

# **SYSTEM RESTORATION PROCEDURES**

**FOR**

**NORTHERN REGIONAL GRID**



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## **PREFACE**

Northern region comprises of states of Uttar Pradesh, Haryana, Delhi, Punjab, Rajasthan, Jammu & Kashmir, Himachal Pradesh and UT Chandigarh. Power supply to the above states in the Northern Region is available through integrated operation of the grid co-ordinated through the Regional Load Despatch Centre (RLDC) at Katwaria Sarai, New Delhi. Apart from system operation and control on real time basis, one of the important responsibilities of RLDC is 'System Restoration' following a grid disturbance. A grid disturbance is the situation where disintegration and collapse of grid either in part or full takes place in an unplanned and abrupt manner, affecting the power supply in a large area. As per section 6.8 of the Indian Electricity Grid Code (IEGC), detailed plans and procedures for the restoration of the regional grid is to be developed by RLDC in consultation with all regional constituents. The current document viz. 'System Restoration Procedures for Northern Regional Grid' has been prepared in line with the above directive of IEGC and is a revision to the similar document issued earlier by NRLDC in February, 1998.

This document aims to provide the philosophical guidelines and the macro-level sequencing of the various operations to be performed during system restoration. However, in real time situation, depending upon the actual system conditions certain deviations may be essential to achieve the ultimate objective of speedy normalization. Therefore, during system revival, the constituents shall have to act judiciously and any such deviations which are required for achieving the ultimate objective of speedy revival may be carried out in consultation with NRLDC. At the time of system restoration after total blackout, due care also needs to be taken to extend start-up power to the thermal generating stations and to pass on immediate relief to railway traction, nuclear stations and emergency loads as well as to maintain load-generation balance. In the event of a total blackout, the initial moments are extremely precious and a desired action taken at first instance can help in speedy restoration of the system while a small delay or lapse in taking the initial action may prove to be extremely costly. It is, therefore, necessary that all essential loads be clearly identified and operating personnel associated with the system operation and load despatch functions are thoroughly acquainted with the restoration procedures so as to minimize the time taken in system revival.

## **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 March, 2001 is 26678.06 MW with a peak demand of around 21500 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 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 and Western U.P. and Northern Rajasthan, a large quantum of power flow through the long lengths thereby sometimes resulting 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 endanger grid security. All these factors coupled with the equipment failure / faults / maloperation 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 sectionalized manner. Therefore, based on the geographical boundaries and for ease and speedy restoration, the Northern Region has 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 BBMB-Delhi 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 been defined on the criteria of most likely possibility. However 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 fast flow of the information.

### **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 all the 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. In the past 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 usually resulted in considerable delays. 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 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 existing 132 KV circuit between Singrauli and Rihand (Hydro) which is being 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 Load Generation Balance :**

**While restoring the system, load generation balance is to be maintained 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 maintain a balance between load and generation, the estimate of the generation likely to be available in each sub-system vis-à-vis the essential load to be met has also been explained in each of the section under sub-section 'Subsystem Overview' and all the constituent must endeavour to maintain a 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 in free governor mode of operation, in order to control the system parameters in the different islands which may be formed after a disturbance or in the subsystems, which are being build-up during revival of the system

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

- Start-up power to Generating Stations.
- Power supply to Railway Traction.
- Auxiliary power to Nuclear Stations.
- 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 achieving a target for the purpose of redundancy and reliability. In order to achieve this objective to the extent possible, simultaneous and parallel action should be initiated at all such places 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.

## **SECTION-2**

### **RESTORATION OF EASTERN U.P. SUBSYSTEM**

#### **2.1 SUBSYSTEM OVERVIEW**

##### **2.1.1. Possible connections with other Subsystems:**

- a) With Western U.P. Subsystem :
  - i) 400 kV Lucknow-Moradabad S/C
  - ii) 400 kV Panki - Muradnagar S/C
  - iii) 220 kV Panki-Mainpuri S/C
  - iv) 220 kV Kanpur-Mainpuri S/C
- b) With BBMB - Delhi Subsystem:
  - i)  $\pm$  500 kV Rihand - Dadri HVDC bipole
  - ii) 400 KV Kanpur-Ballabharh S/C
  - iii) 400 KV Kanpur-Agra S/C
  - iv) 400 kV Unnao-Agra S/C

##### **2.1.2. Major Generating Stations:**

- a) Thermal: Singrauli, Rihand(Th), Anpara, Obra(Th),  
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) WR - on 400 KV Vindhyachal AC By-Pass link : 100 MW
  - b) Rihand (Hy) - Self start : 250 MW
  - c) Obra (Hy)-Start-up from Rihand(Hy) : 50 MW
- Total: : 400 MW**

**Note:** This is the minimum quantum of power from WR to be available during the initial period of import. Depending upon the actual scenario, this quantum may be correspondingly high upto about 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)           | Railway Traction            | : <u>110 MW</u> |
| <b>TOTAL</b> |                             | <b>: 400 MW</b> |

2.1.5. **System Synchronization:**

After subsystems build - up and stabilization, the Eastern U.P.

Subsystem can be synchronized with BBMB – Delhi Subsystem and

Western U. P. Subsystem at the following possible connections:

- a) With BBMB-Delhi 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 be taken

as described under para 2.4.2.

## **2.2**

### **SUBSYSTEM RESTORATION PROCEDURE**

The Eastern U.P. Subsystem shall be built-up by availing start-up

power from Western Region on Vindhyachal A.C. By-pass Link

specific details regarding operation of 400 KV Vindhyachal A.C. By

pass Link are given at Section -7). 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 CPCC - Kanpur 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 as well as at Kanpur), Vindhyachal shall initiate action for extension of Western Region (WR) supply to Singrauli. The supply shall be finally extended by Vindhyachal to Singrauli after confirming the readiness from Singrauli end. (The specific operations to be carried out at Vindhyachal are given under Section -7).

