

**NATIONAL THERMAL POWER CORPORATION LTD.  
1X500 MW NTPC FERZE GANDHI UNCHAHAR TPP  
STAGE-IV**

**VOLUME-II B**

**TECHNICAL SPECIFICATIONS  
FOR  
VIBRATION ISOLATION SYSTEM  
FOR  
TG FOUNDATION (1 NOS)**

**SPECIFICATION NO. PE-TS-401-613-C001 (REV 0)**



**BHARAT HEAVY ELECTRICALS LIMITED  
Project Engineering Management  
PPEI BUILDING, HRD & ESI COMPLEX  
Plot No. 25, Sector 16A  
NOIDA, U.P. – 201301  
CONTENTS**

1. SECTION-A SCOPE OF WORK
2. SECTION-B PROJECT INFORMATION
3. SECTION-C SPECIFIC TECHNICAL REQUIREMENTS
4. SECTION-D STANDARD TECHNICAL SPECIFICATON FOR VIS



PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV

**TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION A

REV.NO. 0 DATE 23-04-2014

Page 1 of 3

**SECTION 'A'**

**SCOPE OF WORK**



PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV

**TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION A

REV.NO. 0 DATE 23-04-2014

Page 2 of 3

## SCOPE

### 1. Supply of Vibration Isolation System (VIS)

- i) Vibration Isolation System (VIS)
- ii) Tools and facilities required for erection and commissioning including seaworthy packing & transportation etc. complete.

### 2. Supervision of erection and commissioning of the VIS.

Vendor shall deploy experienced manpower for setting the VIS in position and final adjustments after machine installation. Vendor shall also confirm the readiness at site before deploying the manpower for supervision of erection. Vendor shall furnish proposed erection strategy of the entire system and procedure for replacement of VIS and downtime involved.

### 3. Design & Engineering for the Vibration Isolation System

Design and engineering shall consist of the following:

- i) Selection of Vibration Isolation System (VIS).
- ii) Static and dynamic analysis and design of RCC deck slab (supporting arrangement for the equipment supported on VIS)
- iii) Calculation of loads on supporting structure along with their points of application and deflection limitations.
- iv) Calculation should establish that no dynamic loads are transferred to the structure supporting VIS and that the foundation system meets the amplitude/frequency requirements.
- v) Checking of stiffness for structure supported on VIS.

### 4. Documentation

Vendor shall furnish following documents:

- i) Bill of materials of various elements included in the supply along with detailed specifications of system and various items included in supply and standards local or international standards to which they conform.
- ii) General Arrangement (GA) drawing showing location and supporting details of VIS.
- iii) GA and reinforced concrete details drawings for deck slab including bar bending schedule.
- iv) Embedment drawings showing location of all embedment and their details pertaining to RCC deck slab.
- v) Design document.
- vi) Methodology of providing the shuttering and its removal as well as concreting of deck slab, installation of VIS and sequence of above operation.
- vii) Installation and maintenance manual indicating equipment, procedures, etc. necessary for installation/maintenance of VIS.



PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV

**TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION A

REV.NO. 0 DATE 23-04-2014

Page 3 of 3

- viii) List of power plants where such systems have been successfully installed for such applications.
- ix) Performance certificate from the end user/customer for at least two successfully executed contracts for such system.



PROJECT :IX500 MW NTPC, FGUTPP STAGE-IV

**TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION B

REV.NO. 0 DATE 23-04-2014

Page 1 of 2

**SECTION 'B'**

**PROJECT INFORMATION**



PROJECT :1X500 MW NTPC, FGUTPP STAGE-IV

**TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION B

REV.NO. 0 DATE 23-04-2014

Page 2 of 2

**PROJECT INFORMATION**

1.	Owner	NATIONAL THERMAL POWER CORPORATION LTD.
2.	Project	1X500 MW NTPC FGUTPP STAGE-IV
3.	No of Units	1
4.	Consultant	NATIONAL THERMAL POWER CORPORATION LTD.
5.	Location	The plant is located in Raebareli district of Uttar Pradesh, it is bounded by villages khnapur, Faridpur and Khaliqpur Khurd. Mustafabad town is located at adistance of about 3 kms from the plant. Unchahar railway station on Allahabad-Raebareli broad gauge (BG) section of Northern Railway (NR) is 2 kms away. The nearest airport is located at Lucknow a distance of approximately 110 km from the project site.
6.	District	Raebareli district of Uttar Pradesh
7.	Nearest Major Town	Mustafabad town is located at a distance of about 3 kms from the plant.
8.	Nearest Railway station	Unchahar railway station on Allahabad-Raebareli broad gauge(BG) section of Northern Railway(NR) is 2 kms away.
9.	Nearest Airport	The nearest airport is located at Lucknow a distance of approximately 110 km from the project site.



PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV  
**TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION C

REV.NO. 0 DATE 23-04-2014

Page 1 of 5

**SECTION 'C'**

**SPECIFIC TECHNICAL REQUIREMENTS**





**PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV  
TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION C

REV.NO. 0 DATE 23-04-2014

Page 2 of 5

**1. General Requirement**

- 1.01. In case of any conflict between section-C and section-D, Section-C will prevail over Section-D.
- 1.02. Bidder shall quote based on the input drawings as per Table-1 to satisfy the design requirement as per the relevant applicable codes refer annexure- I, and section -D.

Table-1

<u>Sl. No</u>	<u>TITLE</u>	<u>DRAWING NO.</u>
1	LOAD ON FOUNDATION	0-13100-S2151 (R0)
2	FOUNDATION PLAN	0-13100-S2152 (R0)
3	FOUNDATION PLAN	0-13100-S2153 (R0)
4	FOUNDATION PLAN	0-13100-S2154 (R0)
5	FOUNDATION PLAN	1-13100-S2155 (R0)
6	LIST OF EMBEDDED PARTS	2-13100-S2156 (R0)

- 1.03. Bidder shall furnish the information about the entire range of spring units, damper units and spring cum damper units, manufactured by the vendor. The information to be furnished should include the load carrying capacity, stiffness (vertical & horizontal), damping resistance, dimension of spring and damper units as well as quality plan.
- 1.04. The vibration isolation system supplied shall be of proven make and shall be in successful operation supporting machines like turbo-generators.
- 1.05. The isolation efficiency of at least 90% shall be provided for the Turbo-generator
- 1.06. The nominal spring capacity shall be at least 25% higher than the actual spring-supported weight for the TG.

**2. Seismic Loading:**

Seismic loads shall be calculated adopting the site specific seismic information as specified in annexure-II

**3. Wind Loading :**

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 "Vb" at ten metres above the mean ground level: 47 m/s.
- b. The risk coefficient "K1" : 1.07



**PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV  
TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION C

REV.NO. 0 DATE 23-04-2014

Page 3 of 5

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).

