Annexure-II

BACK

जलवायवी सारणी

CLIMATOLOGICAL TABLE

स्टेशन : सिंगरौली STATION : Singrauli

अक्षांश LAT. 24°25' देशांतर LONG. 81°52' समुद्री तल से ऊंचाई HEIGHT ABOVE M.S.L. 272 मीटर METRES

प्रेक्षणों पर आधारित BASED ON OBSERVATIONS 1971-2000

माह MONTH		स्टेशन स्तर पर वायुदाब STATION LEVEL PRESSURE hPa	वायु तापमान AIR TEMPERATURE MEAN सूखा बल्ब DRY BULB °C	गीला बल्ब WET BULB °C	अधिकतम का औसत DAILY MAX °C	न्यूनतम का औसत DAILY MIN °C	सर्वोच्च तापमान HIGHEST IN THE MONTH °C	सबसे कम तापमान LOWEST IN THE MONTH °C	EXTREMES HIGHEST °C	दिनांक और वर्ष DATE AND YEAR	LOWEST °C	दिनांक और वर्ष DATE AND YEAR	आर्द्रता HUMIDITY RELATIVE HUMIDITY %	वाष्प दाब VAPOUR PRESSURE hPa	मेघ की मात्रा CLOUD AMOUNTS ALL CLOUDS Octas of sky	निम्न मेघ LOW CLOUDS	वर्षा RAINFALL MONTHLY TOTAL मिमी. mm	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	सर्वाधिक वर्षा के महीने का योग TOTAL IN WETTEST MONTH WITH YEAR मिमी. mm	सर्वाधिक सूखाग्रस्त महीने का योग TOTAL IN DRIEST MONTH WITH YEAR मिमी. mm	24 घंटों में सर्वाधिक वर्षा MEAVIEST FALL IN 24 HOURS मिमी. mm	दिनांक और वर्ष DATE AND YEAR	पवन की औसत गति MEAN WIND SPEED कि.मी. प्र. घं. Km/h
जनवरी JAN	I	985.7	12.9	10.8	24.5	8.7	29.4	4.3	32.8	21 1969	1.0	17 1962	76	11.5	1.2	1.0	27.4	2.1	118.1 1971	0.0	49.4	21 1971	1.1
	II	982.4	21.5	15.0									47	12.0	1.1	0.9							
फरवरी FEB	I	983.7	15.8	12.8	27.4	11.3	32.8	6.3	37.4	28 1989	2.0	10 1974	69	12.5	1.1	0.9	23.8	2.0	83.0 1984	0.0	37.0	9 1994	1.5
	II	980.2	24.8	16.5									40	12.2	1.0	0.7							
मार्च MAR	I	981.1	22.5	16.3	33.1	15.8	38.3	10.5	41.2	30 1972	4.6	10 1972	51	13.8	0.8	0.6	12.5	1.1	58.7 1967	0.0	36.2	12 1990	1.9
	II	977.1	31.0	18.8									27	12.0	1.0	0.7							
अप्रैल APR	I	976.9	29.1	19.5	39.0	21.6	42.9	16.9	43.8	10 1969	11.8	1 1968	38	15.0	0.7	0.5	6.6	0.8	50.0 1983	0.0	40.8	19 1983	2.0
	II	972.5	36.8	21.2									21	12.7	1.2	0.8							
मई MAY	I	973.0	32.8	22.6	41.8	26.0	45.0	21.6	46.6	30 1988	17.0	9 1960	39	19.4	0.8	0.6	10.8	1.4	104.6 1982	0.0	88.8	5 1982	2.4
	II	968.8	39.1	23.5									24	16.4	1.6	1.1							
जून JUN	I	969.1	31.8	25.0	38.8	27.4	44.3	23.2	47.4	9 1966	20.0	27 1968	58	26.3	2.8	2.1	144.3	6.8	675.3 1971	8.4 1965	180.2	7 1971	3.4
	II	965.5	35.5	25.3									46	24.0	4.1	3.0							
जुलाई JUL	I	969.1	28.1	25.5	32.9	25.4	37.6	23.0	43.2	1 1987	17.0	22 1968	80	30.5	5.2	3.8	338.3	14.0	504.8 1969	67.7 1987	180.8	16 1980	3.4
	II	966.2	30.1	26.0									72	30.3	5.9	4.4							
अगस्त AUG	I	970.5	27.6	25.4	31.9	25.0	35.2	23.1	38.8	3 1972	17.4	4 1968	83	30.7	5.2	4.0	331.9	14.5	635.7 1982	154.4 1978	176.5	8 1972	2.6
	II	967.6	29.3	26.0									76	30.8	5.7	4.3							
सितम्बर SEP	I	974.8	27.2	24.8	32.3	24.0	35.2	21.5	39.0	11 1969	18.2	27 1972	81	29.3	3.7	2.8	248.8	10.0	635.0 1987	44.4 1965	307.9	1 1997	2.2
	II	971.5	29.3	25.2									71	28.7	4.5	3.2							
अक्टूबर OCT	I	980.4	24.5	21.2	32.8	19.9	35.5	14.9	38.4	5 1966	12.2	31 1964	73	22.9	1.3	0.9	37.9	2.2	208.4 1999	0.0	101.0	5 1999	1.2
	II	977.0	29.1	22.1									52	21.1	1.7	1.1							
नवम्बर NOV	I	984.3	18.9	15.8	29.7	13.7	32.7	9.4	35.9	4 1965	4.0	30 1970	71	15.7	0.7	0.5	8.0	0.6	118.0 1969	0.0	99.4	11 1989	0.8
	II	980.6	25.5	18.3									47	15.4	0.7	0.5							
दिसम्बर DEC	I	986.8	14.1	11.7	25.9	9.0	29.1	5.4	32.2	16 1985	1.0	27 1961	73	12.0	0.7	0.5	9.2	0.9	63.8 1997	0.0	33.2	2 1986	0.8
	II	983.1	21.8	15.6									49	12.9	0.7	0.5							
वार्षिक माध्य ANNUAL MEAN	I	977.9	23.8	19.3	32.5	18.9	45.1	4.0	43.8	10	1.0	17	66	19.9	2.0	1.5	1199.5	56.2	2082.3	505.5	307.9	1	1.9
कुल TOTAL OR	II	974.3	29.5	21.1					4	1969	1	1962	48	18.9	2.4	1.8			1971	1965	9	1997	
वर्षों की संख्या NUMBER OF YEARS	I	29	30	30	30	30	30	30	43		43		30	30	30	30	28	28	41	41	41		29