- ii) In the event of any unforeseen difficulty in availing the WR supply on 400 KV Vindhyachal AC By-pass Link, the start-up power at Singrauli would be availed from the back-up 132 KV source viz. 132 KV ckt. from Vindhyachal / Renusagar/Rihand (Hydro).
- iii) Vindhyachal HVDC station shall also extend power to Kanpur on 400 kV Vindhyachal-Kanpur circuit after taking necessary clearance/ confirmation from NRLDC/CPCC-Kanpur. While charging 400 kV Vindhyachal-Kanpur circuit, the bus reactors at Vindhyachal shall be suitably used so as to reduce the bus voltage at Vindhyachal end to a value lower than 1.0 p.u.

**Caution:**

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-Kanpur / Singrauli, except that just before extending the supply, Vindhyachal shall confirm from Singrauli about its readiness .

## 2.2.2 SINGRAULI

Singrauli shall avail start-up power from Western Region through 400

K V 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) ]. In addition, the following shall be carried out by Singrauli STPS:

- (i) Start-up power shall be extended by Singrauli to Rihand (Th).
- (ii) Start-up power shall be extended by Singrauli to Anpara (Th).
- (iii) Power shall be extended by Singrauli to Rihand (Hy) on 132 kV

- (iv) Singrauli shall also keep itself in readiness for charging 400 KV circuit from Singrauli to Kanpur and the circuit shall be charged as soon as necessary instructions / code is issued by NRLDC / CPCC, Kanpur.

### **Caution**

- (i) 132 KV Singrauli-Rihand (Hydro) circuit is always to be kept in charged condition from Singrauli end so that in the event of a black out, Rihand (Hydro) may self start the units and synchronise with the supply from Singrauli. Alternatively in the event of any delay / failure in self start of units at Rihand (Hydro) the extended supply from Singrauli can be used by Rihand (Hydro) as start-up power.
- (ii) Extension of power from Singrauli to Rihand (Th) and Anpara on 400 KV circuits and to Rihand (Hy) on 132 kV ckt 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 .
- (iii) In the event of charging of 400 kV Singrauli- Kanpur ckt. from Singrauli end the bus / line reactors at Vindhyachal and Singrauli end shall be used for reducing the voltage at Singrauli end to a value lower than 1.0 p.u.

#### **2.2.3 RIHAND (Hydro) ( PIPRI)**

- (i) Self-start the units at Rihand (Hy) and synchronise the same with power extended from Singrauli on 132 KV Rihand (Hy) – Singrauli S/C.
- (ii) In the event of inability of Rihand (Hy) to self-start, avail start-up power from Singrauli on 132 KV Singrauli-Rihand (Hydro) S/C and start units.

- (iii) Extend the power to Anpara if Anpara has not yet received power from Singrauli .
- (iv) Extend power from Rihand (Hy) to Obra (Hy) and Obra (Th) for synchronization / start-up of the generating units.
- (v) Extend power to Robertsganj for Railway Traction.

### **Caution**

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 co-ordinated by CLDS, Lucknow . Furthermore, in order to stabilize the units at Rihand (Hydro), these must be synchronized with the Western Region supply extended from Singrauli at the earliest opportunity.

#### **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 circuit.
- (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) Charge 400 KV Anpara-Obra line for further extending power to Tanda Thermal Station through Sultanpur.

#### **Caution**

- (i) In the event of separate supplies at Singrauli and Rihand (Hy), the possible mix - up of supplies extended at Anpara is to be safe- guarded 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).
- (ii) The 400 KV Anpara-Obra Ckt. would be charged only after sufficient number of units (say about 3 units) at Rihand (Hydro) have been started - up and synchronized with the WR supply extended to Singrauli.

#### **2.2.6 OBRA (Hydro)**

- (i) Self start the units and synchronise with the supply extended from Rihand(Hy).
- (ii) In case of inability to self-start, start-up the units by availing start-up power from Rihand (Hy).

- (iii) Extend supply to Obra (Th).

#### 2.2.7 **OBRA (Thermal)**

- (i) Avail start-up power from Rihand (Hy)./Obra (Hy) and start up the units.
- (ii) Extend power to Allahabad for Railway traction and further extension towards Panki.
- (iii) 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.

#### 2.2.8 **KANPUR**

- (i) Kanpur shall avail Western Region power available at Vindhyachal/Singrauli through 400 kV Vindhyachal-Kanpur line or alternatively through 400 kV Singrauli-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.
- (iv) Extend start -up power to Unchahar TPS on 220 KV Kanpur-Unchahar circuit.

#### 2.2.9. **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, Naubasta and Sarojini Nagar grid stations).
- (iii) Extend start-up power to Panki TPS.
- (iv) Extend supply to Fatehpur.
- (v) In the event of any delay in getting the supply from Kanpur end and availability of the same from Fatehpur end (through Anpara-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.

#### **2.2.10 UNCHAHAR**

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

Priority 1: Vindhyachal-Kanpur 400 KV - Kanpur 220 KV – Unchahar

Priority 2: Anpara-Obra-Allahabad-Fatehpur-Unachahar.

#### **2.2.11. ALLAHABAD**

- (i) Allahabad to get supply in the following descending order of priority:

Priority 1: Anpara-Obra-Allahabad.

