BHUTAN POWER CORPORATION LIMITED

BHUTAN POWER SYSTEM OPERATOR (BPSO)

THIMPHU: BHUTAN

BHUTAN POWER SYSTEM CONTINGENCY PLAN

&

OPERATING PROCEDURES

Reviewed and updated in November 2019

BPSO

Table of Contents

1 INTRODUCTION

The **Bhutan Power System Contingency Plan & Operating Procedures** document shall be the dynamic document which will be updated with change in power system network. Any necessary revision arising out of the changes in the power system network shall be made after thorough discussion in the Operation Coordination Committee (OCC) meeting. The endorsement shall also be done by OCC forum.

2 SYSTEM IMPROVEMENT FEATURES

The power system infrastructural features such as the pondage and the reactors play a critical role in improving the grid security. Brief explanation on the utilization of pondage and the reactors at various plants and substation is as described below.

2.1 Basochu (BHP) Pondage

Under normal condition, Basochu pondage shall be kept filled to meet the Thimphu load during emergency. BHP shall inform the System Operator before depletion or maintenance of the pondage.

2.2 Reactor in Tala Hydro Power Plant (THP)

THP has a shunt reactor of 1x63 MVAR, which shall be connected to the 400kV bus when the system voltage goes above the permissible limit of 1.05 times the rated voltage while the same shall be disconnected when the system voltage goes below the permissible limit of 0.95 times the rated voltage.

2.3 Reactor in Kurichu Hydro Power Plant

Kurichhu Hydropower Plant (KHP) has a shunt reactor of 1x5 MVAR, which shall be connected to the 132kV bus when the system voltage goes above the permissible limit of 1.05 times the rated voltage while the same shall be disconnected when the system voltage goes below the permissible limit of 0.95 times the rated voltage.

2.4 Reactor at Jigmeling

Jigmeling has a shunt reactor of 2 x 80 MVAR, which shall be connected to the 400kV bus when the system voltage goes above the permissible limit of 1.05 times the rated voltage while the same shall be disconnected when the system voltage goes below the permissible limit of 0.95 times the rated voltage. As per the requirement of the grid, the System Operator shall instruct operators at Jigmeling to put ON both the reactors.

2.5 Reactor at MHEP

Mangdechu Hydro Electric Plant (MHEP) has a shunt reactor of 1x80 MVAR, which shall be connected to the 400kV bus when the system voltage goes above the permissible limit of 1.05 times the rated voltage while the same shall be disconnected when the system voltage goes below the permissible limit of 0.95 times the rated voltage.

3 BUS CONFIGURATION

With the bus coupler remaining healthy, the bus configuration shall be kept as described below.

3.1 220kV Semtokha substation

a. The 220kV Chukha-Semtokha line and one of the 50MVA, 220/66kV transformers shall be connected to Bus A.

b. The 220kV Rurichu-Semtokha line and other 50 MVA, 220/66kV transformers shall be connected to Bus B.

c. The bus coupler shall be kept closed.

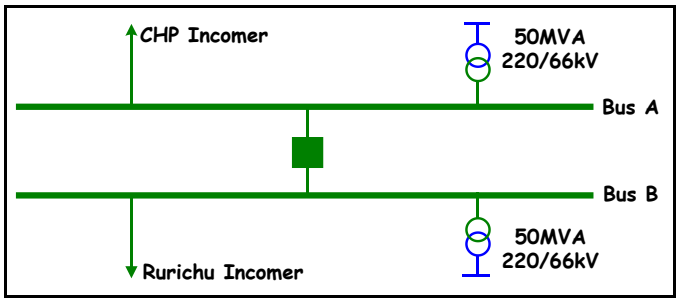


Figure 3-1 *Bus Configuration of Semtokha Substation*

3.2 220kV Chukha Switchyard

a. Three generating units along with all the 220kV export feeders (220kV Chukha-Birpara line-I & II) and 220kV Chukha-Malbase line-III shall be connected to Bus A. The configuration shall be changed depending on the season, especially the 220kV Chukha-Malbase feeder.

b. The other generating unit along with Bhutan loads (220kV Chukha-Semtokha line and 2x20MVA, 220/66kV transformers) shall be connected to Bus B.

c. The bus coupler shall be kept closed.

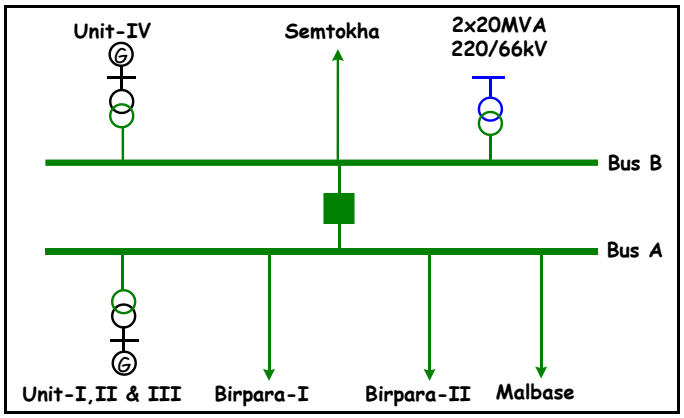


Figure 3-2 *Bus Configuration of Chukha Switchyard*

3.3 400kV Malbase substation

a. The 400kV Tala-Malbase line and 400kV Malbase-Siliguri line shall be connected to 400kV Bus A, while 400/220kV 200MVA ICT shall be connected to 400kV Bus B.

b. The tie-breaker shall be kept closed.

c. The 220kV Chukha-Malbase line and 220kV Malbase-Birpara line shall be connected to 220kV Bus A, while the 400/220kV 200MVA Inter connecting transformer (ICT) along with the Bhutan load (220kV Malbase-Singhegaon line, 220kV Malbase-Damdum and all 220/66kV transformers) shall be connected to 220kV Bus B.

d. The bus coupler shall be kept closed.

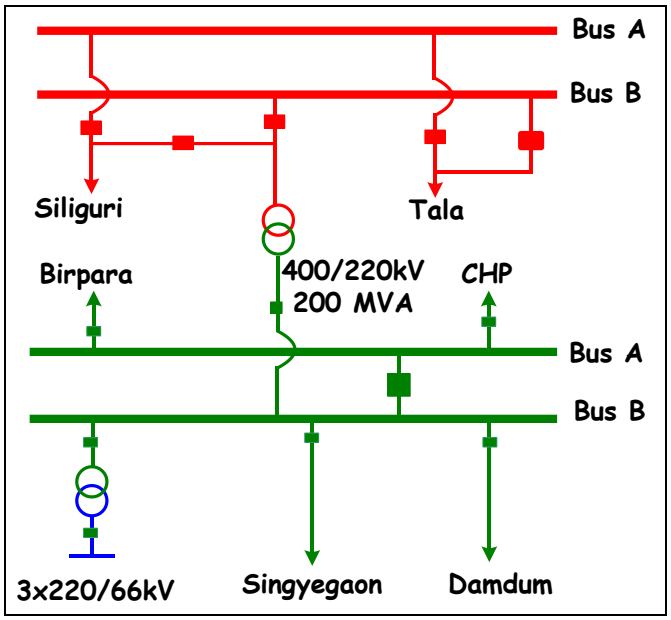


Figure 3-3 *Bus Configuration of Malbase Substation*

3.4 220kV Rurichu Switchyard

a. One generating unit along with the 220kV Rurichu-Semtokha line shall be connected to Bus A, while the other generating unit along with the 220kV Rurichu-Tsirang line and 30MVA, 220/66kV ICT shall be connected to Bus B.

b. The bus coupler shall be kept closed.

