21.5	1968	2.3	0.1	24.4	1969	11.4	1.2	26.4	1970	16.0	1.4	25.2	1971	23.7	2.3	25.6	1972	25.4	7.4	23.4	1973	16.0	1.4	25.2	1974	3.5	0.5	21.5	1975	2.3	0.1	24.4	1976	11.4	1.2	26.4	1977	16.0	1.4	25.2	1978	23.7	2.3	25.6	1979	25.4	7.4	23.4	1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																							
YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1953	16.7	1.7	22.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1954	10.3	1.2	24.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1955	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1956	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1957	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1958	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1959	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1960	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1961	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1962	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1963	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1964	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1965	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1966	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1967	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1968	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1969	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1970	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1971	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1972	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1973	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1974	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1975	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1976	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1977	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1978	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1979	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<b>वर्ष</b> <b>YEAR</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th>YEAR</th> <th>WIND VELOCITY</th> <th>WIND PERCENTAGE</th> <th>WIND PERIOD</th> </tr> </thead> <tbody> <tr><td>1953</td><td>16.7</td><td>1.7</td><td>22.3</td></tr> <tr><td>1954</td><td>10.3</td><td>1.2</td><td>24.0</td></tr> <tr><td>1955</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1956</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1957</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1958</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1959</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1960</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1961</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1962</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1963</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1964</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1965</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1966</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1967</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1968</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1969</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1970</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1971</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1972</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1973</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1974</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1975</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1976</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1977</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1978</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1979</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1980</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> </tbody> </table>			YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD	1953	16.7	1.7	22.3	1954	10.3	1.2	24.0	1955	11.4	1.2	26.4	1956	16.0	1.4	25.2	1957	23.7	2.3	25.6	1958	25.4	7.4	23.4	1959	16.0	1.4	25.2	1960	3.5	0.5	21.5	1961	2.3	0.1	24.4	1962	11.4	1.2	26.4	1963	16.0	1.4	25.2	1964	23.7	2.3	25.6	1965	25.4	7.4	23.4	1966	16.0	1.4	25.2	1967	3.5	0.5	21.5	1968	2.3	0.1	24.4	1969	11.4	1.2	26.4	1970	16.0	1.4	25.2	1971	23.7	2.3	25.6	1972	25.4	7.4	23.4	1973	16.0	1.4	25.2	1974	3.5	0.5	21.5	1975	2.3	0.1	24.4	1976	11.4	1.2	26.4	1977	16.0	1.4	25.2	1978	23.7	2.3	25.6	1979	25.4	7.4	23.4	1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																							
YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1953	16.7	1.7	22.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1954	10.3	1.2	24.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1955	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1956	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1957	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1958	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1959	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1960	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1961	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1962	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1963	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1964	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1965	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1966	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1967	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1968	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1969	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1970	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1971	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1972	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1973	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1974	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1975	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1976	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1977	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1978	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1979	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1980	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<b>वर्ष</b> <b>YEAR</b>																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
<table border="1"> <thead> <tr> <th>YEAR</th> <th>WIND VELOCITY</th> <th>WIND PERCENTAGE</th> <th>WIND PERIOD</th> </tr> </thead> <tbody> <tr><td>1953</td><td>16.7</td><td>1.7</td><td>22.3</td></tr> <tr><td>1954</td><td>10.3</td><td>1.2</td><td>24.0</td></tr> <tr><td>1955</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1956</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1957</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1958</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1959</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1960</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1961</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1962</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1963</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1964</td><td>23.7</td><td>2.3</td><td>25.6</td></tr> <tr><td>1965</td><td>25.4</td><td>7.4</td><td>23.4</td></tr> <tr><td>1966</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1967</td><td>3.5</td><td>0.5</td><td>21.5</td></tr> <tr><td>1968</td><td>2.3</td><td>0.1</td><td>24.4</td></tr> <tr><td>1969</td><td>11.4</td><td>1.2</td><td>26.4</td></tr> <tr><td>1970</td><td>16.0</td><td>1.4</td><td>25.2</td></tr> <tr><td>1971</td><td></td></tr></tbody></table>			YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD	1953	16.7	1.7	22.3	1954	10.3	1.2	24.0	1955	11.4	1.2	26.4	1956	16.0	1.4	25.2	1957	23.7	2.3	25.6	1958	25.4	7.4	23.4	1959	16.0	1.4	25.2	1960	3.5	0.5	21.5	1961	2.3	0.1	24.4	1962	11.4	1.2	26.4	1963	16.0	1.4	25.2	1964	23.7	2.3	25.6	1965	25.4	7.4	23.4	1966	16.0	1.4	25.2	1967	3.5	0.5	21.5	1968	2.3	0.1	24.4	1969	11.4	1.2	26.4	1970	16.0	1.4	25.2	1971																																																																																																																																																																																																																																																																																																																																																																																														
YEAR	WIND VELOCITY	WIND PERCENTAGE	WIND PERIOD																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1953	16.7	1.7	22.3																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1954	10.3	1.2	24.0																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1955	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1956	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1957	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1958	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1959	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1960	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1961	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1962	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1963	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1964	23.7	2.3	25.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1965	25.4	7.4	23.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1966	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1967	3.5	0.5	21.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1968	2.3	0.1	24.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1969	11.4	1.2	26.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1970	16.0	1.4	25.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1971																																																																																																																																																																																																																																																																																																																																																																																																																																																																													



CLAUSE NO.	TECHNICAL REQUIREMENTS 																
	<p style="text-align: right;"><b>ANNEXURE- (d)</b></p> <p><b>CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT</b></p> <p>All structures shall be designed for wind forces in accordance with IS 875 (Part-3) and as specified in this document. See Annexure – B for site specific information.</p> <p>Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.</p> <p>Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.</p> <p>Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than "5" and/or if the fundamental frequency of the structure is less than 1 Hz.</p> <p>Susceptibility of structures to across-wind forces, galloping, flutter, ovaling etc. should be examined and designed/detailed accordingly following the recommendations of IS 875(Part-3) and other relevant Indian standards.</p> <p>It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.</p> <p><b>Damping in Structures</b></p> <p>The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 80%;">a) Welded steel structures</td> <td style="width: 20%;">: 1.0%</td> </tr> <tr> <td>b) Bolted steel structures</td> <td>: 2.0%</td> </tr> <tr> <td>c) Reinforced concrete structures</td> <td>: 1.6%</td> </tr> <tr> <td>d) Steel stacks</td> <td>: As per IS 6533 &amp; CICIND Model Code whichever is more critical.</td> </tr> </table> <p><b>SITE SPECIFIC DESIGN PARAMETERS</b></p> <p>The various design parameters, as defined in IS 875 (Part-3), to be adopted for the project site shall be as follows:</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 80%;">a) The basic wind speed "<math>V_b</math>" at ten metre above the mean ground level: 39 metre/second</td> <td style="width: 20%;"></td> </tr> <tr> <td>b) The risk coefficient "<math>K_1</math>"</td> <td>: 1.06</td> </tr> <tr> <td>c) Category of terrain</td> <td>: Category-2</td> </tr> </table>			a) Welded steel structures	: 1.0%	b) Bolted steel structures	: 2.0%	c) Reinforced concrete structures	: 1.6%	d) Steel stacks	: As per IS 6533 & CICIND Model Code whichever is more critical.	a) The basic wind speed " $V_b$ " at ten metre above the mean ground level: 39 metre/second		b) The risk coefficient " $K_1$ "	: 1.06	c) Category of terrain	: Category-2
a) Welded steel structures	: 1.0%																
b) Bolted steel structures	: 2.0%																
c) Reinforced concrete structures	: 1.6%																
d) Steel stacks	: As per IS 6533 & CICIND Model Code whichever is more critical.																
a) The basic wind speed " $V_b$ " at ten metre above the mean ground level: 39 metre/second																	
b) The risk coefficient " $K_1$ "	: 1.06																
c) Category of terrain	: Category-2																
<p style="text-align: center;"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b></p>	<p style="text-align: center;"><b>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2</b></p>	<p style="text-align: center;"><b>SUB-SECTION-D-01 CIVIL WORKS</b></p>	<p style="text-align: center;"><b>PAGE 333 OF 340</b></p>														

CLAUSE NO.	TECHNICAL REQUIREMENTS 														
	<p style="text-align: right;">Annexure-(E)</p> <p><b>CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT</b></p> <p>All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1):2002 and IS:1893 (Part 4):2005. Pending finalization of Parts 2, 3 and 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for structures other than the buildings and industrial structures including stack-like structures.</p> <p>A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Annexure-I.</p> <p>Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.</p> <p>The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Annexure-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 and Part 4).</p> <p><b>Damping in Structures</b></p> <p>The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:</p> <table border="0" style="width: 100%; margin-left: 40px;"> <tr> <td style="width: 60%;">Steel structures</td> <td style="width: 20%;"></td> <td style="width: 20%; text-align: right;">2 %</td> </tr> <tr> <td>Reinforced structures</td> <td>Concrete</td> <td style="text-align: right;">5 %</td> </tr> <tr> <td>Reinforced Stacks</td> <td>Concrete</td> <td style="text-align: right;">3 %</td> </tr> <tr> <td>Steel stacks</td> <td></td> <td style="text-align: right;">2 %</td> </tr> </table>			Steel structures		2 %	Reinforced structures	Concrete	5 %	Reinforced Stacks	Concrete	3 %	Steel stacks		2 %
Steel structures		2 %													
Reinforced structures	Concrete	5 %													
Reinforced Stacks	Concrete	3 %													
Steel stacks		2 %													
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 334 OF 340												

CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	<p><b>Method of Analysis</b></p> <p>Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).</p> <p>In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).</p> <p>For buildings, if the design base shear (VB) obtained from modal combination is less than the base shear (<math>\bar{V}B</math>) computed using the approximate fundamental period (<math>T_a</math>) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of <math>\bar{V}B/ VB</math>. However, no reduction is permitted if <math>\bar{V}B</math> is less than VB.</p> <p>For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 &amp; 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (<math>A_h</math>) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Annexure-I. Further, the spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the building falls to the left of the peak in the spectral acceleration curve.</p> <p><b>Design/Detailing for Ductility for Structures</b></p> <p>The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.</p> <p><u>SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT</u></p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 335 OF 340

Annexure-2**CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT**

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

**Damping in Structures**

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

- |    |                                |   |    |
|----|--------------------------------|---|----|
| a) | Steel structures               | : | 2% |
| b) | Reinforced Concrete structures | : | 5% |
| c) | Reinforced Concrete Stacks     | : | 3% |
| d) | Steel stacks                   | : | 2% |

### Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear ( $V_B$ ) obtained from modal combination is less than the base shear ( $\bar{V}_B$ ) computed using the approximate fundamental period ( $T_a$ ) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of  $\bar{V}_B / V_B$ . However, no reduction is permitted if  $\bar{V}_B$  is less than  $V_B$ .

For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value ( $A_h$ ) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Appendix-I.

### Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

**SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT**

The various site specific seismic parameters for the project site shall be as follows:

- |    |  |          |
|----|--|----------|
| 1) | Peak ground horizontal acceleration (MCE)  | : 0.41 g |
| 2) | Multiplied factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra  |          |
| a) | for ordinary moment resisting steel frames designed and detailed as per IS:800   | : 0.103  |
| b) | for braced steel frames designed and detailed as per IS:800  | : 0.077  |
| c) | For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920  | : 0.062  |
| d) | for RCC chimney  | : 0.205  |
| e) | for liquid retaining tanks   | : 0.123  |
| f) | for steel chimney  | : 0.154  |
| g) | for design of structures not covered under 2 (a) to 2 (f) above and under 3 below  | : 0.103  |
| 3) | Multiplied factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted | : 0.205  |

Notes:

1. g = Acceleration due to gravity
2. For industrial structures, analysis for verification of mechanism shall be carried out as per IS:1893 (Part 4):2015

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

**HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS**  
(In units of 'g')


Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1.000	1.000	1.000
0.03	1.000	1.000	1.000
0.04	1.555	1.405	1.293
0.05	2.190	1.828	1.578
0.06	2.898	2.267	1.857
0.07	3.670	2.720	2.131
0.075	3.670	3.175	2.267
0.08	3.670	3.175	2.500
0.083	3.670	3.175	2.500
0.085	3.670	3.175	2.500
0.09	3.670	3.175	2.500
0.1	3.670	3.175	2.500
0.105	3.670	3.175	2.500
0.11	3.670	3.175	2.500
0.115	3.670	3.175	2.500
0.12	3.670	3.175	2.500
0.125	3.670	3.175	2.500
0.13	3.670	3.175	2.500
0.135	3.670	3.175	2.500
0.14	3.670	3.175	2.500
0.145	3.670	3.175	2.500
0.15	3.670	3.175	2.500
0.2	3.670	3.175	2.500
0.22	3.670	3.175	2.500
0.23	3.670	3.175	2.500
0.24	3.670	3.175	2.500
0.3	3.670	3.175	2.500
0.35	3.670	3.175	2.500
0.4	3.670	3.175	2.500
0.45	3.111	2.822	2.222
0.5	2.800	2.540	2.000
0.55	2.545	2.309	1.818
0.6	2.333	2.117	1.667
0.65	2.154	1.954	1.538
0.7	2.000	1.814	1.429
0.75	1.867	1.693	1.333
0.8	1.750	1.588	1.250
0.85	1.647	1.494	1.176
0.9	1.556	1.411	1.111
0.95	1.474	1.337	1.053
1	1.400	1.270	1.000

**HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS**  
(In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
1.05	1.333	1.210	0.952
1.1	1.273	1.155	0.909
1.15	1.217	1.104	0.870
1.2	1.167	1.058	0.833
1.25	1.120	1.016	0.800
1.3	1.077	0.977	0.769
1.35	1.037	0.941	0.741
1.4	1.000	0.907	0.714
1.45	0.966	0.876	0.690
1.5	0.933	0.847	0.667
1.55	0.903	0.819	0.645
1.6	0.875	0.794	0.625
1.65	0.848	0.770	0.606
1.7	0.824	0.747	0.588
1.75	0.800	0.726	0.571
1.8	0.778	0.706	0.556
1.85	0.757	0.686	0.541
1.9	0.737	0.668	0.526
1.95	0.718	0.651	0.513
2	0.700	0.635	0.500
2.05	0.683	0.620	0.488
2.1	0.667	0.605	0.476
2.15	0.651	0.591	0.465
2.2	0.636	0.577	0.455
2.25	0.622	0.564	0.444
2.3	0.609	0.552	0.435
2.35	0.596	0.540	0.426
2.4	0.583	0.529	0.417
2.45	0.571	0.518	0.408
2.5	0.560	0.508	0.400
2.55	0.549	0.498	0.392
2.6	0.538	0.488	0.385
2.65	0.528	0.479	0.377
2.7	0.519	0.470	0.370
2.8	0.500	0.454	0.357
2.85	0.491	0.446	0.351
2.9	0.483	0.438	0.345
2.95	0.475	0.431	0.339
3	0.467	0.423	0.333
3.05	0.459	0.416	0.328
3.1	0.452	0.410	0.323
3.15	0.444	0.403	0.317

**HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS**  
**(In units of 'g')**

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
3.2	0.438	0.397	0.313
3.25	0.431	0.391	0.308
3.3	0.424	0.385	0.303
3.35	0.418	0.379	0.299
3.4	0.412	0.374	0.294
3.45	0.406	0.368	0.290
3.5	0.400	0.363	0.286

CLAUSE NO.	TECHNICAL REQUIREMENTS 		
	<p style="text-align: right;">Annexure-(f)</p> <p style="text-align: center;"><b>QA REQUIREMENT</b></p> <p>All Civil, Structural and Architectural construction work at the project shall be executed strictly in accordance with the Quality Assurance guidelines specified in separate part of this Specification.</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO. CS--9585-001-2	SUB-SECTION-D-01 CIVIL WORKS	PAGE 336 OF 340



3x800 MW PATRATU TPS

GYPSUM DEWATERING EQUIPMENT

TECHNICAL SPECIFICATION

SPECIFICATION No: PE-TS-434-571-A901

SECTION : I


Sub Section : C

REV. 00

**SECTION: I**

**SUB SECTION: C**


**TECHNICAL SPECIFICATION**

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
<b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SHEET 1 OF 19</b>		

**SECTION: I**

**SUB-SECTION: C 1**

**SPECIFIC TECHNICAL REQUIREMENT**

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>		
	<b>TECHNICAL SPECIFICATION</b>			<b>SECTION : I</b>
	<b>GYPSUM DEWATERING EQUIPMENT</b>			<b>SUB-SECTION : C1</b>
	<b>SPECIFIC TECHNICAL REQUIREMENT</b>			<b>REV. 00</b>
			<b>SHEET 2 OF 19</b>	

### 1.1 FUNCTION

The purpose of this specification is to provide details of the complete Gypsum Dewatering Equipment (GDWE) for PVUNL Patratu TPS 3x800 MW, under the scope of this tender.

### 1.2 TECHNICAL INFORMATION

1.2.1	Quantity of Gypsum De-Watering Equipment (GDWE)	Two (2) Sets (one working +one standby)
1.2.2	Capacity of Gypsum DeWATERing Equipment	136.0 Tones per hour (wet cake) minimum at outlet of Vacuum belt filter for each belt filter
1.2.3	Moisture content	10% (max)
1.2.4	Chloride content	100 ppm or less
1.2.5	Gypsum purity	90% or more [by BHEL]

### 2.1 SCOPE OF SUPPLY & SERVICES

The specification covers Supply part, Services part and Mandatory spares comprising of design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site, assembly AND services part covers **supervision services for** erection & commissioning, trial run at site and carrying out Performance guarantee tests at site, training of customer/ client O&M staff covering all aspects of the GDE- Operation & Maintenance, Troubleshooting etc., training of customer at manufacturer's works (6 man-days including lodging and boarding) & handover in flawless condition of the package to the customer complete with all accessories


**Design:** Broadly includes basic engineering, detail engineering, preparation and submission of engineering drawings/ calculations/ datasheets/ quality assurance documents/field quality plans, storage instructions, commissioning procedures, Erection & assembly Drawings, operation & maintenance manuals, performance guarantee test procedures and assisting BHEL in obtaining time bound approval from Customer.

**Supply:** Broadly Includes manufacturing/ fabrication, shop floor testing, stage inspections, final inspections, painting, packing & forwarding.

**Services:** Broadly includes supervision services for erection & commissioning, trial run at site and carrying out Performance Guarantee tests at site, training of Customer's Engineering Personnel at manufacturer's works covering design familiarization, training on product design features etc. (6 man-days including lodging and boarding), training of Customer's O&M staff covering all aspects of Operation & Maintenance, Troubleshooting etc. (6 days) at Site & handover in flawless condition of the package to the customer.

2.1.1 The scope of supply for Gypsum Dewatering Equipment shall include but not limited to the following:

- 2.1.1.1 Primary hydro cyclone: Two (2) sets
- i. Hydrocyclone clusters
  - ii. Anchor bolts, nuts and washers

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
<b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SHEET 3 OF 19</b>		

- iii. Flanges for inlet and overflow
- iv. A variety size of vortex finders for all the hydro cyclone
- v. Accessory piping within the skid
- vi. Piping, valves, instruments as per the terminal points defined elsewhere in the specification

2.1.1.2 Secondary hydro cyclone: Two (2) sets

- i. Hydrocyclone clusters
- ii. Anchor bolts, nuts and washers
- iii. Flanges for inlet and overflow
- iv. A variety size of vortex finders for all the hydro cyclone
- v. Accessory piping within the skid
- vi. Piping, valves, instruments as per the terminal points defined elsewhere in the specification

2.1.1.3 Vacuum belt filters complete with Accessories including discharge chute up to the gypsum conveyor skirt board (*width of Gypsum conveyor belt is 650 mm and that of skirt board top is 433 mm*), driving motors (IE3) inverter duty with VFD and inverter panel: Two (2) numbers

2.1.1.4 Vacuum receivers with Anchor bolts, nuts and washers: Two (2) Sets.

Filtrate extraction pumps (total 2 nos., 1 no. per receiver tank) shall be provided. Refer Scheme No. PE-FEP-00 for the typical arrangement. The extraction system of the filtrate complete with pumps, valves, instruments and accessories along with associated supports, fasteners, gaskets etc. with drive (IE3 motor). Bidder to also include all connection bolts/nuts/washers for installation. Required instruments and any safety device shall be supplied.

Bidder to include the same in the P&ID scheme & submit for the approval of BHEL/Customer.

2.1.1.5 Vacuum pumps with drive (IE3 motor), All connection bolts/nuts/washers for installation, Required instruments and any safety device: Two (2) numbers


Bidder to consider the requirement of the vertical seal water sump pumps (2 nos., 1 working + 1 stand by) in scope for pumping the water expended from the Vacuum pump(s) to the Cake/cloth Wash Tank(s).

Civil work of the sump shall be in BHEL scope and the bidder shall provide inputs.

The system shall be complete with pumps, valves, instruments and accessories along with associated supports, fasteners, gaskets etc. with drive (IE3 motor). Also, bidder to include all connection bolts/nuts/washers for installation. Required instruments and any safety device shall be supplied.

Bidder to include the same in the P&ID scheme & submit for the approval of BHEL/Customer.

2.1.1.6 Vent fan including enclosure and its complete arrangement from VBF till exhaust: Two (2) numbers

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>
	<b>TECHNICAL SPECIFICATION</b>	<b>SECTION : I</b>
	<b>GYPSUM DEWATERING EQUIPMENT</b>	<b>SUB-SECTION : C1</b>
	<b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>REV. 00</b>
		<b>SHEET 4 OF 19</b>

2.1.1.7 Complete arrangement for Filter Cloth and Gypsum Cake washing (excluding Tanks & their Instruments), pumps with motors (IE3), associated piping, valves, spray nozzles & accessories for: One (1) set\*

Two (2) nos. of belt filter cum cake washing tanks are envisaged for both the belt filters. Each tank shall be provided with 2 nos. (1 working + 1 standby) of wash pumps. The bidder shall provide suitable arrangement for the washing of belt filter cloth and gypsum cake including piping / valves / instruments etc.

The Scope of supply of Wash tank(s) with inlet/outlet nozzle and its instrumentation is in BHEL's scope. Inlet piping along with associated instruments/ valves from process water Terminal point (TP) to the tanks inlet nozzles, Process water Outlet piping from the tanks outlet nozzles for cake wash and belt wash comprising of the wash pumps, their motors (IE3) along with associated instruments/ valves etc. shall be in the bidder scope.

However, bidder scope shall be limited to the Engineering as per clause 2.1.1.9 (ii) (g) of this sub-section for the overflow and drain of the tanks.


2.1.1.8 Coupling with guards, wherever applicable: One (1) set\*

2.1.1.9 Piping, Valves and Accessories

(i) Complete engineering and supply of interconnected piping (slurry, air and water pipes) along with valves, rubber lining (wherever applicable, shall be supplied in erectable condition i.e., no rubber lining to be done at Site), instruments, valves, supports, gaskets, fasteners and accessories which is integral to Gypsum Dewatering Equipment – One (1) set\* which is broadly defined below:

- a. Slurry piping from Primary hydro cyclones underflow to Vacuum Belt Filters
- b. Filtrate piping from Vacuum belt filters to Vacuum receivers and further up to the extraction pumps discharge.
- c. Air piping from vacuum receivers to vacuum pumps to atmosphere
- d. Vacuum pumps seal water / drain water pipes to/ from wash tanks. Supply of seal water to vacuum pump shall be provided through clarified water pump as specified in P&ID. Seal water drain from vacuum pump shall be collected in sump pit and shall be routed back to clarified water tank through seal water sump pump as mentioned at clause 2.1.1.5 above.
- e. Process water piping from TP outside building to wash tanks along with overflow and drain piping of tanks.
- f. Instrument air piping from TP outside building up to equipment related to the equipment

(ii) Scope of below-mentioned interconnected piping (slurry, air and water pipes) along with valves, rubber lining (wherever applicable, shall be supplied in erectable condition i.e., no rubber lining to be done at Site), supports, gaskets, fasteners and accessories which is non

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 5 OF 19</b>	
<b>SPECIFIC TECHNICAL REQUIREMENT</b>			

integral to Gypsum Dewatering Equipment are **limited to engineering only** and supply shall be made by BHEL. **Engineering includes layout & routing of pipes, preparation of isometric drawings and BOQ:**

- a. Primary hydro cyclone feed tank outlet to the inlet flange of Primary hydro cyclones along with recirculation piping to feed tank
- b. Primary hydro cyclones over flow to Inlet of secondary hydro cyclone feed tank
- c. Secondary hydro cyclone feed tank outlet to inlet flange of secondary hydro cyclones along with recirculation piping to feed tank
- d. Secondary hydro cyclones underflow to filtrate tank
- e. Secondary hydro cyclones overflow to inlet flange of waste water tank
- f. Vacuum receiver drain through filtrate extraction pumps (bidder scope) to Filtrate tank and other associated drains of vacuum belt filters to filtrate tank
- g. Overflow and drain piping of cake/cloth wash tanks.

2.1.1.10 Expansion Joints at suction and discharge of each pump/other equipment, as applicable: One (1) Set\*

2.1.1.11 Instruments for the entire gypsum dewatering equipment including integral piping as defined at 2.1.1.9 above (minimum requirement for each gypsum dewatering equipment is given in the P&ID): One (1) set\*

2.1.1.12 Electric equipments common including but not limited to

- i. Local control panel, if required
- ii. LV, HT Motors (as applicable)
- iii. Junction Box
- iv. Instruments
- v. Push buttons


2.1.1.13 All motors shall be provided with suitable double compression cable gland.

Sizes of cables shall be informed by BHEL during detail engineering. Bidder to provide suitable gland with respect to sizes of cables.

Bidder shall provide cable glands and lugs for all equipment in his scope. Cables shall be terminated using double compression type cable glands and solder less crimping type tinned copper cable lugs.

Bidder shall provide junction box. The Junction box shall have provision for installing glands of suitable size on the bottom of the box.

2.1.1.14 Control System: Control system shall be DDCMIS/ DCS which shall be BHEL scope. Each equipment shall be furnished with required instrumentation and electrical accessory devices mounted and connected to a junction box/ cabinet.

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 6 OF 19</b>	
<b>SPECIFIC TECHNICAL REQUIREMENT</b>			

**2.1.1.15 SIGNALS [Refer Electrical/C&I portion/ P&IDs of this specification, as well]**

**2.1.1.15.1 Alarm Signal:**

- a) Bearing temperature high: Bidder shall supply bearing Temperature Transmitter for initiating alarm for "Bearing temperature high". Bearing temperature transmitter shall be provided with local display also. Bearing temperature transmitter (with 2V3 logic) shall be provided for HT motors (> 200 KW) at both the driving and non-Driving ends.
- b) Vibration Monitoring System, is envisaged for HT Motor, which is in BHEL scope. However, for mounting of vibration sensors/probe on DE&NDE Bearing, vendor to provide vibration pad (of dimension of 80mm x 80mm x 10mm each) for mounting of sensors with a provision i.e. M6x1 threaded hole, 13mm deep, predrilled in each pads. Bidder to provide Single notch/slot (of dimension 30mm x 15mm x 3mm) on the circumference of the coupling of Motor for mounting of key phasor. There shall be space and provision in the assembled machine train for mounting the phase marker bracket supplied by BHEL.

**2.1.1.15.2 Interlock signal:**

- a) Cake/Belt filter wash tank level low
- b) Cake/Belt filter wash tank level high


**2.1.1.16 First fill lubricants:** All the first fill and one year's toppings requirements of consumables such as grease, oil, lubricants, servo fluids etc. which will be required to put the equipment covered under the scope of specifications into successful commissioning/initial operation and to establish completion to facilities should be provided by contractor/supplier. Refer Clause 7.0 of this sub-section for further details.