**4. Material of construction**

- i. Minimum Grade of Concrete: M35.
- ii. TMT HYSD (Thermo-mechanically Treated High Yield Strength Deformed Bars) steel bars of grade Fe 500D conforming to IS 1786.

**5. Documents to be submitted by vendor**

- i. Soft copy of all documents/drawings shall be furnished in pdf and AutoCAD format as applicable.
- ii. Hard copies shall also be submitted.
- iii. Submission of civil drawings/documents shall be as mentioned in the table below

	Drawing	Document
For Approval	Soft copy + 6 nos. hard copies	Soft copy + 3 no. hard copy +2 CD
For RFC	Soft copy + 15 nos. hard copies	1 sets of paper print + 2CD

**6. Material (Design & Supply)**

6.01. Steel helical springs and viscous dampers shall consist of:

- a. Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc.
- b. Frames for pre-stressing of spring elements.
- c. Suitable hydraulic jack system including electric pumps, high pressure tubes etc. required for the erection, alignment etc. of the spring units. One set of extra hydraulic jacks, and hand operated pumps shall also be provided.
- d. Any other items may be required for the pre-stressing, erection, release of pre-stress, alignment and commissioning of the steel helical springs and viscous dampers.

6.02. The design of the supporting arrangement for the equipment supported on steel helical springs and viscous dampers shall be done by vendor. The supporting arrangement shall consist of an RCC deck supported on steel helical spring units and viscous dampers which in turn shall be supported on RCC substructure/steel structure.



**PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV  
TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION C

REV.NO. 0 DATE 23-04-2014

Page 4 of 5

- 6.03. The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 Hz.
- 6.04. The damper units or spring cum damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures ranging from 0 to 50° c. The damping resistance of the individual damper units should be such that the designed damping can be provided using reasonable number of units within available space.
- 6.05. The sizes of the spring units, damper units, spring cum damper units should be such that groups of such units can be accommodated on column heads in case of elevated foundations and on pedestals/walls in case of foundations at ground level.
- 6.06. The steel helical springs and viscous dampers shall be designed for a minimum operating life of 30 years.

## **7. Manufacturing & Testing**

- 7.01. Complete manufacturing and testing of the steel helical springs and viscous dampers shall be done at the manufacturing shop of the vendor. For this purpose the vendor shall submit the detailed programme for approval of customer and take up the manufacturing / testing after approval of such quality plan. The quality plan shall include:

- Manufacturing schedule and quality check exercised during manufacturing.
- Detail of test to be carried out at the manufacturing shop with its schedule.
- Special requirements, if any, regarding concreting of top deck.
- Complete step- by- step procedure covering the installation and commissioning of the spring system.
- Manuals for erection, commissioning, testing and maintenance of the steel helical springs and viscous dampers.
- A checklist for confirming the readiness of the civil fronts for erection of steel helical springs and viscous dampers.
- Checklist for equipment required at each stage of erection.
- Bill of materials (data sheet) of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.
- Bill of material (data sheet) for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc. with their rating and numbers.
- Any other details which may be necessary to facilitate design and construction of the foundations / structures.

- 7.02. The springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedure shall be finalised on the basis of the above codes and the quality plans be drawn accordingly.

## **8. Transportation**



**PROJECT: 1X500 MW NTPC FGUTPP STAGE-IV  
TECHNICAL SPECIFICATIONS FOR VIS  
FOR TG (1 NOS.) FOUNDATION**

SPECIFICATION NO. PE-TS-401-613-C001

VOLUME II B

SECTION C

REV.NO. 0 DATE 23-04-2014

Page 5 of 5

8.01. Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit and handling.

8.02. The vendor shall be responsible for any loss or damage during transportation, handling.

**9. Erection and Commissioning**

9.01. Complete erection and commissioning of the steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. all shall be supervised by a specialist supervisor.

9.02. The scope of work shall be deemed to include all activities, which may not have been explicitly mentioned but are reasonably implied for the successful commissioning of steel helical springs and viscous dampers.

9.03. The vendor shall guarantee the performance of the steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as "Guarantee Period".

**10. Supervision**

The supervision of installation of steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of vendor, trained for this purpose.

**11. Realignment of Spring System**

If any realignment of the steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the vendor.

## ANNEXURE-I (Section-C)

### **Codes and Standards**

Some of the relevant applicable Indian standards and codes, etc. applicable to this section of the specification are listed below:

DIN : 4024 Machine foundations; Flexible supporting structures for machine with rotating masses.

DIN : 2089 Helical compression springs out of round wire and rod: calculation & design.

DIN : 2096 Helical compression springs out of round wire and rod: quality requirements for hot formed compression springs.

VDI : 2056 Criteria for assessing mechanical vibrations of machine.

VDI : 2060 Criteria for assessing the state of balance of rotating rigid bodies.

# ANNEXURE - II



CLAUSE NO.	TECHNICAL REQUIREMENTS	ANNEXURE - XXVI																
	<p style="text-align: right;"><b>ANNEXURE - EQ</b></p> <p><b>CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT</b></p> <p>All structures 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. Pending finalisation of Parts 2 to 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.</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-EQ1.</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). The site specific acceleration spectra along with multiplying factors specified in Annexure-EQ1 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).</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><tr><td>a)</td><td>Steel structures</td><td>:</td><td>2%</td></tr><tr><td>b)</td><td>Concrete structures and brick structures in cement mortar</td><td>:</td><td>5%</td></tr><tr><td>c)</td><td>Concrete Stacks / ND Cooling Towers</td><td>:</td><td>2%</td></tr><tr><td>d)</td><td>Steel stacks</td><td>:</td><td>As per IS:6533 &amp; CICIND Model Code, whichever is more critical.</td></tr></table>	a)	Steel structures	:	2%	b)	Concrete structures and brick structures in cement mortar	:	5%	c)	Concrete Stacks / ND Cooling Towers	:	2%	d)	Steel stacks	:	As per IS:6533 & CICIND Model Code, whichever is more critical.	
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FGUTPP Stage – IV (1 x 500) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI PART-B	Sub-Section - D-01 Civil Works	Annexure –EQ Page 1 of 6															

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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>If the design base shear (<math>V_B</math>) , 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/ V_B</math>. However, no reduction is permitted if <math>\bar{V}_B</math> is less than <math>V_B</math>.</p> <p>For building 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-EQ1.</p> <p>Further, 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.</p> <p><b>Design/Detailing for Ductility</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>		
FGUTPP Stage – IV (1 x 500) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI PART-B	Sub-Section - D-01 Civil Works	Annexure –EQ Page 2 of 6