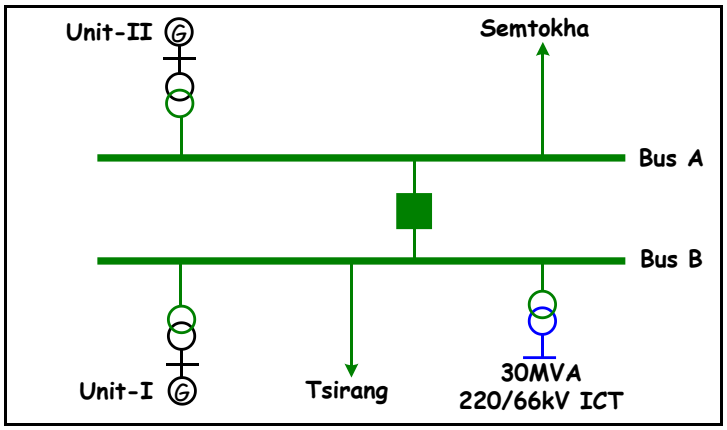


Figure 3-4 *Bus Configuration of Rurichu Switchyard*

3.5 220kV Tsirang Substation

a. The 220kV Dagachu-Tsirang line, 220kV Tsirang–Jigmeling line and one of the 10MVA, 220/66kV transformers shall be connected to Bus A, while 220kV Rurichu-Tsirang line and other 10MVA, 220/66kV transformer shall be connected to Bus B.

b. The bus coupler shall be kept closed.

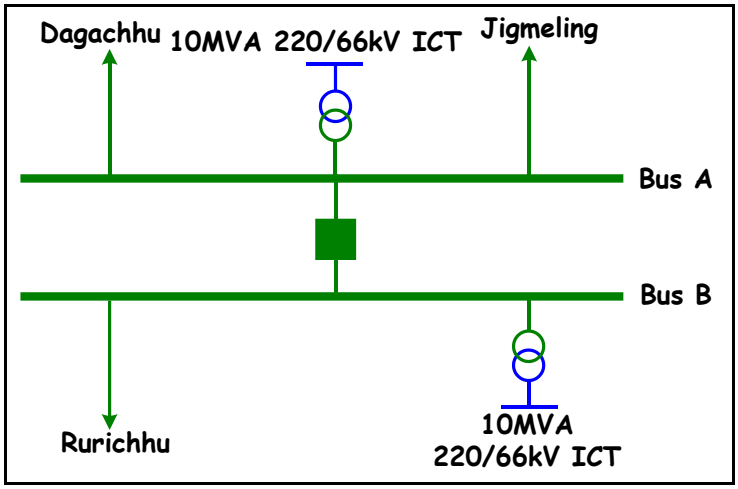


Figure 3-5 *Bus Configuration of Tsirang Substation*

3.6 400/220kV Jigmeling Substation

a. 400kV MHPA-Jigmeling Feeder 1 & 2 and 400kV Jigmeling-Alipurduar feeder 1&2 shall be connected to Bus A.

b. 400kV MHPA-Jigmeling feeder 3 & 4 along with 500MVA, 400/220kV ICT shall be connected to Bus B.

c. All tie breaker shall kept closed

d. The 220kV Tsirang–Jigmeling line along with 2X63/80MVA, 220/132kV ICT shall be connected to Bus A.

e. The bus coupler shall be kept Closed.