**2.1.1.17 Suitable Painting and rust prevention during shipment and construction.**

**2.1.1.18 Seaworthy packing & forwarding to project site (applicable where the equipment is transported through sea route).** Refer project information specified elsewhere in the specification. Otherwise, packing specification of equipment of Indian origin will be followed.

**2.1.2 Services to be provided by the bidder:**

- (i) Detailed Erection and commissioning procedure shall be submitted by successful bidder for carrying out the erection and commissioning at site by BHEL.
- (ii) Supervision for Erection & Commissioning, trial run at site
- (iii) Performance guarantee tests at site & handover in flawless condition of the package to the customer
- (iv) Training of customer/ clients' O&M staff covering all aspects of the GDE- Operation & Maintenance, Trouble-shooting etc. at site (6 days)
- (v) Training of customer at manufacturer's works covering design familiarization, training on product design features etc. (6 man-days including lodging and boarding)

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
<b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SHEET 7 OF 19</b>		

(vi) For supervision services, visits shall be planned by BHEL site team and prior intimation shall be sent to supplier for visit to site. Bidder shall be informed around 10 days in advance for the requirement of visit at site. Visiting team shall consist of one or two expert of bidder as deemed necessary.

2.1.3 Mandatory spares as defined as Annexure-II, Sub Section-D of Section I.


2.1.4 Recommended spare parts list to be furnished (is not part of scope of supply)

2.1.5 Any other items required not covered above but required for the completeness of the equipment scope; same shall be included in the offer and shall be supplied by the Bidder/supplier. Bidder shall refer to the P&ID enclosed in Annexure-IV, Sub-Section-D of Section-I for the items under the bidder's scope. All the items indicated in the P&ID are minimal requirements.

*[Wherever (\*) is marked, one (1) set means complete requirement for both the Gypsum Dewatering Equipment]*

<b>2.2 PROCESS DESCRIPTION</b>	
1.	Common gypsum dewatering equipment is envisaged for all three units. The dewatering equipment shall receive the gypsum slurry from Primary Hydro cyclone feed pumps (BHEL Scope). Gypsum Dewatering Equipment shall be suitable for handling slurry from all three FGD absorber units. Two sets of primary hydrocyclone (1W+1S) with accessories shall be in vendor scope. Primary hydrocyclone underflow shall be taken to VBF inlet.
2.	The overflow from the primary sets of hydro-cyclone shall be taken to a secondary hydro-cyclone feed tank (BHEL Scope). Secondary Hydro cyclone feed pumps (BHEL Scope) shall transfer the slurry from tanks to secondary hydro cyclone. Two sets of Secondary hydro cyclones (1 working+1 stand by) and its accessories shall be in vendor scope. Bidder shall offer the suitable combination of hydrocyclone clusters as per the requirement.
3.	The underflow from the secondary hydro-cyclone shall be taken to the filtrate water tank. The over flow from the secondary hydro-cyclone shall be taken to a waste water storage tank.
4.	Two (2) nos. of belt filter cum cake washing tank (BHEL scope) is envisaged for both the belt filters. Each tank shall be provided with 2 nos. of belt filter wash cum cake wash pumps.

<b>2.3 TERMINAL POINTS</b>	
1.	Primary hydro cyclone feed slurry will be provided by BHEL at the inlet flange of the primary hydro cyclone.
2.	Primary hydro cyclone overflow launder outlet flange. Further piping by BHEL to secondary hydrocyclone feed tank.
3.	Secondary hydro cyclone feed slurry will be provided by BHEL at the inlet flange of secondary hydro cyclone.
4.	Secondary hydro cyclone underflow launder outlet flange and overflow launder outlet flange. Further piping by BHEL to waste water and filtrate tank.
5.	Outlet flanges at filtrate extraction pumps discharge expansion joints and TP near VBF for other drain such as cloth wash, dyke drain etc.
6.	Process/clarified water & instrument air will be provided at one location, located at 5 m from building boundary. Further piping from terminal point to GDE utilities are in bidder's scope.

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
<b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SHEET 8 OF 19</b>		

7.	Discharge of Gypsum through discharge chute onto the gypsum belt conveyor is in bidder's scope. Please refer enclosed P&IDs, typical layout & preliminary drawing of GDE for the details in the scope.
----	--

2.4 For Electrical scope, refer Electrical specification (Sub-section- C3, Section-I).

2.5 For Control & Instrumentation (C&I) scope, refer C&I specification (Sub-section- C4, Section-I).

### **3.0 CODES & STANDARDS AND OTHER REQUIREMENTS**

3.1 The design and manufacturing of vacuum belt filter shall follow the latest applicable Indian / International (ASME / EN /Japanese) Standards.


3.2 The performance tests shall be carried out in accordance with ASME PTC 40 (2017) code.

3.3 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

- a) Indian Electricity Act
- b) Indian Electricity Rules
- c) Indian Explosives Act
- d) Indian Factories Act and State Factories Act
- e) Indian Boiler Regulations (IBR)
- f) Regulations of the Central Pollution Control Board, India
- g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- h) Pollution Control Regulations of Department of Environment, Government of India
- i) State Pollution Control Board.
- (j.) Rules for Electrical installation by Tariff Advisory Committee (TAC).
- (k.) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996
- (l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
- (m.) Explosive Rules, 1983
- (n.) Petroleum Act, 1984
- (o.) Petroleum Rules, 1976,
- (p.) Gas Cylinder Rules, 1981
- (q.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
- (r.) Workmen's Compensation Act, 1923
- (s.) Workmen's Compensation Rules, 1924
- (t.) PVUNL Safety Rules for Construction and Erection
- (u.) PVUNL Safety Policy
- (v.) Any other statutory codes / standards / regulations, as may be applicable.

3.4 Unless covered otherwise in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:


- a) Bureau of Indian standards (BIS)


	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 9 OF 19</b>	
<b>SPECIFIC TECHNICAL REQUIREMENT</b>			


- b) Japanese Industrial Standards (JIS)
- c) American National Standards Institute (ANSI)
- d) American Society of Testing and Materials (ASTM)
- e) American Society of Mechanical Engineers (ASME)
- f) American Petroleum Institute (API)
- g) Standards of the Hydraulic Institute, U.S.A.
- h) International Organization for Standardization (ISO)
- i) Tubular Exchanger Manufacturer's Association (TEMA)
- j) American Welding Society (AWS)
- k) National Electrical Manufacturers Association (NEMA)
- l) National Fire Protection Association (NFPA)
- m) International Electro-Technical Commission (IEC)
- n) Expansion Joint Manufacturers Association (EJMA)
- o) Heat Exchange Institute (HEI)
- p) IEEE standard
- q) JEC standard

- 3.5 Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the BHEL Customer's approval, for which the bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases, the bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.
- 3.6 Two (2) English language copies of all national and international codes and/or standards used in the design of the plant and equipment shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.
- 3.7 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the BHEL shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of BHEL such changes and advise BHEL of the resulting effect.

<b>4.0 DETAILED TECHNICAL SPECIFICATION</b>	
<b>4.1</b>	<b>DETAILED SPECIFICATION</b>
4.1.1	Bidder shall supply two stage gypsum dewatering equipment consisting of primary hydro cyclones, vacuum belt filters and secondary hydro cyclones for dewatering of gypsum from absorber to less than 10% moisture at the design capacity specified elsewhere in the specification.
4.1.2	Bidder shall supply 2x100% gypsum dewatering equipment with each stream sized to dewater <b>136 TPH (Wet cake)</b> produced by the all three FGD units operating at design point. All other stipulations with respect to sizing and design of the dewatering equipment, auxiliaries and other systems shall be in line with this specification.
<b>4.2</b>	<b>Hydro-cyclones</b>
4.2.1	Two (2) sets of primary hydro cyclones are envisaged, each set shall be sized to dewater the gypsum slurry produced by the unit operating at design point.


	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>
	<b>TECHNICAL SPECIFICATION</b>	<b>SECTION : I</b>
	<b>GYPSUM DEWATERING EQUIPMENT</b>	<b>SUB-SECTION : C1</b>
	<b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>REV. 00</b>
		<b>SHEET 10 OF 19</b>
4.2.2	Each set of primary hydro-cyclone shall be provided with 10% spare hydro-cyclones. The capacity defined in the previous clause shall be met with spare hydro-cyclones out of service.	
4.2.3	The primary hydro-cyclone shall be installed directly above the belt filters. The overflow of the hydro-cyclones shall be taken to Hydro-cyclone Waste Water tank via secondary hydro-cyclone feed tank and secondary waste water hydrocyclone as shown in the relevant P&IDs.	
4.2.4	The primary hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose. The outlet water content in the gypsum shall be as per the requirement of the vacuum belt filters.	
4.2.5	The Primary hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The feed chamber shall be provided with a minimum lining thickness of 25 mm. Liners shall have a <b>minimum wear life of not less than 7000 hours</b> .	
4.2.6	Two (2) sets of secondary hydro cyclones are to be installed. Each set of hydro-cyclone shall be sized to process the maximum discharge from the secondary hydro-cyclone feed pumps. A minimum 10% spare hydro-cyclones shall be provided in each set. Secondary Hydro-cyclones shall be of modular construction and of proven design. The secondary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.	
4.3	<b>Vacuum Belt Filters (VBF)</b>	
4.3.1	Two (2) numbers of Vacuum Belt Filters each of capacity <b>136 TPH (Wet cake)</b> is envisaged. Each vacuum belt filter shall be sized to meet the following requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum: <ul style="list-style-type: none"> <li>▪ Outlet Moisture: 10% (maximum)</li> <li>▪ Chloride content: 100 ppm (maximum)</li> <li>▪ Gypsum Purity: 90% (minimum) – by BHEL</li> </ul>	
4.3.2	The Vacuum Belt Filters shall have the following characteristics: <ol style="list-style-type: none"> <li>a) Very rigid frame and rolls, no deformation whatsoever may occur.</li> <li>b) All rolls shall be installed perfectly horizontally</li> <li>c) There shall be no vacuum under the slurry deposition zone.</li> <li>d) Deposit thickness control and directional stability control</li> <li>e) The slurry shall be put on the belt in counter current relative to the rotation of band.</li> <li>f) The vacuum chambers shall be easily opened for inspection and cleaning.</li> </ol>	
4.3.3	The vacuum belt filter shall be proven design in operation for similar capacities. The filter cloth shall be polyester or polypropylene as per the proven design of the supplier and shall be guaranteed for a <b>minimum life of not less than 7000 hours</b> . In case the bidder does not stand guarantee for specified life, they shall supply additional sets of filter cloth(s) to meet the cumulative life of 7000 hours. The same is applicable for main as well as mandatory spares and shall be supplied along with main supplies and mandatory spares.	
4.3.4	The complete frame of the filter and all parts in contact with gypsum shall be made of corrosion resistant material or shall be provided with corrosion resistant liners of proven design. Accordingly, bidder may consider 'Corten / Weathering Steel' or 'SS 304' or any other suitable corrosion resistant material conforming to ASTM A606-4, A588, A847 etc. as applicable. The material so selected, should be meeting the strength requirement of the belt filter.	

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>
	<b>TECHNICAL SPECIFICATION</b>	<b>SECTION : I</b>
	<b>GYPSUM DEWATERING EQUIPMENT</b>	<b>SUB-SECTION : C1</b>
	<b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>REV. 00</b>
		<b>SHEET 11 OF 19</b>
4.3.5	<p>In case, the contractor offers a design with an underlying belt for carrying the filter cloth, the same shall be endless, factory vulcanized rubber belts. The belt shrouds and the sealing belts shall provide a leak tight arrangement to prevent overflow of gypsum slurry. The sealing belt shall have <b>minimum life of not less than 7000 hours</b>.</p> <p>In case the bidder does not stand guarantee for specified life, they shall supply additional sets of filter cloth(s) to meet the cumulative life of 7000 hours. The same is applicable for main as well as mandatory spares and shall be supplied along with main supplies and mandatory spares.</p>	
4.3.6	The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.	
4.3.7	The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation as per the bidder's proven practice. The belt filter shall have an automatic cloth tensioning mechanism. Pull chord switches shall be provided for each vacuum belt filter. Four (04) no.'s of Belt sway switches shall be provided for each vacuum belt filter. Cake thickness sensors with double redundancy shall be provided for each vacuum belt filter which shall control the speed of the vacuum belt filter in turn.	
4.3.8	Differential Pressure indicator shall be provided at the discharge line of Belt filter wash Pump for each vacuum Belt filter. Flow indicator shall be provided for cloth washing line of each vacuum belt filter. Flow indicator shall be provided for cake washing line of each vacuum belt filter as per P&ID enclosed.	
4.3.9	The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum. One stage of cloth washing arrangement shall also be provided.	
4.3.10	The filtrate from gypsum slurry and cake washing shall be taken to single/ multiple vacuum receiver tank(s) as per the proven practice of the supplier. Each belt filter shall have an independent vacuum pump.	
4.3.11	Gypsum cake from each belt filter shall be discharged through a suitable chute onto belt conveyor being provided by BHEL. Direct impact of material on conveyor belt shall be avoided by providing suitable chute arrangement. Gypsum Handling Conveyor Belt (BHEL's scope) width shall be of 650 mm.	
4.3.12	A 2 m (min.) wide platform shall be provided all around each belt filter for easy approach & maintenance. or it may provide a common platform of <b>3.3m</b> (approx.) width. In case, common platform for VBF is provided, a movable platform along with access ladder shall be provided for approaching components on other side of VBF. The elevation of discharge point of vacuum belt filter shall be as per the Drawing of Gypsum Dewatering Building provided in the Sub Section-7 of Section-II. Any changes for optimization of the layout shall be suggested by Bidder accordingly.	
4.3.13	The service factor of the gear unit (if any) shall be minimum 1.5.	
4.3.14	Piping and wiring within the skid should be in the vendor's scope.	
4.3.15	All client end connection flanges shall be ANSI B 16.5/AWWA.	
4.4	<b>Vacuum System</b>	
4.4.1	The filtrate from each set of the belt filter and cake washing shall be taken to single/multiple receiver tank(s) as per the supplier's proven practice. Each belt filter shall be provided with an independent vacuum pump sized to meet the requirements of the belt filter operating at its maximum capacity. An additional 10% margin over the above shall be provided each vacuum pump.	
4.4.2	Each Vacuum pump shall have its own piping system, which connects the pump with the associated vacuum belt filter. Bidder to provide Equipment layout and General Arrangement (GA) of the Components in Gypsum dewatering building along with the offer.	

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>  <b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 12 OF 19</b>	


  

4.4.2	The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitation under all operating conditions.
4.4.3	The seals shall be of proven design.
4.4.4	Silencers shall be provided, if required, to limit the noise level to values stipulated elsewhere in this specification.
4.4.5	The vacuum receiver and pump internals shall be suitably lined to protect against the corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application.
4.4.6	Each vacuum receiver tank(s) shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm.
4.4.7	The filtrate extraction pump shall be capable of pumping filtrate water with solid concentration not less than 10% and particle lumps of 6-7 mm. A 10% margin shall be provided in each of the pump.
4.5	<b>COMMON REQUIREMENTS FOR PUMPS (Vacuum, Filtrate Extraction, Cake/Cloth Wash)</b>
4.5.1	All the pump wear parts in contact with the slurry shall be provided with replaceable rubber/elastomer liners suitable for the fluid handled. The Bidder can also offer a hi-chrome alloy line pump if the Bidder has previous experience of the same for similar applications. The material used by the contractor shall be proven in previous installations.
4.5.2	All the slurry pumps shall be provided with motorized suction and discharge valves. In addition, flushing water lines with motorized/ pneumatic valves shall be provided for each pump for automatic flushing of the pump after each shut down. The flushing water for the pumps shall be taken from the process water supply. The process water lines shall be provided with pneumatic/motorized valves as per the proven practice of the Bidder.
4.5.3	The pump shall be provided with seals of proven type and shall be designed for minimization of seal water consumption. The shaft shall be supported on heavy-duty ball/roller bearings.
4.5.4	All pumps shall be designed to withstand a test pressure of 1.5 times the maximum possible pump shut off pressure under maximum suction pressure conditions.
4.5.5	Product water flushing lines and drains are to be supplied for each pump handling the prevailing water to avoid corrosion if the pump is out of operation for extended periods.
4.5.6	Pumps must be carefully set to ensure that the net positive suction head available under all operating conditions will be adequate. The NPSH Values are to be referred to the least favorable operating conditions- lowest atmospheric pressure, lowest level of water on the suction side of the pump and highest temperature of the pumped fluid. An adequate safety margin of normally greater than 1 m to the max NPSH required shall be provided.
4.5.7	All pumps shall be fitted with suction and discharge pressure gauges. Pressure gauges shall be with diaphragm seal for slurry application. Pressure gauges for other medium shall be with gate valves. All the wetted parts shall be SS 316 or equivalent.
4.5.8	Venting valve shall be fitted to all pumps at suitable points on the pump casing unless the pump is self-venting due to the arrangement of the suction and discharge nozzles. Drainage facilities shall be provided on the pump casing or adjacent pipe work to facilitate the dismantling of pumps.
4.5.9	Pumps not to be damaged during reverse rotation at up to 150% of design RPM, at full discharge head in the event that a pump trips while the other operating pump remain on line. Check valve/ NRVs have to be considered as per requirement of operation.
4.5.10	Pumps shall have stable head-capacity characteristics curve from run-off to shut-off. Shut-off head should be minimum 115% of Best Efficiency Point (BEP).

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>  <b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 13 OF 19</b>	


  

4.5.11	Selection of Duty point should preferably be at BEP (Best Efficiency Point) or slightly at the left of BEP. Selection of Duty point beyond 115% of BEP will not be acceptable. It should be noted that head variation is due to level variation in tank. Pump has to run in the system without compromising its NPSH requirement at lowest water level in tank. Hence, when tanks are filled-up and are at normal water level, pump will operate at the right of BEP, pump's operating zone should be considered accordingly.
4.5.12	External flushing is required to remove the accumulated particles and all related information should be mentioned in datasheet.
4.5.13	Pump should have adjustment provision of axial clearance between casing and impeller for maintenance of performance at best efficiency when there is wear in between impeller and casing.
4.5.14	In case rubber or nonmetallic linings are used, these will be two piece molded under pressure and adjusted to the screwed metallic clamping which have been welded to the casting.
4.5.15	Each pump will have a coupling of adequate size, designed for full load and capable of supporting start-up on overload moments. Each half of the coupling will be factory mounted and locked to its shaft. The coupling must be able to accept the adjustment of the impeller.
4.5.16	The pumps shall have mechanical seals of cartridge type with self-lubrication sliding ring cartridges. The static part will be mounted on the seal plate with circumferential ring (O-ring) or another flexible sealing ring. Built in seal design will not be accepted.
4.5.17	The sealing areas shall be designed in such a way so that solids do not precipitate in them or affect the cooling or affect the adjustment and mechanical functioning of the seals. Seals which do not need jet cleaning are preferred.
4.5.18	Pump induced vibration due to flow pulsations shall be avoided through suitable design.
4.5.19	Each rotating equipment shall be first statically balanced and then dynamically balanced according to ISO 1940 (in the case of impellers this shall be done before and after mounting of the service rotor shaft).
4.5.20	The material and thickness of the liners of slurry pumps (Filtrate Extraction pumps) shall ensure a minimum service life of 2 years before replacement. All the wear parts of the pump shall be <b>guaranteed for a minimum wear life of not less than 14000 hours.</b>
4.5.21	Coupling halves shall be machine matched to ensure accurate alignment. Couplings must have a rated capacity of at least 120% of the maximum potential power transmission requirement.
4.5.22	All rotating parts such as coupling shall be covered with suitable protective guards. Guards shall be easily removable type. Coupling shall be of flexible type made of cast steel. The bidder shall furnish both halves of the coupling. Both the Coupling halves shall be bored and keyed to fit shafts of the pump and the motor by bidder. The coupling between shafts shall be so designed that they become tight during pump operation.
4.5.23	A common base plate shall be provided for pump assembly & Motor and the same shall be rigidly constructed, adequately braced and provided with finish pads for mounting pump.
4.5.24	Pump manufacturer is to supply base plate along with Foundation bolt & Nut, "Taper wedge" and the necessary fastener for Pump and Motor with Base plate. Even if Motor is excluded from their scope, necessary fastener for motor foot with base plate will remain in pump scope of supply in order to avoid any problem.

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>  <b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 14 OF 19</b>	

4.5.25	Nameplate: All equipment shall be provided with name plates indicating the item number and service name. Nameplates shall be of 304 Stainless steel plate and placed at a readily visible location. Nameplate of main equipment shall have enough information, which will be confirmed during engineering phase. Stainless steel nameplates for all instruments and valves shall be provided.
4.5.26	Rotation arrows shall be cast in or attached with stainless steel plate on each item of rotation equipment at a readily visible location.
4.5.27	Unless otherwise specified, all items where the weight exceeds 15 kg shall be provided with suitable lifting lugs, ears or ring bolts or tapped holes for lifting rings. Minimum shock factor for lifting lugs shall be 2.0. The position of lifting lugs and reference dimension shall be shown on GA and/or outline drawings. NDT shall be conducted for lifting lugs. When any spreader bars are required for lifting and laydown, the bidder shall provide spreader bar with equipment.
4.5.28	Skid Mount/Transportation: Equipment shall be fabricated as skid mount design as much as practical to minimize erection at the site.
4.5.29	Two pieces of stainless steel earth lugs shall be provided with equipment diagonally. The position of earth lugs shall be shown on each GA and/or outline drawing.
4.5.30	Provide double nuts for anchor bolts.
4.5.31	Bidder shall provide allowable vibration level on foundation in foundation drawings and/or general arrangement drawings.
4.5.32	If the driver/driven equipment train is in the resonance condition or any vibration problems occur, the bidder shall solve the problems in a timely manner.
<b>4.6</b>	<b>GENERAL</b>
4.6.1	Bidder shall provide the mating flanges with the necessary gaskets.
4.6.2	All the surfaces of the carbon steel should be rust prevented before shipment for the period of at least 12 months for storage and construction.
4.6.3	Bidder to provide capacity of crane or hoist required for safe material handling and the details of heaviest component to be handled.
4.6.4	Bidder to provide Pipe & Valve Material as per the Annexure VIII, Sub-Section-D, Section-I of the Specification.
4.6.5	A 1000 mm wide platform with suitable approach shall be provided by the bidder for each hydrocyclone.
4.6.6	A 1500 mm space around all the pumps shall be provided by the bidder during finalization of layout.
4.6.7	<p>“Equipments requiring monitoring during regular operation shall be approachable from the ground floor through staircase. Staircase with minimum width of 1200 mm shall be provided for approach to elevated structures at 5 m height from the nearest platform. Below this height, a vertical ladder with minimum clear width of 600 mm may also be acceptable.”</p> <p>With reference to above, bidder is required to furnish input to BHEL suiting to the layout requirement.</p>
4.6.8	The list of all Bought out items with makes and country of origin and contact details of the manufacturers to be mentioned along with offer to be submitted. Acceptance of makes shall be subject to BHEL’s Customer’s acceptance during the detailed engineering without cost and delivery implication to BHEL.

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>		
	<b>TECHNICAL SPECIFICATION</b>			<b>SECTION : I</b>
	<b>GYPSUM DEWATERING EQUIPMENT</b>			<b>SUB-SECTION : C1</b>
	<b>SPECIFIC TECHNICAL REQUIREMENT</b>			<b>REV. 00</b> <b>SHEET 15 OF 19</b>

### 5.0 PROCESS FLOW DIAGRAMs (PFDs) & P&IDs

The Piping and Instrumentation Diagram are enclosed in Annexure-IV, Sub-Section-D of Section-I.

#### 5.1 PROCESS PARAMETERS FOR PRIMARY HYDROCYCLONE

S.no	Parameters	Primary Hydro Cyclone Feed Slurry	Primary Hydro Cyclone Over Flow	Primary Hydro Cyclone-Under Flow
a.	Total Flow (m <sup>3</sup> /hr.)	709.9	528.0 (*1)	181.7 (*1)
b.	Total Flow (t/hr.)	835.3	588.2 (*1)	247.1 (*1)
c.	Operating Temp (C)	63	63	63
d.	Design Temp (C)	70	70	70
e.	Solid (wt. %)	25	16.6 (*1)	> 45 (*2)
f.	Density (Kg/m <sup>3</sup> )	1177	1114 (*1)	1360 (*1)
g.	pH	4-7	4-7	4-7
h.	Cl-(mg/l)	25000	25000	25000

#### 5.2 PROCESS PARAMETERS FOR SECONDARY HYDROCYCLONE

a.	Parameters	Secondary Hydro cyclone – Feed Slurry	Secondary Hydro cyclone-Overflow	Secondary Hydro cyclone-Under flow
b.	Total flow (m <sup>3</sup> /hr)	528.0	329.9 (*1)	198.1 (*1)
c.	Total flow (t/hr)	588.2	338.2 (*1)	250 (*1)
d.	Operating Temp (° C)	63	63	63
e.	Design Temp (C)	70	70	70
f.	Solid (wt %)	16.6	3 (*2)	35 (*1)
g.	Density (kg/m <sup>3</sup> )	1114	1025	1262
h.	pH	4-7	4-7	4-7
i.	Cl <sup>-</sup> (mg/l)	25000	25000	25000

#### 5.3 DATA SHEET OF BELT FILTER:

	Parameters	Belt Filter Feed Slurry	Product Gypsum	Filtrate	Washing Water**
a.	Total Flow (m <sup>3</sup> /hr)	181.7 (*1)			
b.	Total Flow (t/hr)-Wet	247.1 (*1)	122.9		
c.	Temp (°C)	70.0			
d.	Solid (% wt)	>45 (*2)	>90 (*2)	<0.2	
e.	Slurry conc. (% wt)	1360 (*1)	>90		
f.	pH	4~7	5~8		
g.	Cl	<25000	<100 ppm (*2)		
h.	Belt filter and the peripherals shall be designed at 136 TPH (wet cake) discharge of product gypsum <b>a.</b> **Quantity of water shall be finalized by the vendor. <b>b.</b> *Property of process water is as given in 5.7.				
i.	*1) shall be finalized by vendor. *2) Shall be guaranteed by vendor				



3x800 MW PATRATU TPS

SPECIFICATION No: PE-TS-434-571-A901

**TECHNICAL SPECIFICATION  
GYPSUM DEWATERING EQUIPMENT**

SECTION : I

SUB-SECTION : C1

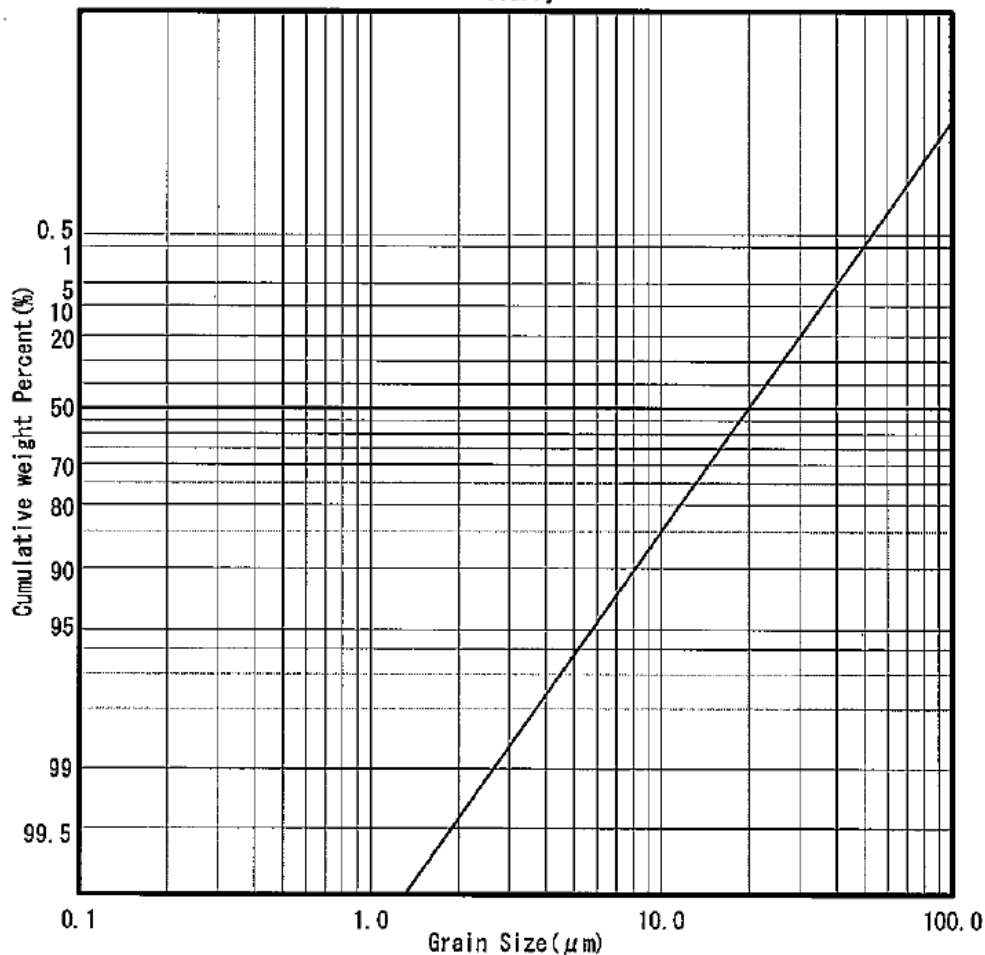
REV. 00

**SPECIFIC TECHNICAL REQUIREMENT**

SHEET 16 OF 19

**5.4 GYPSUM PARTICLE SIZE AT HYDRO CYCLONE FEED SLURRY IS SHOWN BELOW:**

Gypsum Particle Size Distribution Design Data at Hydrocyclone Feed Slurry



Note:


1. Vendor to submit the Particle Size Distribution (PSD) based on their design for PHC & SHC underflow and overflow
2. Hydro cyclone backpressure shall not exceed 20m H.

