भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
उत्तर क्षेत्रीय विद्युत समिति
Northern Regional Power Committee

दिनांक: 17.10.2024

सेवा में : संरक्षण उप-समिति के सदस्य (सूची के अनुसार) ।
To: Members of Protection Sub-Committee (As per mail list)

विषय: संरक्षण उप-समिति की 53 वीं बैठक की कार्यसूची |
Subject: Agenda for 53rd Protection Sub-Committee Meeting.

संरक्षण उप-समिति की **53 वीं बैठक, दिनांक 22.10.2024 को 10:30 बजे** से **एनआरपीसी सचिवालय, कटवारिया सराय, नई दिल्ली** में आयोजित की जाएगी | उक्त बैठक की कार्यसूची संलग्न है । यह उत्तर क्षेत्रीय विद्युत् समिति की वेबसाइट (http://164.100.60.165/) पर भी उपलब्ध है | कृपया बैठक मे उपस्थिति सुनिश्चित करें ।

The **53rd meeting** of Protection Sub-Committee is scheduled to be held on **22.10.2024** at **10:30 Hrs** at **NRPC Secretariat, Katwaria Sarai, New Delhi**. The agenda for the meeting is attached herewith. The same is also available on NRPC website (http://164.100.60.165/). Kindly make it convenient to attend the same.

Signed by Reeturaj Pandey
Date: 17-10-2024 12:11:04

ऋतुराज पाण्डेय
कार्यपालक अभियंता (संरक्षण)

Agenda of 53rd Protection Sub-Committee Meeting (22nd October, 2024)

Contents

Agenda for
53rd Meeting of Protection Sub-Committee (PSC) of
Northern Regional Power Committee

Date and time of meeting	:	***22.10.2024 10.30 Hrs.***
Venue	:	***NRPC Secretariat, Katwaria Sarai, New Delhi***

A.1. Confirmation of minutes of 52nd meeting of Protection Sub-Committee

A.1.1 52nd PSC meeting was held on 20.09.2024. Minutes of the meeting were issued vide letter dtd. 07.10.2024. No comment has been received till the date.

Decision required from Forum:

Forum may approve the minutes of 52nd PSC meeting.

A.2. Submission of protection performance indices to NRPC Secretariat on monthly basis (agenda by NRPC Secretariat)

A.2.1 *As per clause 15 (6) of IEGC 2023;*

- *Users shall submit the following protection performance indices of previous month to their respective RPC and RLDC on monthly basis for 220 kV and above (132 kV and above in NER) system, which shall be reviewed by the RPC:*

*a) The **Dependability Index** defined as* $D = Nc/Nc+Nf$

*b) The **Security Index** defined as* $S = Nc/Nc+Nu$

*c) The **Reliability Index** defined as* $R = Nc/ Nc+Ni$

where,

Nc is the number of correct operations at internal power system faults,

Nf is the number of failures to operate at internal power system faults, *Nu is the number of unwanted operations,*

Ni is the number of incorrect operations and is the sum of Nf and Nu

Further, as per clause 15 (7) of IEGC 2023;

- *Each user shall also submit the reasons for performance indices less than unity of individual element wise protection system to the respective RPC and action plan for corrective measures. The action plan will be followed up regularly in the respective RPC.*

A.2.2 In earlier PSC meeting, it was decided that each utility shall submit the Performance indices of previous month by 7th day of next month.

A.2.3 Accordingly, the status of the indices reported for the month of September-2024 is attached as **Annexure- I.**

A.2.4 Further, based on submitted data by the utilities as on date, the summary of events of September-2024 that caused indices less than unity is also attached as **Annexure-II.** Most of the concerned utilities have submitted the reason for the same and corrective action taken to resolve the related issue. However, who have not submitted, may send at the earliest.

A.2.5 As per discussion of the 52nd PSC meeting, concerned utilities who have not submitted the Performance indices for any of month from June,2024 to August,2024, a letter dated 01.10.2024 (enclosed as **Annexure-III**) was sent to direct the concerned officials to submit the Protection Performance indices of previous month by 7th day of next month. SLDCs were requested to send the compiled data of all utilities (GENCOs, & TRANSCOs) under their jurisdiction.

A.2.6 In view of above, it is requested that utilities may submit the performance indices of previous month by 7th day of next month element wise along with the reason for indices less than unity and corrective action taken.

Decision required from Forum:

Members may deliberate on delay from utilities in submission of indices, and action taken in cases where indices are less than one.

A.3. Annual protection audit plan for FY 2024-25 and third-party protection audit plan (agenda by NRPC Secretariat)

Annual Internal Audit Plan:

A.3.1 As per clause 15 of IEGC 2023;

- *Annual audit plan for the next financial year shall be submitted by the users to their respective RPC by 31st October. The users shall adhere to the annual audit plan and report compliance of the same to their respective RPC.*

A.3.2 In the 48th, 49th, 50th, 51st and 52nd PSC meetings, all utilities were requested to submit the annual protection audit plan.

A.3.3 Further, as per discussion of the 52nd PSC meeting, a letter dated 04.10.2024 (enclosed as **Annexure-IV**) has also been sent to concerned utilities for expediting submission of Annual Internal Protection Audit Plan for FY 2024-25.

A.3.4 Some utilities have submitted their annual audit plans (enclosed as **Annexure- V**) and others may submit annual audit plan for FY 2024-25 at the earliest.

Third party protection audit:

A.3.5 As per clause 15 of IEGC 2023:

All users shall also conduct third party protection audit of each sub-station at 220 kV and above (132 kV and above in NER) once in five years or earlier as advised by the respective RPC.

A.3.6 Further, as per discussion of the 52nd PSC meeting, a letter dated 10.10.2024 (enclosed as **Annexure-VI**) has also been sent to concerned utilities for expediting submission of Third-Party Protection Audit Plan. SLDCs have been requested to send the compiled data of all utilities (GENCOs, & TRANSCOs) under their jurisdiction.

A.3.7 Some utilities have submitted their third-party protection audit plans (enclosed as **Annexure-VII)** and other remaining may submit the same at the earliest.

A.3.8 Further, POWERLINK vide mail dated 11.10.2024 (enclosed as **Annexure-VIII**) submitted that Protection Plan is not applicable for POWERLINK as substation, Bays & Relay are being maintained by POWERGRID of its transmission lines. The associated substation ends are also mentioned in the annexure-VIII. In view of above, Forum may direct POWERGRID and UPPTCL to ensure the Internal and Third-party Protection audit of concerned substations along with these lines.

A.3.9 The utilities may update the status of 3rd party protection audit as per the submitted audit plans. Subsequently, the audit reports along with compliance status may be submitted to NRPC Secretariat regularly.

A.3.10 Most of the utilities have not still submitted the action taken reports against the observations of audits. The same may be expedited.

Decision required from Forum:

Utilities may submit annual audit plan for FY 2024-25 & 3rd Party Protection audit plan and comply the same timely. Compliance report for the audited substation may be submitted within one month of audit.

A.4. Annual protection audit plan for FY 2025-26 (agenda by NRPC Secretariat)

A.4.1 As per clause 15 of IEGC 2023;

- *Annual audit plan for the next financial year shall be submitted by the users to their respective RPC by 31st October. The users shall adhere to the annual audit plan and report compliance of the same to their respective RPC.*

A.4.2 In view of above, all utilities are requested to submit the annual protection audit plan for FY-2025-26.

Decision required from Forum:

Utilities may submit annual internal protection audit plan for FY 2025-26 latest by 31st October 2024 and comply the submitted schedule timely.

A.5. Compliance of recommendations of protection audit (agenda by NRPC Secretariat)

A.5.1 As per clause 15 of IEGC 2023*;*

- *All users shall conduct internal audit of their protection systems annually, and any shortcomings identified shall be rectified and informed to their respective*

RPC. The audit report along with action plan for rectification of deficiencies detected, if any, shall be shared with respective RPC for users connected at 220 kV and above (132 kV and above in NER).

- *All users shall also conduct third party protection audit of each sub-station at 220 kV and above (132 kV and above in NER)* ***once in five years*** *or earlier as advised by the respective RPC.*
- *The protection audit reports, along with action plan for rectification of deficiencies detected, if any, shall be submitted to the respective RPC* ***and*** *RLDC or SLDC, as the case may be,* ***within a month of submission of third-party audit report****. The necessary compliance to such protection audit report shall be followed up regularly in the respective RPC.*

A.5.2 Utilities have submitted the internal audit report based on the audit done at their substations. After the 52nd Protection Sub- Committee meeting, received reports are attached as **Annexure-IX** and received reports of 3rd Party audit are attached as **Annexure-X.**

A.5.3 However, compliance of audit recommendations has not been reported to NRPC Secretariat, UPPTCL has sent the compliance report along with observations of previous audits. The same is attached as **Annexure- XI.**

A.5.4 Further, the concerned utilities may submit the protection audit report (for audited S/s as per submitted plan) and action plan for rectification of deficiencies within a month after issuance of audit report.

Decision required from Forum:
Forum may discuss audit report as well as action taken by utilities on recommendations of audit.

A.6. Violation of protection standard in case of tripping of the Inter-Regional lines of voltage class 220 kV and above (agenda by NRPC Secretariat)

A.6.1 NLDC vide letter dated 20.09.2024 has informed the violation of protection standard in case of tripping of Inter Regional Lines of voltage class 220 kV and above.

A.6.2 As per section 3.e of Grid Standards Regulation of CEA, 2010, fault is to be cleared within the following time:

Sl. No.	Nominal System Voltage in kV rms	Maximum time of fault clearing in msec
1	400	100
2	220	160

A.6.3 NLDC has prepared the list of tripping of Inter Regional Lines of voltage class 220 kV and above, during the month of August 2024 in which violations has been observed. The same is attached as **Annexure-XII.**

A.6.4 It has been observed that fault had not cleared within specified time during these incidents.

A.6.5 The same was also instructed in the last PSC meeting to ensure fault clearance within specified time.

A.6.6 In view of above, it is again required to take appropriate actions/remedial measures to get fault cleared within specified time above-mentioned.

A.6.7 Further, all the utilities are also requested to ensure the fault clearance of the 220kV and above Inter-Regional lines within specified time to avoid any violation of protection standards.

Decision required from Forum:

Forum may deliberate and direct all utilities to ensure the fault clearance of the 220kV and above Inter-Regional lines within specified time as per Grid Standards Regulation of CEA, 2010.

A.7. Finalization of Protection philosophy for Power Transformer and Reactor of Northern Region (agenda by NRPC Secretariat)

A.7.1 In In 71st NRPC meeting the finalized protection philosophy for Northern Region was approved in line with the decision of 49th Protection Sub-Committee meeting.

A.7.2 In addition to that, the draft for the protection philosophy of power transformer and reactor was prepared and put up as agenda for finalization of the same in the 50th PSC meeting (held on 29.4.2024). However, the same could not be finalized.

A.7.3 Further, a meeting was held on 27.09.2024 to discuss and draft protection philosophy for “Power Transformer and Reactor” of Northern Region. The minutes of meeting were issued vide letter dated 08.10.2024 (enclosed as **Annexure-XIII**). The updated philosophy is also attached in the annexure-XIII. Utilities are requested to submit any further comments/ observations and may also present the same in the meeting for deliberation.

Decision required from Forum:

Members may discuss and finalize the protection philosophy of power transformer and reactor.

A.8. Status of remedial actions recommended during previous PSC meetings (agenda by NRLDC)

A.8.1 As per the discussion in pervious PSC meetings, necessary remedial actions were recommended based on the analysis and discussion of the grid events. It is expected that necessary actions would have taken place. In view of the same, constituents are requested to share the status of remedial actions taken. List of points to be discussed in 53rd PSC meeting is attached as **Annexure-XIV.** Constituents can email the details via mail to NRLDC and NRPC.

Decision required from Forum:

Forum may like to discuss.

A.9. Availability and Standardization of recording instrument (Disturbance recorder and Station Event Logger) (agenda by NRLDC)

A.9.1 As per IEGC clause 17

1) *All users shall keep the recording instruments (disturbance recorder and event logger) in proper working condition.*
2) *The disturbance recorders shall have time synchronization and a standard format for recording analogue and digital signals.*

A.9.2 IEGC clause 37.2 (c) also mandates the submission of Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) within 24 hrs of the event.

A.9.3 During FTC process, cases of non-availability of station event logger and non-standardisation of recording instruments have been observed.

A.9.4 Data of recording instruments (DR/EL) are very helpful in grid event analysis and is being used in availability verification of transmission lines. Complete and conclusive analysis of any grid event is not possible without these recording instruments and thus their standardisation is very important.

A.9.5 Therefore, availability of disturbance recorder with standardisation, time sync and correct nomenclature and station event logger need to be ensured by users at the station of their respective control area.

A.9.6 Deliberation on this subject was done during pervious PSC meeting. Details were received from UP, Uttarakhand & Haryana only.

A.9.7 In view of above, all the constituents are requested share the updated details w.r.t. availability and standardisation of disturbance recorder and event logger at the station of their respective control area in format attached as **Annexure-XV.**

Decision required from Forum:

Members may like to discuss.

A.10. Analysis of the tripping events occurred during September-2024 and status of remedial action taken (agenda by NRLDC)

a) **Frequent elements tripping during September 2024:** The following transmission elements were frequently tripped during the month of **September'24**:

S. NO.	Element Name	No. of forced outages	Utility/SLDC
1	220 KV Khara(UP)-Saharanpur(PG) (UP) Ckt-1	6	PG/UP
2	220 KV Nara(UP)-Roorkee(UK) (UP) Ckt-1	6	UP/Utt
3	220 KV Saharanpur(PG)-Shamli(UP) (UP) Ckt-1	8	PG/UP
4	220 KV Sarna(PS)-Udhampur(PDD) (PDD) Ckt-1	5	PS/J&K
5	400 KV Agra-Unnao (UP) Ckt-1	5	UP
6	400 KV Anpara_B(UPUN)-Sarnath(UP) (UP) Ckt-2	3	UP

7	400 KV Bareilly-Unnao (UP) Ckt-1	3	UP
8	400 KV Jaunpur -Obra_C_TPS (UP) Ckt-1	3	UP

A.10.1 List of tripping is attached as **Annexure-XVI**.

A.10.2 It may be noted that frequent tripping of such elements affects the reliability and security of the grid. Hence, utilities are requested to analyse the root cause of the tripping and share the remedial measures taken/being taken in this respect.

b) Protection related issues in multiple elements tripping and status of re-medial measures:

In some of the tripping incidents occurred during September 2024, there was some issues related to protection system. List of the such tripping incidents is attached as **Annexure-XVII.** Concerned utility are requested to apprise the status of remedial actions to forum.

c) Detailed analysis of multiple elements tripping events:

The list of major tripping events occurred during September 2024 is attached as **Annexure-XVII**. Concerned constituents/utilities are requested to share the detailed analysis of the tripping elements along with status of remedial action taken/to be taken.

Decision required from Forum:

Members may like to discuss.

A.11. Corrective action for healthiness of 500kV Mundra-Mahindergarh SPS (agenda by NRLDC)

A.11.1 On 17th May 2024 on outage of both pole (carrying total ~1500MW), SPS of 500kV HVDC Mundra-Mahindergarh inter regional link didn't operate. This issue was discussed during 51st and 52nd PSC meeting and ADANI was requested to share the details w.r.t. SPS operation during the meeting.

A.11.2 Further, NRLDC in coordination with NLDC conducted an online discussion meeting with concerned stakeholders (SLDCs, ADANI, POWERGRID) on 12th August 2024, for further remedial actions required to make this SPS healthy.

A.11.3 Following actions were decided during the meeting:

i. POWERGRID, ADANI and concerned states were requested to identify the issue in communication links and take expeditious actions to make the all the communication link healthy. POWERGRID & ADANI shall review the healthiness of SPS system at different load centres and communication path between them in coordination with the SLDCs.

ii. States were requested to go through the details of load feeders mentioned in SPS document and share the changes / modifications as per present scenario and share the inputs w.r.t. unavailability in identified load feeders and load shedding. SLDCs shall share the revised updated feeder details (radial) along with expected average/peak load relief through respective feeders.

iii. SLDCs in coordination with their transmission and protection team shall share the status and healthiness of existing SPS system along with details of availability of communication path for incorporation of proposed revised/additional feeders.

A.11.4 Load end details have been received from UP, Haryana, Punjab Rajasthan & Delhi. Details are attached as **Annexure-XVIII**.

A.11.5 Regarding communication network and hardware system, ADANI has submitted the status of their healthiness. As per details submitted, counter status was found OFF at Alwar, Ratangarh, Gobindgarh, Malerkotla, Bamnauli, Shamli and Dhanonda.

A.11.6 Constituents were also requested to share the nodal officer for coordination with the ADANI team for further remedial actions. Details received from UP, Punjab, Rajasthan & Haryana. BBMB & Delhi are requested to share the details of their control area at the earliest.

A.11.7 In view of above, ADANI is requested to coordinate with the respective states to rectify the issues in the SPS system and share the status of remedial action taken / planned to be taken. Desired remedial actions need to be expedited.

Decision required from Forum:

Members may like to discuss.

A.12. To prepare a SOP for revision & implementation of protection settings during modification of existing network (agenda by NRLDC)

A.12.1 NLDC in coordination with NRLDC and WRLDC have facilitated shutdown of 400kV Bhinmal-Zerda and 400kV Kankroli-Bhinmal for implementation of bypass arrangement after receiving consents from concerned RPCs as required by NLDC outage team. Thereafter, the bypass work was carried out on evening of 11.10.2024.

A.12.2 Shutdown was facilitated on request from POWERGRID as following reply was received from their side when we asked for implementing the bypass arrangement:

Reply from POWERGRID:

"The bypass arrangement scheme is newly implemented, and this is first time when changeover/bypass arrangement is used therefore, before revival all the required settings and scheme changeover needs to be validated.

Now while enabling bypass arrangement, we have to change relay setting (M1 and M2) at Kankroli and Zerda S/S. Zerda S/S belongs to GETCO where additional time is required for implementing and checking revised settings.

At Bhinmal End changeover scheme has been implemented for tele protection signal, so after making necessary modification in primary ckt. Tele protection tripping is required to be validated between Kankroli and Zerda S/S for which shut down is mandatorily required."

A.12.3 POWERGRID raised concern regarding the simultaneous implementation of settings at Bhinmal, Kankroli and Zerda end and further mentioned that GETCO requires additional time for checking the settings.

A.12.4 In view of above, a common SOP may be prepared for revision and implementation of protection setting during modification in existing network.

Decision required from Forum:

Members may like to discuss.

A.13. SPS for Bhimsar Solar Substation- AGE24L_ 500 MW Solar Power Project at Bhimsar, Jaisalmer, Rajasthan (agenda by AGEL)

A.13.1 Adani Green Energy Ltd. Vide mail dated 13.10.2024 has proposed an SPS for Bhimsar, Rajasthan – AGEL 24L.

A.13.2 With consideration of single line capacity to evacuate power from Bhimsar Plant, AGEL intimated to implement the proposed SPS to avoid total Generation loss and black out in the event of tripping of one line and overloading of other line.

A.13.3 The Proposed SPS scheme is attached as **Annexure-XIX.**

A.13.4 Stakeholders may submit comments.

Decision required from Forum:

Forum may discuss and consider to approve the proposed SPS scheme accordingly.

A.14. Review suggestions on the Protection Philosophy / Protocol of Northern Region (agenda by AGEL)

A.14.1 As per discussion of the meeting on Protection philosophy for Power Transformer and Reactor in Northern Region held on 27.09.2024 at NRPC, AGEL has suggested following aspects related to 220 kV Lines to incorporate.

a. Philosophy for 220 kV Over voltage – Second Stage

As per the philosophy, the Over voltage protection is not applicable for 220 kV lines. In view of voltage fluctuations and Transients for protection of equipment, AGEL suggests to keep the high set i.e. second stage of Over Voltage 140% pick up with Time delay of 100 msec.

b. Philosophy for 220 kV Hybrid Line i.e. Cable + Overhead Transmission Line.

I. As per item no. 1 (12) of the **Annexure-XIII** in the philosophy related to the Auto Reclosure, AGEL suggests that 'for 220 kV Cable and Hybrid Line Auto Reclosure requirement to be excluded or not applicable'.

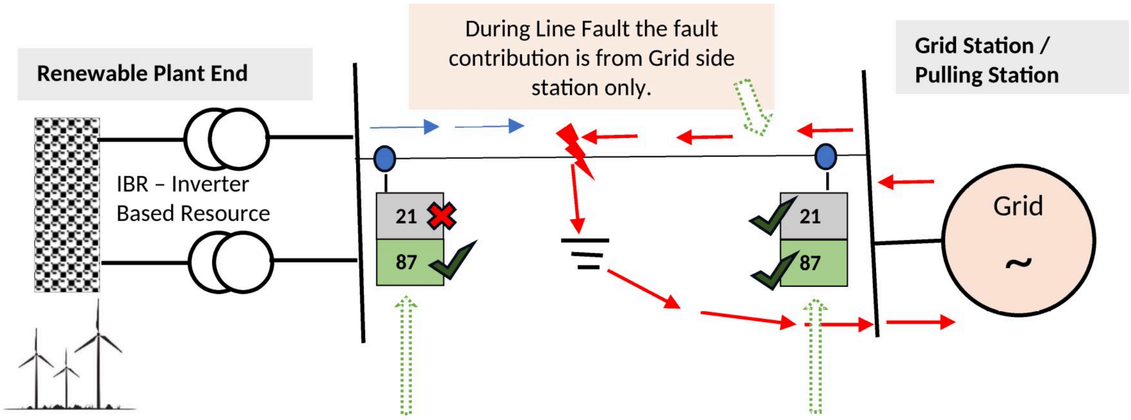
II. The Over voltage protection for Transmission line of 220 kV Cable is specified in item no. 1 (14) of the **Annexure-XIII** in the philosophy related to Over Voltage Protection, which is proposed to be applicable for Hybrid Line also i.e. Transmission line having Cable and O/H Line.

c. Review of Distance Protection requirement Philosophy for Renewable plants having one evacuation line. (Point No. 1)

i. For Renewable plants with a single evacuation line, the requirement of Line Distance Protection at Renewable Plant needs to be reviewed due to following reasons.

1. During the line fault the contribution from Renewable plant is negligible, the fault is fed from grid side source or connected station end only, as being a Radial feeder.
2. Due to (1) above, the operation of distance protection employed at Renewable plant cannot detect and interpret the fault impedance as compared to opposite end i.e. Grid source and there is no operation of distance protection at Renewable Plant end. However, operation of the distance protection may happen due to voltage dip and coincidental measurement of impedance within the Zone with normal current.
3. The Line Differential Protection employed at both ends detect the fault on current differential principle and assures the protection as required.
4. The following conceptual schematic indicates the operation of protection for fault on the single line connected with renewable plant with Grid station

Conceptual Schematic indicating the Non detection of Fault by Distance Protection at Renewable plant end having single evacuation Line



The Distance Protection at Grid end station is assured however the same at Renewable Station can not detect the fault as distance protection.

The Line Differential Protection at both end is assured to operate due to difference of current as per the setting.

Fault Current fed from Grid side end
Normal Current from Renewable plant end

A.14.2 Looking to the above phenomena, to avoid complexity of scheme and undesired operations at Renewable Plant end following is suggested by AGEL.

A.14.3 **Proposal of AGEL: -**

It is proposed for the Renewable plants with single evacuation line connected with Grid station that,

- The Line Distance Protection (Impedance based measurement) at Renewable plant end is not required as to be considered as Radial Feeder.
- For 220 kV and above lines, Redundant i.e. two Main Protections (main-1 and Main-2) Current based Line Differential Protection with Back up Earth fault protection is required.
- For such Lines, other schemes like interstrip signaling, Direct Trip & Auto re-closure scheme based on Differential Protection and other schemes as per Philosophy are required.

- The Distance Protection at Grid End station is to be considered as per philosophy without any change.
- The Back Up Earth fault Protection at Grid End Station should be coordinated with the Renewable Plant Power Transformer HV side or Main Substation Bus coupler, as the case may be.

Decision required from Forum:

Members may discuss and consider to amend the finalized Protection Philosophy/Protocol of Northern Region related to Transmission line.

*****

Members of Protection Sub-Committee (FY 24-25)

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46	Lalitpur Power Generation Company Ltd	Head of Maintenance, GM Electrical	alokkumar.ltp@lpgcl.com, aupadhyay.ltp@lpgcl.com
47	MEJA Urja Nigam Ltd.	AGM-EMD	SPSPUNDIR@NTPC.CO.IN
48	Adani Power Rajasthan Limited*	COO, Thermal, O&M	jayadeb.nanda@adani.com
49	JSW Energy Ltd. (KWHEP)*	Head Regulatory & Power Sales	jyotiprakash.panda@jsw.in
50	TATA POWER RENEWABLE*	Zonal Head, NR	dhmahabale@tatapower.com
51	UT of J&K*	Chief Engineer, JKPCL	cejkpcl2@gmail.com
52	UT of Ladakh*	Chief Engineer, LPDD	cepdladakh@gmail.com
53	UT of Chandigarh	Executive Engineer	elop2-chd@nic.in
54	Noida Power Company Limited	Head – Power Purchase	ssrivastava@noidapower.com
55	Fatehgarh Bhadla Transmission Limited	Head-Protection, AESL	Sunil.Raval@adani.com
56	NTPC Vidyut Vyapar Nigam Ltd.	CEO	ceonvvn@ntpc.co.in
57	ReNew Power Private Limited*	CEO	sumant@renew.com
58	NTPC Green Energy Limited*	CEO	rajivgupta@ntpc.co.in
59	Azure Power India Pvt. Limited*	CEO	sunil.gupta@azurepower.com
60	Avaada Energy Private Limited*	CEO	kishor.nair@avaada.com
61	Adani Green Energy Limited*	COO	chaitanya.sahoo@adani.com
*	*Organizations from where nominations are not received for PSC, memebers of NRPC have been mentioned. Nomination for PSC forum may be sent at the earliest.*		

Annexure-I

Status of perfomance indices report of September 2024		
S. No.	Utility	Status of Protection Performance indices
1	PGCIL	Recevied (NR-1, 2
2	NTPC	Recevied (dadri Thermal, Tanda
3	BBMB	Not Recevied
4	THDC	Received (Tehri)
5	SJVN	Recevied
6	NHPC	Recevied
7	NPCIL	Recevied (RAP-1-2, 5-6, NAP 1-2,
8	Delhi SLDC	Not Recevied
9	Haryana SLDC	Not Recevied
10	Rajasthan SLDC	Not Recevied
11	Uttar Pradesh SLDC	Not Recevied
12	Uttarakhand SLDC	Not Recevied
13	Punjab SLDC	Not Recevied
14	Himachal Pradesh SLDC	Not Recevied
15	DTL	Recevied
16	HVPNL	Recevied
17	RRVPNL	Recevied
18	UPPTCL	Recevied
19	PTCUL	Recevied
20	PSTCL	Not Recevied
21	HPPTCL	Recevied
22	IPGCL	Recevied (CCGT Bawana-III, PPS-I)
23	HPGCL	Not Recevied
24	RRVUNL	Recevied
25	UPRVUNL	Recevied (DTPS anpara, Obra B)
26	UJVNL	Recevied (Dharashu, Tiloth)
27	HPPCL	Not Recevied
28	PSPCL	Received (GATPL, 220kV GHTP, Ranjeet Sagar Dam HEP)
29	HPSEBL	Not Recevied
30	Prayagraj Power Generation Co. Ltd.	Recevied
31	Aravali Power Company Pvt. Ltd	Recevied
32	Apraava Energy Private Limited	Not Recevied
33	Talwandi Sabo Power Ltd.	Recevied
34	Nabha Power Limited	Recevied
35	MEIL Anpara Energy Ltd	Not Recevied
36	Rosa Power Supply Company Ltd	Recevied
37	Lalitpur Power Generation Company Ltd	Recevied
38	MEJA Urja Nigam Ltd.	Not Recevied
39	Adani Power Rajasthan Limited	Recevied
40	JSW Energy Ltd. (KWHEP)	Not Recevied
41	AESL	Recevied (ATIL, ATSCL, BKTL, FBTL, GTL, HPTSL, MTSCL, OCBTL)
42	Tata Power Renewable Energy Ltd.	Recevied (TPREL, TPGEL, TPSL)
43	UT of J&K	Not Recevied
44	UT of Ladakh	Not Recevied
45	UT of Chandigarh	Not Recevied
46	INDIGRID	Recevied
47	POWERLINK	Not Recevied
48	ADHPL	Recevied
49	Sekura Energy Limited	Not Recevied
50	WUPPTCL	Recevied

Reasons for Performance Indices less than Unity- September 2024

LPGCL

Case-1 Tripping of 220kV Dunara – LPGCL line

No. of unwanted operation -1

No. of correct operation-1

No. of failure to operate-0

No. of incorrect operation-1

Reason for Unwanted operation – Direct trip received at LPGCL end for single phase to earth fault tripping.

Corrective action taken- Issue with the Dunara end distance relay was identified jointly with UPPTCL officials, and changes were made in the relay output configuration. The functioning of the 220 kV Dunara end distance relay is being kept under observation.

Pragati Power Station – III (CCGT, Bawana)

Case-1 Tripping of Generator Transformer GT # 2

No. of unwanted operation -1

No. of correct operation-1

No. of failure to operate-0

No. of incorrect operation-1

Reason for Unwanted operation – Tripping due to operation of Buchholz Protection. One out of four screws of the terminal box cover found missing which made way for water to enter.

Corrective action taken- The missing screw was replaced with a new one. Canopy arrangement has been made over the Buchholz relay to prevent any such event in future.

UPPTCL

Case-1 Tripping of 220/132kV 160MVA ICT-2 at Ghazipur (Prayagraj Zone)

No. of unwanted operation -1

No. of correct operation-0

No. of failure to operate-0

No. of incorrect operation-1

Reason for Unwanted operation – Tripping due to DC cable damage of HV side R, B phase.

Corrective action taken- Faulty cable replaced.

Case-2 Tripping of 220 kV S/S Gola- Shahjahanpur line (Lucknow Zone)

No. of unwanted operation -0

No. of correct operation-1

No. of failure to operate-1

No. of incorrect operation-1

Reason for failure to operate – CB operated delayed (UPPTCL may apprise)

Corrective action taken- makeup of the low pressure of the 01 pole of SF6 GAS Circuit Breaker has been done at Gola end.

Case-3 Tripping of 500MVA ICT-1 at Basti (Gorakhpur Zone)

No. of unwanted operation -1

No. of correct operation-0

No. of failure to operate-0

No. of incorrect operation-1

Reason for Unwanted operation – HV side relay setting issue.

Corrective action taken- Setting has been corrected (from Non directional to directional).

Case-4 Tripping of 220kV Anand-Nagar to PGCIL (Gorakhpur zone)

No. of unwanted operation -1

No. of correct operation-0

No. of failure to operate-0

No. of incorrect operation-1

Reason for Unwanted operation – Tripping due to damage FO cable. Unwanted DTR command issued.

Corrective action taken- Damage FO cable replaced in CRP and proper taping of FO and control cable done to attend unwanted DTR command.

Case-5 Tripping of 220kV Mant to Mathura line (Agra Zone)

No. of unwanted operation -1

No. of correct operation-2

No. of failure to operate-0

No. of incorrect operation-1

Reason for Unwanted operation – Tripping on overcurrent protection.

Corrective action taken- Not received from utility

Case-6 Tripping of 400 kV Panki-Rewa Road line (Agra Zone)

No. of unwanted operation -1

No. of correct operation-0

No. of failure to operate-0

Reason for Unwanted operation – tripped at Rewa Road end in Zone-2 and due to A/R of 400kV Panki-Unnao line at that time.

Corrective action taken- Not received from utility

Case-7 Tripping of 400 kV Panki-Unnao line (Agra Zone)

No. of unwanted operation -1

No. of correct operation-0

No. of failure to operate-0

Reason for Unwanted operation – Tripping occurred at 400 kV S/S Unnao, after blast of CB pole of 400 kV Unnao- Agra line.

Corrective action taken- Not received from utility

Case-8 Tripping of 400 kV Panki-Unnao line (Agra Zone)

No. of unwanted operation -1

No. of correct operation-0

No. of failure to operate-0

Reason for Unwanted operation – 400 kV Unnao-Panki line tripping occurred only at Unnao end due to PD.

Corrective action taken- Not received from utility

ADHPL

Case- 1 Tripping of BusBar A at 220kV Prini Substation

No. of unwanted operation -1

No. of correct operation-0

No. of failure to operate-0

Reason for Unwanted operation – Bus Bar Relay B-90 CT module mal operated.

Corrective action taken- Not received from utility

POWERGRID- NR-2

Case-1 Tripping of 400KV LUDHIANA-PATIALA-II at Ludhiana end on 02.09.2024

No. of unwanted operation -1

Reason for Unwanted operation - Line tripped from Ludhiana end only due to manual error during DC earth rectification at Patiala (PG)

Corrective action taken- Not received from utility

Case-2 Tripping of 400KV KISHENPUR-SAMBA-Ion 14.09.2024

No. of unwanted operation -1

Reason for Unwanted operation – Line tripped due to DT received at Samba end caused by manual error at Kishenpur SS during DC earth fault rectification.

Corrective action taken- Not received from utility

POWERGRID NR-2 due to Others

Case-1 Tripping of 400KV DEHAR (BBMB) - PANCHKULA (PGCIL) LILO PORTION on 15.09.2024 at Dehar end only

No. of unwanted operation -1

Reason for Unwanted operation – tripped from Dehar (BBMB) due to maloperation of Auto reclose scheme at Dehar (BBMB). Bay and protection at Dehar (BBMB) is owned by Dehar (BBMB)

Corrective action taken- Not received from utility (BBMB may update).

Case-2 Tripping 400KV JALANDHAR-NAKODAR & 400KV KURUKSHETRA-NAKODAR on 19.09.2024

No. of unwanted operation -1 for each element.

Reason for Unwanted operation – Line tripped on operation of 400KV Bus bar protection at PSTCL Nakodar resulting in tripping of all feeders connected to 400KV Bus. 400KV Bus Bar protection operated during testing/commissioning of 400KV Bus bar relay for new ICT-3 bay at Nakodar(PSTCL).

Corrective action taken- Not received from utility (PSTCL may update).

RVPN

Case-1 220 KV KANKROLI -BAMAN TUKRA LINE at 220 KV GSS Kankroli on 01.09.2024

No. of Unwanted operation – 1

Reason of unwanted operation – PSL for carrier and LBB setting were wrong.

Corrective Action taken – PSL for carrier and LBB setting rectified.

Case-2 220 kV Chittorgarh-Sawa line ckt. 2 At GSS CHITTORGARH on 10.09.2024

No. of Unwanted operation – 1

Reason of unwanted operation – VT selection problem due to defective isolator contact.

Corrective Action taken – Isolator contact replaced, problem rectified.

Case-3 220 KV BORANADA-BALOTRA LINE & 220 KV Jalore-Balotra line at Balotra on 12.09.2024

No. of Unwanted operation – 1

No. of failures to operate – 1

Reason of unwanted operation – CB of Balotra – Jalore Line Defective at 220 KV GSS Balotra.

Corrective Action taken – CB problem not rectified till date, efforts are being made. (may apprise current status).

Case-4 220 KV Bansur-Kotputli PGCIL Ckt-IInd at 220KV GSS Bansur on 23.09.2024

No. of Unwanted operation – 1

Reason of unwanted operation – CB tripped at Bansur end with pole discrepancy relay due to DC problem.

Corrective Action taken – DC problem rectified.

Case-5 220 KV Bikaner-Bikaner Interconnector I at Bikaner on 24.09.2024

No. of Unwanted operation – 2

Reason of unwanted operation – CB tripped without any indication due to DC problem.

Corrective Action taken – DC problem rectified.

Case-6 220 kV Surpura-Tinwari II Line at 220 KV GSS Surpura on 24.09.2024

No. of Unwanted operation – 1

Reason of unwanted operation – Line tripped with other faulty line due to misbehave of CVT on nearby fault.

<u>Corrective Action taken</u> – Trying to find out the solution. (may apprise current status).

Case-7 220 KV Madri- Banswara Line & 220KV Debari- Madri line at 220 KV GSS Madri on dated 25.09.2024

No. of Unwanted operation – 1

No. of failures to operate - 1

<u>Reason of unwanted operation</u> –TOR found disabled in relay setting due to this relay failed to operate after reclosing.

<u>Corrective Action taken</u> – TOR enabled and the problem rectified.

Case-8 220 KV BHILWARA-BAMANTUKDA LINE at Bhilwara on 30.09.2024

No. of Unwanted operation – 1

<u>Reason of unwanted operation</u> – CB wiring problem.

<u>Corrective Action taken</u> – CB wiring problem rectified.

Annexure-III

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
उत्तर क्षेत्रीय विद्युत समिति
Northern Regional Power Committee

दिनांक: 01.10. 2024

सेवा में / To,

As per Protection Sub-Committee (PSC) addressee list

विषय: मासिक आधार पर एनआरपीसी सचिवालय को एक से कम सूचकांकों के लिए कारण और सुधारात्मक कार्रवाई के साथ सुरक्षा प्रदर्शन सूचकांक प्रस्तुत करने के संदर्भ में ।

Subject: Submission of Protection Performance indices along with reason and corrective action taken for indices less than unity to NRPC Secretariat on monthly basis -reg.

Ref: IEGC 2023 & discussion of 52nd Protection Sub-Committee (PSC) meeting, held on 20.09.2024.

It is to mention that as per clause 15 (6) of IEGC 2023, users shall submit the protection performance indices of previous month to their respective RPC and RLDC on monthly basis for 220 kV and above (132 kV and above in NER) system. Further, as per clause 15 (7) of IEGC 2023, each user shall also submit the reasons for performance indices less than unity of individual element wise protection system to the respective RPC and action plan for corrective measures. The action plan will be followed up regularly in the respective RPC.

NRPC Secretariat is regularly discussing protection performance indices, received from utilities, in Protection Sub-Committee (PSC) Meetings. **In earlier PSC meetings, it was decided that each utility shall submit the Performance indices of previous month by 7th day of next month.**

However, it has been found that Performance indices have not been submitted from your organization for any of the months from June,2024 to August,2024 even after the same was highlighted in previous Protection Sub-Committee (PSC) meetings.

Therefore, it is requested to direct the concerned officials to submit the Protection Performance indices of previous month by 7th day of next month element wise along with corrective action taken for indices less than unity at seo-nrpc@nic.in. SLDCs may send the compiled data of all utilities (GENCOs, & TRANSCOs) under their jurisdiction.

Signed by Dharmendra Kumar Meena
Date: 01-10-2024 16:47:07

(डी. के. मीणा)
अधीक्षण अभियंता (संरक्षण)

Addressee List

S. No.	Organization	Designation	Email-ID
1	HPGCL	SE/M&T RGTPP	semt.rgtpp@hpgcl.org.in
2	UPRVUNL	Chief Engineer, (L-2)	ce.ppmm@uprvunl.org
3	HPPCL	Managing Director	md@hppcl.in
4	HPSEB	Managing Director	md@hpseb.in
5	Delhi SLDC	General Manager	gmsldc@delhisldc.org
6	Haryana SLDC	Chief Engineer (SO&C)	cesocomml@hvpn.org.in
7	Rajasthan SLDC	Chief Engineer (LD)	ce.ld@rvpn.co.in
8	Uttar Pradesh SLDC	Director	directorsldc@upsldc.org
9	Uttarakhand SLDC	Chief Engineer	anupam_singh@ptcul.org
10	Punjab SLDC	Chief Engineer	ce-sldc@punjabsldc.org
11	Himachal Pradesh SLDC	Managing Director	mdhpsldc@gmail.com
12	UT of J&K	Chief Engineer, JKPCL	cejkpcl2@gmail.com
13	UT of Ladakh	Chief Engineer, LPDD	cepdladakh@gmail.com
14	UT of Chandigarh	Executive Engineer	elop2-chd@nic.in
15	MEIL Anpara Energy Ltd	President	sudheer.kothapalli@meilanparapower.com
16	MEJA Urja Nigam Ltd.	AGM-EMD	SPSPUNDIR@NTPC.CO.IN
17	JSW Energy Ltd. (KWHEP)	Head Regulatory & Power Sales	jyotiprakash.panda@jsw.in
18	POWERLINK	Group Head-Procurement, IT & BE	sandeep.shukla@tatapower.com

Annexure-IV

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
उत्तर क्षेत्रीय विद्युत समिति
Northern Regional Power Committee

दिनांक: 04 अक्टूबर, 2024

सेवा में / To,
संरक्षण उप-समिति (पीएससी) की सूची के अनुसार / As per Protection Sub-Committee (PSC) addressee list

विषय: वित्तीय वर्ष 2024-25 के लिए वार्षिक आंतरिक सुरक्षा आडिट प्लान प्रस्तुत करने के संदर्भ में ।
Subject: Submission of Annual Internal Protection Audit Plan for FY 2024-25 - reg.

Ref: IEGC 2023 & discussion of 52nd Protection Sub-Committee (PSC) meeting, held on 20.09.2024.

It is to mention that as per clause 15 (1) of IEGC 2023, all users shall conduct internal audit of their protection systems annually, and any shortcomings identified shall be rectified and informed to their respective RPC. The audit report along with action plan for rectification of deficiencies detected, if any, shall be shared with respective RPC for users connected at 220 kV and above (132 kV and above in NER). Further, as per clause 15 (5) of IEGC 2023, **Annual audit plan for the next financial year shall be submitted by the users to their respective RPC by 31st October**. The users shall adhere to the annual audit plan and report compliance of the same to their respective RPC:

NRPC Secretariat is regularly discussing the status of Annual Internal Protection Audit Plan in Protection Sub-Committee (PSC) Meetings and concerned are being directed to submit the same accordingly.

However, some organizations have not submitted the Annual Internal Protection Audit Plan and some have submitted partially even after the same was highlighted in previous Protection Sub-Committee (PSC) meetings.

Therefore, it is requested to direct the concerned officials to submit the Annual Internal Protection Audit Plan for FY 2024-25 at the earliest and comply the same timely. Further, audit report along with action plan for deficiency detected, if any may also be submitted. SLDCs may send the compiled data of all utilities (GENCOs, & TRANSCOs) under their jurisdiction.

Signed by Dharmendra
Kumar Meena
Date: 05-10-2024 10:53:48

(डी. के. मीणा)
अधीक्षण अभियंता (संरक्षण)

Addressee list			
S. No.	NRPC Member	Email-ID	Current Status
1	SJVN	sjvn.cso@sjvn.nic.in	Received (Rampur)
2	NPCIL	df@npcil.co.in rajeshsharma@npcil.co.in	Not Received
3	Delhi SLDC	gmsldc@delhisldc.org	Not Received
4	Haryana SLDC	cesocomml@hvpn.org.in	Not Received
5	Rajasthan SLDC	ce.ld@rvpn.co.in	Not Received
6	Uttar Pradesh SLDC	sera@upsldc.org	Not Received
7	Uttarakhand SLDC	anupam_singh@ptcul.org	Not Received
8	Punjab SLDC	ce-sldc@punjabsldc.org	Not Received
9	Himachal Pradesh SLDC	cehpsldc@gmail.com	Not Received
10	IPGCL	arif.ipgcl@gmail.com	Received (PPCL)
11	HPGCL	semt.rgtpp@hpgcl.org.in	Not Received
12	UPRVUNL	ce.ppmm@uprvunl.org	Received (obra -B, Anpara-B switch yard, Harduganj-C,D,E))
13	UJVNL	mdujvnl@ujvnl.com	Received (Khodri, Chibro, Vyasi)
14	HPPCL	md@hppcl.in	Not Received
15	PSPCL	ce-ghtp@pspcl.in	Not Received
16	HPSEBL	md@hpseb.in	Not Received
17	Talwandi Sabo Power Ltd.	Vibhav.Agarwal@vedanta.co.in	Not Received
18	Nabha Power Limited	sk.narang@larsentoubro.com	Not Received
19	MEIL Anpara Energy Ltd	sudheer.kothapalli@meilanparapower.com	Not Received
20	MEJA Urja Nigam Ltd.	SPSPUNDIR@NTPC.CO.IN	Not Received
21	Tata Power Renewable Energy Ltd.	dhmahabale@tatapower.com	Recevied (TPGEL, BTPSL)
22	UT of J&K	cejkpcl2@gmail.com	Not Received
23	UT of Ladakh	cepdladakh@gmail.com	Not Received
24	UT of Chandigarh	elop2-chd@nic.in	Not Received
25	POWERLINK	sandeep.shukla@tatapower.com	Not Received

Annexure-V

Status of Internal Protection Audit Plan for FY 2024 -25

S. No.	NRPC Member	Category	Status
1	PGCIL	Central Government owned Transmission Company	Received
2	NTPC	Central Generating Company	Received
3	BBMB		Received
4	THDC		Received
5	SJVN		Received (Rampur)
6	NHPC		Received
7	NPCIL		
8	Delhi SLDC	SLDC	
9	Haryana SLDC		
10	Rajasthan SLDC		
11	Uttar Pradesh SLDC		
12	Uttarakhand SLDC		
13	Punjab SLDC		
14	Himachal Pradesh SLDC		
15	DTL	State Transmission Utility	Received
16	HVPNL		Received
17	RRVPNL		Received
18	UPPTCL		Received for Jhansi, Lucknow, Meerut, Gorakhpur, Prayagraj, Agra zone)
19	PTCUL		Received
20	PSTCL		Received
21	HPPTCL		Received
22	IPGCL	State Generating Company	Received (PPCL)
23	HPGCL		
24	RRVUNL		Received
25	UPRVUNL		Received (obra -B, Anpara-B switch yard, Harduganj-C,D,E))
26	UJVNL		Received (Khodri, Chibro, Vyasi, Dharasu , Tiloth)
27	HPPCL		
28	PSPCL	State Generating Company & State owned Distribution Company	Received (Ranjet sagar dam)
29	HPSEBL	Distribution company having Transmission connectivity ownership	
30	Prayagraj Power Generation Co. Ltd.	IPP having more than 1000 MW installed capacity	Received
31	Aravali Power Company Pvt. Ltd		Received
32	Apraava Energy Private Limited		Received
33	Talwandi Sabo Power Ltd.		
34	Nabha Power Limited		
35	MEIL Anpara Energy Ltd		Received
36	Rosa Power Supply Company Ltd		Received
37	Lalitpur Power Generation Company Ltd		Received
38	MEJA Urja Nigam Ltd.		
39	Adani Power Rajasthan Limited		Received
40	JSW Energy Ltd. (KWHEP)		Received
41	AESL	Other transmission licensee	Received (ATIL -400kV Mohindergarh S/s, OBTL, FBTL, MTSCL, ATSCL, HPTSL, BKTL, GTL)
42	Tata Power Renewable Energy Ltd.		Recevied (TPGEL, BTPSL)
43	UT of J&K	UT of Northern Region	
44	UT of Ladakh		
45	UT of Chandigarh		
46	INDIGRID		Received
47	ADHPL		Received
48	Sekura Energy Limited		

Annexure-VI

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
उत्तर क्षेत्रीय विद्युत समिति
Northern Regional Power Committee

दिनांक: 10 अक्टूबर, 2024

सेवा में / To,

संरक्षण उप-समिति (पीएससी) की सूची के अनुसार / As per Protection Sub-Committee (PSC) addressee list

विषय: तृतीय पार्टी सुरक्षा आडिट प्लान प्रस्तुत करने के संदर्भ में।
Subject: Submission of third-party protection audit plan-reg.

Ref: IEGC 2023 & discussion of 52nd Protection Sub-Committee (PSC) meeting, held on 20.09.2024.

It is to mention that as per clause 15 (2) of IEGC 2023, all users shall also conduct third-party protection audit of each sub-station at 220 kV and above (132 kV and above in NER) once in five years or earlier as advised by the respective RPC. Further, as per clause 15 (4) of IEGC 2023, the third-party protection audit report shall contain information sought in the format enclosed as Annexure–1 (of IEGC 2023). The protection audit reports, along with action plan for rectification of deficiencies detected, if any, shall be submitted to the respective RPC and RLDC or SLDC, as the case may be, within a month of submission of third-party audit report. The necessary compliance to such protection audit report shall be followed up regularly in the respective RPC.

NRPC Secretariat is regularly discussing the status of Third-Party Protection Audit Plan in Protection Sub-Committee (PSC), OCC & NRPC Meetings and concerned are being directed to submit the same accordingly.

However, some organizations have not submitted their Third-Party Protection Audit Plan and some have sent it partially, even after the same was highlighted in previous Protection Sub-Committee (PSC) meetings.

Therefore, it is requested to direct the concerned officials to submit the Third-Party Protection Audit Plan at the earliest and comply the same timely. Further, audit report along with action plan for deficiency detected, if any may also be submitted. SLDCs may send the compiled data of all utilities (GENCOs, & TRANSCOs) under their jurisdiction.

Signed by Dharmendra Kumar Meena
Date: 11-10-2024 12:43:05

(डी. के. मीना)
अधीक्षण अभियंता (संरक्षण)

Addressee List

S. No.	NRPC Member	Email-ID	Status
1	PGCIL	gunjan.agrawal@powergrid.in	
2	NTPC	dmandal@ntpc.co.in HRASTOGI@NTPC.CO.IN	Received (Tanda)
3	BBMB	dirpc@bbmb.nic.in	
4	THDC	rrsemwal@thdc.co.in	
5	NPCIL	df@npcil.co.in rajeshsharma@npcil.co.in	
6	Delhi SLDC	gmsldc@delhisldc.org	
7	Haryana SLDC	cesocomml@hvpn.org.in	
8	Rajasthan SLDC	ce.ld@rvpn.co.in	
9	Uttar Pradesh SLDC	sera@upsldc.org	
10	Uttarakhand SLDC	anupam_singh@ptcul.org	
11	Punjab SLDC	ce-sldc@punjabsldc.org	
12	Himachal Pradesh SLDC	cehpsldc@gmail.com	
13	DTL	bharatgujardtl@gmail.com	
14	HVPNL	cetspkl@hvpn.org.in	
15	RRVPNL	ce.mps@rvpn.co.in	
16	UPPTCL	md@upptcl.org	
17	PTCUL	setandchld@gmail.com	
18	PSTCL	ce-pm@pstcl.org	
19	HPPTCL	md.tcl@hpmail.in	
20	IPGCL	arif.ipgcl@gmail.com	
21	HPGCL	semt.rgtpp@hpgcl.org.in	
22	RRVUNL	cmd@rrvun.com	
23	UPRVUNL	ce.ppmm@uprvunl.org	Received (DTPS-Anpara)
24	UJVNL	mdujvnl@ujvnl.com	
25	HPPCL	md@hppcl.in	
26	PSPCL	ce-ghtp@pspcl.in	
27	HPSEBL	md@hpseb.in	
28	Aravali Power Company Pvt. Ltd	brahmajig@ntpc.co.in	
29	Talwandi Sabo Power Ltd.	Vibhav.Agarwal@vedanta.co.in	
30	Nabha Power Limited	sk.narang@larsentoubro.com	
31	MEJA Urja Nigam Ltd.	SPSPUNDIR@NTPC.CO.IN	
32	Tata Power Renewable Energy Ltd.	dhmahabale@tatapower.com	
33	UT of J&K	cejkpcl2@gmail.com	
34	UT of Ladakh	cepdladakh@gmail.com	
35	UT of Chandigarh	elop2-chd@nic.in	
36	INDIGRID	vivek.karthikeyan1@indigrid.com	
37	POWERLINK	sandeep.shukla@tatapower.com	

Annexure-VII

Status of 3rd Party Protection Audit Plan

S. No.	NRPC Member	Category	Status	Schedule submitted as per utililty	Present Status Comlpleted (yes/no)
1	PGCIL	Central Government owned Transmission Company			
2	NTPC	Central Generating Company	Received (Tanda)	By 17.07.2025	
3	BBMB				
4	THDC		Received (Tehri)	March 2026	
5	SJVN		Received	FY-2025-26 for RHPS, Nov 24- March 25 for NJHPS	
6	NHPC		Received	FY-2025-26	
7	NPCIL				
8	Delhi SLDC				
9	Haryana SLDC				
10	Rajasthan SLDC				
11	Uttar Pradesh SLDC				
12	Uttarakhand SLDC				
13	Punjab SLDC				
14	Himachal Pradesh SLDC				
15	DTL	State Transmission Utility			
16	HVPNL				
17	RRVPNL				
18	UPPTCL				
19	PTCUL				
20	PSTCL				
21	HPPTCL				
22	IPGCL	State Generating Company			
23	HPGCL				
24	RRVUNL				
25	UPRVUNL		Received (DTPS-Anpara)	01.05.2024	Revised schedule will be submitted
26	UJVNL				
27	HPPCL				
28	PSPCL	State Generating Company & State owned Distribution Company			
29	HPSEBL	Distribution company having Transmission connectivity ownership			
30	Prayagraj Power Generation Co. Ltd.	IPP having more than 1000 MW installed capacity	Received	Dec-24	
31	Aravali Power Company Pvt. Ltd				
32	Apraava Energy Private Limited		Received	By May, 2025	
33	Talwandi Sabo Power Ltd.				
34	Nabha Power Limited				
35	MEIL Anpara Energy Ltd		Received	Dec-24	
36	Rosa Power Supply Company Ltd		Received	By 30.09.2024	May update current status
37	Lalitpur Power Generation Company Ltd		Conducted	26.03.2024	
38	MEJA Urja Nigam Ltd.				
39	Adani Power Rajasthan Limited		Received (Kawai)	September, 2024	May update current status
40	JSW Energy Ltd. (KWHEP)		Received	December 2024 to March 2025	
41	AESL	Other Transmission Licensee	Received (ATIL -400kV Mohindergarh S/s,)	400kV Mohindergarh SS- Q2 , FY 2025-26	
			Received (OBTL)	OBTL-Q1 , FY 2025-26	
			Received (FBTL)	FBTL-Q3 , FY 2025-26	
			Received (MTSCL)	MTSCL-Q4 , FY 2025-26	
			Received (ATSCL)	ATSCL-Q1 , FY 2026-27	
			Received (HPTSL)	HPTSL- Q2 , FY 2026-27	
			Received (BKTL)	BKTL-Q3 , FY 2026-27	
			Received (GTL)	GTL- Q3 & Q4, FY 2026-27	
42	Tata Power Renewable Energy Ltd.	IPP having less than 1000 MW installed capacity (alphabetical rotaional basis)			
43	UT of J&K	UT of Northern Region			
44	UT of Ladakh				
45	UT of Chandigarh				
46	INDIGRID		Received (NRSS 29)	FY 24-25	
47	ADHPL		Received	30.09.2024	May update current status
48	Sekura Energy Limited				

* Revised Schedule

Annexure-VIII

Email **LokeshAgrawal**

RE: Submission of third-party protection audit plan-reg.

From : sandeep shukla <sandeep.shukla@tatapower.com> Fri, Oct 11, 2024 02:39 PM
Subject : RE: Submission of third-party protection audit plan-reg.
To : LokeshAgrawal <lokesh.cea@gov.in>
Cc : surangev@tatapower.com, Sh V K Singh <ms-nrpc@nic.in>, Santosh Kumar <seo-nrpc@nic.in>, Reeturaj Pandey <pandeyr.cea@gov.in>, Kaushik Panditrao <kaushik.panditrao@gov.in>

Dear Sir,

All transmission lines which mentioned below belong to Powerlinks Transmission Limited and substation , Bays & Relay are being maintained by Powergrid :

S.N.	Line details	Voltage	Conductor		Sub
1	Muzaffarpur-Gorakhpur I	400kV	ACSR	QUAD-MOOSE	bot
2	Muzaffarpur-Gorakhpur II	400kV	ACSR	QUAD-MOOSE	bot
3	Gorakhpur-Lucknow I	400kV	ACSR	TWIN-MOOSE	bot
4	Gorakhpur-Lucknow II	400kV	ACSR	TWIN-MOOSE	bot
5	Bareilly-Bareilly I	400kV	ACSR	TWIN-MOOSE	One end
6	Bareilly-Bareilly II	400kV	ACSR	TWIN-MOOSE	One end
7	Bareilly-Meerut I	400kV	ACSR	TWIN-MOOSE	bot
8	Bareilly-Meerut II	400kV	ACSR	TWIN-MOOSE	bot
9	Meerut-Mandola I	400kV	ACSR	TWIN-MOOSE	bot
10	Meerut-Mandola II	400kV	ACSR	TWIN-MOOSE	bot

So, this Protection Plan is not applicable for us .

This is for your information pl.

Regards,
Sandeep Kumar Shukla
Group Head-Procurement, IT & BE.
Powerlinks Transmission Limited – 10th floor, DLF Tower A, District Centre, Jasola, New Delhi 110025, India

From: Lokesh Agrawal <lokesh.cea@gov.in>
Sent: 11 October 2024 13:31
To: ce-pm <ce-pm@pstcl.org>; mdtcl <md.tcl@hpmail.in>; arifipgcl <arif.ipgcl@gmail.com>; semtrgtpp <semt.rgtpp@hpgcl.org.in>; cmd <cmd@rrvun.com>; ceppmm <ce.ppmm@uprvunl.org>; mdujvnl <mdujvnl@ujvnl.com>; md <md@hppcl.in>; ce-ghtp <ce-ghtp@pspcl.in>; md <md@hpseb.in>; brahmajig <brahmajig@ntpc.co.in>; VibhavAgarwal <Vibhav.Agarwal@vedanta.co.in>; sknarang <sk.narang@larsentoubro.com>; SPSPUNDIR <SPSPUNDIR@NTPC.CO.IN>; Mahabale Deepak <dhmahabale@tatapower.com>; cejkpcl2 <cejkpcl2@gmail.com>; cepdladakh <cepdladakh@gmail.com>; elop2-chd <elop2-chd@nic.in>; vivekkarthikeyan1 <vivek.karthikeyan1@indigrid.com>; Shukla Sandeep <sandeep.shukla@tatapower.com>
Cc: Sh Singh <ms-nrpc@nic.in>; Santosh Kumar <seo-nrpc@nic.in>; Reeturaj Pandey <pandeyr.cea@gov.in>; Kaushik Panditrao <kaushik.panditrao@gov.in>
Subject: Submission of third-party protection audit plan-reg.

[EXTERNAL sender, Exercise caution..!]

महोदय/महोदया,

Please find attached letter on cited subject matter for kind necessary action.

सादर,
लोकेश अग्रवाल,
सहायक कार्यपालक अभियंता (संरक्षण),
उत्तर क्षेत्रीय विद्युत् समिति सचिवालय,
नई दिल्ली - 110016

============ Forwarded message ============
From: Lokesh Agrawal <lokesh.cea@gov.in>
To: "gunjanagrawal"<gunjan.agrawal@powergrid.in>, "dmandal"<dmandal@ntpc.co.in>, "HRASTOGI"<HRASTOGI@NTPC.CO.IN>, "dirpc"<dirpc@bbmb.nic.in>, "rrsemwal"<rrsemwal@thdc.co.in>, "df"<df@npcil.co.in>, "rajeshsharma"<rajeshsharma@npcil.co.in>, "gmsldc"<gmsldc@delhisldc.org>, "cesocomml"<cesocomml@hvpn.org.in>, "celd"<ce.ld@rvpn.co.in>, "sera"<sera@upsldc.org>, "anupam_singh"<anupam_singh@ptcul.org>, "ce-sldc"<ce-sldc@punjabsldc.org>, "cehpsldc"<cehpsldc@gmail.com>,

"bharatgujardtl"<bharatgujardtl@gmail.com>, "cetspkl"<cetspkl@hvpn.org.in>, "cemps"<ce.mps@rvpn.co.in>, "md"<md@upptcl.org>, "setandchld"<setandchld@gmail.com>
Cc: "Sh Singh"<ms-nrpc@nic.in>, "Santosh Kumar"<seo-nrpc@nic.in>, "Reeturaj Pandey"<pandeyr.cea@gov.in>, "Kaushik Panditrao"<kaushik.panditrao@gov.in>
Date: Fri, 11 Oct 2024 13:30:11 +0530
Subject: Submission of third-party protection audit plan-reg.
============ Forwarded message ============

महोदय/महोदया,

Please find attached letter on cited subject matter for kind necessary action.

