འབྲུག་གློག་ཤུགས་རིང་ལུགས་ལས་སྡེད།

Bhutan Power System Operator

གནས་ཤུགས་དང་རང་བཞིན་ཐོན་སྐྱེད་ལྷན་ཐག

Ministry of Energy and Natural Resources

Power System Operation Division

Bhutan Power System Contingency Plan and Operating Procedures

(Version 2026-1)

July 10, 2026

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1. Introduction

The **Bhutan Power System Contingency Plan & Operating Procedures** is a vital document that outlines the strategies and procedures for ensuring the reliability, security, and stability of the Bhutan power system network. This document provides a comprehensive overview of the measures to be taken in case of any contingency events, such as system failures, blackouts, and other unplanned disruptions in the power system. The objective of the Contingency Plan is to ensure the continuous supply of electricity to the customers while minimizing the impact of any disruptions on the system. The Bhutan power system network is constantly evolving, and new technologies, infrastructure, and equipment are being introduced, which can impact the stability of the system. As a result, it is essential that the Contingency Plan is updated regularly to reflect these changes and ensure that the operating procedures are in line with the latest network advancements.

This Contingency and Operating Procedures is for peak generation scenario from July to September 2026.

Assumption: 200MVA ICT at MHP is kept out of service for the simulation. The ICT has been out of service since 31st March, 2026 and will be remain out for nearly 9 months (As per 80th OCC). Additionally, the inter-tripping of 30MVA ICT at BHP during the tripping of 220kV BHP-Semtokha line is considered not operational. The inter-tripping scheme was once made functional, however, it is currently no functioning as intended (As per 80th OCC).

2. Contingency Ranking

To carry out the contingency analysis, it is important to first identify the critical elements in the network whose outage/shutdown would have an adverse effect on the system. The Single contingency RANK feature in PSSE software was used to ranked the critical elements. The RANK evaluates the severity of single branch outages and ranks them based on their impact in the grid. The expected load and the generation for July month has been considered to rank the contingencies. The contingency analysis was carried out and prepared the restoration procedures for smooth and faster restoration of power supply to affected areas/regions.

2.1. Contingency Ranking for Peak Generation 2026

The contingency ranking for peak generation scenario for 2026 (July to September) is illustrated in Figure *1*. The elements with the highest performance index (PI) value are the most critical elements in the system which will have adverse impact to the system such as overloading of other transmission elements, that will result blackout. The top 15 critical elements are identified through contingency ranking.

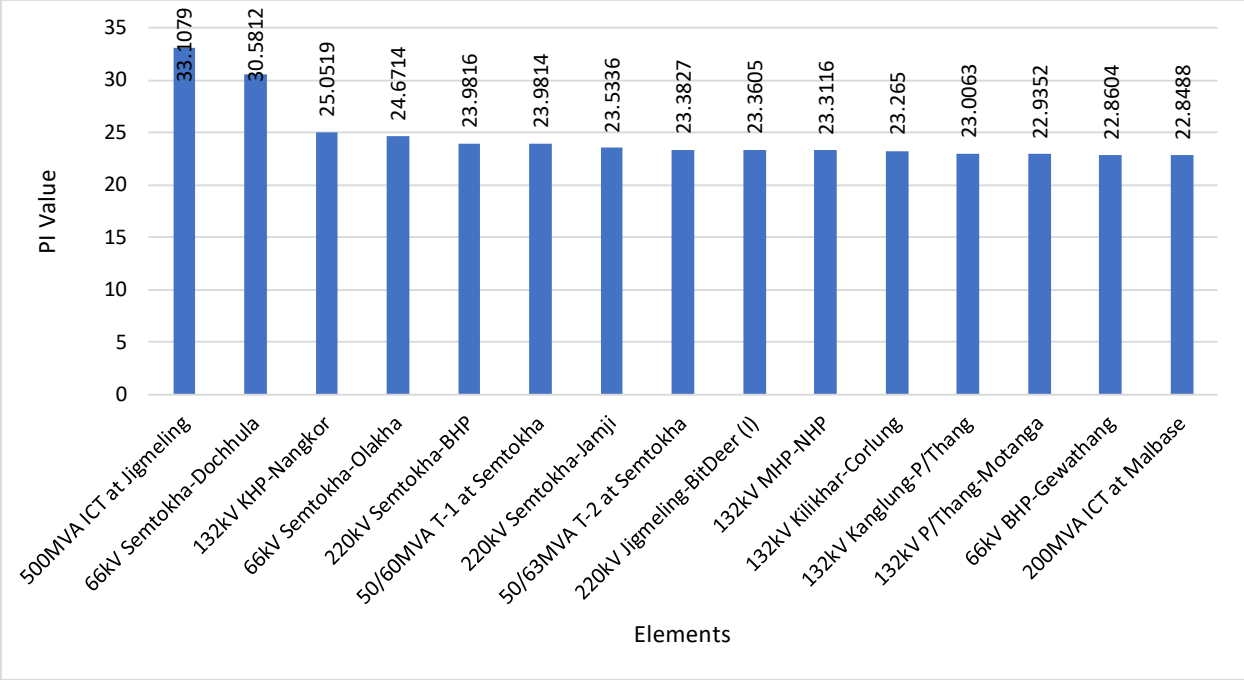

Figure 1: Contingency Ranking for July to September 2026

3. Analysis and Operating Procedures for N-1 Contingency during Peak Generation Scenario 2026

3.1. Contingency of 500MVA ICT at Jigmeling

During the outage/contingency of 400/220kV, 500MVA ICT at Jigmeling, most of the elements are getting overloaded and results in complete blackout. The loading of the elements for pre-and-post contingency of 500MVA ICT is shown in Figure *2*.

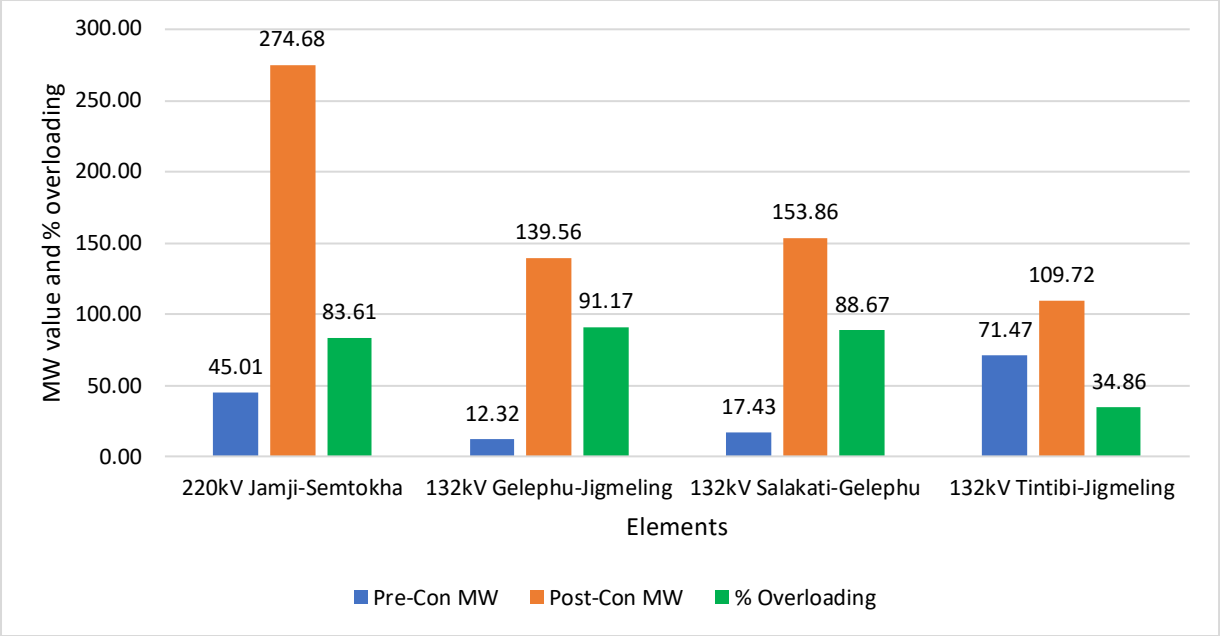

Figure 2: Elements loading during the contingency of 500MVA ICT at Jigmeling

A. Short-Term Solution

To avoid the overloading and cascading impact due to outage of 500MVA ICT at Jigmeling, the rapid load reduction of 200kV BitDeer substation was implemented as the short-term solution. The moment ICT tripping, 2x220kV Jigmeling-BitDeer lines and 3x100MVA transformers at 220kV BitDeer substation will get tripped as shown in Figure *3*.