**5.5 GYPSUM PARTICLE SIZE AT BELT FILTER FEED SLURRY IS SHOWN BELOW:**

Vendor to submit PSD graph design data at VBF inlet / PHC outlet.

**5.6 DESIGN CONDITIONS OF PRIMARY & SECONDARY HYDRO CYCLONES:**

1.	Primary hydrocyclone quantity	:	2 sets (1W+1SB)
2.	Secondary hydrocyclone quantity	:	2 sets (1W+1SB)
3.	Primary hydrocyclone capacity	:	781 m <sup>3</sup> /hr each
4.	Secondary hydrocyclone capacity	:	581 m <sup>3</sup> /hr each
5.	Type of hydro cyclone	:	Vertical
6.	Material (MOC) of Cyclone Clusters	:	Polyurethane/Urethane
7.	MOC of Feed chamber	:	CS+25 mm rubber lining
8.	MOC of overflow chamber	:	CS+12mm rubber lining
9.	MOC of under flow chamber	:	CS+12mm rubber lining


	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>		
	<b>TECHNICAL SPECIFICATION</b>			<b>SECTION : I</b>
	<b>GYPSUM DEWATERING EQUIPMENT</b>			<b>SUB-SECTION : C1</b>
	<b>SPECIFIC TECHNICAL REQUIREMENT</b>			<b>REV. 00</b>
				<b>SHEET 17 OF 19</b>


5.7 PROCESS WATER CHARACTERISTICS			
S.No.	Constituents	Unit	Water quality
1.	Calcium as CaCO <sub>3</sub>	ppm	145.5
2.	Magnesium as CaCO <sub>3</sub>	ppm	81
3.	Sodium as CaCO <sub>3</sub>	ppm	70
4.	Potassium as CaCO <sub>3</sub>	ppm	7
5.	Iron as Fe	ppm	0.3
6.	Total alkalinity as CaCO <sub>3</sub>	ppm	187.6
7.	Chlorides as CaCO <sub>3</sub>	ppm	62.3*
8.	Sulphate as CaCO <sub>3</sub>	ppm	54.5
9.	pH		7.0 – 8.2
10.	Turbidity	NTU	<5

Note: Process water will be used for belt/cloth and gypsum cake washing. Any treatment, if required shall be in the bidder's scope.

**\*Chloride in ppm – 44.17**

6.0 SPARES, TOOLS & TACKLES	
6.1	<b>START UP &amp; COMMISSIONING SPARES</b>
	Start-up & Commissioning Spares shall be part of the main supply of the GDE. Start-up & commissioning spares are those spares which may be required during the start-up and commissioning of the equipment. All spares required for successful operation till commissioning of GDE shall come under this category. Bidder shall provide an adequate stock of such start-up and commissioning spares to be brought by him to the site for the equipment erection and commissioning. The spares must be available at Site before the equipment's are energized. List shall be furnished by bidder along with bid as indicated at Section-III.
6.2	<b>MANDATORY SPARES</b>
	<p>a) The list of mandatory spares considered essential by the BHEL's Customer/Employer is indicated in Annexure-II of Sub Section-D of Section-I in the specification. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidder's design) in the 'Schedule of Mandatory Spares' whether or not he considers it necessary for the Employer to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in their Bid. Whenever the quantity is mentioned in "sets", the bidder has to give the item details and prices of each item.</p> <p>b) Whenever the quantity is indicated as a percentage, it shall mean percentage of total population of that item in the station (project), unless specified otherwise, and the fraction will be rounded off to the next higher whole number. Wherever the requirement has been specified as a 'set' (marked by **) it will include the total requirement of the item for a unit,</p>

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>  <b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 18 OF 19</b>	
	<p>module or the station as specified. Where it is specified as 'set' (marked by*) it would mean the requirement for the single equipment / system as the case may be. Also one set for the particular equipment. e.g. 'set' of bearings for a pump would include the total number of bearings in a pump. Also the 'set' would include all components required to replace the item; for example, a set of bearings shall include all hardware normally required while replacing the bearings.</p> <p>c) The assembly / sub assembly which have different orientation (like left hand, right hand, top or bottom), different direction of rotation or mirror image positioning or any other regions which result in maintaining two different sets of spares to be used for subject assembly / sub-assembly shall be considered as different type of assembly/sub-assembly.</p> <p>d) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.</p> <p>e) The Employer reserves the right to buy any or all the mandatory spare parts.</p> <p>f) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until &amp; unless specified otherwise.</p> <p>Bidder to provide the split up price for mandatory spares during placement of order as per price format.</p>		
<b>6.3</b>	<b>RECOMMENDED SPARES:</b>		
	<p>In addition to the spare parts mentioned above, the bidder shall also provide a list of recommended spares for 3 years of normal operation of the plant and indicate the list. This list shall take into consideration the mandatory spares specified in the relevant sub-Section and should be independent of the list of the mandatory spares.</p>		
<b>6.4</b>	<b>SPECIAL TOOLS &amp; TACKLES:</b>		
	<p>Any special tools &amp; tackles required for the entire equipment to disassemble, assemble or maintain the units, they shall be included in the quotation and furnished as part of the initial supply of the machine. List of special tools &amp; tackles shall be decided by bidder as per his proven practice. When special tools are provided, they shall be packaged in separate, boxes with lugs and marked as "Special Tools for (tag / item number)." Each tool shall be stamped or tagged to indicate its intended usage. Levers and eye bolts for the removal of parts to be serviced shall be submitted with special tools. List shall be furnished by bidder along with bid as indicated at Section-III.</p>		
<b>7.0</b>	<b>FIRST FILL OF CONSUMABLES</b>		
<b>7.1</b>	<p>Bidder's scope shall include supply and filling of all the first fill and one year's topping requirement of consumables, greases, oils, all chemicals, lubricants, grease, filters and consumable items for operation up to commissioning including top up requirements. All lubricants proposed for the plant operation shall be suitable for all operating and environmental conditions that will be met on site consistent with good maintenance procedures as instructed in the maintenance manuals.</p>		
<b>7.2</b>	<p>Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants of each variety of lubricants, servo fluids, gases, chemicals etc. (as applicable)</p>		

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>TECHNICAL SPECIFICATION GYPSUM DEWATERING EQUIPMENT</b>  <b>SPECIFIC TECHNICAL REQUIREMENT</b>	<b>SECTION : I</b>	
		<b>SUB-SECTION : C1</b>	
		<b>REV. 00</b>	
		<b>SHEET 19 OF 19</b>	

	used which is expected to be utilized during the first year of operation. This additional quantity shall be supplied in separate containers.
7.3	Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals including items qualities and quantities required per month of the plant operation for the BHEL/BHEL's Customer's approval herein shall be furnished within 2 months of placement of Order. On completion of erection, complete list of bearings/equipment giving their location and identification marks shall be furnished to BHEL along with lubrication requirements. All types of chemicals, consumables, lubricants and grease shall be readily obtainable locally and the number of different types shall be kept to a minimum. As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

#### **8.0 LIST OF REFERENCE DRAWINGS BY BHEL**

The drawings specified in in Annexure-IV, Sub-Section-D of Section-I are being provided along with the tender specification for engineering, estimation and calculation purpose of the bidder.

#### **9.0 PAINTS /PAINTING**

Bidder shall follow BHEL/ Customer painting philosophy specified Sub-Section- C2-B Section-I in the specification. Painting Schedule (Drawing No. 9585-001-109-PVM-H-001) is provided. However, for components where no specific requirement is stipulated, the bidder shall follow its standard practice suitable for operating condition and subject to customer approval during detail engineering.

#### **10.0 EXCLUSIONS**

Below are excluded from scope of the GDWE Supplier:

- a) All utilities such as instrument air and process water up to terminal point
- b) Control System (excluding Junction box)
- c) Lifting equipments for Material handling
- d) 3D Modeling
- e) Gypsum Conveyor from the discharge of chute.
- f) Tanks and their instruments & Slurry Pumps (except Filtrate Extraction).
- g) Vibration Monitoring System for HT motors.
- h) Civil work.

#### **11.0 BID EVALUATION CRITERIA FOR POWER CONSUMPTION – Refer Annexure-IV of Price Schedule**

Bidder is required to quote (GPC) Guaranteed Power Consumption for the complete GDWE in the price schedule issued along with NIT. In case of non-submission of filled up format, the bid shall be liable for rejection. Value for power consumption quoted by the bidder in the specified format, shall be considered as final and any request by bidder for any change in quoted power consumption at any later date, shall not be considered by BHEL.

**3x800 MW PATRATU TPS**

SPECIFICATION No: PE-TS-434-571-A901

**TECHNICAL SPECIFICATION**

SECTION : I

**GYPSUM DEWATERING EQUIPMENT  
SPECIFIC TECHNICAL REQUIREMENT**

SUB-SECTION : C 2

REV. 00

**SECTION: I**

**SUB-SECTION: C 2**

**CUSTOMER SPECIFICATION**



**PART - C**

**GENERAL TECHNICAL REQUIREMENTS**

**EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER STATION  
EXPANSION PHASE-I (3x800 MW)**

**TECHNICAL SPECIFICATION  
SECTION-VI, PART-C  
BID DOC NO: CS-9585-001-2**



NOT-APPLICABLE PORTION FOR GDWE ARE REMOVED FROM GTR.

## GENERAL TECHNICAL REQUIREMENTS


### PART - C


### CONTENTS


Clause No.	Description	Page No.
1.00.00	Introduction	1
2.00.00	Brand Name	1
3.00.00	Base Offer & Alternate Proposals	1
4.00.00	Completeness of Facilities	1
5.00.00	Codes & Standards	2
6.00.00	Equipment Functional Guarantee	4
7.00.00	Design of Facilities/ Maintenance & Availability Considerations	5
8.00.00	Documents, Data and Drawings to be furnished by Contractor	6
9.00.00	Technical Co-ordination Meeting	22
10.00.00	Design Improvements	22
11.00.00	Equipment Bases	23
12.00.00	Protective Guards	23
13.00.00	Lubricants, Servo fluids and Chemicals	23
14.00.00	Lubrication	24
15.00.00	Material of Construction	24
16.00.00	Rating Plates, Name Plates & Labels	24
17.00.00	Tools and Tackles	25
18.00.00	Welding	25





<b>Clause No.</b>	<b>Description</b>	<b>Page No.</b>
19.00.00	Colour Code for All equipments/Pipings/PipeServices	26
20.00.00	Protection and Preserveative shop Coating	26
21.00.00	Quality Assurance Programme	27
22.00.00	General Requirements - Quality Assurance	28
23.00.00	Quality Assurance Documents	33
24.00.00	Project Manager's Supervision	35
25.00.00	Inspection, Testing and Inspection Certificates	36
26.00.00	Pre-commissioning and Commissioning Facilities	39
27.00.00	Taking over	42
28.00.00	Training of Employer's Personnel	42
29.00.00	Safety Aspects during Construction and Erection	44
30.00.00	Noise Level	44
31.00.00	Packaging and Transportation	45
32.00.00	Electrical Equipments/Enclosures	45
33.00.00	Instrumentation and Control	45
34.00.00	Electrical Noise Control	46
35.00.00	Surge protection for solid state equipment	47
36.00.00	Instrument Air System	47
37.00.00	Tapping Points for Measurements	47
38.00.00	System Documentation	47
39.00.00	Maintenance Manuals of Electronic Modules	48