6

CLAUSE NO.	TECHNICAL REQUIREMENTS
	<p style="text-align: right;"><b><u>ANNEXURE – EQ1</u></b></p> <p><b><u>SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT</u></b></p> <p>The various site specific seismic parameters for the project site shall be as follows:</p> <ol style="list-style-type: none"> <li>1) Peak ground horizontal acceleration : 0.26g</li> <li>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 <ol style="list-style-type: none"> <li>a) for moment resisting steel frames designed and detailed as per IS:800 and moment resisting RC frames designed and detailed as per IS:456 : 0.091</li> <li>b) for braced steel frames designed and detailed as per IS:800 : 0.068</li> <li>c) for moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.055</li> <li>d) for design of structures not covered under 2 (a) to 2 (c) above and under 3 below : 0.091</li> </ol> </li> <li>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 : 0.13</li> </ol> <p>Note: g = Acceleration due to gravity</p> <p>The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.</p>
FGUTPP Stage – IV (1 x 500) FPC PACKAGE	<div style="display: flex; justify-content: space-between;"> <div style="width: 25%;"> TECHNICAL SPECIFICATIONS SECTION VI PART-B </div> <div style="width: 25%;"> Sub-Section - D-01 Civil Works </div> <div style="width: 50%; text-align: right;"> Annexure –EQ Page 3 of 6 </div> </div>

8



CLAUSE NO.	TECHNICAL REQUIREMENTS																																																																																																																
	<p style="text-align: center;"><b><u>HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS</u></b> <b><u>In units of 'g'</u></b></p>																																																																																																																
	<table><tr><th rowspan="2">Time Period (Sec)</th><th colspan="2">Damping Factor (as a percentage of critical damping)</th></tr><tr><th>2%</th><th>5%</th></tr><tr><td>0.000</td><td>1.000</td><td>1.000</td></tr><tr><td>0.030</td><td>1.000</td><td>1.000</td></tr><tr><td>0.050</td><td>1.645</td><td>1.445</td></tr><tr><td>0.100</td><td>3.231</td><td>2.379</td></tr><tr><td>0.120</td><td>3.868</td><td>2.713</td></tr><tr><td>0.123</td><td>3.868</td><td>2.755</td></tr><tr><td>0.125</td><td>3.868</td><td>2.755</td></tr><tr><td>0.150</td><td>3.868</td><td>2.755</td></tr><tr><td>0.200</td><td>3.868</td><td>2.755</td></tr><tr><td>0.250</td><td>3.868</td><td>2.755</td></tr><tr><td>0.300</td><td>3.868</td><td>2.755</td></tr><tr><td>0.350</td><td>3.868</td><td>2.755</td></tr><tr><td>0.400</td><td>3.868</td><td>2.755</td></tr><tr><td>0.450</td><td>3.868</td><td>2.755</td></tr><tr><td>0.500</td><td>3.868</td><td>2.755</td></tr><tr><td>0.550</td><td>3.868</td><td>2.755</td></tr><tr><td>0.561</td><td>3.868</td><td>2.755</td></tr><tr><td>0.598</td><td>3.868</td><td>2.755</td></tr><tr><td>0.602</td><td>3.868</td><td>2.755</td></tr><tr><td>0.613</td><td>3.795</td><td>2.755</td></tr><tr><td>0.630</td><td>3.695</td><td>2.683</td></tr><tr><td>0.650</td><td>3.582</td><td>2.600</td></tr><tr><td>0.675</td><td>3.449</td><td>2.504</td></tr><tr><td>0.700</td><td>3.326</td><td>2.414</td></tr><tr><td>0.750</td><td>3.104</td><td>2.253</td></tr><tr><td>0.800</td><td>2.910</td><td>2.113</td></tr><tr><td>0.850</td><td>2.739</td><td>1.988</td></tr><tr><td>0.900</td><td>2.587</td><td>1.878</td></tr><tr><td>0.950</td><td>2.451</td><td>1.779</td></tr><tr><td>1.000</td><td>2.328</td><td>1.690</td></tr><tr><td>1.050</td><td>2.217</td><td>1.610</td></tr><tr><td>1.100</td><td>2.116</td><td>1.536</td></tr><tr><td>1.150</td><td>2.024</td><td>1.470</td></tr><tr><td>1.200</td><td>1.940</td><td>1.408</td></tr><tr><td>1.250</td><td>1.862</td><td>1.352</td></tr></table>			Time Period (Sec)	Damping Factor (as a percentage of critical damping)		2%	5%	0.000	1.000	1.000	0.030	1.000	1.000	0.050	1.645	1.445	0.100	3.231	2.379	0.120	3.868	2.713	0.123	3.868	2.755	0.125	3.868	2.755	0.150	3.868	2.755	0.200	3.868	2.755	0.250	3.868	2.755	0.300	3.868	2.755	0.350	3.868	2.755	0.400	3.868	2.755	0.450	3.868	2.755	0.500	3.868	2.755	0.550	3.868	2.755	0.561	3.868	2.755	0.598	3.868	2.755	0.602	3.868	2.755	0.613	3.795	2.755	0.630	3.695	2.683	0.650	3.582	2.600	0.675	3.449	2.504	0.700	3.326	2.414	0.750	3.104	2.253	0.800	2.910	2.113	0.850	2.739	1.988	0.900	2.587	1.878	0.950	2.451	1.779	1.000	2.328	1.690	1.050	2.217	1.610	1.100	2.116	1.536	1.150	2.024	1.470	1.200	1.940	1.408	1.250	1.862	1.352
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0.400	3.868	2.755																																																																																																															
0.450	3.868	2.755																																																																																																															
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0.550	3.868	2.755																																																																																																															
0.561	3.868	2.755																																																																																																															
0.598	3.868	2.755																																																																																																															
0.602	3.868	2.755																																																																																																															
0.613	3.795	2.755																																																																																																															
0.630	3.695	2.683																																																																																																															
0.650	3.582	2.600																																																																																																															
0.675	3.449	2.504																																																																																																															
0.700	3.326	2.414																																																																																																															
0.750	3.104	2.253																																																																																																															
0.800	2.910	2.113																																																																																																															
0.850	2.739	1.988																																																																																																															
0.900	2.587	1.878																																																																																																															
0.950	2.451	1.779																																																																																																															
1.000	2.328	1.690																																																																																																															
1.050	2.217	1.610																																																																																																															
1.100	2.116	1.536																																																																																																															
1.150	2.024	1.470																																																																																																															
1.200	1.940	1.408																																																																																																															
1.250	1.862	1.352																																																																																																															
FGUTPP Stage – IV (1 x 500) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI PART-B	Sub-Section - D-01 Civil Works	Annexure –EQ Page 4 of 6																																																																																																														

