# Annexure 1: Operating Conditions used to calculate Primary Reserve requirement Summer Peak Base Case

	Den and and					Droop	Reserve	Reserve (
Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	(MW/Hz)	(+ve)	ve)
	MANGLA PP	470	500	200	2245	250	30	270
	Ghazi Barotha	1350	1450	1190	7250	725	100	160
	Turbela PP	4790	4840	3840	24013	875	50	950
	WARSAK	155	202	25	724	101	47	130
	Malakand PP	70	82	41	286	41	12	29
	DARAL KHWAR	30	32	20	160	16	2	10
	GOLEN	30	108	20	216	54	78	10
Hudro	ALLAI	70	122	60	276	61	52	10
Hydro	DBR-KWR	120	130	70	455	65	10	50
	KHNKHR	10	72	10	252	36	62	0
	PATRIND	124	150	68	750	75	26	57
	NBONGSC	37	84	30	87	42	47	7
	GULPUR	80	100	10	200	50	20	70
	CHASMA	114	114	18	570	0	0	96
	KAROT	720	720	232	3362	0	0	488
		8170	8706	5833	40845	2391	535	2338
	JABBAN	22	22	12	36			
	DARGAI	13	15	5	29			
	PEHUR	10	28	5	38			
	GML-ZAM	9	17	5	39			
	KRM.GRHI	5	5	0	3			
	JAGRAN	24	33	5	59			
Concell Mundae	MARALA SH	7	8	4	15			
Small Hydro	SHADIWL	8	14	8	20			
	NANDPR	6	14	6	18			
	RENALA	1	1	1	1			
	SHISHI	2	2	1	2			
	RESHUN	4	4	2	4			
	JINNAH	39	96	24	249			
		150	258	77	512			
	JDW	24	26	10	73			
Pagase	CHINIOTPP	27	62	20	57			

### Operating Reserve Policy



Dagass	ΕΔΤΙΜΔ	33	66	20	204			
	AL MOIZ	32	00	25	234			
	AL WOLZ	1/	30	10	135			
		100	184	65	559			
	K2 Unit	1032	1040	730	5595			
Nuclear	K3 Unit	1032	1040	730	5595			
Nuclear	CHASHNUP	1241	1263	800	9170			
		3305	3343	2260	20360			
	ATLAS	165	180	75	304	90	15	90
	NSHTCHN	172	195	68	345	98	23	104
	NISHT-PWR	189	195	68	345	98	6	121
	AGI-IPP	145	156	68	281	78	11	77
	K.E.I.	115	124	44	149	62	9	71
	LIBERTY Tech	160	188	69	333	94	28	91
	LIBERTY Power	179	194	90	889	90	16	89
	HUBCO Narowal	175	190	77	321	95	15	98
	ENDTION	152	166	63	1109	77	14	89
		479	500	477	2611	222	24	205
	POLISH	475	412	200	2011	102	127	75
	KARCO	2/3	412	200	436	207	137	292
	CUDDU	305	340	200	4241	307	51	303
	GUD.CCPP	236	340	240	2256	150	44	56
	RALLOKI	1039	480	340	3259	240	85 (0	209
	DALLON	1038	1098	/30	5368	512	60	308
		940	1025	720	5581	315	85	220
	HBS	991	1050	750	5706	490	59	241
Thermal	TRIMMU	1025	1105	840	3441	515	80	185
	UCH2	364	372	298	2397	124	8	66
	HALMOR	163	175	119	837	82	12	44
	ORIENT	165	185	120	884	87	20	45
	SAIF	180	204	120	975	95	24	60
	SAPHIRE	165	190	121	908	89	25	44
	ENGRO Power	113	130	40	654	65	17	73
	NANDPR	434	474	315	4006	226	40	119
	PRT CFPP	420	450	330	1636	180	30	90
	LUCKY	560	606	303	2485	242	46	257
	SECL	1120	1200	600	4692	480	80	520
	SAHIWAL	1160	1242	660	4856	497	82	500
	TEL	280	300	110	1146	120	20	170
	THAL NOVA	280	300	110	1146	120	20	170
	HUB CHINA	341	625	270	1950	250	284	71
	AFSLALP	175	350	175	1141	140	175	0
	AESPKGN	335	350	170	991	140	15	165
	SABA	110	120	25	396	48	10	85
	571571	12944	15511	9011	70729	6721	1667	1922
		13044	15511	5011	70756	0/21	1007	4033
	QAD-SOLAR	50	100	0				
	APPO Solar	70	100	0				
	CREST ENE	50	100	0				
Solar	RESTGREEN	70	100	-				
		70	100	0				
	ZENFA SOLAR	75	100	0				
		315	500	0				
	HAWA	38	50	16				
	MASTER	38	50	16				
	ZEPHYR	37	50	16				
	G AHMD	38	50	0				
	ARTISTIC	38	50	0				
	ACT2	38	50	0				
	DIN-E	38	50	0				
	LIBERTY1	38	50	0				
	LIBERTY2	35	50	0				
	INDUS	39	50	0				
	NASDA	39	50	0				
	LAKESIDE	38	50	0				
	METRO-2	45	58	0				
	MASTER GR	37	50	0				
	FFCEL	36	50	0				
	METRO	26	50	o				
	WIETRO	30	50	-				
	TAPAL	21	30	0				
	TAPAL	21	30	0				

### Operating Reserve Policy



Wind	GULAHMAD	37	50	10				
	YUNUS	39	50	16				
	SAPHIRE	38	50	0				
	TGF	32	50	10				
	FWEL-I	28	50	0				
	FWEL-II	32	50	0				
	TENAGA	28	50	16				
	DAWOOD	35	50	16				
	SACHAL	32	50	0				
	JPLL	38	50	0				
	TGS	34	50	0				
	TGT	37	50	0				
	TRICON 1	38	50	10				
	TRICON 2	38	50	10				
	TRICON 3	38	50	10				
	NOORIABAD	8	12	6				
	TRICOM	35	50	0				
	ZORLU	34	57	0				
		1331	1852	171				
	Total	27214	30354	17416	133013	9111	2202	7171



# Summer Off-peak Base Case

Plant Turce	Bower Blant	Baon	Demos	Desire	Maria	Droop	Reserve	Reserve (
Plant Type	Power Plant	Pgen	Pmax	Pmin	IVIW.S	(MW/Hz)	(+ve)	ve)
	MANGLA PP	420	570	170	2559	285	150	250
	Ghazi Barotha	1116	1450	1100	7250	725	334	16
	Turbela PP	3940	3948	2698	19336	864	8	1242
	WARSAK	155	202	25	724	101	47	130
	Malakand PP	70	82	41	286	41	12	29
	DARAL KHWAR	30	32	20	160	16	2	10
	GOLEN	30	108	20	216	54	78	10
Under	ALLAI	60	122	80	276	61	62	0
Hydro	DBR-KWR	130	130	70	455	0	0	60
	KHNKHR	10	72	10	252	36	62	0
	PATRIND	124	150	68	750	75	26	56
	NBONGSC	37	84	30	87	42	47	7
	GULPUR	80	100	10	200	50	20	70
	CHASMA	114	114	18	570	0	0	96
	KAROT	620	720	232	3362	360	100	388
		6936	7884	4591	36483	2710	947	2366
	JABBAN	22	22	12	36			
	DARGAI	13	15	5	29			
	PEHUR	5	28	5	38			
	GML-ZAM	9	17	5	39			
	KRM.GRHI	5	5	0	3			
	JAGRAN	24	33	5	59			
Small Hydro	MARALA SH	7	8	4	15			
,	NANDPR	6	14	6	18			
	RENALA	1	1	1	1			
	SHISHI	2	2	1	2			
	RESHUN	4	4	2	4			
	JINNAH	39	96	24	249			
		137	245	69	492			
	JDW	24	26	10	73			
Dagass	CHINIOTPP	27	62	20	57			

### Operating Reserve Policy



Dagass	FATIMA	32	66	25	294			
	AL MOIZ	17	30	10	135			
		100	184	65	559			
	K2 Unit	1032	1040	730	5595			
Number of Street	K3 Unit	1032	1040	730	5595			
Nuclear	CHASHNUP	926	947	600	7078			
		2990	3027	2060	18269			
	NSHTCHN	110	195	68	345	98	85	42
	NISHT-PWR	109	195	68	345	98	86	41
	AGL-IPP	140	156	68	281	78	16	72
	K.E.L	44	124	44	149	62	80	0
	Liberty Tech	69	188	69	333	94	119	0
	Liberty Power	194	194	90	889	0	0	104
	FNDTION	156	166	63	1109	77	10	93
	UCH 1	500	500	477	2611	0	0	23
	КАРСО	416	430	125	3010	135	14	291
	GUDDU	290	300	210	2163	50	10	80
	GUD-CCPP	480	480	340	3259	0	0	140
	BALLOKI	776	1098	730	5968	512	322	46
	HBS	934	1050	750	5706	490	116	184
	TRIMMU	932	1105	840	3989	515	173	92
Thermal	UCH2	360	372	298	2397	174	12	62
	HALMOR	123	175	119	837	82	52	4
	SAPHIRE	125	130	66	621	65	5	59
	ENGRO Power	100	130	40	654	65	30	60
	NANDPR	354	354	248	2914	0	0	106
	PRT CFPP	840	900	660	3272	360	60	180
	LUCKY	600	606	303	2485	242	6	297
	SECL	1200	1200	600	4692	0	0	600
	SAHIWAL	1160	1242	660	4856	497	82	500
	TEL	300	300	110	1146	0	0	190
	THAL NOVA	300	300	110	1146	0	0	190
	HUB CHINA	300	625	270	1950	250	325	30
	AESLALP	175	350	175	1141	140	175	0

# Operating Reserve Policy



	AESPKGN	170	350	170	991	140	180	0
		11257	13215	7771	59259	4223	1958	3486
	QAD-SOLAR	20	100	0				
	CREST ENE	20	100	0				
Solar	BESTGREEN	35	100	0				
	ZENFA SOLAR	75	100	0				
		150	400	0				
	HAWA	27	50	16				
	MASTER	23	50	16				
	ZEPHYR	20	50	16				
	G AHMD	27	50	0				
	ARTISTIC	27	50	0				
	ACT2	27	50	0				
	DIN-E	27	50	0				
	LIBERTY1	27	50	0			ļ]	ļ!
	LIBERTY2	25	50	0			ļ]	L
	INDUS	23	50	0			ļļ	
	NASDA	20	50	0			<b>└───</b> ┦	L
	LAKESIDE	26	50	0				
	METRO-2	31	50	0			<b>├</b> ───┦	
	MASTER GR	20	50	0			┝───┦	
	METRO	20	50	0				
	тарді	15	30	0			<b>├───</b> ┦	
		35	99	0				
	ARTISTIC	25	50	16				
Wind	GULAHMAD	20	50	10				
	YUNUS	23	50	16				
	SAPHIRE	23	50	0				
	TGF	23	50	10				
	FWEL-I	20	50	0				
	FWEL-II	23	50	0				
	TENAGA	20	50	16				
	DAWOOD	25	50	16				
	SACHAL	25	50	0				
	JPLL	30	50	0				
	TGS	27	50	0				
	TGT	30	50	0				
	TRICON 1	32	50	10				
	TRICON 2	32	50	10				
	TRICON 3	27	50	10				
	NOORIABAD	8	12	6				
	TRICOM	25	50	0				
	ZORLU	17	57	0				
		900	1852	171				
	Total	22470	26807	14726	115061	6933	2905	5852



### Winter Peak – Base case

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (-ve)
	Ghazi Barotha	526	580	460	2900	290	54	66
	Turbela PP	500	650	375	3267	325	150	125
	Malakand PP	23	23	14	82	0	0	10
	DARAL KHWAR	30	68	20	340	34	38	10
	GOLEN	20	50	20	100	25	30	0
	ALLAI	40	40	40	90	0	0	0
	DBR-KWR	70	70	70	245	0	0	0
Hydro	KHNKHR	10	10	10	35	0	0	0
	PATRIND	69	69	68	345	0	0	2
	NBONGSC	37	37	30	38	0	0	7
	GULPUR	20	20	10	40	0	0	10
	CHASMA	58	58	18	290	0	0	40
	KAROT	160	180	58	841	90	20	102
		1564	1855	1192	8613	764	292	372
	JABBAN	11	11	6	18			
	PEHUR	5	5	5	7			
	GML-ZAM	9	9	5	20			
	KRM.GRHI	5	5	0	3			
Concell Museless	JAGRAN	10	10	5	18			
Small Hydro	MARALA SH	7	7	4	0			
	NANDPR	6	14	6	15			
	JINNAH	39	39	24	101			
	SHISHI	2	2	1	3			
		94	102	56	185			
	WDL	24	26	10	73			
Dagass	CHINIOTPP	27	62	20	57			
Bagass	FATIMA	25	32	32	142			
	AL MOIZ	17	30	10	135			
		93	150	72	407			
	K2 Unit	1032	1032	730	5552			

# Operating Reserve Policy



	K3 Unit	1032	1032	730	5552			
Nuclear	CHASHNUP	1241	1241	800	9004			
	Call Insertion of	3305	3305	2260	20108			
	ACL IDD	150	156	69	201	70	6	00
	AGL-IPP ATLAS	212	150	75	201	/0	0	120
	ATLAS	117	105	13	360	00	70	130
	NSHICHN	11/	195	60	345	58	/8	49
	K.E.L	114	124	44	145	02	10	122
	NISHT-PWK	170	195	00	345	70	17	122
	LIBERTT Tech	1/0	155	77	343	100	17	105
	HUBCO Narowal	155	212	62	1247	100	55	107
	Foundation	1/0	400	240	1247	6/	10	107
	GUD-CCPP	480	480	340	3255	0		140
	UCH 1	550	550	4//	2893	0		/3
	Engro Power	110	110	89	553	0	0	21
Thermal	Engro Thar	602	602	300	2095	0	0	302
	BALLOKI	1135	1189	/30	6463	555	54	405
	TRIMMU	1141	1200	840	3/39	559	23	301
	UCH2	372	372	298	2397	0	0	74
	HBS	1155	1189	750	6465	555	34	405
	TEL	301	301	110	1150	0	0	191
	SECL	850	1230	600	4809	492	380	250
	LUCKY	303	606	303	2485	242	303	0
	THAL NOVA	300	300	110	1146	0	0	190
	Hub China	275	625	275	3	1950	0	250
	SAHIWAL	1240	1242	660	4856	497	2	580
		10105	11472	6414	45744	5455	1017	3941
Solar								
	HAWA	27	50	16				
	TENAGA	20	50	16				
	DAWOOD	25	50	16				
	ZEPHYR	26	50	16				
	SACHAL	32	50	0				
	JPLL	38	50	0				
	TGS 1	34	50	0				
	TGS 2	37	50	0				
Wind	ACT2	27	50	- 0				
	DIN-F	27	50	0				
	LIBERTY1	27	50	0				
	LIBERTY2	25	50	0				
	NASDA	28	50	0				
	LAKESIDE	26	50	0				
	MASTER GR	26	50	0				
	NOORIABAD	8	12	6			——————————————————————————————————————	
	NOOMADAD	422	760	70				
		452	700	12				
	Total	15593	17644	10065	75057	6219	1309	4313



# Winter off-peak – Base Case

Diant Trunc	Danner Diant	Deser	Densen	Duration	Maria	Droop	Reserve	Reserve (-
Plant Type	Power Plant	Pgen	Pmax	Pmin	IVIW.S	(MW/Hz)	(+ve)	ve)
	Turbela PP	210	390	210	1872	195	180	0
	Malakand PP	23	23	14	82	0	0	10
	DARAL KHWAR	15	15	10	75	0	0	5
Hydro	GULPUR	20	20	10	40	0	0	10
	CHASMA	58	58	18	290	0	0	40
	KAROT	160	180	58	841	90	20	102
		486	686	320	3199	285	200	167
	JABBAN	11	11	6	18			
	JAGRAN	10	10	5	18			
	MARALA SH	7	7	4	13			
Small Hydro	RESHUN	3	4	2	7			
Sinan nyuro	RENALA	1	1	1	1			
	JINNAH	34	34	21	89			
	SHISHI	2	2	1	3			
		68	69	39	150			
	JDW	24	26	10	73			
	CHINIOTPP	27	27	20	25			
Bagass	FATIMA	32	32	25	142			
-	AL MOIZ	17	30	10	135			
		100	115	65	375			
	K2/K3 UNT	745	1040	730	5595			
Mandanan	K3/K3 UNT	745	1040	730	5595			
Nuclear	CHASHNUP	1000	1263	800	9170			
		2490	3343	2260	20360			
	FNDTION	80	170	63	1140	80	90	17
	GUD-CCPP	150	240	170	1630	120	90	0
	UCH 1	148	190	171	992	89	42	0
	Engro Power	100	110	89	553	55	10	11
	ENGRO Thar	590	602	300	2095	241	12	290
	BALLOKI	900	1189	730	6463	555	289	170
Thermal	TRIMMU	907	1200	484	3739	559	293	423
	UCH2	368	372	298	2461	50	4	70
	TEL	300	301	110	1150	120	1	190
	SECL	800	1250	600	4888	500	450	200
	LUCKY	303	606	303	2485	242	303	0
	THAL NOVA	300	300	110	1146	0	0	190
		4946	6530	3428	28742	2610	1584	1561
Solar								
	HAWA	20	50	16				
	ZEPHYR	20	50	16				
	DIN-E	10	50	0				
	LIBERTY1	10	50	0				
	LIBERTY2	10	50	0				
	MASTER GR	10	50	0				
Wind	DAWOOD	20	50	16				
	SACHAL	20	50	0				
	JPLL	20	50	0				
	TGS 1	20	50	0				
	TGS 2	10	50	0				
	NOORIABAD	8	12	6				
		178	561	55				
	Total	8268	11304	6167	52826	2895	1784	1728

# Annexure 2: Technical data of power plants and minutes of meetings with stakeholders

### Calculations for Frequency Regulation Characteristics (β)

To maintain system frequency according to grid code requirement, there are requirements on frequency regulation characteristics along with maintaining minimum primary reserves on the generating units. According to the grid code,

- Target frequency is 50±.05 Hz which will be maintained during normal operating conditions
- Frequency Sensitive Band (50±.2 Hz) allow Frequency variations while ramping up generation and load pick-up, i.e., after N-1 the frequency need to be stabilized within this level but through secondary control will be ramped up to target frequency level
- Tolerance Frequency Band (50±.5 Hz) are protected periods of operation of the system during contingency period
- Contingency Frequency Band (49.3 Hz 50.5 Hz) is the maximum expected absolute value of the instantaneous Frequency after the occurrence of an imbalance, beyond which SO shall deploy emergency measures such as Demand Control or Automatic Low Frequency Demand Disconnection.
- A Significant Frequency Disturbance Event is deemed to have occurred if the Frequency falls below 49.3 Hz or rises above 50.5 Hz.

According to the above criteria, the reserves and frequency regulation need to maintained in a manner that during N-1 contingency the frequency nadir do not violate contingency frequency band and after activation of primary reserves the frequency settle within frequency sensitive band. As.

$$\Delta f = \frac{\Delta P}{\beta_g + \beta_l}$$

Where,

 $\Delta f$  is the steady state frequency;

 $\Delta P$  is the active power imbalance;

 $\beta_l$  is the load damping; and

 $\beta_g$  is the sum of frequency regulation from all generating units.

In the above equation,  $\beta_g$  and  $\beta_l$  equals to;

$$\beta_g = \sum_{i=1}^n \beta_{g,i}$$

$$\& \beta_{g,i} = \frac{P_i}{R_i \cdot f_n}$$

$$\beta_l = \frac{P_{load} \cdot D}{f_n}$$

Where,



 $P_i$  is the rated power of generating unit i

 $R_i$  is the governor droop of generating unit i

*f*<sup>*n*</sup> is the nominal frequency

*P*<sub>load</sub> is the connected load

D is the load damping

If, during contingency of N-1 (K-2 tripping resulting in 1040 MW of power imbalance), steady state frequency has to be maintained at 49.8 then the frequency regulation requirement with governor dead band of 0.05 Hz will be:

$$\Delta f = \frac{\Delta P}{\beta_g + \beta_l}$$
$$(.2 - .05) = \frac{1040}{\beta_g + \beta_l}$$
$$\beta_g + \beta_l = 0.15 * 1040 = 6933 \frac{MW}{Hz}$$

if  $P_{load} = 20000 \text{ MW}$  and Damping is 2, then

$$\beta_l = \frac{P_{load} \cdot D}{f_n} = \frac{20000 * 2}{5} = 800 \frac{MW}{Hz}$$
$$\gg \beta_g = 6133 \frac{MW}{Hz}$$

with droop of 4%, the available genertion with FGMO will be

$$\beta_g = \frac{\sum P_i}{R_i \cdot f_n} \gg \sum P_i = 6133 * .04 * 50 = 12,266 MW$$

When 90% of reserve power is provided by NTDC and 10% by KE, 11040 MW of NTDC generating units will be operating on FGMO mode and 1226 MW of KE generating units will be operating under FGMO mode.

The study has also analyzed the BESS with droop of 0.5 % and capacity of 500 MW, the frequency regulation provided by the BESS will be

$$\beta_{BESS} = \frac{P_{BESS}}{R_{BESS} \cdot f_n} \text{ with } P_{BESS} = 500 \text{ MW}, R_{BESS} = 0.5\% \gg \beta_{BESS} = 2000 \text{ MW}/Hz$$

The implementation of BESS will minimize the frequency regulation requirement from generating units thereby less generation on FGMO will be required.

Governor Droop analysis: Dated May 03, 2023

### Event Summary

Time of Event: May 03, 2023, 14:34:20

Frequency drop trend

14:34:20 - 50.31 14:34:32- 49.54



14:34:37 - 49.27

Generation: 15,300 MW.

Under frequency stage – 1 Operated due to tripping of K-2 (550MW).

Load tripped due to under frequency = 406MW.

Manual opening = 124MW.

Total = 530MW.

ROCOF Operated = No.

System normalized @ 1450hrs.

### **Data Summary- Frequency Trend**



Plant	Unit	Rated MW	Operating MW	%	Max MW	Delta P	Hz @ Max MW	% Op MW	Settling Time		Droon Setting
Thank	Onic				max mm	Шах		, vop mit	(500)		Droop Secting
SECL	Unit #1	620	619	100%	636	17	50.27	3%	20		5%
SECL	Unit#2	620	324	52%	336	12	50.27	4%	17		5%
Lucky	Unit#1	608	608	100%	620.13	12	50.02	2%	18		5%
HBS	GT-1	410	411	100%	424	12	50.17	3%	12	Generation further dropped till 49.3 Hz.	4%
HBS	GT-2	410	404	100%	413.8	10	50.26	3%	12	Generation further dropped till 49.3 Hz.	4%
HBS	ST	400	400	100%	411	10	50.17	3%	18		4%
Bhikki	GT-1	410	394	96%	409	15	50.302	4%	16	Generation further dropped till 49.3 Hz.	4%
Bhikki	GT-2	410	392	96%	406	14	50.26	4%	11	Generation further dropped till 49.3 Hz.	4%
Bhikki	ST	400	322	81%	343	21	50.026	7%	60	Load remaind setlled at 330 MW.	4%
Balloki	GT-1	410	381	94%	394	13	50.138	3%	11	Generation further dropped till 49.3 Hz.	4%
Balloki	GT-2	410	392	96%	410	18	50.138	5%	12	Generation further dropped till 49.3 Hz.	4%
Balloki	ST	400	384	96%	403	19	50.26	5%	54		4%

### Data Summary- Plant Data

### **Observations**

• Most plants were operating at rated load so margin for frequency response was not available/very minimal.



- A momentary increase in Generation is observed but not sustainable (Probably due to ROCF).
- Increase in generation was from 2  $\sim$ 7% of operating load.
- Maximum generation point was reached from 50.302 ~ 50.02.
- Most generating units achieved maximum generation in 3-5 seconds of frequency drop and then gradually reduced generation to initial dispatch time within 20 Secs.

### **Observations- RLNG Plants**

• <u>All GT's dropped generation after initial momentary response with a drop in</u> <u>frequency. This situation further Jeopardized frequency management.</u> This is likely due to reduction in input fuel pressure as a result of change in compressor speed.



Pre Incident Operating MW	381	393	384.6	397.472	394.073	332.088	411.307	403.514	400.406
Minimum MW	367.305	376.655	384.6	378.692	374.229	331.942	393.283	384.254	399.217
Delta	13.695	16.345	o	18.78	19.844	0.146	18.024	19.26	1.189
Unit	BLK GT-1	BLK GT-2	BLK ST	BKI GT-1	BKI GT-2	BKI ST	HBS GT-1	HBS GT-2	HBS ST

### **Observations- Coal Fired Plants**









### **Recommendations**

- Primary frequency response capability analysis to be carried out in consultation with IPPs & Industry notables as per demonstrated values and any additional margin (if available).
- Working document/Operating Procedure to be developed and presented to the authority based on capability analysis & S.O. Operational modalities.
- It is mandatory to operate IPP(s) at partial loads to get primary frequency response.
- Gas Turbine based IPPs to be asked to justify drop in generation in response to frequency drop.
- Principally Secondary frequency response is essential for an effective implementation of primary frequency response. However, till the time AGC is not available operation team has to develop an SOP to timely become aware of a Primary response trigger and manage system accordingly.

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# MoM with RLNG-fired power plants

# DATE: 29-08-23

# Venue: NPCC Committee Room

# Agenda:

Financial & Technical Implications of adjusting Primary Reserves Technical Limits in Thermal Power Plants in accordance with Grid Code 2023

# Participants:

- Wajid Ali Chatha, Manager (Regulatory Affairs & Grid Code Compliance), NPCC with team.
- > Abdul Basit, Manager (Research & Development), NPCC, NTDC.
- Saeed Ahmed (Additional Manager RCC), NPCC, NTDC
- > Mr. Imtiaz Ahmed, Deputy Manager, NPCC, NTDC
- Representatives from Punjab Thermal Power (Pvt) Limited
- Representatives from Quaid-e-Azam Thermal Power (Pvt) Limited
- > Representatives from National Power Parks Management Company (Pvt) Ltd.

# Discussion:

> The Grid Code 2023 provision states

**OC 5.4.7.2. (d)** A Frequency Dead band of no greater than  $\pm$  0.05 Hz may be applied to the operation of the Governor Control System. The design, implementation and operation of the Frequency Dead band shall be agreed with the SO prior to commissioning of the Generating Unit/Station.

- The above-mentioned provision regarding the frequency dead band is replicated from the Grid Code 2023. It should be noted that all the IPPs thermal power plants possess the technical capabilities to comply with the GC23 OC 5.4.7.2 (d) provision.
- Currently most of the GPPs are non-complaint with the above-mentioned provisions as they are following dead band of 2005 Grid Code with ±0.5Hz dead band.
- Punjab Thermal, being a relatively new plant have disabled its frequency response altogether & have mentioned that enabling the primary frequency response causes problems for them in invoice settlement.
- NPCC recommended that initially dead band of frequency response of selected Thermal Generation Units be reduced to 0.2Hz for trail purposes & dead band should be gradually reduced further to align with the 0.05 Hz limits based on the findings of trail period & activation of frequency response on all eligible plants.
- The independent thermal power plants were asked to provide all the technical specification, limitation of maximum power provided by machine in response to variations as well as the flexibility provided by manufacturer on withstanding the frequency variation of ±0.5Hz of their GUs. This data will be used by NPCC R&D



Section to produce an accurate model of frequency response on the system with respect to the  $\pm 0.2$ Hz dead band limit.

- Before agreeing to any formal agreement, a trial period will be conducted to examine the practical implications of implementing the above-mentioned provision on the Thermal Power Plants and the System.
- Major issue highlighted by plats was that since the plants are given a set value of MW to dispatch, enabling the governor response at ±0.05Hz would make it practically impossible for plant to maintain a single energy level output. QATPL raised concern regarding the billing process of the energy dispatched with the governor response enabled at ±0.05Hz and requested that a comprehensive methodology that accurately encompasses the dispatch orders of NPCC and response of GUs with the implementation of GC23 provisions.
- It was agreed that a dispatch compliance monitoring mechanism will be developed and implemented so as to accurately monitor the power output of thermal plants relative to the system frequency.
- CPPA team mentioned that existing PPA's don't allow an upper dispatch tolerance level so once a formal frequency response mechanism is agreed subsequently some terms of PPAs might require amendments.

# MoM with coal-fired power plants

# DATE: 18-09-23

# Venue: NPCC Committee Room

# Agenda:

Technical Implications of adjusting Primary Reserves Technical Limits in Coal Based IPPs in accordance with Grid Code 2023

# Participants:

- 1) Wajid Ali Chatha, Manager (Regulatory Affairs & Grid Code Compliance), NPCC.
- 2) Abdul Basit, Manager (Research & Development), NPCC, NTDC.
- 3) Saeed Ahmed (Additional Manager RCC), NPCC, NTDC.
- 4) Salman Gul, Dy Manager (Regulatory Affairs & Grid Code Compliance), NPCC.
- 5) Mubashir Hussain, Dy Manager (Reg Affairs & Grid Code Compliance), NPCC.
- 6) Imtiaz Ahmed, Deputy Manager, NPCC, NTDC.
- 7) Mirza Shoaib Ahmed, Asst Manager, (Reg Affairs & Grid Code Compliance), NPCC.
- 8) Representatives from The Hub Power Company Limited (Thar Energy Limited)
- 9) Representatives from The Hub Power Company Ltd (ThalNova Power Thar Pvt)
- 10)Representatives from Port Qasim Electric Power Company (PQEPC)Power Project
- 11)Representatives from Lucky Electric Power Company
- 12)Representatives from Shanghai Electric (SECL) (Thar Block-I)
- 13)Representatives from China Power Hub Generation Company



# **Discussion**:

> The Grid Code 2023 provision states

**OC 5.4.7.2. (d)** A Frequency Dead band of no greater than  $\pm 0.05$  Hz may be applied to the operation of the Governor Control System. The design, implementation and operation of the Frequency Dead band shall be agreed with the SO prior to commissioning of the Generating Unit/Station.

- The above-mentioned provision regarding the frequency dead band is replicated from the Grid Code 2023. It should be noted that all the IPPs coal-based power plants possess the technical capabilities to comply with the GC23 OC 5.4.7.2 (d) provision.
- NPCC team mentioned that it is assessing a step wise application of the dead band for frequency response of selected Thermal Generation Units be reduced to 0.2Hz. This is for the purpose of conducting studies/demos on the response of the system by the changes in the mentioned settings. Later once the frequency response becomes active at all respective IPPs. the dead band will be further reduced to 0.05 Hz.
- The independent coal-based power plants are required to provide, Unit's operation status, DCS Trend along with Excel sheet of following in maximum resolution of Unit Active Power (MW) & System Frequency, Governor droop status along with frequency dead band, limitation of maximum power provided by machine in response to variations as well as the flexibility provided by manufacturer on withstanding the frequency variation of ±0.5Hz of their GUs. This data will be used by NPCC R&D Section to produce an accurate model of frequency response on the system with respect to the ±0.2Hz dead band limit.
- Before agreeing to any formal agreement, a trial period will be conducted to examine the practical implications of implementing the above-mentioned provision on the Thermal Power Plants and the System.
- IPPs were instructed by NPCC that all instances of abnormalities of load variation due to change in frequency should be sent to NPCC for examination and further proceedings.
- Representatives from HUBCO along with other participant shared their concern regarding frequent and abrupt frequency variations in the system and requested that NPCC operate the system within the safe technical limits so as to avoid such fluctuations.
- HUBCO stated its concern that with the primary frequency reserves activated and the dead band reduced to ±0.2Hz, the generation units will be adversely affected due to the sudden and continuous variations in frequency of the system. If the current practices of NCC continue in the future, the IPPs will be forced to either increase their



dead band range or disconnect from the system as their equipment is their first priority.

- Representatives from HUBCO opined that it would be more effective for all power plants to enable their Primary Frequency Response simultaneously, as a step-by-step activation would not be productive.
- NPCC team informed that as per O.C. 5.4.13 of the Grid Code 2023, System Operator is in process of preparing a comprehensive reserves management policy to be further submitted to Authority for review. Concerned raised by Plants shall be dually considered in the reserve management policy draft.

# MoM with CPPA-G

DATE: 25-09-23

# Venue: NPCC Committee Room

# Agenda:

Dispatch variability due primary frequency reserve

# Participants:

**CPPA-G**: Mubashar Ahmad Qureshi (CTO), Atif Rafique, Bilal Rafique, Bilal Ijaz

**NPCC**: Sajjad Akhtar (G.M, System operations), Wajid Ali Chattha, Saeed Ahmad, Taswar Abbas, Imtiaz Ahmad, Salman Gul, Mubashir Hussain, Mirza Shoaib Ahmed

# Discussion:

- It was highlighted by NPCC team that sessions have been conducted with GPPs & CFPPs to discuss activation of Frequency reserves at their respective facilities in line with provisions of Grid Code 2023. These plants have highlighted that in case of operating in frequency sensitive mode, plant's dispatch will be varied with change of frequency outside the dead band which can lead to deviation of NEO from actual dispatch instruction and since currently there is no provision of tolerance in lower dispatch variation so plants will be subject to financial implications.
- CPPA team clarified that contractually NPCC is mandated to operate and control power plants within the permissible Technical Limits. Moreover, IPPs are also obligated to follow NPCC despatch instructions. Contrary, all the associated financial implications shall remain attributed to IPPs in its entirety. However, operational instances of power plant while operating on frequency sensitive mode, if any, shall be verified by



NPCC otherwise CPPA could not compute actual quantum of FTADL and other related financial implications accordingly.

- > Both parties agreed on following action items:
  - Plants should be asked by NPCC to submit their consent / comments regarding activation of frequency sensitive mode operation in writing.
  - Considering the possible dispatch variation while operation of power plants in frequency sensitive mode, a prior strategy for dispatch instruction compiling and verification needs to be developed to avoid complexity at later stage. Following comprehensive dispatch analysis, a trail period of 7 ~ 15 days may be considered to observe behaviour of different plants.
  - Since adequate frequency reserves availability is a regulatory obligation along with a genuine requirement of system stability, thus necessary amendment in PPA's will be required following a mutual consensus with the IPPs.

### PPA 8.3 Turbine Governor Operation test reports

CHINA POWER HUB



### CPHGC

### 2×660MW Coal-Fired Power

Project

### ARTICLE VIII TESTING AND

### CAPACITY RATINGS OF THE PPA

Section 8.3(a)(iv) Part- I

Steam Turbine Governor Operation

TEST PROCEDURE TO DEMONSTRATE COMPLIANCE WITH THE PPA

BETWEEN

CENTRAL POWER PURCHASING AGENCY (GUARANTEE) LIMITED

AND

CHINA POWER HUB GENERATION COMPANY LIMITED

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### **Steam Turbine Governor Operation**

This test procedure is prepared and released by CPECC NWPEDI - TEPC for the use of PPA related test to be carried out at CPHGC 2×660MW Coal-Fired Power Project

Date:

Accepted for use by EPC :

(Name & Signature): 3 2 (Farry)

Accepted for use by China Power Hub Generation Company Ltd .:

(Name & Signature):

用害烟 (show)

Accepted for use by Engineer:

(Name & Signature):



**Operating Committee Approval (signature)** 

No.	NAME	SIGNATURE
1	MANSOOR HUSSAIN	All auso
2	ASIM ABBAS	Nint
3	花寺李	花寺
4	Muhammad Zalaria	Baugos.
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#### I. CONCERNING

Complex: CPHGC 2×660MW Coal-fired Power Project

Employer: China Power Hub Generation Company Ltd. (CPHGC)

EPC: CPECC NWPEDI - TEPC

Engineer: SGS

Power Purchaser: Central Power Purchasing Agency (Guarantee) Limited (CPPA-G)

#### II. OBJECTIVE

Frequency stability is one of the prevailing concerns of a Transmission System Operator, whose duty is the flaw-less operation of the Grid. Operation of electrical Grids must be reliable.

#### Stage

The test is part of Commissioning Tests after synchronization of CPHGC 2×660MW Coal-fired Power Project with the Grid.

#### PPA reference (s)

Technical requirements on the test after synchronization in the PPA shall meet the following document.

Article VIII	Testing and Capacity Ratings
Section 8.3	Testing upon and after Synchronization of the Complex and Commissioning Tests
8.3(a)(iv)	Steam turbine Over Speed Protection
PPA Schedule 7	Commissioning and Testing

### **III. CRITERIA FOR COMPLIANCE**

Criteria for compliance will be that:

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In accordance with Schedule 7 of Power Purchase Agreement:

The Operation of the speed governor will be demonstrated over its range, the droop being adjusted from 3% to 8%.

IV.METHOD OF TESTING

 $DROOP\% = \frac{(df/f)}{(dp/p)} \times 100\%$ 

df=frequency difference

f=system frequency

dp=load variation

p =unit load

#### a. Test Coordination

The co-ordination of the test will be done by CPECC NWPEDI - TEPC. The Engineer shall be informed on a continuous basis in order to provide his consent to proceed.

#### b. Pre-conditions

- 1) List of monitored variable has been loaded in and ready for record
- 2) Get the consent from NPCC for the test
- 3) Prepare boiler and steam disposal for the load variation
- 4) Warn the Grid operator of exact date and time of test, as the Grid may be upset due to the effect of load variation.

#### c. During Test

- 1) The Unit is running stable at 60%, 75% and 90% Load. Test shall be performed for droop settings of 3%, 4.5% and 8% at each of above set loads.
- 2) Generator shall run at rated speed synchronized with the Grid.

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- 3) Give an interference signal from DCS against the droop settings at 3%, 4.5% and 8% each. Frequency injection (disturbance) applied at different steps are ±0.067 Hz (±4r/min)and ±0.1 Hz (±6r/min) and last for 1 min, required by standard GB/T30370-2013 Guide of primary frequency control test and performance acceptance for thermal power generating units.
- 4) Record the speed of the generator, the active power Pn, main steam pressure.
- 5) Repeat step 3 for three different loading conditions of 60%, 75% and 90%.
- 6) The Unit goes back to Base Load

#### d. End of Test

The end of each test will be the point at which all readings have been taken.

#### e. Results

After the test is finished, all relevant documents will be copied and signed by all Parties involved. This means that only these documents may be used for determination of the results. In case of electronic recording, it is required to create printouts as far as possible or copies of files will be handed over.

### V. PROTOCOL

The protocol shall contain all used printouts and plant data information. It shall be clear if the test is in compliance with the requirements of the PPA.

CPHGC CPPA / NTDC EPC SGS Sign: Sign: Sign: Sign: Name: Name: Name: Name:

Signed for acceptance of the Test result<sup>1</sup>

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 Steam Turbine Governor Operation

 Date:
 Date:

 Date:
 Date:

 I Please put initials of all involved party representative on each separate page of the Procedure

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#### Steam Turbine Governor Operation

#### Droop 3% Load 60% Load 75% Load 90% Load Frequency (0.067)0.067 (0.1)0.1(0.067)0.067 (0.1)0.1(0.067)0.067 (0.1)0.1 Difference (HZ) Load variation After 14.667 14.667 29.3 29.3 14.667 29.3 14.667 29.3 14.667 14.667 29.3 29.3 Stabilization (MW) Load before Test (MW) Steady load after Test (MW) Actual Load variation after stabilization (MW) Stability time (s)

### Log Sheet Turbine governor operation Test

### Log Sheet Turbine governor operation Test

Droop		4.5%											
Load		60% L	.oad			75% Load				90% Load			
Frequency Difference (HZ)	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1	
Load variation After	9.78	9.78	19.6	19.6	9.78	9.78	19.6	19.6	9.78	9.78	19.6	19.6	
Allt	4 3	⊻	ÎΞ	,	snight	1	J.	du	Å	A	KB	]	



				Ste	am Tu	bine Gov	ernor O	peration
Stabilization (MW)								
Load before Test (MW)								
Steady load after Test (MW)			5					
Actual Load variation after stabilization (MW)								

# Log Sheet Turbine governor operation Test

Droop						8%	6				_	
Load		60% L	.oad			75% L	oad		90% Load			
Frequency	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1
Difference (HZ)												
Load variation												
After	5.5	5.5	16.5	16.5	5.5	5.5	16.5	16.5	5.5	5.5	16.5	16.5
Stabilization												
(MW)												
Load before Test												
(MW)												
Steady load after												
Test (MW)												
Actual Load												
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 variation after
 stabilization
 Image: Constraint of the stabilization (MW)
 Image: Constraint of the stabilization (MW)

 Stability time (s)
 Image: Constraint of the stabilization (MW)
 Image: Constraint of the stabilization (MW)
 Image: Constraint of the stabilization (MW)

#### Performance acceptance list

UNIT	Date	Time
index	Standard requirement	Experimental value(mean)
Droop%	3%-8%	
Response time	less than 3s	
Stability time	less than 60s	
Dead band	土0.033HZ	

### Signed for acceptance of the Test result<sup>1</sup>

CPHGC	CPPA / NTDC	EPC	SGS
Sign:	Sign:	Sign:	Sign:
Name:	Name:	Name:	Name:
Date:	Date:	Date:	Date:

<sup>1</sup> Please put initials of all involved party representative on each separate page of the Procedure.