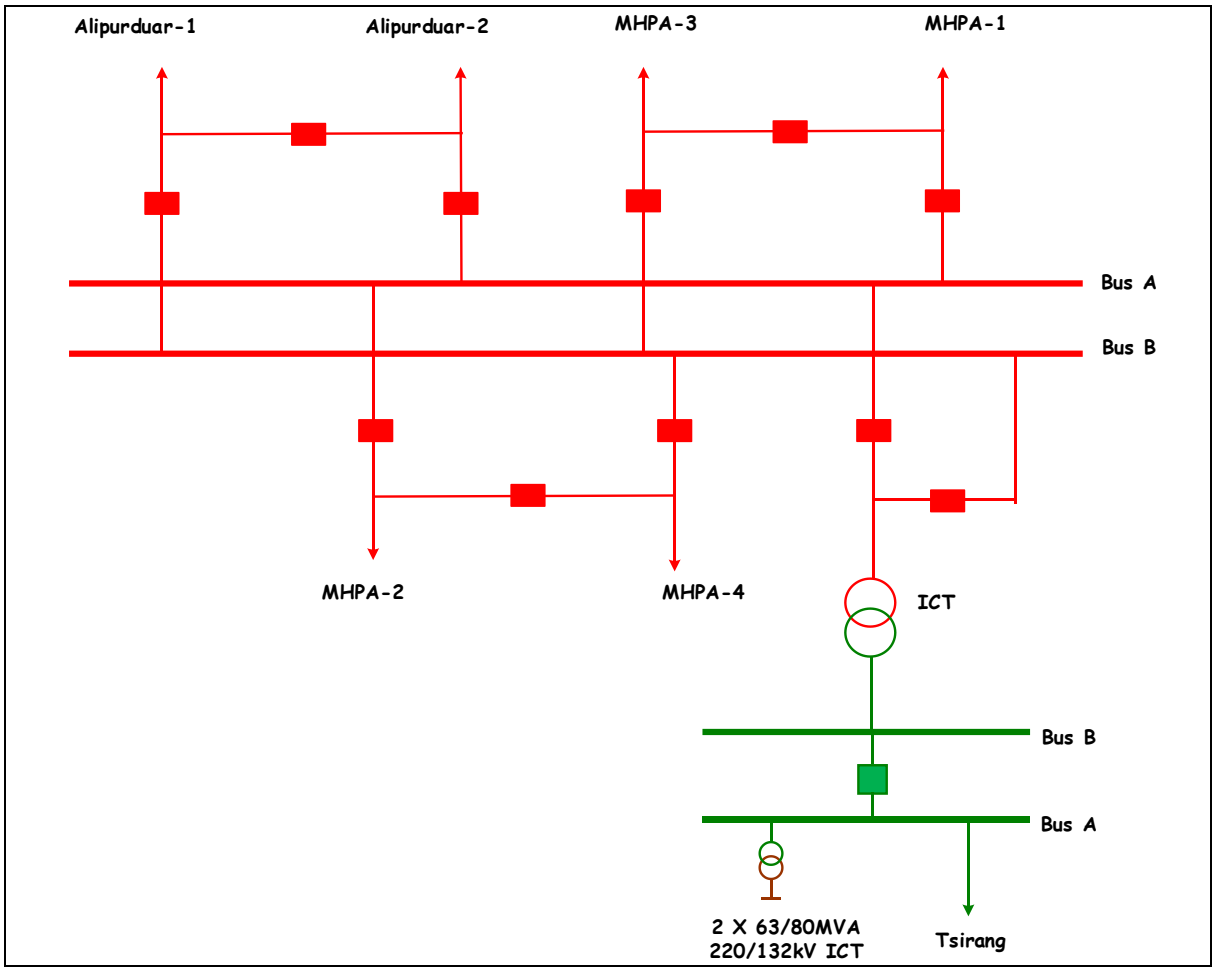


Figure 3-6 Bus Configuration of 400 kV Jigmeling Substation

4 SYSTEM UNDER NORMAL CONDITION

Under normal condition, the system for the western grid will be kept as follows irrespective of the seasons:

a. Both the 66kV Chukha-Semtokha line and 220kV Chukha-Semtokha line shall be in service to form a ring. However, in the Peak Season, the 66kV Olakha-Bjemina shall be kept opened to avoid the overloading.

b. Both the 66kV Rurichu-Semtokha line and 220kV Rurichu-Semtokha line shall be service to form a ring.

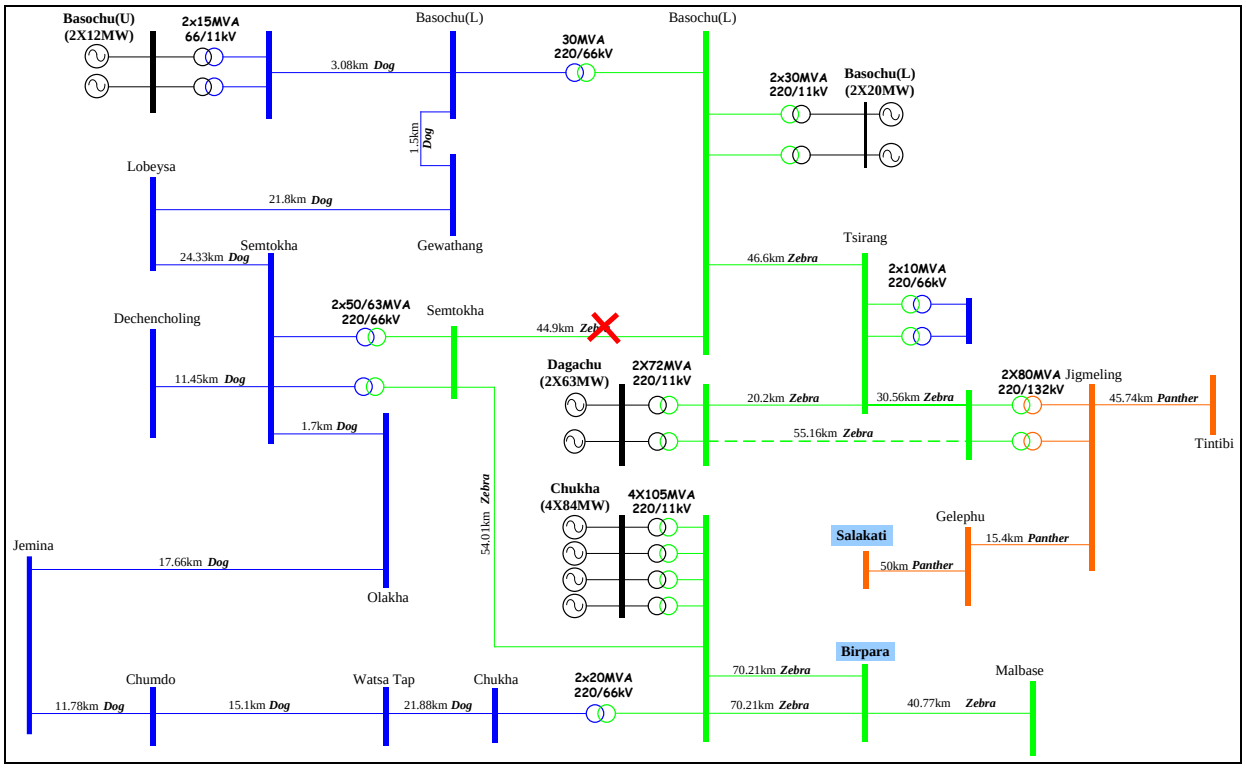
c. The 66kV Chukha-Phuentsholing line, 66kV Pling-Gomtu and with 66kV Phuentsholing-Malbase line shall be kept in ring with 220kV Chukha-Malbase and 220kV Malbase-Damdum.

d. The eastern and western grid shall be kept connected via 220kV Tsirang-Jigmeling line.

e. During the peak seasons, all the international lines shall be kept in service. However, during the lean seasons some international lines shall be kept OPEN/CLOSE as per system requirement.

5 CONTINGENCY AND OPERATING PROCEDURE

5.1 Failure of 220kV Rurichu-Semtokha line



During the peak seasons, there is a high probability of getting 66kV Rurichu-Gewathang-Lobeysa line overloaded when there is a failure of 220kV Rurichhu-Semtokha line. So, 30MVA ICT at BHP shall be kept opened, thereby segregating the lower and upper stage of BHP.

System Operator shall instruct BHP to back down their generation, if required, so that the power flowing towards east should be such that 132 kV Jigmeling-Gelephu-Salakati section is not overloaded.

