XI PLAN PROGRAMME

6.1 In transmission system development in the country, the focus of XI Plan programme is formation of the National Power Grid which has been recognized as a flagship endeavor towards planned growth of power sector on the path leading to fulfillment of the objective of 'Electricity for All' at affordable prices. A strong All India Grid would enable exploitation of unevenly distributed generation resources in the country to their optimum potential by providing enhanced margins in inter-regional transmission system. These margins, together with open access in transmission, would facilitate increased real time trading in electricity leading to market determined generation dispatches thereby resulting in supply at reduced prices to the distribution utilities and ultimately to the consumers. Development of National Grid has been necessitated by the large thermal generation potential in eastern part of the country and equally large hydro generation potential in north-eastern part. It has also been spurred by the opportunity provided by open access, variation in hydrology / hydro potential and diversity of load across the country.

6.2 Evolving the perspective transmission system for XI Plan end scenario

6.2.1 Identification of 11th Plan transmission expansion plan was done based on Power System Studies corresponding to the scenario at the end of 11th Plan. The phased implementation programme was subsequently worked out keeping in view identification of projects, schemes and transmission elements that should be implemented matching with programme of generation capacity addition and load growth on yearly basis up to 2011-12. Timely development of transmission network requires firming-up of the specific schemes and

proposals particularly in respect of inter-state transmission system, which need to be done at least 5 years ahead of the target date of completion. Meeting this requirement, most of the 11th Plan schemes have already been identified, discussed in the Regional Standing Committees on Transmission Planning, finalized, scheme formulated and process of investment approval initiated. Investment approvals for some of the schemes have already been obtained and have taken-off into the construction stage. The ***"PERSPECTIVE TRANSMISSION PLAN 2011-2012"*** brought out by CEA, as a prelude to planning of 10th and 11th Plan transmission system, has been the basis for identifying the alternatives for the detailed studies based on which the specific schemes were evolved, discussed and firmed-up.

6.2.2 The above process was adopted to evolve the inter-state transmission system for the 11th Plan. Of the evolved system, the transmission system required to be in place by the year 2009-10 has been firmed-up. Some of the schemes for 2010-12 have also been firmed-up in consultation with the stakeholders through the process of discussions in the Regional Standing Committees on Transmission Planning. A few schemes required for completion by the end of 11th Plan are under process of firming-up.

6.2.3 The transmission schemes for power evacuation and regional system strengthening corresponding to additional generation capacity of the following 11th Plan Central sector generation projects have already been identified/firmed-up:

Northern Region: Parbati-II HEP (800 MW), Parbati-III HEP (520 MW), Chamera- III HEP (231 MW), Uri-II HEP (240 MW), Kishanganga HEP (330 MW), Koldam HEP (800 MW), Tehri-II PSS HEP (1000 MW), Koteshwar HEP (400 MW) and RAPP U 5&6 APP (440 MW)

Western Region; Sipat-II+I (1000 + 1980 MW), Kawas-II (725 + 575 MW) and Gandhar-II (725 + 575 MW)

Southern Region: Kudankulam U1&2 (2000 MW), PFBR (500 MW), Kaiga U3&4 (220 + 220 MW) and Neyveli TPS II (500 MW).

Eastern Region: Maithon RB (1000 MW), Barh (1980 MW) and Teesta Low Dam III &IV (292 MW).

North Eastern Region: Monarchak CCGT (280 MW), Turial HEP (60 MW), Ranganadi II (130 MW), Tuivai HEP (210 MW) and Lower Kopili HEP (150 MW)

The transmission schemes are:

Region	**Scheme/ scheme group**	**Transmission System**
NR	Evacuation System for Koldam (800 MW), Parbati-II (800 MW) and Parbati-III (520 MW)	<u>Transmission system common with Parbati II and Koldam</u> 1. Koldam – Nalagarh 400kV D/C line (quad) <u>Transmission system for Koldam</u> 1. 2 nos. 400kV bays for Koldam-Nalagarh/ Parbati II 2. Koldam – Ludhiana 400kV D/C line <u>Transmission system for Parbati II</u> 1. Parbati II - Koldam 400kV 2xS/C line (quad) <u>Transmission system for Parbati III</u> 1. LILO of one circuit of Parbati II - Koldam 400kV line at Parbati III 2. Creation of 400kV pooling point at Parbati (Panarsa) 3. LILO of both Parbati II - Koldam 400kV 2xS/C line at Panarsa 4. Panarsa – Amritsar 400kV D/C line
NR	Evacuation System for Chamera- III (231 MW)	1. Creation of 400/220kV pooling station near Hamirpur 2. Chamera III – Hamirpur, 220kV

		D/C line 3. Hamirpur – Jullundur 400kV D/C line (220kV operated)
NR	Evacuation System for Uri-II HEP (240 MW)	1. Uri-I – Uri-II, 400kV S/C 2. Uri-II – Wagoora 400kV S/C line
NR	Evacuation System for Kishanganga HEP (330 MW)	1. Kishanganga – New Wanpow 220kV D/C line via Alistang S/S 2. Kishanganga – Amargarh 220kV D/C line via Alistang S/S
NR	Evacuation System for Rampur HEP (434 MW)	1. LILO of Nathpa Jhakri - Nalagarh 400 kV D/C at Rampur HEP 2. Ludhiana - Patiala 400 kV D/C 3. LILO of Patiala -Hissar 400 kV line at Kaithal 4. LILO of Nalagarh - Kaithal 400 kV line at Patiiala
NR	Evacuation System for Tehri PSS (1000 MW) & Koteshwar (400 MW), Lohari Nagpala HEP (600 MW)	<u>With Koteshwar</u> 1. Establishment of 400kV GIS Tehri Pooling Station 2. LILO of Tehri – Meerut 765kV at Tehri Pooling Point 3. Koteshwar – Tehri Pooling Point , 400kV D/C line 4. Series Compensation 50 % on the Tehri – Meerut 765kV 2xS/C lines (charged at 400kV) <u>With Tehri PSS</u> 1. Tehri – Tehri Pooling Station, 400kV S/C (quad) line 2. LILO of Bareilly – Mandaula 400kV D/C line at 400kV Meerut S/S 3. Charging Tehri Pooling Stn – Meerut line at 765kV 4. Tehri Pooliong Station (GIS) 765/400kV , 3x1500MVA 5. Meerut S/S (GIS) 765/400kV, 3x1500MVA 6. Modification of Series capacitors on the Tehri-Meerut lines for 765kV operation <u>With Lohari Nagpala</u> 1. Lohari Nagpala HEP – Tehri/Koteshwar Pooling Point 400kV D/C line (triple moose)

		2. Meerut – Agra 765kV S/C line 3. Second 765/400kV transformer at Agra 765kV S/S-
NR	Evacuation System for Tapovan Vishnugad HEP (520 MW) and Lata Tapovan (108 MW)	1. Tapovan Vishnugad – Roorkee 400kV D/C line (the line to be routed via Kuwari Pass where a 400/132kV pooling station is proposed) 2. Lata Tapovan – Kuwari Pass Pooling Station 132kC D/C line
NR	Evacuation System for RAPP U 5&6 APP (440 MW)	1. RAPP – Kankroli 400kV D/C line 2. RAPP – Kota 400kV S/C line 3. Kota 400/220kV S/S 2x315 MVA 4. Kankroli 400/220kV S/S, 3x315 MVA <u>Supplementary regional schemes to match with RAPP 5&6</u> 1. Kota – Merta 400kV D/C line 2. Kankroli – Jodhpur 400kV S/C line
NR	**Northern Region System Strengthening -V**	1. Moga-Bhiwadi, 400kV D/C line 2. Agra-Bhiwadi, 400kV D/C line 3. LILO of Hissar-Jaipur 400kV D/C line at Bhiwadi 4. Agra Sw.Stn.-Extn- 2 bays 5. Moga S/S - Extn. – 2 Bays + 2x63 MVAR line reactor on Bhiwadi-Moga D/C line 6. Bhiwadi S/S – Extn. – 6 Bays + 2x63 MVAR line reactor on Bhiwadi-Moga D/C line, 1x50 MVAR reactor on Bhiwadi-Jaipur S/C line and 1x80 MVAR reactor at Bhiwadi

Region	**Scheme/ scheme group**	**Transmission System**
WR	Evacuation System for Sipat-II+I (1000 + 1980 MW)	<u>ATS with Sipat-I (3x660 MW)</u> 1. Sipat-Seoni 765 kV 2X S/C 2. Seoni-Khandwa 400 kV D/C 3. Nagda-Dehgam 400 kV D/C 4. LILO of Korba-Raipur at Sipat 400 kV D/C