Priority 2: Vindhyachal-Kanpur-Panki-Fatehpur-Allahabad

- (ii) After availing the supply at Allahabad extend it to Railway traction .
- (iii) Extend supply to Obra (Th) in consultation with UPPCL Control Room, in case the supply at Allahabad has been received through priority 2.
- (iv) Extend supply to Fatehpur in consultation with UPPCL Control Room, in case the supply at Allahabad has been received through priority-1.

2.2.12. **FATEHPUR**

- (i) Fatehpur to get supply in the following descending order of priority:

Priority 1: Anpara-Obra-Allahabad-Fatehpur

Priority 2: Vindhyachal-Kanpur-Panki-Fatehpur

- (ii) After availing the supply at Fatehpur extend it for Railway traction .
- (iii) Supply be extended to Naubasta also for Railway Traction if Naubasta has not received the supply so far.
- (iv) Start up supply to be extended to Unchahar on request in case Unchahar has not received the supply so far from Kanpur end.
- (v) Extend supply to Allahabad in consultation with UPPCL Control Room in case the supply at Fatehpur has been received through priority-2.

- (vi) Extend supply to Panki in consultation with UPPCL Control Room in case the supply at Fatehpur has been received through priority-1.

**2.2.13: SULTANPUR**

- (i) Sultanpur to get power from Obra (Th) over 400 KV Obra-Sultanpur line. In case of over voltage, Sultanpur to charge reactors at the station to control over voltages.
- (ii) Extend start up power to Tanda TPS

**2.2.14 TANDA**

- (i) Avail start-up power at Tanda from Obra (Th) via Sultanpur i.e. Obra 400 kV –Sultanpur 400kV –Sultanpur 220 kV -Tanda 220 KV.

**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. Therefore, while carrying out the restoration in the Northern Region with the help of Western Region 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 upto 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 possible number of units simultaneously after cross checking the power availability aspect from NRLDC/ CPCC-Kanpur.

- (iii) 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, particularly Singrauli STPS and Rihand (Hydro).
- (iv) 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 BBMB-Delhi Sub-System**

The Eastern U.P. Subsystem shall be synchronized with BBMB-Delhi 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 be disconnected from WR keeping into consideration the aspects as stated in the following para.

### **2.4.2 Disconnection from the Western Region**

As long as Eastern U.P. Subsystem remains connected with WR, 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 between the two regions thereby endangering the security of the Western Region also. Hence the disconnection of the built-up Eastern U.P. Subsystem from WR 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 it has to be ensured that the Eastern UP Subsystem has been stabilized and built-up to a considerable size (say to a minimum size of around 1000 MW with about 4 generating units from Singrauli, Rihand and Anpara complex having been synchronized).
- (ii) The BBMB-Delhi subsystem has also been built up adequately and stabilized so that immediately after disconnection from WR, the Eastern U.P. Subsystem can be synchronised with the BBMB-Delhi Subsystem.
- (iii) The circuits where the Eastern U.P. Subsystem and BBMB-Delhi Subsystem shall be synchronized have been identified and ready for operation.
- (iv) Power flow on the Vindhyachal AC By-pass Link has been made in almost floating condition (say less than 20-30 MW). In order to control the flow on AC By-pass Link, 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) – (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 before synchronization with BBMB-Delhi Subsystem is only indicative and based on the “most likely possibility” criteria. However, as the disconnection of the Eastern U.P. Subsystem from WR 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

## **SECTION-3**

### **RESTORATION OF BBMB - DELHI SUBSYSTEM**

#### **3.1 SUBSYSTEM OVERVIEW**

##### **3.1.1. Possible connections with other subsystems:**

a) With Western U.P. Sub-system :

1. 400 KV Dadri – Muradnagar
2. 400 KV Agra– Murad Nagar

b) With Eastern U.P. Subsystem:

1.  $\pm 500$  kV HVDC Rihand – Dadri Bipole
2. 400 KV Kanpur - Ballabgarh
3. 400 KV Kanpur - Agra

c) With Rajasthan Sub-system:

1. 400 kV Bassi-Hissar
2. 400 kV Ballabgarh-Bassi
3. 400 kV Agra-Bassi
4. 220 kV BTPS -Alwar
5. 220 kV Agra-Bharatpur

##### **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, Uri, Bairasiul, Ranjit Sagar,
- c) Gas: Dadri (GPS), Auraiya, Faridabad (Gas) , I.P.Extn (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)           | I.P.Extn (Gas) | 50 MW                 |
| f)           | Pong           | 120 MW                |
| g)           | Faridabad GPS  | 140 MW                |
| h)           | Salal HEP      | 105 MW                |
| i)           | Uri HEP        | 40 MW                 |
| j)           | Lower Jhelum   | <u>30 MW</u>          |
| <b>TOTAL</b> |                | <b><u>1225 MW</u></b> |

**3.1.4. Requirement of start - up power :**

|              |                      |                       |
|--------------|----------------------|-----------------------|
| 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>685 MW</u>         |
| <b>TOTAL</b> |                      | <b><u>1225 MW</u></b> |

**3.1.5. System Synchronisation:**

After subsystem build up and stability the BBMB -Delhi Subsystem can be synchronized with other subsystems in the following manner:

- a) With Eastern U.P. Subsystem:

Initially the BBMB-Delhi Subsystem shall be synchronized with the Eastern U.P. Subsystem at the following possible connections:

- i) 400 KV Kanpur - Agra at Kanpur/Agra
- ii) 400 KV Kanpur-Ballabgarh at Kanpur/Ballabgarh

b) With Rajasthan Subsystem

Subsequently, the combined BBMB – Delhi + 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-Bassi at Bassi/Ballabgarh
- iii) 400 kV Agra-Bassi at Bassi/Agra
- iv) 220 KV Khetri-Jaipur at Jaipur

c) With Western U.P. Subsystem

Finally, the combined Delhi-BBMB + 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
- v) 400 KV Lucknow-Moradabad at Lucknow / Moradabad

The above synchronizing sequence is only indicative. However, based on the actual size and geography of a particular subsystem being built-up, the sequence of restoration particularly Western U.P. Subsystem shall be synchronized first or the Rajasthan System shall be decided on seeing the real time conditions.