सादर,

लोकेश अग्रवाल,

सहायक कार्यपालक अभियंता (संरक्षण),

उत्तर क्षेत्रीय विद्युत् समिति सचिवालय,

नई दिल्ली - 110016

Annexure-IX

Pragati Power Corporation Limited			
Report of the Protection Audit			
A. General Information:			
i) Name of utility	1500 MW Combined Cycle Pragati Power Station - III (CCGT, Bawana)	**ii) Name of Voltage level of sub-station:**	400 KV
iii) Date of commissioning		**iv) Type of bus-switching scheme:**	One and a Half Breaker Scheme
v) Name and Organization of Audit Team	Pragati Power Corporation Limited, Uttam Kumar Sarkar, Manager (Electrical)	**vi) Name of representative from utility whose audit is being carried out**	Manoj Goyal , Dy. Mgr (Protection)

B. Check List for Protection Audit

S.No	Check		Functional/Non Functional/ Enable/Disabled	Type of relay * (Numerical)/Static/Electromechanical)	Setting as found in the field*/**	Compliance status w.r.t. regulatory provisions
1	**DC system**					
	No. of independent DC Sources	4 NOS. 220V DC (21.08.2024)	Functional			
1 D	Potential between +ive & earth (Source-1) ------V	136.60				Comply
	Potential between -ive & earth (Source-1) ------V	102.50				Comply
2 D	Potential between +ive & earth (Source-2) ------V	136.80				Comply
	Potential between -ive & earth (Source-2) ------V	101.40				Comply
0 FA	Potential between +ive & earth (Source-1) ------V	89.90				Comply
	Potential between -ive & earth (Source-1) ------V	149.10				Comply
0 FB	Potential between +ive & earth (Source-2) ------V	88.10				Comply
	Potential between -ive & earth (Source-2) ------V	148.10				Comply
2	**Event Logger panel**	YES	Functional		Inbuilt in Numerical protection relays	Comply

Manoj Goyal

[illegible]

3	**Event Logger Time Synchronised**	YES				Comply
	Disturbance Recorder	Yes	Functional		Inbuilt in Numerical protection relays	Comply
	DR Time Synchronised	Yes				Comply
4	**Transformer Protection Panel: GTGT # 1 (220.6 MVA)**					
	Tripping by Buchholz relay(Alarm)	Yes	Functional		Alarm as well as trip	Comply
	Differential Protection	Yes	Functional	Numeric/Siemens/7UT633	SLOPE 1 - 0.2 I/In, SLOPE 2 - 0.8 I/In	Comply
	2^{nd} Harmonic Block(Setting)	Yes	Functional		2nd - 15%, nth - 30%	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	REF Protection	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Backup over current	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Earth Fault protection	Yes	Functional	Numeric/Siemens/7UT633	Ie> - 0.1 A, T Ie> - 3 sec, Ie>> - 6 A, T Ie>> - 0.15 sec	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Over Flux Protection	Yes	Functional	Numeric/Siemens/7UT633	U/f > 1.10 , Time - 5 sec (Alarm).	Comply
					U/f >> 1.40, Time - 2 sec (Trip). Thermal curve also set	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Local Breaker Back up	Yes	Functional	Numeric/Siemens/7SS52		Comply
	Retrip	Yes	Functional		T1 – 50 msec	Comply

	Current and Time setting	Yes	Functional		Current - 0.10 I/In, T - 200 ms	Comply
	Seperate single and three phase initiation	No				Comply
	Earth fault					Comply
	Event Logger	Yes	Functional		In built in numerical relay	Comply
5	**Transformer Protection Panel: GTGT # 2 (220.6 MVA)**					
	Tripping by Buchholz relay(Alarm)	Yes	Functional		Alarm as well as trip	Comply
	Differential Protection	Yes	Functional	Numeric/Siemens/7U T633	SLOPE 1 - 0.2 I/In, SLOPE 2 - 0.8 I/In	Comply
	2^{nd} Harmonic Block(Setting)	Yes	Functional		2nd - 15%, nth - 30%	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	REF Protection	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Backup over current	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Earth Fault protection	Yes	Functional	Numeric/Siemens/7U T633	Ie> - 0.1 A, T Ie> - 3 sec, Ie>> - 6 A, T Ie>> - 0.15 sec	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Over Flux Protection	Yes	Functional	Numeric/Siemens/7U T633	U/f > 1.10 , Time - 5 sec (Alarm).	Comply
					U/f >> 1.40, Time - 2 sec (Trip). Thermal curve also set	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Local Breaker Back up	Yes	Functional	Numeric/Siemens/7S S52		Comply
	Retrip	Yes	Functional		T1 – 50 msec	Comply

	Current and Time setting	Yes	Functional		Current - 0.10 I/In, T - 200 ms	Comply
	Seperate single and three phase initiation	No				Comply
	Earth fault					Comply
	Event Logger	Yes	Functional		In built in numerical relay	Comply
6	**Transformer Protection Panel: GTGT # 3 (220.6 MVA)**					
	Tripping by Buchholz relay(Alarm)	Yes	Functional		Alarm as well as trip	Comply
	Differential Protection	Yes	Functional	Numeric/Siemens/7UT633	SLOPE 1 - 0.2 I/In, SLOPE 2 - 0.8 I/In	Comply
	2^{nd} Harmonic Block(Setting)	Yes	Functional		2nd - 15%, nth - 30%	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	REF Protection	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Backup over current	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Earth Fault protection	Yes	Functional	Numeric/Siemens/7UT633	Ie> - 0.1 A, T Ie> - 3 sec, Ie>> - 6 A, T Ie>> - 0.15 sec	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Over Flux Protection	Yes	Functional	Numeric/Siemens/7UT633	U/f > 1.10 , Time - 5 sec (Alarm).	Comply
					U/f >> 1.40, Time - 2 sec (Trip). Thermal curve also set	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Local Breaker Back up	Yes	Functional	Numeric/Siemens/7SS52		Comply
	Retrip	Yes	Functional		T1 – 50 msec	Comply
	Current and Time setting	Yes	Functional		Current - 0.10 I/In, T - 200 ms	Comply

	Seperate single and three phase initiation	No				Comply
	Earth fault					Comply
	Event Logger	Yes	Functional		In built in numerical relay	Comply
7	**Transformer Protection Panel: GTGT # 4 (220.6 MVA)**					
	Tripping by Buchholz relay(Alarm)	Yes	Functional		Alarm as well as trip	Comply
	Differential Protection	Yes	Functional	Numeric/Siemens/7U T633	SLOPE 1 - 0.2 I/In, SLOPE 2 - 0.8 I/In	Comply
	2^{nd} Harmonic Block(Setting)	Yes	Functional		2nd - 15%, nth - 30%	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	REF Protection	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Backup over current	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Earth Fault protection	Yes	Functional	Numeric/Siemens/7U T633	Ie> - 0.1 A, T Ie> - 3 sec, Ie>> - 6 A, T Ie>> - 0.15 sec	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Over Flux Protection	Yes	Functional	Numeric/Siemens/7U T633	U/f > 1.10 , Time - 5 sec (Alarm).	Comply
					U/f >> 1.40, Time - 2 sec (Trip). Thermal curve also set	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Local Breaker Back up	Yes	Functional	Numeric/Siemens/7S S52		Comply
	Retrip	Yes	Functional		T1 – 50 msec	Comply
	Current and Time setting	Yes	Functional		Current - 0.10 I/In, T - 200 ms	Comply
	Seperate single and three phase initiation	No				Comply

Manoj Goyal [signature]

	Earth fault					Comply
	Event Logger	Yes	Functional		In built in numerical relay	Comply
8	**Transformer Protection Panel: STGT # 1 (292 MVA)**					
	Tripping by Buchholz relay(Alarm)	Yes	Functional		Alarm as well as trip stage	Comply
	Differential Protection	Yes	Functional	Numeric/Siemens/7U T633	SLOPE 1 - 0.2 I/In, SLOPE 2 - 0.8 I/In	Comply
	2nd Harmonic Block(Setting)	Yes	Functional		2nd - 15%, nth - 30%	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	REF Protection	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Backup over current	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Earth Fault protection	Yes	Functional	Numeric/Siemens/7U T633	Ie> - 0.1 A, T Ie> - 3 sec, Ie>> - 6 A, T Ie>> - 0.15 sec	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Over Flux Protection	Yes	Functional	Numeric/Siemens/7U T633	U/f > 1.10 , Time - 5 sec (Alarm).	Comply
					U/f >> 1.40, Time - 2 sec (Trip). Thermal curve also set	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Local Breaker Back up	Yes	Functional	Numeric/Siemens/7S S52		Comply
	Retrip	Yes	Functional		T1 – 50 msec	Comply
	Current and Time setting	Yes	Functional		Current - 0.10 I/In, T - 200 ms	Comply
	Seperate single and three phase initiation	No				Comply
	Earth fault					Comply

	Event Logger	Yes	Functional		In built in numerical relay	Comply
9	**Transformer Protection Panel: STGT # 2 (292 MVA)**					
	Tripping by Buchholz relay(Alarm)	Yes	Functional		Alarm as well as trip stage	Comply
	Differential Protection	Yes	Functional	Numeric/Siemens/7UT633	SLOPE 1 - 0.2 I/In, SLOPE 2 - 0.8 I/In	Comply
	2nd Harmonic Block(Setting)	Yes	Functional		2nd - 15%, nth - 30%	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	REF Protection	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Backup over current	No				Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Earth Fault protection	Yes	Functional	Numeric/Siemens/7UT633	Ie> - 0.1 A, T Ie> - 3 sec, Ie>> - 6 A, T Ie>> - 0.15 sec	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Over Flux Protection	Yes	Functional	Numeric/Siemens/7UT633	U/f > 1.10 , Time - 5 sec (Alarm).	Comply
					U/f >> 1.40, Time - 2 sec (Trip). Thermal curve also set	Comply
	Event Logger operation	Yes	Functional		In built in numerical relay	Comply
	Local Breaker Back up	Yes	Functional	Numeric/Siemens/7SS52		Comply
	Retrip	Yes	Functional		T1 – 50 msec	Comply
	Current and Time setting	Yes	Functional		Current - 0.10 I/In, T - 200 ms	Comply
	Seperate single and three phase initiation	No				Comply
	Earth fault					Comply
	Event Logger	Yes	Functional		In built in numerical relay	Comply

10	**Distance Protection Panel: 400KV Bawana Bahadurgurh Ckt**	CT Ratio=1000/1	Functional			
	Line Length – 49.00 km					
	Pole discrepancy relay	Yes	Functional		1.5 sec	Comply
	PLCC panel	Yes	Functional			
	Zone-1/2/3/4/5 (Settings)	Yes	Functional	Numerical/Siemens/7 SA522	Zone1 - 12.971Ω	80 % of the Main Line
					Zone 2 - 19.455 Ω	120 % of the Main Line
					Zone 3 - 52.967 Ω	120 % (Main Line + Longest Adjacent Line)
					Zone 4 - 3.244 Ω	20 % of main Line in reverse direction
	Time check-Z-1/2/3/4/5 (Settings)	Yes	Functional		Zone 1 - 0 sec	Comply
					Zone 2 - 0.35 sec	Comply
					Zone 3 - 1.0 sec	Comply
					Zone 4 - 0.5 sec	Comply
	SOTF	Yes	Functional	Numerical/Siemens/7 SA522	I>>> - 2500A	Comply
	Aided schemes	No				
	Fault Locator	Yes	Functional	Numerical/Siemens/7 SA522	Start - Pick up	Comply
	Power swing (Settings R and X)	Yes	Functional	Numerical/Siemens/7 SA522	Enabled	Comply
	All Zone block	Yes		Numerical/Siemens/7 SA522	All Zones Blocked	Comply
	DR	Yes			Inbuilt in numerical relay	Comply
	Binary Inputs	No				
	Breaker Contacts					
	Carrier Receive	Yes	Functional			Comply
	Time Synchronization	Yes	Functional			Comply

Manjeet Shekhar

	Over voltge	Yes	Functional		110 %, 5 sec.	Comply
	Over voltge 2	Yes	Functional		140 %, 0.10 sec	
11	**Distance Protection Panel: 400KV Bawana Bhiwani Ckt**	CT Ratio=1000/1	Functional			
	Line Length – 97.40 kM					
	Pole discrepancy relay	Yes	Functional		1.5 Secs	
	PLCC panel	Yes	Functional			
	Zone-1/2/3/4/5 (Settings)	Yes	Functional	Numerical/Siemens/7 SA522	Zone 1 - 25.793 Ω	80 % of the Main Line
					Zone 2 - 38.684 Ω	120 % of the Main Line
					Zone 3 - 71.247 Ω	120 % (Main Line + Longest Adjacent Line)
					Zone 4 - 6.447 Ω	20 % of main Line in reverse direction
	Time check-Z-1/2/3/4/5 (Settings)	Yes	Functional		Zone 1 - 0 sec	Comply
					Zone 2 - 0.35 sec	Comply
					Zone 3 - 1.5 sec	Z 3 of main line found to be encroaching into the other voltage level. Hence Time delay of 1.5 secs is correct.
					Zone 4 - 0.5 sec	Comply
	SOTF	Yes	Functional	Numerical/Siemens/7 SA522	I>>> - 2500A	Comply
	Aided schemes	No				
	Fault Locator	Yes	Functional	Numerical/Siemens/7 SA522	Start - Trip	Comply
	Power swing (Settings R and X)	Yes	Functional	Numerical/Siemens/7 SA522	Enabled	Comply
	All Zone block	Yes	Functional	Numerical/Siemens/7 SA522	All Zones Blocked	Comply
	DR	Yes				
	Binary Inputs	No				
	Breaker Contacts					

	Carrier Receive	Yes	Functional			
	Time Synchronization	Yes	Functional			
	Over voltge	Yes	Functional		110 %, 5 sec.	Comply
	Over voltge 2	Yes	Functional		142 %, 0.10 sec	Comply
12	**400 kV Bus Protection**	Yes	Functional	Numeric/Siemens/7SS52	Diff Current - 0.9 I/In	Comply
	EL output for this event	Yes	Functional		Inbuilt in numerical relay	Comply
	DR if available	Yes	Functional		Inbuilt in numerical relay	Comply
13	**Single Phase Auto Recloser Scheme**	Yes	Functional			
14	**CT**					
	Suitable as per fault level	Yes				
15	**DG Set**	Yes	Functional		Auto	Comply
16	**Mock Testing of a sample protection associated with transmission line**	Yes/No				

1500 MW Pragati Power Station – III (CCGT, Bawana)

Pragati Power Corporation Limited

(A Govt. of NCT of Delhi Undertaking)

Observations on the Internal Protection Audit Conducted in the month of August 2024

1. DC system found healthy and balanced.
2. GPS Clock found healthy and functional.
3. All relays were time synchronized to the GPS clock.
4. Settings of Generator Transformers found matching to the recommendations of the OEM i.e M/ s BHEL.
5. Pole Discrepancy time delays of Main HVCB of Bawana – Bahadurgarh as well as Bawana – Bhiwani Circuits were found to be set at 2.5 seconds. The same were rectified to 1.5 seconds
6. It was observed that the Zone 3 time delay of Bawana – Bhiwani Line set at 1.5 seconds. In order to check the correctness, setting calculations were reviewed and it was found that the Zone 3 reach was encroaching into the other voltage level. Hence, the time delay of 1.5 seconds is justified.
7. Power Swing Blocking was found to be set for "Zone 2 and higher" in both the transmission lines. The same was modified to "Block for all Zones"
8. A time delay of 100 milliseconds has been introduced in the Stage 2 Over Voltage Settings.

03/10/2024

Arif Rahman

Dy. Gen. Manager (Protection)

PPS – III, Bawana

AN INTERNAL AUDIT REPORT

ON

400/132 kVSWITCHYARD AT ANPARA-BTPS

APRIL 2024

EXECUTIVE SUMMARY

EMD III BTPS Anpara has carried out "Internal protection audit of 400/132 kV Substation at Anpara, BTPS "as per guidelines of New grid code 2024 on April 2024 .This Protection Audit covers the review of protection of ICT, Station Transformers, CW'S, Transmission lines (400 &132 kV) and other protection infrastructure installed at Anpara, BTPS. The power is evacuated through seven 400 kV and three 132 kV lines to Northern region grid.

The scope of this Protection involves the Review of the implemented protection schemes/philosophy & review of main & backup Protection setting & coordination in the switchyard which includes protection of ICT, Station Transformers, CW'S, Transmission lines (400 &132 kV), reactors, circuit breakers, bus bar etc. as per CBIP/NRLDC/NRP etc. guidelines. This also involves Reviewing of availability/healthiness of communication links like PLCC, optical fiber used for protection, healthiness/ adequacy of 220/ 48/ 24 V DC, GPS/TSU, and circuit breaker report.

The major equipment for which protection audit has been carried out are as under:

- ICT (3X100 MVA)
- Station Transformer (2 X 40MVA & 2*60 MVA)
- CW'S (3*40 MVA)
- Transmission Lines (7*400 kV & 3*132 kV)
- Bus Reactor (63 MVAR)
- 400 & 132 kV Bus bars.

As a general finding from this audit, it is observed that the 400/132 kV substation equipment is also well protected as per Northern region Power Committee recommendation. 400 kV and 132 kV lines, ST’S, and CW’S have independent main-1 and main-2 functional protection. Bus bar, bus reactor are also well protected as per NRPC defined Protection. Operational protection setting is in order.

The state of DC supply at substation inspected and found in order. Time. Functionality of GPS/TSU, circuit breaker reports is also inspected and all are found in satisfactory state.

Details of protection schemes and review of protection setting and necessary recommendation ofsetting wherever needed are listed in the audit report.

General Observation and Philosophy adopted in substations

Philosophy used for Distance protection:

The philosophy adopted for 400/132 kV lines Distance protection relay settings is given belowwhich is generally in accordance with Task force guidelines, given below

Distance protection settings:

Zone-1 Reach: Set to 80% of the Protection lineZone-1 Time : Instantaneous

Zone-2 Reach: 100% of the protected line + 50% of the shortest line emanating from the far endbus bar, or, 120% of the Protected line, whichever is higher

Zone-2 Time : 350ms for short lines (<100km) and 500ms for long lines >100km

Zone-3 Reach : 120% of the protected line + 100% of the longest line emanating from the farend bus bar, or 100% of the Protected line + 100% of the longest line emanating from the far end bus bar + 25% of the longest line emanating from the far end of the second line considered, whichever is lower.

The zone setting to be limited such that it will not reach into the next voltage levelZone-3 Time : 1000ms
Zone-3R or Zone 4: 25% of the Zone-1 reachesZone-3R or Zone 4 Time: 1000 ms
Resistive Reach Setting: Zone-1 Setting is restricted by R/X ratio)

Zone	ABB REL-670		SIEMENS 7SA522		MICOM P-443/443	
	P-P	P-E	P-P	(P-E)*(1+RE/RL)	P-P	P-E
Zone-1	30	50	15	50	30	50
Zone-2	60	75	30	75	60	75
Zone-3	75	125	37.5	125	75	125
Reverse Zone	60	75	30	75	75	125

Value of P-E to be fed in the relay shall be calculated as belowP-E (Zone-1):50/ (1+RE/RL)
P-E (Zone-2): 75/ (1+RE/RL) P-E (Zone-3): 125/ (1+RE/RL)P-E
(Zone-4): 75/ (1+RE/RL)

Philosophies used for Transformer protection:

The philosophy adopted for Transformer protection relay settings is given below which isgenerally in accordance with CBIP guidelines, given below

Group-A			Group-B	
Differential Protection	**HV Back Up Over Current and Earth Fault**	**Over Fluxing Protection**	**LV Back Up Over Current and Earth Fault**	**Restricted Earth Fault**

General protections in 400/132 kV switchyard:

400/132 kV substation Anpara-BTPS Protection System		
SLNO	**Description**	**400/132 KV**
1	**Name Of Grid Substation**	400/132 kV Anpara-BTPS
2	**Highest Voltage Level**	400
3	**Year Of Installation**	--
4	**No Of Feeders**	11 -4(132KV),7(400KV)
5	**No of Units**	2
6	**No of Transformers, Make andCapacity**	ICT'S:3*100 MVA (400/132) kV ST'S:2*60 MVA (132/6.9) kV,2*40 MVA (132/6.9 kV)CW'S:3*40MVA (132/6,9 Kv)
7	**Busbar Arrangement**	(400 kV buses) and (132kV buses)
8	**Present Busbar Switching Status**	Fully Commissioned. bays are connected to different buses
9	**Busbar Protection**	Provided
10	**Relay System Status**	In Service
11	**DC Supply System**	Transmission Unit i)Two Nos of Battery Bank with 220 V DC,400AH Capacity, Two no 1500 AH capacity and Four no's of battery Chargers for 2200V System(Float cum Boost) are in service Four Nos of Battery Bank with 48 V DC,400AH Capacity and Four no's of battery Chargers for 48 V System (Float cum Boost) are in service at ATPS, BTPS.
12	**DC Supply Capacity andAdequacy**	DC system is adequate for the station load
13	**DC System Earth Fault Status**	Both the systems are Healthy
14	**PLCC**	healthy
15	**GPS Clock Receiver & Synchronization Of Relay Status**	Provided
16	**Common Event Logger Status**	Not-Provided
17	**Line Disturbance Recorder**	Not-Provided
18	**LBB Protection status**	Provided
19	**General Observation of Relay**	System is working satisfactorily.

Relays used for transmission line, Transformer, Bus bar, and Reactor:

Table-1 Relay used for Transmission Line Protection:-

Sl No	**Name of Line**	Main I (Distance, Diff, Backup earth fault)	Main II (Distance, Diff, Backup O/C earthfault)
1	ANPARA SINGRAULI L1	AVERA P-442	SIEMENS, SIPROTECH 7SA52
2	ANPARA OBRA L2	SIEMENS, SIPROTECH 7SA52	ABB REL-670
3	ANPARA SARNATH L3	SIEMENS, SIPROTECH 7SA52	ABB REL-670
4	ANPARA SARNATH L5	SIEMENS, SIPROTECH 7SA52	ABB REL-670
5	ANPARA MAU L6	SIEMENS, SIPROTECH 7SA52	ABB REL-670
6	ANPARA B TO ANPARA D L8	ALSTOM, MICOMP-543	ABB REL-670
7	ANPARA B TO ANPARA D L9	ALSTOM, MICOMP-543	ABB REL-670
8	ANPARA BINA LINE L1	ABB REL-670	MICOM P-142
9	ANPARA PIPRI IIL34	ABB REL-670	MICOM P-142
10	ANPARA PIPRI IIL4	ABB REL-670	MICOM P-142

Table-2 Relays used for Transformer Protection:

Sl. No.	Transformer Details	Group-A			Group-B	
		Differential Protection	HV Back Up Over Current and Earth Fault	Over Fluxing Protection	LV Back Up Over Current and Earth Fault	Restricted Earth Fault
1	ICT 1 400/132kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P-142	MICOM P-645
2	ICT 2 400/132kV	MICOM P-645	MICOM P-645,P142	MICOM P-645	MICOM P-142	MICOM P-645
3	ICT 3 400/132kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P-142	MICOM P-645
4	ST-1 132/6.9kV	MICOM P-645	MICOM P-142	MICOM P-645	MICOM P-142	MICOM P-645
5	ST-2 132/6.9kV	MICOM P-645	MICOM P-142	MICOM P-645	MICOM P-142	MICOM P-645
6	ST-3 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
7	ST-4 132/6.9kV	DTH 32 HG	CDD 21	GTT		
8	CW-1 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P-142	MICOM P-645
9	CW-2 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P-142	MICOM P-645
10	CW-3 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P142	MICOM P-645

Table-3 Relay used for Bus bar Protection:-

Sl.No.	**Name of Bay**	Main-I	Main-II
1	Bus Section-1	MICOM,P-142	MICOM,P-141
2	Bus section-2	MICOM,P-142	EE,MCAG
3	400 kV Bus Bar	HITACHI-P 34964	-
4	132 kV Bus Bar	EE,CAG	-
5	132 kV Bus Coupler	EE,CDA	-
6	ATPS Bus Bar	EE,CAG	-
7	ATPS Bus Coupler	MICOM,P-142	-

Table-4 Relay used for Reactor Protection:

Sl. No.	**Name of Reactor**	**Differential Protection (Make & Model)**	**REF Protection (Make & Model)**	**Back-Up Impedance Protection (Make & Model)**
1	Bus Reactor	ALSTOM, P-645	-	-

INPUT DATA FOR TRANSMISSION LINE PROTECTION

Table-4 Input Data for Transmission Line Protection:

S. No.	**Description**	Units	Line	Line	Line	Line	Line
0	**Station Name**		ANPARA -BTPS	ANPARA -BTPS	ANPARA - BTPS	ANPARA - BTPS	ANPARA - BTPS
1	**Line Reference**		ANPARA-SINGURAULI LINE -L1	ANPRA – OBRA LINE L2	ANPARA-SARNATH LINE L3	ANPARA-SARNATH LINE	ANPARA-MAU LINE
1.1	Line voltage level	kV	400	400	400	400	400
1.2	Name of remote substation		SINGURALI	OBRA	SARNATH	SARNATH	MAU
2	**Main 1**		YES	YES	YES	YES	YES
2.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
2.2	Model & Make		MICOM P-442	SIEMENS, SIPROTECH 7SA52	SIEMENS, SIPROTECH 7SA52	SIEMENS, SIPROTECH 7SA52	SIEMENS, SIPROTECH 7SA52
3	**Main 2 protection**		YES	YES	YES	YES	YES
3.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
3.2	Model & Make		SIEMENS, SIPROTECH 7SA52	ABB REL-670	ABB REL-670	ABB REL-670	ABB REL-670
4	**LBB Protection**		YES	YES	YES	YES	YES
4.1	Protection Type		ELECTRO MECHNICAL	ELECTRO MECHNICAL	ELECTRO MECHNICA	ELECTRO MECHNICAL	ELECTRO MECHNICA
4.2	Model & Make		EE,CTIG	EE,CTIG	EE,CTIG	HITACHI, 3E81766	HITACHI, 3E81766
5	**CT data for Main 1**						
5.1	Ratio	A/A	1000/1	1000/1	1000/1	1000/1	1000/1
6	**CT data for Main 2**						
6.1	Ratio	A/A	1000/1	1000/1	3000/1	3000/1	1000/1
7	PT Ratio	kV/V	400/110	400/110	400/110	400/110	400/110
8	**PROTECTED LINE DATA**						

8.1	Line Length	Km	26.80	37	156.7	156.7	262
8.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.0275	0.0275	0.0275
8.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.331	0.331	0.331
8.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.261	0.261	0.261
8.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.031	1.031	1.031
8.6	Line Impedance	Ohms	2.270 (213.6mOhm)				
8.7	Line Angle	Deg	84.60 (j 2.260Ohm)				
9	**ADJECENT SHORTEST LINE**		SINRAULI-VINDHYACHAL	ANPARA-OBRA	SARNATH-AZAMGARH	SARNATH-AZAMGARH	MAU-AZAMGRAH
9.1	Line Length	Km	3.34	37	101.9	101.9	9.24
9.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.0275	0.0275	0.0275
9.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.331	0.331	0.331
9.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.261	0.261	0.261
9.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.031	1.031	1.031
10	**ADJECENT LONGEST LINE**		SINRAULI-LUCKNOW	OBRA-Sultanpur	SARNATH L5	SARNATHL6	MAU
10.1	Line Length	Km	408.6	237	156	156	48.2
10.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.0275	0.0275	0.0275
10.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.331	0.331	0.331
10.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.261	0.261	0.261
10.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.031	1.031	1.031
10	**ADJECENT SECOND LONGEST LINE**		SINRAULI-FATEHPUR		SARNATHL-VARNASI	SARNATHL-VARNASI	MAU-IBRAHIMPATTI BALLA
10.1	Line Length	Km	331	179	107	107	9.24
10.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.0275	0.0275	0.0275
10.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.331	0.331	0.331
10.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.261	0.261	0.261
10.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.031	1.031	1.031
11	Arc Resistance(Assumed for all lines)	Ohm	5	5	5	5	5

11.1	Typical earth fault coverage (Assumed for all lines)	Ohm	10	10	10	10	10
11.2	Fault current local end	kA	39	39	39	39	39
11.3	Fault current Remote end	kA	37	37	37	37	37

S. No.	**Description**	**Units**	**Line**	**Line**	**Line**	**Line**	**Line**
0	**Station Name**		ANPARA -BTPS	ANPARA -BTPS	ANPARA - BTPS	ANPARA - BTPS	ANPARA - BTPS
1	**Line Reference**		ANPARA D-ANPARA B L8	ANPARA D-ANPARA B L9	ANPARA - BINA	ANPARA-PIPRI-I	ANPARA-PIPRI-II
1.1	Line voltage level	kV	400	400	132	132	132
1.2	Name of remote substation		ANPARA-D	ANPARA-D	BINA	PIPRI	PIPRI
2	**Main 1**		YES	YES	YES	YES	YES
2.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
2.2	Model & Make		MICOM P-543	MICOM P-543	ABB REL-670	ABB REL-670	ABB REL-670
3	**Main 2 protection**		YES	YES	YES	YES	YES
3.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
3.2	Model & Make		ABB REL-670	ABB REL-670	MICOM P-142	MICOM P-142	MICOM P-142
4	**LBB Protection**		YES	YES	YES	YES	YES
4.1	Protection Type		Static	Static-	Electromechanical	Electromechanical -	Electromechanical -
4.2	Model & Make		HITACHI	HITACHI	CTIG	CTIG	CTIG
5	**CT data for Main 1**						
5.1	Ratio	A/A	1000/1	1000/1	600/1	600/1	600/1
6	**CT data for Main 2**		1000/1	1000/1	600/1	600/1	600/1

7	PT Ratio	kV/V	400/110	400/110	132/110	132/110	132/110
8	**PROTECTED LINE DATA**						
8.1	Line Length	Km	5.02	5.02	9.5	28	28
8.2	Positive seq. RESISTANCE	Ohms/Km	0.0146	0.0146	0.162	0.162	0.162
8.3	Positive seq. REACTANCE	Ohms/Km	0.2531	0.2531	0.3861	0.3861	0.3861
8.4	Zero seq. RESISTANCE	Ohms/Km	0.248	0.248	0.4056	0.4056	0.4056
8.5	Zero seq. REACTANCE	Ohms/Km	0.9984	0.9984	1.622	1.622	1.622
9	**ADJECENT SHORTEST LINE**		ANPARA D-ANPARA B L9	ANPARA D-ANPARA B L8	-	PIPRI-KANAURIYA	PIPRI-KANAURIY
9.1	Line Length	Km	5.02	5.02	-	6.5	6.5
9.2	Positive seq. RESISTANCE	Ohms/Km	0.0146	0.0146	-	0.162	0.162
9.3	Positive seq. REACTANCE	Ohms/Km	0.2531	0.2531	-	0.3861	0.3861
9.4	Zero seq. RESISTANCE	Ohms/Km	0.248	0.248	-	0.4056	0.4056
9.5	Zero seq. REACTANCE	Ohms/Km	0.9984	0.9984	-	1.622	1.622
10	**ADJECENT LONGEST LINE**		ANPARA D-ANPARA B L9	ANPARA D-ANPARA B L8	-	PIPRI-SONENAGAR	PIPRI-SONENAGAR
10.1	Line Length	Km	0.0146	0.0146	-	186	186
10.2	Positive seq. RESISTANCE	Ohms/Km	0.2531	0.2531	-	0.162	0.162
10.3	Positive seq. REACTANCE	Ohms/Km	0.248	0.248	-	0.3861	0.3861
10.4	Zero seq. RESISTANCE	Ohms/Km	0.9984	0.9984	-	0.4056	0.4056
10.5	Zero seq. REACTANCE	Ohms/Km	0.0146	0.0146	-	1.622	1.622
10	**ADJECENT SECOND LONGEST LINE**		-	-	-	PIPRI -GARWA	PIPRI -GARWA
10.1	Line Length	Km	-	-	-	102	102
10.2	Positive seq. RESISTANCE	Ohms/Km	-	-	-	0.162	0.162
10.3	Positive seq. REACTANCE	Ohms/Km	-	-	-	0.3861	0.3861
10.4	Zero seq. RESISTANCE	Ohms/Km	-	-	-	0.4056	0.4056
10.5	Zero seq. REACTANCE	Ohms/Km	-	-	-	1.622	1.622
11	Remote End Transformers						
11.1	MVA		-	-	3*20	-	-
11.2	Voltage ratio	kV/kV	-	-	132/33	-	-
11.1	% Impedance	%	-	-	10	-	-

Review of 400/132 kV TRANSMISSION LINE PROTECTION SETTINGS:

REVIEW OF ANPARA- SINGRAULI LINE L1:

Table-5 Review of Anpara Singrauli Line:

Name of Transmission Line			ANPARA SINGRAULI L1							
Main I	Alstom P442									
	Existing Settings		Existing Settings		Existing Settings		Existing Settings		Existing Settings	
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
Resistive reach-phase (Ω)	8.250		-		16.50		20.63		20.63	
Resistive reach-ground (Ω)	13.75		-		20.63		20.64		20.64	
Impedance -phase resistive reach (Ω)	1.819		-		2.729		47.49		0.276	
Time delay (ms)	0		-		500		1.55		500	
Distance Schemes										
Standard mode	POPZ2									
Fault Type	Both Fault									
Trip Mode	IP.Z1&CR									
t Reversal Guard(ms)	60									
Power Swing Blocking	Enable									
ΔR	7.610									

ΔX	7.610									
Un Blocking delay(s)	2									
Blocking Zones	11111									
Over Current										
Function	Disabled									
Direction	Directional FWD									
Pick up	1.5									
Time delay	1									
Earth Fault										
Function	IEC S Inverse									
Direction	Directional FWD									
Pick up	0.2									
Time delay	1.5									
Main-2	**SIEMENS 7SA522**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Direction	Forward		Forward		Forward		Forward		Reverse	
Resistive reach for ph-ph faults (Ω)	3.620		8.250		8.250		10.310		8.250	
Reactance Reach (Ω)	1.810		2.720		2.720		47.290		0.280	
Resistive reach for ph- E faults (Ω)	3.620		6.880		6.880		11.460		6.880	

Time delay (ms)	0		0		500		1.50		500	
Power swing Blocking										
Block Zones	11111									
Over Current	Disabled									
Iph>Pick up(A)	0.10									
Time Delay(s)	0.5									
3I0>Pick up(A)	0.2									
T3I0>Time Delay(S)	2									
Earth Fault										
3I0 Pick up(A)	4.0									
T 3I0 Time Delay(S)	0.3									
LBB	**EE,CTIG**									
Over current protection										
Pick up	0.2									
delay	0.3									

REVIEW OF ANPARA- OBRA LINE L2:

Table-6 Review of Anpara - Sultanpur (Obra) line L2:

Name of Transmission Line			ANPARA OBRA L2							
Main I	**Siemens 7SA52**		**Existing Settings**		**Existing Settings**		**Existing Settings**		**Existing Settings**	
	Existing Settings									
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
Resistive reach for ph-ph faults (Ω)	4.240		1.500		8.470		10.590		10.590	
Reactance Reach (Ω)	2.690		3.00		4.040		36.370		1.240	
Resistive reach for ph- E faults (Ω)	12.120		3.00		20.960		34.930		34.930	
Time delay (ms)	0		0		350		1000		500	
Power Swing										
Blocked Zones	11111									
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	

Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	9.80		-		18.3705		140.01		3.06	
R1PP/PE (Ω)	0.81		-		1.52625		11.63		0.25	
X0PE (Ω)	30.518		-		57.2205		436.11		9.54	
R0PE (Ω)	7.726		-		14.4855		110.40		2.41	
RFPP (Ω)	29.39		-		61.60		77.00		77.00	
RFPE (Ω)	44.09		-		76.20		127.00		127.00	
tPP (ms)	0		-		350		1000		500	
tPE (ms)	0		-		350		1000		500	
Power Swing Blocking										
X1lnFw(Ω)	113.11									
R1ln(Ω)	9.40									
R1FlnFw(Ω)	183.69									
X1lnRv(Ω)	24.61									
R1FlnRv(Ω)	183.61									
tP1(S)	0.021									
LBB	**EE,CTIG**									
Over current protection										
Pick up	0.4									
delay	0.4									

REVIEW OF ANPARA SARNATH L3:

Table-7 Review of Anpara-Sarnath line L3:

Name of Transmission Line			ANPARA SARNATH L3							
Main I	Siemens 7SA52		Existing Settings		Existing Settings		Existing Settings		Existing Settings	
	Existing Settings									
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
Resistive reach for ph-ph faults (Ω)	4.24		12.050		8.470		10.590		10.590	
Reactance Reach (Ω)	11.410		17.120		17.120		34.23**0**		1.240	
Resistive reach for ph- E faults (Ω)	13.970		8.890		20.960		34.930		34.930	
Time delay (ms)	0		0		350		1000		500	
Power Swing Blocking										
Blocked Zones	11111									
Over Current	TOC ANSI									
Pick up 51-B	0.2									
Time Delay 51-B	0.3									
Pick up 51N-B	Disabled									
Time Delay51N-B	0.2									

Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	41.51		-		62.27		102.74		0.86	
R1PP/PE (Ω)	3.45		-		5.17		7.17		0.10	
X0PE (Ω)	129.30		-		193.96		268.82		2.48	
R0PE (Ω)	32.73		-		49.10		68.05		0.78	
RFPP (Ω)	50.80		-		61.60		77.00		77.00	
RFPE (Ω)	30.80		-		76.20		127.00		127.00	
tPP (ms)	0		-		350		1000		500	
tPE (ms)	0		-		350		1000		500	
LBB	**EE, CTIG**									
Over current protection										
Pick up	0.2									
delay	0.4									

REVIEW OF ANPARA SARNATH L5:

Table-8 Review of Anpara-Sarnath line L5:

Name of Transmission Line			ANPARA SARNATH L5							
Main I	Siemens 7SA52		Existing Settings		Existing Settings		Existing Settings		Existing Settings	
	Existing Settings									
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
Resistive reach for ph-ph faults (Ω)	4.240		12.050		8.470		10.590		10.590	
Reactance Reach (Ω)	11.410		17.120		17.120		34.230		1.240	
Resistive reach for ph- E faults (Ω)	13.970		8.890		20.960		34.930		34.930	
Time delay (ms)	0		0		350		1000		500	
Power Swing Blocking										
Blocked Zones	11111									
Over Current	TOC ANSI									
Pick up 51-B	0.2									
Time Delay 51-B	0.3									
Pick up 51N-B	Disabled									
Time Delay51N-B	0.2									

Main-2	**ABB REL-670**									
Distance Protection	Zone 1		Zone-IB		Zone 2		Zone-3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	41.51		-		68.75		86.30		0.86	
R1PP/PE (Ω)	3.45		-		5.71		7.17		0.10	
X0PE (Ω)	129.30		-		214.15		268.82		2.48	
R0PE (Ω)	32.73		-		54.21		68.05		0.78	
RFPP (Ω)	30.80		-		61.60		77.00		77.00	
RFPE (Ω)	50.80		-		76.20		127.00		127.00	
tPP (ms)	0		-		350		1000		500	
tPE (ms)	0		-		350		1000		500	
LBB	**EE, CTIG**									
Over current protection										
Pick up	1.1									
delay	0.4									

REVIEW OF ANPARA MAU L6:

Table-9 Review of Anpara-Mau line L6:

Name of Transmission Line			ANPARA MAU L6							
Main I	Siemens 7SA52		Existing Settings		Existing Settings		Existing Settings		Existing Settings	
	Existing Settings									
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
Resistive reach for ph-ph faults (Ω)	4.24		20.500		8.470		10.590		10.590	
Reactance Reach (Ω)	19.080		28.620		28.620		57.240		1.240	
Resistive reach for ph- E faults (Ω)	13.970		22.250		20.960		34.930		34.930	
Time delay (ms)	0		0		500		1000		500	
Power Swing Blocking										
Blocked Zones	11111									
Over Current	TOC ANSI									
Pick up 51-B	0.2									
Time Delay 51-B	0.3									
Pick up 51N-B	Disabled									
Time Delay51N-B	0.2									

Main-2	**ABB REL-670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	69.38		-		88.24		102.83		0.86	
R1PP/PE (Ω)	5.764		-		7.33		8.54		0.10	
X0PE (Ω)	216.10		-		274.86		320.28		2.48	
R0PE (Ω)	54.71		-		69.58		81.08		0.78	
RFPP (Ω)	30.80		-		61.60		77.00		77.00	
RFPE (Ω)	50.80		-		76.20		127.00		127.00	
tPP (ms)	0		-		500		1000		500	
tPE (ms)	0		-		500		1000		500	

Power Swing Blocking	
X1lnFw(Ω)	113.11
R1ln(Ω)	9.40
R1FlnFw(Ω)	183.69
X1lnRv(Ω)	24.61
R1FlnRv(Ω)	183.61
tP1(S)	0.021
LBB	**EE,CTIG**
Over current protection	
Pick up	1.1
delay	0.4

REVIEW OF ANPARA B TO ANPARA D L8:

Table-10 Review of Anpara B-Anpara D line L8:

Name of Transmission Line	
Main I	**Alstom MICOM P-543**
Settings	**Existing Settings**
Phase Differential	Enable
IS1(mA)	200
IS2(A)	2
K1 slope (%)	30
K2 slope (%)	100
Delay (ms)	0
Distance polygenic scheme	
Z1 Reach(Ω)	0.28
Z1 Angle(Ω)	87
R1 Ph. Reach(Ω)	4.4
R1 Gnd. Reach(Ω)	280.0
Z2 Reach(Ω)	0.53
Z2 Angle(Ω)	87
R2 Ph. Reach(Ω)	8.25
R2 Gnd. Reach(Ω)	1.88
Z3 Reach(Ω)	0.7

Z3 Angle(Ω)	87
R3 Ph. Reach(Ω)	11
R3 Gnd. Reach(Ω)	2.5
Z4 Reach(Ω)	0.09
Z4 Angle(Ω)	87
R4 Ph. Reach(Ω)	1.38
R4 Gnd. Reach(Ω)	0.31
Earth Fault	
Function	IEC S Inverse
Pick up	0.2
TMS	0.25
Main II	**ABB REL670**

Distance Protection	Zone 1		Zone IB		Zone-2		Zone-3		Zone-4
Settings									
Direction	Forward		Forward		Forward		Forward		Reverse
X1PP/PE (Ω)	1.016		-		1.89		2.52		0.254
R1PP/PE (Ω)	0.059		-		0.11		0.15		0.015
X0PE (Ω)	3.35		-		6.28		8.37		0.84
R0PE (Ω)	0.76		-		1.43		1.90		0.19
RFPP (Ω)	20.00		-		50.00		60.00		116.69
RFPE (Ω)	4.53		-		8.50		40.00		58.30
tPP (ms)	0		-		350		1000		500
tPE (ms)	0		-		300		800		500

LBB	EE, HITACHI,3 E81766
Over current protection	
Pick up	1.1
delay	0.4

REVIEW OF ANPARA B TO ANPARA D L9:

Table-11 Review of Anpara B-Anpara D line L9

Name of Transmission Line		
Main I	**Alstom MICOM P-543**	
Settings	**Existing Settings**	
Phase Differential	Enable	
IS1(mA)	200	
IS2(A)	2	
K1 slope (%)	30	
K2 slope (%)	100	
Delay (ms)	0	

Distance polygenic scheme	
Z1 Reach(Ω)	0.28
Z1 Angle(Ω)	87
R1 Ph. Reach(Ω)	4.4
R1 Gnd. Reach(Ω)	1
Z2 Reach(Ω)	0.53
Z2 Angle(Ω)	87
R2 Ph. Reach(Ω)	8.25
R2 Gnd. Reach(Ω)	1.88
Z3 Reach(Ω)	0.7
Z3 Angle(Ω)	87
R3 Ph. Reach(Ω)	11
R3 Gnd. Reach(Ω)	2.5
Z4 Reach(Ω)	0.09
Z4 Angle(Ω)	87
R4 Ph. Reach(Ω)	1.38
R4 Gnd. Reach(Ω)	0.31
Earth Fault	
Function	IEC S Inverse
Pick up	0.2
TMS	0.25

Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	1.016		-		1.89		2.52		0.25	
R1PP/PE (Ω)	0.06		-		0.11		0.15		0.01	
X0PE (Ω)	3.35		-		6.28		8.37		0.84	
R0PE (Ω)	0.76		-		1.43		1.90		0.19	
RFPP (Ω)	20.00		-		50.00		60.00		116.69	
RFPE (Ω)	4.53		-		8.50		40.00		58.30	
tPP (ms)	0		-		350		1000		500	
tPE (ms)	0		-		300		800		500	
LBB	**EE, HITACHI,3 E81766**									
Over current protection										
Pick up	1.1									
delay	0.4									

REVIEW OF 132 KV ANPARA B TO BINA LINE:

Table-12 Review of 132kV Anpara B-Bina line:

Name of Transmission Line			ANPARA B TO BINA LINE							
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	4.25		-		4.78		7.63		0.55	
R1PP/PE (Ω)	1.65		-		1.82		2.91		0.21	
X0PE (Ω)	13.99		-		15.73		25.10		1.81	
R0PE (Ω)	3.60		-		4.05		6.46		0.47	
RFPP (Ω)	12.75		-		40.00		20.82		3.30	
RFPE (Ω)	19.13		-		60.00		7.91		2.47	
tPP (ms)	0		-		350		800		450	
tPE (ms)	0		-		350		800		450	
Power Swing Blocking										
X1lnFw(Ω)	8.06									
R1ln(Ω)	2.79									
R1FlnFw(Ω)	8.80									
X1lnRv(Ω)	8.06									
tP1(S)	0.001									
Over Current										
Pick up	0.4									
Time delay	0.1									

Back up Over Current and Earth Fault	
Over Current	
Pick up	204
Time delay	0.25
Earth Fault	
Pick up	120
Time Delay	0.12

REVIEW OF 132 KV ANPARA B TO PIPRI LINE I&II:

Table-13 Review of 132kV Anpara B-Pipri Line I&II:

Name of Transmission Line			ANPARA B TO PIPRI LINE I&II							
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	9.12		-		13.67		87.08		2.28	
R1PP/PE (Ω)	3.47		-		5.21		33.19		0.87	
X0PE (Ω)	29.98		-		44.97		286.42		7.50	
R0PE (Ω)	7.72		-		11.58		73.74		1.93	
RFPP (Ω)	14.95		-		18.42		74.38		9.74	
RFPE (Ω)	13.47		-		15.21		43.19		10.25	
tPP (ms)	0		-		350		800		160	

tPE (ms)	0	0	-		350		800		160	
Power Swing Blocking										
X1lnFw(Ω)	91.43									
R1ln(Ω)	33.19									
R1FlnFw(Ω)	34.85									
X1lnRv(Ω)	91.43									
tP1(S)	0.045									
Back up Over Current and Earth Fault										
Over Current										
Pick up(A)	300									
Time delay(S)	0.01									
Earth Fault										
Pick up(A)	120									
Time Delay(S)	0.01									

REVIEW OF 132 KV ANPARA B TO MORWA LINE:

Table-14 Review of 132kV Anpara Morwa Line:

Name of Transmission Line			ANPARA B TO PIPRI LINE I&II							
Main II	**ABB REL670**									
Distance Protection Settings	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Direction	Forward		Forward		Forward		Forward		Reverse	
X1PP/PE (Ω)	5.19		-		6.74		36.10		1.30	
R1PP/PE (Ω)	2.06		-		2.68		14.34		0.52	
X0PE (Ω)	16.96		-		22.04		118.11		4.24	
R0PE (Ω)	4.95		-		6.43		4.48		1.24	
RFPP (Ω)	30		-		60		75		7.80	
RFPE (Ω)	35		-		70		85.00		5.85	
tPP (ms)	0		-		400		800		500	
tPE (ms)	0		-		400		800		500	

Power Swing Blocking	
X1lnFw(Ω)	37.91
R1ln(Ω)	14.34
R1FlnFw(Ω)	227.43
X1lnRv(Ω)	37.91
tP1(S)	0.045

Back up Over Current and Earth Fault	
Over Current	
Pick up (%)	120% of Ib
Time delay(S)	0.44
Earth Fault	
Pick up (%)	20
Time Delay(S)	0.44
RelayMake	MICOMP-142
Over Current	Existing settings
Function	IEC S Inverse
Pick up (A)	0.30
TimeDelay (Sec)	0. 25
Earth Fault	Existing settings
Function	IEC S Inverse
Pick up (A)	0.12
Time Delay(Sec)	0.12

REVIEW NOTES TRANSMISSION LINES:

Distance based Main-1 and Main-2 protection is provided to all 400 kV lines. All 132 kV lines are protected by main distance and current based backup protection.

INPUT DATA FOR TARNSFORMER PROTECTION:

Table-15 Input Data for Transformer Protection**:**

S. No.	Description	Units	Value	Value	Value	Value	Value
0	**Substation Name**		ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS
1	**Transformer Name**		ICT 1	ICT 2	ICT 3	ST-1	ST-2
2	**Rating**						
2.1	MVA	MVA	100	100	100	40	40
2.2	Voltage Ratio	kV / kV	400/132	400/132	400/132	132/6.9	132/6.9
3	**Impedance**	%	10	10	10	14.08	14.08
4	**Vector Group**		YNa0d11	YNa0d11	YNa0d11	YNd11	YNd11
5	**OLTC Data**						
5.1	Min Tap (%)	% (-)	10	10	10	10	10
5.2	Max Tap (%)	% (+)	10	10	10	10.15	10.15
5.3	No. of Steps		17	17	17	17	17
6	**Differential Protection**		YES	YES	YES	YES	YES
6.1	Differential CT Ratio						
6.2	HV CT Ratio (Main & ICT)	A/A	500/1	500/1	500/1	300/1	300/1
6.3	LV1 CT Ratio (Main & ICT)	A/A	600/1	600/1	600/1	3000/1	3000/1
6.4	Differential Relay						
6.5	Make		MICOM	MICOM	MICOM	MICOM	MICOM
6.6	Model		P-645	P-645	P-645	P-645	P-645
7	**REF Protection**		YES	YES	YES	YES	YES

7.1	REF Protection CTs						
7.2	CT Ratio	A/A	600/1	600/1	600/1	300/1	300/1
7.6	REF Relay						
7.7	Make		MICOM	MICOM	MICOM	MICOM	MICOM
7.8	Model		P-645	P-645	P-645	P-645	P-645
7.9	Rstab Range (Ω)	Ohms	-	-	-	-	-
8	**Over Fluxing Protection**		YES	YES	YES	YES	YES
8.1	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.2	Model		P-645	P-645	P-645	P-645	P-645
8	**HV Back-up Protection**		YES	YES	YES	YES	YES
8.1	HV Back-up Protection Relay		Numerical	Numerical	Numerical	Numerical	Numerical
8.2	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.3	Model		P-645	P-645	P-645	P-645	P-645
8.4	HV Back-up Protection CTs						
8.5	Ratio	A/A	500/1	500/1	500/1	300/1	300/1
9	**LV Back-up Protection**		YES	YES	YES	YES	YES
9.1	LV Back-up Protection Relay		Numerical	Numerical	Numerical	Electro mechanical	Electro mechanical
9.2	Make		MICOM	MICOM	MICOM	EE	EE
9.3	Model		P-142	P-142	P-142	CAG-37	CAG-37
9.4	LV Back-up Protection CTs						
9.5	Ratio	A/A	600/1	600/1	600/1	3000/1	3000/1
S. No.	**Description**	**Units**	**Value**	**Value**	**Value**	**Value**	**Value**
0	**Substation Name**		ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS

1	**Transformer Name**		ST-3	ST-4	CW-1	CW-2	CW-3
2	**Rating**						
2.1	MVA	MVA	60	60	40	40	40
2.2	Voltage Ratio	kV/kV	132/6.9	132/6.9	132/6.9	132/6.9	132/6.9
3	**Impedance**	%	10	10	16.94	16.94	16.94
4	**Vector Group**		YN. d11.d11	YN. d11.d11	YNd11	YNd11	YNd11
5	**OLTC Data**						
5.1	Min Tap (%)	% (-)	10	10	12.27	12.27	12.27
5.2	Max Tap (%)	% (+)	10	10	10	10	10
5.3	No. of Steps		17	17	17	17	17
6	**Differential Protection**		YES	YES	YES	YES	YES
6.1	Differential CT Ratio						
6.2	HV CT Ratio (Main & ICT)	A/A	300/1	300/1	300/1	300/1	300/5
6.3	LV1 CT Ratio (Main & ICT)	A/A	3000/1	3000/1	4000/1	4000/1	2000/5
6.3	LV2 CT Ratio (Main & ICT)	A/A	-	-	-	-	-
6.4	Differential Relay						
6.5	Make		MICOM	MICOM	MICOM	MICOM	MICOM
6.6	Model		P-645	P-645	P-645	P-645	P-645
7	**REF Protection**		YES	YES	YES	YES	NO
7.1	REF Protection CTs						
7.2	CT Ratio	A/A	300/1	300/1	300/1	300/1	-
7.6	REF Relay						

7.7	Make		MICOM	MICOM	MICOM	MICOM	-
7.8	Model		P-645	P-645	P-645	P-645	-
7.9	Rstab Range (Ω)	Ohms	-	-	-	-	
8	**Over Fluxing Protection**		YES	YES	NO	NO	NO
8.1	Make		MICOM	MICOM	-	-	-
8.2	Model		P-645	P-645	-	-	-
8	**HV Back-up Protection**		YES	YES	YES	YES	YES
8.1	HV Back-up Protection Relay		Numerical	Numerical	Numerical	Numerical	Numerical
8.2	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.3	Model		P-645	P-645	P-645	P-645	P-645
8.4	HV Back-up Protection CTs						
8.5	Ratio	A/A	300/1	300/1	300/1	300/1	300/5
9	**LV Back-up Protection**		YES	YES	YES	YES	YES
9.1	LV Back-up Protection Relay		Electro mechanical	Electro mechanical	Electro mechanical	Electro mechanical	Electro mechanical
9.2	Make		CAG-37	CAG-37	CAG-37	CAG-37	CAG-37
9.3	Model						
9.4	Ratio	A/A	3000/1	3000/1	4000/1	4000/1	2000/5

REVIEW OF TRANSFORMER PROTECTION RELAY SETTINGS:

Table-16 Review of Transformer Protection Relay Settings**:**

Main-I	ICT1		ICT2		ICT3		ST-1		ST-2					
Relay make	**MICOM P-645**		**MICOM P-645**		**MICOM P-645**		**MICOM P-645**		**MICOM P-645**					
Differential Protection	Existing settings		Existing settings		Existing settings		Existing settings		Existing settings		Unit		CT ratio	
diff Id	0.2		0.2		0.2		0.2		0.2		A	Iref	ICTs 1,2&3	HV-500/1
Diff I>>	-		-		-		-		-		A	Iref		LV-600/1
Diff I>>>	-		-		-		-		-		A	Iref	ST-1&2	LV-3000/1
slope 1	30		30		30		30		30			%		
slope 2	70		70		70		80		80			%		HV-300/1
Over Fluxing Protection													Neutral CT ratios	
V/f Alarm	2.42		2.42		2.42		2.42		2.42		V/Hz		ICTs 1,2&3	600/1
Time delay	5		5		5		5		5		sec			
V/f Trip	2.530		2.530		2.530		2.640		2.640		V/Hz		ST-1&2	300/1
Time delay	3		3		3		18		18		sec			
REF Protection HV side	Disabled				Disabled									
High Impedance Type														
Pickup	0.09		0.09		0.09		0.1		0.1		A			
Stabilizing Resistor	-		-		-		-		-		ohm			
BACK UP HV SIDE OVER CURRENT AND EARTH FAULT PROTECTION														

Relay Make			MICOM P-142				MICOM P-142		MICOM P-142	
Over Current			Existing settings				Existing settings		Existing settings	
Function			IEC S Inverse				IEC S Inverse		IEC S Inverse	
Pick up (A)			0.30						0.75	
Time Delay (Sec)			0. 5				0.35		0.35	
Earth Fault			Existing settings				Existing settings		Existing settings	
Function			IEC S Inverse				IEC S Inverse		IEC S Inverse	
Pick up (A)			0.10				-		0.10	
Time Delay (Sec)			0.35				0.1		0.1	

LV side Over current and Earth fault protection

Relay Make	MICOM P-142		MICOM P-142		MICOM P-142	
Over Current	Existing settings		Existing settings		Existing settings	
Function	IEC S Inverse		IEC S Inverse		IEC S Inverse	
Pick up (A)	0.75		0.75		0.75	
Time Delay	**0.35**		**0.35**		**0.35**	

(Sec)					
Function	-	-	-	-	-
Pick up (A)	-	-	-	-	-
Time Delay (Sec)	-	-	-	-	-
Earth Fault	Existing settings		Existing settings		Existing settings
Pick up (A)	0.1		0.1		0.15
Time Delay (TMS)	0.35		0.35		0.30

Main-I	ST-3													
Relay make	**MICOM P-645**													
Differential Protection	Existing settings										Unit		CT ratio	
diff Id	0.2										A	Iref	ST-3&4	HV-500/1
Diff I>>	-										A	Iref		LV-600/1
Diff I>>>	-										A	Iref	CW-1&2	LV-4000/1 HV-300/1
slope 1	30											%	CW-3	LV-2000/5 HV-300/5
slope 2	80											%		
Over Fluxing Protection														

V/f Alarm	2.42				-	-	-	-	-	-	-	Neutral CT ratios	
Time delay	10				-	-	-	-	-	-	-	ST-3&4	3000/1
V/f Trip	2.64				-	-	-	-	-	-	-	CW-1&2	300/1
Time delay	18				-	-	-	-	-	-	-	CW-3	300/1
REF Protection HV side													

High Impedance Type											
Pickup	0.1								-	-	A
Stabilizing Resistor	-								-	-	ohm

Back up		
Relay Make		
HV side Over current and Earth fault protection		
Over Current		
Function	IEC S Inverse	
Pick up (A)	0.75	
Time Delay (Sec)	0.35	

Function	DT
Pick up (A)	0.63
Time Delay (Sec)	0.5
Earth Fault	
Function	IEC S Inverse
Pick up (A)	0.1
Time Delay (s)	1

REVIEW NOTES TRANSFORMER PROTECTION:

400/132 kV Substation of BTPS was audited and it is observed that Transformer main -I, main-II, and Back up protection settings are in order. Based on the review the necessary suggestions in the operationalrelay setting are listed in the below table

Note	• For ST-1, 2, 3 and 4 - LV side earth fault protection is not provided. This Protection may be considered. • For CW-1, 2, 3, - HV & LV side earth fault protection is not provided. This Protection may be considered.

INPUT DATA FOR BUS REACTOR PROTECTION:

Input Data for Bus Reactor Protection**:**

Sl. No	Description	Unit	Value
	Substation Name		
1	**Name**		Bus Reactor
2	**Rating**		
2.1	MVA	MVAR	63
2.2	Voltage Level	kV	420
3	**Impedance**	%	2304
4	**Differential Protection**		YES
4.1	Differential CT Ratio		
4.2	HV CT Ratio (Main & ICT)	A/A	100/1
4.3	LV CT Ratio (Main & ICT)	A/A	100/1
4.4	Differential Relay		Numerical
4.5	Make		MICOM
4.6	Model		P-645
5	**REF Protection**		NO
5.1	REF Protection neutral side		-
5.2	CT Ratio	A/A	-
5.3	REF Relay		-
5.4	Make		-
5.6	Rstab Range (Ω)	Ohms	-
6	**Back-up Protection**		YES
6.1	Back-up Protection Relay		ELECT MECH
6.2	Make		EE
6.3	Model		MCAG
6.4	Back-up Protection CTs Ratio	A/A	100/1

REVIEW OF BUS REACTOR PROTECTION SETTINGS:

Review of Bus Reactor Protection Settings**:**

Sl No.	Description			BUS REACTOR	
				Adopted Settings	
1	Make			ALSTOM	
2	Capacity(MVAR)			63	
3	Voltage Level (KV)			420	
4	% Impedance			2304	
5	MAIN			MAIN-I	MAIN-I
6	Differential	Relay Model &make		MICOMP-645	
		Adopted CT Ratio	HV	100/1	100/1
			LV	100/1	100/1
		Biased	M1 (%)	20	20
			M2 (%)	60	60
			Is/Id min	0.2	0.2
7	Back Up Over Current	Relay Model &make			
		CT Ratio	HV	100/1	100/1
			LV	100/1	100/1
		Settings			
		Over current	Pick up (A)	1.4	1.4
			Time delay (Sec)	0.4	0.4
		Earth fault	Pick up (A)	0.5	0.5
			Time delay (Sec)	0.4	0.4

REVIEW NOTES OF BUS REACTOR PROTECTION

400/132 kV Substation of BTPS was audited and it is observed that Bus Reactor protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table

* **Note -** For Bus Reactor as per NRPC guidelines REF protection should be given.

REVIEW OF BUS BAR PROTECTION:

400/132 kV Substation of BTPS was audited and it is observed that Bus Bar protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table

Table-16 Review of Bus Bar Protection Settings**:**

Sl. No.	**BAY**	**PROTECTION**	**Main-I**		**Main-II**	
			Existing settings		**Existing settings**	
1	Bus selector-1	Over Current	Pick up I=2400 A Time delay=1.0 sec		Pick up I=8000 A Time delay=0sec	
		Earth Fault	Pick up I=300A Time delay=1.2sec		Pick up I=300A Time delay=1.2 sec	
2	Bus selector -2	Over Current	Pick up I=2400 A Time delay=1.0 sec		Pick up I=1200 Time delay=0 sec	
		Earth Fault	Pick up I=300A Time delay=1.2sec		Pick up I=1200 Time delay=0 sec	
		CB Fail	I<40 A IN<40 A I sef<20 mA		-	
3	400 kV BUS BAR	Voltage differential	Check Zone=200 V Zone A=200 V Zone B=200 V Zone C =200 V		-	-
		95 Wire supervision relay	Pick up VS=14 V		-	-
4	132 KV BUS BAR	Differential	Check Zone=0.75 A Zone A=0.75 A Zone B=0.75 A Zone C =0.75 A		-	-
		Bus wire supervision	Pick up=5 V		-	-

5	132 BUS COUPLER	Over Current	Pick up=1.25 A Delay =0.8 Sec		-	-
		Earth Fault	Pick up=0.8A Delay =0.8 Sec		-	-
6	ATPS BUS BAR	Differential	Check Zone=0.75 A Zone A=0.75 A Zone B=0.75 A Zone C =0.75 A		-	-
		Bus wire supervision	Pick up=5 V		-	- -
7	ATPS BUSCOUPLER	Over Current	Pick up=1.25 A Delay =1 Sec		-	-
		Earth Fault	Pick up=0.8A Delay =0.8 Sec		-	-

Review of Auxiliary Protection Infrastructure: -

In this section, the details of the batteries and chargers are described. There are four sets of battery banks of 220 V inSubstation and three set of 48 V. The DC system in DTPS is adequate for the station and it is satisfactory.

Details of DC system data noted by CPRI team during field audit are given below: -

Table-17 Review of 220 V battery bank for ATPS.

DC BATTERY SYSTEM OF 220 V (2 Battery Banks) IN ATPS		
Bank	Bank-1	Bank-2
Make	EXIDE	HBL
Type	OPZS400PSTBS400	T-420 H-HOP
Year of Commissioning	2019	2017
No Of Cells	110*2.02V	110*2.02V
Capacity	400Ah	420Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	CHHABI	CHLORIDE
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	232 V	227.4V
Positive-Earth	160 V	160 V
Negative-Earth	72 V	72 V

Table-18 Review of 220 V battery bank for BTPS

DC BATTERY SYSTEM OF 220 V (2 Battery Banks) IN BTPS		
Bank	Bank-1	Bank-2
Make	EXIDE	HBL
Type	OPZS1450P	T1500SHDP
No Of Cells	110*2.02V	110*2.02V
Year of Commissioning	2018	2018
Capacity	1450Ah	1500Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS

Make	YUASA	CHLORIDE
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	235 V	232 V
Positive-Earth	116.0 V	116V
Negative-Earth	115.5 V	115.5 V

Review of 48 V battery bank for ATPS

DC BATTER SYSTEM OF 48 V (2 Battery Banks) IN ATPS		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	T-200 H-HDD	T-200 H-HDD
No Of Cells	24*2.24V	24*2.24V
Year of Commissioning	2018	2018
Capacity	200Ah	200Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	ADOR POWER	ADOR POWER
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	53.98 V	54 V
Positive-Earth	51.4V	35V
Negative-Earth	-53.3 V	-53.5 V

Table-20 Review of 48 V battery bank for BTPS

DC BATTER SYSTEM OF 48 V (2 Battery Banks) IN BTPS		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	T-500 H-HDD	T-500 H-HDD
No Of Cells	24*2.24V	24*2.24V
Year of Commissioning	2018	2018
Capacity	500Ah	500Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	AFCO INDUSTRIAL	AFCO INDUSTRIAL
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	53.9 V	53.9 V
Positive-Earth	31.3 V	31.3 V
Negative-Earth	-51V	-51V

Review of Circuit Breaker Test Reports

Circuit breaker test reports are verified that all the lines closing time is less than 120ms and are in order. The Overall performance of all the circuit breaker is satisfactory as per testing reports.

Table-18 Review of Circuit Breaker Test Reports:

Breaker Name	Close coil (milli seconds)	Trip Coil-I (milli seconds)	Trip Coil-II (milli seconds)	Remark (as per CBIP guide lines)
L1	92.3	24.3	24.1	ok
L2	98.1	19.0	18.6	ok
L3	97.9	18.9	21.5	ok
L4	48.9	19.2	19.2	ok
L6	113.1	21.5	21.0	ok
L5	114.8	21.5	21.6	ok
L8	114.2	21.5	21.4	ok
L9	116.6	21.6	21.8	ok
BINA(L-1)	3.4	3.6	3.4	ok
PIPRI LINE(L-3&4)	49.9	19.3	19.0	ok
G-1	96.7	17.5	17.0	ok
G-2	95.8	20.8	20.8	ok
G-3	90.4	19.5	18.6	ok
G-4	115.1	22.7	22.6	ok
G-5	114.4	22.9	22.5	ok
ICT-1	98.4	16.6	16.6	ok
ICT-II	89.9	19.2	19.5	ok
ICT III	82.2	16.4	16.0	ok
CW-II	74.2	36.8	36.0	ok
ST-I	70.6	37.0	36.0	ok
ST-II	67.3	35.1	34.3	ok
ATPS BT	114.4	21.6	21.6	ok
BTPS BC	116.4	21.2	21.3	ok
ATPS BC	97.0	22.2	21.4	ok

Audit finding and observation.

Audit finding and observations:

1. Station 4,132 KV ICTs is protected by electro-mechanical so these relays may be replaced by numerical relays for better performance in terms of Synchronizing and disturbance/event recording facility.
2. 400kV Lines are protected as main-1 and main-2 distance protection. All 132 kV lines are also protected as main distance and backup over current protection.
3. All ICTs and station transformer are well protected.
4. Painting of Marsiling boxes, 132 KV ABCB Breakers, structures and poles are required.
5. Lighting panels are to be well covered and also to be protected from rainwater.
6. The substation Power equipment Earthing is measured a few sample locations. It is found that Earthing of power equipment withsubstation ground mat is proper, and its value is less than 1 ohm.
7. Earthing of Current transformers marshaling boxes in ATPS switchyard are to be strengthened.
8. The D C battery bank supplies are well maintained. Station-1, 48 V battery bank -2 is non-functional.
9. The periodic test reports of Circuit breakers and relays are to be reviewed and it is found that their performance is satisfactory in terms of breaker opening, closing times.
10. Anpara-Obra line setting should be revised in view of change of line parameter of adjacent lines from Obra substation.