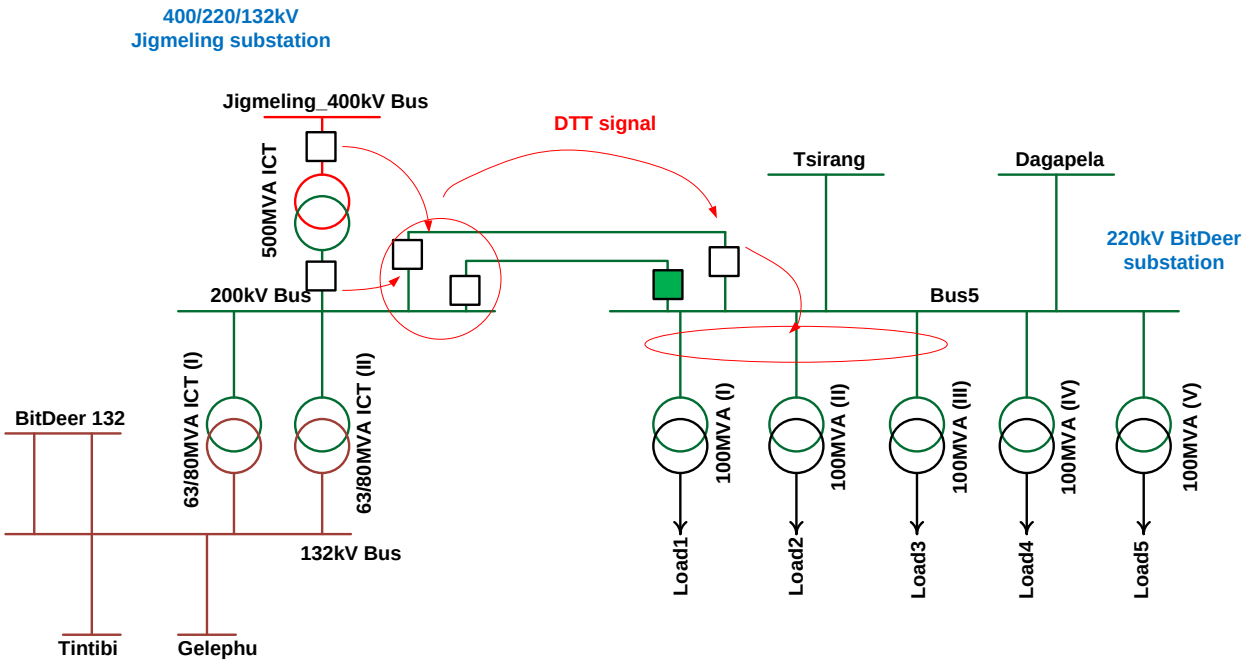

Figure 3: Rapid load reduction at 220kV BitDeer substation during contingency of 500MVA ICT at Jigmeling

Following procedures will be followed by System Operator to restore the system:

i. Closed 500MVA ICT at Jigmeling.
ii. Closed 2x220kV Jigmeling-BitDeer lines.
iii. Closed 3x100MVA transformers at 220kV BitDeer substation and resume the load.

B. Dagachhu Generation < 63MW

In case, the Dagachhu generation is less than 63MW (only one unit in service), there is possibility that 132kV Salakati-Gelephu-Jigmeling lines and 132kV Tintibi-Jigmeling line will get overloaded and tripped during the outage of 500MVA ICT at Jigmeling. This will result blackout of Gelephu and 132kV BitDeer substation.

Following procedures will be followed by System Operator to restore the power supply:

i. Closed 500MVA ICT at Jigmeling;
ii. Closed 2x220kV Jigmeling-BitDeer lines.
iii. Closed 132kV Salakati-Gelephu-Jigmeling lines.
iv. Closed 132kV Tintibi-Jigmeling line.
v. Closed 3x100MVA transformers at 220kV BitDeer substation and resume the load.
vi. Resume load at 132kV BitDeer substation.

3.2. Contingency of 66kV Semtokha – Dochhula line

The outage of 66kV Semtokha-Dochhula line will result in overloading of 220/66kV 30MVA ICT at BHP, 66kV BHP-Gewathang-Lobeysa-Dochhula, thereby causing power outage in Gewathang, Lobeysa, and Dochhula substation. Additionally, the 9MWp Sephu solar generation that is being evacuated to Gewathang substation will be affected. Figure *4* illustrates the overloading of transmission elements during the outage of 66kV Semtokha-Dochhula line.

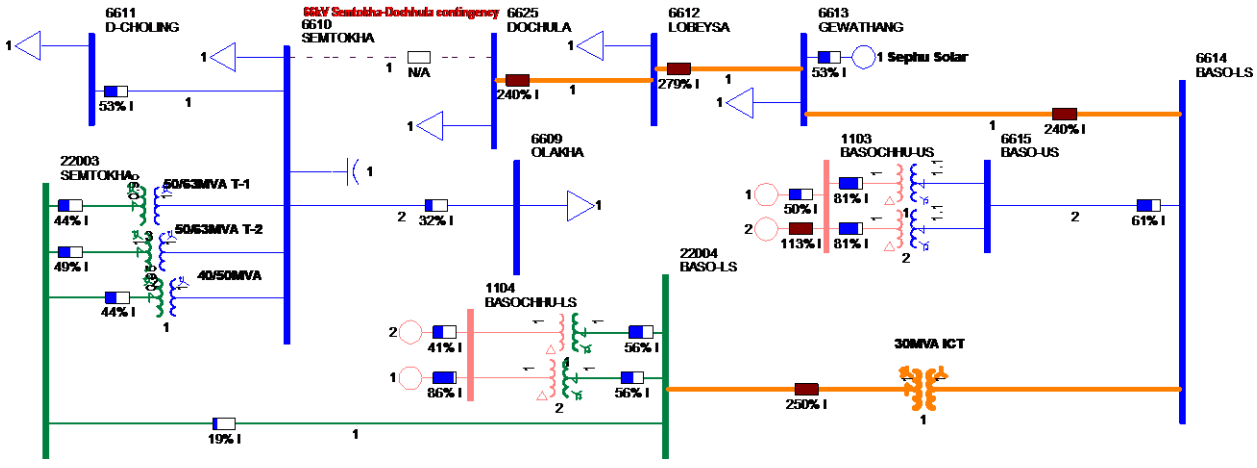

Figure 4: Network diagram showing outage of 66kV Semtokha-Dochhula line

A. Short-Term Solution

The overcurrent (O/C) protection settings at Lobeysa substation for Dochhula line has set at 250A, where the line will trip the moment power flow exceed 20MW, thereby preventing overloading of 30MVA ICT at BHP and 66kV BHP-Gewathang-Lobeysa line. The Dochhula substation will experience momentary blackout.

Following restoration procedures will be followed by System Operator to restore the power supply:

i. Close 66kV Semtokha-Dochhula line.
ii. Close 66kV Lobeysa-Dochhula line.
iii. Resume load at Dochhula substation.

3.3. Contingency of 66kV Semtokha – Olakha line

During the contingency of 66kV Semtokha-Olakha line, the 66kV Jemina-Changedaphu line, 66kV Jamji-Jemina line, and 2x30MVA transformers at Jamji substation will get overloaded. The overloading and tripping of these elements will result power disruption in Olakha, Changedaphu, Jemina, Pangbisa, Haa, and Paro substation. The Figure *5* illustrates the overloading of elements during the outage of 66kV Semtokha-Olakha line.

