

**2 X 800 MW GADARWARA STPP– STG PKG
2 X 800 MW GADARWARA STPP– SG PKG**

VOLUME –IIB

**TECHNICAL SPECIFICATION
FOR
PLATE HEAT EXCHANGERS**

Specification No. : PE-TS-394/395-179-N001 (Rev 0)



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA-201301**



TITLE :
TECHNICAL SPECIFICATION FOR
PLATE HEAT EXCHANGERS
PREAMBLE

SPEC. NO.: PE-TS-394/395-179-N001

VOLUME II B

SECTION

REV. NO. 0

DATE 07.11.13

The tender document contains three (3) volumes. The bidder shall meet the requirements of all the three volumes.

1.1 Volume -I CONDITIONS OF CONTRACT

This consists of four parts as below:

Volume - I A: This part contains instructions to bidders for making bids to BHEL.

Volume - I B: This part contains general commercial conditions of the tender and includes provision that vendor shall be responsible for the quality of item supplied by their sub-vendors.

Volume - I C: This part contains special conditions of contract.

Volume - I D: This part contains commercial conditions for erection and commissioning site work, as applicable.

1.2 Volume - II TECHNICAL SPECIFICATIONS Technical requirements are stipulated in Volume II which comprises of :

Volume - II A: General Technical Conditions

Volume - II B: Technical specification including drawings, if any.

1.2.1 Volume - II B : This volume is sub-divided into following sections:

Section – A: This section outlines the scope of enquiry.

Section – B: This section provides “Project Information”

Section – C: This section indicates technical requirements specific to the contract, not covered in Section-D.

Section – D: This section comprises of technical specifications of equipments complete with data sheet A, B & C.

Data sheet-A specifies data and other requirements pertaining to the equipment.

Data sheet - B specifies data to be filled by the bidder (Data Sheet B is contained in Volume - III)

Data sheet - C indicates data documents to be furnished after the award of contract as per agreed schedule by the vendor (as applicable).

1.2.2 Volume - III: TECHNICAL SCHEDULES - This volume contains technical schedules and Data Sheets - B, which are to be duly filled by the bidder and the same shall be furnished with the technical bid as per instructions given in Volume-III.

2.0 The requirements mentioned in Section C/Data Sheets-A of Section-D shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section -D



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TITLE :
TECHNICAL SPECIFICATION FOR
PLATE HEAT EXCHANGERS

SPECIFICATION NO. PE-TS-394/395-179-N001

VOLUME II B

SECTION A

REV. NO. 0 DATE 07.11.13

SHEET 1 OF 1

1.00.00 SCOPE

This enquiry covers the design, manufacture, assembly, inspection and testing at manufacturer's and/ or his sub-contractors works, painting, proper packing & delivery of the item namely **PLATE HEAT EXCHANGERS** complete with all accessories, commissioning spares (if any), counter flanges with nuts, bolts, gaskets and coatings (wherever necessary), including special tools & tackles (if any), including site PG test as mentioned in this specification for following projects:

- 2 X 800 MW GADARWARA STPP STAGE-1- STG
- 2 X 800 MW GADARWARA STPP STAGE-1- SG

2.00.00 GENERAL TECHNICAL INSTRUCTIONS

2.01.00 It is not the intent to specify herein all the details of design and manufacture. However the equipment shall conform in all respects to high standards of design, engineering and workmanship, and shall be capable of performing the required duties in a manner acceptable to Engineer/ Owner, who will interpret the meaning of drawing and specifications, and shall be entitled to reject any component or material, which in his judgement is not in full accordance herewith.

2.02.00 The omission of specific reference to any component/ accessories necessary for the proper performance of Plate Heat Exchangers shall not relieve the bidder of the responsibility of providing such facilities to complete the supply of heat exchangers at quoted prices.

2.03.00 Design/ drawings/ data sheets etc. shall be subject to approval of BHEL as per specification, in the event of order.

2.04.00 BHEL's / customer's representative shall be given access to the shop in which the equipment are being manufactured or tested and all test records shall be made available to him.

2.05.00 The equipment covered under this specification shall not be despatched unless the same have been finally inspected, accepted and shipping release issued by BHEL.

2.06.00 PHE-SG Aux. have been indicated with two alternatives, as per Data Sheet A of Section - D of Vol II B. Bidder to quote for both the alternatives, however one of the alternatives shall be selected by BHEL, same shall be informed during technical evaluation of bids.



TITLE :
**SPECIFIC TECHNICAL REQUIREMENTS
FOR
PLATE HEAT EXCHANGERS**

SPECIFICATION NO. PE-TS-394/395-179-N001

VOLUME II B

SECTION C

REV. NO. 0 DATE 07.11.13

SECTION B
PROJECT INFORMATION



TITLE :
SPECIFIC TECHNICAL REQUIREMENTS
FOR
PLATE HEAT EXCHANGERS

SPECIFICATION NO. PE-TS-394/395-179-N001


VOLUME II B

SECTION C


REV. NO. 0 **DATE 07.11.13**

SECTION B-1


2 X 800 MW NTPC GADARWARA STPP STAGE I – STG PKG

CLAUSE NO.	PROJECT INFORMATION	ANNEXURE-I	
	INTRODUCTION		
1.00.00	BACKGROUND Gadarwara Thermal Power Project (Gadarwara TPP) is being set up as a regional power project for the benefit of States/UTs of Western Region. This project is being set up in two stages. Each stage shall comprise of two units of 800 MW.		
1.01.00	Location and The site is located near villages Gangai & Umaraiya (about 9 Kms from Gadawara town in Narsingpur district of Madhya Pradesh. The major cities Bhopal & Jabalpur are located at about 210 Kms & about 140 kms respectively from proposed project site. The nearest BG Railway Station, Gadawara, on Jabalpur- Itarsi Section on central railway main Line is about 9 Kms from proposed project site. The nearest commercial airport, Bhopal and Jabalpur are located about 240 Kms and about 155 Kms respectively from site. The plant latitude and longitude are 22° 51' 42" N and 78° 52' 08" respectively. Vicinity plan of the proposed project is placed at Annexure –A-I		
1.02.00	Land About 1844 acres of land (Private Land- about 1480 acres and Govt. Land- about 364 acres) has been envisaged for the project. In-principle land availability clearance has been obtained from Govt. of Madhya Pradesh vide letter dated 19.05.08.		
1.03.00	Water The make-up water requirement is estimated as 4680 Cubic Meter/Hr with ash circulation system and about 5980 Cubic Meter/Hr with once through ash water system. The source of water for the Project is Narmada River at a distance of about 30 Kms from the project site. Govt. of Madhya Pradesh vide dated 19.05.08. has accorded water commitment from Narmada river for the project. CWC vide letter dated 27.07.12 have concurred water availability confirmation accorded by State Govt.		
1.04.00	Capacity 2 x 800 MW - Present proposal 2 x 800 MW - In Future		
GADARWARA SUPER THERMAL POWER PROJECT (2X800 MW) STEAM TURBINE GENERATOR PACKAGE & SG PACKAGE		TECHNICAL SPECIFICATION SECTION-VI PART-A	PROJECT INFORMATION PAGE 1 OF 9




CLAUSE NO.	PROJECT INFORMATION	ANNEXURE-I	
1.05.00	Meteorological data Important meteorological data from nearest observatory at Narsinghpur is placed at Annexure-A-II.		
1.06.00	Plant Water Scheme The Plant water scheme is described below.		
1.06.01	Condenser Cooling (CW) Water System It is proposed to provide recirculating type CW system with induced draft type cooling towers. For the recirculating type CW system it is proposed to supply clarified water as make up. Raw water from the make-up water pump house shall be pumped to a Water Pretreatment Plant (PT - CW system). The treated clarified water shall be led to the cold water channel of CW system. Designed Clarified Water Analysis is given in this subsection. CW system shall be operated at a C.O.C of about 4.0. Chemical treatment programme (using acid dosing and scale cum corrosion inhibitors dosing) may be employed in addition to blow down of CW water to control the CW system chemistry in case CW system is required to be operated beyond 4.0 COC. CW blow down shall be drawn from the discharge of CW pumps and the same shall be led to a Service water Tank. For carrying circulating water from CW pump house to TG-area and from TG area to cooling tower, steel lined concrete encased duct would be provided. For interconnecting CW duct with CW pump, condenser and cooling towers, steel pipes would be used. Cooled water from cooling tower will be led to CW pump house through the cold water channel by gravity.		
1.06.02	Equipment Cooling Water (ECW) System (Unit Auxiliaries) The plant auxiliaries of Steam Generator and Turbine Generator shall be cooled by Demineralised (DM) water in a closed circuit. The primary circuit DM water shall be cooled through plate type heat exchangers by Circulating Water tapped from CW system in a closed secondary circuit. The hot secondary circuit cooling water shall be cooled in the cooling towers and shall be returned back to the system. It is proposed to provide independent primary cooling water circuit for Steam Generator & auxiliaries and TG & its auxiliaries.		
1.06.03	Station Auxiliaries Cooling Water System The station auxiliaries such as Air compressors, Compressors of ash handling plant, Cooling water circuit of Air Conditioning system, compressor of mill reject system etc. shall be cooled by separate cooling water System using separate set of pumps and cooling towers.		
GADARWARA SUPER THERMAL POWER PROJECT (2X800 MW) STEAM TURBINE GENERATOR PACKAGE		TECHNICAL SPECIFICATION SECTION-VI PART-A	PROJECT INFORMATION PAGE 2 OF 9