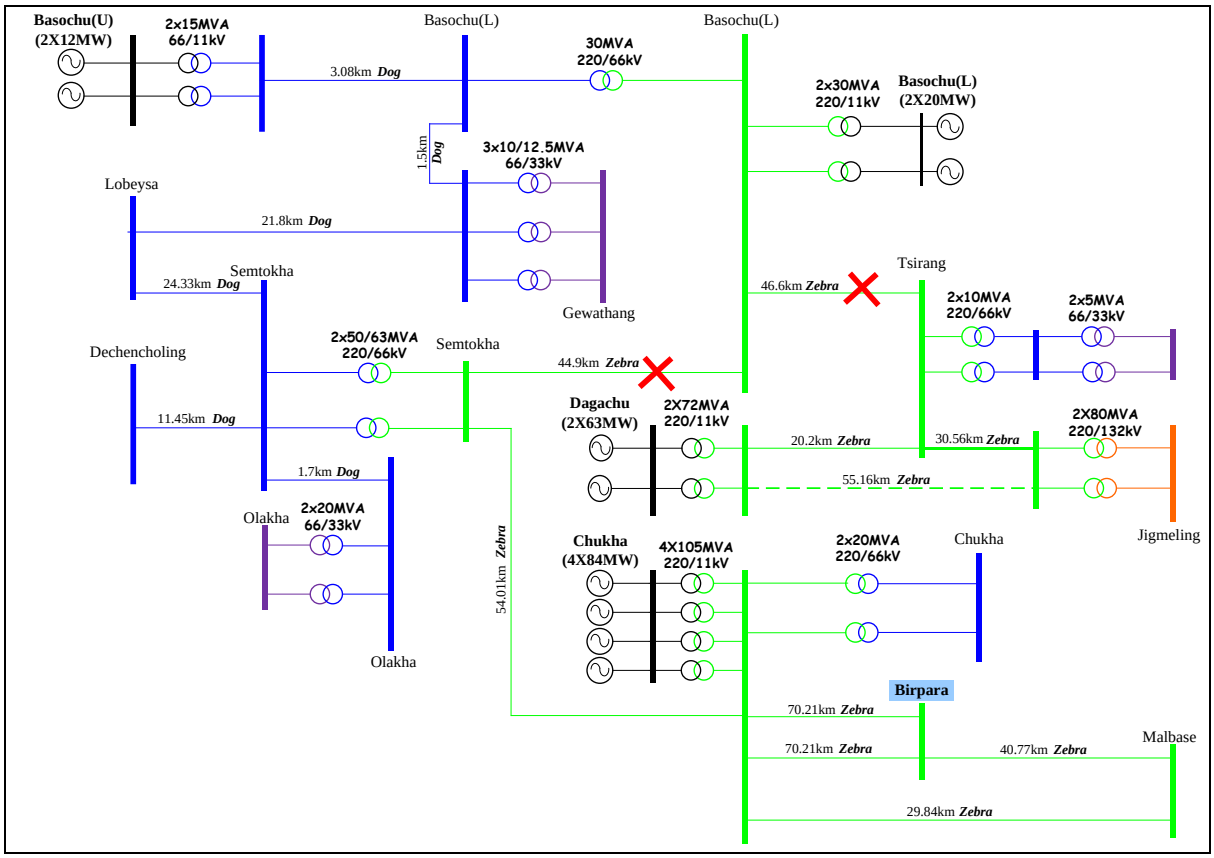
5.2 Failure of 220kV Rurichu-Semtokha and 220kV Rurichu-Tsirang Lines

If the 220kV Rurichu-Semtokha line fails along with the failure of 220kV Rurichu-Tsirang line, the System Operator shall instruct BHP to back down its generation till its total generation is equal to carrying capacity of the 66kV Rurichu-Lobeysa line during peak seasons.

System Operator shall instruct DHPC to back down its generation, if required, power flowing towards east should be such that 132 kV Jigmeling-Gelephu-Salakati section is not overloaded.

In such cases, if it leads to overloading of 132kV Nangkor-Deothang line, 132kV Nangkor-Nganglam or 132kV Nganglam-Tintibi shall be kept opened. Coincidentally, in such a case, if the Nganglam load (DCCL) is under shutdown, DHPC shall back down its generation.

After the clearance of faults on the above lines, the synchronization shall be carried out at BHP end.

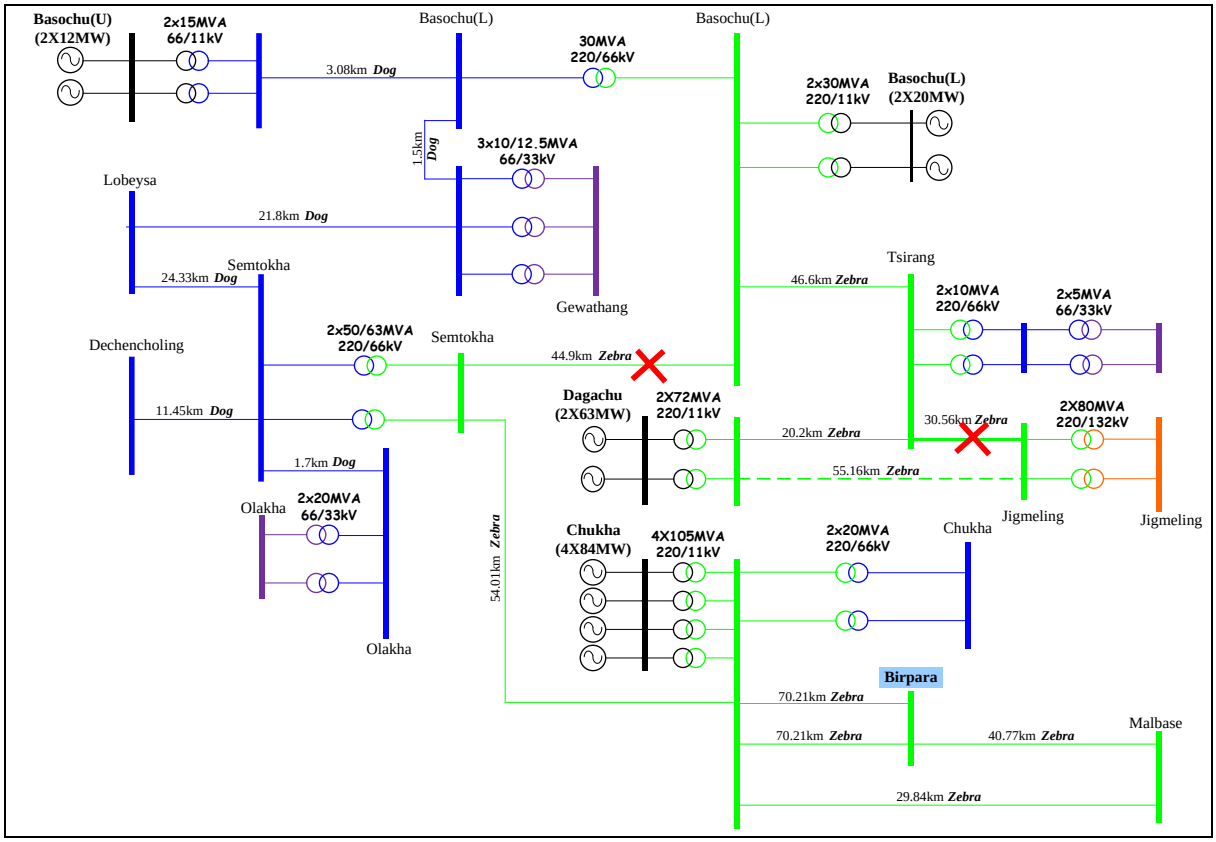


5.3 Failure of 220kV Rurichhu-Semtokha and 220kV Tsirang-Jigmeling Lines

If the 220kV Rurichhu – Semtokha line fails along with the failure of 220kV Tsirang – Jigmeling line, the System Operator shall instruct Dagachhu Hydropower Corporation Ltd. (DHPC) and BHP to back down its generation until its total generation is equal to power carrying capacity of the 66kV Rurichhu – Lobeysa line depending upon priority.