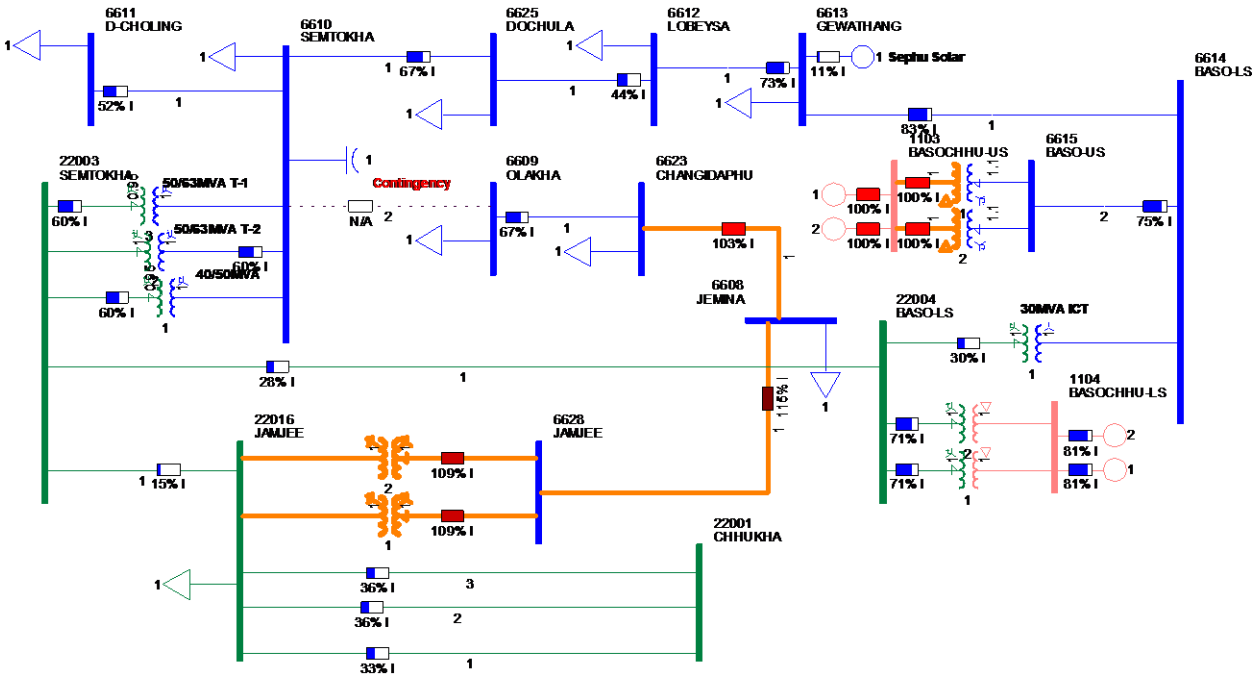

Figure 5: Network diagram showing outage of 66kV Semtokha-Olakha line

System Operator shall immediately check and confirmed the circuit breaker (CB) status of 220/66kV, 2x30MVA transformers at Jamjee substation. If CBs of that transformer remains intact, **follow the following sequence for faster restoration and avoid tripping on overloading**.

i. Test charge the 66kV Semtokha-Olakha line. If test charge is successful, the power supply to the affected regions will be restored.

ii. If test charge of 66kV Semtokha-Olakha line is unsuccessful, and all CBs of 2x30MVA transformers at Jamji has been operated, manually OPEN 66kV Jamji-Pangbisa line at Jamjee end and closed 2x30MVA transformers at Jamji, thereby restoring power supply to Jemina, Changedaphu, and Olakha.

iii. If the loading of 2x30MVA transformers at Jamji is below 55MW, extend the supply to Pangbisa and Haa by closing 66kV Jamji-Pangbisa line at Jamji end.

iv. If the loading in 2x30MVA transformers at Jamji is more than its capacity during the prolonged outage of 66kV Semtokha-Olakha line, the load shedding shall be carried out from Paro in coordination with Paro substation and ESD-Paro. The priority shall be given to residential loads.

3.4. Contingency of 220kV Semtokha – BHP line

The outage/contingency of 220kV Semtokha-BHP line will result overloading of 66kV BHP-Gewathang-Lobeysa lines. This will result supply interruption in Gewathang substation and also the evacuation of Sephu solar plant (9MWp).

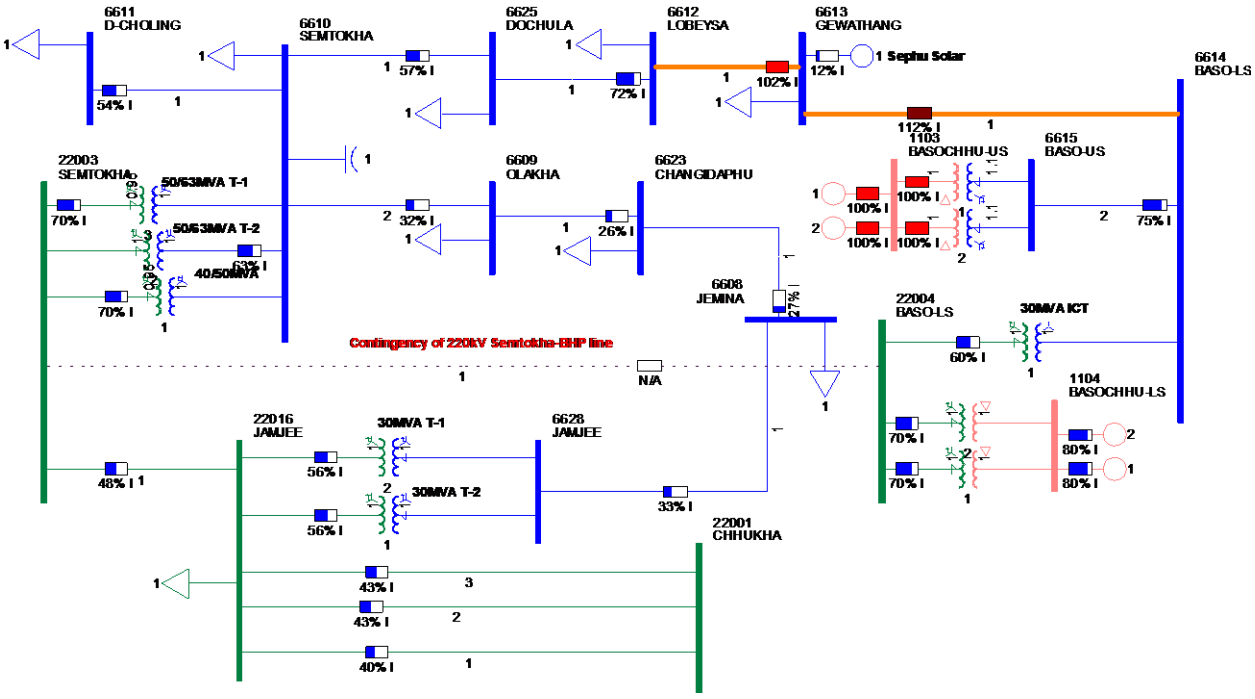

Figure 6: Network diagram showing outage of 220kV Semtokha-BHP line

During the outage of 220kV Semtokha-BHP line, the 66kV BHP-Gewathang-Lobeysa lines will get overloaded and tripped resulting further cascading overloading of 66kV Semtokha-Dochhula line. The BHP upper stage generation will evacuated via 30MVA ICT and 220kV BHP-Tsirang line.

Following procedures will be followed by the System Operator to restore the power supply:

i. Dochhula load will become zero during the blackout and should not be connected until all 66kV lines are charged.
ii. Closed 66kV Semtokha-Dochhula lines, 66kV BHP-Gewathang-Lobeysa-Dochhula lines section.
iii. Hand-trip 30MVA ICT at BHP (BHP upper stage generation will be evacuated via 66kV lines).
iv. Resume Dochhula load.

Note:

During the planned shutdown of the 220kV Semtokha-BHP line, first the 30MVA ICT will opened and then the 220kV Semtokha-BHP line to avoid the overloading of 66kV lines from BHP till Dochhula.

3.5. Contingency of 50/63MVA Transformer at Semtokha

The outage of one of the 50/63MVA transformer at Semtokha substation will caused overloading of another 40/50MVA transformer as shown in Figure 7. This will result cascading overloading and blackout.

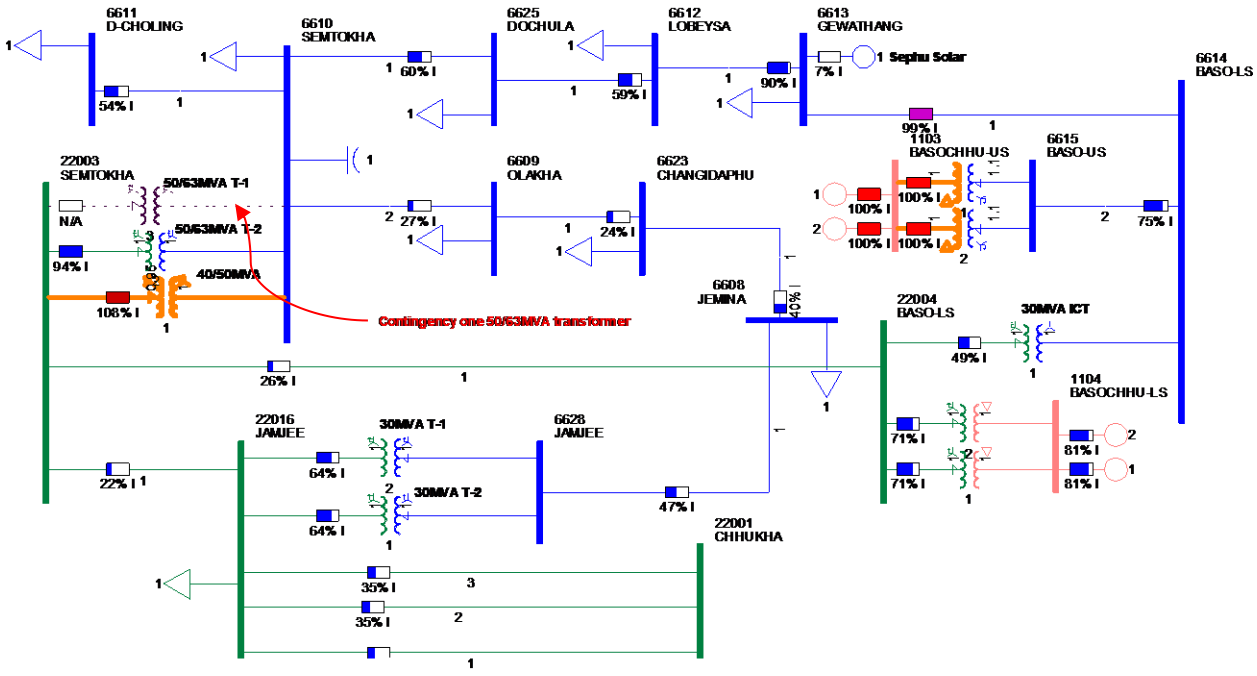

Figure 7: Network diagram showing outage of one of 50/63MVA transformer at Semtokha