### 3.2 **SUBSYSTEM RESTORATION PROCEDURE:**

3.2.1 The BBMB - Delhi 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 AREA** - consisting of the hydro units of BBMB, thermal and hydro units of Punjab & Haryana and hydro units of H.P.
- (iii) **DADRI (NTPC) AREA** – consisting of units at Dadri (Gas) and Dadri (Thermal).
- (iv) **AURAIYA (Gas) AREA** - consisting of Auraiya (Gas) alongwith traction load at Agra / Mathura / Phaphund.
- (v) **J & K & NORTH PUNJAB AREA** - consisting of hydro units in J & K system and North Punjab.

At the time of subsystem built-up, the actions to be taken at the major generating stations / grid substations in the BBMB-Delhi Subsystem are as given below.

#### 3.2.2 **DELHI AREA:**

- i) In case of survival of Delhi inner ring, it shall be synchronised with Faridabad (Gas) supply on 220 KV Ballabhgarh- BTPS Ckt. at BTPS.
- ii) In case of collapse / non-survival of Delhi inner ring, the GT's at Delhi are to be immediately self-started and supply is to be extended for meeting the emergency loads and to Park Street for railway traction . DVB has also to ensure that I.P. and

Rajghat units are also extended power at the earliest suitable opportunity.

- ii) After stabilisation of supply in Delhi area (availability of around three GT's and one unit each at IP (Th) and Rajghat), power supply would be extended to BTPS on 220 KV I.P.Extn. - BTPS ckt. for synchronization with Faridabad GPS supply at BTPS.
- iii) As soon as stabilised power supply from the BBMB Subsystem is available at the periphery of Delhi Area (say at Ballabgarh / BTPS / Mandola), DVB shall synchronise its running machines with the same.

*Note: For extending quick startup 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 DVB 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 straight from Faridabad to BTPS and no load would be put in between except 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.
- iii) From Ballabhgarh at 66 KV start-up supply shall be extended to Faridabad (Th) after 2 GTs are operational at Faridabad (Gas) and these are feeding a stable load at BTPS / 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 at Okhla would be added / removed in a controlled and gradual manner. Necessary coordination / control in this respect shall be carried out by BTPS and Delhi System.

- 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 startup power in the following descending order of priority:

Priority 1: From Faridabad GPS via 220 KV Faridabad (Gas) – Samaypur – Bhallabhgarh – BTPS

Loading in the built up area shall be controlled by BTPS /Delhi System as explained in para 3.2.2.1 above.

Priority 2: BBMB power via 220 kV Panipat – Narela(DVB) – Bawana – Najafgarh- Bamnauli-Mehrauli – BTPS

DVB shall not add any load at any of the above enroute substations unless asked by NRLDC to do so to control system parameters (Except 30-40 MW load at Narela for Railway Traction purposes).

Priority 3: BBMB power via 400 KV Panipat - 400 kV Dadri - 400 KV Samaypur-220 kV Samaypur – 220 KV Ballabhgarh-220 kV BTPS

Priority 4: Power from stabilized Delhi Area on 220 KV IP Extn. - BTPS (after synchronization of around 3

GTs at IP Extn. and one unit each at Rajghat and IP).

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

### **Caution**

In case the units at BTPS are started using the supply from Faridabad GPS and the Delhi area is built up separately by self starting the GTs at IP Ext, then the two supplies are to be synchronized at BTPS on 220 KV BTPS- I.P. Extn Ckt. as soon as the supply in Delhi Area is stabilised

#### **3.2.3 BBMB AREA:**

- i) For starting BBMB System the units at Bhakra(R) shall be self started and the supply shall be extended to Ganguwal and Jamalpur.
- ii) From Ganguwal the supply shall be extended to units at Bhakra (L) (Three machines each at Bhakra (R) and Bhakra (L) would be operated to provide power system stability and adequate hot spinning reserves needed to control the system parameters in a weak system).
- ii) 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 the supply shall be extended to Panipat 220 kV.
- vi) From Ganguwal the supply shall also be extended to Dehar HEP and units at Dehar would be synchronized.

#### 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.
- 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) – Ganguwal - Mohali- Ropar

Priority 2: Bhakra (R) - Ganguwal-Govindgarh II– Govindgarh I – Ropar

Priority 3: Bhakra (R) - Ganguwal - Ganguwal (132 KV)- Kotla-Ropar-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) -Ganguwal-Govindgarh-II-Govindgarh-  
I-Malerkotla (PSEB)-Barnala(PSEB) – Lehra  
Mohabat-Bhatinda

**3.2.3.5 PONG:**

The start up supply to Pong shall be extended in the following  
sequence:

Bhakra (R) - Jamalpur-Jalandhar-Pong.

**3.2.3.6 BAIRASIUL:**

Bairasiul shall avail the start up power from Pong.