After the clearance of faults on the above lines, the line shall be closed at Jigmeling end. Similarly, for 220kV Rurichhu-Semtokha, it shall be closed at Rurichu end.

If 220kV Tsirang-Jigmeling could not be closed, 220kV BHP-Tsirang shall be kept opened at both ends after which 220kV Tsirang-Jigmeling shall be closed. DHPC shall then be synced at Tsirang end.



5.4 Failure of 220kV Chukha-Semtokha and 220kV Rurichhu-Tsirang lines

If 220kV Chukha-Semtokha line and 220kV Rurichhu-Tsirang line fails during the lean generation, Basochu pondage shall be utilized to meet the Thimphu load including the Lobeysa load.

5.4.1 Operation procedure for above line failure

The following procedure shall be followed:

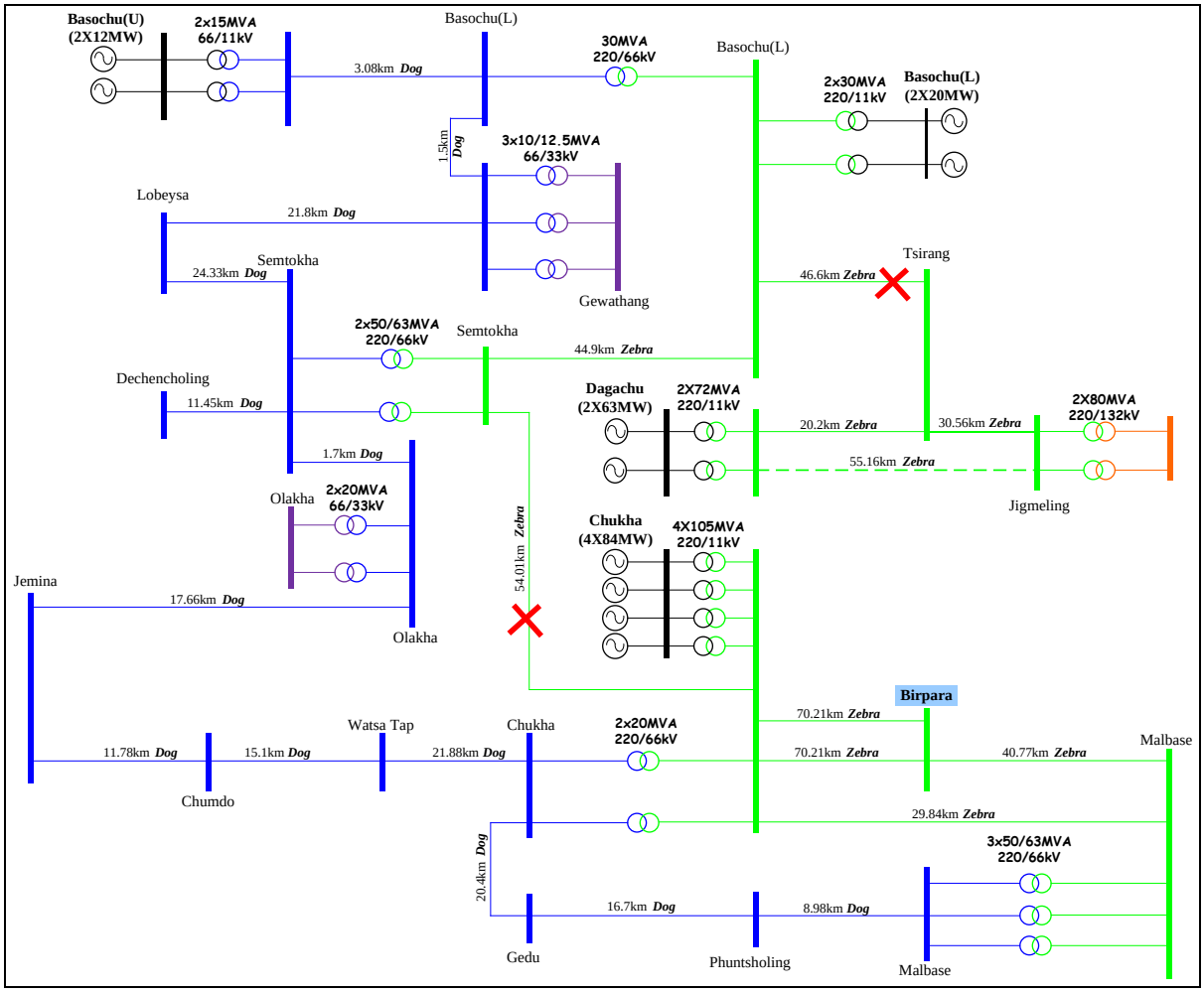
a. The System Operator shall coordinate with BHP to utilize the pondage for generation to meet the load of Thimphu. The prioritization of distribution feeder in Thimphu shall be carried out by Substation Maintenance Division (SMD), Semtokha in coordination with Electricity Services Division (ESD), Thimphu.

b. The System Operator shall coordinate with the shift in-charge of Semtokha, BHP and CHP to extend the BHP power supply to Chukha and synchronize at Chukha end once the 220kV Chukha-Semtokha line is restored.

c. Similarly, in case of 220kV Rurichu-Tsirang line, the line shall be closed at Rurichu end.

d. After synchronization, BHP shall refill the pondage immediately following the utilization, backing down the generation of the BHP lower stage.

e. BHP generation needs to back down its generation by 16-17MW to make the power flow in 66kV SEM-OLA to 30MW (CTR: 300/1A) depending on requirement.