A. Short term solution:

At Semtokha substation, the inter-tripping scheme has been implemented at both Semtokha and Lobeysa substation. The 66kV Semtokha-Dochhula will trip from Semtokha end and 66kV Lobeysa-Dochhula line will trip from Lobeysa end resulting momentary blackout of Dochhula substation.

Following procedures will be followed by System Operator to restore the power supply:

i. Close 50/63MVA transformer at Semtokha substation (Which was tripped)
ii. Close 66kV Semtokha-Dochhula line.
iii. Resume Dochhula load.

During the prolonged outage of the 50/63MVA transformer, the load shedding will be done from Dochhula substation to prevent continuous overloading of another transformer. The total Dochhula load shall be maintained below 40MW.

3.6. Contingency of 220kV Jigmeling-BitDeer line

The outage/contingency of 220kV Jigmeling-BitDeer line will result overloading of another 220kV Jigmeling-BitDeer line as shown in Figure *8*. The power flow will exceed the carrying capacity of the transmission line. During the prolonged outage of one of the 220kV Jigmeling-BitDeer line, the load at 220kV BitDeer substation will be maintained less than 155MW. The load shedding will enable to maintain the loading of another 220kV Jigmeling-BitDeer line within the limit.

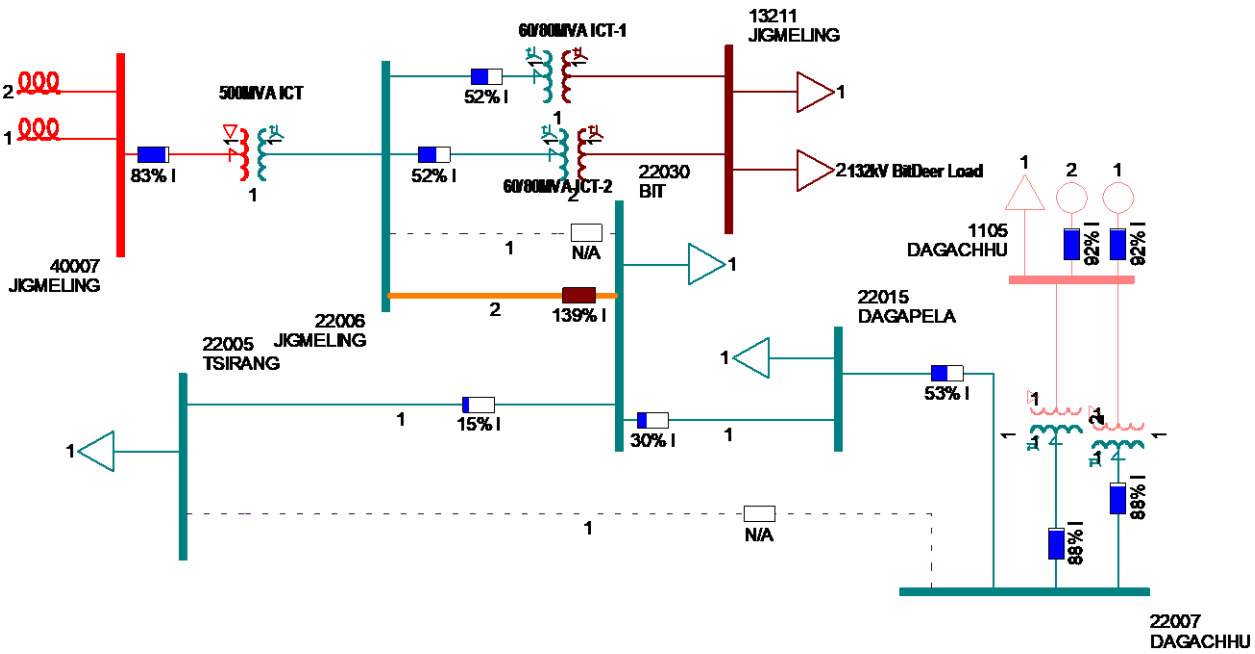

Figure 8: Network diagram showing outage of 1x220kV Jigmeling-BitDeer line

3.7. Contingency of 220kV BitDeer-Dagapela line

During normal system condition, the 220kV DHP-Tsirang line will remain open and 220kV DHP-Dagapela-BitDeer lines section will kept closed as illustrated in Figure *9*. This arrangement is mainly to prevent overloading of 500MVA ICT Jigmeling and enable more load drawl by BitDeer.

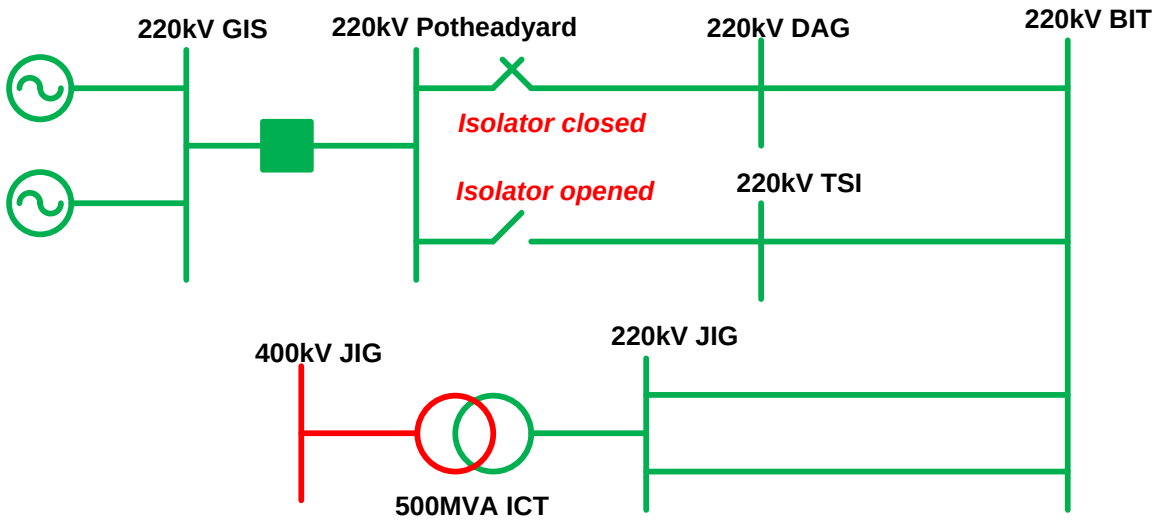

Figure 9: Connection of DHP during normal system condition

During the outage of 220kV BitDeer-Dagapela line, the Dagapela substation and DHP will be interrupted. In the event of prolonged outage, both 220kV Tsirang and Dagapela lines from DHP will be put into service as illustrated in Figure *10*.