**3.2.3.7 SURATGARH**

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

Priority-1: From BBMB System Bhakra (R) - Ganguwal-  
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

***(a direct switchable link between 220 kV bus of Dadri(Gas) and Dadri (Thermal) is to be provided by NTPC)***

- ii) In the event of tripping of all the GT's at Dadri, they shall be self started ***(Additional DG set at Dadri is to be provided by NTPC)*** and start up power would be extended to Dadri(Th) .
- iii) In the event of build up of the Dadri Area by self starting the units at Dadri (Gas), the supply shall be synchronized with BBMB supply at 400 kV Dadri - Panipat Ckt. At Dadri / Panipat and then the supply shall be extended to Ballabgarh for extending power/ synchronization with Delhi Area.
- iv) In the event of failure in obtaining startup supply from Dadri (Gas), BBMB supply shall be extended to Dadri 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 in consultation with Malanpur (WR) the units at Auraiya to be synchronized with Western Regional Grid for stability.
- ii) From Auraiya supply is to be extended to 220 KV Phaphund and Agra - Mathura for railway traction .
- iii) The generating units at Auraiya shall be synchronised with the BBMB - Delhi subsystem supply received through Ballabhgarh 400 KV-Agra 400 KV-Auraiya 400 KV.(Before this, connection with Malanpur(WR) shall be disconnected).

#### **Caution**

- i) In the event of connection with Malanpur, Auraiya (Gas) has to regulate its generation in such a manner that the flow on 220 KV Auraiya-Malanpur line remains almost in floating condition and

any possible drawal / injection on this line may be carried out in consultation with Malanpur (WRLDC).

- ii) 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 BBMB-Delhi Subsystem.
- iii) In case of failure in self starting of GT's at Auraiya, the same are to be started by taking start up supply in the following descending order of priority

Priority-1: Western Grid supply from Malanpur

Priority-2: BBMB - Delhi subsystem through 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 first then it shall be extended upto 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.

**3.2.6.3 Chamera HEP**

- i) Chamera shall self start its units and extend supply to Kishenpur.

**3.2.6.4 KISHANPUR**

- i) The generating units at three hydro stations in J & K and North Punjab area viz. Salal, Ranjeet Sagar and Chamera shall be self started and supply shall be extended to Kishenpur

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

Bhakra(R)- Jamalpur – Jalandhar – Dasuya – Sarna – Kishenpur and synchronized with supply in J & K area

- iii) In the event of failure of self start facility at any of the hydro station in J & K and North Punjab Area (Ranjit Sagar, Salal , Chamera), Power shall be extended from Kishanpur to the concerned Power station.

- iv) 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 / Bemina.

- 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 BBMB -Delhi 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 be synchronised with the Rajasthan and Western U.P. Subsystem thereafter.

#### **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 synchronised 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 sections / buses area to be maintained within normal range by use of bus / line reactor and 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 BBMB-Delhi Sub-system refer Exhibit-3A.

- ii) For detailed Start-up Sequence in BBMB Subsystem refer Exhibit 3 B.

## SECTION-4

### RESTORATION OF RAJASTHAN SUBSYSTEM

#### 4.1 SUBSYSTEM OVERVIEW

##### 4.1.1. Possible connection with other Subsystems:

- a) With BBMB-Delhi subsystem
  - i) 400 KV Ballabgarh - Bassi
  - ii) 400 KV Hissar - Bassi
  - iii) 400 KV Agra – Bassi
  - iv) 220 KV BTPS –Alwar
  - v) 220 KV Agra –Bharatpur
  - vi) 220 KV Khetri-Jaipur

##### 4.1.2. Major Generating Stations:

- a) Thermal: KTPS
- b) Hydro: Rana Pratap Sagar (RPS), Jawahar Sagar (JS), Mahi
- c) Gas: Anta
- d) Nuclear: RAPS (A), RAPS (B)

##### 4.1.3. Sources of Start-up power

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

#### 4.1.4. Requirement of Start-up power:

|    |                     |   |                      |
|----|---------------------|---|----------------------|
| a) | Start-up at Kota    | : | 30 MW                |
| b) | RAPS (A) & RAPS (B) | : | 50 MW                |
| c) | Railway Traction    | : | 70 MW                |
| d) | Emergency Loads     | : | <u>180 MW</u>        |
|    | <b>Total</b>        | : | <b><u>330 MW</u></b> |

#### 4.1.5. System Synchronisation:

After build-up of the Rajasthan Sub-system, it can be synchronized with the combined BBMB-Delhi and Eastern U.P. Subsystems at the following possible connections.

- i) 400 KV Hissar-Bassi at Hissar/Bassi
- ii) 400 KV Ballabgarh - Bassi at Ballabgarh/Bassi.
- iii) 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 synchronise the units at R.P.Sagar.
- (iii) Extend start-up power to Jawahar Sagar .
- (iv) Extend supply to Kota (S)

#### 4.2.2. **KOTA (SAKATPURA) 220 kV SUB-STATION**

- (i) Kota (S) Sub-station shall 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). Parallely 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 to Kota (T).
- (iii) Kota (S) shall extend power supply for Railway Traction.
- (iv) In case RAPS (A) / RAPS (B) islands have survived then the supply from these islands be extended to Kota(S) and synchronized. Alternatively, in the event of tripping of RAPS(A) / RAPS(B) islands, start-up power is to be extended to RAPS(A) and RAPS(B) from Kota (S).
- (v) In case Anta has survived on house load or is able to self start then it shall extend supply to Kota (S) / for synchronisation or alternatively start-up power / reference shall be extended from Kota (S) to Anta for synchronization of GTs.
- (vi) Extend supply to Jaipur for Railway traction and/or other emergency load.