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : सिधी
STAION : Sidhi

मौसम परिघटना / WEATHER PHENOMENA — No. OF DAYS WITH

MONTH		RFT 0.3 mm OR more	HAIL	THUNDER	FOG	DUST STORM	SQUALL
JAN	I	2.8	0.0	0.0	0.1	0.0	0.0
	II						
FEB	I	2.5	0.0	0.0	0.0	0.0	0.0
	II						
MAR	I	1.9	0.0	0.0	0.0	0.0	0.0
	II						
APR	I	1.3	0.0	0.0	0.0	0.0	0.0
	II						
MAY	I	2.3	0.0	0.0	0.0	0.0	0.0
	II						
JUN	I	8.3	0.0	0.0	0.0	0.0	0.0
	II						
JUL	I	18.4	0.0	0.1	0.0	0.0	0.0
	II						
AUG	I	18.1	0.0	0.0	0.0	0.0	0.0
	II						
SEP	I	12.3	0.0	0.1	0.0	0.0	0.0
	II						
OCT	I	3.2	0.0	0.0	0.0	0.0	0.0
	II						
NOV	I	0.9	0.0	0.0	0.0	0.0	0.0
	II						
DEC	I	1.0	0.0	0.0	0.0	0.0	0.0
	II						
ANNUAL TOTAL OR MEAN	I	73.1	0.0	0.2	0.1	0.0	0.0
	II						
NUMBER OF YEARS	I, II	30					

पवन / WIND

MONTH		No. of days with wind speed (Km.p.h.) 62 or more	20-61	1-19	0	Percentage No. of days wind from N	NE	E	SE	S	SW	W	NW	CALM
JAN	I	0	0	2	29	1	0	1	0	0	1	4	0	93
	II	0	0	5	26	3	2	3	0	0	0	7	2	83
FEB	I	0	0	3	25	1	1	3	0	0	1	6	0	88
	II	0	0	9	19	5	1	6	0	1	0	17	2	68
MAR	I	0	0	4	27	1	0	2	0	1	2	7	0	87
	II	0	0	16	15	8	2	6	0	2	2	28	2	50
APR	I	0	0	7	23	1	1	3	0	2	2	15	0	76
	II	0	0	21	9	8	3	8	1	2	2	42	2	32
MAY	I	0	0	11	20	2	0	5	0	2	5	20	0	66
	II	0	0	21	10	7	4	12	1	2	4	37	1	32
JUN	I	0	0	15	15	2	1	7	1	2	11	27	0	49
	II	0	0	18	12	5	2	13	1	4	5	30	1	39
JUL	I	0	0	14	17	1	0	6	1	4	7	27	0	54
	II	0	0	12	19	2	1	8	1	4	4	20	0	60
AUG	I	0	0	12	19	1	1	9	1	3	5	20	0	60
	II	0	0	11	20	2	1	10	1	2	2	18	0	64
SEP	I	0	0	9	21	1	1	6	1	2	4	16	0	69
	II	0	0	9	21	1	1	7	0	2	1	15	0	73
OCT	I	0	0	4	27	2	0	2	0	1	2	6	0	87
	II	0	0	4	27	2	1	3	0	1	0	7	1	85
NOV	I	0	0	1	29	0	0	0	0	0	1	1	0	98
	II	0	0	2	28	1	0	2	0	0	0	2	0	95
DEC	I	0	0	1	30	0	0	1	0	1	1	2	0	95
	II	0	0	1	30	1	1	1	0	0	0	2	0	95
ANNUAL TOTAL OR MEAN	I	0	0	85	280	1	0	4	0	2	3	13	0	77
	II	0	0	127	238	4	2	7	0	2	2	19	1	63
NUMBER OF YEARS	I, II	30				30								