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS	
6.02.00	<p>Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.</p>	
7.00.00	<p><b>DESIGN OF FACILITIES/ MAINTENANCE &amp; AVAILABILITY CONSIDERATIONS</b></p>	
7.01.00	<p><b>DESIGN OF FACILITIES</b></p> <p>All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.</p> <p>The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best coordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.</p>	
7.02.00	<p><b>MAINTENANCE AND AVILABILITY CONSIDERATIONS</b></p> <p>Equipment/works offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.</p> <p>Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours , clearly defining the spare parts and man-hour requirement for each stage.</p> <p>Lifting devices i.e. hoists and chain pulley jacks ,etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.</p> <p>Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the contractor for lifting the equipment and accessories covered under the specification.</p>	
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p> <p>PAGE 5 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
8.00.00	<b>DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR</b>			
8.01.00	<p>Bidders may note that this is a turnkey contract. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely engineered plant shall be provided in respect of mechanical, electrical and power systems, control &amp; instrumentation, civil &amp; structural works.</p> <p>The Contractor shall furnish engineering data /drawings in accordance with the schedule of information as specified in Technical Data Sheets and Technical Specification.</p> <p>A comprehensive engg and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.</p>			
8.02.00	The number of copies/prints/CD-ROMs/manuals to be furnished for various types of document is given in <b>Annexure-VI</b> to this Part-C, Section-VI of the Technical Specification.			
8.03.00	The documentation that shall be provided by the Contractor is indicated in the various sections of specification. This documentation shall include but not be limited to the following:			
8.03.01	<p>A) <b>BASIC ENGINEERING DOCUMENTATION</b></p> <p>Prior to commencement of the detailed engineering work, the Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:</p> <ul style="list-style-type: none"> <li>i) System description of all the mechanical, electrical, control &amp; instrumentation &amp; civil systems.</li> <li>ii) Technology scan for each system / sub-system &amp; equipment.</li> <li>iii) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.</li> <li>iv) Optimisation studies including thermal cycle optimisation.</li> <li>v) Sizing criteria of all the systems, sub-systems/ equipments/ structures/ equipment foundations alongwith all calculations justifying and identifying the sizing and the design margins.</li> </ul>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 6 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>vi) Schemes and Process &amp; Instrumentation diagrams for the various systems/ sub-system with functional write-ups.</p> <p>vii) Water Balance diagram.</p> <p>viii) Operation Philosophy and the control philosophy of the Main Plant and other plants.</p> <p>ix) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Employer's scope. This drawing shall also be furnished in the form of CD-ROMs to the Employer for engineering of areas not included in bidder's scope.</p> <p>x) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area, transformer yard, switchyard and other areas included in the scope of the bidder.</p> <p>xi) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.</p> <p>The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed &amp; finalised with the Employer.</p> <p><b>B) DETAILED ENGINEERING DOCUMENTS</b></p> <p>i) General layout plan of the station.</p> <p>ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.</p> <p>iii) Flow diagram, process and instrumentation diagrams along with write up and system description.</p> <p>iv) Start up curves for boiler and both turbines and boiler combined together as a unit for various start ups, viz. cold, warm and hot start up.</p> <p>v) Piping isometric, composite layout and fabrication drawings.</p> <p>vi) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.</p>			
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p align="center"><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p align="center"><b>PAGE 7 OF 111</b></p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>vii) Technical data sheets for all bought out and manufactured items. Contractor shall use the Employer's specifications as a base for placement of orders on their sub vendors.</p> <p>viii) Detailed design calculations for components, system, piping etc., wherever applicable including sizing calculations for all auxiliaries like mills, fans, BFPs, CEPs, Heaters/ Deaerators, Condensers, vacuum pumps etc.</p> <p>ix) Boiler pressure part schedule and sizing calculations. Boiler performance data and boiler design dossier.</p> <p>x) Transient, hydraulic and thermal stress analysis of piping and system wherever applicable &amp; input and output data alongwith stress analysis isometrics showing nodes..</p> <p>xi) Thermal cycle information (heat balance diagrams, boiler performance calculations, condenser and heat exchanger thermal calculations etc.).</p> <p>xii) Characteristic Curves/ Performance Correction Curves. Hydraulic &amp; Mechanical design calculations for condensers &amp; heaters.</p> <p>xiii) Comprehensive list of all terminal points which interface with Employer's facilities, giving details of location, terminal pressure, temperature, fluid handled &amp; end connection details, forces, moments etc.</p> <p>xiv) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.</p> <p>xv) Protection system diagrams and relay settings.</p> <p>xvi) Cables schedules and interconnection diagrams.</p> <p>xvii) Cable routing plan.</p> <p>xviii) Instrument schedule, measuring point list, I/O list, Interconnection &amp; wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.</p> <p>xix) Alarm and annunciation/ Sequence of Event (SOE) list and alarms &amp; trip set points.</p>			
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p align="center"><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p align="center"><b>PAGE 8 OF 111</b></p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
8.03.02	<p>xx) Sequence and protection interlock schemes.</p> <p>xxi) Type test reports, insulation co-ordination study report and power system stability study report.</p> <p>xxii) Control system configuration diagrams and card circuit diagrams and maintenance details.</p> <p>xxiii) Detailed DDCMIS system manuals.</p> <p>xxiv) Detailed flow chart for digital control system.</p> <p>xxv) Mimic diagram layout, Assignment for other application engg.</p> <p>xxvi) Civil and Structural works drawings and documents for all structures, facilities, architectural works, foundations underground and overground works and super-structural works as included in the scope of the bidder civil calculation sheets including structural analysis and design alongwith output results.</p> <p>xxvii) Underground facilities, levelling ,sanitary, land scaping drawings.</p> <p>xxviii) Geotechnical investigation and site survey reports (if and as applicable).</p> <p>xxix) Model study reports wherever applicable.</p> <p>xxx) Functional &amp; guarantee test procedures and test reports.</p> <p>xxxi) Documentation in respect of Quality Assurance System, and Documentation in respect of Commissioning, as listed out elsewhere in this specification.</p> <p>The Contractor's while sumitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter alongwith the date vide which the submissions are made.</p> <p><b>INSTRUCTION MANUALS</b></p> <p>The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in <b>Annexure-IV</b>. The Contract shall not be considered to be completed</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 9 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.</p> <p><b>A) ERECTION MANUALS</b></p> <p>The erection manuals shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.</p> <ol style="list-style-type: none"> <li>a) Erection strategy.</li> <li>b) Sequence of erection.</li> <li>c) Erection instructions.</li> <li>d) Critical checks and permissible deviation/tolerances.</li> <li>e) List of tool, tackles, heavy equipments like cranes, dozers, etc.</li> <li>f) Bill of Materials</li> <li>g) Procedure for erection and General Safety procedures to followed during erection/installation.</li> <li>h) Procedure for initial checking after erection.</li> <li>i) Procedure for testing and acceptance norms.</li> <li>j) Procedure / Check list for pre-commissioning activities.</li> <li>k) Procedure / Check list for commissioning of the system.</li> <li>l) Safety precautions to be followed in electrical supply distribution during erection.</li> </ol> <p><b>B) OPERATION &amp; MAINTENANCE MANUALS</b></p> <ol style="list-style-type: none"> <li>a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the</li> </ol>			
<p align="center">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p align="center">TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p align="center">GENERAL TECHNICAL REQUIREMENTS</p>	<p align="center">PAGE 10 OF 111</p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>manufacturers shall be typewritten with a margin on the left hand side.</p> <p>b) The arrangement and contents of O &amp; M manuals shall be as follows :</p> <p>1) <u>Chapter 1 - Plant Description</u> : To contain the following sections specific to the equipment/system supplied</p> <p>(a) Description of operating principle of equipment / system with schematic drawing / layouts.</p> <p>(b) Functional description of associated accessories / controls. Control interlock protection write up.</p> <p>(c) Integrated operation of the equipment alongwith the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).</p> <p>(d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.</p> <p>(e) Design data against which the plant performance will be compared.</p> <p>(f) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.</p> <p>(g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).</p> <p>(h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).</p> <p>2) <u>Chapter 2.0 - Plant Operation</u>: To contain the following sections specific to the equipment supplied</p> <p>(a) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.</p> <p>(b) Limiting values of all protection settings.</p> <p>(c) Various settings of annunciation/interlocks provided.</p>			
<p align="center">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p align="center">TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p align="center">GENERAL TECHNICAL REQUIREMENTS</p>	<p align="center">PAGE 11 OF 111</p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>(d) Startup and shut down procedure for equipment alongwith the associated systems in step mode.</p> <p>(e) Do's and Don'ts related to operation of the equipment.</p> <p>(f) Safety precautions to be take during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.</p> <p>(g) Parameters to be monitored with normal value and limiting values.</p> <p>(h) Equipment isolating procedures.</p> <p>(i) Trouble shooting with causes and remedial measures.</p> <p>(j) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.</p> <p>(k) Routine Operational Checks, Recommended Logs and Records</p> <p>(l) Change over schedule if more than one auxiliary for the same purpose is given.</p> <p>(m) Preservation procedure on long shut down.</p> <p>(n) System/plant commissioning procedure.</p> <p>3) <u>Chapter 3.0 - Plant Maintenance</u>- To contain the following sections specific to the equipment supplied.</p> <p>(a) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. &amp; population.</p> <p>(b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.</p> <p>(c) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.</p> <p>(d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.</p>			
<p align="center">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p align="center">TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p align="center">GENERAL TECHNICAL REQUIREMENTS</p>	<p align="center">PAGE 12 OF 111</p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
8.03.03	<p>(e) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out.</p> <p>(f) Overhauling schedules linked with running hours/calendar period alongwith checks to be done.</p> <p>(g) Long term maintenance schedules</p> <p>(h) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.</p> <p>(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly &amp; at longer intervals to ensure trouble free operation and quantity required for complete replacement..</p> <p>(j) Tolerance for fitment of various components.</p> <p>(k) Details of sub vendors with their part no. in case of bought out items.</p> <p>(l) List of spare parts with their Part No, total population, life expediency &amp; their interchangeability with already supplied spares to NTPC.</p> <p>(m) List of mandatory and recommended spare list along with manufacturing drawings, material specification &amp; quality plan for fast moving consumable spares.</p> <p>(n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.</p> <p>(o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.</p> <p>After finalization and approval of the Employer, the O &amp; M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O &amp; M manuals have been supplied to the Employer.</p> <p>If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &amp;M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 13 OF 111	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.</p>			
8.03.03	<p><b>PLANT HANDBOOK AND PROJECT COMPLETION REPORT</b></p>			
8.03.03.01	<p><b>PLANT HANDBOOK</b></p>			
	<p>The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including</p> <ul style="list-style-type: none"> <li>i) Design and performance data.</li> <li>ii) Process &amp; Instrumentation diagrams.</li> <li>iii) Single line diagrams.</li> <li>iv) Sequence &amp; Protection Interlock Schemes.</li> <li>v) Alarm and trip values.</li> <li>vi) Performance Curves.</li> <li>vii) General layout plan and layout of main plant building and auxiliary buildings</li> <li>viii) Important Do's &amp; Don't's</li> </ul> <p>The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.</p>			
8.03.03.02	<p><b>PROJECT COMPLETION REPORT</b></p> <p>The Contractor shall submit a Project Completion Report at the time of handing over the plant.</p>			
8.03.04	<p><b>DRAWINGS</b></p> <ul style="list-style-type: none"> <li>a) i) All the plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.</li> </ul>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>		<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 14 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per <b>Annexure-VI</b> of Part-C. The soft copies shall be uploaded by the vendors in C-folders, a Web-based system of NTPC ERP, for which a username and password will be allotted to the new vendor by NTPC.</p> <p>Similarly, the vendor can download the drawings/documents, approved/ commented by NTPC, through above site.</p> <p>The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.</p> <p>iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per <b>Annexure-VI</b> of Part-C.</p> <p>iv) Contractor shall prepare the model of all the facilities located in Main Power Block area, covering Transformer Yard, TG building (including all facilities ), Boiler area, ESP area, chimney area and any other facility located in Main Plant Block area in an integrated &amp; intelligent 3D software solution using rule based, data centric 3D design software with equipment drawings, data sheets, intelligent P&amp;ID correlated with intelligent 3D Model, BOQ, schematics and logic diagrams etc. attached to the respective equipment / systems in the aforesaid 3D model.</p> <p>All piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.), General Arrangement drawings of major buildings, structural arrangement drawings and RCC layout drawings shall necessarily be extracted from the aforesaid 3D model and submitted for employer's review along with the 3D review model to enable NTPC to review and approve these drawings.</p> <p>Contractor shall prepare and provide 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc.), which is extracted from intelligent 3D model and shall make a presentation of the same every 3 months from LOA to enable NTPC to review the progress of engineering or as &amp; when required by employer.</p> <p>After the completion of engineering of respective area i.e. TG building/ Boiler/ ESP etc., the corresponding complete 3D review model shall be handed over to the employer for its reference.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 15 OF 111	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>b) All documents/text information shall be in latest version of MS Office/MS Excel/PDF format as applicable.</p> <p>c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.</p> <p>d) Each drawing submitted by the Contractor (including those of subvendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.</p> <p>e) The drawings submitted by the Contractor (or their subvendors) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.</p> <p>The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".</p> <p>Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature.</p> <p>f) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project . The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections &amp; dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or</p>			
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p align="center"><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p align="center"><b>PAGE 16 OF 111</b></p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.</p> <p>g) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.</p> <p>h) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.</p> <p>i) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Employer prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/ representative of Employer based on requirements of such piping indicated in approved/ finalised Flow Scheme/ Process &amp; Instrumentation Diagrams and/or the requirements cropping up for draining &amp; venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this turnkey package.</p> <p>Assessing &amp; anticipating the requirement and supply of all piping and equipment shall be done by the contractor well in advance so as not to hinder the progress of piping &amp; equipment erection, subsequent system charging and its effective draining &amp; venting arrangement as per site suitability.</p> <p>j) As Built Drawings</p> <p>After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to "as built" conditions and submit no. of copies as per <b>Annexure VI</b>.</p> <p>k) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor shall make a visit to site to see the existing facilities and understand the layout</p>			
<p align="center">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p align="center">TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p align="center">GENERAL TECHNICAL REQUIREMENTS</p>	<p align="center">PAGE 17 OF 111</p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS 		
8.04.00	<p>completely and collect all necessary data/ drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems &amp; facilities within his scope of work as well as interface engineering &amp; integration of systems, facilities, equipment &amp; works under Employer's scope and submit all necessary drawings/ documents for the same.</p> <p>l) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The Employer shall review the drawings and return soft copy to the Contractor authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.</p> <p>m) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.</p> <p><b>ENGINEERING INFORMATION SUBMISSION SCHEDULE</b></p> <p>Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts.</p> <p>i) Information that shall be submitted for the approval to the Employer before proceeding further, and</p> <p>ii) Information that would be submitted for Employer's information only.</p> <p>The Master Drawing List(MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.</p> <p>The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 18 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
<p><b>8.05.00</b></p> <p>8.05.01</p> <p>8.05.02</p> <p>8.05.03</p>	<p><b>Engineering Co-ordination Procedure</b></p> <p>The following principal coordinators will be identified by respective organizations at time of award of contract :</p> <p>NTPC Engineering Coordinator (NTPC EC) :</p> <p>Name : _____</p> <p>Designation : _____</p> <p>Address : _____</p> <p>a) Postal : _____</p> <p>b) Telegraphic / e-Mail : _____</p> <p>c) FAX : _____ TELEPHONE : _____</p> <p>Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):</p> <p>Name : _____</p> <p>Designation : _____</p> <p>Address : _____</p> <p>a) Postal : _____</p> <p>b) Telegraphic / e-Mail : _____</p> <p>c) FAX : _____ TELEPHONE : _____</p> <p>All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.</p> <p>Contractor's/Vendor's Drawing Submission and Approval Procedure :</p> <p>a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for NTPC's information/ interface and or review and approval are referred by the general term "drawings".</p> <p>b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.</p>			
<p><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p><b>PAGE 19 OF 111</b></p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.</p> <p>d) Employer and contractor shall follow their own numbering systems for the drawings. However, Employer shall intimate the contractor, NTPC drawing number on receipt of the first submission of each drawing. Vendor, thereafter, shall indicate NTPC's drawing number in subsequent Submission, in the space provided for this purpose in title plate, in addition to his own drawing number.</p> <p>e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems &amp; facilities within his scope of work as well as interface engineering &amp; integration of systems, facilities, equipment &amp; works under Employer's scope and submit all necessary drawings/ documents for the same.</p> <p>f) <b>Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.</b></p> <p>g) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by NTPC and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories :</p> <p>CATEGORY- I:      Approved</p> <p>CATEGORY- II      Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments.</p> <p>CATEGORY –III    Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted.</p> <p>CATEGORY -IV     For information and records.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 20 OF 111	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>h) Contractor shall resubmit the drawings approved under Category II, III &amp; IVR within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number enclosed in a triangle (eg. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawing identifying the changes for Employer's review and approval. <b>Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.</b></p> <p>i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to NTPC for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.</p> <p>j) It is responsibility of the Contractor/ Vendor to get all the drawings approved in the Category I &amp; IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.</p> <p>k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.</p> <p>l) These comments will be taken care by the contractor while submitting the revised drawing.</p> <p>The contractor shall use a single transmittal for drawings. Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.</p>			
8.06.00	<b>ENGINEERING PROGRESS AND EXCEPTION REPORT</b>			
8.06.01	<p>The Contractor shall submit every month an Engineering progress and Exception Report giving the status of each engineering information including</p> <p>a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission</p> <p>b) Drawings which were not submitted as per agreed schedule.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 21 OF 111	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
8.06.02	<p>The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.</p>			
9.00.00	<p><b>TECHNICAL CO-ORDINATION MEETING</b></p>			
9.01.00	<p>The Contractor shall be called upon to organise and attend monthly Design/ Technical Co-ordination Meetings (TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of contract. The Contractor shall attend such meetings at his own cost at NEW DELHI / NOIDA or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.</p>			
9.02.00	<p>The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Contractor shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Contractor will be reviewed by the Employer as far as practicable within three (3) weeks from the date of receipt of the drawing. The comments of the Employer shall then be discussed across the table during the above Technical Co-ordination Meeting (s) wherein best efforts shall be made by both sides to ensure the approval of the drawing.</p>			
9.02.01	<p>The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.</p>			
9.02.02	<p>Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.</p>			
9.03.0	<p>Any delays arising out of failure by the Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.</p>			
10.00.00	<p><b>DESIGN IMPROVEMENTS</b></p> <p>The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.</p> <p>If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change.</p>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>		<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 22 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
14.01.00	Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.		
15.00.00	<b>MATERIAL OF CONSTRUCTION</b>		
15.01.00	All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilised for various components shall be those which have established themselves for use in such applications.		
16.00.00	<b>RATING PLATES, NAME PLATES &amp; LABELS</b>		
16.01.00	Each main and auxiliary item of plant shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.		
16.02.00	Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Employer or as detailed in appropriate section of the technical specifications.		
16.03.00	Such nameplates or labels shall be of white nonhygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back.		
16.04.00	Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with enamel. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.		
16.05.00	Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support.		
16.06.00	Valves, steam traps and strainers shall be identified by Employer's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire.		
16.07.00	Safety and relief valves shall be provided with the following:  a) Manufacturer's identification.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 24 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
	b) Nominal inlet and outlet sizes in mm. c) Set pressure in Kg/cm <sup>2</sup> (abs). d) Blowdown and accumulation as percentage of set pressure. e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.		
16.08.00	All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.		
16.09.00	All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.		
17.00.00	<p><b>TOOLS AND TACKLES</b></p> <p>The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required and other instruments for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.</p> <p>The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Employer.</p>		
18.00.00	<b>WELDING</b>		
18.01.00	If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be performed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.		
19.00.00	<b>COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES</b>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 25 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS	
19.01.00	<p>All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer's standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.</p>	
20.00.00	<p><b>PROTECTION AND PRESERVATIVE SHOP COATING</b></p>	
20.01.00	<p><b>PROTECTION</b></p>	
	<p>All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. All primers/paints/coatings shall take into account the hot humid, corrosive &amp; alkaline, subsoil or over ground environment as the case may be. The requirements for painting specification shall be complied with as detailed out in Part-A &amp; B of the Technical Specification.</p>	
20.02.00	<p><b>PRESERVATIVE SHOP COATING</b></p> <p>All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification.</p> <p>Transformers and other electrical equipments, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.</p>	
20.03.00	<p>Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.</p>	
20.04.00	<p>All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Employer.</p>	
20.05.00	<p>All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.</p>	
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p> <p>PAGE 26 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
20.06.00	Painting for Civil structures and equipment/system covered under this package shall be done as specified under technical requirements on civil works in relevant part of this specifications.			
21.00.00	<b>QUALITY ASSURANCE PROGRAMME</b>			
21.01.00	<p>To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS-14001. A quality assurance programme of the contractor shall generally cover the following:</p> <ol style="list-style-type: none"> <li>a) His organisation structure for the management and implementation of the proposed quality assurance programme</li> <li>b) Quality System Manual</li> <li>c) Design Control System</li> <li>d) Documentation Control System</li> <li>e) Qualification data for Bidder's key Personnel.</li> <li>f) The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.</li> <li>g) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.</li> <li>h) Control of non-conforming items and system for corrective actions.</li> <li>i) Inspection and test procedure both for manufacture and field activities.</li> <li>j) Control of calibration and testing of measuring testing equipments.</li> <li>k) System for Quality Audits.</li> <li>l) System for indication and appraisal of inspection status.</li> <li>m) System for authorising release of manufactured product to the Employer.</li> </ol>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 27 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
	<p>n) System for handling storage and delivery.</p> <p>o) System for maintenance of records, and</p> <p>p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as <b>Annexure-I</b> and <b>Annexure-II</b> respectively.</p>		
22.00.00	<b>GENERAL REQUIREMENTS - QUALITY ASSURANCE</b>		
22.01.00	<p>All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS-01-QAI-P-1/F3-R0. Monthly progress reports shall be furnished.</p>		
22.02.00	<p>Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media through C-folders, a web based system of NTPC ERP in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM (As per format at Annexure-I)</p>		
22.03.00	<p>Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site (As per format at Annexure – II).</p>		
22.04.00	<p>The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 28 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
	<p>Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.</p>		
22.05.00	<p>The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the format enclosed at <b>Annexure-V</b>. The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.</p>		
22.06.00	<p>The contractor shall have suitable Field Quality Organization with adequate manpower at Employer's site, to effectively implement the Field Quality Plan (FQP) and Field Quality Management System for site activities. The contractor shall submit the details of proposed FQA setup (organizational structure and manpower) for employer's approval. The FQA setup shall be in place at least one month before the start of site activities.</p>		
22.07.00	<p>No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).</p>		
22.08.00	<p>All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details</p>		
22.09.00	<p>All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer.</p> <p>All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.</p>		
22.10.00	<p>All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.</p>		
22.11.00	<p>All brazers, welders and welding operators employed on any part of the contract either in Contractor's/sub-contractor's works or at site or elsewhere shall be qualified</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 29 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer..			
22.12.00	For all IBR pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. However, other piping shall be as per relevant code. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding			
22.13.00	All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.			
22.14.00	No welding shall be carried out on cast iron components for repair.			
22.15.00	Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.			
22.16.00	All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of correlation of the test report with the job.  In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 40 mm shall be ultrasonically tested..			
22.17.00	The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Monthly progress reports on sub-contractor detail submission / approval shall be furnished preferably on enclosed format at <b>Annexure-IV</b> . Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.			
22.18.00	For components/equipment procured by the contractors for the purpose of the			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 30 OF 111	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.</p>			
22.19.00	<p>Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.</p>			
22.20.00	<p>The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.</p>			
22.21.00	<p>Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.</p>			
22.22.00	<p>For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.</p>			
22.23.00	<p>Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.</p>			
22.24.00	<p><b>Environmental Stress Screening</b></p> <p>All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the</p>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 31 OF 111</p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>contractor / sub – contractor should meet the following.</p> <p>1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.</p> <p style="text-align: center;"><b>Or</b></p> <p>In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.</p> <p><b><u>Elevated Temperature Test Cycle</u></b></p> <p>During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.</p> <p>During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.</p> <p>In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.</p> <p>2) <b><u>Burn in Test Cycle</u></b></p> <p>The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.</p> <p>The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.</p> <p>During the above tests, the process I/O and other load on the system shall</p>			
<p style="text-align: center;">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p style="text-align: center;">TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p style="text-align: center;">GENERAL TECHNICAL REQUIREMENTS</p>	<p style="text-align: center;">PAGE 32 OF 111</p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
22.25.00	<p>be simulated by simulated inputs and in the case of control systems; the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.</p> <p>During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.</p> <p>The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine &amp; acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.</p>			
23.00.00	<b>QUALITY ASSURANCE DOCUMENTS</b>			
23.01.00	The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick ( ✓)mark.			
23.01.01	<p>Each QA Documentation shall have a project specific Cover Sheet bearing name &amp; identification number of equipment and including an index of its contents with page control on each document.</p> <p>The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.</p> <p>The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.</p>			
23.02.00	<p>Typical contents of QA Documentation is as below:-</p> <p>(a.) Quality Plan</p> <p>(b.) Material mill test reports on components as specified by the specification and approved Quality Plans.</p> <p>(c.) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.</p> <p>(d.) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 33 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>(e.) Heat Treatment Certificate/Record (Time- temperature Chart)</p> <p>(f.) All the accepted Non-conformance Reports (Major/Minor)/deviation, including complete technical details / repair procedure).</p> <p>(g.) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.</p> <p>(h.) Certificate of Conformance (COC) wherever applicable.</p> <p>(i.) MDCC</p>			
23.03.00	<p>Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.</p>			
23.04.00	<p>Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.</p> <p>(a.) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.</p> <p>(b.) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.</p> <p>(c.) If a decision is made for despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions &amp; submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.</p>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>		<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 34 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
23.05.00	<p><b>TRANSMISSION OF QA DOCUMENTATION</b></p> <p>On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Employer.</p> <p>For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.</p>			
24.00.00	<p><b>PROJECT MANAGER'S SUPERVISION</b></p>			
24.01.00	<p>To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section GCC, the Contractor shall proceed to comply with the Project Manager's decision.</p>			
24.02.00	<p>The work shall be performed under the supervision of the Project Manager.</p> <p>The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:</p> <ul style="list-style-type: none"> <li>(a.) Interpretation of all the terms and conditions of these documents and specifications:</li> <li>(b.) Review and interpretation of all the Contractor's drawing, engineering data, etc:</li> <li>(c.) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :</li> <li>(d.) Inspect, accept or reject any equipment, material and work under the contract :</li> <li>(e.) Issue certificate of acceptance and/or progressive payment and final payment certificates</li> <li>(f.) Review and suggest modifications and improvement in completion schedules from time to time, and</li> <li>(g.) Supervise Quality Assurance Programme implementation at all stages of the works.</li> </ul>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>		<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 35 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
25.00.00	<b>INSPECTION, TESTING AND INSPECTION CERTIFICATES</b>			
25.01.00	The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.			
25.02.00	The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.			
25.03.00	The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.			
25.04.00	The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.			
25.05.00	When the factory tests have been completed at the Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.			
25.06.00	In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 36 OF 111	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
	<p>specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.</p>		
25.07.00	<p>The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.</p>		
25.08.00	<p>To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.</p>		
25.09.00	<p>All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.</p>		
25.10.00	<p><b>Associated document for Quality Assurance programme</b></p>		
25.10.01	<p>Manufacturing Quality Plan Format No. : QS-01-QAI-P-09/F1-R1 enclosed at <b>Annexure-I.</b></p>		
25.10.02	<p>Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1 enclosed at <b>Annexure-II.</b></p>		
25.10.03	<p>List of items requiring quality plan and sub supplier approval. Format No.: QS-01-QAI-P-01/F3-R0 (<b>Annexure-III</b>).</p>		
25.10.04	<p>Status of items requiring Quality Plan and sub supplier approval. Format enclosed at <b>Annexure-IV.</b></p>		
25.10.05	<p>Field Welding Schedule Format enclosed at <b>Annexure-V.</b></p>		
25.11.00	<p><b>TESTING OF MAJOR DESIGN FEATURES:</b></p> <p>The major design features of the system shall be demonstrated by the Contractor at the Contractor's works or any other place mutually agreed within Six months from the date of LOA. These are the system function tests, which have a major impact on the detailed system design &amp; finalization of important engineering documents like</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 37 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>configuration, functional grouping, BOM etc., but do not require a fully engineered system for conductance. Bidder shall identify these features &amp; include detailed test procedures in the bid, which shall be finalized during discussions with the bidder before award. The developments and any augmentation of standard features undertaken by the Bidder to fulfill the various specification requirements, shall be also be tested during these major design tests. This shall include but not be limited to the following.</p> <p>a) System accuracy tests of DDCMIS for the various type of inputs identified in Part-B.</p> <p>b) Loop reaction time for sample loops/ logics.</p> <p>c) SOE functionality tests.</p> <p>d) Server changeover.</p> <p>e) Various response times, having serious implication on operation &amp; maintenance philosophy.</p> <p>f) Duty cycle of controller/ HMIPIS with simulated load, representative of the final engineered load.</p> <p>g) Unified HMI for DDCMIS.</p> <p>The results of the above tests, after its acceptance by the Employer, shall be properly documented and submitted to Employer.</p> <p><b>If any of the envisaged tests have been carried out by Bidder in a previous NTPC project, then the same need not be specifically conducted by the Bidder for this project, provided it is clearly established by the Bidder &amp; accepted by the Employer that there is no difference between the system offered for this project &amp; the previous NTPC project with respect to the test. However, even in such a case, test report of the previous project shall be submitted by the Bidder as a part of MDFT (Major Design Feature Test) test report.</b></p>			
25.12.00	<b>DEMONSTRATION OF APPLICATION ENGINEERING</b>			
25.12.01	<p>Based on NTPC inputs, the Contractor shall prepare and submit typical implemented scheme in their system ( Control system &amp; HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following.</p> <p>(i) Logics/Loops:</p> <p>a) Drive logics implementation for each type of binary drive along with its display in HMI.</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 38 OF 111	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	i) Safety valves and associated vent pipes for which it shall not exceed 105 dBA-115 dBA. ii) Regulating drain valves in which case it shall be limited to 90 dBA-115 dBA. iii) Mill noise which will be limited to 85-90 dBA. iv) TG unit in which case it shall not exceed 90 dBA. v) For HP-LP bypass valves and other intermittantly operating control valves, the noise level shall be within the limit of 90 dBA. vi) For BFP Motor Noise level shall be with in the limit of 90 dBA.			
31.00.00	<b>PACKAGING AND TRANSPORTATION</b>  All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting despatch of equipment. Before despatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before despatch of materials for transportation.			
32.00.00	<b>ELECTRICAL EQUIPMENTS/ENCLOSURES</b>			
32.01.00	All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specifications.			
33.00.00	<b>INSTRUMENTATION AND CONTROL</b>  All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.			
33.01.00	All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.			
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b>		<b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b>	<b>GENERAL TECHNICAL REQUIREMENTS</b>	<b>PAGE 45 OF 111</b>

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS																				
	<p>All scales and charts shall be calibrated and printed in Metric Units as follows:</p> <table border="0"> <tr> <td style="padding-right: 20px;">1. Temperature</td> <td>- Degree centigrade (deg C)</td> </tr> <tr> <td>2. Pressure</td> <td>- Kilograms per square centimetre (Kg/cm<sup>2</sup>). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.</td> </tr> <tr> <td>3. Draught</td> <td>- Millimetres of water column (mm wc).</td> </tr> <tr> <td>4. Vacuum</td> <td>- Millimeters of mercury gauge (mm Hg) or water column (mm Wcl).</td> </tr> <tr> <td>5. Flow (Gas)</td> <td>- Tonnes/ hour</td> </tr> <tr> <td>6. Flow (Steam)</td> <td>- Tonnes/ hour</td> </tr> <tr> <td>7. Flow (Liquid)</td> <td>- Tonnes / hour</td> </tr> <tr> <td>8. Flow base</td> <td>- 760 mm Hg. 15 deg.C</td> </tr> <tr> <td>9. Density</td> <td>- Grams per cubic centimetre.</td> </tr> </table>			1. Temperature	- Degree centigrade (deg C)	2. Pressure	- Kilograms per square centimetre (Kg/cm <sup>2</sup> ). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.	3. Draught	- Millimetres of water column (mm wc).	4. Vacuum	- Millimeters of mercury gauge (mm Hg) or water column (mm Wcl).	5. Flow (Gas)	- Tonnes/ hour	6. Flow (Steam)	- Tonnes/ hour	7. Flow (Liquid)	- Tonnes / hour	8. Flow base	- 760 mm Hg. 15 deg.C	9. Density	- Grams per cubic centimetre.
1. Temperature	- Degree centigrade (deg C)																				
2. Pressure	- Kilograms per square centimetre (Kg/cm <sup>2</sup> ). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.																				
3. Draught	- Millimetres of water column (mm wc).																				
4. Vacuum	- Millimeters of mercury gauge (mm Hg) or water column (mm Wcl).																				
5. Flow (Gas)	- Tonnes/ hour																				
6. Flow (Steam)	- Tonnes/ hour																				
7. Flow (Liquid)	- Tonnes / hour																				
8. Flow base	- 760 mm Hg. 15 deg.C																				
9. Density	- Grams per cubic centimetre.																				
33.02.00	<p>All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plan-in connection at rear.</p>																				
33.03.00	<p>All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised &amp; components shall be of industrial grade or better.</p>																				
34.00.00	<p><b>ELECTRICAL NOISE CONTROL</b></p> <p>The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-61000-2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems as per EN-50082-2 (1995).</p>																				
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p align="center"><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p align="center"><b>PAGE 46 OF 111</b></p>																		

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
35.00.00	<p><b>SURGE PROTECTION FOR SOLID STATE EQUIPMENT</b></p> <p>All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates. etc. shall be submitted by the Bidder.</p>			
36.00.00	<p><b>INSTRUMENT AIR SYSTEM</b></p> <p>The instrument air supply system as supplied by the Bidder for various pneumatic control &amp; instrumentation devices like pneumatic actuators, power cylinders, E/P converters, piping / tubing etc.</p> <p>Each pneumatic instrument shall have an individual air shut - off valve. The pressure regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.</p>			
37.00.00	<p><b>TAPPING POINTS FOR MEASUREMENTS</b></p> <p>Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.</p> <p>For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Contractor will be intimated about thread standard to be adopted.</p> <p>The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Contractor.</p> <ul style="list-style-type: none"> <li>i) Temperature test pockets with stub and thermowell</li> <li>ii) Pressure test pockets</li> </ul>			
38.00.00	<p><b>SYSTEM DOCUMENTATION</b></p> <p>The Bidder shall provide drawings, system overview &amp; description, hardware/ software details, technical literature, functional &amp; hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C&amp; I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&amp;I systems/ sub-systems/ equipment to enable review by Employer during detailed engineering stage and to provide information to plant personnel for operation &amp; Maintenance (including quick diagnostics &amp; trouble shooting) of these C&amp;I systems/ sub-systems/ equipment at site. The minimum</p>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>		<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 47 OF 111</p>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
38.01.00	<p>documentation requirements for C&amp;I systems shall be as stipulated under C&amp;I "Technical Data Sheets" Part of specifications. In addition to this, system documentation for DDCMIS shall include as a minimum to that specified elsewhere in the Technical Specification.</p> <p>The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.</p>			
39.00.00	<p><b>MAINTENANCE MANUALS OF ELECTRONIC MODULES</b></p> <p>The Contractor shall have to furnish two(2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him. The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further, the contractor shall furnish a set of operating manuals which should include block diagrams, make, model/type, details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.</p>			
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p align="center"><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p align="center"><b>PAGE 48 OF 111</b></p>	


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
<b>LIST OF CODES AND STANDARDS</b>			
	<b>Indian Standards</b>	<b>Title</b>	<b>International and Internationally recognised standards</b>
	IS:277	Galvanised steel sheets (plain or corrugated)	
	IS:655	Specification for metal air duct	
	IS:800	Code of practice for use of structural steel in general building construction	BS 449:1969 BS 5950 ASA A57, 1-1952
	IS:807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Association of Australia). DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960 BS 1757:1951 BS 2573:part-I:1960	Draft Revision of A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev
	IS:875	Code of practice for design loads (other than earthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)	National Building code of Canada (1953)-Part-IV  Design section 4.1
	IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957) (ISO/R-64-1958)
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b>	<b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b>	<b>GENERAL TECHNICAL REQUIREMENTS</b>	<b>PAGE 49 OF 111</b>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		एनटीपीसी NTPC	
			(ISO/R-65-1958) (BS 1387 : 1957)	
IS:1239 Part-II	Mild steel tubulars and other wrought steel pipe fittings	BS 1387 : 1967 BS 1387 :1967 BS 1740 :1965		
IS:2825	Code for unfired vessels			
IS:1520	Horizontal centrifugal pumps for clear cold and fresh water			
IS:1600	Code for practice for performance of constant speed IC Engines for general purpose			
IS:1601	Specification for perform- ance of constant speed IC Engines for general Purpose			
IS:1893	Criteria for earthquake resistant design of structures			
IS1978-1971	Line Pipe April 1969.	API Standards 5L		
IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954		
IS:2266	Steel wire ropes for general engineering purposes	BS :302 : 1968		
IS:2312	Propellant type Ventilation fans			
IS:2365	Steel wire suspension ropes for lifts and hoists	BS : 1957		
IS:3346	Method for the determin- ation of thermal	DIN 52612 (Deutscher Normenausschuss)		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)		TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 50 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		एनटीपीसी NTPC
		<p>conductivity of thermal insulation materials (two slab guarded hot plate method)</p> <p>IS:3354 Outline dimensions for electric lifts.</p> <p>IS:3401 Silica gel</p> <p>IS:3588 Specification for electrical axial flow fans</p> <p>IS:3589 Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diametre)</p> <p>IS:3677 Unbonded rock and slag wool for thermal insulation</p> <p>IS:3815 Point hook with shank for general engineering purposes</p> <p>IS:3895 Specification for monocrystallines semiconductor rectifier cells and stacks</p> <p>IS:3963 Roof extractor unit</p> <p>IS:3975 Mild steel wires, strips and tapes for armouring cables</p> <p>IS:4503 Shell and tube type heat Exchanger</p> <p>IS:4540 Specification for monocrystallines rectifier assembly</p>	<p>ASTM C 163-1964 (American Society of Testing and materials)</p> <p>ASTM C 167-1974</p> <p>ASTM C 177-1963</p> <p>BS 482 - 1968 Doc.:67/3 1284 (Revision of BS 2903) (Issued BS)</p>
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 51 OF 111


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		एनटीपीसी NTPC
		equipment	
IS:4671		Expanded polystyrene for thermal insulation purpose	
IS:4736		Hot dip zinc coating on steel tubes	
IS:4894		Centrifugal fans	
IS:5456		Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	
IS:5749		Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 BS 3017-1958
IS:6392		Steel pipe flanges	BS 4504 : 1969
IS:6524 Part-I		Code of practice for design of tower cranes Static and rail mounted	BS 2799 : 1956
IS:7098		Cross linked Polyethylene insulated PVC sheathed cables	Standard No. 1 to IPCEA (USA) Pub. No. 5-66-524
IS:7373		Specification for wrought aluminium and aluminium sheet and strips	
IS:7938		Air receivers for compressed air installation	
ISO:1217		Displacement compressor-Acceptance test	
ASHRAE-33		Methods of testing for rating of forced circulation air cooling and air heating coils.	
ASHRAE-52-76		Air cleaning device used in general ventilation for removing particle matter.	
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b>	<b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b>	<b>GENERAL TECHNICAL REQUIREMENTS</b>	<b>PAGE 52 OF 111</b>


CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS		
	<p>ASHRAE-22-72 Method of testing for rating of water cooled refrigerant condensers.</p> <p>ASHRAE 23-67 Methods of testing for rating of positive displacement refrigerant compressors.</p> <p>ARI-450-6 Standard for water cooled refrigerant condensers.</p> <p>ARI-550 Standard for centrifugal water chilling packages.</p> <p>ARI-410 Standard for forced circulation air cooling and air heating coils</p> <p>ARI-430/435 Central station AHU/Application of Central Station AHU BS:848 Fans (Part-1,2)</p> <p>BS:400 Low carbon steel cylinders for the storage &amp; transport of permanent gases.</p> <p>BS:401 Low carbon steel cylinders for the storage &amp; transport of liquified gases.</p> <p>CTI Code Acceptance test code for Water Cooling Tower. ACT-105</p> <p>ANSI-31.5 Refrigerant piping</p> <p>ASME-PTC- Atmospheric Water Cooling Equipment 23-1958</p> <p>AMCA A-21C Test Code for air moving devices</p> <p>API:618 Reciprocating Compressor for general refinery services.</p> <p>HYDRAULIC INSTITUTE STANDARDS.</p> <p>HYDRANT SYSTEM MANUALS OF TAC.</p> <p>TAC MANUALS OF SPRAY SYSTEM</p> <p>NFPA USA/ NSC UK/ UL USA/ FM USA STANDARDS.</p> <p>INDIAN EXPLOSIVES ACT.</p> <p>INDIAN FACTORIES ACT.</p> <p>STANDARD OF TUBULAR EXCHANGER MANUFACTURER'S ASSOCIATION.</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</p>	<p>GENERAL TECHNICAL REQUIREMENTS</p>	<p>PAGE 53 OF 111</p>