#### 4.2.3 **JAWAHAR SAGAR HEP**

Jawahar Sagar HEP to avail start-up power from R.P.Sagar.

#### 4.2.4. **KOTA (THERMAL)**

Kota (Th) to avail start up power from Kota (S).

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

- i) In case of survival of either of RAPS islands, synchronise with ota (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)
- (iii) In case of tripping of RAPS (B), avail start-up power from Kota (S)/Anta.
- (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)/RAPS (B) and synchronise. Alternatively receive the supply from Kota(S) / RAPS (B) and synchronise.
- (ii) In case of tripping of units at Anta, self start GT's at Anta and synchronise them with Kota (S)
- (iii) In case of any problem in self starting of units at Anta, avail start-up power from Kota (S)/RAPS (B) and start GT's.
- (iv) Extend supply from Anta to Dausa and Bharatpur for Railway Traction.

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

- (i) Avail power supply from Kota (S).

- (ii) From Jaipur 220 kV extend power to Dausa and Bharatpur for Railway Traction and other emergency loads.
- (iii) Extend power to Khetri in case there is delay in getting BBMB supply.
- (iv) From Jaipur 220 kV sub-station extend power to Heerapura / Bassi 400 kV substation for synchronisation with BBMB-Delhi 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.

#### **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.

- (iv) The start-up of Anta is to be closely monitored. In case of its self-start, the supply from Anta must be synchronised with supply at Kota (S) at the earliest opportunity.

#### 4.3

#### **SYNCHRONISATION OF RAJASTHAN SUBSYSTEM**

Rajasthan System is to be synchronised with the BBMB-Delhi and Eastern UP Subsystem at the following possible connections:

- (i) 400 kV Hissar-Bassi at Hissar / Bassi.
- (ii) 400 KV Ballabhgarh-Bassi at Bassi / Ballabhgarh
- (iii) 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.

## **SECTION-5**

### **RESTORATION OF WESTERN U.P. SUBSYSTEM**

#### **5.1 SUBSYSTEM OVERVIEW**

##### **5.1.1. Possible connections with other Subsystems:**

- a) With BBMB-Delhi Subsystem
  - i) 400 kV Dadri - Muradnagar
  - ii) 400 kV Agra-Muradnagar
  - iii) 220 kV BTPS - NOIDA
  - iv) 220 kV Harduaganj -Agra
- b) With Eastern U.P. Subsystem
  - i) 400 kV Lucknow-Moradabad
  - ii) 400 kV Panki - Muradnagar
  - iii) 220 kV Panki-Mainpuri
  - iv) 220 kV Kanpur-Mainpuri

##### **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 : 150 MW
- Total: 400 MW**

5.1.4. **Requirement of Start -up power:**

|    |                        |   |                      |
|----|------------------------|---|----------------------|
| a) | Start-up Power to NAPS | : | 40 MW                |
| b) | Railway Traction       | : | 30 MW                |
| c) | Other Essential loads  | : | <u>330 MW</u>        |
|    | <b>Total</b>           | : | <b><u>400 MW</u></b> |

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 BBMB-Delhi Sub system shall be synchronised.
- b) Subsequently, the combined BBMB-Delhi Subsystem + Eastern U.P. Subsystem shall be synchronised with the Rajasthan Subsystem.
- c) Finally, the combined Eastern U.P. Subsystem + BBMB-Delhi 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-Muradnagar at Agra/Muradnagar
  - iii) 400 kV Panki-Muradnagar at Panki/Muradnagar
  - iv) 400 kV Lucknow-Moradabad at Lucknow-Moradabad

The above synchronizing sequence is only indicative only and has been planned on the basis of experience derived from the past incidences. However, in following a particular sequence for synchronization of different subsystems, NRLDC shall also keep in consideration the actual situation prevailing in real time conditions and shall act accordingly.

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 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 upto 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 (Old) 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 upto Moradabad through Nehtaur.
- ii) The generating units of Tanakpur shall be self started and the supply shall be extended upto Moradabad through Barielly 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 upto Moradabad, the reference would be extended from Moradabad upto Tanakpur through Barielly 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 Delhi-BBMB sub-system has been stabilized and supply is available at Agra/Sikandara then the supply to NAPS is to be extended through Agra-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 also, 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.
- ii) Since the extension of supply from the stabilized Delhi-BBMB 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 BBMB-Delhi subsystem through Agra and Harduaganj

**Note:** In order to provide quick start-up power to NAPS and to avoid poisoning out of its units, possibility of providing a direct 220 KV line between NAPS and Dadri Gas (NTPC) is to be explored.

**5.2.6      HARDUAGANJ**

Harduaganj is an important station in the Western U.P. Subsystem as from this station supply to Railway Traction is extended on the Tundla-Delhi Section (Subsection : Daudkhan-Sahibabad) through Siarsaul (Aligarh) grid sub-station. The power supply to Harduaganj shall be extended in following descending order of priority:

- Priority 1: From Yamuna Complex via Muradnagar – Khurja-Harduaganj.
- Priority 2: From Ramganga and / or Tanakpur hydro stations via Moradabad – NAPS – Harduaganj.
- Priority 3: From BBMB-Delhi Subsystem via Auraiya-Agra-Harduaganj (Normally the supply from Auraiya shall be extended only after the supply in Auraiya Area gets adequately stabilized).

**Caution**

In the event of survival of NAPS Island the supply can be extended from NAPS to Harduaganj after the connection and stabilization of the NAPS Island with other network in Western U.P. System.

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 BBMB-Delhi + 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.

## **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
- Central Railways
- Western Railways

Annex-1 and Annex-2 gives the details of section lengths and loads in different sections of Northern Railway, Central and Western Railway respectively.