8

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<b><u>HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS</u></b> <b><u>In units of 'g'</u></b>		
	<b>Time Period</b> <b>(Sec)</b>	<b>Damping Factor (as a percentage of critical damping)</b>	
		<b>2%</b>	<b>5%</b>
	1.300	1.791	1.300
	1.350	1.724	1.252
	1.400	1.663	1.207
	1.450	1.606	1.166
	1.500	1.552	1.127
	1.550	1.502	1.090
	1.600	1.455	1.056
	1.650	1.411	1.024
	1.700	1.369	0.994
	1.750	1.330	0.966
	1.800	1.293	0.939
	1.850	1.258	0.914
	1.900	1.225	0.889
	1.950	1.194	0.867
	2.000	1.164	0.845
	2.050	1.136	0.824
	2.100	1.109	0.805
	2.150	1.083	0.786
	2.200	1.058	0.768
	2.250	1.035	0.751
	2.300	1.012	0.735
	2.350	0.991	0.719
	2.400	0.970	0.704
	2.450	0.950	0.690
	2.500	0.931	0.676
	2.550	0.913	0.663
	2.600	0.895	0.650
	2.650	0.878	0.638
	2.700	0.862	0.626
	2.750	0.847	0.615
	2.800	0.831	0.604
	2.850	0.817	0.593
	2.900	0.803	0.583
	2.950	0.789	0.573
	3.000	0.776	0.563
	3.050	0.763	0.554
FGUTPP Stage – IV (1 x 500) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI PART-B	Sub-Section - D-01 Civil Works	Annexure –EQ Page 5 of 6

✓

CLAUSE NO.	TECHNICAL REQUIREMENTS																																																																
	<p style="text-align: center;"><b><u>HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS</u></b> <b><u>In units of 'g'</u></b></p> <table><tr><th rowspan="2">Time Period (Sec)</th><th colspan="2">Damping Factor (as a percentage of critical damping)</th></tr><tr><th>2%</th><th>5%</th></tr><tr><td>3.100</td><td>0.751</td><td>0.545</td></tr><tr><td>3.150</td><td>0.739</td><td>0.537</td></tr><tr><td>3.200</td><td>0.728</td><td>0.528</td></tr><tr><td>3.250</td><td>0.716</td><td>0.520</td></tr><tr><td>3.300</td><td>0.705</td><td>0.512</td></tr><tr><td>3.350</td><td>0.695</td><td>0.504</td></tr><tr><td>3.400</td><td>0.685</td><td>0.497</td></tr><tr><td>3.450</td><td>0.675</td><td>0.490</td></tr><tr><td>3.500</td><td>0.665</td><td>0.483</td></tr><tr><td>3.550</td><td>0.656</td><td>0.476</td></tr><tr><td>3.600</td><td>0.647</td><td>0.469</td></tr><tr><td>3.650</td><td>0.638</td><td>0.463</td></tr><tr><td>3.700</td><td>0.629</td><td>0.457</td></tr><tr><td>3.750</td><td>0.621</td><td>0.451</td></tr><tr><td>3.800</td><td>0.613</td><td>0.445</td></tr><tr><td>3.850</td><td>0.605</td><td>0.439</td></tr><tr><td>3.900</td><td>0.597</td><td>0.433</td></tr><tr><td>3.950</td><td>0.589</td><td>0.428</td></tr><tr><td>4.000</td><td>0.582</td><td>0.423</td></tr></table>			Time Period (Sec)	Damping Factor (as a percentage of critical damping)		2%	5%	3.100	0.751	0.545	3.150	0.739	0.537	3.200	0.728	0.528	3.250	0.716	0.520	3.300	0.705	0.512	3.350	0.695	0.504	3.400	0.685	0.497	3.450	0.675	0.490	3.500	0.665	0.483	3.550	0.656	0.476	3.600	0.647	0.469	3.650	0.638	0.463	3.700	0.629	0.457	3.750	0.621	0.451	3.800	0.613	0.445	3.850	0.605	0.439	3.900	0.597	0.433	3.950	0.589	0.428	4.000	0.582	0.423
Time Period (Sec)	Damping Factor (as a percentage of critical damping)																																																																
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FGUTPP Stage – IV (1 x 500) EPC PACKAGE	TECHNICAL SPECIFICATIONS SECTION VI PART-B	Sub-Section - D-01 Civil Works	Annexure –EQ Page 6 of 6																																																														



TITLE:

**STANDARD TECHNICAL  
SPECIFICATION FOR VIBRATION  
ISOLATION SYSTEM**

SPECIFICATION NO. PE-TS-999-600-C026

VOLUME - II B

SECTION - D

REV. NO. 0 DATE 05/07/2010

SHEET 1 OF 5

**VOLUME: II B**

**SECTION - D**

**SUB-SECTION - D26**

**VIBRATION ISOLATION SYSTEM**

**SPECIFICATION NO. PE-TS-999-600-C026**



**Bharat Heavy Electricals Limited**  
Project Engineering Management



TITLE:

**STANDARD TECHNICAL  
SPECIFICATION FOR VIBRATION  
ISOLATION SYSYTEM**

SPECIFICATION NO. PE-TS-999-600-C026

VOLUME - II B


SECTION - D

REV.NO. 0 DATE 05/07/2010

SHEET , 2 OF 5

**C O N T E N T**

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	Supply of VIS	3
3.00.00	Supervision of Erection and Commissioning	3
4.00.00	Design Engineering of Vibration Isolation System	3
5.00.00	Quality Plan and Test Certificate	5
6.00.00	Environmental Protection	5

	TITLE:	SPECIFICATION NO. PE-TS-999-600-C026	
	STANDARD TECHNICAL SPECIFICATION FOR VIBRATION ISOLATION SYSYTEM	VOLUME - II B	
		SECTION - D	
		REV.NO. 0	DATE 05/07/2010
	SHEET : 3	OF 5	

**VIBRATION ISOLATION SYSTEM**

1.00.00

SCOPE

This section covers supply, supervision of erection/ commissioning & design engineering of the vibration isolation system (VIS) suitable for ID/PA/FD Fans/ TDBFP/MDBFP/TURBOGENERATORS/MILLS .The vibration isolation system shall be of proven make and should be in successful operation for similar machines.

2.00.00

Supply of VIS

VIS shall be supplied complete along with recommended spares if any. The selection of VIS shall be done by the vendor, in case not done by customer , so that the amplitude at bearing locations are within permissible limits as per machine supplier recommendation or ISO10816 whichever is governing and no dynamic loads are transferred to the structure supporting VIS. Minimum 90 % isolation shall be achieved and the system shall be capable of withstanding Seismic/Wind forces.

3.00.00

Supervision of Erection and Commissioning

3.01.00

Manual

Vendor shall supply installation and maintenance manual indicating equipment, procedures etc. necessary for installation and replacement of VIS with downtime involved.

3.02.00

Tools and facilities

Vendor shall supply all tools and facilities as required for successful erection and commissioning of VIS. Vendor shall deploy experienced manpower to supervise successful installation of VIS

4.00.00

Design Engineering of Vibration Isolation System

4.01.00

Dynamic Analysis

The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. Isolation efficiency of at least 90 % shall be obtained. The fundamental natural frequency shall be sufficiently above or below the



TITLE:

**STANDARD TECHNICAL  
SPECIFICATION FOR VIBRATION  
ISOLATION SYSYTEM**

SPECIFICATION NO. PE-TS-999-600-C026

VOLUME - II B

SECTION - D

REV.NO. 0 DATE 05/07/2010

SHEET : 4 OF 5

frequency corresponding to operating speed. Vibration amplitude shall be calculated at all bearing locations and shall satisfy the permissible limits as per ISO 10816 or as specified by the machine supplier. Transient analysis shall be carried out for the short circuit /blade failure condition with an appropriate force function if required by the machine supplier. The forces for which substructure is to be designed shall be furnished.

