

CLAUSE NO.	TECHNICAL REQUIREMENTS																		
<p><b>12.00.00(D)</b></p>	<p style="text-align: right;"><b>Annexure- (D)</b></p> <p><b><u>CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT</u></b></p> <p>All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See site specific information below.</p> <p>Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.</p> <p>Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.</p> <p>Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than "5" and/or if the fundamental frequency of the structure is less than 1 Hz.</p> <p>Susceptibility of structures to across-wind forces, galloping, flutter, ovaling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.</p> <p>It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.</p> <p><b>Damping in Structures</b></p> <p>The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:</p> <p>a) Welded steel structures : 1.0%</p> <p>b) Bolted steel structures/RCC structures : 2.0%</p> <p>c) Prestressed concrete structures : 1.6%</p> <p>d) Steel stacks : As per IS:6533 &amp; CICIN Model Code whichever is more critical.</p> <p><b>SITE SPECIFIC DESIGN PARAMETERS</b></p> <p>The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:</p> <table border="1" data-bbox="391 1535 1421 1759"> <thead> <tr> <th>DESCRIPTION</th> <th>TELANGANA</th> <th>NABINAGAR</th> <th>GADARWARA</th> </tr> </thead> <tbody> <tr> <td>Basic wind speed "Vb" at ten meters above the mean ground level</td> <td>44 m/s</td> <td>47 m/s</td> <td>39 m/s</td> </tr> <tr> <td>Risk coefficient "K1"</td> <td>1.07</td> <td>1.07</td> <td>1.06</td> </tr> <tr> <td>Category of terrain</td> <td>Category-2</td> <td>Category-2</td> <td>Category-2</td> </tr> </tbody> </table>			DESCRIPTION	TELANGANA	NABINAGAR	GADARWARA	Basic wind speed "Vb" at ten meters above the mean ground level	44 m/s	47 m/s	39 m/s	Risk coefficient "K1"	1.07	1.07	1.06	Category of terrain	Category-2	Category-2	Category-2
DESCRIPTION	TELANGANA	NABINAGAR	GADARWARA																
Basic wind speed "Vb" at ten meters above the mean ground level	44 m/s	47 m/s	39 m/s																
Risk coefficient "K1"	1.07	1.07	1.06																
Category of terrain	Category-2	Category-2	Category-2																
<p>GADARWARA STPP STAGE--II (2X800MW)            TELANGANA STPP STAGE-II (3X800MW)            NABINAGAR STPP STAGE--II (3X800MW)            BULK BTG PACKAGE</p>	<p>TECHNICAL SPECIFICATION            SECTION-VI, PART-B            BID DOC. NO.:            CS-8014/9592/0371-001A-2</p>	<p>SUB-SECTION-D-1            CIVIL WORKS            ANNEXURES</p>	<p>PAGE            1528 OF 1545</p>																

CLAUSE NO.	TECHNICAL REQUIREMENTS																		
12.00.00(E)	<p style="text-align: right;"><b>Annexure-(E)</b></p> <p><b>CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT</b></p> <p>All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.</p> <p>Site specific seismic study has been conducted for the project sites. The peak ground horizontal acceleration for the project sites, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I (Project-wise).</p> <p>Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.</p> <p>The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).</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 style="width: 100%; border: none;"> <tr> <td style="width: 5%;">a)</td> <td style="width: 70%;">Steel structures</td> <td style="width: 5%; text-align: center;">:</td> <td style="width: 10%;">2%</td> </tr> <tr> <td>b)</td> <td>Reinforced Concrete Structures</td> <td style="text-align: center;">:</td> <td>5%</td> </tr> <tr> <td>c)</td> <td>Reinforced Concrete Stacks</td> <td style="text-align: center;">:</td> <td>3%</td> </tr> <tr> <td>d)</td> <td>Steel stacks</td> <td style="text-align: center;">:</td> <td>2%</td> </tr> </table>			a)	Steel structures	:	2%	b)	Reinforced Concrete Structures	:	5%	c)	Reinforced Concrete Stacks	:	3%	d)	Steel stacks	:	2%
a)	Steel structures	:	2%																
b)	Reinforced Concrete Structures	:	5%																
c)	Reinforced Concrete Stacks	:	3%																
d)	Steel stacks	:	2%																
GADARWARA STPP STAGE--II (2X800MW) TELANGANA STPP STAGE-II (3X800MW) NABINAGAR STPP STAGE--II (3X800MW) BULK BTG PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-8014/9592/0371-001A-2	SUB-SECTION-D-1 CIVIL WORKS ANNEXURES	PAGE 1529 OF 1545																