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### BALLOKI

Ballocki



#### Turbine Governor Droop

#### Date: 15-05-2018

Time:	13:55 hrs
To	1710 hr

#### Turbine Governor Droop Test

Dp Injection mHz	Droop (%)	% Load	GT-1 Load (MW)	Intermediate GT-1 Load (MW)	GT-2 Load (MW)	Intermediate GT-2 Load (MW)	ST Load (MW)	Complex Load (MW)
-100mHz	4	80	283	303	285	301	317	921
+100mHz	4	80	300	278	307	284	304	866
-200mHz	4	80	300	337	300	338	322	997
*200mHz	4	80	287	249	295	256	305	810
-100mHz	4	70	277	300	282	301	310	911
+100mHz	4	70	281	263	281	262	303	828
-200mHz	4	70	280	323	280	314	308	945
+200mHz	4	70	281	244	283	241	292	777
250mHz	5	70	282	312	280	312	317	941
+300mHz	6	80	300	262	300	263	309	834
350mHz	7	80	305	348	305	349	326	1023

#### Signed for acceptance of readings<sup>1</sup>

NTDC/CPPA-G	HEI/GE	I.E
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Sign: Marcher	Sign: 7. This	Sign: Sign
Name: ASHA	Name: Tang Zhongen	Name: 2APAR TOOBAL
Date: 15/5/18	Date: 2016 . 5, 15	Date: 15/5/2018
	NTBC/CPPA-G Sign: NSULALI Name: ASHAR ALI Date: 15/5/18	NTEC/CPPA-G HEI/GE Sign: the Hell Sign: 7.74.24 Name: ASHAR Hell Sign: 7.74.24 Name: Tang Zhongh Date: 15/5/18 Date: 2014.5,15

<sup>1</sup> Please put initials of all involved party representative on each separate page of the Proc.

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			12	30 M	W C	CPP	HBS	5	
	<i>ι</i>	I. TEST ACCI The table below 2_resulting response	EPTANCE is for diffe	rent droop se i be recorded.	ttings and	frequency	injection	for GTs	and the
	<u></u>	df injected in mHz	Droop 2% dP	Droop 3% dP	Droop 4% dP	Droop 5% dP	Droop 6% dP	Droop 7% dP	Dreop 8% dP
		±100 mHz	10%					-	
5		±150 mHz		10%				-	
	×	0.7 ±200 mHz		:	10%				
		-05 ±250 mHz		6	- 250m)	10% B 319MW	: : :	:	
		+0.6 ±300 mHz		6	· · · ·	+3001413	10% Z4041		
		-07 ±350 mHz		X			-350m#3	10% 324mi	
		<b>± 0.8</b> ±400 mHz		2				-400mH +400mH	2 327MW 10% 236MW
5		Above chart modif	ied as per req	puirement. Tes	st Range 2- て 、	8%. Were	net	ta	rtad no
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		Data Logging De	vices						
		Power Construction	Corporation o	f China (Power	r China)	At	69	3	Page 7 / 9



### 1230 MW CCPP HBS TEST POINTS 1. The table below is for frequency injection for GTs and the resulting response on ST will be recorded. GT#02 +200mHz -100mHz +100mHz -200mHz Test number (Load Variation) (Load Variation) (Lond Variation) (Load Variation) 2.80 280 280 , je Intermediate complex load 1: 70% load (MW) 289 MW 16 210 321 Befine 320 320 320 319 Intermediate complex load 2: 80% load (MW) 320MW 30 361 280 Ater 340 Set Speed Droop for the above test $\frac{\mathcal{L}}{\mathcal{L}}$ %. Load verses Time Trend will be taken for the above. Hitte 2 Page 679 ð Power Construction Corporation of China (Power China)

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		12	30 M	W C	CPP.	HBS	<b>)</b>	<u></u>
GT	I. TEST ACC The table below resulting respon	EPTANCE is for diffe se on ST will	rent droop se be recorded.	ttings and	frequency	injection	for GTs	and the
	df injected in mHz	Droop 2% dP	Droop 3% dP	Droop 4% dP	Droop 5% dP	Droop 6% dP	Droop 7% dP	Droop 8% dP
,	±100 mHz	10%		·	,			- - -
)	±150 mHz		10%		· · ·			· · · · · · · · · · · · · · · · · · ·
<i></i>	±200 mHz			10%		9,011 I		
	±250 mHz			· · · ·	-2501418 34141W +250mHB 27941W	÷		
	±300 mHz		8	· · · · · · · · · · · · · · · · · · ·	-300mHZ +300mHZ	364MW 10% 276MW		
	±350 mHz	······································				-3504/13 +3504/18	278 MW	
	±400 mHz		0				400 MHB	365 MW 10%
N-1	Above chart modi	fied as per rec	Juirement. To	st Range 2	-8%.	L		
) .	Broop @	2% a	nd 03	% w	ne on	not -	feAn	l on
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# 1230 MW CCPP HBS

 

 I. TEST POINTS The table below is for frequency injection for GTs and the resulting response on ST will be recorded.
 SFm.f
 Time
 1/20
 AH.

 GT #0
 SFm.f
 Time
 1/20
 AH.

 Test number
 -100mHz (Load Variation)
 +100mHz (Load Variation)
 -200mHz (Load Variation)
 +200mHz (Load Variation)

 Intermediate complex load
 Before
 281
 280
 280
 280

Intermediate complex load	Before	281	280	280	280
1: 70% load (MW)	After	305	260.23	319	239
Intermediate complex	Before	321	320	319	321
load 2: 80% load (MW)	After	339	301	361	280

Set Speed Droop for the above test ..... %.

Load verses Time Trend will be taken for the above.

Power Construction Corporation of China (Power China) Page 6/9



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Steam Turbine Governor Operation

#### Log Sheet Turbine Governor Operation Test

DATE: 2022-03-07

Droop%		4.5%										
load		60%				75%			90%			
Frequency Difference(HZ)	-0.0667	0.0667	-0.1	0.1	-0.0667	0.0667	-0.1	0.1	-0.0667	0.0667	-0.1	0.1
Load variation After stabilization(MW)	-9.8	9.8	-19.6	19.6	-9.8	9.8	-19.6	19.6	-9.8	9.8	-19.6	19.6
Start time	11:05	11:01	11:13	11:10	12:26	12:28	12:30	12:33	14:40	14:44	14:55	14:47
Load before Test (MW)	396	397	396,8	395.8	494.3	494.7	495	494.9	594.7	592.4	593.4	593.8
Steady load after Test(MW)	385.9	406.4	377.6	415.2	484.8	504.6	475.8	514.4	585.1	603.1	574.5	613,6
Actual Load variation after stabilization(MVV)	-10.1	9.4	-19.2	19.4	-9.5	9,9	-19,2	19.5	-9,6	10.7	-18.9	19.1
Stability time(s)	45	48	43	47	-38	48	45	35	31	30	36	31
Response time(s)	2.3	2.6	1.7	1.5	1.3	1.8	1.5	1.3	1.8	1.7	1.9	1.6

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	3%~8%	4.5%
Response time	Less than 3s	ok
Stability time	Less than 60s	ok
Dead band	$\pm 0.033$ HZ	±2 rpm

#### Sign for acceptance of the test result

Issued by	LEPCL	CPPA-G/NTDC	SEPCOIII	ENGINEER
Sign	At-c	FAREED ALMAD	诸纪	副言語於
Name	AHSAN IRSHA	Satil TAMIL	Tinglibing	wind Gang the BO
Date	7" MAR 2022	HAMZA AMAN	07/03/2022	7/0/2022
		7th mAR 2022		





Log Sheet Turbine Governor Operation Test

DATE: 2022-03-07

Droop%		3%											
load		60%				75%				90%			
Frequency Difference(HZ)	-0.0667	0.0667	-0.1	0.1	-0.0667	0.0667	-0.1	0.1	-0.0667	0.0667	-0.1	0.1	
Load variation After stabilization(MW)	-14.7	14.7	-29.3	29.3	-14.7	14.7	-29.3	29.3	-14.7	14.7	-29.3	29.3	
Start time	10:30	10:26	10:46	10:38	12:35	12:37	12:39	12:41	14:24	14:22	14:26	14:29	
Load before Test (MW)	397.5	395.5	396.6	396	494.5	495.6	494.7	494.8	593.8	594.1	594.6	594.3	
Steady load after Test(MW)	383.1	408.9	367.5	425.5	480.1	510.4	465.6	523.8	579.3	609	565	623.4	
Actual Load variation after stabilization(MW)	-14.1	13.5	-29.1	28.9	-14.4	14.8	-29.1	29	-14.5	14.9	-29.6	29.1	
Stability time(s)	46	49	48	50	45	38	46	47	49	31	40	52	
Response time(s)	2.1	2.4	1.9	1.8	1.5	1.3	1.2	1.8	1.5	1.8	2.1	2.3	

Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	3%~8%	3%
Response time	Less than 3s	ok
Stability time	Less than 60s	ok
Dead band	±0.033HZ	±2 rpm

Sign for acceptance of the test result

Issued by	LEPCL	CPPA-G/NTDC	SEPCOIII	ENGINEER
Sign	Ale	FAREED AHMAD	流いを	IP) 200
Name	AHSAN ZRSHAD	Gjaffail SAJID TAMIL	Jinglibing	Vang Grang Zhao Bo
Date	7th MAR 2022	HAM2D AMAN	07/03/2022	07/03/2022
		7HL MAR 2022		4 B

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Steam Turbine Governor Operation

### Log Sheet Turbine Governor Operation Test

DATE: 2022-03-07

TIME: <u>10:20-15:00</u>

Droop%	<u> </u>	8%										
load		60%			75%			90%				
Frequency Difference(HZ)	-0.0667	0.0667	-0.1	0.1	-0.0667	0.0667	-0,1	0.1	-0.0667	0.0667	-0,1	.0.1
Load variation After stabilization(MVV)	-5	5	-11	11	-5	5	-11	11	-5	5	-11	11
Start time	11:24	11:20	11:30	11:27	12:15	12:13	12:33	12:17	14:48	14:49	14:50	14:51
Load before Test (MW)	395.4	394.9	396.2	395.9	494.9	495.6	495.1	495	592,8	593.6	594.4	594.1
Steady load after Test(MW)	390.7	400	385.3	407	490	500.5	483.3	505.6	588.2	598.9	583.5	605:2
Actual Load variation after stabilization(MW)	-4.7	5.1	-10.9 <sup>.</sup>	11.1	-4.9	4,9	-10;8	10.6	-4.6	5.3	-10.9	11.1
Stability time(s)	-55	37	42	40	36	40	42	40	41	44	24	20
Response time(s)	2.1	2.2	1.8	1.5	2,1	1.6	1.9	1.7	1.3	1.2	1.6	1.7

Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	3%~8%	8%
Response time	Less than 3s	ok
Stability time	Less than 60s	ok
Dead band	±0.033HZ	±2 rpm

Sign for acceptance of the test result

Issued by	LEPCL	CPPA-G/NTDC	SEPCOIII	ENGINEER
Sign	Al	FAREED AHMAD	清公平	AN TONA
Name	AHSAN ZRSHAD	SATIO TAMIL	Ting li bing	Wang Cong Thank o
Date	7 <sup>th</sup> MAR 2022	HAMZA AMAN	07/03/2022	of half ont
		714 MAR 2022		Constants w

7th MAR 2022
CPHGC



CPHGC

# **Steam Turbine Governor Operation** Log Sheet Of Turbine governor operation Test

UNIT:_	1 Date: Aug 05 20	<u>19</u> S	start Time:_	11:16	End Time:_	11:39
	Droop			3%		
	Load		60	% Load		
	Start time	11:21	11:16	11:38	11:26	
	Frequency Difference (HZ)	0.067	-0.067	0.1	-0.1	1
	Speed Difference (rpm)	-4	4	-6	6	
	Load variation After Stabilization (MW)	-14.667	14.667	-29.3	29.3	
	Load before Test (MW)	394.7	396.43	396.3	395.58	
	Steady load after Test (MW)	380.68	411.1	367.15	425.07	
	Actual Load variation After stabilization (MW)	-14.04	14.66	-29.16	29.4	
	Frequency before Test (HZ)	49.839	49.815	50.026	50.10	
	Steady Frequency after Test (HZ)	49.907	49.836	49.987	50.173	
	Stability time (s)	57.00	43.41	47.00	54.14	
	Response time (s)	1sec	1sec	1sec	1 sec	

#### Performance acceptance list

Index ·	Standard requirement	Experimental value(mean)		
Droop%	3%	ОК		
Response time	less than 3s	OK		
Stability time	less than 60s	ОК		
Dead band	±0.033HZ (±2rpm)	OK		
P~ (M M	me z	En Jugh &		

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### Log Sheet Of Turbine governor operation Test

UNIT	: <u>1</u> Date: <u>July 30 20</u>	<u>19 Sta</u>	art Time: <u>2</u>	0:28	End Time:	21:45
ſ	Droop		3	%		
ľ	Load		75%	Load		
	Start time	20:28	20:38	20:58	21:44	
	Frequency Difference (HZ)	0.067	-0.067	0.1	-0.1	-
	Speed Difference (rpm)	-4	4.	-6	6	
-	Load variation After Stabilization (MW)	-14.667	14.667	-29.3	29.3	
	Load before Test (MW)	494.58	495.67	495.19	493.97	
	Steady load after Test (MW)	479.94	509.71	465.20	522.37	
-	Actual Load variation After stabilization (MW)	-14.63	14.038	-29.9	28.405	
	Frequency before Test (HZ)	50,425	50.583	50.56	50.132	
	Steady Frequency after Test (HZ)	50.418	50.536	50.551	50.174	
	Stability time (s)	37.94	56.00	44.46	25.30	1
	Response time (s)	1sec	lsec	1sec	1 sec.	]

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)		
Droop%	3%	OK		
Response time	less than 3s	OK		
Stability time	less than 60s	ОК		
Dead band	$\pm 0.033$ HZ ( $\pm 2$ rpm)	OK.		
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UNIT:	1 Date: July 31 20	<u>19 Sta</u>	rt I ime: <u> </u>	2:37	End Time:	<u>15:00</u>
	Droop		3'	%		
	Load		90%	Load		
	Start time	12:37	12:42	13:05	12:49	
	Frequency Difference (HZ)	0.067	-0.067	.0.1	-0.1	
	Speed Difference (rpm)	-4	4	-6	6	
	Load variation After Stabilization (MW)	-14.667	14.667	-29.3	29:3	
	Load before Test (MW)	594.311	594.311	593.33	593.701	
	Steady load after Test (MW)	579.533	608.818	564.52	623.009	
	Actual Load variation After stabilization (MW)	-14:778	14.507	-28.809	29.308	
	Frequency before Test (HZ)	50.071	49,90	50.402	49.955	_
	Steady Frequency after Test (HZ)	50.086	49.94	50.343	50.007	
	Stability time (s)	44.93	48.95	49	37.78	
	Response time (s)	lsec	1sec	Iseo	1sec	

## Steam Turbine Governor Operation

#### Performance acceptance list

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Index	Standard requirement	Experimental value(mean)		
Droop%	3%	OK		
Response time	less than 3s	OK		
Stability time	less than 60s	OK.		
Dead band	$\pm 0.033$ HZ ( $\pm 2$ rpm)	ОК		
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	Log Sheet Of Tu	rbine go	vernor op	eration T	est	
JNIT <u>:</u>	1 Date: Aug 05 201	<u>9 </u> Ŝt	art Time: <u>0</u>	9:52	End Time:	11:0
	Droop		4.:	5%		
	Load		60%	Load		
	Start time	09:52	10:55	11:01	11:06	
	Frequency Difference (HZ)	0.067	-0.067	0,1	-0,1	
	Speed Difference (rpm)	-4	4	-6	6	
	Load variation After Stabilization (MW)	-9.78	9.78	-19.6	19.6	
	Load before Test (MW)	396.19	396.06	395.58	396.19	
	Steady load after Test (MW)	386.28	405.83	375.89	415.23	
	Actual Load variation After stabilization (MW)	-9.9	9.76	-19.68	19.04	
	Frequency before Test (HZ)	50.467	50.34	50.499	49.997	
	Steady Frequency after Test (HZ)	50.475	50.399	50.349	50.054	
	Stability time (s)	56.00	40.00	51.00	43.00	
	Response time (s)	1 sec	1sec	1sec	lsec	

#### Steam Turbine Governor Operation

#### vernor operation Test

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droon%	4.5%	OK
Response time	less than 3s	OK
Stability time	less than 60s	ОК
Dead band	±0.033HZ (±2rpm)	OK

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	Log Sheet Of Tu	rbine go	vernor o	peration T	est	
UNIT:	1 Date: July 30 201	<u>9 S</u>	tart Time:	<u>19:34</u>	End Time:	19:57
	Droop		.4	1.5%		
	Load		759	% Load		
	Start time	19:34	19:39	19:43	19:56	
	Frequency Difference (HZ)	0.067	-0.067	0.1	-0.1	
	Speed Difference (rpm)	-4	4	-6	6	
	Load variation After Stabilization (MW)	-9.78	9.78	-19.6	19.6	
	Load before Test (MW)	495.55	494,70	494.94	494.21	
	Steady load after Test (MW)	485.83	504,60	475.29	514.09	
	Actual Load variation After stabilization (MW)	-9.719	9.902	-19.65	19,87	
	Frequency before Test (HZ)	50.081	50:417	50.335	50,46	
	Steady Frequency after Test (HZ)	50.156	50.487	50.358	50.428	
	Stability time (s)	47.12	48.72	54.00	33.41	
	Response time (s)	Tsec	Isec	1 sec	Isec	

#### Steam Turbine Governor Operation

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	4.5%	оқ
Response time	less than 3s	OK
Stability time	less than 60s	OK:
Dead band	±0.033HZ (±2rpm)	ОК

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	Log Sheet Of Tu	rbine go	vernor oj	peration To	est	
UNIT:	1 Date: July 31 201	<u>9 St</u>	art Time:	10:27	End Time:	12:27
	Droop		4	.5%		
	Load		90%	6 Load		
	Start time	10:46	10:27	10:51	12:26	
	Frequency Difference (HZ)	0.067	-0,067	0.1	-0.1	
	Speed Difference (rpm)	-4	4	-6	6	
	Load variation After Stabilization (MW)	-9,78	9.78	-19.6	19.6	
	Load before Test (MW)	594.311	593.945	593,335	592.969	
	Steady load after Test (MW)	584,546	603.732	573.699	612,243	
	Actual Load variation After stabilization (MW)	-9:766	<b>9:787</b> °	-19.636	19.274	
	Frequency before Test (HZ)	49.719	50,125	50,171	50.271	
	Steady Frequency after Test (HZ)	49.777	50.114	50.150	50.362	
	Stability time (s)	56	40.82	32.97	54.27	
	Response time (s)	1sec	lsec	1 sec	lsec	

#### Steam Turbine Governor Operation \_

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	4,5%	ОК
Response time	less than 3s	OK.
Stability time	less than 60s	OK.
Dead band	$\pm 0.033$ HZ ( $\pm 2$ rpm)	OK.

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Log Sheet Of Turbine governor operation Test						
UNIT:	1 Date: Aug 05 201	<u>9 St</u>	art Time:_	09:21	End Time:	09:41
1	Droop			8%		
	Load		60	% Load		
	Start time	09:21	09:24	09:31	09:40	
	Frequency Difference (HZ)	0.067	-0.067	0.1	-0.1	
	Speed Difference (rpm)	-4	4	-6	6	7
	Load variation After Stabilization (MW)	-5.5	5,5	-11	11	
1	Load before Test (MW)	395.94	395.7	396.19	396.19	
	Steady load after Test (MW)	390.69	400.9	385.05	406.9	
	Actual Load variation After stabilization (MW)	-5.24	5.24	-11.13	10.74	
	Frequency before Test (HZ)	50,324	50.104	50.115	50,096	
	Steady Frequency after Test (HZ)	50.215	50:091	50.288	50.149	
	Stability time (s)	54.00	33.00	54.00	47.00	
	Response time (s)	Isec	lsec	lsec	1sec	

#### Steam Turbine Governor Operation

#### Performance acceptance list

Standard requirement	Experimental value(mean)
8%	OK.
less than 3s	ОК
less than 60s	ОК
±0.033HZ (±2rpm)	ОК
	Standard requirement   8%   less than 3s   less than 60s   ±0.033HZ (±2rpm)

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Steam	Tur	bine	Governor	Operation	

UNIT <u>:</u>	<u>1</u> Date: July 30 20	<u>19 Sta</u>	rt Time:	17:50	End Time:	18:21	
	Droop		8	%			
-	Load		75% Load				
	Start time	17:50	18:20	18:06	18:10		
	Frequency Difference (HZ)	0.067	-0.067	0,1	-0,1		
	Speed Difference (rpm)	4	4	-6	.6		
	Load variation After Stabilization (MW)	-5.5	5.5	-11	11		
	Load before Test (MW)	495.55	495.31	494.702	494.458		
	Steady load after Test (MW)	489.65	500.806	484.041	505.778		
	Actual Load variation After stabilization (MW)	-5,902	5.49	-10,66	11.316		
	Frequency before Test (HZ)	50.438	50,451	49.887	49,994		
-	Steady Frequency after Test (HZ)	50.412	50.435	49.877	50.021		
	Stability time (s)	41.21	.44.00	41.11	39.86	1	
	Response time (s)	1sec	1sec	1sec	1sec	1	

#### Log Sheet Of Turbine governor operation Test

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	8%.	OK
Response time	less than 3s	OK
Stability time	less than 60s	OK
Dead band	±0.033HZ (±2rpm)	OK

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	Log Short Ox 10	80.					
UNIT	<u>1</u> Date: July 31 20	<u>19</u> Sta	rt Time:	08:54	End Time:	10:20	
	Droop		8%				
	Load		90%	6 Load			
	Start time	08:54	09:02	09:14	10:19	]	
	Frequency Difference (HZ)	0.067	-0.067	0,1	-0.1		
ſ	Speed Difference (rpm)	-4	4	-6	6		
-	Load variation After Stabilization (MW)	-5:5	5.5	-11	11		
	Load before Test (MW)	593,823	593.701	593.945	594.556		
	Steady load after Test (MW)	588,332	599.318	582.959	605.591		
	Actual Load variation After stabilization (MW)	-5.49	5.617	-10.986	11.035		
	Frequency before Test (HZ)	49.971	50.364	50.22	50,18		
	Steady Frequency after Test (HZ)	49,934	50,338	50.23	50.137		
	Stability time (s)	39.98	55.98	55	34.84		
-	Response time (s)	Isec	1sec	Isec	lsec	1	

#### Steam Turbine Governor Operation

#### Log Sheet Of Turbine governor operation Test

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	8%	ОК
Response time	less than 3s	ОК
Stability time	less than 60s	ОК
Dead band	±0.033HZ (±2rpm)	ОК

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Steam Turbine Governor Operation

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Name:	Name:	Name:	Name:
Muhammad	Mughees	Liu Zhaoyong	Hugh Xiang
Shoukat Ali	Ahmed	Chief Engineer	Project
Manager	Asst Manager		Manager
Technical	Protection and		
A (	Control	_	
Sign: Mayee	Sign: Mr Mahi		
Name:	Name:		
Sahibzada	M. Mohsin		
Abdul Haseeb	Khan		
Asst Manager	Asst Manager		
Technical	Protection and		
	Control		
Date: Aug 09,2018	Date: 09-08-201	Date: 20 (1.08-05	Date:
	Name: Muhammad Shoukat Ali Manager Technical Sign: Name: Sahibzada Abdul Haseeb Asst Manager Technical Date: Arg 9,2018	Name: Name;   Muhammad Mughees   Shoukat Ali Ahmed   Manager Asst Manager   Technical Protection and   Control Sign:   Sign: Marking   Name: Sign:   Name: Name:   Sahibzada M. Mohsin   Abdul Haseeb Khan   Asst Manager Protection and   Control Date: 09-08-101	Name: Name: Name:   Muhammad Mughees Liu Zhaoyong   Shoukat Ali Ahmed Chief Engineer   Manager Asst Manager Protection and   Technical Protection and Chief Engineer   Sign: Mame: Sign:   Name: Sign: Mame:   Name: Sign: Mame:   Name: Name: Name:   Sahibzada M. Mohsin Abdul Haseeb   Abdul Haseeb Khan Asst Manager   Technical Protection and Control   Date: Aug 09, 2019 Date: 09-08-101?   Date: Aug 09, 2019 Date: 09-08-101?

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#### Steam Turbine Governor Operation

#### Log Sheet Of Turbine governor operation Test

UNIT: <u>2</u> Date:	July 30 2	2019	Start T	ime:	6:51	End T	ime: <u>2</u>	<u>1:18</u>
Droop		3%						
Load		60%	Load			75%	Load	
Start time	16:51	16:59	17:07	17:13	20:55	21:00	21:06	21:17
Frequency Difference (HZ)	0.067	-0.067	0.1	-0.1	0.067	-0.067	Q.1	-0.1
Speed Difference (rpm)	-4	4	-6	6	-4	4	-6	6
Load variation After Stabilization (MW)	-14.667	14.667	-29.3	29.3	-14.667	14.667	-29.3	29.3
Load before Test (MW)	395,58	395,82	396.43	396.31	494.824	494.458	495.312	494,824
Steady load after Test (MW)	381.54	410.35	368.12	425.58	480.572	509.604	466.626	521.808
Actual Load variation After stabilization (MW)	-14.03	14.52	-28.31	29.27	-14.252	15.146	-28.686	26.983
Frequency before Test (HZ)	49.927	49.995	49.918	49.756	50.208	50.522	50.444	49.695
Steady Frequency after Test (HZ)	49.832	50,04	49.795	49,835	50.228	50.522	50.353	49.723
Stability time (s)	53.00	49.50	50.95	49.10	33.24	29.35	57,83	35,31
Response time (s)	1sec	lsec	1 sec.	Isec	Isec	1sec	1 sec	Isec

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	3%	OK.
Response time	less than 3s	ОК
Stability time	less than 60s	OK
Dead band	±0.033HZ (±2rpm)	OK
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	Log Sheet Of Tu	irbine gov	vernor op	eration 7	ſest		
UNIT:	2 Date: July 31 20	<u>19</u> Sta	irt Time:	11:01	End Time:	12:18	
	Droop		3%				
	Load		90%	Load			
	Start time	11:01	11:07	11:17	12:17		
	Frequency Difference (HZ)	0.067	-0.067	0.1	-0,1		
Ī	Speed Difference (rpm)	-4	.4	-6	.6	-	
	Load variation After Stabilization (MW)	-14.667	.14.667	-29.3	29.3		
	Load before Test (MW)	593.823	593.701	594.256	593.701		
	Steady load after Test (MW)	579.016	608,472	564.282	622.876		
	Actual Load variation After stabilization (MW)	-14.807	14.77	-29.973	29.175	]	
	Frequency before Test (HZ)	50.143	49.9	50.194	50.258		
	Steady Frequency after Test (HZ)	50.096	50.059	50,11	50.287		
Γ	Stability time (s)	39.7	43.2	47.89	57.28	]	
	Response time (s)	lsec	lsec	Isec	İsec	]	

#### Steam Turbine Governor Operation

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	3%	ОК
Response time	less than 3s	ОК
Stability time	less than 60s	OK
Dead band	$\pm 0.033$ HZ ( $\pm 2$ rpm)	ОК
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#### Steam Turbine Governor Operation

#### Log Sheet Of Turbine governor operation Test

UNIT: 2 Date:	July 30 :	2019	Start 7	ime: <u>1</u>	6:20	End T	ime: <u>2</u>	<u>0:39</u>
Droop				4.	5%			
Load		60%	Load			7.5%	Load	
Start time	16:20	16:32	16:38	16:43	20:20	20:27	20:32	20:38
Frequency Difference (HZ)	0:067	-0.067	0.1	-0.1	0.067	-0.067	0:1	-0.1
Speed Difference (rpm)	-4	4	-6	6	-4.	4	-6	б
Load variation After Stabilization (MW)	-9.78	9.78	-19.6	19.6	-9.78	9.78	-19.6	19.6
Load before Test (MW)	396.802	395.703	395.825	395.703	494.58	495.679	494.824	495.068
Steady load after Test (MW)	387.158	405.485	376.782	415.356	485.181	505.200	475.903	514.722
Actual Load variation After stabilization (MW)	-9.643	9.782	-19.043	19.65	-9.399	9.521	-18.921	19.653
Frequency before Test (HZ)	50,009	50.326	50.38	50.406	. 49.733	50.417	.50,396	50.537
Steady Frequency after Test (HZ)	49:973	50.316	50.253	50.448	49.739	50.403	.50.37	50.515
Stability time (s)	36.99	48.56	54.00	43.85	50.00	54.00	43.00	37.69
Response time (s)	İsec	1sec	Isec	lsec	lsec	1sec	1sec-	lsec

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	<i>4.5</i> %	OK
Response time	less than 3s	OK
Stability time	less than 60s	ОК
Dead band	±0.033HZ (±2rpm)	ОК
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	Log Sheet Of Tu	irbine gov	vernor og	peration [	<b>Fest</b>	
UNIT:	<u>2</u> Date: July 31 20	<u>19</u> Sta	art Time:	10:19	End Time:	10:52
	Droop		4	.5%		
	Load		90%	6 Load		
	Start time	10:19	10:26	10:32	10:51	1
	Frequency Difference (HZ)	0,067	-0.067	.0.1	-0.1	
	Speed Difference (rpm)	-4	4	-6	6	
	Load variation After Stabilization (MW)	-9.78	9.78	-19.6	19.6	
	Load before Test (MW)	593.57 <u>9</u>	594,556	593.701	594.067	]
	Steady load after Test (MW)	583.985	603.711	574.065	613.661	
	Actual Load variation After stabilization (MW)	-9.594	9.155	-19.636	19,594	
	Frequency before Test (HZ)	50.148	50.019	50.105	50.169	]
	Steady Frequency after Test (HZ)	50.139	50.149	50.124	50.160	]
	Stability time (s)	29,175	34.17	38.38	32.7	1
	Response time (s)	lsec	Isec	Isec	lsec	

#### Steam Turbine Governor Operation

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	4.5%	ОК
Response time	less than 3s	ОК
Stability time	less than 60s	ОК
Dead band	±0.033HZ (±2rpm)	ОК

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#### Steam Turbine Governor Operation

#### Log Sheet Of Turbine governor operation Test

UNIT: <u>2</u> Date:	July 30 2	<u>2019                                    </u>	Start 7	[ime:]	5:27	End T	ime: <u>2</u>	<u>):09</u>
Droop				8	%			
Load		60%	Load			75%	Load	
Start time	15:27	15:35	15:46	15:50	19:40	19:47	19:53	20:08
Frequency Difference (HZ)	0.067	-0.067	0.1	-0,1	0.067	-0.067	0.1	-0.1
Speed Difference (rpm)	-4	-4	-6	.6	-4	4	-6	6
Load variation After Stabilization (MW)	-5.5	5.5	-11	11	-5.5	5.5	-11	11
Load before Test (MW)	395.337	396.314	396.069	396.060	495.679	494.946	495.435	494.946
Steady load after Test (MW)	390.94	401.196	385.501	406.75	489.697	500.456	484.167	506.177
Actual Load variation After stabilization (MW)	-4.39	4.883	-10.56	10.686	-5.982	5.510	-11.267	11.231
Frequency before Test (HZ)	50,308	50.238	50.05	49.896	50.339	50.397	50.447	50.123
Steady Frequency after Test (HZ)	50,255	50,194	50.009	49,858	50,197	50,4	50.446	50.191
Stability time (s)	49.368	45.494	51.576	57.46	34.00	33.13	40.30	52.00
Response time (s)	1sec	Isec	1sec	lsec	1 sec	1sec	1 sec	1sec

Index	Standard requirement	Experimental value(mean)
Droop%	8%	ОК
Response time	less than 3s	OK.
Stability time	less than 60s	ОК
Dead band	±0.033HZ (±2rpm)	ОК
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F: 2 Date: July 31 20	<u>)19</u> Sta	rt Time:(	08:56	End Time:	09
Droop		.8	%		
Load		90%	Load		
Start time	08:56	09:02	09:07	09:17	
Frequency Difference (HZ)	0.067	-0.067	0.J	-0.1	
Speed Difference (rpm)	-4	4	-6	6	
Load variation After Stabilization (MW)	-5.5	5.5	-11	11	
Load before Test (MW)	593.579	593.975	594.32	593.727	
Steady load after Test (MW)	588.574	599.508	583.3	604.809	
Actual Load variation After stabilization (MW)	-5:05	5.534	-11.02	11.083	
Frequency before Test (HZ)	50.123	50,366	50.035	50.423	
Steady Frequency after Test (HZ)	50.212	50.376	50.02	50,461	
Stability time (s)	47.6	27.46	27,45	42	
Response time (s)	1 sec	1 sec	1sec	1 sec	

#### **Steam Turbine Governor Operation**

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)
Droop%	8%	OK.
Response time	less than 3s	OK
Stability time	less than 60s	ОК
Dead band	±0.033HZ (±2rpm)	OK

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#### Steam Turbine Governor Operation

CPHGC	لر	NTDC	ÉPC	IE(SGS)
Sign: 7/17	fign: ·	Sign Shark	Sign: 列起勇	Sign: Hugh show
Name:	Name:	Name:	Name:	Name:
Gu Yu	Muhammad	Mughees	Liu Zhaoyong	Hugh Xiang
Senior	Shoukat Ali	Ahmed	Chief Engineer	Project
Manager	Manager	Asst Manager		Manager
_	Technical	Protection and		
	. n	Control	_	
	Sign: A free	Sign: M. Mela		
	Name:	Name:		
	Sahibzada	M. Mohsin		
	Abdul Haseeb	Khan		
	Asst Manager	Asst Manager		
	Technical	Protection and		
	<u> </u>	Control		
Date: 05 05/200	Date: Aug 09,2018	Date: of of -10	Date: 2019.08.05	Date:
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Steam Turbine Governor Operation

#### Log Sheet Turbine governor operation Test Unit 1

Droop					Anni Seda	3	%						
Load	60	0% Load	(198MV	<b>()</b>	7	5% Load	1 (248MV	BMW) 90% Load (29			(297MV	(297MW)	
Frequency Difference (HZ)	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1	
Load Variation after Stabilization (MW)	7.41	-7.41	14.67	-14.67	7.41	-7.41	14.67	-14.67	7.41	-7.41	14.67	-14.67	
Load before Test (MW)	197.91	198.15	198.15	198.29	248	247.73	247.86	247.73	297.35	298.86	297.13	297.05	
Steady Load after Test (MW)	205.40	190.52	212.74	183.32	255.31	240.34	262.83	262.69	304.58	289.42	311.55	282.0	
Actual Load Variation after Stabilization (MVV)	7.49	-7.63	14.59	-14.93	7.31	-7.39	14.93	-14.96	7.23	-7.39	14.42	-15.05	
Stability Time (s)	46	47	39	50	40	28	44	37	26	36	21	40	
Response Time (s)	1	1	2	2	1	1	1	1	2	1	2	2	

Index	Standard requirement	Experimental value(mean)		
Droop%	3%-8%	3%		
Response time	less than 3s	ок		
Stability time	less than 60s	ок		
Dead band	土0.033HZ	<u>+</u> 2% RPM		

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#### Steam Turbine Governor Operation

Log Sheet Turbing	e governor	operation	Test Unit 1
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Οτοορ	-	<u> </u>		<del>.</del> .		4.	5%					
Load	60	% Load	(198MV	V)	7	5% Load	1 (248MV	3	90	)% Load	(297MV	V)
Frequency Difference (HZ)	-0:067	0,067	-0.1	0.1	-0:067	0.067		0.1	-0.067	0.067	-0.1	0/1
Load Variation after Stabilization (MW)	4.94	-4.94	9.78	-9.78	4.94	-4:94	9.78	-9.78	4.94	-4,94	9.78	-9.78
Load before Test (MW)	198.35	198.02	198,02	198.02	247,67	247.84	247,95	247,86	297.08	296.91	297.19	296.59
Steady Load after Test (MW)	202.96	193.13	207.9	188.46	252.67	247.89	257.78	238.25	301,83	291.92	.306.8	287.52
Actual Load Variation after Stabilization (MW)	4.61	-4.89	9.88	-9,56	5.0	-4.95	.9.83	-9.61	4.75	-4.99	9.61	-9.07
Stability Time (s)	43	35	53	52	38	.33	30	41	17	20	20	19
Response Time (s)	1	2	.1	1	2	2	2	2	2	2	2.	2

#### Performance acceptance list

Index	Standard requirement	Experimental value(mean)				
Droop%	3%-8%	4,5%				
Response time	less than 3s	ок				
Stability time	less than 60s	ОК				
Dead band	土0.033HZ	±2% RPM				

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#### Steam Turbine Governor Operation

#### Log Sheet Turbine governor operation Test Unit 1

Droop						8%	b.					
Load	6	0% Load	(198M)	N)	75	% Load	(248MV	n)	90	)% Load	(297MV	V)
Frequency Difference (HZ)	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0,1	0:1	-0.067	0.067	-0.1	0.1
Load Variation after Stabilization (MW)	2.78	-2.78	5.50	-5.50	2.78	-2.78	5.50	-5.50	2.78	-2.78	5,50	-5.50
Load before Test (MW)	198,13	198.07	198,15	197,82	247.95	247.86	247.95	247.59	297.11	297.46	297.13	297-27
Steady Load after Test (MW)	200.96	195.24	203.56	192.19	250,61	245.01	253.41	242.34	299.8	294.64	302.71	291.72
Actual Load Variation after Stabilization (MW)	2,53	-2.83	5,41	-5,63	2.66	-2,85	5.46	-5.25	2.69	-2.82	5.58	-5,50
Stability Time (s)	39	-31	38	31	27	27	33	21	11	25	23	31
Response Time (s)	<u>1</u>	t	1	1	2:	'n	1	į	2	2	2	2

Standard requirement	Experimental value(mean)			
3%-8%	8%			
less than 3s	ок			
less than 60s	ОК			
±0.033HZ	±2% RPM			
	Standard requirement 3%-8% less than 3s less than 60s ±0,033HZ			

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Steam Turbine Governor Operation

Signed for acceptance of the Test result<sup>1</sup>

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EPTL	CPPA-G / NTDC	EPC	Engineer
Smallalg°	Sign:	sign:	sign: えい申る
Name: MRAN lettice	Name: Mizza Asadullah Klum	Name: Fu changhony	Name: Lin Chang
Date: 22 Jue M	Date: 22 05/2019	Date: 2019.6.22	Date: 22-Jun - 2019

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Steam Turbine Governor Operation

Droop						39	6					
Load	60	% Load	(198M\	N)	75	% Load	(248MV	V)	90% Load (297MW)			
Frequency Difference (HZ)	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0:1	0,1	-0.067	0.067	-0.1	0.1
Load Variation after Stabilization (MW)	7.41	-7.41	14,67	-14.67	7:41.	-7,41	14.67	-14.67	7,41	-7,41	14.67	-14.67
Load before Test (MW)	197.74	198.13	198,13	197.71	248.06	248,25	248.03	248	297	297	296,91	296:81
Steady Load after Test (MW)	205.27	190,74	212.90	183.08	255.66	.2,40.86	262.75	233.17	303,7	289.8	311.72	282
Actual Load Variation after Stabilization (MW)	7,53	-7.39	14.77	-14.63	7.6	-7,39	14,72	-14.83	7,43	-7,2	14.81	-14,81
Stability Time (s)	58	45.	50	51	43	50	54	56	33	23	55	42
Response Time (s)	1	3	1	2	.2	1	2	1	1	2	1	2

#### Log Sheet Turbine governor operation Test Unit-2

Index	Standard requirement	Experimental value(mean)			
Droop%	3%-8%	3%			
Response time	less than 3s	ОК			
Stability time	less than 60s	ОК			
Dead band	±0,033HZ	<u>+</u> 2% RPM			

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Steam Turbine Governor Operation

Droop		<u></u>				4.5	%					
Load	60	60% Load (198MW)			75	% Load	(248MV	Ŵ)	90% Load (297MW)			V)
Frequency Difference (HZ)	-0.067	0.067	-0.1	.0.1	-0:067	0,067	-0.1	0.1	-0,067	0,067	-0.1	-0,1
Load Variation after Stabilization (MW)	4.94	-4.94	9.78	-9,78	4.94	-4.94	9.78	-9.78	4,94	-4.94	9,78	-9,78
Load before Test (MW)	196.09	198.15	198.26	197,93	247.84	248.08	248.11	247,95	297.04	295.91	297.11	297:05
Steady Load after Test (MW)	203	193.27	207.98	188.13	252,94	243.11	257.64	235.31	301,8	291.75	307,02	287:14
Actual Load Variation after Stabilization (MW)	4.91	-4.68	9.7	-9.8	5.1	-4.97	9.53	-9,64	4.79	-5.16	9,91	-9,91
Stability Time (s)	40	43	55	. 59	31	33	-35	30	38	18	34	48
Response Time (s)	1	.2	2	2	i	Γ.	1	1	.1	2	2	2

### Log Sheet Turbine governor operation Test Unit-2

Index	Standard requirement	Experimental value(mean)			
Droop%	3%-8%	4.5%			
Response time	less than 3s	ок			
Stability time	less than 60s				
Dead band	±0.033HZ	±2% RPM			

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Steam Turbine Governor Operation

Droop						89	6					
Load	.60	% Load	(198MV	V)	75	% Load	(248MV	<b>v</b> )	90% Load (297MW)			
Frequency Difference (HZ)	-0:067	0,067	-0,1	0.1	-0.067	0,067	-0.1	0.1	-0.067	0.067	-0.1	0.1
Load Variation after Stabilization (MW)	2.78	-2.78	5.50	-5.50	2.78	-2.78	5.50	-5.50	2.78	-2.78	5,50	-5.50
Load before Test (MW)	198.1	197.7	197,96	197.88	248.03	247.7	248.03	248.03	296.85	296.83	297.05	296.8
Steady Load after Test (MW)	200.9	184,94	203.51	192.36	250:72	244.93	253.66	242.43	299.83	296,83	302.57	. 291.*
Actual Load Variation after Stabilization (MW)	2.8	-2.78	5,55	-5:52	2.69	-2.77	5.63	-5.8	2.96	-2.68	5,52	-5.6
Stability Time (s)	37	30	41	44	15	19	31	28	50	40	41	47
Response Time (s)	2	1	2	1	1	1	2.	2	.2	1	2	1

Index	Standard requirement	Experimental value(mean)			
Droop%	3%-8%	8%			
Response time	less than 3s	OK.			
Stability time	less than 60s	ок			
Dead band	±0.033HZ	+2% RPM			

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Steam Turbine Governor Operation

Signed for acceptance of the Test result<sup>1</sup>

EPTL	CPPA-G / NTDC	EPC	Engineer
sign: Annoulhabe	Sign:	Sign:	sign: 2.1 \$2
Name: IMDAN LUHAUR	Name: ASILI ABBAS	Name: Fu chang luozy	Name: Lin Chang
Date: 20.06.19	Date: 20.06.2019	Date: 20/9.6.20	Date: 20-Jun-2019

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#### Log Sheet Turbine governor operation Test

#### **Test calculation table**

	3%		
	75% L	bad	
(0.067)	0.067	(0.1)	0.1
14.667	(14.667)	29.3	(29.3)
495	494.71	496.88	496.09
509.67	479.426	525.44	467.4
14.67	-15.284	28.554	-28.69
55	48	56	56
	(0.067) 14.667 495 509.67 14.67 55	3%     75% Ld     (0.067)   0.067     14.667   (14.667)     495   494.71     509.67   479.426     14.657   -15.284     55   48	3%     75% Load     (0.067)   0.067   (0.1)     14.667   (14.667)   29.3     495   494.71   496.88     509.67   479.426   525.44     14.67   -15.284   28.554     55   48   56

#### Performance acceptance list

#### Time: 17:08

#### Steam Turbine No.: 1

Date: 2017.9.26

Index	Standard requirement	Experimental value (mean)
Droop%	3%~8%	3%
response time	less than 3s	1s
Stability time	less than 60s	54s
Dead band	±0.033Hz	±2rpm
2	200 1 3 herry	5
		4.00~

Date: 2017.9.13



#### Test calculation table

Time: 14:52

Steam Turk	oine No.	:1										
Droop%						5	%					
Load		60%	Load			75%	Load			90%	Load	
Frequency difference(Hz)	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1
Load variation after stabilization( MW)	8.8.	(8.8)	17.6	(17.6)	8.8.	(8.8)	17.6	(17.6)	8.8.	(8.8)	17.6	(17.6)
Load Before Test(MW)	401.087	399.78	399.272	402.039	501.319	500.085	500.375	501.755	599.808	601.188	598.864	598.864
Steady load after test(MW)	408.496	392.662	415.396	384.891	509.018	491.296	517.371	484.541	609.105	591.456	617.022	582.375
Actual s Load variation after stabilization( MW)	7.41	-7.118	16.124	-17.148	7.699	-8.789	16.998	-17.214	9.297	-9.732	18.158	-16.489
Stability time(s)	50	36	49	53	31	25	59	47	55	48	51	49

#### Performance acceptance list

#### Date: 2017.9.13

#### Time: 14:52

Steam Turbine No.: 1

Index	Standard requirement	Experimental value (mean)
Droop%	3%~8%	5%
response time	less than 3s	1s
Stability time	less than 60s	46s
Dead band	±0.033Hz	±2rpm

±0.033Hz Brzny izhzz 255 h.a.g.

