



SYSTEM RESTORATION PROCEDURES FOR NORTHERN REGION

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CONTENTS

	Page No.
SECTION-1: RESTORATION OF NORTHERN REGIONAL GRID	2-7
SECTION-2: RESTORATION OF EASTERN U.P. SUBSYSTEM	8-27
SECTION-3: RESTORATION OF NORTH-CENTRAL SUBSYSTEM	28-41
SECTION-4: RESTORATION OF RAJASTHAN SUBSYSTEM	42-47
SECTION-5: RESTORATION OF WESTERN U.P. SUBSYSTEM	48-54
SECTION-6: POWER SUPPLY TO RAILWAY TRACTION	55-59
SECTION-7: OPERATION OF 400 kV VINDHYACHAL A.C. BY-PASS LINK	60-63
SECTION-8: OPERATION OF 400 kV SASARAM A.C. BY-PASS LINK	64-66

EXHIBITS

EXHIBIT-1A: NORTHERN REGIONAL GRID : MAJOR SUBSYSTEMS
EXHIBIT-1B: NORTHERN REGIONAL GRID : SUBSYSTEMS SYNCHRONISATION
EXHIBIT-2A: EASTERN U.P.SUBSYSTEM : RESTORATION STAGES
EXHIBIT-2B: EASTERN U.P.SUBSYSTEM : START-UP SEQUENCE
EXHIBIT-3A: NORTH-CENTRAL SUBSYSTEM : RESTORATION STAGES
EXHIBIT-3B: NORTH-CENTRAL SUBSYSTEM : START-UP SEQUENCE
EXHIBIT-4A: RAJASTHAN SUBSYSTEM : RESTORATION STAGES
EXHIBIT-4B: RAJASTHAN SUBSYSTEM : START-UP SEQUENCE
EXHIBIT-5A: WESTERN U.P. SUBSYSTEM : RESTORATION STAGES
EXHIBIT-5B: WESTERN U.P. SUBSYSTEM : START-UP SEQUENCE
EXHIBIT-6A: POWER SUPPLY TO RAILWAY TRACTION
EXHIBIT-6B: POWER SUPPLY TO RAILWAY TRACTION
EXHIBIT-7A: 400 kV VINDHYACHAL A.C. BY -PASS LINK
EXHIBIT-8A: 400 kV SASARAM A.C. BY -PASS LINK

Reference pages for generating stations (In alphabetical sequence)

Generating Stations	Page No(s)
EASTERN U.P. SUB-SYSTEM	
Anpara(Th)	16
Obra (Hy)	18
Obra (Th)	18 & 20
Panki (Th)	18
Renusagar (Th)	14-15
Rihand (Hy)	13
Rihand (Th)	16
Singrauli (Th)	11-12
Tanda(Th)	22
Unchahar (Th)	19
NORTH-CENTRAL SUB-SYSTEM	
Auraiya (Gas)	38
Baira Siul (Hy)	36
Badarpur (Th)	33
Bhakra –L (Hy)	34
Bhakra –R (Hy)	34
Bhatinda (Th)	35
Baspa (Hy)	36
Chamera I & II (Hy)	39
Dadri (Gas)	37
Dadri (Th)	37
Dehar (Hy)	34
Delhi GT (Gas)	31
Faridabad (Gas)	32
Faridabad (Th)	32
Indraprastha (Th)	31
Jhakri (Hy)	36
Lehra Mohhabat (Th)	35
Lower Jhelum (Hy)	40

Panipat (Th)	35
Pragati (Gas)	31
Pong (Hy)	35-36
Rajghat (Th)	31
Ranjit Sagar (Hy)	39
Ropar (Th)	35
Salal (Hy)	39
Uri (Hy)	40
RAJASTHAN SUB-SYSTEM	
Anta (Gas)	45
Jawahar Sagar (Hy)	43
Kota (Th)	44
RAPS-A (Nuclear)	44
RAPS-B (Nuclear)	45
R.P.Sagar (Hy)	43
Suratgarh (Th)	37 & 46
WESTERN U.P. SUB-SYSTEM	
Chibro (Hy)	50
Chilla (Hy)	51
Khara (Hy)	50-51
Khodri (Hy)	50
Maneri Bhali (Hy)	51
NAPS (Nuclear)	52
Ramganga (Hy)	51-52
Tanakpur (Hy)	51-52

SECTION-1

RESTORATION OF NORTHERN REGIONAL GRID

SECTION-1

RESTORATION OF NORTHERN REGIONAL GRID

1.1 GENERAL

Northern Region is the largest region amongst the five regions of the country in terms of geographical area as well as the number of constituents. The total effective installed capacity in the region, as on 1st January 2004 is 29344.77 MW with a peak demand of around 24000 MW. As per the geographical structure of the region, the major generating sources are located either in the south-eastern part of the region consisting of Super Thermal Power Stations at Singrauli, Rihand and Anpara or in north-western part of the region consisting of hydro generating stations of BBMB, SJVN and NHPC. Due to the location of the major generating sources at the extreme ends and load centres in the central part of the region, consisting of Delhi, Haryana, Punjab, Western U.P. and Northern Rajasthan, a large quantum of power flows through the long lengths thereby sometimes result in high loading of transmission network with large voltage gradients. Further, due to a large gap in demand and availability during the peak hours as well as sudden change in weather conditions, at times the system parameters undergo wide variations and threaten grid security. All these factors coupled with the equipment failure / faults / mal-operation lead to system contingencies.

1.2 System restoration:

Since the Northern Region consists of a large network, in the event of a total black out, extending start-up power from one end of region to the other end is rather impractical, and the restoration has to be achieved in a sectionalised manner. Therefore, based on the geographical boundaries and for ease and speedy restoration, at the time of black-start the Northern Region is considered to have been divided into different “subsystems” so that in the event of total grid failure, initially each subsystem is to be restored independently as per details given in the following sections:

- Section-2** - Restoration of Eastern U.P. Subsystem.
Section-3 - Restoration of North-Central (NC) Subsystem.
Section-4 - Restoration of Rajasthan Subsystem.
Section-5 - Restoration of Western U.P. Subsystem.

Once the subsystems are separately built-up, these can be synchronized in stages to integrate into the complete system. For the purpose of quick understanding and ease of restoration, each Section has been further sub-divided into following Sub-sections:

- Subsystem Overview.
- Subsystem Restoration Procedure.
- Subsystem Synchronisation.
- Restoration Stages and Start-up Sequence in a Subsystem.

By following the steps as detailed in the above Sub-sections, each of the subsystems can be restored independently and thereafter the complete system can be integrated in the fastest possible manner. Exhibit 1A and Exhibit 1B explains the boundaries and the synchronizing sequence of different subsystems respectively. These boundaries have however, been defined on the criteria of most likely possibility and during the actual operations there can be variations in the above boundaries and / or sequence, depending upon the real time situations and other factors, for which NRLDC shall carry out the overall co-ordination. Therefore, in the event of a disturbance all the constituents should remain in contact with NRLDC for instant exchange of the information, and for carrying out co-ordinated efforts.

1.3 Restoration of power supply to Nuclear Stations:

In order to meet the "Safety norms of the Nuclear Stations" it is essential that power supply to the Nuclear Stations is restored on priority basis. The description of the restoration of different subsystems contained in different sections of this document, also contain the steps to be taken for speedy restoration of power supply to the Nuclear Stations.

1.4 Restoration of power supply to Railway Traction:

Since power supply to the Railway Traction is of vital importance, in the event of system black out, the power supply to Railway Traction has to be restored on

top most priority. Section-6 of this document explains the detailed steps to be taken for early restoration of power supply for Railway Traction.

1.5 **Start-up power from Western Region (WR):**

Since major Super Thermal Power Stations in the region, namely; Singrauli, Rihand and Anpara, having a total installed capacity of 4630 MW are located in the extreme south - eastern part of the region, it is very essential that for fast normalization of the system the start-up power to these stations be extended at the earliest opportunity. Initially the start-up power to these stations was extended from the hydro station of U.P. at Rihand (Hy) or on 132 kV ckt. from Vindhyachal (WR) to Singrauli and Rihand. It has however, been observed that both these sources are “weak” and not very much reliable. Therefore, since February 1997, a provision has been made to avail start-up power from Western Region on 400 kV Vindhyachal AC Bypass Link. This link was successfully utilized to extend start-up power to Northern Region during the collapse of Eastern U.P. Subsystem on 01.08.1999 and 22.09.1999 as well as during the failure of the complete Northern Regional Grid on 02.01.2001 and its operation has found to be satisfactory. Section-7 of this document explains the set-up of 400 kV Vindhyachal A.C. By Pass Link and the steps for its operation.

After the establishment of 400 kV Vindhyachal A.C Bypass Link, the 132 kV ckt. from Vindhyachal to Singrauli / Rihand, as mentioned above can be used as a supplementary link. Similarly the 132 kV circuit between Singrauli and Rihand (Hydro) which has been looped-in / looped-out at Renusagar Thermal Station of Hindalco can also be used to supplement the start up functions by availing the supply from Renusagar as per the agreed arrangement.

1.6 **Start-up power from Eastern Region (ER):**

Since last one year, Sasaram HVDC Back -to -Back station (commissioned in the month of September, 2002) connecting Northern Region with Eastern Region is also operational and is extensively used for transferring power between the two regions in asynchronous mode. In the event of black-out in Northern region, this link can also be utilized for availing black-start Power assistance from Eastern Region, by operating it in Radial mode. Section-8 of this document explains the set-up of Sasaram 400 kV A.C. Radial Mode operation, and the steps involved in availing black-start Power.

While restoring the system, besides maintaining load generation balance, sufficient operative spinning reserve is to be kept in each subsystem and all efforts need to be carried out by all the constituents to maintain the parameters within the subsystem, near nominal values for security of operation of the restored subsystem as well as for ease of synchronization.

In order to provide a valuable guidance to maintain a balance between load and generation, the estimate of the immediate support/generation likely to be available in each sub-system vis-à-vis the essential load to be met during the system restoration has been explained in each of the section under sub-section 'Subsystem Overview'. All the constituent must endeavour to maintain a load-generation balance in their respective areas in line with the details given in this document. At the same time, it is extremely important that the different generating units are operated with their governor in normal mode so as to take small variations. In order to control the system parameters and catering any other eventualities a close monitoring and check is to be maintained on the different loads which are energized in the different islands formed after a disturbance in any subsystem.

During system restoration, the following loads are to be met on priority basis:

- Start-up power to Generating Stations.
- Auxiliary power to Nuclear Stations.
- Power supply to Railway Traction.
- Power Supply to essential and emergency loads

Therefore, while reviving the system, due importance must be given to all above loads. In the document at various places different priorities have been shown for the purpose of redundancy and reliability in achieving the target. In order to achieve this objective, at all such places simultaneous action should be initiated and/or prepared and kept in readiness, so that in the event of difficulties in achieving the target through first priority, it may be achieved through the subsequent ones without much loss of time.

1.8 Voltage Control during build-up of system:

Following a blackout, quick restoration of the network is a basic requirement. This is often constrained by the high voltage levels during restoration. In order to ensure that the voltage levels remain at a satisfactory level, the following steps may be taken:

- (i) Select generating units may be operated in under-excited mode at low power levels say less than 5% of full load. This would provide sufficient reactive sinks while building up of the system. In the build-up of the Northern Region some of the generating stations where at least one unit can be operated in such a manner are Rihand (Hydro), Obra (Hydro), Chibro, Khodri, Ramganga, Bhakra (L), Bhakra (R), Jhakri, Baspa, Bairasiul, Chamera I & II, Salal, RSD, Pong, RPS & JS.
- (ii) In order to avoid tripping of 220/132 kV, 220/66 kV and 220/33 kV transformers on over-fluxing, the Tap Changer may be used to control this situation by going to the minimum tap position (i.e. more number of turns).
- (iii) While extending the network, a small load may be switched in at the substation before charging any line further.

1.9 Monitoring of air pressure at substations:

Under a blackout situation, a restoration is often delayed due to the Circuit Breakers (CBs) getting locked out on account of low air pressure after the air compressors trip. This is due to air leakages in the system. Wherever DG sets are provided in the substation, air compressors could be started immediately and the air pressure be maintained.

In order to cut down delays in restoration of the system in the event of contingencies, the leakages in the compressed air system should be monitored and checked on a regular basis as a routine check. Furthermore, DG sets, if so far not available, may be provided by the utilities at the substations, at least at all the 400 kV substations and the 220 kV substations falling in the trunk route in the system restoration procedure.

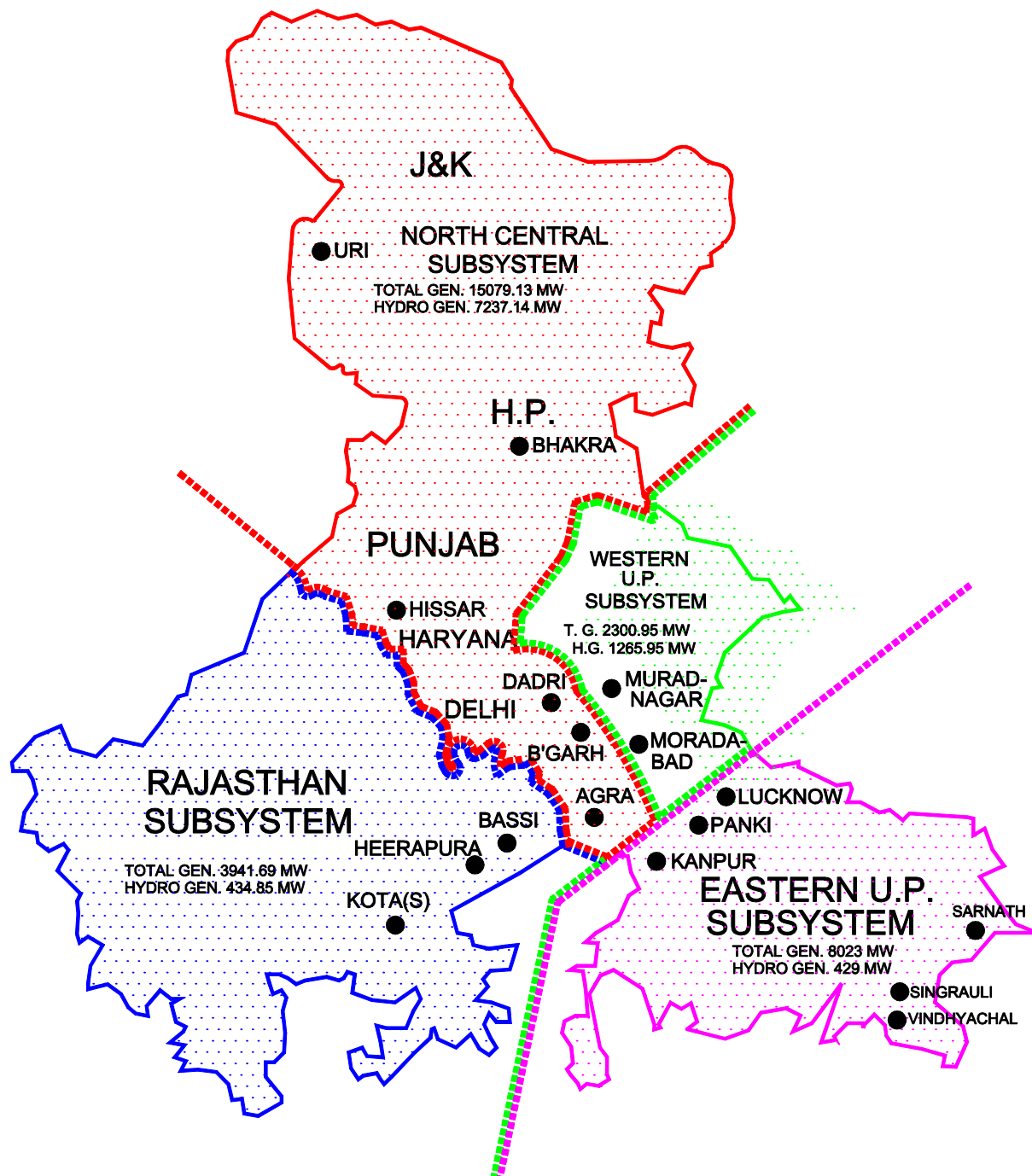
1.10 Mock trials:

The restoration procedure would be used only in case of a disturbance/blackout. It is important that when there is an actual disturbance all the players play their respective roles without any problem. As a confidence building exercise as well as to ensure success in the event of a contingencies, mock trials of certain steps in the restoration procedure, wherever feasible needs to be done regularly, at least once in six months. It is suggested that these trials be done at least for the following locations, which would basically involve start-up of unit, and / or extension of supply to the adjacent substation

as mentioned in this procedure. Splitting of buses at substations, wherever possible may also be done to facilitate mock trial:

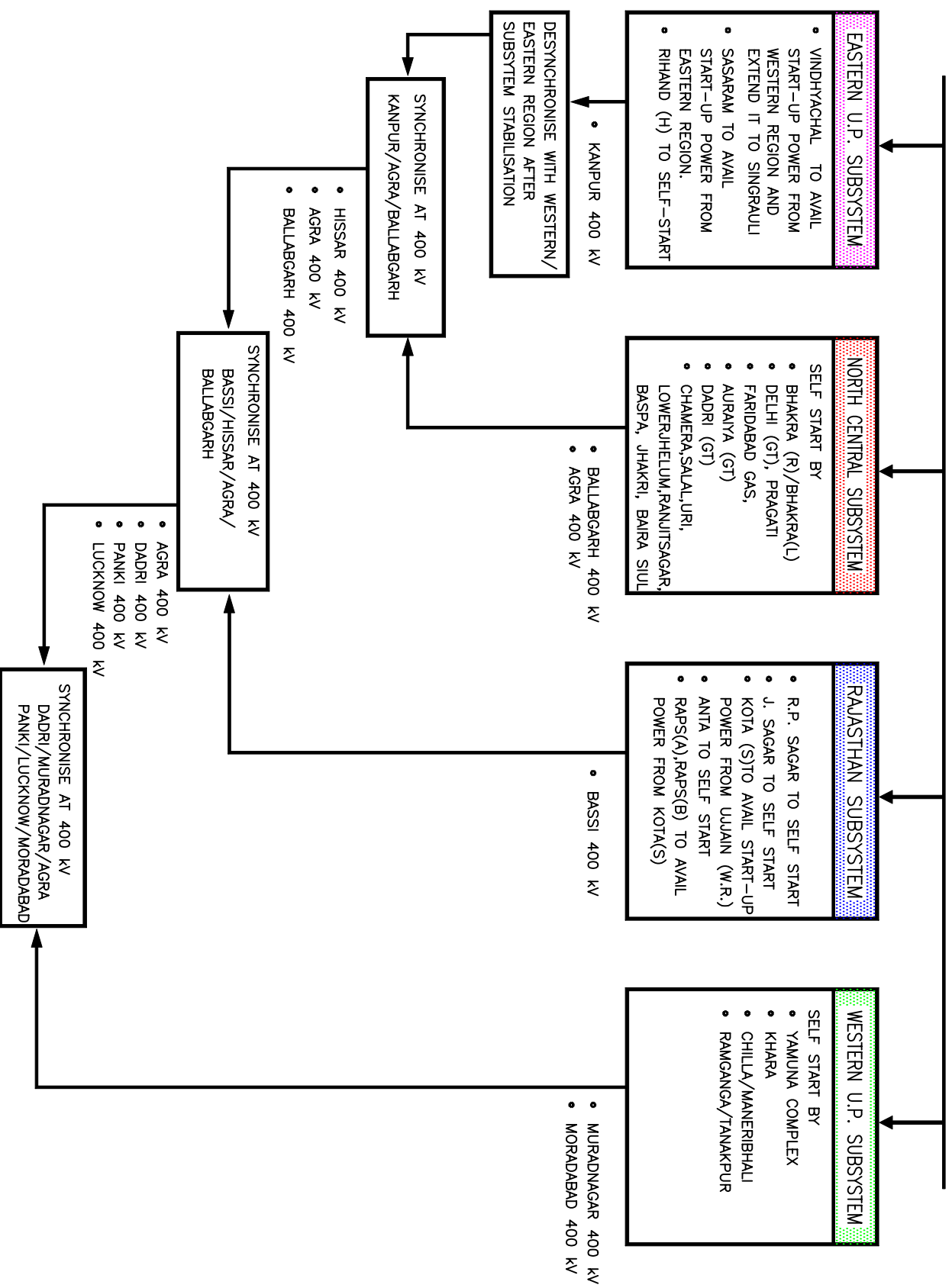
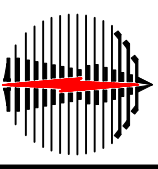
1. AC bypass at Vindhyachal HVDC back-to-back station
2. AC bypass at Pusaoli HVDC back to back station
3. Rihand (Hydro) Hydro Plant
4. Renusagar Thermal Plant
5. Bhakra (Right) Hydro Plant
6. Bhakra (Left) Hydro Plant
7. B'Siul Hydro Plant
8. Salal Hydro Plant
9. Chamera-I Hydro Plant
10. Chamera-II Hydro Plant
11. Uri Hydro Plant
12. Nathpa Jhakri Hydro Plant
13. Baspa Hydro Plant
14. Faridabad (Gas) Plant
15. Auraiya (Gas) Plant
16. Dadri (Gas) Plant
17. Delhi GTs Plant
18. Pragati Gas Plant
19. Chibro Hydro Plant
20. Khodri Hydro Plant
21. Ramganga Hydro Plant
22. Rana Pratap Sagar Hydro Plant
23. Jawahar Sagar Hydro Plant