Internal Protection Audit Report of
1X120 MW Generating unit, and Station Transformers

Of

'C' Thermal power station,

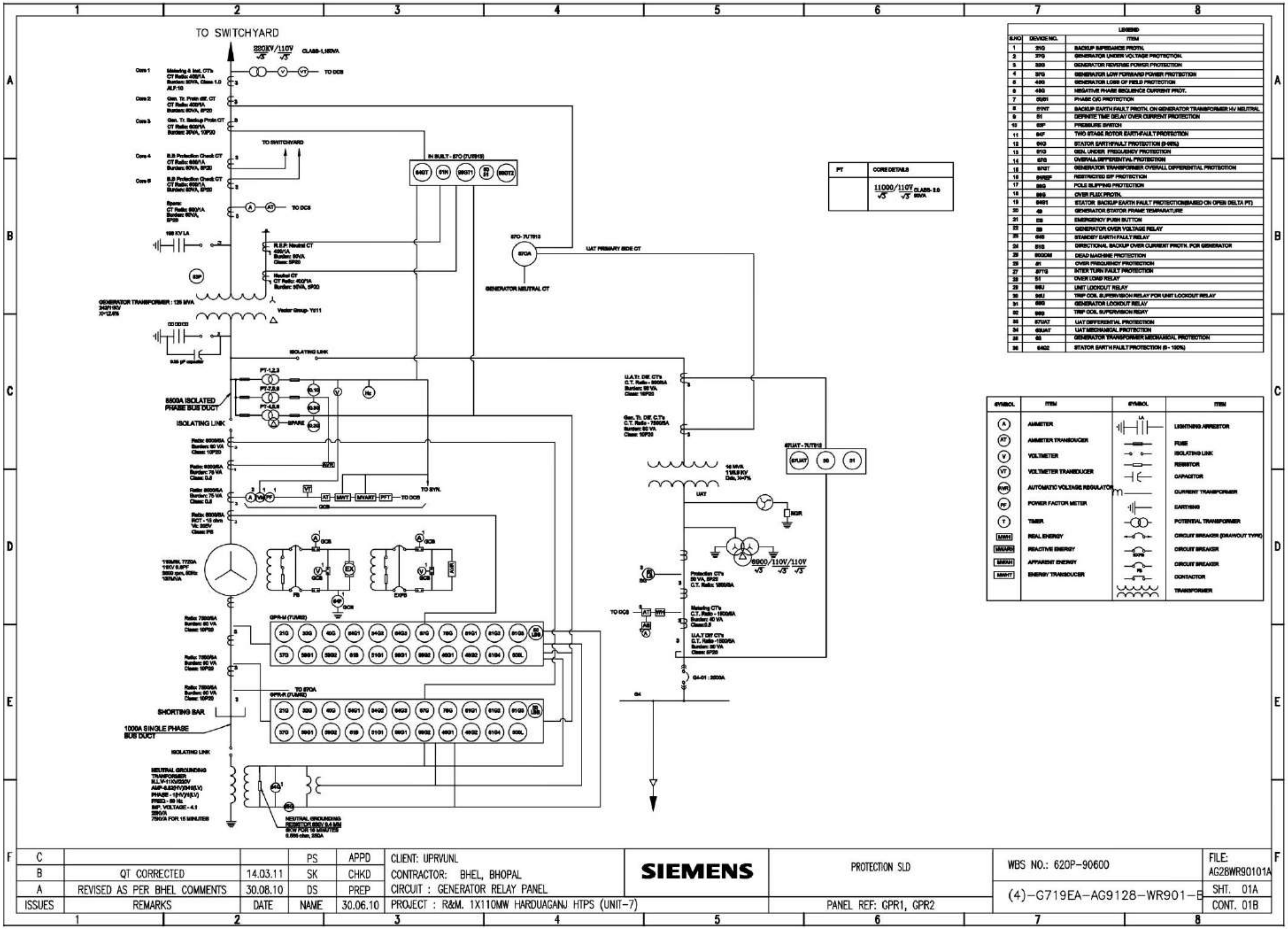
Harduaganj Thermal Power Plant, Kasimpur, Aligarh

DETAIL OF SYSTEM INSTALLED IN 1X120 MW UNIT-07, CTPS, HTPP

THE ELECTRICAL SYSTEM COMPRISES OF FOLLOWING:

Sl. No.	Electrical component	Installed quantity
1	120 MW Generator	1 Set
2	125 MVA, 11/220 kV Generating Transformer	1 Set
4	20 MVA, 132/6.9 kV Station Transformers	3 Set
5	10 MVA, 132/6.9 kV Station Transformers	1 Set
5	220/132 kV Switchyard	1 Set

SLD of Unit 7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APPD
CLIENT: UPRVUNL
CONTRACTOR: BHEL, BHOPAL
CIRCUIT : GENERATOR RELAY PANEL
PROJECT : R&M. 1X110MW HARDUAGANJ HTPS (UNIT-7)
SIEMENS
PROTECTION SLD
PANEL REF: GPR1, GPR2
WBS NO.: 620P-90600
(4)-G719EA-AG9128-WR901-B
FILE:
AG28WR90101A
SHT. 01A
CONT. 01B

1.120 MW GENERATOR

I. Detail Technical specifications of the 120 Mw turbogenerator:

Turbogenerator, 120 MW, 141176 KVA, Voltage rating-11000 V, Full load current-7410 A, Frequency-50 Hz, Coolant: Hydrogen, Gas Pressure: 2.1 kg/cm2, Insulation Class-F, Make-Bharat Heavy Electricals Limited

II. List of electrical components installed in 120 MW Generator:

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	03 Set
B	Voltage transformer	01 Set
C	Generator protection and monitoring equipment	LS
D	Numerical Protection relays	03 Set

CURRENT TRANSFORMER:-

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	Error calculated	CT CLASS	Knee point voltage	Sec Res	Remark
1	Generator Phase Side duct	CORE-A	8000/5	8000/5	------	PS			
		CORE-B	8000/5	8000/5	------	0.5			
		CORE-C	8000/5	8000/5	------	0.5			
		CORE-D	8000/5	8000/5	------	10P20			
2	Generator Neutral Side duct	CORE-1	8000/5	8000/5	------	PS			
		CORE-2	8000/5	8000/5	------	0.2			
		CORE-3	8000/5	8000/5	------	0.2			

VOLTAGE TRANSFORMER:-

Sl. No.	Location of VT	VT Desig.	VT Ratio	MAKE	HSV	CLASS	VF	Il	Type	Ins class
1	PT CUBICLE	01VT	11KV/√3/ 110V/√3			10P20			Indoor	B
2		02 VT	11KV/√3/ 110V/√3			10P20			Indoor	B
3		03 VT	11KV/√3/ 110V/√3			10P20			Indoor	B

Numerical protection relay:-

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	Remark
1	GEN PROTN. RELAY-GR1	GRP-1	SIEMENS/ 7UM62	7UM6225-5EB92-0BA0	---------	YES	
2	Overall differential Relay (87O)	GRP-1	SIEMENS/ 7UT613	7UT6131-6EB22-1BBO/FF	-----------	YES	
2	GEN PROTN. RELAY-GR2	GRP-2	SIEMENS/ 7UM62	7UM6225-5EB92-0CB0	---------	YES	
3	Bandpass filter for 100% SEF	GRP-1	SIEMENS/ 7XT34	7XT3400-0CA00	--------	YES	
4	20 Hz Generator for 100%	GRP-1	SIEMENS/ 7XT33	7XT3300-0CA00	--------	YES	
5	Control unit for REF	GRP-2	SIEMENS/ 7XT71	7XT7100-0EA00	--------	YES	
6	Resistor for 1-3Hz REF	GRP-2	SIEMENS/ 7XR6004	7XR6004-0CA00	--------	YES	

DETAILS OF GENERATOR PROTECTION SETTINGS:-

GRP Relay Settings					
Gen. Diff. Protection 7UM66					
Device configuration					
Protection	**ANSI CODE**	**GRP M 7UM66**	**GRP R 7UM66**	**Recommended**	**Remark**
GRP Chge option		Disabled	Disabled		
Fault Value		RMS Value	RMS Value		
	50/51	Disabled	Side 2		
	50/51/67	Non Direc. Side 2	Side 2		
	51V	IEC Side 2	Disabled		
	49	Enabled	Disabled		
	46	Enabled	Enabled		
	51 Startup	Disabled	Disabled		
	87G/87T	Generator / Motor	Generator / Motor		
	87N	Disabled	Disabled		
	40	Enabled	Enabled		
	32R	Enabled	Enabled		
	32F	Enabled	Enabled		
	21	Enabled	Enabled		
	78 Out - Of Step	Enabled	Enabled		
	27	Enabled	Enabled		
	59	Enabled	Enabled		
	81 O /U	Enabled	Enabled		
	24 V/F	Enabled	Enabled		
	27 Inverse	Disabled	Disabled		
	59 N / 67 GN	Non Dir. VO	Non Dir. VO		
	50N / 51 G	Disabled	Disabled		
	27 / 59 TN (3H)	Disabled	Disabled		
	100 % SGF Prot	Enabled	Enabled		
	50N / 51 G Sens. B	Disabled	Disabled		
	Inetr turn Prot	Disabled	Enabled		
	64R (R,Fn)	Disabled	Disabled		
	64R1 3 Hz	Enabled	Enabled		
	48 Startup Motor	Disabled	Disabled		
	66 REST. Inhibit	Disabled	Disabled		
	50 BF	Side 2	Side 2		
	50/27	Enabled	Enabled		
DC Protection		Disabled	Disabled		
	60 FL	Disabled	Disabled		
M. V. Superv.		Disabled	Disabled		
74 Trip Ct Supv		Disabled	Disabled		
Threeshold		Disabled	Disabled		

Ext. Trip1		Disabled	Disabled		
Ext. Trip 2		Disabled	Disabled		
Ext. Trip 3		Disabled	Disabled		
Ext. Trip 4		Disabled	Disabled		
RTD Box Input		Disabled	Disabled		
RTD Connection		6 RTD Simlex	6 RTD Simlex		

P. SYSTEM DATA 1

	GRP M	GRP R		Recommended	Remark
STRPNT -> OBJ S1	Yes	Yes			
In - Pri I SIDE 1	8000 A	8000 A			
In Sec I SIDE 1	5 A	5 A			
CT Angle Wo	0	0			
Factor IEE1	80	80			
STRPNT -> OBJ S2	Yes	Yes			
IN Pri I Side 2	8000	8000 A			
IN Sec I Side 2	5 A	5 A			
Factor IEE2	60	60			
Grd Term. IEE2	Terminal Q7	Terminal Q7			
Vnom Primary	11.0 KV	11.0 KV			
Vnom Secondry	110 V	110 V			
VN Connection	Neutr. Transf.	Neutr. Transf.			
Factor VN	50	50			
Starpnt Side 1	Isolated	Isolated			
Starpnt Side 2	Isolated	Isolated			
UN Gen /Motor	11.0 KV	11.0 KV			
PN Gen / Motor	141.17 MVA	141.17 MVA			
Rated Frequency	50 Hz	50 Hz			
Phase SEQ	ABC	ABC			
Scheme	Unit. Transf.	Unit. Transf.			
Factor R SGF	24	24			
Temp. Unit	Celcius	Celcius			
Tmin Trip Cmd	0.15 Sec	0.15 Sec			
BKR Closed I Min	0.20 A	0.20 A			
Transducer 1	10 V	10 V			
Transducer 2	10 V	10 V			
Transducer 3	With Filter	With Filter			

Protection

	Function	GRP - M	GRP - R	Recommended	Remark

50/51/67 >>					
	FCT 50/51/67	ON	ON		
	67-2 Pickup	5.14 A	5.14 A		
	67-2 Delay	0.10 Sec	0.10 Sec		
46 Neg. Seq.					
	FCT 46	ON	ON		
	46 I2 >	7.40%	7.40%		
	46 T WARN	5.00 Sec	5.00 Sec		
	46 Perm. Time K	8.6 Sec	8.6 Sec		
	46 T Cool Down	1563 Sec	1563 Sec		
	46-2 Pickup	62%	62%		
	46-2 Delay	3.00 Sec	3.00 Sec		
87 Diff. Prot					
	FCT 87G / 87T	ON	ON		
	INC. Char. Start	Off	Off		
	87-1	0.1 I / Ino	0.1 I / Ino		
	87-2	6.0 I / Ino	6.0 I / Ino		
	T Start Max	5.0 Sec.	5.0 Sec.		
40 Underexit.					
	FCT 40	ON	ON		
	40-1 I/Xd Char.	0.49	0.49		
	40-1 Angle	80 Degree	80 Degree		
	40-1 Delay	10.00 Sec	10.00 Sec		
	40-2 I/Xd Char.	0.44	0.44		
	40-2 Angle	90 Degree	90 Degree		
	40-2 Delay	10.00 sec	10.00 sec		
	40-3 I/xd Char.	1.13	1.13		
	40-3 Angle	110 Degree	110 Degree		
	40-3 Delay	0.5 Sec	0.5 Sec		
	40T Shrt Uex<	0 Sec	0 Sec		
	40 Excit. Volt	OFF	OFF		
	40 Vexcit. <	3.50 V	3.50 V		
32 R Rev. Power					
	FCT 32R	ON	ON		
	32R Pickup	-0.50%	-0.50%		
	32R T-SV-OPEN	10.00 Sec	10.00 Sec		
	32R T-SV-CLOSED	2.00 sec	2.00 sec		
32 F For. Power					
	FCT 32F	ON	ON		
	32F Pickup P<	0.60%	0.60%		
	32F Pickup P>	101.90%	101.90%		
	32F Delay P<	10.00 Sec	10.00 Sec		
	32F Delay P>	Infinite	Infinite		
21 Impedence					
	FCT 21	ON	ON		
	21 I> Pickup	5.14 Amp	5.14 Amp		
	21 V<SEAL-IN	OFF	OFF		

	21 V<	80.0 V	80.0 V		
	21 T-SEAL In	4.00 Sec	4.00 Sec		
	21 Pickup Z1	1.29 Ohm	1.29 Ohm		
	21 Dealy Z1	0.60 Sec	0.60 Sec		
	21 Pickup Z1B	1.84 Ohm	1.84 Ohm		
	21 Delay Z1B	0.60 Sec	0.60 Sec		
	21 Pickup Z2	5.10 Ohm	5.10 Ohm		
	21 Delay Z2	2.00 Sec	2.00 Sec		
	21 Dealy T End	Infinite	Infinite		
	Power Swing	OFF	OFF		
	P/SPOL TPOL	1.60 Ohm	1.60 Ohm		
	dz / dt	60.0 Ohm/Sec	60.0 Ohm/Sec		
78 OUT-OF-STEP					
	78 Out - Of - Step	ON	ON		
	78 I1 > Release	123.20%	123.20%		
	78 I2 < Release	20.60%	20.60%		
	78 Za	1.46 Ohm	1.46 Ohm		
	78 Zb	3.48 Ohm	3.48 Ohm		
	78 Zc	1.57 Ohm	1.57 Ohm		
	78 Zd-Zc	0.45 Ohm	0.45 Ohm		
	78 PHI POLYGON	90.0 Degree	90.0 Degree		
	78 REP. CHAR. 1	1	1		
	78 REP. CHAR. 2	3	3		
	78 T Holding	25.00 Sec	25.00 Sec		
	78 T Signal	0.05 Sec	0.05 Sec		
27 Undervoltage					
	FCT 27	ON	ON		
	27-1 Pickup	77.0 V	77.0 V		
	27-1 Delay	2.00 Sec	2.00 Sec		
	27-2 Pickup	71.5 V	71.5 V		
	27-2 Delay	0.00 Sec	0.00 Sec		
59 OverVoltage					
	FCT 59	ON	ON		
	59-1 Pickup	121.0 V	121.0 V		
	59-1 Delay	5.00 Sec.	5.00 Sec.		
	59-2 Pickup	154.0 V	154.0 V		
	59-2 Delay	0.10 Sec	0.10 Sec		
81 O/U Frequency					
	FCT 81 O/U	ON	ON		
	81-1 Pickup	48.50 Hz	48.50 Hz		
	81-1 Delay	5.00 sec	5.00 Sec		
	81-2 Pickup	47.40 Hz	47.40 Hz		
	81-2 Delay	1.00 Sec	1.00 Sec		
	81-3 Pickup	47.40 Hz	47.40 Hz		
	81-3 Delay	1.00 Sec	1.00 Sec		
	81-4 Pickup	52.50 Hz	52.50 Hz		
	81-4 Delay	1.00 sec	1.00 sec		

	Threshold 81 4	81 Automatic	81 Automatic		
	Vmin	65.0 V	65.0 V		
24 V/F					
	FCT 24 V/F	ON	ON		
	24-1 Pickup	1.15	1.15		
	24-1 Delay	10.00 Sec	10.00 Sec		
	24-2 Pickup	1.4	1.4		
	24-2 Delay	1.00 sec	1.00 sec		
	24-t (V/F =1.05)	20000 Sec	20000 Sec		
	24-t (V/F =1.10)	6000 Sec	6000 Sec		
	24-t (V/F =1.15)	165 Sec	165 Sec		
	24-t (V/F =1.20)	80 Sec	80 Sec		
	24-t (V/F =1.25)	50 Sec	50 Sec		
	24-t (V/F =1.30)	5 Sec	5 Sec		
	24-t (V/F =1.35)	4 Sec	4 Sec		
	24-t (V/F=1.40)	1 Sec	1 Sec		
	24.T COOL DOWN	3600 Sec	3600 Sec		
59N/67GN					
	FCT 59N/67GN	ON	ON		
	59N Pickup	6.4 V	6.4 V		
	59N/67GN delay	1.00 sec	1.00 sec		
100 % SGF-PROT					
	100% SGF-PROT	ON	ON		
	R< SGF Alarm	154 Ohm	154 Ohm		
	R << SGF TRIP	31 Ohm	31 Ohm		
	T SGF Alarm	10.00 Sec	10.00 Sec		
	T SGF Trip	1.00 Sec	1.00 Sec		
	SGF I>>	1.50 A	1.50 A		
	V20 Min	0.3 V	0.3 V		
	I20 Min	5 mA	5 mA		
	PHI | SGF	2 degree	2 degree		
64R 1-3 Hz					
	64R 1-3 Hz	ON	ON		
	64R-1 Pickup	25.0 K Ohm	25.0 K Ohm		
	64R-2 Pickup	1.0K Ohm	1.0 K Ohm		
	64R-1 Delay	10.00 sec	10.00 sec		
	64R-2 Delay	5.00 sec	5.00 sec		
	Qc <	0.02 mAs	0.02 mAs		
50/27 Inadver					
	FCT 50/27	ON	ON		
	50/27 I stage	4.6 AMP	4.6 AMP		
	50/27 V1<	77.0 V	77.0 V		
	50/27 T- Pickup	3.00 Sec	3.00 Sec		
	50/27 T-DRP OUT	1.00 Sec	1.00 Sec		

125 MVA, 11/220 KV GENERATING TRANSFORMER

Detail Technical specifications of the 125 MVA Generator Transformer:

Generator-Transformer-, 125 MVA, Rated Voltage-(at no load)-242kV/11kV, Rated Current-HV-298.2 LV-6560.8, Frequency-50 Hz, Vector group-YNd11, Sl. No-2023657, Make- BHEL LTD.

II. **List of electrical components installed in 125 MW Generator Transformer:-**

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	02 Set
B	Numerical Protection relays	01 No.

A. CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	CLASS	Knee point voltage	Sec Res	Remark
1	HV SIDE	CT-1	CORE-1	400/1 A	0.2			
			CORE-2	400/1 A	10P20			
			CORE-3	400/1 A	5P20			
			CORE-4	600/1 A	PS			
			CORE-5	600/1 A	PS			
2	Neutral Side	CT-2	CORE-1	400/1	5P20			
			CORE-2	400/1	5P20			

B. Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Over-all Diff. Relay with inbuilt REF and OVER FLUX protection	GRP- 1	SIEMENS / 7UT613	7UT6131-6EB22-1BBO/FF		YES	

220 KV GT#7 Bay (21) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 21	UNIT#7 BAY	Lightning arrestor	3
			Current transformer	3
			Isolators	4 set
			Earth switch	N/A
			Circuit breaker	3

DETAIL OF GENERATING TRANSFORMER PROTECTION SETTING: -

GRP Relay Settings				
Over All Diff. Protection (87-O) 7UT61				
Device configuration				
Protection	**ANSI CODE**		**Recommended**	**Remark**
GRP Chge option		Disabled		
Prot. Object		3-Phase Transf.		
Diff. Prot.		Enabled		
Ref. Prot.		Disabled		
Cold Load Pickup		Disabled		
DMT/IDMT Phase		TOC IEC		
DMT/IDMT 3IO		TOC IEC		
DMT/IDMT EARTH		Definite time		
DMT 1 Phase		Enabled		
Unbalance load		Disabled		
Therm. Overload		Disabled		
Over Exc. Prot.		Enabled		
breaker failure		Disabled		
Discon. Meas. Loc.		Disabled		
M.V. Superv.		Enabled		
trip cir. Sup.		Disabled		
ext. Trip 1		Disabled		
ext. trip 2		Disabled		
P. SYSTEM DATA 1				
		GRP M	**Recommended**	**Remark**
NO Conn. Meas. Loc		3		
NO Assig Meas. Loc		3		
Number of sides		2		
Assignm. 3M,2S		M1, M2+M3		
Aux. CT IX1		conn/not assig		
Aux. CT IX2		not connected		
Aux. CT IX3		side 1 earth		
Aux CT IX3 Type		1A/5A input		
VT set		Side 2		
VT U4		not connected		
VT U4 Type		U delta Transf.		
Rated Frequency		50 Hz		
Phase SEQ		L1, L2, L3		
Temp. Unit		Celsius		

UN-PRI side 1		242.0 KV		
SN-Side 1		125.00 MVA		
STAR PNT SIDE 1		Earthed		
Connection S1		Y		
UN-Pri side 2		11.0 Kv		
SN Side 2		125.00 MVA		
STAR PNT SIDE 2		Isolated		
Connection S2		D		
Vector Grp S2		II		
DMT/IDMT Ph at		side 1		
DMT/IDMT 3Io at		side 1		
DMT/IDMT E at		Aux. CT IX1		
DMT 1 Phase at		Aux. CT IX3		
STRPNT -> Obj M1		Yes		
IN-PRI CT M1		400A		
IN-SEC CT M1		1A		
STRPNT -> Obj M2		Yes		
IN-PRI CT M2		7500 A		
IN-SEC CT M2		5A		
STARPNT ->Obj M3		Yes		
IN-PRI CT M3		8000 A		
IN-SEC. CT M3		5A		
Earth IX1 at		Terminal Q8		
IN-PRI CT IX1		400 A		
IN-SEC CT IX1		1 A		
Earth IX3 at		Terminal R7		
IN-PRI CT IX3		400 A		
IN-SEC CT IX3		1 A		
UN-PRI VT SET		11.0 Kv		
UN-SEC VT SET		110 V		
CORRECT. U Ans		0.00 Degree		
SwitchgCBaux S1		Qo		
SwitchgCBaux S2		none		
SwitchgCBaux M1		none		
SwitchgCBaux M2		none		
SwitchgCBaux M3		none		

Protection GROUP - A

	Function	GRP - M	Recommended	Remark
Power System Data-2				
	P.Q. sign	not reversed		
	pole open Current S1	0.50I / Ins		
	Pole open Current S2	0.40I / Ins		
	Pole open Current M1	0.20 A		
	Pole open Current M2	0.20 A		
	Pole open Current M3	0.40 A		

Diff. Protection				
	Diff. Prot.	On		
	INC.CHAR.START	Off		
	Inrush 2 Harm.	On		
	Restr. N. harm.	5. Harmonic		
	I-Diff>	0.20I / Ino		
	I-Diff>>	10.0I / Ino		
	T start max	5.0 sec		
	2.0 harmonic	10%		
	n. harm.	20%		
Phase OverCurrent				
	Phase O/C	ON		
	Inrush Rest. Ph	Off		
	I >>	∞ I / Ins		
	T I>>	0.10 Sec		
	I>	6.00 I / Ins		
	T I >	0.15 Sec		
	If	1.20 I / Ins		
	T If	0.30 sec		
	TOC Drop-Out	Disk Emulation		
	IEC Curve	Normal Inverse		
	2. Harm. Phase	15%		
	I Max InRr. Ph.	7.50 I / ins		
	Cross Blk. Phase	NO		
	T Cross blk. Ph.	0.00 Sec		
3IO O/C				
	3IO O/C	ON		
	Inrush Rest. 3IO	OFF		
	3IO >>	∞ I/Ins		
	T 3IO >>	∞ sec		
	3 IO >	0.40 I/Ins		
	T 3IO >	1.25 Sec.		
	3 Iof	0.30 I/Ins		
	T 3IOf	0.30 sec		
	TOC Drop out	Disk Emulation		
	IEC Curve	Normal Inverse		
	2. Harm. 3IO	15%		
	I Max In Rr. 3IO	7.50 I/Ins		
Earth O/c				
	Earth O/C	ON		
	Inrush Rest. Earth	Off		
	IE >>	∞ A		
	T IE >>	1.50 Sec		
	IE >	0.30 A		
	T IE >	1.50 Sec.		

	2. Harm. Earth	15%		
	I Max In Rr. E	7.50 A		
1 Phase O/C				
	1 Phase O/C	ON		
	1 Phase I>>	∞ A		
	T 1 Phase I>>	0.10 Sec.		
	1 phase I >	0.10 A		
	T 1 Phase I>	0.00 Sec.		
Over Excit.				
	Over exc. Prot	ON		
	U/f >	1.15		
	T U/f >	10.00 sec.		
	U/f >>	1.4		
	T U/f >>	1.00 sec		
	t (U/f = 1.05)	20000 Sec.		
	t (U/f = 1.10)	6000 Sec.		
	t (U/f = 1.15)	165 Sec.		
	t (U/f = 1.20)	60 Sec.		
	t (U/f = 1.25)	30 Sec.		
	t (U/f = 1.30)	5 Sec.		
	t (U/f = 1.35)	4 Sec.		
	t (U/f = 1.40)	1 Sec.		
	T COOL DOWN	0 Sec.		

Mechanical protection tripping and Annunciation healthiness:-

SI. No.	MECHANICAL PROTECTION	SETTINGS		Tr. GT#7		
		ALARM	TRIP	ALARM	TRIP	healthiness
1.	OTI	85	95	85	95	ok
2.	WTI	90	100	90	100	ok
3.	BUCKHOLZ	Alarm	Trip	ok	Ok	ok
4.	PRV	---	Trip		Ok	ok
5.	LOW OIL LEVEL	Alarm	----	Ok		ok
6.	SOURCE A SUPPLY	Alarm	----	Ok		ok
7.	SOURCE B SUPPLY	Alarm	----	Ok		ok
8.	COOLER CONTROL SUPPLY	Alarm	----	Ok		ok

CIRCUIT BREAKER OPERATION:-

SI. NO.	Transformer Designator	CB Operation		
		By TNC switch Remote	By protection/Inter trip	Emergency trip elec. & mech.
1.	Tr. GT#7	OK	OK	OK

CIRCUIT BREAKER ANNUNCIATION:-

		Indication			Annunciation			
SI NO	Circuit Breaker	CB ON-OFF	Trip circuit Healthy	SF Pressure normal	D.C. Fail	Trip Circuit Faulty	Breaker Lockout	Transformer Conditioning Monitoring
1	CB	OK	OK	OK	OK	OK	OK	NA

4. **STATION AND UNIT TRANSFORMERS**

I. Detail Technical specifications of the Station Transformer

Detail Technical specifications				
	Station Transformers		Unit station Transformer	
Number	9T	10-T	R-1	R-2
Manufacturer/ Country	RUSSIAN	CGL/INDIA	CGL/INDIA	CGL/INDIA
Year Manufactured	1965	2013	1976	2009
Type	STEP DOWN	STEP DOWN	STEP DOWN	STEP DOWN
Serial#	860809	T10169/2	23829	23828
Rating (MVA)	10MVA	20MVA	20MVA	20MVA
Serial Voltage (kV)	132/6.9	132/6.9	132/6.9	132/6.9
AMPERES (A) HV/LV		87.5/1749.5	87.5/1675	87.5/1675
Phases	3	3	3	3
Frequency (Hz)	50 Hz	50 Hz	50 Hz	50 Hz
Cooling	ONAN/ONAF	ONAN/ONAF	ONAN/ONAF	ONAN/ONAF
Oil type	MINERAL/TRANSFORMER OIL	MINERAL/TRANSFORMER OIL	MINERAL/TRANSFORMER OIL	MINERAL/TRANSFORMER OIL
Oil Capacity (kg)	15000	12100	17280	17280
Drainage/ Containment	DRAIN VALVE ON TANK	DRAIN VALVE ON TANK	DRAIN VALVE ON TANK	DRAIN VALVE ON TANK
Separation	-	-	-	-
Blast wall	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE
OLTC	ON LOAD	ON LOAD	ON LOAD	ON LOAD
Protection relays	ZIV 81DV-L4F-2D0ED62NU	ZIV 81DV-L4F-2D0ED62NU	ZIV 81DV-L4F-2D0ED62NU	ZIV 81DV-L4F-2D0ED62NU

. **List of electrical components installed in 10 MVA 9T Transformer:-**

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	02 Set
B	Numerical Protection relays	01 No.

Transformer Currently Out of service

CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designa tio n	CT Ratio	Ratio adopted	CLASS	Knee point voltage	Sec Res	Remark
1	HV SIDE	CT-1	CORE-1	300/5	0.2			
			CORE-2	300/5	0.2			
			CORE-3	600/5	PS	>500		
			CORE-4	600/5	PS	>500		
			CORE-5	600/5	PS	>500		
2	Neutral Side	CT-2	CORE-1	200/1				

Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Transformer Diff. Relay protection	MCR	ZIV 81DVL4F-2D0ED62NU			YES	

132 KV Tr. 9T Bay (781) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 781	Tr. 9T BAY	Lightning arrestor	3
			Current transformer	3
			Isolators	2 set
			Earth switch	N/A
			Circuit breaker	3

DETAILS OF TRANSFORMER PROTECTION SETTINGS:-

Tr. 9T (10 MV,132/6.9 KV) Relay Settings			
Transformer Diff. Protection			
General Settings			
Settings	**Group 1**	**Recommended**	**Remark**
Name	9T_DIFF		
Unit In Service	Yes		
Winding 1 ratio	120		
Winding 2 ratio	200		
Winding 3 ratio	1		
Phase VT Ratio	1200		
Neutral VT Ratio	1200		
Gnd 1 CT Ratio	1		

Gnd 2 CT Ratio	200		
Phase Sequence	ABC		
Number of Windings	Two Windings		
Diff curr measure	Times Tap		
Reference Angle	VA		
Neutral Voltage Origin	Transformer		
Connection Groups			
Settings	**Group 1**	**Recommended**	**Remark**
Wndg 1 connection	WYE		
ZS Filter wndg 1	Yes		
Wndg 2 connection	DELTA		
Wndg 2 phase ang	11		
ZS Filter wndg 2	No		
Wndg 3 connection	WYE		
Wndg 3 phase ang	0		
ZS Filter wndg 3	No		
Zero Seq Filter Type	Phase Channels		
Gnd C1 Winding	1		
Gnd C2 Winding	2		
Autotransformer	No		
Protection			
Differential Units			
Settings	**Group 1**	**Recommended**	**Remark**
Restraint Type	(I1+I2)/2		
Reference Wndg	Winding 1		
Tap winding 1	0.36A		
Tap winding 2	4.37A		
Tap winding 3	5.00A		
Fault Detector Supervision	No		
Differential			
Settings	**Group 1**	**Recommended**	**Remark**
Diff Enable	**No**		
Sensitivity	0.3xtap (pu)		
Restraint slope 1	30%		
R Slope 1 Start	0.36xtap (pu)		
Restraint slope 2	70%		
R Slope 2 Start	2.16xtap (pu)		
Ext Fault Block Enable	Yes		
2nd Restr. Enab.	No		
2nd Restraint PU	0.4		
3rd Restr. Enab.	No		
3rd Restraint PU	0.4		
4th Restr. Enab.	No		
4th Restraint PU	0.4		

5th Restr. Enab.	No		
5th Restraint PU	0.4		
Harmonic Restrain Mode	Continous		
Diff Time Delay	0s		
H Blocking Logic	OR		
Cross Blocking Time	0.1s		
2nd Block. Enab.	Yes		
2nd Blocking PU	15%		
3rd Block. Enab.	No		
3rd Blocking PU	20%		
4th Block. Enab.	No		
4th Blocking PU	20%		
5th Block. Enab.	Yes		
5th Blocking PU	25%		
Harmonic Blocking Mode	Continous		
Inhibition Time for Harmonics	80s		
Inhibition of Harmonic Blocking/Restraint with voltage	No		
Parallel Transformer	No		

Instantaneous Differential

Settings	Group 1	Recommended	Remark
Inst Diff Enable	**Yes**		
Inst Diff Pickup	6xtap (pu)		
Inst Diff Delay	0s		
Ext Fault BlockEnable	No		

External Fault Detector

Settings	Group 1	Recommended	Remark
Enable	**Yes**		
Current Minimum Level	0.1xtap (pu)		

Winding 1 Phase Time Overcurrent

Settings	Group 1	Recommended	Remark
Phase TOC Enable	**Yes**		
Phase TOC Pickup	0.85A		
Phase TOC Curve	[IEC] Inverse		
Phase TOC Dial	0.4		
Phase TOC Definite Time	0.05s		
Phase TOC Direction	None		
Phase TOC Direct Unit	67F		

Winding 1 Neutral Time Overcurrent

Settings	Group 1	Recommended	Remark
Neutral TOC Enable	No		
Neutral TOC Pickup	**0.15A**		

Neutral TOC Curve	Definite Time		
Neutral TOC Dial	0.1		
Neutral TOC Delay	0.05s		
Neutral TOC Direction	None		
Neutral TOC Direct Unit	67N-V		
Winding 1 Instantaneous Phase Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Phase IOC Enable	**No**		
Phase IOC Pickup	3.60A		
Phase IOC Delay	0s		
Phase IOC Direction	None		
Phase IOC Direct Unit	67F		
Winding 1 Neutral Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Neutral IOC Enable	**No**		
Neutral IOC Pickup	2.00A		
Neutral IOC Delay	0s		
Neutral IOC Direction	None		
Neutr IOC Direct Unit	67N-V		
Winding 2 Phase Time Overcurrent			
Settings	**Group 1**	**Recommended**	**Remark**
Phase TOC Enable	**Yes**		
Phase TOC Pickup	0.20A		
Phase TOC Curve	[IEC] Inverse		
Phase TOC Dial	0.2		
Phase TOC Definite Time	0.05s		
Phase TOC Direction	None		
Phase TOC Direct Unit	67F		
Winding 2 Phase Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Phase IOC Enable	**Yes**		
Phase IOC Pickup	1.00A		
Phase IOC Delay	0s		
Phase IOC Direction	None		
Phase IOC Direct Unit	67F		
Ground Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Gnd IOC Enable	**No**		
Gnd IOC Pickup	0.1A		
Gnd IOC Delay	0s		
Restricted Earth Faults Channel 1			
Settings	**Group 1**	**Recommended**	**Remark**

REF Enable	**No**		
REF Pickup	0.1A		
REF Restraint Slope	0%		
REF Delay	0.01s		

Mechanical protection tripping and Annunciation healthiness:-

SI. No.	MECHANICAL PROTECTION	SETTINGS		Tr. 9T		
		ALARM	TRIP[	ALARM	TRIP	Healthiness
1.	OTI	75	80	Currently Transformer Out of service		
2.	WTI	80	90			
3.	BUCKHOLZ	Alarm	Trip			
4.	PRV	---	Trip			
5.	LOW OIL LEVEL	Alarm	----			
6.	SOURCE A SUPPLY	Alarm	----			
7.	SOURCE B SUPPLY	Alarm	----			
8.	COOLER CONTROL SUPPLY	Alarm	----			

CIRCUIT BREAKER OPERATION:-

SI. NO.	Transformer Designator	CB Operation		
		By TNC switch Remote	By protection/Inter trip	Emergency trip elec. & mech.
1.	Tr. 9T	NA	NA	NA

CIRCUIT BREAKER ANNUNCIATION:-

		Indication			Annunciation			
SI NO	Circuit Breaker	CB ON-OFF	Trip circuit Healthy	SF Pressure normal	D.C. Fail	Trip Circuit Faulty	Breaker Lockout	Transformer Conditioning Monitoring
1	CB	OK	OK	OK	OK	--	OK	NA

List of electrical components installed in 20 MVA 10T Transformer:-

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	02 Set

B	Numerical Protection relays	01 No.

CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	CLASS	Knee point voltage	Sec Res	Remark
1	HV SIDE	CT-1	CORE-1	300/5	0.2			
			CORE-2	300/5	0.2			
			CORE-3	600/5	PS	>500		
			CORE-4	600/5	PS	>500		
			CORE-5	600/5	PS	>500		
2	Neutral Side	CT-2	CORE-1	200/1				

Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Transformer Diff. Relay protection	MCR	ZIV 81DV-L4F-2D0ED62NU			YES	

132 KV Tr. 10T Bay (782) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 782	Tr. 10T BAY	Lightning arrestor	3
			Current transformer	3
			Isolators	2 set
			Earth switch	N/A
			Circuit breaker	3

DETAILS OF TRANSFORMER PROTECTION SETTINGS:-

Tr. 10T (20 MV,132/6.9 KV) Relay Settings			
Transformer Diff. Protection			
General Settings			
Settings	**Group 1**	**Recommended**	**Remark**
Name	ST_10T		
Unit In Service	Yes		
Winding 1 ratio	120		
Winding 2 ratio	200		
Winding 3 ratio	1		
Phase VT Ratio	1200		

Neutral VT Ratio	1		
Gnd 1 CT Ratio	200		
Gnd 2 CT Ratio	200		
Phase Sequence	ABC		
Number of Windings	Two Windings		
Diff curr measure	Times Tap		
Reference Angle	VA		
Neutral Voltage Origin	Transformer		

Connection Groups

Settings	Group 1	Recommended	Remark
Wndg 1 connection	WYE		
ZS Filter wndg 1	Yes		
Wndg 2 connection	DELTA		
Wndg 2 phase ang	11		
ZS Filter wndg 2	No		
Wndg 3 connection	WYE		
Wndg 3 phase ang	0		
ZS Filter wndg 3	No		
Zero Seq Filter Type	Phase Channels		
Gnd C1 Winding	1		
Gnd C2 Winding	2		
Autotransformer	No		

Protection

Differential Units

Settings	Group 1	Recommended	Remark
Restraint Type	(I1+I2-Id)/2		
Reference Wndg	Winding 1		
Tap winding 1	0.73A		
Tap winding 2	8.74A		
Tap winding 3	1.00A		
Fault DetectorSupervision	Yes		

Differential

Settings	Group 1	Recommended	Remark
Diff Enable	**Yes**		
Sensitivity	0.3xtap (pu)		
Restraint slope 1	30%		
R Slope 1 Start	0.15xtap (pu)		
Restraint slope 2	70%		
R Slope 2 Start	2xtap (pu)		
Ext Fault Block Enable	Yes		
2nd Restr. Enab.	No		
2nd Restraint PU	0.4		

3rd Restr. Enab.	No		
3rd Restraint PU	0.4		
4th Restr. Enab.	No		
4th Restraint PU	0.4		
5th Restr. Enab.	No		
5th Restraint PU	0.4		
Harmonic Restrain Mode	Continuous		
Diff Time Delay	0s		
H Blocking Logic	2 OUT OF 3		
Cross Blocking Time	0.1s		
2nd Block. Enab.	Yes		
2nd Blocking PU	15%		
3rd Block. Enab.	No		
3rd Blocking PU	20%		
4th Block. Enab.	No		
4th Blocking PU	20%		
5th Block. Enab.	Yes		
5th Blocking PU	25%		
Harmonic Blocking Mode	Continuous		
Inhibition Time for Harmonics	80s		
Inhibition of Harmonic Blocking/Restraint with voltage	No		
Parallel Transformer	No		

Instantaneous Differential

Settings	Group 1	Recommended	Remark
Inst Diff Enable	**Yes**		
Inst Diff Pickup	5xtap (pu)		
Inst Diff Delay	0s		
Ext Fault Block Enable	No		

External Fault Detector

Settings	Group 1	Recommended	Remark
Enable	**Yes**		
Current Minimum Level	1xtap (pu)		

Winding 1 Phase Time Overcurrent

Settings	Group 1	Recommended	Remark
Phase TOC Enable	**Yes**		
Phase TOC Pickup	0.80A		
Phase TOC Curve	[IEC] Inverse		
Phase TOC Dial	0.1		
Phase TOC Definite Time	0.3s		
Phase TOC Direction	None		

Phase TOC Direct Unit	67F		

Winding 1 Neutral Time Overcurrent			
Settings	**Group 1**	**Recommended**	**Remark**
Neutral TOC Enable	**Yes**		
Neutral TOC Pickup	0.20A		
Neutral TOC Curve	[IEC] Inverse		
Neutral TOC Dial	0.2		
Neutral TOC Delay	0.15s		
Neutral TOC Direction	None		
Neutral TOC Direct Unit	67N-V		

Winding 1 Phase Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Phase IOC Enable	**Yes**		
Phase IOC Pickup	4.50A		
Phase IOC Delay	0.1s		
Phase IOC Direction	None		
Phase IOC Direct Unit	67F		

Winding 1 Neutral Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Neutral IOC Enable	**Yes**		
Neutral IOC Pickup	4.50A		
Neutral IOC Delay	0.06s		
Neutral IOC Direction	None		
Neutr IOC Direct Unit	67N-V		

Ground Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Gnd IOC Enable	**No**		
Gnd IOC Pickup	0.1A		
Gnd IOC Delay	0s		

Time Overcurrent			
Settings	**Group 1**	**Recommended**	**Remark**
Overload Enable	**Yes**		
Overload Pickup	6.50A		
Overload Curve	Definite Time		
Overload Dial	1		
Overload Definite Time	1800s		

Restricted Earth Faults			
Settings	**Group 1**	**Recommended**	**Remark**
REF Enable	**Yes**		
REF Pickup	0.1A		
REF Restraint Slope	25%		
REF Delay	0s		

Mechanical protection tripping and Annunciation healthiness:-

SI. No.	MECHANICAL PROTECTION	SETTINGS		Tr. 10T		
		ALARM	TRIP	ALARM	TRIP	Healthiness
1.	OTI	85	95	85	95	Ok
2.	WTI	90	100	90	100	Ok
3.	BUCKHOLZ	Alarm	Trip	Ok	Ok	
4.	PRV		Trip		Ok	
5.	LOW OIL LEVEL	Alarm		Ok		
6.	SOURCE A SUPPLY	Alarm		Ok		
7.	SOURCE B SUPPLY	Alarm		Ok		
8.	COOLER CONTROL SUPPLY	Alarm		Ok		

CIRCUIT BREAKER OPERATION:-

SI. NO.	Transformer Designator	CB Operation		
		By TNC switch Remote	By protection/Inter trip	Emergency trip elec. & mech.
1.	Tr. 10T	OK	OK	OK

CIRCUIT BREAKER ANNUNCIATION:-

		Indication			Annunciation			
SI NO	Circuit Breaker	CB ON-OFF	Trip circuit Healthy	SF Pressure normal	D.C. Fail	Trip Circuit Faulty	Breaker Lockout	Transformer Conditioning Monitoring
1	CB	OK	OK	OK	OK	OK	OK	NA

List of electrical components installed in 20 MVA R1 Transformer:-

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	02 Set
B	Numerical Protection relays	01 No.

CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	CLAS S	Knee point voltage	Sec Res	Remark
1	HV SIDE	CT-1	CORE-1	200/1	1.0			
			CORE-2	200/1	5P			
			CORE-3	600/1	10P			
			CORE-4	800/1	5P			
			CORE-5	800/1	5P			
2	Neutral Side	CT-2	CORE-1	200/1				

Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Transformer Diff. Relay protection	MCR	ZIV 81DV-L4F-2D0ED62NU			YES	

132 KV Tr. R1 Bay (783) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 783	Tr. R1 BAY	Lightning arrestor	2 Set
			Current transformer	3
			Isolators	3 set
			Earth switch	N/A
			Circuit breaker	3

DETAILS OF TRANSFORMER PROTECTION SETTINGS:-

Tr. R1 (20 MV,132/6.9 KV) Relay Settings			
Transformer Diff. Protection			
General Settings			
Settings	**Group 1**	**Recommended**	**Remark**
Name	ST_R1		
Unit In Service	Yes		
Winding 1 ratio	600		

Winding 2 ratio	400		
Winding 3 ratio	1		
Phase VT Ratio	1200		
Neutral VT Ratio	1		
Gnd 1 CT Ratio	200		
Gnd 2 CT Ratio	200		
Phase Sequence	ABC		
Number of Windings	Two Windings		
Diff curr measure	Times Tap		
Reference Angle	VA		
Neutral Voltage Origin	Transformer		
Connection Groups			
Settings	**Group 1**	**Recommended**	**Remark**
Wndg 1 connection	WYE		
ZS Filter wndg 1	Yes		
Wndg 2 connection	DELTA		
Wndg 2 phase ang	11		
ZS Filter wndg 2	No		
Wndg 3 connection	WYE		
Wndg 3 phase ang	0		
ZS Filter wndg 3	No		
Zero Seq Filter Type	Phase Channels		
Gnd C1 Winding	1		
Gnd C2 Winding	2		
Autotransformer	No		
Protection			
Differential Units			
Settings	**Group 1**	**Recommended**	**Remark**
Restraint Type	(I1+I2-Id)/2		
Reference Wndg	Winding 1		
Tap winding 1	0.15A		
Tap winding 2	4.18A		
Tap winding 3	1.00A		
Fault Detector Supervision	Yes		
Differential			
Settings	**Group 1**	**Recommended**	**Remark**
Diff Enable	**Yes**		
Sensitivity	0.3xtap (pu)		
Restraint slope 1	30%		
R Slope 1 Start	0.15xtap (pu)		
Restraint slope 2	70%		
R Slope 2 Start	2xtap (pu)		
Ext Fault Block Enable	Yes		
2nd Restr. Enab.	Yes		
2nd Restraint PU	0.4		
3rd Restr. Enab.	Yes		

3rd Restraint PU	0.4		
4th Restr. Enab.	Yes		
4th Restraint PU	0.4		
5th Restr. Enab.	Yes		
5th Restraint PU	0.4		
Harmonic Restrain Mode	Continuous		
Diff Time Delay	0s		
H Blocking Logic	OR		
Cross Blocking Time	0.1s		
2nd Block. Enab.	Yes		
2nd Blocking PU	15%		
3rd Block. Enab.	No		
3rd Blocking PU	20%		
4th Block. Enab.	No		
4th Blocking PU	20%		
5th Block. Enab.	Yes		
5th Blocking PU	25%		
Harmonic Blocking Mode	Continuous		
Inhibition Time for Harmonics	80s		
Inhibition of Harmonic Blocking/Restraint with voltage	No		
Parallel Transformer	No		
External Fault Detector			
Settings	**Group 1**	**Recommended**	**Remark**
Enable	**Yes**		
Current MinimumLevel	0.75xtap (pu)		
Winding 1 Phase Time Overcurrent			
Settings	**Group 1**	**Recommended**	**Remark**
Phase TOC Enable	**Yes**		
Phase TOC Pickup	0.16A		
Phase TOC Curve	[IEC] Inverse		
Phase TOC Dial	0.4		
Phase TOC Definite Time	0.05s		
Phase TOC Direction	None		
Phase TOC Direct Unit	67F		
Winding 1 Neutral Time Overcurrent			
Settings	**Group 1**	**Recommended**	**Remark**
Neutral TOC Enable	**Yes**		
Neutral TOC Pickup	0.04A		
Neutral TOC Curve	[IEC] Inverse		
Neutral TOC Dial	0.2		
Neutral TOC Delay	0.05s		
Neutral TOC Direction	None		

Neutral TOC Direct Unit	67N-V		
Winding 1 Phase Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Phase IOC Enable	**Yes**		
Phase IOC Pickup	0.90A		
Phase IOC Delay	0.1s		
Phase IOC Direction	None		
Phase IOC Direct Unit	67F		
Winding 1 Neutral Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Neutral IOC Enable	**Yes**		
Neutral IOC Pickup	1.00A		
Neutral IOC Delay	0.06s		
Neutral IOC Direction	None		
Neutr IOC Direct Unit	67N-V		
Ground Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Gnd IOC Enable	Yes		
Gnd IOC Pickup	0.5A		
Gnd IOC Delay	0.06s		
Restricted Earth Faults			
Settings	**Group 1**	**Recommended**	**Remark**
REF Enable	Yes		
REF Pickup	0.1A		
REF Restraint Slope	0%		
REF Delay	0s		

Mechanical protection tripping and Annunciation healthiness:-

SI. No.	MECHANICAL PROTECTION	SETTINGS		Tr. R1		
		ALARM	TRIP	ALARM	TRIP	Healthiness
1.	OTI	NA	NA			
2.	WTI	80	90	80	90	Ok
3.	BUCKHOLZ	Alarm	Trip	Ok	Ok	Ok
4.	PRV		Trip		Ok	Ok
5.	LOW OIL LEVEL	Alarm		Ok		Ok
6.	SOURCE A SUPPLY	Alarm		Ok		Ok
7.	SOURCE B SUPPLY	Alarm		Ok		Ok
8.	COOLER CONTROL SUPPLY	Alarm		Ok		Ok

CIRCUIT BREAKER OPERATION:-

SI. NO.	Transformer Designator	CB Operation		
		By TNC switch Remote	By protection/Inter trip	Emergency trip elec. & mech.
1.	Tr. R1	OK	OK	OK

CIRCUIT BREAKER ANNUNCIATION:-

		Indication			Annunciation			
SI NO	Circuit Breaker	CB ON-OFF	Trip circuit Healthy	SF Pressure normal	D.C. Fail	Trip Circuit Faulty	Breaker Lockout	Transformer Conditioning Monitoring
1	CB	OK	OK	OK	OK	OK	OK	NA

List of electrical components installed in 20 MVA R2 Transformer:-

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	02 Set
B	Numerical Protection relays	01 No.

CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	CLASS	Knee point voltage	Sec Res	Remark
1	HV SIDE	CT-1	CORE-1	200/1	0.2s			
			CORE-2	200/1	5P20			
			CORE-3	600/1	10P20			
			CORE-4	800/1	10P20			
			CORE-5	800/1	10P20			
2	Neutral Side	CT-2	CORE-1	200/1				

Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Transformer Diff. Relay protection	MCR	ZIV 81DV-L4F-2D0ED62NU			YES	

132 KV Tr. R2 Bay (784) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 784	Tr. R2 BAY	Lightning arrestor	2 Set
			Current transformer	3
			Isolators	3 set
			Earth switch	N/A
			Circuit breaker	3

DETAILS OF TRANSFORMER PROTECTION SETTINGS:-

Tr. R2 (20 MV,132/6.9 KV) Relay Settings			
Transformer Diff. Protection			
General Settings			
Settings	**Group 1**	**Recommended**	**Remark**
Name	**ST_R1**		
Unit In Service	Yes		
Winding 1 ratio	800		

Winding 2 ratio	400		
Winding 3 ratio	1		
Phase VT Ratio	1200		
Neutral VT Ratio	1		
Gnd 1 CT Ratio	200		
Gnd 2 CT Ratio	200		
Phase Sequence	ABC		
Number of Windings	Two Windings		
Diff curr measure	Times Tap		
Reference Angle	VA		
Neutral Voltage Origin	Transformer		
Connection Groups			
Settings	**Group 1**	**Recommended**	**Remark**
Wndg 1 connection	WYE		
ZS Filter wndg 1	Yes		
Wndg 2 connection	DELTA		
Wndg 2 phase ang	11		
ZS Filter wndg 2	No		
Wndg 3 connection	WYE		
Wndg 3 phase ang	0		
ZS Filter wndg 3	No		
Zero Seq Filter Type	Phase Channels		
Gnd C1 Winding	1		
Gnd C2 Winding	2		
Autotransformer	No		
Protection			
Differential Units			
Settings	**Group 1**	**Recommended**	**Remark**
Restraint Type	(I1+I2)/2		
Reference Wndg	Winding 1		
Tap winding 1	0.15A		
Tap winding 2	4.18A		
Tap winding 3	1.00A		
Fault Detector Supervision	Yes		
Differential			
Settings	**Group 1**	**Recommended**	**Remark**
Diff Enable	Yes		
Sensitivity	0.3xtap (pu)		
Restraint slope 1	30%		
R Slope 1 Start	0.15xtap (pu)		
Restraint slope 2	70%		
R Slope 2 Start	2xtap (pu)		
Ext Fault Block Enable	Yes		
2nd Restr. Enab.	Yes		
2nd Restraint PU	0.4		
3rd Restr. Enab.	Yes		
3rd Restraint PU	0.4		

4th Restr. Enab.	Yes		
4th Restraint PU	0.4		
5th Restr. Enab.	Yes		
5th Restraint PU	0.4		
Harmonic Restrain Mode	Continuous		
Diff Time Delay	0s		
H Blocking Logic	OR		
Cross Blocking Time	0.1s		
2nd Block. Enab.	Yes		
2nd Blocking PU	15%		
3rd Block. Enab.	No		
3rd Blocking PU	20%		
4th Block. Enab.	No		
4th Blocking PU	20%		
5th Block. Enab.	Yes		
5th Blocking PU	25%		
Harmonic Blocking Mode	Continuous		
Inhibition Time for Harmonics	80s		
Inhibition of Harmonic Blocking/Restraint with voltage	No		
Parallel Transformer	No		
External Fault Detector			
Settings	**Group 1**	**Recommended**	**Remark**
Enable	Yes		
Current Minimum Level	0.75xtap (pu)		
Winding 1 Phase Time Overcurrent			
Settings	**Group 1**	**Recommended**	**Remark**
Phase TOC Enable	**Yes**		
Phase TOC Pickup	0.12A		
Phase TOC Curve	[IEC] Inverse		
Phase TOC Dial	0.4		
Phase TOC Definite Time	0.05s		
Phase TOC Direction	None		
Phase TOC Direct Unit	67F		
Winding 1 Neutral Time Overcurrent			
Settings	**Group 1**	**Recommended**	**Remark**
Neutral TOC Enable	**Yes**		
Neutral TOC Pickup	0.03A		
Neutral TOC Curve	[IEC] Inverse		
Neutral TOC Dial	0.2		
Neutral TOC Delay	0.05s		
Neutral TOC Direction	None		
Neutral TOC Direct Unit	67N-V		
Winding 1 Phase Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**

Phase IOC Enable	**Yes**		
Phase IOC Pickup	0.68A		
Phase IOC Delay	0.1s		
Phase IOC Direction	None		
Phase IOC Direct Unit	67F		
Winding 1 Neutral Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Neutral IOC Enable	Yes		
Neutral IOC Pickup	0.80A		
Neutral IOC Delay	0.06s		
Neutral IOC Direction	None		
Neutr IOC Direct Unit	67N-V		
Ground Instantaneous			
Settings	**Group 1**	**Recommended**	**Remark**
Gnd IOC Enable	Yes		
Gnd IOC Pickup	0.5A		
Gnd IOC Delay	0.06s		
Restricted Earth Faults Channel 1			
Settings	**Group 1**	**Recommended**	**Remark**
REF Enable	Yes		
REF Pickup	0.1A		
REF Restraint Slope	0%		
REF Delay	0s		

<u>Mechanical protection tripping and Annunciation healthiness:-</u>

SI. No.	**MECHANICAL PROTECTION**	**SETTINGS**		**Tr. R2**		
		ALARM	**TRIP**	**ALARM**	**TRIP**	**Healthiness**
1.	**OTI**	**80**	**90**	**80**	**90**	**Ok**
2.	**WTI**	**NA**	**NA**			
3.	**BUCKHOLZ**	**Alarm**	**Trip**	**Ok**	**Ok**	**Ok**
4.	**PRV**		**Trip**		**Ok**	
5.	**LOW OIL LEVEL**	**Alarm**		**Ok**		**Ok**
6.	**SOURCE A SUPPLY**	**Alarm**		**Ok**		**Ok**
7.	**SOURCE B SUPPLY**	**Alarm**		**Ok**		**Ok**
8.	**COOLER CONTROL SUPPLY**	**Alarm**		**Ok**		**Ok**

CIRCUIT BREAKER OPERATION:-

SI. NO.	Transformer Designator	CB Operation		
		By TNC switch Remote	By protection/Inter trip	Emergency trip elec. & mech.
1.	Tr. R2	OK	OK	OK

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CIRCUIT BREAKER ANNUNCIATION:-

		Indication			Annunciation			
SI NO	Circuit Breaker	CB ON-OFF	Trip circuit Healthy	SF Pressure normal	D.C. Fail	Trip Circuit Faulty	Breaker Lockout	Transformer Conditioning Monitoring
1	CB	OK	OK	OK	OK	OK	OK	NA

OBSERVATION:

As a general finding from this audit, it is observed that:

1. Generator is well protected as per recommended settings.
2. GRP has independent main-1 and main-2 functional Numerical protection.
3. Dedicated differential protection of Generator transformer is not available.
4. UAT is not available, Unit auxiliaries are from 20 MVA station transformers R1 and R2.
5. Positive of one number DC source is earthed.
6. GRP relays are not Time synchronized with GPS, as GPS is not available.
7. Single line diagram (SLD) of ACDB and DCDB not available.
8. EDG supply at 1X110MW Unit found in order.
9. Time Functionality circuit breaker, relay testing reports is also checked, and all are found in satisfactory state.

Internal Protection Audit Report of

220/132 kV SWITCH YARD

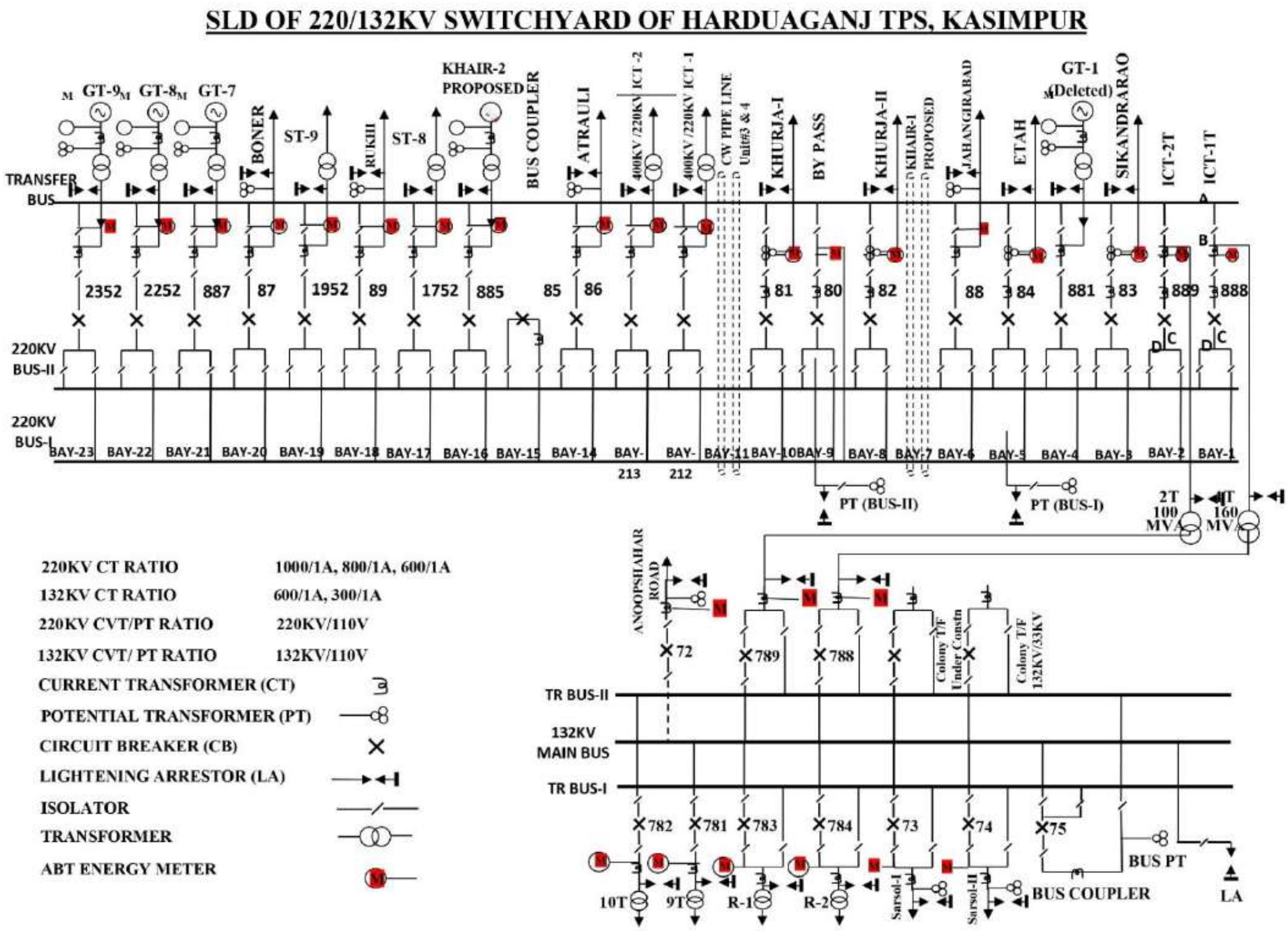
of

'C' Thermal power station,

Harduaganj Thermal Power Plant, Kasimpur, Aligarh

INTERNAL PROTECTION AUDIT 220/132 KV HTPP, KASIMPUR ALIGARH

SLD of 220/132 KV Switchyard



DC SUPPLY SYSTEMS OF SWITCHYARD

No	DC supply systems		220V DC 1	220V DC 2
1	Type of Batteries	Non Sealed/Sealed lead with recombination of gas/Nickel-Cadmium/Other	Non sealed lead acid 500AH	EXIDE make Non sealed lead acid 500AH
2	Number of Cells per bank		110	110
3	Date of procurement/ commissioning of the Battery		2006	2022
4	Is the battery functional and in good condition?	Yes/No	NO	Yes
5	Availability of Battery Charger	Yes/No	VERTIV make float cum boost charger	float cum boost charger
6	Date of procurement/ commissioning of the Charger		2018	2008
7	Is the Charger functional ?	Yes/No	Yes	Boost mode functioning, but Float nor working
8	Used combination for charging	Two sets of battery and charger /single battery with charger /one battery with two chargers	Two sets of battery and charger	
9	Measured voltage (to be measured at the farthest panel)			
	Positive to Earth		-	123 V
	Negative to Earth		-	122 V

10	Availability of Battery Ground Fault Detectors?	Yes/No	No	No
12	The protection relays and trip circuits are segregated into two independent system feed through fuses from two different DC sources	Yes/No	No	
13	**Maintenance/ Testing Plan**			
	What is the maintenance/ testing plan/ schedule followed by the utility for maintenance of battery and charger?	Daily maintenance plan included measurement of specific gravity and visual checks.		

DC SUPPLY SYSTEMS of PLCC

No	DC supply systems		50 DC 1	50V DC 2
	Type of Batteries	Non Sealed/Sealed lead with recombination of gas/ Nickel-Cadmium/Other	EXIDE make Non sealed lead acid 600AH	EXIDE make Non sealed lead acid 600AH
2	Number of Cells per bank		25	25
3	Date of procurement/ commissioning of the Battery		2017	2021
4	Is the battery functional and in good condition?	Yes/No	Yes	Yes
5	Availability of Battery Charger	Yes/No	VERTIV make 50V 100A float cum boost charger	VERTIV make 50V 50A float cum boost charger
6	Date of procurement/ commissioning of the Charger		2018	2021
7	Is the Charger functional ?	Yes/No	Yes	Yes
8	Used combination for charging	Two sets of battery and charger /single battery with charger /one battery with two chargers	Two sets of battery and charger	
9	Measured voltage (to be			

	measured at the farthest panel)			
	Positive to Earth		+26 V	+24 V
	Negative to Earth		-27 V	-28 V
10	Availability of Battery Ground Fault Detectors?	Yes/No	No	No
12	The protection relays and trip circuits are segregated into two independent system feed through fuses from two different DC sources	Yes/No	No	
13	**Maintenance/ Testing Plan**			
	What is the maintenance/ testing plan/ schedule followed by the utility for maintenance of battery and charger?		Daily maintenance plan included measurement of specific gravity and visual checks.	

DC SUPPLY SYSTEMS of Unit 7

No	***DC supply systems***		***220V DC 1***	***220V DC 2***
	Type of Batteries	Non Sealed/Sealed lead with recombination of gas/ Nickel-Cadmium/Other	Non sealed lead acid 500AH	Non sealed lead acid 850AH
2	Number of Cells per bank		110	110
3	Date of procurement/ commissioning of the Battery		2005	2013
4	Is the battery functional and in good condition?	Yes/No	NO	Yes
5	Availability of Battery Charger	Yes/No	Yes	Yes
6	Date of procurement/ commissioning of the Charger		NA	2014
7	Is the Charger functional ?	Yes/No	Boost mode functioning , but Float mode not working	Yes
8	Used combination for charging	Two sets of battery and charger /single battery with charger /one battery with two chargers	Two sets of battery and charger	
9	Measured voltage (to be measured at the farthest panel)			
	Positive to Earth		+130	5 V
	Negative to Earth		-110	-215 V

10	Availability of Battery Ground Fault Detectors?	Yes/No	No	No
12	The protection relays and trip circuits are segregated into two independent system feed through fuses from two different DC sources	Yes/No	No	
13	**Maintenance/ Testing Plan**			
	What is the maintenance/ testing plan/ schedule followed by the utility for maintenance of battery and charger?		Daily maintenance plan included measurement of specific gravity and visual checks.	