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CLAUSE NO.	PROJECT INFORMATION	ANNEXURE-I	
1.06.04	Ash Water System It is proposed to operate ash water system in a closed circuit. The ash water from the ash dyke shall be recirculated after treating a part of the quantity in a side stream lime softening plant as the case may be. Make up to the ash water system (to compensate for the ash water system blow down and evaporation loss in ash dyke) shall be supplied from excess CW blow down water (Service water) and raw water supply from water source of the plant. In addition, provision shall be kept to supply treated water from Central Monitoring Basin of Liquid Effluent Treatment Plant.		
1.06.05	Other Miscellaneous Water Systems a) CW system blow down water shall be used for the plant service water requirement, dust suppression system of coal handling plant, makeup to the Ventilation system, ash slurry pumps sealing, sealing of Vacuum pumps (if applicable) of Ash Handling plant, make-up to fire water storage tanks and cooling water requirement of hydrogen generation plant. The service (wash water) water collected from various areas shall be treated using oil water separators, tube settlers, coal settling pits etc. as per requirement and treated water from liquid effluent treatment plant shall be recycled back to the service water system for re-use. The excess service water shall be led to central monitoring basin for disposal. b) Separate water Pre-treatment plants are proposed for Circulating Water (PT-CW) system, Demineralisation Plant (PT-DM) plant and potable (PT-Pot) water systems. c) The drinking water requirement of the plant and colony shall be provided from the above mentioned Water (PT-Pot) pretreatment plant. d) Steam Cycle make-up water, makeup to the primary circuit of ECW (unit auxiliaries) system, boiler fill water and makeup to the hydrogen generation plant shall be provided from Demineralising plant. e) The quality of clarified water & DM water is given in this sub-section at Annexure-A-III.		
1.07.00	Criteria for Earthquake Resistant Design of Structures and Equipment All power plant structures and equipment, including plant auxiliary structures and equipment shall be designed as per the criteria specified in sub-section-D1 of Section-VI (Part-A).		
GADARWARA SUPER THERMAL POWER PROJECT (2X800 MW) STEAM TURBINE GENERATOR PACKAGE		TECHNICAL SPECIFICATION SECTION-VI PART-A	PROJECT INFORMATION PAGE 3 OF 9

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CLAUSE NO.	PROJECT INFORMATION	ANNEXURE-I		
	<p>In case the acceleration criteria considered by the Bidder for the design of anchorage bolts of Steam Turbine and Generator with TG Deck in his bid is different with respect to above criteria, he shall indicate the same in his bid. The same will be discussed with the Bidder and finalized considering the following:</p> <p>a) The earthquake design acceleration for the steam turbine and generator acting at the centre of gravity depends upon the layout/configuration/size of TG deck supporting columns and beams which are to be jointly decided by NTPC and the bidder.</p> <p>b) As the data regarding Foundation GA & loading data to be furnished by Bidder may not be available at tender stage, the acceleration criteria proposed by the bidder can not be confirmed for acceptance at the award stage. The same can be confirmed after jointly finalizing the TG substructure arrangement by NTPC and Bidder.</p> <p>c) TG deck acceleration values will be limited to the design values adopted by Bidder by suitably increasing the size of the TG supporting columns/beams during detailed engineering.</p> <p>Accordingly Bidder has to make equipment/piping layout clearing the TG column/beams.</p>			
1.08.00	<p>Criteria for Wind Resistant Design of Structures and Equipment</p> <p>All structures and equipment of the power plant, including plant auxiliary structures and equipment, shall be designed for wind forces as given as given in sub-section-D1 of Section-VI (Part-A).</p> <p style="text-align: center;">2</p>			
GADARWARA SUPER THERMAL POWER PROJECT (2X800 MW) STEAM TURBINE GENERATOR PACKAGE		TECHNICAL SPECIFICATION SECTION-VI PART-A	PROJECT INFORMATION	PAGE 4 OF 9

ANNEXURE-A-I



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जलवायवी साणी
CLIMATOLOGICAL TABLE

EXHIBIT - 1


स्टेशन: गदरवार
STATION: Gadwar


स्थिति: 28° 57' N, 76° 11' E
LOCATION: 28° 57' N, 76° 11' E

समय: 1992 से 1990 तक के अवधि
PERIOD: 1992 TO 1990

आधार: 1990 तक के अवधि
BASED ON OBSERVATIONS FROM 1992 TO 1990

MONTH	STATION LEVEL PRESSURE	MEAN					EXTREMES		HUMIDITY		CLOUD		NO. OF WETTEST MONTHS		NO. OF DRIEST MONTHS		MEAN WIND SPEED
		GR. WET WET WET	GR. DRY WET WET	GR. MAX WET WET	GR. MIN WET WET	HIGHEST WET WET	DATE WET WET	DATE WET WET	RELATIVE WET WET	RELATIVE WET WET	AMOUNT WET WET	AMOUNT WET WET	NO. OF WETTEST MONTHS	NO. OF WETTEST MONTHS	NO. OF DRIEST MONTHS	NO. OF DRIEST MONTHS	
JAN	978.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
FEB	977.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
MAR	976.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
APR	975.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
MAY	974.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
JUN	973.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
JUL	972.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
AUG	971.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
SEP	970.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
OCT	969.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
NOV	968.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
DEC	967.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4
TOTAL	966.0	12.0	9.0	24.0	0.2	30.0	2.0	34.0	0.0	12.0	1.0	0.0	1.0	1.0	1.0	1.0	2.4

CLAUSE NO.	PROJECT INFORMATION		ANNEXURE-I	
				ANNEXURE-A-III
	DESIGN CLARIFIED WATER ANALYSIS			
	Sl. No.	Constituent	as	mg per litre
	1.	Calcium	CaCO ₃	102
	2.	Magnesium	CaCO ₃	41
	3.	Sodium	CaCO ₃	35
	4.	Potassium	CaCO ₃	3
	5.	Total Alkalinity	CaCO ₃	113
	6.	P-Alkalinity	CaCO ₃	Nil
	7.	Chloride	CaCO ₃	43
	8.	Sulphate	CaCO ₃	25
	9.	Silica (Reactive)	SiO ₂	16
	10.	Iron	Fe	0.3 mg/l
	11.	pH Value	-	6.8 - 8.5
	12.	Turbidity	NTU	10
	Note- Clarified water shall be used as make up water for cooling water system.			
GADARWARA SUPER THERMAL POWER PROJECT (2X800 MW) STEAM TURBINE GENERATOR PACKAGE S. S. / R		TECHNICAL SPECIFICATION SECTION-VI PART-A		PROJECT INFORMATION PAGE 8 OF 8

CLAUSE NO.	PROJECT INFORMATION ANNEXURE-I																					
	<p style="text-align: right;">ANNEXURE – A-III</p> <p style="text-align: center;">ANALYSIS OF DM WATER TO BE USED FOR MAKE-UP WATER TO CONDENSER</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Sl.No.</th> <th style="text-align: left;">Characteristics</th> <th style="text-align: left;">Value</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Silica (Max.)</td> <td>0.01 ppm as SiO₂</td> </tr> <tr> <td>2.</td> <td>Iron as Fe</td> <td>Nil</td> </tr> <tr> <td>3.</td> <td>Total hardness</td> <td>Nil</td> </tr> <tr> <td>4.</td> <td>pH value</td> <td>6.8 -7.3</td> </tr> <tr> <td>5.</td> <td>Conductivity</td> <td>Not more than 0.1micro mho/cm excluding the effects of free CO₂</td> </tr> </tbody> </table>				Sl.No.	Characteristics	Value	1.	Silica (Max.)	0.01 ppm as SiO ₂	2.	Iron as Fe	Nil	3.	Total hardness	Nil	4.	pH value	6.8 -7.3	5.	Conductivity	Not more than 0.1micro mho/cm excluding the effects of free CO ₂
Sl.No.	Characteristics	Value																				
1.	Silica (Max.)	0.01 ppm as SiO ₂																				
2.	Iron as Fe	Nil																				
3.	Total hardness	Nil																				
4.	pH value	6.8 -7.3																				
5.	Conductivity	Not more than 0.1micro mho/cm excluding the effects of free CO ₂																				
GADARWARA SUPER THERMAL POWER PROJECT (2X300 MW) STEAM TURBINE GENERATOR PACKAGE <i>25/6/14</i>	TECHNICAL SPECIFICATION SECTION-VI PART-A	PROJECT INFORMATION	PAGE 9 OF 9																			

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ANNEXURE-WL(GADARWARA)

CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

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.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

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.