NORTHERN REGIONAL GRID : MAJOR SUBSYSTEM



SCALE: NOT TO SCALE

NORTHERN REGIONAL GRID : SUBSYSTEM SYNCHRONISATION



SECTION-2

RESTORATION OF EASTERN U.P. SUBSYSTEM

SECTION-2

RESTORATION OF EASTERN U.P. SUBSYSTEM

2.1 SUBSYSTEM OVERVIEW

2.1.1. Important Connecting Links with other Subsystems:

- a) With Western U.P. Subsystem :
 - i) 400 kV Lucknow-Moradabad S/C
 - ii) 400 kV Panki - Muradnagar S/C
- b) With North-Central (NC) Subsystem:
 - i) $\pm$ 500 kV Rihand - Dadri HVDC Bipole
 - ii) 400 kV Kanpur-Ballabgarh S/C
 - iii) 400 kV Kanpur-Agra (PG) S/C
 - iv) 400 kV Unnao-Agra (UPPCL) S/C

2.1.2. Major Generating Stations:

- a) Thermal: Singrauli, Rihand(Th), Anpara, Obra(Th), Renusagar, Unchahar, Tanda, and Panki .
- b) Hydro: Rihand (Hy), Obra (Hy)
- c) Gas: Nil
- d) Nuclear: Nil

2.1.3. Sources of Start - up Power:

- a) From WR - on 400 kV Vindhyachal AC By-Pass link : 100 MW
- b) From ER - on 400 kV Sasaram-Sarnath S/C : 100 MW
- b) Rihand (Hy) - Self start : 150 MW
- c) Obra (Hy)-Start-up from Rihand(Hy) : 50 MW
- Total : 400 MW**

Note: In the initial run-up very nominal quantum (only 100 MW) of assistance has been kept from WR and ER so that such a support is instantaneously available without any affect on the parameters/health of the other region. However, depending upon the actual scenario, this quantum may be higher and even go up to the level of 300-400 MW.

2.1.4. **Requirement of Start-up Power:**

The approximate estimation of the start-up power requirement in the initial stages at various plants / loads are as below, corresponding to the availability mentioned at 2.1.3 above:

a)	Start up power at Singrauli	: 70 MW
b)	Start up power at Rihand	: 50 MW
c)	Start up power at Anpara	: 70 MW
d)	Start up power at Unchahar	: 40 MW
e)	Start up power at Obra(Th)	: 40 MW
f)	Start up power at Tanda	: 20 MW
g)	Start up power at Panki	: 20 MW
h)	Start up power at Renusagar	: 10 MW
i)	Railway Traction and other essential Load	: <u>80 MW</u>
TOTAL		: 400 MW

2.1.5. **System Synchronization:**

After subsystems build - up and stabilization, the Eastern U.P. Subsystem can be synchronized with North-Central (NC) Subsystem and Western U. P. Subsystem at the following possible connections:

- a) With North-Central (NC) Subsystem:
 - i) On 400 kV Kanpur - Agra circuit at Kanpur / Agra, or alternatively;
 - ii) On 400 kV Kanpur – Ballabhgarh circuit at Kanpur / Ballabhgarh

- b) With Western-U.P.sub-system:
- i) On 400 kV Panki – Muradnagar circuit at Panki / Muradnagar or alternatively;
- ii) On 400 kV Lucknow-Moradabad circuit at Lucknow / Moradabad

Caution

Before synchronization with other subsystems, the action in regard to disconnection of Eastern U.P. Subsystem from WR / ER be taken as described under para 2.4.2.

2.2

SUBSYSTEM RESTORATION PROCEDURE

- i) In order to build-up the Eastern UP subsystem, the following avenues are available as start-up power:
 - From WR through 400 kV Vindhyachal AC By-pass link
 - From ER through 400 kV Sasaram AC By-pass link
 - Self start by Rihand(Hy) and Obra(Hy)
 - From Renusagar station of Hindalco
 - From WR through 132 kV Vindhyachal-Singrauli line
- ii) The Eastern U.P. Subsystem shall be built-up primarily by availing start-up power from Western Region on Vindhyachal A.C. By-pass Link and from Eastern Region on Sasaram A.C. By-pass Link to be supplemented by the self-start of hydro units at Rihand hydro and / or by availing possible support from the generation at Renusagar. (Specific details regarding operation of 400 kV Vindhyachal A. C. By-pass Link and radial mode operation of Sasaram HVDC link are given at Section –7 & 8 respectively) At the time of subsystem built-up, the actions to be taken at the major generating stations / grid sub-stations in the Eastern U.P. Subsystem are as given below:

2.2.1

VINDHYACHAL HVDC (Back to Back Station)

- i) In the event of total loss of power supply at Vindhyachal (North) 400 kV Bus, the station would immediately contact NRLDC and

400 kV Singrauli Sub-station to ascertain the status of power supply. In case of total loss of supply in Eastern U.P. (total loss of supply at Singrauli, Kanpur and other neighbouring stations), Vindhyachal shall initiate action for extension of Western Region (WR) supply to Singrauli. Vindhyachal shall finally extend the supply to Singrauli after confirming the readiness from Singrauli end. (The specific operations to be carried out at Vindhyachal are given under Section -7).

- ii) Vindhyachal HVDC station shall keep itself in readiness to charge 400 kV Vindhyachal-Kanpur circuit after obtaining necessary clearance/ confirmation from NRLDC/CPCC, NR-I. While charging 400 kV Vindhyachal-Kanpur circuit, the bus reactors at Vindhyachal shall be suitably used so as to control the bus voltage at Vindhyachal end to a value lower than 1.0 p.u.
- iii) In the event of any difficulty/problem in availing the power from WR on 400 kV Vindhyachal AC By-pass Link, due to any unforeseen problem, the matter shall immediately be brought to the notice of Singrauli and NRLDC.

Note:

Even though, NRLDC Control Room and Vindhyachal HVDC station shall endeavour to confirm the actions to be taken in the event of total black-out in the Eastern U.P., extension of WR power from Vindhyachal to Singrauli shall be carried out without waiting for any code from NRLDC / CPCC,NR-I / Singrauli, except that just before extending the supply, Vindhyachal shall interact with Singrauli and obtain its readiness for the same.

2.2.2

SINGRAULI

Singrauli shall avail start-up power from Western Region through 400 kV Vindhyachal AC By-pass Link and put it to immediate utilization for lighting up of the units at the station. [For the specific number of units to be lighted up please also refer para 2.3. (ii)]. Simultaneously, the persons at Singrauli shall also take up the following actions:

- (i) Start-up power shall be extended by Singrauli to Rihand (Th) by charging one circuit of 400 kV Singrauli-Rihand D/C line from Singrauli end.
- (ii) Start-up power shall be extended by Singrauli to Anpara (Th) by charging 400 kV Singrauli-Anpara line from Singrauli end.
- (iii) Singrauli shall extend power to Renusagar/Rihand (Hy) on 132 kV Singrauli-Renusagar-Rihand(Hy) line in order to extend the start-up power/ synchronisation of two supplies in consultation with Renusagar/Rihand (Hy).
- (iv) Singrauli shall also extend supply to 400 kV Kanpur by charging one circuit of 400 kV Singrauli-Allahabad line. While charging 400 kV Singrauli-Allahabad circuit, the bus reactors at Vindhyachal/Singrauli shall be suitably used so as to maintain the bus voltage at Singrauli end to a value around 1.0 p.u.

Caution

- (i) In the event of non-availability of start-up power from WR through Vindhyachal AC bypass link Singrauli shall immediately request Renusagar for extending start-up power. Renusagar will extend start-up power to Singrauli on 132 kV Renusagar-Singrauli line.
- (ii) In the scenario of non-availability of start-up power from WR through Vindhyachal AC bypass link Singrauli shall avail start-up power in following descending order of priority; (i) from Renusagar (ii) from Rihand(Hy) and (iii) from WR on 132 kV Vindhyachal-Singrauli line.
- (iii) 132 kV Singrauli-Renusagar-Rihand (Hy) circuit is always to be kept in charged condition from Rihand (Hy) end. **(The Rihand (Hy) end breaker of 132 kV Singrauli-Renusagar-Rihand (Hy) circuit is presently out of service. Till the time, breaker at Rihand (Hy) end is brought back in service, the 132 kV Singrauli-Renusagar-Rihand (Hy) circuit shall be kept charge from Singrauli end. UPPCL/ UPJVUNL shall however expedite to bring back the Rihand (Hy) end breaker, in service, at**

the earliest.) In the event of a black out, Rihand (Hydro) may self start the units and extend the supply up to Renusagar. (For extending start-up power in the event of collapse of all the units at Renusagar or for synchronisation, in the event of survival of Renusagar) Alternatively in the event of any delay / failure in self start of units at Rihand (Hydro) the extended supply from Renusagar/ Singrauli can be used by Rihand (Hydro) as start-up power.

- (iv) Extension of power from Singrauli to Rihand (Th) and Anpara on 400 kV circuits shall be carried out without waiting for any code from NRLDC, except that just before charging the line Singrauli shall confirm from the other ends about their readiness . However, extension of supply to/from Renusagar/Rihand (Hy) at 132 kV level shall be depending on the conditions in real time and based on the status of Renusagar stated under para 2.2.3.b.

2.2.3.a. RIHAND (Hydro) (PIPRI)

- (i) Self-start the units at Rihand (Hy) and extend the power up to Renusagar/Singrauli on 132 kV Rihand (Hy) –Renusagar-Singrauli S/C, in order to synchronise the Rihand(Hy) supply with Renusagar/Singrauli supply. However, in the event of non-survival of Renusagar, the extended supply from Rihand (Hy) can be used by Renusagar for start-up of its units.
- (ii) In the event of failure of Rihand (Hy) to self-start, avail start-up power from Renusagar/Singrauli on 132 kV Singrauli-Renusagar-Rihand (Hydro) S/C and start units.
- (iii) Extend power to Obra (Hy) for synchronization / start-up of the units at Obra(Hy).
- (iv) Extend start-up power to Anpara (Th) through 132 kV Rihand (Hy)- Anpara line.

Caution

- (i) For fast build - up of the sub-system in UP area and to regulate the system parameters, the early start-up of the units at Rihand (Hydro) is extremely essential and the same is to be closely monitored and coordinated by CLDS, Lucknow . Furthermore, in order to stabilize the units at Rihand (Hydro), these must be synchronized with the supply extended from Renusagar / Singrauli at the earliest opportunity.
- (ii) In the event that the units at Rihand (Hy) have been self started and the supply from Renusagar/Singrauli has not been extended due to any unforeseen reasons, the Rihand (Hy) should take necessary steps for building up of the system viz. extending the supply to Obra (Hy), Anpara and a close watch and control over the parameter is to be maintained.

2.2.3.b. RENUSAGAR

Under normal conditions the connections of Renusagar with Rihand (Hydro) / Singrauli is as given in annexure –2A.

Case (a) Renusagar island and survives:

In case of survival of Renusagar, the following action shall be taken up by the Renusagar.

- (i) Renusagar shall extend the supply to Rihand (H) in order to extend start-up power/ reference to Rihand (H) units for starting-up or for synchronisation. After the power is extended from Renusagar upto Rihand (H), the synchronisation at Rihand (H) bus would be the responsibility of Rihand (H) and would be carried out by the station by varying its own generations as well as at Renusagar by coordinating with it.
- (ii) In case the units at Rihand (H) self-start before the start-up power/ reference is extended from Renusagar, then Rihand (H) shall extend reference towards Renusagar and the extended supply / reference from Rihand (H) would be synchronised by Renusagar with its own supply by

closing the bus-coupler. (In this condition the responsibility of synchronisation would be that of Renusagar and it would be done by the station by varying its own generation as well as that at Rihand (H) by coordinating with it).

- (iii) In case there is some delay in getting the WR supply from Vindhyachal at Singrauli and Singrauli station wants start-up power from Renusagar / Rihand (H), then the same shall be extended by Renusagar upto Singrauli by operating the appropriate breaker.

Case (b) Renusagar does not survives:

In case the Renusagar does not survive, then Renusagar shall take the following action to build-up generation at the station.

- (i) Avail start-up power from Rihand (H) if the units at Rihand (H) are able to self-start and supply is extended by Rihand (H) up to Renusagar.
- (ii) In case the units at Rihand (H) could not be self started and / or there is some delay in self-starting Rihand (H) units and before that the supply is available at Singrauli 132 KV Bus through Vindhyachal 400 KV link, then Renusagar shall avail start-up power from Singrauli.
- (iii) The priority for getting the start-up power at Renusagar would be from Rihand (H) followed by Singrauli. The necessary monitoring and coordination with the concerned stations in this regard would be done by Renusagar.
- (iv) In case Rihand (H) and Renusagar sub-systems have been synchronised and build-up as a sub-system and Singrauli is being built-up as separate subsystem by availing start-up power from Vindhyachal, then also the Rihand (H) and Renusagar sub-system can be synchronised with Singrauli (WR supply) by getting Singrauli supply extended upto Renusagar and synchronisation at Renusagar. The synchronisation responsibility would be that of Renusagar and the station would achieve this by varying its own generation in consultation with Rihand (H) and Singrauli.

2.2.4. RIHAND (THERMAL)

- (i) Rihand (Thermal) shall convey to Singrauli its readiness to avail the start-up power and the same shall be obtained from Singrauli on 400 kV Singrauli-Rihand circuit.
- (ii) After getting the start up power, the station shall light up the units and synchronise the same. [For the specific number of units to be lighted up please also refer para 2.3. (ii)].

2.2.5 ANPARA

- (i) Anpara shall convey to Singrauli its readiness to avail start up power and the same shall be obtained from Singrauli on 400 kV Singrauli-Anpara line.
- (ii) In the event of any delay in getting the start up power from Singrauli and the same is available at Rihand (Hydro), Anpara shall avail start up power from Rihand (Hydro).
- (iii) After getting the start up power, the station shall light up the units and synchronize the same. [For the number of units to be lighted up please also refer para 2.3. (ii)]
- (iv) Extend start-up power to Obra(Th): 400 kV side, by charging 400 kV Anpara-Obra line.
- (v) Keep itself ready to extend supply to Sarnath / receive supply from Sarnath, so that WR supply and ER supply can be joined together at Sarnath/Anpara.

Caution

In the event of separate supplies at Singrauli and Rihand (Hy), the possible mix - up of supplies extended at Anpara is to be safeguarded by Anpara. In the event of getting separate supplies

at 400kV (from Singrauli) and 132 kV (from Rihand (Hydro)) buses, Anpara is to synchronise these two supplies at its 400 / 132 kV ICT in consultation with Singrauli and Rihand (Hydro).

2.2.6 400 kV ALLAHABAD

- (i) Allahabad shall avail Western Region power available at Singrauli through 400 kV Singrauli- Allahabad line.
- (ii) Maintain voltage at Allahabad 400 kV bus in the range of around 400 kV by using line/bus reactors available at Allahabad.
- (iii) Extend supply to Kanpur for Railway traction load and start-up power for Unchahar and Panki TPS.
- (iv) Keep itself ready to extend supply to Sarnath / receive supply from Sarnath, so that WR supply and ER supply can be joined together at Sarnath/Allahabad.

2.2.7 KANPUR

- (i) Kanpur shall avail Western Region power available at Vindhyachal/Singrauli through 400 kV Singrauli-Allahabad-Kanpur line or alternatively through 400 kV Vindhyachal-Kanpur line.
- (ii) Activate SVCs at Kanpur in voltage control mode and by adjusting set points, maintain voltage at Kanpur 400 kV bus in the range of around 390 kV .
- (iii) Extend supply to Panki for Railway traction load and start-up power for Panki TPS through 220 kV Kanpur-Panki circuit or alternatively through 400 kV Kanpur-Panki circuit.
- (iv) Extend start -up power to Unchahar TPS on 220 kV Kanpur-Unchahar circuit.
- (v) Extend supply to Naubasta for Railway Traction load.

2.2.8 OBRA (Hydro)

- (i) Self start the units and synchronise with the supply extended from Rihand(Hy).
- (ii) In case of failure to self-start the units, start-up the units by availing start-up power from Rihand (Hy).
- (iii) Extend supply to Obra (Th): 220 kV side, in case of start-up power to Obra (Th) can not be made available from ER supply at Sahupuri.

2.2.9 OBRA (Thermal): 400 kV side

- (i) Avail start-up power from Anpara through 400 kV Anpara-Obra line and start up the units.
- (ii) In the scenario of non-receipt of start-up power by Tanda from ER supply, Charge 400 kV Obra-Sultanpur line for extending start-up power to Tanda. In case of over voltages, the bus reactor at Obra be put into operation and the voltage at Obra 400 kV bus be maintained less than 1.0 p.u.

2.2.10 PANKI

- (i) Panki sub-station to get supply from Kanpur on 220 kV Kanpur-Panki circuit or alternatively through 400 kV Kanpur-Panki circuit.
- (ii) Extend supply to Railway traction (At Panki, and Sarojini Nagar grid stations).
- (iii) Extend start-up power to Panki TPS.
- (vi) In the event of any delay in getting the supply from Kanpur end and availability of the same from Fatehpur end (through Obra-Allahabad-Fatehpur-Panki route) avail the supply from Fatehpur and extend it for railway traction and start up of unit at Panki TPS.

Caution

After availing the Western Region supply upto Panki, UPPCL shall use it only for railway traction load and start-up of thermal units at Panki. Beyond Panki the power would not be extended by UPPCL on the Western side without specific clearance of NRLDC.