		5. LILO of Bhilai-Satpura at Seoni 400 kV D/C 6. Seoni 765/400 kV 7x500 MVA and 400/220 kV 2x315 MVA s/s 7. Rajgarh 400/220 kV 2x315 MVA s/s by LILO of Sardar Sarovar - Dhule D/C line <u>ATS with Sipat-II (2x500 MW)</u> 1. Khandwa-Rajgarh 400 kV D/C 2. Bina-Gwalior 765 kV S/C (initially op. at 400 kV) 3. Seoni 765/400 kV 3x500 MVA (Aug.) 4. Bhatapara 400/220 kV 2x315 MVA s/s by LILO of Korba-Raipur line <u>Sipat-II Supplementary Tr. System</u> 1. Seoni-Wardha 765 kV S/C (initially op. at 400 kV) 2. Wardha-Akola 400 kV D/C 3. Akola-Aurangabad 400 kV D/C 4. Wardha 400/220 kV 2x315 MVA s/s
WR	Evacuation System for Kawas-II (725 + 575 MW) and Gandhar-II (725 + 575 MW)	<u>ATS with Gandhar-II</u> 1. Gandhar (NTPC)-Rajkot (GEB) 400 kV D/C 2. Gandhar (NTPC)-Kawas 400 kV D/C 3. LILO of both circuits of Bina - Nagda 400 kV D/C line at Shujalpur 4. Establishment of 2x315 MVA 400/220 kV substation at Shujalpur <u>ATS with Kawas-II</u> 1. Kawas-II-Vapi (PG) 400 kV D/C Quad 2. Vapi (PG)- Navi Mumbai 400 kV D/C 3. LILO of Kalwa-Pune (PG) 400 kV S/C line at Navi Mumbai, 4. Vapi (PG)-Khadoli (DNH) 220 kV D/C 5. Establishment of 400/220 kV 2x315 MVA S/S at Navi Mumbai (GIS in case adequate land is not available). 6. LILO of Apta-Kalwa and

		Kharghar-Kandalgaon 220 kV D/C lines at Navi Mumbai. (LILO works under preview of MSEB, 220 kV bay provision at Navi Mumbai by PGCIL) 7. Installation of 400/220 kV 1x315 MVA 3rd transformer at Vapi
WR	Western Region **System Strengthening Scheme -II**	<u>For absorbing import in eastern and central part of WR grid</u> 1. Seoni-Wardha 765 kV S/C (2nd ckt 400 kV operation. 2. Raipur-Wardha 400 kV D/C with series compensation of 25% fixed. 3. Bhadrawati-Parli (PG) 400 kV D/C 4. Wardha-Parli (PG) 400 kV D/C Quad 5. Parli (PG)-Parli (MSEB) 400 kV D/C. 6. Parli (PG)-Pune (PG) 400 kV D/C 7. LILO of Lonikhand-Kalwa 400 kV line at Pune (PG) near Chinchwad) 8. Pune (PG)-Aurangabad 400 kV D/C 9. Powergrid 400/220 kV 2x315 MVA substation at Pune. <u>For regional strengthening in southern Maharashtra</u> 1. LILO of Sholapur-Karad at Pandharpur 2. Pandharpur 400 kV s/s. 3. Parli (PG)- Pandharpur 400 kV D/C 4. Pandharpur-Kolhapur 400 kV D/C <u>For regional strengthening in Gujarat</u> 1. Rajgarh-Karamsad 400 kV D/C line with 25% fixed series compensation. 2. LILO of both ckts of Gandhar-Dehgam 400 kV D/C line at Karamsad. 3. Limbdi-Ranchhodpura-Zerda 400 kV D/C.

		<u>For regional strengthening in northern Madhya Pradesh</u> 1. Korba-Damoh-Bhopal 400 kV D/C. 2. Powergrid 400/220 kV, 2x315 MVA substation at Damoh.

Region	**Scheme/ scheme group**	**Transmission System**
SR	Evacuation System for Kudankulam U1&2 (2000 MW)	1. Kudankulam (NPC) – Tirunelveli (PG) 400kV (quad) 2xD/C line-I & II 2. Tirunelveli (PG) – Udumalpet 400kV D/C line 3. Tirunelveli (PG) – Edamon (KSEB) 400kV D/C line, (multi circuit line) 4. Edamon – Muvattupuzha(PG) 400kV quad D/C line 5. Muvattupuzha – North Tricur (PG) 400kV quad D/C line 6. LILO of both circuits of Madurai (PG) – Trivendram (PG) 400kV D/C line at Tirunelveli 7. 400/220kV S/S at Tirunveli, 2x315 MVA 8. 400/220kV S/S at Muvattupuzha, 2x315 MVA 9. Trivendram 400/220kV S/S Extn. – 3rd 1x315 MVA transformer 10. Udumalpet 400/220kV S/S Extn. – 3rd 1x315 MVA transformer 11. 2x63 MVAR bus reactor at Tirunveli and 1x63 MVAR bus reactor at Muvattupuzha 400 kV S/Ss 12. 1x63 MVAR line reactor at each end of each circuit of Tirnuveli – Muvattupuzha 400kV D/C line 13. 1x63 MVAR switchable line reactor at each end of each circuit of Timuveli – Udumalpet 400kV D/C line
SR	Evacuation System for	1. KPFBR – Kancheepuram 220kV D/C line

	Kalpakkam PFBR (500 MW)	230kV D/C line 2. KPFBR – Arni 230kV D/C line 3. KPFBR – Sirucheri 230kV D/C line 4. KPFBR – MAPS 230kV S/C (with one spare phase) Cable link
SR	**Evacuation System for** Kaiga U3&4 (220 + 220 MW)	1. Narendra(PG) – Davanagere (KPTCL) 400kV D/C line 2. Mysore (PG) – Kozhikode (PG) 400kV D/C line 3. LILO of Kolar – Sriperumbudur (PG) 400kV S/C at Melakottaiyur (PG) 4. Melakottaiyur 400/220kV S/S 2x315 MVA 5. Kozhikode 400/220kV S/S 2x315 MVA 6. Hiriyur 400/220kV S/S Extn-1x315 MVA 7. Narendra 400/220kV S/S bay Extn. 8. Mysore 400/220kV S/S bay Extn. 9. Davanagere 400/220kV S/S bay Extn. 10. 1x50 MVAR switchable line reactor at Melakottaiyur end of Kolar – Sriperumbudur 400kV S/C line to be LILOed at Melakottaiyur
SR	Evacuation System for Neyveli TPS II (500 MW)	1. Neyveli TS-II Expansion (NLC) – Neyveli TS-II Existing (NLC) 400kV 2xS/C line 2. Neyveli TS-II(NLC) – Pugalur (PG) 400kV D/C line 3. Pugalur (PG) – Madurai (PG) 400kV D/C line 4. Udumalpet – Arasur (PG) 400kV D/C line 5. LILO of Neyveli – Sriperumbudur 400kV S/C line 6. LILO of Ramagundam – Khammam 400kV S/C line at Warangal (PG) 7. Pugalur 400/220kV S/S 2x315 MVA 8. Warangal 400/220kV S/S 2x315 MVA 9. Arasur 400/220kV S/S 2x315

		MVA 10. Pondicherry 400/220kV S/S 2x315 MVA 11. Madurai 400/220kV S/S bay Extn. 12. Udumalpet 400/220kV S/S bay Extn. 13. 1x50 MVAR switchable line reactor for each circuit, at Pugalur end of Neyveli – Pugalur 400kV D/C line.

Region	Scheme/ scheme group	Transmission System
ER	Evacuation System for North Karanpura (1980 MW) and Maithon RB (1000 MW)	<u>With North Karanpura:</u> 1. North Karanpura – Sasaram 765kV S/C line with 2x1500MVA, 765/400kV s/s at Sasaram 2. North Karanpura – Ranchi 400kV D/C line 3. North Karanpura – WR pooling Station near Sipat 765kV S/C line with 2x1500MVA, 765/400kV s/s at WR pooling station near Sipat 4. WR pooling station near Sipat – Sipat 765kV S/C line 5. WR pooling station near Sipat – Seoni 765kV S/C line <u>With Maithon RB:</u> 1. Maithon RB-Maithon PG 400kV D/C line 2. Maithon RB – Ranchi 400kV D/C line 3. Biharsharif – Sasaram 400kV D/C line <u>With North Karanpura or Maithon RB for the Northern Region:</u> 1. Sasaram-Fatehpur-Agra 765kV S/C lines with 765kV s/s at Agra having 2x1500 MVA 765/400kV transformers and 765/400kV s/s at Fatehpur having 2x1500 MVA 765/400kV & 2x315 MVA 400/220 kV transformer and

		LILOs of Singrauli/Allahabad – Kanpur/Mainpuri 400kv lines at Fatehpur.
ER	Evacuation System for Barh (1980 MW)	1. LILO of Kahalgaon – Patna 400kV D/C quad line at Barh 2. Barh – Balia 400kV D/C quad line 3. Balia – Bhiwadi 2500 MW ± 500kV HVDC Bipole line 4. Seoni – Bina 765kV S/c line (to be initially operated at 400kV) 5. Balia 400kV S/S extn 6. Bhiwadi 400kV S/S extn 7. Seoni 400kV S/s extn 8. Bina 400kV Sw. Stn. Extn. 9. Balia and Bhiwadi HVDC Converter Stations
ER	Evacuation System for Teesta Low Dam III &IV (292 MW)	1. Teesta Stage III – New Jalpaiguri, 220kV S/C line with Twin-Moose conductor. 2. Teesta Stage III – Teesta Stage IV S/S, 220kV S/C line with Moose conductor. 3. Teesta Stage IV – New Jalpaiguri, 220kV D/C line. (These lines would be constructed by WBSEB, as the whole of the power would be absorbed by West Bengal.)