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.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.

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.

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) 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. |

ANNEXURE-B

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:

- a) The basic wind speed " V_b " at ten metres above the mean ground level : 39 metres/second
- b) The risk coefficient " K_r " : 1.06
- c) Category of terrain : Category-2

Note: Notwithstanding the values of the above mentioned parameters, the design wind pressure so computed at any point shall not be taken less than 1500 N/Sq. metre for all classes of structures, i.e. A, B & C, as defined in IS: 875 (Part-3).

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ANNEXURE-EQ (GARDARWARA)

Gadarwara Thermal Power Project

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):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.

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.

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 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).

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).

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 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.

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.

ANNEXURE - I

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) : 0.18 g
- 2) Multiplying 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 : 0.0525
 - b) for braced steel frames designed and detailed as per IS:800 : 0.039
 - c) For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.0315
 - d) for steel chimney : 0.079
 - e) for design of structures not covered under 2 (a) to 2 (d) above and under 3 below : 0.0525
- 3) Multiplying 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 : 0.105

Note: g = Acceleration due to gravity

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

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)	
	2%	5%
0	1	1
0.03	1	1
0.04	1.287	1.178
0.05	1.564	1.337
0.06	1.835	1.482
0.07	2.101	1.618
0.08	2.361	1.746
0.09	2.618	1.866
0.1	2.871	1.982
0.105	2.996	2.037
0.11	3.121	2.092
0.115	3.245	2.145
0.12	3.368	2.198
0.123	3.442	2.229
0.127	3.500	2.270
0.13	3.500	2.300
0.135	3.500	2.500
0.14	3.500	2.500
0.145	3.500	2.500
0.15	3.500	2.500
0.2	3.500	2.500
0.25	3.500	2.500
0.3	3.500	2.500
0.35	3.500	2.500
0.4	3.500	2.500
0.43	3.500	2.500
0.45	3.500	2.500
0.48	3.500	2.500
0.49	3.369	2.500
0.5	3.302	2.500
0.52	3.175	2.212
0.555	2.975	2.072
0.56	2.948	2.054
0.565	2.922	2.035
0.57	2.896	2.018
0.575	2.871	2.000
0.58	2.847	1.983
0.585	2.822	1.966

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)	
	2%	5%
0.59	2.798	1.949
0.595	2.775	1.933
0.6	2.752	1.917
0.65	2.540	1.769
0.7	2.359	1.643
0.75	2.201	1.533
0.8	2.064	1.438
0.85	1.942	1.353
0.9	1.834	1.278
0.95	1.738	1.211
1	1.651	1.150
1.05	1.572	1.095
1.1	1.501	1.045
1.15	1.436	1.000
1.2	1.376	0.958
1.25	1.321	0.920
1.3	1.270	0.885
1.35	1.223	0.852
1.4	1.179	0.821
1.45	1.139	0.793
1.5	1.101	0.767
1.55	1.065	0.742
1.6	1.032	0.719
1.65	1.001	0.697
1.7	0.971	0.676
1.75	0.943	0.657
1.8	0.917	0.639
1.85	0.892	0.622
1.9	0.869	0.605
1.95	0.847	0.590
2	0.826	0.575
2.05	0.805	0.561
2.1	0.786	0.548
2.15	0.768	0.535
2.2	0.750	0.523
2.25	0.734	0.511
2.3	0.718	0.500
2.35	0.703	0.489
2.4	0.688	0.479

ANNEXURE - I

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)	
	2%	5%
2.45	0.674	0.469
2.5	0.660	0.460
2.55	0.647	0.451
2.6	0.635	0.442
2.65	0.623	0.434
2.7	0.611	0.426
2.75	0.600	0.418
2.8	0.590	0.411
2.85	0.579	0.404
2.9	0.569	0.397
2.95	0.560	0.390
3	0.550	0.383
3.05	0.541	0.377
3.1	0.533	0.371
3.15	0.524	0.365
3.2	0.516	0.359
3.25	0.508	0.354
3.3	0.500	0.348
3.35	0.493	0.343
3.4	0.486	0.338
3.45	0.479	0.333
3.5	0.472	0.329
3.55	0.465	0.324
3.6	0.459	0.319
3.65	0.452	0.315
3.7	0.446	0.311
3.75	0.446	0.307
3.8	0.435	0.303
3.85	0.423	0.299
3.9	0.413	0.295
3.95	0.402	0.291
4	0.392	0.288



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SECTION C
SPECIFIC TECHNICAL REQUIREMENTS



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1.0 GENERAL :

The Plate heat Exchangers complete with all accessories including special tools and tackles (if any) shall conform to the standard technical specifications and Data Sheet-A of Section-D. In addition, the requirements of this Section C shall also be complied with. However, wherever the details given in Section-D and Data Sheet-A are different, the requirements of Data Sheet - A shall prevail. Similarly in the event of contradictions between Section - C & Section - D/ Data Sheet-A, Section-C shall prevail.

Number of Plate Heat Exchangers to be supplied shall be as under:

- Total Six (6) nos. PHE for 2 X 800 MW GADARWARA STPP– STG PKG
Viz. 3 nos [2W + 1S] per Unit
- Total Six (4) nos. PHE for 2 X 800 MW GADARWARA STPP– SG PKG
Viz. 2 nos [1W + 1S] per Unit

PHE –SG Aux. have been indicated with two alternatives, as per Data Sheet A of Section - D of Vol II B. Bidder to quote for both the alternatives, however one of the alternatives shall be selected by BHEL, same shall be informed during technical evaluation of bids.

2.0 SYSTEM DESCRIPTION :

2.1 The Plate Heat Exchanger are intended to be used in closed circuit DM cooling water circuit for Cooling Hot passivated DM Water by Auxiliary Cooling Water (Clarified Water) in case of following Projects:

1. 2 X 800 MW GADARWARA STPP– STG PKG
2. 2 X 800 MW GADARWARA STPP– SG PKG

2.2 Passivated DM Water is circulated through various auxiliary coolers of TG & Boiler, in closed loop by means of pumps. This DM water picks up heat from different cooling equipment's. Heat from DM water is transferred to auxiliary cooling water (Secondary side) thru' the Plate Heat Exchangers covered under this specification.

2.3 The analysis of DM Water, Clarified Water (Auxiliary cooling water) to be handled by the Plate Heat Exchangers are given in Data Sheet-A.

2.4 A strainer of 2 mm size at ACW inlet lines of PHE is provided and backwashing of PHE's is not envisaged.

3.0 SCOPE OF SUPPLY :

3.1 Number of Plate Heat Exchangers to be supplied shall be as under. For design parameters etc. refer Data Sheet-A enclosed herewith.

3.1.1 For 2 X 800 MW GADARWARA STPP– STG PKG
Total Six (6) nos . PHE Viz. 3 nos [2W + 1S] per Unit

3.1.2 For 2 X 800 MW GADARWARA STPP – SG PKG
Total Six (4) nos . PHE Viz. 2 nos [1W + 1S] per Unit

3.2 Each Plate Heat Exchanger (quantity and other details specified in Data Sheet-A) shall be complete with the following accessories and auxiliaries.



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- (i) Suitable drain and vent connections for both primary (DMCW) and Secondary Water (Clarified Water) streams complete with isolation valves.
- (ii) Supporting arrangement complete with foundation plate channels, anchor bolts, nuts, sleeves, inserts etc.
- (iii) Lifting arrangement i.e., lifting lugs, eye bolts etc.
- (iv) Matching counter flanges with necessary bolts, nuts, and gaskets for all flanged terminal points, including for DMCW and ACW inlet/outlet nozzles.
- (v) Other accessories as required to make PHE's complete in all respects.
- (vi) Commissioning spares, if any.
- (vii) One Ratchet spanner per PHE is included in bidder's scope of supply .
- (viii) Matching piece (Reducer/Expander), with coatings (as required), to match the PHE nozzle connection with connecting pipe size as indicated in Data Sheet.
- (ix) Mandatory spares as applicable for each project as per data sheet A.

3.3 Finish paints for touch-up painting of equipment after erection at site in sealed containers.

3.4 Various drawings, datasheets, test reports/ certificates, instruction manuals for erection, operation and maintenance etc., as specified in Data Sheet-C.