2.2.11 UNCHAHAR

Unchahar shall avail start-up power in the following descending order of priority and revive the units at the earliest:

Priority 1: Kanpur 400 kV - Kanpur 220 kV –Unchahar. (WR supply)

Priority 2: Obra 220 kV-Allahabad-Fatehpur-Unchahar. (ER supply)

2.2.12 SASARAM HVDC (Back to Back Station)

In the event of total loss of power supply at Sasaram (North) 400 kV Bus, the station would immediately contact NRLDC and 400 kV Sarnath/Allahabad Sub-station to ascertain the status of power supply. In case of total loss of supply in Eastern U.P. (total loss of supply at Sarnath, Kanpur and other neighbouring substations), Sasaram shall initiate action for extension of Eastern Region (ER) supply to Sarnath. Sasaram shall finally extend the supply to Sarnath after confirming the readiness from Sarnath end. (The specific operations to be carried out at Sasaram are given under Section -8).

2.2.13 SARNATH

- (i) Sarnath shall avail Eastern Region power available at Sasaram North Bus through 400 kV Sasaram-Sarnath line.
- (ii) Maintain voltage at Sarnath 400 kV bus in the range of around 400 kV by using line/bus reactors available at Sarnath/Sasaram.
- (iii) Extend supply to Sahupuri for Railway traction load and start-up power for Obra TPS.

- . (iv) Extend supply to 220 kV Azamgarh for extension of start-up power to Tanda TPS.
- (v) Keep itself ready to extend supply to Allahabad or Anpara / receive supply from Allahabad or Anpara, so that WR supply and ER supply can be joined together at Sarnath/Allahabad/Anpara.

2.2.14 SAHUPURI

- (i) Sahupuri shall avail Eastern Region power available at Sarnath through 220 kV Sarnath-Sahupuri line.
- (ii) Extend supply to Railway traction load.
- (iii) Extend start-up power to Obra TPS through 220 kV Sahupuri-Obra line.
- (iv) In case of non –receipt of power from Sarnath, avail ER supply from Dehri and extend the same for Railway traction purposes only.

2.2.15 OBRA (Thermal): 220 kV side

- (i) Avail start-up power from ER supply available at Sahupuri and start up the units.
- (ii) In the event of non-availability of supply at Sahupuri or there may be considerable delay foreseen in getting supply from Sahupuri, Avail start-up power from Rihand (Hy)/Obra (Hy) and start up the units.
- (iii) Extend power to Allahabad for Railway traction and further extension towards Panki.

Caution

- (i) Obra (Th):220 kV side may get start-up power from any of the two sources; viz. from WR through Vindhyachal/ Singrauli/Rihand(Hy) or from ER through Sahupuri. **The two supplies which available at 220 kV Obra from western or eastern region, although coming out from a synchronously connected ER-WR system should not be**

synchronized/joined at Obra unless specifically advised to do so by NRLDC/CLDS, Lucknow. Joining the two supplies at Obra 220 kV may result in large power flow from ER to WR through a weak 132 kV link. More details regarding this aspect has been given at para2.3 (iii)

2.2.16 AZAMGARH

- (i) Azamgarh shall avail Eastern Region power available at Sarnath through 220 kV Sarnath-Azamgarh line.
- (ii) Extend supply to 220 kV Gorakhpur for extension of start-up power to Tanda TPS.

2.2.17 220 kV ALLAHABAD

- (i) Allahabad to get supply through 220 KV Obra-Allahabad.
- (ii) After availing the supply at Allahabad extend it to Railway traction.
- (iii) Extend supply to Fatehpur for Railway traction purpose.
- (iv) In the scenario of non-available of supply at Obra (Th) 220 KV side and the same is available at Fatehpur 220 KV side, avail supply from Fatehpur.
- (v) Extend supply to Obra (Th) in consultation with UPPCL Control Room, in case Obra (Th) has not received start-up power yet.

2.2.18. FATEHPUR

- (i) Fatehpur to get supply through 220 kV Obra-Allahabad-Fatehpur.
- (ii) After availing the supply at Fatehpur extend it for Railway traction.
- (iii) In case of Panki 220 KV not yet received supply from Kanpur and there maybe inordinate delay in reaching supply at Kanpur, extend supply to Naubasta for Railway traction, Panki for Railway traction and start-up power to Panki (Th) units and Unchahar for starting up the units.

- (iv) In the scenario of non-availability of supply at Obra (Th)/Allahabad and the same is available at Panki/Naubasta, avail supply from Panki/Naubasta in consultation with CLDS, Lucknow.
- (v) Extend supply to Allahabad in consultation with CLDS, Lucknow in case the supply at Fatehpur has been received through Panki/Naubasta.

2.2.18: SULTANPUR

- (i) In case of non-availability of ER supply at Azamgarh, Sultanpur to get power from Obra (Th) over 400 KV Obra-Sultanpur line.
- (ii) Maintain voltage at Sultanpur 400 kV bus in the range of around 400 kV by using bus reactors available at Sultanpur.
- (iii) Extend start up power to Tanda TPS

2.2.19 TANDA

Tanda shall avail start-up power in the descending order of priority as given under:

Priority –I: ER supply through 400 kV Sasaram-400 kV Sarnath-220 kV Sarnath- 220 kV Azamgarh-220 kV Gorakhpur-220 KV Tanda.

Priority –II: WR supply through 400 kV Vindhyachal-400 kV Singrauli-400 kV Anpara-400 kV Obra-400 kV Sultanpur-220 kV Sultanpur-220 kV Tanda

2.3 CAUTION

- (i) As per the standing arrangement, in the event of black out in the Northern Region, support of the order of 100 MW can immediately be availed from the Western Region without undergoing the exercise of exchange of codes etc. and any additional support thereafter would depend on the system conditions persisting at that time in the Western Region and Eastern Region. Therefore, while carrying out the restoration in the Northern Region with the help of WR/ER support, at the first

instance only the essential load as specified in this document (start up power to the generating units and railway traction feeders etc.) would be energized and connection of any other feeders / load can be done only after looking into the actual availability of power at that moment in consultation with NRLDC.

- (ii) While working out the requirement of start up power (para 2.1.4) it has been estimated that initially one 500 MW and one 200 MW unit at Singrauli and Anpara each and one 500 MW unit at Rihand would be lighted up as soon as start-up power is received at the respective stations. This has been planned on the presumption that to start with around 100 MW power can be availed from WR. However on the basis of experience from the past disturbances in NR and with favourable conditions prevailing in the WR grid, it is possible that during such situations larger quantum of power ; say up-to 400 MW, may be availed from WR and the thermal stations in NR may be able to start-up more number of units simultaneously. Therefore, different thermal power stations, particularly Singrauli, Rihand and Anpara must explore the possibility of starting up of maximum number of units simultaneously after cross checking the power availability aspect from NRLDC/CLDS-Lucknow.

- iii) **Joining of two supplies i.e. one from WR and other from ER:** In the event of blackout in the Region, the NR can avail start-up power from WR through Vindhyaachal AC bypass link, as well as from ER through Sasaram AC bypass link. Joining of the two supplies extended to NR through WR and ER is desirable, to achieve reliability and redundancy in supply. The supplies from two different sources made available to NR can be joined somewhere in NR, as the supplies coming from virtually one source i.e. Central Region or combined Western-Eastern Region. (The WR & ER are being operated in parallel and the two regions are synchronously connected through 400 kV Raipur-Raurkela D/C and 220 kV Korba-Budipadhar T/C.) However, there is likelihood of wheeling of power from ER to WR through NR or vice-versa also, and the quantum of wheeled power can vary depending on system conditions in the three involved regions.

In the course of availing black-start assistance by NR from two neighbouring regions, there may be four paths available for joining of WR & ER which can be considered.

Option 'A': through 400 kV Anpara

400 kV Vindhyachal- 400 kV Singrauli- **400 kV Anpara**- 400 kV Sarnath- 400 kV Sasaram.

Option 'B': through 400 kV Allahabad

400 kV Vindhyachal- 400 kV Singrauli- **400 kV Allahabad**- 400 kV Sarnath-400 kV Sasaram.

Option 'C': through 132 kV Rihand(Hy) or Pipri

400 kV Vindhyachal- 400 kV Singrauli- 132 kV Singrauli- **132 kV Pipri**- 132 kV Anpara- 400 kV Anpara- 400 kV Sarnath- 400 kV Sasaram.

Option 'D': through 220 kV Obra

400 kV Vindhyachal- 400 kV Singrauli- 132 kV Singrauli- 132 kV Pipri-132 kV Obra- **220 kV Obra** -220 kV Sahupuri- 220 kV Sarnath- 400 kV Sarnath- 400 kV Sasaram.

All the four options have been studied. In different scenario, power flow (wheeling of power) from ER to WR through NR system (With no load in NR and power flow of 1000 MW from ER to WR through AC interconnections has been considered.) comes out as under,

Option 'A': 350-400 MW (Anpara route)

Option 'B': 300-320 MW (Allahabad route)

Option 'C': 100-110 MW (132 kV Pipri route)

Option 'D': 90-100 MW (220 kV Obra route)

In option 'C' and 'D', although quantum of wheeling of power from ER to WR through NR network is of the order of 100 MW, however, two large and electrically strong ER and WR grid getting connected through a weak 132 kV /220 kV link. Tripping of any element in the serial chain may jeopardise the built-up Eastern UP Subsystem. In view of overall safety and security of the NR grid, these options may not to be the best one.

In option 'A' and 'B', although, quantum of wheeling of power from ER to WR through NR network is of the order of 300-400 MW, however, the power system network beyond Sasaram in ER and beyond Vindhachal in WR is generally capable of handling wheeled power of the order of 300-400 MW. Therefore out of the four options listed on previous page, the first two options viz. option A and option B appear to be the only viable options.

Out of these two options also, joining of ER and WR in NR via Allahabad route is preferable in view of the comparatively longer route resulting in controlled power flow and voltage parameters by the time of interconnection. Initially, Eastern UP island can be built-up separately by availing start-up power from ER and WR. Once, the start-up power has been extended to all thermal power station situated in this zone and supply given to railway traction load, the ER and WR supply can be joined together at Sarnath/Allahabad through 400kV Sarnath-Allahabad line. In case of any problem in 400kV Sarnath-Allahabad line the two supplies can be joined together at Sarnath/Anpara through 400kV Sarnath-Anpara line. The rise in voltages at different nodes in Eastern UP Subsystem can be tackled by appropriate use of bus/line reactors available at Singrauli/ Vindhyachal/ Anpara/ Allahabad/ Sarnath/ Sasaram etc.

- (iv) A strict load-generation balance is to be maintained while building up the subsystem, for which a lead role is to be played by UPPCL Control Room as well as all generating stations, more particularly Singrauli STPS and Rihand (Hydro).
- (v) The voltages in the system are to be closely monitored and Bus-Reactors / SVCs are to be promptly utilised by all the major generating stations / grid sub stations for maintaining the system voltages within normal range.

2.4 **SYNCHRONIZATION**

2.4.1 **Synchronisation with North-Central (NC) Sub-System**

The Eastern U.P. Subsystem shall be synchronized with North-Central (NC) Subsystem through 400 kV Kanpur-Agra line or alternatively through 400 kV Kanpur-Ballabgarh line at Kanpur / Agra / Ballabgarh. However, before synchronization of two subsystems, the Eastern U.P. Subsystem preferably is to disconnect from WR/ER keeping into consideration the aspects as stated in the following para.

2.4.2 **Disconnection from the Western/Eastern Region**

As long as Eastern U.P. Subsystem remains connected with WR/ER, the Subsystem enjoys stability by virtue of its connectivity with a large system. However, such connection cannot be continued for an unspecified period due to the possibility of exchange of large and uncontrolled power (during this period there are chances of wheeling of Power by Eastern UP Subsystem from ER to WR and vice-versa, as ER and WR systems are synchronously connected and Eastern UP Subsystem shall become parallel AC path between ER and WR) among the concerned three regions thereby endangering the security of the Western/Eastern Region also. Hence the disconnection of the built-up Eastern U.P. Subsystem from WR/ER is an important activity and its actual timing would have to be decided keeping in consideration the overall system security aspects. The following factors have to be kept in consideration at the time of disconnection.

- (i) Before disconnection from the WR/ER the following conditions have to be ensured: that
 - (a) The Eastern UP Subsystem has been adequately stabilized and built-up to a considerable size (say to a minimum size of around 2000 MW with around 6 generating units from Singrauli, Rihand, Anpara and nearby complex having been synchronized).
 - (b) The North-Central (NC) subsystem has also been built up adequately and stabilized so that immediately after disconnection

from WR/ER, the Eastern U.P. Subsystem can be synchronised with the North-Central (NC) Subsystem.

- (c) The circuits where the Eastern U.P. Subsystem and North-Central (NC) Subsystem shall be synchronized have been identified and ready for operation.
- (ii) After the conditions listed at i) above are achieved, the Power flow on the Vindhyachal AC By-pass Link and Sasaram AC By-pass Link has been made in almost floating condition (say less than 20-30 MW). In order to control the flows on AC By-pass Links, the lead role shall have to be played by Singrauli STPS and UPPCL Control Room in consultation with NRLDC, in the following manner:
 - By getting the generation regulated at Singrauli – (Singrauli STPS)
 - By getting the generation regulated at Rihand (Hy)/Anpara (Th) – (UPPCL)
 - By getting the load regulated in U.P. System (UPPCL)

Caution

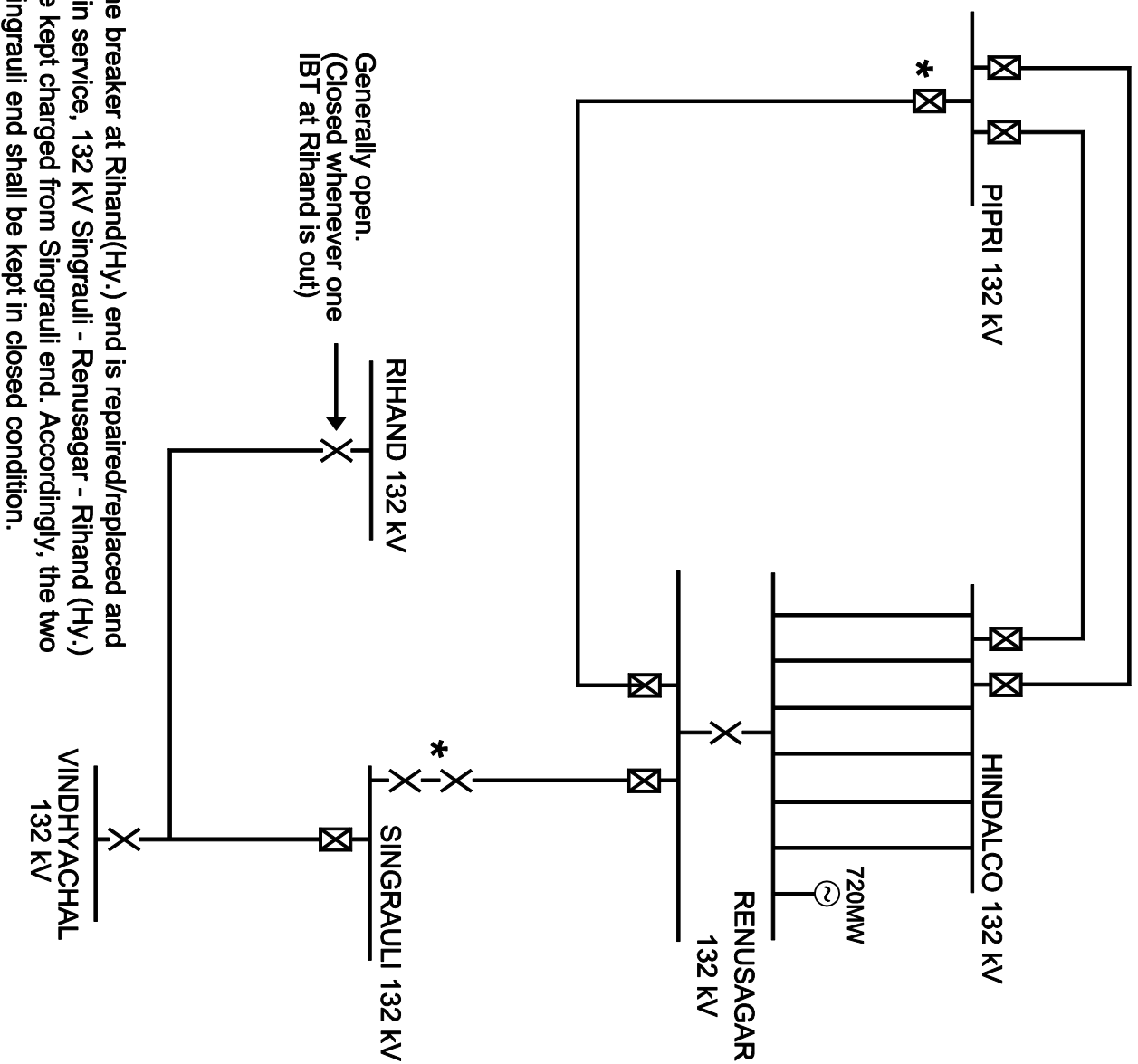
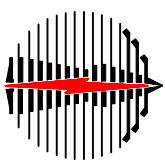
The above stated sequence suggesting the disconnection of Eastern U.P. Subsystem from WR/ER before synchronization with North-Central (NC) Subsystem is only indicative and based on the “most likely possibility” criteria. However, as the disconnection of the Eastern U.P. Subsystem from WR/ER is a critical and very important activity, while deciding the exact timing and sequence of operations, NRLDC shall keep into consideration the actual situation prevailing in the real time and may decide to change the sequence of operations accordingly.