CB AUDIT

No.	CB ID Bay Name	GT#7 Bay No 21	Boner Bay No 20	Atrauli Bay No 14	Khurja-I Bay No 10	Etah Bay No 05	SikandRao Bay No 03
1	CB Rated voltage (KV)	**245**	**245**	**245**	**245**	**245**	**245**
2	Make & Model & Sr. No.	Areva, GL314, 151523	Areva, GL314, 151522	Areva, GL314, 151519	Areva, GL314, 151520	Areva, GL314, 151524	Areva, GL314, 151521
3	Date of commissioning	2011	2011	29.09.2009	04.09.2009	03.08.2009	2009
4	Type of CB (SF6/ MOCB/ ABCB etc.)	SF6	SF6	SF6	SF6	SF6	SF6
5	Is the Breaker healthy/ functional (Yes/ No)	Yes	Yes	Yes	Yes	Yes	Yes
6	Rated Breaking current (kA)	40KA	40KA	40KA	40KA	40KA	40KA
7	Number of closing coils	One	One	One	One	One	One
8	Healthiness of closing coil	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy
9	Number of tripping coils	Two	Two	Two	Two	Two	Two
10	Healthiness of Tripping Coil	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy
11	Trip Circuit Supervision Relay available for monitoring Trip Circuit -1 & Trip Circuit-2 with breaker in both open and closed condition (Yes/ No)	Yes	No	No	No	No	No
12	Are the Trip Circuit Supervision realys functional/ healthy	Yes	No	No	No	No	No

13	One/three pole operation	One Pole Operation	One Pole Operation	One Pole Operation	One Pole Operation	One Pole Operation	One Pole Operation
14	For breakers with single poles, is pole discrepancy relay provided?	Yes	Yes	Yes	Yes	Yes	Yes
15	Does the Pole discrepancy relay have facility for Stage-1 (own breaker tripping) & Stage-2 (Boundary breaker tripping)	No	No	No	No	No	No
16	What monitoring devices are provided for checking the dielectric medium of the breaker? (for eg. Gas pressure low etc.)	Densimonitor	Densimonitor	Densimonitor	Densimonitor	Densimonitor	Densimonitor
17	What action is initiated by each of different Stages of these devices (Alarm/ Block tripping)	Both	Both	Both	Both	Both	Both
18	PIR (Available/ Not)	No	No	No	No	No	No
No.	**CB ID Bay Name**	**Bye Pass CB Bay No 09**	**Bus Coupler Bay No 15**	**Khurja-II Bay No 08**	**ICT-2T Bay No 01**	**ICT-1T Bay No 01**	
1	CB Rated voltage (KV)	**245**	**245**	**245**	**NA**	**245**	
2	Make & Model & Sr. No.	ABB, LTB245E1, 17500689	ABB, LTB245E1, 17500690	ABB, ELFSL4-1, 24500421	**NA**	ABB, ELFSL4-1, 1B105995	
3	Date of commissioning	2009	01.09.2009	28.08.2006	**NA**	1992	
4	Type of CB (SF6/ MOCB/ ABCB etc.)	SF6	SF6	SF6	**NA**	SF6	
5	Is the Breaker healthy/ functional (Yes/ No)	Yes	Yes	Yes	**NA**	Yes	
6	Rated Breaking current (kA)	40KA	40KA	40KA	**NA**	40KA	
7	Number of closing coils	One	One	One	**NA**	One	
8	Healthiness of closing coil	Healthy	Healthy	Healthy	**NA**	Healthy	
9	Number of tripping coils	Two	Two	Two	**NA**	Two	
10	Healthiness of Tripping Coil	Healthy	Healthy	Healthy	**NA**	Healthy	
11	Trip Circuit Supervision Relay available for monitoring Trip Circuit -1 & Trip Circuit-2	Yes	Yes	Yes	**NA**	Yes	

	with breaker in both open and closed condition (Yes/ No)						
12	Are the Trip Circuit Supervision realys functional/ healthy	Yes	Yes	Yes	**NA**	Yes	
13	One/three pole operation	One Pole Operation	One Pole Operation	One Pole Operation	**NA**	One Pole Operation	
14	For breakers with single poles, is pole discrepancy relay provided?	Yes	Yes	Yes	**NA**	Yes	
15	Does the Pole discrepancy relay have facility for Stage-1 (own breaker tripping) & Stage-2 (Boundary breaker tripping)	No	No	No	**NA**	NO	
16	What monitoring devices are provided for checking the dielectric medium of the breaker? (for eg. Gas pressure low etc.)	Densimonitor	Densimonitor	Densimonitor	**NA**	Densimonitor	
17	What action is initiated by each of different Stages of these devices (Alarm/ Block tripping)	Both	Both	Both	**NA**	Both	
18	PIR (Available/ Not)	No	No	No	**NA**	No	

No.	**CB ID Bay Name**	**Jahnbd- Bay No 06**	**Rukhi-II Bay No 18**				
1	CB Rated voltage (KV)	**245**	**245**				
2	Make & Model & Sr. No.	CGL, 200-SFM-40S, 33259C	CGL, 200-SFM-40S / 33257C				
3	Date of commissioning	01.11.2014	01.12.2014				
4	Type of CB (SF6/ MOCB/ ABCB etc.)	SF6	SF6				
5	Is the Breaker healthy/ functional (Yes/ No)	Yes	NO				
6	Rated Breaking current (kA)	40KA	NA				
7	Number of closing coils	One	NA				
8	Healthiness of closing coil	Healthy	NA				

9	Number of tripping coils	Two	NA				
10	Healthiness of Tripping Coil	Healthy	NA				
11	Trip Circuit Supervision Relay available for monitoring Trip Circuit -1 & Trip Circuit-2 with breaker in both open and closed condition (Yes/ No)	Yes	NA				
12	Are the Trip Circuit Supervision realys functional/ healthy	Yes	NA				
13	One/three pole operation	One Pole Operation	NA				
14	For breakers with single poles, is pole discrepancy relay provided?	Yes	NA				
15	Does the Pole discrepancy relay have facility for Stage-1 (own breaker tripping) & Stage-2 (Boundary breaker tripping)	No	NA				
16	What monitoring devices are provided for checking the dielectric medium of the breaker? (for eg. Gas pressure low etc.)	Densimonitor	NA				
17	What action is initiated by each of different Stages of these devices (Alarm/ Block tripping)	Both	NA				
18	PIR (Available/ Not)	No	NA				

No.	CB ID Bay Name	ST-9T	ST-10T	ST-R1	ST-R2	ICT-1T(788)	
1	CB Rated voltage (KV)	145	145	145	145	145	
2	Make & Model & Sr. No.	ABB, LTB145D1/B, 17003160	ABB, LTB145D1/B, Rating Plate Not Available	ABB, LTB145D1/B, 17000836	ABB, LTB145D1/B, 17003161	ABB, LTB145D1/B, 17003200	
3	Date of commissioning	2006 & 2009	2006 & 2009	2006 & 2009	2006 & 2009	2006 & 2009	

4	Type of CB (SF6/ MOCB/ ABCB etc.)	SF6	SF6	SF6	SF6	SF6	
5	Is the Breaker healthy/ functional (Yes/ No)	Yes	Yes	Yes	Yes	Yes	
6	Rated Breaking current (kA)	31.5	31.5	31.5	31.5	31.5	
7	Number of closing coils	1	1	1	1	1	
8	Healthiness of closing coil	Yes	Yes	Yes	Yes	Yes	
9	Number of tripping coils	2	2	2	2	2	
10	Healthiness of Tripping Coil	Yes	Yes	Yes	Yes	Yes	
11	Trip Circuit Supervision Relay available for monitoring Trip Circuit -1 & Trip Circuit-2 with breaker in both open and closed condition (Yes/ No)	No	No	No	No	No	
12	Are the Trip Circuit Supervision relays functional/ healthy						
13	One/three pole operation	Three	Three	Three	Three	Three	
14	For breakers with single poles, is pole discrepancy relay provided?						
15	Does the Pole discrepancy relay have facility for Stage-1 (own breaker tripping) & Stage-2 (Boundary breaker tripping)						
16	What monitoring devices are provided for checking the dielectric medium of the breaker? (for eg. Gas pressure low etc.)	Densi Monitor	Densi Monitor	Densi Monitor	Densi Monitor	Densi Monitor	
17	What action is initiated by each of different Stages of these devices (Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	
18	PIR (Available/ Not)	No	No	No	No	No	

No.	CB ID Bay Name	Hdj-Sarsol-I (73)	Hdj-Sarsol-II (74)	Bus Coupler (75)	Anoopshahar Rd (72)	33KV TF1 EMD III	33KV TF2 EMD III
1	CB Rated voltage (KV)	145	145	145	145	145	145
2	Make & Model & Sr. No.	ABB, LTB145D1/B, 17000837	ABB, LTB145D1/B, 17003162	ABB, LTB145D1/B, 17003164	ABB, LTB145D1/B, 17003163	ABB, LTB145D1/B, 17003198	ABB, LTB145D1/B, 17003198
3	Date of commissioning	2006 & 2009	2006 & 2009	2006 & 2009	2006 & 2009	2006 & 2009	2006 & 2009
4	Type of CB (SF6/ MOCB/ ABCB etc.)	SF6	SF6	SF6	SF6	SF6	SF6
5	Is the Breaker healthy/ functional (Yes/ No)	Yes	Yes	Yes	Yes	Yes	Yes
6	Rated Breaking current (kA)	31.5	31.5	31.5	31.5	31.5	31.5
7	Number of closing coils	1	1	1	1	1	1
8	Healthiness of closing coil	Yes	Yes	Yes	Yes	Yes	Yes
9	Number of tripping coils	2	2	2	2	2	2
10	Healthiness of Tripping Coil	Yes	Yes	Yes	Yes	Yes	Yes
11	Trip Circuit Supervision Relay available for monitoring Trip Circuit -1 & Trip Circuit-2 with breaker in both open and closed condition (Yes/ No)	No	No	No	No	No	No
12	Are the Trip Circuit Supervision realys functional/ healthy						
13	One/three pole operation	Three	Three	Three	Three	Three	Three
14	For breakers with single poles, is pole discrepancy relay provided?						
15	Does the Pole discrepancy relay have facility for Stage-1 (own breaker tripping) & Stage-2 (Boundary breaker tripping)						
16	What monitoring devices are provided for checking the dielectric medium of the breaker? (for eg. Gas pressure low etc.)	Densi Monitor	Densi Monitor	Densi Monitor	Densi Monitor	Densi Monitor	Densi Monitor

17	What action is initiated by each of different Stages of these devices (Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	(Alarm/ Block tripping)	Alarm/ Block tripping)
18	PIR (Available/ Not)	No	No	No	No	No	No

CHECKING OF POLE DISCREPANCY SETTIINGS:

Voltage Level	Feeder Name	Setting
220kV	All Feeders & TBC	1.0sec
220kV	All the GTs, STs, ICTs & BC	0.3sec
220kV		

CHECKING OF CB SF6 Gas Pressure:

CB SF6 GAS PRESSURE:

Voltage Level	Feeder Name	SF6 Pressure found at gauge Kg/cm2 G In three poles
220kV	GT#7	0.85 MPa
220kV	ICT # 1T	7.2 Bar
220kV	Sikardra Rao	0.85 MPa
220kV	Etah	0.87 MPa
220kV	Jahangirabad - I	7.9 Bar
220kV	Khurja - II	6.8 Bar
220kV	Bye Pass CB	6.8 Bar
220kV	Khurja - I	0.86 MPa
220kV	Atrauli	0.86 MPa
220kV	Bus Coupler	6.85 Bar
220kV	Rukhi	8.0 Bar
220kV	Boner	0.86 MPa

CT AUDIT

No	CT ID Bay Name	Voltage level	CT core	Protection/ Metering	CT ratio (All available ratios for a multi-ratio CT)	Ratio Adopted	Connected to which relays/ meters?	Knee Point Voltage
1	**ICT-1T BAY NO.-1**	**220KV**	Core - 1	P	1000-800-**500**-300/1	500/1	Differential	600 @500/1A
			Core - 2	P	1000-800-**500**-300/1	500/1	BU E/F & O/C	600 @500/1A
			Core - 3	M	1000-800-**500**-300/1	500/1	Metering	
			Core - 4	P	1000-800-**500**-300/1	800/1	Shorted	1400 @800/1A

			Core - 5	P	1000-**800**-500-300/1	800/1	BBRP	1400 @800/1A
2	**SIKANDRAO (83) BAY NO.-3**	**220KV**	Core-1	M	800/1	800/1	Metering	
			Core-2	M	800/1	800/1	Shorted	
			Core-3	P	600/1	600/1	Distance	1400 @ 800/1A
			Core-4	P	600/1	600/1	BU E/F & O/C	1400 @ 800/1A
			Core-5	P	800/1	800/1	BBRP	1400 @ 800/1A
3	**ETAH (84) BAY NO.-5**	**220KV**	Core-1	M	800/1	800/1	Metering	
			Core-2	M	800/1	800/1	Shorted	
			Core-3	P	600/1	600/1	Distance	1400 @ 800/1A
			Core-4	P	600/1	600/1	BU E/F & O/C	1400 @ 800/1A
			Core-5	P	800/1	800/1	BBRP	1400 @ 800/1A
4	**JAHANGIRABAD I (88) BAY NO.-6**	**220KV**	Core-1	M	600/1	600/1	Metering	
			Core-2	M	600/1	600/1	Shorted	
			Core-3	P	600/1	600/1	Distance	1400 @600/1A
			Core-4	P	600/1	600/1	B/U	1400 @600/1A
			Core-5	P	600/1	600/1	BBRP	1400 @600/1A
5	**KHURJA II (82) BAY NO.-8**	**220KV**	Core-1	M	800/1	800/1	Metering	
			Core-2	M	800/1	800/1	Shorted	
			Core-3	P	600/1	600/1	Distance	1400 @ 800/1A
			Core-4	P	600/1	600/1	BU E/F & O/C	1400 @ 800/1A
			Core-5	P	800/1	800/1	BBRP	1400 @ 800/1A
6	**BYE PASS BREAKER(80) BAY NO.-9**	**220KV**	Core-1	M	1000/1	1000/1	Metering	
			Core-2	M	800/1	800/1	Shorted	
			Core-3	P	600/1	600/1	Distance	1400 @ 800/1A
			Core-4	P	600/1	600/1	BU E/F & O/C	1400 @ 800/1A
			Core-5	P	800/1	800/1	BBRP	1400 @ 800/1A
7	**KHURJA I (81) BAY NO.-10**	**220KV**	Core-1	M	800/1	800/1	Metering	
			Core-2	M	800/1	800/1	Shorted	
			Core-3	P	600/1	600/1	Distance	1400 @ 800/1A
			Core-4	P	600/1	600/1	BU E/F & O/C	1400 @ 800/1A
			Core-5	P	800/1	800/1	BBRP	1400 @ 800/1A
8	**ATRAULI (86) BAY NO.-14**	**220KV**	Core-1	M	800/1	800/1	Metering	
			Core-2	M	800/1	800/1	Shorted	
			Core-3	P	600/1	600/1	Distance	1400 @ 800/1A
			Core-4	P	600/1	600/1	BU E/F & O/C	1400 @ 800/1A
			Core-5	P	800/1	800/1	BBRP	1400 @ 800/1A
9	**BUS COUPLER BAY NO.-15**	**220KV**	Core-1	M	1000/1	1000/1	Metering	
			Core-2	M	800/1	800/1	Shorted	
			Core-3	P	600/1	600/1	O/C	1400 @ 800/1A
			Core-4	P	600/1	600/1	Shorted	1400 @ 800/1A
			Core-5	P	800/1	800/1	BBRP	1400 @ 800/1A
10	**Boner (87) BAY NO.-20**	**220KV**	Core-1	M	800/1	Metering	Metering	
			Core-2	M	800/1	Shorted	Shorted	
			Core-3	P	600/1	Distance	Distance	1400 @

								800/1A
			Core-4	P	600/1	BU E/F & O/C	BU E/F & O/C	1400 @ 800/1A
			Core-5	P	800/1	BBRP	BBRP	1400 @ 800/1A
11	**GT#7 BAY NO.-21**	**220KV**	Core-1	M	200-**400**/1	Metering	Metering	
			Core-2	P	200-**400**/1	Differential	Differential	600 @ 400/1A
			Core-3	P	200-**400**/1	REF	REF	600 @ 400/1A
			Core-4	P	600/1	BBRP	BBRP	1400 @ 600/1A
			Core-5	P	600/1	BBRP	BBRP	1400 @ 600/1A
12	**ICT-1T (788)**	**132KV**	Core-1	P	**800**-400-200/1	800/1	Differential	1100 @400/1A
			Core-2	P	**800**-400-200/1	800/1	O/C	1100 @400/1A
			Core-3	M	**800**-400-200/1	800/1	Metering	
			Core-4	P	800/1	800/1	Shorted	
			Core-5	P	800/1	800/1	Shorted	

VT AUDIT

No	CVT/VT ID Bay Name	CVT/VT core	Protection/ Metering	Ratio	Ac cy ss	Connected to which relays?	Is the relay setting calculation and relay configuration files based on the VT Ratio? (Applicable for VTs connected to distance protection/ synchro check relays)	For Synchrocheck relays, is the VT Input connected Ph-Ph or Ph-Neutral (Which phases R/Y/B?)	Date of VT Testing	Ratio measured	Error Calculated
1	220KV BUS-I BAY NO.-5	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
2	220KV BUS-II BAY NO.-9	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
3	SIKANDRAO (83) BAY NO.-3	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
4	ETAH (84) BAY NO.-5	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
5	JAHANGIRABAD I (88) BAY NO.-6	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
6	KHURJA II (82) BAY NO.-8	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			

7	KHURJA I (81) BAY NO.-10	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
8	ATRAULI (86) BAY NO.-11	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
9	Rukhi (89) Bay No. 18	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			
10	BONER (87) BAY NO.-20	Core - 1	Protection	220KV/√3/110V/√3	3P	Distance	YES				
		Core - 2	Protection	220KV/√3/110V/√3	3P	BU E/F & O/C	YES				
		Core - 3	Metering	220KV/√3/110V/√3	0.2	Metering		Ph-Ph (R-B)			

COMMUNICATION SYSTEM AUDIT

No	***Communication System***		***220 kV System***
1	a) Type of communication for Main-1 Protection	PLCC/ OPGW	PLCC
	b) Type of communication for Main-2 Protection	PLCC/ OPGW	PLCC
	c) Mode used for Data communication		PLCC
	d) Mode used for Speech communication		PLCC
2	**PLCC Details**		
	a) Do you use PLCC for teleprotection of distance relays ?	Yes/No	Yes
	b) Specify type of Coupling	Ph-Ph/ Ph-G/ Inter-Circuit	Ph-G
	c) Whether redundant PLCC channels provided for 400 kV & 765 kV lines	Yes/ No	No
	d) Specify number of PLCC channels per circuit	One/ Two	One
	e) No. of protection channels No. of data channels No. of speech channels		1 protection 1 speech
	f) Whether dependability & security of each tele-protection channel measured and record kept?	Yes/No	Yes
	g) Is the PLCC equipment and channels healthy & functional	Yes/No	Yes
3	**OPGW Details**		NA

	a) Redundancy maintained by providing two sets of Fibre Optic Equipment	Yes/ No	-
	b) Card level redundancy (Power supply card, protection card, CPU board) maintained in each fibre optic equipment	Yes/ No	-
	c) Separate DC battery supply or common DC battery supply separately fused for each fibre optic equipment.	Yes/No	-
	d) Are the Fibre Optic equipment and channels healthy & functional	Yes/No	-
4	**Time Synchronization Equipment Details**		
	a) Whether GPS based time synchronizing equipment is provided at the substation for time synchronizing of Main relays/ DR/ Event logger/ SAS/ PMU/ Line Current Differential Relays	Yes/ No	Yes
	b) Are Time Synchronization Equipment (TSE) complete with antenna, all cables, processing equipments etc. provided to receive synchronizing pulse through Global Positioning system (GPS) compatible for synchronization of event logger, disturbance recorder and SCADA/ automation system.	Yes/ No	Not applicable
	c) Are the Main Relays/ DR/ Event Logger/SAS/ PMU/ Line current differential relays time synchronized.	Yes/ No	Yes
5	**Disturbance Recorder and Event Logger Details** Check all these items for individual relay.		
	a) Is the Disturbance recorder provided on all the feeders of 765kV, 400 kV & 220 kV Substations?	Yes/ No	No
	b) Is the Fault locator provided on all the line feeders of 765kV, 400 kV & 220 kV Substations?	Yes/ No	Yes
	c) Whether the Disturbance recorder is Standalone or part of main relay	Yes/ No	Standalone
	d) Whether Disturbance Recorder is having automatic fault record download facility to a central PC	Yes/ No	NA
	e) Disturbance Recorders functional ?	Yes/ No	No
	f) Whether substation (765, 400, 220 kV) is having Event Logger facility (stand alone or built-in-SAS)	stand alone/ built-in-SAS	No
	g) Event Logger functional ?	Yes/ No	NA

<u>Relay Make and Model for Main-I and Main-II Relays MCR</u>

Sl.no	Name of the Feeder	Main-I	Main-II

1	220kV Harduaganj- Sikandrao	EASUN REYROLLE	SEL 311
2	220kV Harduaganj-Etah Line	MICOM P442	SEL 311
3	220kV Harduaganj-Jahangirabad Line	EASUN REYROLLE CSC101	SEL 311
5	220kV Harduaganj-Khurja Line I	ZIV	SEL 311
6	220kV Harduaganj-Khurja Line II	EASUN REYROLLE CSC101	SEL 311
7	220kV Harduaganj- Atrauli Line	MICOM P442	SEL 311
8	220kV Harduaganj-Rukhi Line	EASUN REYROLLE CSC101	SEL 311
9	220kV Harduaganj-Boner Line	ZIV	SEL 311
10	220 kV TBC	ZIV	SEL 311

220 KV SIKANDRAO LINE SETTING RELAY MAIN-1

Parameter	**Existing settings**	**Reviewed Settings**	**Remarks**
I abrupt	0.200 A		
I PS	1.200 A		
Kx	0.689		
Kr	0.621		
Km	0		
X line	5.677 ohm		
R_line	1.131 Ohm		
Line length	47.13 km		
U_ PRIMARY	220.0 kV		
CT PRIMARY	0.600 kA		
CT SECONDARY	1.000 A		
R1_pe	8.405 ohm		
X1_pe	4.530 ohm		
R1 EXT_pe	0.010 ohm		
X1 EXT_pe	0.010 ohm		
R2_pe	11.89 ohm		
X2_pe	8.500 ohm		
R3_pe	11.28 ohm		
X3_pe	19.21 ohm		
R4_pe	8.066 ohm		
X4_pe	1.050 ohm		
R5_pe	0.010 ohm		
X5_pe	0.010 ohm		
T1_pe	0.000 s		

T1 EXT_pe	10.00 s		
T2_pe	0.350 s		
T3_pe	.800 s		
T4_pe	0.160 s		
T5_pe	10.00 s		
R1_pp	3.155 ohm		
X1_pp	4.050 ohm		
R1 EXT_pp	0.010 ohm		
X1 EXT_pp	0.010 ohm		
R2_pp	6.638 ohm		
X2_pp	8.500 ohm		
R3_pp	6.030 ohm		
X3_pp	19.21 ohm		
R4_pp	2.816ohm		
X4_pp	1.050 ohm		
R5_pp	0.010 ohm		
X5_pp	0.010 ohm		
T1_pp	0.000 s		
TIEXT_pp	10.00 s		
T2_pp	0.350 s		
T3_pp	0.800 s		
T4_pp	0.160 s		
T5_PP	10.00 s		
Ioc VT fail	100.0 A		
3I0 VT fail	100.0 A		
T VT fail	10.00 s		
T_PS NOBLOCKING	10.00 s		
T VT fail alarm	10.00 s		
I_SOTF	1.800 A		
3I01	100.0 A		
3I02	100.0 À		
3I03	100.0 À		
3I04	100.0 A		
TO1	10.00 s		
TO2	10.00 s		
TO3	10.00 s		
T04	10.00s		
3I0_INV	100.0 A		
T0 factor	13.5		
N0	1		
T0 INV	10.00s		
TIp_AR	0.600s		
T3p_AR	10.00 s		
Dev_Angle AR	30		
T Reclain	25.00 s		

DU AR	10.00 V		
T_PD	10.00 s		
0v1_pe	120.0 v		
0v2_pe	120.0 V		
Tov1_pe	60.00 s		
Tov2_pe	60.00 s		
UV1_pe	53.00 v		
UV2_pe	48.00 v		
Tuv1_pe	10.00 s		
Tuv2_pe	10.00 s		
Ioc pe	100.0 A		
Toc_pe	10.00 s		
Ioc INV	100.0 A		
Toc factor	13.5		
Noc	1		
Toc INV	10.00 s		
I CBF	100.0 A		
3I0 CBF	100.0 A		
T CBF	2.000 s		
3I2 BROKEN COND	0.350 A		
T BROKEN COND	10.00 s		
I_Trip_BROKEN	10.00 s		
I OverLoad	15.00 A		
T OverLoad	3600. s		

220 KV SIKANDRAO LINE SETTING RELAY MAIN-2

Parameter	Existing settings	Unit	Reviewed Settings	Remarks
GENERAL SETTINGS				
CT Ratio Phase	600			
CTRN(IN) Neutral	600			
PT Ratio Phase	2000			
PTRS Synch Voltage(VS)PT Ratio	110			
VNOM Phase Nominal Voltage L-N	63.51 volt in secondary			
EADVS Advanced Settings	Y			
EBBPT Enable busbar PT LOP logic	N			
LINE SETTINGS AND FAULT LOCATOR				
Z1MAG Pos-Seq Line Impedance Mag.	5.85	ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.7	degree		
Z0 MAG Zero-Seq Line Impedance Mag.	17.92	ohm in secondary		
Z0 MAG Zero-Seq Line Impedance	79.45	degree		

Angle				
LL Line Length-unitless	47.13			
EFLOC Fault Location	Y			
PHASE DISTANCE ELEMENT				
ECCVT CCVT Transient Detection	Y			
E21P Mho Phase Distance Element	4			
Mho Phase Distance Element Reach Settings				
Z1P Zone 1	4.62	ohm in secondary		
Z2P Zone 2	6.93	ohm in secondary		
Z3P Zone 3	1.07	ohm in secondary		
Z4P Zone 4	19.61	ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings				
50PP1 Zone 1 Phase-Phase Current FD	0.1	amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1	amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1	amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1	amp in secondary		
GROUND DISTANCE ELEMENTS				
Mho Ground Distance Elements				
E21MG Mho Ground Distance Elements	4			
Z1MG Zone 1	4.62	ohm in secondary		
Z2MG Zone 2	6.93	ohm in secondary		
Z3MG Zone 3	1.07	ohm in secondary		
Z4MG Zone 4	19.61	ohm in secondary		
Quad Ground Distance Elements				
E21XG Quad Ground Distance Elements	4			
XG1 Zone1 Reactance	4.53	ohm in secondary		
XG2 Zone2 Reactance	6.8	ohm in secondary		
XG3 Zone3 Reactance	1.05	ohm in secondary		

XG1l4 Zone4 Reactance	19.21	ohm in secondary		
RG1 Zone 1 Resistance	5.41	ohm in secondary		
RG2 Zone 2 Resistance	8.28	ohm in secondary		
RG3 Zone 3 Resistance	5.06	ohm in secondary		
RG4 Zone 4 Resistance	8.26	ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	I2			
TANG Non-Homogeneous Correction Ang(deg)	-3			
Quad and Mho Ground Distance Fault Detector Settings				
50L1 Zone1 Phase Current FD	0.1	amp in secondary		
50L2 Zone3 Phase Current FD	0.1	amp in secondary		
50L3 Zone3 Phase Current FD	0.1	amp in secondary		
50L4 Zone4 Phase Current FD	0.1	amp in secondary		
50Z1 Zone 1 Residual Current FD	0.1	amp in secondary		
50Z2 Zone 2 Residual Current FD	0.1	amp in secondary		
50Z3 Zone 3 Residual Current FD	0.1	amp in secondary		
50Z4 Zone 4 Residual Current FD	0.1	amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings				
k0M1 Zone1 ZSC Factor Mag.	0.678			
k0A1 Zone 1 ZSC Factor Ang	1.15	degree		
k0M Zones 2,3,4 ZSC Factor Mag	0.687			
k0A zones 2,3,4 ZSC Factor Ang	1.15	degree		
DISTANCE ELEMENT TIME DELAY SETTINGS				
Mho Phase Distance Element Time Delay Settings				
Z1PD Zone 1 Time Delay	0	ms		
Z2PD Zone 2 Time Delay	350	ms		
Z3PD Zone 3 Time Delay	160	ms		
Z4PD Zone 4 Time Delay	800	ms		
Quad and Mho Ground Distance Element Time Delay Settings				

Z1GD Zone 1 Time Delay	0	ms		
Z2GD Zone 2 Time Delay	350	ms		
Z3GD Zone 3 Time Delay	160	ms		
Z4GD Zone 4 Time Delay	800	ms		
Common Phase/Ground Dist. Element Time Delay Settings				
Z1D Zone 1 Time Delay	0	ms		
Z1l2D Zone 2 Time Delay	350	ms		
Z3D Zone 3 Time Delay	160	ms		
Z4D Zone 4 Time Delay	1000	ms		
PHASE OVERCURRENT ELEMENT				
E50P Phase	1			
Phase Instantaneous Overcurrent Elements				
501P Level 1	2	amp in secondary		
502P Level 2	OFF	amp in secondary		
503P Level 3	OFF	amp in secondary		
504P Level 4	OFF	amp in secondary		
Phase Definite Time Overcurrent Elements				
67 P1D Level	0	ms		
67 P2D Level	0	ms		
67 P3D Level	0	ms		
67 P4D Level	0	ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS				
E51G Residual Ground	N			
NEGATIVE SEQUENCE TIME OVERCURRENT ELEMENTS				
E51Q Negative-Sequence	N			
BREAKER FAILURE SETTINGS				
E50BF Breaker Failure	Y			
50BFP Phase Fault Current Pickup	1.2	amp in secondary		
BFPU Breaker Failure Time Delay	180	ms		
RTPU Retrip Time Delay	60	ms		
Out-of-Step Settings				

EOOS Out-of-Step	Y			
OOSB 1 Block Zone 1	Y			
OOSB2 Block Zone 2	N			
OOSB3 Block Zone 3	N			
OOSB4 Block Zone 4	N			
OSBD Out-of-Step Block Time Delay	40	ms		
EOOST Enable Out-of-Step Tripping	N			
OSTD Out-of-Step Trip Time Delay	10	ms		
X1T6 zone 6 Reactive-Top	10.84	ohm in secondary		
X1T5 zone 5 Reactive-Top	8.67	ohm in secondary		
R1R6 zone 6 Resistive-Right	10.46	ohm in secondary		
R1R5 Zone 5 Resistive-Right	8.67	ohm in secondary		
X1B6 Zone 6 Reactive-Bottom	-10.84	ohm in secondary		
X1B5 Zone 5 Reactive Bottom	-8.67	ohm in secondary		
R1L6 Zone 6 Resistive-Left	-10.46	ohm in secondary		
R1L5 Zone 5 Resistive-Left	-6.97	ohm in secondary		
50 ABCP Pos. Seq. Current Supv.	0.2	amp in secondary		
UBD Neg-Seq. current unblock Delay	10	ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4			
LOAD ENCROACHMENT ELEMENT				
ELOAD Load Encroachment	Y			
ZLF Forward Load Impedance	41.17			
ZLR Reverse Load Impedance	41.17			
PALF Positive Forward Load Angle	36.87	degree		
NLAF Negative Forward Load Angle	-36.87	degree		
PLAR Positive Reverse Load Angle	150	degree		
NLAR Negative Reverse Load Angle	216.87	degree		
DIRECTIONAL ELEMENTS				
E32 Directional Control	AUTO			
ELOP Loss-of-Potential	Y			
DIR 3Level 3	R			
DIR 4Level 4	F			
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI			

Z2F Forward Dir. Z2 Threshold	2.9	ohm in secondary		
Z2R Reverse Dir. Z2 Threshold	3.9	ohm in secondary		
50QFP Forward Dir. 3I2 Pickup	0.1	amp in secondary		
50QRP Reverse Dir. 3I2 Pickup	0.05	amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1			
k2 Zero-Seq Restrain Factor I2/I0	0.2			
50 GFP Forward Dir.3I0 Pickup	0.1	amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup	0.05	amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1			
Z0F Forward Dir. Z0 Threshold	9	ohm in secondary		
Z0R Reverse Dir. Z0 Threshold	10	ohm in secondary		
OTHER SETTINGS				
TDUR 1D Single-Pole Min. Trip Duration	180	ms		
TDUR 3D Three pole min. trip Duration	180	ms		
CFD Close Failure Time Delay	1200	ms		
VOLTAGE ELEMENTS				
EVOLT Voltage Elements	N			
SYNCHRONISM CHECK ELEMENT				
E25 Synchronism Check	N			
FREQUENCY ELEMENTS				
E81 Frequency Elements	N			
RECLOSING RELAY SETTINGS				
E79 Reclosures	1			
79OI1 Open Interval	600	ms		
79OI2 Open Interval	0	ms		
79OI3 Open Interval	0	ms		
79OI4 Open Interval	0	ms		
79RSD Reset Time from Reclose Cycle	200	ms		
79RSLD Reset Time from Lockout	25000	ms		
79CLSD Reclose Supv. Time Limit	100	ms		

SWITCH-ONTO-FAULT LOGIC				
ESOTF Switch-Onto-Fault Logic	Y			
EDDSOTF SOTF Disturbance Detector Supervision	Y			
CLOEND Close Enable Time Delay	20	ms		
52AEND 52A Enable Time Delay	OFF			
SOTFD SOTF Duration	120	ms		
ZONE 1 EXTENSION SETTINGS				
EZ1EXT Zone 1 Extension	N			

220 KV ETAH LINE RELAY MAIN-1 - NOT WORKING

220 KV ETAH LINE SETTING RELAY MAIN-2

LINE SETTING HARDUAGANJ ETAH (RELAY MAIN-2)

Parameter	**Existing settings**	**unit**	**Reviewed Settings**	**Remarks**
GENERAL SETTINGS				
CT Ratio Phase	600			
CTRN(IN) Neutral	600			
PT Ratio Phase	2000			
PTRS Synch Voltage(VS)PT Ratio	2000			
VNOM Phase Nominal Voltage L-N	63.51 volt in secondary	volt in secondary		
EADVS Advanced Settings	Y			
EBBPT Enable busbar PT LOP logic	N			
LINE SETTINGS AND FAULT LOCATOR				
Z1MAG Pos-Seq Line Impedance Mag.	9.5	ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.7	degree		
Z0 MAG Zero-Seq Line Impedance Mag.	29.13	ohm in secondary		
Z0 MAG Zero-Seq Line Impedance Angle	79.45	degree		
LL Line Length	77.68 km	km		
EFLOC Fault Location	Y			
PHASE DISTANCE ELEMENT				
ECCVT CCVT Transient Detection	Y			
E21P Mho Phase Distance Element	4			
Mho Phase Distance Element Reach Settings				

Z1P Zone 1	7.62	ohm in secondary		
Z2P Zone 2	14.29	ohm in secondary		
Z3P Zone 3	1.07	ohm in secondary		
Z4P Zone 4	20.93	ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings				
50PP1 Zone 1 Phase-Phase Current FD	0.1	amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1	amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1	amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1	amp in secondary		
GROUND DISTANCE ELEMENTS				
Mho Ground Distance Elements				
E21MG Mho Ground Distance Elements	4			
Z1MG Zone 1	7.62	ohm in secondary		
Z2MG Zone 2	14.29	ohm in secondary		
Z3MG Zone 3	1.07	ohm in secondary		
Z4MG Zone 4	20.93	ohm in secondary		
Quad Ground Distance Elements				
E21XG Quad Ground Distance Elements	4			
XG1 Zone1 Reactance	7.47	ohm in secondary		
XG2 Zone2 Reactance	14.01	ohm in secondary		
XG3 Zone3 Reactance	1.05	ohm in secondary		
XG1l4 Zone4 Reactance	20.5	ohm in secondary		
RG1 Zone 1 Resistance	3.74	ohm in secondary		
RG2 Zone 2 Resistance	11.63	ohm in secondary		
RG3 Zone 3 Resistance	8.43	ohm in secondary		
RG4 Zone 4 Resistance	11.55	ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	I2			
TANG Non-Homogeneous Correction Ang	-3	degree		
Quad and Mho Ground Distance Fault Detector Settings				
50L1 Zone1 Phase Current FD	0.1	amp in secondary		
50L2 Zone3 Phase Current FD	0.1	amp in secondary		
50L3 Zone3 Phase Current FD	0.1	amp in secondary		
50L4 Zone4 Phase Current FD	0.1	amp in secondary		
50Z1 Zone 1 Residual Current FD	0.1	amp in secondary		
50Z2 Zone 2 Residual Current FD	0.1	amp in secondary		
50Z3 Zone 3 Residual Current FD	0.1	amp in secondary		
50Z4 Zone 4 Residual Current FD	0.1	amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings				
k0M1 Zone1 ZSC Factor Mag.	0.678			

k0A1 Zone 1 ZSC Factor Ang	1.15	degree		
k0M Zones 2,3,4 ZSC Factor Mag	0.687			
k0A zones 2,3,4 ZSC Factor Ang	1.15	degree		
DISTANCE ELEMENT TIME DELAY SETTINGS				
Mho Phase Distance Element Time Delay Settings				
Z1PD Zone 1 Time Delay	0		0	
Z2PD Zone 2 Time Delay	350			
Z3PD Zone 3 Time Delay	160			
Z4PD Zone 4 Time Delay	800			
Quad and Mho Ground Distance Element Time Delay Settings				
Z1GD Zone 1 Time Delay	0			
Z2GD Zone 2 Time Delay	350			
Z3GD Zone 3 Time Delay	160			
Z4GD Zone 4 Time Delay	800			
Common Phase/Ground Dist. Element Time Delay Settings				
Z1D Zone 1 Time Delay	0			
Z1l2D Zone 2 Time Delay	350			
Z3D Zone 3 Time Delay	160			
Z4D Zone 4 Time Delay	1000			
PHASE OVERCURRENT ELEMENT				
E50P Phase	1			
Phase Instantaneous Overcurrent Elements				
501P Level 1	2	amp in secondary		
502P Level 2	OFF	amp in secondary		
503P Level 3	OFF	amp in secondary		
504P Level 4	OFF	amp in secondary		
Phase Definite Time Overcurrent Elements				
67 P1D Level	0	ms		
67 P2D Level	0	ms		
67 P3D Level	0	ms		
67 P4D Level	0	ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS				
E51G Residual Ground	N			
NEGATIVE SEQUENCE TIME				

OVERCURRENT ELEMENTS				
E51Q Negative-Sequence	N			
BREAKER FAILURE SETTINGS				
E50BF Breaker Failure	Y			
50BFP Phase Fault Current Pickup	1.2	amp in secondary		
BFPU Breaker Failure Time Delay	180	ms		
RTPU Retrip Time Delay	60	ms		
Out-of-Step Settings				
EOOS Out-of-Step	Y			
OOSB 1 Block Zone 1	Y			
OOSB2 Block Zone 2	N			
OOSB3 Block Zone 3	N			
OOSB4 Block Zone 4	N			
OSBD Out-of-Step Block Time Delay	40	ms		
EOOST Enable Out-of-Step Tripping	N			
OSTD Out-of-Step Trip Time Delay	10			
X1T6 zone 6 Reactive-Top	10.84	ohm in secondary		
X1T5 zone 5 Reactive-Top	8.67	ohm in secondary		
R1R6 zone 6 Resistive-Right	10.46	ohm in secondary		
R1R5 Zone 5 Resistive-Right	8.67	ohm in secondary		
X1B6 Zone 6 Reactive-Bottom	-10.84	ohm in secondary		
X1B5 Zone 5 Reactive Bottom	-8.67	ohm in secondary		
R1L6 Zone 6 Resistive-Left	-10.46	ohm in secondary		
R1L5 Zone 5 Resistive-Left	-6.97	ohm in secondary		
50 ABCP Pos. Seq. Current Supv.	0.2	amp in secondary		
UBD Neg-Seq. current unblock Delay	0.5	ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4			
LOAD ENCROACHMENT ELEMENT				
ELOAD Load Encroachment	Y			
ZLF Forward Load Impedance	41.17			
ZLR Reverse Load Impedance	41.17			
PALF Positive Forward Load Angle	36.87	degree		
NLAF Negative Forward Load Angle	-36.87	degree		
PLAR Positive Reverse Load Angle	150	degree		
NLAR Negative Reverse Load Angle	216.87	degree		
DIRECTIONAL ELEMENTS				
E32 Directional Control	AUTO			
ELOP Loss-of-Potential	Y			

DIR 3Level 3	R			
DIR 4Level 4	F			
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI			
Z2F Forward Dir. Z2 Threshold	4.8	ohm in secondary		
Z2R Reverse Dir. Z2 Threshold	5.8	ohm in secondary		
50QFP Forward Dir. 3I2 Pickup	0.1	amp in secondary		
50QRP Reverse Dir. 3I2 Pickup	0.05	amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1			
k2 Zero-Seq Restrain Factor I2/I0	0.2			
50 GFP Forward Dir.3I0 Pickup	0.1	amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup	0.05	amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1			
Z0F Forward Dir. Z0 Threshold	14.6	ohm in secondary		
Z0R Reverse Dir. Z0 Threshold	15.6	ohm in secondary		
OTHER SETTINGS				
TDUR 1D Single-Pole Min. Trip Duration	180	ms		
TDUR 3D Three pole min. trip Duration	180	ms		
CFD Close Failure Time Delay	1200	ms		
VOLTAGE ELEMENTS				
EVOLT Voltage Elements	N			
SYNCHRONISM CHECK ELEMENT				
E25 Synchronism Check	N			
FREQUENCY ELEMENTS				
E81 Frequency Elements	N			
RECLOSING RELAY SETTINGS				
E79 Reclosures	1			
790I1 Open Interval	600	ms		
790I2 Open Interval	0	ms		
790I3 Open Interval	0	ms		
790I4 Open Interval	0	ms		
79RSD Reset Time from Reclose Cycle	200	ms		
79RSLD Reset Time from Lockout	25000	ms		
79CLSD Reclose Supv. Time Limit	5	ms		
SWITCH-ONTO-FAULT LOGIC				
ESOTF Switch-Onto-Fault Logic	Y			
EDDSOTF SOTF Disturbance Detector Supervision	Y			
CLOEND Close Enable Time Delay	20	ms		

52AEND 52A Enable Time Delay	OFF			
SOTFD SOTF Duration	120	ms		
ZONE 1 EXTENSION SETTINGS				
EZ1EXT Zone 1 Extension	N			

220 KV KHURJA- I LINE SETTING RELAY MAIN-1

General

Settings	Existing settings	Reviewed Settings	Remarks
Name	**khurja I**		
Breaker	**81**		
Unit In Service	**Yes**		
Phase CT Ratio	**600**		
Polarizing CT Ratio	**600**		
Parallel CT Ratio	**1**		
Phase VT Ratio	**2000**		
Busbar VT Ratio	**2000**		
Capacitive VT	**Yes**		
Phase Sequence	**ABC**		

System Impedances Line

Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	5.16Ohm		
Pos. Seq. Angle	79^o		
Pos. Seq. Angle 2	79^o		
Pos. Seq. Angle 3	79^o		
Pos. Seq. Angle 4	79^o		
Pos. Seq. Angle 5	79^o		
Zero Seq. Angle	79^o		
Z1 k0 Factor	3.06		
Zero Seq. Angle 2	79^o		
Z2 k0 Factor	3.06		
Zero Seq. Angle 3	79^o		
Z3 k0 Factor	3.06		
Zero Seq. Angle 4	79^o		
Z4 k0 Factor	3.06		
Zero Seq. Angle 5	79^o		

Z5 k0 Factor	3.06		

Equivalent Parallel Impedance

Settings	Group 1	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Local Source Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Remote Source Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Parallel Line Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Mutual Coupl. Factor	0		
Mutual Coupl. Angle	25º		
Factor I0/I0PAR	0.95		

Fault Locator
Length and Units

Settings	Existing settings	Reviewed Settings	Remarks

Line Length	42.1		
Length Units	Kilometers		
Locator Units	Length Units		

Protection Distance Units
Zone 1 Units

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Zone 1 Enable	Yes		
Direction	Forward		
Ground Reach	4.05Ohm		
Phase Reach	4.05Ohm		
Ground Resist Limit	8.31Ohm		
Phase Resist Limit	3.06Ohm		
Ground Time	0s		
Phase Time	0s		
Tilt Time	0s		
Tilt Angle Type	Calculated		
Tilt Angle	0º		

Zone 2 Units

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Zone 2 Enable	Yes		
Direction	Forward		
Ground Reach	7.74Ohm		
Phase Reach	7.74Ohm		
Ground Resist Limit	9.40Ohm		
Phase Resist Limit	4.14Ohm		
Ground Time	0s		
Phase Time	0s		

Zone 3 Units

Settings	**Existing setting**	**Reviewed Settings**	**Remarks**
Zone 3 Enable	Yes		
Direction	Forward		
Ground Reach	15.29Ohm		
Phase Reach	15.29Ohm		
Ground Resist Limit	10.45Ohm		
Phase Resist Limit	5.20Ohm		

Ground Time	0.8s		
Phase Time	0.8s		

Zone 4 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 4 Enable	Yes		
Direction	Reverse		
Ground Reach	1.05Ohm		
Phase Reach	1.05Ohm		
Ground Resist Limit	8.01Ohm		
Phase Resist Limit	2.46Ohm		
Ground Time	0.16s		
Phase Time	0.16s		

Zone 5 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 5 Enable	No		
Direction	Forward		
Ground Reach	25.00Ohm		
Phase Reach	25.00Ohm		
Ground Resist Limit	20.00Ohm		
Phase Resist Limit	20.00Ohm		
Ground Time	1.5s		
Phase Time	1.5s		

Characteristic

Settings	Existing settings	Reviewed Settings	Remarks
Ground Characteristic	Quadrilateral		
Phase Characteristic	Quadrilateral		

Quadrilateral Characteristic Directional Angle

Settings	Existing settings	Reviewed Settings	Remarks

Dir Characteristic	78º		
Angle			

Close Onto Fault

Settings	Existing settings	Reviewed Settings	Remarks
COF Enable	Yes		
COF Sup Zone	Zone 2		
I COF Pick up	1.50A		
Z1 Ext. After Recl.	No		
2nd Harm. Restraint	0%		
COF Time	300ms		

Fuse Failure

Settings	Existing settings	Reviewed Settings	Remarks
FF Detec Enable	Yes		
FF Input DropOut Time	150ms		
FF Block Enable	Yes		
Voltage Level	30V		

Load Encroachment

Settings	Existing settings	Reviewed Settings	Remarks
Enable Load Encroach	No		
Right Area Resis Limit	325.00Ohm		
Left Area Resis Limit	325.00Ohm		
Right Area Angle	20º		
Left Area Angle	20º		

Power Swing Detector

Settings	Existing settings	Reviewed Settings	Remarks
PS Detec Enable	Yes		
PS Trip Enable	No		
Right Ext Resist Limit	50.00Ohm		
Right Med Resist	25.00Ohm		
Limit			

Right Int Resist Limit	5.00Ohm		
Left Ext Resist Limit	50.00Ohm		
Left Med Resist Limit	25.00Ohm		
Left Int Resist Limit	5.00Ohm		
Resist Limit Angle	75º		
Forward Ext Reach	50.00Ohm		
Forward Med Reach	25.00Ohm		
Forward Int Reach	5.00Ohm		
Reverse Ext Reach	50.00Ohm		
Reverse Med Reach	25.00Ohm		
Reverse Int Reach	5.00Ohm		
I1 Supervision	0.20A		
PS Detec Time	0.03s		
PS Block Reset Time	2s		
PS Trip Type	Slow trip		
Fast Trip Time	0.05s		
PS Cond Reset Time	0.05s		

Overcurrent Directional

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Phase Characteristic Angle	45º		
Neutr Characteristic Angle	45º		
NegSeq Characteristic Angle	45º		
PosSeq Characteristic Angle	45º		
Lack of direction blocking	No		
Min. Phase Voltage	0.2V		
Min. Neutr Voltage	0.2V		
Min. Neg Seq Voltage	0.2V		
Min. Pos Seq Voltage	0.2V		
Coordinating Time	0ms		
Neutr Volt. Comp.	0		
NegSeq Volt.Comp.	0		

Voltage Restoration

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Phase UV reset	105%		

Phase OV reset	95%		
Neutral OV reset	95%		

220 KV KHURJA- I LINE SETTING RELAY MAIN-2

Parameter	**Existing settings**	**Unit**	**Reviewed Settings**	**Remarks**
GENERAL SETTINGS				
CT Ratio Phase	600			
CTRN(IN) Neutral	600			
PT Ratio Phase	2000			
PTRS Synch Voltage(VS)PT Ratio	2000			
VNOM Phase Nominal Voltage L-N	63.51	volt in secondary		
EADVS Advanced Settings	Y			
EBBPT Enable busbar PT LOP logic	N			
LINE SETTINGS AND FAULT LOCATOR				
Z1MAG Pos-Seq Line Impedance Mag.	4.94	ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.7	degree		
Z0 MAG Zero-Seq Line Impedance Mag.	15.45	ohm in secondary		
Z0 MAG Zero-Seq Line Impedance Angle	78.5	degree		
LL Line Length-unitless	41.2			
EFLOC Fault Location	Y			
PHASE DISTANCE ELEMENT				
ECCVT CCVT Transient Detection	Y			
E21P Mho Phase Distance Element	4			
Mho Phase Distance Element Reach Settings				
Z1P Zone 1	4.13	ohm in secondary		
Z2P Zone 2	7.74	ohm in secondary		
Z3P Zone 3	1.07	ohm in secondary		
Z4P Zone 4	15.29	ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings				

50PP1 Zone 1 Phase-Phase Current FD	0.1	amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1	amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1	amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1	amp in secondary		
GROUND DISTANCE ELEMENTS				
Mho Ground Distance Elements				
E21MG Mho Ground Distance Elements	4			
Z1MG Zone 1	4.13	ohm in secondary		
Z2MG Zone 2	7.74	ohm in secondary		
Z3MG Zone 3	1.07	ohm in secondary		
Z4MG Zone 4	15.29	ohm in secondary		
Quad Ground Distance Elements				
E21XG Quad Ground Distance Elements	4			
XG1 Zone1 Reactance	4.05	ohm in secondary		
XG2 Zone2 Reactance	7.59	ohm in secondary		
XG3 Zone3 Reactance (Ohm,sec)	1.05	ohm in secondary		
XG1l4 Zone4 Reactance (Ohm,sec)	14.99	ohm in secondary		
RG1 Zone 1 Resistance (Ohm,sec)	8.31	ohm in secondary		
RG2 Zone 2 Resistance (Ohm,sec)	9.4	ohm in secondary		
RG3 Zone 3 Resistance (Ohm,sec)	8.01	ohm in secondary		
RG4 Zone 4 Resistance (Ohm,sec)	10.45	ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	12			
TANG Non-Homogeneous Correction Ang(deg)	-3			
Quad and Mho Ground Distance Fault Detector Settings				
50L1 Zone1 Phase Current FD(A,sec)	0.1	amp in secondary		
50L2 Zone3 Phase Current FD(A,sec)	0.1	amp in secondary		
50L3 Zone3 Phase Current FD(A,sec)	0.1	amp in secondary		

50L4 Zone4 Phase Current FD(A,sec)	0.1	amp in secondary		
50Z1 Zone 1 Residual Current FD(A,sec)	0.1	amp in secondary		
50Z2 Zone 2 Residual Current FD(A,sec)	0.1	amp in secondary		
50Z3 Zone 3 Residual Current FD(A,sec)	0.1	amp in secondary		
50Z4 Zone 4 Residual Current FD(A,sec)	0.1	amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings				
k0M1 Zone1 ZSC Factor Mag.	0.678			
k0A1 Zone 1 ZSC Factor Ang(deg)	1.15	degree		
k0M Zones 2,3,4 ZSC Factor Mag	0.687			
k0A zones 2,3,4 ZSC Factor Ang(deg)	1.15	degree		
DISTANCE ELEMENT TIME DELAY SETTINGS				
Mho Phase Distance Element Time Delay Settings				
Z1PD Zone 1 Time Delay(cyc)	0	ms		
Z2PD Zone 2 Time Delay(cyc)	0	ms		
Z3PD Zone 3 Time Delay(cyc)	160	ms		
Z4PD Zone 4 Time Delay(cyc)	800	ms		
Quad and Mho Ground Distance Element Time Delay Settings				
Z1GD Zone 1 Time Delay(cyc)	0	ms		
Z2GD Zone 2 Time Delay(cyc)	0	ms		
Z3GD Zone 3 Time Delay(cyc)	160	ms		
Z4GD Zone 4 Time Delay(cyc)	800	ms		
Common Phase/Ground Dist. Element Time Delay Settings				
Z1D Zone 1 Time Delay(cyc)	0	ms		
Z1l2D Zone 2 Time Delay(cyc)	350	ms		
Z3D Zone 3 Time Delay(cyc)	160	ms		
Z4D Zone 4 Time Delay(cyc)	1000	ms		
PHASE OVERCURRENT ELEMENT				
E50P Phase	1			
Phase Instantaneous Overcurrent Elements				
501P Level 1	2	amp in secondary		
502P Level 2	OFF			
503P Level 3	OFF			
504P Level 4	OFF			

Phase Definite Time Overcurrent Elements				
67 P1D Level(cyc)	0	ms		
67 P2D Level(cyc)	0	ms		
67 P3D Level(cyc)	0	ms		
67 P4D Level(cyc)	0	ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS				
E51G Residual Ground	N			
NEGATIVE SEQUENCE TIME OVERCURRENT ELEMENTS				
E51Q Negative-Sequence	N			
BREAKER FAILURE SETTINGS				
E50BF Breaker Failure	Y			
50BFP Phase Fault Current Pickup(A,sec)	1.2	amp in secondary		
BFPU Breaker Failure Time Delay(cyc)	180	ms		
RTPU Retrip Time Delay(cyc)	60	ms		
Out-of-Step Settings				
EOOS Out-of-Step	Y			
OOSB 1 Block Zone 1	Y			
OOSB2 Block Zone 2	N			
OOSB3 Block Zone 3	N			
OOSB4 Block Zone 4	N			
OSBD Out-of-Step Block Time Delay(cyc)	40	ms		
EOOST Enable Out-of-Step Tripping	N			
OSTD Out-of-Step Trip Time Delay(cyc)	10	ms		
X1T6 zone 6 Reactive-Top(Ohm,sec)	10.84	ohm in secondary		
X1T5 zone 5 Reactive-Top(Ohm,sec)	8.67	ohm in secondary		
R1R6 zone 6 Resistive-Right(Ohm,sec)	10.46	ohm in secondary		
R1R5 Zone 5 Resistive-Right(Ohm,sec)	8.67	ohm in secondary		
X1B6 Zone 6 Reactive-Bottom(ohm,sec)	-10.84	ohm in secondary		
X1B5 Zone 5 Reactive Bottom(Ohm,sec)	-8.67	ohm in secondary		
R1L6 Zone 6 Resistive-Left(Ohm,sec)	-10.46	ohm in secondary		
R1L5 Zone 5 Resistive-Left(Ohm,sec)	-6.97	ohm in		

		secondary		
50 ABCP Pos. Seq. Current Supv.(A,sec)	0.2	amp in secondary		
UBD Neg-Seq. current unblock Delay(cyc)	10 ms	ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4			
LOAD ENCROACHMENT ELEMENT				
ELOAD Load Encroachment	Y			
ZLF Forward Load Impedance	41.17			
ZLR Reverse Load Impedance	41.17			
PALF Positive Forward Load Angle(deg)	36.87	degree		
NLAF Negative Forward Load Angle(deg)	-36.87	degree		
PLAR Positive Reverse Load Angle(deg)	150	degree		
NLAR Negative Reverse Load Angle(deg)	216.87	degree		
DIRECTIONAL ELEMENTS				
E32 Directional Control	AUTO			
ELOP Loss-of-Potential	Y			
DIR 3Level 3	R			
DIR 4Level 4	F			
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI			
Z2F Forward Dir. Z2 Threshold(Ohm,sec)	2.5			
Z2R Reverse Dir. Z2 Threshold (Ohm,sec)	3.5			
50QFP Forward Dir. 3I2 Pickup(A,sec)	0.1	amp in secondary		
50QRP Reverse Dir. 3I2 Pickup(A,sec)	0.05	amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1			
k2 Zero-Seq Restrain Factor I2/I0	0.2			
50 GFP Forward Dir.3I0 Pickup(A,sec)	0.1	amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup(A,sec)	0.05	amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1			
Z0F Forward Dir. Z0 Threshold(Ohm,sec)	7.7	ohm in secondary		
Z0R Reverse Dir. Z0 Threshold(Ohm,sec)	8.7	ohm in secondary		
OTHER SETTINGS				
TDUR 1D Single-Pole Min. Trip	180	ms		

Duration(cyc)				
TDUR 3D Three pole min. trip Duration(cyc)	180	ms		
CFD Close Failure Time Delay(cyc)	1200	ms		
VOLTAGE ELEMENTS				
EVOLT Voltage Elements	N			
SYNCHRONISM CHECK ELEMENT				
E25 Synchronism Check	N			
FREQUENCY ELEMENTS				
E81 Frequency Elements	N			
RECLOSING RELAY SETTINGS				
E79 Reclosures	1			
790I1 Open Interval (cyc)	600			
790I2 Open Interval(cyc)	0			
790I3 Open Interval(cyc)	0			
790I4 Open Interval(cyc)	0			
79RSD Reset Time from Reclose Cycle(cyc)	200	ms		
79RSLD Reset Time from Lockout(cyc)	2500	ms		
79CLSD Reclose Supv. Time Limit	100	ms		
SWITCH-ONTO-FAULT LOGIC				
ESOTF Switch-Onto-Fault Logic	Y			
EDDSOTF SOTF Disturbance Detector Supervision	Y			
CLOEND Close Enable Time Delay(cyc)	20	ms		
52AEND 52A Enable Time Delay	OFF			
SOTFD SOTF Duration	120	ms		
ZONE 1 EXTENSION SETTINGS				
EZ1EXT Zone 1 Extension	N			

220 KV KHURJA- II LINE SETTING RELAY MAIN-1

Parameter	**Existing settings**	**Reviewed Settings**	**Remarks**
I abrupt	0.200 A		
I PS	1.200 A		
Kx	0.689		
Kr	0.621		
Km	0		

X line	5.062 ohm		
R_line	1.011 Ohm		
Line length	42.10 km		
U_ PRIMARY	220.0 kV		
CT PRIMARY	0.600 kA		
CT SECONDARY	1.000 A		
R1_pe	8.309 ohm		
X1_pe	4.050 ohm		
R1 EXT_pe	0.010 ohm		
X1 EXT_pe	0.010 ohm		
R2_pe	9.400 ohm		
X2_pe	7.593 ohm		
R3_pe	10.45 ohm		
X3_pe	14.99 ohm		
R4_pe	8.005 ohm		
X4_pe	1.050 ohm		
R5_pe	0.010 ohm		
X5_pe	0.010 ohm		
T1_pe	0.000 s		
T1 EXT_pe	10.00 s		
T2_pe	0.000 s		
T3_pe	.800 s		
T4_pe	0.160 s		
T5_pe	10.00 s		
R1_pp	3.059 ohm		
X1_pp	4.050 ohm		
R1 EXT_pp	0.010 ohm		
X1 EXT_pp	0.010 ohm		
R2_pp	4.146 ohm		
X2_pp	7.593 ohm		
R3_pp	5.200 ohm		
X3_pp	14.99 ohm		
R4_pp	2.460 ohm		
X4_pp	1.050 ohm		
R5_pp	0.010 ohm		
X5_pp	0.010 ohm		
T1_pp	0.000 s		
TIEXT_pp	10.00 s		
T2_pp	0.000 s		
T3_pp	0.800 s		
T4_pp	0.160 s		
T5_PP	10.00 s		
Ioc VT fail	100.0 A		
3I0 VT fail	100.0 A		

T VT fail	10.00 s		
T_PS NOBLOCKING	2.000 s		
T VT fail alarm	10.00 s		
I_SOTF	1.800 A		
3I01	100.0 A		
3I02	100.0 À		
3I03	100.0 À		
3I04	100.0 A		
TO1	10.00 s		
TO2	10.00 s		
TO3	10.00 s		
T04	10.00s		
3I0_INV	100.0 A		
T0 factor	13.5		
N0	1		
T0 INV	10.00s		
TIp_AR	0.800s		
T3p_AR	10.00 s		
Dev_Angle AR	30		
T Reclain	25.00 s		
DU AR	10.00 V		
T_PD	9.00 s		
0v1_pe	120.0 v		
0v2_pe	120.0 V		
Tov1_pe	60.00 s		
Tov2_pe	60.00 s		
UV1_pe	40.00 v		
UV2_pe	40.00 v		
Tuv1_pe	10.00 s		
Tuv2_pe	10.00 s		
Ioc pe	100.0 A		
Toc_pe	10.00 s		
Ioc INV	100.0 A		
Toc factor	13.5		
Noc	1		
Toc INV	10.00 s		
I CBF	100.0 A		
3I0 CBF	100.0 A		
T CBF	2.000 s		
3I2 BROKEN COND	0.350 A		
T BROKEN COND	5.000 s		
I_Trip_BROKEN	20.00 s		
I OverLoad	15.00 A		
T OverLoad	3600. s		

220 KV KHURJA- II LINE SETTING RELAY MAIN-2

Parameter	Existing settings	Unit	Reviewed Settings	Remarks
GENERAL SETTINGS				
CT Ratio Phase	600			
CTRN(IN) Neutral	600			
PT Ratio Phase	2000			
PTRS Synch Voltage(VS)PT Ratio	2000			
VNOM Phase Nominal Voltage L-N	63.51	volt in secondary		
EADVS Advanced Settings	Y			
EBBPT Enable busbar PT LOP logic	N			
LINE SETTINGS AND FAULT LOCATOR				
Z1MAG Pos-Seq Line Impedance Mag.	4.94	ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.7	degree		
Z0 MAG Zero-Seq Line Impedance Mag.	15.45	ohm in secondary		
Z0 MAG Zero-Seq Line Impedance Angle	78.5	degree		
LL Line Length-unitless	41.2			
EFLOC Fault Location	Y			
PHASE DISTANCE ELEMENT				
ECCVT CCVT Transient Detection	Y			
E21P Mho Phase Distance Element	4			
Mho Phase Distance Element Reach Settings				
Z1P Zone 1	4.13	ohm in secondary		
Z2P Zone 2	7.74	ohm in secondary		
Z3P Zone 3	1.07	ohm in secondary		
Z4P Zone 4	15.29	ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings				
50PP1 Zone 1 Phase-Phase Current FD	0.1	amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1	amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1	amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1	amp in secondary		
GROUND DISTANCE ELEMENTS				
Mho Ground Distance Elements				
E21MG Mho Ground Distance Elements	4			
Z1MG Zone 1	4.13	ohm in secondary		
Z2MG Zone 2	7.74	ohm in secondary		
Z3MG Zone 3	1.07	ohm in secondary		
Z4MG Zone 4	15.29	ohm in secondary		
Quad Ground Distance Elements				
E21XG Quad Ground Distance Elements	4			
XG1 Zone1 Reactance	4.05	ohm in secondary		

XG2 Zone2 Reactance	7.59	ohm in secondary		
XG3 Zone3 Reactance	1.05	ohm in secondary		
XG1l4 Zone4 Reactance	14.99	ohm in secondary		
RG1 Zone 1 Resistance	8.31	ohm in secondary		
RG2 Zone 2 Resistance	9.4	ohm in secondary		
RG3 Zone 3 Resistance	8.01	ohm in secondary		
RG4 Zone 4 Resistance	10.45	ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	12			
TANG Non-Homogeneous Correction Ang	-3			
Quad and Mho Ground Distance Fault Detector Settings				
50L1 Zone1 Phase Current FD	0.1	amp in secondary		
50L2 Zone3 Phase Current FD	0.1	amp in secondary		
50L3 Zone3 Phase Current FD	0.1	amp in secondary		
50L4 Zone4 Phase Current FD	0.1	amp in secondary		
50Z1 Zone 1 Residual Current FD	0.1	amp in secondary		
50Z2 Zone 2 Residual Current FD	0.1	amp in secondary		
50Z3 Zone 3 Residual Current FD	0.1	amp in secondary		
50Z4 Zone 4 Residual Current FD	0.1	amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings				
k0M1 Zone1 ZSC Factor Mag.	0.678			
k0A1 Zone 1 ZSC Factor Ang	1.15	degree		
k0M Zones 2,3,4 ZSC Factor Mag	0.687			
k0A zones 2,3,4 ZSC Factor Ang	1.15	degree		
DISTANCE ELEMENT TIME DELAY SETTINGS				
Mho Phase Distance Element Time Delay Settings				
Z1PD Zone 1 Time Delay	0	ms		
Z2PD Zone 2 Time Delay	0	ms		
Z3PD Zone 3 Time Delay	160	ms		
Z4PD Zone 4 Time Delay	800	ms		
Quad and Mho Ground Distance Element Time Delay Settings				
Z1GD Zone 1 Time Delay	0	ms		
Z2GD Zone 2 Time Delay	0	ms		
Z3GD Zone 3 Time Delay	160	ms		
Z4GD Zone 4 Time Delay	800	ms		
Common Phase/Ground Dist. Element Time Delay Settings				
Z1D Zone 1 Time Delay	0	ms		
Z1l2D Zone 2 Time Delay	350	ms		
Z3D Zone 3 Time Delay	160	ms		
Z4D Zone 4 Time Delay	1000	ms		