3.5 Based on the layout requirement, the nozzle orientation shall be for parallel flow viz. The inlet and outlet of DMCW flow shall be on the same side (vertically). And also the inlet and outlet of ACW flow shall be on same side (vertically).

4.0 INSPECTION REQUIREMENTS

4.1 Inspection for "pressing of plates to form whole corrugation of the heat transfer plate" shall be from third party like TUV/Lloyd and certificate shall be submitted for review of BHEL.

- The Pressing of HT plates shall be carried out in one operation.

4.2 DP Test shall be conducted for 10% of HT plates.

BHEL envisage witness of D.P. Test as follows:

- a. 1% witness by Customer.
- b. 2% witness by BHEL.

However during Contract Stage above percentage may vary from 1% to 10% for Customer & from 2% to 10% for BHEL without any commercial implication. However, in case of defect, entire lot shall be tested & only defect free plates shall be accepted.

4.3 10% of Light Box test or equivalent test (Vacuum test / Air Chamber test) shall be witnessed by BHEL/Customer/Third party (TUV/Lloyd or equivalent). However during Contract stage above percentage may vary from 10 to 100 % for BHEL/Customer without any cost implication to BHEL.

4.4 Minimum requirement for quality Plan shall be as per quality plan attached in the Section D of the Vol. IIB. Manufacturing Quality Plan for PHE shall be subject to approval during detail engineering. No price implication shall be admissible to QP approval by BHEL/Customer.

4.5 Hydraulic test for PHE's shall be performed at 1.5 times the design pressure with 30 minutes holding time for each side as per quality plan attached in the Section D of the Vol. IIB.



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4.6 100% PMI Inspection for material grade of PHE Heat Transfer plates shall be from third party like TUV/Lloyd & certificate shall be submitted for review of BHEL.

4.7 BHEL reserves the right to conduct random & independent PMI inspection on PHE's Heat Transfer plates to ascertain the plate material.

4.8 Heat transfer area for the PHE as offered by bidder with technical offer shall be measured by White light scanning method during contract stage to ascertain the correctness of heat transfer area as offered by bidder.

Inspection of plate area measurement for one heat transfer plate per PHE by White Light Scanning shall be from third party like TUV/Lloyd, same shall also be witnessed by BHEL. No type test certificates are acceptable to BHEL for same.

Bidder shall furnish the procedure for White Light Scanning method during detailed engineering viz. after award of contract which shall be subjected to BHEL/Customer approval. The Minimum requirement for White Light Scanning procedure is as per the Annexure-A of the quality plan attached in the Section D of the Vol. IIB.

Bidder to note that Heat Transfer Area measured by White Light Scanning during contract stage should not have negative tolerance more than 3% w.r.t to the heat transfer area indicated by bidder against the offered model of PHE. However in the case of negative tolerance (limited to maximum 3 percent), bidder has to provide additional plates proportionately, as free issue, assembled into all the applicable PHE's before the Final inspection and "As built Certificate" shall be issued by the bidder accordingly. Bidder to note that negative tolerance beyond three percent shall not be accepted, however no credit shall be given to the bidder for positive tolerance of the plate area measurement.

5.0 PERFORMANCE GUARANTEE AND TESTING:

5.1 The PHE shall be guaranteed to meet the performance requirements specified in Section-D and also for trouble free operation after commissioning. Schedule of performance guarantees (enclosed in Volume-III) duly filled and signed shall be furnished with the bid.

5.2 After commissioning of PHE's at site, performance test of all PHE's for each unit individually will be conducted by bidder at project site to ensure that the PHE's meet the specified requirements. In case of any deficiency, the vendor shall rectify the same at site with no additional cost to BHEL. All duly calibrated instruments required for PG testing including for flow measurements shall be arranged by the bidder and taken back after the Test. The computation of flow by characteristics curve of Pumps for PG Testing of PHE's shall not be permitted.

5.3 It is clarified that pressure gauges and temperature gauges are provided at each PHE inlet / outlet on both primary / secondary sides and bidder can install their calibrated instruments on these locations. It is further clarified that due to layout constraints flow measuring instruments installation on pipe is not feasible. Bidder shall arrange the Ultra-sonic flow meter / similar type of instrument for PG testing.

5.4 At the time of performance testing, cleaning of the plates (if required) and instruments like pressure gauges, temp. gauges, flow measuring instruments etc. shall be



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arranged by the bidder and no instruments shall be provided by BHEL for performance testing.

6.0 SPARES :

6.1 **Mandatory Spares:** Shall be as per data sheet A,

7.0 DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER:

No document other than the following is required to be submitted by bidder with the offer unless bidder considers it absolutely necessary.


- a) Compliance certificate as enclosed in Volume III
- b) Schedule of Deviations if any.
- c) Guarantee Schedule.
- d) Schedules of Price & Unit Price for each project.
- e) GA Drg. of PHE indicating all-important details for Layout purpose, withdrawal space required for plates, weight of assembly, nozzle & matching piece details etc.
- f) Confirmation of plate area of the offered model, duly endorsed from the Head of Engg./R&D of Principal supplier of the plate.
- g) Schedule of declaration.

7.1 Other Drawings/ documents as per Data Sheet-C, etc shall be submitted by successful bidder after the award of contract as per the distribution schedule.


8.0 EXCLUSIONS :

The following are excluded from the bidder's scope:

- 8.1 Civil foundation works required for installation of the heat exchangers.
- 8.2 Piping, valves etc., on the external circuit of both primary and secondary water streams.
- 8.3 Erection & Commissioning of equipment at site.

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SECTION - D
PLATE HEAT EXCHANGER
STANDARD TECHNICAL SPECIFICATION
DATA SHEET C
STANDARD QUALITY PLAN

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1.00.01 GENERAL

This specification covers the Design, Performance requirements, Constructional Features, Materials requirements, manufacture, assembly, Inspection and Testing at Manufacturer's and/ or his subcontractor's works and Painting requirements for delivery of Plate Heat Exchanger complete with all accessories as specified herein-after.

2.00.00 CODES AND STANDARDS:

2.01.00 The design, manufacture and testing of the plate heat exchanger complete with all accessories, shall generally conform to the latest editions of the following appropriate standards.

2.01.01 IS/BS/DIN/US Standards regarding pressure vessels, pressure piping, pipes, valves, flanges and other as necessary.

2.01.02 IS/ BS/ DIN/ ASTM for material specification and testing procedures.


2.02.00 In case of any conflict between the above codes/ standards and this specification, the latter shall prevail and in case of any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding

3.00.00 DESIGN AND CONSTRUCTION:

3.01.00 General Requirements:

3.01.01 Unless otherwise necessary, manufacture's standard and proven models of the plate heat exchanger shall be supplied.

3.01.02 The equipment shall be capable of safe, proper and continuous operation at all heat loads and water from up to those corresponding to the operating conditions mentioned in Data Sheet – A furnished a/w project enquiry. Vibration, noise, mechanical and thermal stresses shall be kept

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within allowable units specified by relevant codes/ standards in design. Due attention shall be given to *case of maintenance, repair and cleaning.*

3.01.03 Suitable corrosion allowance shall be provided wherever necessary. The corrosion allowance for the heat exchanger parts such as pressure plates (support plates), nozzles, sliding channels and frame shall be 1.6 mm (minimum).

3.01.04 Each heat exchanger shall be capable of passing a flow of at least 1.1 times the design flow rate on both primary and secondary water sides. Bidder shall indicate maximum pressure drop through the heat exchanger under this condition.

3.01.05 For the purpose of calculating dirty overall heat transfer coefficient, a total fouling factor as given in Data Sheet-A furnished a/w project enquiry shall be assumed. It is expected that the cleaning frequency shall be once in a year with the above fouling factor.

3.01.06 No back wash for the heat exchangers is envisaged.

3.02.00 Performance Requirements:


3.02.01 The pressure drop across plate heat exchanger from inlet to outlet in fouled conditions for primary and secondary sides, shall not be more than those specified in Data Sheet-A furnished a/w project enquiry, for the specified flow rates.

3.02.02 For the specified flow rate and inlet temperature, the primary side (hot fluid) outlet temperature shall not be more than that specified in Data Sheet-A furnished a/w project enquiry.

3.02.03 In the event of failure to meet the above stipulated performance requirements, the equipment will be out rightly rejected.

3.03.00 Construction of Heat Exchanger:

3.03.01 Heat transfer plates shall be packed in a frame consisting of fixed frame plate and movable pressure plate and aligned at top and bottom of carrying bars. Design shall be such that cleaning is possible without dismantling the piping.

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- 3.03.02 Heat transfer plates shall be sealed at their outer edges and around the ports by gaskets in order to prevent leakage and inter-mixing of fluids.

Double sealing arrangement shall be provided at outer edge and around ports. The inter space between the seals shall be vented to atmosphere in order to avoid inter-mixing of liquids in case of gaskets failure.