2.5

START UP STAGES AND SEQUENCE:

- (i) For different Restoration Stages in Eastern U.P. Subsystem refer Exhibit-2A
- (ii) For detailed Start-up Sequence in Eastern U.P. Subsystem refer Exhibit-2B

INTERCONNECTION OF SINGRAULI, PIPRI AND RENUSSAGAR AT 132 kV



LEGEND:

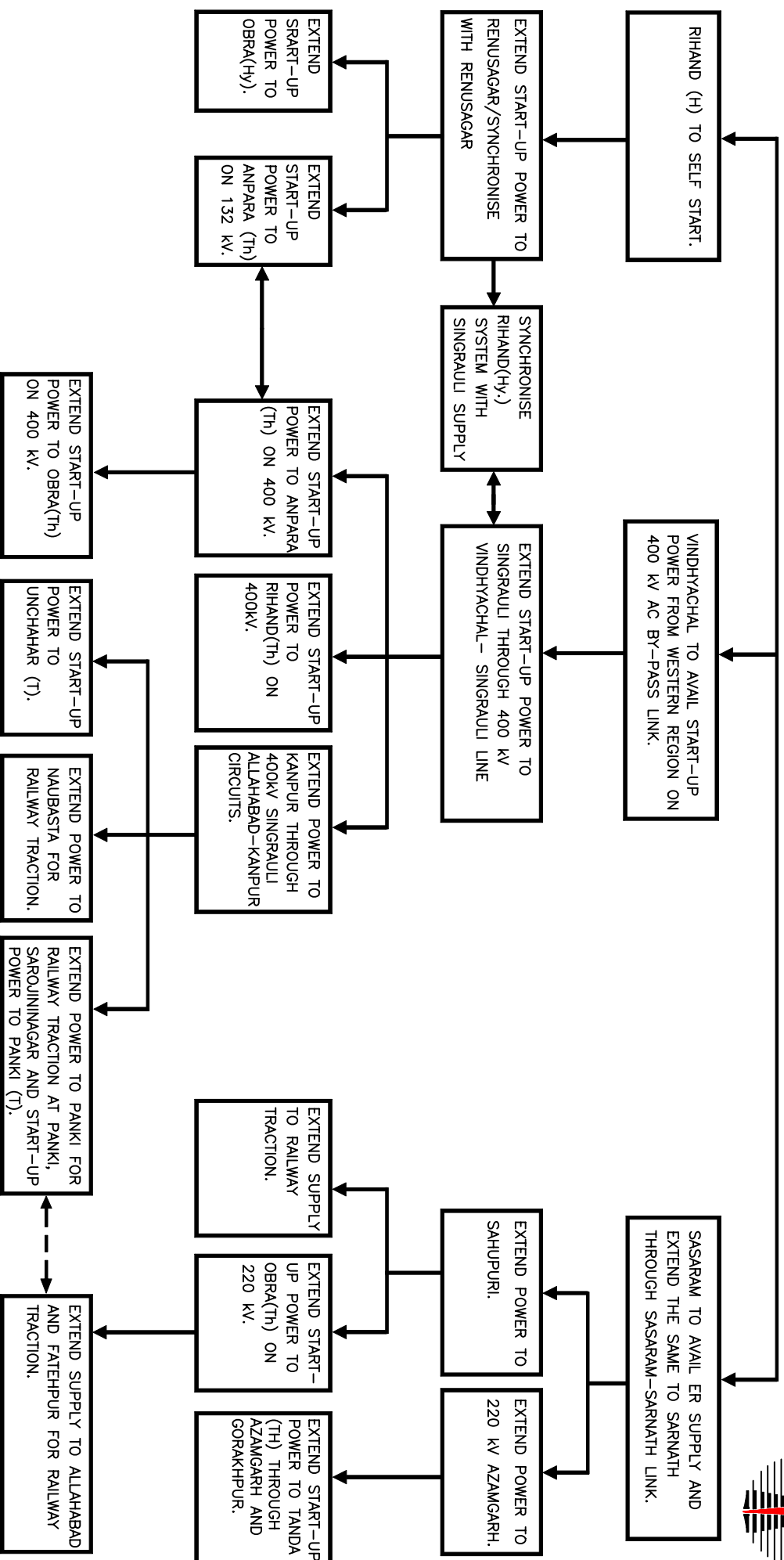
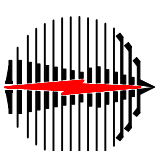
X C.B. NORMALLY OPEN

☒ C.B. NORMALLY CLOSED

* Note:-

Till the time the breaker at Rihand(Hy.) end is repaired/replaced and brought back in service, 132 kV Singrauli - Renussagar - Rihand (Hy.) circuit shall be kept charged from Singrauli end. Accordingly, the two breakers at Singrauli end shall be kept in closed condition.

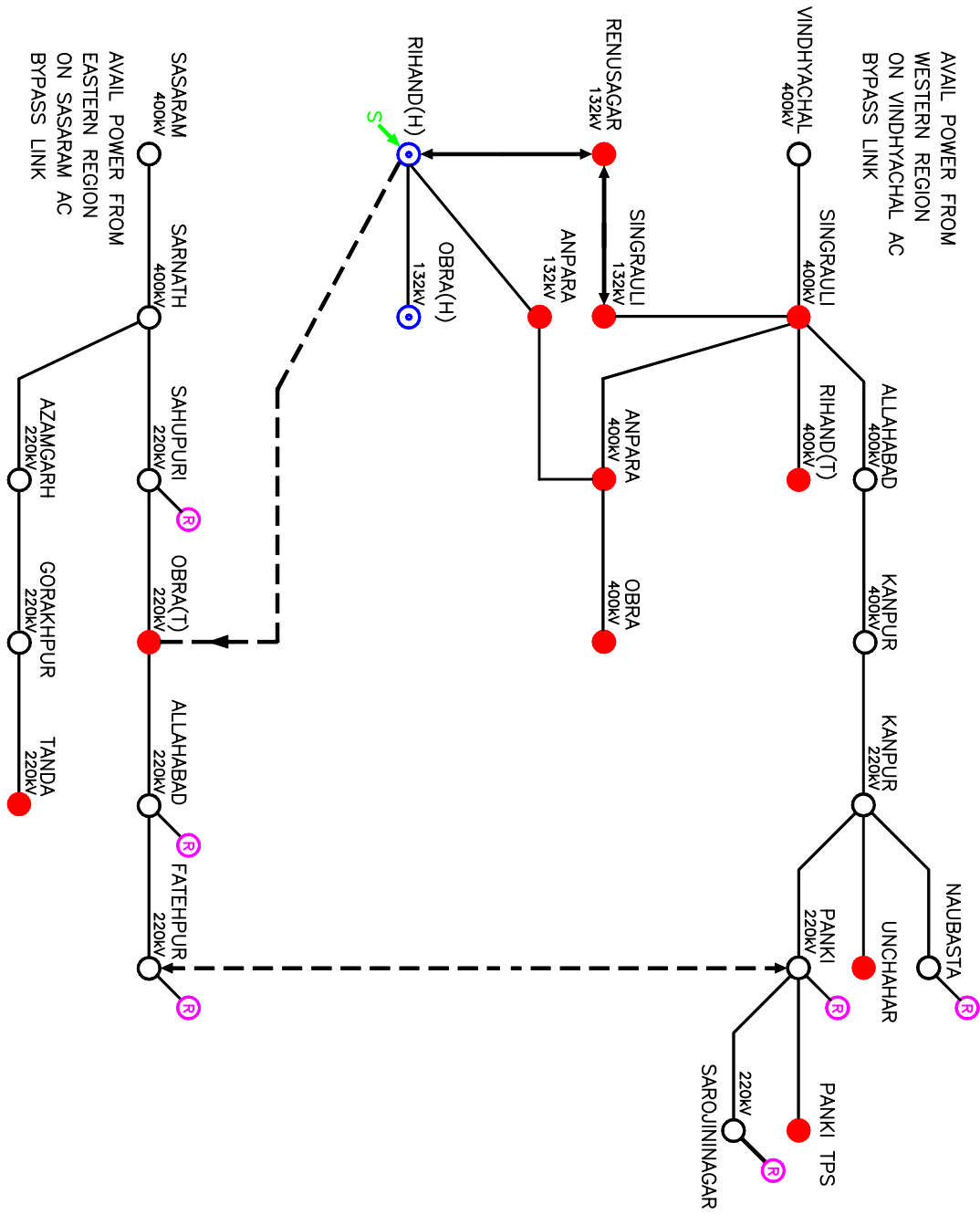
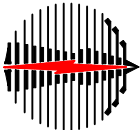
EASTERN U.P. SUBSYSTEM : RESTORATION STAGES



NOTE:–

1. RIHAND (Hy) SHALL SYNCHRONISE WITH THE RENUKULI/ SINGRAULI SUPPLY AT THE EARLIEST OPPORTUNITY.
2. EASTERN U.P. SUBSYSTEM SHALL CONTINUE TO OPERATE IN SYNCHRONISM WITH WESTERN/EASTERN REGION TILL THE SUBSYSTEM GETS ADEQUATELY STRENGTHENED.
3. RAILWAY TRACTION SUPPLY AT SAHUPURI SHALL BE FED FROM EASTERN REGION. IN CASE NON RECEIPT OF SUPPLY FROM SARNATH, SAHUPURI SHALL AVAIL ER SUPPLY FROM DEHRI ON 220 kV AND EXTEND THE SAME FOR RAILWAY TRACTION PURPOSE ONLY.

EASTERN U.P. SUBSYSTEM : START-UP SEQUENCE



LEGEND:-

- STATION TO SELF START
- HYDRO STATIONS
- THERMAL STATIONS
- NUCLEAR STATION
- SUB-STATIONS
- RAILWAY TRACTION

SECTION-3

RESTORATION OF NORTH-CENTRAL SUBSYSTEM

SECTION-3

RESTORATION OF NORTH-CENTRAL(NC) SUBSYSTEM

3.1 SUBSYSTEM OVERVIEW

3.1.1. Important Connecting Links with other subsystems:

- a) With Western U.P. Sub-system :
 - 1. 400 kV Dadri – Muradnagar
 - 2. 400 kV Agra– Murad Nagar
 - 3. 400 kV Mandaula-Meerut D/C
- b) With Eastern U.P. Subsystem:
 - 1. ± 500 kV HVDC Rihand – Dadri Bipole
 - 2. 400 kV Kanpur - Ballabgarh
 - 3. 400 kV Kanpur – Agra(PG)
 - 4. 400 kV Unnao-Agra(UP)
- c) With Rajasthan Sub-system:
 - 1. 400 kV Bassi-Hissar
 - 2. 400 kV Ballabgarh-Bhiwadi
 - 3. 400 kV Agra-Bassi

3.1.2. Major Generating Stations:

- a) Thermal: Dadri (Th), Ropar, Bhatinda, Lehra-Mohabat ,Panipat, Faridabad(Th), BTPS, I.P., Rajghat,
- b) Hydro: Bhakra, Dehar, Pong, Salal, Chamera-I & II, Uri, Bairasiul, Ranjit Sagar, Baspa , Jhakri , Lower Jhelum
- c) Gas: Dadri (Gas), Auraiya, Faridabad (Gas), Pragati gas, Delhi GT (Gas)

3.1.3. Sources of Start-up Power:

a)	Bhakra (Right)	300 MW
b)	Bhakra (Left)	200 MW
c)	Auraiya (Gas)	110 MW
d)	Dadri (Gas)	130 MW
e)	Delhi GT (Gas)	50 MW
f)	Pragati gas	110 MW
f)	Pong	120 MW
g)	Faridabad Gas	140 MW
h)	Salal Hydro	105 MW
i)	Uri Hydro	40 MW
j)	Lower Jhelum Hydro	30 MW
k)	Bairasiul Hydro	<u>60 MW</u>
TOTAL		<u>1395 MW</u>

3.1.4. Requirement of start - up power and other essential load:

a)	Panipat (Th)	40 MW
b)	Ropar	50 MW
c)	Bhatinda	30 MW
d)	Lehra Mohabat	50 MW
e)	BTPS	40 MW
f)	Dadri(Th)	50 MW
g)	IP + Rajghat	40 MW
h)	Faridabad (Th)	20 MW
i)	Railway Traction	220 MW
j)	Other essential load	<u>855 MW</u>
TOTAL		<u>1395 MW</u>

3.1.5. System Synchronization:

After subsystem build up and stabilised, the North-Central (NC) Subsystem can be synchronized with other subsystems in the following manner:

a) With Eastern U.P. Subsystem:

Initially the North-Central (NC) Subsystem shall be synchronized with the Eastern U.P. Subsystem at the following possible connections:

- i) 400 kV Kanpur – Agra(PG) at Kanpur/Agra(PG)
- ii) 400 kV Kanpur-Ballabgarh at Kanpur/Ballabgarh

b) With Rajasthan Subsystem

Subsequently the combined North-Central (NC) + Eastern U.P. Subsystem shall be synchronized with the Rajasthan Subsystem at the Following possible connections:

- i) 400 kV Bassi-Hissar at Bassi / Hissar
- ii) 400 kV Ballabgarh-Bhiwadi at Ballabgarh
- iii) 400 kV Agra-Bassi at Bassi/Agra

c) With Western U.P. Subsystem

Finally, the combined North-Central (NC) + Eastern U.P. + Rajasthan Subsystems shall be synchronized with the Western U.P. Subsystem at the following possible connections:

- i) 400 kV Dadri-Muradnagar at Dadri / Muradnagar
- ii) 400 kV Agra-Muradnagar at Agra / Muradnagar
- iii) 400 kV Panki-Muradnagar at Panki / Muradnagar
- iii) 400 kV Lucknow-Moradabad at Lucknow / Moradabad

The above synchronizing sequence is only indicative. However, based on the actual electrical size and geography of a particular subsystem being built-up, the sequence of synchronization of different Sub-systems can be suitably decided on seeing the real time conditions.

3.2 **SUBSYSTEM RESTORATION PROCEDURE:**

3.2.1 The North-Central (NC) Subsystem at the time of build-up shall be considered to have consisted of the following main areas:

- (i) **DELHI AREA** - consisting of generating units in Delhi System (including BTPS) and Faridabad (Gas).
- (ii) **BBMB AND NEIGHBOURING AREA** - consisting of the hydro units of BBMB, thermal and hydro units of Punjab & Haryana and hydro units of H.P.(including hydro units of IPPs viz. Baspa, Malana etc.)
- (iii) **DADRI (NTPC) AREA** – consisting of units at Dadri (Gas) and Dadri (Thermal) along with traction load being catered at Dadri.
- (iv) **AURAIYA (Gas) AREA** - consisting of Auraiya (Gas) along with traction load at Agra / Mathura / Phaphund.
- (v) **J & K AND NORTH PUNJAB AREA** - consisting of hydro units in J & K, North Punjab and Chamara, Salal and Uri power house of NHPC.

At the time of subsystem built-up, the actions to be taken at the major Generating stations / grid substations in the North-Central (NC) Subsystem are as given below.

3.2.2 **DELHI AREA:**

- i) In case of survival of Delhi inner ring, Delhi shall immediately extend start-up power to Badarpur. In order to strengthen the survived network it shall be synchronized, at the earliest, with the supply from Faridabad (Gas) on 220 kV Ballabhgarh- BTPS Ckt. at BTPS.
- ii) In case of collapse / non-survival of Delhi inner ring, the Delhi GT's and Pragati machines are to be self-started and supply is to be extended for meeting the emergency loads, to Badarpur as start-up power and to Park Street for railway traction. DTL has to ensure that I.P. and Rajghat units are also extended power at the earliest suitable opportunity. The

built-up system would be synchronised with the supply available from Faridabad (gas) at the first opportunity.

- iii) As soon as stabilized power supply from the BBMB Subsystem is available at the periphery of Delhi (say at Ballabhgarh / Mandola), the Delhi Area (consist of generating units in Delhi system, Faridabad gas and BTPS) shall synchronize with the same.

Note: For extending quick start up power to IP (Th) from the GT station of Delhi, the possibility of providing a direct link between Delhi GT station switchyard and IP (Th) Switchyard at 66/33 kV level be explored by DTL on priority basis.

3.2.2.1 FARIDABAD (Gas)

- i) Faridabad GPS would self start GTs and extend supply to BTPS via 220 kV Faridabad - Samaypur – Ballabgarh– BTPS (supply would be extended from Faridabad to BTPS on priority without putting any additional load except 30-40 MW load at Samaypur and traction load at Ballabhgarh).
- ii) To give stability to Faridabad GPS, controlled load in a gradual manner would be put at Okhla feeders from BTPS. In the event of drop in frequency load to be shed immediately in this island in a gradual manner, and the load-generation balance in the island would maintained.
- iii) From Ballabhgarh at 66 kV start-up power shall be extended to Faridabad (Th) after stabilisation of Faridabad (Gas) machines feeding a stable load at Samaypur/ Okhla.

Caution

- i) In order to maintain the load - generation balance in the built up area and to avoid sharp variations in the loading of Faridabad (GTs), the load in Delhi system would be added / removed in a controlled and gradual manner. Necessary coordination / control in this respect shall be carried out by DTL, in coordination with BTPS, Faridabad (gas) and NRLDC.

- ii) While extending the power from Ballabhgarh 66 kV to Faridabad (Th), it would be ensured by HVPN that only the start up power for the thermal units at Faridabad would be availed and no other load at the station be connected without specific clearance from NRLDC.

3.2.2.2 **Badarpur Thermal Power Station (BTPS):**

BTPS shall avail start-up power in the following order of priority:

Priority 1: From Pragati GPS via 220 kV IPextn. – BTPS

Priority 2: From Faridabad GPS via 220 kV Faridabad (Gas) – Samaypur – Bhallabgarh – BTPS

Note: In case of availability of two different supplies at BTPS i.e. from Delhi area and Faridabad gas, the two supplies shall be synchronized at BTPS at the first opportunity, for greater stability of islands.

Loading in the built up area shall be controlled by DTL as explained in para 3.2.2.1 above.

Priority 3: BBMB power via 220 kV Panipat – Narela(DTL) – Bawana – Najafgarh- Bamnauli- Mehrauli – BTPS

DTL will add load at any of the above en-route substations after the supply is available at Narela in an extremely controlled and judicious manner in consultation with NRLDC and keeping a close watch on the system parameters (The 30-40 MW load at Narela for Railway Traction purpose would be provided on priority).

Priority 4: BBMB power via 400 kV Panipat - 400 kV Dadri - 400 kV Samaypur-220 kV Samaypur – 220 kV Ballabhgarh-220 kV BTPS

Priority 5: BBMB power via 220 kV Panipat – Charkhi Dadri – Ballabhgarh – BTPS.

3.2.3 **BBMB AND NEIGHBOURING AREA:**

- i) The units at Bhakra(R) or Bhakra(L) shall be self started and the supply shall be extended to Ganguwal.
- ii) From Ganguwal the supply shall be extended to units at Bhakra (L) / Bhakra (R) as the case may be, and around three (3) machines each at Bhakra (R) and Bhakra (L) would be operated to provide power system stability and adequate spinning reserves so as to control the system parameters in a weak system.
- iii) From Ganguwal supply shall be extended to Ganguwal HEP & Kotla HEP at 132 kV and units at these station would be synchronized.
- iv) From Kotla 132 kV supply shall be extended to Ropar TPS (via Ropar 132 kV) for start up of units.
- v) From Ganguwal supply shall be extended to Panipat 220 kV through Dhulkote.
- vi) From Ganguwal the supply shall be extended to Dehar HEP and units at Dehar would be synchronized.
- vii) From Bhakra(R) supply shall be extended to Jamalpur.

3.2.3.1 **PANIPAT 220 kV (BBMB)**

After availing power from Ganguwal, following actions shall be taken at Panipat 220 kV (BBMB)

- i) Extend power to Panipat (Th).
- ii) Extend power to Narela for Railway Traction load.
- iii) Charge one 220 kV / 400 kV ICT at Panipat and then charge 400 kV line to Dadri.

3.2.3.2 **PANIPAT (TPS)**

After getting the start up power the station shall light up the Generating units and synchronise the same.

3.2.3.3 **ROPAR (Thermal):**

Ropar (Th) shall get start up power in the following descending order of priority:

Priority 1: Bhakra (R)/(L) -Ganguwal - Ganguwal (132 kV)-Kotla-Ropar- Ropar (Th)

Priority 2: Bhakra (R)/(L) – Ganguwal - Mohali- Ropar(Th)

Priority 3: Bhakra (R)/(L) - Ganguwal- Govindgarh II– Govindgarh I – Ropar (Th)

From Ropar power shall be extended to Anandpur Sahib HEP at 132 kV and the generating units at Anandpur Sahib HEP shall be synchronised.

3.2.3.4 **BHATINDA / LEHRA MOHABAT:**

Bhatinda / Lehra-Mohabat shall get start up power in the following descending order of priority :

Priority 1: Bhakra (R) –Jamalpur- Sangrur- Barnala (BBMB)-Lehra Mohabat-Bhatinda;

Priority 2: Bhakra(R)/(L)- Ganguwal- Govindgarh-II- Govindgarh-I Malerkotla -Barnala(PSEB) – Lehra Mohabat- Bhatinda

3.2.3.5 **PONG:**

- i) Avail start-up power from Baira-siul and start the units.