Date: 2017.9.26



#### Test calculation table

Time: 13:34

Steam Tur	bine No.	:1										
Droop%						8	%					
Load		60%	Load			75%	Load			90%	Load	
Frequency difference(Hz)	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1
Load variation after stabilization(M W)	5.5	(5.5)	11	(11)	5.5	(5.5)	11	(11)	5.5	(5.5)	11	(11)
Load Before Test(MW)	396.875	395.567	397.601	394.986	495.654	496.017	495.509	495.363	594.579	594.405	594.651	593.852
Steady load after test(MW)	402.599	389.83	408.714	384.891	502.046	488.899	506.592	483.578	600.171	588.913	606.877	582.066
Actual s Load variation after stabilization(M W)	5.724	-5.737	11.113	-10.095	6.392	-7.118	11.083	-11.785	5.592	-5.492	12.226	-11.786
Stability time(s)	42	51	41	54	45	36	27	27	47	29	32	40

#### Performance acceptance list

#### Date: 2017.9.26 Steam Turbine No.: 1

#### Time:13:34

Index	Standard requirement	Experimental value (mean)
Droop%	3%~8%	8%
response time	less than 3s	1s
Stability time	less than 60s	39s
Dead band	±0.033Hz	±2rpm

#### Signed for acceptance of readings

CPPA-G/NTDC	The Company	TPRI	Engineer
Sign:	Sign: Biran	Sign: Tyte	Sign: § JZ
Mubashin Name: Ahuraf	Name:	Name:	Name: Xu Jomb
Date: 19/2017	Date:	Jom Xuyom Date:	Date: 2017. 9.27

**Operating Reserve Policy** 



#### Log Sheet Turbine governor operation Test

#### Test calculation table

Date: 2017.9.25			Time:	19:37
Steam Turbine No.: 2				
Droop%		3%	5	
Load		75% L	oad	
Frequency difference(Hz)	(0.067)	0.067	(0.1)	0.1
Load variation after stabilization(MW)	14.667	(14.667)	29.3	(29.3)
Load Before Test(MW)	494.838	497.235	496.146	495.565
Steady load after test(MW)	509.458	482.564	525.053	467.02
Actual s Load variation after stabilization(MW)	14.62	-14.671	28.908	-28.545
Stability time(s)	53	58	56	54

#### Performance acceptance list

#### Date: 2017.9.25 Steam Turbine No.: 2

Index	Standard requirement	Experimental value (mean)
Droop%	3%~8%	3%
response time	less than 3s	1s
Stability time	less than 60s	55s
Dead band	±0.033Hz	±2rpm
10	FIRDER (Epterly	thaq_

Time: 19:37



#### Test calculation table

Time: 13:23

Date: 2017	.9.14									Tim	e: 13:23	
Steam Turl	bine No.	.: 2				5	i%					
Load		60%	Load			75%	Load			90%	Load	
Frequency difference(Hz)	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1	(0.067)	0.067	(0.1)	0.1
Load variation after stabilization( MW)	8.8.	(8.8)	17.6	(17.6)	8.8.	(8.8)	17.6	(17.6)	8.8.	(8.8)	17.6	(17.6)
Load Before Test(MW)	400.054	401.071	400.417	401.071	504.426	500.14	500.431	499.67	601.462	600.009	601.099	600.736
Steady load after test(MW)	409.278	392.5	416.832	384.22	512.996	491.57	518.952	482.927	609.96	591.221	618.458	583.522
Actual s Load variation after stabilization( MW)	9.224	-8.571	16.415	-16.851	8.57	-8.57	18.521	-16.743	8.498	-8.788	17.359	-17.214
Stability time(s)	48	38	49	55	55	46	45	56	49	38	34	47

#### Performance acceptance list

#### Date: 2017.9.14

#### Time: 13:23

#### Steam Turbine No.: 2

Index	Standard requirement	Experimental value (mean)
Droop%	3%~8%	5%
response time	less than 3s	1s
Stability time	less than 60s	47s
Dead band	±0.033Hz	±2rpm
	DOTAL ISTORY	\$ 7 7 h.QO~:
		May



#### ВНІККІ ССРР

	Turbine Gov	vernor Droop
to b	s Test Procedure is prepared and releas e carried out at:	sed by HEI for the use of PPA related tests
Dat	e ented for use by client	$\rightarrow$ 1180 MW CCPP BHIKKI
Aut	horized signature	:
HEI	Authorized Signature	:
Ope	Sved John Mehdi/CPPA(G)	
2	Syed Haroon Masood/CPPA(G)	J.P.L.d'
3	Masud Saify/NPCC	New ??
4	Sved Wasim Ur Rehman/OATPL	Coller 18/12/10
	Shamsul Aziz/OATPI	2. wasim.
5		S
5	Akhtar Hussain Mayo/OATPL	
5	Akhtar Hussain Mayo/QATPL	Augu Imagi
5	Akhtar Hussain Mayo/QATPL	Aublu Hmgi
5	Akhtar Hussain Mayo/QATPL	Augu Jungi











VI. TEST A • Amplitude given for o perform	CCEPTANCE of active power resp other couples of droo The Test at D	Croven ponse is stated abo p/sustained freque coop(4 %) d P	we. Corresponden ency injection The subject to syst	p Tont. Il se table can be Company/EPC Contractor conditions 25.
mHz	Droop 4% dP	Droop 5% dP	Droop 6% dP	Droop 7% dP
±200 mHz				
±250 mHz				
±300 mHz				
±350 mHz				
Date:	6-42018 Date: (6	.4.2018 Da	ite: 16/02/20	BDate: 16 4 18
Harbin Eletric Inte	ernational Co., Ltd		15.11	Page 5 / 5



Date:					Itst Log c	meet	45	1
	16-04-2018							
					Tin	ne: <u>14:30</u>	1	-
			Turb	ine Governor D	roop Test		•	
Dp Injection	Droop(%)	0/0	CT 1	Intonnedicto	CT 2		•	
mHz	D100p(70)	Load	Load	GT-1 Load	G1-2 Load	Intermediate GT-2 Load	ST	Complex
-100	4	70	274	311	273	311	306	932
+100	4	70	272	256	273	256	287	806
-200	4	70	272	305	271	302	291	895
+200	4	70	271	236	274	237	284	755
-100	4	80	315	333	316	333	326	993
+100	4	80	315	332 297	315	384 297	326	<b>994</b> 920
-200	4	80	316	354	316	354	331	1041
+200	4	80	315	279	316	278	308	865
+250	5	70	273	236	274	234	289	761
-300	6	70	274	314	273	316	309	939
+380 -350	7	70	271	315	273	314	300	928
EMPLOYE	R/NESPAK	NT	DC/ CPI				10	
liant	R	a. M	Der er	li H	EI/GE A	LSTOM	<u> </u>	2 0
<sup>11</sup> 5 <sup>11</sup> .	AU	Sign: 9		Sign	: 24	Sig Sig	n. (	tell
Name:	ther.	Name	uhamin h	- Ali Nam	e:HAN	C2-I Nar	ne: ZN	FARIC
Date:	16.4.2018	Date: (	6.4.20	18 Date	16/001	weit Dat	e 161	4/2018
						- 10 Dat	<u></u>	112-03
				No.	of she	ts: 48.		
						1		
							1	

#### PQEPC CFPP



#### PREPC

Steam	Turbine	Governor O	peration
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Log Sheet Of Turbine Governor Operation Test

UNIT1#			Date	e:2	2018.2.	2			Ti	me: <u>1</u> 2	2:17-10	5:56
Droop						3%	6					
Load		60%	Load			·75%]	Load			90%	Load	
Start time	12:20	12:17	12:32	12:24:	14:59	15:06	15:03	15: 13	16: 45	16: 47	16:56	16: 52
Frequency Difference(HZ)	-0.067	0.067	-0.1	0.1	-0,067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1
Load variation after stabilization(MW)	14.667	-14.667	29,3	-29.3	14.667	-14.667	29.3	29.3	14.667	-14.667	29,3	-29.3
Load before Test (MW)	395.9	395.5	397.5	396.3	496.1	495.1	495.5	494.0	593.2	593.6	594.6	594.6
Steady load after Test(MW)	410.4	381.0	425.9	367.1	510.4	480.6	524.6	464.9	607.8	579.0	623.9	565.2
Actual Load variation after stabilization(MW)	14.5	-14.5	28.4	-29.2	14.3	-14.5	29.1	-29.1	14.6	-14.6	29.3	-29.4
Stability time(s)	40.9	49.18	51.9	51.4	38	47.3	47.7	42	39.6	41	54	44.1
Response time(s)	1	1	1	1	1	1	1	ĩ	1	1	1	1

Index	Standard requirement	Experimental value(mean)		
Droop%	3%-8%	3%		
Response time	less than 3s	Ok		
Stability time	less than 60s	Ok		
Dead band	±0.033HZ	±2 r/min		

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## PREPL

Steam Turbine Governor Operation

## Log Sheet Of Turbine Governor Operation Test

0.10	11:57-10	ime:	T			8.2.2	201	Date:	1			1#	UNIT
					5%	4.	1997 - 1997 -					roop	Dro
	Load	90%			Load	75%			oad	60% L		oad	Loa
16: 32	16: 40	16: 25	16: 29	14: 54	14: 56	14: 48	14: 51	12:10	12:13	11: 57	12: 02	art Time	Start 7
0.1	-0.1	0.067	-0.067	0.1	-0.1	0.067	-0.067	0.1	-0.1	0.067	-0.067	equency erence(HZ)	Frequ
-19,6	19.6	-9.78	9.78	-19.6	19.6	-9.78	9.78	-19.6	19.6	-9.78	9.78	variation after zation(MW)	Load varia stabilizati
593.4	595.0	594.8	593.3	494.5	494.5	495.2	494.9	396.2	394.6	396.5	394.2	ore Test (MW)	Load before
573.9	614.6	585.1	603.0	475.3	514.3	485.6	504.8	376.6	415.3	387.2	404.9	iy load after est(MW)	Steady le Test(
-19.5	19.6	-9.7	9.7	-19.2	19.8	-9.6	9,9	-19.6	20.7	-9.3	10.7	Load variation bilization(MW)	Actual Loa after stabiliz
39.3	56	37.8	46.5	42.7	50	50	38.9	51	39.8	42.7	43	ility time(s)	Stability
1	1	1	1	1	1	1	1	1	1	1	- 1	oonse time(s)	Respons
	16: 40 -0.1 19.6 595.0 614.6 19.6 56 1	16: 25 0.067 -9.78 594.8 585.1 -9.7 37.8 1	16: 29         -0.067         9.78         593.3         603.0         9.7         46.5         1	14: 54 0.1 -19.6 494.5 475.3 -19.2 42.7 1	14, 56 -0.1 19.6 494.5 514.3 19.8 50 1	14: 48 0.067 -9.78 495.2 485.6 -9.6 50 1	14: 51 -0.067 9.78 494.9 504.8 9.9 38.9 1	12:10 0.1 -19.6 396.2 376.6 -19.6 51 1	12: 13       -0.1       19.6       394.6       415.3       20.7       39.8       1	111: 57         0.067         -9.78         396.5         387.2         -9.3         42.7         1	12: 02 -0.067 9.78 394.2 404.9 10.7 43 1	art Time equency rence(HZ) rariation after zztion(MW) by load after est(MW) Load variation billization(MW) sility time(s)	Start 7 Frequ Differen Load varie stabilizati Load before * Steady le Test( Actual Loa after stabiliz Stability Respons

#### Performance Acceptance List

 Index	Standard requirement	Experimental value(mean)
 Droop%	3%-8%	4.5%
Response time	less than 3s	Ok
 Stability time	less than 60s	Ok
 Dead band	±0.033HZ	±2 r/min

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## PABPL

Steam Turbine Governor Operation

UNIT 1#			Date:	20	18.2.2				Tin	ne: <u>1</u>	1:31-1	6:18
Droop						8%	ó					
Load		60%	Load			75% I	load			90% I	load	
Start Time	11.44	11:31	11:52	11:48	14:34	14:31	14:41	14:36	16:07	15:58	16:18	16:11
Frequency Difference(HZ)	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1	-0.067	0.067	0.1	0.1
Load variation after stabilization(MW)	5.5	-5.5	19.6	-19.6	5.5	-5.5	19.6	-19.6	5.5	-5.5	19.6	-19.6
Load before Test (MW)	395.5	394.5	396.8	397.2	494.2	496.3	495.4	493.9	593.8	595.2	593.3	594.8
Steady load after Test(MW)	402.3	389.0	413.3	378.5	500.1	490.5	511.8	477.7	599.4	589.7	609.9	578.3
Actual Load variation after stabilization(MW)	6.2	-5.5	16.5	-18.7	5.9	-5.8	16.4	-16.2	5.6	-5.5	16.6	-16.5
Stability time(s)	40	38	46	47	40	51.2	42	33.6	41.8	51.6	51	48.1
Response time(s)	1.03	1	1	1.024	1	1	1	1	1	1	1	1

## Log Sheet Of Turbine Governor Operation Test

#### Performance Acceptance List

Index	Standard requirement	Experimental value(mean)
Droop%	3%-8%	8%
Response time	less than 3s	Ok
Stability time	less than 60s	Ok
Dead band	±0.033HZ	±2r/min

PQEPC	CPPA / NTDC	SEPCOIII	SGS
Sign: Br 23	Sign: JAM M	Sign: JUP	Sign: And
Name: Liu Chao	Name: Javaid Aslam	Name: Yu Fan Wei	Name: Li Xiao Hui
Date: 02/02/18	Date: 2/2/2018	Date: 02/02/18	Date: MMR



## PREPL

Steam Turbine Governor Operation

	L	og Shee	et Of T	urbine	Gover	nor Op	eratio	ll lest		Final	12.18-1	10.53
INIT 2#			Date:	201	18.2.2				-	Time:	15.10-	17.55
Droop						3%	1					
Load		60% L	oad			75% L	oad			90% L	.oad	
Start time	19:43	19:40	19:53	19:46	18:04	18:01	18:21	18:07	13:18	13:21	13:43	13:24
Frequency Difference(HZ)	-0.067	0.067	-0.1	0.1	-0.067	0,067	-0.1	0.1	-0.067	0,067	-0.1	0.1
Load variation after stabilization(MW)	14,667	-14.667	29.3	-29.3	14,667	-14.667	29.3	29.3	14.667	-14.667	29.3	-29.3
Load before Test (MW)	396.1	395.9	395.0	395.5	495.4	494.7	495.6	495.1	593.1	594.0	595.1	593.6
Steady load after Test(MW)	410.8	381.3	423.7	366.1	510.0	480,1	525.1	465.9	607.7	579.2	624.0	563.8
Actual Load variation after stabilization(MW)	14.7	-14.6	28.7	-29.4	14.6	-14.6	29.5	29.2	14.6	-14.8	28.9	-29.8
Stability time(s)	43.4	45.7	42	43.5	47.4	37.8	54	41	49.4	53.5	46.2	44
Response time(s)	1	1	I	1	1	1	1	1	1	1	1	1

#### ...... anotion Test

3%-8%	3%
370-870	
	01
less than 3s	Ok
	Ok
less than 60s	1
±0.033HZ	±2 r/min
	less than 3s less than 60s ±0.033HZ

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## PREPC

Steam Turbine Governor Operation

# Log Sheet Of Turbine Governor Operation Test

	L	og Shee	et OF I	uroin	201	0 7 7	P			Time:	13:04-	19:34
INIT2#			1	Jate: _	201	0.2.2 A	5%			and the second second		
Droop						4.		1				
Load		60% L	oad			75%	Load			90%	Load	
Start Time	19: 25	19: 21	19: 34	19:28	17: 50	17: 48	17: 57	17: 53	13: 06	13: 04	13: 14	13: 09
Frequency Difference(HZ)	-0.067	0.067	-0.1	0.1	-0,067	0.067	-0,1	0.1	-0.067	0.067	-0,1	0,1
Load variation after stabilization(MW)	9.78	-9.78	19.6	-19.6	9.78	-9.78	19.6	-19,6	9,78	-9.78	19.6	-19.6
Load before Test (MW)	396.2	396.9	395.7	396.2	494.5	495.4	495.2	495.0	593.1	593.1	594.3	594.1
Steady load after Test(MW)	406.0	387.1	415.4	376.8	504.2	485.6	514.9	475.3	603.4	583.3	613.7	574.1
Actual Load variation after	9.8	-9.8	19.7	-19.4	9.7	-9.8	19.7	-19.7	10.3	-9,8	19.4	-20.0
Stability time(s)	43	52	47	49	49.8	52.3	50.7	41.8	49	38	51.5	47
Response time(s)	1	1	1	1	1	1	1	1	1	1	1	I

rmance Acceptance List	a t t subsement	Experimental value(mean		
Index	Standard requirement			
moon	3%-8%	4.5%		
Droop%	378-070	Ok		
Domonse time	less than 3s	UK		
Response time	1 11 60a	Ok		
Stability time	less than ous	LO duin		
	±0.033HZ	±2 r/min		
Dead band				

It in the I

2 - 2 2

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# PQEPC

Date: 51/0/12

Steam Turbine Governor Operation

UNIT	2#			Date	e: <u>2</u>	018.2.2				Tim	12	43-19	.11
Dro	op						8%						
			60%	Load			75% L	oad			90% Load		
Loa	au						10.20	17.42	17:34	12:49	12:43	13:00	12:56
Start	Time	19: 04	19:00	19:11	19:07	17:31	17:28	17.42					
Frequ	uency nce(HZ)	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1
Load v af stabilizat	ariation fter tion(MW)	5.5	-5.5	19.6	-19.6	5.5	-5.5	19.6	-19.6	5.5	-5.5	19.6	-19.6
Load be	efore Test 4W)	396.0	396.8	396.9	396.1	495.1	495.2	494.7	493.9	593.9	594.2	594.0	594.
Steady	load after (MW)	401.5	391.3	413.3	379.7	500.6	489,7	511.2	477.4	599.5	588.3	610.5	577
Actual Lo	bad variation after ation(MW)	5.5 -5.5		16.4	-16.4	5.5	-5.5	16.5	-16.5	5.6	-5.9	16.5	-10
Stabil	Stability time(s) 49.5 39.7		39.7	39.6	50	39.8	35.5	49.7	45.4	45.2	36	44.3	3
Respo	Response time(s) 1 1		1	1	1	1	1	1	1	1	1	1	
Perfor	mance A	cceptar	nce Lis	t		1	uiroman	+	-1	Experir	nental va	alue(me	an)
	Inc	dex			Star	andard req	%				8%		
	Dro	op%				less tha	in 35				Ok		
	Respon	nse time				less that	n 60s				Ok		
	Dead	bility time Dead band				±0.03	3HZ				±2r/m	nin	
L							1					805	
	PQEP	с		CPP	A / NTI	DC		SEPO	COIII			863	
Sign:	in the	3	Si	gn:	ga	m	Sign:	う	4 I	-	Sign:	5	1
Name	: Liu Chao		N	ame: Jav	aid Asla	m	Name	: Yu Fa	n Wei		Name: L	i Xiao I	Hui

Date: 07/07/18 Date: 2/2/2018 Date: 02/02/18

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## QATPL CFPP

	哈电集团	псі			It ve	enture	H & B I B R I	
		1	Turbine G	overnor Droop '	Test Log S	Sheet		
Date	16 04 2019							
Date: _	10-04-2018				Tir	ne: <u>14:30</u>	1	
			Turb	ine Governor Di	roop Test			
Dp Injection mHz	n Droop(%)	%	GT-1	Intermediate	GT-2	Intermediate	ST	Comple
-100	4	70	274	GT-1 Load	Load	GT-2 Load	Load	Load
+100	4	70	272	256	273	256	306	932
-200	4	70	272	305	271	302	201	806
+200	4	70	271	236	274	237	291	895
-100	4	80	315	333	316	333	326	003
+100	4	80	315	332 297	315	324 297	326	993 004 an
-200	4	80	316	354	316	354	331	1041
+200	4	80	315	279	316	278	308	865
+250	5	70	273	236	274	234	289	761
-300	6	70	274	314	273	316	309	939
+380 -350	0 7	70	271	315	273	314	300	078
)								
	FR/NESDAK	NT	DC/ CPI	PA-G HF	I/GE AI	STOM		,
EMPLOY	ENTESTAR						- / /	2.0
EMPLOY Sign:	h	Sign:		sign:	THE	A Sign	1. (	felse
EMPLOY Sign: Name:	Manson Ali Hor.	Sign: M Name M	uhounn	Sign:	HAN	2. Sign C2-I Nam	ne: ZM	FAR I
EMPLOY Sign: Name: Date:	Manson Ali Hor. 16.4.2018	Sign: M Name Sl Date: /6	uhomin hauten	Sign: Sign: A.A. Name 18 Date:	HAN 16/00/	2. Sign 12-I Nam 2018 Date	ne: ZAM	4/11 =AR II 1/2018
EMPLOY Sign: Name: Date:	Manson Alli Khor. 16.4.2018	Sign: Name SU Date: 16	uhomin nautur 1.4.20	Name 18 Date: No. 5	HAN HAN 16/00/ 8 shee	2 Sign 12 Nan 1018 Date ts : 48 .	ne: 201 ne: 201	4/11 =AR II 1/2018
EMPLOY Sign: Name: Date:	Marson Ali Hor. 16.4.2018	Sign: Name SU Date: /6	uhommin nautur 1.4.20	Name Name No. G	HAN 16/00/ 18/00/	24 Sign 275 Nan 2018 Date ts : 48,	ne: 2111 ne: 2111	4/11 =AR II 1/2018
EMPLOY Sign: Name: Date:	Manson Ali Hor. 16.4.2018	Sign: S Name SU Date: 16	uhomin rauten j. y. 20	No. 5	HAN 16/00/ 16/00/	2. Sign 2.75 Nan 2018 Date fts : 48,	ne: 211 :: 16/0	4/2018

SKM

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## 1263 MW Punjab Thermal Power Private Limited



#### PPA 8.3 (a) (iv) Turbine Governor Droop Test

As per approved procedures, frequency injection will be applied on individual GTs independently and the frequency response will be checked. GT(s) will be on prime frequency response. Steam Turbine (ST) will be on sliding pressure mode and will respond with lag which will be noted in the corresponding log sheet of the approved commissioning procedure of PPA 8.3 (a) (iv). Below are filled reference tables for Gas Turbine(s) loads. The values are driven from the formula given in above mentioned procedure and depicted below as well with Gas Turbine(s) rated load of 410 MW (gross) each at reference site conditions.

Droop % = 
$$\frac{\frac{\Delta f}{f}}{\frac{\Delta P}{P}} \times 100$$

The methodology of test and test acceptance criteria shall remain as per approved commissioning procedure which is same as of Simple Cycle mode. The test results from simple cycle on both GTs are attached herewith for reference.

GT load change at 70% and 80% (As per Table at Section VI of procedure)

Test number	-100 mHz (Load Variatio n)	+100 mHz (Load Variatio n)	-200 mHz (Load Variatio n)	+200 mHz (Load Variatio n)	-300 mHz (Load Variatio n)	+300 mHz (Load Variatio n)	-400 mHz (Load Variatio n)	+400 mHz (Load Variatio n)
Intermedi ate complex load 1: 70% GT load (MW)	Min14 MW (5 sec)	Min -14 MW (9 sec)	Min 29 MW (14.6 sec)	Min -29 MW (14.5 sec)	Min 43 MW (23 sec)	Min -43 MW (19 sec)	50 MW* (26 sec)	-50 MW* (23 see)
Actual GT Load (MW)	T <sub>1</sub> 23:45 P <sub>1</sub> 287 T <sub>2</sub> 23:55 P <sub>2</sub> 311 ΔP 24	T <sub>1</sub> 23:56 P <sub>1</sub> 287 T <sub>2</sub> 00:06 P <sub>2</sub> 264 ΔP 23	$\begin{array}{ccc} T_1 & 00:09 \\ P_1 & 287 \\ T_2 & 00:19 \\ P_2 & 330 \\ \Delta P & 43 \end{array}$	T <sub>1</sub> 00:30 P <sub>1</sub> 287 T <sub>2</sub> 00:40 P <sub>2</sub> 243 ΔP 44	T <sub>1</sub> 00:48 P <sub>1</sub> 287 T <sub>2</sub> 00:58 P <sub>2</sub> 337 ΔP 50	T <sub>1</sub> 00:59 P <sub>1</sub> 287 T <sub>2</sub> 01:09 P <sub>2</sub> 237 ΔP 50	T <sub>1</sub> 01:10 P <sub>1</sub> 287 T <sub>2</sub> 01:20 P <sub>2</sub> 337 ΔP 50	T <sub>1</sub> 01:21 P <sub>1</sub> 287 T <sub>2</sub> 01:31 P <sub>2</sub> 237 ΔP 50
Stabilizati on Time (seconds)	14.8 sec	14 sec	30 sec	24 sec	30 sec	30 sec	30 sec	30 sec
Intermedi ate complex load 2: 80% load (MW)	Min 16 MW (8 sec)	Min -16 MW (8 sec)	Min 33 MW (18 sec)	Min -33 MW (14.8 sec)	Min 49MW (30 sec)	Min - 49MW (30 sec)	50 MW* (30 sec)	-50 MW* (30 sec)
Actual GT Load	T <sub>1</sub> 05:13 P <sub>1</sub> 328 T <sub>2</sub> 05:23 P <sub>2</sub> 350	T <sub>1</sub> 05:24 P <sub>1</sub> 328 T <sub>2</sub> 05:34 P <sub>2</sub> 306	T <sub>1</sub> 05:35 P <sub>1</sub> 328 T <sub>2</sub> 05:45 P <sub>2</sub> 372	$\begin{array}{ccc} T_1 & 05:46 \\ P_1 & 328 \\ T_2 & 05:56 \\ P_2 & 284 \end{array}$	$\begin{array}{ccc} T_1 & 05:58 \\ P_1 & 328 \\ T_2 & 06:08 \\ P_2 & 378 \end{array}$	T <sub>1</sub> 06:10 P <sub>1</sub> 328 T <sub>2</sub> 06:20 P <sub>2</sub> 278	T <sub>1</sub> 06:22 P <sub>1</sub> 328 T <sub>2</sub> 06:32 P <sub>2</sub> 378	T <sub>1</sub> 06:34 P <sub>1</sub> 328 T <sub>2</sub> 06:44 P <sub>2</sub> 227

China Machinery Engineering Corporation (CMEC)





1263 MW Punjab Thermal Power Private Limited



Stabilizati on Time (seconds)	12 sec	13 sec	25 sec	24 sec	30 sec	30 sec	30 sec	30 sec
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- \*OEM backed recommendations regarding the incorporated MW limiter against frequency response to be provided by PTPL before COD, 70% load is considered 287MW and 80% load is considered 328 MW as per rated conditions.
- Droop Setpoint 4%.
- GT(s) total response time is within 30 seconds. The maximum of load gradient value calculated from the formula against the corresponding load percentage will be achieved in 10 seconds. (The response time of GTs agreed at the time of simple cycle testing at GTs is attached herewith)

GT load variation at different droop settings as per test points given in approved commissioning procedures (8.3 (a) (iv) Turbine Droop Governor Test

Droop Setpoint	2%	3	%	4	%	5	%	6	%	7	1%	8	%
DF injected	N/A	+150 mHz	-150 mHz	+200 mHz	-200 mHz	+250 mHz	-250 mHz	+300 mHz	-300 mHz	+350 mHz	-350 mHz	+400 mHz	-400 mHz
DP Variation	N/A	Min 4	1 MW	Min 4	1 MW	Min 4	1 MW	Min 4	1 MW	Min 4	IMW	Min 4	IMW
		01:36	01:47	02:00	02:12	02:28	02:37	02:51	03:03	03:15	03:33	03:45	03:57
Load Before Test at GT(MW)	N/A	287	287	287	287	287	287	287	287	287	287	287	287
Load after Test at GT (MW)	N/A	254	322	243	330	243	330	243	330	243	330	237	330
Load Variation after stability at GT (MW)	N/A	0	0	0	0	0	0	0	0	0	0	0	0
Stability Time (s)	N/A	17 sec	16 sec	24 sec	24.4 sec	25 sec	23 sec	23 sec	24.8 sec	26.5 sec	24.5 sec	29 sec	28 sec

Gas Turbine Load- 70% (As per Table at Section VII of Procedure)

· The power plant was designed in 2017 as per the prevailing Grid Code.

OEM range for the droop settings are 3% to 8%. (OEM settings are attached herewith).

The test is to be conducted keeping in view the limits allowed by OEM.

China Machinery Engineering Corporation (CMEC)









GT(s) total response time is within 30 seconds. The maximum of load gradient against the calculated from the formula against the corresponding load percentage will be achieved in 10 seconds. (The response time of GTs agreed at the time of simple cycle testing at GTs is attached herewith)

PTPL CMEC/SIEMENS OMS CPPA-G Sign: 1~ Sign: Sign:/ Sign: Name: AIJAZ MoliSIA DGATT Name: M-1 Name: HAFY MEHROZ KAAN Date: 23.05-2023 Date: Date: 23-05-23 Date: 23 TASIR SINAS VASIR AMMAD Vasir Special witness by NPCC I. Name Signature Armiting Atrinal Signature Multigromad Friday Pum. 7 23/05/20

China Machinery Engineering Corporation (CMLC)

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## 1263 MW Punjab Thermal Power Private Limited

#### PPA 8.3 (a) (iv) Turbine Governor Droop Test

As per approved procedures, frequency injection will be applied on individual GTs independently and the frequency response will be checked. GT(s) will be on prime frequency response. Steam Turbine (ST) will be on sliding pressure mode and will respond with lag which will be noted in the corresponding log sheet of the approved commissioning procedure of PPA 8.3 (a) (iv). Below are filled reference tables for Gas Turbine(s) loads. The values are driven from the formula given in above mentioned procedure and depicted below as well with Gas Turbine(s) rated load of 410 MW (gross) each at reference site conditions.

Droop % = 
$$\frac{\frac{\Delta f}{f}}{\frac{\Delta P}{P}} \times 100$$

The methodology of test and test acceptance criteria shall remain as per approved commissioning procedure which is same as of Simple Cycle mode. The test results from simple cycle on both GTs are attached herewith for reference.

Test number	n)	mHz (Load Variatio n)	-200 mHz (Load Variatio n)	+200 mHz (Load Variatio n)	-300 mHz (Load Variatio n)	+300 mHz (Load Variatio n)	-400 mHz (Load Variatio n)	+400 mHz (Load Variatio n)
Intermedi ate complex load 1: 70% GT load (MW)	Min14 MW (7 sec)	Min -14 MW (5 sec)	Min 29 MW (13 sec)	Min -29 MW (14 sec)	Min 43 MW (23 sec)	Min -43 MW (22 sec)	50 MW* (27 sec)	-50 MW* (25 sec)
Actual GT Load (MW)	T <sub>1</sub> 01:16 P <sub>1</sub> 287 T <sub>2</sub> 01:26 P <sub>2</sub> 309 ΔP 22	T <sub>1</sub> 01:27 P <sub>1</sub> 287 T <sub>2</sub> 01:37 P <sub>2</sub> 265 ΔP 22	T <sub>1</sub> 01:38 P <sub>1</sub> 287 T <sub>2</sub> 01:48 P <sub>2</sub> 330 ΔP 43	T <sub>1</sub> 01:49 P <sub>1</sub> 287 T <sub>2</sub> 01:59 P <sub>2</sub> 243 ΔP 44	T <sub>1</sub> 02:00 P <sub>1</sub> 287 T <sub>2</sub> 02:10 P <sub>2</sub> 337 ΔP 50	T <sub>1</sub> 02:11 P <sub>1</sub> 287 T <sub>2</sub> 02:21 P <sub>2</sub> 237 ΔP 50	T <sub>1</sub> 02:23 P <sub>1</sub> 287 T <sub>2</sub> 02:33 P <sub>2</sub> 337 ΔP 50	T <sub>1</sub> 02:34 P <sub>1</sub> 287 T <sub>2</sub> 02:44 P <sub>2</sub> 237 $\Delta P$ 50
Stabilizati on Time (seconds)	15 sec	14.9 sec	26.6 sec	27 sec	30 sec	29.5 sec	30 sec	29 sec
Intermedi ate complex load 2: 80% load (MW)	Min 16 MW (8 sec)	Min -16 MW (8 sec)	Min 33 MW (18 sec)	Min -33 MW (16 sec)	Min 49MW (30 sec)	Min - 49MW (25 sec)	50 MW* (30 sec)	-50 MW* (28 sec)
Actual GT Load	T <sub>1</sub> 05:14 P <sub>1</sub> 328 T <sub>2</sub> 05:24	Ti 05:25 Pi 328 Ti 05:35 Pi 306	T <sub>1</sub> 05:36 P <sub>1</sub> 328 T <sub>2</sub> 05:46 P <sub>2</sub> 372	$\begin{array}{rrrr} T_1 & 05:47 \\ P_1 & 328 \\ T_2 & 05:57 \\ P_2 & 285 \end{array}$	T1 05:59 P1 328 T2 06:09 P2 378	T <sub>1</sub> 06:11 P <sub>1</sub> 328 T <sub>2</sub> 06:21 P <sub>2</sub> 278	T <sub>1</sub> 06:23 P <sub>1</sub> 328 T <sub>2</sub> 06:33 P <sub>2</sub> 378	$\begin{array}{rrrr} T_1 & 06:35 \\ P_1 & 328 \\ T_2 & 06:45 \\ P_2 & 278 \end{array}$

GT load change at 70% and 80% (As per Table at Section VI of procedure)





1263 MW Punjab Thermal Power Private Limited



Stabilizati on Time (seconds)	15 sec	13 sec	26 sec	26 sec	30 sec	30 sec	30 sec	28 sec
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- \*OEM backed recommendations regarding the incorporated MW limiter against frequency response to be provided by PTPL before COD. 70% load is considered 287MW and 80% load is considered 328 MW as per rated conditions.
- Droop Setpoint 4%.
- GT(s) total response time is within 30 seconds. The maximum of load gradient value calculated from the formula against the corresponding load percentage will be achieved in 10 seconds. (The response time of GTs agreed at the time of simple cycle testing at GTs is attached herewith)

GT load variation at different droop settings as per test points given in approved commissioning procedures (8.3 (a) (iv) Turbine Droop Governor Test

Droop Setpoint	2%	3	%	4	%	5	%	6	%	7	%	8	%
DF injected	N/A	+150 mHz	-150 mHz	+200 mHz	-200 mHz	+250 mHz	-250 mHz	+300 mHz	-300 mHz	+350 mHz	-350 mHz	+400 mHz	-400 mHz
DP Variation	N/A	Min 4	1 MW	Min 4	1 MW	Min 4	IMW	Min 4	1 MW	Min 4	1 MW	Min 4	1 MW
		02:50	03:02	03:14	03:25	03:36	03:47	03:58	04:10	04:22	04:34	04:46	04:57
Load Before Test at GT(MW)	N/A	287	287	287	287	287	287	287	287	287	287	287	287
Lead after Test at GT (MW)	N/A	254	322	243	330	243	330	243	330	243	331	237	338
Load Variation after stability at GT (MW)	N/A	0	0	0	0	0	0	0	0	0	0	0	o
Stability Time (s)	N/A	18 scc	18 sec	22 sec	25 sec	26 sec	27 500	24 sec	25 sec	24 sec	22 sec	28 sec	27 sec

Gas Turbine Load- 70% (As per Table at Section VII of Procedure)

The power plant was designed in 2017 as per the prevailing Grid Code.

OEM range for the droop settings are 3% to 8%. (OEM settings are attached herewith).

The test is to be conducted keeping in view the limits allowed by OEM.