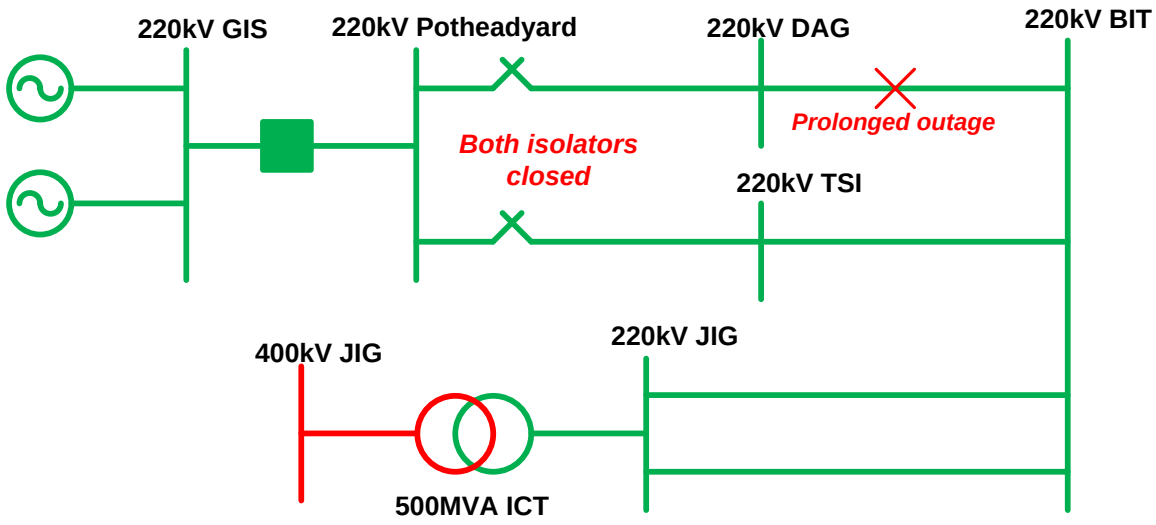

Figure 10: Connection of DHP during prolonged outage of 220kV BitDeer-Dagapela line

Following procedures will be followed by System Operator to restore the power supply:

i. Test charge the 220kV BitDeer – Dagapela line. If test charging is successful and withstand, extend the supply to DHP and synchronize DHP machines.

ii. If test charge is not successful due to permanent fault and prolonged outage, System Operator shall immediately instruct DHP to connect both 220kV Tsirang and Dagapela lines by closing line isolators.

3.8. Contingency of 132kV Jigmeling-Tintibi line

The outage of 132kV Jigmeling-Tintibi line in the absence of ICT at MHP, the 132kV Motanga-Rangia and 132kV Burgangchhu-Panbang-Nanglam lines will get overloaded as shown in Figure *11*. It will get tripped on thermal overcurrent protection and resulted blackout in whole eastern region, affecting loads and generation from Nikachhu, Kurichhu, Burgangchhu, and Yungichhu.

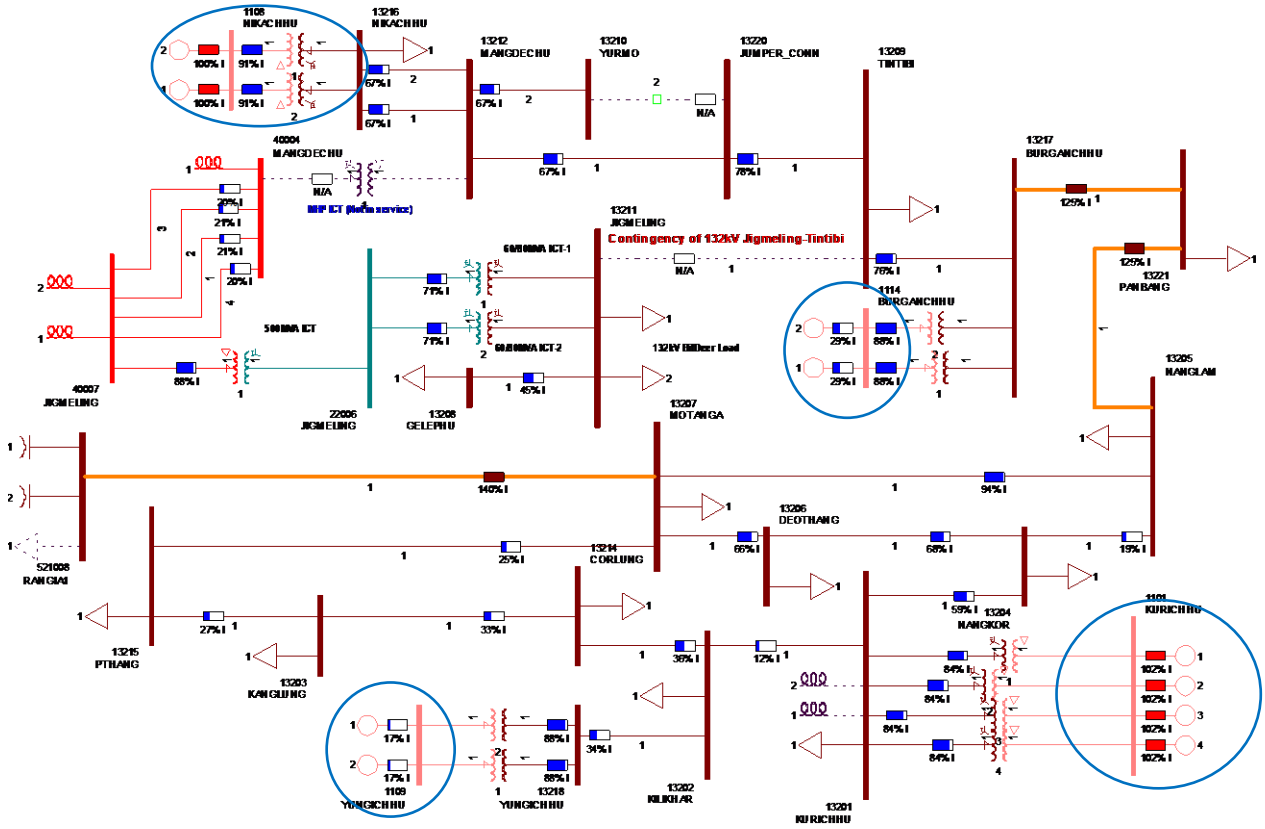

Figure 11: Network diagram showing outage of 132kV Jigmeling-Tintibi line

Following procedures will be followed by System Operator to restore the power supply:

i. Close 132kV Motanga-Rangia line as soon as possible in coordination with NLDC India.

ii. Side by side, the closing of 132kV Jigmeling-Tintibi line must be attempted.

iii. If (i) & (ii) are successful, restore the generating plants that might have tripped during the outage of 132kV Jigmeling-Tintibi and 132kV Motanga-Rangia lines.

iv. If there is permanent fault in 132kV Jigmeling-Tintibi line, the generation from Kurichhu can be backdown to maintain the loading of 132kV Motanga-Rangia line within thermal limit of around 96MW.

3.9. Contingency of 132kV Burgangchhu-Panbang line

During the contingency of 132kV Burgangchhu-Panbang line, the 132kV Tintibi-Jigmeling line get overloaded and trip resulting blackout of Tintibi and Yurmo along with Burgangchhu and Nikachhu generation as illustrated in Figure *12*.