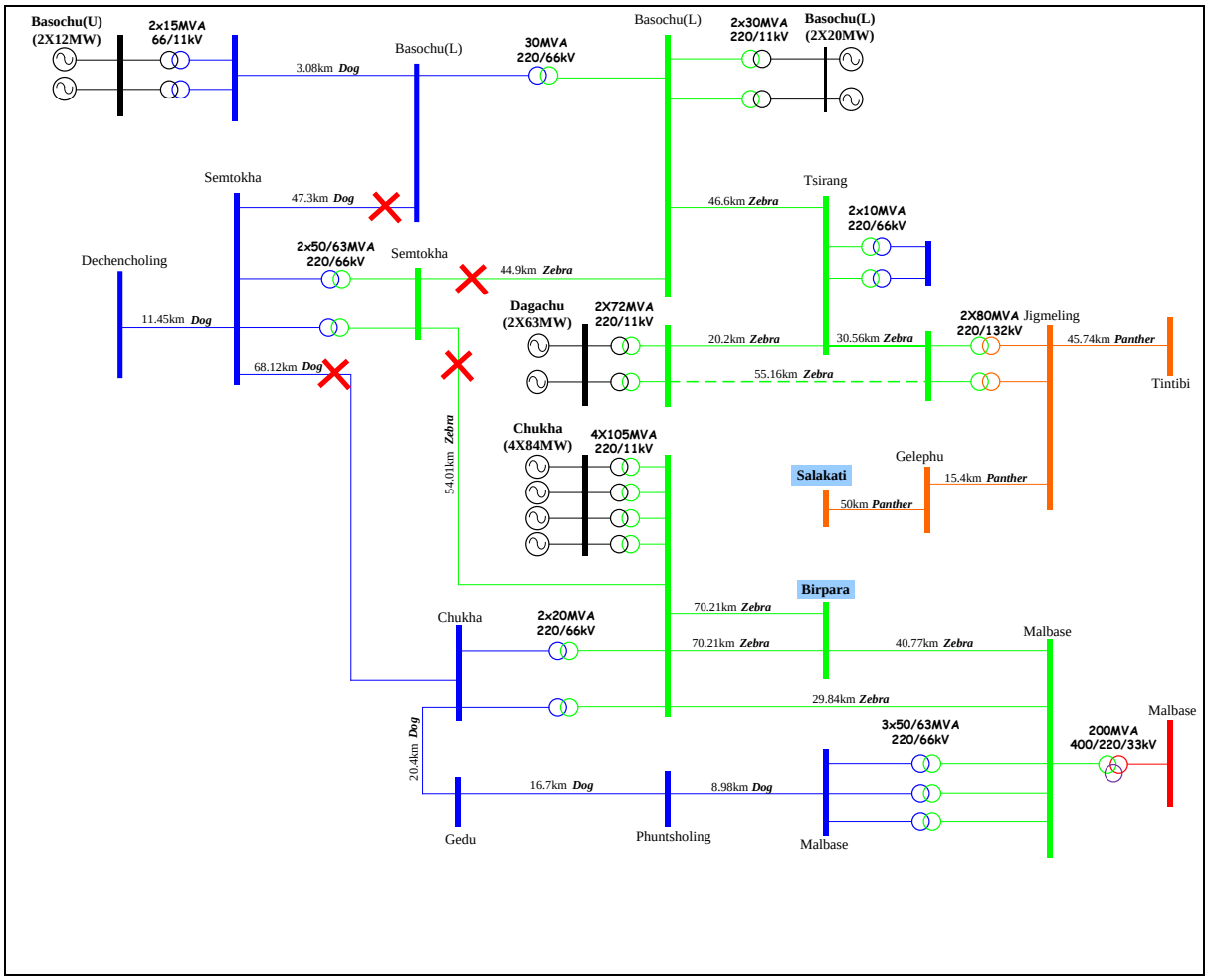


5.5 Western black out (Semtokha)

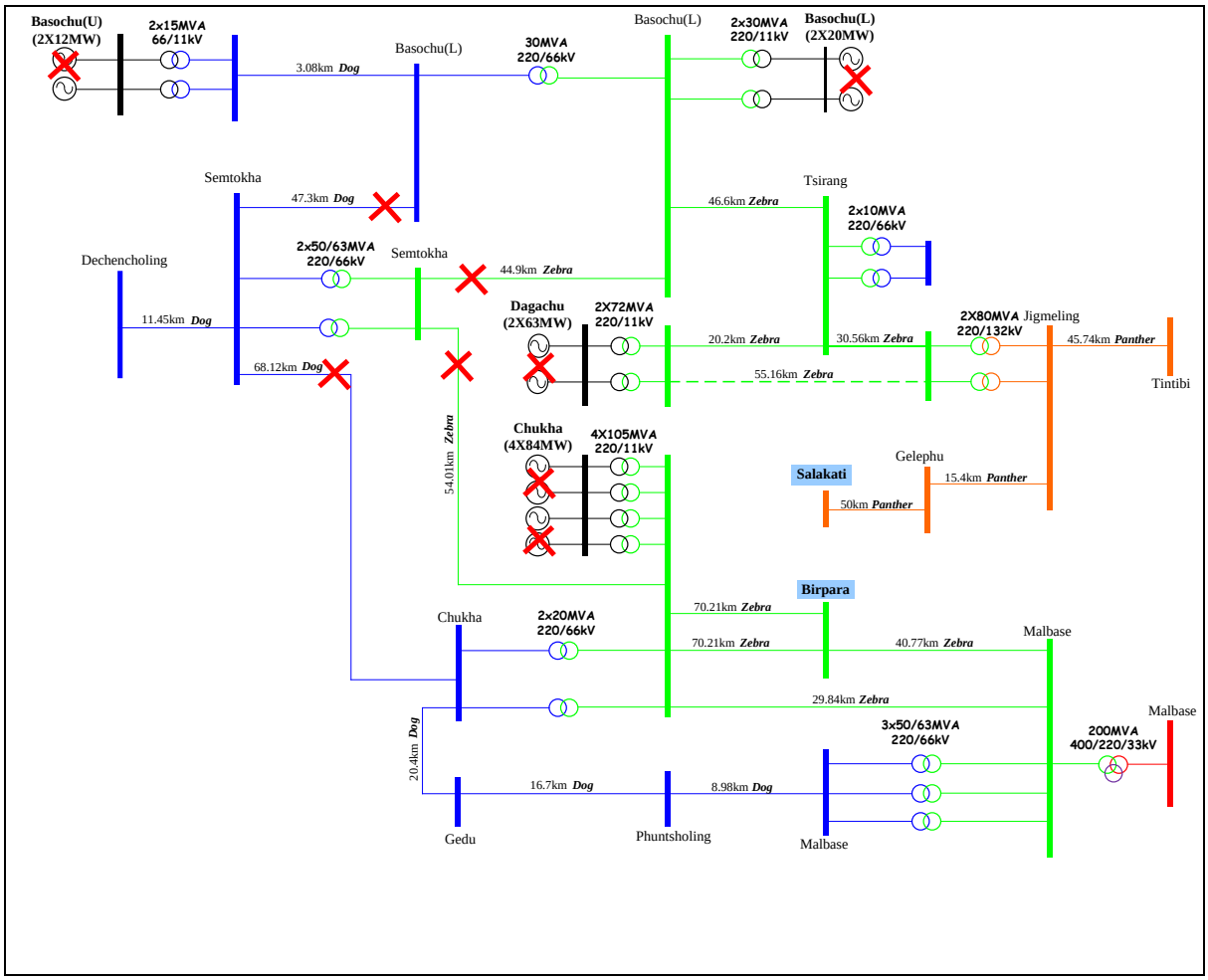
The western black out especially in Semtokha substation can be seen in different scenarios as explained below:

Scenario 1: Failure of 220kV and 66 kV lines to Semtokha with CHP intact

CHP shall immediately extend the grid supply to Semtokha considering the stability of the Indian grid and CHP. Then the supply shall be extended to BHP and synchronize with the grid at their end.