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<p><b>Method of Analysis</b></p> <p>Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).</p> <p>In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893.</p> <p>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>For buildings, 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><b>Design/Detailing for Ductility for Structures</b></p> <p>The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.</p>		
GADARWARA STPP STAGE--II (2X800MW) TELANGANA STPP STAGE-II (3X800MW) NABINAGAR STPP STAGE--II (3X800MW) BULK BTG PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-8014/9592/0371-001A-2	SUB-SECTION-D-1 CIVIL WORKS ANNEXURES	PAGE 1530 OF 1545

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<p style="text-align: right;"><b>APPENDIX – I GADARWARA</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 (MCE) : 0.18 g</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 special moment resisting steel building frames designed and detailed as per IS:800 : 0.045</li> <li>b) for special concentrically braced steel building frames designed and detailed as per IS:800 : 0.034</li> <li>c) for special moment resisting RC building frames designed and detailed as per IS:456 and IS:13920 : 0.027</li> <li>d) for RCC chimney, RCC Natural Draft Cooling Tower : 0.09</li> <li>e) For Liquid retaining tanks (ground supported) :0.054</li> <li>f) for Steel chimney, Absorber tower, Vessels : 0.068</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 : 0.09</li> </ol> <p>Note: g = Acceleration due to gravity</p> <p>The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.</p>		
GADARWARA STPP STAGE--II (2X800MW) TELANGANA STPP STAGE-II (3X800MW) NABINAGAR STPP STAGE--II (3X800MW) BULK BTG PACKAGE	TECHNICAL SPECIFICATION SECTION-VI, PART-B BID DOC. NO.: CS-8014/9592/0371-001A-2	SUB-SECTION-D-1 CIVIL WORKS ANNEXURES	PAGE 1531 OF 1545

CLAUSE NO.

TECHNICAL REQUIREMENTS

APPENDIX – I GADARWARA

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1	1	1
0.03	1	1	1
0.04	1.287	1.233	1.178
0.05	1.564	1.450	1.337
0.06	1.835	1.656	1.482
0.07	2.101	1.853	1.618
0.08	2.361	2.042	1.746
0.09	2.618	2.225	1.866
0.1	2.871	2.402	1.982
0.105	2.996	2.489	2.037
0.11	3.121	2.575	2.092
0.115	3.245	2.660	2.145
0.12	3.368	2.743	2.198
0.123	3.442	2.793	2.229
0.127	3.500	2.859	2.270
0.13	3.500	3.175	2.300
0.135	3.500	3.175	2.500
0.14	3.500	3.175	2.500
0.145	3.500	3.175	2.500
0.15	3.500	3.175	2.500
0.2	3.500	3.175	2.500
0.25	3.500	3.175	2.500
0.3	3.500	3.175	2.500
0.35	3.500	3.175	2.500
0.4	3.500	3.175	2.500
0.43	3.500	3.175	2.500
0.45	3.500	3.175	2.500
0.48	3.500	3.175	2.500
0.49	3.369	3.175	2.500
0.5	3.302	2.860	2.500
0.52	3.175	2.750	2.212
0.555	2.975	2.577	2.072
0.56	2.948	2.554	2.054
0.565	2.922	2.531	2.035
0.57	2.896	2.509	2.018
0.575	2.871	2.487	2.000