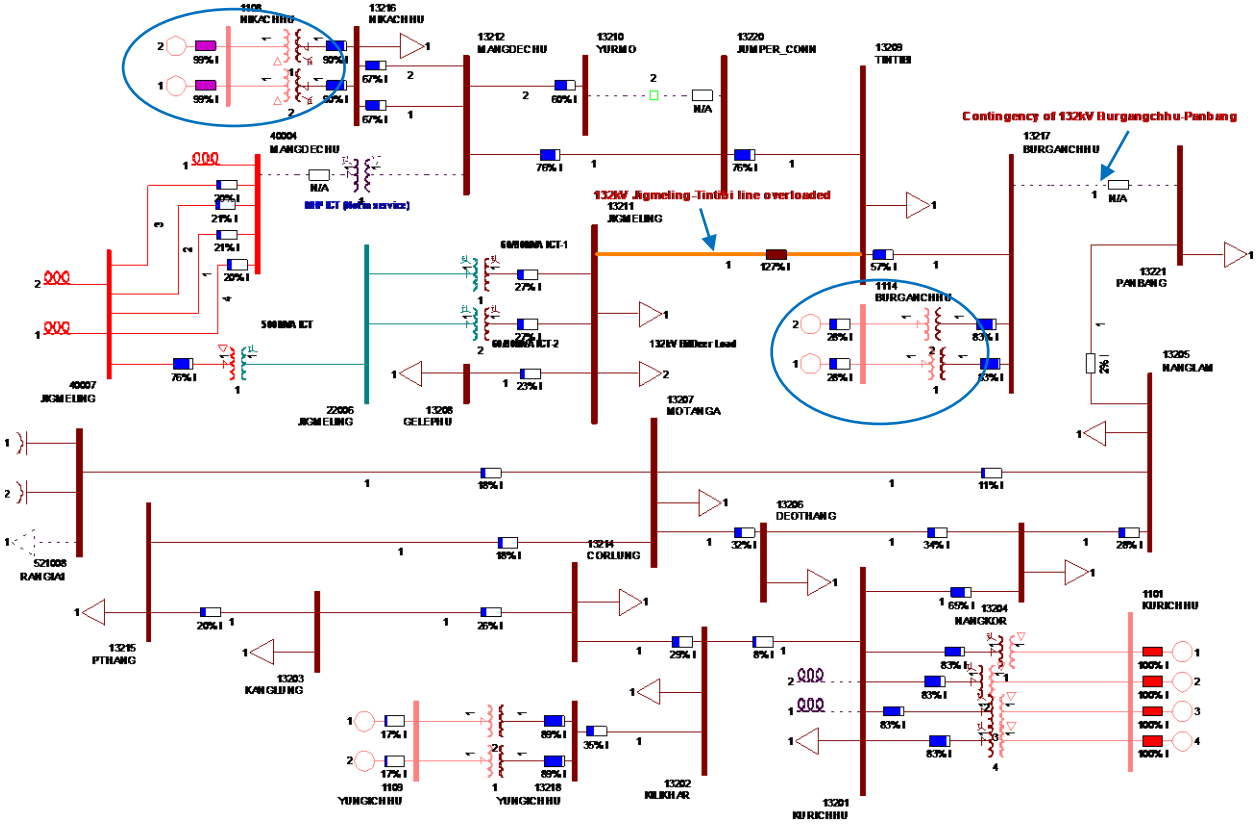

Figure 12: Network diagram showing outage of 132kV Burgangchhu-Panbang line

Following procedures will be followed by System Operator to restore the power supply:

i. Immediately charge the 132kV Jigmeling-Tintibi line.
ii. Extend power supply to Burgangchhu and synchronize the one of the Burgangchhu machines. The Burgangchhu should run only one machine until 132kV Burgangchhu-Panbang line is restored.
iii. Extend power supply to Yurmo and then to Nikachhu and synchronize Nikachhu machines. Side by side, resume GDL load of Samcholing to full load.
iv. Test charge the 132kV Burgangchhu-Panbang line. It test charging withstand, the grid is normalized.

v. If (v) is not successful due to permanent fault (prolonged outage), the generation from Nikachhu and Burgangchhu shall be back down and maintain loading of 132kV Jigmeling-Tintibi line within the limit.

4. Analysis and Operating Procedures for N-2 Contingency during Peak Generation Scenario 2026

4.1. Contingency of 66kV Semtokha-Olakha and 66kV Semtokha-Dochhula lines

The outage of 66kV Semtokha-Olakha and 66kV Semtokha-Dochhula at same time will caused overloading of 66kV BHP-Gewathang-Lobeysa-Dochhula lines and 30MVA ICT at BHP as shown in Figure *13*.

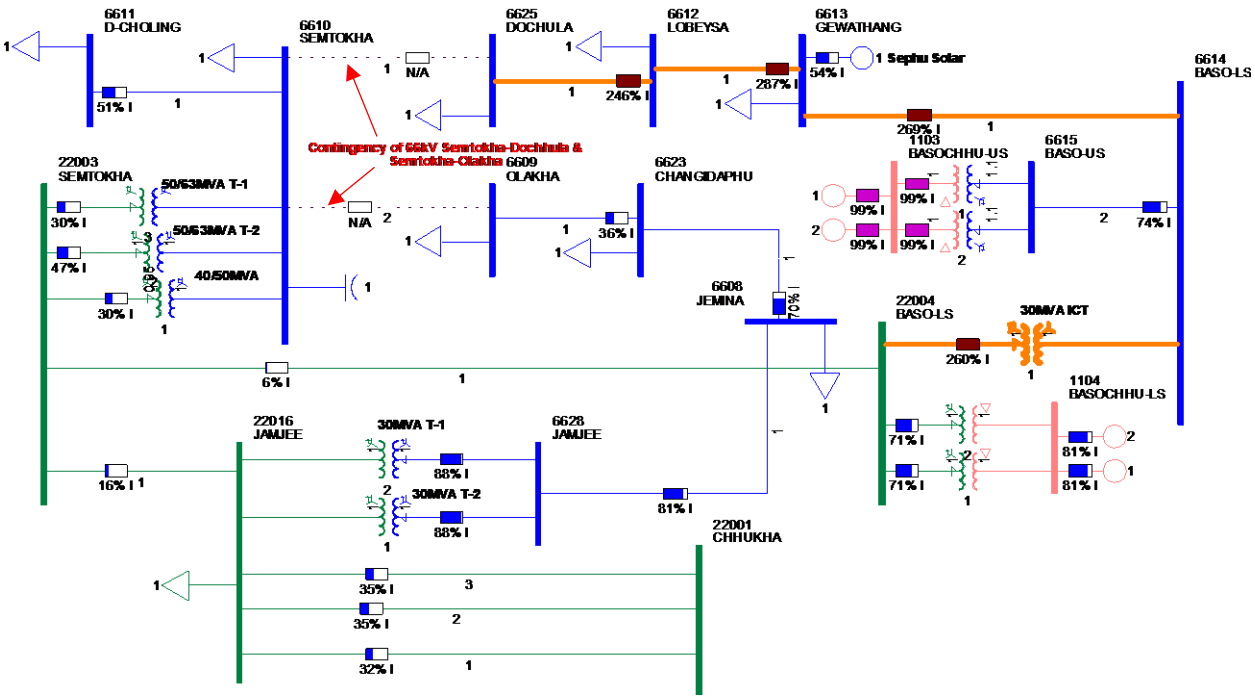

Figure 13: Network diagram showing outage of 66kV Semtokha-Dochhula and 66kV Semtoka-Olakha lines

Based on overcurrent protection setting implemented at Lobeysa substation for 66kV Lobeysa-Dochhula line, it will trip and the Dochhula substation will be blackout momentarily.

Due to outage of 66kV Semtokha-Olakha lines, the 2x30MVA transformers at Jamji will get overloaded and trip causing blackout in Paro, Haa, Pangbisa, Jemina, Changedaphu, and Olakha.

Following procedures will be followed by System Operator to restore the power supply:

i. Maintain Dochhula load zero until 66kV Semtokha-Dochhula and 66kV Lobeysa-Dochhula are restored.
ii. Closed 66kV Semtokha-Dochhula and 66kV Lobeysa-Dochhula lines.
iii. If 66kV Semtokha-Dochhula line has permanent fault and remain out of service for longer time, load shedding will be carried out from Dochhula substation and maintained below 20MW.
iv. In the event of prolonged outage of 66kV Semtokha-Olakha line, follow the restoration procedures outlined in (4.3) above.

4.2. Contingency of 220kV Semtokha-Jamji and 220kV Semtokha-BHP line

The outage of 220kV Semtokha-Jamji and 220kV Semtokha-BHP lines will result overloading of multiple transmission elements and caused blackout in Thimphu including Wangduephodrang, Punakha, Paro, Haa, and Gasa region. Figure *14* illustrates the overloading of the elements and the affected regions.

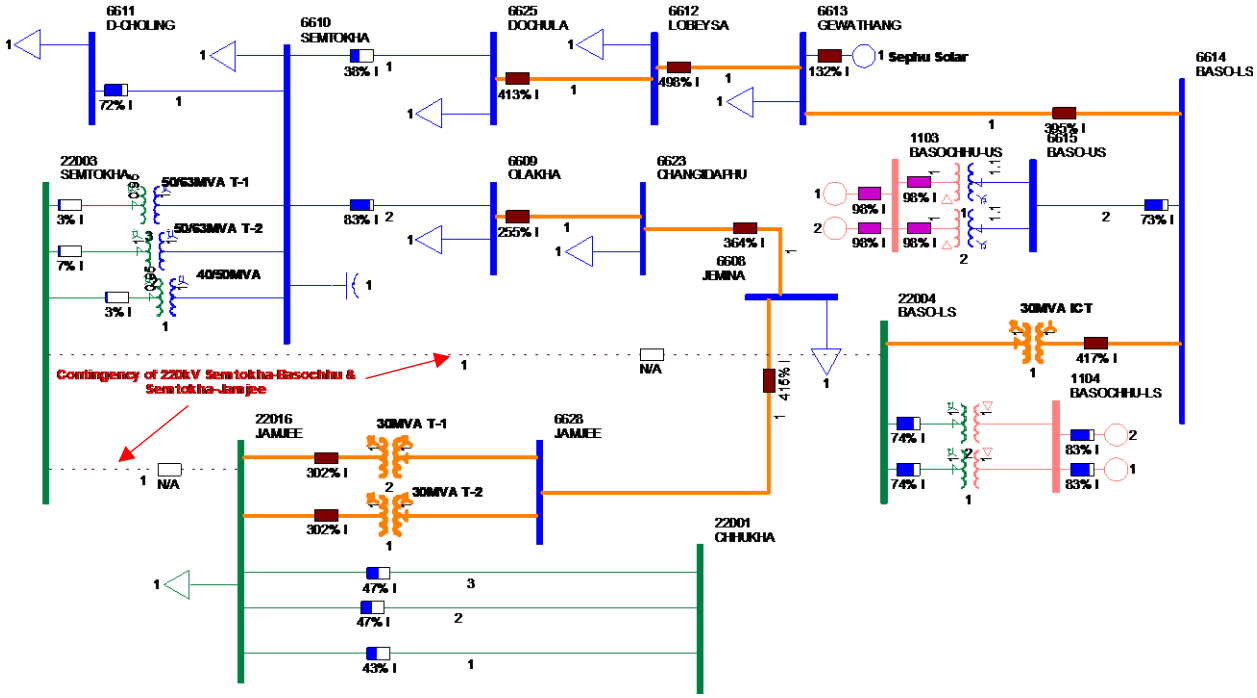

Figure 14: Network diagram showing outage of 220kV Semtokha – Jamji and 220kV Semtokha – BHP lines