- ii) Synchronise with BBMB supply extended to Pong via Bhakra (R) - Jamalpur- Jullandhar- Pong. In case of non-availability of start-up power from Bairasiul, use the available BBMB supply for start-up of the units.
- iii) In case of units at Bairasiul could not be started, extend start-up power to Bairasiul.

3.2.3.6 **BAIRASIUL:**

- i) Self- start the units and extend supply to Pong for starting the units.
- ii) Extend supply to Jessore.
- iii) In case of any problem in self-starting the units, avail BBMB supply from Pong and start the units.

3.2.3.7 **BASPA:**

- i) Self- start the units and extend supply/ synchronize to/with Jhakri.
- ii) In case of any problem in self starting the units, avail supply from Jhakri and start the units.

3.2.3.8 **JHAKRI:**

- i) Self- start the units and extend supply to 400 kV Abdullapur for catering Railway traction load and other essential load in that area.
- ii) Synchronise with the supply extended from Baspa. In case of machines at Baspa could not be started, extend supply to Baspa.
- iii) In case of any problem in self starting the units, avail supply from Baspa and start the units
- iv) In the event of non-availability of supply in Baspa/Jhakri area, the BBMB supply shall be extended to this area through Panipat(Th)-Narwana-Kaithal-Pehowa-Shahbad-Abdullapur 220 kV- Abdullapur 400 kV-Jhakri 400kV.

3.2.3.9 **SURATGARH STPS**

Suratgarh shall avail start-up power in the following descending order of priority:

Priority-1: From BBMB System through Bhakra (R)-Jamalpur-Sangrur- Hissar- Khetri- Ratangarh- Suratgarh

Priority-2: From Rajasthan Subsystem through Kota (S)-Jaipur-Khetri- Ratangarh- Suratgarh

Caution

A possible mixing up of the supply from BBMB Subsystem and Rajasthan Subsystem at Khetri is to be safeguarded by RRVPN.

3.2.4 **DADRI (NTPC) AREA**

- i) In case the GT's at Dadri survive on house load, then Dadri (Gas) would extend start up power to Dadri (Thermal) at 220 kV and extend supply to Railway Traction load.
- ii) In the event of tripping of all the GT's at Dadri, these shall be self started and start up power would be extended to Dadri (Th). Supply shall be extended to Railway Traction load on priority.
- iii) In the event of build up of the Dadri Area by self starting the units at Dadri (Gas) and synchronisation of unit(s) at Dadri(Thermal), the supply shall be extended up to Dadri 400 kV for synchronization with BBMB supply at 400 kV Dadri - Panipat Ckt. The supply shall also be extended to 400 kV Ballabgarh for extending power/ synchronization with Delhi Area.
- iv) In the event of any difficulty in self-starting the GTs at Dadri (gas) and/or extending the supply to the units at Dadri(Th), BBMB supply shall be extended to Dadri 400 kV sub-station for start-up of generating units, through Panipat 220 kV -Panipat 400 kV -Dadri 400 kV.

3.2.5 **AURAIYA (Gas) AREA:**

- i) The GT's at Auraiya are to be self-started and to be synchronized with Western Regional Grid in consultation with Malanpur (WR). The synchronisation with WR is being done mainly to provide stability to the developed system. However, the power flow on the 220 kV Auraiya-Malanpur link shall be maintained close to zero or as permitted by MP/WRLDC so that no adverse effect be experienced by the WR system in and around Malanpur and Auraiya GPP shall achieve such conditions by controlling generation at Auraiya.
- ii) From Auraiya supply shall be extended to 220 kV Phaphund for railway traction load .
- iii) From Auraiya supply shall be extended to 220 kV Sikandara for railway traction load at Agra and Mathura and to 400kV Agra(PG) substation through 400kV Agra(UP) for synchronisation with North-Central subsystem.
- iv) The Auraiya (gas) area shall be synchronised with the North-Central (NC) Subsystem at Agra (PG) 400 kV. (Before this, connection with Malanpur(WR) shall be disconnected).

Caution

- i) In case of synchronisation of the units at Auraiya with Malanpur (Western Regional grid), the Auraiya-Malanpur connection shall be disconnected before synchronizing with the North-Central (NC) Subsystem.
- ii) In case of failure in self starting of GT's at Auraiya, the same can be started by availing start up supply in the following descending order of priority

Priority-1: Western Grid supply from Malanpur

Priority-2: North-Central (NC) subsystem supply through Ballabhgarh-Agra -Auraiya 400 kV.

3.2.6 J&K AND NORTH PUNJAB AREA

Action to be taken at the major generating stations / grid sub-stations in J & K and North Punjab Area is as given below:

3.2.6.1 RANJIT SAGAR HEP

- i) Generating units at Ranjit Sagar HEP shall be self started and from this load around Sarna shall be fed. When BBMB supply is extended to Sarna through Jalandhar and Dasuya, the supply from Ranjeet Sagar HEP shall be synchronised with the BBMB supply at Sarna.
- ii) From Sarna power shall be extended to Kishenpur and synchronized with the supply from Salal / Chamera. Alternatively if the stabilized supply at Kishenpur is built up early then it shall be extended up to Sarna for synchronization with BBMB / North Punjab System.

Note: PSEB shall develop synchronizing facility at its 220 kV Sarna Sub-station in order to synchronise the different Subsystems built up in J & K Area, BBMB Area and Northern Punjab.

3.2.6.2 SALAL HEP

- i) Salal to self start its units and extend supply to Kishenpur.
- ii) Extend supply to Jammu to cater essential load of Jammu area.

3.2.6.3 CHAMERA HEP

- i) Chamera I shall self start its units and extend supply / synchronized with Chamera II.
- iv) Chamera II shall self start its units and extend supply / synchronized with Chamera I.
- iii) The combined supply of Chamera I & II shall be extended to 400 kV Kishenpur.

3.2.6.4 **KISHENPUR**

- i) The generating units at three hydro stations around Jammu and North Punjab area viz. Salal, Ranjeet Sagar and Chamera shall be self started and supply shall be extended to Kishenpur and synchronized. In the event of any difficulty in self starting the units at any station, supply from Kishenpur shall be extended to the concerned station.

- ii) Power from BBMB Complex shall be also extended to 220 kV Kishenpur sub-station in the following sequence:

Bhakra(R)- Jamalpur – Jallandhar – Dasuya – Sarna – Kishenpur and the two supplies shall be synchronized.

- iii) From Kishenpur supply shall also be extended to Pampore in case of non-availability of supply from Hydro units in the valley area.

3.2.6.5 **VALLEY AREA:**

- i) The hydro units at Valley i.e. at Uri and Lower Jhelum would be self-started and synchronised at Uri / Ziankote.
- ii) The supply from the Valley Area shall be extended through 220 kV Pampore Sub-station to Kishenpur for synchronisation with BBMB/J & K & North Punjab Area.

3.3 **SYNCHRONISATION:**

The North-Central Sub-system shall be synchronised with the Eastern U.P. Subsystem through 400 kV Kanpur-Agra Ckt. at Kanpur / Agra or alternatively through 400 kV Kanpur - Bhallabgarh Ckt. at Kanpur / Bhallabgarh . The combined subsystems shall also be synchronised with the Rajasthan and Western U.P. Subsystem.

Caution

- i) A strict load-generation balance shall have to be maintained while developing the subsystem.

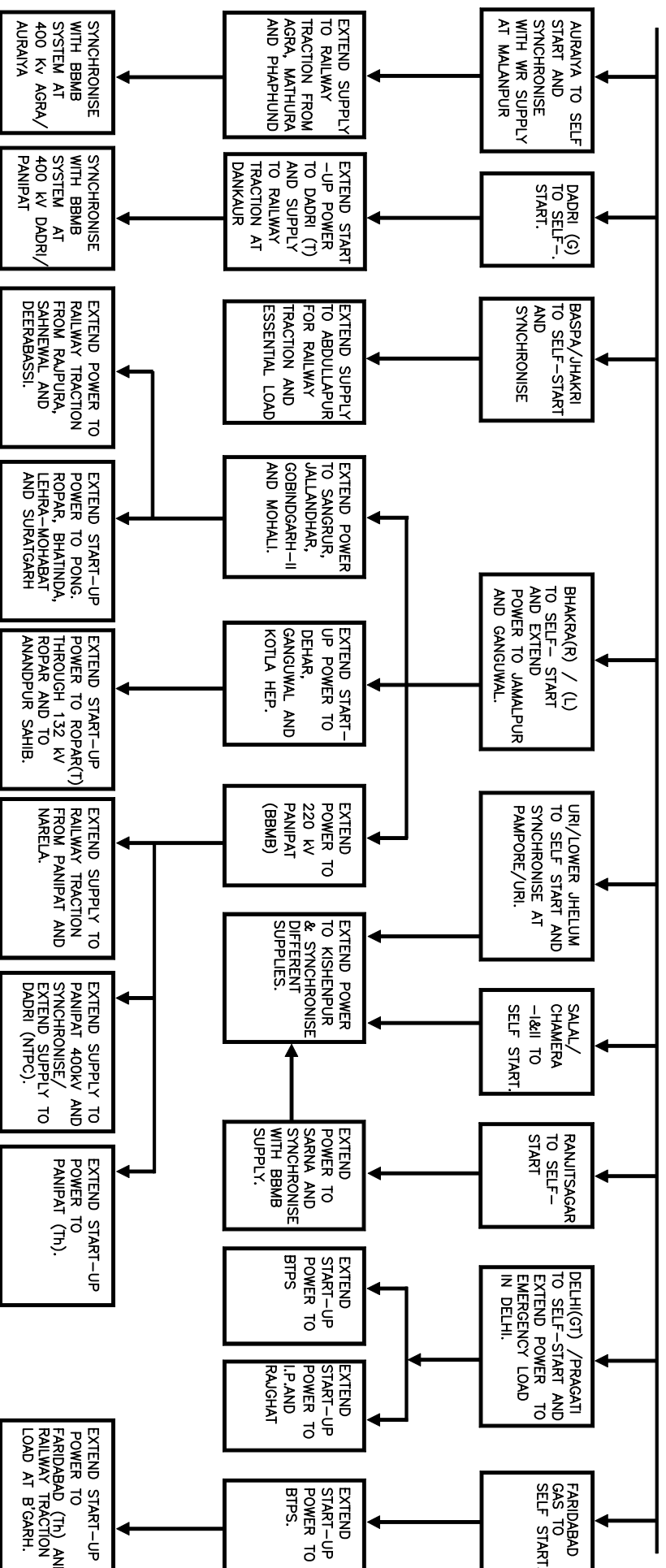
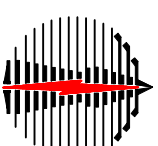
- ii) Due to start up of the areas separately, the related supplies are to be synchronized at the earliest opportunity and a combined subsystem is to be formed at the earliest for strengthening the subsystem.
- iii) The railway traction load at the various points and start up supplies to generating stations is to be extended on top priority.
- iv) The voltages at different nodes / buses are to be maintained within normal range by use of bus / line reactors and by operating the units in synchronous condenser mode wherever applicable for absorbing / generating VARs.

3.4

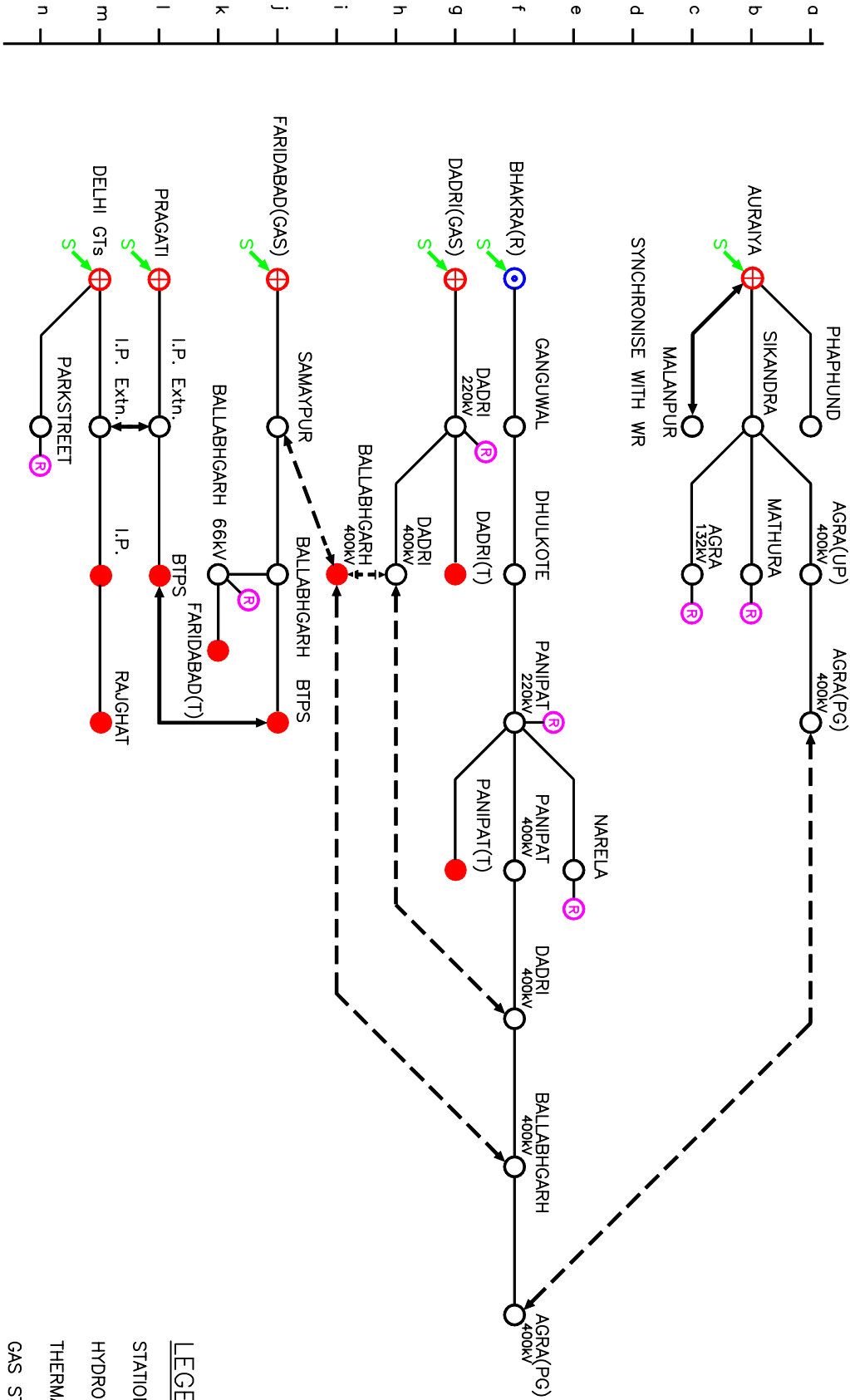
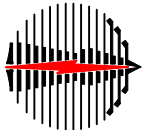
START-UP STAGES AND SEQUENCE:

- i) For different Restoration Stages in North-Central (NC) Sub-system refer Exhibit-3A.
- ii) For detailed Start-up Sequence in North-Central (NC) Sub-system refer Exhibit -3 B.

NORTH CENTRAL SUBSYSTEM : RESTORATION STAGES



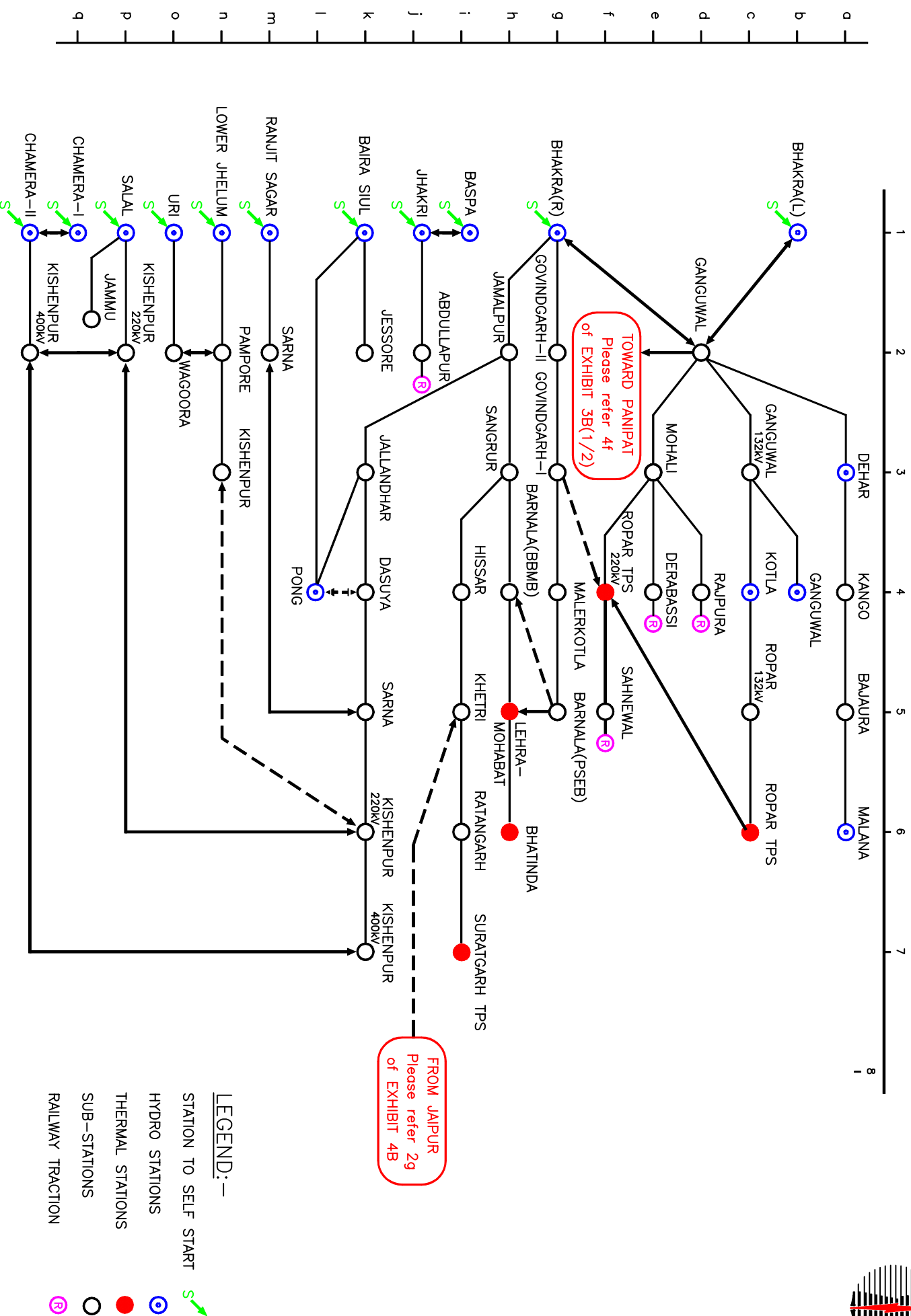
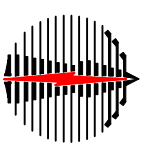
NORTH-CENTRAL SUBSYSTEM (PART-1): START-UP SEQUENCE



LEGEND:-

- STATION TO SELF START
- HYDRO STATIONS
- THERMAL STATIONS
- GAS STATION
- SUB-STATIONS
- RAILWAY TRACTION

NORTH-CENTRAL SUBSYSTEM (PART-2): START-UP SEQUENCE



SECTION-4

RESTORATION OF RAJASTHAN SUBSYSTEM

SECTION-4

RESTORATION OF RAJASTHAN SUBSYSTEM

4.1 SUBSYSTEM OVERVIEW

4.1.1. Important Connecting Links with other Subsystems:

- a) With North-Central (NC) subsystem
 - i) 400 kV Ballabgarh - Bhiwadi
 - ii) 400 kV Hissar - Bassi
 - iii) 400 kV Agra – Bassi

4.1.2. Major Generating Stations:

- a) Thermal: Suratgarh STPS, Kota TPS
- b) Hydro: Rana Pratap Sagar (RPS), Jawahar Sagar (JS), Mahi
- c) Gas: Anta, Ramgarh GT
- d) Nuclear: RAPS (A), RAPS (B)

4.1.3. Sources of Start-up power

a)	RPS -Self start	:	150 MW
b)	JS HEP- Self start	:	100 MW
c)	Anta(Gas)	:	<u>80 MW</u>
Total:			<u>330 MW</u>

4.1.4. Requirement of Start-up power:

a)	Start-up at Kota	:	40 MW
b)	RAPS (A) & RAPS (B)	:	50 MW
c)	Railway Traction	:	70 MW
d)	Other Essential Loads	:	<u>170 MW</u>
Total			<u>330 MW</u>

4.1.5. **System Synchronization:**

After build-up of the Rajasthan Sub-system, it can be synchronized with the combined North-Central (NC) and Eastern U.P. Subsystems at the following possible connections.