The gasket arrangement shall be such that it receives continuous support to ensure a long gasket life. The gasket should be able to retain their properties and shape over a life period of 10 years.

- 3.03.03 Heat transfer plates shall be provided with sufficient thickness in order to impart sufficient rigidity to the plates particularly from handling considerations. Plates shall have contact points in order to provide inter-plate supports. The recesses on the plates are suitably strengthened by a reinforcement plate.

Plate thickness shall be adequate to withstand all operating conditions as specified in data sheet A furnished a/w project enquiry.. Flanges shall be as per ANSI 16.5 or equivalent. Thickness of pressure and frame plates shall be as per ASME Sect. VIII div.1.25% extra capacity for additional plates shall be provided in frame.

Each Plate shall be numbered in sequence. The number shall be marked by indelible ink on the plate to permit easy reassembly. The plates shall be pressed from one piece. They shall be pressed in single/ progressive manner.

The corrugation shall be smooth, uniform and identical for every plate. The PHE bottom frame plate and support should have fixing lugs and cleats to keep provision for enabling to fit trough with outlet nozzle fitted underneath to collect and drain out water in the event of leakages.

- 3.03.04 Frame for each heat exchanger shall have extra capacity to accommodate the additional plates, if required in future because of any reason whatsoever. The extra capacity to be provided is indicated in Data Sheet-A furnished a/w project enquiry.

The upper carrying bar and lower guide bar shall be rigid in construction

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without any risk of sagging or buckling, and shall facilitate easy guiding of the plates.

3.03.05 All inlet, outlet and other nozzles shall be flanged type and shall be as specified in Data Sheet-A. Counter flanges complete with gaskets, bolts, nuts and coatings (wherever necessary) shall be supplied for the nozzle connections. The nozzle sizes of primary/ secondary streams of PHE's shall be of adequate size within acceptable range of velocity. The size selection shall be subject to approval in the event of order.

3.03.06 If necessary, relief valves shall be provided on both the streams.

3.04.00 **Materials of construction:**

Material of the heat transfer plates and gaskets shall be consistent with the fluid handled. However, material specification for various parts shall be equal or superior to those specified in Data Sheet - A furnished a/w project enquiry.

4.00.00 **FOUNDATION AND LIFTING ARRANGEMENTS:**

4.01.00 Plate heat exchanger shall be supplied with necessary foundation plates, anchor bolts, sleeves, nuts, inserts etc.


4.02.00 Plate heat exchanger shall be equipped with suitable lifting lugs/ eyebolts to facilitate handling during erection and maintenance.

5.00.00 **PAINTING:**

5.01.00 The surface preparation of all exterior and interior surfaces of plate heat exchanger shall include the following:

- a) Removal of oil, grease, dirt and swarf etc
- b) Removal of rust and scale etc.,
- c) Sand blasting/ shot blasting.

5.02.00 All exterior surfaces of PHE's shall be sand/ shot blasted, painted with

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primer and finish coated with coal tar based epoxy coating of min. 250 microns thickness. Color shade etc. shall be subject to BHEL/ Customer approval.

6.00.00 SHOP INSPECTION AND TESTS:

6.01.00 General:

6.01.01 Manufacturer shall conduct all tests and stage inspections as per the approved quality plan to ensure that the plate heat exchanger shall conform to the requirements of this specification and of the applicable codes/ standards.

6.01.02 All materials used for manufacture/ fabrication of the plate heat exchanger components shall be of tested quality. Relevant test certificates for chemical analysis, mechanical tests and heat treatment shall be made available before the final shop inspection. In case the relevant test certificates are not available, the manufacturer shall arrange to carry out the necessary tests required as per approved quality plan and applicable codes at his cost, for which samples shall be identified by BHEL's representative.


6.01.03 All shop tests shall be conducted in the presence of BHEL's representative and test certificates for the same shall be furnished to BHEL for approval.

6.01.04 Qualification of welding procedures and welders shall be as per ASME B&PV Code, Section-IX/applicable code.


6.02.00 Heat Transfer Plates:

6.02.01 Plate material used for pressing shall be furnished with mill test report showing chemical and physical properties and heat treatment records. Suitable correlating mark shall be available, so that BHEL's inspector can identify the material with test certificates before pressing the plates.

6.02.02 After pressing visual and dimensional checks on the plates shall be made in the presence of BHEL's inspector, on sampling basis.

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- 6.02.03 The heat transfer plates from each lot of the plates shall be tested by liquid/ dye penetrant test in order to check for cracks and other surface defects in presence of BHEL/customer's representative/Third party (Llyods, TUV or equivalent). If any defect is detected in any of these plates, the whole lot shall be tested and plates without defects only shall be accepted. Plate cleaning agent, liquid penetrant and developer shall not contain any halogen .Procedure for light box test and DP test shall be submitted to purchaser's approval. For Quantum of check , Refer Section C.
- 6.02.04 The heat transfer plates shall be tested by light box test in order to check for cracks and other surface defects in presence of BHEL/customer's representative/Third party (Lloyds', TUV or equivalent). The plates without defects only shall be accepted. For Quantum of check , Refer Section C.
- 6.03.00 **Gaskets:**
- 6.03.01 Certificate on Chemical composition of the gasket material shall be furnished to prove the quality. Sample testing in presence of BHEL's inspector shall also be conducted, if desired.
- 6.03.02 Shore hardness test shall be conducted on the gasket and certificate shall be furnished. Sample tests shall also be done in presence of BHEL's inspector.
- 6.03.03 Visual and dimensional check on a sampling basis shall be done. Plates and gaskets assembled together will be inspected for proper assembly.
- 6.04.00 **Frame Assembly:**
- 6.04.01 All materials for various components of frame assembly viz. frame plate, pressure plate, carrying bar, guide bar, tightening/ clamping bolts and nuts etc., shall be of tested quality and test certificates for chemical composition and physical properties shall be furnished.
- 6.04.02 If the thickness of the plates used for frame and pressure plates is 40 mm or more the same shall be checked ultrasonically to demonstrate the absence of lamination and lack of fusion etc.
- 6.05.00 All weld joints used for Fabrication of Heat exchangers shall be subjected to suitable non destructive examination. This shall include 100 % magnetic particle examination or other suitable NDT of all welds.

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7.00.00 Document submission:


7.01.00 The tenderer shall submit during contract stage a curve showing expected DM Water (Primary side) temperature at heat exchanger outlet for each one degree centigrade variation in ACW (Secondary side) temperature, all other parameters remaining unchanged. Similar curve for expected DM Water outlet temperature for variation of ACW flow rate with ACW inlet temperature remaining unaltered shall also be furnished. The bidder shall also furnish various curves to enable, apply corrections during site PG testing in the event of any data variation from the stipulated design parameters.


7.02.00 Bidder shall also furnish thermal design calculations at contract stage to justify the no. of plates offered.


DM WATER TEMP
20.03/11/06

		TECHNICAL SPECIFICATION FOR PLATE HEAT EXCHANGER		Technical specification no	PE-TS-394/395-179-N001 (Rev 0)
		DATASHEET - A		Vol/Section	IIB/D
				Rev	0
				date	07.11.2013
		PROJECT		2 X 800 MW GADARWARA STPP -STG PKG	
1.0	General			(TG AUX.)	
1.1	Number of Plate Heat Exchanger		Nos	Total Six (6) nos [2W+1S Per Unit]	
1.2	Arrangement			3 x 50% per unit	
1.3	Location			Indoor	
1.4	Primary side (Hot) Fluid			Passivated DM water (Refer enclosed water analysis)	
1.5	Secondary side (Cold) fluid			Cooling Water (Refer enclosed water analysis)	
1.6	Connecting Pipe size	(Primary Side)	NB	450	
		(Secondary Side)	NB	450	
2.0	Design				
2.1	Design Pressure		Kg/cm ² (g)	10	
2.2	Operating Pressure	(Primary Side)	Kg/cm ² (g)	About 8 Kg/sq. cm	
		(Secondary Side)	Kg/cm ² (g)	About 3 Kg/sq. cm	
2.3	Mechanical Design Temp.		°C	60	
2.3	Heat Transfer per Sq.Mtr. Of Heat Transfer Plate		Kcal/Hr./m ²	6500 (Max.)	
2.4	Minimum Heat Transfer Area		Sq. M.	-	
2.5	Specific Heat of Fluid	(Primary Side)	Cal/gmDeg. C	1.0	
		(Secondary Side)	Cal/gmDeg. C	1.0	
2.6	Density of Fluid	(Primary Side)	gm/cc	1.0	
		(Secondary Side)	gm/cc	1.0	
3.0	Guaranteed Performance Requirements for each Heat Exchangers in fouled condition:				
3.1	Flow rate	(DMCW Side)	M ³ /hr	1110	
		(ACW Side)	M ³ /hr	1260	
3.2	Inlet temperature	(DMCW Side)	°C	46	
		(ACW Side)	°C	36	
3.3	Outlet temp	(DMCW Side)	°C	38	
		(ACW Side)	°C	43	
3.4	* Allowable pressure drop across heat exchanger from inlet to outlet in fouled conditions at design flow	(DMCW Side)	MWC	7	
		(ACW Side)	MWC	7	
* High pressure drop than the specified figure will not be accepted, no credit shall be, however, given for lower pressure drop in bid evaluation. Pressure drop mentioned shall be calculated against flow mentioned at S. No 3.1					
4.0	Additional HT plates on Design Plates		%	NIL	
5.0	Heat Transfer Coefficient/Margin				
5.1	Overall fouling resistance	Hr m ² deg C/Kcal		0.00008	
5.2	Minimum corrosion allowance (refer note 1)		mm	1.6	
6.0	Material of Construction :				
6.1	Heat Transfer Plates (Minimum acceptable plate thickness 0.6 mm). Refer Note no. 3			SS-AISI-316	
6.2	Plate Gasket			Nitrile Rubber	