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p><b>Miscellaneous</b></p> <p>IS:802 Code of practice for use of structural steel in (Relevant parts) overhead transmission line towers.</p> <p>IS:803 Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.</p> <p>IS:10430 Creteria for design of lined canals and liner for selection of type of lining.</p> <p>IS:11592 Code of practice for selection and design of belt conveyors.</p> <p>IS:12867 PVC handrails covers.</p> <p>CIRIA Design and construction of buried thin-wall pipes.</p> <p>Publication</p> <p><b>REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION</b></p> <p>The design, manufacture, inspection, testing &amp; installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalentents.</p> <p><b>Temperature Measurements</b></p> <ol style="list-style-type: none"> <li>1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).</li> <li>2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.</li> <li>3. Temperature measurement by electrical Resistance thermometers - IS:2806.</li> <li>4. Thermometer - element - Platinum resistance - IS:2848.</li> </ol> <p><b>Pressure Measurements</b></p> <ol style="list-style-type: none"> <li>1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964). b) Electronic transmitters BS:6447.</li> <li>2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.</li> <li>3. Process operated switch devices (Pr. Switch) BS-6134.</li> </ol>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS	PAGE 71 OF 111	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p><b>Flow Measurements</b></p> <p>Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.</p> <p>Measurement of fluid flow in closed conduits - BS-1042.</p> <p><b>Electronic Measuring Instrument &amp; Control Hardware/ Software</b></p> <ol style="list-style-type: none"> <li>1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.</li> <li>2. Safety requirements for electrical and electronic measuring and controlling instrument - ANSI C 39.5 - 1974.</li> <li>3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.</li> <li>4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).</li> <li>5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.</li> <li>6. Printed circuit boards - IPC TM - 650, IEC 326 C.</li> <li>7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.</li> <li>8. Edge socket connectors - IEC 130-11.</li> <li>9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.</li> <li>10. Dimensions of attachment plugs &amp; receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).</li> <li>11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).</li> <li>12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.</li> <li>13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.</li> <li>14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.</li> <li>15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.</li> </ol>			
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p align="center"><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p align="center"><b>PAGE 72 OF 111</b></p>	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS			
	<p>16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.</p> <p>17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.</p> <p>18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.</p> <p>19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.</p> <p>20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.</p> <p>21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232-D-1987.</p> <p>22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.</p> <p><b>Instrument Switches and Contact</b></p> <p>1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.</p> <p>2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.</p> <p><b>Enclosures</b></p> <p>1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).</p> <p>2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).</p> <p>3. Protection class for Enclosures, cabinets, control panels &amp; desks - IS:2147 - 1962.</p> <p><b>Apparatus, enclosures and installation practices in hazardous area</b></p> <p>1. Classification of hazardous area - NFPA 70 - 1984, Article 500.</p> <p>2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.</p> <p>3. Intrinsically safe apparatus - NFPA 493 1978.</p> <p>4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.</p> <p>5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.</p>			
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2</b></p>	<p align="center"><b>GENERAL TECHNICAL REQUIREMENTS</b></p>	<p align="center"><b>PAGE 73 OF 111</b></p>	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS (Annexure-VI)																																			
	<table border="1"> <thead> <tr> <th>S.No</th> <th>Description of Drgs/Docs</th> <th>No of Prints</th> <th>of No of CD ROMs/DVDs/Portable Hard Disk</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>           Drawings, Data sheets, Design calculations, Purchase specifications and other documents            First submission and submission with major changes  <ul style="list-style-type: none"> <li>▪ Layout (A0&amp;A1 sizes)</li> <li>▪ Other Drawings/Documents (A0&amp;A1 sizes)</li> <li>▪ P&amp;ID (All sizes)</li> </ul>           a) Final drawings/documents (Directly to site)            b) "As Built" Drawing/Documents (Directly to site)            c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.         </td> <td>           4            2            4            6            6            2         </td> <td>           -            -            -            2            2            2         </td> </tr> <tr> <td>2</td> <td>Erection Manual (Directly to site)</td> <td>4 sets</td> <td>2</td> </tr> <tr> <td>3</td> <td>           Operation &amp; Maintenance manual            i) First Submission         </td> <td>1 set</td> <td>--</td> </tr> <tr> <td></td> <td>ii) Final Submission (Directly to site)</td> <td>4 sets</td> <td>2</td> </tr> <tr> <td>4</td> <td>           Plant Hand Book            i) First Submission         </td> <td>1</td> <td>1</td> </tr> <tr> <td>5</td> <td>           Commissioning and Performance Test Procedure manual            i) First Submission         </td> <td>1 set</td> <td>--</td> </tr> <tr> <td></td> <td>ii) Final Submission (Directly to site)</td> <td>4 sets</td> <td>2</td> </tr> </tbody> </table>	S.No	Description of Drgs/Docs	No of Prints	of No of CD ROMs/DVDs/Portable Hard Disk	1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents First submission and submission with major changes <ul style="list-style-type: none"> <li>▪ Layout (A0&amp;A1 sizes)</li> <li>▪ Other Drawings/Documents (A0&amp;A1 sizes)</li> <li>▪ P&amp;ID (All sizes)</li> </ul> a) Final drawings/documents (Directly to site) b) "As Built" Drawing/Documents (Directly to site) c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.	4 2 4 6 6 2	- - - 2 2 2	2	Erection Manual (Directly to site)	4 sets	2	3	Operation & Maintenance manual i) First Submission	1 set	--		ii) Final Submission (Directly to site)	4 sets	2	4	Plant Hand Book i) First Submission	1	1	5	Commissioning and Performance Test Procedure manual i) First Submission	1 set	--		ii) Final Submission (Directly to site)	4 sets	2			
S.No	Description of Drgs/Docs	No of Prints	of No of CD ROMs/DVDs/Portable Hard Disk																																	
1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents First submission and submission with major changes <ul style="list-style-type: none"> <li>▪ Layout (A0&amp;A1 sizes)</li> <li>▪ Other Drawings/Documents (A0&amp;A1 sizes)</li> <li>▪ P&amp;ID (All sizes)</li> </ul> a) Final drawings/documents (Directly to site) b) "As Built" Drawing/Documents (Directly to site) c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.	4 2 4 6 6 2	- - - 2 2 2																																	
2	Erection Manual (Directly to site)	4 sets	2																																	
3	Operation & Maintenance manual i) First Submission	1 set	--																																	
	ii) Final Submission (Directly to site)	4 sets	2																																	
4	Plant Hand Book i) First Submission	1	1																																	
5	Commissioning and Performance Test Procedure manual i) First Submission	1 set	--																																	
	ii) Final Submission (Directly to site)	4 sets	2																																	
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS Annexure-VI	PAGE 83 OF 111																																	

CLAUSE NO.	GENERAL TECHNICAL REQUIREMENTS (Annexure-VI)			
	S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
	6	Performance and Functional Guarantee Test Report i) First Submission	2 sets	--
		ii) Approved Copies (Direct to Site)	4 sets	2
	7	Project Completion Report (Directly to site)	6 sets	2
	8	QA programme including Organisation for implementation and QA system manual(with revisions)	1	--
	9	Vendor details in respect of proposed vendors including contractor's evaluation report.	2	--
	10	Manufacturing QPs, Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc i) For review/comment	1	--
		ii) Approved final copies of Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc (Direct to Site)	4	2
	11	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals i) For review/comment	1 set	--
		ii) Approved copies (Direct to Site)	4 sets	2
	12	QA Documentation Package for items / equipment manufactured and despatched to site	2 sets	2
	13	QA Documentation Package for field activities on equipment/systems at site	2 sets	2
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-C BID DOC. NO.:CS-9585-001-2	GENERAL TECHNICAL REQUIREMENTS Annexure-VI	PAGE 84 OF 111	





# **SUB-SECTION-IV**


## **FUNCTIONAL GUARANTEES**

**EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER STATION  
EXPANSION PHASE-1 (3x800 MW)**

**TECHNICAL SPECIFICATION  
SECTION-VI, PART-A  
BID DOC NO: CS-9585-001-2**

CLAUSE NO.	FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES		
<p>1.00.00</p> <p>1.00.01</p>	<p style="text-align: center;"><b>FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES FOR SHORTFALL IN PERFORMANCE AND GUARANTEE TESTS</b></p> <p>The term "Performance Guarantees" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in this Sub-Section shall have the same meaning and shall be synonymous to "Guarantee Test(s)".</p> <p>The term "BMCR" (Boiler Maximum Continuous Rating) appearing in the Technical Specification shall mean the maximum continuous steam output of Steam Generator (as defined Cl. No. 1.02.00 Sub-section A-02, Part-B) at super heater outlet at rated parameters.</p> <p>The term "TMCR" (Turbine maximum continuous rating) appearing in the technical specification shall mean 800 MW electrical power output at generator terminals (power at generator terminals as per clause indicated in this sub-section) under rated steam parameters, 0% cycle make-up and 160 mmHg (abs) condenser pressure unless used in conjunction with a different cycle make-up and/or a different condenser pressure and /or a different throttle steam pressure.</p> <p><b>PERFORMANCE GUARANTEES</b></p> <p><b>General Requirements</b></p> <p>a) The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.</p> <p>b) The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values whatsoever and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.</p> <p>c) The Contractor shall conduct performance test and demonstrate all the guarantees covered herein, during performance guarantee/acceptance test. The various tests which are to be carried out during performance guarantee/acceptance test are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Employer on each unit individually.</p> <p>d) All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation, shall be included in the bid price.</p> <p>e) It is the responsibility of the contractor to perform the Performance</p>		
<p style="text-align: center;">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-1 (3X800 MW)</p>	<p style="text-align: center;">TECHNICAL SPECIFICATIONS SECTION – VI, PART-A BID Doc. No.- CS-9585-001-2</p>	<p style="text-align: center;">SUB-SECTION-IV FUNCTIONAL GUARANTEES</p>	<p style="text-align: center;">PAGE 1 OF 98</p>

CLAUSE NO.	FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES			
	<p>Guarantee/Acceptance test as specified in this subsection. The performance tests will be performed using only the normal number of Employer supplied operating staff. Contractor, vendor or other subcontractor personnel shall only be used for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.</p> <p>f) The Contractor shall make the plant ready for the performance guarantee tests.</p> <p>g) All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the contractor shall get these instruments calibrated in an independent test Institute approved by the Employer. All test instrumentation required for performance tests shall be supplied by the contractor and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subjected to the approval of the Employer. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.</p> <p>h) Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping &amp; valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the contractor free of cost.</p> <p>i) The Performance / Acceptance test shall be carried out as per the agreed procedure. The PG test procedure including demonstration tests shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award. After the conductance of Performance test, the contractor shall submit the test evaluation report of Performance test results to Employer promptly but not later than one months from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Employer after completing each test run.</p> <p>The P&amp;G test procedures shall be submitted for equipments/ system &amp; subsystem under Contractor's scope for all Guarantees under category I, II &amp; III as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations &amp; detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.</p> <p>j) The contractor shall submit for Employer's approval the detailed Performance Test procedure containing the following:</p>			
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-1 (3X800 MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION – VI, PART-A BID Doc. No.- CS-9585-001-2</p>	<p>SUB-SECTION-IV FUNCTIONAL GUARANTEES</p>	<p>PAGE 2 OF 98</p>	

CLAUSE NO.	FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES			
	<p>a) Object of the test.</p> <p>b) Various guaranteed parameters &amp; tests as per contract.</p> <p>c) Method of conductance of test and test code.</p> <p>d) Duration of test, frequency of readings &amp; number of test runs.</p> <p>e) Method of calculation.</p> <p>f) Correction curves.</p> <p>g) Instrument list consisting of range, accuracy, least count, and location of instruments.</p> <p>h) Scheme showing measurement points.</p> <p>i) Sample calculation.</p> <p>j) Acceptance criteria.</p> <p>k) Any other information required for conducting the test.</p> <p>k) In case during performance guarantee tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the Employer and re-conduct the performance guarantee test(s) with Employer's consent. However if the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit specified at clause 1.01.02 of this subsection, Employer will accept the equipment/system/plant after levying liquidated damages as per clause 1.01.02 of this sub-section. If, however, the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following:</p> <p><b>i) For Category-I Guarantees</b></p> <p>Reject the equipment/system/plant and recover from the Contractor the payments already made</p> <p style="text-align: center;">OR</p>			
<p style="text-align: center;">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-1 (3X800 MW)</p>	<p style="text-align: center;">TECHNICAL SPECIFICATIONS SECTION – VI, PART-A BID Doc. No.- CS-9585-001-2</p>	<p style="text-align: center;">SUB-SECTION-IV FUNCTIONAL GUARANTEES</p>	<p style="text-align: center;">PAGE 3 OF 98</p>	

CLAUSE NO.	FUNCTIONAL GUARANTEES, LIQUIDATED DAMAGES			एनटीपीसी NTPC
	<p>Accept the equipment/system/plant after levying Liquidated Damages as specified hereunder. The liquidated damages, for shortfall in performance indicated in clause 1.01.02 for this sub-section are on per unit basis and shall be levied separately for each unit, except for the rate indicated for auxiliary power consumption for station auxiliaries which is on station basis. The liquidated damages shall be prorated for the fractional parts of the deficiencies. The performance guarantees coming under this category shall be called 'Category - I' Guarantees.</p> <p><b>ii) For Category-II Guarantees</b></p> <p>Reject the equipment/plant/system and recover from the Contractor the payments already made. The performance guarantees under this category shall be called 'Category - II ' Guarantees. Conformance to the performance requirements under Category -II is mandatory.</p> <p><b>iii) For Category-III Guarantees</b></p> <p>Reject the equipment / system/plant &amp; recover from the Contractor the payments already made.</p> <p style="text-align: center;">OR</p> <p>Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the EMPLOYER. Such damages shall, however be limited to the cost of replacement of the equipment(s) / system(s) replacement of which shall remove the deficiency so as to achieve the guarantee performance. These parameters/capacities shall be termed as category - III, guarantees.</p>			
1.01.00	<b>GUARANTEES UNDER CATEGORY - I</b>			
1.01.01	<p>The performance guarantees which attract liquidated damages (LD) are as follows:</p> <p><b>i) Unit Heat Rate</b></p> <p>a) Unit Heat rate in kcal/kWhr under rated steam conditions at <b>160 mm Hg (abs) condenser pressure</b> with zero (0%) make up at 800 MW unit load (i.e. 100% of rated load).</p> <p>b) Unit Heat rate in kcal/kWhr under turbine throttle main steam pressure of 210 Kg/cm<sup>2</sup> (abs) and turbine throttle main steam temperature / reheat steam temp. at turbine inlet of 600 deg C / 600 deg C at 160 mm Hg (abs) condenser pressure with zero make up at 600 MW unit load (i.e. 75% of rated load) .</p>			
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-1 (3X800 MW)	TECHNICAL SPECIFICATIONS SECTION – VI, PART-A BID Doc. No.- CS-9585-001-2	SUB-SECTION-IV FUNCTIONAL GUARANTEES	PAGE 4 OF 98	

Refer GPC format Annexure-IV, for more details pertaining to Gypsum Dewatering Equipment




# **SUB-SECTION–E-04**


## **FGD SYSTEM**


**BIDDER(S) TO CONSIDER FOR THE ITEMS IN THEIR SCOPE FOR THE GYPSUM DEWATERING EQUIPMENT, AS APPLICABLE**


**EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER STATION  
EXPANSION PHASE–I (3X 800MW)**

**TECHNICAL SPECIFICATION  
SECTION-VI, PART-B  
BID DOC NO.:CS-9585-001-2**

CLAUSE NO.	QUALITY ASSURANCE	
<b>FLUE GAS DESULPHURISATION SYSTEM</b>		
<b>1.00.0</b>	<b>FLUE GAS DESULPHURISATION SYSTEM</b>	
<b>1.01.0</b>	<b>Mills:</b>	
1.01.01	Raw material for shaft, coupling, gears and pinions, top and bottom races and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.	
1.01.02	Wear-resistant parts shall be UT/RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out.	
1.01.03	Butt welds in the tube/separator/body casing of the mill shall be tested by RT and MPI. All other welds in main tube/separator shall be tested by MPI/LPI for acceptance. The tube shall be statically balanced.	
1.01.04	All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.	
<b>1.02.0</b>	<b>Feeders:</b>	
1.02.01	Any welds in the casing/pulley fabrication shall be checked with MPI.	
1.02.02	Routine tests shall be done as per relevant Indian Standards or equivalent International Standards.	
1.02.03	All major items like plates for casing, head pulley, tail pulley, pulley shaft and major castings shall be procured with respective material test certificates.	
1.02.04	Calibration check shall be carried out on all feeders.	
<b>1.03.0</b>	<b>Dampers:</b>	
1.03.01	All the dampers shall be subjected to operational test/checks.	
1.03.02	Gas tight Dampers shall be subjected to shop leakage test to demonstrate the guaranteed tightness as per NTPC Tech Specification.	
<b>1.04.0</b>	<b>PIPING, VALVE AND SPECIALITIES:</b>	
1.04.01	All pipes and fittings shall be tested as per applicable code.	
1.04.02	All valves shall be hydraulically/Air tested for body, seat and back-seat (if applicable) as per relevant standard.	
1.04.03	NDT on valves shall be as per relevant standard.	
1.04.04	Valves shall be offered for hydro test in unpainted conditions.	
1.04.05	Functional checks of the valves for smooth opening and closing shall also be done.	
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b>	<b>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO.:CS-9585-001-2</b>	<b>SUB-SECTION – E-04 FGD SYSTEM</b>  <b>Page 1 of 4</b>

CLAUSE NO.	QUALITY ASSURANCE	
1.05.00	<b>TANKS / VESSELS:</b>	
1.05.01	<b>Atmospheric tanks:</b>	
	i) All welds joints shall be DP tested and complete tanks shall be water fill tested. ii) All atmospheric storage tanks fabricated and erected at site shall be subjected to tests (Hydro, NDT and Vacuum) according to design code as applicable. iii) Rubber lining shall be tested for hardness and spark test, as applicable.	
1.05.02	<b>Pressure vessels:</b>	
	1) NDT on weld joint shall be as per respective code requirements or the minimum as specified as below: i) 100% DPT on root run of butt weld, nozzle welds and finished fillet welds. ii) 10% DPT on all finished butt welds. iii) 10% RT (covering all 'T'/cross joints) of butt welds. 2) Butt welds of dished ends shall be stress relieved and subjected to 100% RT. 3) Each finished vessels shall be hydraulically tested to 150% of the design pressure for a duration of 30 minutes.	
<del>1.06.00</del>	<del><b>HEAT EXCHANGER/HEATER:</b></del>	
<del>1.06.01</del>	<del>All material shall be tested for chemical and mechanical properties and NDT as per relevant standard.</del>	
<del>1.06.02</del>	<del>NDT on welds and other checks shall be as per relevant code.</del>	
<del>1.06.03</del>	<del>Air heaters shall be subjected to dimensional and clearance checks as per standard practice</del>	
<del>1.06.04</del>	<del>Lub. oil system, drive system, soot blowing system etc. of Air heaters shall be checked suitably as per standard practice</del>	
1.07.00	<b>PUMPS:</b>	
1.07.01	UT on shaft forgings (greater or equal to 40mm) and MPI/DPT shall be done on shafts and impeller to ensure freedom from defects.	
1.07.02	The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut off head, whichever is higher. The test pressure shall be maintained for at least half an hour.	
1.07.03	The pump rotating parts shall be subjected to static and dynamic balancing.	
1.07.04	All pumps shall be tested at shop for capacity, head efficiency and brake horse power at rated speed as per relevant/applicable standard.	
1.07.05	Noise and vibration shall be measured during the performance testing at shop.	
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b>	<b>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO.:CS-9585-001-2</b>	<b>SUB-SECTION – E-04 FGD SYSTEM</b>
<b>Page 2 of 4</b>		

CLAUSE NO.	QUALITY ASSURANCE		
<p><b>1.08.00</b></p> <p>1.08.01</p> <p>1.08.02</p> <p>1.08.03</p> <p>1.08.04</p>	<p><b>STRUCTURES , DUCTS, HOPPERS:</b></p> <p>All materials shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% Ultrasonically tested.</p> <p>Visual inspection of all welds shall be performed in accordance with AWS D1.1.</p> <p>NDT requirements of structural steel welds shall be as under:</p> <ul style="list-style-type: none"> <li>i) 100% RT/UT on butt-welds of plate thickness <math>\geq 32</math>mm.</li> <li>ii) For plates of <math>25\text{mm} \leq \text{thickness} &lt; 32\text{mm}</math>-10% RT and 100% MPI.</li> <li>iii) For plates of thickness <math>&lt; 25\text{mm}</math>-10% MPI/LPI.</li> </ul> <p>Edge for shop and field weld shall be examined by MPI for plate thickness <math>\geq 32</math>mm.</p>		
<p><b>1.09.00</b></p> <p>1.09.01</p> <p>1.09.02</p> <p>1.09.03</p> <p>1.09.04</p> <p>1.09.05</p>	<p><b>VACUUM BELT FILTER SYSTEM:</b></p> <p>Impeller, casing and shaft of vacuum pumps shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% Ultrasonically tested.</p> <p>UT on shaft (if greater or equal to 40mm) and impeller shall be carried out.</p> <p>All vacuum pumps shall be tested at shop for capacity, power, pressure, efficiency, noise and vibration etc.</p> <p>Filter cloths and belts shall be tested for physical properties as per relevant standard</p> <p>Hydro cyclones shall be checked by visual, dimensional etc.</p>		
<p><b>1.10.00</b></p> <p>1.10.01</p> <p>1.10.02</p>	<p><b>SPRAY NOZZLES:</b></p> <p>Spray nozzles shall be tested for physical properties</p> <p>Spray nozzles also shall be subjected to performance test.</p>		
<p><b>1.11.00</b></p> <p>1.11.01</p> <p>1.11.02</p> <p>1.11.03</p>	<p><b>AGITATORS:</b></p> <p>Rubber lining shall be tested for hardness and spark test</p> <p>Impellers shall be tested for dimensional and balancing check</p> <p>Gear Boxes shall be tested for run test as per standard practice</p>		
<p><b>1.12.00</b></p> <p>1.12.01</p> <p>1.12.02</p>	<p><b>FANS:</b></p> <p>Rotor components shall be subjected to ultrasonic test at mill and magnetic particle inspection / liquid penetrant examination after rough machining.</p> <p>Butt welds in rotor components shall be subjected to 100% RT and all welds shall be magnetic particle/dye penetrant tested after stress relieving.</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</p>	<p>TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO.:CS-9585-001-2</p>	<p>SUB-SECTION – E-04 FGD SYSTEM</p>	<p>Page 3 of 4</p>

CLAUSE NO.	QUALITY ASSURANCE		
1.12.03	All rotating components and assemblies of fan shall be balanced dynamically		
1.12.04	Performance test shall be carried out on fans as per Technical specification/ Relevant standard		
1.12.05	Test for Natural Frequency and hardness of Fans blades shall be carried out as per Technical specification/ Relevant standard		
1.13.00	<p><b>Thermal Insulation, Lagging &amp; Cladding:</b></p> <p>(a) <b>Lightly resin bonded mineral wool:</b></p> <p>LRB mattresses/sections of Rockwool/ Glasswool shall conform to &amp; tested as per relevant clauses of Indian Standards and shall meet the requirements of NTPC data sheet. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per NTPC approved data sheet / as given in respective Sub-Section of Technical Requirements of Steam Generator &amp; Auxiliaries.</p> <p>(b) <b>Lagging &amp; Cladding:</b></p> <p>All insulation shall be protected by means of an outer covering of Aluminium sheeting confirming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of NTPC data sheet.</p>		
1.14.00	<b>OTHER CRITICAL EQUIPMENTS:</b>		
1.14.01	Checks/ NDTs shall be done as per relevant Indian Standards or equivalent International Standards.		
<p align="center">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</p>	<p align="center">TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC NO.:CS-9585-001-2</p>	<p align="center">SUB-SECTION – E-04 FGD SYSTEM</p>	<p align="center">Page 4 of 4</p>





SPECIFICATION No: PE-TS-434-571-A901  
SECTION : I  
SUB-SECTION : C2-B  
REV. 00  
Painting (Customer Specification)


SUB – SECTION – A-12  
**SURFACE PREPARATION & PAINTING**

EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER STATION EXPANSION  
PHASE –I ( 3X 800MW)

TECHNICAL SPECIFICATION  
SECTION-VI  
BID DOC. NO.: CS:9585-001-2

CLAUSE NO.	 <b>TECHNICAL REQUIREMENTS</b>		
<b>1.00.00</b>	<b>SPECIFICATION OF SURFACE PREPARATION &amp; PAINTING</b>		
1.01.00	Surface preparation methods and paint/primer materials shall be of the type specified herein. If the contractor desires to use any paint/primer materials other than that specified, specific approval shall be obtained by the contractor in writing from the employer for using the substitute material.		
1.02.00	All paints shall be delivered to job site in manufacturers sealed containers. Each container shall be labelled by the manufacturer with the manufacturer's name, type of paint, batch number and colour.		
1.03.00	Unless specified otherwise, paint shall not be applied to surfaces of insulation, surfaces of stainless steel/nickel/ copper/brass/ monel/ aluminum/ hastelloy/lead/ galvanized steel items, valve stem, pump rods, shafts, gauges, bearing and contact surfaces, lined or clad surfaces.		
1.04.00	All pipelines shall be Colour coded for identification as per the NTPC Colour-coding scheme, which will be furnished to the contractor during detailed engineering.		
1.05.00	<b>SURFACE PREPARATION</b>		
1.05.01	All surfaces to be painted shall be thoroughly cleaned of oil. Grease and other foreign material. Surfaces shall be free of moisture and contamination from chemicals and solvents.		
1.05.02	<p>The following surface preparation schemes are envisaged here. Depending upon requirement any one or a combination of these schemes may be used for surface preparation before application of primer.</p> <p>SP1            Solvent cleaning</p> <p>SP2            Application of rust converter (Ruskil or equivalent grade)</p> <p>SP3            Power tool cleaning</p> <p>SP4            Shot blasting (shot blasting shall be used as surface preparation method for hot worked pipes prior to application of primer)</p> <p>SP4*          Shot blast cleaning/ abrasive blast cleaning to SA21/2 (near white metal) 35-50 microns</p> <p>SP5            Shot blasting/ abrasive blasting.</p> <p>SP6            Emery sheet cleaning/Manual wire brush cleaning.</p>		
1.06.00	<b>APPLICATION OF PRIMER/PAINT</b>		
1.06.01	The paint/primer manufacturer's instructions covering thinning, mixing, method of application, handling and drying time shall be strictly followed and considered as part of this specification. The Dry film thickness (DFT) of primer/paint shall be as specified herein.		
1.06.02	Surfaces prepared as per the surface preparation scheme indicated herein shall be applied with primer paint within 6 hours after preparation of surfaces.		
1.06.03	Where primer coat has been applied in the shop, the primer coat shall be carefully examined, cleaned and spot primed with one coat of the primer before applying intermediate and finish coats. When the primer coat has not been applied in the shop, primer coat shall be applied by brushing, rolling or spraying on the same day		
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b>	<b>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO. CS-9585-001-2</b>	<b>SUB-SECTION - A-12 SURFACE PREPARATION &amp; PAINTING</b>	<b>Page 1 of 9</b>

CLAUSE NO.	 <b>TECHNICAL REQUIREMENTS</b>		
<p><b>1.06.04</b></p> <p><b>1.06.05</b></p> <p><b>1.06.06</b></p> <p><b>1.06.07</b></p> <p><b>1.06.08</b></p> <p><b>1.06.09</b></p>	<p>as the surface is prepared. Primer coat shall be applied prior to intermediate and finish coats.</p> <p>Steel surfaces that will be concealed by building walls shall be primed and finish painted before the floor is erected. Tops of structural steel members that will be covered by grating shall be primed and finish painted before the grating is permanently secured.</p> <p>Following are the Primer/painting schemes envisaged herein:</p> <p>PS3 - Zinc Chrome Primer (Alkyd base) by brush/Spray to IS104.</p> <p>PS3* - Zinc Chrome primer (Alkyd base) by dip coat.</p> <p>PS4 - Synthetic Enamel (long oil alkyd) to IS2932.</p> <p>PS5 - Red Oxide Zinc Phosphate primer (Alkyd base) to IS 12744</p> <p>PS9 - Aluminium paint to IS 2339.</p> <p>PS9* - Heat resistant Aluminium paint to IS-13183 Gr.-1</p> <p>PS13 - Rust preventive fluid by spray, dip or brush.</p> <p>PS14 - weldable primer-Deoxaluminat or equivalent.</p> <p>PS16 - High Build Epoxy CDC mastic `15` .</p> <p>PS17 - Aliphatic Acrylic Polyurethane CDE134 ,%V=40.0(min.)</p> <p>PS18 - Epoxy based TiO2 pigmented coat</p> <p>PS19 - Epoxy Zinc rich primer (92% zinc in dry film (min.), %VS=40.0(min.)</p> <p>PS-20 - Epoxy based finish paint</p> <p>All weld edge preparation for site welding shall be applied with one coat of weldable primer.</p> <p>For internal protection of pipes/tubes, VCI pellets shall be used at both ends after sponge testing and ends capped. VCI pellets shall not be used for SS components and composite assemblies.</p> <p>SG membrane walls and other Flue gas swept pressure part surfaces shall be applied with appropriate primer for protection of surfaces during transit, storage and erection.</p> <p>a) All un-insulated equipments, pipes, valves etc covered in sub-section A-08 (Steam Turbine &amp; Auxiliary system) shall be painted with paint not inferior to Epoxy resin based paints with minimum DFT of 150 micron. The paint shall be applied in three stages i.e. primer, intermediate and finish coats in following manner:</p> <ul style="list-style-type: none"> <li>▪ Primer coat – Epoxy based zinc phosphate</li> <li>▪ Intermediate - Epoxy based TiO2 pigmented coat</li> <li>▪ Finish coat - Epoxy based finish coat</li> </ul> <p>b) Equipment, pipes etc. with high temperature shall be painted with heat resistant aluminum paint (to be selected based on the service condition of component as per IS-13183). Two coats of paint shall be applied with total DFT 40 micron.</p> <p>c) Surface preparation before painting shall be carried out according to requirement indicated in this sub-section and international standard</p>		
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO. CS-9585-001-2</b></p>	<p align="center"><b>SUB-SECTION - A-12 SURFACE PREPARATION &amp; PAINTING</b></p>	<p align="center">Page 2 of 9</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.06.10	<p>A) Specification for the application of Epoxy coating for internal protection of DM tank &amp; other vessels/tanks (as applicable) shall be as follows:</p> <p>Primer : One coat of unmodified epoxy resin along with polyimide hardener.</p> <p>Paint : Two (2) coats unmodified epoxy resin along with Aromatic adduct hardener.</p> <p>Total thickness of primer and paint should not be less than 400 microns.</p> <p>B) Specification for application of chlorinated Rubber paint for external protection vessel, tanks, piping, valves &amp; other equipments shall be as follows:</p> <p>i) For Indoor vessel, tanks, piping, valves &amp; other equipments:</p> <p>(a) Surface preparation shall be done either manually or by any other approved method.</p> <p>(b) Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns.</p> <p>(c) Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns.</p> <p>(d) Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns.</p> <p>Total DFT of paint system shall not be less than 150 microns.</p> <p>ii) For Outdoor vessel, tanks, piping, valves &amp; other equipments:</p> <p>(a) Surface preparation shall be blast cleared using non-siliceous abrasive after usual wire brushing, which shall conform to Sa 2-1/2 Swiss Standard.</p> <p>(b) Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.</p> <p>(c) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.</p> <p>(d) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.</p> <p>The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied.</p> <p>Total DFT shall not be less than 300 microns.</p>			
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b>	<b>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO. CS-9585-001-2</b>	<b>SUB-SECTION - A-12 SURFACE PREPARATION &amp; PAINTING</b>	<b>Page 3 of 9</b>	




- ii) Painting specification for inside surfaces (such as inner surfaces of ducts/ tanks/ mills/ dampers/ ESP etc.) that are not covered specifically in above clauses, shall be provided with 2 coats of suitable primer i.e. PS5/ PS9 (Total DFT 60/40 micron) based on the temperature.