मेघ / CLOUD

MONTH		No. of days with cloud amount (all clouds) OKTAS 0	1-2	3-5	6-7	8	No. of days with low cloud amount OKTAS 0	1-2	3-5	6-7	8	FOG
JAN	I	25	0	1	3	2	25	1	2	1	2	0
	II	25	0	2	2	2	25	1	2	1	2	0
FEB	I	22	0	1	3	2	22	1	3	1	1	0
	II	23	0	2	2	1	23	1	3	0	1	0
MAR	I	26	0	2	2	1	27	1	2	0	1	0
	II	25	0	2	3	1	25	1	3	1	1	0
APR	I	27	0	1	2	0	26	1	2	1	0	0
	II	24	0	2	3	1	24	1	4	1	0	0
MAY	I	25	0	2	3	1	26	1	3	1	0	0
	II	21	0	3	6	1	23	1	6	1	0	0
JUN	I	16	0	3	7	4	17	2	6	2	3	0
	II	9	0	4	12	5	11	2	11	4	2	0
JUL	I	4	1	6	13	7	7	3	12	4	5	0
	II	2	0	5	14	10	4	2	14	5	6	0
AUG	I	4	1	5	13	8	6	3	13	3	6	0
	II	3	0	5	13	10	4	3	14	4	6	0
SEP	I	11	1	4	9	5	14	2	8	2	4	0
	II	7	1	6	10	6	9	3	12	2	4	0
OCT	I	24	0	2	4	1	24	1	4	1	1	0
	II	21	0	4	6	1	22	2	5	1	1	0
NOV	I	26	0	1	2	1	27	0	2	0	1	0
	II	26	0	1	2	1	27	0	2	0	1	0
DEC	I	27	0	1	2	1	28	1	1	0	1	0
	II	27	0	1	2	1	26	1	2	1	1	0
ANNUAL TOTAL OR MEAN	I	239	4	29	60	33	251	15	57	16	26	0
	II	215	3	36	73	38	229	17	75	20	24	0
NUMBER OF YEARS	I, II	30					30					

दृश्यता / VISIBILITY — No. OF DAYS WITH VISIBILITY

MONTH		UP TO 1 Km.	1-4 Kms.	4-10 Kms.	10-20 Kms.	OVER 20 Kms.
JAN	I	0.0	0.1	4.5	6.0	20.4
	II	0.0	0.0	4.5	5.9	20.6
FEB	I	0.0	0.0	3.6	5.9	18.4
	II	0.0	0.0	3.4	5.8	18.8
MAR	I	0.0	0.0	3.2	7.6	20.2
	II	0.0	0.0	3.9	7.5	19.6
APR	I	0.0	0.0	2.7	6.4	20.9
	II	0.0	0.0	4.8	6.0	19.2
MAY	I	0.0	0.0	2.7	7.6	20.7
	II	0.0	0.0	5.5	7.9	17.6
JUN	I	0.0	0.0	9.8	5.9	14.2
	II	0.0	0.1	15.4	5.3	9.2
JUL	I	0.0	0.4	19.5	5.6	5.5
	II	0.0	0.3	21.8	5.1	3.9
AUG	I	0.0	0.2	17.4	7.8	5.5
	II	0.0	0.0	20.3	6.8	4.0
SEP	I	0.0	0.3	10.7	8.9	10.1
	II	0.0	0.3	13.8	8.7	7.3
OCT	I	0.0	0.0	5.1	8.6	17.4
	II	0.0	0.0	6.4	7.7	16.8
NOV	I	0.0	0.0	1.8	7.8	20.4
	II	0.0	0.0	2.2	7.6	20.3
DEC	I	0.0	0.0	3.0	7.8	20.2
	II	0.0	0.0	2.5	6.9	21.6
ANNUAL TOTAL OR MEAN	I	0.0	0.9	82.6	85.9	195.5
	II	0.0	0.7	102.3	81.2	180.9
NUMBER OF YEARS	I, II	30				

D-1-12(E)

Annexure-(E)

CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT

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

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

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

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

Damping in Structures

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

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

Method of Analysis

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

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

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

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

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.