- i) 400 kV Hissar-Bassi at Hissar/Bassi
- ii) 400 kV Agra-Bassi at Agra/Bassi

4.2 **SUBSYSTEM RESTORATION PROCEDURE**

At the time of subsystem build up, the action to be taken at the major generating stations / grid substations is as given below:

4.2.1. **R.P. SAGAR HEP**

- (i) R.P. Sagar HEP shall self-start and synchronise with WR supply on 132 kV R.P.Sagar-Gandhisagar line for stabilization.
- (ii) In case of any problem in self starting of units at R.P. Sagar, avail start-up power from Gandhi Sagar (WR) and start the units at R.P.Sagar.
- (iii) Extend start-up power or receive power from Jawahar Sagar as the case may be.
- (iv) Extend supply to Kota (S)

4.2.2 **JAWAHAR SAGAR HEP**

Jawahar Sagar HEP shall self start the units and extend power to R.P.Sagar. In case of problem in self-starting the units, avail start-up power from R.P.Sagar and start-up its units.

4.2.3 **KOTA (SAKATPURA) 220 kV SUB-STATION**

- (i) Avail power from Ujjain (WR) on 220 kV Ujjain-Kota circuit and start-up power shall be extended to Kota (Th), RAPS (A) and

RAPS (B). Simultaneously synchronization with the supply from R.P. Sagar shall also be carried out.

- (ii) In case start-up power from Ujjain is not available, Kota (S) shall avail the power from RP Sagar and extend it to Kota (Th), RAPS (A) and RAPS (B).
- (iii) Extend power supply for Railway Traction.
- (iv) Synchronize with supply extended from survived RAPS (A) / RAPS (B) islands.
- (v) Synchronise with supply extended from Anta or, in case request received from Anta, start-up power / reference shall be extended from Kota (S) to Anta, in consultation with RRVPN control room.
- (vi) Extend supply to Jaipur for Railway traction and/or other essential load.

4.2.4. **KOTA (THERMAL)**

- i) Kota (Th) to avail start-up power from Kota (S).
- ii) Extend supply to Jaipur, in case of supply could not be extended to Jaipur through Kota (S).

4.2.5. **RAPS (A) & RAPS (B)**

- i) In case of survival of either of RAPS islands, extend supply to Kota(S) and synchronise with Kota (S) once the supply around Kota (S) has been stabilised.
- ii) In case of tripping of RAPS (A), avail start-up power from Kota (S). In case of non-availability of power from Kota(S) / RP Sagar, RAPP(A) shall initiate action to draw power from Western Grid by charging 132/220 kV, 50 MVA transformer at RAPP(A) through 132 kV Gandhi Sagar-RP Sagar line.

- (iii) In case of tripping of RAPS (B), avail start-up power from Kota (S). In case of any problem in RAPS (B)-Kota (S) ckt, the start-up power can be availed through Anta/RAPS (A)
- (iv) In case RAPS (B) survives, then, in consultation with RRVPN Control Room, it shall extend power to Anta for starting of GTs / synchronisation.

4.2.6. **ANTA (Gas)**

- (i) In case, Anta has survived on house load, extend supply to Kota (S) for synchronisation/build-up of system. Alternatively receive the supply from Kota (S) / RAPS (B), if 220 kV Kota (S) / RAPS (B) buses are in charged condition. The two supplies also to be synchronised at the earliest opportunity.
- (ii) In case of tripping of units at Anta, self start GT's at Anta and extend supply to Kota (S).
- (iii) In case of any problem in self starting of units at Anta or extending supply to Kota (S), request Kota(S) to extend supply and start GT's /synchronise.
- (iv) Extend supply from Anta to Sawai-madhopur, Dausa and Bharatpur for Railway Traction load.

4.2.7. **JAIPUR 220 kV SUB-STATION**

- (i) Avail power supply from Kota (S)/Kota (Th).
- (ii) Extend power to Dausa and Bharatpur for Railway Traction and other emergency loads.
- (iii) Extend power to Khetri for further extension to Suratgarh as start-up power, in case there is delay in getting BBMB supply at Khetri.

- (iv) Extend power to Heerapura / Bassi 400 kV substation for synchronisation of Rajasthan Subsystem with North-Central (NC) Subsystem.

4.2.8 **KHETRI 220 kV SUB-STATION**

- (i) Khetri shall get BBMB supply from Hissar and start up power shall be extended to Suratgarh.
- (ii) In case there is delay in getting BBMB supply then Khetri shall avail power through Jaipur from Rajasthan Subsystem and extend it to Suratgarh.

4.2.9 **SURATGARH STPS**

Suratgarh STPS shall avail start-up power in the following descending order of priority:

Priority-1: From BBMB System through Bhakra (R)- Jamalpur-Sangrur- Hissar- Khetri- Ratangarh- Suratgarh

Priority-2: From Rajasthan Subsystem through Kota (S)-Jaipur-Khetri- Ratangarh- Suratgarh

Caution

- (i) While restoring the Subsystem, the load generation balance is to be maintained.
- (ii) In case of survival of RAPS (A)/RAPS (B) islands, these must be synchronized with the supply of R.P Sagar / Kota (S) at the earliest opportunity.
- (iii) The power supply to Railway Traction and RAPS (A) / RAPS (B) is to be extended on top priority.
- (iv) In case, Kota (S) has availed start-up power from Ujjain and RP Sagar has been started up separately, then the two supplies are

to be synchronized at Kota (S) / R.P. Sagar for stability and then the supply be extended further to other stations.

4.3 SYNCHRONISATION OF RAJASTHAN SUBSYSTEM

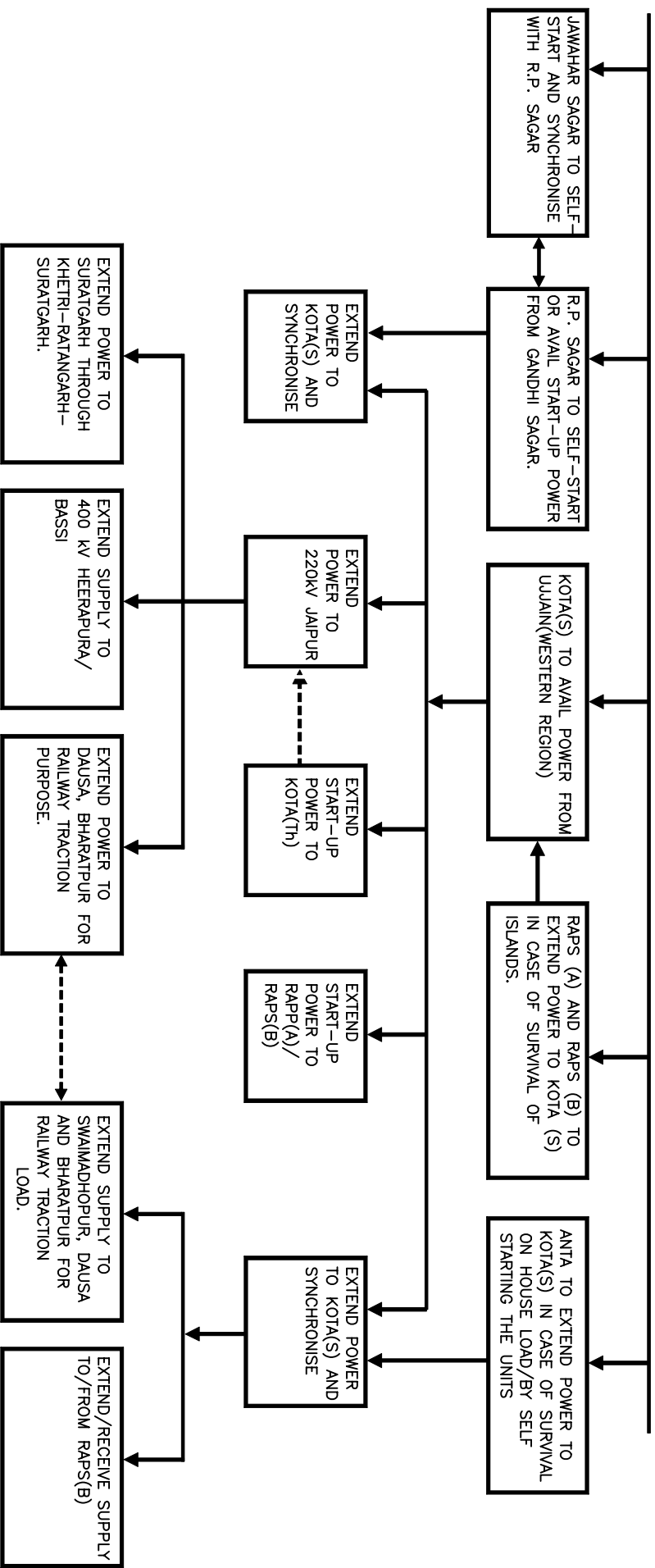
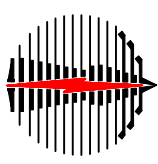
Rajasthan System is to be synchronised with the North-Central (NC) and Eastern UP Subsystem at the following possible connections:

- (i) 400 kV Hissar-Bassi at Hissar / Bassi.
- (ii) 400 kV Agra-Bassi at Bassi/Agra

4.3 START-UP STAGES AND SEQUENCE

- (i) For different Restoration Stages in Rajasthan Subsystem , refer Exhibit- 4A .
- (ii) For detailed Start-up Sequence in Rajasthan Subsystem refer Exhibit-4B.

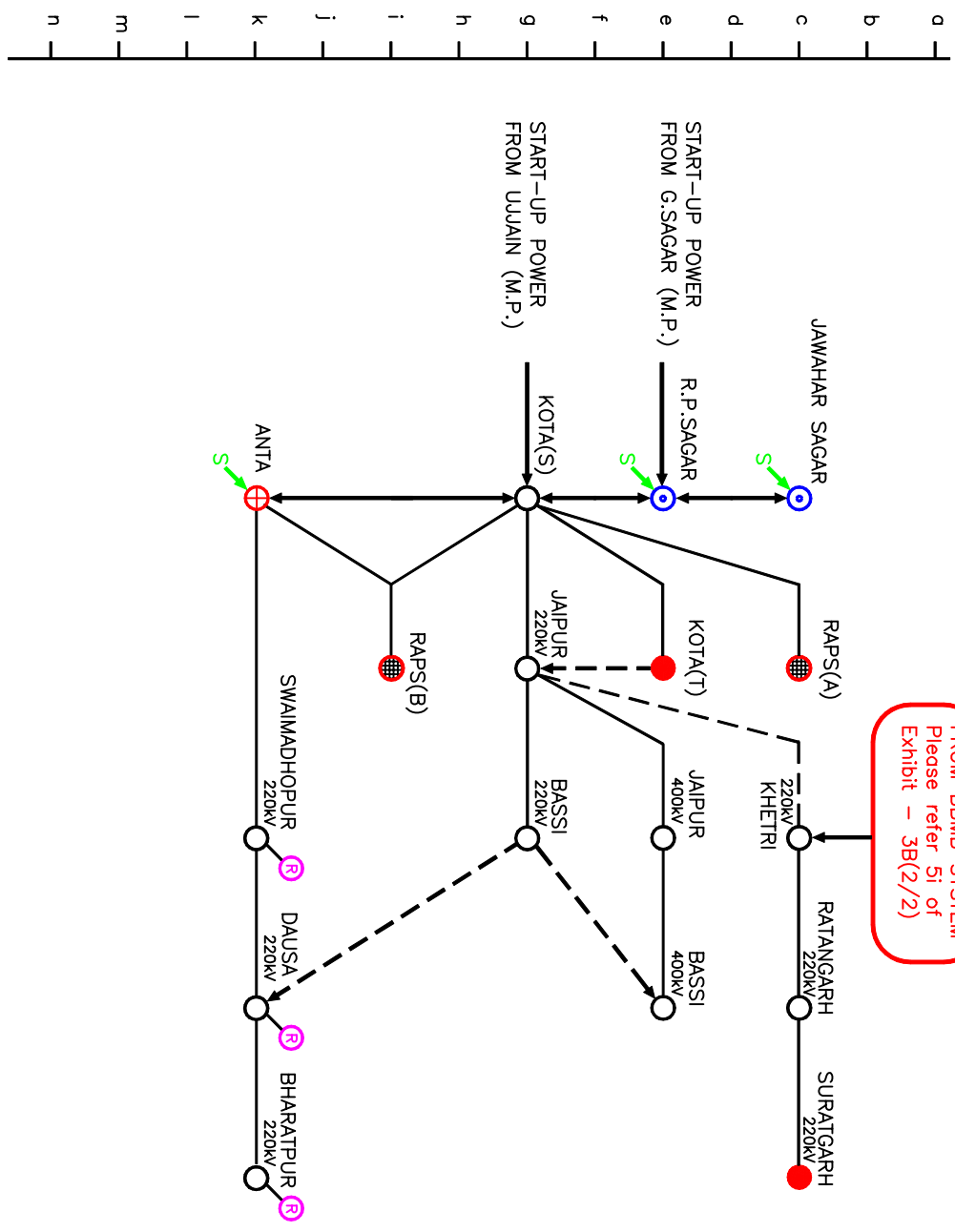
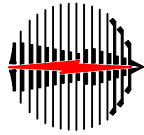
RAJASTHAN SUBSYSTEM : RESTORATION STAGES



NOTE:—

- 1 KOTA(S) SHOULD AVAIL SUPPLY FROM UJAIN AND IN THE EVENT OF ANY DIFFICULTY IN GETTING SUPPLY FROM UJAIN, IT SHALL AVAIL SUPPLY FROM R.P. SAGAR.
- 2 IF R.P. SAGAR IS NOT ABLE TO SELF START OR IS UNABLE TO AVAIL START-UP POWER FROM GANDHI SAGAR THEN SUPPLY SHALL BE TAKEN FROM KOTA(S).

RAJASTHAN SUBSYSTEM : START-UP SEQUENCE



LEGEND:-

- STATION TO SELF START
- HYDRO STATIONS
- THERMAL STATIONS
- GAS STATIONS
- NUCLEAR STATION
- SUB-STATIONS
- RAILWAY TRACTION

SECTION-5

RESTORATION OF WESTERN U.P. SUBSYSTEM

SECTION-5

RESTORATION OF WESTERN U.P. SUBSYSTEM

5.1 SUBSYSTEM OVERVIEW

5.1.1. Important Connecting Links with other Subsystems:

- a) With North-Central (NC) Subsystem
 - i) 400 kV Dadri - Muradnagar
 - ii) 400 kV Agra(UP)-Muradnagar
- b) With Eastern U.P. Subsystem
 - i) 400 kV Lucknow-Moradabad
 - ii) 400 kV Panki - Muradnagar

5.1.2. Major Generating Stations

- a) Thermal: Harduaganj, Parichha
- b) Hydro: Chibro, Khodri, Dhakarani, Dhalipur, Kulhal, Khara, Chilla, Maneri Bhali, Ramganga, Tanakpur
- c) Gas: Nil
- d) Nuclear: NAPS

5.1.3. Sources of Start-up power

- | | | |
|----|----------------------------|----------------------|
| a) | Chibro - Self start : | 150 MW |
| b) | Ramganga -Self start: | 100 MW |
| c) | Remaining hydro stations : | <u>150 MW</u> |
| | Total: | <u>400 MW</u> |

5.1.4. Requirement of Start -up power:

- | | | | |
|----|------------------------|---|----------------------|
| a) | Start-up Power to NAPS | : | 40 MW |
| b) | Other Essential loads | : | <u>360 MW</u> |
| | Total | : | <u>400 MW</u> |

5.1.5. **System Synchronisation:**

For synchronization of Western U.P. Subsystem with other Subsystems, the preferable system synchronising sequence shall be as follows:

- a) Initially the Eastern U.P. Sub-system and North-Central (NC) Subsystem shall be synchronised.
- b) Subsequently, the combined North-Central (NC) Subsystem + Eastern U.P. Subsystem shall be synchronised with the Rajasthan Subsystem.
- c) Finally, the combined Eastern U.P. Subsystem + North-Central (NC) Subsystem + Rajasthan Subsystem shall be synchronised with Western U.P. Subsystem at the following possible connections:
 - i) 400 kV Dadri-Muradnagar at Dadri/Muradnagar
 - ii) 400 kV Agra(UP)-Muradnagar at Agra(UP)/Muradnagar
 - iii) 400 kV Panki-Muradnagar at Panki/Muradnagar
 - iv) 400 kV Lucknow-Moradabad at Lucknow/Moradabad

The above synchronizing sequence is indicative only and has been planned on the basis of experience derived from the past incidences. However, in real time conditions adopting a particular sequence for synchronization of different subsystems would depend on the actual situation prevailing at that particular time and the sequence may accordingly be followed /suitably modified.

5.2 **SUBSYSTEM RESTORATION PROCEDURE**

The Western U.P. Subsystem shall consist of the following sub-sections:

- Yamuna Complex - consisting of hydro stations at Chibro, Khodri, Dhakrani, Dhalipur and Kulhal.
- Khara hydro station
- Chilla and Maneri Bhali hydro stations
- Ramganga and Tanakpur Hydro Stations
- NAPS Island

At the time of subsystem built up, the action to be taken at the major generating stations / grid substations is as follows:

5.2.1. **YAMUNA COMPLEX**

- i) The generating units of Chibro power house to be self-started and supply is to be extended to Khodri.
- ii) The generating units at Khodri to be self started /synchronized with the supply extended from Chibro and the combined supply shall be extended to 220 kV Saharanpur and Rishikesh sub-station.
- iii) Dhakrani, Dhalipur & Kulhal hydro stations to start their machines and synchronise with the supply from Khodri/Chibro
- iv) From Khodri and Kulhal supply shall also be extended to Majri (HP) and Giri (HP) respectively for extending reference to the hydro stations of H.P. and to meet emergency load.
- v) 220 kV Saharanpur shall extend supply to the 220 kV Muradnagar through Shamli and Baraut.
- vi) Muradnagar shall also extend supply to 220 kV Noida through Sahibabad to meet the emergency loads.
- vii) 400 kV Bus of Muradnagar sub-station shall be charged through 220 kV / 400 kV ICTs at Muradnagar for extension of supply up to Moradabad and synchronization with other Subsystems .