#### F) FGD System

- (i) Surface preparation shall be blast cleaned conforming to Sa 2-1/2 Swiss Standard.
- (ii) Primer coat shall consist of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns.
- (iii) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns.
- (iv) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 75 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided.

EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	BID DOC. NO. CS-9585-001-2	TECHNICAL SPECIFICATIONS SECTION VI, PART-B	TECHNICAL REQUIREMENTS	SUB-SECTION -A-12 Surface Preparation & Painting	Page 9 of 9
--	----------------------------	--	---------------------------	---	-------------

 <b>RANIPET</b>	<b> Bharat Heavy Electricals Limited  Boiler Auxiliaries Plant  Ranipet – 632 406</b>		BHEL DOC NO.	PS : PATR :FGD: R4R3-R4S4
			REVISION NO.	07
			DATE	25.11.2019



## PATRATU STPP FGD PACKAGE

**PAINTING SCHEME for FGD SYSTEM, GATES& DAMPERS**

**NTPC CONTRACT NO: 01/PVUNL-CS-9585-001-2/N0A-SC**

**NTPC DRG NO: 9585-001-109-PVM-H-001**

**BHEL RANIPET Customer No(s): R4R3, R4S3-R4S4**

Prepared By	Reviewed & Approved By
 <b>Rajamanickam M</b> Dy. Mgr/QA	 <b>K.C. (Narayana Krishna)</b> Certification signature by Digital Signature <nirajkrishna@npc.co.in> by Niraj/KRISHNA Date: 2019.12.04 Time: 16:40:05 IST Reason: CAT I Location: NTPCEOC

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

### RECORD OF REVISION

REV NO	DATE	DETAILS OF REVISION
00	25.08.2018	Original Issue - First Submission Revised Issue <b>NTPC comments:</b> This document can be reviewed in totality after receipt of inputs on FGD system. Any equipment detail and any missing equipment can be reviewed only after receiving of basic drawings of FGD system <b>BHEL reply:</b> We wish to submit that the painting scheme was prepared after taking all the inputs from Engg in the form of PGMA release. Hence there will not be any equipment missed. Also Engg has confirmed that it has started the submission of basic documents. <b>NTPC comments:</b> SI no: 09 of FGD, what all items are covered under emergency quench system? Kindly mention here <b>BHEL reply:</b> Items covered under the emergency quench system are mentioned in the PGMA details at the end of the document. <b>NTPC comments:</b> SI no: 10 of FGD, kindly include details of items covered under air oxidation system <b>BHEL reply:</b> Items covered under air oxidation system are mentioned in the PGMA details at the end of the document. <b>NTPC comments:</b> SI no: 11 of FGD, kindly include details of items covered under oxidation air distribution system <b>BHEL reply:</b> Items covered under the oxidation air distribution system are mentioned in the PGMA details at the end of the document.
01	06.12.2018	<b>NTPC comments:</b> SI no: 12 of FGD, Description not clear. Kindly give detail & Indicate temperature & Primer paint <b>BHEL reply:</b> Expansion joint comes in the bypass ducts. It is of straight pieces without any round corner joints. It is of metallic in construction. The items covered in the PGMA are mentioned in the PGMA details at the end of the document. Temperature and primer paint is changed as per comments and finish paint is incorporated. <b>NTPC comments:</b> SI no: 13 of FGD, Description not clear. Kindly give detail& indicate temperature & primer paint <b>BHEL reply:</b> Expansion joints between scrubbers comes in the absorber region. It is of non-metallic in construction. The reason for giving painting is that items like flanges and sleeves are envisaged in this PGMA, hence painting is given. Temperature is indicated in the document. Primer paint is changed as per comments and finish paint incorporated. <b>NTPC comments:</b> SI no: 14&15 of FGD, Indicate temperature ad primer and finish paints <b>BHEL reply:</b> Temperature, Primer and finish paints are incorporated in the document. <b>NTPC comments:</b> SI no: 16, 17, 19, 23, 29,30,34, 37 of FGD, comments on paints <b>BHEL reply:</b> Comments on paints are incorporated in all the above sl nos. Also since as per spec for civil works, finish coat of 70 microns only specified, hence finish DFT of 70µ and Total DFT of 245µ is indicated. <b>NTPC comments:</b> SI no: 21, 27, 32 of FGD, Furnish details <b>BHEL reply:</b> Details of all PGMA's are mentioned at the end of the document.

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
02	11.01.2019							
			<p><b>NTPC comments:</b> SI no: 4&amp; 5 Give details surface finish and primer on inside surfaces</p> <p><b>BHEL reply:</b> Incorporated in the document.</p> <p><b>NTPC comments:</b> PHC, SHC &amp; Vacuum Belt Filter related items to be covered.</p> <p><b>BHEL reply:</b> Incorporated in the document.</p> <p><b>NTPC comments:</b> Blower with motor, is it seal air fan, kindly give basis for painting of this item; Motor paint will be RAL 5012.</p> <p><b>BHEL reply:</b> It is seal air fan as it supplies seal air. Motor paint shade will be RAL 5012 only which will be indicated by the electrical group in the drawing. The basis for selecting the paint is as per Sub- Section A-12, B) Steam generator and Auxiliaries and Clause 20.03.00 of Part- C Section VI. Since it is under auxiliaries, we have chosen this painting. Also the surfaces are less than 95°C. Hence we request you to retain the same painting specification.</p> <p><b>NTPC comments:</b> Furnish paint details of major electrical equipment like motors, Transformers, bus duct, MCC &amp; control panels, cable trays etc</p> <p><b>BHEL reply:</b> Electrical items are bought out items and therefore the painting specification will be given by respective Engg group as per the tender specification in the drawing itself which will submitted to NTPC for approval. Therefore, the painting of electrical items is not covered under this painting scheme. This is the practice which is being followed for Auxiliaries as well. Also we would like to state that same comment was given for Dadri FGD painting scheme and the above reply was also accepted by M/s NTPC. We request you to kindly accept our explanation and accord approval.</p> <p><b>NTPC comments:</b> Please include the surface coating and painting details for individual equipment of LHP/GHP</p> <p><b>BHEL reply:</b> We would like to state that scope of LHP, Limestone handling plant and GHP, Gypsum handling plant lies with BHEL, ISG, Bangalore. They will be submitting the separate painting scheme for the LHP and GHP. Also we would like to inform that all items pertaining to Ranipet scope of supply has been included in this painting scheme. We request you to kindly approve the painting scheme.</p> <p><b>NTPC comments:</b> The same has to be ensured and taken care in the respective equipment drgs.</p> <p><b>BHEL reply:</b> BHEL will ensure the same in the respective equipment drawings.</p> <p><b>NTPC comments:</b> SI no: 5&amp; 7 of FGD, Inorganic ethyl zinc silicate primer to be applied as per spec requirement as proposed for all other items.</p> <p><b>BHEL reply:</b> Incorporated in the document.</p> <p><b>NTPC comments:</b> SI no: 24 of FGD, Other Items—Blast cleaning</p> <p><b>BHEL reply:</b> Incorporated in the document.</p> <p><b>NTPC comments:</b> Please clarify whether SS lining is all around the cylindrical and conical portion of silo?</p> <p>The inside painting of silo where SS lining is not provided shall be as per structural steel painting scheme</p> <p><b>BHEL reply:</b> SS lining is all around the conical portion of silo. For cylindrical portion- inside painting, primer as given for structural steel painting scheme is incorporated in the document.</p> <p><b>NTPC comments:</b> SI no: 39 to 41, Painting scheme to be followed as per (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9) in line with other FGD components. Details of related items to be included in the list.</p> <p><b>BHEL reply:</b> Incorporated in the document.</p>					
03	30.01.2019							

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)	
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)		
03	30.01.2019			<p><b>NTPC comments:</b> SI no: 03 of Painting scheme to be followed as per (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9) in line with other FGD components, Motor paint RAL 5012</p> <p><b>BHEL reply:</b> We wish to state that the referred item is coming under gates and dampers which is part of auxiliaries and therefore painting under Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6 of 9 is considered. Also these components are sub-items to the main component. Hence we request you to accept the painting as mentioned under above spec.</p> <p><b>NTPC comments:</b> Note 11 to be incorporated</p> <p><b>BHEL reply:</b> Note incorporated in the document.</p> <p><b>NTPC comments:</b> Inside surface painting on silo (cylindrical portion) shall be as per outside surface painting scheme of Limestone silo</p> <p><b>BHEL reply:</b> We wish to state that the painting envisaged is until erection only. Once the system is commissioned, paint will peel off completely and application of intermediate and finish paints will become redundant, therefore we have proposed only primer. Also primer given is of Inorganic Zinc silicate which offers superior protection against corrosion, abrasion and chemical resistance. Hence we request you to kindly consider and approve the painting envisaged.</p> <p><b>NTPC comments:</b> Blast cleaning to be done. Is there any liner provided on mill inside surface? Inorganic ethyl zinc silicate primer to be applied as per spec requirement as proposed for all other items.</p> <p><b>BHEL reply:</b> Blast cleaning is incorporated in the document. We wish to state that rubber liner is provided on the mill inside surface as per the specification. Primer paint of Epoxy zinc phosphate primer is envisaged as per the spec requirement vide clause <b>Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9</b>. We request you to kindly accept our proposed painting and approve our document.</p> <p><b>NTPC comments:</b> As commented earlier, all painting coats on inside surface of silo (cylindrical portion) shall be same as per outside surface painting scheme of Limestone silo.</p> <p><b>BHEL reply:</b> Based on NTPC directive, we have incorporated in the document. Kindly approve the document.</p> <p><b>Revised Issue-</b> New PGMA added under FGD system and Engg has deleted some PGMA too as they have been amalgamated, hence addition &amp; deletion of new PGMA done under SI nos: 2,3,5,7,11,13,15,20, 21,22, 23, 24, 28,29, 30, 34, 35, 36, 37, 38, 40, 41, 42, 46, 47&amp; 48 under FGD and resubmitted for your kind approval. There is no change in the painting scheme, only the PGMA are added/deleted under the above mentioned SI nos. We request you to kindly review and approve our painting scheme.</p> <p><b>NTPC comments:</b> SI no: 18 of FGD, earlier painting scheme as per S.N. 17 (PGMA 257) is different.</p> <p><b>BHEL reply:</b> We wish to submit that the painting for PGMA 257 is same only. The commented SI no is SI no: 18 which is of duct structures hence painting as per Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03 is given.</p> <p><b>NTPC comments:</b> Miscellaneous FGD system removed in this revision? Limestone silo accessories missing in this revision.</p> <p><b>BHEL reply:</b> We wish to submit that our Engg has removed this PGMA as they have added the items under new PGMA for which painting is given in SI no: 30 of this painting scheme. (FW 725 is Nozzles and Flanges which are Miscellaneous FGD items and FW 723&amp; 724 are limestone silo accessories). We also wish to add that there is no change in the painting specification. Since many of the PGMA are added and some are deleted, we have gone for this resubmission of the painting scheme. We request you to kindly approve the painting scheme.</p>					
04	18.02.2019								
05	05.03.2019								
06	25.10.2019								
07	25.11.2019								

748358/2022/PS-PFM-MAX

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

**NTPC comments:** PHC & SHC and accessories structural items missing in this revision.

**BHEL reply:** Our Engg has amalgamated these PGMAs with FW 738 PGMA (Gypsum Belt filter and accessories). Hence those PGMAs are removed from the painting scheme. We wish to add that there is no change in the painting specification and same painting specification is only retained. We request you to kindly approve the painting scheme.

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
1	Slurry recirculation pump System (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 212	Blast Cleaning to SA 2 1/2 (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Light Blue, RAL 5012	75	300
2	Absorber System Internals – Structural items (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 213	Blast cleaning to Sa 2 1/2	<b>Primer:</b> Two coats of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 50µ/coat  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL9002	75	300
3	Mist eliminator and accessories, Absorber baffle grating support, Mist eliminator support & Absorber Spray pipe support - Structural items (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 215 FW 216 FW 217 FW 218	Blast cleaning to Sa 2 1/2	<b>Primer:</b> Two coats of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 50µ/coat  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL9002	75	300

## 1. FGD SYSTEM

748358/2022/PS-PEM-MAX

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
4	Absorber System- Base (Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)	FW 219	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<p><b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00</p> <p><b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min..30% on pigment) DFT = 100 µm per coat (min)</p>	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min..1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
5	Absorber system structures, Absorber shear plate, Hook up duct structure (Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)	FW 220 FW 231 FW 238	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<p><b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00</p> <p><b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min..30% on pigment) DFT = 100 µm per coat (min)</p>	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min..1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
6	Absorber system casing bottom (Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)  Inside surfaces of Absorber casing top& bottom is lined with C-276 material, hence no paint is envisaged.	FW 221	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
7	Absorber system casing top, Duct supports & Structures for RC pump house (Tec. Spec. Sec.VI, Part-B, Subsection- D-01, cl. 6.04.03)	FW 222 FW 232 FW 234 FW 236	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
8	Absorber system accessories (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 223	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ	75	300
					100		25	

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
9	Emergency Quench water tank- Outside surfaces <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)</b>	FW 226	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	intermediate paint pigmented with MIO/Tio2 DFT- 100µ		<b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002		
				<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
10	Emergency Quench water tank- Inside surfaces	FW 226	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm	<b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	100	<b>Primer Coat:</b> Two coats of Red Oxide Zinc phosphate primer, (Primer is only envisaged as lining is given in inside surfaces of the tank) DFT = 30 µm per coat; Total DFT- 60µ		

748358/2022/PS-PEM-MAX

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
11	Emergency quench system Handling Equipment RC pump (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 227 FW 249	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002	75  25	300
12	Air oxidation system (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 230	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002	75  25	300
13	Oxidation Air distribution system & Slurry distribution system, Absorber W/D interface and W/D wash system (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 228 FW 229 FW 243 FW 244	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Sky blue, Shade no.101 of IS:5	75  25	300
14	Expansion joint between bypass	FW 251	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (two coats)	60	NIL	--	60

748358/2022/PS-PEM-MAX

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
15	(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6, 9 of 9) Temp>60°C		Power Tool Cleaning to St3 (SSPC-SP3)	HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	20	HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	20	40
	Expansion joint between scrubbers	FW 252	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	60	NIL	--	60
16	(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6, 9 of 9) Temp>60°C		Power Tool Cleaning to St3 (SSPC-SP3)	HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	20	HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	20	40
	Ducts between bypass duct inlet& Absorber (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6, 9 of 9) Temp-150°C	FW 255	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	60	NIL	--	60
16	(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6, 9 of 9) Temp-150°C		Flue gas swept surface (Inside)	HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	20	HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	20	40
			Insulated surfaces					

748358/2022/PS-PEM-MAX

SI No	SURFACE LOCATION		PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
					PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
17	Ducts between Absorber & Stack (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6, 9 of 9) Temp-60°C	Flue gas swept surface (Inside) Insulated surfaces	FW 257	Power Tool Cleaning to St3 (SSPC-SP3)  Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)  HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	60  20	NIL  HR Aluminium paint to IS 13183 Gr.I (upto 600 deg C)	--  20	60  40
18	Duct structure between by pass duct & Absorber (Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	FW 260		<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment) DFT = 100 µm per coat (min)	75  100	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70  245	

748358/2022/PS-PEM-MAX

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
19	Duct structure between Absorber & Stack <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)</b>	FW 262	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<p><b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00</p> <p><b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min..30% on pigment) DFT = 100 µm per coat (min)</p>	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min..1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
20	Foundation material for duct structures, Absorber, RC shed,tanks, pipe racks& Silo Structure	FW 280 FW 281 FW 282 FW 283 FW 740 FW 760 FW 762 FW 763	Temporary rust preventive fluid application as per PRQA 523 DFT- 20µ	All Threaded and other surfaces of foundation bolt and its materials shall be coated with temporary rust preventive fluid. During execution of civil works the dried film of coating will be removed using Organic Solvents.				
21	Structures for Elevator& Supporting structures for Emergency Quench Water Tank <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)</b>	FW 285 FW 292	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min..1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
22	Elevator and accessories <b>(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)</b>	FW 293 FW 716	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey white, Shade no. RAL 9002	75	300

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
23	Galleries and railings for Stairs, Absorber, Dampers, Ducts, Tanks <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.08, 6.04.09)</b>	FW 237 FW 610 FW 612 FW 613 FW 722	Gratings- Blast cleaning to Sa 2½	Hand rails, Gratings- Hot dip galvanizing to 610gms/sq.m (minimum) and to a coating thickness of 87µm (minimum)				
24	Galleries and railings for Stairs, Absorber, Dampers, Ducts, Tanks – Structures other than the above <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)</b>	FW 237 FW 610 FW 612 FW 613 FW 722	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	75	70	245
25	Slurry pumps & accessories <b>(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)</b>	FW 701	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ	100	75	300

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
26	Water pumps & accessories (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 702	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	intermediate paint pigmented with MIO/Tio2 DFT- 100µ  <b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/Tio2 DFT- 100µ	100	Shade: Light Blue, RAL 5012  <b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Light Blue, RAL 5012	75	300
27	Monorail for hoist & cranes (Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)	FW 710	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0AE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
28	Handling Equipment in FGD (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 713 FW 714	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/Tio2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002	75	300

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
29	Man hole door & Viewing ports (Tec. Spec VI, Part B, Subsection A-12 Page 6 of 9)	FW 239 FW 717	Power Tool Cleaning to st3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	60	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)	40	100
30	Agitator support, Air cannon silo, Bag filter and fan assy silo and Nozzles and Flanges (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)	FW 721 FW 723 FW 724 FW 725	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/TiO2 DFT- 100µ	100  100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002	75  25	300
31	Limestone silo structures (Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)	FW 730	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	75  100	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
32	Limestone Silo- Outside surfaces (Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)	FW 731	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<p><b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00</p> <p><b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)</p>	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
33	Lime stone Silo- Inside surfaces (Conical portion)	FW 731	Blast cleaning to Sa 2½ (Near white metal) with surface profile 35-50µm conforming to ISO 8501-1	<p><b>Primer:</b> Two coats of Red Oxide Zinc phosphate primer to IS: 12744 (SS lining is inside the Limestone silo conical portion, hence primer is only envisaged; SS lining will be done at shops itself)</p>	60	NIL	--	60
34	Lime stone Silo- Inside surfaces (Cylindrical portion)	FW 731	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<p><b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00</p> <p><b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)</p>	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
35	Limestone silo approach platform, Platform for Pipe racks <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.08, 6.04.09)</b>	FW 733 FW 766 FW 767	Gratings- Blast cleaning to Sa 2½;	Hand rails, Ladders, Gratings- Hot dip galvanizing to 610gms/sq. m (minimum) and to a coating thickness of 87µm (minimum)				
36	Limestone silo approach platform, Pipe racks platform- Structures other than the above <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)</b>	FW 733 FW 766 FW 767	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<p><b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00</p> <p><b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)</p>	<p>Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)</p> <p>DFT = 35 µm per coat, Shade: Grey white RAL9002</p>	75	70	245
37	Limestone Mill – Outside surfaces <b>(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)</b>	FW 735	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<p><b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ</p> <p><b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/Tio2 DFT- 100µ</p>	<p><b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 75µ</p> <p><b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002</p>	100	75	300
38	Lime stone mill- Inside surfaces	FW 735	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<p><b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ</p>	<p><b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ</p>	100	--	100

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
39	Gypsum belt filter and accessories Structural items <b>(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)</b>	FW 738	Blast Cleaning to SA 2 1/2 (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/Tio2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002	75	300
40	Lime stone slurry storage tank, Auxiliary absorber tank, Filtrate tank, Wastage water tank, Hydro cyclone waste water tank, Neutralization tank, Process Water tank, Belt filter washing tank, Primary Hydro-cyclone feed tank Outside surfaces <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)</b>	FW 742 FW 743 FW 744 FW 745 FW 747 FW 748 FW 785 FW 786 FW 802	Blast cleaning to Sa 2 1/2 (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
41	Lime stone slurry storage tank, Auxiliary absorber tank, Filtrate tank, Wastage water tank, Hydro cyclone waste water tank, Neutralization tank, Process Water tank, Belt filter washing tank, Primary Hydro-cyclone feed tank Inside surfaces	FW 742 FW 743 FW 744 FW 745 FW 747 FW 748 FW 749 FW 785 FW 786 FW 802	Blast cleaning to Sa 2 1/2 (Near white metal) with surface profile 35-50µm	<b>Primer:</b> Two coats of Red Oxide Zinc phosphate primer to IS: 12744 (Lining is inside the tanks, hence primer is only envisaged for protection till erection)	60	NIL	--	60

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
42	Process water pipe accessories, Cooling water pipe accessories (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 7 of 9)	FW 751 FW 752	Power Tool Cleaning to Sf3 (SSPC-SP3)	<b>Primer:</b> Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)  <b>Intermediate:</b> One coat of Synthetic Enamel undercoat to IS: 2932	50  30	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)- DFT- 35µ/ coat Identification Tag: Sea Green Shade no: 217 as per IS 5	70	150
43	Slurry pipe accessories (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 7 of 9)	FW 753	Power Tool Cleaning to Sf3 (SSPC-SP3)	<b>Primer:</b> Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)  <b>Intermediate:</b> One coat of Synthetic Enamel undercoat to IS: 2932	50  30	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)- DFT- 35µ/ coat Identification Tag: Sea Green Shade no: 217 as per IS 5	70	150
44	Service Air pipe accessories (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 7 of 9)	FW 754	Power Tool Cleaning to Sf3 (SSPC-SP3)	<b>Primer:</b> Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)  <b>Intermediate:</b> One coat of Synthetic Enamel undercoat to IS: 2932	50  30	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)- DFT- 35µ/ coat Identification Tag: Sky blue Shade no: 101 as per IS 5	70	150
45	Instrument air pipe accessories (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 7 of 9)	FW 755	Power Tool Cleaning to Sf3 (SSPC-SP3)	<b>Primer:</b> Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)  <b>Intermediate:</b> One coat of Synthetic Enamel undercoat to IS: 2932	50  30	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)- DFT- 35µ/ coat Identification Tag: Sky blue Shade no: 101 as per IS 5	70	150
46	All Valves and fittings (Temp <95 deg C) (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 7 of 9)	FW 815 to FW 851	Power Tool Cleaning to Sf3 (SSPC-SP3)	<b>Primer:</b> Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)  <b>Intermediate:</b> One coat of Synthetic Enamel undercoat to IS: 2932	50  30	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)- DFT- 35µ/ coat	70	150

748358/2022/PS-PEM-MAX

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
47	Structure for Pipe racks & Trestle for pipe racks & Structures inside Gypsum dewatering building and Ball mill building <b>(Tec. Spec. Sec.- VI, Part-B, Sub section D-01, cl. 6.04.03)</b>	FW 761 FW 765 FW 768 FW 769 FW 787	Blast cleaning to Sa 2½ (Near white metal) with surface profile 40-60µm conforming to ISO 8501-1	<b>Primer Coat:</b> One coat of two component moisture curing Inorganic Ethyl Zinc Silicate Primer to IS 14946, (Solid by volume- 60% (min)), (Metallic zinc content 80% (min)) DFT = 75 µm per coat (min.) Zinc dust composition shall be Type-II as per ASTM D520-00  <b>Intermediate Coat:</b> One coat of two component polyamide cured Epoxy based MIO pigmented Intermediate coat (solid by volume- 80% (min), containing lamellar MIO min.30% on pigment)) DFT = 100 µm per coat (min)	75	Two coats of Two Pack Aliphatic Isocyanate cured acrylic finish Paint to IS 13213 (solid by volume- 55% (min) with gloss retention (SSPC paint spec no.36, ASTM D4587, D2244, D523 of level 2 after min.1000 hours of exposure. Gloss loss less than 30 and color change less than 2.0ΔE)  DFT = 35 µm per coat, Shade: Grey white RAL9002	70	245
48	Supports for Cable trays, Tools, Air receivers, commissioning spares <b>(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 9 of 9)</b>	FW 779 FW 798 FW 988 FW 996 FW 997	Blast Cleaning to SA 2 ½ (Near white metal) with surface profile 40 – 60 µm	<b>Primer:</b> One coat of Epoxy resin based Epoxy Zinc phosphate primer to IS 13238 DFT- 100µ  <b>Intermediate:</b> One coat of Two component epoxy based intermediate paint pigmented with MIO/Tio2 DFT- 100µ	100	<b>Finish:</b> One coat of Epoxy based finish paint to IS 14209; DFT- 75µ  <b>Finish:</b> One coat of acrylic aliphatic polyurethane paint to IS 13213 DFT-25µ Shade: Grey White, RAL 9002	75	300