**4.02.00 Static Analysis**

The static analysis shall include the

- a) Dead weights of machine stationary parts,
- b) Dead weights of machine rotary parts
- c) Loads due to machine power torque
- d) Loads due to maximum allowable unbalance
- e) Temperature loads
- f) Loads due to blade unbalance/short circuit
- g) Erections loads
- h) Seismic Loads
- i) Any other loads given by the supplier

Various load combinations must be investigated to obtain the most severe loads for foundation design purpose as per relevant IS codes or as per machine supplier recommendation whichever is more critical.

**4.03.00 Check for Shaft Misalignment**

Foundation deck must be adequately stiff to withstand all operating load combinations without excessively upsetting the rotor shaft alignment. The structural design must carefully be analysed for relative deflection for the members supporting machine shaft to satisfy the limits as given by machine supplier if any.

**4.04.00 Design of RCC deck supported on VIS**

Vendor shall provide General arrangement drawing of deck showing location and supporting detail of VIS, all embedment and their details as per the machine supplier drawing.

RCC design shall be done by working stress method for all machine foundations. Minimum reinforcement shall be governed by IS : 2974 as well IS : 456.

All documents/drawings shall be supplied in 25 (twenty five) prints. All calculations shall be supplied in 6 (six) sets. Soft copy of the drawings in Auto Cad shall be supplied along with the soft copy of the documents supplied



TITLE:

**STANDARD TECHNICAL  
SPECIFICATION FOR VIBRATION  
ISOLATION SYSYTEM**

SPECIFICATION NO. PE-TS-999-600-C026

VOLUME - II B

SECTION - D

REV.NO. 0 DATE 05/07/2010

SHEET 5 OF 5

All documentation shall be in English language and all RCC/structural design shall be conforming to the relevant Indian Standard Code of practice.

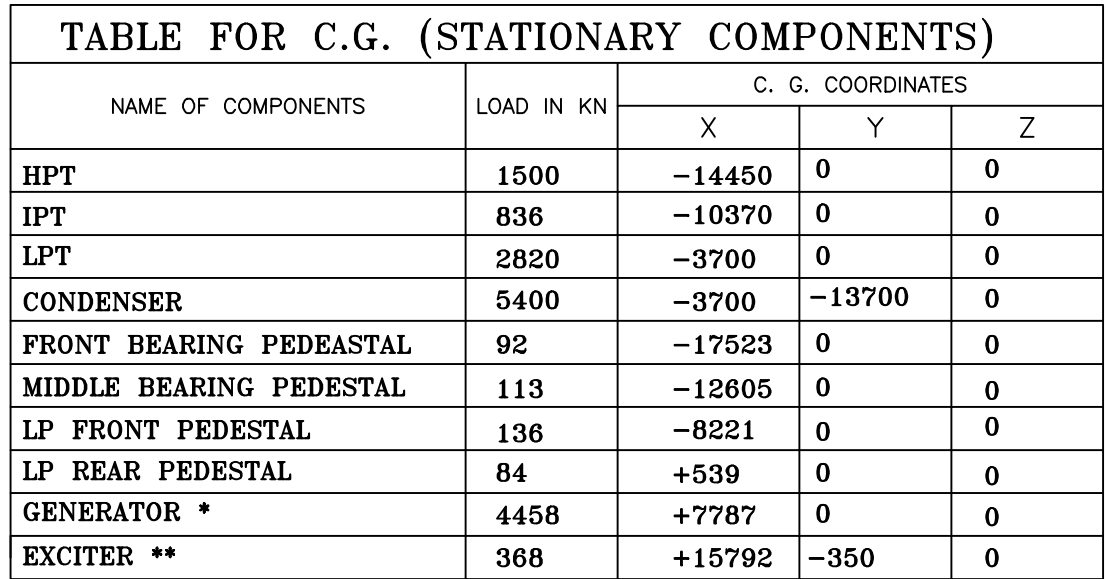
**5.00.00 Quality Plan and Test Certificate**

Vendor shall furnish the quality plan and Test certificate for the hardware in their scope of supply. The quality plan shall be reviewed by BHEL /Consultant wherein the inspection and hold points shall be indicated. Vendor shall submit test certificate based on approved Quality Plan. Despatch of material by the vendor shall only take place after the receipt of Material Dispatch Clearance Certificate (MDCC) issued by BHEL/Consultant on the basis of test reports/test certificates submitted by the Vendor after manufacture.

**6.00.00 Environmental Protection**

VIS shall be suitably protected against environmental damages e.g. abrasion, discolouration, corrosion, oily water etc. to give a prolonged service matching the plant life.





\* THE LOAD SHOWN FOR GENERATOR, I.E. 4458 KN, INCLUDES STATIONARY COMPONENTS OF GENERATOR STATOR (=3726 KN) AND ROTOR LOAD AT STANDSTILL (=732KN). THIS IS DUE TO THE FACT THAT GENERATOR BEARINGS ARE END SHIELD MOUNTED & ROTOR LOAD GET TRANSFERRED, VIA STATOR BODY TO FOUNDATION.

\*\* THE LOAD SHOWN FOR EXCITOR, I.E. 368 KN, INCLUDES STATIONARY COMPONENTS OF EXCITER STATOR (=328 KN) AND EXCITER ROTOR LOAD AT STANDSTILL (=40 KN). THIS IS DUE TO THE FACT THAT EXCITER BEARING IS MOUNTED ON EXCITER BED PLATE & EXCITER ROTOR LOAD GETS TRANSFERRED, VIA BED PLATE TO FOUNDATION.