China Machinery Engineering Corporation (CMEC)









GT(s) total response time is within 30 seconds. The maximum of load gradient against the calculated from the formula against the corresponding load percentage will be achieved in 10 seconds. (The response time of GTs agreed at the time of simple cycle testing at GTs is attached herewith)

PTPL CPPA-G CMEC/SIEMENS OMS Sign: 1 Sign: Sign: ( Sign Name: Aivez Mohsin Name: M. Name: Raw A Name: TE HROZ DGMT KHAN Date: 23-05-23 Date: 23-05-2023 Date: Date: 13-05-23 Tasa Secas TASIR AHMAD 2. Name signature Multiammad Farcogy Dun Multiammad Farcogy Dun 23]

China Machinery Engineering Corporation (CMEC)-

## TCB CFPP





TCB-1

#### Steam Turbine Governor Operation Log Sheet Turbine Governor Operation Test 1 Date: Dec 27th, 2022 Start Time: 09:55 End Time: 13:45 Unit: 1 Droop% 3% Load 60% 75% 90% Frequency -0.067 0.067 -0.1 -0.067 0.067 -0.1 0.067 0.1 0.1 0.1 -0.067 -0.1 Difference (Hz) Load variation After 14.7 -14.7 29.3 -29.3 14.7 -14.7 29.3 -29.3 14.7 -14.7 29.3 -29.3 Stabilization (MW) 09:58:33 09:55:32 10:07:08 10:03:30 11:45:47 11:43:10 12:06:59 11:48:26 13:30:20 13:24:19 13:42:53 12:34:02 Start time Load before Test 396.11 396.38 395.4 395.9 495.70 494.85 498.39 497.27 594.23 592.79 594.27 593.35 (MW) Steady load after 410.13 381.64 424.22 366.0 510.12 480.45 527.01 465.47 607.33 578.90 624.65 564.12 Test (MW) Actual Load variation after 14.02 28.82 -29.9 28.62 -14.74 14.42 -14.4 -31.80 13.10 -13.89 30.38 -29.23 stabilization (MW)

#### Signed for acceptance of the Test results

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Stability time (s)

Response time (s)

CPPA-G/NTDC	SEC	ENGINEER		
Sign:	Sign: NGreen	Sign:		
Name:	Name: Oben Shanshan	Name Noted For Information Only Technical Strength		
Date: The	Date:	Date:		
- J	Der 27th, 2022	Dec. 274 .2022		
	CPPA-GATDC Sign: Name: Date:	CPPA-G/VTDC SEC Sign: Sign: North Name: Name: Date: Date: Dec 27th, 2021		

Note: Please put initials of all involved party representative on each separate page of the Procedure

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								S	team Turb	ine Gover	nor Open	tion
		Log	Sheet T	urbine	Gover	nor Op	eration	Test 2				
Unit: <u>1</u>	. 1	Date: <u>D</u>	ec 27th	,2022	i	Start T	'ime: <u>09</u>	) <u>;38</u>	End Ti	me: <u>13</u>	:24	
Droop%	Droop% 4,5%											
Load		60	1%			75	%			90	%	
Frequency Difference (Hz)	-0.067	0.067	~-0,1	0.1	-0.067	0,067	-0,1	0.1	-0.067	0.067	-0,1	0,1
Load variation After Stabilization (MW)	9,78	-9.78	19.7	-19.7	9.78	-9.78	19:7	-19.7	9.78	-9.78	19.7	-19.7
Start time	09:43:58	09:39:37	09:50:53	09:49:01	11:34:20	11:31:30	11:39:39	11:37:15	13:06:03	13:02:54	13:20:13	13:09:0
Load before Test (MW)	394.54	396,98	397,28	395.94	496.56	496.31	495.73	494.97	593,42	594.69	594.88	593.69
Steady load after Test (MW)	405.5	387.83	417.38	376.49	505.10	486.19	515.30	475.08	602.49	583.34	614.38	572.7
Actual Load variation after stabilization (MW)	10.96	-9.15	20.1	-19.45	8.54	-10.12	19,57	-19.89	9.07	-11.35	19.50	-20.96
Stability time (s)	28	29	46	-54	23	40	47	49	34	32	45	55
Response time (s)	1	3	1	_1	-1	1	1	1	1	1	1	1

Signed for acceptance of the Test results

TCB-1	CPPA-G/NTDC	SEC	ENGINEER
Sign Z R BL Name: Whay The along	Sign: Name:	Sign: NJM Name: Chen Shansha	Sign: Nameote con prosection Previewed State of production office State of production State of production St
Date: Pec, 27th, 202	Date: Hyb	Date: Dec 22th, 2022	Date: Dec. 27th 2022

Note: Please put initials of all involved party representative on each separate page of the Procedure

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								S	ieam Turb	ine Gove	nor Opera	ation
	<u> </u>					~			andre viere			
Kinite 1	т	Log S	heet T	urbine 2022	Gover	nor Up Start T	eration	1 est 5	End Ti	me: 13	:02	
Chitc_1		Jaic. 1)	ct 27 ,	4044		Juit		100				
Droop%						8	%	<sup>-</sup>				
Load	<b></b>	60	%			75	%			90	20	
Frequency Difference (Hz)	-0.067	0.067	-0.1	0.1	-0,067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1
Load variation After Stabilization (MW)	5.5	-5.5	11	-11	5.5	-5.5	11	-11	5,5	-5.5	11	-11
Start time	09:21:58	09:08:18	09:34:25	09:29:50	11:23:20	5 11:21:42	11:28:12	11:25:44	12:53:54	12:51:39	12:59:18	12:56:45
Load before Test (MW)	395.86	395.67	395.62	394.13	496.43	495.87	495.5	495.98	592.42	593.00	593.57	592.07
Steady load after Test (MW)	401.84	390.67	406.99	383.83	501.99	489.84	508.71	484.13	600.49	586.39	606.23	581.71
Actual Load variation after stabilization (MW)	5,98	-5.0	11.37	-10,3	5:56	-6.03	13.21	-11.76	8.07	-6.61	12,66	-10.36
Stability time (s)	17	38	22	41	33	29	26	27	31	11	22	33
Response time (s)	2	0.9	3	2	2	1	1	1	1	2	1	1
Performance A Date: <u>Dec 27<sup>t</sup></u>	ccepta: h, 2022	nce Lis	t	Time	13:0	2						
In	dex		<b>—</b>	Standa	rd Rec	uiremet	nt	Expe	rimenta	l Value	(mean)	
Dro	000%				3%-8	%			(	)K	,Z	_
Respo	nse tim	e		le	ess that	1 3 s			1.3	б sec		
Stabil	ity time	:		le	ss than	60 s			37.	64 sec		
Dead	l band				£0.033	HZ			(	ЭК		
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Date: Dec, >	فد, <sup>11</sup>	u Date	Ľ		i I	Date: Dec 2	7 <sup>₩</sup> ,	2012	Date:	ec. 27	₩.~	20
Note: Please pu	t initial:	s of all	involve	d party	repres	entative	on each	1 separa	te page	of the l	Procedu	re
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Log Sheet Turbine Governor Operation Test 1												
Unit: 2	_ 1	Date: <u>D</u>	ec 27th.	<u>, 2022</u>		Start I	'ime: <u>1</u>	5:40	End Time: <u>19:05</u>			
Droop%		3%										
Load		60%				75	%			90	1%	
Frequency Difference (Hz)	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	0.1
Load variation After Stabilization (MW)	14.7	-14.7	29.3	-29.3	14.7	-14.7	29.3	-29.3	14.7	-14.7	29.3	29.3
Start time	15:45:43	15:43:36	15:51:08	15:48:13	16:52:48	16:50:00	16:57:55	16:55:26	18;47:53	18:45:06	19:00:36	18:50:51
Load before Test (MW)	396.5	396.7	395.1	395.4	495.88	496.1	496.05	494.99	595.73	595.44	595,90	594.41
Steady load after Test (MW)	410.8	381.8	424.1	366.1	508.8	480.8	524.64	465.53	609.8	580,30	626,38	565.37
Actual Load variation after stabilization (MW)	:14:3.	-14.9	29.0	-29.3	13.0	-15.3	28.59	-29.46	14.07	-15,14	. 30,48	-29.54
Stability time (s)	33	32	46	40	30	37	42	39	48	26	50	43
Response time (s)	.1	1	2	1	1	1	1	1	2	1	2	1

#### Signed for acceptance of the Test results

TCB-1	CPPA-¢/NTDC	SEC	ENGINEER
Sign: Z A Mu Name: Way Kiewing	Sign: Name:	Sign: Utotrey Name: Chen Shourshan	Sign: Nam Sorteo For Inverses of the second Society of the second seco
Date: Dec, 27th, 202	Date:	Date: Dec 27 <sup>04</sup> , 2022	Date: Dec. 27th, 2002

Note: Please put initials of all involved party representative on each separate page of the Procedure

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								51	eam Turb	ine Gover	nor Open	ition
Unit: 2	, I	Log S Date: <u>D</u>	Sheet T ec 27 <sup>th</sup> .	urbine _ <u>2022</u>	Gover	nor Op Start T	eration 'ime: <u>1</u>	Test 2	End Ti	me: <u>18</u>	:43	
Droop%						4.5	5%					
Load		60	%			75	%			90	%	
Frequency Difference (Hz)	-0.067	0.067	-0.1	0.1	-0.067	0,067	-0.1	0.1	-0.067	0.067	<b>-0.</b> 1	0.1
Load variation After Stabilization (MW)	9.78	-9.78	19.7	-19.7	9.78	-9.78	19,7	-19.7	9.78	-9.78	19.7	-19\7
Start time	15:36:01	15:33:41	15:40:34	15:38:21	16:38:36	16:35:45	16:44:32	16:41:32	18:36:18	18:34:03	18:41:30	18:39:19
Load before Test (MW)	395.9	396.1	397.5	396.7	495.8	494.9	495.0	493,2	594.7	-595.5	595.8	595.28
Steady load after Test (MW)	406.5	386.7	416.3	377.4	505.8	485.5	513.6	474.8	604.97	584.6	614.4	574.99
Actual Load variation after stabilization (MW)	10.6	-9;4	18.8	-19:3	. 10.0	-9.4	18.6	-18.4	10.27	10.9	18.6	20.29
Stability time (s)	26	40	31	32	34	36	30	33	30	25	.32	30
Response time (s)	1	1	1	1	1	1	1	1	2	1	2	1

#### Signed for acceptance of the Test results

TCB-1	CPPA-G/NTDC	SEC	ENGINEER
Sign: IA34	Sign:	Sign:	Sign:
Name: Wang The diany	Name:	Name: Chen Sheinsha	Name Aprice For INFORMATION CHILDS PAS CSTC DEAMBARDS TECHNICAL SEPTEMENTED INDIZI
Date: Dec, 27th, 702	Date: Jul	Date: Der 27 <sup>04</sup> , 2020	Date: Dec. 27th, 2022
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Unit: 2	_ 1	Date: D	ec 27 <sup>th</sup>	,2022		Start T	'ime: <u>1</u>	<u>5:21</u>	End Ti	ime: <u>18</u>	:21		
Droop%						. 8	%						
Load		60	%			75	%			90	)%		
Frequency Difference (Hz)	-0.067	0.067	-0.1	0.1	-0.067	0.067	-0.1	.0.1	-0.067	0.067	-0.1	0.1	
Load variation After Stabilization (MW)	5.5	-5.5	11	-11	5.5	-5:5	11	-11	5.5	-5.5	11	-11	
Start time	15:24:22	15:21:35	15:29:40	15:26:58	16:27:43	16:25:19	16:32:25	16:30:00	18:13:52	18:11:46	18:18:24	18:16:06	
Load before Test (MW)	396.5	397.9	396.4	396.7	494.6	494.3	494,6	494,7	594.6	595.2	596.3	594.8	
Steady load after Test (MW)	402.4	390.5	407.05	385.9	500,5	488,3	507.0	483.1	601.5	589.3	607.5	583.2	
Actual Load variation after stabilization (MW)	5,9	-7.4	10.65	-10.8	5.9	-6.0	12.4	-11.6	6.9	-5.9	11.2	-11.6	
Stability time (s)	14	51	37	29	4	39	17	36	15	29	20	22	
Response time (s)	1	1	2	1	1	1	1	1	1	2	1	1	
Performance A Datë: <u>Dec 27<sup>i</sup></u>	ccepta) <u> -, 2022</u>	nce Lis	t	Time:	18:21	<u>L</u>							
In	dex			Standa	rd Req	uiremer	it.	Experimental Value (mean)					
Dro	op%				3%-89	6-8%				OK			
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ThalNova

## Thar Nova Power thar (Pvt) Limited







Turbine Governor Operation Test

Project Name:

1x330 MW - Thal Nova Power Thar (Private) Limited

Droop						3	%					
Load		60 %	Load			75 %	Load			90 %	Load	
Frequency Difference (Hz)	0.067	-0.067	0.1	-0.1	0.067	-0.067	0.1	-0.1	0.067	-0.067	0.1	-0.1
Speed Difference (RPM)	4	-4	6	-6	4	-4	6	-6	4	-4	6	-6
Load Variation after Stabilization (MW)	-7.33	7.33	-14.67	14.67	-7.33	7.33	-14.67	14.67	-7.33	7.33	-14.67	14.67
Load before Test (MW)	197.88	198.02	197.26	198.09	247.52	248.21	247.38	247.8	297.09	297,44	296.61	297.51
Steady Load after Test (MW)	190.66	205.16	183.25	212.78	239.97	254.52	232.83	262.01	289.75	304.71	282.06	312.06
Actual Load Variation after Stabilization (MW)	-7.22	7.14	-14.01	14.69	-7.55	6.31	-14.55	14.21	-7.34	7.27	-14.53	14.55
Stability Time (s)	20	26	23	30	33	22	21	25	33	45	31	31

#### Signatures:

TNPTL	CPPA-G	EPC	Engineer	
Sign: Had	Sign Sign .	Sign: The C	Reported Sign:	2
Name: M. Ayes	- Khan Name:2) Amir N 3) Huning Sch	Sh Name: Sw Name: Sword	Name: R. Pau	NERGY .
aleu1 +	1	Site Office		Nazim Uddin
Date:	69/0172023	*		ph 2110342-3

Attachments:

- DCS Trends





**Turbine Governor Operation Test** 

Project Name:

Name of Test:

### 1x330 MW - Thal Nova Power Thar (Private) Limited

00p 4.5 %												
	60 %	Load		75 % Load				90 % Load				
0.067	-0.067	0.1	-0,1	0.067	-0.067	0.1	-0,1	0.067	-0.067	0,1	-0,1	
4	-4	6	-6.	4	-4	6	-6	4	-4	6	-0	
-4,89	4,89	-9.78	9.78	-4,89	4,89	-9.78	9.78	-4.89	4.89	-9.78	9,78	
198.09	198.02	197.74	/ 197.74	247.25	247,86	247.04	248.14	296.41	297.37	296.54	.297.71	
193.07	202.55	188.20	207.70	242.65	252.19	237:56	257,41	292.08	301.63	287.27	307.26	
-5.02	4.53	-9,54	9.96	-4.60	4.33	-9,48	9.27	-4.33	4.26	-9.27	9.55	
35	27	26	27	25	24	30	26	27	35	33	40	
	0,067 4 -4.89 193,09 193,07	60 %           0.067         -0.067           4         -4           -4.89         4.89           198.09         198.02           193.07         202.55           -5.02         4.53           35         27	60 % Load           0.067         -0.067         D.1           4         -4         6           -4.89         4.89         -9.78           198.09         198.02         197.74           193.07         202.55         188.20           -5.02         4.53         -9.54           35         27         26	60 % Load           0.067         -0.067         0.1         -0.1           4         -4         6         -6           -4.89         4.89         -9.78         9.78           198.09         198.02         197.74         197.74           193.07         202.55         188.20         207.70           -5.02         4.53         -9.54         9.96           35         27         26         27	60 % Load           0.067         -0.067         0.1         -0.1         0.067           4         -4         6         -5         4           -4.89         4.89         -9.78         9.78         -4.89           198.09         198.02         197.74         197.74         247.25           193.07         202.55         188.20         207.70         242.65           -5.02         4.53         -9.54         9.96         -4.60           35         27         26         27         25	4.5           60 % Load         75 %           0.067         -0.067         0.1         -0.1         0.067         -0.067           4         -4         6         -5         4         -4           -4.89         4.89         -9.78         9.78         -4.89         4.89           198.09         198.02         197.74         197.74         247.25         247.86           193.07         202.55         188.20         207.70         242.65         252.19           -5.02         4.53         -9.54         9.96         -4.60         4.33           35         27         26         27         25         24	4.5 %           60 % Load         75 % Load           0.067         -0.067         0.1         -0.1         0.067         -0.067         0.1           4         -4         6         -6         4         -4         6           -4.89         4.89         -9.78         9.78         -4.89         4.89         -9.78           198.09         198.02         197.74         197.74         247.25         247.86         247.04           193.07         202.55         188.20         207.70         242.65         252.19         237.56           -5.02         4.53         -9.54         9.96         -4.60         4.33         -9.48           35         27         26         27         25         24         30	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	

#### Signatures:

TNPTL	CPPA-G	EPC	Engineer
sigh ARh	w for the	sign: Bufer	Sign:
Name WATA	1) Ai jirz Molicin Namerz) Amir Nizar 3) firm schrief	Static: Siyond	Name: R. Panoho
		Site Office	S) H276
Date:	09/01/2023	*	Hond F 10/1 Ph 2110342-3
Attachments:			1 10352 1 (10352

#### Attachments:

- DCS Trends e e

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**Project Name:** 

Name of Test:

### 1x330 MW - Thal Nova Power Thar (Private) Limited

					8	%						
	60 %	Load		75 % Load				90 % Load				
0.067	-0.067	0.1	-0:1	0.067	-0.067	.0.1	-0,1	0.067	-0,067	0.1	-0.1	
4	4	6	-6	4	-4	6		4	-4	6	-6	
-2.75	2.75	- <b>5</b> ,5	5.5	-2.75	2.75	-5.5	5.5	-2.75	2,75	-5.5	3.5	
197.81	197.81	198.22	198,36	247.59	248.14	247 11	248.28	296.82	296,54	297.23	297.23	
195.34	200.76	192.25	203,37	244.84	250.54	241.68	253.36	294.14	299.50	291.60	302.38	
-2.47	2.95	-5.97	5,01	-2.75	2,4	-5:43	5.08	-2,68	2.96	-5.63	5815	
31	25	33	31	26	24	27	27	32	-28	31	37	
	0.067 4 -2.75 197.81 -195.34 -2.47 -31	60 %           0.067         -0.067           4         -4           -2.75         2.75           197.81         197.81           195.34         200.76           -2.47         2.95           31         25	60 % Load           0.067         -0.067         0.1           4         -4         5           -2.75         2.75         -5.5           197.81         197.81         198.22           195.34         200.76         192.25           -2.47         2.95         -5.97           31         25         33	60 % Load           0.067         -0.067         0.1         -0.1           4         -4         5         -6           -2.75         2.73         -5.5         5.5           197.81         197.81         198.22         198.36           195.34         200.76         192.25         203.37           -2.47         2.95         -5.97         5.01           31         25         33         31	60 % Load         0.067         0.067         0.1         -0.1         0.067           4         -4         6         -6         4           -2.75         2.75         -5.5         5.5         -2.75           197.81         197.81         198.22         198.36         247.59           195.34         200.76         192.25         203.37         244.84           -2.47         2.95         -5.97         5.01         -2.75           31         25         33         31         26	60 % Load         75 %           0.067         -0.067         0.1         -0.1         0.067         -0.067           4         -4         5         -5         4         -4           -2.75         2.75         -5.5         5.5         -2.75         2.75           197.81         197.81         198.22         198.36         247.59         248.14           195.34         200.76         192.25         203.37         244.84         256.54           -2.47         2.95         -5.97         5.01         -2.75         2.4           31         25         33         31         26         24	8 %           60 % Load         75 % Load           0.067         -0.067         0.1         -0.1         0.067         -0.067         0.1           4         -4         5         -6         4         -4         5           -2.75         2.75         .5.5         5.5         -2.75         2.75         -5.5           197.81         197.81         198.22         198.36         247.59         248.14         247.11           195.34         200.76         192.25         203.37         244.84         250.54         241.68           -2.47         2.95         -5.97         5.01         2.75         2.4         -5.43           31         25         33         31         26         24         27	8 %           60 % Load         75 % Load           0.067         -0.067         0.1         -0.1         0.067         -0.067         0.1         -0.1           4         -4         6         -6         4         -4         8         -6           -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5           197.81         197.81         198.22         198.36         247.59         248.14         247.11         248.28           193.34         200.76         192.25         203.37         244.84         250.54         241.68         253.36           -2.477         2.95         -5.97         5.01         -2.75         2.4         -5.43         5.08           31         25         33         31         26         24         27         27	8 %           60 % Load         75 % Load           0.067         -0.067         0.1         -0.1         0.067         0.1         -0.1         0.067           4         -4         5         -5         4         -4         6         -6         4           -2.75         2.75         -5.5         5.5         -2.75         2.73         -5.5         5.5         -2.75           197.81         197.81         198.22         198.36         247.59         248.14         247.11         248.28         296.82           195.34         200.76         192.25         203.37         244.84         256.54         241.68         253.36         294.14           -2.477         2.95         -5.97         5.01         -2.75         2.4         -5.43         5.08         -2.68           31         25         33         31         26         24         27         27         32	8 %           60 % Load         75 % Load         90 %           0.067         -0.067         0.1         -0.1         0.067         -0.1         -0.067         0.1         -0.067           4         -4         5         -6         4         -4         6         -6         4         -4           -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5         -2.75         2.75           197.81         198.22         198.36         247.59         248.14         247.11         248.28         296.82         296.54           195.34         200.76         192.25         203.37         244.84         250.54         241.68         253.36         294.14         299.50           -2.477         2.95         -5.97         5.01         -2.75         2.4         -5.43         5.08         -2.66         2.96           31         25         33         31         26         24         27         27         32         28	8 % $60 \%$ Load         75 % Load         90 % Load           0.067         -0.067         0.1         -0.1         0.067         -0.1         0.067         -0.1         0.067         -0.1         0.067         -0.1         0.067         -0.1         0.067         -0.1         0.067         -0.1         0.067         -0.167         0.1           4         -4         6         -6         4         -4         6         -6         4         -4         6           -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5         -2.75         2.75         -5.5         5.5         -2.75         2.75 <t< td=""></t<>	

#### Signatures:

FNPTL	CPPA-G	EPC	Engineer
Sign: Harbor	An Aris	Sign: Jeg Ruyong	1 Sign:
Name: Mr Ayaz Khan	DAIDE MORDA Name 2) Anir Nizer 3) Murui & C	Name: Digonez	Name: R. Panah
Nex 201		Resources Import & Export	H276 (0)
Date:	09/01/2023	Thar Power Plant Proj	ect
Attachments:		Sile Office	the at 2110352 A
- DCS Tren	ds		
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Name of Test:

**Turbine Governor Operation Test** 

**Project Name:** 

1x330 MW - Thai Nova Power Thar (Private) Limited

Date: 08/01/2023 - 09/01/2023

Time: 19:40 hrs - 02:00 hrs

Index	Standard Requirement	<b>Result Value</b>
Droop %	3%-8%	3%,4.5%&8%
Response time	less than 3s	OK
Stability time	less than 60s	OK
Dead band	土 0.033Hz	:†. 2rpm

#### Signatures:

TNPTL	CPPA-G	EPC	Engineer
sign Althon	Station .	sign: The Dupong	Sign:
Name Mi Heyna Khow	1) Ajue Molisin Name: ) Amir Kizar 3) Kand Jan Mod	Names Like Photo	Name: R. Para
	1	Thar Power Plant Project	Nazim Uddin
Date:	09/01/2023	Site Office	Ph 2110342-3 Fax: 2110352
			slamabad

#### Attachments:

- DCS Trends



## Thar Energy Limited CFPP



HUBCO

#### Log Sheet Turbine Governor Operation Test

Droop						4.	<del>3%</del> 5°/-						
Load	60% Load					75% Load				90% Load			
Frequency Difference (Hz)	to-067	-0-067	to.1	-0.(	to.067	-0.067	+0.1	-0.1	to.067	-0.067	10.1	-0.1	
Load Variation after Stabilization (MW)	-4.89	+4.89	-9.18	+9.78	-4.89	+4.89	-9.78	+9.18	-4.89	+4.89	-9.78	±4.18	
Load before Test (MW)	197.77	198.51	198.24	198.70	246.77	246.22	247.09	246.49	296.37	297.13	297.11	297.71	
Steady Load after Test (MW)	192.47	203.26	187.80	208.89	241.66	252.34	236.66	257.17	291,42	302.11	286.26	308.09	
Actual Load Variation after Stabilization (MW)	- 5.3	+4.75	- 10.44	+10.19	- 5.11	+6.12	- 10.43	+10.68	- 4.95	+ 4.98	- 10-85	+10.38	
Stability Time (s)	230	230	230	230	230	230	230	230	230	L 30	230	230	

TEL CPPA-G / NTDC EPC Engineer Sign: Sign: Sign: Sign: A.F. Name: Frent Ahur / Name: Name: A Rezaei Lar Name on Kha A Date: 8 19.08 Date: 8/9/2222 Date: Date: 2022 ENERG H 276 Nazim Uddin Road F-10/1 Ph 2110342-3 Fax 2110352 Thar Power Plant Project Site Office A \* amabac

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#### Log Sheet Turbine Governor Operation Test

Droop	-4.5%- 3.1.										_	
Load	60% Load					75%	Load		90% Load			
Frequency Difference (Hz)	+0.067	-0.067	+0.(	-0-(	40.067	-0.087	to.(	-0.1	40.067	~ 0.061	10.1	-0.1
Load Variation after Stabilization (MW)	- 7.33	+7.33	-14.67	+14-67	-7.33	+7.33	-14-67	+14.67	-7.33	+7.33	-14.67	+14.67
Load before Test (MW)	198.91	198.98	197.99	198.57	247.07	247.45	247.37	246.96	296.78	29 7.82	297.13	297.99
Steady Load after Test (MW)	190.41	206.37	182.64	213.56	2.38.69	255.17	236.91	261.76	289.01	305.18	280.77	312.38
Actual Load Variation after Stabilization (MW)	-8.51	+7-39	-15.27	+ 14.99	-8.38	+7.72	-15.46	+ 14.8	-7.77	+7.36	- 16.36	+14.39
Stability Time (s)	230	230	230	230	230	230	230	230	130	230	230	230

TEL CPPA-G / NTDC EPC Engineer Sign: Sign: A Sign: Sign: han Name: A. Rezaer for Name: Forced Amul Name: Name forg nz tha C Date: te: 0022 50 Nazim Uddin 2022 50 Nazim Uddin 2004 6.101 2004 6.101 50 210342.3 Fax 2110342.3 ENERG Date: 8/2/2012 Date: Date 200 91 Thar Power Plant Project Site Office \* amabad Page 8 of 10 N



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#### Log Sheet Turbine Governor Operation Test

Droop		8%										
Load		60% Load				75%	Load		90% Load			
Frequency Difference (Hz)	+0.067	-0.067	+0.1	-0.1	40.067	- 0.067	+0.1	-0.1	+0.067	-0.067	+0.1	- 0 . 1
Load Variation after Stabilization (MW)	-2.75	+1.75	-5.5	+5.5	-2.15	+2.75	-5.5	+ 5.5	-2.75	+ 2.75	-5.5	+5.5
Load before Test (MW)	197.63	197.96	197.33	198.02	246.22	247.51	246.68	247.45	296.22	296.86	297.11	297.44
Steady Load after Test (MW)	194.89	200.79	192.52	203.89	243.99	249.92	240.94	252.89	293.95	299.63	290.90	302.57
Actual Load Variation after Stabilization (MW)	-2.74	+2.83	-4.81	+ 5.87	- 2.23	+2.4(	- 5.74	+5.44	- 2.33	+ 2.77	- 6.21	+ 5.13
Stability Time (s)	230	230	230	230	130	130	130	230	230	230	230	130

EPC Engineer CPPA-G / NTDC TEL Sign: Sign: A.) Sign: Sign an Name: Forced Alw Name: A. Rezaei for Name Name: Khan M ar Date: 8/9/22 Date: 2022.09-08 Date: 0 Date: 8/9/2022 ENERG Thar Power Plant Project H 276 Nazim Uddin Road F-10/5 Ph. 2110342-3 Fax. 211034 Site Office + ax 2110352 amabad Page 9 of 10



# Annexure 3: Operating Conditions used to calculate Primary Reserve requirement with high penetration of VRE

## Summer Peak – VRE case

Plant Type	Bower Blant	Bron	Dmax	Denin	Maria	Droop	Reserve	Reserve
Plant Type	rowerriant	rgen	FINAX	rmin	IVIW.5	(MW/Hz)	(+ve)	(-ve)
	MANGLA PP	470	500	200	2245	250	30	270
	Ghazi Barotha	1350	1450	1190	7250	725	100	160
	Turbela PP	4790	4840	3840	24013	875	50	950
	WARSAK	155	202	25	724	101	47	130
	Malakand PP	70	82	41	286	41	12	29
	DARAL KHWAR	30	32	20	160	16	2	10
	GOLEN	30	108	20	216	54	78	10
Hudro	ALLAI	70	122	60	276	61	52	10
nyuro	DBR-KWR	120	130	70	455	65	10	50
	KHNKHR	10	72	10	252	36	62	0
	PATRIND	124	150	68	750	75	26	57
	NBONGSC	37	84	30	87	42	47	7
	GULPUR	80	100	10	200	50	20	70
	CHASMA	114	114	18	570	0	0	96
	KAROT	720	720	232	3362	0	0	488
		8170	8706	5833	40845	2391	535	2338
	JABBAN	22	22	12	36			
	DARGAI	13	15	5	29			
	PEHUR	10	28	5	38			
	GML-ZAM	9	17	5	39			
	KRM.GRHI	5	5	0	3			
	JAGRAN	24	33	5	59			
Cmall Hudro	MARALA SH	7	8	4	15			
Small Hydro	SHADIWL	8	14	8	20			
	NANDPR	6	14	6	18			
	RENALA	1	1	1	1			
	SHISHI	2	2	1	2			
	RESHUN	4	4	2	4			
	JINNAH	39	96	24	249			
		150	258	77	512			
	JDW	24	26	10	73			

## Operating Reserve Policy



	CHINIOTPP	27	62	20	57			
Bagass	FATIMA	32	66	25	294			
, in the second s	AL MOIZ	17	30	10	135			
		100	184	65	559			
	K2 Unit	1032	1040	730	5595			
Nuclear	K3 Unit	1032	1040	730	5595			
Nuclear	CHASHNUP	1241	1263	800	9170			
		3305	3343	2260	20360			
	ATLAS	165	180	75	304	90	15	105
	NSHTCHN	172	195	68	345	98	23	127
	NISHT-PWR	189	195	68	345	98	6	127
	AGL-IPP	145	156	68	281	78	11	88
	K.E.L	115	124	44	149	62	9	80
	LIBERTY Tech	160	188	69	333	94	28	91
	LIBERTY Power	174	194	90	889	90	20	84
	HUBCO narowal	175	190	77	321	95	15	113
	FNDTION	148	166	63	1109	77	18	103
	UCH 1	491	500	477	2611	165	9	23
	КАРСО	578	640	206	4241	187	62	434
	GUDDU	394	440	310	3017	216	46	130
	GUD-CCPP	440	480	340	3259	240	40	140
	BALLOKI	977	1098	730	5968	512	121	368
	BHIIKI	519	688	490	3882	309	169	198
	HBS	907	1050	750	5706	490	143	300
	TRIMMU	333	365	280	1051	183	32	85
Thermal	UCH2	360	372	298	2397	174	12	74
	HALMOR	105	115	86	550	52	10	29
	ORIENT	115	120	73	574	24	5	47
	SAIF	123	136	80	650	61	13	56
	SAPHIRE	118	125	88	598	57	7	37
	ENGRO Power	99	130	40	654	65	31	90
	NANDPR	430	474	315	4006	226	44	159
	PRT CFPP	340	450	330	1636	180	110	120
	LUCKY	337	606	303	2485	242	269	303

## Operating Reserve Policy



	SECL	1200	1200	600	4692	0	0	600
	SAHIWAL	700	1242	660	4856	497	542	582
	TEL	300	300	110	1146	0	0	190
	THAL NOVA	300	300	110	1146	0	0	190
	HUB CHINA	300	625	270	1950	250	325	355
	AESLALP	175	350	175	1141	140	175	175
	AESPKGN	342	350	170	991	140	8	180
	SABA	96	120	25	396	48	24	95
		11522	13863	7938	63679	5237	2341	5877
	QAD-SOLAR	50	100	0				
	ADDO Solar	70	100	0				
		70	100					
6 - I	CRESTENE	50	100	0				
Solar	BESTGREEN	70	100	0				
	ZENFA SOLAR	75	100	0				
	INCREASED PENETRATIO	1600	2500					
		1915	3000	0				
	HAWA	38	50	16				
	MASTER	38	50	16				
	ZEPHYR	37	50	16				
	G AHMD	38	50	0				
	ARTISTIC	38	50	0				
	ACT2	38	50	0				
	DIN-E	38	50	0				
	LIBERTY1	38	50	0				
	LIBERTY2	35	50	0				
	INDUS	39	50	0				
	NASDA	39	50	0				
	LAKESIDE	38	50	0				
	METRO-2	45	58	0				
	MASTER GR	37	50	0				
	FFCEL	36	50	0				
	METRO	36	50	0				
	TAPAL	21	30	0				
	UEPL	65	99	0				
	ARTISTIC	35	50	16				
Wind	GULAHMAD	37	50	10				
	YUNUS	39	50	16				
	SAPHIRE	38	50	0				
	TGF	32	50	10				
	FWEL-I	28	50	0				
	FWEL-II	32	50	0				
	TENAGA	28	50	16				
	DAWOOD	35	50	16				
	SACHAL	32	50	0				
	JPLL	38	50	0				
	TGS	34	50	0				
	TGT	37	50	0				
	TRICON 1	38	50	10				
	TRICON 2	38	50	10				
	TRICON 3	38	50	10				
	NOORIABAD	8	12	6				
	TRICOM	35	50	0				
	ZORLU	34	57	0				
	INCREASED PENETRATIC	721	1000	0				
		2052	2852	171				
	Total	27214	32206	16343	125955	7628	2876	8215



## Summer Off-peak – VRE case

Direct Trees	Dames Diant	Deser	0	Dentin		Droop	Reserve	Reserve
Plant Type	Power Plant	Pgen	Pmax	Pmin	WW.S	(MW/Hz)	(+ve)	(-ve)
	MANGLA PP	420	570	170	2559	285	150	250
	Ghazi Barotha	1116	1450	1100	7250	725	334	16
	Turbela PP	3940	3948	2698	19336	864	8	1242
	WARSAK	155	202	25	724	101	47	130
	Malakand PP	70	82	41	286	41	12	29
	DARAL KHWAR	30	32	20	160	16	2	10
	GOLEN	30	108	20	216	54	78	10
1 barding	ALLAI	60	122	80	276	61	62	0
Hydro	DBR-KWR	130	130	70	455	0	0	60
	KHNKHR	10	72	10	252	36	62	0
	PATRIND	124	150	68	750	75	26	56
	NBONGSC	37	84	30	87	42	47	7
	GULPUR	80	100	10	200	50	20	70
	CHASMA	114	114	18	570	0	0	96
	KAROT	620	720	232	3362	360	100	388
		6936	7884	4591	36483	2710	947	2366
	JABBAN	22	22	12	36			
	DARGAI	13	15	5	29			
	PEHUR	5	28	5	38			
	GML-ZAM	9	17	5	39			
	KRM.GRHI	5	5	0	3			
	JAGRAN	24	33	5	59			
Small Hydro	MARALA SH	7	8	4	15			
	NANDPR	6	14	6	18			
	RENALA	1	1	1	1			
	SHISHI	2	2	1	2			
	RESHUN	4	4	2	4			
	JINNAH	39	96	24	249			
		137	245	69	492			
	JDW	24	26	10	73			

## Operating Reserve Policy



Dagass	FATIMA	32	66	25	294			
	AL MOIZ	17	30	10	135			
		100	184	65	559			
	K2 Unit	1032	1040	730	5595			
	K3 Unit	1032	1040	730	5595			
Nuclear	CHASHNUP	926	947	600	7078			
		2990	3027	2060	18269			
	NSHTCHN	110	195	68	345	98	85	42
	NISHT-PWR	109	195	68	345	98	86	41
	AGL-IPP	68	156	68	281	78	88	0
	K.E.L	44	124	44	149	62	80	0
	Liberty Tech	69	188	69	2	333	119	0
	Liberty Power	131	194	90	9	889	63	41
	FNDTION	156	166	63	1109	77	10	93
	UCH 1	500	500	477	2611	0	0	23
	КАРСО	416	430	125	3010	135	14	291
	GUDDU	290	300	210	2163	50	10	80
	GUD-CCPP	480	480	340	3259	0	0	140
	BALLOKI	786	1098	730	5968	512	312	56
	HBS	777	1050	750	5706	490	273	27
	TRIMMU	560	740	560	2937	333	180	0
inermai	UCH2	360	372	298	2397	174	12	62
	HALMOR	123	175	119	837	82	52	4
	SAPHIRE	125	130	66	621	65	5	59
	ENGRO Power	100	130	40	883	65	30	60
	NANDPR	354	354	248	2914	0	0	106
	PRT CFPP	700	900	660	3272	360	200	40
	LUCKY	303	606	303	2485	242	303	0
	SECL	1200	1200	600	4692	0	0	600
	SAHIWAL	820	1242	660	4856	497	422	160
	TEL	300	300	110	1146	0	0	190
	THAL NOVA	300	300	110	1146	0	0	190
	HUB CHINA	300	625	270	1950	250	325	30
	AESPKGN	290	350	170	991	140	60	120

## Operating Reserve Policy



		9771	12500	7316	56085	5028	2729	2455
	QAD-SOLAR	20	100	0				
	CREST ENE	20	100	0				
	BESTGREEN	35	100	0				
Solar	ZENFA SOLAR	75	100	0				
	INCREASED PENETRATIO	1000	2500	0				
		1150	2900	0				
	HAWA	27	50	16				
	MASTER	23	50	16				
	ZEPHYR	20	50	16				
	G AHMD	27	50	0				
	ARTISTIC	27	50	0				
	ACT2	27	50	0				
	DIN-E	27	50	0				
	LIBERTY1	27	50	0				
	LIBERTY2	25	50	0				
	INDUS	23	50	0				
	NASDA	20	50	0				
	LAKESIDE	26	50	0				
	METRO-2	31	58	0				
	MASTER GR	26	50	0				
	FFCEL	20	50	0				
	METRO	20	50	0				
	TAPAL	15	30	0				
	UEPL	35	99	0				
	ARTISTIC	25	50	16				
Wind	GULAHMAD	20	50	10				
	YUNUS	23	50	16				
	SAPHIRE	23	50	0				
	TGF	23	50	10				
	FWEL-I	20	50	0				
	FWEL-II	23	50	0				
	TENAGA	20	50	16				
	DAWOOD	25	50	16				
	SACHAL	25	50	0				
	JPLL	30	50	0				
	TGS	27	50	0				
	TGT	30	50	0				
	TRICON 1	32	50	10				
	TRICON 2	32	50	10				
	TRICON 3	27	50	10				
	NOORIABAD	8	12	6				
	TRICOM	25	50	0				
	ZORLU	17	57	0				
	INCREASED PENETRATIC	486	1000	0				
		1386	2852	171				
	Total	22470	29592	14271	111887	7738	3676	4821



## Winter Peak – VRE case

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (-ve)
	Ghazi Barotha	526	580	460	2900	290	54	66
	Turbela PP	500	650	375	3267	325	150	125
	Malakand PP	23	23	14	82	0	0	10
	DARAL KHWAR	30	68	20	340	34	38	10
	GOLEN	20	50	20	100	25	30	0
	ALLAI	40	40	40	90	0	0	0
Hydro	DBR-KWR	70	70	70	245	0	0	0
nyuro	KHNKHR	10	10	10	35	0	0	0
	PATRIND	69	69	68	345	0	0	2
	NBONGSC	37	37	30	38	0	0	7
	GULPUR	20	20	10	40	0	0	10
	CHASMA	58	58	18	290	0	0	40
	KAROT	160	180	58	841	90	20	102
		1564	1855	1192	8613	764	292	372
	JABBAN	11	11	6	18			
	PEHUR	5	5	5	7			
	Gomal Zam	9	9	5	20			
	Kuram garhi	5	5	0	3			
Small Hydro	JAGRAN	10	10	5	18			
Small Hyuro	MARALA SHAH	7	7	4	0			
	NANDI PUR	6	14	6	15			
	JINNAH	39	39	24	101			
	SHISHI	2	2	1	3			
		94	102	56	185			
	JDW	24	26	10	73			
	CHINIOTPP	27	62	20	57			
Bagass	FATIMA	25	32	32	142			
	AL MOIZ	17	30	10	135			
		93	150	72	407			
	K2 Unit	1032	1032	730	5552			
	K2 U-3	1032	1032	730	5552			
Nuclear	K3 Unit	1032	1032	/30	5552			
	CHASHNUP	1241	1241	800	9004			
		3305	3305	2260	20108			
	ATLAS	213	213	75	360	0	0	138
	NSHTCHN	117	195	68	345	98	78	49
	K.E.L	114	124	44	149	62	10	70
	NISHT-PWR	190	195	68	345	98	5	122
	LIBERTY Tech	178	195	69	345	78	17	109
	FNDTION	1/0	186	63	1247	8/	16	107
	GOD-CCPP	340	480	340	3259	240	140	73
		550	550	4//	2893	0	0	/3
	Engro Power	110 E40	110	200	2005	241	62	240
	Engro Thar	540	1100	300	2095	241	250	240
	TRIMANU	830	1189	/30	2601	262	359	100
		373	273	200	2001	302	155	50
		3/2	372	298	2357	0	0	29/
	TEI	300	301	110	1150	120	1	190
	SECI	1230	1230	600	4809	120		630
	LUCKY	303	606	303	2485	242	303	0.00
		300	300	110	1146	242		190
	SAHIWAI	704	1242	660	4856	/97	538	130
		2005	96.90	5474	4050	2670	1694	2510
		0000	5005	5474	41577	2075	1004	2510
Solar	INCREASED PENETRATI	1500	2500	0				
	HAWA	27	50	16				
	TENAGA	20	50	16				
	DAWOOD	25	50	16				
	ZEPHYR	26	50	16				
	SACHAL	32	50	0				
	JPLL	38	50	0				
	TGS 1	34	50	0				
	TGS 2	37	50	0				