Following procedures will be followed by System Operator to restore the power supply:

i. Test charge immediately 220kV Semtokha-Jamji line. If withstand test charge, the power supply to the affected regions will be restored.
ii. If (i) failed, test charge 220kV Semtokha-BHP line. If withstand test charge, the power supply to the affected regions will be restored.
iii. If both 220kV lines couldn't be charged, restoration to be carried out as followed;
   a. *Keep 30MVA ICT at BHP Open*

b. Keep GDL Dochhula, Taba and Damji at 0MW.

c. Charge 2x30MVA transformers at Jamjee and extend supply to synchronize BHP upper state.

4.3. Contingency of 220kV Semtokha-BHP and 220kV BHP-Tsirang line

The outage of 220kV Semtokha-BHP and 220kV BHP-Tsirang lines will results overloading of 66kV BHP-Gewathang-Lobeysa-Dochhula lines and 30MVA ICT at BHP. There will be interruption of both BHP lower and upper stage generation. Additionally, the Lobeysa and Gewathang substations will remained blackout as illustrated in Figure *15*.

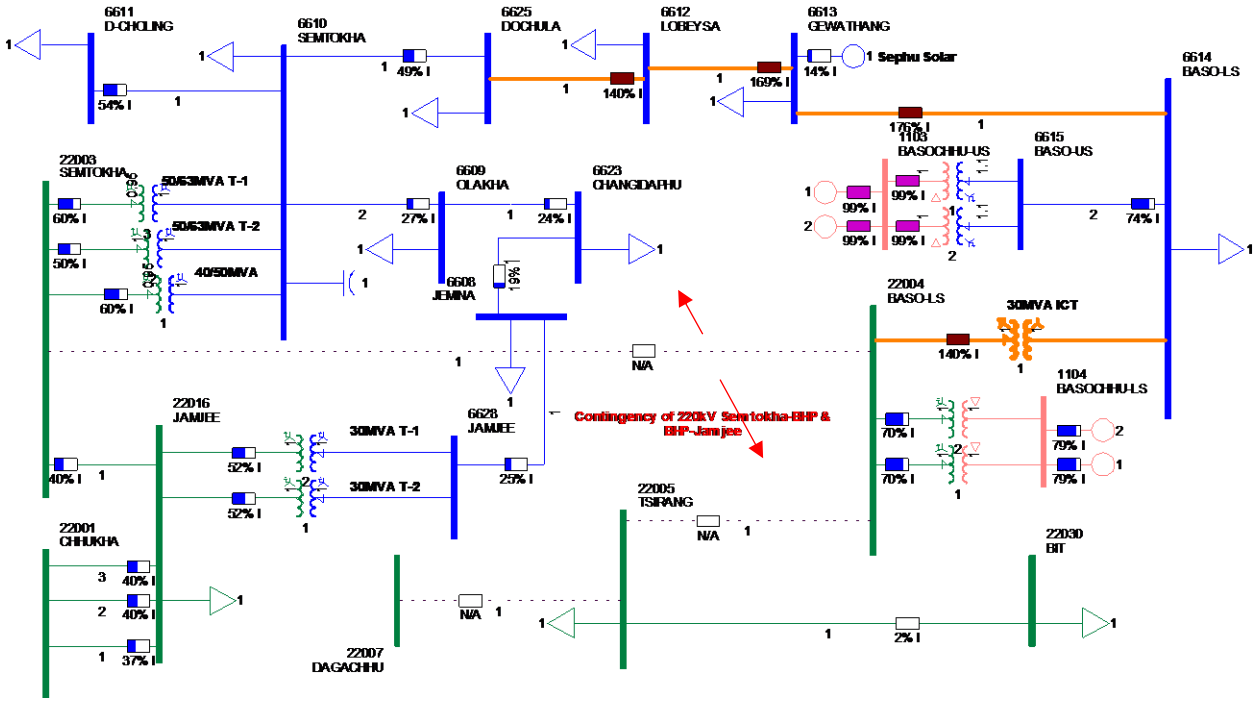

Figure 15: Network diagram showing outage of 220kV Semtokha-BHP and 220kV BHP-Tsirang lines

During the outage of 220kV BHP-Semtokha and 220kV BHP-Tsirang, 66kV BHP-Gewathang-Lobeysa-Dochhula lines will get overloaded and tripped. Additionally, the BHP both upper and lower stage units will trip as there is no evacuation transmission lines.

Following procedures will be followed by System Operator to restore the power supply:

i. Test charge immediately 220kV Semtokha-BHP line. If the line withstands test charge, the power supply to the affected regions will be restored.

ii. If (i) failed, following procedure will be followed to restore:

a. Hand trip 30MVA ICT at BHP if CB did not get opened or keep open if the CB has been operated.

b. Charge 220kV BHP-Tsirang line and synchronize BHP lower stage units.

c. *Extend supply to synchronize BHP upper stage units from 66kV BHP-Gewathang-Lobeysa-Dochhula line.*

4.4. Contingency of 2x220kV Jigmeling-BitDeer lines

Outage of both 220kV Jigmeling-Bitdeer lines would lead to overloading of most critical transmission lines i.e., 220kV Jamjee-Semtokha-BHP-Tsirang-Bitdeer lines as presented in Figure *16* and resulted widespread blackout.

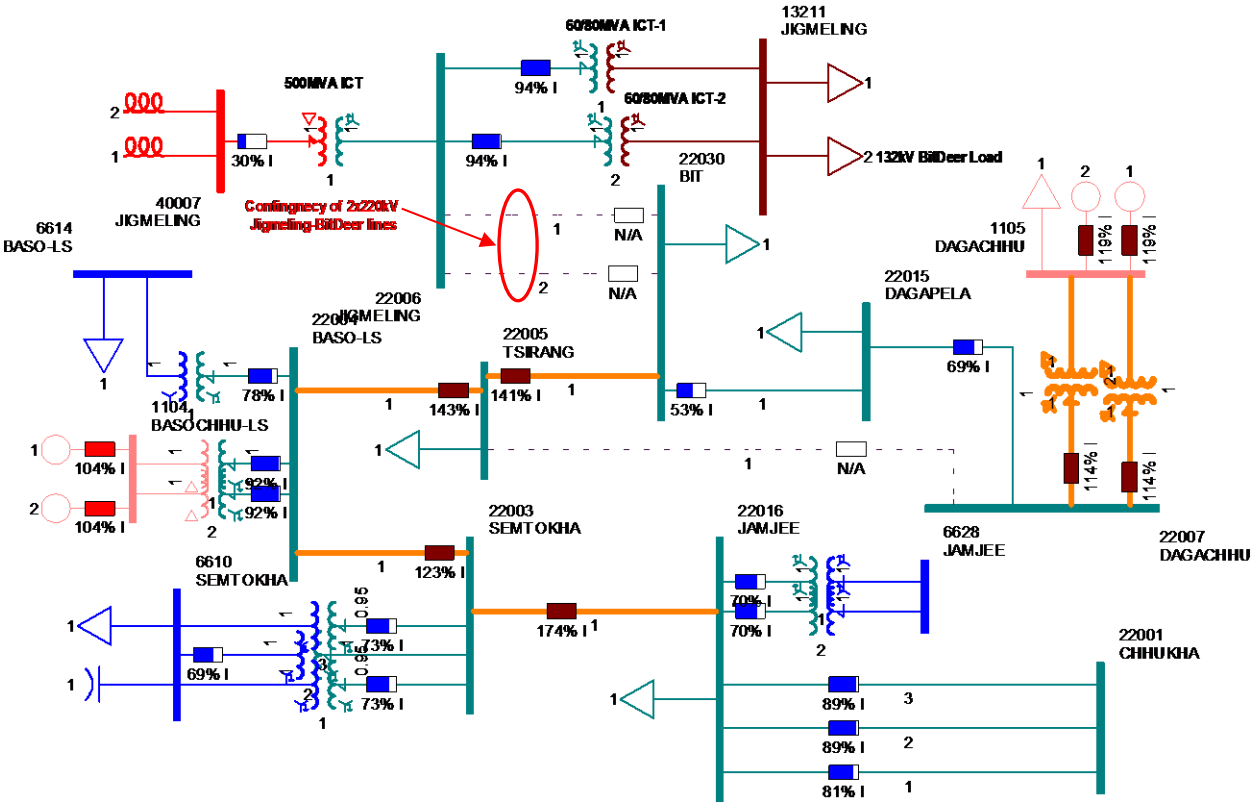

Figure 16: Network diagram showing outage of 2x220kV Jigmeling-BitDeer lines

However, the scheme implemented as discussed in (4.1), the 3x100MVA transformers at 220kV BitDeer substation will get trip during the tripping of 2x220kV Jigmeling-BitDeer lines, thereby reducing loading in 220kV Jamji-Semtokha-BHP-Tsirang-BitDeer lines.