APPENDIX-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 special moment resisting steel frames designed and detailed as per IS:800 : 0.045

   b) For special concentrically braced steel frames designed and detailed as per IS:800 : 0.034

   c) For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.027

   d) for RCC chimney, RCC Natural Draft Cooling Tower : 0.09

   e) for Liquid retaining tanks : 0.054

   f) for Steel chimney, Absorber Tower, Vessels : 0.068

   g) for design of structures not covered under 2 (a) to 2 (f) above and under 3 below, in general (excluding special structure/ configuration/materials) : 0.045

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

Note: g = Acceleration due to gravity

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

APPENDIX – I

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0.000	1.000	1.000	1.000
0.030	1.000	1.000	1.000
0.040	1.368	1.289	1.226
0.050	1.743	1.570	1.435
0.060	2.126	1.844	1.632
0.070	2.514	2.113	1.820
0.080	2.907	2.378	2.001
0.090	3.305	2.638	2.174
0.100	3.706	2.895	2.342
0.110	4.111	3.150	2.506
0.108	4.030	3.099	2.473
0.110	4.111	3.150	2.506
0.115	4.315	3.276	2.586
0.120	4.520	3.401	2.665
0.125	4.520	3.526	2.743
0.130	4.520	3.650	2.820
0.135	4.520	3.650	2.820
0.140	4.520	3.650	2.820
0.145	4.520	3.650	2.820
0.150	4.520	3.650	2.820
0.200	4.520	3.650	2.820
0.250	4.520	3.650	2.820
0.300	4.520	3.650	2.820
0.350	4.520	3.650	2.820
0.370	4.397	3.650	2.820
0.410	3.968	3.383	2.820
0.430	3.784	3.226	2.753
0.450	3.616	3.082	2.631
0.520	3.129	2.667	2.277
0.555	2.932	2.499	2.133
0.560	2.905	2.477	2.114

APPENDIX – I

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0.565	2.880	2.455	2.096
0.570	2.854	2.433	2.077
0.575	2.830	2.412	2.059
0.580	2.805	2.391	2.041
0.585	2.781	2.371	2.024
0.590	2.758	2.351	2.007
0.595	2.734	2.331	1.990
0.600	2.712	2.312	1.973
0.650	2.503	2.134	1.822
0.700	2.324	1.981	1.691
0.750	2.169	1.849	1.579
0.800	2.034	1.734	1.480
0.850	1.914	1.632	1.393
0.900	1.808	1.541	1.316
0.950	1.713	1.460	1.246
1.000	1.627	1.387	1.184
1.050	1.550	1.321	1.128
1.100	1.479	1.261	1.076
1.150	1.415	1.206	1.030
1.200	1.356	1.156	0.987
1.250	1.302	1.110	0.947
1.300	1.252	1.067	0.911
1.350	1.205	1.027	0.877
1.400	1.162	0.991	0.846
1.450	1.122	0.957	0.817
1.500	1.085	0.925	0.789
1.550	1.050	0.895	0.764
1.600	1.017	0.867	0.740
1.650	0.986	0.841	0.718
1.700	0.957	0.816	0.696
1.750	0.930	0.793	0.677
1.800	0.904	0.771	0.658
1.850	0.879	0.750	0.640

APPENDIX – I

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

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
1.900	0.856	0.730	0.623
1.950	0.834	0.711	0.607
2.000	0.814	0.694	0.592
2.050	0.794	0.677	0.578
2.100	0.775	0.660	0.564
2.150	0.757	0.645	0.551
2.200	0.740	0.630	0.538
2.250	0.723	0.616	0.526
2.300	0.707	0.603	0.515
2.350	0.692	0.590	0.504
2.400	0.678	0.578	0.493
2.450	0.664	0.566	0.483
2.500	0.651	0.555	0.474
2.550	0.638	0.544	0.464
2.600	0.626	0.533	0.455
2.650	0.614	0.523	0.447
2.700	0.603	0.514	0.439
2.750	0.592	0.504	0.431
2.800	0.581	0.495	0.423
2.850	0.571	0.487	0.415
2.900	0.561	0.478	0.408
2.950	0.552	0.470	0.401
3.000	0.542	0.462	0.395
3.050	0.533	0.455	0.388
3.100	0.525	0.447	0.382
3.150	0.517	0.440	0.376
3.200	0.508	0.433	0.370
3.250	0.501	0.427	0.364
3.300	0.493	0.420	0.359
3.350	0.486	0.414	0.353
3.400	0.479	0.408	0.348
3.450	0.465	0.402	0.343
3.500	0.452	0.396	0.338