	ACT2	27	50	0				
Wind	DIN-E	27	50	0				
	LIBERTY1	27	50	0				
	LIBERTY2	25	50	0				
	NASDA	28	50	0				
	LAKESIDE	26	50	0				
	MASTER GR	26	50	0				
	NOORIABAD	8	12	6				
	INCREASED PENETRATI	600	1000	0				
		1032	1760	72				
	Total	15593	19361	9125	71290	3443	1976	2882



## Winter off-peak – VRE Case

Diard Tree	Denne Di	Deser	Deres	Dent	Maria	Droop	Reserve	Reserve (-
Plant Type	Power Plant	Pgen	Pmax	Pmin	IVIW.S	(MW/Hz)	(+ve)	ve)
	Turbela PP	210	390	210	1872	195	180	0
	Malakand PP	23.33	23.33	13.5	81.655	0	0	9.83
	DARAL KHWAR	15	15	10	75	0	0	5
Hydro	GULPUR	20	20	10	40	0	0	10
	CHASMA	58	58	18	290	0	0	40
	KAROT	160	180	58	840.6	90	20	102
		486.33	686.33	319.5	3199.26	285	200	166.83
	JABBAN	11	11	6	17.6			
	JAGRAN	10	10	5	18.2			
	MARALA SH	7.4	7.4	4	13.468			
Small Hydro	RESHUN	3	4	2	7.28			
Sman nyuro	RENALA	1	1.1	0.5	1.1			
	JINNAH	34.4	34.4	21	89.096			
	SHISHI	1.5	1.5	0.5	3			
		68.3	69.4	39	149.744			
	JDW	24	26	10	73.32			
	CHINIOTPP	27	27	20	24.57			
Bagass	FATIMA	32	32	25	142.4			
	AL MOIZ	17	30	10	134.7			
		100	115	65	374.99			
	K2 Unit	745	1040	730	5595.2			
Nuclean	K3 Unit	745	1040	730	5595.2			
Nuclear	CHASHNUP	1000	1263	800	9170.02			
		2490	3343	2260	20360.4			
	UCH 1	500	550	477.2	2892.5	257.5	50	22.8
	Engro Power	90	110	89.2	553.3	55	20	0.8
	ENGRO Thar	580	602	300	2094.96	240.8	22	280
	BALLOKI	1135	1189	730	6463.46	554.6	54	405
Thermal	TRIMMU	380	395	167	1137.6	197.5	15	213
	UCH2	114	124	99.2	777.48	62	10	14.8
	SECL	600	1250	600	4887.5	500	650	0
	THAL NOVA	205	300	110	1146.39	120	95	95
		3604	4520	2572.6	19953.2	1987.4	916	1031.4
Solar	INCREASED DENETRA	1100	2500	0				
55161	HAWA	1100	2500	15.0				
	ZEDHVR	20	50	15.9				
	DIN-F	10		13.3				
	LIBERTY1	10	49.5	0.3				
	LIBERTY2	10	49.5	0.3				
	MASTER GR	10	49.5	0.3				
	DAWOOD	20	50	15.9				
Wind	SACHAL	20	50	0				
	JPLL	20	50	0				
	TGS 1	20	50	0				
	TGS 2	10	50	0				
	NOORIABAD	7.8	12	6				
	INCREASED DENETRA	414	1000	-				
	INCREASED PENETRA	414	1560.5	54.9				
	Total	8440	12794	5311	44038	2272	1116	1198



# Annexure 4: Operating Conditions used to calculate Secondary Reserve requirement

## Base Cases

## Summer Peak (Case A): baseload coal-fired power plants

Diant Trees	Dames Diant	Deser	Demonst	Dentin		Droop	Reserve	Reserve	Cost	Operating Cost
Plant Type	Power Plant	Pgen	Pmax	Pmin	IVIW.S	(MW/Hz)	(+ve)	(-ve)	(Rs/kWh)	(Rs/kWh)
	MANGLA	470	500	200	2245	250	30	270	0.07	31,490
	Ghazi Barotha	1350	1450	1190	7250	725	100	160	0.08	106,650
	Turbela	3380	3430	2430	16669	875	50	950	0.04	145,340
	Turbela 4 Extension	1410	1410	1410	7343	0	0	0	0.13	188,940
	WARSAK	155	202	25	724	101	47	130	0.11	16,585
	MLKND	70	82	40.5	286	41	12	29	0.32	22,117
	DARAL KHWAR	30	32	20	160	16	2	10	0.32	9,480
	GOLEN	30	108	20	216	54	78	10	0.34	10,320
Hydro	ALLAI	70	122	60	276	61	52	10	0.22	15,050
	DBR-KWR	120	130	70	455	65	10	50	0.22	25,800
	KHNKHR	10	72	10	252	36	62	0	0.21	2,110
	PATRIND	124	150	67.5	750	75	26	57	0.18	21,755
	NBONGSC	37	84	29.6	87	42	47	7	0.48	17,775
	GULPUR	80	100	10	200	50	20	70	0.19	15,520
	CHASMA	114	114	18	570	0	0	96	0.19	21,774
	KAROT	720	720	232	3362	0	0	488	0.19	137,520
	Sub Total	8170	8706	5832.6	40844	2391	535.297	2337.7		
	JABBAN	22	22	12	36				0.28	6,050
	DARGAI	13	15	4.5	29				0.09	1,144
	PEHUR	10	28	5	38				0.63	6,340
	GML-ZAM	9	17	5	39				0.63	5,706
	KRM.GRHI	5	5	0.31	3				0.26	1,275
	JAGRAN	24	33	5	59				2.59	62,160
Concell University	MARALA SH	7	8	4	15				2.59	19,166
Small Hydro	SHADIWL	8	14	8	20				0.18	1,424
	NANDPR	6	14	6	18				0.13	792
	RENALA	1	1	0.5	1				0.34	342
	SHISHI	2	2	0.5	2				0.34	513
	RESHUN	4	4	2	4				0.34	1,368
	JINNAH	39	96	24	249				0.27	10,424
	Sub Total	150	258	76.81	512					
	JDW	24	26	10	73				9.05	217,260
	CHINIOTPP	27	62	20	51				10.34	279,309

## Operating Reserve Policy



Bagass	FATIMA	32	66	25	294				10.34	331.030
Dagass	AL MOIZ	17	30	10	135				10.18	173.143
	Sub Total	100	194	65	552					
		1022	1040	720	502				0.95	990.400
	K2 UNT	1032	1040	730	5575				0.95	980,400
Nuclear		1052	1040	200	9170				0.55	1 260 856
	CHASHNUP	2205	2242	2250	20200				1.02	1,200,030
	Sub Total	3305	3343	2260	20360					
	ATLAS	165	180	75	304	90	15	90	35.47	5,852,880
	NSHICHN	1/2	195	68	345	97.5	23	104	41.92	7,210,532
	NISHT-PWR	189	195	68	345	97.5	6	121	11.40	2,153,863
	AGL-IPP	145	156	68	281	/8	11	//	36.64	5,312,307
	K.E.L	115	124	44	149	62	9	/1	41.39	4,759,921
	LIBERTY Tech	160	188	69	333	94	28	91	42.91	6,865,440
	LIBERTY Power	185	194	90	889	90	9	95	5.52	1,020,571
	HUBCO Narowal	1/5	190	11	321	95	15	98	40.57	7,100,083
	FNDTION	152	100	477	2611	/6.85	13.5	13.9	9.43	1,433,129
	DCH I	490	500	4//	2611	233	10	12.8	3.10	1,520,186
	KOUSH	350	412	200	2458	192.8	62	150	30.46	10,661,042
	KAPLO	620	640	206	4241	307	20	414.2	30.46	18,885,274
	GUDDU	320	340	240	2296	150	20	80	10.02	3,207,552
	GUD-CCPP	460	480	340	3259	240	20	120	11.98	5,511,812
	BALLOKI	1080	1098	730	5968	512.2	18	350	22.56	24,366,226
	BHIIKI	1015	1025	720	5581	315.2	10	295	22.34	22,678,186
	HBS	1040	1050	750	5706	490	10	290	22.34	23,236,762
Thermal	TRIMMU	1090	1105	840	3441	515	15	250	22.16	24,156,308
	UCHZ	364	3/2	298	2397	124	8	66.4	13.42	4,884,032
	HALMOR	163	1/5	119	837	82	12	44	28.20	4,596,054
	ORIENT	1/5	185	120	884	86.5	10	55	27.21	4,760,949
	SAIF	195	204	120	975	95.2	9	75	28.01	5,461,232
	SAPHIRE	180	190	121	908	89	10	59	27.71	4,988,362
	ENGRO Power	120	130	40	654	65	10	80	9.86	1,183,648
	NANDPR	434	474	315	4006	225.6	40	119	28.03	12,166,452
	PRICEPP	330	450	330	1636	180	120	0	22.84	7,536,474
	LUCKY	303	606	303	2485	242.4	303	0	13.86	4,200,/31
	SECL	941	1200	600	4692	480	259	341	4.41	4,145,105
	SAHIWAL	1230	1242	660	4856	496.8	12	570	23.29	28,644,732
	TEL	290	300	110	1146	120	10	180	5.18	1,503,505
	THAL NOVA	290	300	110	1146	120	10	180	5.19	1,505,100
	HUB CHINA	275	625	270	1950	250	350	5	22.85	6,284,713
	AESLALP	185	350	175	1141	140	165	10	43.34	8,017,695
	AESPKGN	335	350	170	991	140	15	165	37.63	12,607,547
	SABA	110	120	25	396	48	10	85	44.41	4,885,315
	Sub Total	13843	15511	9010.6	70738	6721	1667.5	4832.4		
	QAD-SOLAR	50	100	0					32.46	1,622,920
Solar	APPO Solar	70	100	0					47.15	3,300,374
	CREST ENE	50	100	0					50.29	2 51/ 3/5
	CREDT ENE	50	100	-					50.25	2,514,545
	BESTGREEN	70	100	0					50.02	3,501,449
	ATLAS SOLAR	75	100	0					14.62	1,096,500
	Sub Total	315	500	0						-
	HAWA	38	50	15.9					38.68	1,482,532
	MASTER	38	50	15.9					44.46	1,704,305
	ZEPHYR	37	50	15.9					35.74	1,314,160
	G AHMD	38	50	0.3					44.46	1,704,305
	ARTISTIC	38	50	0.3					21.37	819,310
	ACT2	38	50	0.3					13.96	535,065
	DIN-E	38	50	0.3					14.12	541,298
	LIBERTY1	38	50	0.3					11.82	453,259
	LIBERTYZ	35	50	0.3					11.82	416,258
	NASDA	20	50	0.3					14.33	502,510
	LAKESIDE	20	50	0.3					13.60	542,236
	METRO-2	20	50	0.3					26 77	1,629,727
	MASTER GR	43	50	0.3					14.47	531.9/2
	FFCEL	36	50	0.3					11.76	423.209
	METRO	20	50						26.70	4 333 300
		36	50	0					36.77	1,323,290
		21	00	0.3					33.29	705,025
									34.39	2,232,793
	OEPL ARTISTIC	55	55	15.0					31.37	753 437
Wind	ARTISTIC	35	50	15.9					21.37	752,427
Wind	ARTISTIC GULAHMAD	35	50	15.9 10					21.37	752,427 509,802
Wind	GULAHMAD YUNUS	35	50 50 50	15.9 10 15.9					21.37 13.87 38.56	752,427 509,802 1,508,178


TGF	32	50	10					45.98	1,474,675
FWEL-I	28	50	0					42.05	1,184,317
FWEL-II	32	50	0					41.73	1,338,429
TENAGA	28	50	15.9					47.07	1,325,642
DAWOOD	39	50	15.9					50.23	1,768,121
SACHAL	32	50	0					50.23	1,610,953
JPLL	38	50	0					50.23	1,925,288
TGS	34	50	0					39.37	1,324,342
TGT	37	50	0					39.37	1,447,538
TRICON 1	38	50	10					39.64	1,488,277
TRICON 2	38	50	10					39.64	1,488,277
TRICON 3	38	50	10					39.64	1,488,277
NOORIABAD	8	12	6					39.64	310,058
TRICOM	39	50	0					39.64	1,395,260
ZORLU	34	57	0					18.32	616,219
Sub Total	1331	1852	170.9						
Total	27214	30354	17416	133006	9111	2202.8	7170.1		352,732,674

## Summer Peak (Case B): fast-ramping power plants

Diant Tuna	Dowor Diant	Bron	Denay	Desin	Maria	Droop	Reserve	Reserve	Cost	Operating Cost
Plant Type	Power Plant	Pgen	Pmax	Pmin	IVIW.S	(MW/Hz)	(+ve)	(-ve)	(Rs/kWh)	(Rs/kWh)
	MANGLA	470	500	200	2245	250	30	270	0.067	31,490
	Ghazi Barotha	1350	1450	1190	7250	725	100	160	0.079	106,650
	Turbela	3380	3430	2430	10009	875	50	950	0.043	145,340
	Turbela 4 Extension	1410	1410	1410	7343	0	0	0	0.134	188,940
	WARSAK	155	202	25	724	101	47	130	0.107	10,585
	MLKND	70	82	40.5	286	41	12	29	0.316	22,117
	DARAL KHWAR	30	32	20	160	10	2	10	0.316	9,480
	GOLEN	30	108	20	216	54	78	10	0.344	10,320
Hydro	ALLAI	70	122	60	276	61	52	10	0.215	15,050
	DBR-KWR	120	130	70	455	65	10	50	0.215	25,800
	KHNKHR	10	72	10	252	36	62	0	0.211	2,110
	PATRIND	124	150	67.5	750	75	26	57	0.175	21,755
	NBONGSC	37	84	29.6	87	42	47	7	0.4804	17,775
	GULPUR	80	100	10	200	50	20	70	0.194	15,520
	CHASMA	114	114	18	570	0	0	96	0.191	21,774
	KAROT	720	720	232	3362	0	0	488	0.191	137,520
	Sub Total	8170	8706	5833	40844	2391	535	2338		
	JABBAN	22	22	12	30				0.275	6,050
	DARGAI	13	15	5	29				0.088	1,144
	PEHUR	10	28	5	38				0.634	6,340
	GML-ZAM	9	17	5	39				0.634	5,706
	KRM.GRHI	5	5	0	3				0.255	1,275
	JAGRAN	24	33	5	59				2.59	62,160
Small Hydro	MARALA SH	7	8	4	15				2.59	19,100
Smanriyaro	SHADIWL	8	14	8	20				0.178	1,424
	NANDPR	6	14	6	18				0.132	792
	RENALA	1	1	1	1				0.342	342
	SHISHI	2	2	1	2				0.342	513
	RESHUN	4	4	2	4				0.342	1,308
	JINNAH	39	96	24	249				0.267	10,424
	Sub Total	150	258	77	512					
	MDI	24	26	10	73				9.0525	217,260
Bagass	CHINIOTPP	27	62	20	51				10.3447	279,309
	FATIMA	32	00	25	294				10.3447	331,030
	AL MOIZ	17	30	10	135				10.1849	173,143
	Sub Total	100	184	65	552					-
	K2 UNT	1032	1040	730	5595				0.95	980,400
Nuclear	K3 UNT	1032	1040	730	5595				0.95	980,400
TENCICUI.	CHACHNIER	1241	1262	900	9170				1 016	1 260 956



	Sub Total	3305	3343	2260	20360					-
	ATLAS	80	180	75	304	90	100	5	35.472	2,837,760
	NSHTCHN	70	195	68	345	97.5	125	2	41.9217	2,934,519
	NISHT-PWR	189	195	68	345	97.5	6	121	11.3961	2,153,863
	AGL-IPP	145	150	68	281	78	11	77	30.0300	5,312,307
	K.E.L	50	124	44	149	62	74	6	41.39062	2,069,531
	LIBERTY Tech	80	188	69	333	94	108	11	42.909	3,432,720
	LIBERTY Power	185	194	90	889	90	9	95	5.5100	1,020,571
	HUBCO Narowal	90	190	77	321	95	100	13	40.5719	3,651,471
	FNDTION	152	100	63	1109	76.85	13.5	89	9.42848	1,433,129
	UCH 1 BOUSH	490	500	477	2611	233	10	12.8	3.10242	1,520,186
	KOUSH	220	412	200	2438	192.8	192	20	30.40012	0,701,220
	GUDDU	300	340	200	2296	150	340	34.2	10 0236	3,207,552
	GUD-CCPP	460	480	340	3259	240	20	120	11.9822	5,511,812
	BALLOKI	1060	1098	730	5968	512.2	38	330	22.56132	23,914,999
	BHIIKI	995	1025	720	5581	315.2	30	275	22.34304	22,231,325
	HBS	1020	1050	750	5706	490	30	270	22.34304	22,789,901
	TRIMMU	1080	1105	840	3441	515	25	240	22.16175	23,934,690
Thermal	UCH2	364	372	298	2397	124	8	00.4	13.41767	4,884,032
	OBJENT	103	175	119	837	82	12	44	28.19005	4,590,054
	SAIF	1/3	204	120	975	95.2	40		28.00632	5,461,232
	SAPHIRE	195	190	120	9/13	89.2	10	59	27.71	4,988.302
	ENGRO Power	120	130	40	034	05	10	80	9.86	1,183,648
	NANDPR	450	474	315	4006	225.6	24	135	28.03	12,614,985
	PRT CFPP	378	450	330	1030	180	72	48	22.84	8,632,688
	LUCKY	580	606	303	2485	242.4	26	277	13.86	8,041,004
	SECL	1180	1200	600	4692	480	20	580	4.41	5,197,900
	SAHIWAL	1230	1242	660	4850	496.8	12	570	23.29	28,644,732
	TEL	290	300	110	1140	120	10	180	5.18	1,503,505
		290	300	110	1140	120	10	180	5.19	1,505,100
	AESLALP	185	350	175	1950	140	105	330	43.34	8.017.695
	AESPKGN	202	350	170	991	140	148	32	37.63	7,602,163
	HUBCO CCFP	240	1200	240	3390	480	960	0	40.57	9,737,250
	SABA	35	120	25	396	48	85	10	44.41	1,554,418
	Sub Total	13843	16711	9251	74134	7201	2868	4592		
	QAD-SOLAR	50	100	0					32.46	1,622,920
	APPO Solar	70	100	0					47.15	3,300,374
	CREST ENE	50	100	0					50.29	2,514,345
Solar	DECTORED:		100	-					30.23	
	BESTGREEN	70	100	0					50.02	3,501,449
	ATLAS SOLAR	75	100	0					14.62	1,096,500
	SUD TOTAL	315	500	0						
	MASTER	38	50	10					38.68	1,482,532
	ZEPHYR	30	50	10					35.74	1.314,160
	G AHMD	38	50	0					44.40	1,704,305
	ARTISTIC	38	50	0					21.37	819,310
	ACT2	38	50	0					13.90	535,065
	DIN-E	38	50	0					14.12	541,298
	LIBERTY2	38	50	0					11.82	453,259
	INDUS	39	50	0					14.39	562,916
	NASDA	39	50	0					13.80	542,296
	LAKESIDE	38	50	0					13.83	519,320
	METRO-2	45	58	0					36.77	1,639,727
	MASTER GR	37	50	0					14.47	531,943
	FFLEL	30	50	0					11.76	423,209
	METRO	30	50	0					36.77	1,323,290
	LIEPI	21	30	0					33.29	703,025
	ARTISTIC	35		10					21.37	752,427
Wind	GULAHMAD	37	50	10					13.87	509,802
	YUNUS	39	50	10					38.50	1,508,178
	SAPHIRE	38	50	0					48.55	1,860,953
	TGF	32	50	10					45.98	1,474,675
	FWEL-I	28	50	0					42.05	1,184,317
	FWEL-II	32	50	0					41.73	1,338,429
	TENAGA	28	50	16					47.07	1,325,642
	SACHAL	35	50	16					50.23	1,768,121
	IPLI	32	50	0					50.23	1,010,933
	TGS	30	50	0					39.37	1,324,342
	TGT	37	50	0					39.37	1,447,538
	TRICON 1	38	50	10					39.64	1,488,277
	TRICON 2	38	50	10					39.64	1,488,277
	TRICON 3	38	50	10					39.64	1,488,277
	NOORIABAD	8	12	6					39.64	310,058
	TRICOM	35	50	0					39.64	1,395,260
	ZORLU Fulb Taba	34	57	0					18.32	616,219
	SUD TOTAL	1331	1852	1/1						
	Total	27214	31554	17656	136402	9591	3403	6930		335 862 377



## Summer Off Peak (Case A): baseload coal-fired power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (-ve)	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	MANGLA	420	570	170	2559	285	150	250	0.07	28,140
	Ghazi Barotha	1116	1450	1100	5078	725	334	16	0.08	88,175
	Turbela	3470	3478	2478	16892	1739	8	992	0.04	149,210
	Turbela 4 Extension	470	470	470	2201	101	47	130	0.13	62,980
	MLKND	70	82	41	286	41	12	29	0.32	22,117
	DARAL KHWAR	30	32	20	160	10	2	10	0.32	9,480
	GOLEN	30	108	20	216	54	78	10	0.34	10,320
Hydro	ALLAI	80	122	80	276	61	42	0	0.22	17,200
	DBR-KWR KHNKHR	110	130	/0	433	20	62	40	0.22	23,050
	PATRIND	124	150	68	750	75	26	50	0.18	21,698
	NBONGSC	37	84	30	87	42	47	7	0.48	17,775
	GULPUR	80	100	10	200	50	20	70	0.19	15,520
	CHASMA	114	114	18	570	0	0	96	0.19	21,774
	Sub Total	6936	7884	4841	34127	3650	947	2006	0.19	118,420
	JABBAN	22	7004	12	30	5050	547	2050	0.28	6.050
	DARGAI	13	15	5	29				0.09	1,144
	PEHUR	5	28	5	38				0.63	3,170
	GML-ZAM	9	17	5	39				0.63	5,706
	KRM.GRHI	5	5	0	3				0.26	1,275
Small Hydro	JAGRAN MARALA SH	24	33	3	59				2.59	02,100
Sman Hyuro	NANDPR	0	14	6	18				0.13	792
	RENALA	1	1	1	1				0.34	342
	SHISHI	2	2	1	2				0.34	513
	RESHUN	4	4	2	4				0.34	1,368
	Sub Total	127	245	60	49				0.27	10,424
	JUD TOTAL	157	243	10	432				9.05	217 260
D	CHINIOTPP	27	62	20	51				10.34	279,307
Bagass	FATIMA	32	00	25	294				10.34	331,030
	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	100	184	65	552					
	K2 UNT	1032	1040	730	5595				0.95	980,400
Nuclear	K3 UNT	1032	1040	730	5595				0.95	980,400
	CHASHNUP	926	947	600	7078				1.02	940,816
		2990	3027	2060	18209	97.5		37	41.97	4 401 779
	NISHT-PWR	180	195	08	345.15	97.5	13	112	11.40	2.051.298
	AGL-IPP	140	150	68	280.8	78	10	72	30.04	5,129,124
	K.E.L	44	124	44	148.8	62	80	0 0	41.39	1,821,187
	Liberty Tech	69	188	69	332.76	94	119		42.91	2,960,721
	LIBERTY Power	194	194	90	888.64	0	0	104	5.52	1,070,220
	UCH 1	500	500	477.2	2011	0.83	0	23	3.43	1,551,210
	KAPCO	410	430	124.8	3010	135	14	291	30.46	12,671,410
	GUDDU	290	300	210	2163	50	10	80	10.02	2,906,844
	GUD-CCPP	480	480	340	3259.2	0	0	140	11.98	5,751,450
	BALLOKI	1060	1098	730	5968.22	512.2	38	3 330	22.50	23,914,999
	TRIMMU	1020	1000	840	3988.05	515	25	240	22.10	23,934,690
Thermal	UCH2	300	372	297.6	2396.92	173.6	12	2 62	13.42	4,830,361
	HALMOR	150	175	119	830.5	82	23	31	28.20	4,229,498
	SAPHIRE	125	130	60	621.4	65	3	5 59	27.71	3,464,140
	ENGRO Power	120	130	40	653.9	65	10	80	9.80	1,183,648
	PRT CFPP	660	900	240	3272.4	360	240		28.03	15.072.948
	LUCKY	303	606	303	2484.6	242.4	303	s C	13.86	4,200,731
	SECL	1000	1200	600	4692	0	134	400	4.41	4,695,730
	SAHIWAL	1170	1242	660	4856.22	496.8	72	2 510	23.29	27,247,428
	THAL NOVA	300	300	110	1146.39	0	0	190	5.18	1,555,350
	HUB CHINA	270	025	270	1140.39	250	355	190	22.85	6,170,445
	AESLALP	175	350	175	1141	140	175	s c	43.34	7,584,300
	AESPKGN	170	350	170	990.5	140	180	0 0	37.63	6,397,860
	Sub Total	11257	13215	7771	59259	4223	1958	3486		
	QAD-SOLAR	20	100	0					32.46	649,168
Salaa	CREST ENE	20	100	0					50.29	1,005,738
Solar	ATLAS SOLAR	33	100	0					14.67	1,750,725
	Sub Total	150	400	0						2,000,200
	HAWA	27	50	10					38.68	1,045,816
	MASTER	23	50	10					44.46	1,022,640
	ZEPHYR	20	50	10					35.74	714 866



	G AHMD	27	50	0					44.46	1,202,260
	ARTISTIC	27	50	0					21.37	577,962
	ACT2	27	50	0					13.96	377,449
	DIN-E	27	50	0					14.12	381,845
	LIBERTY1	27	50	0					11.82	319,740
	LIBERTY2	25	50	0					11.82	293,639
	INDUS	23	50	0					14.39	331,014
	NASDA	20	50	0					13.86	277,294
	LAKESIDE	26	50	0					13.83	366,342
	METRO-2	31	58	0					36.77	1,156,708
	MASTER GR	26	50	0					14.47	375,246
	FFCEL	20	50	0					11.76	235,218
	METRO	20	50	0					36.77	735,480
	TAPAL	15	30	0					33.29	495,931
	UEPL	35	99	0					34.39	1,203,601
Wind	ARTISTIC	25	50	10					21.37	530,782
wind	GULAHMAD	20	50	10					13.87	277,318
	YUNUS	23	50	16					38.56	886,859
	SAPHIRE	23	50	0					48.55	1,110,034
	TGF	23	50	10					45.98	1,040,273
	FWEL-I	20	50	0					42.05	835,449
	FWEL-II	23	50	0					41.73	944,161
	TENAGA	20	50	10					47.07	935,142
	DAWOOD	25	50	10					50.23	1,247,279
	SACHAL	25	50	0					50.23	1,255,693
	JPLL	30	50	0					50.23	1,506,831
	TGS	27	50	0					39.37	1,063,017
	TGT	30	50	0					39.37	1,181,130
	TRICON 1	32	50	10					39.64	1,268,342
	TRICON 2	32	50	10					39.64	1,268,342
	TRICON 3	27	50	10					39.64	1,071,741
	NOORIABAD	8	12	0					39.64	310,058
	TRICOM	25	50	0					39.64	984,254
	ZORLU	17	57	0					18.32	311,430
	Sub Total	900	1852	171						
	Total	22470	26807	14976	112699	7873	2905	5582		248,828,452

### Summer Off Peak (Case B): fast-ramping power plants

Diant Tune	Danie Diant	Dava	Denser	Denta		Droop	Reserve	Reserve	Cost	Operating Cost
Plant Type	Power Plant	Pgen	Pmax	Pmin	IVIW.S	(MW/Hz)	(+ve)	(-ve)	(Rs/kWh)	(Rs/kWh)
	MANGLA	420	570	170	2559	285	150	250	0.067	28,140
	Ghazi Barotha	1116	1450	1100	5078	725	334	16	0.079	88,175
	Turbela	3470	3478	2478	16892	1739	8	992	0.043	149,210
	Turbela 4 Extension	470	470	470	2261	0	0	0	0.134	62,980
	WARSAK	155	202	25	724	101	47	130	0.107	16,585
	MLKND	70	82	41	286	41	12	29	0.316	22,117
	DARAL KHWAR	30	32	20	160	16	2	10	0.316	9,480
	GOLEN	30	108	20	216	54	78	10	0.344	10,320
Under	ALLAI	80	122	80	276	61	42	0	0.215	17,200
nyaro	DBR-KWR	130	130	70	455	0	0	60	0.215	27,950
	KHNKHR	10	72	10	252	36	62	0	0.211	2,110
	PATRIND	104	150	68	750	75	46	37	0.175	18,200
	NBONGSC	37	84	30	87	42	47	7	0.480	17,775
	GULPUR	80	100	10	200	50	20	70	0.194	15,520
	CHASMA	114	114	18	570	0	0	96	0.191	21,774
	KAROT	620	720	232	3362	360	100	388	0.191	118,420
	Sub Total	6936	7884	4841	34127	3585	947	2096		
	JABBAN	22	22	12	36				0.275	6,050
	DARGAI	13	15	5	29				0.088	1,144
	PEHUR	5	28	5	38				0.634	3,170
	GML-ZAM	9	17	5	39				0.634	5,706
	KRM.GRHI	5	5	0	3				0.255	1,275
	JAGRAN	24	33	5	59				2.590	62,160
Small Hydro	MARALA SH	7	8	4	15				2.590	19,166
	NANDPR	6	14	6	18				0.132	792
	RENALA	1	1	1	1				0.342	342
	SHISHI	2	2	1	2				0.342	513
	RESHUN	4	4	2	4				0.342	1,368
	JINNAH	39	96	24	249				0.267	10,424
	Sub Total	137	245	69	492					
	JDW	24	26	10	73				9.053	217,260
	CHINIOTPP	27	62	20	51				10.345	279,307
Bagass	FATIMA	32	66	25	294				10.345	331,030
	AL MOIZ	17	30	10	135				10.185	173,143
	Sub Total	100	184	65	552					
	K2 UNT	1032	1040	730	5595				0.950	980,400



Nuclear	K3 UNT	1032	1040	730	5595				0.950	980,400
Nuclear	CHASHNUP	926	947	600	7078				1.016	940,816
	Sub Total	2990	3027	2060	18269					
	NSHTCHN	105	195	68	345.15	97.5	90	37	41.922	4,401,779
	NISHT-PWK	180	195	68	345.15	97.5	15	112	26 627	2,051,298
	K.E.L	44	130	44	148.8	62	80	0	41.391	1.821.187
	LIBERTY Tech	69	188	69	332.76	94	0	98	42.909	2,960,721
	LIBERTY Power	194	194	90	888.64	0	0	95	5.517	1,070,220
	FNDTION	156	165.5	63	1109.489	76.85	10	93	9.428	1,470,843
	UCH 1	500	500	477.2	2611	0	0	23	3.102	1,551,210
	KAPCO	416	430	124.8	3010	135	14	291	30.460	12,6/1,410
	GUD-CCPP	480	480	340	3259.2	30	10	140	11.982	5.751.456
	BALLOKI	750	1098	730	5968.22	512.2	348	20	22.561	16,920,990
	HBS	780	1050	750	5706.4	490	270	30	22.34	17,427,571
	TRIMMU	860	1105	840	3988.65	515	245	20	22.16	19,059,105
Thermal	UCH2	360	372	297.6	2396.92	173.6	12	62	13.42	4,830,361
	HALMOR	150	175	119	836.5	82	25	31	28.20	4,229,498
	SAPHIKE ENGRO power	125	130	66	621.4	20	5	55	27.71	3,464,140
	NANDPR	354	354	248	2914.02	0	10	106	28.03	9,923,788
	PRT CFPP	728	900	660	3272.4	360	172	68	22.84	16,625,918
	LUCKY	580	606	303	2484.6	242.4	26	277	13.86	8,041,004
	SECL	1180	1200	600	4692	0	20	580	4.41	5,197,900
	SAHIWAL	911	1242	660	4856.22	496.8	331	251	23.29	21,215,732
	TEL	300	300	110	1146.39	0	0	190	5.18	1,555,350
	THAL NOVA	300	300	110	1146.39	0	0	190	5.19	1,557,000
	HUBCO CEDD	240	1200	2/0	1950 6473	250	25	330	22.85	9 737 256
	AFSLALP	175	350	175	1141	140	175	0	43.34	7,584,306
	AESPKGN	170	350	170	990.5	140	180	0	37.63	6,397,860
	Sub Total	11257	14415	8011	65732	4703	3039	3335		-,,
	QAD-SOLAR	20	1242	660	4856.22	496.8			32.46	649,168
	CREST ENE	20	300	110	1146.39	0			50.29	1,005,738
Solar	BESTGREEN	35	300	110	1146.39	0			50.02	1,750,725
	ATLAS SOLAR	75	625	270	1950	250			14.62	1,096,500
	Sub Total	150	2467	1150						
	HAWA	27	50	16					38.68	1,045,816
	MASTER	23	50	16					44.46	1,022,640
	C AHMD	20	50	16					35.74	1 202 260
	ARTISTIC	27	50	0					21.37	577.962
	ACT2	27	50	0					13.96	377,449
	DIN-E	27	50	0					14.12	381,845
	LIBERTY1	27	50	0					11.82	319,740
	LIBERTY2	25	50	0					11.82	293,639
	INDUS	23	50	0					14.39	331,014
	LAKESIDE	20	50	0					13.00	366 3/2
	METRO-2	31	58	0					36.77	1,156,708
	MASTER GR	26	50	0					14.47	375,246
	FFCEL	20	50	0					11.76	235,218
	METRO	20	50	0					36.77	735,480
	TAPAL	15	30	0					33.29	495,931
	UEPL APTISTIC	35	99	0					34.39	1,203,601
Wind	GULAHMAD	23	50	10					13.87	277.318
	YUNUS	23	50	16					38.56	886,859
	SAPHIRE	23	50	0					48.55	1,116,634
	TGF	23	50	10					45.98	1,040,273
	FWEL-I	20	50	0					42.05	835,449
	FWEL-II	23	50	0					41.73	944,161
	TENAGA	20	50	16					47.07	935,142
	SACHAL	25	50	10					50.23	1,247,275
	JPLL	30	50	0					50.23	1,506,831
	TGS	27	50	0					39.37	1,063,017
	TGT	30	50	0					39.37	1,181,130
	TRICON 1	32	50	10					39.64	1,268,342
	TRICON 2	32	50	10					39.64	1,268,342
	INCORIABAD	27	50	10					39.64	1,071,741
	TRICOM	20	12	6					39.64	984 254
	ZORLU	17	57	0					18.32	311,430
	Sub Total	900	1852	171					20.02	
	Tabal	22470	20074	16266	110173	0.200	2006	E420		249 720 059



## Winter Peak (Case A): baseload coal-fired power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (- ve)	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	Ghazi Barotha	526	580	460	2,031	290	54	66	0.08	41,583
	Turbela	500	650	375	3,268	325	150	125	0.04	21,500
	DARAL KHWAR	23	68	20	340	- 3/	- 38	10	0.32	9,180
	GOLEN	20	50	20	100	25	30		0.32	6.880
	ALLAI	40	40	40	90			-	0.22	8,600
Under	DBR-KWR	70	70	70	245	-	-	-	0.22	15,050
Hydro	KHNKHR	10	10	10	35	-	-	-	0.21	2,110
	PATRIND	69	69	68	345	-		2	0.18	12,075
	NBONGSC	37	37	30	38	-	-	7	0.48	17,775
	CHASMA	58	58	10	290	-	•	10	0.15	5,000
	KAROT	160	180	58	841	90	- 20	102	0.19	30,560
	Sub Total	1 564	1.855	1 192	7 745	764	292	372		50,500
	JABBAN	11	11	6	18				0.28	3,025
	PEHUR	5	5	5	7				0.63	3,170
	GML-ZAM	9	9	5	20				0.63	5,706
	KRM.GRHI	5	5	0	3				0.26	1,275
Small Hydro	JAGRAN	10	10	5	18				2.59	25,900
Sinan nyaro	MAKALA SH	/	14	4	-				2.59	19,166
	JINNAH	39	39	24	101				0.13	10.424
	SHISHI	2	2	1	3				0.34	513
	Sub Total	94	102	56	185					
	JDW	24	26	10	73				9.05	217,260
Pagare	CHINIOTPP	27	62	20	51				10.34	279,307
Dagass	FATIMA	25	32	32	142				10.34	258,618
	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	93	150	72	401					
	K2 UNT	1,032	1,032	730	5,552				0.95	980,400
Nuclear	K3 UNT	1,032	1,032	/30	5,552				0.95	980,400
	CHASHNUP	1,241	1,241	800	9,004				1.02	1,260,856
	AGLIDD	3,303	3,303	2,200	20,100	70	6	92	26.64	5 495 490
		150	212	75	201	/0	0	129	30.04	7 555 526
	NSHTCHN	117	195	68	345	- 98	- 78	49	41.92	4.904.839
	K.E.L	114	124	44	149	62	10	70	41.39	4,718,531
	NISHT-PWR	190	195	68	345	98	5	122	11.40	2,165,259
	LIBERTY Tech	178	195	69	345	78	17	109	42.91	7,637,802
	HUBCO narowal	159	212	77	358	106	53	82	40.57	6,450,932
	FNDTION CORP.	1/0	186	63	1,24/	8/	16	10/	9.43	1,602,842
	GOD-CCPP	480	480	340	3,255	-	-	73	3.10	5,751,456
	Engro Power	110	110	89	553			21	9.86	1.085.010
Thermal	Engro Thar	602	602	300	2,095	-	-	302	5.13	3,090,608
	BALLOKI	1,135	1,189	730	6,463	555	54	405	22.56	25,607,098
	TRIMMU	1,141	1,200	840	3,739	559	59	301	22.16	25,286,557
	UCH2	372	372	298	2,397	-	-	74	13.42	4,991,373
	HBS	1,155	1,189	/50	6,465	555	34	405	22.34	25,806,211
	SECI	850	1 230	600	1,150		380	250	5.10 A A1	3 744 250
	LUCKY	303	606	303	2,485	242	303	-	13.86	4,200,731
	THAL NOVA	300	300	110	1,146	-	-	190	5.19	1,557,000
	Hub China	275	625	275	3	1,950	0	250	22.85	6,284,713
	SAHIWAL	1,240	1,242	660	4,856	497	2	580	23.29	28,877,616
	Sub Total	10,105	11,472	6,414	45,744	5,455	1,017	3,941		
Solar	-									
	HAWA	27	50	16					38.68	1,045,816
	TENAGA	20	50	16					47.07	935,142
	ZEDHVR	25	50	16					35.74	927.042
	SACHAL	32	50	-					50.23	1.610.953
	JPLL	38	50	-					50.23	1,925,288
	TGS	34	50	-					39.37	1,324,342
Wind	TGT	37	50	-					39.37	1,447,538
	ACT2	27	50	0					13.96	377,449
	DIN-E	27	50	0					14.12	381,845
		27	50	0					11.82	319,740
	NASDA	25	50	0					13.86	382,549
	LAKESIDE	26	50	0					13.83	366,342
	MASTER GR	26	50	0					14.47	375,246
	NOORIABAD	8	12	6					39.64	310,058
	Sub Total	432	760	72						
	Total	15,593	17,644	10,065	74,183	6,219	1,309	4,313		197,758,886