PHASE OVERCURRENT ELEMENT				
E50P Phase	1			
Phase Instantaneous Overcurrent Elements				
501P Level 1	2	amp in secondary		
502P Level 2	OFF	amp in secondary		
503P Level 3	OFF	amp in secondary		
504P Level 4	OFF	amp in secondary		
Phase Definite Time Overcurrent Elements				
67 P1D Level	0	ms		
67 P2D Level	0	ms		
67 P3D Level	0	ms		
67 P4D Level	0	ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS				
E51G Residual Ground	N			
NEGATIVE SEQUENCE TIME OVERCURRENT ELEMENTS				
E51Q Negative-Sequence	N			
BREAKER FAILURE SETTINGS				
E50BF Breaker Failure	Y			
50BFP Phase Fault Current Pickup	1.2	amp in secondary		
BFPU Breaker Failure Time Delay	180	ms		
RTPU Retrip Time Delay	60	ms		
Out-of-Step Settings				
EOOS Out-of-Step	Y			
OOSB 1 Block Zone 1	Y			
OOSB2 Block Zone 2	N			
OOSB3 Block Zone 3	N			
OOSB4 Block Zone 4	N			
OSBD Out-of-Step Block Time Delay	2			
EOOST Enable Out-of-Step Tripping	N			
OSTD Out-of-Step Trip Time Delay	10	ms		
X1T6 zone 6 Reactive-Top	10.84	ohm in secondary		
X1T5 zone 5 Reactive-Top	8.67	ohm in secondary		
R1R6 zone 6 Resistive-Right	10.46	ohm in secondary		
R1R5 Zone 5 Resistive-Right	8.67	ohm in secondary		
X1B6 Zone 6 Reactive-Bottom	-10.84	ohm in secondary		
X1B5 Zone 5 Reactive Bottom	-8.67	ohm in secondary		
R1L6 Zone 6 Resistive-Left	-10.46	ohm in secondary		

R1L5 Zone 5 Resistive-Left	-6.97	ohm in secondary		
50 ABCP Pos. Seq. Current Supv.	0.2	amp in secondary		
UBD Neg-Seq. current unblock Delay	10	ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4			
LOAD ENCROACHMENT ELEMENT				
ELOAD Load Encroachment	Y			
ZLF Forward Load Impedance	41.17			
ZLR Reverse Load Impedance	41.17			
PALF Positive Forward Load Angle	36.87	degree		
NLAF Negative Forward Load Angle	-36.87	degree		
PLAR Positive Reverse Load Angle	150	degree		
NLAR Negative Reverse Load Angle	216.87	degree		
DIRECTIONAL ELEMENTS				
E32 Directional Control	AUTO			
ELOP Loss-of-Potential	Y			
DIR 3Level 3	R			
DIR 4Level 4	F			
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI			
Z2F Forward Dir. Z2 Threshold	2.5	ohm in secondary		
Z2R Reverse Dir. Z2 Threshold	3.5	ohm in secondary		
50QFP Forward Dir. 3I2 Pickup	0.1	amp in secondary		
50QRP Reverse Dir. 3I2 Pickup	0.05	amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1			
k2 Zero-Seq Restrain Factor I2/I0	0.2			
50 GFP Forward Dir.3I0 Pickup	0.1	amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup	0.05	amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1			
Z0F Forward Dir. Z0 Threshold	7.7	ohm in secondary		
Z0R Reverse Dir. Z0 Threshold	8.7	ohm in secondary		
OTHER SETTINGS				
TDUR 1D Single-Pole Min. Trip Duration	180	ms		
TDUR 3D Three pole min. trip Duration	180	ms		
CFD Close Failure Time Delay	1200	ms		
VOLTAGE ELEMENTS				
EVOLT Voltage Elements	N			
SYNCHRONISM CHECK ELEMENT				
E25 Synchronism Check	N			

FREQUENCY ELEMENTS				
E81 Frequency Elements	N			
RECLOSING RELAY SETTINGS				
E79 Reclosures	20	ms		
790I1 Open Interval	600	ms		
790I2 Open Interval	0	ms		
790I3 Open Interval	0	ms		
790I4 Open Interval	0	ms		
79RSD Reset Time from Reclose Cycle	200	ms		
79RSLD Reset Time from Lockout	25000	ms		
79CLSD Reclose Supv. Time Limit	100	ms		
SWITCH-ONTO-FAULT LOGIC				
ESOTF Switch-Onto-Fault Logic	Y			
EDDSOTF SOTF Disturbance Detector Supervision	Y			
CLOEND Close Enable Time Delay	20	ms		
52AEND 52A Enable Time Delay	OFF	ms		
SOTFD SOTF Duration (cyc)	120	ms		
ZONE 1 EXTENSION SETTINGS				
EZ1EXT Zone 1 Extension	N			

220 KV ATRAULI LINE SETTING RELAY MAIN-1

Parameter	**Existing Setting**	**Reviewed Settings**	**Remarks**
CONFIGURATION			
Settings Group 1	Enabled		
Settings Group 2	Disabled		
Settings Group 3	Disabled		
Settings Group 4	Enabled		
Dist. Protection	Enabled		
Power- Swing	Enabled		
Back-up I>	Disabled		
Neg Sequence O/C	Disabled		
Broken Conductor	Enabled		
Earth Fault PROT	Disabled		
Aided D.E.F	Disabled		
Volt Protection	Disabled		

CB Fail & I<	Disabled		
Supervision	Enabled		
System Checks	Disabled		
Thermal Overload	Disabled		
Internal A/R	Enabled		
GENERAL SETTINGS			
Phase CT Primary	600 A		
Phase CT Sec'y	1.000 A		
Mcomp CT Primary	800 A		
Mcomp CT Sec'y	1.000 A		
CT Ratio Phase	400		
CTRN(IN) Neutral	400		
Main VT Primary	220 KV		
Main VT Sec'y	110 V		
C/S VT Primary	220 KV		
C/S VT Secondry	110 V		
C/S Input	A-N		
Main VT location	Line		
DISTANCE ELEMENT			
LINE SETTINGS GROUP1			
Line Length	17.50 Km		
Line Impedance	2.860 Ohm		
Line Angle	78.7 Degree		
Zone Settings GROUP 1			
kZ1 Res Comp	0.667		
kZ1 Angle	minus 2.200 degree		
Z1	2.289 Ohm		
Z1X	2.240 Ohm		
R1G	10.44 Ohm		
R1Ph	3.450 Ohm		
tZ1	0.00 sec		
kZ2 Res comp	0.667		
kZ2 Angle	minus 2.200 degree		
Z2	3.439 Ohm		
R2G	11.19 Ohm		
R2Ph	4.190 Ohm		
tZ2	350.0 ms		
kZ3/4 Res Comp	0.667		
kZ3/4 Angle	minus 2.200 degree		
Z3	6.941 Ohm		

R3G-R4G	11.19Ohm		
R3Ph-R4Ph	4.310 Ohm		
tZ3	800.0 ms		
Z4	572.0 mohm		
tZ4	160.0 msec		
Serial Cmp. Line	Disabled		
Overlap Z mode	Disabled		
Z1m Tilt Angle	0.000 Degree		
Z1p tilt Angle	0.000 Degree		
Z2/Zp Tilt Angle	0.000 Degree		
Fwd z chgt Delay	30.00 msec		
kzm Mutual comp	0		
kZm Angle	0		
DISTANCE SCHEMES GROUP 1			
Standard Mode	B.O.P Z1		
Fault type	Both enabled		
Trip Mode	1P. Z1 & CR		
tReversal guard	20.00 ms		
SOTF Delay	110.00 s		
Z1Ext fail	Enabled		
Weak Infeed: Mode Status	Disabled		
POWER SWING GROUP 1			
Delta R	500 mohm		
Delta X	500 mohm		
IN>status	Enabled		
IN>%Imax	40%		
I2>Status	Enabled		
I2>%Imax	30%		
ImaxLine>status	Enabled		
ImaxLine>	3 Amp		
Delta I status	Enabled		
Unblocking delay	30s		
out of step	1		
stable swing	1		
BROKEN CONDUCTOR GROUP 1			
Broken conductor	Enabled		
I2/I1 setting	0.2		
I2/I1 time delay	60s		
I2/I1 trip	Disabled		

SUPERVISION GROUP 1			
VTS Time Delay	5s		
VTS I2 AND I0 Inh	50 mA		
CTS Status	Enabled		
CTS VN<Inhibit	1.000V		
CTS IN>Set	100.0 mA		
CTS Time Delay	5s		
CVTS Status	Enabled		
CVTS VN>	1.00V		
CVTS Time delay	100.0s		
AUTORECLOSE GROUP 1			
1P trip mode	1		
1P dead time 1	600ms		
Reclaim time	25s		
Close pulse time	200 ms		
Discrim. Time	100ms		
A/R Inhibit Wind	5s		
DISTANCE ELEMENT			
LINE SETTINGS GROUP 4			
Line Length	17.50 Km		
Line Impedance	2.863 Ohm		
Line Angle	78.0 Degree		
ZONE SETTINGS GROUP 4			
kZ1 Res Comp	1		
kZ1 Angle	minus 2.200 degree		
Z1	2.289 Ohm		
R1G	10.44 Ohm		
R1Ph	3.430 Ohm		
tZ1	0.00 sec		
kZ2 Res comp	1		
kZ2 Angle	minus 2.200 degree		
Z2	3.430 Ohm		
R2G	11.25 Ohm		
R2Ph	4.280 Ohm		
tZ2	350.0 ms		

kZ3/4 Res Comp	1		
kZ3/4 Angle	0		
Z3	6.940 Ohm		
R3G-R4G	11.36 Ohm		
R3Ph-R4Ph	10.12 Ohm		
tZ3	1 second		
Z4	572.0 mohm		
tZ4	160.0 msec		
Serial Cmp. Line	Disabled		
Overlap Z mode	Disabled		
Z1m Tilt Angle	0.000 Degree		
Z1p tilt Angle	0.000 Degree		
Z2/Zp Tilt Angle	0.000 Degree		
Fwd z chgt Delay	30.00 msec		
DISTANCE SCHEMES GROUP 4			
Standard Mode	P.O.P Z1		
Fault type	Both enabled		
Trip Mode	1P. Z1 & CR		
tReversal guard	20.00 ms		
SOTF Delay	110.00 s		
Z1Ext fail	Enabled		
Weak Infeed: Mode Status	Disabled		
POWER SWING GROUP 4			
Delta R	500 mohm		
Delta X	500 mohm		
IN>status	Enabled		
IN>%Imax	40%		
I2>Status	Enabled		
I2>%Imax	30%		
ImaxLine>status	Enabled		
ImaxLine>	3 Amp		
Delta I status	Enabled		
Unblocking delay	30s		
out of step	1		
stable swing	1		
BROKEN CONDUCTOR GROUP 4			
Broken conductor	Enabled		
I2/I1 setting	0.2		

I2/I1 time delay	60s		
I2/I1 trip	Disabled		
SUPERVISION GROUP 1			
VTS Time Delay	5s		
VTS I2 AND I0 Inh	50 mA		
CTS Status	Disabled		
CVTS Status	Disabled		
AUTORECLOSE GROUP 4			
1P trip mode	1		
1P dead time 1	600ms		
Reclaim time	25s		
Close pulse time	200 ms		
Discrim. Time	100ms		
A/R Inhibit Wind	5s		

220 KV ATRAULI LINE SETTING RELAY MAIN-2

Parameter	Existing settings	Unit	Reviewed Settings	Remarks
GENERAL SETTINGS				
CT Ratio Phase	600			
CTRN(IN) Neutral	600			
PT Ratio Phase	2000			
PTRS Synch Voltage(VS)PT Ratio	110			
VNOM Phase Nominal Voltage L-N	63.51	volt in secondary		
EADVS Advanced Settings	Y			
EBBPT Enable busbar PT LOP logic	N			
LINE SETTINGS AND FAULT LOCATOR				
Z1MAG Pos-Seq Line Impedance Mag.	2.86	ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.7	degree		
Z0 MAG Zero-Seq Line Impedance Mag.	8.75	ohm in secondary		
Z0 MAG Zero-Seq Line Impedance Angle	79.45	degree		
LL Line Length-unitless	17.5			
EFLOC Fault Location	Y			
PHASE DISTANCE ELEMENT				
ECCVT CCVT Transient Detection	Y			
E21P Mho Phase Distance Element	4			

Mho Phase Distance Element Reach Settings				
Z1P Zone 1	2.29	ohm in secondary		
Z2P Zone 2	4.29	ohm in secondary		
Z3P Zone 3	0.57	ohm in secondary		
Z4P Zone 4	6.87	ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings				
50PP1 Zone 1 Phase-Phase Current FD	0.1	amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1	amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1	amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1	amp in secondary		
GROUND DISTANCE ELEMENTS				
Mho Ground Distance Elements				
E21MG Mho Ground Distance Elements	4			
Z1MG Zone 1	2.29	ohm in secondary		
Z2MG Zone 2	4.29	ohm in secondary		
Z3MG Zone 3	0.57	ohm in secondary		
Z4MG Zone 4	6.87	ohm in secondary		
Quad Ground Distance Elements				
E21XG Quad Ground Distance Elements	4			
XG1 Zone1 Reactance	2.24	ohm in secondary		
XG2 Zone2 Reactance	4.21	ohm in secondary		
XG3 Zone3 Reactance	0.56	ohm in secondary		
XG1l4 Zone4 Reactance	6.54	ohm in secondary		
R1G Zone 1 Resistance	8.49	ohm in secondary		
R2G Zone 2 Resistance	9.49	ohm in secondary		
R3G Zone 3 Resistance	8.11	ohm in secondary		
R4G Zone 4 Resistance	10.49	ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	12			
TANG Non-Homogeneous Correction Ang	-3	degree		
Quad and Mho Ground Distance Fault Detector Settings				
50L1 Zone1 Phase Current FD	0.1	amp in secondary		
50L2 Zone3 Phase Current FD	0.1	amp in secondary		
50L3 Zone3 Phase Current FD	0.1	amp in secondary		
50L4 Zone4 Phase Current FD	0.1	amp in secondary		
50Z1 Zone 1 Residual Current FD	0.1	amp in secondary		
50Z2 Zone 2 Residual Current FD	0.1	amp in secondary		
50Z3 Zone 3 Residual Current FD	0.1	amp in secondary		
50Z4 Zone 4 Residual Current FD	0.1	amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings				
k0M1 Zone1 ZSC Factor Mag.	0.678			
k0A1 Zone 1 ZSC Factor Ang	1.15	degree		

k0M Zones 2,3,4 ZSC Factor Mag	0.687			
k0A zones 2,3,4 ZSC Factor Ang	1.15	degree		
DISTANCE ELEMENT TIME DELAY SETTINGS				
Mho Phase Distance Element Time Delay Settings				
Z1PD Zone 1 Time Delay	0	ms		
Z2PD Zone 2 Time Delay	17.5	ms		
Z3PD Zone 3 Time Delay	160	ms		
Z4PD Zone 4 Time Delay	800	ms		
Quad and Mho Ground Distance Element Time Delay Settings				
Z1GD Zone 1 Time Delay	0	ms		
Z2GD Zone 2 Time Delay	350	ms		
Z3GD Zone 3 Time Delay	160	ms		
Z4GD Zone 4 Time Delay	800	ms		
Common Phase/Ground Dist. Element Time Delay Settings				
Z1D Zone 1 Time Delay	0	ms		
Z1l2D Zone 2 Time Delay	350	ms		
Z3D Zone 3 Time Delay	160	ms		
Z4D Zone 4 Time Delay	800	ms		
PHASE OVERCURRENT ELEMENT				
E50P Phase	1			
Phase Instantaneous Overcurrent Elements				
501P Level 1	2	amp in secondary		
502P Level 2	OFF	amp in secondary		
503P Level 3	OFF	amp in secondary		
504P Level 4	OFF	amp in secondary		
Phase Definite Time Overcurrent Elements				
67 P1D Level	0	ms		
67 P2D Level	0	ms		
67 P3D Level	0	ms		
67 P4D Level	0	ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS				
E51G Residual Ground	N			
NEGATIVE SEQUENCE TIME OVERCURRENT ELEMENTS				
E51Q Negative-Sequence	N			

BREAKER FAILURE SETTINGS				
E50BF Breaker Failure	Y			
50BFP Phase Fault Current Pickup	1.2	amp in secondary		
BFPU Breaker Failure Time Delay	180	ms		
RTPU Retrip Time Delay	60	ms		
Out-of-Step Settings				
EOOS Out-of-Step	Y			
OOSB 1 Block Zone 1	Y			
OOSB2 Block Zone 2	N			
OOSB3 Block Zone 3	N			
OOSB4 Block Zone 4	N			
OSBD Out-of-Step Block Time Delay	40	ms		
EOOST Enable Out-of-Step Tripping	N			
OSTD Out-of-Step Trip Time Delay	10	ms		
X1T6 zone 6 Reactive-Top	10.84	ohm in secondary		
X1T5 zone 5 Reactive-Top	8.67	ohm in secondary		
R1R6 zone 6 Resistive-Right	10.46	ohm in secondary		
R1R5 Zone 5 Resistive-Right	8.67	ohm in secondary		
X1B6 Zone 6 Reactive-Bottom	-10.84	ohm in secondary		
X1B5 Zone 5 Reactive Bottom	-8.67	ohm in secondary		
R1L6 Zone 6 Resistive-Left	-10.46	ohm in secondary		
R1L5 Zone 5 Resistive-Left	-6.97	ohm in secondary		
50 ABCP Pos. Seq. Current Supv.	0.2	amp in secondary		
UBD Neg-Seq. current unblock Delay	10	ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4			
LOAD ENCROACHMENT ELEMENT				
ELOAD Load Encroachment	Y			
ZLF Forward Load Impedance	41.17			
ZLR Reverse Load Impedance	41.17			
PALF Positive Forward Load Angle	36.87	degree		
NLAF Negative Forward Load Angle	-36.87	degree		
PLAR Positive Reverse Load Angle	150	degree		
NLAR Negative Reverse Load Angle	216.87	degree		
DIRECTIONAL ELEMENTS				
E32 Directional Control	AUTO			
ELOP Loss-of-Potential	Y			
DIR 3Level 3	R			
DIR 4Level 4	F			
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI			

Z2F Forward Dir. Z2 Threshold	1.4	ohm in secondary		
Z2R Reverse Dir. Z2 Threshold	2.4	ohm in secondary		
50QFP Forward Dir. 3I2 Pickup	0.1	amp in secondary		
50QRP Reverse Dir. 3I2 Pickup	0.05	amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1			
k2 Zero-Seq Restrain Factor I2/I0	0.2			
50 GFP Forward Dir.3I0 Pickup	0.1	amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup	0.05	amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1			
Z0F Forward Dir. Z0 Threshold	4.4	ohm in secondary		
Z0R Reverse Dir. Z0 Threshold	5.4	ohm in secondary		
OTHER SETTINGS				
TDUR 1D Single-Pole Min. Trip Duration	180	ms		
TDUR 3D Three pole min. trip Duration	180	ms		
CFD Close Failure Time Delay	1200	ms		
VOLTAGE ELEMENTS				
EVOLT Voltage Elements	N			
SYNCHRONISM CHECK ELEMENT				
E25 Synchronism Check	N			
FREQUENCY ELEMENTS				
E81 Frequency Elements	N			
RECLOSING RELAY SETTINGS				
E79 Reclosures	20	ms		
79OI1 Open Interval	600	ms		
79OI2 Open Interval	0	ms		
79OI3 Open Interval	0	ms		
79OI4 Open Interval	0	ms		
79RSD Reset Time from Reclose Cycle	25000	ms		
79RSLD Reset Time from Lockout	1000	ms		
79CLSD Reclose Supv. Time Limit	0	ms		
SWITCH-ONTO-FAULT LOGIC				
ESOTF Switch-Onto-Fault Logic	Y			
EDDSOTF SOTF Disturbance Detector Supervision	Y			
CLOEND Close Enable Time Delay	20	ms		
52AEND 52A Enable Time Delay	OFF	ms		
SOTFD SOTF Duration	120	ms		

ZONE 1 EXTENSION SETTINGS				
EZ1EXT Zone 1 Extension	N			

220 KV BONER LINE SETTING RELAY MAIN-1

General

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Name	HDJ-BONER,220KV LINE		
Breaker	CB-87		
Unit In Service	Yes		
Phase CT Ratio	600		
Polarizing CT Ratio	600		
Parallel CT Ratio	1		
Phase VT Ratio	2000		
Busbar VT Ratio	2000		
Capacitive VT	Yes		
Phase Sequence	ABC		

System Impedances Line Impedance

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Pos. Seq. Magnitude	2.86Ohm		
Pos. Seq. Angle	79º		
Pos. Seq. Angle 2	79º		
Pos. Seq. Angle 3	79º		
Pos. Seq. Angle 4	79º		
Pos. Seq. Angle 5	79º		
Zero Seq. Angle	79º		
Z1 k0 Factor	3.06		
Zero Seq. Angle 2	79º		
Z2 k0 Factor	3.06		
Zero Seq. Angle 3	79º		
Z3 k0 Factor	3.06		
Zero Seq. Angle 4	79º		
Z4 k0 Factor	3.06		

Zero Seq. Angle 5	79º		
Z5 k0 Factor	3.06		

Equivalent Parallel Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Local Source Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Remote Source Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Parallel Line Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Mutual Coupl. Factor	0		
Mutual Coupl. Angle	25º		
Factor I0/I0PAR	0.95		

Fault Locator Length and Units

Settings	Existing settings	Reviewed Settings	Remarks
Line Length	23.36		
Length Units	Kilometers		
Locator Units	Length Units		

Parallel Line Coupling

Settings	Existing settings	Reviewed Settings	Remarks
Mut Coupl. Comp.	No	No	No
Ena			

Protection Distance Units

Zone 1 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 1 Enable	Yes		
Direction	Forward		
Ground Reach	2.29Ohm		
Phase Reach	2.29Ohm		
Ground Resist Limit	7.94Ohm		
Phase Resist Limit	2.69Ohm		
Ground Time	0s		
Phase Time	0s		
Tilt Time	0s		
Tilt Angle Type	Calculated		
Tilt Angle	0º		

Zone 2 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 2 Enable	Yes		
Direction	Forward		
Ground Reach	3.44Ohm		
Phase Reach	3.32Ohm		
Ground Resist Limit	8.57Ohm		
Phase Resist Limit	3.76Ohm		
Ground Time	0.35s		
Phase Time	0.35s		

Zone 3 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 3 Enable	Yes		
Direction	Forward		
Ground Reach	6.06Ohm		
Phase Reach	6.06Ohm		

Ground Resist Limit	8.69Ohm		
Phase Resist Limit	3.44Ohm		
Ground Time	0.8s		
Phase Time	0.8s		

Zone 4 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 4 Enable	Yes		
Direction	Reverse		
Ground Reach	1.05Ohm		
Phase Reach	1.05Ohm		
Ground Resist Limit	7.78Ohm		
Phase Resist Limit	2.53Ohm		
Ground Time	0.16s		
Phase Time	0.16s		

Zone 5 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 5 Enable	No		
Direction	Forward		
Ground Reach	25.00Ohm		
Phase Reach	25.00Ohm		
Ground Resist Limit	20.00Ohm		
Phase Resist Limit	20.00Ohm		
Ground Time	1.5s		
Phase Time	1.5s		

Characteristic

Settings	Existing settings	Reviewed Settings	Remarks
Ground Characteristic	Quadrilateral		
Phase Characteristic	Quadrilateral		

Quadrilateral Characteristic Directional Angle

Settings	Existing settings	Reviewed Settings	Remarks
Dir Characteristic Angle	78º		

Close Onto Fault

Settings	Existing settings	Reviewed Settings	Remarks

COF Enable	Yes		
COF Sup Zone	Zone 2		
I COF Pick up	1.50A		
Z1 Ext. After Recl.	No		
2nd Harm. Restraint	0%		
COF Time	300ms		

Fuse Failure

Settings	Existing settings	Reviewed Settings	Remarks
FF Detec Enable	Yes		
FF Input DropOut Time	150ms		
FF Block Enable	Yes		
Voltage Level	30V		

Load Encroachment

Settings	Existing settings	Reviewed Settings	Remarks
Enable Load Encroach	No		
Right Area Resis Limit	325.00Ohm		
Left Area Resis Limit	325.00Ohm		
Right Area Angle	20º		
Left Area Angle	20º		

Power Swing Detector

Settings	Existing settings	Reviewed Settings	Remarks
PS Detec Enable	Yes		
PS Trip Enable	No		
Right Ext Resist Limit	50.00Ohm		
Right Med Resist Limit	25.00Ohm		
Right Int Resist Limit	5.00Ohm		
Left Ext Resist Limit	50.00Ohm		
Left Med Resist Limit	25.00Ohm		
Left Int Resist Limit	5.00Ohm		
Resist Limit Angle	75º		
Forward Ext Reach	50.00Ohm		

Forward Med Reach	25.00Ohm		
Forward Int Reach	5.00Ohm		
Reverse Ext Reach	50.00Ohm		
Reverse Med Reach	25.00Ohm		
Reverse Int Reach	5.00Ohm		
I1 Supervision	0.20A		
PS Detec Time	0.03s		
PS Block Reset Time	2s		
PS Trip Type	Slow trip		
Fast Trip Time	0.05s		
PS Cond Reset Time	0.05s		

Overcurrent Directional

Settings	Existing settings	Reviewed Settings	Remarks
Phase Characteristic Angle	45º		
Neutr Characteristic Angle	45º		
NegSeq Characteristic Angle	45º		
PosSeq Characteristic Angle	45º		
Lack of direction blocking	No		
Min. Phase Voltage	0.2V		
Min. Neutr Voltage	0.2V		
NegSeq Volt.Comp.	0		

Voltage Restoration

Settings	Existing settings	Reviewed Settings	Remarks
Phase UV reset	105%		
Phase OV reset	95%		
Neutral OV reset	95%		

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	Existing settings	Unit	Reviewed Settings	Remarks
GENERAL SETTINGS				
CT Ratio Phase	600			
CTRN(IN) Neutral	600			
PT Ratio Phase	2000			
PTRS Synch Voltage(VS)PT Ratio	2000			
VNOM Phase Nominal Voltage L-N	63.51	Volt in secondary		
EADVS Advanced Settings	Y			
EBBPT Enable busbar PT LOP logic	N			
LINE SETTINGS AND FAULT LOCATOR				
Z1MAG Pos-Seq Line Impedance Mag.	2.85	ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.7	degree		
Z0 MAG Zero-Seq Line Impedance Mag	8.76	ohm in secondary		
Z0 MAG Zero-Seq Line Impedance Angle	79.45			
LL Line Length-unitless	23.36	km		
EFLOC Fault Location	Y			
PHASE DISTANCE ELEMENT				
ECCVT CCVT Transient Detection	Y			
E21P Mho Phase Distance Element	4			
Mho Phase Distance Element Reach Settings				
Z1P Zone 1	2.29	ohm in secondary		
Z2P Zone 2	3.44	ohm in secondary		
Z3P Zone 3	1.07	ohm in secondary		
Z4P Zone 4	8.31	ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings				
50PP1 Zone 1 Phase-Phase Current FD	0.1	amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1	amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1	amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1	amp in secondary		
GROUND DISTANCE ELEMENTS				
Mho Ground Distance Elements				
E21MG Mho Ground Distance Elements	4			
Z1MG Zone 1	2.29	ohm in secondary		
Z2MG Zone 2	3.44	ohm in secondary		
Z3MG Zone 3	1.07	ohm in secondary		
Z4MG Zone 4	8.31	ohm in secondary		
Quad Ground Distance Elements				

E21XG Quad Ground Distance Elements	4			
XG1 Zone1 Reactance	2.75	ohm in secondary		
XG2 Zone2 Reactance	3.37	ohm in secondary		
XG3 Zone3 Reactance	1.05	ohm in secondary		
XG4 Zone4 Reactance	8.15	ohm in secondary		
RG1 Zone 1 Resistance	2.7	ohm in secondary		
RG2 Zone 2 Resistance	3.76	ohm in secondary		
RG3 Zone 3 Resistance	2.53	ohm in secondary		
RG4 Zone 4 Resistance	3.88	ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	I2			
TANG Non-Homogeneous Correction Ang(deg)	-3			
Quad and Mho Ground Distance Fault Detector Settings				
50L1 Zone1 Phase Current FD	0.1	amp in secondary		
50L2 Zone3 Phase Current FD	0.1	amp in secondary		
50L3 Zone3 Phase Current FD	0.1	amp in secondary		
50L4 Zone4 Phase Current FD	0.1	amp in secondary		
50Z1 Zone 1 Residual Current FD	0.1	amp in secondary		
50Z2 Zone 2 Residual Current FD	0.1	amp in secondary		
50Z3 Zone 3 Residual Current FD	0.1	amp in secondary		
50Z4 Zone 4 Residual Current FD	0.1	amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings				
k0M1 Zone1 ZSC Factor Mag.	0.678			
k0A1 Zone 1 ZSC Factor Ang	1.15	degree		
k0M Zones 2,3,4 ZSC Factor Mag	0.687			
k0A zones 2,3,4 ZSC Factor Ang	1.15	degree		
DISTANCE ELEMENT TIME DELAY SETTINGS				
Mho Phase Distance Element Time Delay Settings				
Z1PD Zone 1 Time Delay	0	ms		
Z2PD Zone 2 Time Delay	350	ms		
Z3PD Zone 3 Time Delay	160	ms		
Z4PD Zone 4 Time Delay	800	ms		
Quad and Mho Ground Distance Element Time Delay Settings				
Z1GD Zone 1 Time Delay	0	ms		
Z2GD Zone 2 Time Delay	350	ms		
Z3GD Zone 3 Time Delay	160	ms		
Z4GD Zone 4 Time Delay	800	ms		
Common Phase/Ground Dist. Element Time Delay Settings				

Z1D Zone 1 Time Delay	0	ms		
Z1l2D Zone 2 Time Delay	350	ms		
Z3D Zone 3 Time Delay	160	ms		
Z4D Zone 4 Time Delay	1000	ms		
PHASE OVERCURRENT ELEMENT				
E50P Phase	1			
Phase Instantaneous Overcurrent Elements				
501P Level 1	2	amp in secondary		
502P Level 2	OFF	amp in secondary		
503P Level 3	OFF	amp in secondary		
504P Level 4	OFF	amp in secondary		
Phase Definite Time Overcurrent Elements				
67 P1D Level	0	ms		
67 P2D Leve	0	ms		
67 P3D Level	0	ms		
67 P4D Level	0	ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS				
E51G Residual Ground	N			
NEGATIVE SEQUENCE TIME OVERCURRENT ELEMENTS				
E51Q Negative-Sequence	N			
BREAKER FAILURE SETTINGS				
E50BF Breaker Failure	Y			
50BFP Phase Fault Current Pickup	1.2	amp in secondary		
BFPU Breaker Failure Time Delay	180	ms		
RTPU Retrip Time Delay	60	ms		
Out-of-Step Settings				
EOOS Out-of-Step	Y			
OOSB 1 Block Zone 1	Y			
OOSB2 Block Zone 2	N			
OOSB3 Block Zone 3	N			
OOSB4 Block Zone 4	N			
OSBD Out-of-Step Block Time Delay	40	ms		
EOOST Enable Out-of-Step Tripping	N			
OSTD Out-of-Step Trip Time Delay	10	ms		
X1T6 zone 6 Reactive-Top	10.84	ohm in secondary		

X1T5 zone 5 Reactive-Top	8.67	ohm in secondary		
R1R6 zone 6 Resistive-Right	10.46	ohm in secondary		
R1R5 Zone 5 Resistive-Right	8.67	ohm in secondary		
X1B6 Zone 6 Reactive-Bottom	-10.84	ohm in secondary		
X1B5 Zone 5 Reactive Bottom	-8.67	ohm in secondary		
R1L6 Zone 6 Resistive-Left	-10.46	ohm in secondary		
R1L5 Zone 5 Resistive-Left	-6.97	ohm in secondary		
50 ABCP Pos. Seq. Current Supv.	0.2	amp in secondary		
UBD Neg-Seq. current unblock Delay	10	ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4			
LOAD ENCROACHMENT ELEMENT				
ELOAD Load Encroachment	Y			
ZLF Forward Load Impedance	41.17			
ZLR Reverse Load Impedance	41.17			
PALF Positive Forward Load Angle	36.87	degree		
NLAF Negative Forward Load Angle	-36.87	degree		
PLAR Positive Reverse Load Angle	150	degree		
NLAR Negative Reverse Load Angle	216.87	degree		
DIRECTIONAL ELEMENTS				
E32 Directional Control	AUTO			
ELOP Loss-of-Potential	Y			
DIR 3Level 3	R			
DIR 4Level 4	F			
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI			
Z2F Forward Dir. Z2 Threshold	1.4	ohm in secondary		
Z2R Reverse Dir. Z2 Threshold	2.4	ohm in secondary		
50QFP Forward Dir. 3I2 Pickup	0.1	amp in secondary		
50QRP Reverse Dir. 3I2 Pickup	0.05	amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1			
k2 Zero-Seq Restrain Factor I2/I0	0.2			
50 GFP Forward Dir.3I0 Pickup	0.1	amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup	0.05	amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1			
Z0F Forward Dir. Z0 Threshold	4.4	ohm in secondary		
Z0R Reverse Dir. Z0 Threshold	5.4	ohm in secondary		
OTHER SETTINGS				
TDUR 1D Single-Pole Min. Trip Duration	180	ms		
TDUR 3D Three pole min. trip Duration	180	ms		
CFD Close Failure Time Delay	1200	ms		

VOLTAGE ELEMENTS				
EVOLT Voltage Elements	N			
SYNCHRONISM CHECK ELEMENT				
E25 Synchronism Check	N			
FREQUENCY ELEMENTS				
E81 Frequency Elements	N			
RECLOSING RELAY SETTINGS				
E79 Reclosures	1			
790I1 Open Interval	600	ms		
790I2 Open Interval	0	ms		
790I3 Open Interval	0	ms		
790I4 Open Interval	0	ms		
79RSD Reset Time from Reclose Cycle	200	ms		
79RSLD Reset Time from Lockout	25000	ms		
79CLSD Reclose Supv. Time Limit	100	ms		
SWITCH-ONTO-FAULT LOGIC				
ESOTF Switch-Onto-Fault Logic	Y			
EDDSOTF SOTF Disturbance Detector Supervision	Y			
CLOEND Close Enable Time Delay	20	ms		
52AEND 52A Enable Time Delay	OFF	ms		
SOTFD SOTF Duration	120	ms		
ZONE 1 EXTENSION SETTINGS				
EZ1EXT Zone 1 Extension	N			

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	Existing Setting	**Reviewed Settings**	**Remarks**
I abrupt	0.200 A		
I PS	1.200 A		
Kx	0.74		
Kr	0.84		
Km	0		
X line	6.111 ohm		
R_line	1.651 Ohm		
Line length	48.70 km		
U_ PRIMARY	220.0 kV		
CT PRIMARY	0.600 kA		
CT SECONDARY	1.000 A		

R1_pe	8.491 ohm		
X1_pe	4.790 ohm		
R1 EXT_pe	0.010 ohm		
X1 EXT_pe	0.010 ohm		
R2_pe	9.680 ohm		
X2_pe	7.376 ohm		
R3_pe	10.49 ohm		
X3_pe	14.30 ohm		
R4_pe	8.119 ohm		
X4_pe	1.050 ohm		
R5_pe	0.010 ohm		
X5_pe	0.010 ohm		
T1_pe	0.000 s		
T1 EXT_pe	10.00 s		
T2_pe	0.350 s		
T3_pe	1.000 s		
T4_pe	0.160 s		
T5_pe	10.00 s		
R1_pp	3.241 ohm		
X1_pp	4.790 ohm		
R1 EXT_pp	0.010 ohm		
X1 EXT_pp	0.010 ohm		
R2_pp	4.428 ohm		
X2_pp	7.376 ohm		
R3_pp	5.24 ohm		
X3_pp	14.30 ohm		
R4_pp	2.869 ohm		
X4_pp	1.050 ohm		
R5_pp	0.010 ohm		
X5_pp	0.010 ohm		
T1_pp	0.000 s		
TIEXT_pp	10.00 8		
T2_pp	0.350 s		
T3_pp	1.000 s		
T4_pp	0.160 s		
T5_PP	10.00 s		
Ioc VT fail	100.0 À		
3I0 VT fail	100.0 A		
T VT fail	10.00 s		
T_PS NOBLOCKING	10.00 s		
T VT fail alarm	0.000 s		
I_SOTF	2.000 A		
3I01	100.0 A		
3I02	100.0 À		

3I03	100.0 À		
3I04	100.0 A		
TO1	10.00 s		
TO2	10.00 s		
TO3	10.00 s		
T04	10.00s		
3I0_INV	100.0 A		
T0 factor	13.5		
N0	1		
T0 INV	10.009		
TIp_AR	0.600s		
T3p_AR	10.00 s		
Dev_Angle AR	30		
T Reclain	25.00 s		
DU AR	10.00 V		
T_PD	10.00 s		
0v1_pe	70.00 v		
0v2_pe	120.0 V		
Tov1_pe	3.000 s		
Tov2_pe	60.00 s		
UV1_pe	30.00 v		
UV2_pe	1.000 v		
Tuv1_pe	3.000 s		
Tuv2_pe	60.00 s		
Ioc pe	100.0 A		
Toc_pe	10.00 s		
Ioc INV	100.0 A		
Toc factor	13.5		
Noc	1		
Toc INV	10.00 s		
I CBF	100.0 A		
3I0 CBF	100.0 A		
T CBF	2.000 s		
3I2 BROKEN COND	0.333 A		
T BROKEN COND	0.200 s		
I_Trip_BROKEN	10.00 s		
I OverLoad	15.00 A		
T OverLoad	3600. s		

220 KV JAHANGIRABAD LINE SETTING RELAY MAIN-2

LINE SETTING HARDUAGANJ JAHANGIRABAD LINE

	Existing settings	Reviewed Settings	Remarks
GENERAL SETTINGS			
CT Ratio Phase	600		
CTRN(IN) Neutral	600		
PT Ratio Phase	2000		
PTRS Synch Voltage(VS)PT Ratio	2000		
VNOM Phase Nominal Voltage L-N	63.51 volt in secondary		
EADVS Advanced Settings	Y		
EBBPT Enable busbar PT LOP logic	N		
LINE SETTINGS AND FAULT LOCATOR			
Z1MAG Pos-Seq Line Impedance Mag.	6.11 ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.7 degree		
Z0 MAG Zero-Seq Line Impedance Mag.	27.23 ohm in secondary		
Z0 MAG Zero-Seq Line Impedance Angle	79.45 degree		
LL Line Length	47.8 km		
EFLOC Fault Location	Y		
PHASE DISTANCE ELEMENT			
ECCVT CCVT Transient Detection	Y		
E21P Mho Phase Distance Element	4		
Mho Phase Distance Element Reach Settings			
Z1P Zone 1 (Ohm,sec)	4.81 ohm in secondary		
Z2P Zone 2 (Ohm,sec)	7.33 ohm in secondary		
Z3P Zone 3 (Ohm,sec)	1.07 ohm in secondary		
Z4P Zone 4(Ohm,sec)	14.59 ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings			
50PP1 Zone 1 Phase-Phase Current FD	0.1 amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1 amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1 amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1 amp in secondary		
GROUND DISTANCE ELEMENTS			
Mho Ground Distance Elements			

E21MG Mho Ground Distance Elements	4		
Z1MG Zone 1	4.81 ohm in secondary		
Z2MG Zone 2	7.33 ohm in secondary		
Z3MG Zone 3	1.07 ohm in secondary		
Z4MG Zone 4	14.59 ohm in secondary		
Quad Ground Distance Elements			
E21XG Quad Ground Distance Elements	4		
XG1 Zone1 Reactance	4.79 ohm in secondary		
XG2 Zone2 Reactance	7.18 ohm in secondary		
XG3 Zone3 Reactance	1.05 ohm in secondary		
XG1l4 Zone4 Reactance	14.3 ohm in secondary		
R1G Zone 1 Resistance	8.49 ohm in secondary		
R2G Zone 2 Resistance	9.49 ohm in secondary		
R3G Zone 3 Resistance	8.11 ohm in secondary		
R4G Zone 4 Resistance	10.49 ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	I2		
TANG Non-Homogeneous Correction Ang	minus 3(deg)		
Quad and Mho Ground Distance Fault Detector Settings			
50L1 Zone1 Phase Current FD	0.1 amp in secondary		
50L2 Zone3 Phase Current FD	0.1 amp in secondary		
50L3 Zone3 Phase Current FD	0.1 amp in secondary		
50L4 Zone4 Phase Current FD	0.1 amp in secondary		
50Z1 Zone 1 Residual Current FD	0.1 amp in secondary		
50Z2 Zone 2 Residual Current FD	0.1 amp in secondary		
50Z3 Zone 3 Residual Current FD	0.1 amp in secondary		
50Z4 Zone 4 Residual Current FD	0.1 amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings			
k0M1 Zone1 ZSC Factor Mag.	0.678		

k0A1 Zone 1 ZSC Factor Ang	1.15 degree		
k0M Zones 2,3,4 ZSC Factor Mag	0.687		
k0A zones 2,3,4 ZSC Factor Ang	1.15 degree		
DISTANCE ELEMENT TIME DELAY SETTINGS			
Mho Phase Distance Element Time Delay Settings			
Z1PD Zone 1 Time Delay	0 ms		
Z2PD Zone 2 Time Delay	350 ms		
Z3PD Zone 3 Time Delay	160 ms		
Z4PD Zone 4 Time Delay	800 ms		
Quad and Mho Ground Distance Element Time Delay Settings			
Z1GD Zone 1 Time Delay	0 ms		
Z2GD Zone 2 Time Delay	350 ms		
Z3GD Zone 3 Time Delay	160 ms		
Z4GD Zone 4 Time Delay	800 ms		
Common Phase/Ground Dist. Element Time Delay Settings			
Z1D Zone 1 Time Delay	0 ms		
Z1l2D Zone 2 Time Delay	350 ms		
Z3D Zone 3 Time Delay	160 ms		
Z4D Zone 4 Time Delay	800 ms		
PHASE OVERCURRENT ELEMENT			
E50P Phase	1		
Phase Instantaneous Overcurrent Elements			
501P Level 1	2 amp in sec		
502P Level 2	OFF		
503P Level 3	OFF		
504P Level 4	OFF		
Phase Definite Time Overcurrent Elements			
67 P1D Level	0 ms		
67 P2D Level	0 ms		
67 P3D Level	0 ms		
67 P4D Level	0 ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS			
E51G Residual Ground	N		
NEGATIVE SEQUENCE TIME OVERCURRENT ELEMENTS			
E51Q Negative-Sequence	N		
BREAKER FAILURE SETTINGS			
E50BF Breaker Failure	Y		

50BFP Phase Fault Current Pickup(A,sec)	1.2 amp in sec		
BFPU Breaker Failure Time Delay(cyc)	180 ms		
RTPU Retrip Time Delay(cyc)	60 ms		
Out-of-Step Settings			
EOOS Out-of-Step	Y		
OOSB 1 Block Zone 1	Y		
OOSB2 Block Zone 2	N		
OOSB3 Block Zone 3	N		
OOSB4 Block Zone 4	N		
OSBD Out-of-Step Block Time Delay	40 ms		
EOOST Enable Out-of-Step Tripping	N		
OSTD Out-of-Step Trip Time Delay	10 ms		
X1T6 zone 6 Reactive-Top	10.84 ohm in secondary		
X1T5 zone 5 Reactive-Top	8.67 ohm in secondary		
R1R6 zone 6 Resistive-Right	10.46 ohm in secondary		
R1R5 Zone 5 Resistive-Right	8.67 ohm in secondary		
X1B6 Zone 6 Reactive-Bottom	10.84 ohm in secondary		
X1B5 Zone 5 Reactive Bottom	8.67 ohm in secondary		
R1L6 Zone 6 Resistive-Left	-10.46		
R1L5 Zone 5 Resistive-Left	-6.97		
50 ABCP Pos. Seq. Current Supv.	0.2 amp in secondary		
UBD Neg-Seq. current unblock Delay	10 ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4		
LOAD ENCROACHMENT ELEMENT			
ELOAD Load Encroachment	Y		
ZLF Forward Load Impedance	41.17		
ZLR Reverse Load Impedance	41.17		
PALF Positive Forward Load Angle	36.87		
NLAF Negative Forward Load Angle	-36.87		
PLAR Positive Reverse Load Angle	150 degree		
NLAR Negative Reverse Load Angle	216.87 degree		
DIRECTIONAL ELEMENTS			
E32 Directional Control	AUTO		
ELOP Loss-of-Potential	Y		
DIR 3Level 3	R		

DIR 4Level 4	F		
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI		
Z2F Forward Dir. Z2 Threshold	3.1 ohm in secondary		
Z2R Reverse Dir. Z2 Threshold	4.1 ohm in secondary		
50QFP Forward Dir. 3I2 Pickup	0.1 amp in secondary		
50QRP Reverse Dir. 3I2 Pickup	0.05 amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1		
k2 Zero-Seq Restrain Factor I2/I0	0.2		
50 GFP Forward Dir.3I0 Pickup	0.1 amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup	0.05 amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1		
Z0F Forward Dir. Z0 Threshold	13.6 ohm in secondary		
Z0R Reverse Dir. Z0 Threshold	14.6 ohm in secondary		
OTHER SETTINGS			
TDUR 1D Single-Pole Min. Trip Duration	180 ms		
TDUR 3D Three pole min. trip Duration	180 ms		
CFD Close Failure Time Delay	1200 ms		
VOLTAGE ELEMENTS			
EVOLT Voltage Elements	N		
SYNCHRONISM CHECK ELEMENT			
E25 Synchronism Check	N		
FREQUENCY ELEMENTS			
E81 Frequency Elements	N		
RECLOSING RELAY SETTINGS			
E79 Reclosures	20ms		
790I1 Open Interval	600ms		
790I2 Open Interval	0		
790I3 Open Interval	0		
790I4 Open Interval	0		
79RSD Reset Time from Reclose Cycle	200ms		
79RSLD Reset Time from Lockout	25000ms		
79CLSD Reclose Supv. Time Limit	100ms		

SWITCH-ONTO-FAULT LOGIC			
ESOTF Switch-Onto-Fault Logic	Y		
EDDSOTF SOTF Disturbance Detector Supervision	Y		
CLOEND Close Enable Time Delay	20ms		
52AEND 52A Enable Time Delay	OFF		
SOTFD SOTF Duration	120ms		
ZONE 1 EXTENSION SETTINGS			
EZ1EXT Zone 1 Extension	N		

220 KV TBC SETTING RELAY MAIN-1

General

Settings	Existing settings	Reviewed Settings	Remarks
Name	220KV LINE		
Breaker	52		
Unit In Service	Yes		
Phase CT Ratio	600		
Polarizing CT Ratio	600		
Parallel CT Ratio	1		
Phase VT Ratio	2000		
Busbar VT Ratio	2000		
Capacitive VT	Yes		
Phase Sequence	ABC		

System Impedances Line Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	9.52Ohm		
Pos. Seq. Angle	79º		
Pos. Seq. Angle 2	79º		
Pos. Seq. Angle 3	79º		
Pos. Seq. Angle 4	79º		
Pos. Seq. Angle 5	79º		
Zero Seq. Angle	79º		
Z1 k0 Factor	3.06		
Zero Seq. Angle 2	79º		
Z2 k0 Factor	3.06		
Zero Seq. Angle 3	79º		
Z3 k0 Factor	3.06		
Zero Seq. Angle 4	79º		

Z4 k0 Factor	3.06		
Zero Seq. Angle 5	79º		
Z5 k0 Factor	3.06		

Equivalent Parallel Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Local Source Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Remote Source Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Pos. Seq. Magnitude	6.25Ohm		
Pos. Seq. Angle	75º		
Zero Seq. Magnitude	6.25Ohm		
Zero Seq. Angle	75º		

Parallel Line Impedance

Settings	Existing settings	Reviewed Settings	Remarks
Mutual Coupl. Factor	0		
Mutual Coupl. Angle	25º		
Factor I0/I0PAR	0.95		

Fault Locator Length and Units

Settings	Existing settings	Reviewed Settings	Remarks
Line Length	77.67		
Length Units	Kilometers		
Locator Units	Length Units		

Parallel Line Coupling

Settings	Existing settings	Reviewed Settings	Remarks
Mut Coupl. Comp.	No		
Ena			

Protection Distance Units
Zone 1 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 1 Enable	No		
Direction	Forward		
Ground Reach	4.50Ohm		
Phase Reach	4.50Ohm		
Ground Resist Limit	8.49Ohm		
Phase Resist Limit	3.24Ohm		
Ground Time	0s		
Phase Time	0s		
Tilt Time	0s		
Tilt Angle Type	Calculated		
Tilt Angle	0º		

Zone 2 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 2 Enable	Yes		
Direction	Forward		
Ground Reach	6.80Ohm		
Phase Reach	6.80Ohm		
Ground Resist Limit	9.60Ohm		
Phase Resist Limit	4.42Ohm		
Ground Time	0.35s		
Phase Time	0.35s		

Zone 3 Units

Settings	Existing settings	Reviewed Settings	Remarks
Zone 3 Enable	Yes		
Direction	Forward		
Ground Reach	19.20Ohm		
Phase Reach	19.20Ohm		
Ground Resist Limit	10.49Ohm		
Phase Resist Limit	5.24Ohm		
Ground Time	0.8s		
Phase Time	0.8s		

Zone 4 Units

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Zone 4 Enable	Yes		
Direction	Reverse		
Ground Reach	1.05Ohm		
Phase Reach	1.05Ohm		
Ground Resist Limit	8.11Ohm		
Phase Resist Limit	3.28Ohm		
Ground Time	0.16s		
Phase Time	0.16s		

Zone 5 Units

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Zone 5 Enable	No		
Direction	Forward		
Ground Reach	25.00Ohm		
Phase Reach	25.00Ohm		
Ground Resist Limit	20.00Ohm		
Phase Resist Limit	20.00Ohm		
Ground Time	1.5s		
Phase Time	1.5s		

Characteristic

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Ground Characteristic	Quadrilateral		
Phase Characteristic	Quadrilateral		

Quadrilateral Characteristic Directional Angle

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Dir Characteristic			
Angle	78º	78º	78º

Close Onto Fault

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
COF Enable	Yes		
COF Sup Zone	Zone 2		

I COF Pick up	1.50A		
Z1 Ext. After Recl.	No		
2nd Harm. Restraint	0%		
COF Time	300ms		

Fuse Failure

Settings	Existing settings	Reviewed Settings	Remarks
FF Detec Enable	Yes		
FF Input DropOut Time	150ms		
FF Block Enable	Yes		
Voltage Level	30V		

Load Encroachment

Settings	Existing settings	Reviewed Settings	Remarks
Enable Load Encroach	No		
Right Area Resis Limit	325.00Ohm		
Left Area Resis Limit	325.00Ohm		
Right Area Angle	20º		
Left Area Angle	20º		

Power Swing Detector

Settings	Existing settings	Reviewed Settings	Remarks
PS Detec Enable	Yes		
PS Trip Enable	No		
Right Ext Resist Limit	50.00Ohm		
Right Med Resist Limit	25.00Ohm		
Right Int Resist Limit	5.00Ohm		
Left Ext Resist Limit	50.00Ohm		
Left Med Resist Limit	25.00Ohm		
Left Int Resist Limit	5.00Ohm		
Resist Limit Angle	75º		
Forward Ext Reach	50.00Ohm		
Forward Med Reach	25.00Ohm		
Forward Int Reach	5.00Ohm		
Reverse Ext Reach	50.00Ohm		
Reverse Med Reach	25.00Ohm		

Reverse Int Reach	5.00Ohm		
I1 Supervision	0.20A		
PS Detec Time	0.03s		
PS Block Reset Time	2s		
PS Trip Type	Slow trip		
Fast Trip Time	0.05s		
PS Cond Reset Time	0.05s		

Overcurrent Directional

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Phase Characteristic Angle	45º		
Neutr Characteristic Angle	45º		
NegSeq Characteristic Angle	45º		
PosSeq Characteristic Angle	45º		
Lack of direction blocking	No		
Min. Phase Voltage	0.2V		
Min. Neutr Voltage	0.2V		
0ms Neutr Volt. Comp.	0		
NegSeq Volt.Comp.	0		

Voltage
Voltage Restoration

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
Phase UV reset	105%		
Phase OV reset	95%		
Neutral OV reset	95%		

220 KV TBC SETTING RELAY MAIN-1

Settings	**Existing settings**	**Reviewed Settings**	**Remarks**
GENERAL SETTINGS			
CT Ratio Phase	600		
CTRN(IN) Neutral	600		

PT Ratio Phase	2000		
PTRS Synch Voltage(VS)PT Ratio	2000		
VNOM Phase Nominal Voltage L-N	63.51 Volt in secondary		
EADVS Advanced Settings	Y		
EBBPT Enable busbar PT LOP logic	N		
LINE SETTINGS AND FAULT LOCATOR			
Z1MAG Pos-Seq Line Impedance Mag.	13.71 ohm in secondary		
Z1ANG Pos-Seq Line Impedance Angle	78.30 degree		
Z0 MAG Zero-Seq Line Impedance Mag.	60.97 ohm in secondary		
Z0 MAG Zero-Seq Line Impedance Angle	82.79 degree		
LL Line Length	81.96 km		
EFLOC Fault Location	Y		
PHASE DISTANCE ELEMENT			
ECCVT CCVT Transient Detection	Y		
E21P Mho Phase Distance Element	4		
Mho Phase Distance Element Reach Settings			
Z1P Zone 1	10.97 ohm in secondary		
Z2P Zone 2	16.14 ohm in secondary		
Z3P Zone 3	1.43 ohm in secondary		
Z4P Zone 4	23.12 ohm in secondary		
Mho Phase Distance Overcurrent Fault Detector Settings			
50PP1 Zone 1 Phase-Phase Current FD	0.1 amp in secondary		
50PP2 Zone 2 Phase-Phase Current FD	0.1 amp in secondary		
50PP3 Zone 3 Phase-Phase Current FD	0.1 amp in secondary		
50PP4 Zone 4 Phase-Phase Current FD	0.1 amp in secondary		
GROUND DISTANCE ELEMENTS			
Mho Ground Distance Elements			
E21MG Mho Ground Distance Elements	4		
Z1MG Zone 1	10.97 ohm in secondary		
Z2MG Zone 2	16.81 ohm in secondary		
Z3MG Zone 3	1.43 ohm in secondary		
Z4MG Zone 4	23.6 ohm in secondary		
Quad Ground Distance Elements			
E21XG Quad Ground Distance Elements	4		
XG1 Zone1 Reactance	10.74 ohm in secondary		
XG2 Zone2 Reactance	16.14 ohm in secondary		
XG3 Zone3 Reactance	1.4 ohm in secondary		
XG4 Zone4 Reactance	23.12 ohm in secondary		
RG1 Zone 1 Resistance	12.24 ohm in secondary		
RG2 Zone 2 Resistance	14.26 ohm in secondary		
RG3 Zone 3 Resistance	11.39 ohm in secondary		

RG4 Zone 4 Resistance	14.82 ohm in secondary		
XGPOL Quad Ground Polarizing Quantity	I2		
TANG Non-Homogeneous Correction Ang(deg)	-3		
Quad and Mho Ground Distance Fault Detector Settings			
50L1 Zone1 Phase Current FD	0.1 amp in secondary		
50L2 Zone3 Phase Current FD	0.1 amp in secondary		
50L3 Zone3 Phase Current FD	0.1 amp in secondary		
50L4 Zone4 Phase Current FD	0.1 amp in secondary		
50Z1 Zone 1 Residual Current FD	0.1 amp in secondary		
50Z2 Zone 2 Residual Current FD	0.1 amp in secondary		
50Z3 Zone 3 Residual Current FD	0.1 amp in secondary		
50Z4 Zone 4 Residual Current FD	0.1 amp in secondary		
Zero Sequence Compensation (ZSC) Factor Settings			
k0M1 Zone1 ZSC Factor Mag.	0.678		
k0A1 Zone 1 ZSC Factor Ang(deg)	1.15 degree		
k0M Zones 2,3,4 ZSC Factor Mag	0.687		
k0A zones 2,3,4 ZSC Factor Ang(deg)	1.15 degree		
DISTANCE ELEMENT TIME DELAY SETTINGS			
Mho Phase Distance Element Time Delay Settings			
Z1PD Zone 1 Time Delay	0 ms		
Z2PD Zone 2 Time Delay	350 ms		
Z3PD Zone 3 Time Delay	160 ms		
Z4PD Zone 4 Time Delay	800 ms		
Quad and Mho Ground Distance Element Time Delay Settings			
Z1GD Zone 1 Time Delay	0 ms		
Z2GD Zone 2 Time Delay	350 ms		
Z3GD Zone 3 Time Delay	160 ms		
Z4GD Zone 4 Time Delay	800 ms		
Common Phase/Ground Dist. Element Time Delay Settings			
Z1D Zone 1 Time Delay	0 ms		
Z1l2D Zone 2 Time Delay	350 ms		
Z3D Zone 3 Time Delay	160 ms		
Z4D Zone 4 Time Delay	1000 ms		
PHASE OVERCURRENT ELEMENT			
E50P Phase	1		
Phase Instantaneous Overcurrent Elements			
501P Level 1	2 amp in secondary		
502P Level 2	OFF		
503P Level 3	OFF		
504P Level 4	OFF		
Phase Definite Time Overcurrent Elements			

67 P1D Level	0 ms		
67 P2D Level	0 ms		
67 P3D Level	0 ms		
67 P4D Level	0 ms		
RESIDUAL GROUND TIME OVERCURRENT ELEMENTS			
E51G Residual Ground	N		
NEGATIVE SEQUENCE TIME OVERCURRENT ELEMENTS			
E51Q Negative-Sequence	N		
BREAKER FAILURE SETTINGS			
E50BF Breaker Failure	Y		
50BFP Phase Fault Current Pickup	1.2 amp in secondary		
BFPU Breaker Failure Time Delay	180 ms		
RTPU Retrip Time Delay	60 ms		
Out-of-Step Settings			
EOOS Out-of-Step	Y		
OOSB 1 Block Zone 1	Y		
OOSB2 Block Zone 2	N		
OOSB3 Block Zone 3	N		
OOSB4 Block Zone 4	N		
OSBD Out-of-Step Block Time Delay	40 ms		
EOOST Enable Out-of-Step Tripping	N		
OSTD Out-of-Step Trip Time Delay	10 ms		
X1T6 zone 6 Reactive-Top	10.84 ohm in secondary		
X1T5 zone 5 Reactive-Top	8.67 ohm in secondary		
R1R6 zone 6 Resistive-Right	10.46 ohm in secondary		
R1R5 Zone 5 Resistive-Right	8.67 ohm in secondary		
X1B6 Zone 6 Reactive-Bottom	minus10.84 ohm in secondary		
X1B5 Zone 5 Reactive Bottom	minus 8.67 ohm in secondary		
R1L6 Zone 6 Resistive-Left	minus 10.46 ohm in secondary		
R1L5 Zone 5 Resistive-Left	minus 6.97 ohm in secondary		
50 ABCP Pos. Seq. Current Supv	0.2 amp in secondary		
UBD Neg-Seq. current unblock Delay	10 ms		
UBOSBF Out-of-Step Angle Change Unblock Rate	4		
LOAD ENCROACHMENT ELEMENT			

ELOAD Load Encroachment	Y		
ZLF Forward Load Impedance	41.17		
ZLR Reverse Load Impedance	41.17		
PALF Positive Forward Load Angle	36.87 degree		
NLAF Negative Forward Load Angle	minus 36.87 degree		
PLAR Positive Reverse Load Angle	150 degree		
NLAR Negative Reverse Load Angle	216.87 degree		
DIRECTIONAL ELEMENTS			
E32 Directional Control	AUTO		
ELOP Loss-of-Potential	Y		
DIR 3Level 3	R		
DIR 4Level 4	F		
ORDER Ground Dir, Priority(combo of Q,V,I)	QVI		
Z2F Forward Dir. Z2 Threshold	6.9 ohm in secondary		
Z2R Reverse Dir. Z2 Threshold	7.9 ohm in secondary		
50QFP Forward Dir. 3I2 Pickup	0.1 amp in secondary		
50QRP Reverse Dir. 3I2 Pickup	0.05 amp in secondary		
a2vPos-Seq Restrain Factor, I2/I1	0.1		
k2 Zero-Seq Restrain Factor I2/I0	0.2		
50 GFP Forward Dir.3I0 Pickup	0.1 amp in secondary		
50 GRP Reverse Dir. 3I0 Pickup	0.05 amp in secondary		
a0 Pos-Seq Restrain Factor, I0/I1	0.1		
Z0F Forward Dir. Z0 Threshold	30.5 ohm in secondary		
Z0R Reverse Dir. Z0 Threshold	31.5 ohm in secondary		
OTHER SETTINGS			
TDUR 1D Single-Pole Min. Trip Duration	180 ms		
TDUR 3D Three pole min. trip Duration	180 ms		
CFD Close Failure Time Delay	1200 ms		
VOLTAGE ELEMENTS			
EVOLT Voltage Elements	N		
SYNCHRONISM CHECK ELEMENT			
E25 Synchronism Check	N		
FREQUENCY ELEMENTS			
E81 Frequency Elements	N		
RECLOSING RELAY SETTINGS			
E79 Reclosures	1		
790I1 Open Interval	600 ms		
790I2 Open Interval	0 ms		

79OI3 Open Interval	0 ms		
79OI4 Open Interval	0 ms		
79RSD Reset Time from Reclose Cycle	200 ms		
79RSLD Reset Time from Lockout	25000 ms		
79CLSD Reclose Supv. Time Limit	100 ms		
SWITCH-ONTO-FAULT LOGIC			
ESOTF Switch-Onto-Fault Logic	Y		
EDDSOTF SOTF Disturbance Detector Supervision	Y		
CLOEND Close Enable Time Delay	20 ms		
52AEND 52A Enable Time Delay	OFF		
SOTFD SOTF Duration	120 ms		
ZONE 1 EXTENSION SETTINGS			
EZ1EXT Zone 1 Extension	N		

ICT 1T

160 MVA, 220/132 KV INTERCONNECTING TRANSFORMER

Detail Technical specifications of the 160 MVA Interconnecting Transformer:

Transformer:- 160 MVA, Rated Voltage-(at no load)-220kV/132kV, Rated Current- HV-420.38 LV-700.65, Frequency-50 Hz, Vector group-Yna0d11, Make- Bharat Bijlee.

Mechanical protection tripping and Annunciation healthiness ICT 1T:-

SI. No.	MECHANICAL PROTECTION	SETTINGS				
		ALARM	TRIP	ALARM	TRIP	DOT
1.	OTI	85	95			
2.	HVI WTI					
3.	LV WTI					
4.	BUCKHOLZ	Alarm	Trip			
5.	PRV		Trip			
6.	LOW OIL LEVEL	Alarm				
7.	SOURCE A SUPPLY	Alarm				

8.	**SOURCE B SUPPLY**	**Alarm**				
9.	**COOLER CONTROL SUPPLY**	**Alarm**				

List of electrical components installed in ICT-1T Transformer:-

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	02 Set
B	Numerical Protection relays	03 No.

A. Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Diff. Relay protection	MCR	Easun Reyrolle, CSC 326			YES	
2.		MCR	Easun Reyrolle, CSC 211			YES	
3.		MCR	Easun Reyrolle, CSC 211			YES	

ICT 1T

No	*Relay configuration - Power Transformers protections*					
1	Are used 2 groups of protections (Group A and Group B) for transformer protection?	Yes /No	No			
2	Are Group A and Group B protections connected to separate DC sources for power transformers?	Yes /No	No			
3	Do the Group A and Group B protections have separate lockout relays?	Yes /No	Yes			

	Details of type relays		Main	Back up		Other Protections
			-	HV	LV	
	Details of composite type numerical relays					
	Relay make and model		Easun Reyrolle, CSC 326	Easun Reyrolle, CSC 211	Easun Reyrolle, CSC 211	-
	Whether the relay is functional?	Yes /No	Yes	Yes	Yes	-
	Date of testing		19.12.2023	19.12.2023	19.12.2023	-
	Mention all the active protection		87T	67RYBN	67RYBN	-
	differential protections		Yes			-
	REF protection		Yes			-
4	Back-up directional O/C +E/F protection		No	Yes	Yes	-
	Overfluxing protection		Yes			-
	Connected to Trip Coil 1/Trip Coil2/Both		Both	Both	Both	-
	Feed from DC supply 1/DC supply2		DC Supply 2	DC Supply 2	DC Supply 2	-
	Breaker failure active	Yes /No	No	No	No	-
	Disturbance Reporder active	Yes /No	No	No	No	-
	Connected to dedicated CT core? Define CT core No.to which the relay is connected		Yes, Refer CT Audit details	Yes, Refer CT Audit details	Yes, Refer CT Audit details	
	CT ratio selected	Yes /No	500/1	500/1	800/1	
	Is CT supervision enabled or Not in case of Transformer differential protection ?	Yes /No	No			
5.1	Are all the Lock out relays (86) considered for Transformer protection provided with supervision relays (74/ 86) ?	Yes/No	Yes			
5.2	Provided with Trip Circuit supervision relays (95/TC-1 and 95/TC-2) ?	Yes/No	No			
6	Do the Transformer protection panels have supervision relays for DC supply-1 & DC supply-2 (74/DC-1 & 74/DC-2)?	Yes/No	Yes			
7	OTI/WTI working	Yes /No	Yes			
8	Bucholz/PRD working	Yes/No	Yes			
9	LA rating HV side	Yes/No	196kV			

10	LA rating IV side	Yes/No	120kV		
11	**Details of separate relays if applicable**				
	Relay 1 make and model		-		
	Functions available in Relay 1	Auto reclose/ Breaker Failure/ 67/67N/51/51N	-		
	Relay 1 Functional	Yes/ No	-		
	Date of Testing		-		

160 MVA ICT 1T RELAY SETTING			
	Existing Settings	Reviewed Settings	Remarks
Common parameters			
HV WIND CONN	Y-0 D-1		
MV WIND CONN	Y-0 D-1		
LV WIND CONN	Y-0 D-1		
VET GRP ANGLE	11		
SN	160 MVA		
HV UN	220 kV		
HV VT RATIO	2000		
HV 3U0 VT RATIO	2000		
HV CT PRIMARY	500 A		
HV CT SECONDARY	1.0 A		
HV NCT PRIMARY (REF)	500 A		
HV NCT SECONDARY (REF)	1.0 A		
HV NCT PRIMARY (BU)	1200 A		
HV NCT SECONDARY (BU)	1.0 A		
MV UN	132.0 kV		
MV VT RATIO	1200		
MV 3U0 VT RATIO	1200		
MV CT PRIMARY	800 A		
MV CT SECONDARY	1.0 A		
MV NCT PRIMARY (REF)	1200 A		
MV NCT SECONDARY (REF)	1.0 A		
MV NCT PRIMARY (BU)	1200 A		
MV NCT SECONDARY (BU)	1.0 A		
LV UN	11.0 kV		
LV VT RATIO	100		
LV CT PRIMARY	2500 A		
LV CT SECONDARY	1.0 A		
LV PRIMARY INSIDE DELTA	3000 A		
LV SECONDARY INSIDE DELTA	1.0 A		
	Existing Settings	**Recommended Settings**	**Remarks**
REF Set			
HV REF I0D	2.000 A		
HV REF SLOPE	0.5		
HV REF TRIP T	0.030 s		
HY REF ALARM I0D	2.000 A		

HV REF ALARM T	0.030 s		
MV REF I0D	2.000 A		
MV REF SLOPE	0.5		
MV REF TPIP T	0.030 s		
MV REF ALAEH I0D	2.000 A		
MV REF ALARM T	0.030 s		
HV Backup Settings			
HV OC I1	5.000 A		
T HV OC I1	0.500 s		
HV OC I2	5.000 A		
T HV OC I2 .	0.500 s		
IDMTL HV OC TimeMult	1		
IDMTL HV OC CRV SEL	1		
IDMTL HV OC I	5.0 A		
HV DIS PH-N X	10.0 Ohm		
HV DIS PH-N R	1 ohm		
HV DIS DFFSET RATIO	1		
HV K FACTOR	1		
T HV DIS PH-N	5.000 s		
HV DIS1 PH-PH X1	10 ohm		
HV DIS1 PH-PH R1	1 ohm		
HV DIS1 OFFSET RATIO	1		
T HV DIS2 PH-PH	5 s		
HV DIS2 PH-PH X2	10 ohm		
HV DIS2 PH-PH R2	1 ohm		
HV DIS2 OFFSET RATIO	1		
T HV DIS2 PH-PH	5 s		
HV NC IO1	10:00 AM		
T HV NC I01	5 s		
HV NC I02	10:00 AM		
T HV NC I02	5 s		
IDMTL HV NC TimeMult	1		
IDMTL HV NC CRV SEL	1		
IDMTL HV NC I0	5 amp		
HV 3U0 ALARM	100 V		
T HV 3U0 ALARM	5 s		
HV 3U0 TRIP	100 V		
T HV 3UO TRIP	5 s		
IDMTL HV NeuTimeMult	1		
IDMTL HV Neu CRV SEL	1		
IDMTL HV Neu IO	5 amp		
HV THERM OVLD I	0.924 A		
HV THERM Timeconst	10 s		

HV WeightFactor H/C	1		
HV OVLD I	2 amp		
HV BLK VOL REGU I	2 amp		
T HV BLK VOL REGU I	10 s		
T HV OVLD I	10 s		
MV Backup Settings			
MV OC I1	5.000 A		
T MV OC I1	0.500 s		
MV OC I2	5.000 A		
T MV OC I2 .	0.500 s		
IDMTL MV OC TimeMult	1		
IDMTL MV OC CRV SEL	1		
IDMTL MV OC I	5.0 A		
MV DIS PH-N X	10.0 Ohm		
MV DIS PH-N R	1 ohm		
MV DIS DFFSET RATIO	1		
MV K FACTOR	1		
T MV DIS PH-N	5.000 s		
MV DIS1 PH-PH X1	10 ohm		
MV DIS1 PH-PH R1	1 ohm		
MV DIS1 OFFSET RATIO	1		
T MV DIS2 PH-PH	5 s		
MV DIS2 PH-PH X2	10 ohm		
MV DIS2 PH-PH R2	1 ohm		
MV DIS2 OFFSET RATIO	1		
T MV DIS2 PH-PH	5 s		
MV NC IO1	10:00 AM		
T MV NC I01	5 s		
MV NC I02	10:00 AM		
T MV NC I02	5 s		
IDMTL MV NC TimeMult	1		
IDMTL MV NC CRV SEL	1		
IDMTL MV NC I0	5 amp		
MV 3U0 ALARM	100 V		
T MV 3U0 ALARM	5 s		
MV 3U0 TRIP	100 V		
T MV 3UO TRIP	5 s		
IDMTL MV NeuTimeMult	1		
IDMTL MV Neu CRV SEL	1		
IDMTL MV Neu IO	5 amp		
MV OVLD I	2 amp		
T MV OVLD I	10.00s		

LV Backup Settings			
LV OC I1	5.000 A		
T LV OC I1	0.500 s		
HLV OC II	5.000 A		
T LV OC I2 .	0.500 s		
IDMTL LV OC TimeMult	1		
IDMTL LV OC CRV SEL	1		
IDMTL LV OC I	5.0 A		
LV NC IO1	10:00 AM		
T LV NC I01	5 s		
LV NC I02	10:00 AM		
T LV NC I02	5 s		
IDMTL LV NC TimeMult	1		
IDMTL LV NC CRV SEL	1		
IDMTL LV NC I0	5 amp		
LV 3U0 ALARM	100 V		
T LV 3U0 ALARM	5 s		
LV 3U0 TRIP	100 V		
LV OVLD I	2 amp		
T LV OVLD I	10 s		
LWIND OVLD I	20 s		
T LWIND OVLD I	10 s		
DIFFERENTIAL SETTING			
INST DIFF ID	8.400 Amp		
PER DIFF ID	0.200 A		
DIFF IR1	0.840 A		
DIFF IR2	4.200 A		
DIFF SLOPE S1	0		
DIFF SLOPE S2	0.35		
DIFF 2ND HAR RATIO	0.2		
DIFF 5TH HAR RATIO	0.35		
Overflux Settings			
HV Ubase	63.51 V		
HV DEF V/F Alarn	1.1		
HV T DEF V/F Alarm	10.00 s		
HV DEF V/F Trip	1.2		
HV T DEF V/F Trip	3.000s		
HV T1 IVR V/F=1.10	90.00 s		
HV T2 IVR V/F=1.15	80.00 3		
HV T3 IYR V/F=I.20	70.00 3		

HV T4 IVR V/F=1.25	60.00 3		
HV T5 IVR V/F=1.30	50.00 3		
HV T6 IVR V/F-1.35	45.00 s		
HV T7 IVR V/F=1.40	40.00 s		
HV T8 IVR ?/F=1.45	35.00 s		
HV T9 IVR V/F=1.50	30.50 s		
HV T1O IVR V/F=1.55	25.00 s		
HV T11 IVR V/F=1.60	20.00 s		
HV T12 IVR V/F=1.65	15.00 s		
HYVT13 IVR V/F=1.70	10.00 s		
MV Ubase	57.30 v		
MV DEF V/F Alarm	1.1		
MV T DEF V/F Alarm	10.00s		
MV DEF V/F Trip	1.2		
MV T DEF V/F Trip	10.00 s		
MV T1 IVR V/F=1.10	90.00 s		
MV T2 IVR V/F=1.15	80.00 3		
MV T3 IYR V/F=I.20	70.00 3		
MV T4 IVR V/F=1.25	60.00 3		
HlMV T5 IVR V/F=1.30	50.00 3		
MV T6 IVR V/F-1.35	45.00 s		
MV T7 IVR V/F=1.40	40.00 s		
MV T8 IVR ?/F=1.45	35.00 s		
MV T9 IVR V/F=1.50	30.50 s		
MV T1O IVR V/F=1.55	25.00 s		
MV T11 IVR V/F=1.60	20.00 s		
MV T12 IVR V/F=1.65	15.00 s		
MV T13 IVR V/F=1.70	10.00 s		
CBF SETTING			
I HV CBF1	100.0 amp		
T HV CBF1	10.00s		
I HV CBF 2	100.0 amp		
T HV CBF2	10.00s		
OTHER SETTING			
HV1 I2 DET SET	8		
HV2 I2 DET SET	8		
MV1 I2 DET SET	8		
MV2 I2 DET SET	8		
T I2 DET	5		

TRIPPING DETAILS OF SWITCHYARD

S.No.	Date	Tripped Equipment	Time	AR operated or Not	Tripping details							
					Main#1				Main#2			
					Zone	Phase	Fault Distance (KM)	Fault Current	Zone	Phase	Fault Distance	Fault Current
1.	16.03.2023	Harduaganj Khurja Line-II	11:15 Hr		1	RYB	20.88	-	1	B	21.65	6.076 kA
2.	16.03.2023	Harduaganj Khurja Line-II	12:05 Hr		1	RYB	21.00	-	1	B	21.81	6.048 kA
3.	24.03.2023	Harduaganj Boner Line	20:02 Hr		2	RYB	-	-	2	Y	27.32	7.473 kA
4.	31.03.2023	Harduaganj TBC to (Rukhi)	21:20 Hr		1	B	21.57	5.726kA	1	-	-	-
5.	15.04.2023	Harduaganj to Jahangirabad Line-I	10:46 Hr		-	-	-	-	-	-	-	-
6.	20.04.2023	Harduaganj to Sikandrao Line	17:00 Hr		1	R	22.55	6.070kA	-	-	-	-
7.	25.04.2023	Harduaganj to Etah Line	23:44 Hr		1	B	10.42	10.513kA	-	-	-	-
8.	30.04.2023	Harduaganj to Sikandrao Line	17:11Hr		1	R	29.17	4.953kA	1	RYB	29.13	-
9.	12.05.2023	Harduaganj Boner Line	11:27Hr		1	RY	-	-	1	RY	3.12	32.806kA
10.	25.05.2023	Harduaganj to Sarsol Line-II (132kv)	21:12 Hr		1	RYB	8.570	3.620kA	-	-	-	-
11.	28.05.2023	Harduaganj TBC to (Rukhi)	04:44 Hr		1	B	35.30	3.738kA	-	-	-	-
12.	03.06.2023	Harduaganj to Jahangirabad Line-I	05:06 Hr		1	RYB	17.38	-	1	R	14.19	7.208 kA
13.	08.06.2023	Harduaganj to Anoopshare Road (132KV)	18:39 Hr		-	YB	-	2.546kA	-	-	-	-
14.	20.06.2023	Harduaganj TBC to (Rukhi)	14:01 Hr		1	B	-	-	1	B	34.55	3.954 kA
15.	27.06.2023	Harduaganj to Sarsol Line-I (132kv)	11:57 Hr		1	RYB	4.48	3.947kA	-	-	-	-
16.	30.06.2023	Harduaganj TBC to (Rukhi)	21:25 Hr		1	R	-	-	1	R	-	3.875 kA

17.	01.07.2023	Harduaganj to Etah Line	08:01 Hr		1	B	4.13	14.588kA		-	-	-	-	
18.	02.07.2023	Harduaganj to Sarsol Line-I (132kv)	03:17 Hr		1	YB	3.254	5.072kA		-	-	-	-	
19.	08.07.2023	Harduaganj to Sarsol Line-II (132kv)	20:08 Hr		1	RYB	3.164	4.242kA		-	-	-	-	
20.	11.07.2023	Harduaganj TBC to (Rukhi)	09:21 Hr		1	B	38.25	3.643kA		-	-	-	-	
21.	14.07.2023	Harduaganj TBC to (Rukhi)	14:04 Hr		1	RY	-	-		1	RY	61.28	5.446kA	
22.	20.07.2023	Harduaganj Khurja Line-I	10:55 Hr		1	R	40.673	-		1	R	34.84	4.142kA	
23.	21.07.2023	Harduaganj TBC to (Rukhi)	04:25 Hr		1	R	34.206	4.596kA		1	R	20.15	6.175kA	
24.	28.07.2023	Harduaganj Khurja Line-II	04:30 Hr		1	Y	12.82	8.603kA		1	RYB	-	-	
25.	03.08.2023	Harduaganj to Sarsol Line-II (132kv)	18:30 Hr		1	Y	4.045	4.558kA		-	-	-	-	
26.	10.08.2023	Harduaganj Khurja Line-I	12:41 Hr		1	R	30.88	-		1	R	30.32	4.097kA	
27.	13.08.2023	Harduaganj to Jahangirabad Line-I	03:25 Hr		1	R	15.44	-		1	R	12.51	7.922kA	
28.	22.08.2023	Harduaganj to Etah Line	15:13 Hr		1	YB	23.65	13.304kA		-	-	-	-	
29.	23.08.2023	Harduaganj to Sarsol Line-I (132kv)	06:10 Hr		1	R	3.795	5.109kA		-	-	-	-	
30.	24.08.2023	Harduaganj to Etah Line	18:14 Hr		1	R	44.61	3.886kA		-	-	-	-	
31.	06.09.2023	Harduaganj to Etah Line	04:56 Hr		1	B	46.40	3.710kA		-	-	-	-	
32.	11.09.2023	Harduaganj Boner Line	19:50 Hr	A.R.	1	B	10.465	-		1	B	10.49	12.858kA	
33.	13.09.2023	Harduaganj TBC to (Rukhi)	01:29 Hr		1	R	31.68	4.286kA		-	-	-	-	
34.	17.09.2023	Harduaganj TBC to (Rukhi)	09:09 Hr		1	R	-	-		1	R	1.5	26.790kA	
35.	17.09.2023	Harduaganj TBC to (Rukhi)	19:31 Hr		1	B	35.27	3.807kA		-	-	-	-	

36.	24.09.2023	Harduaganj TBC to (Rukhi)	06:11 Hr		1	B	-	-		1	B	35.36	4.178 kA	
37.	25.09.2023	Harduaganj TBC to (Rukhi)	00:29 Hr		1	R	37.63	3.677kA		-	-	-	-	
38.	25.09.2023	Harduaganj to Sikandrao Line	12:53 Hr		-	-	-	-		1	B	30.14	3.961 kA	
39.	29.09.2023	Harduaganj Boner Line	20:41 Hr		3	B	4.58	5.285kA		-	-	-	-	
40.	29.09.2023	Harduaganj TBC to (Rukhi)	20:41 Hr		1	RYB	16.57	583A		1	B	-	9.837 kA	
41.	08.10.2023	Harduaganj TBC to (Rukhi)	05:44 Hr		-	-	-	-		1	B	37.25	2.779 kA	
42.	12.10.2023	Harduaganj to Sarsol Line-II (132kv)	14:08 Hr		4	RYB	1.527	-		-	-	-	-	
43.	13.10.2023	Harduaganj TBC to (Rukhi)	01:35 Hr		-	-	-	-		1	B	30.89	3.178 kA	
44.	13.10.2023	Harduaganj TBC to (Rukhi)	04:59 Hr		1	B	-	-		1	B	30.92	3.241 kA	
45.	14.10.2023	Harduaganj to Jahangirabad Line-I	23:24 Hr		1	RYB	36.25	-		1	R	31.54	3.830 kA	
46.	17.10.2023	Harduaganj to Sarsol Line-I (132kv)	20:11 Hr		4	B	1.844	9.002kA		-	-	-	-	
47.	19.10.2023	Harduaganj to Sikandrao Line	09:26 Hr		-	-	-	-		1	B	19.38	6.226 kA	
48.	21.10.2023	Harduaganj Khurja Line-I	13:36 Hr	AR	1	R	-	-		1	R	22.44	5.726 kA	
49.	26.10.2023	Harduaganj to Jahangirabad Line-I	23:26Hr		1	B	18.63	-		1	B	15.50	6.752 kA	
50.	27.10.2023	Harduaganj to Sarsol Line-II (132kv)	18:26 Hr		1	RYB	6.087	-		-	-	-	-	
51.	27.10.2023	Harduaganj to Sarsol Line-II (132kv)	20:54 Hr		1	B	6.236	4.179kA		-	-	-	-	
52.	07.11.2023	Harduaganj to Etah Line	13:36 Hr		1	R	60.42	2.957kA		-	-	-	-	
53.	07.11.2023	Harduaganj to Etah Line	22:46 Hr	AR	1	B	43.29	3.964kA		-	-	-	-	

54.	20.11.2023	Harduaganj Khurja Line-I	04:38 Hr		1	B	-	-		1	B	35.52	4.777 kA	
55.	02.12.2023	Harduaganj Khurja Line-I	03:46 Hr		2	R	-	-		-	-	-	-	
56.	17.12.2023	Harduaganj TBC to (Rukhi)	00:15 Hr		1	RY	31.66	8.570kA		-	-	-	-	
57	27.12.2023	Harduaganj Boner Line	03:02 Hr		1	R	-	-		1	R	-	-	

132 KV Harduaganj- Sarsol-1 feeder:-

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	01 Set
B	Numerical Protection relays	01 No.

CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	CLASS	Knee point voltage	Sec Res	Remark
1	132 KV switchyard	CT-1	CORE-1	400/1	PS			
			CORE-2	400/1	PS			
			CORE-3	400/1	0.2			

Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Feeder Distance protection Relay	MCR	Alstom Mi-Com			YES	

132 KV Harduaganj-Sarsol-1 Bay (73) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 73	132 KV Harduaganj-Sarsol-1 BAY	Lightning arrestor	3
			Current transformer	3
			Isolators	3 set
			Earth switch	N/A
			Circuit breaker	3

LINE SETTING HARDUAGANJ SARSOL CKT1 LINE			
CONFIGURATION		**Recommended**	**Remark**
Settings Group 1	Enabled		
Settings Group 2	Disabled		
Settings Group 3	Disabled		
Settings Group 4	Disabled		
Dist. Protection	Enabled		
Power- Swing	Disabled		
Back-up I>	Disabled		
Neg Sequence O/C	Disabled		
Broken Conductor	Disabled		
Earth Fault PROT	Disabled		
Aided D.E.F	Disabled		
Volt Protection	Enabled		
CB Fail & I<	Disabled		
Supervision	Enabled		
System Checks	Disabled		
Thermal Overload	Disabled		
Internal A/R	Disabled		
GENERAL SETTINGS			
Phase CT Primary	400 A		
Phase CT Sec'y	1.000 A		
Mcomp CT Primary	400 A		
Mcomp CT Sec'y	1.000 A		
CT Ratio Phase	400		
CTRN(IN) Neutral	400		
Main VT Primary	132 KV		
Main VT Sec'y	110 V		
C/S VT Primary	132 KV		

C/S VT Secondry	110 V		
PT Ratio Phase	1200		
PTRS Synch Voltage(VS)PT Ratio	1200		
VNOM Phase Nominal Voltage L-N(V,sec)	63.51		
C/S Input	A-N		
Main VT location	Bus		
DISTANCE ELEMENT			
LINE SETTINGS			
Line Length	15.34 Km		
Line Impedance	2.234 Ohm		
Line Angle	68.5 Degree		
Zone Settings			
kZ1 Res Comp	0.667		
kZ1 Angle	12 degree		
Z1	1.793 Ohm		
Z1X	15.00 Ohm		
R1G	8.980 Ohm		
R1Ph	10.00 Ohm		
tZ1	0.00 sec		
kZ2 Res comp	0.667		
kZ2 Angle	12.00 degree		
Z2	2.689 Ohm		
R2G	9.150 Ohm		
R2Ph	20.00 Ohm		
tZ2	350.0 msec		
kZ3/4 Res Comp	0.667		

kZ3/4 Angle	12.00 Degree		
Z3	8.734 Ohm		
R3G-R4G	9.150 Ohm		
R3Ph-R4Ph	30.00 Ohm		
tZ3	1.000 Sec		
Z4	448.0 ohm		
tZ4	160.0 msec		
Serial Cmp. Line	Disabled		
Overlap Z mode	Disabled		
Z1m Tilt Angle	0.000 Degree		
Z1p tilt Angle	0.000 Degree		
Z2/Zp Tilt Angle	0.000 Degree		
Fwd z chgt Delay	30.00 msec		
kzm Mutual comp	0		
kZm Angle	0		
DISTANCE SCHEMES			
Standard Mode	P.U.P Z2		
Fault type	Both enabled		
Trip Mode	1P. Z1 & CR		
tReversal guard	20.00 ms		
SOTF Delay	10.00 s		
Z1Ext fail	Disabled		
Weak Infeed: Mode Status	Disabled		
VOLT PROTECTION			
V<Measur't Mode	Phase_Phase		
V<1 Function	DT		
V<1 Voltage set	92.00 V		
V<1 Time Delay	5.000 s		

V<2 Status	Enabled		
V<2 Voltage Set	92.00 V		
V<2 Time Delay	5.00 s		
Overvoltage			
V>Measur't mode	Phase_Neutral		
V>1 Function	DT		
V>1 Voltage set	185.0 V		
V>1 Time Delay	10.00 sec		
V>2 status	Enabled		
V>2 Volage Set	185.0 V		
V>2 Time Delay	35.54 sec		
VT SUPERVISION			
VTS Time Delay	1.00 s		
VTS I2 & I0 Inh	50.00 mA		
Detect 3P	Disabled		
CTS Status	Disabled		
CVTS Status	Disabled		

132 KV Harduaganj- Sarsol-2 feeder:-

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	01 Set
B	Numerical Protection relays	01 No.

CURRENT TRANSFORMER

Sl. No.	**Location of CT**	**CT Designation**	**CT Ratio**	**Ratio adopted**	**CLASS**	**Knee point voltage**	**Sec Res**	**Remark**
1	132 KV switchyard	CT-1	CORE-1	400/1	PS			
			CORE-2	400/1	PS			
			CORE-3	400/1	0.2			

Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Feeder Distance protection Relay	MCR	Alstom MiCom			YES	

132 KV Harduaganj-Sarsol-2 Bay (74) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 74	132 KV Harduaganj-Sarsol-2 BAY	Lightning arrestor	3
			Current transformer	3
			Isolators	3 set
			Earth switch	N/A
			Circuit breaker	3

LINE SETTING HARDUAGANJ SARSOL CKT-2 LINE			
CONFIGURATION		**Recommended**	**Remark**
Settings Group 1	Enabled		
Settings Group 2	Disabled		
Settings Group 3	Disabled		
Settings Group 4	Disabled		
Dist. Protection	Enabled		
Power- Swing	Disabled		
Back-up I>	Disabled		
Neg Sequence O/C	Disabled		
Broken Conductor	Disabled		
Earth Fault PROT	Disabled		
Aided D.E.F	Disabled		
Volt Protection	Enabled		

CB Fail & I<	Disabled		
Supervision	Enabled		
System Checks	Disabled		
Thermal Overload	Disabled		
Internal A/R	Disabled		
GENERAL SETTINGS			
Phase CT Primary	400 A		
Phase CT Sec'y	1.000 A		
Mcomp CT Primary	400 A		
Mcomp CT Sec'y	1.000 A		
CT Ratio Phase	400		
CTRN(IN) Neutral	400		
Main VT Primary	132 KV		
Main VT Sec'y	110 V		
C/S VT Primary	132 KV		
C/S VT Secondry	110 V		
PT Ratio Phase	1200		
PTRS Synch Voltage(VS)PT Ratio	1200		
VNOM Phase Nominal Voltage L-N(V,sec)	63.51		
C/S Input	A-N		
Main VT location	Bus		
DISTANCE ELEMENT			
LINE SETTINGS			
Line Length	15.34 Km		
Line Impedance	2.234 Ohm		
Line Angle	68.5 Degree		
Zone Settings			

kZ1 Res Comp	0.667		
kZ1 Angle	12 degree		
Z1	1.793 Ohm		
Z1X	15.00 Ohm		
R1G	8.980 Ohm		
R1Ph	10.00 Ohm		
tZ1	0.00 sec		
kZ2 Res comp	0.667		
kZ2 Angle	12.00 degree		
Z2	2.689 Ohm		
R2G	9.150 Ohm		
R2Ph	20.00 Ohm		
tZ2	350.0 msec		
kZ3/4 Res Comp	0.667		
kZ3/4 Angle	12.00 Degree		
Z3	8.734 Ohm		
R3G-R4G	9.150 Ohm		
R3Ph-R4Ph	30.00 Ohm		
tZ3	1.000 Sec		
Z4	448.0 ohm		
tZ4	160.0 msec		
Serial Cmp. Line	Disabled		
Overlap Z mode	Disabled		
Z1m Tilt Angle	0.000 Degree		
Z1p tilt Angle	0.000 Degree		
Z2/Zp Tilt Angle	0.000 Degree		
Fwd z chgt Delay	30.00 msec		
kzm Mutual comp	0		

kZm Angle	0		
DISTANCE SCHEMES			
Standard Mode	P.U.P Z2		
Fault type	Both enabled		
Trip Mode	1P. Z1 & CR		
tReversal guard	20.00 ms		
SOTF Delay	10.00 s		
Z1Ext fail	Disabled		
Weak Infeed: Mode Status	Disabled		
VOLT PROTECTION			
V<Measur't Mode	Phase_Phase		
V<1 Function	DT		
V<1 Voltage set	92.00 V		
V<1 Time Delay	5.000 s		
V<2 Status	Enabled		
V<2 Voltage Set	92.00 V		
V<2 Time Delay	5.00 s		
Overvoltage			
V>Measur't mode	Phase_Phase		
V>1 Function	DT		
V>1 Voltage set	185.0 V		
V>1 Time Delay	10.00 sec		
V>2 status	Enabled		
V>2 Volage Set	185.0 V		
V>2 Time Delay	22.13 sec		
VT SUPERVISION			
VTS Time Delay	2.00 s		

VTS I2 & I0 Inh	50.00 mA		
Detect 3P	Disabled		
CTS Status	Disabled		
CVTS Status	Disabled		

132 KV Harduaganj- Anupshahr Road feeder:-

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	01 Set
B	Numerical Protection relays	01 No.

CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	CLASS	Knee point voltage	Sec Res	Remark
1	132 KV switchyard	CT-1	CORE-1	300/1	0.2 S			
			CORE-2	300/1	5P20			
			CORE-3	300/1	10P20			
			CORE-4	800/1	10P20			
			CORE-5	800/1	10P20			

Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	Feeder Distance protection Relay	MCR	Alstom MiCom			YES	
2.	Directional O/C & E/F Relay	MCR	Alstom MiCom			YES	

132 KV Harduaganj-Anupshahr Road Bay (72) Description:-

SI. NO.	BAY No.	Detail	Auxiliaries installed	Qty.
1	BAY 72	132 KV Harduaganj-AnupShahr Road BAY	Lightning arrestor	3
			Current transformer	3
			Isolators	2 set
			Earth switch	N/A
			Circuit breaker	3

LINE SETTING HARDUAGANJ - Anupshahr Road LINE			
Distance Relay			
CONFIGURATION		**Recommended**	**Remark**
Settings Group 1	Enabled		
Settings Group 2	Disabled		
Settings Group 3	Disabled		
Settings Group 4	Disabled		
Dist. Protection	Enabled		
Power- Swing	Enabled		
Back-up I>	Disabled		
Neg Sequence O/C	Disabled		
Broken Conductor	Enabled		
Earth Fault PROT	Disabled		
Aided D.E.F	Disabled		
Volt Protection	Disabled		
CB Fail & I<	Disabled		
Supervision	Enabled		
System Checks	Disabled		
Thermal Overload	Disabled		

I< Protection	Disabled		
Residual O/U NVD	Disabled		
Freq Protection	Disabled		
Internal A/R	Disabled		
CT AND VT RATIOS			
Phase CT Primary	300 A		
Phase CT Sec'y	1.000 A		
Mcomp CT Primary	1.000 A		
Mcomp CT Sec'y	1.000 A		
CT Ratio Phase	300		
Main VT Primary	132 KV		
Main VT Sec'y	110 V		
4th VT Primary	110 V		
4th VT Secondry	110 V		
PT Ratio Phase	1200		
VNOM Phase Nominal Voltage L-N(V,sec)	63.51		
C/S Input	A-N		
Main VT location	Line		
CT polarity	Standard		
DISTANCE ELEMENT			
LINE SETTINGS			
Line Length	5.400 Km		
Line Impedance	591.0 mOhm		
Line Angle	68.7 Degree		
Zone Settings			
kZ1 Res Comp	667.0m		
kZ1 Angle	0 degree		
Z1	470.0 mOhm		

R1G	3.920 Ohm		
R1Ph	1.420 Ohm		
tZ1	0.00 sec		
kZ2 Res comp	667.0m		
kZ2 Angle	0.00 degree		
Z2	3.110 Ohm		
R2G	4.890 Ohm		
R2Ph	2.380 Ohm		
tZ2	300.0 msec		
kZ3/4 Res Comp	667.0m		
kZ3/4 Angle	0.00 Degree		
Z3	6.639 Ohm		
R3G-R4G	6.170 Ohm		
R3Ph-R4Ph	3.670 Ohm		
tZ3	800 mSec		
Z4	111.0 mohm		
tZ4	200.0 msec		
Serial Cmp. Line	Disabled		
Overlap Z mode	Disabled		
Z1m Tilt Angle	0.000 Degree		
Z1p tilt Angle	0.000 Degree		
Z2/Zp/q Tilt Angle	0.000 Degree		
Fwd z chgt Delay	30.00 msec		
V Mem Validity	10.00 s		
Earth I detect.	50.00 mA		
kzm Mutual comp	0		
kZm Angle	0		

DISTANCE SCHEMES			
Standard Mode	Basic + Z1X		
Fault type	Both enabled		
Trip Mode	Force 3 poles		
tReversal guard	20.00 ms		
SOTF Delay	10.00 s		
Z1Ext fail	Disabled		
Weak Infeed: Mode Status	Disabled		
Loss of load : Mode Status	Disabled		
Power - Swing			
Delta R	3.00 Ohm		
Delta X	3.00 Ohm		
IN> Status	Enabled		
IN> (%Imax)	40.00%		
I2> Status	Enabled		
I2> (%Imax)	30.00%		
ImaxLine> status	Enabled		
ImaxLine >	3.00 A		
Delta I Status	Enabled		
Unblocking Delay	2.00 sec		
Out of step	1		
Stable Swing	1		
Broken Conductor			
Broken conductor	Enabled		
I2/I1 Setting	200.0m		
I2/I1 Time delay	5.000 sec		
I2/I1 Trip	Disabled		

VT SUPERVISION			
VTS Time Delay	5.00 s		
VTS I2 & I0 Inh	50.00 mA		
Detect 3P	Disabled		
CTS Status	Disabled		
CVTS Status	Disabled		
Directional O/C & E/F Relay			
Configuration			
Setting Group 1	Enabled		
Setting Group 2	Disabled		
Setting Group 3	Disabled		
Setting Group 4	Disabled		
Overcurrent	Disabled		
Neg Sequence O/C	Disabled		
Broken Conductor	Disabled		
Earth Fault 1	Disabled		
Earth Fault 2	Enabled		
SEF/REF Prot'n	Disabled		
Residual O/V NVD	Disabled		
Thermal Overload	Disabled		
Neg Sequence O/V	Disabled		
Cold Load Pickup	Disabled		
Selective Logic	Disabled		
Admit Protection	Disabled		
Power Protection	Disabled		
Volt Protection	Disabled		
Freq Protection	Disabled		

CB Fail	Disabled		
Supervision	Enabled		
Fault Locator	Disabled		
System Checks	Disabled		
Auto - Reclose	Disabled		
CT AND VT RATIOS			
Phase CT Primary	300 A		
Phase CT Sec'y	1.000 A		
E/F CT Primary	300.0 A		
E/F CT Secondry	1.000 A		
SEF CT Primary	1.00 A		
SEF CT Secondry	1.00 A		
CT Ratio Phase	400		
Main VT Primary	132 KV		
Main VT Sec'y	110 V		
C/S VT Primary	132.0 KV		
C/S VT Secondry	110 V		
PT Ratio Phase	1200		
VNOM Phase Nominal Voltage L-N(V,sec)	63.51		
C/S Input	A-N		
Main VT location	Line		
C/S V kSM	1		
C/S Phase kSA	0.000 Degree		
EARTH FAULT 2			
IN2> Input	Drived		
IN2>1 Function	IEC S Inverse		
IN2>1 Direction	Directional Fwd		
IN2> 1 Current	200.0 mA		

IN2>1 TMS	200.0 m		
IN2>1 DT Adder	0.00 s		
IN2>1 tReset	0.00 s		
IN2 > 2 Function	Disabled		
IN2 > 3 Status	Disabled		
IN2 > 4 Status	Disabled		
IN2 > POL			
IN2 > Char Angle	-45.00 Degree		
IN2 > POL	Zero Sequence		
IN2 > Vnpol Set	5.00 V		
CB FAIL & I <			
CB FAIL & I <	Under Current		
I < Current Set	100.0 mA		
ISEF < Current	20.00 mA		
VT Supervision			
VTS Status	Block		
VTS Reset Mode	Manual		
VTS Time Delay	5.00 s		
VTS I > Inhibit	10.00 A		
VTS I2 > Inhibit	50.00 mA		

OBSERVATIONS:

As a general finding from this audit. It is observed that

1. 220 kV/132kV C_TPS substation equipments are well protection as per Northern region Power Committee recommendation.
2. All 220 kV lines have independent main-1 and main-2 functional Numerical protection.
3. BBRP of 220kV Substation is not functional.
4. 160MVA, 220/132kV ICT-1T & STs are well protected as per guidelines.
5. The state of DC supply at substation inspected and found in order.
6. Time Functionality of GPS/TSU, circuit breaker, relay testing reports is also inspected, and all are found in satisfactory state.
7. One number DC source of switchyard is out of service as its battery bank is very old 2006 make.
8. Circuit Breaker of 220 KV Harduaganj-Rukhi feeder is in damaged condition, being fed by bypass circuit breaker at present.
9. Only one 220/132 KV, 160 MVA ICT is available to feed 132 KV switchyard, other ICT got damaged in 2021.
10. PLCC system of 220 KV Harduaganj- Etah is out of service, due to damage in its cards.
11. One no. distance protection relay of 220 KV Harduaganj- Etah is defective.
12. Event logger, Substation Automation System (SAS) , Disturbance recorder etc. are not available in MCR of 220/132 KV switchyard.
13. The control panels of all bays are very old style and not compatible with SAS.
14. PMU of 220 KV Harduaganj-Rukhi feeder and Harduaganj-Jahangirabad feeder is not available, it is under procurement.
15. Forward Zone (3) is defined as Z4 and Reverse Zone (4) is defined as Z3 in all MAIN-II (SEL make) relays of 220 KV feeders.
16. Single line diagram (SLD) of ACDB and DCDB not available.

Internal Protection Audit Report

of

400kV Switchyard,

ICTs, STs & Bus Reactor,

of

‘E’ Thermal Power Station,

Harduaganj Thermal Power Plant, Kasimpur, Aligarh

Annexure–1

(1)Protection system checklist:

(a) General Information:

S. No	Particular	Detail
1	Substation name	400kV EHV Switchyard Harduaganj Ex-II
2	Name of Owner Utility	U. P. Rajya Vidyut Utpadan Nigam LTD.
3	Voltage Level (s) or highest voltage level	420kV
4	Date of commissioning of the substation	02.09.2019
5	Checking and validation date	30.04.2024
6	Previous Relay Test Reports	Available
7	SPS scheme implemented (if any)	NA

(i) Short circuit current rating of all equipment (for all voltage level) :

S. No	Voltage level	Equipment	Short circuit current rating
1	**400kV**	Circuit Breaker	50kA
2		Current transformer	50kA
3		CVT	50kA
4		Isolators	50kA
5		Lightening Arrester	
6	**220kV (Concerned Bays of ICTs)**	Circuit Breaker	40kA
7		Current transformer	40kA
8		CVT	40kA
9		Isolators	40kA
11		Lightening Arrester	40kA

(ii) **Record of previous tripping's (in last one year) and details of protection operation**

S. No	Date	Tripped Equipment	Time	AR operated or Not	Tripping details									
					Main#1					Main#2				
					Zone	Phase	Fault Distance	Fault Current	DTPC Signal	Zone	Phase	Fault Distance	Fault Current	DTPC Signal
1.	06/02/2023	Harduaganj-Sikandrabad Line 1	2:20Hr	AR operated	Gen Trip Zone-1	B-Ph	39.65km	4.69kA	CR Tx-01					
2.	07/04/2023	Harduaganj-Aligarh Line2	15:48Hr		Gen Trip Zone-1	R,Y-Ph	24.59km	10.183kA	DTPC CH 1: Tx01,	Gen Trip Zone-1	R,Y-Ph			CH 2:Tx-01 & Rx -01
3.	11/04/2023	Harduaganj-Sikandrabad Line 1	00:46Hr	AR operated	Gen Trip Zone-1	B-Ph	48.9km	5.228kA	DTPC CH-1: Tx01,Rx-00					Ch-2: Tx-01, Rx-00
4.	16/04/2023	Harduaganj-Sikandrabad Line 1	20:40Hr	AR operated										
5.	05/05/2023	Harduaganj-Sikandrabad Line 1	21:43Hr	AR operated	Gen Trip Zone-1	B-Ph	46.7 km	5.54kA						
6.	10/05/2023	Harduaganj-Sikandrabad Line 1		AR operated	Gen Trip Zone-1	B-Ph	80.06km	3.51kA		Gen Trip Zone-1	B-Ph	79.36km	3.528kA	
7.	16/06/2023	Harduaganj-Sikandrabad Line 1	20:38Hr		Gen Trip Zone-1 86A&86B	B-Ph	46.57km	5.63kA	DRPC Main-1 CR Tx=02 Rx=00 DT Tx=00 Rx=	Gen Trip SOTF trip		47.2km	5.91kA	DRPC Main-2 CR Tx=02 Rx=00 DT Tx=00 Rx=
8.	10/07/2023	Harduaganj-Aligarh Line2	08:46Hr		86 A &B Operated (CH2_DT Received)				DTPC counter Main-1 DT Rx=07					Main2 DT Rx
9.	09/08/2023	Harduaganj-Sikandrabad Line 1	17:10Hr		86 A &B Operated (CH2_DT Received)				DT-Rx=01					DT Rx=01
10.	11/08/2023	Harduaganj-Sikandrabad Line 1	21:52Hr		Gen Trip Zone-1	B-Ph	82.37 km	3.399kA	CR Tx=01	Gen Trip Zone-1	B-Ph	82.6 km	3.40kA	CR Tx=01
11.	03/09/2023	Harduaganj-Sikandrabad Line 1	00:49Hr	AR operated	Gen Trip Zone-1	Y-Ph	84.6 km							
12.	06/10/2023	Harduaganj-Sikandrabad Line 1	02:16Hr	AR operated	Gen Trip Zone-1	B-Ph	83.52 km	3.44kA		Gen Trip Zone-1	B-Ph			
13.	12/10/2023	ICT-2	14:09Hr		86A&86B operated SBEF	Y-Ph								
14.	21/10/2023	Harduaganj-Sikandrabad Line 1	03:39Hr	AR operated	Gen Trip Zone-1	B-Ph	106.93km	2.59kA		Gen Trip Zone-1	B-Ph	107.3km	3.94kA	
15.	23/10/2023	Harduaganj-Sikandrabad Line 1	02:45Hr	AR operated	Gen Trip Zone-1	Y-Ph	108.6 km	2.646 KA		Gen Trip Zone-1	Y-Ph	108.6 km	4.14 KA	
16.	26/10/2023	Harduaganj-Sikandrabad Line 1	23:33Hr	AR operated	Gen Trip Zone-1	B-Ph	79.19 km	3.460kA		Gen Trip Zone-1	B-Ph	80.5 km	3.44kA	

17.	07/11/2023	Harduaganj-Sikandrabad Line 1	23:57Hr		GEN TRIP, Zone-1 Trip 86A and 86B operated	RPH Y-PH B-PH			Main-1 C R Tx=02,	GEN TRIP, Zone-1 Trip	R-PH Y-PH B-PH			Main-2 CR Tx=03
18.	26/12/2023	Harduaganj-Sikandrabad Line 1		AR operated	Gen Trip Zone-1	R-Ph	114.09km	2.492kA	Main-1 CR Tx=01 DT Rx=01					Main-2 CR Tx=01
19.	28/12/2023	Harduaganj-Sikandrabad Line 1	06:26Hr		Gen Trip Zone-1	Y-Ph B-Ph	77.7 km(Y-Ph) 111.9km(B-Ph)	2.434kA	Main-1 CR Tx=01				4.100kA	DRPC Main#1 C R TX=02

(iii) Overall single line diagram (SLD) -Attached

(iv) AC aux SLD -Attached

(v) DC aux SLD -Attached

(vi) SAS architecture diagram -Attached

(b) **The preliminary report shall inter-alia contain the following:**

TABLE A: FORMAT OF PRELIMINARY REPORT		
S. No.	**Issues**	**Remarks**
1	Recommendation of last protection checking and validation	NA
2	Review of existing settings at substation	NA
3	Disturbance Recorder out available for last 6 tripping's (Y/N)	N
4	Chronic reason of tripping, if any	NA
5	Major non-conformity/deficiency observed	NA

(i) Current Transformer Details

S. No.	Particulars	Details
1	Manufacturer	ABB
2	Date of Mfg. Month/year	Oct-2017
3	CT ratio:	3000-2000-1000-500/1-1-1-1-1A
4	Type:	Oil filled outdoor single phase Hermetically sealed
5	Tank Design:	Dead Tank Type
6	Rated voltage:	400kV(rms)
7	High system voltage:	420kV(rms)
8	Rated primary current:	3000A
9	Ratedsecondarycurrent:	1A
10	Short time with stand current:	50kA(rms)
11	Number of cores for CT:	5
12	Current ratio:	Core 1&2:3000-2000-1000/1-1 Core 3,4&5:3000-2000-1000-500/1-1-1
13	Output burden:	20VAOn all taps for metering cores
14	Accuracy class:	PS: 1,2,4&5,0.2S: for meteringcores3
15	Knee point voltage at different taps:	3000@3000/1, 2000@2000/1,1000@1000/1,500@500/1
16	Maximum excitation current at knee point Voltage at different ratios:	20@3000/1,30@2000/1, 60@1000/1,120@500/1
17	Instrument security factor at different ratios:	<5 For Metering Core at lowest Tap & Using aux .CT
18	Degree of protection:	IP55
19	Internal insulation:	Oil
20	Insulation class:	A

(ii) Details of Primary Connection For Ratio Selection

Primary			Secondary									
AMPS	RECONN/ LINK CONN	Terminals	CORE 1		CORE 2		CORE 3		CORE 4		CORE 5	
			A	CONN	A	CONN	A	CONN	A	CONN	A	CONN
3000		P1-P2	1.0	1S1-1S4	1.0	2S1-2S4	1.0	3S1-3S5	1.0	4S1-4S5	1.0	5S1-5S5
2000			1.0	1S1-1S3	1.0	2S1-2S3	1.0	3S1-3S4	1.0	4S1-4S4	1.0	5S1-5S4
1000			1.0	1S1-1S2	1.0	2S1-2S2	1.0	3S1-3S3	1.0	4S1-4S3	1.0	5S1-5S3
500				-		-	1.0	3S1-3S2	1.0	4S1-4S2	1.0	5S1-5S2

(iii) Details of Current Transformers

		CORE 1	CORE 2	CORE 3	CORE 4	CORE 5
I	A	3000-2000-1000/1	3000-2000-1000/1	3000-2000-1000-500/1	3000-2000-1000-500/1	3000-2000-1000-500/1
B	VA	-	-	20	__-	-
CL		PS	PS	0.2S	PS	PS
ISF/ALF				<5		
Vk	V	>1000/400/300	>1000/400/300	-	>3000/2000/1000/500	>3000/2000/1000/500
Rct	Ohm	<15/10/5	<15/10/5	-	<15/10/5/2.5	<15/10/5/2.5
Io	mA	<20/30/60 at Vk	<20/30/60 at Vk		<20/30/60/120 at Vk	<20/30/60/120 at Vk

(iv) Details of Capacitive Voltage Transformers

S. No.	Rated system voltage:	400kV(rms)
1	Highest system voltage:	420kV(rms)
2	Rated frequency:	50Hz
3	Rated primary voltage:	400kV
4	Rated secondary voltage:	110/√3
5	Rated voltage factor:	1.2contand1.5for30sec
6	Number of cores per CVT:	3
7	Output burden:	75VA,.2 class /200VA,3P class
8	Accuracy class:	3P/3P/0.2
9	Class of insulation:	A
10	Capacitor details:	
11	High voltage capacitance:	4632pF
12	Intermediate voltage capacitance:	88000 pF

13	Nominalinter mediate voltage	
14	Degree of protection:	IP55
15	Rated total thermal burden:	750VA
16	Partial discharge level:	As Per IEC-61869-5
17	Self-resonating frequency:	>700kHz
18	Bandwidth:	40-500 kHz
19	Radiointerferencelevelat508 kV:	<1000μvolts

(vii) Any other equipment/system relevant for protection system operation: NA

(d)

(i) Transmission Line Distance Protection/Differential Protection

a. Name and Length of Line

S.No.	Name	Length (km)
1.	400kV Harduaganj- Sikandrabad Line1	115.179
2.	400kV Harduaganj-Aligarh Line2	39.762

b.	Whether series compensated or not	Not
c.	Mode of communication used (PLCC/OPGW)	OPGW
d.	Carrier aided scheme if any	Permissive Under reach
e.	Relay connected to Trip Coil-1 or 2 or both	Both
f.	CT ratio and PT ratio	2000/1A, 400kV/110V
g.	Feed from DC supply-1 or 2	YES
h.	Connected to dedicated CT core (mention name)	-
i.	Other requirements for protection checking and validation	-

j. Relay Make and Model for Main-I and Main-II

S.No	Name of the Feeder	Main-I	Main-II
1	400kV Harduaganj- Sikandrabad Line1	ABB REL-670	SIEMENS SIPROTEC 7SA522
2	400kV Harduaganj-Aligarh Line2	ABB REL-670	SIEMENS SIPROTEC 7SA522

k. List of all active protections & settings

(1) 400kVTRANSMISSIONLINEPROTECTION SETTINGS:

Name of Transmission Line	**400kV Harduaganj- Sikandrabad Line1**							
Main I: REL-670 (ABB)								
Distance Protection	**Zone 1**		**Zone 2**		**Zone 3**		**Zone 4**	
Settings	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**
Direction	Forward	Forward	Forward	Forward	Forward	Forward	**Reverse**	**Reverse**
IBase(A)	2000	-	2000	-	2000	-	2000	-
U Base(kV)	400	-	400	-	400	-	400	-
X1PP/PE (ohm/p)	30.50	-	53.37	-	83.09	-	7.62	-
R1PP/PE (ohm/p)	2.53	-	4.43	-	6.90	-	0.63	-
X0PE (ohm/p)	98.59	-	172.54	-	260.69	-	24.65	-
R0PE (ohm/p)	24.79	-	43.38	-	67.52	-	6.20	-
RFPP (ohm/l)	30.00	30	60.00	60	75.00	75	75.00	75
RFPE (ohm/l)	50	50	75.00	75	125.00	125	125.00	125
T PP (ms)	0	0	350	350ms	1000ms	1sec	500ms	As per comment of NRLDC during First charging
T PE (ms)	0	0	350	350ms	1000ms	1sec	500ms	
MAIN II -7SA522 (SEIMENS)								
Distance Protection	**ZONE1**		**ZONE2**		**ZONE3**		**ZONE4**	
Settings	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**
Direction	Forward	Forward	Forward	Forward	Forward	Forward	**Reverse**	**Reverse**
I Base(A)	2000		2000		2000		2000	
U Base(kV)	400		400		400		400	
R, Resistance for ph-ph fault	20.970		36.690		51.120		5.240	
X, Reactance	16.770		29.360		45.700		4.190	

RE, Resistance for ph-e fault	12.810		16.730		18.820		41.610	
Delay for Single phase (ms)	0		350					As per comment of NRLDC during First charging
Delay for Multi-phase (ms)	0		350		1000		500	
Zone Reduction Angle (load Compensation)	15 degrees							
Distance Protection General Setting								
Distance Protection	ON							
Phase Current Threshold for dist. meas.	.10A							
Angle Of Inclinationz dist. Charact.	85degree							
Series Compensated line	NO							
Mutual coupling parall. line compensation	YES							
Instantaneous trip after SOTF	With zone Z1B							
R load (Min Load Impedance aa(ph-ph/ph-e)	168/168 ohm							
PHI load, maximum Load Angle(ph-ph/ph-e)	30degree							
Z1B enabled before 1st A/R	NO							
Main I: REL-670 (ABB)					**MAIN II -7SA522 (SEIMENS)**			
SOTF Protection								
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
Operation	ON				Inst. High speed SOTF	ON		
I Base	2000A	-			I>>>pickup	0.86A		
Mode	Impedance	-						
Auto nit	OFF	-						
IPh<	20%IB	20%IB						
UPh<	40%UB	40%UB						

Duration(s)	0.02	-						
T SOTF(s)	0.200	0.2sec						
T DLD(s)	0.500	-						
PHASE SELECTION (PDIS 21)								
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
I Base	2000A	-						
U Base	400KV	-						
IN Block PP	40%IPh	40%IPh						
IN Release PE	20%IPh	20%IPh						
RLd Fw	69.94	-						
RLdRv	69.94	-						
ArgLd	39deg	30deg						
X1	76.86	-						
X0	248.45	-						
RFFwPP	75	-						
RFRvPP	75	-						
RFF w PE	82.50	-						
RFR v PE	82.50	-						
I Min Op PP	10%IB	20%IB						
IMinOpPE	5%IB	20%IB						
Earth Fault Protection (Residual Over current)								
Main I: REL-670 (ABB)					**MAIN II -7SA522 (SEIMENS)**			
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
DirMode1	Non directional				Earth Fault over current function	**ON**		
Angle RCA	65Degree	65Degree			Block E/F For Distance Prot	**With Every Pickup**		

Operating Characteristics1	IEC Normal Inverse	IEC Normal Inverse			Block E/F For Dist. Prot pick up	**In each Zone**		
IN1> (%IB)	20	20			Block E/F for 1 Pole Dead Time	**YES**		
Time Multiplier Setting K1	0.53	Coordinated as per downstream setting			Single Pole trip with earth fit. Prot.	**NO**		
DirMode2	Off	-			2nd Harmonic	**15%**		
DirMode3	Off	-			Max Current, Overriding Inrush Restraint	**7.50A**		
DirMode4	Off	-			Instantaneous Mode after SOTF	**With pickup and direction**		
					Trip Time Delay after SOTF	**0.00 sec**		
					IEC Curve	**Normal Inverse**		
					Operating Mode	**Non Directional**		
					3IOp Pickup	**.20A**		
					3IOp Time Delay	**.53 sec**		
					Additional Time Delay	**0.00 sec**		
Two Step Over Voltage Protection								
Main I: REL-670 (ABB)					**MAIN II -7SA522 (SEIMENS)**			
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
U base (kV)	400.00	-			Operating Mode U ph-e	ON	ON	
Operation Step1	On	-			U ph-e >pickup	69.8V	69.8V	

Characteristics1	Definite Time	-			Time delay TU ph-e>	5.00 sec	5.00 sec	
OpMode1	1out of 3	-			U ph-e >>pickup	95.2V	95.2V	
U1> (%UB)	110.0	110.0			Time delay TU ph-e>>	0.10 sec	0.10 sec	
Def. time delay t1(s)	5.0	5						
Operation Step2	On	ON						
Characteristics1	Definite Time	-						
OpMode1	1out of 3	-						
U1> (%UB)	150.0	140-150						
Def. time delay t1(s)	0.1	0.1						
Two Step Under Voltage Protection								
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
Operation Step 1	ON							
Characteristics1	Definite Time							
OpMode1	1out of 3							
U1< (%UB)	70							
t 1	5sec							
Operation Step2	OFF							
Fuse Failure Supervision function								
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
Op Mode	UZsIZs	UZsIZs						
Operation	ON	ON						
3U0> (%UB)	30	30						
3I0< (%IB)	10	10						
3U2 (%UB)	20	20						
3I2< (%IB)	10	10						

Op DUDI	On	On						
DU> (%UB)	60	60						
DI< (%IB)	15	15						
UPh> (%UB)	70	70						
IPh> (%IB)	10	10						
Sellan	On	On						
USealln< (%UB)	70	70						
IDLD< (%IB)	5	5						
UDLD< (%UB)	60	60						
Fault Locator Function								
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
R1A(ohm/p)	1.043	-						
X1A(ohm/p)	12.884	-						
R1B(ohm/p)	0.637	-						
X1B(ohm/p)	7.863	-						
R1L(ohm/p)	3.167	-						
X1L(ohm/p)	38.124	-						
R0L(ohm/p)	30.983	-						
X0L(ohm/p)	123.242	-						
R0M(ohm/p)	23.960	-						
X0M(ohm/p)	77.76	-						
Line Length	115.2	-						
STUB PROTECTION								
Operation	On	ON			Operation	ON, only active with lose of V. T		
I base(A)	2000	-			I ph	1.5A		
Release Mode	Release	Release			Time Delay	0.10sec		
I> (%IB)	150	150						
BROKEN CONDUCTOR								

Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
OPERATION	ON	ON						
I Base	2000A	-						
Iub>	50%IM	50%IM						
IP>	10%IB	20%IB						
Toper	5.00s	5.00 s						
Power Swing Detection Function								
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
X1InFw/Rv (ohm)	87.24	-			Power Swing Operation Mode	All zone Blocked		
R1FInFw/Rv (ohm)	78.75	-			Power swing Trip	NO		
R1LIn (ohm)	6.90	-			Tele protection For Distance Protection			
Operation Ld. Ch	On	-			Tele protection For Distance Pro	ON		
RLdOutFw/Rv (ohm)	69.94	-			Type of Line	Two Terminal		
kLdRFw/Rv	0.57/.75	-			Memorize Receive Signal	NO		
I base(A)	2000	-						
tEF	0.0sec							
tP1	.030							
tP2	.010							
tW	.250							
tH	.5							
tR1	.3							
tR2	2	2sec						
IM in Op PE	10%IB	20%IB						

Scheme communication logic								
Settings	Existing	Recommended	Remark		**Settings**	Existing	Recommended	Remark
Operation	On							
Scheme Type	Permissive UR							
T Coord(s)	0.1							
t SendMin(s)	0.1							

(2) 400kVTRANSMISSIONLINEPROTECTION SETTINGS: Harduaganj- AligarhLine2

Name of Transmission Line	**400kV Harduaganj- AligarhLine2**							
Main I: REL-670(ABB)								
Distance Protection	**Zone 1**		**Zone 2**		**Zone 3**		**Zone 4**	
Settings	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**
Direction	Forward	Forward	Forward	Forward	Forward	Forward	**Reverse**	**Reverse**
I Base(A)	2000		2000		2000		2000	
U Base(kV)	400		400		400		400	
X1PP/PE (ohm/p)	10.53		18.43		128.60		2.62	
R1PP/PE (ohm/p)	.88		1.53		10.68		.22	
X0PE (ohm/p)	34.04		59.56		415.71		8.51	
R0PE (ohm/p)	8.56		14.97		104.51		2.14	
RFPP (ohm/I)	30.00		60.00		75.00		75.00	
RFPE (ohm/I)	50.00		75.00		125.00		125.00	
T PP (ms)	0	0	350	350ms	1000	1000ms	500	As per comment of NRLDC during First charging
T PE (ms)	0	0	350	350ms	1000	1000ms	500	

MAIN II: 7SA522 (SEIMENS)								
Distance Protection	**Zone 1**		**Zone 2**		**Zone 3**		**Zone 4**	
Settings	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**	**Existing**	**Recommended**
Direction	Forward	Forward	Forward	Forward	Forward	Forward	**Reverse**	**Reverse**
I Base(A)	2000		2000		2000		2000	
U Base(kV)	400		400		400		400	
R, Resistance for ph-ph fault	7.250		12.670		73.900		4.360	
X, Reactance	5.790		10.130		70.730		1.450	
RE, Resistance for ph-e fault	10.550		10.910		18.820		40.040	
Delay for Single phase (ms)	0		350	350ms				
Delay for Multi-phase (ms)	0		350	350ms	1000ms	1000ms	500	As per comment of NRLDC during First charging
Zone Reduction Angle (load Compensation)	15 degrees							
Distance Protection General Setting								
Settings	**Existing**	**Recommended**						
Distance Protection	ON							
Phase Current Threshold for dist. meas.	.10A							
Angle Of Inclination, dist. Charact.	85degree							
Series Compensated line	NO							
Mutual coupling parall. line compensation	YES							
Instantaneous trip after SOTF	With zone Z1B							
R load (Min Load Impedanceaa(ph-ph/ph-e)	168/168 ohm							
PHI load, maximum	30degree							

Load Angle(ph-ph/ph-e)								
Z1B enabled before 1st A/R	NO							
Main I: REL-670(ABB)					**MAIN II: 7SA522 (SEIMENS)**			
PHASE SELECTION (PDIS 21)								
Settings	**Existing**	**Recommended**	**Remark**		**Settings**	**Existing**	**Recommended**	**Remark**
I Base	2000A							
U Base	400KV							
IN Block PP	40%IPh							
IN Release PE	20%IPh							
RLd Fw	69.94							
RLd Rv	69.94							
Arg Ld.	44 deg							
X1	25.53							
X0	85.77							
RFFwPP	75							
RFRvPP	75							
RF Fw PE	82.50							
RF Rv PE	82.50							
IM in Op PP	10%IB							
IM in Op PE	5%IB							
SOTF Protection								
Settings	**Existing**	**Recommended**	**Remark**		**Settings**	**Existing**	**Recommended**	**Remark**
Operation	ON				Inst. High speed soft	ON		
I Base	2000A				I>>>pickup	.86A		
Mode	Impedance							
Auto ln it	On							
I Ph<	20%IB	20						
U Ph<	40%UB	40						
T Duration(s)	0.02	-						
T SOTF(s)	0.200	.2						
T DLD(s)	0.500	-						
Earth Fault Protection(Residual Over current)								
Settings	**Existing**	**Recommended**	**Remark**		**Settings**	**Existing**	**Recommended**	**Remark**

DirMode1	Forward				Earth Fault over current function	**ON**		
Operating Characteristics1	IEC Normal Inverse				Block E/F For Distance Prot	**With Every Pickup**		
IN1> (%IB)	20	20			Block E/F For Dist. Prot pick up	**In each Zone**		
Time Multiplier Setting K1	0.53	Coordinated as per downstream setting			Block E/F for 1 Pole Dead Time	**YES**		
DirMode2	Off				Single Pole trip with earth flt. Prot.	**NO**		
DirMode3	Off				2nd Harmonic	**15%**		
DirMode4	Off				Max Current, Overriding Inrush Restraint	**7.50A**		
					Instantaneous Mode after SOTF	**With pickup and direction**		
					Trip Time Delay after SOTF	**0.00 sec**		
					IEC Curve	**Normal Inverse**		
					Operating Mode	**Non-Directional**		
					3IOp Pickup	**.20A**		
					3IOp Time Delay	**.53 sec**		
					Additional	**0.00 sec**		

					Time Delay			
Two Step Over Voltage Protection								
Settings	**Existing**	**Recommended**	**Remark**		**Settings**	**Existing**	**Recommended**	**Remark**
U base(kV)	400.00							
Operation Step1	On				Operating Mode U ph-e	ON		
Characteristics1	Definite Time				U ph-e >pickup	69.8V		
OpMode1	1out of 3				Time delay T U ph-e>	5.00 sec		
U1> (%UB)	110.0	110			U ph-e >>pickup	95.2V		
Def. time delay t1(s)	5.0	5sec			Time delay TU ph-e>>	.10 sec		
Operation Step2	On							
Characteristics1	Definite Time							
OpMode1	1out of 3							
U1> (%UB)	150.0	140-150						
Def. time delay t1(s)	0.1	0.10						
Two Step Under Voltage Protection								
Settings	**Existing**	**Recommended**	**Remark**		**Settings**	**Existing**	**Recommended**	**Remark**
Operation Step 1	ON							
Characteristics1	Definite Time							
OpMode1	1out of 3							
U1< (%UB)	70	70						
t 1	5sec	5						
Operation Step2	OFF							
Fuse Failure Supervision function								
Operation	ON							
I Base	2000A							
U Base	400KV							

Op Mode	UZsIZs							
3U0> (%UB)	30							
3I0< (%IB)	10							
3U2 (%UB)	20							
3I2< (%IB)	10							
Op DUDI	On							
DU> (%UB)	60							
DI< (%IB)	15							
UPh> (%UB)	70							
IPh> (%IB)	10							
Sellan	On							
USealln< (%UB)	70							
IDLD< (%IB)	5							
UDLD< (%UB)	60							
Fault Locator								
R1A(ohm/p)	1.043							
X1A(ohm/p)	12.884							
R1B(ohm/p)	0.676							
X1B(ohm/p)	8.346							
R1L(ohm/p)	1.093							
X1L(ohm/p)	13.161							
R0L(ohm/p)	10.696							
X0L(ohm/p)	42.545							
R0M(ohm/p)	28.088							
X0M(ohm/p)	72.870							
Line Length	39.762							

STUB PROTECTION								
Settings	**Existing**	**Recommended**	**Remark**		**Settings**	**Existing**	**Recommended**	**Remark**
Operation	On							
I base(A)	2000							
Release Mode	Release							
I> (%IB)	150							
Broken Conductor								
Operation	ON							
I Base	2000A							
Iub>	50%IM							
IP>	10%IB							
Toper	5.00							
Power Swing Detection Function								
Settings	**Existing**	**Recommended**	**Remark**		**Settings**	**Existing**	**Recommended**	**Remark**
Operation	ON							
X1InFw/Rv (ohm)	135.03							
R1FInFw/Rv (ohm)	78.75							
R1LIn (ohm)	10.68							
OperationLd Ch	On							
RLdOutFw/Rv (ohm)	69.94							
kLdRFw/Rv	0.50							
I base(A)	2000							
tEF	0.0sec							
tP1	.030							
tP2	.010							
tW	.250							
tH	.5							
tR1	.3sec							
tR2	2sec	2sec						
Scheme communication logic								

Operation	On							
Scheme Type	Permissive UR							
T Coord(s)	0.1							
T SendMin(s)	0.1							
Tele protection For Distance Protection								
Tele protection For Distance Pro	ON							
Type of Line	Two Terminal							
Memorize Receive Signal	NO							

l. Status of Power Swing/Out of Step/SOTF/Breaker Failure/Broken Conductor/STUB/Fault Locator/DR/VT fuse fail/Overvoltage Protection/Trip Circuit supervision/Auto-reclose/Load encroachment etc.