Region	**Scheme/ scheme group**	**Transmission System**
NER	Evacuation System for Monarchak CCGT (280 MW)	1. Tripura GBPS – Silchar 220kV D/C single moose line 2. Silchar – Kopili (new) 220kV D/C single moose line 3. Tripura GBPS – Agartala 132kV D/C line 4. Silchar 220/132kV S/S
NER	Evacuation System for Turial HEP (60 MW)	1. Turial HEP – Kolasib 132kV S/C line 2. LILO of Jiribam – Aizawal 132kV S/C line at Turial HEP
NER	Evacuation System for Subnasiri Lower HEP	1. Biswanath Chariyali to be developed as a pooling station in NER

	(2000 MW)	2. Subansiri – Biswanath Chariyali 400kV 2xD/C Quad lines. 3. Biswanath Chariyali – Agra, HVDC Bipole, +/- 600kV, 4000 MW.

6.2.4 A few transmission schemes, particularly those required for completion towards the last years of the 11th Plan are yet to be evolved / firmed-up. These include evacuation system and regional system strengthening schemes corresponding to those newly identified/uncertain generation projects where the time frame for the generation project is not yet firm. These generation projects are:

Region	**Generation projects**
NR	Lakhwar Vyasi HEP (420 MW), Kotli Behl HEP (960 MW), Luhri HEP (465 MW), Vishnugad Pipalkote (440 MW) , Barsingsar (NLC) (250 MW)
WR	Bhilai JV-SAIL (750 MW)
SR	Tuticorin (JV- NLC) (500MW), Ennore (JV-TN & NTPC) (1000MW), Kayamkulam-II (1950 MW)
ER	Nabi Nagar JV-Rlws. (1000 MW), Farakka III (500 MW), IB Valley TPS (660 MW), Hirma (800 MW)
NER	Kameng HEP (600 MW), Bhareli L Dam II (600 MW), Kameng Dam (150 MW), Dikrong HEP (110 MW), Kapek Leyak HEP (160 MW), Tuivai HEP (210 MW), Ranganadi II (130 MW), Kopili HEP (150 MW), Siang Middle HEP (1000 MW)

6.2.5 Transmission schemes for 11th Plan generation capacities under the State sector and the Private sector have also been tentatively evolved. These transmission schemes are required to be firmed-up by the State transmission utilities. The schemes are given at Appendix 6.1 to 6.5.

6.3 Load Flow Studies for the perspective transmission system for XI Plan end scenario.

6.3.1 Based on the updated 11th Plan All India Generation and Demand Scenario, and the projected power exchange requirement Load Flow studies have been carried out for 2011-12. The transmission system as already firmed-up has been tested through these load flow studies to ascertain the reliability of perspective system. Some of the 11th Plan transmission system which is yet to firmed along with the corresponding generation, has also been included in this as per tentatively identified proposal. The dispatches considered, and the load flow cases are discussed in the subsequent paras of this section.

6.3.2 Dispatches considered:

Based on the season-wise and peak / off-peak availability and demand scenarios as detailed in above Annexes, following PEAK and OFF-PEAK Dispatches have been considered for studying the requirement of transmission system in the country. These dispatches have been worked out so as to achieve matching Demand and Generation for steady-state load flow studies. In this, the dispatches have been worked out to evolve test load flows so that the evolved inter-regional system would be able to cater to the required transmission needs on all-India basis.

Accordingly, following NINE numbers of Dispatch-Demand scenarios (SIX representing PEAK and THREE representing OFF-PEAK) have been studied:

CASE-1

(Load flows for this case are depicted in Exhibit-1)

Winter Peak_Average

MW

Regions	Dispatch	Demand	Deficit/Surplus
Northern	36050	43920	-7870
Western	46310	50770	-4460
Southern	34890	37510	-2620
Eastern*	25750	13240	12510
North-Eastern	4600	2160	2440
Total -India	147600	147600	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-2

(Load flows for this case are depicted in Exhibit-2)

Winter Peak_Northern Region Focus

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	36050	44820	-8770
Western	46310	49870	-3560
Southern	34890	37510	-2620
Eastern*	25750	13240	12510
North-Eastern	4600	2160	2440
Total	147600	147600	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-3

(Load flows for this case are depicted in Exhibit-3)

Winter Peak_Western Region Focus

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	36050	42920	-6870
Western	46310	51770	-5460
Southern	34890	37510	-2620
Eastern*	25750	13240	12510
North-Eastern	4600	2160	2440
Total	147600	147600	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-4

(Load flows for this case are depicted in Exhibit-4)

Winter Peak_Southern Region Focus

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	36050	43520	-7470
Western	46310	50370	-4060
Southern	34890	38310	-3420
Eastern*	25750	13240	12510
North-Eastern	4600	2160	2440
Total	147600	147600	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-5
(Load flows for this case are depicted in Exhibit-5)

Monsoon Peak

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	41560	40340	1220
Western	40970	46600	-5630
Southern	33140	34480	-1340
Eastern*	13620	11920	1700
North-Eastern	6000	1950	4050
Total	135290	135290	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-6
(Load flows for this case are depicted in Exhibit-6)

Summer Peak

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	42220	44820	-2600
Western	45470	51770	-6300
Southern	35040	36400	-1360
Eastern*	19660	13240	6420
North-Eastern	6000	2160	3840
Total	148390	148390	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-7
(Load flows for this case are depicted in Exhibit-7)

Winter Off Peak

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	25500	31380	-5880
Western	34000	33660	340
Southern	24910	24910	0
Eastern*	14000	8610	5390
North-Eastern	1560	1410	150
Total	99970	99970	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-8
(Load flows for this case are depicted in Exhibit-8)

Monsoon Off Peak

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	31380	31380	0
Western	31570	33660	-2090
Southern	24910	24910	0
Eastern*	9310	8610	700
North-Eastern	2800	1410	1390
Total	99970	99970	0

*- includes import from Chukha and Tala HEP, Bhutan

CASE-9
(Load flows for this case are depicted in Exhibit-9)

Summer Off Peak

MW

Regions	Dispatch	Demand	Export(+) / Import(-)
Northern	36060	40340	-4280
Western	36240	36240	0
Southern	26820	26820	0
Eastern*	12270	9270	3000
North-Eastern	2800	1520	1280
Total	114190	114190	0

*- includes import from Chukha and Tala HEP, Bhutan

6.3.3 Network Description

6.3.3.1 During the 11th Plan, 20700 MW of inter-regional transmission capacity is planned to be added. This would take the total inter-regional to be 37150 MW by the end of 11th Plan period that is by 2011-12.

6.3.3.2 The most important inter-regional transmission system planned during the 11th Plan is from NER from where additional transmission capacity of 5000 MW would be needed to export power generated at various new Hydro projects. Towards meeting this requirement, a ± 600 kV HVDC Bipole link of 4000 MW capacity from pooling station in NER at Biswanath Chariyali to Agra and Bongaigaon (NER) – Silliguri (ER) 400kV D/C lines are planned.

The HVDC option for exporting power from NER has been preferred over 400kV system because it would have required higher capital cost and more Right of Way and over 765kV system because 765kV system causes wide voltage fluctuations particularly when quantum of power to be transmitted has wide variations, as is the case with hydro power from NER.

6.3.3.3 Barh – Balia 400kV (Quad Moose) has been planned as a part of Barh TPS evacuation system. Sasaram – Fatehpur 765kV S/C line, initially at 400kV operation, has been planned as a part of Maithon TPS evacuation system and up grading this to 765kV operation is planned with North Karanpura evacuation system. These lines would give additional **3500 MW** of transmission capacity between ER and NR.

6.3.3.4 For strengthening the links from ER to WR, a second Rourkela – Raipur 400kV D/C line with TCSC, North Karanpura – Sipat 765kV S/C line, Hirma – Sipat 400kV D/C line and Hirma – Raipur 400kV D/C line have been planned. These would provide additional **5700 MW** of transmission capacity between ER and WR.

6.3.3.5 For strengthening the links between NR and WR, the Agra – Gwalior line would be operated at 765kV and alongwith a new second 765kV line between the two points. In addition to the above, two new transmission corridors have been planned between NR and WR. These are Kankroli (Raj.) – Zerda (Guj.) and RAPP (Raj.) – Nagda (M.P.) 400kV D/C lines. With these in place, **5500 MW** transmission capacity would be added between NR-WR.

6.3.3.6 It is also felt that, SR may also be required to be connected with rest of the national Power Grid, with a synchronous link. For this, a 400kV D/C line between Parli(WR) and Raichur(SR) has been considered. This would not only help in forming a fully synchronous National Power Grid but also make available the needed comfort of providing an alternative path in case of contingencies of outage of HVDC links connecting SR with neighboring

Regions. With this, the WR-SR transmission capacity would increase by 1000MW.

6.3.3.7 Thus, with the addition of these new inter-regional capacities of 20700 MW, the total inter-regional transmission capacity of National Power Grid, as it would take shape by end of 11th Plan, is foreseen to be 37150 MW.