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 Bihar (Eastern region supply) :**

Northern Railways shall feed traction loads of Jeonathpur and Chunar traction substations through their own network from Bihar.

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

From Eastern U.P. Subsystem the following traction load shall be fed:

- Lucknow
- i) Section = Mugalsarai-Allahabad-Kanpur-
  - ii) Sub-Section = Pahara-Jhinjhak
  - iii) Max. Railway traction load = 110 MW(140 MVA)
  - iv) Feeding grid sub-stations= Obra, Allahabad,Fatehpur, Naubasta, Panki

#### 6.2.3 **Power supply from Auraiya(Gas)**

From Auraiya the following traction load of Northern Railway shall be fed:

- i) Section = Kanpur-Tundla
- ii) Sub-Section = Jhinjhak-Daudkhan
- iii) Max. Railway traction load = 40 MW (50 MVA)
- iv) Feeding grid sub-stations= Auraiya(Phaphund)

#### 6.2.4 **Power supply from Western U.P. Subsystem**

From western U.P subsystem the following traction load shall be fed:

- i) Section = Tundla-Delhi
- ii) Sub-Section = Daudkhan-Dadri
- iii) Max. Railway traction load = 30 MW(40 MVA)
- iv) Feeding grid sub-stations = Harduaganj(Siarsaul)

Remark: After commissioning of 220 kV Dadri-Dankaur ckts the traction load Siarsaul shall be fed from Dadri(Gas) Station.

#### 6.2.5 **Power supply from BBMB-DELHI Subsystem :**

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

- i) Section = Delhi ring
- ii) Sub-Section = Hazrat Nizamuddin -Azadpur
- iii) Max. Railway traction load = 15 MW(20 MVA)

- iv) Feeding grid sub-stations= Park street(DVB)
- b) From HVPN/Delhi system the following traction load shall be fed:
  - i) Section = Delhi-Ambala-Saharanpur
  - ii) Sub-Section = Azadpur-Ambala-Saharanpur
  - iii) Max. Railway traction load = 55 MW(65 MVA)
  - iv) Feeding grid sub-stations= Narela(DVB), Panipat(HVPN), Abdullapur(HVPN)
- c) From PSEB system the following traction load shall be fed:
  - i) Section = Ludhiana-Ambala-Kalka
  - ii) Sub-Section = Ludhiana-Ambala-Kalka
  - iii) Max. Railway traction load = 30 MW(35 MVA)
  - iv) Feeding grid sub-stations= Rajpura, Sahnewal, Dera-Bassi

### 6.3. **CENTRAL RAILWAY:**

#### 6.3.1 **Power supply from M.P.:**

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

#### 6.3.2 **Power supply from Faridabad(Gas)**

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

- i) Section = Delhi-Mathura
- ii) Sub-Section = Faridabad-Ajhal
- iii) Max. Railway traction load = 25 MW(30 MVA)
- iv) Feeding grid sub-stations= Ballabgarh 220 kV

#### 6.3.3 **Power supply from Auraiya(G)**

From Auraiya(G) the following traction load of Central Railway shall be fed:

- i) Section = Mathura-Agra
- ii) Sub-Section = Ajhal-Mania
- iii) Max. Railway traction load = 25 MW(30 MVA)
- iv) Feeding grid sub-stations= Auraiya(Agra/Mathura)

#### 6.4 **WESTERN RAILWAY:**

##### 6.4.1 **Power supply from Auraiya(G)**

From Auraiya(G) the following traction load of Western Railway shall be fed:

- i) Section = Agra-Bayana
- ii) Sub-Section = Yamuna bridge-Rupbagh
- iii) Max. Railway traction load = 5 MW (7 MVA)
- iv) Feeding grid sub-stations= Auraiya(Agra)

##### 6.4.2 **Power supply from Rajasthan Subsystem**

- i) Section = Mathura-Bayana-Mumbai
- ii) Sub-Section = Mureshirampur-Kurlasi
- iii) Max. Railway traction load = 70 MW (90 MVA)
- iv) Feeding grid sub-stations= Kota, Jaipur,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 shall have a limitation in regard to the ramp up rates. 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 restricted to bare minimum 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:**

- i) Refer Exhibit-6A for Northern Railway Traction Supply.
- ii) Refer Exhibit-6B for Central Railway and Western Railway/Traction Supply.