### DESCRIPTIONS

- (A) STATIC LOADS OF STATIONARY COMPONENTS, FOR STABILITY REASONS PART OF THE CONDENSER WEIGHT IS HANGING ON LP OUTLET CASING. MAX POSSIBLE ACCUMULATION OF CONDENSATE IN CONDENSER 198 KN.
- (B) STATIC LOADS OF ROTATING ELEMENTS AND THEIR FOUNDATION LOADS.
- (C) FORCES DUE TO POWER TORQUE.
- (D) VACUUM LOAD DUE TO COMPENSATOR BELLOWS IN LP BEARING CASING OR CONDENSER EXPANSION BELLOWS.
- (E) THERMAL ELONGATION OF CONDENSER CAUSES COMPRESSION OF CONDENSER SPRINGS AND LIFTING OF LP OUTLET CASING.
- (F) COOLING WATER DRAIN OF 2240 KN FROM ONE HALF OF CONDENSER DURING OPERATION.
- (G) CONDENSATE PUMP FAILURE.
- (H) STEAM PIPING FORCES ARE ACTING THROUGH TURBINE CASINGS TO EMBEDDED FIXING POINT IN FOUNDATION. PIPING TENSILES SUSPENDED ON FOUNDATION IN HP AND IP AREA ARE TO BE CONSIDERED WITH 400 KN AND 300 KN RESPECTIVELY.
- (I)  $\epsilon_{\text{HORIZ}} (\mu = 0.2)$  SHOWN FOR START UP OF TURBINE AND GENERATOR AT COOLING DOWN. THE SIGNS ARE REVERSED. MAXIMUM VALUES OF REACTION FORCES TO FIXING POINTS ARE SHOWN ONLY.
- (J) DYNAMIC FOUNDATION LOADS DUE TO UNBALANCE ON HP-IP-OR-LP ROTOR.
- (K) LOSS OF BLADE UNBALANCE.
- (M) SHORT CIRCUIT FORCES
- TIME FUNCTION SHORT CIRCUIT TORQUE MK.
- $MK = 10904e - 1/0.14 \text{ SIN } wt - 5452e - 1/0.21 \text{ S}m2wt + 1069e - 1/0.14 \text{ KNm.}$
- $MKmax = 14585Nm$
- $W = 314 \text{ CYCLES/sec} = \text{ANGULAR FREQUENCY}$
- ROTOR MOMENT OF INERTIA AROUND THE AXIS =  $834 \text{ Mgm}^2$
- ROTOR MOMENT OF INERTIA AROUND THE AXIS =  $10 \text{ Mgm}^2$
- OPERATING SPEED  $n = 50 \text{ 1/sec}$
- SEISMIC LOADS DURING OPERATION ( $\epsilon_{\text{HORIZ}} =$  AND  $\epsilon_{\text{VERT}} = g$ )
- (N) STRETCH ELONGATION OF FOUNDATION BOLTS IN KN.
- (O) ERECTION AND ALIGNMENT OF TURBINE AND GENERATOR ROTOR REMOVAL AND DENSITY TEST OF CONDENSER.

REFERENCE DRAWINGS:-

1. FOUNDATION PLANS
2. INFLUENCE FACTOR OF SHAFTING
3. DESCRIPTION OF FOUNDATION LOADS
4. GENERATOR OUTLINE
5. EXCITER OUTLINE
6. CONDENSER

NOTE:

1. THE FOUNDATION DESIGNER SHOULD ADD HIS NORMAL DESIGN MARGINS TO THESE COMBINED LOADS.
2. ALL FORCES AND LOADS ARE SHOWN IN KILO NEWTONS.
3. ALL ELEVATIONS ARE SHOWN IN METERS.
4. IF A LOAD POINT NO. IS SHOWN AT MORE THAN ONE LOCATION, THE LOAD SHOWN IN TABLE IS APPLICABLE TO EACH SUCH LOAD POINT NO.

GRADE OF UNTOL.DIM
M/CG.- <del>Q</del> /M/ <del>F</del> AA0230208
WELDING- <del>A</del> /B/ <del>C</del> / <del>D</del> AA0621104
GAS CUTTING-'T3'AA0621101

GMS No./ C.B.O.M			STATUS OF DRUG
AGREED DEPT	NAME	SIGN	DATE

NTPC DRG. No.	1450-001R-TGHW-PVM-V-277
NBPL DRG. No.	
PROJECT	FEROZE GANDHI UNCHAHAR THERMAL POWER PROJECT STAGE-IV 1X500MW

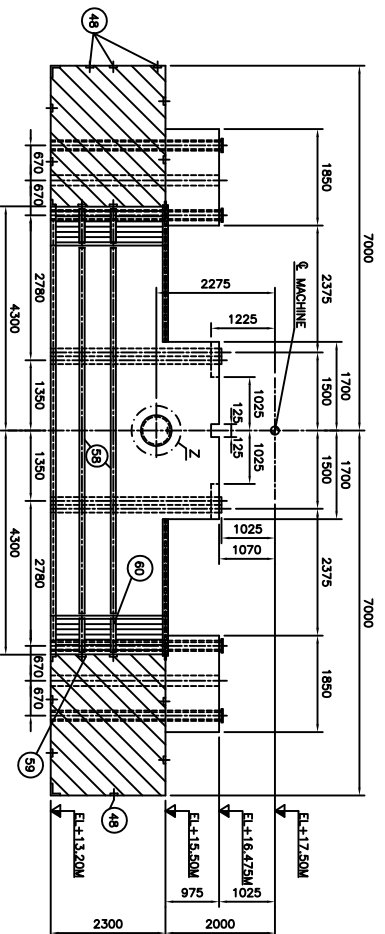
OWNER <b>NTPC</b>	<b>NTPC Limited</b> (A GOVERNMENT OF INDIA ENTERPRISE)
CONTRACTOR <b>NSPCL</b>	<b>NTPC BHEL Power Projects Private Limited</b> (A Joint Venture Company of NTPC & BHEL) Y.S.R. Puram, Village Manavaram, Sri Kalahasti Mandal, Distt. Chittoor - 517620 (A.P.)
<b>भारत भारती</b> <b>BHEL</b>	<b>भारत भारती</b> <b>BHARAT HEAVY ELECTRICALS LTD</b> RANIPUR, HARDWAR

DEPT PED		SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.
CODE 4066		NTS	-	-	-
TITLE :			CARD CODE	DRAWING NO.	
LOAD ON FOUNDATION				0-13100-S2151	
			7	22	
			SHEET NO. 01	No. OF SHEETS	