Details of inter-regional links planned for 11th Plan, are given below:

Inter-Regional Transmission Capacity – 11th Plan

Name of System	Power Transfer Capacity (MW)
NER - NR :	
BiswanathChariyali – Agra HVDC Bipole at ± 600kV	4000
NER-NR total	**4000**
NER - ER :	
Bongaigaon – Silliguri 400kV D/C	1000
NER-ER total	**1000**
ER - NR :	
Barh – Balia 400kV D/C (Quad Moose)	1200
Sasaram – Fatehpur 765kV S/C (40% Series Comp.)	2300
ER-NR total	**3500**
ER - WR :	
Rourkela – Raipur 400kV D/C line-2 (with TCSC)	1400
North Karanpura - Sipat 765kV S/C	2300
Hirma – Sipat 400kV D/C	1000
Hirma – Raipur 400kV D/C	1000
ER-WR total	**5700**
NR - WR :	
Agra-Gwalior 765kV S/C line-1 (operation at 765kV)	1200
Agra-Gwalior 765kV S/C line-2	2300
Kankroli - Zerda 400kV D/C	1000
RAPP-Nagda 400kV D/C	1000
NR-WR total	**5500**
WR - SR :	
Parli – Raichur 400KV D/C	1000
ER-WR total	**1000**
All India (addition during 11th Plan)	**20700**

6.3.4 Load Flow Cases:

The above described system has been planned after considering many alternatives which were tested to perform under diverse load-dispatch

scenarios as detailed in previous sections and under credible contingencies of critical lines and components. For National Grid System planning, following steady-state contingency criteria, has been considered without rescheduling of generation:

- Outage of one 400kV D/C line (with or without series compensation), or
- Outage of one 765kV S/C line (with or without series compensation), or
- Outage of one 765/400kV transformer, or
- Outage of one pole of an HVDC Bipole with healthy pole carrying up to 10% over loading for short duration under steady state, or
- Outage of one module of an HVDC Back-t-back facility.

Steady-state behavior of the finalized network for National Grid, under basic load-dispatch scenarios (referred to as Base Cases) and corresponding significant contingencies (referred to as Outage Cases) have been reported in the subsequent sections of this Chapter.

A list of reported Base Cases and Outage Cases is given below:

Sl. No.	**Dispatch Case**		**Base / Outage Case**	**Outage of -**	**Exhibit No / Page**
1	**Case-1.0**	**Winter Peak Average**	**Base case**		**1.0 6/48**
2	**Case-2.0**	**Winter Peak NR Focus**	**Base case**		**2.0 6/49**
3	Case-2.1	Winter Peak NR Focus	Outage Case	Sasaram - Allahabad 400kV D/C out	2.1 6/50
4	Case-2.2	Winter Peak NR Focus	Outage Case	Sasaram - Fatehpur 765kV S/C out	2.2 6/51

5	Case-2.3	Winter Peak NR Focus	Outage Case	Muzaffarpur - Gorakhpur 400kV D/C out	2.3 6/52
6	Case-2.4	Winter Peak NR Focus	Outage Case	Purnia - Muzaffarpur 400kV D/C out	2.4 6/53
7	Case-2.5	Winter Peak NR Focus	Outage Case	Barh - Balia 400kV D/C out	2.5 6/54
8	Case-2.6	Winter Peak NR Focus	Outage Case	North Karanpura - Sasaram 765kV S/C out	2.6 6/55
9	Case-2.7	Winter Peak NR Focus	Outage Case	Balia - Bhiwadi HVDC One Pole out	2.7 6/56
10	Case-2.8	Winter Peak NR Focus	Outage Case	Agra - Gwalior 765kV S/C out	2.8 6/57
11	Case-2.9	Winter Peak NR Focus	Outage Case	Bina - Gwalior 765kV S/C out	2.9 6/58
12	**Case-3.0**	**Winter Peak WR Focus**	**Base case**		**3.0 6/59**
13	Case-3.1	Winter Peak WR Focus	Outage Case	North Karanpura - Sipat 765kV S/C out	3.1 6/60
14	Case-3.2	Winter Peak WR Focus	Outage Case	Hirma - Raipur 400kV D/C out	3.2 6/61
15	Case-3.3	Winter Peak WR Focus	Outage Case	Rourkela - Raipur 400kV D/C out	3.3 6/62
16	**Case-4.0**	**Winter Peak SR Focus**	**Base case**		**4.0 6/63**
17	Case-4.1	Winter Peak SR Focus	Outage Case	Talcher - Kolar HVDC one pole out	4.1 6/64
18	Case-4.2	Winter Peak SR Focus	Outage Case	Chandrapur - Ramagundam B-t-B out	4.2 6/65
19	Case-4.3	Winter Peak SR Focus	Outage Case	Parli - Raichur 400kV D/C out	4.3 6/66
20	**Case-5.0**	**Monsoon Peak**	**Base case**		**5.0 6/67**
21	Case-5.1	Monsoon Peak	Outage Case	Agra - Gwalior 765kV S/C out	5.1 6/68
22	Case-5.2	Monsoon Peak	Outage Case	RAPP - Nagda 400kV D/C out	5.2 6/69

23	Case-5.3	Monsoon Peak	Outage Case	Kankroli - Zerda 400kV D/C out	5.3 6/70
24	**Case-6.0**	**Summer Peak**	**Base case**		**6.0 6/71**
25	Case-6.1	Summer Peak	Outage Case	North Karanpura - Sipat 765kV S/C out	6.1 6/72
26	Case-6.2	Summer Peak	Outage Case	Hirma - Raipur 400kV D/C out	6.2 6/73
27	Case-6.3	Summer Peak	Outage Case	Rourkela - Raipur 400kV D/C out	6.3 6/74
28	Case-6.4	Summer Peak	Outage Case	Agra - Gwalior 765kV S/C out	6.4 6/75
29	Case-6.5	Summer Peak	Outage Case	RAPP - Nagda 400kV D/C out	6.5 6/76
30	Case-6.6	Summer Peak	Outage Case	Kankroli - Zerda 400kV D/C out	6.6 6/77
31	**Case-7.0**	**Winter Off-Peak**	**Base case**		**7.0 6/78**
32	**Case-8.0**	**Monsoon Off-Peak**	**Base case**		**8.0 6/79**
33	**Case-9.0**	**Summer Off-Peak**	**Base case**		**9.0 6/80**

6.4 Description of Load Flow Cases:

6.4.1.0 Case-1.0:

(Winter Peak Average - Base Case)

This is a base case for a typical Winter Peak scenario in which the deficit in Availability/Demand on all-India basis is distributed on proportional basis to all the three deficit regions viz. NR, WR and SR. Thus NR needs to import 7870 MW, WR 4460 MW and SR 2620 MW. These import needs are met from export of 12510 MW from ER and 2440 MW from NER. As detailed in previous sections, the all-India MW availability during Winter Peak scenario of 2011-12 would be 147608 MW, whereas, the corresponding total demand

of all the five regions would be 150300 MW. Thus the availability would be less by about 2700 MW at peak demand time.

In this scenario, NR receives 800 MW from NER and 7570 MW from ER. The critical lines are Muzaffarpur – Gorakhpur 400kV D/C line carrying 1760 MW, and Sasaram – Fatehpur 765kV S/C line carrying 2350 MW. Further, NR sends 500 MW to WR. WR imports 4550 MW directly from ER and transfers 590 MW to SR. Loadings on ER-WR and ER-SR are within safe limits. Load flows are plotted in Exhibit-1.0.

6.4.2.0 Case-2.0:

(Winter Peak Northern Region Focus - Base Case)

This is second base case for Winter Peak scenario with focus on Northern Region, where the deficit in Availability/Demand is adjusted in the demands of only WR and SR, thus maintaining the Northern Region demand. In this scenario, NR needs to import 8770 MW, WR 3560 MW and SR 2620 MW. These import needs are met from export of 12510 MW from ER and 2440 MW from NER.

In this scenario, NR receives 800 MW from NER and 7850 MW from ER and 120 MW from WR. The critical lines are Muzaffarpur – Gorakhpur 400kV D/C line carrying 1820 MW, and Sasaram – Fatehpur 765kV S/C line carrying 2430 MW. WR imports 4270 MW directly from ER and transfers 120 MW to NR and 590 MW to SR. Loadings on ER-WR and ER-SR are within safe limits.

Load flows are plotted in Exhibit-2.0.

Outage Cases for following critical contingencies, for this Base Case, are reported in the subsequent sections.