Caution

Having the supply extended from Khodri and Kulhal generating stations, HPSEB shall use the supply only for extending reference to hydro stations and emergency loads (Initially to be restricted to around 20 MW maximum)

5.2.2. **KHARA HYDRO STATION:**

- i) The units at Khara shall be self started / synchronized with the supply extended from stations in Yamuna complex viz. Chibro Khodri, Dhakrani, Dhalipur and Kulhal.

- ii) In the event of any problem in self-starting of the units at Khara the start-up power at Khara shall be availed from Yamuna Complex.
- iii) Alternatively in the event of any problem in self-starting of the units at Yamuna Complex the start-up power shall be extended from Khara.
- iv) In the event of start up of Yamuna Complex and Khara separately, the two supplies shall be synchronized at the earliest opportunity.

5.2.3. **CHILLA AND MANERI BHALI HYDRO STATIONS**

- i) The hydro station at Chilla and Maneri Bhali shall be self started and synchronized with the supply extended from Yamuna Complex through Rishikesh.
- ii) In the event of any difficulty in self starting of above units start up power shall be availed through Rishikesh.
- iii) From Rishikesh the supply shall be further extended to 220 kV Muradnagar through Muzafarnagar and Meerut.
- iv) From 220 kV Muradnagar supply shall be extended to Muradnagar 400 kV for further interconnections.
- v) After the supply at Muradnagar 400 kV is stabilised, it shall be extended to Moradabad 400 kV.

5.2.4. **RAMGANGA AND TANAKPUR HYDRO STATIONS**

- i) The generating units at Ramganga shall be self started and the supply shall be extended up to Moradabad through Nehtaur.
- ii) The generating units of Tanakpur shall be self started and the supply shall be extended upto Moradabad through Bareilly and the two supplies at Moradabad (one from Ramganga and other from Tanakpur) would be synchronized

- iii) In the event of any problem in self starting the units at Tanakpur and/or charging the line up to Moradabad, the reference would be extended from Moradabad upto Tanakpur through Bareilly and thereafter the generating units at Tanakpur would be started and synchronized.
- iv) Similar approach (as stated at iii) above) would be taken in the event of any problem in start-up of units at Ramganga.

5.2.5 **NAPS ISLAND**

Case a) NAPS Islands and Survives

- i) In case of survival of NAPS Island, the following actions shall be taken in the descending order of priority in order to stabilise the NAPS island.

Priority-1: The units at Ramganga shall be self-started and the supply shall be extended upto NAPS through Ramganga – Nehtaur - Moradabad for synchronization at NAPS.

Priority-2: The hydro units at Yamuna complex (Chibro, Khodri, Dhakrani, Dhalipur and Kulhal) shall be self started and the supply shall be extended upto Muradnagar 220 kV as stated under para 5.2.1. From Muradnagar the supply shall be extended upto NAPS through Muradnagar-Khurja-NAPS for synchronization at NAPS

Priority-3: In case there is in-ordinate delay in the above two operations and by that time the North Central sub-system has been stabilized and supply is available at Agra(new) substation of UPPCL then the supply to NAPS is to be extended through Agra (new)-Harduaganj-NAPS for synchronization at NAPS

Caution

- i) In the event of survival of NAPS island, UPPCL has to take necessary steps to extend the stabilized supply from the built up Western UP subsystem to NAPS at the earliest. After synchronizing the Western UP

Subsystem with NAPS, all care is to be taken by UPPCL to avoid any sudden variation in the load in the Western U.P. sub-system which may otherwise result in collapse of the sub-system and poisoning out of the nuclear units. NAPS would also keep itself in close contact with UPPCL Control Room at Lucknow as well as concerned substation at UPPCL where the connectivity with NAPS exists, for coordination in respect of load-generation balance.

- ii) Since the extension of supply from the stabilized North-Central Subsystem to NAPS being at the farthest end, may take relatively longer time, this arrangement has been shown as the last priority (no.3). However, in the event of inordinate delay in extension of supply from Western UP subsystem as shown under first two priorities, priority 3 would be the only alternative and till such period all care would be taken by UPPCL / NAPS to save the NAPS island by maintaining load generation balance.

Case b) Non-survival of NAPS Island

In case of collapse of NAPS Island and tripping of units at NAPS following actions shall be taken in the descending order of priority.

- Priority-1: Ramganga shall self-start and shall extend start-up supply to NAPS at 220 kV through Nehtaur and Moradabad.
- Priority-2: The generating units at Yamuna complex (Chibro, Khodri, Dhakrani, Dhalipur and Kulhal) would self start and this supply shall be extended to NAPS at 220kV through Muradnagar and Khurja.
- Priority-3: In case of inordinate delay in getting the supply from either of the first two priorities, the supply would be extended to NAPS at 220 kV from the built up and stabilised North-Central (NC) subsystem through Agra(new) and Harduaganj.
- Priority-4: In case there is inordinate delay in getting the supply from either of the first three priorities and by that time the North-Central Sub-system has been stabilized, then the supply

to NAPS is to be extended through 400 kV Mandaula-400 kV Meerut-220 kV Simbholi-220 kV NAPS.

Note: In order to provide quick start-up power to NAPS and to avoid poisoning out of its units, provision of direct 220 kV line between NAPS and Dadri Gas (NTPC) was recommended by the D.P.Sinha committee. The work is required to be carried out at the earliest.

5.3 CAUTION:

- i) In the event of tripping of NAPS units, the supply to NAPS is to be extended on priority basis.
- ii) At all times, load - generation balance is to be maintained in the built up subsystem by bringing the generation / load in a gradual manner and maintaining system parameters in normal range.

5.4 SYNCHRONISATION:

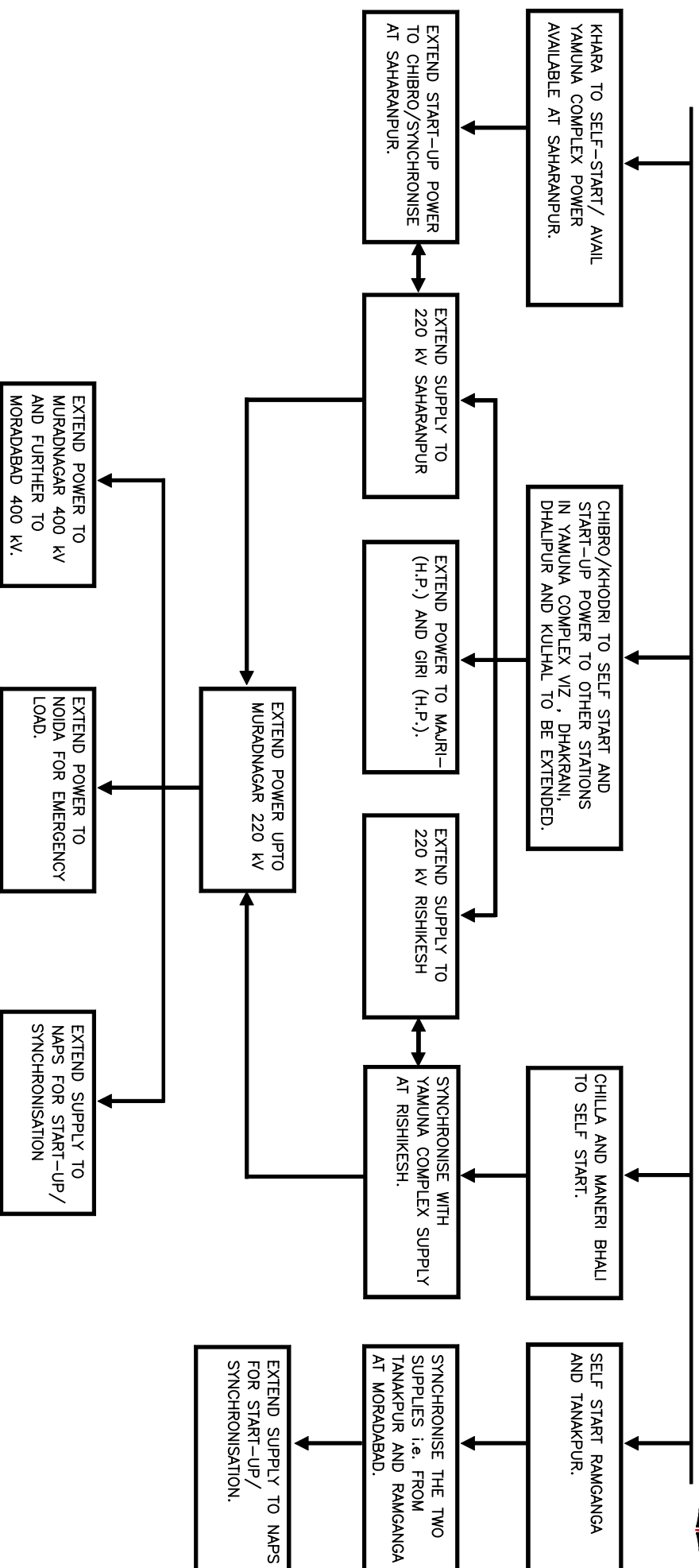
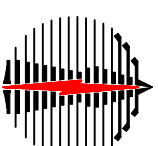
The synchronisation of the Western U.P. Subsystem can be carried out with the combined North-Central (NC) + Eastern U.P. + Rajasthan subsystem at the following possible connections:

- 400 kV Dadri-Muradnagar at Dadri/ Muradnagar
- 400 kV Agra-Muradnagar at Agra/Muradnagar
- 400 kV Panki-Muradnagar at Panki/Muradnagar
- 400 kV Lucknow-Moradabad at Luckno/Moradabad

5.5 START-UP STAGES AND SEQUENCE:

- i) For different Restoration Stages in Western U.P. Subsystem refer Exhibit-5A
- ii) For detailed Start-up Sequence in Western U.P. Subsystem refer Exhibit- 5 B.

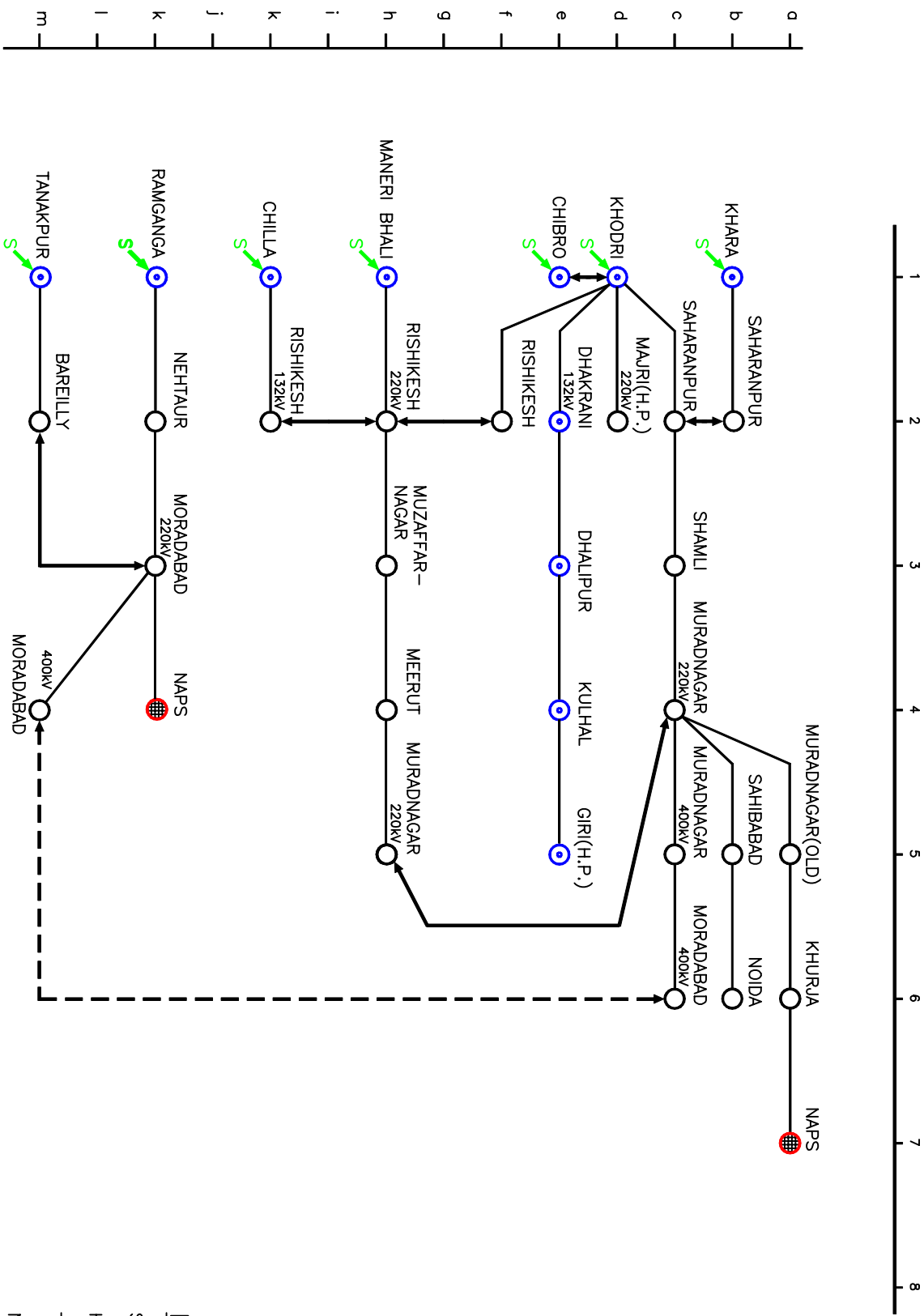
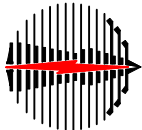
WESTERN U.P. SUBSYSTEM : RESTORATION STAGES



NOTE:-

- 1 IF FOR ANY REASON CHIBRO CAN NOT START THEN ANY OTHER POWER STATION IN SUCCESSION VIZ KHODRI, DHAKRANI, DHALIPUR AND/OR KULHAL HAS TO START AND EXTEND POWER UPTO MURADNAGAR.
- 2 IN THE EVENT OF NON START-UP OF ANY POWER HOUSE OF YAMUNA COMPLEX, KHARA SUPPLY AVAILABLE AT SAHARANPUR SHALL BE SENT BACKWARDS TO YAMUNA COMPLEX.
- 3 IN CASE OF COLLAPSE OF NAPP ISLAND RAMGANGA IS TO SELF START AND EXTEND POWER TO NAPP. IF THERE IS INORDINATE DELAY IN GETTING THE SUPPLY FROM WESTERN U.P. AND AVAILABILITY OF NORTH-CENTRAL SUB SYSTEM SUPPLY AT HARDUAGANU 220 kV, THEN SUPPLY CAN BE AVAILED BY NAPP FROM HARDUAGANU IN CO-ORDINATION WITH CLDS LUCKNOW AND NRLDC.

WESTERN U.P. SUBSYSTEM : START-UP SEQUENCE



LEGEND:-

- STATION TO SELF START
- HYDRO STATIONS
- THERMAL STATIONS
- NUCLEAR STATION
- SUB-STATIONS
- RAILWAY TRACTION

SECTION-6

POWER SUPPLY TO RAILWAY TRACTION

SECTION-6

POWER SUPPLY TO RAILWAY TRACTION

6.1 POWER SUPPLY TO RAILWAY TRACTION

From the networks of Northern Region, power is fed to the following Zones of Railways:

- Northern Railways (NR)
- North Central Railways (NCR)
- West Central Railways (WCR)

During system restoration, it is proposed to meet the power requirement of each of the Railway Zone in the following manner.

6.2 NORTHERN RAILWAY:

6.2.1 Power supply from North-Central (NC) Subsystem:

a) From Delhi system the following traction load shall be fed:

- i) Section = Delhi ring
- ii) Traction/Grid Substation = Chanakya Puri
- iii) Max. Railway traction load = 15 MW (20 MVA)
- iv) Feeding grid sub-stations= Park street (DTL)

b) From HVPN/Delhi system the following traction load shall be fed:

- i) Section = Delhi-Ambala-Saharanpur
- ii) Traction Substation = Diwana to Shahbad, Narela, Jagadhari
- iii) Max. Railway traction load = 55 MW (65 MVA)
- iv) Feeding grid sub-stations= Narela(DTL), Panipat(HVPN), Abdullapur(PG).

c) From PSEB system the following traction load shall be fed:

- i) Section = Kalka-Ambala-Una- Ludhiana
- ii) Traction Substation = Sanehwal, Rajpura, Ghaggar, Anandpur Sahib, Kurali
- iii) Max. Railway traction load = 40 MW (50 MVA)
- iii) Feeding grid sub-stations = Rajpura, Sahnewal, Dera-Bassi, Anandpur Sahib.

d) From Faridabad (Gas) the following traction load shall be fed:

- i) Section = Delhi-Ballabhgarh
- ii) Traction Substation = Ballabhgarh
- iii) Max. Railway traction load = 15 MW (20 MVA)
- iv) Feeding grid sub-stations = Ballabhgarh 220 kV

6.2.2 **Power Supply from Eastern UP Sub system:**

From Eastern U.P. Subsystem (Built-up by availing start-up power from WR through Vindhyachal AC bypass link) the following traction load of Northern Railway shall be fed:

- i) Section = Kanpur-Lucknow
- ii) Traction Substation = Amousi
- iii) Max. Railway traction load = 6 MW (8 MVA)
- iv) Feeding grid sub-stations = Sarojininagar 220 kV

6.3. **NORTH CENTRAL RAILWAY:**

6.3.1 **Power supply from North-Central Subsystem:**

a) From Faridabad (Gas) the following traction load of North Central Railway shall be fed:

- i) Section = Ballabhgarh-Mathura
- ii) Traction Substation = Hodal
- iii) Max. Railway traction load = 15 MW (20 MVA)
- iv) Feeding grid sub-stations = Ballabhgarh 220 kV

- b) From Auraiya (G) the following traction load of North Central Railway shall be fed:
- i) Section = Mathura-Agra
 - ii) Traction Substation = Mathura, Pathauli, Bhandai
 - iii) Max. Railway traction load = 25 MW (30 MVA)
 - iv) Feeding grid sub-stations = Auraiya (Agra/Mathura)
- c) From Auraiya the following traction load of North Central Railway shall be fed:
- i) Section = Kanpur-Tundla
 - ii) Traction Substation = Phaphund to Hathras
 - iii) Max. Railway traction load = 40 MW (50 MVA)
 - iv) Feeding grid sub-stations = Auraiya (Phaphund)
- d) From Dadri (gas) the following traction load of North Central Railway shall be fed:
- i) Section = Tundla-Delhi
 - ii) Traction Substation = Mehrawal to Sahibabad
 - iii) Max. Railway traction load = 30 MW (40 MVA)
 - iv) Feeding grid sub-stations = Dadri (Dankaur)

6.3.2

Power Supply from Eastern UP Sub system:

- a) From Eastern U.P. Subsystem (Built-up by availing start-up power from ER through Sasaram AC bypass link) the following traction load shall be fed:
- i) Section = Mugalsarai-Allahabad-Kanpur
 - ii) Traction Substation = Jeonathpur to Rasulabad
 - iii) Max. Railway traction load = 65 MW (80MVA)
 - iv) Feeding grid sub-stations = Sahupuri, Obra, Allahabad, Fatehpur

b) From Eastern U.P. Subsystem (Built-up by availing start-up power from WR through Vindhyachal AC bypass link) the following traction load shall be fed:

- i) Section = Allahabad-Kanpur
- ii) Traction Substation = Malwan to Rura
- iii) Max. Railway traction load = 60 MW (75 MVA)
- iv) Feeding grid sub-stations = Naubasta, Panki

6.3.3 **Power supply from Rajasthan Subsystem:**

From Rajasthan Subsystem the following traction load of North Central Railway shall be fed:

- i) Section = Agra-Bayana
- ii) Traction Substation = Bayana
- iii) Max. Railway traction load = 8 MW (10 MVA)
- iv) Feeding grid sub-stations = Dausa, Bharatpur.