S. No.	**Protection**	**Status**		
a.	Power Swing	Enabled		
b.	Out of Step	-		
c.	SOTF	Enabled		
d.	Breaker Failure	Enabled		
e.	Broken Conductor	Enabled		
f.	STUB	Enabled		
g.	Fault Locator	Enabled		
h.	DR	Enabled		
i.	VT fuses fail	Enabled		
j.	Overvoltage Protection	Enabled		
k.	Trip Circuit supervision	Enabled		
l.	Auto-reclose	Enabled		
m.	Load encroachment	Enabled		

(ii) Shunt Reactor & Inter-connecting Transformer Protection

Inter-connecting Transformer Protection (ICT-1&2)

S. No.	Particulars	Unit	Details
i.	Manufacturer		**TTDI, Hyderabad**
ii.	Nos.		02
iii.	Type		Three Phase
iv.	Applicable Standard		IEC:60076-7
v.	Full Load Rating	MVA	315
vi.	Voltage Ratio	kV	400/√3/220/√3/33
vii.	Frequency	Hz	50
viii.	Cooling Fan		ONAN/ONAF/ODAF
ix.	ONAN	MVA	189
x.	ONAF	MVA	252
xi.	OFAF	MVA	315
xii.	Vector Group		YNa0d11
xiii.	Max. Temperature Rise oil	^{0}C	35
xiv.	Max. Temperature Rise Winding	^{0}C	40
xv.	Over Ambient Temperature	^{0}C	50
xvi.	Impedance Value at Participation Rated MVA Base		12.5±10%
xvii.	Tapping Range		10% to (-)10%
xviii.	Tapping Step		1.25%
xix.	Type of Tap Changer		OLTC
xx.	Efficiency (at full load)		99.85% Unity pf

BUS Reactor Details

S. No.	Particulars	Unit	Details
	Make		BHEL
ii.	Quantity Required		1No.
iii.	Installation		Outdoor
iv.	**Ratings**		
v.	Nominal System Voltage	kV	400/√3
vi.	Highest System Voltage	kV	420/√3
vii.	Short Circuit Level (SYMM)	kA	40kAfor2Sec
viii.	Rated Voltage	kV	420/√3
ix.	Highest design voltage	kV	420/√3
x.	Number of Phases and Rated Frequency		3, 50Hz
xi.	Rating (Three Phase/Single Phase)	MVAR	80
xii.	Winding Connection		Star with neutral brought out
xiii.	Design ambient temp.	oC	50
xiv.	Cooling		ONAN
xv.	Neutral Earthing	Bus	solidly Earthed

		Reactor	
xvi.	Duration of Short Circuit Current		50kAfor1Sec
xvii.	Linearity of Voltage Curve		Upto1.5PU
xviii.	Zero sequence impedance	Ohm	2095to2205
xix.	**Insulation withstand**		
xx.	Impulse(1.2/50msecWave)	kVpeak	HV-1300, N-550

a.	Whether two groups of protections used (Group A and Group B)	NA
b.	Do the groups have separate DC sources	NA
c.	Feed from DC supply-1 or 2	YES
d.	Connected to dedicated CT core (mention name)	--
e.	CT ratio and PT ratio	1000/1 A 400 kV/110 V
f.	Relay connected to Trip Coil-1 or 2 or both	Both
g.	Other requirements for protection checking and validation	-

e. CT ratio and PT ratio

S. No.	CT ratio	HV winding	MV winding	LV winding
i.	CT Ratio for OC	2000/1(Phase) and 2000/1 (Tie)	1000/1	-
ii.	CT Ratio for 87T	2000/1(Phase) and 2000/1(Tie)	1000/1	-
iii.	CT Ratio for REF	1000/1	1000/1	-
iv.	CT Ratio for 87C	1000/1	1000/1	-

h. Relay Make and Model

S. No.	Transformer Details	Relay Make	Relay model
1.	ICT-1	ABB	RET670 RED670 REC670
2.	ICT-2	ABB	RET670 RED670 REC670
3.	ST-1	ABB	RET670-1 RET670-2 REC670
4.	ST-2	ABB	RET670-1 RET670-2 REC670
5.	BUS REACTOR	ABB	RET-670 REC-670

Mechanical Protection tripping and Annunciation Healthiness						
Rating of Transformer MVA& KV Class.	**Buchholz**	**PRV**	**OSR**	**OTI**	**WTI**	**MOG**
400/220/33KV ICT-1 315 MVA	O. K	O. K	O. K	O.K	O.K	O.K
400/220/33KV ICT-2 315MVA	O.K	O.K	O.K	O.K	O.K	O. K
400/11.5/11.5KV ST No.1 100MVA	O.K	O.K	O.K	O.K	O.K	O. K
400/11.5/11.5KV ST No.2 100MVA	O.K	O.K	O.K	O. K	O. K	O. K
400KV BUS REACTOR 80MVAR	O.K	O.K	O.K	O.K	O.K	O.K

ICT1&2 RET 670

Main CT/PT Ratios

CT for Diff. Protection-Main HV	2000/1A
CT for Diff. Protection-TIE HV	2000/1A
CT for Diff. Protection-LV	1000/1A

Transformer Differential Protection (87T)			
Description	**Setting**	**Recommended**	**Remarks**
Trans. Rating	315MVA		
Trans. Vector Group	Yny0		
HV side Full Load Current (Pri)	474.7A		
HV side Full Load Current (Sec)	0.277A		
LV side Full Load Current (Pri)	827A		
LV side Full Load Current (Sec)	0.827A		
Diff. Pick UP Id>(restraint)	20% of full load current		
Slope Section 2	40%		
Slope Section 3	80%		
2nd Harmonic Blocking	15%		
5th Harmonic Blocking	25%		
SOTF MODE	OFF		
I Diff Alarm	.08 IB		
t Alarm Delay	5 sec		
Id Min	.20 IB		
End Section1	1.25 IB		
End Section	3.00 IB		
HV Over FlHV Over Flux protection:			
Trip Voltage in %	**Trip Voltage**	**Time(Sec.)**	**Remark**

110	69.85	9000	**As Provided by OEM**
118	74.93	90	
126	80.01	25	
134	85.09	6	
142	90.17	2	
150	95.25	0.5	
IV Over Fluxing Protection:			
Trip Voltage in %	**Trip Voltage**	**Exp. Time (Sec.)**	**Remark**
110	69.85	9000	**As Provided by OEM**
118	74.93	90	
126	80.01	25	
134	85.09	6	
142	90.17	2	
150	95.25	0.5	
Stand by Earth Fault Protection (Residual Over Current)			
Description	**Setting**		
Operating mode	Non-Dir		
Pickup Current (3I0)	0.15A [>15% of full load (1000)]		
T ms	1.2sec		
IEC Curve	IEC Definite Time		

REF Protection			
PHASE	Trip Voltage	Series Resistor	Recommended
NCT	67V	1622ohm	67V
REF Protection Alarm			
PHASE	Alarm Voltage	Recommended	
NCT	32V	32V	

ICT 1&2 RED 670

Cable Differential Protection(87L)			
Setting	Existing	Recommended	Remark
Operation	ON		
Id Min	.20IB		
Id Min High	.80IB		
tId Min High	1sec		
Id Umer	8IB		
NegSeqDiffEn	off		
Cross Block En	yes		
I2/I1 Ratio	10%		
I5/I1 Ratio	25%		
Curve Type	IEC Def. Time		
K	1		
I diff Alarm	.15IB		
T Alarm Delay	10sec		
IBase	827A		

Directional Earth Fault Protection (Residual Over Current)			
Setting	**Existing**	Recommended	Remark
Operating mode	Nondirectional	Nondirectional	
Pickup Current (3I0)	0.0.454A [>20% of full load (0.227A)]		
Pickup Voltage (3U0)	6.35V (>10% of 63.5)		
T ms	0.45		
Relay Characteristics Angle (RCA)	65 deg.		
IEC Curve	IEC. NOM INV		
Directional Over Current Protection (Phase Over Current):			
Setting	**Existing**	Recommended	Remark
Operating mode	Forward	Forward	
Pickup Current (3I0)	0.3412A [>150% of full load (0.277A)]	150%	
Pickup Voltage (3U0)	6.35V (>10% of 63.5)		
T ms	0.29		
Relay Characteristics Angle (RCA)	55 deg.	65deg	
IEC Curve	IEC. NOM INV	IEC. NOM INV	
Non-Directional Over Current Protection (DMT)			
Setting	**Existing**	Recommended	Remark
Operating mode	Non-Dir.		
Pickup Current (3I0)	2.184A [>960% of full load (0.227A)]		
Pickup Voltage (3U0)	6.35V (>10% of 63.5)		
Time	0.05sec		
Relay Characteristics Angle (RCA)	45 deg.		
IEC Curve	IEC DEF. Time		

STATION TRANSFORMER 1&2

RET-1

Main CT/PT Ratios

CT for Diff. Protection-Main HV	500/1A
CT for Diff. Protection-TIE HV	500/1A
CT for Diff. Protection-LV1	3000/1A
CT for Diff. Protection-LV2	3000/1A

Transformer Differential Protection (87T)			
Setting	**Existing**	Recommended	Remark
Trans. Rating	100MVA		
Trans. Vector Group	YNyn0yn0		
HV side Full Load Current (Pri)	144A		
HV side Full Load Current (Sec)	0.288A		
LV side Full Load Current (Pri)	2510A		
LV side Full Load Current (Sec)	1.673A		
Diff. Pick UP Id>(restraint)	30% of full load current		
Slope Section 2	40%		
Slope Section 3	80%		
2^{nd} Harmonic Blocking	15%		
5^{th} Harmonic Blocking	25%		
SOTF MODE	OFF		
I Diff Alarm	.08 IB		
t Alarm Delay	5 sec		
Id Min	.30 IB		
End Section1	1.25 IB		
End Section	3.00 IB		
HV Stand by Earth FHV Stand by Earth Fault Protection (DMT)			
Setting	**Existing**	Recommended	Remark
Operating mode	Non-Dir		
Pickup Current (3I0)	0.0288A [>20% of full load (0.144)]CTR-1000/1		
Time Delay	1.50		
IEC Curve	IEC Define Time		
HV Over Fluxing Protection			
Trip Voltage in %	**Trip Voltage**	**Setting Time(Sec.)**	Remark
110	69.85	9000	**As Provided by OEM**
118	74.93	90	
126	80.01	25	
134	85.09	6	

142	90.17	2	
150	95.25	0.5	
LV1 Stand by Earth Fault Protection (DMT)			
Setting	**Existing**	Recommended	Remark
Operating mode	Non-Dir		
Pickup Current (3I0)	0.33A [>33% of full load(1)] CTR-300/1(IB-300)		
T (ms)	.60		
IEC Curve	IEC Very inverse		
LV2 Stand by Earth Fault Protection (DMT):			
Setting	**Existing**	Recommended	Remark
Operating mode	Non-Dir		
Pickup Current (3I0)	0.33A [>33% of full load (1)] CTR-300/1(IB-300)		
T ms	.60		
IEC Curve	IEC Very Inverse		

ST 1&2 RET-2

Main CT/PT Ratios

CT for REF. Protection	1/1A
CT for HV. Protection	500/1A
CT for LV1. Protection	3000/1A
CT for LV2. Protection	3000/1A

HV REF Protection			
PHASE	Trip Voltage	Series Resistor	
NCT	13V	325 Ohm	
HV REF Protection Alarm	**Time-5sec**		
PHASE	Alarm Voltage	Series Resistor	
NCT	7V	325 Ohm	
HV Earth Fault Protection (Residual Over Current)			
Setting	**Existing**	Recommended	Remark
Operating mode	Non-Dir		
Pickup Current (3I0)	0.0.576A [>20% of full load(0.288)] IB-144		
T ms	0.5		
IEC Curve	IEC Normal Inverse		
HV Phase Over Current Fault Protection			
sETTING	**Existing**	Recommended	Remark
Operating mode	Non-Dir		
Pickup Current (3I0)	0.345A [>120% of full		

	load(0.288)] IB-144A		
T ms	0.2		
IEC Curve	IEC Normal Inverse		
LV1 & LV2 Over Current Fault Protection (IDMT):			
Setting	**Existing**	Recommended	Remark
Operating mode	Non-Dir		
Pickup Current (3I0)	0.874A [>100% of full load(0.874)] IB-2624A		
T ms	0.2		
IEC Curve	IEC Normal Inverse		
LV1&2 Earth Fault Protection (Residual Over Current)::			
Setting	**Existing**	Recommended	Remark
Operating mode	Non-Dir		
Pickup Current (3I0)	0.262A [>30% of full load(0.874)] IB-2624		
T ms	0.05		
IEC Curve	IEC Normal Inverse		

80MVAR BUS REACTOR

Transformer Differential Protection			
Setting	**Existing**	Recommended	Remark
Trans. Rating	80MVAr		
Trans. Vector Group	Y		
Full Load Current (Pri)	110A		
Slope Section 2	40%		
Slope Section 3	80%		
2nd Harmonic Blocking	15%		
5th Harmonic Blocking	25%		
SOTF MODE	OFF		
I Diff Alarm	.10 IB		
t Alarm Delay	10 sec		
Id Min	.20 IB		
End Section1	1.25 IB		
End Section	3.00 IB		
High impedance Differential (REF)			
Operation	ON		
U>Alarm	3V	4V	
T Alarm	10 sec	5sec	
U>Trip	15V	20V	
Series Resistor	275 ohms	1000ohm	
Impedance protection 1-(Mho Distance PDIS-21)			
Setting	**Existing**	Recommended	Remark
Operation	On	On	
I Base	110A	110A	
U Base	420V	420V	
Dir Mode	offset	offset	
Load Enc Mode	off	off	
Reach Mode	Under reach	Under reach	
Off set Mho Dir	Non-Directional	Non-Directional	
Op Mode PE	On	On	
Z PE	1323	1323	
Z Ang PE	90	90	
KN	.03	.03	
KN Ang	-180	0	
Z Rev PE	1323	1323	
Op Mode PE	On	On	
T PE	1.00 sec	1.00 sec	
IMinOpPE	10%IB	10%IB	
Op Mode PP	On	On	
ZPP	1323	1323	
Z Ang PP	90	0	

Z Rev PP	1323	1323	
Op Mode PP	On	On	
T PP	1 sec	1 sec	
I Min Op PP	10%IB	10%IB	
Secondary System Supervision (Fuse Failure)			
Setting	**Existing**	Recommended	Remark
Operation	ON		
I Base	200A		
U Base	400Kv		
Op Mode	UZsIZs	UZsIZs	
3U0>	30%UB	30%UB	
3I0<	10%IB	10%IB	
3U2>	30%UB	20%UB	
3I2<	10%IB	10%IB	

List of all active protections along with settings

S. No.	PROTECTION TYPE	IED	PANEL
1.	TRANSFORMER DIFFERENTIAL (87AT)	RET670	4R10B
2.	HIGH IMPEDANCE REF (64R)		
3.	STANDBY EARTHFAULT (51NS)		
4.	HV SIDE OVERFLUXING (24)		
5.	IV SIDE OVERFLUXING (24)		
6.	HV DIRECTIONAL O/C (67)	RED670	4R10A
7.	HV DIRECTIONAL E/F (67N)		
8.	CABLE DIFFERENTIAL (87C)		
9.	SYNCHRO CHECK AND ENERGIZING CHECK (25)	REC670	

j. Status of Differential Protection/Restricted Earth Fault Protection/Back-up Directional Overcurrent/Backup Earth fault/ Breaker Failure

S. No.	Protection	Status		
1.	Differential Protection	Enabled		
2.	Restricted Earth Fault Protection	Enabled		
3.	Back-up Directional Overcurrent	Enabled		
4.	Backup Earth fault	Enabled		
5.	Breaker Failure	Enabled		

k. Status of Oil Temperature Indicator/Winding Temperature Indicator/Buchholz/Pressure Release Device etc.
For ICT-1&2 and ST-1&2

S. No.	Indicator	Status	Alarm	Trip
1.	Oil Temperature Indicator	Healthy	95^0C	100^0C
2.	Winding Temperature Indicator	Healthy	105^0C	115^0C
3.	Buchholz	Healthy		
4.	Pressure Release Device	Healthy		

S. No.	Cooler	ON	OFF
1.	FAN	65^0C	55^0C
2.	PUMP	70^0C	60^0C

(iii) Busbar Protection Relay

a. Busbar and redundant relay make and model.

S. No	Busbar	Make	Main-I	Main-II
1	400 kV BUS-1	ABB	REB670_1	REB670_2
2	400 kV BUS-2	ABB	REB670_1	REB670_2

Bus-1&Bus2, Main-1 &Main-2 (Bus bar Protection)

Id Alarm Setting	Time Delay	401(BAY)	404(BAY)	407(BAY)	410(BAY)	403(BAY)	406(BAY)	409(BAY)	412(BAY)
200A	10sec	.067A	.067A	.067A	.067A	.067A	.067A	.067A	.067A
Open CT Setting	Time Delay	401	404	407	410	403	406	409	412
200A	5sec	.067A	.067A	.067A	.067A	.067A	.067A	.067A	.067A
End Fault Protection	Time Delay	401	404	407	410	403	406	409	412
150% of IB	.04sec	.2275	1.5	1.5	.2275	.5955	.0575	.072	.072
Re trip setting	time	401	404	407	410	403	406	409	412
20% of IB	.100sec	.0303	.2	.2	.0303	.0794	.00767	.0096	.0096
LBB Protection	time	401	404	407	410	403	406	409	412
20% of IB	.200sec	.0303	.2	.2	.0303	.0794	.00767	.0096	.0096

NOTE- ALL Value OF Current in Secondary, CTR-3000/1A

BBP Zone A			
Setting	**Existing**	Recommended	Remark
Operation	ON		
Diff Oper Lev	2400A		
Diff Trip Out	Self-Reset		
T Trip Hold	.200sec		
Check Zone Sup	Off		
Fast OCT Oper	Supervise		
Slow OCT Oper	Supervise		
OCT Oper Lev	200A		
T Slow OCT	5sec		
O CT Release lLev	3000A		
Id Alarm Lev	200A		
tId Alarm	10sec		
Lin Alarm Lev	3000A		
Sens Oper Lev	200A		
Sens Lin Block	1000A		
Sens Diff Oper	Off		
T Sens Diff	.400Sec		

b.	Dedicated CT core for each busbar protection (Yes/No)	Yes
c.	Breaker Failure relay included (Yes/No), if additional then furnish make and model	RET/REL-670
d.	Trip issued to both Busbar protection in case of enabling	NO
e.	Isolator indication and check relays	-
f.	Other requirements for protection checking and validation	-

(iv) AC auxiliary system

a.	Source of AC auxiliary system	2Nos
b.	Supply changeover between sources (Auto/Manual)	Manual
c.	Diesel generator (DG) details	NA
d.	Maintenance plan and supply changeover periodicity in DG	--
e.	Other requirements for protection checking and validation	--

f. Single Line Diagram

(v) DC auxiliary system

a. Type of Batteries (Make, vintage, model)

DC BATTERY SYSTEM OF 400kV SWITCHYARD		
Bank	Bank-1	Bank-2
Make	Exide	Exide
Type	Lead Acid cells	Lead Acid cells
Year of Commissioning	2019	2019
No Of Cells	107	107
Capacity	400Ah	400Ah
Battery Charger Details		
Status	Healthy	Healthy
Make	Chloride	Chloride
Style	FLOAT CUM BOOST CHARGER	FLOAT CUM BOOST CHARGER
Measured voltage		
Positive-Negative	237	236
Positive-Earth	119	118
Negative-Earth	117	117
Ground fault detector	-	-

b.	Status of battery Charger	Healthy
c.	Measured voltage (positive to earth and negative to earth)	119,117,118,117
d.	Availability of ground fault detectors	-
e.	Protection relays and trip circuits with independent DC sources	--
f.	Other requirements for protection checking and validation	--

g. Communication system

a.	Mode of communication for Main-1 and Main-2 protection	FOTE
b.	Mode of communication for data and speech communication	FOTE
c.	Status of PLCC channels	Not in service
d.	Time synchronization equipment details	GPS
e.	OPGW on geographically diversified paths for Main-1 and main-2 relay	
f.	Other requirements for protection checking and validation	

(vi) Circuit Breaker Details

a. Details and Status

S. No.	Circuit Breaker type:	SF6
i.	Tank Design:	Live
ii.	Execution of Poles:	3Single Phase
iii.	Rated Voltage:	420kV
iv.	Rated Current:	3150A
v.	Class(AsperIEC-62271-100):	C2– M2
vi.	Details of Operating Mechanism:	Spring
vii.	Symmetrical Breaking Current:	50kA(rms)
viii.	Asymmetrical Breaking Current:	61.2kA(peak)
ix.	Short Time Withstand Current and Time:	50kAfor1sec
x.	Making Current:	125kA(peak)
xi.	Operating Duty:	O-0.3s-CO-3min-CO
xii.	DC Component	50%
xiii.	First –pole-to-clear factor	1.3
xiv.	Total breaktime (considering to lardacein standard):	60ms
xv.	Enclosure Protection:	IP55
xvi.	Rated pressureofSF6:	6.0 barat20°C

xvii.	Alarm:	5.2Mpa(abs)at20°C
xviii.	Lockout:	5.0MPa(abs)at20°C

b.	Healthiness of Tripping Coil and Trip circuit supervision relay	Both Healthy
c.	Single Pole/Multi pole operation	Both
d.	Pole Discrepancy Relay available(Y/N)	Yes (1sec)
e.	Monitoring Devices for checking the dielectric medium	-
f.	Other requirements for protection checking and validation	-

(vii) Current Transformer (CT)/Capacitive Voltage Transformer (CVT) Details
Current Transformer (CT)

a.	CT name and voltage level	Dead Tank Type 400kV(rms) 420kV(rms)(highest System Voltage)
b.	**CT core connection details**	
c.	Accuracy Class	PSCore1,2,4&5, 0.2Scores3for metering
d.	Whether Protection/Metering	Both core1,2,4&5 for protection Core3 for metering
e.	CT ratio available and ratio adopted	Core 1&2:**3000**-2000-1000/1-1 Core 3,4&5:3000-**2000**-1000-500/1-1-1
f.	Details of last checking and validation of CT healthiness	
g.	Other requirements for protection checking and validation	

CT core connection details

Primary			**Secondary**									
AMPS	**RECONN** / **LINK CONN**	**TERMINALS**	**CORE 1**		**CORE 2**		**CORE 3**		**CORE 4**		**CORE 5**	
			A	**CONN**	**A**	**CONN**	**A**	**CONN**	**A**	**CONN**	**A**	**CONN**
3000		P1-P2	1.0	1S1-1S4	1.0	2S1-2S4	1.0	3S1-3S5	1.0	4S1-4S5	1.0	5S1-5S5
2000			1.0	1S1-1S3	1.0	2S1-2S3	1.0	3S1-3S4	1.0	4S1-4S4	1.0	5S1-5S4
1000			1.0	1S1-1S2	1.0	2S1-2S2	1.0	3S1-3S3	1.0	4S1-4S3	1.0	5S1-5S3
500				-		-	1.0	3S1-3S2	1.0	4S1-4S2	1.0	5S1-5S2

Capacitive Voltage Transformer (CVT)

a.	CVT name and voltage level	400kV(rms) 420kV(rms) (highest System Voltage)
b.	CVT core connection details	
c.	Accuracy Class	3P/3P/0.2
d.	Whether Protection/Metering	Both
e.	CVT ratio available and ratio adopted	400kV/√3/110V/√3
f.	Details of last checking and validation of CVT healthiness	
g.	Other requirements for protection checking and validation	

h. Other protections: Direction earth fault, negative sequence, over current, over voltage, over frequency, under voltage, under frequency, forward power, reverse power, out of step/power swing, HVDC protection etc.

S. No.	Protection	Status
i.	Direction earth fault	O.K.
ii.	Negative sequence	NA
iii.	Over current	O.K
iv.	Over voltage	O.K
v.	Over frequency	O.K
vi.	Under voltage	O.K
vii.	Under frequency	NA
viii.	Forward power	NA
ix.	Reverse power	NA
x.	Out of step	NA
xi.	Power swing	O.K
xii.	HVDC protection	NA

3. **OBSERVATIONS:**

As a general finding from this audit, It is observed that:

(1) 400 kV E_TPS substation equipments are well protection as per Northern region Power Committee recommendation.

(2) Both 400 kV lines have independent main-1 and main-2 functional Numerical protection.

(3) Bus bar and bus reactor of 400kV Substation are also well protected as per NRPC defined Protection schemes. Operational protection settings are in order.

(4) Both ICTs & STs are well protected as per guidelines.

(5) The state of DC supply at substation inspected and found in order.

(6) Time Functionality of GPS/TSU, circuit breaker, relay testing reports is also inspected, and all are found in satisfactory state.

Internal Protection Audit Report

of

2X250 MW Generating unit,

transformers, 220 kV switchyard ,6.6kV switchgear

of

‘D’ Thermal power station,

Harduaganj Thermal Power Plant, Kasimpur, Aligarh

THE ELECTRICAL SYSTEM COMPRISES OF FOLLOWING:

Sl. No.	Electrical component	Installed quantity
1	250 MW Generator	2 Set
2	315 MVA, 16.5/220 kV Generating Transformer	2 Set
3	31.5 MVA, 16.5/6.6kV Unit Auxiliary Transformer	2 Set
4	50 MVA, 132/6.9 kV Station Transformers	2 Set
5	220kV Switchyard	1 Set
6	6.6 kV Switchgear system	2 Set

DETAIL OF DC SYSTEM INSTALLED IN 2X250 MW UNIT-08 & 09, DTPS, HTPP

DC SYSTEM									
NAME OF UNIT-2X250 MW UNIT-08 & 09									
DETAIL OF THE BATTERY: -Ni-Cd Battery, 570AH/1.2V									
DETAIL OF DC SYSTEM: 220 V DC SOURCE-1 AND SOURCE-2									
Sl. No.	**DC source**	**Sr. No**	**Charging o/p current**	**Charger o/p voltage**	**Availability of DC grounding**	**Voltage earth to'+'**	**Voltage earth to'-'**	**Physical condition**	**Remark**
1	Unit-08, 220 V DC Charger-1 Make-HBL POWER SYS LTD	6776-3030	250 A	220V	OK	110V	110V	GOOD	
2	Unit-08, 220 V DC Charger-2 Make-HBL POWER SYS LTD	6777-3030	250 A	220V	OK	110V	110V	GOOD	
3	Unit-09, 220 V DC Charger-1 Make-HBL POWER SYS LTD	6778-3030/	250 A	220V	OK	110V	110V	GOOD	
4	Unit-09, 220 V DC Charger-2 Make-HBL POWER SYS LTD	6779-3030	250 A	220V	OK	110V	110V	GOOD	

Availability of DC Source							
NAME OF UNIT-2X250 MW UNIT-08 & 09 and Extended MCR							
Sl. No.	**Description**	**No. of DC Source Available**	**Source-1 (Volts)**	**Source-2 (Volts)**	**DC change-over**	**Availability of DC at all relays**	**Remark**
1	GRP -8 Feeder	02	220	220	Healthy	Available	
2	BCU-8 Feeder	02	220	220	Healthy	Available	
3	Excitation cubicle-8 feeder (DAVR)	02	220	220	Healthy	Available	
4	6.6 kV switchgear 8UA	02	220	220	Healthy	Available	

5	6.6 kV switchgear 8UB	02	220	220	Healthy	Available	
6	6.6 kV station s/g 8S1	02	220	220	Healthy	Available	
7	6.6 kV station s/g 8S2	02	220	220	Healthy	Available	
8	Extended MCR-8	02	220	220	Healthy	Available	
9	GRP -9 Feeder	02	220	220	Healthy	Available	
10	BCU-9 Feeder	02	220	220	Healthy	Available	
11	Excitation cubicle-9 feeder (DAVR)	02	220	220	Healthy	Available	
12	6.6 kV switchgear 9UA	02	220	220	Healthy	Available	
13	6.6 kV switchgear 9UB	02	220	220	Healthy	Available	
14	6.6 kV station s/g 9S1	02	220	220	Healthy	Available	
15	6.6 kV station s/g 9S2	02	220	220	Healthy	Available	
16	Extended MCR-9	02	220	220	Healthy	Available	

1.250 MW GENERATOR

I. Detail Technical specifications of the 250 Mw turbogenerator:

Turbogenerator, 250 MW, 294100 KVA, TYPE: TG-HH-0250-2, Voltage rating-16500 V, Full load current-10291 A, Frequency-50 Hz, Coolant: Hydrogen, Gas Pressure: 4 kg/cm2, Insulation Class-F, Make- Bharat Heavy Electricals Limited

II. List of electrical components installed in 250 MW Generator:

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	03 Set
B	Voltage transformer	03 Set
C	Generator protection and monitoring equipment	LS
D	Numerical Protection relays	04 Set

A. CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	Error calculated	CT CLASS	Knee point voltage	Sec Res	Remark
1	Generator Neutral Side duct	CORE-A	12500/5	12500/5	------	PS	2000	5	
		CORE-B	12500/5	12500/5	------	PS	2000	5	
		CORE-C	12500/5	12500/5	------	0.2	-----	----	
		CORE-D	12500/5	12500/5	------	0.2	------	-----	
		CORE-E	12500/5	12500/5	------	PS	2000	5	
2	Generator Phase Side duct	CORE-F	12500/5	12500/5	------	PS	2000	5	
		CORE-G	12500/5	12500/5	------	0.2	-------	-----	
		CORE-H	12500/5	12500/5	------	0.2	--------	------	

B. VOLTAGE TRANSFORMER

Sl. No.	Location of VT	VT Desig.	VT Ratio	MAKE	HSV	CLASS	VF	Il	Type	Ins class
1	PT CUBICLE	01VT	16.5KV/√3/ 100V/√3	Pragati Electricals	24kV	3p/0.2	1.2 Cont. & 1.9 for 30 sec	24/55/ 125kVp 60 VA	Indoor	B
2		02 VT	16.5KV/√3/ 100V/√3	Pragati Electricals	24kV	3p/0.2	1.2 Cont. & 1.9 for 30 sec	24/55/ 125kVp 60 VA	Indoor	B
3		03 VT	16.5KV/√3/ 100V/√3	Pragati Electricals	24kV	3p/0.2	1.2 Cont. & 1.9 for 30 sec	24/55/ 125kVp 60 VA	Indoor	B

C. Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	Remark
1	GEN PROTN. RELAY-GR1	GRP-8A	SIEMENS/ 7UM62	7UM6225-5EB92-0BA0	V04.63.02	YES	
2	GEN PROTN. RELAY-GR2	GRP-8B	C 7UM62	7UM6225-5EB92-0CB0	V04.63.02	YES	
3	Frequency Generator	GRP-8B	SIEMENS/ 7XT34	7XT3400-0CA00	--------	YES	
4	20 Hz Band pass filter	GRP-8B	SIEMENS/ 7XT33	7XT3300-0CA00	--------	YES	
5	Control unit for REF	GRP-8A	SIEMENS/ 7XT71	7XT7100-0EA00	--------	YES	
6	Resistor coupling unit for REF	GRP-8A	SIEMENS/ 7XR6004	7XR6004-0CA00	--------	YES	
7	GEN PROTN. RELAY-GR1	GRP-9A	SIEMENS/ 7UM62	7UM6225-5EB92-0BA0	V04.63.02	YES	
8	GEN PROTN. RELAY-GR2	GRP-9B	SIEMENS/ 7UM62	7UM6225-5EB92-0CB0	V04.63.02	YES	
9	Frequency Generator	GRP-9B	SIEMENS/ 7XT34	7XT3400-0CA00	--------	YES	
10	20 Hz Band pass filter	GRP-9B	SIEMENS/ 7XT33	7XT3300-0CA00	--------	YES	
11	Control unit for REF	GRP-9A	SIEMENS/ 7XT71	7XT7100-0EA00	--------	YES	
12	Resistor coupling unit for REF	GRP-9A	SIEMENS/ 7XR6004	7XR6004-0CA00	--------	YES	
13	Disturbance Recorder	GRP-8C	SIMEAS R-ZE 8/16	7KE6000-0dd41-4ck2/cc	--------	YES	**SOFTWARE EXPIRED**
14	Disturbance Recorder	GRP-9C	SIMEAS R-ZE 8/16	7KE6000-0dd41-4ck2/cc	--------	YES	**SOFTWARE EXPIRED**

Sr. No.	Particulars	Adopted setting	Recommended Setting	Group	Date of testing		Remark
					Unit-08	Unit-09	
	GR1 Relay						
a	Generator differential						
	87-1 Pickup Value of Differential Curr.	0.10 I/InO	0.10 I/InO	A	09.06.2021	04.01.2023	
	87-1 T I-DIFF> Time Delay	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
	87-2 Pickup Value of High Set Trip	7.0 I/InO	7.0 I/InO	A	09.06.2021	04.01.2023	
	87-2 T I-DIFF>> Time Delay	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
b	**Differential Protection; Group Characteristic**						
	87 Slope 1 of Tripping Characteristic	0.25	0.25	A	09.06.2021	04.01.2023	
	87 Base Point for Slope 1 of Charac.	0.00 I/InO	0.00 I/InO	A	09.06.2021	04.01.2023	
	87 Slope 2 of Tripping Characteristic	0.60	0.60	A	09.06.2021	04.01.2023	
	87 Base Point for Slope 2 of Charac.	1.60 I/InO	1.60 I/InO	A	09.06.2021	04.01.2023	
	87 I-RESTRAINT for Start Detection	0.10 I/InO	0.10 I/InO	A	09.06.2021	04.01.2023	
	87 Factor for Increas. of Char. at Start	1.0	1.0	A	09.06.2021	04.01.2023	
	87 Maximum Permissible Starting Time	5.0 sec	5.0 sec	A	09.06.2021	04.01.2023	
	87 Pickup for Add-on Stabilization	4.00 I/InO	4.00 I/InO	A	09.06.2021	04.01.2023	
	87 Duration of Add-on Stabilization	15 Cycle	15 Cycle	A	09.06.2021	04.01.2023	
	87 Time for Cross-block Add-on Stabiliz.	15 Cycle	15 Cycle	A	09.06.2021	04.01.2023	
c	Under excitation Protection						
	40 Underexcitation Protection	ON	ON	A	09.06.2021	04.01.2023	
	40 T-Short Time Delay (Char. & Vexc<)	0.10 sec	0.10 sec	A	09.06.2021	04.01.2023	
	40 State of Excitation Volt. Supervision	OFF	OFF	A	09.06.2021	04.01.2023	

	40 Excitation Voltage Superv. Pickup	3.50 V	3.50 V	A	09.06.2021	04.01.2023	
	40 Undervoltage blocking Pickup	25.0 V	25.0 V	A	09.06.2021	04.01.2023	
	40 Susceptance Intersect Characteristic1	0.55	0.55	A	09.06.2021	04.01.2023	
	40 Inclination Angle of Characteristic 1	80 °	80 °	A	09.06.2021	04.01.2023	
	40 Characteristic 1 Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	40 Susceptance Intersect Characteristic2	0.49	0.49	A	09.06.2021	04.01.2023	
	40 Inclination Angle of Characteristic 2	90 °	90 °	A	09.06.2021	04.01.2023	
	40 Characteristic 2 Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	40 Susceptance Intersect Characteristic3	1.10	1.10	A	09.06.2021	04.01.2023	
	40 Inclination Angle of Characteristic 3	100 °	100 °	A	09.06.2021	04.01.2023	
	40 Characteristic 3 Time Delay	0.30 sec	0.30 sec	A	09.06.2021	04.01.2023	
d	32R Reverse Power Protection						
	32R Reverse Power Protection	ON	ON	A	09.06.2021	04.01.2023	
	32R P> Reverse Pickup	-0.50 %	-0.50 %	A	09.06.2021	04.01.2023	
	32R Time Delay Long (without Stop Valve)	oo sec	02 sec	A	09.06.2021	04.01.2023	
	32R Time Delay Short (with Stop Valve)	oo sec	10 sec	A	09.06.2021	04.01.2023	
	32R Pickup Holding Time	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
e	32F Forward Power Supervision						
	32F Forward Power Supervision	ON	ON	A	09.06.2021	04.01.2023	
	32F P-forw.< Supervision Pickup	0.5 %	0.5 %	A	09.06.2021	04.01.2023	
	32F T-P-forw.< Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	

	32F P-forw.> Supervision Pickup	96.6 %	96.6 %	A	09.06.2021	04.01.2023	
	32F T-P-forw.> Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	
f	**21 Impedance Protection; Group General**						
	21 Impedance Protection	ON	ON	A	09.06.2021	04.01.2023	
	21 Fault Detection I> Pickup	6.75 A	6.75 A	A	09.06.2021	04.01.2023	
	21 State of Undervoltage Seal-in	OFF	OFF	A	09.06.2021	04.01.2023	
	21 Undervoltage Seal-in Pickup	80.0 V	80.0 V	A	09.06.2021	04.01.2023	
	21 Duration of Undervoltage Seal-in	4.00 sec	4.00 sec	A	09.06.2021	04.01.2023	
	21 T END: Final Time Delay	3.00 sec	3.00 sec	A	09.06.2021	04.01.2023	
g	**21 Impedance Protection; Group Zones**						
	21 Impedance Zone Z1	1.46 Ohm	1.46 Ohm	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z1 Time Delay	0.60 sec	0.60 sec	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z1B	3.07 Ohm	3.07 Ohm	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z1B Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z2	3.07 Ohm	3.07 Ohm	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z2 Time Delay	2.00 sec	2.00 sec	A	09.06.2021	04.01.2023	
h	**21 Impedance Protection; Group Power swing**						
	Power Swing Blocking	OFF	OFF	A	09.06.2021	04.01.2023	
	Distance betw. Power Swing - Trip-Pol.	1.60 Ohm	1.60 Ohm	A	09.06.2021	04.01.2023	
	Rate of Change of dZ/dt	60.0 Ohm/s	60.0 Ohm/s	A	09.06.2021	04.01.2023	
	Power Swing Blocking locks out	Zone Z1	Zone Z1	A	09.06.2021	04.01.2023	
	Power Swing Action Time	3.00 sec	3.00 sec	A	09.06.2021	04.01.2023	
i	**27 Undervoltage**						
	27 Undervoltage Protection	ON	ON	A	09.06.2021	04.01.2023	

	27-1 Pickup	77.0 V	77.0 V	A	09.06.2021	04.01.2023	
	27-1 Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	27-2 Pickup	65.0 V	65.0 V	A	09.06.2021	04.01.2023	
	27-2 Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	
	27 V<, V<< Drop Out Ratio	1.05	1.05	A	09.06.2021	04.01.2023	
j	**59 Overvoltage**						
	59 Overvoltage Protection	ON	ON	A	09.06.2021	04.01.2023	
	59-1 Pickup	121.0 V	121.0 V	A	09.06.2021	04.01.2023	
	59-1 Time Delay	5.00 sec	2.00 sec	A	09.06.2021	04.01.2023	
	59-2 Pickup	154.0 V	154.0 V	A	09.06.2021	04.01.2023	
	59-2 Time Delay	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
	59 V>, V>> Drop Out Ratio	0.95	0.95	A	09.06.2021	04.01.2023	
	59 Measurement Values	Voltage protection with V-Phase-Phase	Voltage protection with V-Phase-Phase	A	09.06.2021	04.01.2023	
k	**81 Over/Under Frequency Prot**						
	81 Over/Under Frequency Protection	ON	ON	A	09.06.2021	04.01.2023	
	81-1 Pickup	48.50 Hz	48.50 Hz	A	09.06.2021	04.01.2023	
	81-1 Time Delay	5.00 sec	5.00 sec	A	09.06.2021	04.01.2023	
	81-2 Pickup	47.40 Hz	47.40 Hz	A	09.06.2021	04.01.2023	
	81-2 Time Delay	2.00 sec	2.00 sec	A	09.06.2021	04.01.2023	
	81-3 Pickup	51.00 Hz	51.00 Hz	A	09.06.2021	04.01.2023	
	81-3 Time delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	81-4 Pickup	52.00 Hz	52.00 Hz	A	09.06.2021	04.01.2023	
	81-4 Time delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	81 Handling of Threshold Stage 81-4	Freq. prot. stage automatic	Freq. prot. stage automatic	A	09.06.2021	04.01.2023	
	81 Minimum Required Volt. for Operation	70.0 V	70.0 V	A	09.06.2021	04.01.2023	
l	Overexcit. Protection (Volt/Hertz)						
	24 Overexcit. Protection (Volt/Hertz)	ON	ON	A	09.06.2021	04.01.2023	
	24-1 V/f Pickup	1.10	1.10	A	09.06.2021	04.01.2023	
	24-1 V/f Time Delay	2.00 sec	2.00 sec	A	09.06.2021	04.01.2023	

	24-2 V/f Pickup	1.40	1.40	A	09.06.2021	04.01.2023	
	24-2 V/f Time Delay	1.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
m	Overexcit. Protection (Volt/Hertz); Group Characteristics						
	24 V/f = 1.05 Time Delay	20000 sec	20000 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.10 Time Delay	6000 sec	6000 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.15 Time Delay	240 sec	240 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.20 Time Delay	60 sec	60 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.25 Time Delay	30 sec	30 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.30 Time Delay	19 sec	19 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.35 Time Delay	13 sec	13 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.40 Time Delay	10 sec	10 sec	A	09.06.2021	04.01.2023	
	24 Time for Cooling Down	3600 sec	3600 sec	A	09.06.2021	04.01.2023	
n	59N/67GN Stator Ground Fault Prot						
	59N/67GN Stator Ground Fault Prot.	ON	ON	A	09.06.2021	04.01.2023	
	59N V0> Pickup	5.0 V	5.0 V	A	09.06.2021	04.01.2023	
	59N/67GN Time Delay	1.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
o	Group Interturn Protection						
	Interturn Protection	ON	ON	A	09.06.2021	04.01.2023	
	Pick up Value V Interturn>	10.0 V	10.0 V	A	09.06.2021	04.01.2023	
	Time Delay of Trip Command	2.00 sec	2.00 sec	A	09.06.2021	04.01.2023	
	Reset Ratio of V Interturn>	80 %	80 %	A	09.06.2021	04.01.2023	
p	50/27 Inadvertent Energization						
	50/27 Inadvertent Energization	ON	ON	A	09.06.2021	04.01.2023	
	50/27 I Stage Pickup	5.0 A	5.0 A	A	09.06.2021	04.01.2023	
	50/27 Release Threshold V1<	77.0 V	77.0 V	A	09.06.2021	04.01.2023	
	50/27 Pickup Time Delay T V1<	3.00 sec	3.00 sec	A	09.06.2021	04.01.2023	

	50/27 Drop Out Time Delay T V1<	1.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
q	Group 50/51/67 I>> (with direction)						
	50/51/67 Overcurrent Time Protection I>>	ON	ON	A	09.06.2021	04.01.2023	
	50/51/67-2 Pickup	4.80 A	4.80 A	A	09.06.2021	04.01.2023	
	50/51/67-2 Time Delay	5.00 sec	5.00 sec	A	09.06.2021	04.01.2023	
r	Negative Sequence (Time Overcurrent); Group 46						
	46 Negative Sequence Protection	ON	ON	A	09.06.2021	04.01.2023	
	46 Continuously Permissible Current I2	6.6 %	6.59 %	A	09.06.2021	04.01.2023	
	46 Warning Stage Time Delay	20.00 sec	20.00 sec	A	09.06.2021	04.01.2023	
	46 Permissible Negative Sequence Time K	1.0 sec	1.0 sec	A	09.06.2021	04.01.2023	
	46 Time for Cooling Down	0 sec	0 sec	A	09.06.2021	04.01.2023	
	46-2 Pickup	53 %	53.51 %	A	09.06.2021	04.01.2023	
	46-2 Time Delay	3.00 sec	3.00 sec	A	09.06.2021	04.01.2023	
2	**GR2 Relay**						
a	50/51 I> (with undervoltage seal-in						
	50/51 Overcurrent Time Protection I>	ON	ON	A	09.06.2021	04.01.2023	
	50/51-1 Pickup	4.52 A	4.52 A	A	09.06.2021	04.01.2023	
	50/51-1 Time Delay	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
	50/51 State of Undervoltage Seal-in	OFF	OFF	A	09.06.2021	04.01.2023	
	50/51 Undervoltage Seal-in Pickup	80.0 V	80.0 V	A	09.06.2021	04.01.2023	
	50/51 Duration of Undervoltage Seal-in	4.00 sec	4.00 sec	A	09.06.2021	04.01.2023	
	50/51 I> Drop Out Ratio	0.95	0.95	A	09.06.2021	04.01.2023	
b	50/51/67 I>> (with direction);						
	50/51/67 Overcurrent Time Protection I>>	ON	ON	A	09.06.2021	04.01.2023	
	50/51/67-2 Pickup	4.80 A	4.80 A	A	09.06.2021	04.01.2023	
	50/51/67-2 Time Delay	5.00 sec	5.00 sec	A	09.06.2021	04.01.2023	
c	46 Negative Sequence						

	46 Negative Sequence Protection	ON	ON	A	09.06.2021	04.01.2023	
	46 Continously Permissible Current I2	6.6 %	6.59 %	A	09.06.2021	04.01.2023	
	46 Warning Stage Time Delay	20.00 sec	20.00 sec	A	09.06.2021	04.01.2023	
	46 Permissible Negative Sequence Time K	1.0 sec	1.0 sec	A	09.06.2021	04.01.2023	
	46 Time for Cooling Down	0 sec	0 sec	A	09.06.2021	04.01.2023	
	46-2 Pickup	53 %	53.51%	A	09.06.2021	04.01.2023	
	46-2 Time Delay	3.00 sec	3.00 sec	A	09.06.2021	04.01.2023	
d	87 Differential Protection						
	87-1 Pickup Value of Differential Curr.	0.10 I/InO	0.10 I/InO	A	09.06.2021	04.01.2023	
	87-1 T I-DIFF> Time Delay	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
	87-2 Pickup Value of High Set Trip	7.0 I/InO	7.0 I/InO	A	09.06.2021	04.01.2023	
	87-2 T I-DIFF>> Time Delay	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
e	87 Differential Protection; Group Characteristic						
	87 Slope 1 of Tripping Characteristic	0.25	0.25	A	09.06.2021	04.01.2023	
	87 Base Point for Slope 1 of Charac.	0.00 I/InO	0.00 I/InO	A	09.06.2021	04.01.2023	
	87 Slope 2 of Tripping Characteristic	0.60	0.60	A	09.06.2021	04.01.2023	
	87 Base Point for Slope 2 of Charac.	1.60 I/InO	1.60 I/InO	A	09.06.2021	04.01.2023	
	87 I-RESTRAINT for Start Detection	0.10 I/InO	0.10 I/InO	A	09.06.2021	04.01.2023	
	87 Factor for Increas. of Char. at Start	1.0	1.0	A	09.06.2021	04.01.2023	
	87 Maximum Permissible Starting Time	5.0 sec	5.0 sec	A	09.06.2021	04.01.2023	
	87 Pickup for Add-on Stabilization	4.00 I/InO	4.00 I/InO	A	09.06.2021	04.01.2023	
	87 Duration of Add-on Stabilization	15 Cycle	15 Cycle	A	09.06.2021	04.01.2023	

	87 Time for Cross-block Add-on Stabiliz.	15 Cycle	15 Cycle	A	09.06.2021	04.01.2023	
f	40 Under excitation Protection						
	40 Under excitation Protection	ON	ON	A	09.06.2021	04.01.2023	
	40 T-Short Time Delay (Char. & Vexc<)	0.10 sec	0.10 sec	A	09.06.2021	04.01.2023	
	40 State of Excitation Volt. Supervision	OFF	OFF	A	09.06.2021	04.01.2023	
	40 Excitation Voltage Superv. Pickup	3.50 V	3.50 V	A	09.06.2021	04.01.2023	
	40 Undervoltage blocking Pickup	25.0 V	25.0 V	A	09.06.2021	04.01.2023	
g	Under excitation Protection; Group Characteristics						
	40 Susceptance Intersect Characteristic1	0.55	0.55	A	09.06.2021	04.01.2023	
	40 Inclination Angle of Characteristic 1	80 °	80 °	A	09.06.2021	04.01.2023	
	40 Characteristic 1 Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	40 Susceptance Intersect Characteristic2	0.49	0.49	A	09.06.2021	04.01.2023	
	40 Inclination Angle of Characteristic 2	90 °	90 °	A	09.06.2021	04.01.2023	
	40 Characteristic 2 Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	40 Susceptance Intersect Characteristic3	1.10	1.10	A	09.06.2021	04.01.2023	
	40 Inclination Angle of Characteristic 3	100 °	100 °	A	09.06.2021	04.01.2023	
	40 Characteristic 3 Time Delay	0.30 sec	0.30 sec	A	09.06.2021	04.01.2023	
h	**32R Reverse Power Protection**						
	32R Reverse Power Protection	ON	ON	A	09.06.2021	04.01.2023	
	32R P> Reverse Pickup	-0.50 %	-0.50 %	A	09.06.2021	04.01.2023	

	32R Time Delay Long (without Stop Valve)	oo sec	oo sec	A	09.06.2021	04.01.2023	
	32R Time Delay Short (with Stop Valve)	oo sec	oo sec	A	09.06.2021	04.01.2023	
	32R Pickup Holding Time	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
i	**32F Forward Power Supervision**						
	32F Forward Power Supervision	ON	ON	A	09.06.2021	04.01.2023	
	32F P-forw.< Supervision Pickup	0.5 %	0.5 %	A	09.06.2021	04.01.2023	
	32F T-P-forw.< Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	
	32F P-forw.> Supervision Pickup	96.6 %	96.6 %	A	09.06.2021	04.01.2023	
	32F T-P-forw.> Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	
	32F Method of Operation	Method accurate	Method accurate	A	09.06.2021	04.01.2023	
j	**21 Impedance Protection**						
	21 Impedance Protection	ON	ON	A	09.06.2021	04.01.2023	
	21 Fault Detection I> Pickup	6.75 A	6.75 A	A	09.06.2021	04.01.2023	
	21 State of Undervoltage Seal-in	OFF	OFF	A	09.06.2021	04.01.2023	
	21 Undervoltage Seal-in Pickup	80.0 V	80.0 V	A	09.06.2021	04.01.2023	
	21 Duration of Undervoltage Seal-in	4.00 sec	4.00 sec	A	09.06.2021	04.01.2023	
	21 T END: Final Time Delay	3.00 sec	3.00 sec	A	09.06.2021	04.01.2023	
k	**21 Impedance Protection; Group Zones**						
	21 Impedance Zone Z1	1.46 Ohm	1.46 Ohm	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z1 Time Delay	0.60 sec	0.60 sec	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z1B	3.07 Ohm	3.07 Ohm	A	09.06.2021	04.01.2023	
	21 Impedance Zone Z1B Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	
	21 Impedanz Zone Z2	3.07 Ohm	3.07 Ohm	A	09.06.2021	04.01.2023	

	21 Impedance Zone Z2 Time Delay	2.00 sec	2.00 sec	A	09.06.2021	04.01.2023	
l	**21 Impedance Protection; Group Power swing**						
	Power Swing Blocking	OFF	OFF	A	09.06.2021	04.01.2023	
	Distance betw. Power Swing - Trip-Pol.	1.60 Ohm	1.60 Ohm	A	09.06.2021	04.01.2023	
	Rate of Change of dZ/dt	60.0 Ohm/s	60.0 Ohm/s	A	09.06.2021	04.01.2023	
	Power Swing Blocking locks out	Zone Z1	Zone Z1	A	09.06.2021	04.01.2023	
	Power Swing Action Time	3.00 sec	3.00 sec	A	09.06.2021	04.01.2023	
m	**78 Out-of-Step Protection**						
	78 Out-of-Step Protection	ON	ON	A	09.06.2021	04.01.2023	
	78 Pickup Curr. for Measur. Release I1>	120.0 %	120.0 %	A	09.06.2021	04.01.2023	
	78 Pickup Curr. for Measur. Release I2<	20.0 %	20.0 %	A	09.06.2021	04.01.2023	
	78 Resistance Za of the Polygon (width)	1.60 Ohm	1.60 Ohm	A	09.06.2021	04.01.2023	
	78 Reactance Zb of the Polygon (reverse)	3.52 Ohm	3.52 Ohm	A	09.06.2021	04.01.2023	
	78 Reactance Zc of Polygon(forw. char.1)	1.78 Ohm	1.78 Ohm	A	09.06.2021	04.01.2023	
	78 Reactance Dif. Char.1-Char.2 (forw.)	0.61 Ohm	0.61 Ohm	A	09.06.2021	04.01.2023	
	78 Angle of Inclination of the Polygon	90.0 °	90.0 °	A	09.06.2021	04.01.2023	
	78 Numb. of Power Swing: Characteristic1	1	1	A	09.06.2021	04.01.2023	
	78 Numb. of Power Swing: Characteristic2	4	4	A	09.06.2021	04.01.2023	
	78 Holding Time of Fault Detection	25.00 sec	25.00 sec	A	09.06.2021	04.01.2023	
	78 Min. Signal Time for Annun. Char. 1/2	0.05 sec	0.05 sec	A	09.06.2021	04.01.2023	
n	27 Undervoltage						

	27 Undervoltage Protection	ON	ON	A	09.06.2021	04.01.2023	
	27-1 Pickup	77.0 V	77.0 V	A	09.06.2021	04.01.2023	
	27-1 Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	27-2 Pickup	65.0 V	65.0 V	A	09.06.2021	04.01.2023	
	27-2 Time Delay	oo sec	oo sec	A	09.06.2021	04.01.2023	
	27 V<, V<< Drop Out Ratio	1.05	1.05	A	09.06.2021	04.01.2023	
o	59 Overvoltage						
	59 Overvoltage Protection	ON	ON(ALARM only)	A	09.06.2021	04.01.2023	A
	59-1 Pickup	121.0 V	132.0 V	A	09.06.2021	04.01.2023	
	59-1 Time Delay	5.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
	59-2 Pickup	154.0 V	154.0 V	A	09.06.2021	04.01.2023	
	59-2 Time Delay	0.00 sec	0.00 sec	A	09.06.2021	04.01.2023	
	59 V>, V>> Drop Out Ratio	0.95	0.95	A	09.06.2021	04.01.2023	
	59 Measurement Values	Voltage protection with V-Phase-Phase	Voltage protection with V-Phase-Phase	A	09.06.2021	04.01.2023	
p	81 Over/Under Frequency Prot						
	81 Over/Under Frequency Protection	ON	ON	A	09.06.2021	04.01.2023	
	81-1 Pickup	48.50 Hz	48.50 Hz	A	09.06.2021	04.01.2023	
	81-1 Time Delay	5.00 sec	5.00 sec	A	09.06.2021	04.01.2023	
	81-2 Pickup	47.40 Hz	47.40 Hz	A	09.06.2021	04.01.2023	
	81-2 Time Delay	2.00 sec	2.00 sec	A	09.06.2021	04.01.2023	
	81-3 Pickup	51.00 Hz	51.00 Hz	A	09.06.2021	04.01.2023	
	81-3 Time delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	81-4 Pickup	52.00 Hz	52.00 Hz	A	09.06.2021	04.01.2023	
	81-4 Time delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	81 Handling of Threshold Stage 81-4	Freq. prot. stage automatic	Freq. prot. stage automatic	A	09.06.2021	04.01.2023	
	81 Minimum Required Volt. for Operation	70.0 V	70.0 V	A	09.06.2021	04.01.2023	
q	24 Overexcit. Protection (Volt/Hertz)						
	24 Overexcit. Protection (Volt/Hertz)	ON	ON	A	09.06.2021	04.01.2023	

	24-1 V/f Pickup	1.10	1.10	A	09.06.2021	04.01.2023	
	24-1 V/f Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	24-2 V/f Pickup	1.40	1.40	A	09.06.2021	04.01.2023	
	24-2 V/f Time Delay	1.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
r	24 Overexcit. Protection (Volt/Hertz); Group Characteristics						
	24 V/f = 1.05 Time Delay	20000 sec	20000 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.10 Time Delay	6000 sec	6000 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.15 Time Delay	240 sec	240 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.20 Time Delay	60 sec	60 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.25 Time Delay	30 sec	30 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.30 Time Delay	19 sec	19 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.35 Time Delay	13 sec	13 sec	A	09.06.2021	04.01.2023	
	24 V/f = 1.40 Time Delay	10 sec	10 sec	A	09.06.2021	04.01.2023	
	24 Time for Cooling Down	3600 sec	3600 sec	A	09.06.2021	04.01.2023	
s	59N/67GN Stator Ground Fault Prot						
	59N/67GN Stator Ground Fault Prot.	ON	ON	A	09.06.2021	04.01.2023	
	59N V0> Pickup	5.0 V	5.0 V	A	09.06.2021	04.01.2023	
	59N/67GN Time Delay	1.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
t	100% Stator-Ground-Fault Protection						
	100% Stator-Ground-Fault Protection	ON	ON	A	09.06.2021	04.01.2023	
	Pickup Value of Alarm Stage Rsgf<	402 Ohm	402 Ohm	A	09.06.2021	04.01.2023	
	Pickup Value of Tripping Stage Rsgf<<	40 Ohm	40 Ohm	A	09.06.2021	04.01.2023	
	Time Delay of Alarm Stage Rsgf<	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	Time Delay of Tripping Stage Rsgf<<	1.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
	Pickup Value of I SGF>> Stage	0.40 A	0.40 A	A	09.06.2021	04.01.2023	

	Supervision Threshold of 20Hz Voltage	0.5 V	0.5 V	A	09.06.2021	04.01.2023	
	Supervision Threshold of 20Hz Current	5 mA	5 mA	A	09.06.2021	04.01.2023	
	Correction Angle for I SGF 100%	-14 °	-14 °	A	09.06.2021	04.01.2023	
	Resistance Rps	75.0 Ohm	46.0 Ohm	A	09.06.2021	04.01.2023	
	Parallel Load Resistance	oo Ohm	oo Ohm	A	09.06.2021	04.01.2023	
u	Interturn Protection; Group I/T Prot						
	Interturn Protection	OFF	OFF	A	09.06.2021	04.01.2023	
v	64 Rotor Ground Fault Protection						
	64 Rotor Ground Fault Protection (1-3Hz)	ON	ON	A	09.06.2021	04.01.2023	
	64R-1 Pickup	25.0 kOhm	25.0 kOhm	A	09.06.2021	04.01.2023	
	64R-2 Pickup	5.0 kOhm	5.0 kOhm	A	09.06.2021	04.01.2023	
	64R-1 Time Delay	10.00 sec	10.00 sec	A	09.06.2021	04.01.2023	
	64R-2 Time Delay	1.00 sec	1.00 sec	A	09.06.2021	04.01.2023	
	Pickup Value of open Rotor Circuit (Qc)	0.00 mAs	0.00 mAs	A	09.06.2021	04.01.2023	
	Testing Resistor	3.3 kOhm	3.3 kOhm	A	09.06.2021	04.01.2023	

2. 315 MVA, 16.5/220 KV GENERATING TRANSFORMER

Detail Technical specifications of the 315 MVA Generator Transformer:

Generator-Transformer-, 315 MVA, Rated Voltage-(at no load)-230kV/16.5kV, Rated Current-HV-790.72 LV-11022.14, Frequency-50 Hz, Vector group-Ynd11, Sl. No-HT1770/12928, Make-EMCO LTD.

II. **List of electrical components installed in 250 MW Generator:**

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	06 Set
B	Numerical Protection relays	04 No.

A. CURRENT TRANSFORMER

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	Error calculated	CLASS	Knee point voltage	Sec Res	Remark
1	HV SIDE BUSHING	CT-1	CORE-1	832/1.8	0%	5	------	------	
		CT-3	CORE-2	1000/1	0%	PS	1000	8	
			CORE-1	1600/1	0%	PS	1600	5	
2	HV SIDE NEUTRAL	CT-4	CORE-1	1000/1	0%	PS	1000	5	
			CORE-2	1000/1	0%	5P20	-------	1000	

B. Numerical protection relay:

Sl. No.	Relay Designation	Location	Make/Model	MLFB No.	Firmware	Functional	REMARK
1	DIFF. PROTN. RELAY 87GT-51NGT	GRP-8A	SIEMENS/ 7UT61	7UT6135-5EB92-1AC2	V04.62.05	YES	
2	GT OC EF PROTN. RLY 64GT/51GT	GRP-8B	SIEMENS/7SJ8022	7SJ8022-5EB90-1FA0	04.62.04	YES	
3	DIFF. PROTN. RELAY 87GT-51NGT	GRP-9A	SIEMENS/ 7UT61	7UT6135-5EB92-1AC2	V04.62.05	YES	

4	GT OC EF PROTN. RLY 64GT/51GT	GRP-9B	SIEMENS/7SJ8022	7SJ8022-5EB90-1FA0	04.62.04	YES	

DETAIL OF GENERATING TRANSFORMER PROTECTION SETTING: -

Sr. No.	Particulars	Adopted setting	Recommended setting	Group	Date of testing		Remark
1	**DIFF. PROTN. RELAY 87GT-51NGT**				Unit-09	Unit-09	
a	87 Differential Protection						
	87 Differential Protection	ON	ON	A	08.06.2021	05.01.2023	
	87 Increase of Trip Char. During Start	OFF	OFF	A	08.06.2021	05.01.2023	
	87 Inrush with 2. Harmonic Restraint	ON	ON	A	08.06.2021	05.01.2023	
	87 n-th Harmonic Restraint	OFF	OFF	A	08.06.2021	05.01.2023	
	87 Diff-Prot. with meas. Ground Curr. S2	NO	NO	A	08.06.2021	05.01.2023	
B	87 Differential Protection; Group I-Diff						
	87-1 Pickup Value of Differential Curr.	0.20 I/InO	0.20 I/InO	A	08.06.2021	05.01.2023	
	87-1 T I-DIFF> Time Delay	0.00 sec	0.00 sec	A	08.06.2021	05.01.2023	
	87-2 Pickup Value of High Set Trip	12.0 I/InO	12.0 I/InO	A	08.06.2021	05.01.2023	
	87-2 T I-DIFF>> Time Delay	0.00 sec	0.00 sec	A	08.06.2021	05.01.2023	
C	87 Differential Protection; Group Characteristic						
	87 Slope 1 of Tripping Characteristic	0.25	0.25	A	08.06.2021	05.01.2023	

	87 Base Point for Slope 1 of Charac.	0.00 I/InO	0.00 I/InO	A	08.06.2021	05.01.2023	
	87 Slope 2 of Tripping Characteristic	0.60	0.60	A	08.06.2021	05.01.2023	
	87 Base Point for Slope 2 of Charac.	1.60 I/InO	1.60 I/InO	A	08.06.2021	05.01.2023	
	87 I-RESTRAINT for Start Detection	0.10 I/InO	0.10 I/InO	A	08.06.2021	05.01.2023	
	87 Factor for Increas. of Char. at Start	1.0	1.0	A	08.06.2021	05.01.2023	
	87 Maximum Permissible Starting Time	5.0 sec	5.0 sec	A	08.06.2021	05.01.2023	
	87 Pickup for Add-on Stabilization	4.00 I/InO	4.00 I/InO	A	08.06.2021	05.01.2023	
	87 Duration of Add-on Stabilization	15 Cycle	15 Cycle	A	08.06.2021	05.01.2023	
	87 Time for Cross-block Add-on Stabiliz.	15 Cycle	15 Cycle	A	08.06.2021	05.01.2023	
d	87 Differential Protection; Group Inrush 2.HM						
	87 2nd Harmonic Content in I-DIFF	15 %	15 %	A	08.06.2021	05.01.2023	
	87 Time for Cross-blocking 2nd Harm.	3 Cycle	3 Cycle	A	08.06.2021	05.01.2023	
e	87 Differential Protection; Group Restr. n.HM						
	87 n-th Harmonic Content in I-DIFF	30 %	30 %	A	08.06.2021	05.01.2023	
	87 Time for Cross-blocking n-th Harm.	0 Cycle	0 Cycle	A	08.06.2021	05.01.2023	
	87 Limit IDIFFmax of n-th Harm.Restr.	4.0 I/InO	4.0 I/InO	A	08.06.2021	05.01.2023	

f	50G/51G; Group General						
	50G, 51G Ground Time Overcurrent	ON	ON	A	08.06.2021	05.01.2023	
	50/51G InRush Restrained	OFF	OFF	A	08.06.2021	05.01.2023	
	50/51G Manual Close Mode	Inactive	Inactive	A	08.06.2021	05.01.2023	
g	50G/51G; Group 50G						
	50G-2 Pickup	oo A	oo A	A	08.06.2021	05.01.2023	
	50G-2 Time Delay	oo sec	oo sec	A	08.06.2021	05.01.2023	
	50G-1 Pickup	0.20 A	0.20 A	A	08.06.2021	05.01.2023	
	50G-1 Time Delay	1.00 sec	1.00 sec	A	08.06.2021	05.01.2023	
h	50G/51G; Group Inrush						
	50/51G 2nd harmonic in % of fundamental	15 %	15 %	A	08.06.2021	05.01.2023	
	50/51G Maximum Current for Inr. Rest.	5.00 A	5.00 A	A	08.06.2021	05.01.2023	
2	**GT OC EF PROTN. RLY 64GT/51GT**						
a	DMT / IDMT Phase/Earth Overcurrent						
	Phase Time Overcurrent	ON	ON	A	08.06.2021	05.01.2023	
	Manual Close Mode	I>> instantaneously	I>> instantaneously	A	08.06.2021	05.01.2023	
	Dropout Time Delay DMT Phase	0.00 sec	0.00 sec	A	08.06.2021	05.01.2023	
b	DMT / IDMT Phase/Earth Overcurrent						
	I>>> measurement of	Fundamental component	Fundamental component	A	08.06.2021	05.01.2023	
	I>>> active	Always	Always	A	08.06.2021	05.01.2023	
	I>>> Pickup	oo A	oo A	A	08.06.2021	05.01.2023	
	T I>>> Time Delay	0.00 sec	0.00 sec	A	08.06.2021	05.01.2023	
	I>> measurement of	Fundamental component	Fundamental component	A	08.06.2021	05.01.2023	

	I>> active	Always	Always	A	08.06.2021	05.01.2023	
	I>> Pickup	oo A	oo A	A	08.06.2021	05.01.2023	
	T I>> Time Delay	oo sec	oo sec	A	08.06.2021	05.01.2023	
	I> measurement of	Fundamental component	Fundamental component	A	08.06.2021	05.01.2023	
	I> Pickup	3.00 A	3.00 A	A	08.06.2021	05.01.2023	
	T I> Time Delay	0.10 sec	0.10 sec	A	08.06.2021	05.01.2023	
c	Group Time overcurrent 1Phase						
	1Phase Time Overcurrent	ON	ON	A	08.06.2021	05.01.2023	
d	Time overcurrent 1Phase; Group Settings (REF)						
	1Phase O/C I>> Pickup	0.100 A	0.100 A	A	08.06.2021	05.01.2023	
	T 1Phase O/C I>> Time Delay	0.00 sec	0.00 sec	A	08.06.2021	05.01.2023	
	1Phase O/C I> Pickup	oo A	oo A	A	08.06.2021	05.01.2023	
	T 1Phase O/C I> Time Delay	oo sec	oo sec	A	08.06.2021	05.01.2023	

Mechanical protection tripping and Annunciation healthiness.