		TECHNICAL SPECIFICATION FOR PLATE HEAT EXCHANGER		Technical specification no	PE-TS-394/395-179-N001 (Rev 0)
		DATASHEET - A		Vol/Section	IIB/D
				Rev	0
				date	07.11.2013
	PROJECT		2 X 800 MW GADARWARA STPP -STG PKG		
6.3	Compression/ Pressure plates		Carbon steel to IS-2062 Gr. B, Epoxy painted		
6.4	Guide Rails/ bar		Carbon steel to IS-2062 Gr. B, Epoxy painted with stainless steel cladding		
6.5	Support Beam/ column		Carbon steel to IS-2062 Gr. B, Epoxy painted		
6.6	Nozzle		Carbon steel to IS-2062 Gr. B		
6.7	Nozzle flanges		Carbon steel to IS-2062 Gr. B		
6.8	Flange/ Counter flanges		Carbon Steel as per IS 2062 Gr. B (Confirming to ANSI B 16.5 class, Min.- 150 lb)		
6.9	Tie Bolts & Nuts		IS-1367 Gr 8.8 or equivalent		
6.10	Nozzle flange bolt and nut		SA 193 B7/ SA 194 2H		
6.11	Nozzle flange gasket		3mm wire inserted Red Rubber		
6.12	Name Plate		SS- AISI-316		
6.13	Painting				
	External Surface				
	a.) Surface Preparation		All surface other than stainless steels shall be painted. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by shotblasting etc shall be subjected to BHEL/NTPC approval.		
	b.) Primer		For all the steel surfaces inside the (indoor installation) building, a coat of read oxide primer of minimum thickness of 50 microns followed up with undercoat of synthetic enamel paint of minimum thickness of 50 microns shall be applied. The top coat shall consist of two coats each: of minimum thickness of 50 microns of synthetic enamel paint and thus total thickness shall be minimum 200 microns.		
	c.) Final Paint				
7.0	Extra Carrying capacity to be provided on frame assembly.	%	25		
8.0	Mandatory Spares				
8.1	Plates		20 % of each type and class		
8.2	Gaskets		20 % of each type and class		
8.3	Fasteners		20 % of each type and class		
8.4	Valve		NIL		
8.5	Definitions Regarding %		-	Quantity shall be calculated for % of total population of item in the project (if in fraction, round-off to next higher whole no.)	
9.0	Available space (L x W x H)	mm	_____ Bidder to indicate _____		
10.0	Weight of Assembly	Kg	_____ Bidder to indicate _____		
11.0	Performance Testing		All supplied PHE to be tested by vendor at site to demonstrate guaranteed performance.		
12.0	Performance curves and figures to be furnished during contact stage				
12.1	Primary side water outlet temperature vs. Secondary side water inlet temperature.				
12.2	Primary side water flow (80% to 115%) vs. Pressure drop and outlet temperature (Secondary side flow – 100%)				
12.3	Secondary side water flow (80% to 115%) vs. Secondary side pressure drop and primary side outlet temp (Primary side flow – 100%)				
12.4	Primary side water outlet temperature vs. Primary side inlet temp.				
12.5	Film heat transfer coefficient curve				
12.6	Correction Curves.				
Note: 1	Minimum Corrosion allowance on thickness (as per ASME Sec. VIII Div. I)				
2	Metallurgy shall be suitable for type of water handled for various plates.				
3	Minimum plate thickness of 0.6 mm is without any negative tolerance.				

	TECHNICAL SPECIFICATION FOR		Technical specification No.	PE-TS-394/395-179-N001 (Rev 0)
	PLATE HEAT EXCHANGER		Vol/Section	IIB/D
	DATASHEET - A		Rev	0
			date	07.11.13
SL. NO.	DESCRIPTION	UNIT		
	PROJECT		2 X 800 MW GADARWARA STPP -SG PKG	
1.0	General		Alternative 1	Alternative II
1.1	Number of Plate Heat Exchanger	Nos	Total Six (4) nos [1W+1S Per Unit]	
1.2	Arrangement		2X100% per unit	
1.3	Location		Outdoor	
1.4	Primary side (Hot) Fluid		Passivated DM water (Ref enclosed water analysis)	
1.5	Secondary side (Cold) fluid		Cooling Water (Ref enclosed water analysis)	
1.6	Connecting Pipe size	(Primary Side)	NB	300
		(Secondary Side)	NB	Alternative 1 - 300 Alternative II - 400
2.0	Design			
2.1	Design Pressure	Kg/cm ² (g)	12	
2.2	Operating Pressure	(Primary Side)	Kg/cm ² (g)	About 8.8 Kg/sq. cm
		(Secondary Side)	Kg/cm ² (g)	About 3.2 Kg/sq cm
2.3	Mechanical Design Temp.	°C	60	
2.3	Heat Transfer per Sq.Mtr. Of Heat Transfer Plate	Kcal/Hr./m ²	6500 (Max.)	
2.4	Minimum Heat Transfer Area	Sq. M.	-	
2.5	Specific Heat of Fluid	(Primary Side)	Cal/gmDeg.C	1.0
		(Secondary Side)	Cal/gmDeg.C	1.0
2.6	Density of Fluid	(Primary Side)	gm/cc	1.0
		(Secondary Side)	gm/cc	1.0
3.0	Guaranteed Performance Requirements for each Heat Exchangers in fouled condition:			
3.1	Flow rate	(DMCW Side)	M ³ /hr	500
		(ACW Side)	M ³ /hr	Alternative 1 - 500 Alternative II - 900
3.2	Inlet temperature	(DMCW Side)	°C	44.6
		(ACW Side)	°C	36
3.3	Outlet temp	(DMCW Side)	°C	38
		(ACW Side)	°C	Alternative 1 - 42.6 Alternative II - 39.6
3.4	* Allowable pressure drop across heat exchanger from inlet to outlet in fouled conditions at design flow	(DMCW Side)	MWC	7
		(ACW Side)	MWC	7
* High pressure drop than the specified figure will not be accepted, no credit shall be, however, given for lower pressure drop in bid evaluation. Pressure drop mentioned shall be calculated against flow mentioned at S. No 3.1				
4.0	Additional HT plates on Design Plates	%	NIL	
5.0	Heat Transfer Coefficient/Margin			
5.1	Overall fouling resistance	Hr m ² deg C/Kcal	0.00008	
5.2	Minimum corrosion allowance (refer note 1)	mm	1.6	
6.0	Material of Construction :			
6.1	Heat Transfer Plates (Minimum acceptable plate thickness 0.6 mm). Refer Note no. 3		SS-AISI-316	
6.2	Plate Gasket		Nitrile Rubber	
6.3	Compression/ Pressure plates		Carbon steel to IS-2062 Gr. B, Epoxy painted	
6.4	Guide Rails/ bar		Carbon steel to IS-2062 Gr. B, Epoxy painted with stainless steel cladding	
6.5	Support Beam/ column		Carbon steel to IS-2062 Gr. B, Epoxy painted	
6.6	Nozzle		Carbon steel to IS-2062 Gr. B	
6.7	Nozzle flanges		Carbon steel to IS-2062 Gr. B	