6.3.4 **Power supply from M.P.:**

The North Central Railway to feed traction loads from Hetampur up-to Bina (MP) over their own network including the load of Lalitpur (UP).

6.4 **WEST CENTRAL RAILWAY:**

6.4.1 **Power supply from Rajasthan Subsystem:**

From Rajasthan Subsystem the following traction load of West Central Railway shall be fed:

- i) Section = Mathura-Kota-Mumbai
- ii) Traction Substation = Bharatpur to Ramganjmandi
- iii) Max. Railway traction load = 70 MW (90 MVA)
- iv) Feeding grid sub-stations = Kota(S), Sawai-Madhopur ,Dausa, Bharatpur.

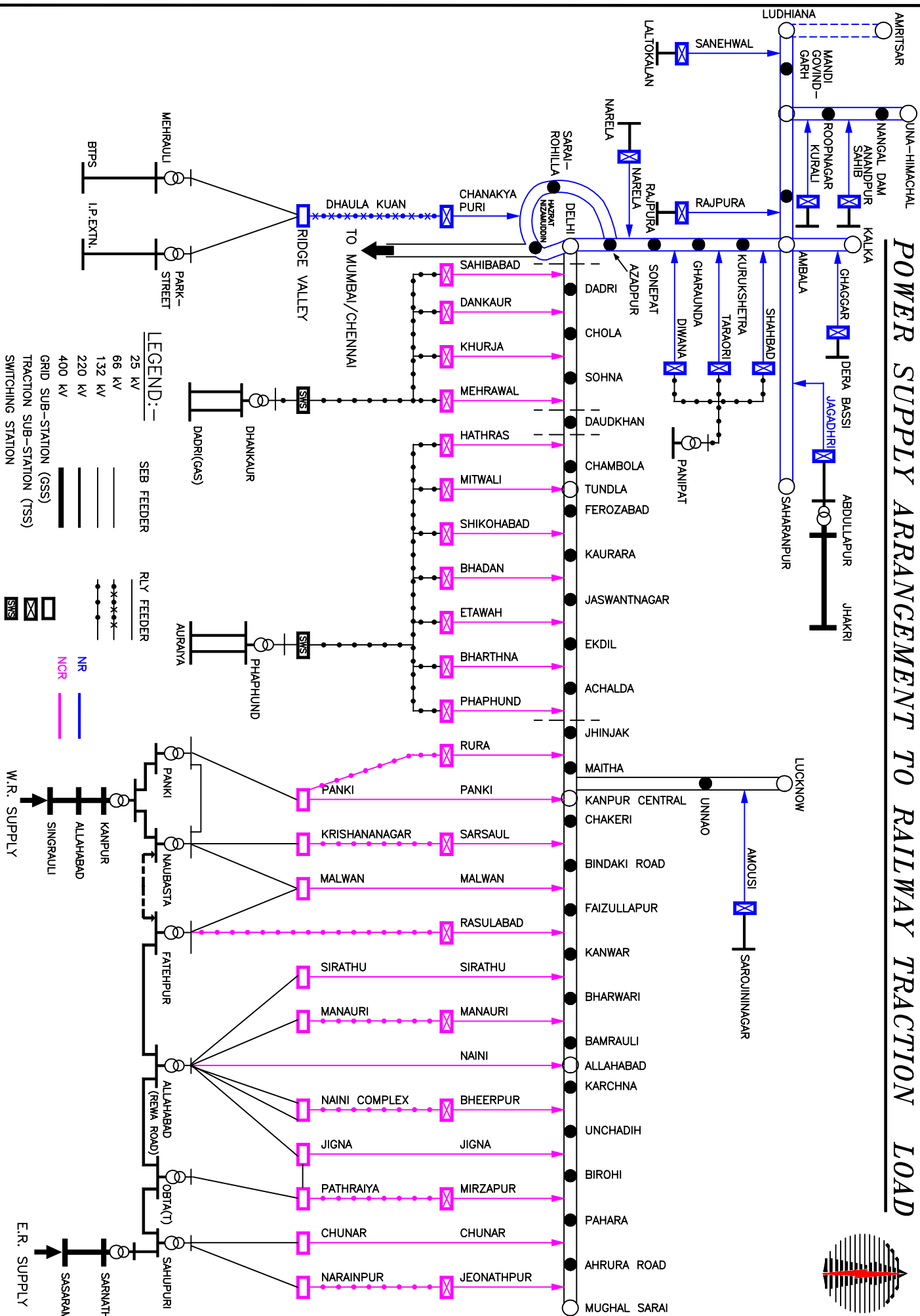
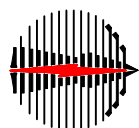
6.5. **CAUTION**

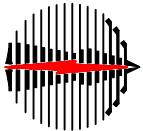
In the event of black start, initially the different subsystems shall be of small size and the running generating units particularly the gas turbines shall have a limitation in regard to the ramp up rates and negative sequence current. The negative sequence current caused primarily due to unbalance load in the system. Therefore, as soon as the power is made available for the purpose of traction, it would be ensured by Railways that the load shall be kept balance and stable and the movements of trains in different sections would be co-ordinated and controlled for avoiding sudden jerks/ramp ups on the system.

6.6. **TRACTION SUB-STATIONS SCHEMATIC DIAGRAMS:**

Refer Exhibit-6A & Exhibit-6B for Traction Supply to Northern Railway, North Central Railway and West Central Railway.

POWER SUPPLY ARRANGEMENT TO RAILWAY TRACTION LOAD





SECTION - 7

OPERATION OF 400 KV VINDHYACHAL A.C. BY-PASS LINK

SECTION - 7

OPERATION OF 400 kV VINDHYACHAL A.C. BY-PASS LINK

7.1 CLOSING OF A.C. BY-PASS LINK

In the event of total black out in the Northern Region (NR), start-up power would be obtained from the Western Region (WR) on Vindhyachal A.C. By-pass link. Since this link connects the two regions, due care is to be taken while carrying out its operation for connecting the two regions. The schematic diagram depicting the set-up of 400 kV Vindhyachal A.C. By-pass link is shown at Exhibit 7A and the sequence of operation to be carried out at Singrauli and Vindhyachal in order to extend the WR power to NR is as stated below:

7.1.1 SINGRAULI:

- i) In the event of total black out in the region, Singrauli shall open breakers for all of its 400 kV Ckts. from Singrauli, except for 400 kV Singrauli-Vindhyachal circuit. In case the breaker of 400 kV Singrauli-Vindhyachal also gets opened then it shall be closed by Singrauli at its end for receiving the supply from Vindhyachal.
- ii) Singrauli shall convey to Vindhyachal Back-to-Back station its readiness to receive power from Western Region through the A.C. By-pass link.
- iii) Singrauli shall simultaneously inform NRLDC Control Room about the request made by it to Vindhyachal Back -to- Back Station for import of start-up power from Western Region.

7.1.2. **VINDHYACHAL HVDC (Back to Back):**

Following actions shall be taken by Vindhyachal Back to Back station:

- i) Vindhyachal Back-to-Back station shall initiate action to extend start-up power to Singrauli through the AC By-pass link as soon as it gathers that there is total loss of supply at 400 kV Singrauli as well as at 400 kV Kanpur sub-stations.
- ii) Ensure that breakers AWL3-Q, AWL4-Q and AWL5-Q controlling Singrauli and Kanpur lines are open.
- iii) Isolate HVDC Block-1 and Block-2 by ensuring that breaker Nos. B1Q11-Q, B1Q21-Q, B2Q11-Q and B2Q21-Q are in open condition.
- iv) Ensure that West Bus 1B is in energised condition. (The continuity of the supply from the Western grid to the Vindhyachal West Bus is to be maintained by keeping the breaker AWL1-Q and / or AWL2-Q in closed conditions)
- v) Close isolators D-11 and D-21 to close A.C. By-pass link and thereby charge North BUS 1A.
(For carrying out the actions detailed at (step i) to step v) above, no code would be required by Vindhyachal from NRLDC/ WRLDC)
- vi) Close breaker AWL3-Q controlling Singrauli line after getting clearance from Singrauli STPS. (The closing of the 400 kV Vindhyachal-Singrauli circuit breaker at Vindhyachal end (AWL3-Q) would result into extension of WR power up to Singrauli STPP)

7.2 **OPENING OF A.C. BY-PASS LINK:**

Once the Eastern U.P. subsystem is stabilized and adequately strengthened, it shall be disconnected from the Western Regional Grid by opening the 400 kV Vindhyachal A.C. By Pass link. Following steps shall be followed in opening of this link.

7.2.2 VINDHYACHAL HVDC (Back-to-Back):

Initiate the disconnection of NR from WR as soon as clearance is received from NRLDC for disconnection of the link by taking following actions.

- i) Open breaker AWL3-Q connecting 400 kV Singrauli-Vindhyachal circuit to Bus 1A. [Just before opening of the breaker, the power flow on the link is to be brought in almost floating condition as per details given under para 2.4.2 iv)]
- ii) Check that Bus 1A has been deenergised.
- iii) Open isolators D 11 and D21 to open A.C. By-pass link.
- iv) Close breaker AWL3-Q connecting 400 kV Singrauli-Vindhyachal circuit to Bus 1A.
- v) Start one block of HVDC Back to Back station by closing required devices and regulate power flow between Western Region and Northern Region as per instruction of NRLDC and WRLDC. This may be followed by closing of the second block.

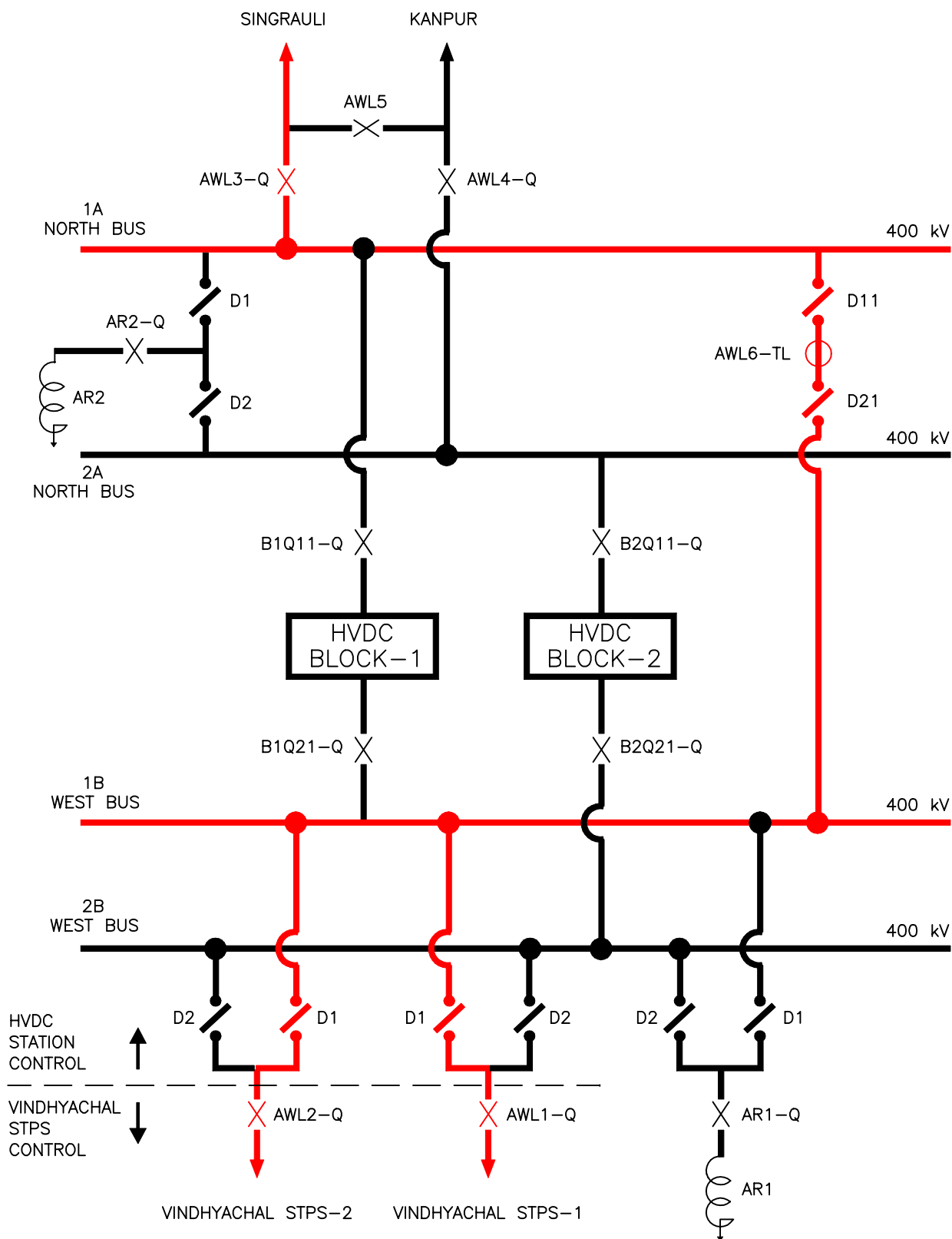
Note: In the event of total collapse in Northern Region, as per the standing arrangement to start with 100 MW power shall be made available from Western Region to Northern Region without any formal exchange of codes between Northern Region and Western Region. Therefore, for initial start up and extending the power from WR to NR, Vindhyachal would not require for formal approval from WRLDC (WRLDC is to be informed by Vindhyachal about above action immediately after the transfer of power).

Caution:

- i) Under the situations as explained at i) above, it would be endeavoured by NR to limit the flow on A.C. by pass link in the range of about 100 MW and any additional supply from WR shall be availed in consultation with WRLDC.

- ii) Since the initial time taken for extending the start-up power from Western Region to Northern Region shall be vital for normalisation of the grid, the operations for closing of A.C. By-pass link should be done in quickest possible manner.
- iii) During the initial build-up of Eastern U.P. Subsystem, at the time of charging of 400 kV Singrauli-Allahabad-Kanpur circuit, the voltage at the Vindhyachal 400 kV bus be maintained in the range of around 390 kV by operating the bus reactors AR2 (breaker AR2-Q) and AR1 (breaker AR1-Q)
- iv) After disconnection of WR from the built-up Eastern U.P. Subsystem, the Vindhyachal HVDC Back -to- Back Block is to be brought back expeditiously so that asynchronous power flow between WR and NR may be started.

VINDHYACHAL HVDC BACK TO BACK STATION



SECTION - 8

OPERATION OF 400 KV SASARAM A.C.BY-PASS LINK

SECTION - 8

OPERATION OF 400 kV SASARAM A.C. BY-PASS LINK

8.1 CLOSING OF SASARAM A.C. BY-PASS LINK

In the event of total black out in the Northern Region (NR), start-up power would be obtained from the Eastern Region (ER) on Sasaram A.C. By-pass link. Since this link connects the two regions, due care is to be taken while carrying out its operation for connecting the two regions. The schematic diagram depicting the set-up of 400 kV Sasaram A.C. By-pass link is shown at Exhibit 8A and the sequence of operation to be carried out at Sasaram and Sarnath in order to extend the ER power to NR is as stated below:

8.1.1 SARNATH:

- i) In the event of total black out in the region, Sarnath shall open breakers for all of its 400 kV Ckts. from Sarnath, except for 400 kV Sarnath - Sasaram circuit. In case the breaker of 400 kV Sarnath-Sasaram also gets opened then Sarnath shall close it at its end for receiving the supply from Sasaram.
- ii) Sarnath shall convey to Sasaram Back-to-Back station its readiness to receive power from Eastern Region through the A.C. By-pass link.
- iii) Sarnath shall simultaneously inform CLDS, LUCKNOW / NRLDC, DELHI about the request made by it to Sasaram Back -to- Back Station for import of start-up power from Eastern Region.

8.1.2. SASARAM HVDC (Back to Back):

Following actions shall be taken by Sasaram Back to Back station:

- i) Sasaram Back-to-Back station shall initiate action to extend start-up power to Sarnath through the AC By-pass link as soon as it gathers that

there is total loss of supply at 400 kV Sarnath , 400 kV Allahabad and other neighbouring stations.

- ii) Isolate HVDC Back-to-Back Block by ensuring that breaker Nos. Q50 and Q51 of Dia CWD50 & CWD10 are in open condition.
- iii) Ensure that Bus II of Eastern side is in energised condition. (The continuity of the supply from the Eastern grid to the Sasaram East Bus is to be maintained by keeping the breaker Q50 of CWD70 or/and CWD80 in closed conditions)
- iv) Close isolators Q20 and Q21 of CWD110 and breaker Q52 of CWD50 and CWD10 to close A.C. By-pass link and thereby charge North BUS II.

Note: For carrying out the actions detailed at step i) to step iv) above, no code would be required by Sasaram from NRLDC/ ERLDC.

- v) Close breaker Q52 of CWD30 controlling Sarnath line after getting clearance from Sarnath. {The closing of the 400 kV Sasaram- Sarnath circuit breaker at Sasaram end (Q52 of CWD30) would result into extension of ER power up to Sarnath}

8.2 OPENING OF SASARAM A.C. BY-PASS LINK:

Once the Eastern U.P. subsystem is stabilized and adequately strengthened, it shall be disconnected from the ER Grid by opening the 400 kV Sasaram A.C. By Pass link. Following procedure shall be adopted in opening of this link.

8.2.1 SASARAM HVDC (Back-to-Back):

Initiate the disconnection of NR from ER as soon as clearance is received from NRLDC for disconnection of the link by taking following actions.

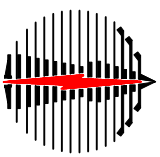
- i) Open breaker Q52 of CWD10 and CWD50.

- ii) Open isolators Q20 and Q21 of CWD110 to open A.C. By-pass link.
- iii) Start HVDC Back to Back Block and close required Isolators and Breakers and regulate power flow between Eastern Region and Northern Region as per instruction of NRLDC and ERLDC.

Note: In the event of total collapse in Northern Region, as per the standing arrangement to start with 100 MW power shall be made available from Eastern Region to Northern Region without any formal exchange of codes between Northern Region and Eastern Region. Therefore, for initial start up and extending the power from ER to NR, Sasaram would not require for formal approval from ERLDC (ERLDC is to be informed by Sasaram about above action immediately after the transfer of power).

Caution:

- i) Under the situations as explained at i) above, it would be endeavoured by NR to limit the flow on A.C. by pass link in the range of about 100 MW and any additional supply from ER shall be availed in consultation with ERLDC.
- ii) At the time of joining of ER and WR through NR system by charging of 400 kV Sarnath-Allahabad or 400 kV Sarnath-Anpara line, the voltage at the Sasaram 400 kV bus be maintained in the range of around 390 kV by operating the reactors available at Sasaram/Sarnath
- iii) After disconnection of ER from the built-up Eastern U.P. Subsystem, the Sasaram HVDC Back-to-Back Block is to be brought back expeditiously so that asynchronous power flow between ER and NR may be started.



SASARAM HVDC BACK TO BACK LINK