Basochu(U)
(2X12MW)
2x15MVA
66/11kV
3.08km Dog
Basochu(L)
30MVA
220/66kV
Basochu(L)
2x30MVA
220/11kV
Basochu(L)
(2X20MW)
Semtokha
47.3km Dog
Tsirang
46.6km Zebra
2x10MVA
220/66kV
Dechencholing
2x50/63MVA
220/66kV
Semtokha
44.9km Zebra
11.45km Dog
Dagachu
(2X63MW)
2X72MVA
220/11kV
20.2km Zebra
30.56km Zebra
2X80MVA
220/132kV
Jigmeling
45.74km Panther
Tintibi
68.12km Dog
55.16km Zebra
54.01km Zebra
Chukha
(4X84MW)
4X105MVA
220/11kV
Gelephu
Salakati
15.4km Panther
50km Panther
Birpara
70.21km Zebra
Chukha
2x20MVA
220/66kV
70.21km Zebra
40.77km Zebra
Malbase
29.84km Zebra
Malbase
3x50/63MVA
220/66kV
200MVA
400/220/33kV
20.4km Dog
16.7km Dog
8.98km Dog
Gedu
Phuntsholing
Malbase

Scenario 2: Failure of Birpara and Binaguri grid with THP, CHP, BHP and DHPC being pulled out



Option 1: The shift in-charge of BHP control room shall first try to get feedback supply from Eastern Grid/MHEP in coordination with System Operator. If power supply is available at Tsirang end, the power shall be extended directly to Semtokha substation, before initiating to normalize BHP machines. Simultaneously, the power from India shall be also extended to CHP and synchronized. BHP machines shall be connected to the grid once the supply is extended to Semtokha substation. The supply shall be further extended to CHP for synchronization with Western Grid.

Option 2: BHP shall immediately extend the supply to Semtokha substation. The shift in-charge of Semtokha substation shall ensure that the loads are gradually applied in consultation with the shift in-charge of BHP. After the complete restoration of power supply to Thimphu, the power shall be extended to CHP depending on the availability of the lines for synchronization at their end. Simultaneously, the power from India shall be also extended to CHP and synchronized.

Option 3: In case of Indian Grid failure with CHP or BHP being pulled out, the shift in-charge of CHP control room shall first try to get feedback supply from Indian Grid. If power supply is available at Birpara end, the power shall be extended directly to Semtokha substation, before initiating to normalize CHP's machines. CHP machines shall be connected to the grid once the supply is extended to Semtokha substation. The supply shall be further extended to BHP for synchronization with Eastern Grid.

Scenario 3: CHP, BHP and DHPC with Tala intact

Basochu shall extend the power supply to Semtokha and simultaneously power from Malbase shall be extended to Chukha and sychronized. After the restoration of power supply to Thimphu, the power shall be further extended to Chukha and synchronized. Here, BHP is presumed to be running in isolation mode. After extending the power to Semtokha, the same shall be extended to Tsirang and then further to Dagachu.

5.6 Failure of any one of 220kV Chukha-Birpara lines during the peak generation

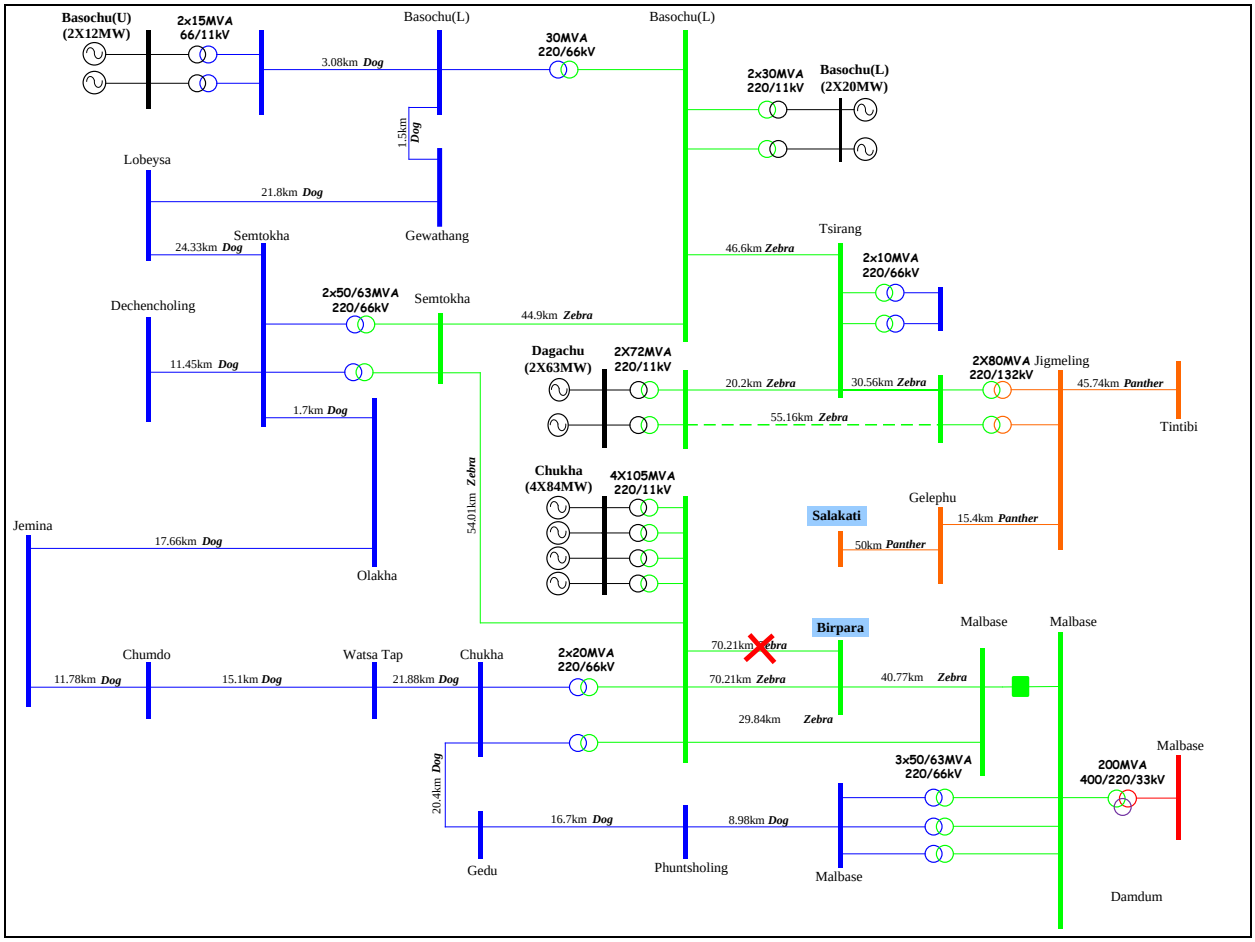
During the peak generation, when one of the 220kV Chukha-Birpara feeder trips, the 220kV bus coupler at Malbase substation shall automatically open by inter-tripping protection scheme for equal sharing of load between the 220kV Chukha-Birpara line and 220kV Chukha-Malbase-Birpara line. However, this scheme shall be disabled during lean season as per the instruction of the System Operator. In general, the following procedures shall be followed:

a. Immediately after the tripping of one of the 220kV Chukha-Birpara lines, the System Operator shall inform the shift in-charge of Malbase substation regarding the failure of the line.