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
01	<b>Gates &amp; Dampers</b> > 95° C Insulated Surfaces & Uninsulated surfaces (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6 of 9)	57 560 57 570 57 580 57 583	Power Tool Cleaning to St3 (SSPC-SP3)	One coat of HR Aluminium paint to IS 13183 Gr. I	20	One coat of HR Aluminium paint to IS 13183 Gr. I	20	40
02	<b>Seal air piping</b> (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 7 of 9)	57 141	Power Tool Cleaning to St3 (SSPC-SP3)	<b>Primer:</b> Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)  <b>Intermediate:</b> One coat of Synthetic Enamel undercoat to IS: 2932	50  30	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)- DFT- 35µ/ coat Identification Tag: Sky blue Shade no: 101 as per IS 5	70	150
03	<b>Blower with Motor Knife Gate valve</b> (Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6 of 9) & (Clause 20.03.00 of Part- C Section VI)	57 491 57 497	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	60	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)  Motor paint Shade: RAL 5012	40	100
04	Ladder, Cage for Ladder Toe Guard Plate Floor Grill, Hand Rails, Hand Rail Post (Tec. Spec. Sec.- VI, Part-B, Sub section D- 01, cl. 6.04.08, 6.04.09)	57 466	Gratings- Blast cleaning to Sa 2½	Hot Dip Galvanizing to 610 gm per sq. Meter (minimum) and to a coating thickness of 87 µm (minimum)				
05	Other Structural Items- Other than sl.no. 4 of above & Mounting bracket	57 209 57 466	Power Tool Cleaning to St3 (SSPC-SP3)	Red Oxide Zinc Phosphate Primer to IS: 12744 (Two coats)	60	Synthetic Enamel to IS 2932 Shade: Grey white RAL 9002 (Two coats)	40	100

**2-GATES & DAMPERS**

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
	(Tec. Spec. Sec.- VI, Part-B, Sub section A-12 Page 6 of 9)							

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

### 3. PAINTING OF DAMAGED AREAS

*Areas where paint has deteriorated badly by erosion and areas where the paint film has lost its adhesion property and where the steel has got rusted appreciably - these areas are to be repainted as per the following procedure:*

SL NO	SURFACE LOCATION	SURFACE PREPARATION	PRIMER, INTERMEDIATE & FINISH
1	Paint damaged Components falling under FGD SI no.01,02,03,04,05,06, 07,08,09,11,12,13,18 19,21,22,24,25,26,27,28,30,31,32,34,36, 37,39,40,47& 48 of FGD.	Hand/ Power Tool cleaning to Bare metal to minimum 6 inches peripheral area adjoining to damaged area	Primer: Epoxy Zinc rich primer to IS 14589, DFT-70µ (If Metal surface exposed) followed by intermediate & finish coat as per respective scheme If primer is intact- Intermediate & finish as per respective scheme
2	Paint damaged components failing under other SI nos of FGD & Gates & Dampers	Power Tool Cleaning to Bare metal	Primer and Finish : As given in respective scheme

#### GENERAL NOTES

- No painting is required for Galvanized, non-ferrous & stainless steel items, except as indicated above.
- Machined items are to be applied with coat of temporary rust preventive oil
- PGMAs covered in sub-supplier (ie., Purchased) items viz., Agitator and other sub-delivery components etc., are not indicated in the above list. However, the Painting Schedule for all items supplied by all sub-suppliers and BOI under the scope of BHEL shall be same as for main equipment covered in this document.
- In sub-assy, wherever plates / sheets of thickness less than or equal to 5mm and rods are used - Power Tool or Hand Tool Cleaning to SSPC - SP 3 / SP 2 shall be followed and painting shall be as per SI no:05 of GAD.
- Ground shade/colour of finish paints and identification tag/band for equipments, fans, piping, pipe services, supporting structures and other components is followed as per NTPC doc no: QS-01-DIV-W-4 at site.
- All components covered under different PGMAs are to be painted. In case any component is left out, the same shall deemed to be included under the relevant section.
- All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, Sleeves shall be coated with temporary rust preventive fluid and during execution of civil works; the dried film of coating shall be removed using organic solvents.
- Painting requirement for all electrical equipment shall be as per the details identified in specification for the respective equipment.
- All steel structures shall be provided with painting as given in the specification. Further, painting system shall also meet the requirements of corrosivity category C3 (durability high) as per ISO 12944.
- Finish coat to be applied after an interval of min 10 hrs and within 6 months (after completion of intermediate coat).
- Bottom of base plate including below zero level portion marked in Supporting Columns of structures which will be embedded in concrete, those surfaces shall be prepared by manual cleaning to ST3 and provided with primer coat of chlorinated rubber based zinc phosphate primer of min. 50 µm DFT.

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

**PAINTING SCHEME- DETAILS OF PROCUREMENT & APPLICATION PROCESSES**

SL NO	TYPE OF PAINT	SPECIFICATION OF PAINT	NO OF PACK	VOLUME OF SOLIDS (% Min)	MODE OF APPLICATION	MIN. OVER COATING INTERVAL (hours)	SHADE
01	Epoxy Zinc phosphate primer	IS 13238	2	40	Spray	24	Grey
02	Zinc Ethyl silicate primer (% Zn on dry film= 80 (min))	IS 14946	2	60	Airless Spray only	24	Grey
03	Epoxy High solid-Polyamide cured Epoxy based MIO pigmented <b>intermediate coat</b>	--	2	80	Airless Spray only	16	Brown
04	Epoxy based finish paint	IS 14209	2	62	Airless Spray only	16	Corresponding shade no
05	Aliphatic isocyanate acrylic polyurethane paint	IS 13213	2	55	Spray	16	Corresponding shade no
06	Heat resistant aluminium paint	IS 13183 Grade II	1	--	Brush/ Spray	24	--
07	Synthetic Enamel undercoat	IS 2932	1	40	Brush/ Spray	12	--
08	Long oil alkyl Synthetic enamel finish paint	IS 2932	1	35	Brush/ Spray	12	Corresponding shade no
09	Red oxide Zinc phosphate primer	IS 12744	1	--	Brush/ spray	12	--

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	

## PGMA DETAILS

SNO	PGMA	PGMA DESCRIPTION	PGMA DETAILS
01	FW 212	Slurry recirculation pump system	RC Pumps incl Shaft seal Common Base Plate Coupling and Guard Gear Box Expansion Bellow Anchor Bolts & Fasteners Special Tools
02	FW 219	Absorber system base	Absorber tank bottom plate
03	FW 220	Absorber system structures	Absorber tank structure Absorber tower structure Spray headers structure
04	FW 221	Absorber system casing bottom	Absorber tank wall casing- bottom
05	FW 222	Absorber system casing top	Absorber Tank wall casing –Top Mist Eliminator supports Spray pipe supports Internal Beam Shim plates in Absorber area Internal Struts
06	FW 223	Absorber system accessories	Nozzles and flanges Inspection doors & Man holes Viewing ports Antifoam dosing equipment Suction strainers- FRP
07	FW 226	Emergency Quench water tank	Base Plate & its supports Roof, Shell
08	FW 227	Emergency Quench System	Emergency Quenching Spray Pipe Nozzle for Emergency Pipe Fasteners Gaskets
09	FW 230	Air oxidation System	Oxidation Blowers Common Base Plate Coupling and Guard Anchor Bolts & Fasteners Expansion Bellow Suction & Discharge Silencers Acoustic Enclosure Water Injection cooling system

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	


Pipe, Valves & Instruments  
Special Tools


SNO	PGMA	PGMA DESCRIPTION	PGMA DETAILS
10	FW 244	Oxidation air distribution System	Pipe & Fittings Flanges
11	FW 251	Expansion joint between bypass	Pipe Hanger, Bottom Elbow, Bottom sliding supports Expansion joints Seal Plates & Fasteners
12	FW 252	Expansion joint between scrubbers	Fabric & its fixing fasteners Sleeves & Flanges Gaskets
13	FW 255	Ducts between bypass duct inlet & booster fan	Plates & Stiffeners Guide Vanes
14	FW 256	Ducts between Booster fan & Absorber	Plates & Stiffeners Guide Vanes
15	FW 257	Ducts between Absorber & stack	Plates & Stiffeners Guide Vanes
16	FW 260	Duct structure between bypass duct & Booster fan	Duct Supports Gusset Plate Divider plate Internal Struts Support bearings
17	FW 261 FW 262	Duct structure between booster fan & absorber & Absorber and Stack	Duct Supports Gusset Plate Divider plate Internal Struts Support bearings
18	FW 292	Structures for Elevator	Columns Seal Plate Bracings Enclosure (Purlin & sheeting)
19	FW 293	Elevator and accessories	Base Frame Buffer Spring Mast Section Cage Control Panel & AC Mandatory Spares

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
				<b>PGMA DETAILS</b>				
20	PGMA FW 310	Structures for booster fan handling	Columns Beams Bracings Seal plate					
21	FW 610 FW 722	Galleries & railings for Scrubbers, Tank	Stairs Handrail Step treads Floor grills Ladders Foundation bolts Fasteners					
22	FW 701	Slurry pumps & accessories	Slurry Pumps incl Shaft seal Common Base Plate Coupling and Guard Belt & Pulley Expansion Bellow Anchor Bolts & Fasteners Motor & accessories Sump Pumps incl Shaft seal Common Base Plate Coupling and Guard Belt & Pulley Anchor Bolts & Fasteners Motor & accessories					
23	FW 710	Monorail for hoist& cranes	Insert Plate Stiffener plate Monorail beam					
24	FW 721	Agitator support	Channels & Beams					
25	FW 730	Limestone silo structures	Columns Beams Bracings Seal plate Angles, channels					

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
			<b>PGMA DESCRIPTION</b>	<b>PGMA DETAILS</b>				
26	FW 731		Limestone silo	Base plate & its supports Shell, Roof				
27	FW 723 FW 724 FW 725		Air cannon Bag filter Nozzles & flanges	Bag filter Air cannon bin activator Nozzles & Flanges				
28	FW 733		Limestone silo approach platforms	Stairs Handrail Step treads Floor grills Ladders Foundation bolts Fasteners				
29	FW 734		Limestone mill	Wet ball mill Hydro cyclone- Mill area Mill circuit pump Mill separator tank with Agitator				
30	FW 742		Lime stone slurry storage tank	Base plate & its supports Shell, Roof				
31	FW 743		Auxiliary Absorber tank	Base plate & its supports Shell, Roof				
32	FW 744		Filtrate tank	Base plate & its supports Shell, Roof				
33	FW 745		Wastage water tank	Base plate & its supports Shell, Roof				
34	FW 747		Hydro cyclone waste water tank	Base plate & its supports Shell, Roof				
35	FW 748 FW 785 FW 786		Process Water tank Belt filter washing tank Primary Hydro cyclone feed tank	Base plate & its supports Shell, Roof				
36	FW 751 FW 752		Process water pipe accessories Cooling water pipe accessories	CS/FRP Pipes & Fittings Sight Glass R Orifice Gaskets & Fasteners				
37	FW 753		Slurry pipe accessories	CSRL/FRP Pipes & Fittings Strainer (Cone) Expansion Joint-Rubber R Orifice Gaskets & Fasteners				

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN (µm min.)
				PAINT	DFT (µm min.)	PAINT	DFT (µm min.)	
			<b>PGMA DESCRIPTION</b>	<b>PGMA DETAILS</b>				
38	FW 754		Service air pipe accessories	GI Pipes & Fittings Flexible Hose Expansion Joint (Metallic) Hose connector R Orifice Gaskets & Fasteners				
39	FW 755		Instrument air pipe accessories	SS Pipes & Fittings Strainer(Y Type) Gaskets & Fasteners				
40	FW 815 to FW 851		Valves and fittings	Globe valves Ball Valves Butterfly Valves Diaphragm Valves Gate Valves CheckValves Pinch Valves Knife Gate Valves Control Valves Relief Valves				
41	FW 761 FW 765		Structures for Pipe racks Structures for Sub pipe racks	Bracings Columns				
42	FW 280 FW 281 FW 282 FW 283 FW 740 FW 760 FW 763		Foundation material for duct structure Foundation material for absorber Foundation material for Tanks Foundation material for Pipe racks Foundation material for Elevator Foundation material for RC pump shed	Foundation bolts Template				
43	FW 766		Platforms for Pipe rack	Stairs Handrail Step treads Floor grills Ladders Foundation bolts Fasteners				
44	FW 768 FW 769		Trestle for Main & sub Pipe racks	Truss Beams, Supports for all Pipes				
45	FW 779		Supports for cable tray	Double Sup Channel & Base plates Single Sup Channel & Base plates				

SI No	SURFACE LOCATION	PGMA	SURFACE PREPARATION	PRIMER		FINISH		TOTAL DFT IN ( $\mu\text{m}$ min.)
				PAINT	DFT ( $\mu\text{m}$ min.)	PAINT	DFT ( $\mu\text{m}$ min.)	
46	FW 996			Cantilever Arm Fasteners & clamps Brackets				
SNO	PGMA		Tools	Erection , commissioning, special tools				
47	FW 798		PGMA DESCRIPTION Air receivers	Instrument Air receivers Any Instruments/Valves				PGMA DETAILS
48	FW 800		Clarified water tank	Base plate & its supports Shell, Roof				
49	FW 802		Neutralization tank & accessories	Base plate & its supports Shell, Roof				
50	FW 988 FW 997 FW 999		Commissioning spares & Mandatory spares	Startup & commissioning spares Mandatory spares				

	<b>3x800 MW PATRATU TPS</b>	<b>SPECIFICATION No: PE-TS-434-571-A901</b>	
	<b>GYPSUM DEWATERING EQUIPMENT</b>	<b>SECTION : I</b>	
	<b>TECHNICAL SPECIFICATION (ELECTRICAL PORTION)</b>	<b>SUB-SECTION : C-3</b>	
		<b>REV. 00</b>	

**SECTION: I**

**SUB-SECTION: C-3**

**TECHNICAL SPECIFICATION (ELECTRICAL PORTION)**

748358/2022/PS-PEM-MAX



TITLE :  
ELECTRICAL EQUIPMENT SPECIFICATION  
FOR  
GYPSUM DEWATERING EQUIPMENT  
3X800 MW PVUNL PATRATU TPP PHASE-1

SPECIFICATION NO.

VOLUME NO. : II-B

SECTION :

REV NO. 00 : DATE : 06.01.2019

SHEET : 1 OF 3

TECHNICAL SPECIFICATION  
FOR  
GYPSUM DEWATERING EQUIPMENT  
(ELECTRICAL PORTION)



**TITLE :**  
**ELECTRICAL EQUIPMENT SPECIFICATION**  
**FOR**  
**GYPSUM DEWATERING EQUIPMENT**  
**3X800 MW PVUNL PATRATU TPP PHASE-1**

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION :

REV NO. **00** : DATE : 06.01.2019

SHEET : 2 OF 3

**1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:**

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for GYPSUM DEWATERING EQUIPMENT .
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “ both end equipment in vendor’s scope”shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

**2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:**

Refer “Electrical Scope between BHEL and Vendor”.

**3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID**

- 3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of



**TITLE :**  
**ELECTRICAL EQUIPMENT SPECIFICATION**  
**FOR**  
**GYPSUM DEWATERING EQUIPMENT**  
**3X800 MW PVUNL PATRATU TPP PHASE-1**

SPECIFICATION NO.	
VOLUME NO. :	<b>II-B</b>
SECTION :	
REV NO. <b>00</b> :	DATE : 06.01.2019
SHEET :	3 OF 3

compliance certificate/No deviation certificate.

- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

**4.0 List of enclosures :**

- a) Electrical scope between BHEL & vendor
- b) Customer (NTPC) specification for Motors
- c) Customer ( NTPC) cabling spec ( to be referred by vendor for their scope of work (as per Electrical scope between BHEL & vendor)).
- d) Quality plan for motors & NTPC quality assurance
- e) Datasheet A for LT Motors (Annexure-I)
- f) Datasheet C for LT & HT Motors (Annexure-X & Annexure-Y)
- g) List of Mandatory Spares ( Annexure-II)
- h) Sub vendor List for Motors & other Electrical items ( Annexure-III)
- i) Electrical Load data format (Annexure –IV)
- j) BHEL cable listing format (Annexure –V)

REV-0, DATE: 08.01.2020

## ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES: GYPSUM DEWATERING SYSTEM  
 SCOPE OF VENDOR: SUPPLY & SUPERVISION OF VENDOR'S EQUIPMENT  
 PROJECT: 3X800 MW PATRATRU TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	11 kV / 3.3 KV / 415 V Switchgear	BHEL	BHEL	HT motor, (Motor feeder) power supply shall be provided by BHEL  For all LT motor & Auxiliary supply, 415 V AC (3 ph. 4 wire)/240 V AC (supply feeder) shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL BHEL BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	BHEL	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling ( max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC etc.	Vendor	BHEL	
6	Cable trays, accessories & cable trays supporting system 100/50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL BHEL	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	a. Cable glands b. Lugs and bimetallic strip for equipment supplied by Vendor	Vendor Vendor	BHEL BHEL	a. Double compression Ni-Cr plated brass cable glands b. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between	Vendor	BHEL	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel

REV-0, DATE: 08.01.2020

**ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR****PACKAGES: GYPSUM DEWATERING SYSTEM  
SCOPE OF VENDOR: SUPPLY & SUPERVISION OF VENDOR'S EQUIPMENT****PROJECT: 3X800 MW PATRATRU TPS**

	equipment supplied by vendor			rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware.	Vendor	BHEL	Makes shall be subject to customer/ BHEL approval at contract stage.
13	HT Motor with base plate and foundation hardware.	Vendor	BHEL	Makes shall be subject to customer/ BHEL approval at contract stage.
14	HT cable & Cable termination kit for HT Motor	BHEL	BHEL	
15	Mandatory spares	Vendor	-	Vendor to quote as per specification.
16	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
17	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	BHEL	
18	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
19	Electrical Equipment & cable tray layout drawings	-	-	Vendor to furnish drawing (both in print form as well as in AUTOCAD) of Gypsum Dewatering Building layout clearly indicating all motors, panels, JB's etc. which require cabling along with their terminal box/location/ Foundation etc.
20	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

**NOTES:**

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.

# **SUB-SECTION – B-07**

## **MOTORS**

**EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER STATION EXPANSION  
PHASE –I ( 3X 800MW)**

**TECHNICAL SPECIFICATION  
SECTION – VI, PART-B  
BID DOC NO. : CS-9585-001-2**

CLAUSE NO.	TECHNICAL REQUIREMENTS																																				
	<p style="text-align: center;"><b>MOTORS</b></p> <p><b>1.00.00 GENERAL REQUIREMENTS</b></p> <p>1.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.</p> <p>1.02.00 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% &amp; -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.</p> <p>1.03.00 Contractor shall provide fully compatible electrical system, equipment, accessories and services.</p> <p>1.04.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes &amp; Standards, especially the Indian Statutory Regulations.</p> <p>1.05.00 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.</p> <p>1.06.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances for contractors equipment and systems shall be under the contractor scope.</p> <p>1.07.00 Degree of Protection</p> <p>Degree of protection for various enclosures as per IEC60034-05 shall be as follows:-</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 5%;">i)</td> <td style="width: 45%;">Indoor motors</td> <td style="width: 10%;">-</td> <td style="width: 40%;">IP 54</td> </tr> <tr> <td>ii)</td> <td>Outdoor motors</td> <td>-</td> <td>IP 55</td> </tr> <tr> <td>iii)</td> <td>Cable box-indoor area</td> <td>-</td> <td>IP 54</td> </tr> <tr> <td>iv)</td> <td>Cable box-Outdoor area</td> <td>-</td> <td>IP 55</td> </tr> </table> <p><b>2.00.00 CODES AND STANDARDS</b></p> <table border="0" style="width: 100%;"> <tr> <td style="width: 5%;">1)</td> <td style="width: 45%;">Three phase induction motors</td> <td style="width: 10%;">:</td> <td style="width: 40%;">IS/IEC:60034</td> </tr> <tr> <td>2)</td> <td>Single phase AC motors</td> <td>:</td> <td>IS/IEC:60034</td> </tr> <tr> <td>3)</td> <td>Crane duty motors</td> <td>:</td> <td>IS:3177, IS/IEC:60034</td> </tr> <tr> <td>4)</td> <td>DC motors/generators</td> <td>:</td> <td>IS/IEC:60034</td> </tr> <tr> <td>5)</td> <td>Energy Efficient motors</td> <td>:</td> <td>IS 12615, IEC: 60034-30</td> </tr> </table>	i)	Indoor motors	-	IP 54	ii)	Outdoor motors	-	IP 55	iii)	Cable box-indoor area	-	IP 54	iv)	Cable box-Outdoor area	-	IP 55	1)	Three phase induction motors	:	IS/IEC:60034	2)	Single phase AC motors	:	IS/IEC:60034	3)	Crane duty motors	:	IS:3177, IS/IEC:60034	4)	DC motors/generators	:	IS/IEC:60034	5)	Energy Efficient motors	:	IS 12615, IEC: 60034-30
i)	Indoor motors	-	IP 54																																		
ii)	Outdoor motors	-	IP 55																																		
iii)	Cable box-indoor area	-	IP 54																																		
iv)	Cable box-Outdoor area	-	IP 55																																		
1)	Three phase induction motors	:	IS/IEC:60034																																		
2)	Single phase AC motors	:	IS/IEC:60034																																		
3)	Crane duty motors	:	IS:3177, IS/IEC:60034																																		
4)	DC motors/generators	:	IS/IEC:60034																																		
5)	Energy Efficient motors	:	IS 12615, IEC: 60034-30																																		
<p style="text-align: center;"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b></p>	<p style="text-align: center;"><b>TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2</b></p>	<p style="text-align: center;"><b>SUB-SECTION-B-07 MOTORS</b></p>	<p style="text-align: center;"><b>PAGE 1 OF 10</b></p>																																		



CLAUSE NO.	TECHNICAL REQUIREMENTS		
	41 deg.C over inlet cooling water maximum temperature of 39 deg.C for thermal class 90 (Y) wet wound Boiler circulation pump motor.		
6.00.00	<b>OPERATIONAL REQUIREMENTS</b>		
6.01.00	<b>Starting Time</b>		
6.01.01	For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.		
6.01.02	For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.		
6.01.03	For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.		
6.01.04	Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.		
6.02.00	<b>Torque Requirements</b>		
6.02.01	Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.		
6.02.02	Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.		
6.03.00	<p><b>Starting voltage requirement</b></p> <p>(a) Up to 85% of rated voltage for ratings below 110 KW</p> <p>(b) Up to 80% of rated voltage for ratings from 110 KW to 200 KW</p> <p>(c) Up to 85% of rated voltage for ratings from 201 KW to 1000 KW</p> <p>(d) Up to 80% of rated voltage for ratings from 1001 KW to 4000 KW</p> <p>(e) Up to 75 % of rated voltage for ratings above 4000KW</p> <p>Except AOP &amp; JOP motors running on D.G emergency supply, starting voltage shall be 80%.</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2	SUB-SECTION-B-07 MOTORS	PAGE 3 OF 10

CLAUSE NO.	TECHNICAL REQUIREMENTS		
<b>7.00.00</b>	<b>DESIGN AND CONSTRUCTIONAL FEATURES</b>		
7.01.00	Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.		
7.02.00	<p>All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACCA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS: 2148 as detailed below</p> <p>(a) Fuel oil area : Group – IIB</p> <p>(b) Hydrogen generation : Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA / IEC60034)</p>		
7.03.00	<p>Winding and Insulation</p> <p>(a) Type : Non-hygroscopic, oil resistant, flame resistant</p> <p>(b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.</p> <p>(c) 11kV &amp; 3.3 kV AC motors : Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Pressure Impregnated i.e. resin poor method. The lightning Impulse &amp; intertern insulation surge withstand level shall be as per IEC-60034 part-15.  However winding insulation for wet wound Boiler circulation pump motor shall be thermal class 90 (Y) or better.</p> <p>(d) 240VAC, 415V AC &amp; 220V DC motors : Thermal Class ( B ) or better</p>		
7.04.00	Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2	SUB-SECTION-B-07 MOTORS	PAGE 4 OF 10

CLAUSE NO.	TECHNICAL REQUIREMENTS		
7.05.00	Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.		
7.06.00	Noise level for all the motors shall be limited to 85dB (A) except for BFP motor for which the maximum limit shall be 90 dB(A). Vibration shall be limited within the limits prescribed in IS/IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.		
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and preferably 2 numbers duplex platinum resistance type temperature detectors.		
7.08.00	Motor body shall have two earthing points on opposite sides.		
7.09.00	11 KV motors shall be offered with Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover and trifurcating sleeves. SIC termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.		
7.10.00	3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided.		
7.11.00	The spacing between gland plate & center of terminal stud shall be as per Table-I.		
7.12.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.		
7.13.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life.		
7.14.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.		
7.15.00	The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same.		
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2</b></p>	<p align="center"><b>SUB-SECTION-B-07 MOTORS</b></p>	<p align="center"><b>PAGE 5 OF 10</b></p>

CLAUSE NO.	TECHNICAL REQUIREMENTS															
8.00.00	<p>The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.</p> <table border="0"> <tr> <td>(a) Below 110KW</td> <td>:</td> <td>11.0</td> </tr> <tr> <td>(b) From 110 KW &amp; upto 200 KW</td> <td>:</td> <td>9.0</td> </tr> <tr> <td>(c) Above 200 KW &amp; upto 1000KW</td> <td>:</td> <td>10.0</td> </tr> <tr> <td>(d) From 1001KW &amp; upto 4000KW</td> <td>:</td> <td>9.0</td> </tr> <tr> <td>(e) Above 4000KW</td> <td>:</td> <td>6 to 6.5</td> </tr> </table>	(a) Below 110KW	:	11.0	(b) From 110 KW & upto 200 KW	:	9.0	(c) Above 200 KW & upto 1000KW	:	10.0	(d) From 1001KW & upto 4000KW	:	9.0	(e) Above 4000KW	:	6 to 6.5
(a) Below 110KW	:	11.0														
(b) From 110 KW & upto 200 KW	:	9.0														
(c) Above 200 KW & upto 1000KW	:	10.0														
(d) From 1001KW & upto 4000KW	:	9.0														
(e) Above 4000KW	:	6 to 6.5														
9.00.00	CW motor shall be designed with minimum power factor of 0.8 at design duty point.															
<b>10.00.00</b>	<b>TYPE TEST</b>															
<b>10.01.00</b>	<b>HT MOTORS</b>															
10.01.01	<p>The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII- (BPS) and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.</p>															
10.01.02	<p>The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.</p>															
10.01.03	<p>In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the employer for waiver of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.</p>															
10.01.04	<p>Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED "and carried out within last ten years from the date of bid opening. These reports should be for</p>															
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW</b></p>	<p align="center"><b>TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2</b></p>	<p align="center"><b>SUB-SECTION-B-07 MOTORS</b></p>	<p align="center"><b>PAGE 6 OF 10</b></p>													