## POWER SUPPLY TO NORTHERN RAILWAY TRACTION SUB-STATIONS

| S No. | 220 kV Grid Station                      | Traction substation | Section                                   | Section Length | Load ( MVA) |
|-------|------------------------------------------|---------------------|-------------------------------------------|----------------|-------------|
| 1     | Sahupuri                                 | Jeonathpur(TSS)*    | Mugalsarai-Ahura Road                     | Km.<br>14      |             |
|       |                                          | Chunar(FPS)*        | Ahura road -Pahara                        | 34             |             |
| 2     | Rewaroad/ Allahabad                      | Mirzapur(TSS)       | Pahara-Birohi                             | 27             |             |
|       |                                          | Jinga(FPS)          | Birohi-Unchadih                           | 32             |             |
|       |                                          | Bheerpur(TSS)       | Unchadih-Karchana                         | 28             |             |
|       |                                          | Naini(FPS)          | Karchana-Bamhraul                         | 29             |             |
|       |                                          | Manuari(TSS)        | Bamhraul-Bharwari                         | 27             |             |
|       |                                          | Sirathu(FPS)        | Bharwari-Kanwar                           | 32             |             |
| 3     | Fatehpur                                 | Rasulabad(TSS)      | Kanwar-Faizullapur                        | 35             |             |
|       |                                          | Malwan(FPS)         | Faizullapur-Bindaki road                  | 44             |             |
| 4     | Naubasta                                 | Sarsaul(TSS)        | Bindaki road-Chakeri                      | 34             |             |
| 5     | Panki                                    | Panki(FPS)          | Chakeri-Maitha                            | 41             | 20 MVA      |
|       |                                          | Rura(TSS)           | Maitha-Jhinjihak                          | 31             |             |
| 6     | Sarojininagar                            | Amousi(TSS)         | Kanpur-Lucknow                            | 72             | 10 MVA      |
| 7     | Auraiya                                  | Phaphund(TSS)       | Jhinjihak-Achalda                         | 37             | 50 MVA      |
|       |                                          | Bharathana(TSS)     | Achalda-Ekdil                             | 30             |             |
|       |                                          | Etawah(TSS)         | Ekdil-Jaswantnagar                        | 26             |             |
|       |                                          | Bhandan(TSS)        | Jaswantnagar-Kuarara                      | 28             |             |
|       |                                          | Sikohabad(TSS)      | Kuarara-Firozabad                         | 31             |             |
|       |                                          | Mitawali(TSS)       | Firozabad-Chambola                        | 38             |             |
|       |                                          | Hathras(TSS)        | Chambola-Daudkhan                         | 49             |             |
| 8     | Siarsaul-Aligarh<br>(Harduaganj section) | Mehrawal(TSS)       | Daudkhan-Sohna                            | 27             | 40 MVA      |
|       |                                          | Khurja(TSS)         | Sohna-Chola                               | 37             |             |
|       |                                          | Dhankaur(TSS)       | Chola-Dadri                               | 31             |             |
|       |                                          | Sahibabad(TSS)      | Dadri-Delhi                               |                |             |
| 8     | Ridge valley(66 kV)                      | Chanakyapuri(TSS)   | Delhi-Ring<br>(Hazrat Nizamuddin-Azadpur) |                | 20 MVA      |
| 9     | Narela                                   | Narela(TSS)         | Azadpur-Sonipat                           | 34             | 25 MVA      |
|       | Panipat                                  | Diwana(TSS)         | Sonipat-Gharaunda                         | 62             | 30 MVA      |
|       |                                          | Taraori(TSS)        | Gharaunda-Kurukshetra                     | 50             |             |
|       |                                          | Sahabad(TSS)        | Kurukshetra-Ambala                        | 49             |             |
| 10    | Rajpura                                  | Rajpura(TSS)        | Ambala-Mandi Govindgarh                   | 56             | 12 MVA      |
| 11    | Sahnewal                                 | Sahehwal(TSS)       | Mandi-Govingarh-Ludhiana                  | 54             | 12 MVA      |
| 12    | Abdullapur                               | Jagadhari(TSS)      | Ambala-Saharanpur                         | 69             | 10 MVA      |
| 13    | Derabassi                                | Ghaggar(TSS)        | Ambala-Kalka                              | 62             | 10 MVA      |

\* In the event of black start, Northern Railway shall feed traction loads of

Jeonathpur and Chunar through their own network from Bihar

## POWER SUPPLY TO CENTRAL RAILWAY TRACTION SUBSTATION

| S no. | 220/132 kV grid S/Stn | Traction substation | Section                           | Section Length ( Km) | Load (MVA)       |
|-------|-----------------------|---------------------|-----------------------------------|----------------------|------------------|
| 1     | Ballabgarh(220kV)     | Ballabgarh Holdal   | Faridabad-Asaoti<br>Asaoti-Ajhais | 30<br>60             | 25 MVA           |
| 2     | Sikandara(220kV)      | Mathura Bhandai     | Ajhais-Kitham<br>Kitham-Mania     | 58<br>58             | 18 MVA<br>11 MVA |
| 3     | Lalitpur(132kV)*      | Lalitpur            | Jakhaura-Jakhluan                 | 37                   | 11 MVA           |

\* In the event of black start, Central Railways shall feed traction loads of Lalitpur from their own network from Western Region.

## POWER SUPPLY TO WESTERN RAILWAY TRACTION SUBSTATION

| S no. | 220/132 kV grid S/Stn | Traction substation           | Section                                                                  | Section Length (km) | Load (MVA)                |
|-------|-----------------------|-------------------------------|--------------------------------------------------------------------------|---------------------|---------------------------|
| 1     | Bharatpur             | Bharatpur                     | Mureshirampur-Salabad                                                    | 59                  | 10 MVA                    |
| 2     | Hindaun               | Bayana<br>Hindaun<br>Gangapur | Salabad-Rupbagh-Fatehsingpura<br>Fatehsingpura-Piloda<br>Piloda-Malarana | 62<br>37<br>55      | 8 MVA<br>10 MVA<br>12 MVA |
| 3     | Jaipur/Kota           | Sawai-Madhopur                | Malarana-Amli                                                            | 53                  | 12 MVA                    |
| 4     | Kota                  | Lakheri<br>Gurla              | Amli-Kapren<br>Kapren-Ravtha road                                        | 51<br>72            | 12 MVA<br>12 MVA          |
| 5     | Kota/Morak            | Ramganj-Mandi                 | Ravtha road-Kurlasi road                                                 | 79                  | 12 MVA                    |
| 6     | Sikandara             | Pathauli                      | Yamuna bridge Rupbagh                                                    | 60                  | 7 MVA                     |

## **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 vi) 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 upto 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 become dead.
- 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 startup 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 Vindhyachal-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 power flow between WR and NR may be started.