# Winter Peak (Case B): fast-ramping power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (-ve)	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	Ghazi Barotha	526	580	460	2031	290	54	66	0.08	41,583
	Turbela	500	650	375	3268	325	150	125	0.04	21,500
	DARAL KHWAR	23	23 68	20	340	34	28	10	0.32	9,480
	GOLEN	20	50	20	100	25	30	10	0.32	6.880
	ALLAI	40	40	40	90	0	0	0	0.22	8,600
Unidea	DBR-KWR	70	70	70	245	0	0	0	0.22	15,050
Hydro	KHNKHR	10	10	10	35	0	0	0	0.21	2,110
	PATRIND	69	69	68	345	0	0	2	0.18	12,075
	NBONGSC	37	3/	30	38	0	0	10	0.48	1/,//5
	CHASMA	20	20	10	290	0	0	10	0.15	3,000
	KAROT	160	180	58	841	90	20	102	0.19	30,560
	Sub Total	1564	1855	1192	7745	764	292	372		
	JABBAN	11	11	6	18				0.28	3,025
	PEHUR	5	5	5	7				0.63	3,170
	GML-ZAM	9	9	5	20				0.63	5,706
	KRM.GRHI	5	5	0	3				0.26	1,275
Small Hydro	JAGRAN	10	10	5	18				2.59	25,900
	NANDR	5	14	4	15				2.55	13,100
	JINNAH	39	39	24	101				0.13	10,424
	SHISHI	2	2	1	3				0.34	513
	Sub Total	94	102	56	185					
	JDW	24	26	10	73				9.05	217,260
Bagass	CHINIOTPP	27	62	20	51				10.34	279,307
208033	FATIMA	25	32	32	142				10.34	258,618
	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	93	150	72	401					
	K2 UNT	1032	1032	730	5552				0.95	980,400
Nuclear	CHASHNUP	1052	1052	800	9004				1.02	1.260.856
	Sub Total	3305	3305	2260	20108					2,200,000
	AGL-IPP	150	156	68	1059	78	6	82	36.64	5,495,490
	ATLAS	213	213	75	277	0	0	138	35.47	7,555,536
	NSHTCHN	117	195	68	1324	98	78	49	41.92	4,904,839
	K.E.L	114	124	44	149	62	10	70	41.39	4,718,531
	NISHT-PWR	190	195	68	1324	98	5	122	11.40	2,165,259
	LIBERTY tech	178	195	69	891	78	17	109	42.91	7,637,802
	FNDTION	159	212	63	1439	106	53	82	40.57	6,450,932
	GUD-CCPP	480	480	340	3259	0	0	140	11.98	5,751,456
	UCH 1	594	597	477	3124	298	3	117	3.10	1,842,837
	ENGRO power	712	712	389	2642	0	0	323	9.86	7,022,976
	BALLOKI	1070	1189	730	6463	555	119	340	22.56	24,140,612
	TRIMMU	1147	1200	840	6036	559	53	307	22.16	25,419,527
	UCH2	372	372	298	2397	0	0	74	13.42	4,991,373
	TEI	301	301	110	1150	0	33	404	5.18	25,765,666
	SECL	1178	1230	600	4809	492	52	578	4.41	5.189.090
	LUCKY	606	606	303	1830	0	0	303	13.86	8,401,463
	THAL NOVA	300	300	110	945	0	0	190	5.19	1,557,000
	HUBCO CCFP	240	1200	240	3656	480	960	0	40.57	9,737,256
	SAHIWAL	660	660	330	4856	0	0	330	23.29	15,370,344
	sub lotal	10105	11511	6049	55816	3544	1406	4056		
Solar										
	HAWA	27	50	16			<u> </u>		38.68	1,045,816
	DAWOOD	20	50	16			<u> </u>		4/.0/	1 247 279
	ZEPHYR	25	50	16					35.74	927.042
	SACHAL	32	50	0					50.23	1,610,953
	JPLL	38	50	0					50.23	1,925,288
	TGS	34	50	0					39.37	1,324,342
Wind	IGT	37	50	0					39.37	1,447,538
	ALIZ DIN E	27	50	0			<u> </u>		13.96	377,449
	LIRERTY1	27	50	0					14.12	381,845
	LIBERTY2	25	50	0					11.82	293,639
	NASDA	28	50	0					13.86	382,549
	LAKESIDE	26	50	0					13.83	366,342
	MASTER GR	26	50	0					14.47	375,246
	NOORIABAD	8	12	6					39.64	310,058
	Sub Total	432	760	72						
	Total	15593	17683	9700	84255	4308	1698	4428		194,977,734



## Winter Off Peak (Case A): baseload coal-fired power plants

						Droop	Reserve	Reserve (-	Cost	Operating Cost
Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	(MW/Hz)	(+ve)	ve)	(Rs/kWh)	(Rs/kWh)
	Turbela	210	390	210	1872	195	180	0	0.04	9,030
	MLKND	23	23	14	82	0	0	10	0.32	7,372
	DARAL KHWAR	15	15	10	75	0	0	5	0.32	4,740
Hydro	GULPUR	20	20	10	40	0	0	10	0.19	3,880
	CHASMA	58	58	18	290	0	0	40	0.19	11,078
	KAROT	160	180	58	841	90	20	102	0.19	30,560
	Sub Total	486	686	320	3199	285	200	167		
	JABBAN	11	11	6	18				0.28	3,025
	JAGRAN	10	10	5	18				2.59	25,900
	MARALA SH	7	7	4	13				2.59	19,166
Small Hudro	RESHUN	3	4	2	7				0.34	1,026
Sman nyuro	RENALA	1	1	1	1				0.34	342
	JINNAH	34	34	21	89				0.27	9,185
	SHISHI	2	2	1	3				0.34	513
	Sub Total	68	69	39	150					
	JDW	24	26	10	73				9.05	217,260
Bagass	CHINIOTPP	27	27	20	22				10.34	279,307
Dagass	FATIMA	32	32	25	142				10.34	331,030
	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	100	115	65	372					
	K2 UNT	745	1040	730	5595				0.95	707,750
Nuclear	K3 UNT	745	1040	730	5595				0.95	707,750
	CHASHNUP	1000	1263	800	9170				1.02	1,016,000
	Sub Total	2490	3343	2260	20360					
	FNDTION	80	170	63	1140	80	90	17	9.43	754,278
	GUD-CCPP	150	240	170	1630	120	90	0	11.98	1,797,330
	UCH 1	148	190	171	992	89	42	0	3.10	459,158
	Engro Power	100	110	89	553	55	10	11	9.86	986,373
	ENGRO Thar	590	602	300	2095	241	12	290	5.13	3,029,001
	BALLOKI	900	1189	730	6463	555	289	170	22.56	20,305,188
Thermal	TRIMMU	907	1200	484	3739	559	293	423	22.16	20,100,707
	UCH2	368	372	298	2461	50	4	70	13.42	4,937,703
	TEL	300	301	110	1150	120	1	190	5.18	1,555,350
	SECL	800	1250	600	4888	500	450	200	4.41	3,524,000
	LUCKY	303	606	303	2485	242	303	0	13.86	4,200,731
	THAL NOVA	300	300	110	1146	0	0	190	5.19	1,557,000
	Sub Total	4946	6530	3428	28742	2610	1584	1561		
Solar										
	HAWA	20	50	16					38.68	773,538
	ZEPHYR	20	50	16					35.74	714,866
	DIN-E	10	50	0					14.12	141,216
	LIBERTY1	10	50	0					11.82	118,248
	LIBERTY2	10	50	0					11.82	118,248
	MASTER GR	10	50	0					14.47	144,681
Wind	DAWOOD	20	50	16					50.23	1,004,554
	SACHAL	20	50	0					50.23	1,004,554
	JPLL	20	50	0					50.23	1,004,554
	TGS	20	50	0					39.37	787,420
	TGT	10	50	0					39.37	393,710
	NOORIABAD	8	12	6					39.64	310,058
	Sub Total	178	561	55						
	Total	8268	11304	6167	52823	2895	1784	1728		73,280,525



## Winter Off Peak (Case B): fast-ramping power plants

Diant Trees	Dames Diant	Dana	0	Dentin		Droop	Reserve	Reserve (-	Cont (Do (b))	Operating Cost
Plant Type	Power Plant	Pgen	Pmax	Pmin	WW.S	(MW/Hz)	(+ve)	ve)	Cost (Rs/KWh)	(Rs/kWh)
	Turbela	210	390	210	1872	195	180	0	0.04	9,030
	MLKND	23	23	14	82	0	0	10	0.32	7,372
	DARAL KHWAR	15	15	10	75	0	0	5	0.32	4,740
Hydro	GULPUR	20	20	10	40	0	0	10	0.19	3,880
	CHASMA	58	58	18	290	0	0	40	0.19	11,078
	KAROT	160	180	58	841	90	20	102	0.19	30,560
	Sub Total	486	686	320	3199	285	200	167		
	JABBAN	11	11	6	18				0.28	3,025
	JAGRAN	10	10	5	18				2.59	25,900
	MARALA SH	7	7	4	13				2.59	19,166
Small Hydro	RESHUN	3	4	2	7				0.34	1,026
Sman Hyuro	RENALA	1	1	1	1				0.34	342
	JINNAH	34	34	21	89				0.27	9,185
	SHISHI	2	2	1	3				0.34	513
	Sub Total	68	69	39	150					
	JDW	24	26	10	73				9.05	217,260
	CHINIOTPP	27	27	20	22				10.34	279,307
Bagass	FATIMA	32	32	25	142				10.34	331,030
	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	100	115	65	372					
	K2 UNT	745	1040	730	5595				0.95	707,750
No. of Street	K3 UNT	745	1040	730	5595				0.95	707,750
Nuclear	CHASHNUP	1000	1263	800	9170				1.02	1,016,000
	Sub Total	2490	3343	2260	20360					
	FNDTION	170	170	63	1139	85	0	107	9.43	1,602,842
	GUD-CCPP	240	240	170	1630	120	0	70	11.98	2,875,728
	UCH 1	198	198	171	1038	0	0	27	3.10	614,279
	ENGRO power	700	712	389	2642	296	12	311	9.86	6,904,611
	BALLOKI	650	794	484	6463	595	144	166	22.56	14,664,858
	TRIMMU	609	805	484	6036	600	196	125	22.16	13,496,506
Thermal	UCH2	368	372	298	2461	186	4	70	13.42	4,937,703
	TEL	301	301	110	1150	0	0	191	5.18	1,560,535
	SECL	660	660	600	4888	500	0	60	4.41	2,907,300
	LUCKY	570	606	303	1830	242	36	267	13.86	7,902,366
	HUBCO CFPP	180	900	180	3656	360	720	0	40.57	7,302,942
	THAL NOVA	300	300	110	945	0	0	190	5.19	1,557,000
	Sub Total	4946	6058	3363	33879	2984	1112	1583		
Solar										
	HAWA	20	50	16					38.68	773,538
	ZEPHYR	20	50	16					35.74	714,866
	DIN-E	10	50	0					14.12	141,216
	LIBERTY1	10	50	0					11.82	118,248
	LIBERTY2	10	50	0					11.82	118,248
	MASTER GR	10	50	0					14.47	144,681
Wind	DAWOOD	20	50	16					50.23	1,004,554
	SACHAL	20	50	0					50.23	1,004,554
	JPLL	20	50	0					50.23	1,004,554
	TGS	20	50	0					39.37	787,420
	TGT	10	50	0					39.37	393,710
	NOORIABAD	8	12	6					39.64	310,058
	Sub Total	178	561	55						
	Total	8268	10832	6101	57960	3269	1312	1750		76,400,373



### VRE Integrated Cases

## Summer Peak (Case A): baseload coal-fired power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (-ve)	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	MANGLA	470	500	200	2245	250	30	270	0.067	31,490
	Ghazi Barotha	1350	1450	1190	7250	725	100	160	0.079	106,650
	Turbela	3380	3430	2430	16669	875	50	950	0.043	145,340
	Turbela 4 Extension	1410	1410	1410	7343	0	0	0	0.134	188,940
	WARSAK	155	202	25	724	101	47	130	0.107	16,585
	MLKND	70	82	40.5	286	41	12	29	0.316	22,117
		30	32	20	160	16	70	10	0.316	9,480
Hudeo		50	100	20	210	54	/0 52	10	0.344	10,320
Hydro	DBR-KWR	120	122	70	455	65	10	50	0.215	25,800
	KHNKHR	10	72	10	252	36	62	0	0.211	2,110
	PATRIND	124	150	67.5	750	75	26	57	0.175	21,755
	NBONGSC	37	84	29.6	87	42	47	7	0.4804	17,775
	GULPUR	80	100	10	200	50	20	70	0.194	15,520
	CHASMA	114	114	18	570	0	0	96	0.191	21,774
	KAROT	720	720	232	3362	0	0	488	0.191	137,520
	Sub Total	8170	8706	5833	40844	2391	535	2338		-
	JABBAN	22	22	12	36				0.275	6,050
	DARGAI	13	15	5	29				0.088	1,144
	PEHUR	10	28	5	38				0.634	6,340
	GML-ZAM	9	17	5	39				0.634	5,706
	KRM.GRHI	5	5	0	3				0.255	1,275
	JAGRAN	24	33	5	59				2.59	62,160
Small Hydro	MARALA SH	7	8	4	15				2.59	19,166
Sindiriyaro	SHADIWL	8	14	8	20				0.178	1,424
	NANDPR	6	14	6	18				0.132	792
	RENALA	1	1	1	1				0.342	342
		2	2	2					0.342	1 269
	IINNAH	39	96	24	2/19				0.342	10.424
	Sub Total	150	258	77	512				0.207	10,424
	JDW	150	230	10	72				9.0535	217.260
	SUMMOTOR	24	20	10	/3				3.0525	217,200
_	CHINIOTPP	27	62	20	51				10.3447	279,309
Bagass		32	66	25	294				10.3447	331,030
	AL MUIZ	1/	30	10	135				10.1849	1/3,143
	Sub Total	100	184	65	552				0.05	-
	K2 UNT	1032	1040	730	5555				0.95	980,400
Nuclear	CHASHNUD	1052	1040	800	9170				1.016	1 260 856
	Sub Total	2205	22/2	2260	20360				1.010	1,200,050
		3305	3343	2200	20300	00	45	105	25.472	-
	ATLAS	105	180	/5	304	90	15	105	35.472	5,852,880
	NISHT_DWR	189	195	68	345	98	125	127	41.3217	2,554,515
	AGL-IPP	105	155	68	281	78	11	88	36,6366	5,312,307
	K.E.L	115	124	44	149	62	9	80	41.39062	4,759,921
	LIBERTY Tech	175	188	69	333	94	13	106	42.909	7,509,075
	LIBERTY Power	180	194	90	889	90	14	90	5.5166	992,988
	HUBCO narowal	175	190	77	321	95	15	113	40.5719	7,100,083
	FNDTION	148	166	63	1109	77	18	103	9.42848	1,395,415
	UCH 1	491	500	477	2611	165	9	23	3.10242	1,523,288
	KAPCO	615	640	206	4241	187	25	434	30.46012	18,732,974
	GUDDU	418	440	310	3017	216	22	130	10.0236	4,189,865
	GUD-CCPP	460	480	340	3259	240	20	140	11.9822	5,511,812
	BALLOKI	10/0	1098	/30	5968	512	28	368	22.56132	24,140,612
		620	1050	490	5882	309	68	198	22.34304	13,852,685
	TRIMMU	350	1050	750	1051	490	40	900 90	22.34304	7 756 612
Thermal	UCH2	360	305	200	2397	103	13	d5 74	13 41767	A 830 361
	HALMOR	105	115	2.50	550	52	10	29	28,19665	2.960.648
	ORIENT	115	120	73	574	24	5	47	27.20542	3,128,623
	SAIF	123	136	80	650	61	13	56	28.00632	3,444,777
	SAPHIRE	118	125	88	598	57	7	37	27.71312	3,270,148
	ENGRO Power	115	130	40	654	65	15	90	9.86373	1,134,329
	NANDPR	430	474	315	4006	226	44	159	28.0333	12,054,319
	PRT CFPP	330	450	330	1636	180	120	120	22.8378	7,536,474
	LUCKY	303	606	303	2485	242	303	303	13.8638	4,200,731
	SECL	941	1200	600	4692	0	259	600	4.405	4,145,105



	SAHIWAL	700	1242	660	4856	497	542	582	23.2884	16,301,880
	TEL	300	300	110	1146	0	0	190	5.18	1,555,350
	THAL NOVA	300	300	110	1146	0	0	190	5.19	1,557,000
	HUB CHINA	275	625	270	1950	250	350	355	22.85	6,284,713
	AESLALP	175	350	175	1141	140	175	175	43.34	7,584,306
	AESPKGN	342	350	170	991	140	8	180	37.63	12,870,989
	SABA	94	120	25	396	48	26	95	44.41	4,174,723
	Sub Total	11522	12962	7029	62670	5227	2241	EROR	44.44	4,114,123
	Sub Total	11522	13003	7930	03075	5257	2341	2020		
	QAD-SOLAR	50	100	0					32.46	1,622,920
	APPO Solar	70	100	0					47.15	3,300,374
	CREST ENE	50	100	0					50.29	2.514.345
Solar	BESTGREEN	70	100	0					50.02	3,501,449
	ATLAS COLAD	70	100						14.62	1,000,000
	ATLAS SOLAK	/5	100	0					14.62	1,096,500
	INCREASED PENETRATIC	1600	2500						15.00	24,000,000
	Sub Total	1915	3000	0						
	HAWA	38	50	16					38.68	1,482,532
	MASTER	38	50	16					44.46	1,704,305
	ZEPHYR	37	50	16					35.74	1,314,160
	G AHMD	38	50	0					44.46	1,704,305
	ARTISTIC	38	50	0					21.37	819,310
	ACT2	38	50	0					13.96	535,065
	DIN-E	38	50	0					14.12	541,298
	LIBERTY1	38	50	0					11.82	453,259
	LIBERTY2	35	50	0					11.82	416,258
	INDUS	39	50	0					14.39	562,916
	NASDA	39	50	0					13.86	542,296
		20	50	0					13.00	E10 220
	METRO 2	AC	50	0					26 77	1 629 727
	MACTED CD	40	30	0					30.77	1,035,727
	MASTER OR	3/	50	0					14.47	433,300
	FFCEL	30	50	0					11.76	425,205
	METRO	36	50	0					36.77	1,323,290
	TAPAL	21	30	0					33.29	703,025
	UEPL	65	99	0					34.39	2,232,793
	ARTISTIC	35	50	16					21.37	752,427
Wind	GULAHMAD	37	50	10					13.87	509,802
, wina	YUNUS	39	50	16					38.56	1,508,178
	CADUIDE	20	50	10					A9 EE	1 900 902
	TOP	30	50	10					40.00	1,000,000
	EWELL	32	50	10					43.30	1,4/4,0/3
		28	50	0					42.05	1,104,51/
	r WEL-II	32	50	0					41.73	1,338,429
	TENAGA	28	50	16					47.07	1,325,642
	DAWOOD	35	50	16					50.23	1,768,121
	SACHAL	32	50	0					50.23	1,610,953
	JPLL	38	50	0					50.23	1,925,288
	TGS	34	50	0					39.37	1,324,342
	TGT	37	50	0					39.37	1,447,538
	TRICON 1	38	50	10					39.64	1,488,277
	TRICON 2	38	50	10					39.64	1,488,277
	TRICON 3	38	50	10					39.64	1,488,277
	NOORIABAD	8	12	6					39.64	310.058
	TRICOM	35	50	0					39.64	1,395,260
	708UU	24	50	0					18 22	616 219
	INCREASED DENIETDATIC	34	5/	0					10.32	10 010,219
	INCREASED PENETRATIC	721	1000	0					15.00	10,815,000
	Sub Total	2052	2852	171						
	Total	27214	32206	16343	125948	7628	2876	8236		327,563,804



## Summer Peak (Case B): fast-ramping power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (-ve)	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	MANGLA	470	500	200	2245	250	30	270	0.07	31,490
	Ghazi Barotha	1350	1450	1190	7250	725	100	160	0.08	106,650
	Turbela	3380	3430	2430	16669	875	50	950	0.04	145,340
	Turbela 4 Extension	1410	1410	1410	7343	101	0	120	0.13	188,940
	MLKND	70	82	40.5	286	41	47	29	0.32	22.117
	DARAL KHWAR	30	32	20	160	16	2	10	0.32	9,480
	GOLEN	30	108	20	216	54	78	10	0.34	10,320
Hydro	ALLAI	70	122	60	276	61	52	10	0.22	15,050
	DBR-KWR	120	130	70	455	65	10	50	0.22	25,800
	KHNKHR	10	72	10	252	36	62	0	0.21	2,110
	NBONGSC	124	150	67.5 29.6	/50	/5	25	5/	0.18	17 775
	GULPUR	80	100	20.0	200	50	20	70	0.19	15,520
	CHASMA	114	114	18	570	0	0	96	0.19	21,774
	KAROT	720	720	232	3362	0	0	488	0.19	137,520
	sub Total	8170.3	8705.6	5832.6	40844.38	2390.8	535.297	2337.7		
	JABBAN	22	22.4	12	35.84				0.28	6,050
	DARGAI	13	15	4.5	28.8				0.09	1,144
	PEHUR	10	28	5	38.08				0.63	6,340
	GML-ZAM	9	17.4	5	39.498				0.63	5,706
	IAGRAN	24	32.5	0.31	2.5				2.59	62,160
	MARALA SH	7.4	8	4	14.56				2.55	19,166
Small Hydro	SHADIWL	8	13.5	8	20.25				0.18	1,424
	NANDPR	6	13.8	6	17.802				0.13	792
	RENALA	1	1	0.5	1				0.34	342
	SHISHI	1.5	1.5	0.5	1.5				0.34	513
	RESHUN	4	4	2	4				0.34	1,368
		39.04	350.1	76.01	248.64				0.27	10,424
	sub rotal	149.94	258.1	76.81	511.62				0.05	217.200
	CHINIOTPP	27 0002	62.4	20	50 544				9.05	217,260
Pagase	ΕΛΤΙΜΑ	27.0002	66	20	292.7				10.34	275,505
Bagass	AL MOIZ	17	30	10	134.7				10.34	173.143
	sub Total	100	184.4	65	552 264					,
	K2 UNT	1032	1040	730	5595.2				0.95	980.400
	K3 UNT	1032	1040	730	5595.2				0.95	980,400
Nuclear	CHASHNUP	1241	1263	800	9170.02				1.02	1,260,856
	sub Total	3305	3343	2260	20360.42					
	ATLAS	165	180	75	304	90	15	90	35.47	5,852,880
	NSHTCHN	70	195	68	345	98	125	2	41.92	2,934,519
	NISHT-PWR	189	195	68	345	98	6	121	11.40	2,153,863
	AGL-IPP	145	156	68	281	/8	11	21	36.64	5,312,307
	IIRFRTY Tech	75	124	44 69	333	94	113	- 21	41.35	2,050,350
	LIBERTY Power	180	194	90	889	90	115	90	5.52	992,988
	HUBCO narowal	175	190	77	321	95	15	98	40.57	7,100,083
	FNDTION	148	166	63	1109	77	18	85	9.43	1,395,415
	UCH 1	491	500	477	2611	165	9	14	3.10	1,523,288
	GUDDU	418	440	310	3017	216	22	108	10.02	4,189,865
	GUD-CCPP	460	480	340	3259	240	20	120	11.98	5,511,812
	BALLONI	620	688	/30	3887	309	20 68	130	22.50	13 852 685
	HRS	1010	1050	750	5706	490	40	260	22.34	22,566,470
	TRIMMU	350	365	280	1051	183	15	70	22.16	7,756,613
	UCH2	360	372	298	2397	174	12	62	13.42	4,830,361
Thermal	HALMOR	105	115	86	550	52	10	19	28.20	2,960,648
	ORIENT	115	120	73	574	24	5	42	27.21	3,128,623
	SAIF	123	136	80	650	61	13	43	28.01	3,444,777
	SAPHIRE ENGRO Downer	118	125	88	598	57	7	30	27.71	3,270,148
	NANDPR	430	474	315	4006	226	15	115	28.03	1,134,329
	PRT CFPP	378	450	330	1636	180	72	48	22.84	8,632,688
	LUCKY	580	606	303	2485	242	26	277	13.86	8,041,004
	SECL	1075	1200	600	4692	0	125	475	4.41	4,735,375
	SAHIWAL	800	1242	660	4856	497	442	140	23.29	18,630,720
	TEL	300	300	110	1146	0	0	190	5.18	1,555,350
	THAL NOVA	300	300	110	1146	0	0	190	5.19	1,557,000



	HUR CHINA	275	625	270	1950	250	350	E	22.85	6 284 713
	HUBCO CCER	2/3	1200	2/0	2700	490	950		40.57	0,204,715
	HUBCU CCPP	240	1200	240	2/30	400	560	0	40.57	3,737,230
	AESLALP	1/5	350	1/5	1141	140	0	0	43.34	7,584,306
	AESPKGN	308	350	170	991	140	42	138	37.63	11,591,417
	SABA	94	120	25	396	48	26	69	44.41	4,174,723
	sub Total	11522	14423	7971.8	62228.58	5530.4	2726	3550.2		
	OAD-SOLAR	50	100	0					32.46	1,622,920
	ADDO Solar	70	100	-					47.15	2 200 274
	APPO Solar	70	100	0					47.15	5,500,574
	CRESTENE	50	100	0					50.29	2,514,345
Solar	BESTGREEN	70	100	0					50.02	3,501,449
	ATLAS SOLAR	75	100	0					14.62	1,096,500
	INCREASED PENETRATIO	1600	2500						15.00	24,000,000
	sub Total	1915	3000	0						
	HAWA	38,3312	50	15.9					38.68	1.482.532
	MASTER	38.3312	50	15.9					44.46	1,704,305
	7EPHYR	36,7666	50	15.9					35.74	1,314,160
	GAHMD	38,3312	49.5	0.3					44.46	1,704,305
	ARTISTIC	38,3312	49.5	0.3					21.37	819,310
	ACT2	38.3312	49.5	0.3					13.96	535.065
	DIN-E	38.3312	49.5	0.3					14.12	541,298
	LIBERTY1	38.3312	50	0.3					11.82	453.259
	LIBERTY2	35,2021	49.5	0.3					11.82	416.258
	INDUS	39,1134	50	0.3					14.39	562,916
	NASDA	39,1134	50	0.3					13.86	542,296
	LAKESIDE	37,5489	49.5	0.3					13.83	519.320
	METRO-2	44,5893	58	0.3					36.77	1.639.727
	MASTER GR	36,7666	49.5	0.3					14.47	531.943
	FFCEL	35,9844	50	0					11.76	423.209
	METRO	25 99/4	50	-					36 77	1 222 290
	TADAL	21 1212	30	0.2					22.29	702.025
		64 0202	30	0.3					24.29	2 222 792
	APTISTIC	25 2021	55	10 0					21.27	752,733
	GULAHMAD	35.2021	50	10.5					13.97	F00 803
	GULAHIMAD	30.7000	00	10					13.07	505,602
	YUNUS	39.1134	50	15.9					38.56	1,508,178
	SAPHIKE	38.3312	50	U					48.55	1,860,953
	TGF	32.073	50	10					45.98	1,474,675
	FWEL-I	28.1617	50	0					42.05	1,184,317
	FWEL-II	32.073	50	0					41.73	1,338,429
	TENAGA	28.1617	50	15.9					47.07	1,325,642
	DAWOOD	35.2021	50	15.9					50.23	1,768,121
	SACHAL	32.073	50	0					50.23	1,610,953
	JPLL	38.3312	50	0					50.23	1,925,288
	TGS	33.6375	50	0					39.37	1,324,342
	TGT	36.7666	50	0					39.37	1,447,538
	TRICON 1	37.5489	50	10					39.64	1,488,277
	TRICON 2	37.5489	50	10					39.64	1,488,277
	TRICON 3	37.5489	50	10					39.64	1,488,277
	NOORIABAD	7.8227	12	6					39.64	310,058
	TRICOM	35.2021	50	0					39.64	1,395,260
	ZORLU	33.6375	56.84	0					18.32	616,219
	INCREASED PENETRATIO	721	1000	0					15.00	10,815.000
	sub Total	2051.6	2852.3	170.9						
	Total	27214	22766	16277	124497	7921.2	2261.2	5007.0		210 702 600
	TUIdi	2/214	32/00	105//	124497	/921.2	3201.3	3007.9		510,705,080