Case-2.1 Sasaram - Allahabad 400kV D/C out

Case-2.2	Sasaram - Fatehpur 765kV S/C out
Case-2.3	Muzaffarpur - Gorakhpur 400kV D/C out
Case-2.4	Purnia - Muzaffarpur 400kV D/C out
Case-2.5	Barh - Balia 400kV D/C out
Case-2.6	North Karanpura - Sasaram 765kV S/C out
Case-2.7	Balia - Bhiwadi HVDC One Pole out
Case-2.8	Agra - Gwalior 765kV S/C out
Case-2.9	Bina Gwalior 765kV S/C out

6.4.2.1 Case-2.1:

(Winter Peak NR Focus - Outage of Sasaram - Allahabad 400kV D/C)

The Sasaram - Allahabad 400kV D/C was carrying 770 MW under base case. Under its outage, flow on Muzaffarpur – Gorakhpur 400kV D/C line increases to 1940 MW and that on Sasaram – Fatehpur 765kV S/C line increases to 2740 MW. These are within loading limits and also justify the need for providing series compensation on these lines. The other ER-NR lines are loaded under limits with comfortable margins. Load flows are plotted in Exhibit-2.1.

6.4.2.2 Case-2.2:

(Winter Peak NR Focus - Outage of Sasaram - Fatehpur 765kV S/C)

The Sasaram – Fatehpur 765kV S/C was carrying 2430 MW under base case. Under its outage, flow on Muzaffarpur – Gorakhpur 400kV D/C line increases to 2090 MW and that on Sasaram – Allahabad 400kV D/C line

increases to 1400 MW. The other ER-NR lines are loaded under limits with comfortable margins. Load flows are plotted in Exhibit-2.2.

6.4.2.3 Case-2.3:

(Winter Peak NR Focus - Outage of Muzaffarpur - Gorakhpur 400kV D/C)

The Muzaffarpur – Gorakhpur 400kV D/C line was carrying 1820 MW under base case. Under its outage, flow on Sasaram – Fatehpur 765kV S/C increases to 2650 MW, on Biharshariff – Balia 400kV D/C line increases from 830 to 1370 MW and that on Barh – Balia 400kV D/C lines increase from 1050 MW to 1260 MW. The other ER-NR lines are loaded under limits with comfortable margins. Load flows are plotted in Exhibit-2.3.

6.4.2.4 Case-2.4:

(Winter Peak NR Focus - Outage of Purnia - Muzaffarpur 400kV D/C)

The Purnia - Muzaffarpur 400kV D/C line was carrying 1500 MW under base case. Under its outage, flow on Purnia - Biharshariff 400kV D/C line increases from 760 to 1590 MW. This is critical though under limits. Loading on Sasaram – Fatehpur 765kV S/C increases to 2470 MW. Loading on other ER-NR lines are also under limits with comfortable margins. Load flows are plotted in Exhibit-2.4.

6.4.2.5 Case-2.5:

(Winter Peak NR Focus - Outage of Barh - Balia 400kV D/C)

The Barh - Balia D/C line was carrying 1040 MW under base case. Under its outage, flow on Patna – Balia 400kV D/C line increases from 780 MW to 1320 MW, on Sasaram – Fatehpur 765kV S/C increases from 2430 MW to 2460 MW and on Muzaffarpur – Gorakhpur 400kV D/C line from 1820 MW to 1930 MW. These loadings are within limits. Loading on other ER-NR lines are also under limits with comfortable margins. Load flows are plotted in Exhibit-2.5.

6.4.2.6 Case-2.6:

(Winter Peak NR Focus - Outage of North Karanpura - Sasaram 765kV S/C)

The North Karanpura – Sasaram 765kV S/C line was carrying 1560 MW under base case. Under its outage, flow on Muzaffarpur – Gorakhpur 400kV D/C line from 1820 MW to 1890 MW. These loadings are within limits. Loading on other ER-NR lines are also under limits with comfortable margins. Load flows are plotted in Exhibit-2.6.

6.4.2.7 Case-2.7:

(Winter Peak NR Focus - Outage of Balia - Bhiwadi HVDC One Pole)

The Balia – Bhiwadi HVDC Bipole line was regulated to carry 1000 MW under base case. Under outage of one pole, flow on the healthy pole is also regulated at 1000 MW, thus making no significant impact on the other circuits. Load flows are plotted in Exhibit-2.7.

6.4.2.8 Case-2.8:

(Winter Peak NR Focus - Outage of Agra - Gwalior 765kV S/C)

The Agra – Gwalior 765kV 2xS/C line was carrying 350 MW under base case. Under outage of one of the S/C, flow on the second circuit is 330 MW and thus having no significant difference in the flow pattern as compared to the base case. Load flows are plotted in Exhibit-2.8.

6.4.2.9 Case-2.9:

(Winter Peak NR Focus - Outage of Bina - Gwalior 765kV S/C)

The Bina - Gwalior 2xS/C line was carrying 1030 MW under base case. Under outage of one S/C, the flow on the second circuit is 840 MW and thus having no significant difference in the flow pattern as compared to the base case. Load flows are plotted in Exhibit-2.9.

6.4.3.0 Case-3.0:

(Winter Peak Western Region Focus - Base Case)

This is third base case for Winter Peak scenario with focus on Western Region, where the deficit in Availability/Demand is adjusted in demands of only NR and SR, thus maintaining the Western Region demand. Thus WR needs to import 5460 MW, NR 6870 MW and SR 2620 MW. These import needs are met from export of 12510 MW from ER and 2440 MW from NER.

In this scenario, WR receives 1210 MW from NR and 4840 MW directly from ER. WR also transfers 590 MW to SR. The critical lines are North Karanpura – Sipat 765kV S/C carrying 910 MW, Hirma – Raipur 400kV D/C line carrying 970 MW, Hirma – Sipat 400kV D/C line is carrying 740 MW, Ranchi – Sipat 400kV D/C lie is 680 MW and Rourkela – Raipur 400kV D/C line carrying 850 MW. Loadings on ER-NR, NR-WR and ER-SR are comfortable.

Load flows are plotted in Exhibit-3.0.

Outage Cases for following critical contingencies, for this Base Case, are reported in the subsequent sections.

Case-3.1	North Karanpura - Sipat 765kV S/C out
Case-3.2	Hirma - Raipur 400kV D/C out
Case-3.3	Rourkela - Raipur 400kV D/C out

6.4.3.1 Case-3.1:

(Winter Peak WR Focus - Outage of North Karanpura - Sipat 765kV S/C)

The North Karanpura – Sipat 765kV S/C line was carrying 910 MW under base case. Under outage of this line, flow on Hirma - Raipur 400kV D/C line changes to 950 MW, on Ranchi - Sipat 400kV D/C line increases to 930 MW and that on the Rourkela – Raipur 400kV D/C line increases to 950 MW. The

other ER-WR and intra WR lines are loaded under limits with comfortable margins. Load flows are plotted in Exhibit-3.1.

6.4.3.2 Case-3.2:

(Winter Peak WR Focus - Outage of Hirma - Raipur 400kV D/C)

The Hirma – Raipur 400kV D/C line was carrying 970 MW under base case. Under outage of this line, flow on Hirma – Sipat 400kV D/C line increases to 1210 MW and that on the Rourkela – Raipur 400kV D/C line increases to 1010 MW. The other ER-WR and intra WR lines are loaded under limits with comfortable margins. Load flows are plotted in Exhibit-3.2.

6.4.3.3 Case-3.3:

(Winter Peak WR Focus - Outage of Rourkela - Raipur 400kV D/C)

The Rourkela – Raipur 400kV D/C line was carrying 850 MW under base case. Under outage of this line, flow on Hirma - Raipur 400kV D/C line increases to 1070 MW, on North Karanpura – Sipat 765kV S/C line to 1010 MW and that on the Ranchi – Sipat 400kV D/C line flow increases to 810 MW. The other ER-WR and intra WR lines are loaded under limits with comfortable margins. Load flows are plotted in Exhibit-3.3.

6.4.4.0 Case-4.0:

(Winter Peak Southern Region Focus - Base Case)

This is the fourth base case for Winter Peak scenario with focus on Southern Region, where the deficit in Availability/Demand is adjusted in demands of only NR and WR, thus maintaining the Southern Region demand. Thus SR needs to import 3420 MW, NR 7470 MW and WR 4060 MW. These import needs are met from export of 12510 MW from ER and 2440 MW from NER.

In this scenario, SR receives 1000 MW via WR and 2420 MW directly from ER. Main links connecting SR with ER are the Talcher – Kolar HVDC Bipole of 2000 MW capacity (to be upgraded to 2500 MW by end of X plan) and HVDC back-to-back modules of 1000 MW capacity at Jeypore

connecting Jeypore (ER) with Gazuwaka (SR), thus providing only asynchronous links between ER and the flows on which can be easily regulated. Similarly, with WR also, SR is connected through HVDC back-to-back at Chandrapur of 1000 MW capacity connecting Chandrapur (WR) with Ramagundam (SR). It is proposed that, by 11th plan Southern Region should also be connected in synchronous mode with rest of India. For this purpose, a route of Parli (WR) – Raichur (SR) has been identified by providing a 400kV D/C line between these two points. In base case, the flows on asynchronous links have been regulated in such a way so that some margins are available to partially meet the contingencies. Therefore, Talcher –Kolar HVDC is operated at 1600 MW, Jeypore b-t-b at 820 MW and Chandrapur b-t-b at 500 MW, thus remaining 500 MW flows on the Parli - Raichur 400kV D/C line.
Load flows are plotted in Exhibit-4.0.

Outage Cases for following critical contingencies, for this Base Case, are reported in the subsequent sections.