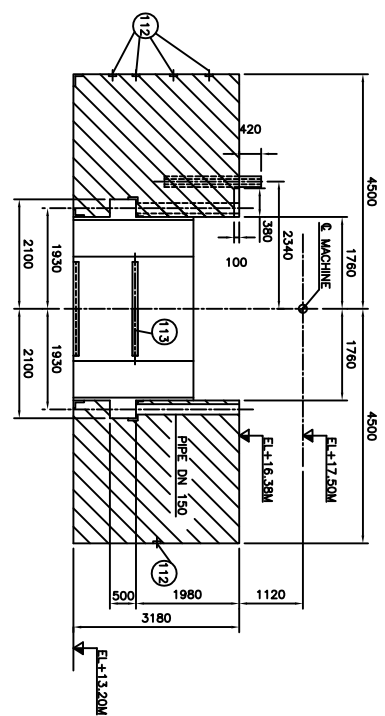




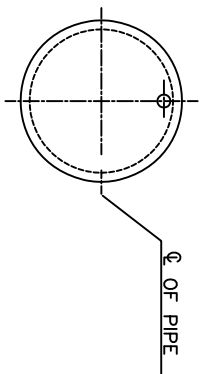




SECTION C-C  
0-13100-S2152



SECTION F-F  
0-13100-S2152

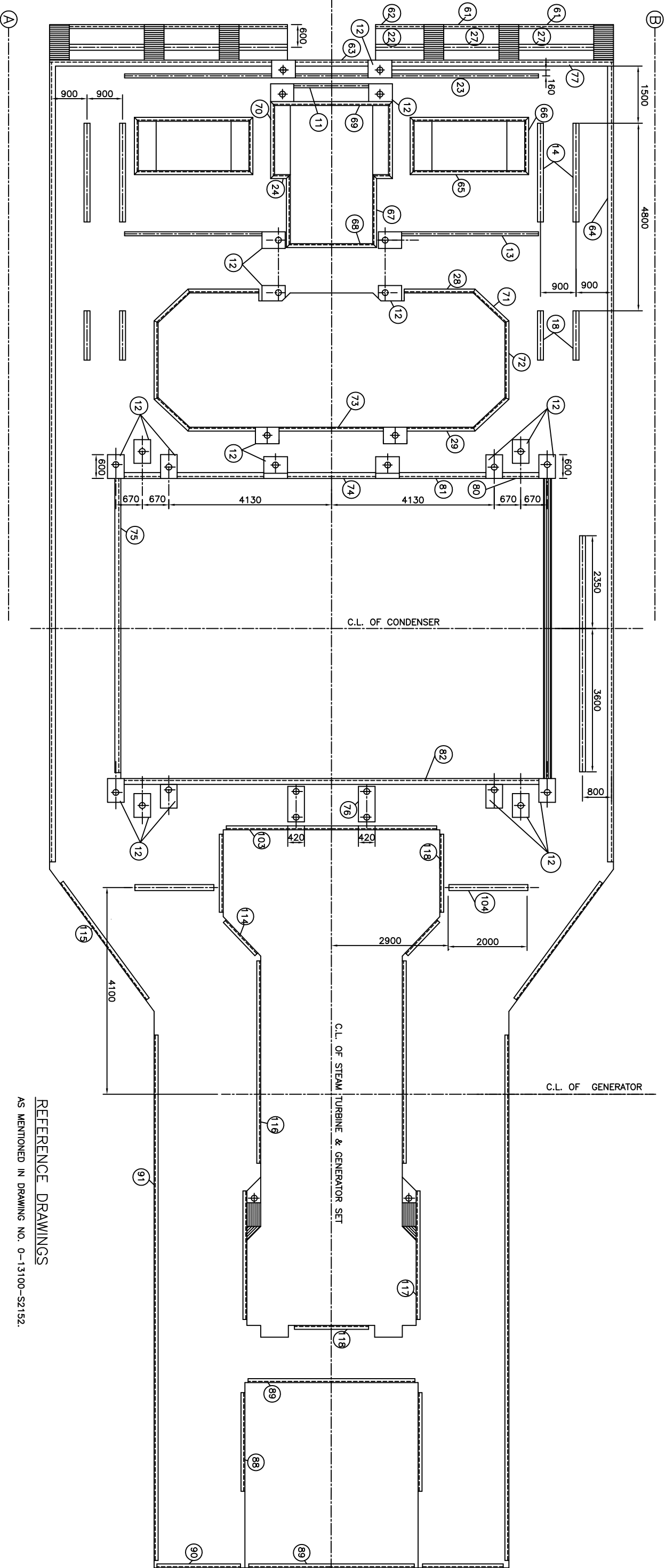


REFERENCE DRAWINGS:—

DRG.NO. 0-13100-S2152.  
DRG.NO. 0-13100-S2153.  
DRG.NO. 1-13100-S2155.  
DRG.NO. 2-13100-S2156.

**NO SIZE**

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IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY



PART NO.	QTY. IN NOS.	DESCRIPTION	SUPPLIER	REMARKS	DRAWING NO.
01	02	ANCHORING PIPE ASSY.	B.H.E.L. HARDWARE	FOR L P GENERATOR PEDESTAL	0-13100-S2152
02	04	ANCHORING ASSY.	"	GRIDER SUPPORT FRONT PLATE	"
03	01	PROTECTING PIPE	"	LP FRONT END	"
04	01	PROTECTING PIPE	"	LP REAR END	"
05	04	PIPE (OD 168.3Xth 10.97) L=3500	BHEL	FOR ANCHOR BOLTS	"
06	04	PIPE (OD 168.3Xth 7.11) L=3500	"	FOR ANCHOR BOLTS	"
07	04	PIPE (OD 168.3Xth 7.11) L=3275	"	FOR ANCHOR BOLTS	"
08	02	PIPE (OD 168.3Xth 7.11) L=3325	"	FOR ANCHOR BOLTS	"
09	02	PIPE (OD 168.3Xth 7.11) L=3530	"	FOR ANCHOR BOLTS	"
10	06	PIPE (OD 168.3Xth 7.11) L=3325	"	FOR ANCHOR BOLTS	"
11	02	FLAT 10X100X1800	NTPC	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	1-13100-S2155
12	24	FLAT 16X420X600	"	FOR FIXING OF ANCHOR NUTS	"
13	02	FLAT 10X100X3400	"	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	"
14	04	FLAT 10X100X2400	"	-DO-	"
15	02	FLAT 10X100X2800	"	-DO-	"
16	04	FLAT 10X100X4500	"	-DO-	"
17	03	FLAT 10X100X3200	"	-DO-	"
18	04	FLAT 10X100X1000	"	-DO-	"
19	01	FLAT 10X100X950	"	-DO-	"
20	04	PLATE 20X300X300	BHEL	FOR ESV-MAINTENANCE SUPPORT	"
21	04	PLATE 20X500X500	NTPC	FOR CROSSOVER PIPE SUPPORT	"
22	02	FLAT 10X100X650	"	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	"
23	02	FLAT 10X100X3400	"	-DO-	"
24	02	ANGLE 100X100X600	"	-DO-	"
25	02	BEAM ISMB 300X1580	BHEL	FOR FIXING OF ESV DURING MAINTEN.	"
26	03	FLAT 10X100X2300	NTPC	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	0-13100-S2152
27	04	FLAT 10X100X1850	"	-DO-	1-13100-S2155
28	02	ANGLE 100X100X1800	"	-DO-	"
29	02	ANGLE 100X100X1750	"	-DO-	"
30	02	T SECTION 100X3175	"	RECOMMENDED FOR FIXING OF PIPING SUPPORTS & FIRE PROTECTION	0-13100-S2152
31	02	T SECTION 100X710	"	-DO-	"
32	02	T SECTION 100X1040	"	-DO-	"
33	04	T SECTION 100X1700	"	-DO-	"
34	02	T SECTION 100X1900	"	-DO-	"
35	02	T SECTION 100X1850	"	-DO-	"
36	04	T SECTION 100X1150	"	-DO-	"
37	02	T SECTION 100X2050	"	-DO-	"
38	02	T SECTION 100X1900	"	-DO-	"
39	02	T SECTION 100X7000	"	-DO-	"
40	01	T SECTION 100X2875	"	-DO-	"
41	01	T SECTION 100X700	"	-DO-	"
42	02	T SECTION 100X2375	"	-DO-	"
43	08	PLATE 25X300X300	BHEL	FOR CLADDING SUPPORTS	"
44	02	PLATE 25X300X2200	"	-DO-	"
45	02	PLATE 25X300X2500	"	-DO-	"
46	02	PLATE 25X300X2800	"	-DO-	"
47	04	PLATE 10X100X1000	"	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	0-13100-S2153
48	04	FLAT 10X100X19800	NTPC	-DO-	0-13100-S2154
49	08	FLAT 10X100X1100	"	-DO-	"
50	02	ANGLE 100X100X5400	"	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	0-13100-S2152
51	02	ANGLE 100X100X10250	"	-DO-	"
52	01	ANGLE 100X100X1400	"	-DO-	"
53	01	ANGLE 100X100X1100	"	-DO-	"
54	01	ANGLE 100X100X2175	"	-DO-	"
55	06	FLAT 10X100X1500	"	-DO-	"