## Summer Off Peak (Case A): baseload coal-fired power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop	Reserve	Reserve	Cost	Operating Cost
		-				(MW/Hz)	(+ve)	(-ve)	(Rs/kWh)	(Rs/kWh)
	MANGLA	420	570	170	2559	285	150	250	0.07	28,140
	Ghazi Barotha Turbela	3470	3478	2478	5078	1739	334	997	0.08	88,175
	Turbela 4 Extension	470	470	470	2261	0	0	0	0.13	62,980
	WARSAK	155	202	25	724	101	47	130	0.11	16,585
	MLKND	70	82	41	286	41	12	29	0.32	22,117
	DARAL KHWAR	30	32	20	100	10	2	10	0.32	9,480
	ALLAI	80	100	80	276	61	42	0	0.22	17,200
Hydro	DBR-KWR	110	130	70	455	65	20	40	0.22	23,650
	KHNKHR	10	72	10	252	36	62	0	0.21	2,110
	PATRIND	124	150	68	750	75	26	50	0.18	21,698
	NBONGSC	37	100	30	200	42	47	70	0.48	17,775
	CHASMA	114	114	18	570	0	0	96	0.19	21,774
	KAROT	620	720	232	3362	360	100	388	0.19	118,420
	Sub Total -1	6936	7884	4841	34127	3650	947	2096		
	JABBAN	22	22	12	36				0.28	6,050
	DARGAI	13	15		29				0.09	1,144
	GML-ZAM	9	17	5	39				0.63	5,706
	KRM.GRHI	5	5	0	3				0.26	1,275
	JAGRAN	24	33	5	59				2.59	62,160
Small Hydro	MARALA SH	7	8	4	15				2.59	19,100
	RENALA	0	14	0	18				0.13	792
	SHISHI	2	2	1	2				0.34	513
	RESHUN	4	4	2	4				0.34	1,368
	JINNAH	39	96	24	249				0.27	10,424
	Sub Total -2	137	245	69	492					
	MDI	24	26	10	73				9.05	217,260
Bagaco	EATIMA	27	02	20	294				10.34	279,307
DaBass	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total 3	100	184	65	552					
	K2 UNT	1032	1040	730	5595				0.95	980,400
Nuclear	K3 UNT	1032	1040	730	5595				0.95	980,400
					100 100				1 0 1	040 014
	CHASHNUP	926	947	000	7078				1.02	940,810
	Sub Total 4	2990	947 3027	2060	18269				1.02	940,810
	Sub Total 4	926 2990 110	947 3027 195	2060 08	18269 345	98	85	42	41.92	4,011,387
	Sub Total 4 NSHTCHN NISHT-PWR AGLIPP	926 2990 110 109	947 3027 195 195	2060 08 08	18269 345 343	98 98 78	85	42	41.92	4,011,387 1,242,175 2,491,289
	Sub Total 4 NSHTCHN NISHT-PWR AGL-IPP K.E.L	920 2990 110 109 68 44	947 3027 195 195 156 124	2060 08 08 08 08 44	18269 345 345 281 149	98 98 78 62	85 86 88 80	42 41 0	41.92 11.40 30.64 41.39	4,611,387 1,242,175 2,491,289 1,821,187
	Sub Total 4 NSHTCHN NISHT-PWR AGL-IPP K.E.L Liberty Tech	928 2990 110 109 68 44 69	947 3027 195 195 130 124 188	600 2060 68 68 68 44 69	18269 345 345 281 149 2	98 98 78 62 333	85 86 88 80 119	42 41 0 0	41.92 41.92 11.40 36.04 41.39 42.91	4,011,387 1,242,175 2,491,289 1,821,187 2,960,721
	Sub Total 4 NSHTCHN NISHT-PWR AGL-IPP K.E.L Luberty Tech Luberty Tech	926) 2990 110 109 68 44 09 160	947 3027 195 195 156 124 188 194	000 08 08 08 08 08 08 08 08 08 08 09 09	18269 345 345 281 149 2 9	98 98 78 62 333 889	85 86 88 80 119 34	42 41 0 0 70 70	41.92 41.92 11.40 36.64 41.39 42.91 5.52	4,011,387 1,242,175 2,491,289 1,821,187 2,960,721 882,050
	Sub Total 4 NSHTCHN NISHT-PWR AGL-IPP K.E.L Liberty Tech Liberty Power FNDTION UCH 1	920 2990 110 109 68 44 69 100 130 500	947] 3027 195 195 136 124 188 194 188	2060 2060 08 08 08 44 09 90 00 03	18269 345 345 281 149 2 9 1109	98 98 78 62 333 889 77 0	85 86 88 80 119 34 10	42 41 0 0 70 93	41.92 41.92 11.40 30.04 41.39 42.91 5.52 9.43 3.10	4,011,387 1,242,175 2,491,289 1,821,187 2,900,721 882,030 1,470,843
	Sub Total 4 NSHTCHN NISHT-PWR AGL-IPP K.E.L Liberty Power FNDTION UCH 1 KAPCO	920 2990 110 109 68 44 69 100 130 500 416	947] 3027 195 195 195 124 188 194 166 500 430	2060 08 08 08 44 09 90 03 47 125	1874 18269 343 343 281 149 2 9 1109 2011 3010	98 98 62 333 889 77 0 133	83 86 88 80 119 34 10 0 14	42 41 0 0 0 70 93 23 23 291	41.92 11.40 30.64 41.39 42.91 5.52 9.43 3.10 30.46	4,611,387 1,242,175 2,491,289 1,821,187 2,900,721 882,050 1,470,843 1,551,210 12,071,410
	Sub Total 4 NSHTCHN NISHT-PWR AGL-IPP K.E.L Liberty Power FNDTION UCH 1 KAPCO GUDDU	920 2990 110 109 08 44 69 100 130 500 410 290	947] 3027 193 195 136 124 188 194 166 500 430 300	2060 68 68 68 68 69 90 63 4477 125 210	18769 18269 345 281 149 2 9 1109 2611 3010 2103	98 98 78 02 333 889 77 0 135 50	85 86 88 80 119 34 10 0 14 14	42 41 0 0 70 93 23 23 291 80	41.92 11.40 30.64 41.39 42.91 5.32 9.43 3.10 30.40 10.02	4,611,387 1,242,175 2,491,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 12,671,410 2,906,844
	CHASHNUP Sub Total 4 NSHTCHN NISHT-FWR AGL-IPP K.E.L Liberty Power FNDTION UCH 1 KAPCO GUDDU GUD-CCPP	928 2990 110 109 08 44 09 130 130 130 130 400 410 290 480	947] 3027 193 155 156 124 188 194 106 500 430 430 480	2060 2060 68 68 68 44 69 90 63 447 125 210 340	1076 18269 345 281 149 2 9 1109 2011 3010 2103 3259	98 98 78 62 333 889 77 0 135 50 50 0 0 0 0 0 0 0	85 86 88 80 119 34 10 0 14 10 0 0 0	42 41 0 0 70 93 23 291 80 140	1.02 41.92 11.40 30.64 41.39 42.91 5.52 9.43 3.10 30.40 10.02 11.98	4,011,387 1,242,175 2,491,289 1,821,187 2,960,721 882,050 1,470,843 1,531,210 12,671,410 2,906,844 5,751,436
	Sub Total 4 NISHTCHN NISHT-PWR AGL-IPP K.E.L Liberty Tech Liberty Tech Liberty Power FNDTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI	920 2990 110 68 44 69 100 150 500 410 290 480 821	947] 3027 195 135 136 124 188 194 106 300 430 300 430 1098	2060 2060 08 08 08 08 08 09 90 03 03 03 03 03 03 03 03 03 03 03 03 03	1078 18269 343 345 281 149 2 9 1109 2011 3010 2103 3259 3998	98 98 78 02 333 889 77 0 135 50 0 0 135 50 0 0 0 512	83 88 80 119 34 10 0 14 10 0 0 2777	42 41 0 0 0 70 93 23 291 80 140 91	1.02 41.92 11.40 30.64 41.39 42.91 5.52 9.43 3.10 30.46 (10.02 11.98 22.30	4,011,387 1,242,175 2,451,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 12,071,410 2,900,844 5,751,430 18,322,844
	Sub Total 4 Sub Total 4 NISHT-PWR AGL-IPP K.E.L Liberty Tech Liberty Tech UCH 1 KAPCO GUDDU GUDDU GUDCU BALLOKI HBS TEIMANI	920 2990 110 109 08 44 69 100 150 500 416 290 416 290 480 821 787 500	947] 3027 195 135 136 124 188 194 188 300 430 430 430 430 430 1098 1098	2060 2060 08 08 08 09 90 03 447 125 210 3400 730 730 550	1078 18269 343 343 281 149 2 9 1109 2011 3010 2163 3229 3908 5706	98 98 78 62 333 889 77 0 135 50 0 135 50 0 0 512 490 333	83 88 80 119 34 0 0 14 10 0 0 277 203 180	42 41 0 0 0 70 93 23 291 80 140 91 37 0	1.02 41.92 11.40 30.04 41.39 42.91 3.10 30.40 10.02 11.98 22.36 22.34 22.34	4,011,387 1,242,175 2,491,289 1,821,187 2,960,721 882,050 1,470,843 1,531,210 12,671,410 2,906,844 3,731,450 18,522,844 17,583,972
Thermal	Sub Total 4 Sub Total 4 NSHTCHN NISHT-PWR AGL-IPP K.E.L LUBerty Tech LUBerty Tech LUBerty Power FNOTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UCH2	920 2990 110 008 44 09 160 136 500 416 290 416 290 480 821 787 560 300	947] 3027 195 195 130 124 188 194 106 500 430 430 430 430 1098 1098 1098 1098 1098	2060 2060 08 08 08 09 90 03 44 09 90 03 04 07 0300 7300 7300 7300 288	1078 18269 18269 343 345 281 149 9 1109 2011 3010 2103 3259 3968 3700 2937 2397	98 98 78 62 333 889 77 0 135 50 0 135 50 0 312 490 333 174	83 86 88 119 34 10 0 14 10 0 14 10 0 277 203 180 12	42 41 0 0 70 93 23 23 291 80 140 91 37 0 0 0 2	1.02 41.92 11.40 30.04 41.39 42.91 3.32 9.43 3.10 30.46 10.02 11.98 22.36 22.34 22.36 13.42	4,011,387 1,242,173 2,491,289 1,821,187 2,960,721 882,056 1,470,843 1,531,210 12,671,410 2,900,844 3,751,436 18,522,844 17,583,972 12,410,380 4,830,361
Thermal	Sub Total 4  NSHT-HN NISHT-PWR AGL-IPP K.E.L Lüberty Power FNDTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR	920 2990 110 08 44 09 160 136 500 416 290 480 821 787 560 300 123	947] 3027 195 195 136 124 188 194 106 500 430 300 430 1098 1050 740 372 175	2060 88 08 08 09 90 03 477 125 210 730 730 730 730 730 730 198 119	1078 18269 343 345 281 149 2 9 1109 2011 3010 2103 3259 3908 5706 2937 2397 837	98 98 78 62 333 889 77 0 135 50 0 0 135 50 0 0 135 30 0 0 131 333 174 82	85 88 88 119 34 10 0 14 14 10 0 0 14 14 10 0 0 277 263 180 12 252	42 41 0 0 70 93 23 23 291 80 91 400 91 37 0 0 02 4	1.02 41.92 11.40 30.64 41.39 42.91 5.52 9.43 3.10 30.46 10.02 11.98 22.50 22.34 22.16 13.42 28.20	4,011,387 1,242,175 2,491,289 1,821,187 2,900,721 882,056 1,470,843 1,351,210 12,671,410 2,900,844 3,751,430 18,572,844 17,583,972 12,410,580 4,830,301 3,466,188
Thermal	Sub Total 4  NSHTCHN NISHT-PWR AGL-IPP K.E.L Liberty Power FNDTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE	920 2990 110 109 68 44 09 160 136 500 416 290 416 290 480 821 787 560 360 360 123 125	947] 3027 195 195 136 124 188 194 106 300 430 300 430 1098 1098 1090 740 372 175 130	2060 88 08 08 09 90 03 477 125 210 340 730 730 730 250 298 119 66	1/07/8 1/82/69 3/45 3/45 2/81 1/49 2 9 1/109 2/011 3/010 2/103 3/259 5/706 2/2377 2/397 3/37 2/397 8/37 6/21	98 98 78 02 333 889 77 0 135 30 0 0 0 512 450 333 174 82 05	85 86 88 80 119 34 10 0 0 14 10 0 0 277 203 180 12 23 252 52 52	42 41 0 0 70 93 23 291 80 140 91 37 0 0 02 4 39	1.02 41.92 11.40 30.04 41.39 42.91 5.52 9.43 3.10 30.46 10.02 11.98 22.30 22.34 22.30 22.34 22.30 22.34 22.30 22.34	4,011,387 1,242,175 2,491,289 1,821,187 2,900,721 882,030 1,470,843 1,551,210 12,071,410 2,900,844 5,751,430 18,522,844 17,588,972 12,410,580 4,830,301 3,408,188
Thermal	Sub Total 4  NSHT-PWR AGL-IPP K.E.L Liberty Power ENDTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO Power NAMDRP	920 2990 110 109 68 44 09 130 130 290 480 821 787 500 360 360 123 125 100	947] 3027 195 195 136 124 188 194 106 300 430 300 430 1098 1098 1050 740 372 135 130	2060 2060 88 08 08 08 08 08 08 08 08 0	1/078 18269 345 345 281 149 2011 3010 2103 3259 5906 2937 2937 2937 2937 021 833	98 98 78 62 333 889 77 0 135 50 0 0 0 512 490 333 174 82 63 0 5 2 0 5 0 5 2 0 5 0 5 0 5 0 5 0 5 0 5	83 86 88 80 119 34 10 0 0 0 277 203 180 12 52 53 30 0 20 2 30 0 20 20 20 20 20 20 20 20 20 20 20 20	42 41 0 0 70 70 23 291 80 140 91 37 0 0 02 4 4 39 00	1.02 41.92 11.40 30.04 41.39 42.91 5.52 9.43 3.10 30.46 10.02 11.98 22.36 22.34 22.16 13.42 28.20 27.71 9.80 27.71 9.80	4,011,387 1,242,175 2,491,289 1,821,387 2,960,721 882,030 1,470,843 1,531,210 12,071,410 2,906,844 5,731,430 18,522,844 17,583,972 12,410,380 4,830,301 3,408,188 3,404,140 980,373 0,0337
Thermal	CHASHNUP  Sub Total 4  NISHT-PWR AGL-IPP K.E.L LÜBerty Tech LÜBerty Tech LÜBerty Tech UCH 1 KAPCO GUDDU GUDU GUD-CCPP BALLOKI HBS TRIIMNU UCH2 HALMOR SAPHIRE ENGRO Power NANDPR PRT CEPP	920 2990 110 109 68 44 69 136 500 416 290 480 821 787 560 360 123 125 100 354	947] 3027 195 136 124 188 194 106 300 430 300 480 1098 1098 1050 740 372 175 130 334	2060 2060 08 08 08 08 08 09 00 03 03 03 03 03 03 03 03 03 00 03 00 03 00 03 00 03 00 03 00 03 00 03 00 03 00 03 04 00 04 00 04 00 04 05 05 05 05 05 05 05 05 05 05 05 05 05	18769 18269 345 345 281 149 29 9 109 2011 3010 2103 3229 5968 5706 2397 237 237 237 237 237 237 237 23	98 98 78 62 333 889 77 0 135 50 0 512 450 0 333 114 82 05 0 52 0 53 0 53 0 53 0 53 0 53 0 53	85 86 88 80 119 34 10 0 0 14 14 10 0 0 277 203 180 12 53 30 30 0 0 240	42 41 0 0 93 23 291 80 91 91 37 0 0 0 23 291 80 91 91 91 91 91 91 91 91 91 91 91 91 91	1.02 41.92 11.40 30.64 41.39 42.91 3.30 3.40 30.46 10.02 11.98 22.36 22.34 22.16 13.42 28.20 0.77.71 9.80 22.84	4,011,387 1,242,175 2,451,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 2,904,843 1,551,210 2,908,844 5,751,450 18,522,844 17,583,977 12,2410,580 4,830,301 3,468,188 3,464,140 980,373 9,923,788
Thermal	Sub Total 4 Sub Total 4 NISHT-PWR AGL-IPP K.E.L Lüberty Tech Lüberty Tech Lüberty Tech UCH 1 KAPCO GUDDU GUDDU GUDDU GUDCU GUDDU HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO Power NANDPR PRT CFPP LÜCKY	920 2990 110 109 08 44 69 100 130 410 290 416 290 480 821 787 500 360 123 125 100 334 660 303	947] 3027 195 195 136 124 188 194 106 500 430 430 430 1098 1050 1098 1050 1098 1050 1098 1050 1098 1055 1056	2060 2060 08 08 08 09 90 03 340 730 730 730 730 730 298 119 06 40 248 600	18769 18269 343 343 281 149 2 9 1109 2011 3010 2103 3229 5706 2397 2397 837 621 883 2914 883 2914	98 98 78 62 333 889 77 0 135 50 0 135 50 0 512 490 333 174 82 05 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	85 88 88 90 119 34 10 0 14 14 10 0 277 203 180 0 12 52 53 30 0 0 0 240 303	42 41 0 0 70 93 23 291 80 91 37 0 91 37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 30.04 41.39 42.91 3.10 30.40 10.02 11.98 22.30 22.34 22.10 13.42 28.20 27.71 9.86 28.03 27.84 13.80	4,011,387 1,242,175 2,491,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 12,071,410 2,900,844 5,731,450 18,522,844 17,583,972 12,410,380 4,830,301 3,408,188 3,404,140 9,9023,788 13,072,948 4,200,731
Thermal	Sub Total 4 Sub Total 4 NISHT-PWR AGL-IPP K.E.L LUBerty Tech LUBerty Tech LUBerty Tech LUBerty Power FNOTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO Power NANDPR PRT CFPP LUCKY SECL	920 2990 110 109 088 44 099 160 136 500 416 290 480 821 787 560 360 123 123 123 123 123 123 125 109 300 303 1060 303 1060 303 1060 303 1060 303 1060 303 1060 303 1060 303 1060 303 1060 303 1060 303 1060 303 1060 305 107 107 107 107 107 107 107 107	947] 3027 195 195 136 124 188 194 166 500 430 430 430 1098 1050 740 372 175 130 130 334 900 600 120	2060 2060 08 08 08 09 90 03 44 77 125 210 340 730 730 730 730 730 298 119 06 6 40 228 028 303 303	1078 18269 18269 343 343 281 149 2 9 1109 2011 3010 2103 3229 5968 5700 2973 2397 2397 2397 837 021 833 2914 3222 2483	98 98 78 78 78 889 77 70 135 50 0 135 50 0 312 490 333 312 490 333 312 490 0 333 0 0 332 0 3 0 0 3 0 0 0 0 0 0 0	83 86 88 119 34 10 0 14 10 0 14 10 0 277 203 180 0 277 203 180 0 277 203 180 0 0 240 0 0 303 30 134	42 41 0 0 70 93 23 291 80 140 91 37 0 0 0 22 4 4 59 00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 36.04 41.39 42.91 3.10 30.40 10.02 11.98 22.36 22.34 22.34 22.10 13.42 28.20 27.71 9.80 28.03 22.84 13.80 4.41	4,011,387 1,242,173 2,431,289 1,821,187 2,960,721 882,030 1,470,843 1,531,210 12,671,410 2,906,844 3,751,430 18,522,844 17,583,972 12,410,380 4,830,301 3,408,188 3,464,140 9,923,788 15,072,948 4,200,731 4,693,730
Thermal	Sub Total 4  Sub Total 4  NSHT-FWR  AGL-IPP K.E.L  Liberty Foch Liberty Power FNDTION UCH 1 KAPCO GUDUU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO POwer NANDPR PRT CFPP LUCKY SECL SAHIWAL	920 2990 110 068 44 099 160 136 500 416 290 480 821 787 560 360 123 105 100 354 060 303 1066 930	947] 3027 195 195 130 124 188 194 106 500 430 300 430 1098 1050 740 372 115 130 130 390 394 900 606 1200 1242	2060 2060 08 08 09 90 03 44 09 90 03 477 123 120 730 730 730 730 730 730 747 747 747 747 747 747 747 74	1078 18269 18269 343 345 281 149 2 9 1109 2011 3010 2103 3259 3968 5700 2937 2397 837 621 883 2914 3272 2485	98 98 78 78 78 78 78 78 78 78 78 78 78 70 0 135 50 0 333 312 490 333 312 490 333 312 490 333 312 490 333 302 490 330 300 242 2 0 340 300 242 2 0 0 340 300 300 300 300 300 300 300 300	83 88 88 119 34 10 0 14 14 10 0 0 14 10 0 0 277 203 180 0 277 203 180 0 240 303 30 0 0 240 303 3134 292	42 41 0 0 70 93 23 291 80 140 91 37 0 0 22 4 4 59 00 106 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 30.04 41.39 42.91 3.52 9.43 3.10 30.40 10.02 11.98 22.56 22.34 22.34 22.36 13.42 28.20 27.71 9.80 28.03 22.84 13.80 22.84 13.80 4.41 23.29	4,011,387 1,242,173 2,491,289 1,821,187 2,960,721 882,056 1,470,843 1,551,210 12,071,410 2,900,844 3,751,436 18,522,844 17,583,972 12,410,580 4,830,361 3,468,188 3,464,140 9,863,373 9,923,788 15,072,948 4,200,731 4,095,730 22,123,980
Thermal	Sub Total 4  NSHT-PWR AGL-IPP K.E.L LUBerty Foch LUBerty Foch LUBerty Foch LUBerty Foch LUBERTY Foch LUCH 1 KAPCO GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO Power NANDPR PRT CFPP LUCKY SECL SAHIWAL TEL TEL	920 2990 110 109 08 44 09 100 136 500 416 290 480 821 787 560 300 123 123 125 100 324 660 303 106 950 300	947] 3027 195 136 124 188 194 106 500 430 300 430 1098 1050 740 372 175 130 374 900 606 1200 1242 300	2060 2060 08 08 08 09 90 03 44 09 90 03 477 125 210 340 730 730 730 730 730 730 730 740 740 740 740 740 740 740 74	1078 18269 18269 345 345 281 149 2 9 1109 2011 3010 2103 3259 3908 5706 2937 2397 837 021 883 2914 3272 2485 4092 4856 1140	98 98 78 78 78 78 78 78 78 78 78 78 78 78 77 0 0 135 50 0 0 135 50 0 333 333 174 82 0 5 2 2 2 0 0 330 0 0 0 0 0 0 0 0 0 0 0 0 0	85 88 88 90 119 34 10 0 0 14 10 0 0 14 10 0 0 277 263 180 12 52 53 0 0 0 240 303 3134 292 0 0	42 41 0 0 70 93 23 291 80 140 91 37 0 0 291 80 0 0 0 290 60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 30.64 41.39 42.91 3.52 9.43 3.10 30.46 10.02 11.98 22.36 22.34 22.36 22.34 22.36 22.34 22.36 22.34 13.42 28.20 27.71 9.80 28.33 22.84 13.86 4.41 23.29 5.18 5.52	4,011,387 1,242,175 2,491,289 1,821,187 2,960,721 882,056 1,470,843 1,351,210 12,671,410 2,900,844 3,751,436 18,522,844 17,583,972 12,410,580 4,830,361 3,468,188 3,464,140 9,962,730 15,072,948 4,200,731 4,609,730 22,123,980
Thermal	Sub Total 4  NSHT-PWR NISHT-PWR AGL-IPP K.E.L Liberty Power FNDTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO Power NANDPR PRT CFPP LUCKY SECL SAHIWAL TEL THAL NOVA HUB CHINA	920 2990 110 109 68 44 09 136 500 416 290 416 290 480 821 787 560 360 360 323 125 100 334 660 303 1066 930 300 300 300 300	947] 3027 195 136 124 188 194 100 300 430 300 430 1098 1098 1098 1098 1098 1090 740 372 130 130 130 0344 900 000 020 000 1242 300 025 124 124 125 135 135 135 135 135 135 135 13	2060 2060 8 08 08 09 90 03 447 7 125 210 340 730 730 730 730 730 730 360 298 119 06 40 298 119 06 40 09 110 208 119 06 119 06 119 06 119 119 06 119 119 119 119 119 119 119 11	1078 18269 18269 345 345 281 149 2 9 1009 2011 3010 2103 3259 3908 3706 2937 2397 2397 2397 2397 2397 2397 2397	98 98 78 78 78 78 78 78 78 78 78 78 78 78 77 0 333 30 512 490 333 174 82 03 05 00 242 00 0300 242 00 0 00 242 00 0 00 242 00 00 242 00 00 00 240 20 00 00 00 00 00 00 00 00 00 00 00 00	85 88 88 80 119 34 10 0 0 14 14 10 0 0 277 203 180 12 52 53 30 0 240 303 134 292 0 0 0 0 240 303	42 41 0 0 70 93 23 291 80 91 80 91 37 0 0 91 37 0 0 02 4 4 39 60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 30.44 41.39 42.91 5.52 9.43 3.10 30.46 10.02 11.98 22.30 22.34 22.16 13.42 28.20 27.71 9.86 28.03 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.84 13.80 22.85 13.80 23.85 13.80 23.85 13.80 23.85 24.85	4,011,387 1,242,175 2,491,289 1,821,187 2,960,721 882,036 1,470,843 1,351,210 12,671,410 2,990,844 5,731,430 18,522,844 17,583,972 12,410,580 4,830,361 3,468,188 3,404,140 986,373 9,923,788 13,072,948 4,200,731 4,695,730 22,123,580 1,355,330 1,557,000 0,170,445
Thermal	Sub Total 4  NSHT-PWR NISHT-PWR AGL-IPP K.E.L Liberty Power FNDTION UCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO Power NANDPR PRT CFPP LUCKY SECL SAHIWAL TEL THAL NOVA HUB CHINA AESPKGN	920 2990 110 109 68 44 09 160 136 500 416 290 416 290 480 821 787 560 360 360 323 125 100 334 660 303 1066 930 300 300 300 300 300 300 300	947] 3027 195 136 124 188 194 106 300 430 300 30	2060 2060 88 08 08 09 90 03 447 72 210 340 730 500 750 500 750 500 750 500 600 00 109 100 100 100 100 100 10	18269 18269 345 345 281 149 29 9 109 2011 3010 2103 3229 3988 3706 2397 2485 24	98 98 78 78 78 78 78 78 78 78 78 70 0 135 50 0 0 135 50 512 490 333 174 82 05 0 0 2512 490 333 174 490 333 30 2512 490 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	85 88 88 80 119 34 10 0 0 240 203 303 134 292 0 0 0 240 303 134 292 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	42 41 0 0 0 70 93 23 291 80 91 80 91 37 0 0 91 37 0 0 02 4 4 39 60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 4.1.92 11.40 36.84 41.39 42.91 3.52 9.43 3.10 30.40 10.02 11.98 22.30 22.34 22.16 13.42 22.26 13.42 22.26 13.42 22.28 4.21 9.80 22.84 13.80 4.41 9.80 22.84 13.80 4.41 9.80 22.84 13.80 3.19 5.18 5.18 5.19 5.18 5	4,011,387 1,242,175 2,491,289 1,821,187 2,900,721 882,050 1,470,843 1,551,210 12,071,410 2,900,844 5,751,430 18,522,844 17,583,972 12,410,580 4,830,301 3,468,188 3,464,140 980,373 9,923,788 15,072,948 4,200,731 4,095,730 22,123,980 1,557,900 6,170,445 10,913,996
Thermal	Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5	920 2990 110 109 08 44 40 160 136 500 416 290 416 290 416 290 416 290 400 416 290 416 290 400 400 400 400 400 400 400 4	347] 3027 195 195 124 188 194 188 194 100 300 430 430 430 430 1098 1050 740 372 175 130 130 334 900 1334 334 300 1200	2060 2060 08 08 08 08 09 90 03 3447 730 730 730 730 730 730 730 298 119 06 40 248 6600 248 6600 303 303 600 110 110 270	18769 18269 18269 343 281 149 2 9 1109 2011 3010 2103 3259 5908 5706 2397 2397 2397 2397 2397 2397 2397 2397 2397 2397 2397 2397 2397 2495 4092 4850 1146 1146 1146 1140 1991 56085	98 98 78 78 78 78 78 78 78 78 78 78 78 78 78	85 88 88 80 119 34 10 0 0 14 14 10 0 0 277 263 180 12 52 5 30 0 240 303 3134 229 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	42 42 41 0 0 0 93 23 291 80 91 40 91 37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 4.1.92 11.40 30.64 41.39 42.91 5.32 9.43 3.10 30.46 10.02 11.98 22.36 22.34 22.10 13.42 28.20 27.71 9.80 22.84 13.86 4.41 23.29 5.18 5.19 22.83 37.03	4,011,387 1,242,175 2,451,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 12,071,410 2,900,844 5,751,450 18,522,844 17,583,972 12,410,580 4,830,361 3,468,188 3,404,140 980,373 9,923,788 15,072,948 4,200,731 4,695,730 22,123,980 1,555,350 1,555,350 1,555,350
Thermal	Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 5 Sub To	920 2990 110 109 68 44 099 100 156 500 416 290 416 290 480 821 787 560 380 123 125 100 334 660 303 1066 950 300 300 270 20 9771 20	947] 3027 195 195 136 124 188 194 166 300 430 430 430 430 430 430 430	2060 2060 08 08 08 08 09 90 03 340 750 730 730 730 730 730 298 119 66 40 248 660 0 303 600 600 600 110 110 270 7316	18269 18269 18269 18269 149 149 19 109 100 2163 3010 2163 3229 3968 5706 2937 2397 837 2397 837 2297 837 2297 837 2297 837 2297 837 2294 4092 4485 1146 1146 1990 391 56085	98 98 78 78 78 78 78 78 78 78 78 78 78 78 78	85 86 88 80 119 34 10 0 0 14 14 10 0 0 2777 203 180 0 12 52 53 30 0 0 240 0 303 134 292 0 0 0 240 0 0 2779	42 42 41 0 0 0 70 93 23 291 80 91 90 91 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 1.02	4,011,387 1,242,175 2,431,289 1,821,187 2,960,721 882,050 1,470,843 1,531,210 12,071,410 2,900,844 5,731,450 18,522,844 17,583,972 12,410,380 4,830,361 3,408,188 3,404,140 9,923,788 15,072,948 4,200,731 4,695,730 22,123,980 1,535,000 0,170,445 10,913,996 649,168
Thermal	Sub Total 4 Sub Total 4 NISHT-PWR AGL-IPP K.E.L LUBerty Tech LUBerty Tech LUBerty Tech LUBerty Tech LUBERTY Tech LUBERTY Tech LUBERTY Tech LUBERTY Tech LUBERTY Tech LUCH 1 KAPCO GUDDU GUD-CCPP BALLOKI HBS TRIMMU UUCH2 HALMOR SAPHIRE ENGRO Power NANDPR PRT CFPP LUCKY SECL SAHIWAL TEL THAL NOVA HUB CHINA AESPKGN SIJD TOtal 5 CAD-SOLAR CREST ENE	920 2990 110 109 068 44 099 160 136 290 416 290 410 290 410 132 100 410 290 410 300 123 123 123 123 123 123 123 100 300 300 303 1066 950 300 300 300 270 290 9771 20 20	947] 3027 195 195 124 188 194 106 500 430 430 430 430 430 430 430 4	2000 2000 08 08 08 09 90 00 03 447 71 125 210 3400 730 7300 7300 298 119 06 6 40 248 600 303 300 303 300 200 298 119 0 6 6 0 0 730 730 7316 0 7316 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	18269 18269 18269 343 343 281 149 2 9 100 201 3010 2103 3229 3908 3700 2937 2337 2337 2337 2337 2337 2337 234 3229 4830 1146 1190 991 56085	98 98 78 78 78 78 78 78 78 78 78 78 78 78 78	85 88 88 80 119 34 10 0 0 14 10 0 0 277 203 180 0 277 30 0 240 303 30 0 240 303 3134 292 0 0 0 2729 0 0 0 2729	42 41 0 0 70 93 23 291 80 140 91 37 0 0 0 0 20 100 100 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 36.04 41.39 42.91 3.30 30.40 10.02 11.98 22.36 22.34 22.36 22.34 22.30 13.42 28.20 27.71 9.80 28.03 22.84 13.80 4.41 23.29 3.18 5.19 22.85 37.63 32.46 50.29	4,011,387 1,242,173 2,431,289 1,821,187 2,960,721 882,030 1,470,843 1,531,210 12,671,410 2,906,844 3,751,430 18,522,844 17,583,972 12,410,380 4,830,301 3,408,188 3,404,140 9,923,788 15,072,948 4,200,731 4,692,730 1,557,000 0,170,445 10,913,996 649,108
Thermal	Sub Total 4  Sub Total 4  NSHTCHN NISHT-PWR AGL-IPP K.E.L LUBerty Foch LUBerty Foch LUBerty Foch LUBerty Power FNOTION UCH 1 KAPCO GUDUU GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO POwer NANDPR PRT CFPP LUCKY SECL SAHIWAL TEL THAL NOVA HUB CHINA AESPKGN SUB TOTAL 5  QUD-CLAR CREST ENE BESTGREEN CATALS SOLAP	920 2990 110 109 08 44 09 160 136 500 416 290 480 300 410 290 480 300 123 105 100 354 060 303 1066 930 300 200 200 20 20 20 20 20 20 20	947] 3027 195 136 124 184 194 106 500 430 430 430 1050 740 1050 740 1050 740 1050 740 1050 740 1050 740 1050 1250 1250 1250 1050	2000 2000 08 08 08 09 90 03 447 72 123 210 3400 7300 70000 70000 70000 70000 70000 70000 700000000	1078 18269 18269 343 345 281 149 2 9 1109 2011 3010 2103 3259 3908 3700 2937 2397 837 021 833 2914 3272 24850 1146 1146 1950 991 56085	98 98 78 78 78 78 78 78 78 78 78 78 78 78 78	85 88 88 90 119 34 10 0 0 14 14 10 0 0 2777 203 180 0 2773 203 180 0 240 303 30 0 240 303 3134 292 0 0 2729	42 41 0 0 70 93 23 291 80 140 91 37 0 0 22 4 4 59 00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 30.04 41.39 42.91 3.32 9.43 3.10 30.46 10.02 11.98 22.36 22.34 22.36 22.34 22.36 13.42 28.20 28.03 22.84 13.86 4.41 23.29 5.18 5.19 22.85 37.03 37.03 32.46 50.29 50.02 14.62 14	4,011,387 1,242,173 2,491,289 1,821,187 2,960,721 882,056 1,470,843 1,551,210 12,671,410 2,900,844 3,751,436 18,522,844 17,583,972 12,410,580 4,830,301 3,468,188 3,464,140 9,863,73 9,923,788 15,072,948 4,200,731 4,695,730 22,123,980 1,555,350 1,557,000 6,170,445 10,913,996 649,168 1,005,738 1,750,725 1,076,725
Thermal	Sub Total 4  NSHT-PWR AGL-IPP K.E.L LUBerty Foch LUBerty Foch LUBerty Foch LUBerty Foch LUBerty Form FNDTION UCH 1 KAPCO GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO POWEr NANDPR PRT CFPP LUCKY SECL SAHIWAL TEL THAL NOVA HUB CHINA AESPKGN SUB TOTAL 5  QAD-SOLAR CAREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC	920 2990 110 109 08 44 09 160 156 500 416 290 480 480 480 123 100 300 123 100 300 300 300 300 300 300 30	947] 3027 195 195 136 124 188 194 106 500 430 300 430 1050 740 372 130 1050 740 372 130 100 300 1250 300 12500 100 100 100 100 100 100 100	2060 2060 08 08 09 90 03 44 09 90 03 03 07 0 0 0 0 0 0 0 0 0 0 0 0 0	1078 18269 18269 18269 143 149 281 109 201 100 2103 3010 2103 30259 5908 5700 2937 2397 621 883 2914 3272 2485 1146 1140 1950 991 56085	98 98 78 78 78 78 78 78 78 78 78 78 78 78 78	83 88 88 119 34 10 0 0 14 10 0 0 0 277 263 180 0 277 263 180 0 277 0 0 240 303 30 0 0 240 303 3134 292 0 0 0 2729	42 41 0 0 70 93 223 291 80 140 91 37 0 02 44 59 60 106 290 106 290 190 0 120 120	1.02 41.92 11.40 30.04 41.39 42.91 3.52 9.43 3.10 30.40 10.02 11.98 22.36 22.34 22.36 22.34 22.36 13.42 28.20 27.71 9.80 28.03 22.84 13.80 4.41 23.29 5.18 3.19 22.85 37.03 32.46 50.29 50.02 13.00 20.02 13.00 20.02 13.00 20.02 13.00 20.02 20.02 13.00 20.02 20.	4,011,387 1,242,173 2,491,289 1,821,187 2,960,721 882,056 1,470,843 1,531,210 12,671,410 2,900,844 3,751,436 18,522,844 17,383,972 12,410,580 4,830,361 3,468,188 3,464,140 986,373 9,923,788 4,200,731 4,695,730 22,123,980 1,555,330 1,555,330 1,555,330 1,555,330 1,555,330 1,555,330 1,555,330 1,555,330 1,557,045 10,913,996 649,168 1,005,738 1,750,725 1,096,500 1,500,050
Thermal	Sub Total 4  NSHT-PWR AGL-IPP K.E.L LUBerty Fech LUBerty Tech LUBerty Tech LUBerty Fech LUBERTY Tech LUBERTY Tech LUBERTY Tech LUCH 1 KAPCO GUD-CCPP BALLOKI HBS TRIMMU UCH2 HALMOR SAPHIRE ENGRO POWEr NANDPR PRT CFPP LUCKY SECL SAHIWAL TEL THAL NOVA HUB CHINA AESPKGN SUB TOTAL S  ACREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC SUB TOTAL 6	920 2990 110 109 68 44 099 160 136 500 416 290 480 0821 787 560 300 123 123 100 300 300 300 300 300 300 30	3027 3027 195 135 136 124 188 194 106 500 430 300 430 1098 1098 1098 1098 1098 1098 1098 109	2000 08 08 08 08 09 90 03 44 09 90 03 07 03 00 07 00 02 08 01 00 02 08 00 00 00 00 00 00 00 00 00	18269 18269 345 345 345 345 281 149 29 9 109 201 300 2103 3229 3988 3706 2397 2397 2397 2397 2397 2397 2397 2397	98 98 78 78 78 78 78 78 78 78 78 78 78 70 77 0 0 330 242 0 330 242 0 0 330 242 0 0 330 242 0 0 330 242 0 0 330 242 0 0 330 340 242 0 0 340 242 0 0 340 242 0 0 340 340 340 340 340 340 340 340 340	85 88 88 80 119 34 10 0 0 14 14 10 0 0 277 263 180 12 52 53 30 0 0 240 303 134 292 0 0 0 2729 0 0 0 0 2729	42 41 0 0 70 93 23 291 80 140 91 37 0 0 22 4 4 59 60 106 0 0 0 0 0 0 0 0 0 0 290 190 120 0 0 2455	1.02 1.02	4,011,387 1,242,175 2,491,289 1,821,187 2,900,721 882,050 1,470,843 1,551,210 12,071,410 2,906,844 5,751,430 18,522,844 17,583,972 12,410,580 4,830,301 3,468,188 3,464,140 986,373 9,923,788 15,072,948 4,200,731 4,095,730 1,557,900 6,170,455 10,913,996 649,108 1,005,738 1,730,725 1,096,500 15,000,000
Thermal	Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 6 Sub To	920 2990 110 109 08 44 49 160 136 290 416 290 416 290 480 821 787 500 380 123 100 334 660 303 1006 930 300 300 300 270 200 271 200 1150 27	947] 3027 195 195 136 124 188 194 100 430 430 430 430 430 430 430 4	2060 2060 08 08 08 08 09 90 03 44 09 90 03 34 07 00 730 730 730 730 730 730	18769 18269 18269 345 345 345 281 149 2 9 1109 2011 3010 2103 3259 5908 5706 2397 2397 2397 2397 2397 2397 2397 2397	98 98 78 62 333 889 77 0 135 30 0 512 490 333 137 490 333 174 82 03 300 3360 3400 242 0 0 3400 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 360 242 0 0 0 0 360 360 360 360 360 360 360 360	83 88 80 119 34 10 0 0 14 14 10 0 0 277 263 180 0 12 52 30 180 0 240 303 303 134 292 0 0 0 240 303 303 134 292 0 0 0 0 2729	422 41 0 0 93 23 291 80 91 40 91 37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 1.02	4,011,387 1,242,175 2,451,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 12,071,410 2,900,844 3,751,245 18,322,844 17,58,372 12,410,580 4,830,301 3,468,188 3,404,140 980,373 9,923,788 15,072,948 4,200,731 4,699,730 22,123,980 1,555,330 1,555,330 1,555,330 1,555,330 1,555,330 1,555,350
Thermal	Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 5 Sub Total 6 Hawa Sub Total 6 Hawa Sub Total 6 Sub Tota	920 2990 110 109 68 44 69 100 150 416 290 416 290 480 821 787 500 380 123 125 100 334 660 303 1006 950 300 300 220 9771 20 20 35 75 1000 1150 27 22	947] 3027 195 195 136 124 188 194 160 300 430 430 430 430 430 430 43	2060 2060 08 08 08 08 08 08 09 90 03 340 730 730 730 730 730 730 730 730 730 73	18269 18269 18269 149 149 2 9 1109 2011 3010 2103 3329 5908 5706 2937 2337 837 2337 837 2234 3292 4092 4856 1146 1146 1146 1950 991 56085	98 98 78 78 78 78 78 78 78 78 78 78 78 78 78	85 86 88 80 119 34 10 0 0 14 14 10 0 0 2777 203 180 0 12 52 5 30 0 0 240 0 0 240 0 0 303 134 292 0 0 0 240 0 0 2729	42 42 41 0 0 0 0 70 93 233 291 80 140 91 37 0 0 62 4 39 00 100 100 100 190 0 190 0 190 0 120 2455	1102 41.92 11.40 30.04 41.39 42.91 3.10 30.40 10.02 11.98 22.30 22.34 22.34 22.30 22.34 22.30 22.34 22.30 22.34 22.30 22.34 23.40 3.10 3.10 3.00 27.71 9.86 28.03 3.19 22.85 3.703 22.84 3.19 22.85 3.703 22.84 3.19 22.85 3.703 22.84 3.19 22.85 3.703 22.84 3.19 22.85 3.703 22.84 3.19 22.85 3.703 22.84 3.19 22.85 3.703 22.84 3.19 22.85 3.703 22.84 3.19 3.19 3.19 3.28 3.19 3.28 3.10 3.00 3.	4,011,387 1,242,175 2,431,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 12,071,410 2,906,844 5,731,430 18,522,844 17,583,972 12,410,380 4,830,301 3,408,188 3,404,140 9,923,788 13,072,948 4,200,731 4,695,730 22,123,980 1,557,000 0,170,445 10,913,996 849,168 1,005,738 1,750,725 1,096,500 1,500,000 1,004,5816 1,022,640
Thermal	Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 4 Sub Total 5 Sub To	920 2990 110 109 68 44 099 160 156 500 416 290 416 290 480 821 787 560 380 123 123 123 125 1000 303 1066 950 300 303 1066 950 300 300 200 200 277 200 270 27	947] 3027 195 135 124 188 194 166 300 400 400 400 400 400 400 400	2000 2016 08 08 08 08 08 08 08 09 09 00 03 00 00 00 00 00 00 00 00 00 00 00	1/07/8	98 98 78 78 78 78 78 78 78 78 78 78 78 78 78	85 86 88 80 119 34 10 0 14 14 10 0 0 14 10 0 0 2777 203 180 0 12 303 180 0 240 0 0 240 0 0 240 0 0 240 0 0 2729	42 42 41 0 0 0 70 93 23 291 80 91 40 91 37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.02 41.92 11.40 30.04 41.39 42.91 3.10 30.40 10.02 11.98 22.30 22.34 22.34 22.30 13.42 28.20 27.71 9.86 28.03 22.84 13.80 4.41 23.29 3.18 5.19 22.85 37.63 32.40 50.29 30.02 14.62 15.00 38.08 44.46 44.46 35.74	4,011,387 1,242,175 2,431,289 1,821,187 2,960,721 882,050 1,470,843 1,551,210 12,671,410 2,906,844 5,751,450 18,522,844 17,583,972 12,410,380 4,830,361 3,408,188 3,404,140 9,923,788 15,072,948 4,200,731 4,695,730 22,123,980 1,355,000 0,170,445 10,913,996 649,108 1,005,738 1,075,731 649,108 1,005,738 1,057,725 1,096,930 1,045,816 1,022,640 714,806



ACT2         27         30         0         13.36         77.48           DIN €         27         30         0         14.12         313.84           UBERTY1         27         30         0         14.12         313.74           UBERTY2         23         30         0         11.82         23.81.843           NDUS         23         30         0         13.83         23.83.93           NDUS         23         30         0         13.83         33.10.14           NASDA         20         30         0         13.83         33.10.14           NASDA         20         30         0         13.83         30.61.42           METRO-2         31         36         0         13.83         30.77.23.48           METRO         20         30         0         14.47         73.23.48           TAPAL         13         39         0         20         30.72           TAPAL         35         39         0         21.33         33.73           METRO         23         30         10         21.33         30.722           METRO         23         30         10											
DIN €         27         30         0          14.12         18.18.3           LUBERTY         25         30         0           11.42         13.37.40           LUBERTY         25         30         0           11.42         23.83.03           NDUS         23         30         0           14.33         23.83.03           NASA         20         30         0           13.36         27.24           MASTR GR         20         30         0           36.77         1.150.708           MATTR CR         23         30         0           36.77         1.150.708           MATTR CR         23         30         0           34.35         1.204.00     <		ACT2	27	50	0					13.96	377,449
LIBERTY1         27         30         0         11.82         131.740           UBERTY2         23         50         0         11.82         131.740           NUS         23         50         0         14.33         331.014           NASDA         200         50         0         14.33         331.014           NASDA         200         50         0         14.33         331.014           LARESIDE         26         50         0         11.83         330.04           METRO-2         31         38         0         14.47         737.240           METRO         20         50         0         14.47         737.240           TAPAL         13         30         0         14.33         349.59.31           LIFF         13         39         0         14.33         349.59.31           ARTISTIC         22         50         10         13.37         340.07           GULAHMAD         20         50         10         13.37         340.03.72           TGF         23         50         10         13.37         34.04.27           VINUS         23         50         10		DIN-E	27	50	0					14.12	381,845
LIBERTY2         22         350         0         11.82         293.03           INDUS         23         50         0         14.83         331.014           NASDA         20         50         0         13.83         331.014           NASDA         20         50         0         13.83         331.014           NASTER GR         20         50         0         13.83         363.042           MATER GR         20         50         0         14.47         373.248           MATER GR         20         50         0         14.47         373.248           MERO         20         50         0         14.47         373.248           MERO         20         50         0         14.47         373.248           UERL         33         99         0         13.33         3495.931           UERL         33         50         10         13.33         3495.931           UERL         33         50         10         13.33         3495.931           UERL         33         50         10         13.33         3495.931           UERL         35         50         0		LIBERTY1	27	50	0					11.82	319,740
NUUS         223         30         0         14.33         313.04           NASDA         20         30         0         13.88         77.234           LAKESIDE         20         30         0         13.88         77.234           MATEG GR         20         30         0         13.83         360.342           MATEG GR         20         30         0         13.83         360.342           MATEG RG         20         30         0         13.83         360.342           TAPAL         20         30         0         14.47         73.54.60           TAPAL         13         30         0         14.33         3.010.41           UEPL         33         99         0         14.33         3.030.81           ARTISTIC         223         30         10         14.33         3.733.87           YUNUS         23         30         10         14.33         3.733.87           YUNUS         23         30         10         14.33         3.733.87           YUNUS         23         30         10         14.33         3.734.83           YUNUS         23         30		LIBERTY2	25	50	0					11.82	293,639
NASDA         220         300         0         13.80         277.294           LAKESIDE         200         300         0         13.83         300.342           METRO-2         31         36         0         13.83         300.342           MASTE GR         200         300         0         14.44         737.3240           FFCEL         200         300         0         14.44         737.3240           METRO         200         300         0         13.83         30.97           LEFL         33         99         0         13.83         30.97.82           GULAHMAD         220         300         100         13.83         30.97.82           GULAHMAD         223         300         100         13.83         30.97.82           TOF         223         300         100         13.83         30.97.82           SAPHIRE         223         300         100         13.83         30.97.82           TOF         223         300         100         14.93         34.93.91.99.91.91.91.91.91.91.91.91.91.91.91.		INDUS	23	50	0					14.39	331,014
LAKESIDE         20         50         0         13.83         303.43         303.43         303.44           METRO-2         31         32         0         10         10         30.77         31.315,708           MASTER GR         20         50         0         10         11.47         372,246           FFCEL         20         50         0         10         11.76         233,218           METRO         20         50         0         10         13.83         30.93,23           TAPAL         135         30         0         10         13.37         733,480           ARTISTIC         23         50         10         10         33.30         30,782           SAPHIRE         23         50         10         13.37         737.348           YUNUS         23         50         10         13.37         33.07.82           SAPHIRE         23         50         10         13.37         33.38           YUNUS         23         50         0         14.43         34.43           YUNUS         23         50         0         14.43         34.43           FWEL-1         20 <td></td> <td>NASDA</td> <td>20</td> <td>50</td> <td>0</td> <td></td> <td></td> <td></td> <td></td> <td>13.86</td> <td>277,294</td>		NASDA	20	50	0					13.86	277,294
MASTER GR         31         38         0          30.77         1,13,708           MASTER GR         20         30         0           11.44         373,248           FFCL         20         30         0           11.47         323,218           MERO         200         30         0           30.77         733,800           TAPAL         133         39         0           30.77         733,900           TAPAL         133         39         0           34.33         1,203,001           ATSTC         23         30         10           38.35         88,853           SMIME         213         300         10           48.35         1,10,034           YUNUS         23         30         0           48.35         1,41,43           TGF         23         30         0           41.73         344,401           TGF         23         30         0           43.37         1,318,433		LAKESIDE	26	50	0					13.83	366,342
MATER GR         20         00         0         14.47         737,340           FECEL         20         50         0         10         1176         233,218           METRO         20         50         0         10         1176         233,218           TAPAL         115         30         0         10         10         33.29         199,931           LUERL         23         39         0         10         10         10         34.33         1,203,001           GUAHMAD         20         50         10         10         10         13.87         727,318           YUNUS         23         30         10         10         10         13.87         727,318           SAPHRE         23         30         10         10         14.43         1,402,73           SAPHRE         23         30         10         10         14.43         1,442,73           SAPHRE         23         30         10         14.44         1,442,73           SAPHRE         23         30         10         14.44         1,442,73           FWEL1         23         30         10         14.44 <t< td=""><td></td><td>METRO-2</td><td>31</td><td>58</td><td>0</td><td></td><td></td><td></td><td></td><td>36.77</td><td>1,156,708</td></t<>		METRO-2	31	58	0					36.77	1,156,708
FreeL         20         30         0         11.70         233,218           METRO         20         30         0          30.77         733,480           TAPAL         13         30         0          33.72         733,480           UFL         33.3         99         0          33.72         733,480           ARTISTC         23         30         0           33.72         733,480           MUM         23.5         39         0           33.72         733,480           MUND         23.5         39         0           34.35         31,030,302           SAPHIRE         23.3         30         0            33.53         888,593           SAPHIRE         23.3         30         0           43.53         11,063           FWEL-1         23.3         30         0           44.03         33.549           FWEL-1         23.3         30         0           47.03         33.749           FWEL-1         23.3         <		MASTER GR	26	50	0					14.47	375,246
METRO         20         50         0         30.77         733,480           TAPAL         15         30         0         33.29         733,480           VINI         312         39         0         33.29         343,93           ARTISTIC         22         30         10         243.33         31,020,0782           VINIO         23         50         10         243.33         30,0782           YUNUS         233         50         10         243.35         38,0782           SAPHIRE         23         50         10         243.85         38,083           FWEL-1         20         50         10         244.53         31,10,034           TGF         23         50         10         244.53         31,040,273           FWEL-1         20         50         10         244.53         31,404,273           FWEL-1         20         50         16         244.03         34,410           TAAGA         20         50         16         244.03         34,272           SACHAL         23         50         16         244.03         34,272           SACHAL         23         50		FFCEL	20	50	0					11.76	235,218
TAPAL         15         30         0         33.29         49.931           UEPL         33         99         0         34.39         1,203,001           ARTISTIC         225         500         10         21.37         7330,782           YUNUS         233         500         100         20         33.29         277,318           YUNUS         233         500         100         20         38.50         886,859           SAPHIRE         233         500         0         20         48.53         1,110,034           TGF         223         500         0         20         445.98         1,004,273           FWEL-1         200         500         0         20         442.05         833,449           TENAGA         200         0         20         442.05         833,449           JAVODD         225         50         10         20         47.07         933,142           DAWOOD         25         50         10         20         50.23         1,205,031           JPLL         30         50         0         20         39.37         1,003,017           TGS         277		METRO	20	50	0					36.77	735,480
Wind         UFL         33         99         0          4         34.39         1,203,001           Wind         GULAHMAD         2.23         30         1.08          4         21.37         330,722           GULAHMAD         2.23         30         1.08           4         21.37         330,722           ShPHIRE         2.23         30         0.10           4         5         1.10,843           TGF         2.23         30         0.0           4         48.55         1.11,034           FWEL1         2.23         30         0.0           4         48.55         1.11,034           DAWOOD         2.23         30         0.0           4         42.03         833,443           JPLL         2.30         0.0         0          4         42.03         833,443           DAWOOD         2.23         30.0         0           4         30.33         1.247,279           SACHAL         2.23         30         0.0           30.33         1.257,083		TAPAL	15	30	0					33.29	495,931
Mind         ARTISTIC         23         30         10          10         21.37         330,782           GULAHMAD         20         00         10           13.87         2777,318           YUNUS         232         00         10           38.50         88.89.39           SAPHIRE         23         00         0           38.50         10.10.34           TGF         23         00         0           45.95         1.04.02.73           FWEL1         223         00         0           42.05         83.54.93           FWEL1         223         00         0           47.07         933.142           DAWOOD         25         00         0           50.33         1.247.079           SACHAL         273         00         0           50.33         1.247.079           SACHAL         133         0.00         0           50.33         1.247.079           SACHAL         23         0.00         0          39.37		UEPL	35	99	0					34.39	1,203,601
Wind         GULAHMAD         20         50         10          13.87         277,318           YUNUS         23         50         10           38.56         886,859           SAPHIRE         23         50         0           48.55         886,859           SAPHIRE         23         50         0           45.5         51,116,83           TGF         23         50         0           45.9         51,116,93           FWE-1         20         50         0           42.05         883,449           FWE-1         23         50         0           41.73         943,140           DAVOOD         25         50         16           50.23         1,247,279           SACHAL         25         50         0           50.23         1,247,279           SACHAL         25         50         0           50.33         1,247,279           SACHAL         327         50         0           50.33         1,263,3		ARTISTIC	25	50	16					21.37	530,782
YUNUS         23         50         16         38.50         38.50         88.6,293           SAPHIRE         23         50         0           48.55         1,110,634           TGF         23         50         0           48.55         1,110,634           FWEL1         23         50         0           45.95         0,832,439           FWEL1         223         50         0           41.73         944,101           TENAGA         20         50         16           47.07         933,142           DAVOOD         225         50         16           50.23         1,255,093           JPLL         30         50         0           39.37         1,205,083           TGS         27         50         0           39.37         1,010,317           TGS         27         50         0           39.44         1,208,342           TRICN 1         32         50         0           39.64         1,208,342	Wind	GULAHMAD	20	50	10					13.87	277,318
SAPHIRE         23         50         0         48.55         1,110,34           TGF         23         50         10          4         45.58         1,040,273           FWEL1         20         50         0          42.05         83,44,09           FWEL1         23         50         0          44.05         83,44,09           FWEL1         23         50         0          44.05         83,44,09           FWEL1         23         50         0          44.05         83,44,09           DAWOOD         25         50         0          44.05         93,142           DAWOOD         25         50         0           50.23         1,215,093           JPLL         30         50         0           50.23         1,200,831           TGS         277         50         0           39.37         1,038,017           TGT         30         50         0           39.33         1,038,017           TRICON 1         32         50         0          <		YUNUS	23	50	10					38.50	886,839
TGF         23         50         10         45.98         1,040,273           FWE-1         20         50         0         42.05         833,449           FWE-11         23         50         0         41.73         934,449           TENAGA         20         50         0         41.73         943,449           DAWOOD         225         50         106         41.73         943,142           DAWOOD         225         50         106         40         50.23         1,247,279           SACHAL         23         50         0         40         50.23         1,255,093           FVEL1         30         50         0         40         40         50.23         1,267,279           SACHAL         23         50         0         40         50.23         1,267,279           SACHAL         30         50         0         40         50.23         1,267,303           TG5         277         50         0         40         39.37         1,063,017           TRICON 1         322         50         10         40         39.44         1,071,418           NOORIABAD         821		SAPHIRE	23	50	0					48.55	1,110,034
FWEL-1         20         50         0         42.05         835,449           FWEL-11         23         50         0         4         42.05         835,449           FWEL-11         23         50         0         4         41.73         944,161           TENAGA         20         50         10         4         47.07         933,142           DAWOOD         225         50         10         4         50.23         1,247,279           SACHAL         23         50         0         4         50.23         1,255,093           JPL         30         50         0         4         50.23         1,255,093           JPL         30         50         0         4         50.23         1,255,093           JPL         30         50         0         4         39.37         1,066,813           TGT         30         50         0         4         39.37         1,068,314           TRICON 1         32         50         10         4         39.64         1,268,342           TRICON 2         32         50         10         4         39.64         1,268,342 <td< td=""><td></td><td>TGF</td><td>23</td><td>50</td><td>10</td><td></td><td></td><td></td><td></td><td>45.98</td><td>1,040,273</td></td<>		TGF	23	50	10					45.98	1,040,273
FWEL-II         23         50         0         41.73         944,161           TENAGA         20         50         106          4         47.07         933,142           DAWOOD         23         50         106           50.23         1,242,279           SACHAL         223         50         0           50.23         1,225,093           JPLL         300         500         0           50.23         1,255,093           JPLL         300         500         0           50.23         1,255,093           TGS         27         500         0           39.37         1,008,317           TGS         27         500         0           39.37         1,008,317           TGS         27         500         0           39.37         1,008,317           TRICON 1         32         50         0.10           39.64         1,268,342           TRICON 2         23         50         0.0           39.64         1,078,342 <t< td=""><td></td><td>FWEL-I</td><td>20</td><td>50</td><td>0</td><td></td><td></td><td></td><td></td><td>42.05</td><td>835,449</td></t<>		FWEL-I	20	50	0					42.05	835,449
TENAGA         20         30         16         47.07         933,142           DAWOOD         23         30         16          50.33         1,247,279           SACHA         23         30         0          50.33         1,247,279           SACHA         23         30         0           50.33         1,247,279           JPLL         30         30         0           50.23         1,247,079           TGS         277         30         0            50.33         1,506,811           TGS         277         30         0            39.37         1,063,017           TGT         30         50         0           39.37         1,013,017           TRICON 1         322         30         0           39.37         1,013,034           TRICON 2         323         305         0           39.44         1,071,41           NORIABAD         82         10            39.44         1,010,41		FWEL-II	23	50	0					41.73	944,161
DAWOOD         25         50         16         50 <th< td=""><td></td><td>TENAGA</td><td>20</td><td>50</td><td>10</td><td></td><td></td><td></td><td></td><td>47.07</td><td>935,142</td></th<>		TENAGA	20	50	10					47.07	935,142
SACHAL         25         50         0         0         50.23         1,255,093           IPL         30         50         0         0         50.23         1,255,093           IPL         30         50         0         0         50.23         1,506,831           TGS         27         50         0         0         0         39.37         3,00,813           TGS         27         50         0         0         0         39.37         3,00,813           TGT         303         50         0         0         0         39.37         3,00,8142           TRICON 1         322         50         101         0         0         39.44         3,064           TRICON 2         232         50         10         0         0         39.44         3,064           NORABAD         8         12         6         0         0         39.44         3,064         3,044           NORABAD         8         12         6         0         0         39.44         3,043         3,043           INCERASED FENETRATIC         17         0         0         0         0         39.44		DAWOOD	25	50	16					50.23	1,247,279
JPLL         330         500         0         50.23         1,500,831           TGS         277         500         0         0         0         39.37         1,003,817           TGT         330         0.00         0         0         39.37         1,003,817           TGT         330         0.00         0         0         39.37         1,003,017           TGT         330         30.00         0         0         39.37         1,013,013           TRICON 1         322         300         0.00         0         0         39.37         1,013,013           TRICON 2         323         30.00         0.00         0         0         39.64         1,208,342           TRICON 3         27         7.00         0.00         0         0         39.64         1,208,342           NORIABAD         88         12         6         0         0         39.64         1,003,304           NORIABAD         88         12         6         0         0         39.64         1,003,42           INCEMASED PENETATIC         400         0         0         0         0         18.52         311,430		SACHAL	25	50	0					50.23	1,255,693
TGS         C7         C5         C7         C5         C7         C5         C7		JPLL	30	50	0					50.23	1,506,831
TGT         330         50         0         39.37         1,181,130           TRICON 1         322         50         100         0         30.0         39.64         1,268,342           TRICON 2         32         50         100         0         0         39.64         1,268,342           TRICON 3         232         50         100         0         0         39.64         1,268,342           TRICON 3         232         50         0.10         0         0         39.64         1,268,342           NOORIABAD         6.23         0.10         0         0         39.64         39.64         1,007,174           NOORIABAD         6.8         1.2         0.0         0         0         39.64         39.64         310,058           TRICOM         2.5         5.0         0.0         0         0         39.64         39.64         39.64         310,058           CORLU         17.7         0         0         0         0         18.32         311,430           INCREASED PENETRATIC         4.0000         0         0         0         0         0         18.32         311,430           Sub Total 7		TGS	27	50	0					39.37	1,063,017
TRICON 1         33         50         10          39.04         39.04         1,208,342           TRICON 2         32         50         10           39.04         1,208,342           TRICON 3         27         50         10           39.04         1,208,342           NOORJABAD         82         0         0           39.04         1,208,342           TRICON 3         27         50         0           39.04         1,208,342           NOORJABAD         82         12         6           39.04         1,208,342           TRICON 4         23         27         50         0           39.04         39.04         39.04         39.04         39.04         310.075           TRICON 4         23         50         0           39.04         39.04         39.04         39.04         310.075         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04         39.04		TGT	30	50	0					39.37	1,181,130
TRICON 2         32         50         100          39.04         39.04         1,208,342           TRICON 3         27         50         100          39.04         1,071,741           NOORIABAD         88         12         0          39.04         1,071,741           TRICOM         23         530         0           39.04         1,071,741           TRICOM         23         530         0           39.04         1,071,741           TRICOM         223         300         0           39.04         39.04         1,010,103           CORU         117         73         0           18.32         311,430           INCREASED PENETATIC         480         0.000         0           15.00         729,000           Sub Total 7         1386         1852         171            229,131,142		TRICON 1	32	50	10					39.64	1,268,342
TRICON 3         27         50         10          39.04         39.04         1,071,741           NOORIABAD         8         12         0           39.04         310.058           TRICOM         25         30         0           39.04         39.04         310.058           TRICOM         25         30         0           39.04		TRICON 2	32	50	10					39.64	1,268,342
NOORIABAD         8         12         6         9         39.04         39.04         310,038           TRICOM         225         50         0         0         100         39.04         39.04         984,254           ZORLU         17         70         0         18.32         311,430           INCREASED PENETRATI         4460         000         0         18.32         311,430           Sub Total 7         1386         1852         171         109524         8678         3676         4551         229,131,142		TRICON 3	27	50	10					39.64	1,071,741
TRICOM         25         50         0          39.64         3984,254           ZORU         17         77         0          18.32         311,430           INCREASED PENETARTIC         460         000         0          18.32         311,430           Sub Total 7         1386         1852         171          5         229,131,142           Total         22470         28592         14521         109524         8678         3676         4551         229,131,142		NOORIABAD	8	12	0					39.64	310,058
ZORLU         11         37         0         18.32         311,430           INCREASED PENETRATIC         480         1000         0         1         15.00         7,290,000           Sub Total 7         1386         1852         171         1         1         2         1         2         2         2         1         2         2         2         1         2         2         2         2         1         1         2         2         2         2         1         1         2         2         2         3         1         3         3         3         3         1         3		TRICOM	25	50	0					39.64	984,254
INCREASED PENETRATIC         486         1000         0         15.00         7,290,000           Sub Total 7         1386         1852         171         2 <th2< th="">         2         <th2< th=""></th2<></th2<>		ZORLU	17	57	0					18.32	311,430
Sub Total 7         1386         1852         171 <td></td> <td>INCREASED PENETRATIC</td> <td>486</td> <td>1000</td> <td>0</td> <td></td> <td></td> <td></td> <td></td> <td>15.00</td> <td>7,290,000</td>		INCREASED PENETRATIC	486	1000	0					15.00	7,290,000
Total 22470 28592 14521 109524 8678 3676 4551 229,131,142		Sub Total 7	1386	1852	171						
		Total	22470	28592	14521	109524	8678	3676	4551		229,131,142