Case-4.1	Talcher - Kolar HVDC one pole out
Case-4.2	Chandrapur - Ramagundam B-t-B out
Case-4.3	Parli - Raichur 400kV D/C out

6.4.4.1 Case-4.1:

(Winter Peak SR Focus - Outage of Talcher - Kolar HVDC one pole)

The Talcher – Kolar Bipole was carrying 1600 MW under base case. Under outage of one of its poles, the flow on the healthy pole is regulated at 1250 MW. Flows on Jeypore b-t-b and Chandrapur b-t-b remains same, thus the synchronous Parli – Raichur 400kV D/C line takes 680 MW. Also, flows on intra-WR lines upto Parli are also within limits with comfortable margins.

The other ER-WR, intra WR and intra SR lines are loaded under limits. Load flows are plotted in Exhibit-4.1.

6.4.4.2 Case-4.2:

(Winter Peak SR Focus - Outage of Chandrapur - Ramagundam link)

The Chandrapur – Ramagundam 400kV line was carrying 500 MW under base case. Under its outage flows the synchronous Parli – Raichur 400kV D/C line increases to 990 MW and the flows on Jeypore b-t-b and Talcher – Kolar link remain same as in base case. Also, flows on intra-WR lines upto Parli are also within limits with comfortable margins. The other ER-WR, intra WR and intra SR lines are loaded under limits. Load flows are plotted in Exhibit-4.2.

6.4.4.3 Case-4.3:

(Winter Peak SR Focus - Outage of Parli – Raichur 400kV D/C line)

The Parli – Raichur 400kV D/C line connecting SR in synchronous mode with rest of all-India grid was carrying 500 MW under base case. Under its outage flows the asynchronous Chandrapur – Ramagundam B-t-B is regulated to carry 970 MW and flow on Talcher-Kolar HVDC Bipole is increased to 1800 MW and on the Gazuwaka HVDC back-to-backs at 650 MW. Also, flows on intra-WR lines upto Parli are also within limits with comfortable margins. The other ER-WR, intra WR and intra SR lines are loaded under limits. Load flows are plotted in Exhibit-4.4.

6.4.5.0 Case-5.0:

(Monsoon Peak - Base Case)

This case reflects the pattern of load flows of a typical 2012 Monsoon peak day with high availability of hydro generation. During Monsoon Peak the all-India Availability/Demand position is surplus by about 25000 MW with normal rainfall. The typical monsoon peak case has been constructed reducing generation from thermal projects and as for as possible, utilizing the hydro generation to meet the demand. Accordingly, following region-wise

import/export picture emerges: NR is exporting 1220 MW, ER 1700 MW and NER 4050 MW, whereas, the WR is importing 5630 MW and SR 1700 MW.

NR receives 950 MW from ER and 2000 MW from NER hydro projects over the BiswanathChariyali – Agra 4000 MW HVDC Bipole, and transfers 4180 MW to WR including its own surplus of 1220 MW. The proposed BiswanathChariyali – Agra HVDC line gets utilized under the Monsoon conditions to full extent when there is outage of any one pole. Utilization of this link on a sustained basis would take place when additional hydro projects get commissioned in NER during 12th Plan. WR receives 1490 MW directly from ER and 4180 MW via NR, which includes 2000 MW form NER through the HVDC Bipole up to Agra and then over the Agra – Gwalior 765kV 2xS/C lines which are carrying 1960 MW. The other two 400kV D/C lines of RAPP – Nagda 400kV D/C line and Kankroli – Zerda 400kV D/C line are carrying 590 MW and 1120 MW, respectively.

Load flows are plotted in Exhibit-5.0.

Outage Cases for following critical contingencies, for this Base Case, are reported in the subsequent sections.

Case-5.1	Agra - Gwalior 765kV S/C out
Case-5.2	RAPP - Nagda 400kV D/C out
Case-5.3	Kankroli - Zerda 400kV D/C out

6.4.5.1 Case-5.1:

(Monsoon Peak Case - Outage of Agra – Gwalior 765kV S/C line)

The Agra – Gwalior 765kV 2xS/C lines are carrying 1960 MW under base case. Under outage of one S/C the second S/C line carries 1820 MW. The RAPP – Nagda 400kV D/C line flow increases to 620 MW and that on the

Kankroli – Zerda 400kV D/C line increases to 1140 MW. These loadings are within limits. Flows on ER-WR links, intra-WR and intra-NR lines are also within limits. Load flows are plotted in Exhibit-5.1.

6.4.5.2 Case-5.2:

(Monsoon Peak Case - Outage of RAPP- Nagda 400kV D/C line)

The RAPP – Nagda 400kV D/C line was carrying 590 MW under base case. Under its outage, flow on the Agra – Gwalior 765kV 2xS/C lines increases to 2160 MW. The Kankroli – Zerda 400kV D/C line increases to 1380 MW. These loadings are within limits. Flows on ER-WR links, intra-WR and intra-NR lines are also within limits. Load flows are plotted in Exhibit-5.2.

6.4.5.3 Case-5.3:

(Monsoon Peak Case - Outage of Kankroli - Zerda 400kV D/C line)

The Kankroli – Zerda 400kV D/C line was carrying 1120 MW under base case. Under its outage, flow on the Agra – Gwalior 765kV 2xS/C lines increases to 2260 MW. The RAPP – Nagda 400kV D/C line flow increases to 1300 MW. These loadings are within limits. Flows on ER-WR links, intra-WR and intra-NR lines are also within limits. Load flows are plotted in Exhibit-5.3.

6.4.6.0 Case-6.0:

(Summer Peak - Base Case)

This case reflects the pattern of load flows of a typical Summer Peak day scenario in 2012 when National Power Grid is fully functional. Under this scenario, the all-India Availability/Demand position is surplus by about 7200 MW, which is on account of high surplus available in ER and NER. However, the NR, WR and SR are likely to be deficit. The typical summer peak case has been constructed reducing generation in thermal projects in ER and hydro projects in NER. Accordingly, following region-wise import/export picture emerges: NR is importing 2600 MW, WR 6300 MW

and SR 1360 MW, whereas, the ER is exporting 6420 MW and NER 3840 MW.

NR receives 3620 MW from ER via 400 and 765kV interconnections with ER and 2000 MW from NER hydro projects over the HVDC Bipole up to Agra, it also transfers 3030 MW to WR.

Under this scenario WR is the region to be watched, which receives 3320 MW directly from ER and 3030 MW via NR. It also transfers a nominal amount of 50 MW to SR. However, the NR –WR links are not that much stressed as they were in the previous base case of Monsoon Peak when NR was exporting its own surplus. Similarly, the ER-WR links are also not stressed that much as was in case of Winter Peak, though in Summer Peak, the WR is importing more power than the Monsoon and Winter peak cases. This has been possible because of optimally planned interconnections between NR-WR, ER-WR, ER-NR and NER-NR.
Load flows are plotted in Exhibit-6.0.

Outage Cases for following critical contingencies, for this Base Case, are reported in the subsequent sections.

Case-6.1	North Karanpura - Sipat 765kV S/C out
Case-6.2	Hirma - Raipur 400kV D/C out
Case-6.3	Rourkela - Raipur 400kV D/C out
Case-6.4	Agra - Gwalior 765kV S/C out
Case-6.5	RAPP - Nagda 400kV D/C out
Case-6.6	Kankroli - Zerda 400kV D/C out

MW Flows on these lines under **Base Case** are as follow:

North Karanpura - Sipat 765kV S/C	700
Hirma - Raipur 400kV D/C	730
Rourkela - Raipur 400kV D/C	610
Agra - Gwalior 765kV 2xS/C	1440
RAPP - Nagda 400kV D/C	270
Kankroli - Zerda 400kV D/C	810

6.4.6.1 Case-6.1:

(Summer Peak Case - Outage of North Karanpura - Sipat 765kV S/C)

Changed MW flows on the above lines under this contingency are given below:

North Karanpura - Sipat 765kV S/C	OUT
Hirma - Raipur 400kV D/C	720
Rourkela - Raipur 400kV D/C	690
Agra - Gwalior 765kV 2xS/C	1630
RAPP - Nagda 400kV D/C	310
Kankroli - Zerda 400kV D/C	830

Load flows are plotted in Exhibit-6.1.

6.4.6.2 Case-6.2:

(Summer Peak Case - Outage of Hirma - Raipur 400kV D/C)

Changed MW flows on the above lines under this contingency are given below:

North Karanpura - Sipat 765kV S/C	670

Hirma - Raipur 400kV D/C	OUT
Rourkela - Raipur 400kV D/C	730
Agra - Gwalior 765kV 2xS/C	1470
RAPP - Nagda 400kV D/C	290
Kankroli - Zerda 400kV D/C	820

Load flows are plotted in Exhibit-6.2.

6.4.6.3 Case-6.3:

(Summer Peak Case - Outage of Rourkela - Raipur 400kV D/C)

Changed MW flows on the above lines under this contingency are given below:

North Karanpura - Sipat 765kV S/C	770
Hirma - Raipur 400kV D/C	800
Rourkela - Raipur 400kV D/C	OUT
Agra - Gwalior 765kV 2xS/C	1490
RAPP - Nagda 400kV D/C	290
Kankroli - Zerda 400kV D/C	820

Load flows are plotted in Exhibit-6.3.