b. If the de-coupling of 220kV bus coupler at Malbase leads to overloading of 66kV Chukha-Gedu line, the shift in-charge of Phuentsholing substation shall open the 66kV Phuentsholing-Malbase line.

c. After the normalization of the 220kV Chukha-Birpara line, System Operator shall instruct the shift in-charge of Malbase substation to close the 220kV bus coupler.

d. System Operator shall instruct the shift in-charge of Phuentsholing substation to close the 66kV Phuentsholing-Malbase line after closing the 220kV bus coupler at Malbase.



5.7 Failure of 220kV D/C Chukha-Birpara lines

The maximum power which can be loaded from the 220 kV Chukha-Malbase line, Zebra Conductor is nearly 200MW considering the current carrying capacity of 600 Amperes as per the CT setting and power factor of 0.9. The following will be applied, depending on the functioning of generation load reduction scheme.

5.7.1 Operation procedure for above line failure

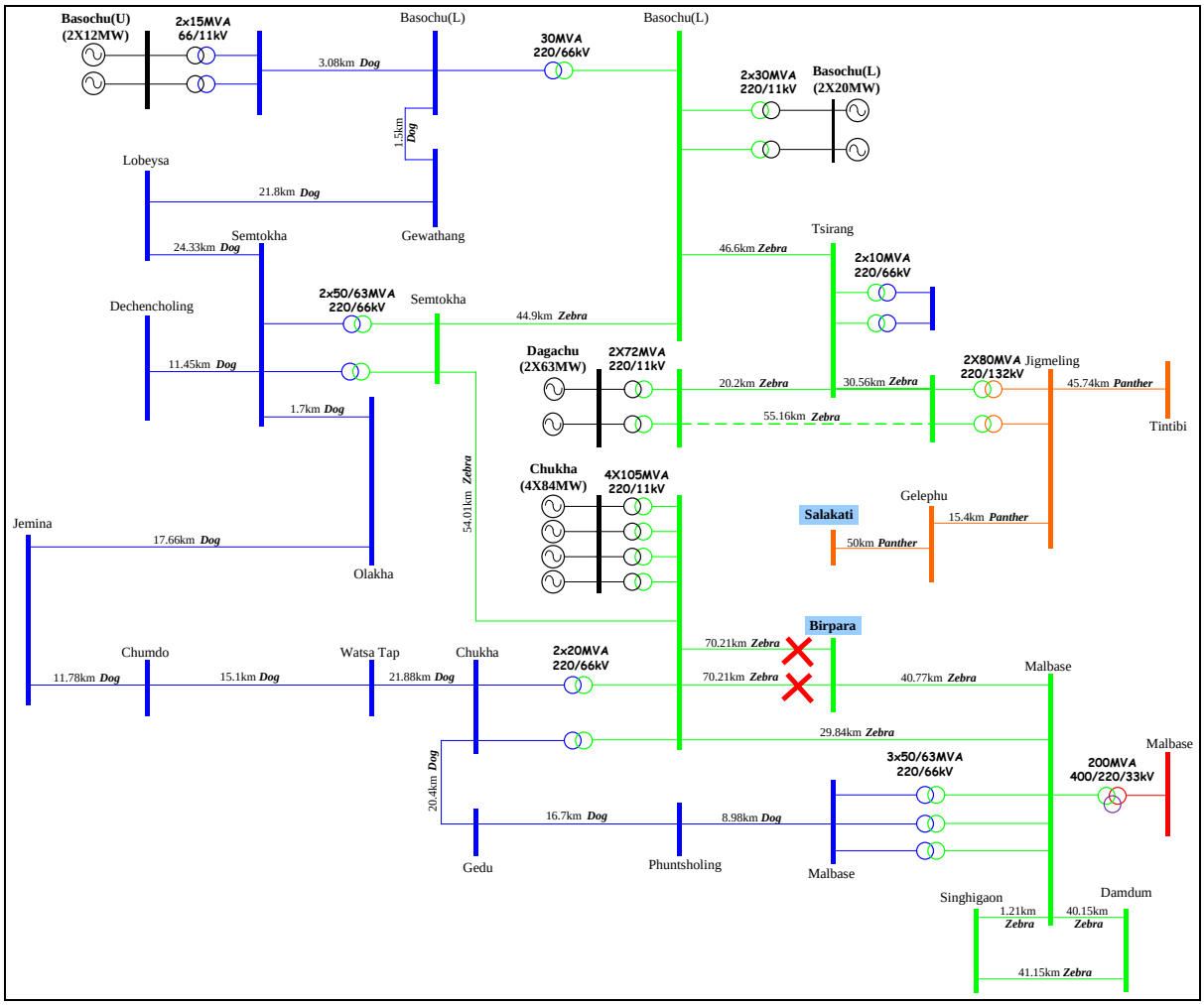
During peak generation, if 220kV D/C Chukha-Birpara line trips, the units of CHP shall trip on over frequency. Until the restoration of 220kV D/C Chukha-Birpara lines, the following procedure shall be followed:

a. The System Operator shall inform the Shift In-charge of CHP, BHP and DHPC regarding the failure of the above lines and instruct CHP and BHP and DHPC to reduce their generation based on priority and ensure that 132kV lines in the East is not overloaded.

b. Shift In-charge at CHP and System Operator shall maintain the total generation such that total power flow through 220kV CHP – Malbase line does not exceed 200MW and 30MW through 66kV Chukha – Phuentsholing line respectively.

c. After normalization of 220kV D/C Chukha – Birpara lines, the Shift In-charge of CHP shall inform System Operator regarding the normalization of lines. System Operator shall inform the BHP and DHPC.

Shift In-charge of CHP, BHP and DHPC may increase their respective generation gradually.



5.8 Total shutdown of KHP during peak season under normal system condition.

During the total shutdown of KHP, western power tends to flow towards the east and hence gets overloaded. In such scenario, 132kV Mat-Rangia line or any line, as per the instruction of the SO, shall be kept opened.

5.9 Utilization of 400/220kV ICT at Jigmeling

In the event of failure of either 132kV Gelephu-Salakati or 132kV Motanga-Rangia during the peak generation of KHP and DHP, 400/220kV ICT shall be utilized.