	TECHNICAL SPECIFICATION FOR		Technical specification No.	PE-TS-394/395-179-N001 (Rev 0)
	PLATE HEAT EXCHANGER		Vol/Section	HB/D
	DATASHEET - A		Rev	0
			date	07.11.13
SL. NO.	DESCRIPTION	UNIT		
	PROJECT		2 X 800 MW GADARWARA STPP -SG PKG	
6.8	Flange/ Counter flanges		Carbon Steel as per IS 2062 Gr. B (Confirming to ANSI B 16.5 class, Min.-150 lb)	
6.9	Tie Bolts & Nuts		IS-1367 Gr 8.8 or equivalent	
6.10	Nozzle flange bolt and nut		SA 193 B7/ SA 194 2H	
6.11	Nozzle flange gasket		3mm wire inserted Red Rubber	
6.12	Name Plate		SS- AISI-316	
6.13	Painting			
	External Surface			
	a.) Surface Preparation		All surface other than stainless steels shall be painted. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by shotblasting etc shall be subjected to BHEL/NTPC approval.	
	b.) Primer		For all the steel surfaces inside the (indoor installation) building, a coat of red oxide primer of minimum thickness of 50 microns followed up with undercoat of synthetic enamel paint of minimum thickness of 50 microns shall be applied. The top coat shall consist of two coats each: of minimum thickness of 50 microns of synthetic enamel paint and thus total thickness shall be minimum 200 microns.	
	c.) Final Paint			
7.0	Extra Carrying capacity to be provided on frame assembly.	%	25	
8.0	Mandatory Spares			
8.1	Plates		2 % of each type	
8.2	Gaskets		30% of total requirement	
8.3	Fasteners		NIL	
8.4	Valve		NIL	
8.5	Definitions Regarding %		Quantity shall be calculated for % of total population of item in the project (if in fraction, round-off to next higher whole no.)	
9.0	Available space (L x W x H)	mm	----- Bidder to indicate -----	
10.0	Weight of Assembly	Kg	----- Bidder to indicate -----	
11.0	Performance Testing		All supplied PHE to be tested by vendor at site to demonstrate guaranteed performance.	
12.0	Performance curves and figures to be furnished during contact stage			
12.1	Primary side water outlet temperature vs. Secondary side water inlet temperature.			
12.2	Primary side water flow (80% to 115%) vs. Pressure drop and outlet temperature (Secondary side flow – 100%)			
12.3	Secondary side water flow (80% to 115%) vs. Secondary side pressure drop and primary side outlet temp (Primary side flow – 100%)			
12.4	Primary side water outlet temperature vs. Primary side inlet temp.			
12.5	Film heat transfer coefficient curve			
12.6	Correction Curves.			
Note: 1	Minimum Corrosion allowance on thickness (as per ASME Sec. VIII Div. I)			
2	Metallurgy shall be suitable for type of water handled for various plates.			
3	Minimum plate thickness of 0.6 mm is without any negative tolerance.			

CLAUSE NO.	PROJECT INFORMATION		ANNEXURE-I																																																					
	<div>ANNEXURE-A-III</div> <div>DESIGN CLARIFIED WATER ANALYSIS</div> <table><tr><th>Sl. No.</th><th>Constituent</th><th>as</th><th>mg per litre</th></tr><tr><td>1.</td><td>Calcium</td><td>CaCO₃</td><td>102</td></tr><tr><td>2.</td><td>Magnesium</td><td>CaCO₃</td><td>41</td></tr><tr><td>3.</td><td>Sodium</td><td>CaCO₃</td><td>35</td></tr><tr><td>4.</td><td>Potassium</td><td>CaCO₃</td><td>3</td></tr><tr><td>5.</td><td>Total Alkalinity</td><td>CaCO₃</td><td>113</td></tr><tr><td>6.</td><td>P-Alkalinity</td><td>CaCO₃</td><td>Nil</td></tr><tr><td>7.</td><td>Chloride</td><td>CaCO₃</td><td>43</td></tr><tr><td>8.</td><td>Sulphate</td><td>CaCO₃</td><td>25</td></tr><tr><td>9.</td><td>Silica (Reactive)</td><td>SiO₂</td><td>16</td></tr><tr><td>10.</td><td>Iron</td><td>Fe</td><td>0.3 mg/l</td></tr><tr><td>11.</td><td>pH Value</td><td>-</td><td>6.8 - 8.5</td></tr><tr><td>12.</td><td>Turbidity</td><td>NTU</td><td>10</td></tr></table> <p>Note- Clarified water shall be used as make up water for cooling water system.</p>				Sl. No.	Constituent	as	mg per litre	1.	Calcium	CaCO ₃	102	2.	Magnesium	CaCO ₃	41	3.	Sodium	CaCO ₃	35	4.	Potassium	CaCO ₃	3	5.	Total Alkalinity	CaCO ₃	113	6.	P-Alkalinity	CaCO ₃	Nil	7.	Chloride	CaCO ₃	43	8.	Sulphate	CaCO ₃	25	9.	Silica (Reactive)	SiO ₂	16	10.	Iron	Fe	0.3 mg/l	11.	pH Value	-	6.8 - 8.5	12.	Turbidity	NTU	10
Sl. No.	Constituent	as	mg per litre																																																					
1.	Calcium	CaCO ₃	102																																																					
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5.	Total Alkalinity	CaCO ₃	113																																																					
6.	P-Alkalinity	CaCO ₃	Nil																																																					
7.	Chloride	CaCO ₃	43																																																					
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GADARWARA SUPER THERMAL POWER PROJECT (2X800 MW) STEAM TURBINE GENERATOR PACKAGE <i>& SLPK.</i>		TECHNICAL SPECIFICATION SECTION-VI PART-A	PROJECT INFORMATION	PAGE 8 OF 9																																																				

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CLAUSE NO.	PROJECT INFORMATION		ANNEXURE-I																			
	<p style="text-align: right;">ANNEXURE A-III</p> <p style="text-align: center;">ANALYSIS OF DM WATER TO BE USED FOR MAKE-UP WATER TO CONDENSER</p> <table border="0" style="width: 100%;"> <thead> <tr> <th style="text-align: left;">Sl.No.</th> <th style="text-align: left;">Characteristics</th> <th style="text-align: left;">Value</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Silica (Max.)</td> <td>0.01 ppm as SiO₂</td> </tr> <tr> <td>2.</td> <td>Iron as Fe</td> <td>Nil</td> </tr> <tr> <td>3.</td> <td>Total hardness</td> <td>Nil</td> </tr> <tr> <td>4.</td> <td>pH value</td> <td>6.8 -7.3</td> </tr> <tr> <td>5.</td> <td>Conductivity</td> <td>Not more than 0.1micro mho/cm excluding the effects of free CO₂</td> </tr> </tbody> </table> <p style="text-align: center; margin-top: 20px;">For passivated DM water pH is around 9.5.</p>				Sl.No.	Characteristics	Value	1.	Silica (Max.)	0.01 ppm as SiO ₂	2.	Iron as Fe	Nil	3.	Total hardness	Nil	4.	pH value	6.8 -7.3	5.	Conductivity	Not more than 0.1micro mho/cm excluding the effects of free CO ₂
Sl.No.	Characteristics	Value																				
1.	Silica (Max.)	0.01 ppm as SiO ₂																				
2.	Iron as Fe	Nil																				
3.	Total hardness	Nil																				
4.	pH value	6.8 -7.3																				
5.	Conductivity	Not more than 0.1micro mho/cm excluding the effects of free CO ₂																				
GADARWARA SUPER THERMAL POWER PROJECT (2X800 MW) STEAM TURBINE GENERATOR PACKAGE <i>210 m.</i>	TECHNICAL SPECIFICATION SECTION-VI PART-A	PROJECT INFORMATION	PAGE 9 OF 9																			

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TITLE :
**TECHNICAL SPECIFICATION FOR
PLATE HEAT EXCHANGERS**

SPECIFICATION NO. PE-TS-393-179-N001

VOLUME II B

SECTION D

REV. NO. 0 DATE 07.11.13

SHEET 1 OF 1

DATA Sheet-C

Drawings / documents distribution schedule to be followed by successful bidder:

1.0 Within 2 weeks from the date of LOI, the successful bidder shall submit following drawings/ documents.

- a) Data Sheet-B duly filed in along with heat transfer calculations.
- b) G.A./ installation drawings, indicating principal dimensions and heights of equipment being supplied, size and location of various nozzles, connection supporting arrangement, withdrawal space & scope of supply etc.
- c) Foundation arrangement drawings, showing load data on supports, size and location of anchor bolts etc.
- d) Quality Plan.
- e) Area & Heat Load Calculations.
- f) Various performance curves as listed in our specification.
- g) Cross-Sectional drawing indicating bill of quantities and materials of construction.
- h) Performance test procedure.

2.0 Within the stipulated time period as per vendor's drawings/ documents schedule, the following shall be submitted but not later than one month before 1st dispatch.

- a) Drawings of components & details as deemed necessary.
- b) Instruction manual for erection, operation & maintenance.
- c) Storage instruction.

3.0 Before despatch of the equipment the bidder shall furnish the following.

- a) Material test certificates.
- b) Shop test reports & certificates.