6.4.6.4 Case-6.4:

(Summer Peak Case - Outage of Agra - Gwalior 765kV S/C)

Changed MW flows on the above lines under this contingency are given below:

North Karanpura - Sipat 765kV S/C	730
Hirma - Raipur 400kV D/C	730

Rourkela - Raipur 400kV D/C	620
Agra - Gwalior 765kV S/C (one ckt OUT)	Flow on 2nd ckt 1330
RAPP - Nagda 400kV D/C	290
Kankroli - Zerda 400kV D/C	820

Load flows are plotted in Exhibit-6.4.

6.4.6.5 Case-6.5:

(Summer Peak Case - Outage of RAPP - Nagda 400kV D/C)

Changed MW flows on the above lines under this contingency are given below:

North Karanpura - Sipat 765kV S/C	720
Hirma - Raipur 400kV D/C	740
Rourkela - Raipur 400kV D/C	620
Agra - Gwalior 765kV 2xS/C	1530
RAPP - Nagda 400kV D/C	OUT
Kankroli - Zerda 400kV D/C	930

Load flows are plotted in Exhibit-6.5.

6.4.6.6 Case-6.6:

(Summer Peak Case - Outage of Kankroli - Zerda 400kV D/C)

Changed MW flows on the above lines under this contingency are given below:

North Karanpura - Sipat 765kV S/C	770
Hirma - Raipur 400kV D/C	750
Rourkela - Raipur 400kV D/C	640

Agra - Gwalior 765kV 2xS/C	1650
RAPP - Nagda 400kV D/C	780
Kankroli - Zerda 400kV D/C	OUT

Load flows are plotted in Exhibit-6.6.

6.4.7 Case-7.0, Case – 8.0 and Case – 9.0:

(Off-Peak Cases - Winter, Monsoon & Summer Off-Peak Base Cases)

Steady-state behavior the National Grid System was also studied for light load conditions for Winter, Monsoon and Summer seasons, to understand pattern of load flows during these different off-peak scenarios.

During Winter Off Peak scenario, the all-India Availability/Demand position is surplus by about 24600 MW, in which all other regions barring NR are having surplus availability. A load flow case with 5880 MW deficit in NR to be met mainly from ER is constructed. Load flows are plotted in Exhibit-7.0

During Monsoon Off Peak scenario, the all-India Availability/Demand position is surplus by about 51500 MW, in which all other regions are having surplus availability. A load flow case with 2090 MW deficit in WR to be met from ER and NER is studied. Load flows are plotted in Exhibit-8.0

During Summer Off Peak scenario, the all-India Availability/Demand position is surplus by about 28500 MW, in which all other regions are having surplus availability. A load flow case with 4280 MW deficit in NR to be met from ER and NER is studied. Load flows are plotted in Exhibit-8.0

All these cases indicate requirement of heavy shunt reactors on 400kV and 765kV buses, which would be firmed while finalizing the transmission elements with specific generation projects.

6.5 Growth in 765kV and HVDC Transmission System during 11th Plan Period

6.5.1 Growth in 765kV transmission System during 11th Plan period is shown in the following Table:

Transmission lines and sub-station at 765kV – Programmed for 11th Plan 2007-12

				As at the end of 10th Plan i.e. 3/2007	2007-08	2008-09	2009-10	2010-11	2011-12	As at the end of 11th Plan i.e. 3/2012
765kV Transmission Lines										
Anpara-Unnao	S/C	UPPCL	ckm	409						409
Kishenpur-Moga L-1(W)	S/C	PGCIL	ckm	275						275
Kishenpur-Moga L-2(E)	S/C	PGCIL	ckm	287						287
Tehri-Meerut Line-1	S/C	PGCIL	ckm	186						186
Tehri-Meerut Line-2	S/C	PGCIL	ckm	184						184
Sipat-Seoni Line-1	S/C	PGCIL	ckm	336						336
Sipat-Seoni Line-2	S/C	PGCIL	ckm	336						336
Sasaram-Fatehpur	S/C	PGCIL	ckm			400				400
Fatehpur-Agra	S/C	PGCIL	ckm				330			330
Agra-Gwalior Line-1	S/C	PGCIL	ckm		110					110
Agra-Gwalior Line-2	S/C	PGCIL	ckm				110			110
SipatPP-Seoni Line-3	S/C	PGCIL	ckm				340			340
SipatPP-Sipat	S/C	PGCIL	ckm					30		30
Seoni-Bina	S/C	PGCIL	ckm				330			330
Seoni-Wardha Line-1	S/C	PGCIL	ckm					210		210
Seoni-Wardha Line-2	S/C	PGCIL	ckm						210	210
Gwalior-Bina Line-1	S/C	PGCIL	ckm			300				300
Gwalior-Bina Line-2	S/C	PGCIL	ckm					300		300
Sasaram-North K. Pura	S/C	PGCIL	ckm				180			180
North K. Pura-SipatPP	S/C	PGCIL	ckm					350		350
TOTAL				**2013**	**110**	**700**	**1290**	**890**	**210**	**5213**
765kV Sub-stations										
Seoni		PGCIL	MVA	3000						3000
Unnao		PGCIL	MVA					2000		2000
Agra		PGCIL	MVA		1000	2000				3000
Meerut		PGCIL	MVA					3500		3500
Fatehpur		PGCIL	MVA			3000				3000
Gwalior		PGCIL	MVA		1000					1000
Bina		PGCIL	MVA				2000			2000
Wardha		PGCIL	MVA						3000	3000
Sipat Pooling Point		PGCIL	MVA				2000			2000
Sasaram		PGCIL	MVA			2000				2000
TOTAL				**3000**	**2000**	**7000**	**4000**	**5500**	**3000**	**24500**

6.5.2 Growth in HVDC transmission System during 11th Plan period is shown in the following Table:

HVDC Transmission Bipole, Back-to-back and Monopole lines and terminal station – Programmed for 11th Plan 2007-12

				As at the end of 10th Plan i.e. 3/2007	2007-08	2008-09	2009-10	2010-11	2011-12	As at the end of 11th Plan i.e. 3/2012
HVDC Bipole Line										
Chnadrapur-Padghe	± 500kV	MSEB	ckm	1504						1504
Rihand-Dadri	± 500kV	PGCIL	ckm	1634						1634
Talcher-Kolar	± 500kV	PGCIL	ckm	2738						2738
Balia-Bhiwadi	± 500kV	PGCIL	ckm	1800						1800
Biswanath-Agra	± 600kV	PGCIL	ckm	3600						3600
TOTAL				**5876**	**0**	**0**	**0**	**0**	**0**	**11276**
HVDC Bi-pole Transmission Capacity										
Chnadrapur-Padghe	bipole	MSEB	MW	1500						1500
Rihand-Dadri	bipole	PGCIL	MW	1500						1500
Talcher-Kolar	bipole	PGCIL	MW	2500						2500
Balia-Bhiwadi	bipole	PGCIL	MW			2500				2500
Biswanath-Agra	bipole	PGCIL	MW					4000		4000
TOTAL				**5500**	**0**	**2500**	**0**	**4000**	**0**	**12000**
HVDC Back-to-back Transmission Capacity										
Vindhachal	b-t-b	PGCIL	MW	500						500
Chandrapur	b-t-b	PGCIL	MW	1000						1000
Gazuwaka	b-t-b	PGCIL	MW	1000						1000
Sasaram	b-t-b	PGCIL	MW	500						500
TOTAL				**3000**	**0**	**0**	**0**	**0**	**0**	**3000**
HVDC Monopole Line										
Barsur-Lower Sileru	200kV	CSEB/ APTRANSCO	ckm	162						162
TOTAL				**162**	**0**	**0**	**0**	**0**	**0**	**162**
HVDC Mono-pole Transmission Capacity										
Barsur-Lower Sileru	monopole	CSEB/ APTRANSCO	MW	200						200

TOTAL				**200**	**0**	**0**	**0**	**0**	**0**	**200**

Appendix- 6.1

	Northern Region
	State Sector Generation Projects
Gen. Project	**Transmission Scheme/Proposal**
HP	
Uhl-III (100MW)	• Uhl-Bassi S/C (LION cond.) • Uhl-Hamirpur D/C
Kashang I & II (126MW)	• LILO of 220 KV Bhabha-KunihарS/C at Kashang
J&K	
Parni (38MW)	Evacuation at lower voltage
Sawalkot (600 MW)	• Sawalkote – Kishenpur 400 kV D/C
Ans-II (30MW)	Evacuation at lower voltage
L. Kalani (50MW)	Evacuation at lower voltage
Punjab	
Shahpurkhandi (168MW)	▪ LILO of Thien – Sarna D/C at Sahapurkandi
UBDC-III (75 MW)	Evacuation at lower voltage
Haryana	
Yamuna Nagar U2 (300MW)	▪ YTPP-Abdullapur 220 kV D/C(with 0.4 ACSR) ▪ YTPP-Yamunanagar 220 kV D/C(with 0.4 ACSR) ▪ YTPP-Ladwa 220 kV D/C(with 0.4 ACSR) ▪ YTPP-Nilokheri 220 kV D/C(with 0.4 ACSR) ▪ Ladwa-Nissing 220 kV D/C(with 0.4 ACSR) ▪ Nilokheri- Karnal 220 kV D/C(with 0.4 ACSR) ▪ New 220/132 kV S/S at Nilokheri with 2x100 MVA transformer ▪ New 220/66 kV S/S at Ladwa with 2x100 MVA transformer ▪ Opening of one circuit of 220 Kaithal – Nissing and Nissing – PTPP D/C line from Nissing end and connecting them so as to form Kaithal – PTPP direct circuit
UP	
Anpara C (1000MW)	• Charging of Anpara- Unnao S/C line at 765kV • 765/400 kV 2x750 MVA, Anpara S/S • 765/400 kV 2x1000 MVA Unnao S/S
Rajasthan	