PART NO.	QTY. IN NOS.	DESCRIPTION		REMARKS	DRAWING NO.
56	04	FLAT 100X100X1800	NTPC	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	0-13100-S2153
57	08	FLAT 100X100X1500	"	-DO-	"
58	04	FLAT 100X100X7000	"	-DO-	"
59	04	FLAT 100X100X1800	"	-DO-	"
60	08	FLAT 100X100X900	"	-DO-	"
61	04	ANGLE 100X100X1850	"	-DO-	1-13100-S2155
62	02	ANGLE 100X100X650	"	-DO-	"
63	01	ANGLE 100X100X1800	"	-DO-	"
64	02	ANGLE 100X100X20700	"	-DO-	"
65	04	ANGLE 100X100X3000	"	-DO-	"
66	04	ANGLE 100X100X1700	"	-DO-	"
67	02	ANGLE 100X100X1650	"	-DO-	"
68	01	ANGLE 100X100X2200	"	-DO-	"
69	01	ANGLE 100X100X3200	"	-DO-	"
70	02	ANGLE 100X100X2000	"	-DO-	"
71	04	ANGLE 100X100X1150	"	-DO-	"
72	02	ANGLE 100X100X2050	"	-DO-	"
73	01	ANGLE 100X100X7200	"	-DO-	"
74	01	ANGLE 100X100X2100	"	-DO-	"
75	01	ANGLE 100X100X7200	"	-DO-	"
76	02	PLATE 100X4200X160	BHEL	FOR FIXING OF ANCHOR NUTS	"
77	02	ANGLE 100X100X5500	NTPC	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	0-13100-S2154
78	02	FLAT 100X100X13800	"	-DO-	"
79	08	FLAT 100X100X2800	"	-DO-	"
80	02	ANGLE 100X100X920	"	-DO-	1-13100-S2155
81	02	ANGLE 100X100X2270	"	-DO-	"
82	01	ANGLE 100X100X10520	"	-DO-	"
88	02	ANGLE 100X100X4350	NTPC	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	1-13100-S2155
89	02	ANGLE 100X100X4000	"	-DO-	"
90	02	ANGLE 100X100X2200	"	-DO-	"
91	02	ANGLE 100X100X15500	"	-DO-	"
92	02	ANGLE 100X100X1650	BHEL	FOR FIXING OF ANCHOR PLATES	0-13100-S2153
93	04	BELM ISMB 300X1500	"	FIX POINT FOR STATOR ALIGNMENT	0-13100-S2152
94	02	BELM ISMB 200X1250	"	FIXPOINT FOR EXCITER ERECT./MAIN.	"
95	05	PLATE 100X250X600	"	RECOMM. FOR SUPPORTING OF GEN. ROTOR DRUM. ERECTION & FOR ADJUST. OF EXCITER	"
96	04	PLATE 100X200X300	"	PLATE FOR ADJUSTING OF EXCITER	"
97	22	PIPE ID min 150 L=2000	"	FOR ANCHOR BOLTS	"
98	06	PIPE ID min 125 L=2000	"	FOR ANCHOR BOLTS	"
99	07	PIPE ID min 80 L=2100	NTPC	FOR CABLES	"
100	02	PIPE ID min 125 L=2590	BHEL	FOR ANCHOR BOLTS	"
101	02	PLATE 25X500X2500	"	RECOMMENDED FOR ERECTION OF TERMINAL BOX	0-13100-S2153
102	02	ANCHOR FOR GEN.	"	AS PER BHEL DRG.NO.2-13800-01001	0-13100-S2152
103	01	ANGLE 100X100X5160	NTPC	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	1-13100-S2155
104	02	FLAT 100X100X2000	"	-DO-	"
105	02	ANGLE 100X100X1350	BHEL	FOR FIXING OF ANCHOR PLATES	0-13100-S2153
106	02	ANGLE 100X100X6000	"	-DO-	"
107	02	ANGLE 100X100X6250	"	-DO-	"
108	02	ANGLE 100X100X600	"	-DO-	"
109	02	ANGLE 100X100X450	"	-DO-	"
110	02	FLAT 100X100X5200	NTPC	RECOMMENDED FOR FIXING OF PIPE SUPPORTS.	"
111	02	FLAT 100X100X1150	"	-DO-	"
112	05	FLAT 100X100X2000	"	-DO-	"
113	01	FLAT 100X100X1950	"	-DO-	"
114	02	ANGLE 100X100X1150	"	-DO-	1-13100-S2155
115	02	ANGLE 100X100X3400	"	-DO-	"
116	02	ANGLE 100X100X4900	"	-DO-	"
117	02	ANGLE 100X100X3220	"	-DO-	"
118	03	ANGLE 100X100X2000	"	-DO-	"

1. FOUNDATION PLAN DRG. NO. 0-13100-S2152.
2. FOUNDATION PLAN DRG. NO. 0-13100-S2153.
3. FOUNDATION PLAN DRG. NO. 0-13100-S2154.
4. FOUNDATION PLAN DRG. NO. 1-13100-S2155.

REFERENCE DRAWINGS:-

1. FOUNDATION PLAN DRG. NO. 0-13100-S2152.
2. FOUNDATION PLAN DRG. NO. 0-13100-S2153.
3. FOUNDATION PLAN DRG. NO. 0-13100-S2154.
4. FOUNDATION PLAN DRG. NO. 1-13100-S2155.

## NOTES:

1. THE LENGTHS OF PIPES ARE DEPENDENT ON T. G. DECK THICKNESS AND SHOULD BE DECIDED AFTER FINALISATION OF T. G. FOUNDATION DESIGN BY THE FOUNDATION DESIGNER .
2. WHERESOEVER MATERIAL IS NOT MENTIONED , IT MAY BE TAKEN AS STRUCTURAL STEEL OF COMMERCIAL QUALITY.
3. MATERIAL OF PIPES IS SEAMLESS PIPE ASTM A106 GR.B. HOWEVER , ERW PIPES CAN ALSO BE USED.

[illegible]