4.0 Distribution of drawings / documents for all projects:

The successful bidder, after the award of the contract shall furnish the drawings/ documents as per the following distribution schedule.

Sl. No.	Type of Document	No of Hard copies	No. of Soft copies
1	Documents submitted for Approval	18 Nos.	2 Nos.
2	Final Distribution(Approved Documents)	18 Nos.	2 Nos.
3	O&M Manuals	18 Nos.	2 Nos.
4	As built drawings	18 Nos.	2 Nos.

STANDARD QUALITY PLAN		CUSTOMER:		PROJECT TITLE:		SPECIFICATION NO. :					
BIDDER/VENDOR:		QUALITY PLAN NO.:		SPECIFICATION TITLE :		SECTION :					
SYSTEM:		ITEM: PHE									
SHEET OF											
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CAT	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	
1.0	RAW MATERIAL INSPECTION										
1.1	Frame Plates & Pressure Plates, Counter Flanges, Connection Lining Material, Top And Bottom Carrying Bar.	Physical Properties	MA	Physical Test	1/ Heat/He -at Batch	1/ Heat/He -at Batch	App. Drg / Data Sheet	Relevant material spec.	Mill TC Or Lab Test Report	√ 2,3 - 1	If co-related mill TCS are not available then check testing carried out by reputed lab
		Chemical Properties	MA	Chemical Analysis	1/ Heat/He -at Batch	1/ Heat/He -at Batch	-do-	-do-	-do-	√ 2,3 - 1	-do-
		Dimensions	MA	Measurement	100%	100%	Approved Drawings	-do-	Inspection Reports	√ 2,3 - 1	
		Workmanship And Finish Lamination (Applicable For Frame And Pressure Plate Only)	MA	Visual	100%	100%	-do-	-do-	-do-	√ 2,3 - 1	
1.2	Heat Transfer Plates	Physical Properties	CR	Ultrasonic Test	100%	100%	SA 435/ SA 578	SA 435/ SA 578	-do-	√ 2,3 - 1	Applicable for plate thickness more than 25 mm only
		Chemical Properties	MA	Physical Test	1/ Heat	1/ Heat	App. Drg. / Data Sheet	-do-	Mill TC Or Lab Test Report	√ 2,3 - 1	Co-related mill TCS to be provided See Remark 1
		Dimensions	MA	Measurement	100%	100%	Approved Drawings	-do-	Inspection Reports	√ 2,3 - 1	
		Dimensions	MA	Measurement	100%	100%	Approved Drawings	-do-	Inspection Reports	√ 2,3 - 1	
1.3	Gaskets	Workmanship And Finish	MA	Visual	-do-	-do-	No damage, No Surface defects.	-do-	-do-	√ 2,3 - 1	Co-related mill TCS to be provided See Remark 1
		Contour	MA	Visual	-do-	-do-	Mfg. Drgs / specification	-do-	-do-	√ 2,3 - 1	

MANUFACTURER/ SUB-SUPPLIER		SIGNATURE		DOC. NO.:		REV. CAT.:	
				Cust. Logo		REV. CAT.:	
				FOR CUST. USE		APPROVED BY	
				REVIEWED BY		APPROVAL SEAL	

LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
**** 1: BHEL 1* SHALL BE CLEARED BY BHEL 2: VENDOR, 3: SUB VENDOR**
P: PERFORM W: WITNESS AND V: VERIFICATION, AS APPROPRIATE
CHP: CUSTOMER SHALL IDENTIFY IN COLUMN "N" AS "W"

FORMAT NO.: QS-01-QAL-P-09/FI-RI
 ENGG. DIV./QA&I
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STANDARD QUALITY PLAN		CUSTOMER:		PROJECT TITLE:		SPECIFICATION NO. :						
SHEET OF		BIDDER/VENDOR:		QUALITY PLAN NO.:		SPECIFICATION TITLE :						
		SYSTEM:		ITEM: PHE		SECTION :						
SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CAT	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS		
					2/3	1			P W V			
1.	2.	3.	4.	5.	6.	7.	8.	9.	** 10.	11.		
		Hardness	CR	Measurement	-do-	Approved Drawings		-do-	2,3 -	1		
1.4	Tightening Bolts & Nuts. (Tie Rod)	Physical Properties	MA	Physical Test	1/ Heat	App. Drg / data sheet	Relevant Material Spec.	Mill Tc Or Lab Test Report	2,3 -	1	Manufacturer test certificate will be submitted for review.	
		Chemical Properties	MA	Chemical Analysis	1/ Heat	1/ Heat	-do-	-do-	-do-	2,3 -	1	-do-
		Dimensions	MA	Measurement	100%	100%	Approved Drawings		IR	2,3 -	1	
		Workmanship and Finish	MA	Visual	100%	100%	-do-		-do-	2,3 -	1	
		Internal Soundness (For diameter >= 40 mm)	CR	UT	100%	100%	See Remark - 3	-do-	2,3 -	1	UT will be carried on raw material stage.	
2.0	IN PROCESS INSPECTION											
		Area Measurement	NA	White Light Scanning	1 per Type	1 per Type	Approved drawing/ data sheet	IR	2,3 -	1	Refer Point No. 3 of remarks	
		Physical Properties	MA	Physical Test	1 Sample per Heat	1 Sample per Heat	Approved drawing/ data sheet	Mill TC or Lab Test Report	2,3 -	1	Manufacturing test certificates will be submitted for review.	
		Chemical Properties	MA	Chemical Analysis	1 Sample per Heat	1 Sample per Heat	Approved drawing/ data sheet	Mill TC or Lab Test Report	2,3 -	1	Manufacturing test certificates will be submitted for review.	
	HT PLATES	Dimension	MA	Measurement	1 Sample per Heat	1 Sample per Heat	Approved drawing/ data sheet	Inspection Report	2,3 -	1		

LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.		DOC. NO.:		REV. CAT.-	
** 1: BHEL 1* SHALL BE CLEARED BY BHEL 2: VENDOR, 3: SUB VENDOR		Cust. Logo			
P: PERFORM W: WITNESS AND V: VERIFICATION, AS APPROPRIATE		FOR CUST. USE			
CHP: CUSTOMER SHALL IDENTIFY IN COLUMN "N" AS 'W'		REVIEWED BY		APPROVED BY	
SIGNATURE		APPROVAL SEAL			

FORMAT NO.: QS-01-QAL-P-09/FI-R1

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ENGG. DIV./QA&I

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**PROCEDURE FOR MEASUREMENT OF HEAT TRANSFER SURFACE AREA OF THE
PHE PLATES**

Definition of Heat transfer area:

The Heat transfer area of the PHE plate is the area of the plate participating in the heat transfer process viz. the wetted surface area inside the gasketed groove of the plate as the Annexure 1.

Steps to Measure the Area:

- 1) The surface area of the plate shall be cleaned thoroughly.
- 2) Apply the developer (as used in Dye Penetrant test) over the entire surface of the plate.
- 3) Fix the reference stickers at several appropriate locations on the plate.
- 4) White light (CFL) is projected on the plate.
- 5) The entire surface area including all the geometrical features of the plate (corrugations) is captured by the 3D camera.
- 6) The 3D image of the plate is then converted into CAD format.
- 7) The surface area can be measured from the 3D- CAD drawing.

ANNEXURE -1

Heat transfer area to be measured – Shown in Hatched portion below

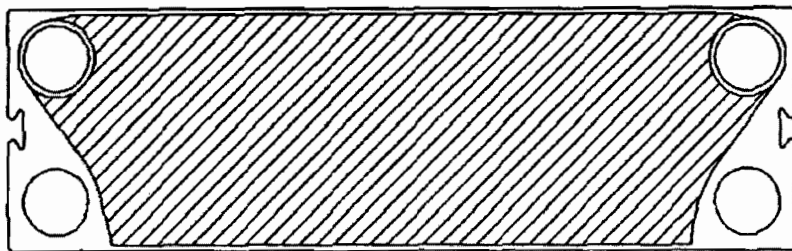


Fig. 1: Wetted Surface Area for Parallel Connection

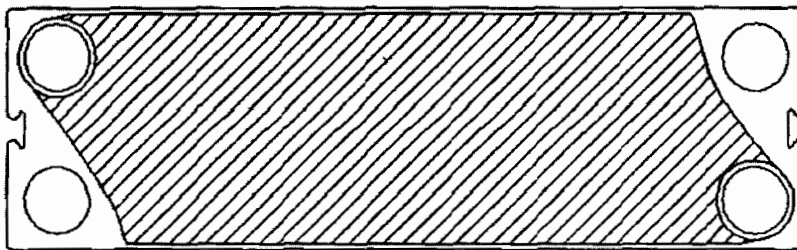


Fig. 2: Wetted Surface Area for Diagonal Connection