Giral U2 (125MW)	▪ Giral – Jaisalmer 220 kV D/C ▪ Giral – Barmer 220 kV D/C
MathaniaISCC (140MW)	▪ LILO of Jodhpur-Tinwari at Mathania-D/C ▪ Mathania-Jodhpur S/C
Uttranchal	
Tuinipalasu (42MW)	To be evacuated through 132 kV line from Khodri
Bawala Nand Prayag (132MW)	▪ Bawala Nand Prayag – Karanpryag 132 kV D/C line
Arkot Tuini (70MW)	▪ To be evacuated through 132 kV line from Khodri

	Northern Region
	Private Sector Generation Projects
Gen. Project	**Transmission Scheme/Proposal**
HP	
Allan Dhungan (192MW)	• Allain Dhuangan – Parbati Pooling station 220 kV D/C • Beyond parbati pooling station, evacuation through Parbati II system
Karcham Wangtoo (1000MW)	• LILO of Baspa – Nathpa Jhakri D/C line at Karchem Wangtoo • Karchem Wangtoo – Abdullapur 400 kV D/C • Beyong Abdullapur tr. System has to be evolved
Dhamvari Sonda (70MW)	• Dhamwari Sunda - Maliana 2xS/C+D/C
UP	
Dadri – Reliance (3740 MW)	Not yet identified
Uttaranchal	
Srinagar (330MW)	• LILO of Vishnupryag-Muzaffarnagar D/C at Srinagar-2xD/C • Srinagar-Kashipur S/C • 400/220 kV Kashipur S/S(aug.)- 2nd 315 MVA Trf • 400\132 kV Srinagar S/S

Appendix- 6.2

	Western Region
	State Sector Generation Projects
Gen. Project	**Transmission Scheme/Proposal**
Gujarat	
Utran CCGT (300MW)	Transmission System yet to be identified
Sikka Repl. Ext. (500MW)	Transmission System yet to be identified
Surat Lignite Ext. (250MW)	Transmission System yet to be identified
Maharashtra	
Khaper Khed Ext (500MW)	Transmission System yet to be identified
Parli Ext. Stage-II (250 MW)	Transmission System yet to be identified
Paras Ext. U-II (250 MW)	Transmission System yet to be identified
Uran GTPS Exp. (1040 MW)	Transmission System yet to be identified
Chhatisgarh	
Korba West Ext (500MW)	Transmission System yet to be identified
Matnar (60 MW)	Transmission System yet to be identified

	Western Region
	Private Sector Generation Projects
Gujarat	
Akhakhol-Paguthan (730MW)	i) LILO of Kawas-Gandhar 400 kV D/C at Akhakhol ii) Akhakhol-Dehgam 400 kV D/C
Essar-Hazira Ext. (1460MW)	Transmission System yet to be identified
Maharashtra	
Nagathone (1000MW)	Transmission System yet to be identified
Talegaon Block-1,2 (1400MW)	Transmission System yet to be identified
Vile-TATA (1000 MW)	Transmission System yet to be identified
Chhatisgarh	
Raigarh (750MW)	Transmission System yet to be identified
Pathdi TPS-LANCO (600MW)	Transmission System yet to be identified
MP	
Maheshwar (400MW)	i) Maheshwar-Pithampura 220 kV D/C ii) Maheshwar-Rajgarh 220 kV D/C iii) Maheshwar-Julwania 220 kV D/C

Appendix- 6.3

	Southern Region
	State Sector Generation Projects
Gen. Project	**Transmission Scheme/Proposal**
AP	
Vijyawada TPP (660MW)	(1) VTPS - Yeddumailaram 400kV D/C (2) VTPS - Narasaraopeta 400kV D/C (3) Tadikonda - Narasaraopeta 400kV S/C (4) 1x315 MVA, 400/220 kV Transf at VTPS switchyard
Jaurala Priya (195MW)	Jurala HEP- Mehboobnagar 220kV D/C
N. Sagar TP Dam (50MW)	Existing system
Karnataka	
Bidadi (1400MW)	Yet to be identified
Varahi (230 MW)	Varahi HEP -Hassan 220kV D/C
Raichur U8 (210 MW)	Existing 400kV system
Bellary Ext. (500 MW)	Yet to be firmed up
Gundia Ext. (300 MW)	Yet to be firmed up
Kerala	
Adirapalli (163MW)	Yet to be firmed up
Kuttiyadi Add. Ext. (100MW)	Existing system
Tamil Nadu	
Bhawani Kathlai U2 (60MW)	Existing system

	Southern Region
	Private Sector Generation Projects
Gen. Project	**Transmission Scheme/Proposal**
AP	
Jegrupadu-III (220MW)	Jegrupadu Extn - Vemagiri 400kV D/C
Gautmi Ext. (134MW)	Gautami-Vemagiri S/S 400kV D/C
Bhopalpalli (500MW)	Yet to be identified
Ramagundam BPL (520MW)	(1) Ramagundam (BPL)- Dichpally 400kV S/C (2) Ramagundam (BPL)- Gajwel 400kV S/C (3) Gajwel S/S- Hyderabad (Mamidipalli) 400kV S/C (4) Ditchpally 400/220kV 2x315MVA S/S (5) Gajwel 400/220kV 2x315MVA S/S (6) Ditchpally 400/220 kV S/S-Ditchpally 220 D/C (7) Ditchpally 400 kV S/S- Nirmal 220 kV s/s 220kVS/C on D/C (8) Gajwel 400/220 kV S/S- Minpur S/S 220 S/C on D/C (9) Gajwel 400 kV S/S- Siddipet S/S 220kV S/C on D/C (10) Gajwel 400 kV S/S- Kamareddy S/S 220kV S/C on D/C (11) Ramagundam (BPL)-Malayalapally 220kV D/C (12) Kamareddy 220/132kV 2x100MVA S/S
Karnataka	
Jinda Ext-Torangallu (500MW)	Yet to be identified
Nagarjuna TPP (1015MW)	Yet to be identified
Kerala	
Kannur CCGT (513MW)	Yet to be identified
Tamil Nadu	
Valuthur Ext. (95MW)	Yet to be identified

Appendix- 6.4

	Eastern Region
	State Sector Generation Projects
Gen. Project	**Transmission Scheme/Proposal**
West Bengal	
Sagardighi-II (800MW)	1. LILO of Farakka-Jeerat-Subhashgram 400 kV S/C at Sagardighi TPS. 2. Sagardighi TPS-Durgapur 400 kV S/C
Bakreshwar U5 & Ext-II (210MW)	1. Existing 400kV and 220kV transmission system will be adequate.
Torsa (50MW)	Not identified.
Raidak (48MW)	Not identified.
Jharkhand	
Tenughat Ext (630MW)	1. Tenughat TPS-Ranchi 400kV D/C-200ckms. 2. Existing TenughatTPS-Biharsariff 400kV S/C line will be charge at 400 kV.
Orissa	
Balimela Ext & DPH (150+60MW)	1. Balimela HEP-Jeypore 200kV D/C line(After dismantling the 3rd Ckt. between Balimela HEP-Jeypore 200kV S/C line.
Badabandha (800 MW)	Not identified.

	Eastern Region
	Private Sector Generation Projects
Orissa	
Ib Stage-II U 5 & 6 (500MW)	1. IB TPS-Meramundali 400 kV D/C – 400kV operation. (The line is to be initially operated at 220kV under Stage-I. The line is under construction)

Appendix- 6.5

	North Eastern Region
	State Sector Generation Projects
Gen. Project	**Transmission Scheme/Proposal**
Meghalya	
Myntdu Stage-I (84MW)	Following system identified. 1. Myntdu – Khliehriat 132kV D/C line.
Uiamtru (36MW)	Following system identified. 1. Umiam Umtru V – Umiam Umtru IV 132kV S/C line.
Mizoram	
Bairabi Dam (80MW)	Following system has been identified. 1. Bairabi – Kolasib 132kV S/C line 2. Bairabi – AizawalKolasib 132kV D/C line
Namrup Ext (100MW)	Transmission system yet to be identified.

	North Eastern Region
	Private Sector Generation Projects
Assam	
Amguri CCGT (100MW)	Following system has been identified. 1. Amguri – Marani 220kV D/C line.