## Summer Off Peak (Case B): fast-ramping power plants

Diant Trees	Davies Diant	Deser	Denser	Duralia		Droop	Reserve	Reserve	Cost	Operating Cost
Plant Type	Power Plant	Pgen	Pmax	Pmin	ww.s	(MW/Hz)	(+ve)	(-ve)	(Rs/kWh)	(Rs/kWh)
	MANGLA	420	570	170	2559	285	150	250	0.07	28,140
	Ghazi Barotha	1116	1450	1100	5078	725	334	16	0.08	88,175
	Turbela	3470	3478	2478	16892	1739	8	992	0.04	149,210
	Turbela 4 Extension	470	470	470	2261	0	0	0	0.13	62,980
	WARSAK	155	202	25	724	101	47	130	0.11	16,585
	MLKND	70	82	41	286	41	12	29	0.32	22,117
	DARAL KHWAR	30	32	20	160	16	2	10	0.32	9,480
	GOLEN	30	108	20	216	54	78	10	0.34	10,320
1 barding	ALLAI	80	122	80	276	61	42	0	0.22	17,200
Hydro	DBR-KWR	130	130	70	455	0	0	60	0.22	27,950
	KHNKHR	10	72	10	252	36	62	0	0.21	2,110
	PATRIND	104	150	68	750	75	46	37	0.18	18,200
	NBONGSC	37	84	30	87	42	47	7	0.48	17,775
	GULPUR	80	100	10	200	50	20	70	0.19	15,520
	CHASMA	114	114	18	570	0	0	96	0.19	21,774
	KAROT	620	720	232	3362	360	100	388	0.19	118,420
	Sub Total	6936	7884	4841	34127	3585	947	2096		
	JABBAN	22	22	12	36				0.28	6,050
	DARGAI	13	15	5	29				0.09	1,144
	PEHUR	5	28	5	38				0.63	3,170
	GML-ZAM	9	17	5	39				0.63	5,706
	KRM.GRHI	5	5	0	3				0.26	1,275
	JAGRAN	24	33	5	59				2.59	62,160
Small Hydro	MARALA SH	7	8	4	15				2.59	19,166
	NANDPR	6	14	6	18				0.13	792
	RENALA	1	1	1	1				0.34	342
	SHISHI	2	2	1	2				0.34	513
	RESHUN	4	4	2	4				0.34	1,368
	JINNAH	39	96	24	249				0.27	10,424
	Sub Total	137	245	69	492					
	JDW	24	26	10	73				9.05	217,260
	CHINIOTPP	27	62	20	51				10.34	279,307



Bagass	FATIMA	32	66	25	294				10.34	331.030
DaBass	AL MOIZ	17	30	10	135		i — — — — — — — — — — — — — — — — — — —		10.18	173,143
	Cub Tatal	100	104	CE.	553				10.10	173,143
	Sub Total	100	184	65	552					
	K2 UNT	1032	1040	730	5595		i		0.95	980,400
Nuclear	K3 UNT	1032	1040	730	5595				0.95	980,400
Nuclear	CHASHNUP	926	947	600	7078				1.02	940,816
	Sub Total	2990	3027	2060	18269					
	NSHTCHN	68	195	68	345 15	97.5	127	0	41.92	2 850 676
	NICHT DWD	190	105	60	345.15	97.5	127	112	41.52	2,050,070
	NISHT-PWK	100	195	00	545.15	37.5	15	112	11.40	2,051,256
	AGL-IPP	68	156	68	280.8	/8	88	0	36.64	2,491,289
	K.E.L	44	124	44	148.8	62	80	0	41.39	1,821,187
	LIBERTY Tech	69	188	69	1.77	332.76	119	0	42.91	2,960,721
	LIBERTY Power	174	194	90	8.56	888.64	20	84	5.52	959,888
	FNDTION	156	165.5	63	1109.489	76.85	10	93	9.43	1,470,843
	UCH 1	500	500	477.2	2611	0	0	23	3.10	1,551,210
	GUDDU	290	300	210	2163	50	10	80	10.02	2.906.844
	GUD.CCPP	480	480	340	3259.2	0		140	11.98	5 751 456
	BALLOVI	400	1008	720	5059.22	512.2	210	140	22.56	10,953,953
	UDS	707	1050	750	5300.22	512.2	210	130	22.30	13,033,302
	HBS	/9/	1050	/50	5706.4	490	253	47	22.34	17,807,403
	TRIMMU	667	740	560	2937.45	332.5	73	107	22.16	14,781,887
Thermorel	UCH2	360	372	297.6	2396.92	173.6	12	62	13.42	4,830,361
	HALMOR	123	175	119	836.5	82	52	4	28.20	3,468,188
	SAPHIRE	125	130	66	621.4	65	5	59	27.71	3,464,140
	ENGRO power	100	130	40	882.7	65	30	60	9.86	986.373
	NANDER	354	354	248	291/ 02	0	0	106	28.03	9 973 788
	DOT CEDD	750	000	240	2014.02	300	150	100	20.03	17 129 200
	PRICEPP	/50	900	660	3272.4	360	150	90	22.84	17,128,350
	LUCKY	580	606	303	2484.6	242.4	26	277	13.86	8,041,004
	SECL	1066	1200	600	4692	0	134	466	4.41	4,695,730
	SAHIWAL	330	621	330	2426	298	291	0	23.29	7,685,172
	TEL	300	300	110	1146.39	0	0	190	5.18	1,555,350
	THAL NOVA	300	300	110	1146.39	0	0	190	5.19	1,557,000
	HUB CHINA	600	625	270	1950	250	25	330	22.85	13,712,100
	HUBCO CERR	240	1200	240	3656	480	960	0	40.57	9,737,256
	HUDCO CIPP	170	200	170	000.5	140	180		40.57	5,131,235
	AESPKGN	1/0	350	170	990.5	140	100	U	37.03	0,337,860
	Sub Total	9771	12649 L	7101	54301	5174	2878	2670		
	OAD-SOLAR	20	100	0			1		32,46	649,168
	QAD-SOLAR	20	100	0					32.46	649,168 1.005,738
	QAD-SOLAR CREST ENE	20 20	100 100	0					32.46 50.29	649,168 1,005,738 1,750,725
Solar	QAD-SOLAR CREST ENE BESTGREEN	20 20 35	100 100 100	0					32.46 50.29 50.02	649,168 1,005,738 1,750,725
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR	20 20 35 75	100 100 100 100	0 0 0					32.46 50.29 50.02 14.62	649,168 1,005,738 1,750,725 1,096,500
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIO	20 20 35 75 1000	100 100 100 100 2500	0 0 0 0					32.46 50.29 50.02 14.62 15.00	649,168 1,005,738 1,750,725 1,096,500 15,000,000
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC	20 20 35 75 1000 1150	100 100 100 2500 <b>2900</b>	0 0 0 0					32.46 50.29 50.02 14.62 15.00	649,168 1,005,738 1,750,725 1,096,500 15,000,000
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total	20 20 35 75 1000 1150	100 100 100 2500 <b>2900</b>	0 0 0 0					32.46 50.29 50.02 14.62 15.00	649,168 1,005,738 1,750,725 1,096,500 15,000,000
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA	20 20 35 75 1000 <b>1150</b> 27	100 100 100 2500 <b>2900</b> 50	0 0 0 0 0 0 16					32.46 50.29 50.02 14.62 15.00 38.68	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER	20 20 35 75 1000 <b>1150</b> 27 23	100 100 100 2500 <b>2900</b> 50 50	0 0 0 0 16 16					32.46 50.29 50.02 14.62 15.00 38.68 44.46	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR	20 20 35 75 1000 <b>1150</b> 27 23 20	100 100 100 2500 <b>2900</b> 50 50 50	0 0 0 0 16 16 16					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,886
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD	20 20 35 75 1000 <b>1150</b> 27 23 20 27	100 100 2500 <b>2900</b> 50 50 50 50	0 0 0 16 16 16 16 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIO Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC	20 20 35 75 1000 <b>1150</b> 27 23 20 27 27 27	100 100 100 2500 <b>2900</b> 50 50 50 50 50	0 0 0 16 16 16 16 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,856 1,202,640 577,962
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2	20 20 35 75 1000 <b>1150</b> 27 27 20 27 27 27	100 100 100 2500 2500 50 50 50 50 50 50 50	0 0 0 16 16 16 16 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E	20 20 35 75 1000 1150 27 23 20 27 27 27 27 27 27 27	100 100 100 2500 <b>2900</b> 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1	20 20 35 75 1000 <b>1150</b> 27 23 20 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIO Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1	20 20 35 75 1000 <b>1150</b> 27 27 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY2	20 20 35 75 1000 1150 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 2900 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,662 377,449 381,845 319,740 293,639
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY2 INDUS	20 20 35 75 1000 1150 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50 50 50	0 0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIO <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 INDUS NASDA	20 20 35 75 1000 <b>1150</b> 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE	20 20 35 75 1000 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 13.86	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2	20 20 35 75 1000 1150 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.83 13.83 36.77	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR	20 20 35 75 1000 <b>1150</b> 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY1 INDUS NASDA LAKESIDE METRO-2 MASTER GR EFCCI	20 20 35 75 1000 27 27 27 27 27 27 27 27 25 23 20 26 31 20 26 31 20 26	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 13.86 13.83 36.77 14.77 11.76	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO.	20 20 35 75 1000 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 2900 50 50 50 50 50 50 50 50 50 50 50 50 5	0 0 0 16 16 16 16 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,826
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO	20 20 35 75 1000 1150 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77 33.29	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,962 377,962 331,014 273,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY1 INDUS NASDA LAKESIDE MASTER GR FFCEL METRO-2 MASTER GR	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 14.39 13.86 13.83 36.77 14.47 11.76 36.77 33.29	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,202,640
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL	20 20 35 75 1000 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 2900 50 50 50 50 50 50 50 50 50 50 50 50 5	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 14.39 13.86 13.83 36.77 14.47 11.76 36.77 33.29 34.39	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,045,816 1,022,640 714,866 1,202,260 577,62 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 2900 50 50 50 50 50 50 50 50 50 50 50 50 5	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000 1,0045,816 1,022,640 714,866 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,661 530,782
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 13.87	649,168 1,005,738 1,750,725 1,096,500 15,000,000 1,045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 36,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC Sub Total HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 25 23 20 26 31 20 20 20 20 20 20 20 20 20 20 20 20 20	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 14.39 13.86 13.83 36.77 14.47 11.62 36.77 33.29 34.39 21.37 33.29	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000,000 10,001,004,816 1,022,640 714,866 1,202,260 714,866 1,202,260 377,449 381,845 319,740 233,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,246 235,218 735,246 235,218 735,48 495,931 1,203,601 530,782 277,318
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 38.56 48.55	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000 1,045,816 1,022,640 714,866 1,202,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,840 495,931 1,203,601 530,782 277,318 888,859 1,116,634
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE TGE	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 <b>2900</b> 50 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 16 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 13.87 38.56 48.55 48.59	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000 1,0045,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318 886,859 1,116,634 1,040,273
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY1 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE TGF	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.66 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 14.39 13.86 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 13.87 38.56 48.55 48.55	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000 1,0045,816 1,022,640 714,866 1,202,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,788 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318 886,859 1,116,634 1,040,273 205,459 205,451 205,455 205,4
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE TGF	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 2900 50 50 50 50 50 50 50 50 50 50 50 50 5	0 0 0 0 16 16 16 16 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 14.39 13.86 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 38.56 48.55 45.98 42.05	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000,000 10,004,816 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318 888,859 1,116,634 1,040,273 835,449
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE TGF FWEL-II FWEL-II	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 33.29 34.39 21.37 13.87 38.56 48.55 45.98 42.05	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000 10,045,816 1,022,640 714,866 1,022,640 714,866 1,202,260 577,962 377,962 371,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318 886,859 1,116,634 1,040,273 835,449 944,161
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE TGF FWEL-I FWEL-I FWEL-I FWEL-I FWEL-I TENAGA	20 20 35 75 1000 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 14.39 13.86 13.83 36.77 36.77 33.29 34.39 21.37 13.87 38.56 48.55 48.55 48.55 41.73	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000 1,0045,816 1,022,640 714,866 1,022,640 714,866 1,202,260 577,962 377,449 3819,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318 886,859 1,116,634 1,040,273 835,449 944,161 935,142
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE TGF FWEL-II TENAGA DAWOOD	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 50 50 50 50 50 50 50 50 50 50 50 50	0 0 0 16 16 16 16 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 14.39 13.86 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 38.56 48.55 45.98 42.05 41.73 37.07 50.23	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000,000 10,000,000 10,001,004,816 1,022,640 714,866 1,202,260 577,62 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318 886,859 1,116,634 1,040,273 835,449 944,161 935,142 1,247,279
Solar	QAD-SOLAR CREST ENE BESTGREEN ATLAS SOLAR INCREASED PENETRATIC <b>Sub Total</b> HAWA MASTER ZEPHYR G AHMD ARTISTIC ACT2 DIN-E LIBERTY1 LIBERTY2 INDUS NASDA LAKESIDE METRO-2 MASTER GR FFCEL METRO TAPAL UEPL ARTISTIC GULAHMAD YUNUS SAPHIRE TGF FWEL-I CATOR CONSTRUC	20 20 35 75 1000 27 23 20 27 27 27 27 27 27 27 27 27 27 27 27 27	100 100 2500 2900 50 50 50 50 50 50 50 50 50 50 50 50 5	0 0 0 16 16 16 0 0 0 0 0 0 0 0 0 0 0 0 0					32.46 50.29 50.02 14.62 15.00 38.68 44.46 35.74 44.46 21.37 13.96 14.12 11.82 11.82 11.82 11.82 11.82 13.83 36.77 14.47 11.76 36.77 33.29 34.39 21.37 38.56 48.55 45.98 42.05 41.73 47.07 50.23 50.23	649,168 1,005,738 1,750,725 1,096,500 15,000,000 10,000 1,045,816 1,022,640 714,866 1,022,640 714,866 1,202,260 577,962 377,449 381,845 319,740 293,639 331,014 277,294 366,342 1,156,708 375,246 235,218 735,480 495,931 1,203,601 530,782 277,318 888,859 1,116,634 1,040,273 835,449 944,161 935,142 1,247,279 1,255,693



TGS	27	50	0					39.37	1,063,017
TGT	30	50	0					39.37	1,181,130
TRICON 1	32	50	10					39.64	1,268,342
TRICON 2	32	50	10					39.64	1,268,342
TRICON 3	27	50	10					39.64	1,071,741
NOORIABAD	8	12	6					39.64	310,058
TRICOM	25	50	0					39.64	984,254
ZORLU	17	57	0					18.32	311,430
INCREASED PENETRATIO	486	1000	0					15.00	7,290,000
Sub Total	1386	2852	171						
Total	22470	29741	14306	107741	8759	3825	4766		223,731,675

### Winter Peak (Case A): baseload coal-fired power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (· ve)	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	Ghazi Barotha	526	580	460	2031	290	54	66	0.079	41,583
	Turbela	500	650	375	3268	325	150	125	0.043	21,500
	MLKND	23	23	14	82	0	0	10	0.316	7,372
	DARAL KHWAR	30	68	20	340	34	38	10	0.316	9,480
	GOLEN	20	50	20	100	25	30	0	0.344	6,880
	ALLAI	40	40	40	90	0	0	0	0.215	8,600
Hudro	DBR-KWR	70	70	70	245	0	0	0	0.215	15,050
inyuro	KHNKHR	10	10	10	35	0	0	0	0.211	2,110
	PATRIND	69	69	68	345	0	0	2	0.175	12,075
	NBONGSC	37	37	30	38	0	0	7	0.4804	17,775
	GULPUR	20	20	10	40	0	0	10	0.194	3,880
	CHASMA	58	58	18	290	0	0	40	0.191	11,078
	KAROT	160	180	58	841	90	20	102	0.191	30,560
	Sub Total	1564	1855	1192	7745	764	292	372		
	JABBAN	11	11	0	18				0.275	3,025
	PEHUR	5	5	5	7				0.634	3,170
	GML-ZAM	9	9	5	20				0.634	5,706
	KRM.GRHI	5	5	0	3				0.255	1,275
Small Hudro	JAGRAN	10	10	5	18				2.59	25,900
Smail Hyuro	MARALA SH	7	7	4	0				2.59	19,166
	NANDPR	6	14	6	15				0.13	792
	JINNAH	39	39	24	101				0.27	10,424
	SHISHI	2	2	1	3				0.34	513
	Sub Total	94	102	56	185					
	WDL	24	26	10	73				9.05	217,260
Bagass	CHINIOTPP	27	62	20	51				10.34	279,307
Dagass	FATIMA	25	32	32	142				10.34	258,618
	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	93	150	72	401					
	K2 UNT	1032	1032	730	5552				0.95	980,400
Number	K3 UNT	1032	1032	730	5552				0.95	980,400
Nuclear	CHASHNUP	1241	1241	800	9004				1.02	1,260,856
	Sub Total	3305	3305	2260	20108					
	ATLAS	213	213	75	359.97	0	0	138	35.47	7,555,530
	NSHTCHN	117	195	68	345.15	97.5	78	49	41.92	4,904,839



	K.E.L	114	124	44	148.8	62	10	70	41.39	4,718,531
	NISHT-PWR	190	195	68	345.15	97.5	5	122	11.40	2,105,259
	LIBERTY Tech	178	195	69	345.15	78	17	109	42.91	7,637,802
	FNDTION	170	185.97	63	1246.75842	87.045	15.97	107	9.43	1,602,842
	GUD-CCPP	340	480	340	3259.2	240	140	0	11.98	4,073,948
	UCH 1	550	550	477.2	2892.5	0	0	72.8	3.10	1,706,331
	Engro Power	110	110	89.2	553.3	0	0.04	0	9.86	1,085,010
	Engro Thar	540	602	300	2094.96	240.8	62	240	5.13	2,772,306
	BALLOKI	830	1189	730	6463.46	554.6	359	100	22.56	18,725,896
	TRIMMU	650	805	560	2601.3	361.5	155	90	22.16	14,405,138
	UCH2	372	372	297.6	2396.92	0	0	74.4	13.42	4,991,373
	HBS	794	794	510	4477.4	0	0	284	22.34	17,740,374
	TEL	300	301	110	1150.2113	120.4	1	190	5.18	1,555,350
	SECL	1230	1230	600	4809.3	0	0	630	4.41	5,418,150
	LUCKY	303	606	303	2484.0	242.4	303	0	13.80	4,200,731
	THAL NOVA	300	300	110	1146.39	0	0	190	5.19	1,557,000
	SAHIWAL	704	1242	660	4856.22	496.8	538	44	23.29	10,395,034
	Sub Total	8005		5474	41977	2679	1684	2510		
Solar	INCREASED PENETRATI	1500	2500	0					15.00	22,500,000
	HAWA	27	50	10					38.68	1,045,816
	TENAGA	20	50	10					47.07	935,142
	DAWOOD	25	50	16					50.23	1,247,279
	ZEPHYR	26	50	16					35.74	927,042
	SACHAL	32	50	0					50.23	1,610,953
	JPLL	38	50	0					50.23	1,925,288
	TGS	34	50	0					39.37	1,324,342
	TGT	37	50	0					39.37	1,447,538
Marcine al	ACT2	27	50	0					13.96	377,449
wind	DIN-E	27	50	0					14.12	381,845
	LIBERTY1	27	50	0					11.82	319,740
	LIBERTY2	25	50	0					11.82	293,639
	NASDA	28	50	0					13.80	382,549
	LAKESIDE	26	50	0					13.83	300,342
	MASTER GR	26	50	0					14.47	375,246
	NOORIABAD	8	12	0					39.64	310,058
	INCREASED PENETRATI	600	1000	0					15.00	9,000,000
	Sub Total	1032	1760	72						
	Total	15593	19361	9125	70416	3443	1976	2882		172,389,615

## Winter Peak (Case B): fast-ramping power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve (+ve)	Reserve (-ve)	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	Ghazi Barotha	520	580	460	2031	290	54	60	0.08	41,583
	Turbela	500	650	375	3268	325	150	125	0.04	21,500
	MLKND	23	23	14	82	0	0	10	0.32	7,372
	DARAL KHWAR	30	68	20	340	34	38	10	0.32	9,480
	GOLEN	20	50	20	100	25	30	0	0.34	6,880
	ALLAI	40	40	40	90	0	0	0	0.22	8,600
Hudro	DBR-KWR	70	70	70	245	0	0	0	0.22	15,050
nyuro	KHNKHR	10	10	10	35	0	0	0	0.21	2,110
	PATRIND	69	69	68	345	0	0	2	0.18	12,075
	NBONGSC	37	37	30	38	0	0	7	0.48	17,775
	GULPUR	20	20	10	40	0	0	10	0.19	3,880
	CHASMA	58	58	18	290	0	0	40	0.19	11,078
	KAROT	160	180	58	841	90	20	102	0.19	30,560
		1564	1855	1192	7745	764	292	372		
	JABBAN	11	11	0	18				0.28	3,025
	PEHUR	5	5	5	7				0.63	3,170
	GML-ZAM	9	9	5	20				0.63	5,706
	KRM.GRHI	5	5	0	3				0.26	1,275
Conall Hudro	JAGRAN	10	10	5	18				2.59	25,900
Small Hydro	MARALA SH	7	7	4	0				2.59	19,166
	NANDPR	6	14	6	15				0.13	792
	JINNAH	39	39	24	101				0.27	10,424
	SHISHI	2	2	1	3				0.34	513
		94	102	56	185					
	WDL	24	26	10	73				9.05	217,260
	CHINIOTPP	27	62	20	51				10.34	279,307
Bagass	FATIMA	25	32	32	142				10.34	258,618
_	AL MOIZ	17	30	10	135				10.18	173,143
		93	150	72	401					
	K2 UNT	1032	1032	730	5552				0.95	980,400
	K3 UNT	1032	1032	730	5552				0.95	980,400
Nuclear	CHASHNUP	1241	1241	800	9004				1.02	1,260,856
		3305	3305	2260	20108					
	ATLAS	213	213	75	277	0	0	138	35.47	7,555,530
	NSHTCHN	117	195	68	1324	98	78	49	41.92	4,904,839



	K.E.L	114	124	44	149	62	10	70	41.39	4,718,531
	NISHT-PWR	190	195	68	1324	98	5	122	11.40	2,165,259
	LIBERTY tech	178	195	69	891	78	17	109	42.91	7,637,802
	FNDTION	170	186	63	1246	87	16	107	9.43	1,602,842
	GUD-CCPP	340	480	340	3259	240	140	0	11.98	4,073,948
	UCH 1	594	597	477	3124	279	3	117	3.10	1,842,837
	ENGRO power	650	712	389	2642	296	62	261	9.86	6,411,425
	BALLOKI	830	1189	730	6463	555	359	100	22.56	18,725,896
	TRIMMU	650	805	560	4049	362	155	90	22.16	14,405,138
	UCH2	372	372	298	2397	0	0	74	13.42	4,991,373
	HBS	644	794	510	4473	357	150	134	22.34	14,388,918
	TEL	301	301	110	1150	0	0	191	5.18	1,560,535
	SECL	1157	1230	600	4809	492	73	557	4.41	5,096,585
	LUCKY	606	606	303	1830	0	0	303	13.86	8,401,463
	THAL NOVA	300	300	110	945	0	0	190	5.19	1,557,000
	HUBCO CCFP	240	1200	240	3050	480	960	0	40.57	9,737,256
	SAHIWAL	339	660	330	4836	497	321	9	23.29	7,894,768
		8005	10353	5384	48865	3978	2348	2621		
Solar	INCREASED PENETRATI	1500	2500	0					15.00	22,500,000
	HAWA	27	50	16					38.68	1,045,816
	TENAGA	20	50	10					47.07	935,142
	DAWOOD	25	50	10					50.23	1,247,279
	ZEPHYR	26	50	16					35.74	927,042
	SACHAL	32	50	0					50.23	1,610,953
	JPLL	38	50	0					50.23	1,925,288
	TGS	34	50	0					39.37	1,324,342
	TGT	37	50	0					39.37	1,447,538
115-1	ACT2	27	50	0					13.96	377,449
Wind	DIN-E	27	50	0					14.12	381,845
	LIBERTY1	27	50	0					11.82	319,740
	LIBERTY2	25	50	0					11.82	293,639
	NASDA	28	50	0					13.86	382,549
	LAKESIDE	20	50	0					13.83	300,342
	MASTER GR	26	50	0					14.47	375,246
	NOORIABAD	8	12	0					39.64	310,058
	INCREASED PENETRATI	600	1000	0					15.00	9,000,000
		1032	1760	72						
		15593	20025	9035	77305	4742	2640	2993		176,850,115

## Winter Off Peak (Case A): baseload coal-fired power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop	Reserve	Reserve (-	Cost	Operating Cost
						(MW/Hz)	(+ve)	ve)	(Rs/kWh)	(Rs/kWh)
Hydro	Turbela	210	390	210	1872	195	180	0	0.04	9,030
	MLKND	23	23	14	82	0	0	10	0.32	7,372
	DARAL KHWAR	15	15	10	75	0	0	5	0.32	4,740
	GULPUR	20	20	10	40	0	0	10	0.19	3,880
	CHASMA	58	58	18	290	0	0	40	0.19	11,078
	KAROT	160	180	58	841	90	20	102	0.19	30,560
	Sub Total	486	686	320	3199	285	200	167		
	JABBAN	11	11	6	18				0.28	3,025
	JAGRAN	10	10	5	18				2.59	25,900
	MARALA SH	7	7	4	13				2.59	19,166
Small Hydro	RESHUN	3	4	2	7				0.34	1,026
Small Hyuro	RENALA	1	1	1	1				0.34	342
	JINNAH	34	34	21	89				0.27	9,185
	SHISHI	2	2	1	3				0.34	513
	Sub Total	68	69	39	150					
	JDW	24	26	10	73				9.05	217,260
	CHINIOTPP	27	27	20	22				10.34	279,307
Bagass	FATIMA	32	32	25	142				10.34	331,030
-	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	100	115	65	372					
	K2 UNT	745	1040	730	5595				0.95	707,750
Number	K3 UNT	745	1040	730	5595				0.95	707,750
Nuclear	CHASHNUP	1000	1263	800	9170				1.02	1,016,000
	Sub Total	2490	3343	2260	20360					
Thermal	UCH 1	500	550	477.2	2892.5	257.5	50	22.8	3.10	1,551,210
	Engro Power	90	110	89.2	553.3	55	20	0.8	9.86	887,736
	ENGRO Thar	580	602	300	2094.96	240.8	22	280	5.13	2,977,662
	BALLOKI	1135	1189	730	6463.46	554.6	54	405	22.56	25,607,098
	TRIMMU	380	395	167	1137.6	197.5	15	213	22.16	8,421,465
	UCH2	114	124	99.2	777.48	62	10	14.8	13.42	1,529,614
	SECL	600	1250	600	4887.5	500	650	0	4.41	2,643,000
	THAL NOVA	205	300	110	1146.39	120	95	95	5.19	1,063,950
	Sub Total	3604	4520	2573	19953	1987	916	1031		
Solar	INCREASED PENETRA	1100	2500	0					15.00	16,500,000
	HAWA	20	50	16					38.68	773,538



	ZEPHYR	20	50	16					35.74	714,866
	DIN-E	10	50	0					14.12	141,216
	LIBERTY1	10	50	0					11.82	118,248
	LIBERTY2	10	50	0					11.82	118,248
	MASTER GR	10	50	0					14.47	144,681
117-1	DAWOOD	20	50	16					50.23	1,004,554
wind	SACHAL	20	50	0					50.23	1,004,554
	JPLL	20	50	0					50.23	1,004,554
	TGS	20	50	0					39.37	787,420
	TGT	10	50	0					39.37	393,710
	NOORIABAD	8	12	6					39.64	310,058
	INCREASED PENETRA	414	1000	0					15.00	6,210,000
	Sub Total	592	1561	55						
	Total	8440	12794	5311	44035	2272	1116	1198		77,465,440

Winter Off Peak (Case B): fast-ramping power plants

Plant Type	Power Plant	Pgen	Pmax	Pmin	Mw.s	Droop (MW/Hz)	Reserve	Reserve (-	Cost (Rs/kWh)	Operating Cost (Rs/kWh)
	Turbela	210	390	210	1977	105	(190)	vej	0.04	9.030
Hydro	MIKND	210	330	210	10/2	195	100	10	0.32	3,030
	DARAL KHWAR	15	15	10	75	0	0		0.32	4,740
	GULPUR	20	20	10	40	0	0	10	0.19	3,880
	CHASMA	58	58	18	290	0	0	40	0.19	11.078
	KAROT	160	180	58	841	90	20	102	0.19	30,560
	Sub Total	486	686	320	3199	285	200	167		
	JABBAN	11	11	6	18				0.28	3,025
	JAGRAN	10	10	5	18				2.59	25,900
	MARALA SH	7	7	4	13				2.59	19,100
Concell Mandam	RESHUN	3	4	2	7				0.34	1,026
Small Hydro	RENALA	1	1	1	1				0.34	342
	JINNAH	34	34	21	89				0.27	9,185
	SHISHI	2	2	1	3				0.34	513
	Sub Total	68	69	39	150					
	JDW	24	26	10	73				9.05	217,260
Barrace	CHINIOTPP	27	27	20	22				10.34	279,307
Dagass	FATIMA	32	32	25	142				10.34	331,030
	AL MOIZ	17	30	10	135				10.18	173,143
	Sub Total	100	115	65	372					
	K2 UNT	745	1040	730	5595				0.95	707,750
Nuclear	K3 UNT	745	1040	730	5595				0.95	707,750
	CHASHNUP	1000	1263	800	9170				1.02	1,016,000
	Sub Total	2490	3343	2260	20360					
	UCH 1	580	597	477	3124	279	17	103	3.10	1,799,404
	ENGRO Power	700	712	389	2642	296	12	311	9.86	6,904,611
	BALLOKI	300	399	270	2490	200	99	30	22.50	6,768,396
	TRIMMU	314	395	167	1987	198	81	147	22.16	6,958,790
Thermal	UCH2	100	124	99	777	62	24	1	13.42	1,341,767
	SECL	1150	1250	600	4888	500	100	550	4.41	5,065,750
	HUBCO CCFP	180	900	180	3656	517	720	0	40.57	7,302,942
	THAL NOVA	280	300	110	945	120	20	170	5.19	1,453,200
	Sub Total	3604	4677	2293	20509	2170	1073	1311		
Solar	INCREASED PENETRA	1100	2500	0					15.00	16,500,000
	HAWA	20	50	16					38.68	773,538
	ZEPHYR	20	50	16					35.74	714,800
	DIN-E	10	50	0					14.12	141,210
	LIBERTY1	10	50	0					11.82	118,248
Wind	LIBERTY2	10	50	0					11.82	118,248
	MASTER GR	10	50	0					14.47	144,681
	DAWOOD	20	50	10					50.23	1,004,554
	SACHAL	20	50	0					50.23	1,004,554
	JPLL	20	50	0					50.23	1,004,554
	TGS	20	50	0					39.37	787,420
	IGI	10	50	0					39.37	393,710
	NOORIABAD	8	12	0					39.64	310,058
	INCREASED PENETRA	414	1000	0					15.00	6,210,000
	Sub Total	592	1561	55						
	Total	8440	12951	5031	44591	2455	1273	1478		70,378,564