CLAUSE NO.	TECHNICAL REQUIREMENTS		
10.01.05	<p>the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.</p> <p><b>LIST OF TYPE TESTS TO BE CONDUCTED</b></p> <p><b>The following type tests shall be conducted on each type and rating of HT motor</b></p> <ul style="list-style-type: none"> <li>(a) No load saturation and loss curves upto approximately 115% of rated voltage</li> <li>(b) Measurement of noise at no load.</li> <li>(c) Momentary excess torque test (subject to test bed constraint).</li> <li>(d) Full load test (subject to test bed constraint)</li> <li>(e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.</li> </ul>		
10.01.06	<p><b>LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED</b></p> <p><b>The following type test reports shall be submitted for each type and rating of HT motor</b></p> <ul style="list-style-type: none"> <li>(a) Degree of protection test for the enclosure followed by IR, HV and no load run test.</li> <li>(b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.</li> <li>(c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15</li> <li>(d) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15</li> </ul>		
<p align="center">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</p>	<p align="center">TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2</p>	<p align="center">SUB-SECTION-B-07 MOTORS</p>	<p align="center">PAGE 7 OF 10</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS		
10.02.00	<b>LT Motors</b>		
10.02.01	LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for employer's approval the reports of all the type tests as listed in this specification and carried out within last <i>ten</i> years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.		
10.02.02	However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the employer either at third party lab or in presence of client/ employer's representative and submit the reports for approval.		
10.02.03	<p><b>LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED</b></p> <p><b>The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only</b></p> <ol style="list-style-type: none"> <li>1. Measurement of resistance of windings of stator and wound rotor.</li> <li>2. No load test at rated voltage to determine input current power and speed</li> <li>3. Open circuit voltage ratio of wound rotor motors ( in case of Slip ring motors)</li> <li>4. Full load test to determine efficiency power factor and slip.</li> <li>5. Temperature rise test.</li> <li>6. Momentary excess torque test.</li> <li>7. High voltage test.</li> <li>8. Test for vibration severity of motor.</li> <li>9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)</li> <li>10. Test for degree of protection and</li> <li>11. Over speed test.</li> </ol>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2	SUB-SECTION-B-07 MOTORS	PAGE 8 OF 10

CLAUSE NO.	TECHNICAL REQUIREMENTS																				
10.03.00	<p>12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1</p> <p>All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.</p>																				
10.04.00	<p>The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.</p> <p style="text-align: center;"><b>TABLE - I</b></p> <p style="text-align: center;"><b>DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Motor MCR in KW</th> <th style="text-align: right;">Minimum distance between centre of stud and gland plate in mm</th> </tr> </thead> <tbody> <tr> <td><b>UP to 3 KW</b></td> <td style="text-align: right;"><b>As per manufacturer's practice.</b></td> </tr> <tr> <td>Above 3 KW - upto 7 KW</td> <td style="text-align: right;">85</td> </tr> <tr> <td>Above 7 KW - upto 13 KW</td> <td style="text-align: right;">115</td> </tr> <tr> <td>Above 13 KW - upto 24 KW</td> <td style="text-align: right;">167</td> </tr> <tr> <td>Above 24 KW - upto 37 KW</td> <td style="text-align: right;">196</td> </tr> <tr> <td>Above 37 KW - upto 55 KW</td> <td style="text-align: right;">249</td> </tr> <tr> <td>Above 55 KW - upto 90 KW</td> <td style="text-align: right;">277</td> </tr> <tr> <td>Above 90 KW - upto 125 KW</td> <td style="text-align: right;">331</td> </tr> <tr> <td>Above 125 KW-upto 200 KW</td> <td style="text-align: right;">203</td> </tr> </tbody> </table> <p>For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.</p> <p><b>PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:</b></p> <p>NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:</p>	Motor MCR in KW	Minimum distance between centre of stud and gland plate in mm	<b>UP to 3 KW</b>	<b>As per manufacturer's practice.</b>	Above 3 KW - upto 7 KW	85	Above 7 KW - upto 13 KW	115	Above 13 KW - upto 24 KW	167	Above 24 KW - upto 37 KW	196	Above 37 KW - upto 55 KW	249	Above 55 KW - upto 90 KW	277	Above 90 KW - upto 125 KW	331	Above 125 KW-upto 200 KW	203
Motor MCR in KW	Minimum distance between centre of stud and gland plate in mm																				
<b>UP to 3 KW</b>	<b>As per manufacturer's practice.</b>																				
Above 3 KW - upto 7 KW	85																				
Above 7 KW - upto 13 KW	115																				
Above 13 KW - upto 24 KW	167																				
Above 24 KW - upto 37 KW	196																				
Above 37 KW - upto 55 KW	249																				
Above 55 KW - upto 90 KW	277																				
Above 90 KW - upto 125 KW	331																				
Above 125 KW-upto 200 KW	203																				
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2	SUB-SECTION-B-07 MOTORS	PAGE 9 OF 10																		

748358/2022/PS-PEM-MAX


CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<b>Motor MCR in KW</b>	<b>Clearance</b>	
	UP to 110 KW	10mm	
	Above 110 KW and upto 150 KW	12.5mm	
	Above 150 KW	19mm	
<p align="center">EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</p>	<p align="center">TECHNICAL SPECIFICATION SECTION – VI, PART-B BID DOC NO. : CS-9585-001-2</p>	<p align="center">SUB-SECTION-B-07 MOTORS</p>	<p align="center">PAGE 10 OF 10</p>





**SUB-SECTION – B-09**  
**CABLING**  
**CABLING, EARTHING AND LIGHTNING**  
**PROTECTION**


EPC PACKAGE FOR  
PATRATU SUPER THERMAL POWER STATION EXPANSION  
PHASE –I ( 3X 800MW)


TECHNICAL SPECIFICATION  
SECTION – VI, PART-B  
BID DOC NO. : CS-9585-001-2


CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.00.00	<b>CODES AND STANDARDS</b>		
1.01.00	<p>All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable .</p> <p>IS:513 Cold rolled low carbon steel sheets and strips.</p> <p>IS:802 Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.</p> <p>IS:1079 Hot Rolled carbon steel sheet &amp; strips</p> <p>IS:1239 Mild steel tubes, tubulars and other wrought steel fittings</p> <p>IS:1255 Code of practice for installation and maintenance of power cables upto and including 33 KV rating</p> <p>IS:1367 Part-13 Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).</p> <p>IS:2147 Degree of protection provided by enclosures for low voltage switchgear and control gear</p> <p>IS:2309 Code of Practice for the protection of building and allied structures against lightning.</p> <p>IS:2629 Recommended practice for hot dip galvanising of iron &amp; steel</p> <p>IS:2633 Method for testing uniformity of coating on zinc coated articles.</p> <p>IS:3043 Code of practice for Earthing</p> <p>IS:3063 Fasteners single coil rectangular section spring washers.</p> <p>IS:6745 Methods for determination of mass of zinc coating on zinc coated iron &amp; steel articles.</p> <p>IS:8308 Compression type tubular in- line connectors for aluminium conductors of insulated cables</p> <p>IS:8309 Compression type tubular terminal ends for aluminium conductors of insulated cables.</p> <p>IS:9537 Conduits for electrical installation.</p> <p>IS:9595 Metal - arc welding of carbon and carbon manganese steels - recommendations.</p> <p>IS:13573 Joints and terminations for polymeric cables.</p> <p>BS:476 Fire tests on building materials and structures</p> <p>IEEE:80 IEEE guide for safety in AC substation grounding</p> <p>IEEE:142 Grounding of Industrial &amp; commercial power systems</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 1 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS		
1.02.00	<p>DIN 46267 (Part-II) Non tension proof compression joints for Aluminium conductors.</p> <p>DIN 46329 Cable lugs for compression connections, ring type ,for Aluminium conductors</p> <p>BS:6121 Specification for mechanical Cable glands for elastomers and plastic insulated cables.</p> <p>Indian Electricity Act.</p> <p>Indian Electricity Rules.</p> <p>Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.</p>		
2.00.00	<b>DESIGN AND CONSTRUCTIONAL FEATURE</b>		
2.01.00	<b>Inter Plant Cabling</b>		
2.01.01	Interplant cabling for main routes shall be laid along overhead trestles/duct banks. Cables from main plant to switchyard control room shall be laid in overhead trestles or duct bank. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly burried cables, if essential ,shall not have concentration of more than 4 cables in one route. All buried cables, Cables for switchyard and CHP shall be armoured		
2.01.02	<p><b>Transformer yard</b></p> <p>In transformer yard cables shall be laid in overhead trestle. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles. In transformer yard, trestle height for rail/road crossing shall be suitable for movement of Generator Transformer with bushing.</p>		
2.01.03	<p><b>Trenches</b></p> <p>PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.</p>		
2.01.04	No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant.		
2.01.05	<p><b>Cable Vault</b></p> <p>Clear access passage of at least 750mm wide &amp; 2.1 mt clear heights shall be provided at entrances and along the cable trays in cable vault. Wherever the passage is through cable routes &amp; across the cable tray the clear height shall not be less than 1.5 mts.</p> <p>Cable vaults shall be provided with adequate drainage facilities for drainage of fire water.</p> <p>Each cable vault should have at least two doors.</p> <p>Exit signs shall be provided near doors for personnel escape in case of emergency</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 2 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS		
2.01.06	<p><b>Boiler Area</b></p> <p>Two separate cable routes one on each side shall be provided for each boiler unit. Cables for on set of auxiliaries such as ID, FD, PA fan &amp; half of the coal mills shall be routed in one route &amp; for other set of auxiliaries through other route.</p> <p>Cable trays in boiler &amp; ESP area shall be supported from the boiler and ESP structures. The same shall be coordinated with SG/ESP contractor.</p> <p>Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in boiler/ESP area.</p>		
2.01.07	<p><b>Turbine Hall Area</b></p> <p>a)Two separate cable routes shall be provided for cable routing of working and standby drives or different set/group (say 50% capacity) of auxiliaries.</p>		
2.01.08	<p><b>OffSite Area</b></p> <p>In offsite pumphouses, overhead cable tray arrangement shall be followed. However cable trenches may be considered below switchgear/mcc.</p> <p>Trestle In fuel oil pump house, overhead cable tray arrangement shall be provided. RCC trenches provided in MCC room shall be separated from fuel oil area to avoid oil accumulation.</p>		
2.01.09	<p>The cable slits to be used for motor/equipment power/control supply shall be sand filled &amp; covered with PCC after cabling.</p>		
2.01.10	<p>Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.</p>		
2.01.11	<p>Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:</p> <ul style="list-style-type: none"> <li>• Meet all safety requirements</li> <li>• Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc</li> </ul>		
<b>3.00.00</b>	<b>EQUIPMENT DESCRIPTION</b>		
3.01.00	<b>Cable trays, Fittings &amp; Accessories</b>		
3.01.01	<p>Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power &amp; control cables and perforated for instrumentation cables.</p>		
3.01.02	<p>Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per Clause No. 3.13.00 of this chapter.</p>		
3.01.03	<p>Cable trays shall have standard width of 150 mm, 300 mm &amp; 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.</p>		
3.01.04	<p>Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip</p>		
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2</b></p>	<p align="center"><b>SUB SECTION- B-09 CABLING, EARTHING &amp; LIGHTNING PROTECTION</b></p>	<p align="center">Page 3 of 20</p>


CLAUSE NO.	TECHNICAL REQUIREMENTS		
<p>3.02.00</p> <p>3.02.01</p> <p>3.02.02</p> <p>3.02.03</p>	<p>galvanised as per Clause No. 3.13.00 of this chapter. Troughs shall be standard width of 50 mm &amp; 75 mm with depth of 25 mm</p> <p><b>Support System for Cable Trays</b></p> <p>Cable tray support system shall be pre-fabricated out of single sheet as per enclosed tender drawings.</p> <p>Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder</p> <p>a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.</p> <p>b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fittings and accessories shall be prefabricated factory galvanised.</p> <p>c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanised surface shall be brushed and red lead primer, oil primer &amp; aluminium paint shall be applied</p> <p>d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.</p> <p>e. The typical arrangement of flexible support system is shown in the enclosed drawings and described briefly below:</p> <p>The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS 1079.</p> <p>f. Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.</p> <p>g. Support system shall be able to withstand</p> <ul style="list-style-type: none"> <li>• weight of the cable trays</li> <li>• weight of the cables (75 Kg/Metre run of each cable tray)</li> <li>• Concentrated load of 75 Kg between every support span.</li> <li>• Factor of safety of minimum 1.5 shall be considered.</li> </ul> <p>The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2</p>	<p>SUB SECTION- B-09 CABLING, EARTHING &amp; LIGHTNING PROTECTION</p>	<p>Page 4 of 20</p>


CLAUSE NO.	TECHNICAL REQUIREMENTS		
3.03.04	<p>the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid.</p> <p>FOR COAL HANDLING PLANT THE FOLLOWING SHALL ALSO BE APPLICABLE:</p> <p>a) All overhead cable routes shall be along the route of the conveyor gallery on separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0M above the grade level except for rail/road crossings where it shall be at 8.0M above grade level. Tap offs from the overhead cable trestle can be through shallow trenches with prior approval of the Employer. Directly buried cable, if essential, shall not have concentration of more than 4 cables on one route.</p> <p>b) Cable trenches shall be provided only in Switchgear/MCC rooms.</p> <p>c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.</p> <p>d) Cables for PCS and BSS shall be routed along the conveyors through GI conduits.</p>		
3.04.00	<b>Pipes, Fittings &amp; Accessories</b>		
3.03.01	Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria		
3.03.02	GI Pipes shall be of medium duty as per IS: 1239		
3.03.03	Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.		
3.03.04	Hume pipes shall be NP3 type as per IS 458.		
3.04.00	<b>Junction Boxes</b>		
3.04.01	<p>Junction box shall be made of Fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:-</p> <p>(a) Impact resistance for impact energy of 2 Joules (IK07) as per BS EN50102</p> <p>(b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb.</p> <p>(c) Class of protection shall be IP 55.</p>		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 5 of 20


CLAUSE NO.	TECHNICAL REQUIREMENTS		
3.04.02	<p>(d) HV test.</p> <p>Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.</p>		
3.05.00	<p><b>Terminations &amp; Straight Through Joints</b></p>		
3.05.01	<p>Termination and jointing kits for 33kV, 11 kV, 6.6 KV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be Pre-moulded type or heat shrinkable type. Further Cold shrinkable type termination and jointing kits are also acceptable. The Cold shrinkable type kits shall be type tested as per relevant standards. Calculation to withstand the required fault level shall also be furnished in case of cold shrinkable type kits. 33 kV, 11 kV, 6.6 KV and 3.3kV grade joints and terminations shall be type tested and Type test reports as per IS:13573 Part-II and IEC60502 shall be furnished. Also, heat shrink material shall comply with requirements of ESI 09-13 (external tests). Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Cable joints and terminations should be with FRLS properties as per IEC 60754-1&amp;2. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the tinned copper solderless crimping type cable lugs &amp; ferrule or mechanical connectors (wherein bolts are tightened that shear off at an appropriate torque) as per DIN standard suitable for aluminium compacted conductor cables. (Tender drg. no 0000-211-POE –A-51-RA of cable lug attached at the end of this chapter)..</p>		
3.05.02	<p>Straight through joint and termination shall be capable of withstanding the fault level of 21 KA for 0.12 Sec. with dynamic peak of 52 KA for 33 KV system &amp; of 40 kA for 0.12 sec with a dynamic peak of 100 kA for 11 kV, 6.6 KV &amp; 3.3 KV system. Straight through joints shall have provisions for shield connection and earthing wherever required and complete with all accessories and consumables suitable for storage without deterioration at a temperature of 50 deg. C with shelf life of more than five years. 1.1 kV grade straight through joints shall also be of proven design</p>		
3.05.03	<p>1.1 KV grade Straight Through Joint shall be of proven design.</p>		
3.06.00	<p><b>Cable glands</b></p>		
3.06.01	<p>Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.</p>		
3.07.00	<p><b>Cable lugs/ferrules</b></p>		
3.07.01	<p>Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating</p>		
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2</p>	<p>SUB SECTION- B-09 CABLING, EARTHING &amp; LIGHTNING PROTECTION</p>	<p>Page 6 of 20</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to DIN standards.		
3.08.00	<b>Trefoil clamps</b>		
3.08.01	Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.		
3.09.00	<b>Cable Clamps &amp; Ties</b>		
3.09.01	The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyester coated ladder lock type. The clamps/ties shall have self locking arrangement & shall have sufficient strength. The cable clamps/ties shall be supplied in finished individual pieces of suitable length to meet the site requirements.		
3.10.00	<b>Receptacles</b>		
3.10.01	Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped gavanised or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break, AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable adjustable mA sensitivity ranging from 30-300 mA		
3.12.00	<b>Cable Drum Lifting Jack</b> The jack for cable drum lifting shall be of screw type with 10 ton capacity. The cable drum jacks shall be manufactured from fabricated steel. The spindles supplied with the cable drum jack shall be manufactured using BSEN-24 grade steel bar with locking collars. Jack nests shall be of SG cast steel. Cable drum jack supplied shall have undergone load testing and reports for the same shall be submitted. At least Two Nos. of jacks shall be supplied for NTPC use. Contractor has to make arrangements for his own jacks for cable reeling/unreeling under his scope of installation.		
3.13.00	<b>Galvanising</b>		
3.13.01	Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.		
3.13.02	The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified		
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 7 of 20

CLAUSE NO.	TECHNICAL REQUIREMENTS		
3.14.00	<b>Welding</b>		
3.14.01	The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595		
4.00.00	<b>INSTALLATION</b>		
4.01.00	<b>Cable tray and Support System Installation</b>		
4.01.01	Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.		
4.01.02	Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/drawings. Vendor shall design the support system along with tray, spacing etc in line with tray loadings/drawings.		
4.01.03	The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.		
4.01.04	The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.		
4.01.05	All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.		
4.01.06	In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.		
4.02.00	<b>Conduits/Pipes/Ducts Installation</b>		
4.02.01	The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.		
4.02.02	GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.		
4.02.03	Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material		
<b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b>	<b>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2</b>	<b>SUB SECTION- B-09 CABLING, EARTHING &amp; LIGHTNING PROTECTION</b>	<b>Page 8 of 20</b>

CLAUSE NO.	TECHNICAL REQUIREMENTS												
4.02.04	<p>Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise</p> <table border="1"> <thead> <tr> <th>Conduit /pipe size (dia).</th> <th>Spacing</th> </tr> </thead> <tbody> <tr> <td>Upto 40 mm</td> <td>1 M</td> </tr> <tr> <td>50 mm</td> <td>2.0 M</td> </tr> <tr> <td>65-85 mm</td> <td>2.5 M</td> </tr> <tr> <td>100 mm and above</td> <td>3.0 M</td> </tr> </tbody> </table>	Conduit /pipe size (dia).	Spacing	Upto 40 mm	1 M	50 mm	2.0 M	65-85 mm	2.5 M	100 mm and above	3.0 M		
Conduit /pipe size (dia).	Spacing												
Upto 40 mm	1 M												
50 mm	2.0 M												
65-85 mm	2.5 M												
100 mm and above	3.0 M												
4.02.05	For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.												
4.03.00	<b>Junction Boxes Installation</b>												
4.03.01	Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.												
4.04.00	<b>Cable Installation</b>												
4.04.01	Cable installation shall be carried out as per IS:1255 and other applicable standards.												
4.04.02	<p>For Cable unloading, pulling etc following guidelines shall be followed in general:</p> <ol style="list-style-type: none"> <li>Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.</li> <li>While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.</li> </ol>												
4.04.03	Cables shall be laid on cable trays strictly in line with cable schedule . Where specific cable layouts are not shown on drawings, Contractor shall route these as directed by the Project Manager												
EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)	TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2	SUB SECTION- B-09 CABLING, EARTHING & LIGHTNING PROTECTION	Page 9 of 20										

CLAUSE NO.	TECHNICAL REQUIREMENTS		
4.04.04	<p>Power and control cables shall be laid on separate tiers inline with the approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with cable clamps/ties with self locking arrangement. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by cable clamps/ties with self locking arrangement at every five meter interval and at every bend. Fibre Optical cable shall be laid in trenches/trays or as decided by Employer.</p>		
4.04.05	Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.		
4.04.06	Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.		
4.04.07	No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.		
4.04.08	In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.		
4.04.09	Wherever few cables are branching out from main trunk route troughs shall be used.		
4.04.10	Wind loading shall be considered for designing support as well Cable trays wherever required.		
4.04.11	Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.		
4.04.12	The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.		
4.04.13	<p><b>Separation</b></p> <p>At least 300mm clearance shall be provided between:</p> <ul style="list-style-type: none"> <li>- HT power &amp; LT power cables,</li> <li>- LT power &amp; LT control/instrumentation cables,</li> </ul>		
4.04.14	<p><b>Segregation</b></p> <ol style="list-style-type: none"> <li>1) Segregation means physical isolation to prevent fire jumping.</li> <li>2) All cables associated with the unit shall be segregated from cables of other units.</li> <li>3) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or</li> </ol>		
<p align="center"><b>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</b></p>	<p align="center"><b>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2</b></p>	<p align="center"><b>SUB SECTION- B-09 CABLING, EARTHING &amp; LIGHTNING PROTECTION</b></p>	<p align="center">Page 10 of 20</p>

CLAUSE NO.	TECHNICAL REQUIREMENTS											
4.04.15	<p>DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.</p> <p>4) In switchyard, control cables of each bay shall be laid on separate racks/trays.</p> <p>Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:</p> <p>Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:</p> <table border="1"> <thead> <tr> <th>No. of cores in cable</th> <th>No. of spare cores</th> </tr> </thead> <tbody> <tr> <td>2C,3C</td> <td>NIL</td> </tr> <tr> <td>5C</td> <td>1</td> </tr> <tr> <td>7C-10C</td> <td>2</td> </tr> <tr> <td>14C and above</td> <td>3</td> </tr> </tbody> </table>	No. of cores in cable	No. of spare cores	2C,3C	NIL	5C	1	7C-10C	2	14C and above	3	
No. of cores in cable	No. of spare cores											
2C,3C	NIL											
5C	1											
7C-10C	2											
14C and above	3											
4.04.16	<p><b>Directly Buried Cables</b></p> <p>a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255 and the enclosed drawings showing cabling details.</p> <p>b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.</p>											
4.04.17	<p>Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags. The cable tag requirements mentioned above shall prevail over Tag requirements mentioned elsewhere in this document for HT power, LT power &amp; control cables.</p>											
4.04.18	<p>While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.</p>											
4.05.00	<p><b>Cable Terminations &amp; Connections</b></p>											
4.05.01	<p>The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor</p>											
<p>EPC PACKAGE FOR PATRATU SUPER THERMAL POWER STATION EXPANSION PHASE-I (3X 800MW)</p>	<p>TECHNICAL SPECIFICATIONS SECTION VI, PART-B BID DOC. NO.:CS- 9585-001-2</p>	<p>SUB SECTION- B-09 CABLING, EARTHING &amp; LIGHTNING PROTECTION</p>	<p>Page 11 of 20</p>									



<b>STANDARD QUALITY PLAN</b>	SPEC. NO.:	DATE: 27.02.2020
CUSTOMER :	QP NO.: PED-5006-00-Q-007, REV.04	
PROJECT:	PO NO.:	
ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SHEET 1 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD				AGENCY	
					M	CAN			D	M	C	N		
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL PLATES, SECTION EYEBOLTS	1 SURFACE CONDITION	MA	VISUAL	100%		MANUFACTURERS DRG./SPEC	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK		P			
		2 DIMENSIONS	MA	MEASUREMENT	SAMPLE		MANUFACTURERS DRG./SPEC	MANUFACTURERS DRG./SPEC	-DO-		P			
		3 PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-		-DO-	TEST REPORT			PW			
1.2	HARDWARES	1 SURFACE CONDITION	MA	VISUAL	100%		MANUFACTURERS DRG./SPEC	FREE FROM CRACKS, UN-EVENNESS ETC	-DO-		P			PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
		2 PROPERTY CLASS	MA	VISUAL	SAMPLES		MANUFACTURERS DRG./SPEC	MANUFACTURERS DRG./SPEC	SUPPLIERS TC & LOG		PW			
1.3	CASTING	1 SURFACE CONDITION	MA	VISUAL	100%			FREE FROM CRACKS, BLOW HOLES ETC	LOG BOOK		PW			HEAT NO. SHALL BE VERIFIED
		2 CHEM & PHY. PRP.	MA	CHEM & MECH TEST	WREAT NO.		MANUFACTURERS DRG./SPEC	MANUFACTURERS DRG./SPEC	SUPPLIERS TC		PW			
		3 DIMENSIONS	MA	MEASUREMENT	100%		MANUFACTURERS DRG./SPEC	MANUFACTURERS DRG./SPEC	LOG BOOK		PV			
1.4	PAINT & VARNISH	1 MAKE SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS		MANUFACTURERS DRG./SPEC	MANUFACTURERS DRG./SPEC	LOG BOOK		PV			


**FOR CUSTOMER REVIEW & APPROVAL**

Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

**BIDDER/ SUPPLIER**

Sign & Date	
Seal	

ENGINEERING		QUALITY	
Prepared by:	Sign & Date	Sign & Date	Name
Reviewed by:	Checked by:	Checked by:	Name

		STANDARD QUALITY PLAN		SPEC. NO.	
		MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		DATE: 27.02.2020	
		CUSTOMER :		QP NO.: PED-506-00-Q-007, REV-04	
		PROJECT:		PO NO.:	
ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM: II		SECTION: II	
				SHEET 2 OF 9	

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD	AGENCY					
					M	CN				D	M	C	N		
1	SHAFT (FORGED OR ROLLED)	1 SURFACE COND	MA	VISUAL	100%	-	7	8	-DC-	-	-	-	-	-	-
15		2 CHEM & PHYSICAL PROPERTIES	MA	CHEM & PHYSICAL TESTS	TREAT NO OR HEAT TREATMENT BATCHING	-	MANUFACTURER'S DRG / SPEC.	MANUFACTURERS DRG / STD	SUPPLIERS TC	PV	-	-	-	-	VENDORS APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		3 DIMENSIONS	MA	MEASUREMENT	100%	-	-DC-	MANUFACTURERS DRG.	LOG BOOK	PV	-	-	-	-	-
		4 INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	100%	ASTM-A388	MANUFACTURERS STD	-DC-	PV	-	-	-	-	FOR DIA OF 55 MM & ABOVE
16	SPACE HEATERS, CONNEXION BOXES, CABLES, CABLE LUGS, CARBON BRUSH TEMP DETECTORS, RTD, BTDS	1 MAKE & RATING	MA	VISUAL	-DC-	-	MANUFACTURERS DRG./STD.	MANUFACTURERS DRG./STD.	-DC-	PV	-	-	-	-	-
		2 PHYSICAL COND.	MA	-DC-	-DC-	-	-	NO PHYS. DAMAGE NO ELECTRICAL DISCONTINUITY	-DC-	PV	-	-	-	-	-
		3 DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURERS DRG / STD	MANUFACTURERS DRG / STD.	-DC-	PV	-	-	-	-	-
		4 PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	-DC-	-DC-	TEST REPORT	PV	-	-	-	-	-

FOR CUSTOMER REVIEW & APPROVAL	
Doc No:	
Reviewed by:	Sign & Date
Approved by:	Name Seal

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

ENGINEERING		QUALITY	
Sign & Date	Name	Sign & Date	Name
<i>[Signature]</i>	Hema K.	<i>[Signature]</i>	<i>[Signature]</i>
Checked by:		Checked by:	
Reviewed by:	<i>[Signature]</i>	Reviewed by:	