<b>CLAUSE NO.</b>	<b>TECHNICAL REQUIREMENTS</b>
-------------------	-------------------------------

**APPENDIX – I GADARWARA**

<b>HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS</b>			
<b>(In units of 'g')</b>			
<b>Time Period (Sec)</b>	<b>Damping Factor (as a percentage of critical damping)</b>		
	<b>2%</b>	<b>3%</b>	<b>5%</b>
0.58	2.847	2.466	1.983
0.585	2.822	2.444	1.966
0.59	2.798	2.424	1.949
0.595	2.775	2.403	1.933
0.6	2.752	2.383	1.917
0.65	2.540	2.200	1.769
0.7	2.359	2.043	1.643
0.75	2.201	1.907	1.533
0.8	2.064	1.788	1.438
0.85	1.942	1.682	1.353
0.9	1.834	1.589	1.278
0.95	1.738	1.505	1.211
1	1.651	1.430	1.150
1.05	1.572	1.362	1.095
1.1	1.501	1.300	1.045
1.15	1.436	1.243	1.000
1.2	1.376	1.192	0.958
1.25	1.321	1.144	0.920
1.3	1.270	1.100	0.885
1.35	1.223	1.059	0.852
1.4	1.179	1.021	0.821
1.45	1.139	0.986	0.793
1.5	1.101	0.953	0.767
1.55	1.065	0.923	0.742
1.6	1.032	0.894	0.719
1.65	1.001	0.867	0.697
1.7	0.971	0.841	0.676
1.75	0.943	0.817	0.657
1.8	0.917	0.794	0.639
1.85	0.892	0.773	0.622
1.9	0.869	0.753	0.605
1.95	0.847	0.733	0.590
2	0.826	0.715	0.575
2.05	0.805	0.698	0.561
2.1	0.786	0.681	0.548
2.15	0.768	0.665	0.535
2.2	0.750	0.650	0.523
2.25	0.734	0.636	0.511

CLAUSE NO.	TECHNICAL REQUIREMENTS			
	APPENDIX – I GADARWARA			
	HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS (In units of 'g')			
Time Period (Sec)	Damping Factor (as a percentage of critical damping)			
	2%	3%	5%	
2.3	0.718	0.622	0.500	
2.35	0.703	0.609	0.489	
2.4	0.688	0.596	0.479	
2.45	0.674	0.584	0.469	
2.5	0.660	0.572	0.460	
2.55	0.647	0.561	0.451	
2.6	0.635	0.550	0.442	
2.65	0.623	0.540	0.434	
2.7	0.611	0.530	0.426	
2.75	0.600	0.520	0.418	
2.8	0.590	0.511	0.411	
2.85	0.579	0.502	0.404	
2.9	0.569	0.493	0.397	
2.95	0.560	0.485	0.390	
3	0.550	0.477	0.383	
3.05	0.541	0.469	0.377	
3.1	0.533	0.461	0.371	
3.15	0.524	0.454	0.365	
3.2	0.516	0.447	0.359	
3.25	0.508	0.440	0.354	
3.3	0.500	0.433	0.348	
3.35	0.493	0.427	0.343	
3.4	0.486	0.421	0.338	
3.45	0.479	0.414	0.333	
3.5	0.472	0.409	0.329	
3.55	0.465	0.403	0.324	
3.6	0.459	0.397	0.319	
3.65	0.452	0.392	0.315	
3.7	0.446	0.386	0.311	
3.75	0.446	0.381	0.307	
3.8	0.435	0.376	0.303	
3.85	0.423	0.371	0.299	
3.9	0.413	0.367	0.295	
3.95	0.402	0.367	0.291	
4	0.392	0.358	0.288	

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	<p style="text-align: right;"><b><u>APPENDIX-I TELANGANA</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 (MCE) : 0.28g</li> <li>2) Multiplying factor to be applied to the 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 special moment resisting steel building frames designed and detailed as per IS:800 : 0.07</li> <li>b) for special concentrically braced steel building frames designed and detailed as per IS:800 : 0.0525</li> <li>c) For special moment resisting RC building frames designed and detailed as per IS:456 and IS:13920 : 0.042</li> <li>d) for RCC chimney, RCC Natural Draft Cooling Tower : 0.14</li> <li>e) for liquid retaining tanks (ground supported) : 0.084</li> <li>f) for steel chimney, Absorber tower, Vessels : 0.105</li> </ol> </li> <li>3) Multiplying factor to be applied to the 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 : 0.14</li> </ol> <p>Note: g = Acceleration due to gravity</p> <p>The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.</p>		
<p>GADARWARA STPP STAGE--II (2X800MW)  TELANGANA STPP STAGE-II (3X800MW)  NABINAGAR STPP STAGE--II (3X800MW)  BULK BTG PACKAGE</p>	<p>TECHNICAL SPECIFICATION  SECTION-VI, PART-B  BID DOC. NO.:  CS-8014/9592/0371-001A-2</p>	<p>SUB-SECTION-D-1  CIVIL WORKS  ANNEXURES</p>	<p>PAGE  1535 OF 1545</p>

CLAUSE NO.