In case, 3x100MVA transformers at BitDeer substation does not get trip, the System Operator in coordination with BitDeer substation will hand trip 3x100MVA transformers.

Following procedures will be followed by System Operator to restore the power supply:

i. Close 2x220kV Jigmeling-BitDeer line one by one.
ii. Resume load at 220kV BitDeer substation.
iii. If (i) is unsuccessful, the 3x100MVA transformers at 220kV BitDeer substation will remain open until two lines are charged.

4.5. Contingency of 132kV Jigmeling-Tintibi & 132kV Motanga-Rangia lines

The outage of 132kV Jigmeling-Tintibi and Motanga-Rangia lines at same time will results blackout in eastern region as shown in Figure *17*. As the nature of outage is similar to the contingency of 132kV Jigmeling-Tintibi line as discussed in (4.8), the same restoration process will be followed.

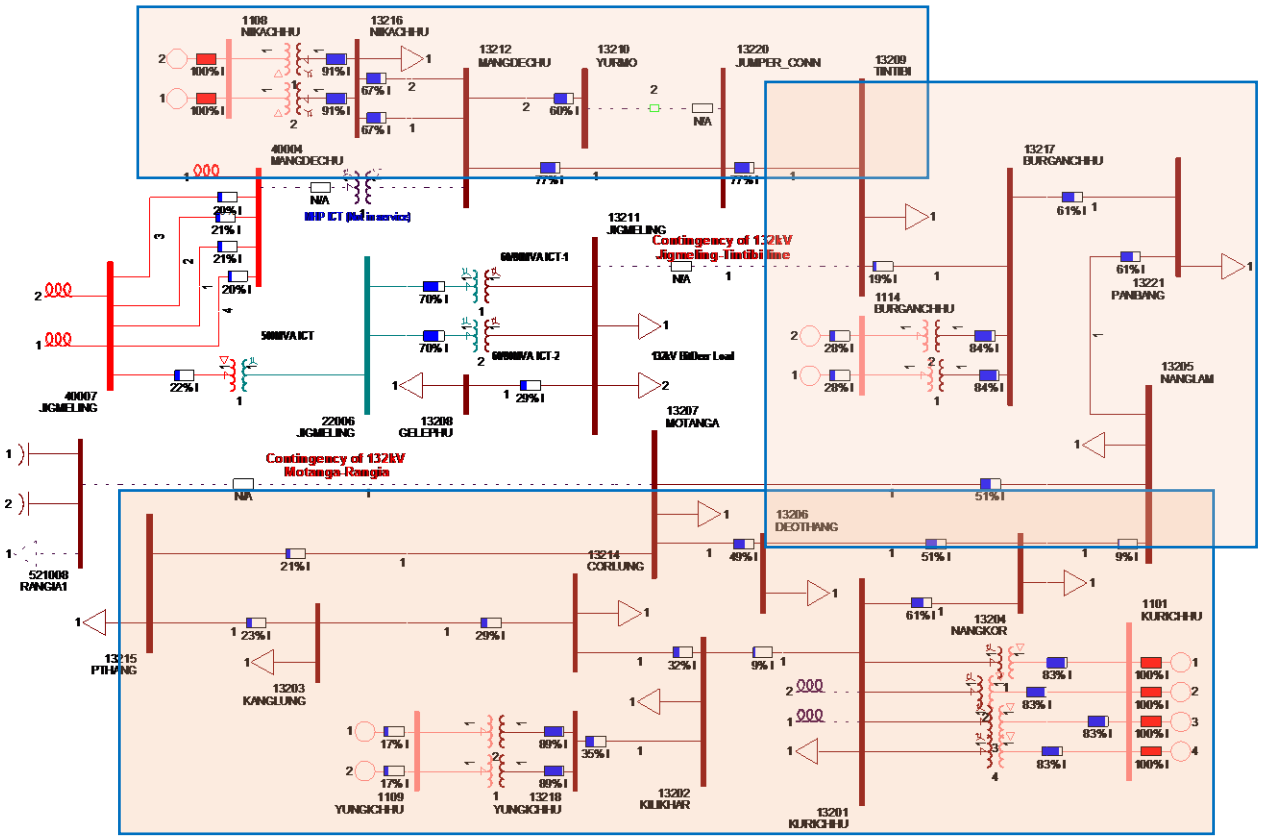

Figure 17: Network diagram showing outage of 132kV Jigmeling-Tintibi and 132kV Motanga-Rangia lines

4.6. Contingency of 2x400kV Jigmeling-Alipurduar lines

The outage of these D/C 400kV lines from Jigmeling-Alipurduar lines will caused overloading of 500MVA ICT at Jigmeling as shown in Figure *18*. The load shedding at BitDeer shall be carried out and maintain the ICT loading below 430MW.

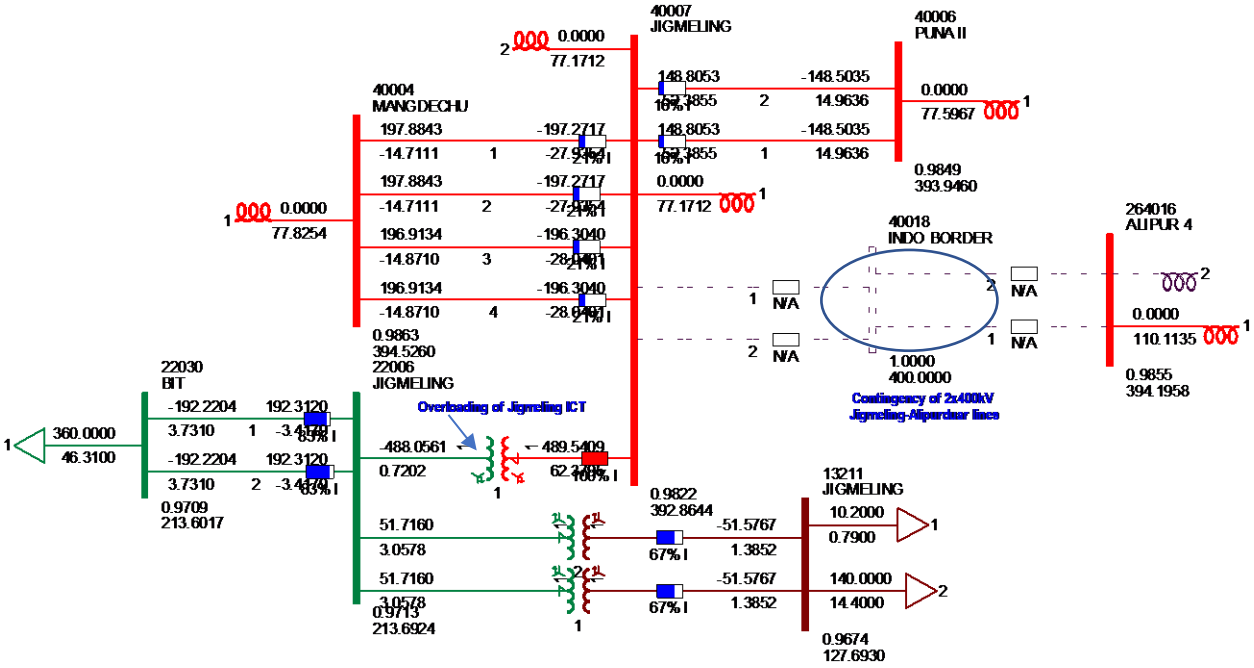

Figure 18: Network diagram showing outage of 2x400kV Jigmeling-Alipurdur lines

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