**TECHNICAL REQUIREMENTS**

APPENDIX – I TELANGANA

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1.000	1.000	1.000
0.03	1.000	1.842	1.450
0.04	1.355	2.032	1.600
0.05	1.716	2.223	1.750
0.06	2.081	2.413	1.900
0.07	2.449	2.604	2.050
0.08	2.820	2.794	2.200
0.09	3.194	2.985	2.350
0.10	3.570	3.175	2.500
0.105	3.759	3.175	2.500
0.106	3.760	3.175	2.500
0.11	3.760	3.175	2.500
0.115	3.760	3.175	2.500
0.12	3.760	3.175	2.500
0.125	3.760	3.175	2.500
0.13	3.760	3.175	2.500
0.135	3.760	3.175	2.500
0.14	3.760	3.175	2.500
0.145	3.760	3.175	2.500
0.15	3.760	3.175	2.500
0.20	3.760	3.175	2.500
0.25	3.760	3.175	2.500
0.27	3.760	3.175	2.500
0.30	3.760	3.175	2.500
0.32	3.760	3.175	2.500
0.35	3.760	3.175	2.500
0.372	3.760	3.175	2.500
0.40	3.500	3.175	2.500
0.402	3.483	3.159	2.488
0.405	3.457	3.136	2.469
0.41	3.415	3.098	2.439
0.425	3.294	2.988	2.353
0.45	3.111	2.822	2.222
0.50	2.800	2.540	2.000

CLAUSE NO.

**TECHNICAL REQUIREMENTS**

APPENDIX – I TELANGANA

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0.55	2.545	2.309	1.818
0.60	2.333	2.117	1.667
0.65	2.154	1.954	1.538
0.70	2.000	1.814	1.429
0.75	1.867	1.693	1.333
0.80	1.750	1.588	1.250
0.85	1.647	1.494	1.176
0.9	1.556	1.411	1.111
0.95	1.474	1.337	1.053
1.0	1.400	1.270	1.000
1.05	1.333	1.210	0.952
1.10	1.273	1.155	0.909
1.15	1.217	1.104	0.870
1.20	1.167	1.058	0.833
1.25	1.120	1.016	0.800
1.30	1.077	0.977	0.769
1.35	1.037	0.941	0.741
1.40	1.000	0.907	0.714
1.45	0.966	0.876	0.690
1.50	0.933	0.847	0.667
1.55	0.903	0.819	0.645
1.60	0.875	0.794	0.625
1.65	0.848	0.770	0.606
1.70	0.824	0.747	0.588
1.75	0.800	0.726	0.571
1.80	0.778	0.706	0.556
1.85	0.757	0.686	0.541
1.90	0.737	0.668	0.526
1.95	0.718	0.651	0.513
2.0	0.700	0.635	0.500
2.05	0.683	0.620	0.488
2.10	0.667	0.605	0.476
2.15	0.651	0.591	0.465
2.20	0.636	0.577	0.455

CLAUSE NO.

**TECHNICAL REQUIREMENTS**

APPENDIX – I TELANGANA

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
2.25	0.622	0.564	0.444
2.30	0.609	0.552	0.435
2.35	0.596	0.540	0.426
2.40	0.583	0.529	0.417
2.45	0.571	0.518	0.408
2.50	0.560	0.508	0.400
2.55	0.549	0.498	0.392
2.60	0.538	0.488	0.385
2.65	0.528	0.479	0.377
2.70	0.519	0.470	0.370
2.74	0.511	0.464	0.365
2.80	0.500	0.454	0.357
2.85	0.491	0.446	0.351
2.88	0.486	0.441	0.347
2.90	0.483	0.438	0.345
2.95	0.475	0.431	0.339
3.0	0.467	0.423	0.333
3.05	0.459	0.416	0.328
3.10	0.452	0.410	0.323
3.15	0.444	0.403	0.317
3.20	0.438	0.397	0.313
3.25	0.431	0.391	0.308
3.30	0.424	0.385	0.303
3.35	0.418	0.379	0.299
3.40	0.412	0.374	0.294
3.45	0.406	0.368	0.290
3.50	0.400	0.363	0.286