Sl. No.	MECHANICAL PROTECTION	SETTING		GT-08			GT-09		
		ALARM	TRIP	ALARM	TRIP	DOT	ALARM	TRIP	DOT
1	OTI	75	85	80°C	85°C	14.03.24	80°C	90°C	15.03.24
2	HV WTI	80	90	75°C	91°C	14.03.24	85°C	90°C	15.03.24
3	LV WTI	80	90	80°C	90°C	14.03.24	80°C	91°C	15.03.24
4	BUCKHOLZ	Alarm	Trip	OP	OP	14.03.24	OP	OP	15.03.24
5	PRV	------	Trip	------	OP	14.03.24	------	OP	15.03.24
6	LOW OIL LEVEL	Alarm	------	OP	------	14.03.24	OP	------	15.03.24
7	SOURCE A SUPPLY	Alarm	------	OP	------	14.03.24	OP	------	15.03.24
8	SOURCE B SUPPLY	Alarm	------	OP	------	14.03.24	OP	------	15.03.24
9	COOLER CONTROL SUPPLY	Alarm	------	OP	------	14.03.24	OP	------	15.03.24

CIRCUIT BREAKER OPERATION

Sl. No.	Transformer Designation	CB Operation		
		By TNC Switch Remote/Loc	By protection/Inter trip	Emergency trip Ele. & mech.
1	GT-08	OK	OK	OK
2	GT-09	OK	OK	OK

CIRCUIT BREAKER ANNUNCIATION

Sl. No.	Circuit Breaker	Indications			Annunciations			Transformer Conditioning Monitoring	Pole Discrepancy
		CB ON-OFF	Trip circuit Healthy	SF6 Pressure Normal	D.C Fail	Trip Circuit Faulty	Breaker Lockout		
1	CB UNIT-08	OK	OK	OK	OK	OK	OK	NA	OK
2	CB UNIT-09	OK	OK	OK	OK	OK	OK	NA	OK

3. 31.5 MVA, 16.5/6.6KV UNIT AUXILIARY TRANSFORMER

I. Detail Technical specifications of the Unit Auxiliary Transformer:

Unit Auxiliary Transformer 31.5 MVA, Rated Voltage-(at no load)-16.5kV/6.9kV, Rated Current-HV-881.77A LV-2108.58A, Frequency-50 Hz, Vector group-Dyn1, Sl. No-HT1772, Cooling-ONAN/ONAF Make- EMCO LTD.

II. List of electrical components installed in 250 MW Generator:

Sl. No.	Electrical component	Installed quantity
A	Current Transformer	As Described
B	Numerical Protection relays	As Described

A. Current Transformer

Sl. No.	**Location of CT**	**CT Designation**	**CT Ratio**	**Ratio adopted**	**Error calculated**	**CLASS**	**Knee point voltage**	**Sec Res**	**Remark**
1	TAP OFF BUS DUCT FOR UAT	CORE-K	1600/1	1600/1	------	5P20	------	------	
		CORE-L	1600/1	1600/1	------	PS	500 V	6 Ohm	
		CORE-M	12500/5	12500/5	------	PS	2000V	5 Ohm	
2	6.6 KV UAT LV SIDE	CORE-C1	1600/1	1600/1	------	0.2	600 V	12.5 Ohm	
		CORE-C2	1600/1	1600/1	------	PS	600 V	12.5 Ohm	
		CORE-C3	1600/1	1600/1	------	PS	-----	-----	
3	6.6 KV UAT LV NEUTRAL	CORE-1	300/1	300/1	------	5P20	-------	------	
		CORE-2	1600/1	1600/1	------	PS	800 V	8 Ohm	
		CT-9	400/5	400/5	------	1	-----	------	

B. Numerical Relays

Sl. No.	**Relay Designation**	**Location**	**Make/Model**	**MLFB No.**	**Firmware**	**Functional**	**REMARK**
1	UAT DIFF. PROTN. RELAY 87UT	GRP-8B	SIEMENS/ 7UT61	7UT6121-5EB90-1AA0	V04.62.07	YES	
2	UATOC REF RELAY-51UAT	GRP-8C	SIEMENS/7SJ8022	7SJ8022-5EB90-1FA0	04.62.04	YES	
3	UAT DIFF. PROTN.	GRP-9B	SIEMENS/ 7UT61	7UT6121-5EB90-1AA0	V04.62.07	YES	

	RELAY 87UT						
4	UATOC REF RELAY-51UAT	GRP-9C	SIEMENS/7SJ8022	7SJ8022-5EB90-1FA0	04.62.04	YES	

DETAIL OF UNIT AUXILIARY TRANSFORMER PROTECTION SETTING: -

Sr. No.	Particulars	Adopted setting	Recommended setting	Group	Date of testing		Remark
1	**UAT DIFF. PROTN. RELAY 87UT**						
a	87 Differential Protection						
	87 Differential Protection	ON	ON	A	Unit-08	Unit-09	
	87 Increase of Trip Char. During Start	OFF	OFF	A	10.06.21	05.01.23	
	87 Inrush with 2. Harmonic Restraint	ON	ON	A	10.06.21	05.01.23	
	87 n-th Harmonic Restraint	OFF	OFF	A	10.06.21	05.01.23	
	87 Diff-Prot. with meas. Ground Curr. S2	NO	NO	A	10.06.21	05.01.23	
b	87 Differential Protection; Group I-Diff						
	87-1 Pickup Value of Differential Curr.	0.20 I/InO	0.20 I/InO	A	10.06.21	05.01.23	
	87-1 T I-DIFF> Time Delay	0.00 sec	0.00 sec	A	10.06.21	05.01.23	
	87-2 Pickup Value of High Set Trip	12.0 I/InO	12.0 I/InO	A	10.06.21	05.01.23	
	87-2 T I-DIFF>> Time Delay	0.00 sec	0.00 sec	A	10.06.21	05.01.23	
c	87 Differential Protection; Group Characteristic						
	87 Slope 1 of Tripping Characteristic	0.25	0.25	A	10.06.21	05.01.23	
	87 Base Point for Slope 1 of Charac.	0.00 I/InO	0.00 I/InO	A	10.06.21	05.01.23	
	87 Slope 2 of Tripping Characteristic	0.60	0.60	A	10.06.21	05.01.23	
	87 Base Point for Slope 2 of Charac.	1.60 I/InO	1.60 I/InO	A	10.06.21	05.01.23	
	87 I-RESTRAINT for Start Detection	0.10 I/InO	0.10 I/InO	A	10.06.21	05.01.23	
	87 Factor for Increas. of Char. at Start	1.0	1.0	A	10.06.21	05.01.23	
	87 Maximum Permissible Starting Time	5.0 sec	5.0 sec	A	10.06.21	05.01.23	

	87 Pickup for Add-on Stabilization	4.00 I/InO	4.00 I/InO	A	10.06.21	05.01.23	
	87 Duration of Add-on Stabilization	15 Cycle	15 Cycle	A	10.06.21	05.01.23	
	87 Time for Cross-block Add-on Stabiliz.	15 Cycle	15 Cycle	A	10.06.21	05.01.23	
d	87 Differential Protection; Group Inrush 2.HM						
	87 2nd Harmonic Content in I-DIFF	15 %	15 %	A	10.06.21	05.01.23	
	87 Time for Cross-blocking 2nd Harm.	3 Cycle	3 Cycle	A	10.06.21	05.01.23	
e	87 Differential Protection; Group Restr. n.HM						
	87 n-th Harmonic Content in I-DIFF	30 %	30 %	A	10.06.21	05.01.23	
	87 Time for Cross-blocking n-th Harm.	0 Cycle	0 Cycle	A	10.06.21	05.01.23	
	87 Limit IDIFFmax of n-th Harm.Restr.	4.0 I/InO	4.0 I/InO	A	10.06.21	05.01.23	
f	50G/51G; Group General						
	50G, 51G Ground Time Overcurrent	ON	ON	A	10.06.21	05.01.23	
	50/51G InRush Restrained	OFF	OFF	A	10.06.21	05.01.23	
	50/51G Manual Close Mode	Inactive	Inactive	A	10.06.21	05.01.23	
g	50G/51G; Group 50G						
	50G-2 Pickup	oo A	oo A	A	10.06.21	05.01.23	
	50G-2 Time Delay	oo sec	oo sec	A	10.06.21	05.01.23	
	50G-1 Pickup	0.20 A	0.20 A	A	10.06.21	05.01.23	
	50G-1 Time Delay	1.00 sec	1.00 sec	A	10.06.21	05.01.23	
h	50G/51G; Group Inrush						
	50/51G 2nd harmonic in % of fundamental	15 %	15 %	A	10.06.21	05.01.23	
	50/51G Maximum Current for Inr. Rest.	5.00 A	5.00 A	A	10.06.21	05.01.23	
2	**UAT OC REF RELAY-51UAT**						
a	DMT / IDMT Phase/Earth Overcurrent						
	Phase Time Overcurrent	ON	ON	A	10.06.21	05.01.23	
	Manual Close Mode	I>> instantaneously	I>> instantaneously	A	10.06.21	05.01.23	
	Dropout Time Delay DMT Phase	0.00 sec	0.00 sec	A	10.06.21	05.01.23	
b	DMT / IDMT Phase/Earth Overcurrent						

	I>>> measurement of	Fundamental component	Fundamental component	A	10.06.21	05.01.23	
	I>>> active	Always	Always	A	10.06.21	05.01.23	
	I>>> Pickup	oo A	oo A	A	10.06.21	05.01.23	
	T I>>> Time Delay	0.00 sec	0.00 sec	A	10.06.21	05.01.23	
	I>> measurement of	Fundamental component	Fundamental component	A	10.06.21	05.01.23	
	I>> active	Always	Always	A	10.06.21	05.01.23	
	I>> Pickup	9.00 A	9.00 A	A	10.06.21	05.01.23	
	T I>> Time Delay	0.00 sec	0.00 sec	A	10.06.21	05.01.23	
	I> measurement of	Fundamental component	Fundamental component	A	10.06.21	05.01.23	
	I> Pickup	1.20 A	1.20 A	A	10.06.21	05.01.23	
	T I> Time Delay	1.00 sec	1.00 sec	A	10.06.21	05.01.23	
c	Time overcurrent 1Phase						
	1Phase O/C I>> Pickup	0.100 A	0.100 A	A	10.06.21	05.01.23	
	T 1Phase O/C I>> Time Delay	0.00 sec	0.00 sec	A	10.06.21	05.01.23	
	1Phase O/C I> Pickup	oo A	oo A	A	10.06.21	05.01.23	
	T 1Phase O/C I> Time Delay	oo sec	oo sec	A	10.06.21	05.01.23	

<u>Mechanical protection tripping and Annunciation healthiness.</u>

Sl. No.	Mechanical protection tripping and Annunciation healthiness	SETTING		UAT-08			UAT-09		
		ALARM	TRIP	ALARM	TRIP	DOT	ALARM	TRIP	DOT
1	OTI	95	100	96°C	103°C	15.03.24	96°C	103°C	15.03.24
2	WTI	100	105	101°C	105°C	15.03.24	101°C	105°C	15.03.24
3	BUCKHOLZ	alarm	trip	OP	OP	15.03.24	OP	OP	15.03.24
4	PRV1	------	trip	------	OP	15.03.24		OP	15.03.24
5	LOW OIL LEVEL	alarm	------	OP	------	15.03.24	OP	------	15.03.24
6	OSR	alarm	trip	OP	------	15.03.24	OP	------	15.03.24
7	SOURCE A SUPPLY	alarm	------	OP	------	15.03.24	OP	------	15.03.24
8	SOURCE B SUPPLY	alarm	------	OP	------	15.03.24	OP	------	15.03.24

4. STATION TRANSFORMER & 220KV SWITCHYARDS

I. Detail Technical specifications of the Station Transformer

Station Transformer- 50 MVA/25MVA/25MVA(ONAF), Rated Voltage-(at no load)-220kV/6.9kV/6.9kv, Rated Current-HV-131.22A, LV1-2091.85A, LV2-2091.85A, Frequency-50 Hz, Vector group-YNyn0yn0, Sl. No-HT1771, Make- EMCO LTD.

II. BAY DESCRIPTION

Sl. No.	BAY No.	Detail	Auxiliaries installed	Quantity
1	BAY 222	Unit-08 Bay	Lightning arrestor	3 Set
			Current transformer	3 Set
			Isolators	3 Set
			Earth switch	3 Set
			Circuit breaker	3 Set
2	BAY 223	Unit-09 Bay	Lightning arrestor	3 Set
			Current transformer	3 Set
			Isolators	3 Set
			Earth switch	3 Set
			Circuit breaker	3 Set
3	BAY 217	Station transformer-1 Bay	Lightning arrestor	3 Set
			Current transformer	3 Set
			Isolators	3 Set
			Earth switch	3 Set
			Circuit breaker	3 Set
4	BAY 219	Station transformer-2 Bay	Lightning arrestor	3 Set
			Current transformer	3 Set
			Isolators	3 Set
			Earth switch	3 Set
			Circuit breaker	3 Set

A. Current transformer

Sl. No.	Location of CT	CT Designation	CT Ratio	Ratio adopted	Error calculated	CLASS	Knee point voltage	Sec Res	Remark
1	Unit-08 Bay	CORE-1	1600-800/1	1600/1	------	PS	1600-800 V	8-4 Ohm	
		CORE-2	1600-800/1	1600/1	------	PS	1600-800 V	8-4 Ohm	
		CORE-3	1600-800-400/1	1600/1	------	0.2S	------	-------	

			CORE-4	1600-800-400/1	1600/1	------	PS	1600-800-400 V	8-4-2 Ohm	
			CORE-5	1600-800-400/1	1600/1	------	PS	1600-800-400 V	8-4-2 Ohm	
2	Unit-09 Bay		CORE-1	1600-800/1	1600/1	------	PS	1600	8-4 Ohm	
			CORE-2	1600-800/1	1600/1	------	PS	1600	8-4 Ohm	
			CORE-3	1600-800-400/1	1600/1	------	0.2S		-------	
			CORE-4	1600-800-400/1	1600/1	------	PS	1600	8-4-2 Ohm	
			CORE-5	1600-800-400/1	1600/1	------	PS	1600	8-4-2 Ohm	
3	Station transformer-1 Bay	HV SIDE	CORE-1	1600-800-600/400/1	1600/1	------	PS	1600 @ 1600/1 A	------	
			CORE-2	1600-800-600/400/1	1600/1	------	PS	1600 @ 1600/1 A	------	
			CORE-3	1600-800-600/400/1	400/1	------	PS		------	
			CORE-4	1600-800-600/400/1	400/1	------	PS	400 @400/1A	------	
			CORE-5	1600-800-600/400/1	400/1	------	PS	400 @400/1A	------	
		HV side bushing	CORE-1	400/1	400/1	------	PS	600	30	
			CORE-2	400/1	400/1	------	PS	600	30	
		HV side neutral bushing	CORE-1	400/1	400/1	------	PS	600	30	
		LV Side	CORE-1	2500/1	2500/1	------	PS	800	30	
			CORE-2	2500/1	2500/1	------	PS	800	30	
		LV Side neutral	CORE-1	300/1	300/1	------	PS	-----	5	
			CORE-2	2500/1	2500/1	------	PS	1000	30	
4	Station	HV SIDE	CORE-1	1600-800-600/400/1	1600/1	------	PS	1600 @ 1600/1 A	------	
			CORE-2	1600-800-600/400/1	1600/1	------	PS	1600 @	------	

								1600/1 A		
			CORE-3	1600-800-600/400/1	400/1	------	PS		------	
			CORE-4	1600-800-600/400/1	400/1	------	PS	400 @400/1A	------	
			CORE-5	1600-800-600/400/1	400/1	------	PS	400 @400/1A	------	
		HV side bushing	CORE-1	400/1	400/1	------	PS	600	30	
			CORE-2	400/1	400/1	------	PS	600	30	
		HV side neutral bushing	CORE-1	400/1	400/1	------	PS	600	30	
		LV Side	CORE-1	2500/1	2500/1	------	PS	800	30	
			CORE-2	2500/1	2500/1	------	PS	800	30	
		LV Side neutral	CORE-1	300/1	300/1	------	PS		5	
			CORE-2	2500/1	2500/1	------	PS	1000	30	

A. Numerical Relays

Sl. No.	**Relay Designation**	**Location**	**Make/Model**	**MLFB No.**	**Firmware**	**Functional**	**Remark**
1	OVERHANG PROTN. RELAY 87HV	GRP-8A	7UT61/siemens	7UT6121-5EB90-1AA0	V04.62.07	YES	
2	OVERHANG PROTN. RELAY 87HV	GRP-9A	7UT61/siemens	7UT6121-5EB90-1AA0	V04.62.07	YES	
3	TRANSFORMER DIFF REL 87T	STX8-RP	7UT61/siemens	7UT6131-5EB92-1AB0	V04.61.04	YES	
4	CABLE DIFF PROT 87C	STX8-RP	7UT61/siemens	7UT6121-5EB90-1AA0	V.04.60.07	YES	
5	LV1 REF PROT 64 RLV1	STX8-RP	7SJ80/siemens	7SJ8011-5EB90-1FA0	04.61.06	YES	
6	LV2 REF PROT 64 RLV2	STX8-RP	7SJ80/siemens	7SJ8011-5EB90-1FA0	04.61.06	YES	
7	HV REF PROT 64 HV/51	STX8-RP	7SJ80/siemens	7SJ8011-5EB90-1FA0	04.61.06	YES	
8	TRANSFORMER DIFF REL 87T	STX9-RP	7UT61/siemens	7UT6131-5EB92-1AB0	V.04.63.01	YES	
9	CABLE DIFF PROT 87C	STX9-RP	7UT61/siemens	7UT6121-5EB90-1AA0	V04.62.07	YES	

10	LV1 REF PROT 64 RLV1	STX9-RP	7SJ80/siemens	7SJ8011-5EB90-1FA0	04.63.05	YES	
11	LV2 REF PROT 64 RLV2	STX9-RP	7SJ80/siemens	7SJ8011-5EB90-1FA0	04.61.06	YES	
12	HV REF PROT 64 HV/51	STX9-RP	7SJ80/siemens	7SJ8011-5EB90-1FA0	04.62.04	YES	

DETAIL OF PROTECTION SETTING: -

Sr. No.	Particulars	Adopted setting	Recommended setting	Group	Date of testing		Remark
					GRP8A	GRP9A	
1	**OVERHANG PROTN. RELAY 87HV**						
a	87 Differential Protection; Group Characteristic						
	87 Slope 1 of Tripping Characteristic	0.25	0.25	A	10.06.21	06.01.23	
	87 Base Point for Slope 1 of Charac.	0.00 I/InO	0.00 I/InO	A	10.06.21	06.01.23	
	87 Slope 2 of Tripping Characteristic	0.60	0.60	A	10.06.21	06.01.23	
	87 Base Point for Slope 2 of Charac.	1.60 I/InO	1.60 I/InO	A	10.06.21	06.01.23	
	87 I-RESTRAINT for Start Detection	0.10 I/InO	0.10 I/InO	A	10.06.21	06.01.23	
	87 Factor for Increas. of Char. at Start	1.0	1.0	A	10.06.21	06.01.23	
	87 Maximum Permissible Starting Time	5.0 sec	5.0 sec	A	10.06.21	06.01.23	
	87 Pickup for Add-on Stabilization	4.00 I/InO	4.00 I/InO	A	10.06.21	06.01.23	
	87 Duration of Add-on Stabilization	15 Cycle	15 Cycle	A	10.06.21	06.01.23	
	87 Time for Cross-block Add-on Stabiliz.	15 Cycle	15 Cycle	A	10.06.21	06.01.23	
b	87 Differential Protection; Group I-Diff Monitor						
	87 Pickup Value of diff. Curr.Monitoring	0.15 I/InO	0.15 I/InO	A	10.06.21	06.01.23	

	87 T I-DIFF> Monitoring Time Delay	2 sec	2 sec	A	10.06.21	06.01.23	
2	**TRANSFORMER DIFF REL 87T**						
a	87 Differential Protection						
	87 Differential Protection	ON	ON	A	10.06.21	06.01.23	
	87 Increase of Trip Char. During Start	OFF	OFF	A	10.06.21	06.01.23	
	87 Inrush with 2. Harmonic Restraint	ON	ON	A	10.06.21	06.01.23	
	87 n-th Harmonic Restraint	OFF	OFF	A	10.06.21	06.01.23	
	87 Diff-Prot. with meas. Ground Curr.	NO	NO	A	10.06.21	06.01.23	
	87 Differential Protection; Group I-Diff				10.06.21	06.01.23	
	87-1 Pickup Value of Differential Curr.	0.20 I/InO	0.20 I/InO	A	10.06.21	06.01.23	
	87-1 T I-DIFF> Time Delay	0.00 sec	0.00 sec	A	10.06.21	06.01.23	
	87-2 Pickup Value of High Set Trip	7.0 I/InO	7.0 I/InO	A	10.06.21	06.01.23	
	87-2 T I-DIFF>> Time Delay	0.00 sec	0.00 sec	A	10.06.21	06.01.23	
b	87 Differential Protection; Group Characteristic						
	87 Slope 1 of Tripping Characteristic	0.25	0.25	A	10.06.21	06.01.23	
	87 Base Point for Slope 1 of Charac.	0.00 I/InO	0.00 I/InO	A	10.06.21	06.01.23	
	87 Slope 2 of Tripping Characteristic	0.60	0.60	A	10.06.21	06.01.23	
	87 Base Point for Slope 2 of Charac.	1.50 I/InO	1.50 I/InO	A	10.06.21	06.01.23	
	87 I-RESTRAINT for Start Detection	0.10 I/InO	0.10 I/InO	A	10.06.21	06.01.23	
	87 Factor for Increas. of Char. at Start	1.0	1.0	A	10.06.21	06.01.23	

	87 Maximum Permissible Starting Time	5.0 sec	5.0 sec	A	10.06.21	06.01.23	
	87 Pickup for Add-on Stabilization	4.00 I/InO	4.00 I/InO	A	10.06.21	06.01.23	
	87 Duration of Add-on Stabilization	15 Cycle	15 Cycle	A	10.06.21	06.01.23	
	87 Time for Cross-block Add-on Stabiliz.	15 Cycle	15 Cycle	A	10.06.21	06.01.23	
	87 Differential Protection; Group Inrush 2.HM				10.06.21	06.01.23	
	87 2nd Harmonic Content in I-DIFF	15 %	15 %	A	10.06.21	06.01.23	
	87 Time for Cross-blocking 2nd Harm.	3 Cycle	3 Cycle	A	10.06.21	06.01.23	
c	87 Differential Protection; Group Restr. n.HM						
	87 n-th Harmonic Content in I-DIFF	30 %	30 %	A	10.06.21	06.01.23	
	87 Time for Cross-blocking n-th Harm.	0 Cycle	0 Cycle	A	10.06.21	06.01.23	
	87 Limit IDIFFmax of n-th Harm.Restr.	1.5 I/InO	1.5 I/InO	A	10.06.21	06.01.23	
d	50G/51G; Group General						
	50G, 51G Ground Time Overcurrent	ON	ON	A	10.06.21	06.01.23	
	50/51G InRush Restrained	OFF	OFF	A	10.06.21	06.01.23	
	50/51G Manual Close Mode	50G-2 instantaneously	50G-2 instantaneously	A	10.06.21	06.01.23	
e	50G/51G; Group 50						
	50G-2 Pickup	0.20 A	0.20 A	A	10.06.21	06.01.23	
	50G-2 Time Delay	1.00 sec	1.00 sec	A	10.06.21	06.01.23	
	50G-1 Pickup	35.00 A	35.00 A	A	10.06.21	06.01.23	
	50G-1 Time Delay	oo sec	oo sec	A	10.06.21	06.01.23	
f	50G/51G; Group Inrush						
	50/51G 2nd harmonic in % of fundamental	15 %	15 %	A	10.06.21	06.01.23	

	50/51G Maximum Current for Inr. Rest.	7.50 A	7.50 A	A	10.06.21	06.01.23	
g	24 Overexcit. Protection (Volt/Hertz)						
	24 Overexcit. Protection (Volt/Hertz)	ON	ON	A	10.06.21	06.01.23	
h	Group 24 Overexcit. Protection (Volt/Hertz); Group 24 V/f Overexc						
	24-1 V/f Pickup	1.10	1.10	A	10.06.21	06.01.23	
	24-1 V/f Time Delay	10.00 sec	10.00 sec	A	10.06.21	06.01.23	
	24-2 V/f Pickup	1.35	1.35	A	10.06.21	06.01.23	
	24-2 V/f Time Delay	5.00 sec	5.00 sec	A	10.06.21	06.01.23	
i	24 Overexcit. Protection (Volt/Hertz);						
	24 V/f = 1.05 Time Delay	20000 sec	20000 sec	A	10.06.21	06.01.23	
	24 V/f = 1.10 Time Delay	20000 sec	20000 sec	A	10.06.21	06.01.23	
	24 V/f = 1.15 Time Delay	240 sec	240 sec	A	10.06.21	06.01.23	
	24 V/f = 1.20 Time Delay	60 sec	60 sec	A	10.06.21	06.01.23	
	24 V/f = 1.25 Time Delay	30 sec	30 sec	A	10.06.21	06.01.23	
	24 V/f = 1.30 Time Delay	20 sec	20 sec	A	10.06.21	06.01.23	
	24 V/f = 1.35 Time Delay	5 sec	5 sec	A	10.06.21	06.01.23	
	24 V/f = 1.40 Time Delay	1 sec	1 sec	A	10.06.21	06.01.23	
	24 Time for Cooling Down	3600 sec	3600 sec	A	10.06.21	06.01.23	
3	**CABLE DIFF PROT 87C**						
a	87 Differential Protection				STRP 1	STRP 2	
	87 Differential Protection	ON	ON	A	08.10.18	06.01.23	
	87 Increase of Trip Char. During Start	ON	ON	A	08.10.18	06.01.23	
	87 Differential Current monitoring	OFF	OFF	A	08.10.18	06.01.23	
	87 I> for Current Guard	0.00 I/InS	0.00 I/InS	A	08.10.18	06.01.23	

b	87 Differential Protection						
	87-1 Pickup Value of Differential Curr.	0.10 I/InO	0.10 I/InO	A	08.10.18	06.01.23	
	87-1 T I-DIFF> Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
	87-2 Pickup Value of High Set Trip	7.0 I/InO	7.0 I/InO	A	08.10.18	06.01.23	
	87-2 T I-DIFF>> Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
c	87 Differential Protection; Group Characteristic						
	87 Slope 1 of Tripping Characteristic	0.25	0.25	A	08.10.18	06.01.23	
	87 Base Point for Slope 1 of Charac.	0.00 I/InO	0.00 I/InO	A	08.10.18	06.01.23	
	87 Slope 2 of Tripping Characteristic	0.60	0.60	A	08.10.18	06.01.23	
	87 Base Point for Slope 2 of Charac.	1.50 I/InO	1.50 I/InO	A	08.10.18	06.01.23	
	87 I-RESTRAINT for Start Detection	0.10 I/InO	0.10 I/InO	A	08.10.18	06.01.23	
	87 Factor for Increas. of Char. at Start	1.0	1.0	A	08.10.18	06.01.23	
	87 Maximum Permissible Starting Time	3.0 sec	3.0 sec	A	08.10.18	06.01.23	
	87 Pickup for Add-on Stabilization	4.00 I/InO	4.00 I/InO	A	08.10.18	06.01.23	
	87 Duration of Add-on Stabilization	15 Cycle	15 Cycle	A	08.10.18	06.01.23	
	87 Time for Cross-block Add-on Stabiliz.	15 Cycle	15 Cycle	A	08.10.18	06.01.23	
d	87 Differential Protection; Group I-Diff Monitor						
	87 Pickup Value of diff. Curr.Monitoring	0.20 I/InO	0.20 I/InO	A	08.10.18	06.01.23	
	87 T I-DIFF> Monitoring Time Delay	2 sec	2 sec	A	08.10.18	06.01.23	
e	50G/51G; Group General						

	50G, 51G Ground Time Overcurrent	ON	ON	A	08.10.18	06.01.23	
	50/51G InRush Restrained	OFF	OFF	A	08.10.18	06.01.23	
f	50G/51G; Group 50G						
	50G-2 Pickup	0.20 A	0.20 A	A	08.10.18	06.01.23	
	50G-2 Time Delay	1.00 sec	1.00 sec	A	08.10.18	06.01.23	
	50G-1 Pickup	35.00 A	35.00 A	A	08.10.18	06.01.23	
	50G-1 Time Delay	oo sec	oo sec	A	08.10.18	06.01.23	
g	50G/51G; Group 51G						
	51G Pickup	4.00 A	4.00 A	A	08.10.18	06.01.23	
	51G Time Dial	oo sec	oo sec	A	08.10.18	06.01.23	
	51G Drop-out Characteristic	Disk Emulation	Disk Emulation	A	08.10.18	06.01.23	
	51G IEC Curve	Normal Inverse	Normal Inverse	A	08.10.18	06.01.23	
h	50G/51G; Group Inrush						
	50/51G 2nd harmonic in % of fundamental	15 %	15 %	A	08.10.18	06.01.23	
	50/51G Maximum Current for Inr. Rest.	0.50 A	0.50 A	A	08.10.18	06.01.23	
4	**LV1 REF PROT 64 RLV1**						
a	64, 50Ns, 51Ns, 67Ns (Sensitive) Gnd Flt						
	(Sensitive) Ground Fault	ON	ON	A	08.10.18	06.01.23	
	50Ns Drop-Out Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
b	64, 50Ns, 51Ns, 67Ns (Sensitive) Gnd Flt, Group50Ns						
	50Ns-2 Pickup	0.10 A	0.10 A	A	08.10.18	06.01.23	
	50Ns-2 Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
	50Ns-1 Pickup	35.00 A	35.00 A	A	08.10.18	06.01.23	
	50Ns-1 Time delay	oo sec	oo sec	A	08.10.18	06.01.23	
5	**LV2 REF PROT 64 RLV2**						
a	64, 50Ns, 51Ns, 67Ns (Sensitive) Gnd Flt; Group General						
	(Sensitive) Ground Fault	ON	ON	A	08.10.18	06.01.23	
	50Ns Drop-Out Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
b	64, 50Ns, 51Ns, 67Ns (Sensitive) Gnd Flt; Group 50Ns						

	50Ns-2 Pickup	0.10 A	0.10 A	A	08.10.18	06.01.23	
	50Ns-2 Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
	50Ns-1 Pickup	35.00 A	35.00 A	A	08.10.18	06.01.23	
	50Ns-1 Time delay	oo sec	oo sec	A	08.10.18	06.01.23	
6	**HV REF PROT 64 HV/51**						
a	50/51 Phase/Ground Overcurrent						
	50, 51 Phase Time Overcurrent	ON	ON	A	08.10.18	06.01.23	
	Manual Close Mode	50-2 instantaneously	50-2 instantaneously	A	08.10.18	06.01.23	
	50 Drop-Out Time Delay	0.00 sec		A	08.10.18	06.01.23	
b	50/51 Phase/Ground Overcurrent						
	50-3 measurement of	Fundamental component	Fundamental component	A	08.10.18	06.01.23	
	50-3 active	Always	Always	A	08.10.18	06.01.23	
	50-3 Pickup	oo A	oo A	A	08.10.18	06.01.23	
	50-3 Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
	50-2 measurement of	Fundamental component	Fundamental component	A	08.10.18	06.01.23	
	50-2 active	Always	Always	A	08.10.18	06.01.23	
	50-2 Pickup	35.00 A	35.00 A	A	08.10.18	06.01.23	
	50-2 Time Delay	oo sec	oo sec	A	08.10.18	06.01.23	
	50-1 measurement of	Fundamental component	Fundamental component	A	08.10.18	06.01.23	
	50-1 Pickup	35.00 A	35.00 A	A	08.10.18	06.01.23	
	50-1 Time Delay	oo sec	oo sec	A	08.10.18	06.01.23	
c	50/51 Phase/Ground Overcurrent						
	51 Pickup	0.50 A	0.50 A	A	08.10.18	06.01.23	
	51 Time Dial	1.00 sec	1.00 sec	A	08.10.18	06.01.23	
	Drop-out characteristic	Disk Emulation	Disk Emulation	A	08.10.18	06.01.23	
	IEC Curve	Normal Inverse	Normal Inverse	A	08.10.18	06.01.23	
d	64, 50Ns, 51Ns, 67Ns (Sensitive) Gnd Flt						
	(Sensitive) Ground Fault	ON	ON	A	08.10.18	06.01.23	
	50Ns Drop-Out Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
e	64, 50Ns, 51Ns, 67Ns (Sensitive) Gnd Flt						

	50Ns-2 Pickup	0.10 A	0.10 A	A	08.10.18	06.01.23	
	50Ns-2 Time Delay	0.00 sec	0.00 sec	A	08.10.18	06.01.23	
	50Ns-1 Pickup	35.00 A	35.00 A	A	08.10.18	06.01.23	
	50Ns-1 Time delay	oo sec	oo sec	A	08.10.18	06.01.23	

Mechanical protection tripping and Annunciation healthiness.

Sl. No.	**DETAIL**	**SETTING**		**ST-08**			**ST-09**		
		ALARM	**TRIP**	**ALARM**	**TRIP**	**DOT**	**ALARM**	**TRIP**	**DOT**
1	OTI	95	100	94°C	100°C	-----	94°C	100°C	-----
2	HV WTI	100	105	100°C	104°C	-----	100°C	104°C	-----
3	LV1 WTI	100	105	99°C	105°C	-----	99°C	105°C	-----
4	LV2 WTI	100	105	99°C	105°C	-----	99°C	105°C	-----
4	BUCKHOLZ	alarm	trip	OP	OP	-----	OP	OP	-----
5	PRV1	-----	trip	-----	OP	-----		OP	-----
6	PRV2	-----	TRIP						
7	LOW OIL LEVEL	alarm	-----	OP	-----	-----	OP	-----	-----
8	OSR	alarm	-----	OP	-----	-----	OP	-----	-----
9	SOURCE A SUPPLY	alarm	-----	OP	-----	-----	OP	-----	-----
10	SOURCE B SUPPLY	alarm	-----	OP	-----	-----	OP	-----	-----

6.6KV SWITCHGEAR

Bus arrangement of 6.6 kV switchgear

BUS #8UA					BUS #8UB				
Panel No.	**Module Type**	**Feeder name**	**Relay**	**CT**	**Panel No.**	**Module Type**	**Feeder name**	**Relay**	CT
1	DB	UST #8A	REF 615	200/1	**1**	DE	Tie from 8S2	REF 541	1600/1
2	DB4	ESP Trf. 8A	REF 541	300/1	**2**	DA	CEP 8B	REM 543	50/1
3	DB	Spare	REF 615	300/1	**3**	DC	I/C from UAT 8	REF 541	1600/1
4	DA	CWP 8A	REM 543	250/1	**4**	DB	AET A	REF 615	100/1
5	DB	IDCT Trf 8A	REF 615	200/1	**5**	DB4	ESP Trf. 8B		300/1
6	DA	ID Fan8A	REM 543	250/1	**6**	DAF	BFP 8B	REM 543	600/1
7	G	Bus VT	---------	--------	**7**	DA	Spare (Old) CWP 5 (New)	REM 543	250/1
8	DA	PA Fan 8A	REM 543	250/1	**8**	DA	Mill 8B	REM 543	75/1
9	DA	FD Fan 8A	REM 543	75/1	**9**	DA	Mill 8D	REM 543	75/1
10	DA	Mill 8A	REM 543	75/1	**10**	DA	Mill 8F	REM 543	75/1
11	DA	Mill 8C	REM 543	75/1	**11**	DA	FD Fan 8B	REM 543	75/1
12	DA	Mill 8E	REM 543	75/1	**12**	DA	PA Fan 8B	REM 543	
13	DAF	Spare BFP	REM 543	600/1	**13**	G	Bus VT		250/1
14	DA	BFP 8A	REM 543	600/1	**14**	DA	ID Fan 8B	REM 543	250/1
15	DA	IAC1	REM 543	50/1	**15**	DB	IDCT Trf 8B	REF 615	200/1
16	DA	CEP 8A	REM 543	50/1	**16**	DA	CWP 8B	REM 543	250/1

17	DC	I/C from UAT 8	REM 541	1600/1	**17**	DB	Spare	REF 615	200/1
18	DA	CEP 8C	REM 543	50/1	**18**	DB	UST 8B	REF 615	200/1
19	DE	Tie from 8S1	REF 541	1600/1					

BUS #8S1					**BUS #8S2**				
Panel No.	**Module Type**	**Feeder name**	**Relay**	**CT**	**Panel No.**	**Module Type**	**Feeder name**	**Relay**	**CT**
1	DE	Tie to 8UA	REF 541	1600/1	**1**	DA	CWP 5	REF 543	250/1
2	DB	SST 9B	REF 615	200/1	**2**	DA	Spare	REM 543	250/1
3	DE	Tie to 9S1	REF 541	2500/1	**3**	DEOG	Tac system	REF 615	1250/1
4	DA	Spare	REM 543	50/1	**4**	DC	I/C from ST 8	REF 541	2500/1
5	DB	Fire Water/ Compressor Trf. 1	REF 615	200/1	**5**	DB	CHP Trf. 1	REF 615	75/1
6	DB	Spare	REF 615	200/1	**6**	DB	AHP trf. 3	REF 615	100/1
7	G	Bus VT			**7**	DB	Spare (Old) TAC System (New)	REF 615	200/1
8	DAF	BFP 8C	REM 543	600/1	**8**	DB	DM/PT/ETP/RW CW/Chlorination Trf.1	REF 615	200/1
9	DA	IAC 3	REM 543	50/1	**9**	DB	Workshop Trf. 1	REF 615	100/1
10	DA	SAC 1	REM 543	50/1	**10**	G	Bus VT	------	------
11	DB	AHP Trf.1	REF 615	30/1	**11**	DB	Spare (Old) CHP Trf. 1 (New)	REF 615	200/1
12	DEOG	CHP Switchgear1	REF 615	1250/1	12	DB	Service Biuilding Trf. 1	REF 615	200/1
13	DB	Raw water trf. 2	REF 615	100/1	13	DE	Tie to 9S2	REF 541	2500/1
14	DB	Spare	REF 615	100/1	14	DB	SST 8A	REF 615	200/1

15	DB	AWRS Service trf. 1	REF 615		15	DE	Tie to 8UA	REF 541	1600/1
16	DC	I/C from ST 8	REF 541	2500/1					

Details of motor with complete specification: -

Parameters	**Bowl Mill**	**PA fan**	**FD Fan**	**BFP**	**CEP**	**ID Fan**	**Compressor**	**CWP**
Quantity	**12**	**4**	**4**	**6**	**6**	**4**	**5**	**5**
Make	BHEL	BHEL	BHEL	BHEL	BHEL	BHEL	Marathon Electric Motor India Ltd.	Crompton and Greaves
Phase	3	3	3	3	3	3	3	3
KW	450	1650	550	4600	325	1750	250	1650
Rated RPM/syn speed	981/1000	1492/1500	1486	1493	1483	746/750	1488	497
Rated V(kV)/Variation	6.6±10%	6.6±10%	6.6	6.6±10%	6.6±10%	6.6±10%	6.6±10%	6.6±10%
Full Load /No LOAD Current (Amp.)	55/25.5	175/43	59	466/110	35.5	194/74	27.5/10	189
Rate F& Variation	50±05%	50±05%	50±05%	50±05%	50±05%	50±05%	50±05%	50±05%
Locked rotor/starting current% of FLC	600%	600% (subjected to tolerence)		450%/FLC& 540%FLC without Is tolerance		600%	550% FLC of 100% V, 470% FLC of 85% V	600
Combined V & F Variation	10% abs	10% abs	10% abs	10% abs	10% abs	10% abs	10% abs	10% abs
Life	50,000 Hrs.	50,000 Hrs.		10,000Hrs		40,000 Hrs.	40,000 Hrs.	40,000 Hrs.
Connection	Star	Star	Star	Star	Star	Star	Star	Star
Method of starting	DOL	DOL	DOL	DOL	DOL	DOL	DOL	DOL
Efficiency	93.40%	96%		97%		96.50%	94%	96%
Frame	1LA7636-6	1LA7802-4	1LA7566-4	cage rotor 1RN7 718-4	1LA7560-4	1LA7903-8	DC 355 F3	VUDC 1700

Rotor Type	Sq. Cage	Sq. Cage		Cage	Sq. Cage	SCIM	Sq. Cage	Sq. Cage Rotor I/M
Power Factor/100%/ 75%/50%	0.77/ 0.70/ 0.59	0.88/0.86/0.81	0.82	0.89/ - /0.88	0.8	0.82/0.80/0.70	0.85/0.83/ 0.77	0.8/0.75/0.65
Insulation Class	F	F	F	F	F	F	F	F VPI (Resin Poor)
Type of enclosure	TETV	TETV	TETV	CACW	TETV	TETV	TEFC/IC411/IP55	
Duty	cont. S-1	cont. S-1	cont.	S-1		cont. S-1	S1-CMR	S1-Cont.
Deg of Protection	IP55	IP55	IP55			IP55	IP55	IP-23

Detail of ABB make 6.6kV Breakers installed in 6.6KV SWITCH GEAR

Type	Module Type	Qty.
3150A SF6 Breaker	DC, DE	20 Nos.
1250A SF6 Breaker:	DA, DAF, DB, DB4	106 Nos.

Detail of ABB make relays installed in 6.6KV SWITCH GEAR

Type	Module Type	Qty.
REM 543	DA, DAF	53 Nos.
REF 541	DC, DE, DB4	24 Nos.
REF 615	DB	49 Nos.

Detail of Software SCADA system Installed for communication with ABB make Relay.

Type	Description	Qty.
800xA 5.0.0 SP2	SCADA SOFTWARE	LS

Sr. No.	**Particulars**	**Setting Group 1**	**Setting Group 2**	**Date of testing**		**Remark**
				Unit-08	**Unit-09**	
1	CWP Relay Used-REM 543 CT Ratio-250/1					
a	**Motor Start**					
	Operation Mode	IIT & Stall	IIT & Stall	23.01.23	23.01.23	
	Start Current (A)	4.8x In	4.8x In	23.01.23	23.01.23	
	Start Time (s)	4	4	23.01.23	23.01.23	
	Time Limit (s)	6	6	23.01.23	23.01.23	

	Count Down rate (s/h)	8	8	23.01.23	23.01.23	
	stall time (s)	28	28	23.01.23	23.01.23	
b	**NEF1 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	0.1xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	4.0xIn	10.0xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
d	**NOC3 Inst**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	7	7	23.01.23	23.01.23	
e	**NOC3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	25	25	23.01.23	23.01.23	

Sr. No.	**Particulars**	**Setting Group 1**	**Setting Group 2**	**Date of testing**		**Remark**
				Unit-08	**Unit-09**	
1	ID Fan Relay Used-REM 543 CT Ratio-250/1					
a	**Motor Start**					
	Operation Mode	IIT & Stall	IIT & Stall	23.01.23	23.01.23	
	Start Current (A)	5.1x In	5.1x In	23.01.23	23.01.23	
	Start Time (s)	4.5	4.5	23.01.23	23.01.23	
	Time Limit (s)	3	3	23.01.23	23.01.23	
	Count Down rate (s/h)					
	stall time (s)	11	11	23.01.23	23.01.23	
b	**NEF1 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	0.1xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	4.0xIn	10.0xIn	23.01.23	23.01.23	

	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
d	**NOC3 Inst**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.50xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	6	6	23.01.23	23.01.23	
e	**NOC3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	25	25	23.01.23	23.01.23	
f	**NPS3 High**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.2xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	2	2	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	1	1	23.01.23	23.01.23	
	Minimum Time (s)	0.1	0.1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooling Time (s)	50	50	23.01.23	23.01.23	
g	**NPS3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.15xIn	0.15xIn	23.01.23	23.01.23	
	Operate Time(s)	3	3	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	0.1	0.1	23.01.23	23.01.23	
	Minimum Time (s)	1	1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooling Time (s)	50	50	23.01.23	23.01.23	
h	**PREV3**					
	Operation mode	3-Phase	3-Phase	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Rotating Direction	forward	forward	23.01.23	23.01.23	
i	**PSV3St1**					
	Operation mode	V2>	V2>	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=1.0	V1<=1.0	23.01.23	23.01.23	
	Operate Time(s)	V1>=1.0	V1>=1.0	23.01.23	23.01.23	

j	**PSV3St2**					
	Operation mode	V2	V2	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=0.04	V1<=0.04	23.01.23	23.01.23	
	Operate Time(s)	V1>=0.04	V1>=0.04	23.01.23	23.01.23	
k	**TOL3 Dev**					
	Start Current (A)	6.0xIn	6.0xIn	23.01.23	23.01.23	
	Start Time (s)	3	3	23.01.23	23.01.23	
	No. of starts	1	1	23.01.23	23.01.23	
	Device Type	Motor	Motor	23.01.23	23.01.23	
	Trip Temp.°C	100	100	23.01.23	23.01.23	
	Prior Alarm °C	90	90	23.01.23	23.01.23	
	Restart Inhibit °C	60	60	23.01.23	23.01.23	
	Ambient Temp. °C	50	50	23.01.23	23.01.23	
l	**UV3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Value	0.8xVn	0.8xVn	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Time Multiplier	0.1	0.1	23.01.23	23.01.23	

Sr. No.	**Particulars**	**Setting Group 1**	**Setting Group 2**	**Date of testing**		**Remark**
				Unit08	**Unit09**	
1	PA FAN Relay Used-REM 543 CT Ratio-250/1					
a	**a. Motor Start**					
	Operation Mode	IIT & Stall	IIT & Stall	23.01.23	23.01.23	
	Start Current (A)	5.1x In	5.1x In	23.01.23	23.01.23	
	Start Time (s)	13	13	23.01.23	23.01.23	
	Time Limit (s)	19	19	23.01.23	23.01.23	
	Count Down rate (s/h)	8	8	23.01.23	23.01.23	
	stall time (s)					
b	**NEF1 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	

	Start Current (A)	0.1xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	4.0xIn	10.0xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
d	**NOC3 Inst**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	4.0xIn	10.0xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
e	**NOC3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	25	25	23.01.23	23.01.23	
f	**NPS3 High**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.2xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	2	2	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	1	1	23.01.23	23.01.23	
	Minimum Time (s)	0.1	0.1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooline Time (s)	50	50	23.01.23	23.01.23	
g	**NPS3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.15xIn	0.15xIn	23.01.23	23.01.23	
	Operate Time(s)	3	3	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	0.1	0.1	23.01.23	23.01.23	
	Minimum Time (s)	1	1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooline Time (s)	50	50	23.01.23	23.01.23	
h	**PREV3**					
	Operation mode	3-Phase	3-Phase	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Rotating Direction	forward	forward	23.01.23	23.01.23	
i	**PSV3St1**					
	Operation mode	V2>	V2>	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	

	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=1.0	V1<=1.0	23.01.23	23.01.23	
	Operate Time(s)	V1>=1.0	V1>=1.0	23.01.23	23.01.23	
j	**PSV3St2**					
	Operation mode	V2	V2	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=0.04	V1<=0.04	23.01.23	23.01.23	
	Operate Time(s)	V1>=0.04	V1>=0.04	23.01.23	23.01.23	
k	**TOL3 Dev**					
	Start Current (A)	6.0xIn	6.0xIn	23.01.23	23.01.23	
	Start Time (s)	4	4	23.01.23	23.01.23	
	No. of starts	3	3	23.01.23	23.01.23	
	Device Type	Motor	Motor	23.01.23	23.01.23	
	Trip Temp.°C	100	100	23.01.23	23.01.23	
	Prior Alarm °C	90	90	23.01.23	23.01.23	
	Restart Inhibit °C	60	60	23.01.23	23.01.23	
	Ambient Temp. °C	50	50	23.01.23	23.01.23	
l	**UV3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Value	0.8xVn	0.8xVn	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Time Multiplier	0.1	0.1	23.01.23	23.01.23	

Sr. No.	Particulars	Setting Group 1	Setting Group 2	Date of testing		Remark
1	FD FAN Relay Used-REM 543 CT Ratio-75/1					
a	**Motor Start**					
	Operation Mode	IIT & Stall	IIT & Stall	23.01.23	23.01.23	
	Start Current (A)	5.1x In	5.1x In	23.01.23	23.01.23	
	Start Time (s)	7.5	7.5	23.01.23	23.01.23	
	Time Limit (s)	11	11	23.01.23	23.01.23	

	Count Down rate (s/h)	8	8	23.01.23	23.01.23	
	stall time (s)			23.01.23	23.01.23	
b.	**NEF1 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	0.1xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	4.0xIn	10.0xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
d	**NOC3 Inst**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	11	11	23.01.23	23.01.23	
e	**NOC3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	25	25	23.01.23	23.01.23	
f	**NPS3 High**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.2xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	2	2	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	1	1	23.01.23	23.01.23	
	Minimum Time (s)	0.1	0.1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooline Time (s)	50	50	23.01.23	23.01.23	
g	**NPS3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.15xIn	0.15xIn	23.01.23	23.01.23	
	Operate Time(s)	3	3	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	0.1	0.1	23.01.23	23.01.23	
	Minimum Time (s)	1	1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooline Time (s)	50	50	23.01.23	23.01.23	
	PREV3					
	Operation mode	3-Phase	3-Phase	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	

	Rotating Direction	forward	forward	23.01.23	23.01.23	
i.	**PSV3St1**					
	Operation mode	V2>	V2>	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=1.0	V1<=1.0	23.01.23	23.01.23	
	Operate Time(s)	V1>=1.0	V1>=1.0	23.01.23	23.01.23	
i.	**PSV3St2**					
	Operation mode	V2	V2	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=0.04	V1<=0.04	23.01.23	23.01.23	
	Operate Time(s)	V1>=0.04	V1>=0.04	23.01.23	23.01.23	
k	**TOL3 Dev**					
	Start Current (A)	6.0xIn	6.0xIn	23.01.23	23.01.23	
	Start Time (s)	3	3	23.01.23	23.01.23	
	No. of starts	1	1	23.01.23	23.01.23	
	Device Type	Motor	NIL	23.01.23	23.01.23	
	Trip Temp.°C	100	100	23.01.23	23.01.23	
	Prior Alarm °C	90	90	23.01.23	23.01.23	
	Restart Inhibit °C	60	60	23.01.23	23.01.23	
	Ambient Temp. °C	50	50	23.01.23	23.01.23	
l	**UV3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Value	0.8xVn	0.8xVn	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Time Multiplier	0.1	0.1	23.01.23	23.01.23	

Sr. No.	**Particulars**	**Setting Group 1**	**Setting Group 2**	**Date of testing**		**Remark**
				Unit-08	**Unit-09**	
1	MILL Relay Used-REM 543 CT Ratio-75/1					

a	**Motor Start**					
	Operation Mode	IIT & Stall	IIT & Stall	23.01.23	23.01.23	
	Start Current (A)	5.0x In	5.0x In	23.01.23	23.01.23	
	Start Time (s)	4	4	23.01.23	23.01.23	
	Time Limit (s)	6	6	23.01.23	23.01.23	
	Count Down rate (s/h)			23.01.23	23.01.23	
	stall time (s)			23.01.23	23.01.23	
b	**NEF1 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	0.1xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	4.0xIn	10.0xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
d	**NOC3 Inst**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	7	7	23.01.23	23.01.23	
e	**NOC3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	25	25	23.01.23	23.01.23	
f	**NPS3 High**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.2xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	2	2	23.01.23	23.01.23	
	k			23.01.23	23.01.23	
	Start delay (s)			23.01.23	23.01.23	
	Minimum Time (s)			23.01.23	23.01.23	
	Maximum Time (s)			23.01.23	23.01.23	
	Cooline Time (s)			23.01.23	23.01.23	
g	**NPS3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.15xIn	0.15xIn	23.01.23	23.01.23	
	Operate Time(s)	3	3	23.01.23	23.01.23	
	k			23.01.23	23.01.23	
	Start delay (s)			23.01.23	23.01.23	
	Minimum Time (s)			23.01.23	23.01.23	

	Maximum Time (s)			23.01.23	23.01.23	
	Cooline Time (s)			23.01.23	23.01.23	
h/	**PREV3**					
	Operation mode	3-Phase	3-Phase	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Rotating Direction	forward	forward	23.01.23	23.01.23	
I	**PSV3St1**					
	Operation mode	V2>	V2>	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=1.0	V1<=1.0	23.01.23	23.01.23	
	Operate Time(s)	V1>=1.0	V1>=1.0	23.01.23	23.01.23	
j	**PSV3St2**					
	Operation mode	V2	V2	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=0.04	V1<=0.04	23.01.23	23.01.23	
	Operate Time(s)	V1>=0.04	V1>=0.04	23.01.23	23.01.23	
k.	**TOL3 Dev**					
	Start Current (A)	6.0xIn	6.0xIn	23.01.23	23.01.23	
	Start Time (s)	4	4	23.01.23	23.01.23	
	No. of starts	2	2	23.01.23	23.01.23	
	Device Type	Motor	Motor	23.01.23	23.01.23	
	Trip Temp.°C	100	100	23.01.23	23.01.23	
	Prior Alarm °C	90	90	23.01.23	23.01.23	
	Restart Inhibit °C	60	60	23.01.23	23.01.23	
	Ambient Temp. °C	50	50	23.01.23	23.01.23	
l.	**UV3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Value	0.8xVn	0.8xVn	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Time Multiplier	0.1	0.1	23.01.23	23.01.23	

Sr. No.	Particulars	Setting Group 1	Setting Group 2	Date of testing		Remark
				Unit-08	Unit-09	
1	BFP Relay Used-REM 543 CT Ratio-600/1					
a	**Motor Start**					
	Operation Mode	IIT & Stall	IIT & Stall	23.01.23	23.01.23	
	Start Current (A)	4.5x In	4.5x In	23.01.23	23.01.23	
	Start Time (s)	4.6	4.6	23.01.23	23.01.23	
	Time Limit (s)	6.9	6.9	23.01.23	23.01.23	
	Count Down rate (s/h)			23.01.23	23.01.23	
	stall time (s)			23.01.23	23.01.23	
b.	**NEF1 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	0.1xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	23.01.23	23.01.23	
	Start Current (A)	4.0xIn	10.0xIn	23.01.23	23.01.23	
	Operate Time(s)	0.05	0.05	23.01.23	23.01.23	
D	**NOC3 Inst**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	8	8	23.01.23	23.01.23	
e.	**NOC3 Low**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	1.10xIn	1.10xIn	23.01.23	23.01.23	
	Operate Time(s)	25	25	23.01.23	23.01.23	
f	**NPS3 High**					
	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.2xIn	0.2xIn	23.01.23	23.01.23	
	Operate Time(s)	2	2	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	1	1	23.01.23	23.01.23	
	Minimum Time (s)	0.1	0.1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooline Time (s)	50	50	23.01.23	23.01.23	
g	**NPS3 Low**					

	Operation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Current (A)	0.15xIn	0.15xIn	23.01.23	23.01.23	
	Operate Time(s)	2	2	23.01.23	23.01.23	
	k	5	5	23.01.23	23.01.23	
	Start delay (s)	0.1	0.1	23.01.23	23.01.23	
	Minimum Time (s)	1	1	23.01.23	23.01.23	
	Maximum Time (s)	1000	1000	23.01.23	23.01.23	
	Cooline Time (s)	50	50	23.01.23	23.01.23	
h.	**PREV3**					
	Operation mode	3-Phase	3-Phase	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Rotating Direction	forward	forward	23.01.23	23.01.23	
i.	**PSV3St1**					
	Operation mode	V2>	V2>	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=1.0	V1<=1.0	23.01.23	23.01.23	
	Operate Time(s)	V1>=1.0	V1>=1.0	23.01.23	23.01.23	
j.	**PSV3St2**					
	Operation mode	V2	V2	23.01.23	23.01.23	
	Start Value	0.1xVn	0.1xVn	23.01.23	23.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	23.01.23	23.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	23.01.23	23.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	23.01.23	23.01.23	
	Operate Time(s)	V1<=0.04	V1<=0.04	23.01.23	23.01.23	
	Operate Time(s)	V1>=0.04	V1>=0.04	23.01.23	23.01.23	
k	**TOL3 Dev**					
	Start Current (A)	6.0xIn	6.0xIn	23.01.23	23.01.23	
	Start Time (s)	4.6	4.6	23.01.23	23.01.23	
	No. of starts	1	1	23.01.23	23.01.23	
	Device Type	Motor	II	23.01.23	23.01.23	
	Trip Temp.°C	100	100	23.01.23	23.01.23	
	Prior Alarm °C	90	90	23.01.23	23.01.23	
	Restart Inhibit °C	60	60	23.01.23	23.01.23	
	Ambient Temp. °C	50	50	23.01.23	23.01.23	
l.	**UV3 Low**					

	lOperation mode	D.T.	D.T.	23.01.23	23.01.23	
	Start Value	0.8xVn	0.8xVn	23.01.23	23.01.23	
	Operate Time(s)	1	1	23.01.23	23.01.23	
	Time Multiplier	0.1	0.1	23.01.23	23.01.23	

Sr. No.	**Particulars**	**Setting Group 1**	**Setting Group 2**	**Date of testing**		**Remark**
				UNIT-08	**UNIT-09**	
1	IAC Relay Used-REM 543 CT Ratio-600/1					
a	**Motor Start**					
	Operation Mode	IIT & Stall	IIT & Stall	24.01.23	24.01.23	
	Start Current (A)	4.4x In	4.4x In	24.01.23	24.01.23	
	Start Time (s)	4	4	24.01.23	24.01.23	
	Time Limit (s)	6	6	24.01.23	24.01.23	
	Count Down rate (s/h)			24.01.23	24.01.23	
	stall time (s)			24.01.23	24.01.23	
b	**NEF1 High**					
	Operation mode	Inst. D.T.	Inst. D.T.	24.01.23	24.01.23	
	Start Current (A)	0.1xIn	0.2xIn	24.01.23	24.01.23	
	Operate Time(s)	0.05	0.05	24.01.23	24.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	24.01.23	24.01.23	
	Start Current (A)	4.0xIn	10.0xIn	24.01.23	24.01.23	
	Operate Time(s)	0.05	0.05	24.01.23	24.01.23	
d	**NOC3 Inst**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	1.10xIn	1.10xIn	24.01.23	24.01.23	
	Operate Time(s)	8	8	24.01.23	24.01.23	
e	**NOC3 Low**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	1.10xIn	1.10xIn	24.01.23	24.01.23	
	Operate Time(s)	25	25	24.01.23	24.01.23	
f	**NPS3 High**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	0.2xIn	0.2xIn	24.01.23	24.01.23	
	Operate Time(s)	2	2	24.01.23	24.01.23	
	k	5	5	24.01.23	24.01.23	

	Start delay (s)	1	1	24.01.23	24.01.23	
	Minimum Time (s)	0.1	0.1	24.01.23	24.01.23	
	Maximum Time (s)	1000	1000	24.01.23	24.01.23	
	Cooline Time (s)	50	50	24.01.23	24.01.23	
g	**NPS3 Low**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	0.15xIn	0.15xIn	24.01.23	24.01.23	
	Operate Time(s)	2	2	24.01.23	24.01.23	
	k	5	5	24.01.23	24.01.23	
	Start delay (s)	0.1	0.1	24.01.23	24.01.23	
	Minimum Time (s)	1	1	24.01.23	24.01.23	
	Maximum Time (s)	1000	1000	24.01.23	24.01.23	
	Cooline Time (s)	50	50	24.01.23	24.01.23	
h	**PREV3**					
	Operation mode	3-Phase	3-Phase	24.01.23	24.01.23	
	Operate Time(s)	1	1	24.01.23	24.01.23	
	Rotating Direction	forward	forward	24.01.23	24.01.23	
i	**PSV3St1**					
	Operation mode	V2>	V2>	24.01.23	24.01.23	
	Start Value	0.1xVn	0.1xVn	24.01.23	24.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75 xVn	24.01.23	24.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10 xVn	24.01.23	24.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	24.01.23	24.01.23	
	Operate Time(s)	V1<=1.0	V1<=1.0	24.01.23	24.01.23	
	Operate Time(s)	V1>=1.0	V1>=1.0	24.01.23	24.01.23	
j	**PSV3St2**					
	Operation mode	V2	V2	24.01.23	24.01.23	
	Start Value	0.1xVn	0.1xVn	24.01.23	24.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75 xVn	24.01.23	24.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10 xVn	24.01.23	24.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	24.01.23	24.01.23	
	Operate Time(s)	V1<=0.04	V1<=0.04	24.01.23	24.01.23	
	Operate Time(s)	V1>=0.04	V1>=0.04	24.01.23	24.01.23	
k	**TOL3 Dev**					
	Start Current (A)	6.0xIn	6.0xIn	24.01.23	24.01.23	

	Start Time (s)	4.6	4.6	24.01.23	24.01.23	
	No. of starts	1	1	24.01.23	24.01.23	
	Device Type	Motor	I	24.01.23	24.01.23	
	Trip Temp.°C	100	100	24.01.23	24.01.23	
	Prior Alarm °C	90	90	24.01.23	24.01.23	
	Restart Inhibit °C	60	60	24.01.23	24.01.23	
	Ambient Temp. °C	50	50	24.01.23	24.01.23	
l.	**UV3 Low**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Value	0.8xVn	0.8xVn	24.01.23	24.01.23	
	Operate Time(s)	1	1	24.01.23	24.01.23	
	Time Multiplier	0.1	0.1	24.01.23	24.01.23	

Sr. No.	**Particulars**	**Setting Group 1**	**Setting Group 2**	**Date of testing**		**Remark**
				UNIT-8	**UNIT-9**	
1	CEP Relay Used-REM 543 CT Ratio-600/1					
a	**Motor Start**					
	Operation Mode	IIT	IIT	24.01.23	24.01.23	
	Start Current (A)	4.8x In	4.8x In	24.01.23	24.01.23	
	Start Time (s)	7.5	7.5	24.01.23	24.01.23	
	Time Limit (s)	11	11	24.01.23	24.01.23	
	Count Down rate (s/h)					
	stall time (s)					
b	**NEF1 High**					
	Operation mode	Inst.	Inst.	24.01.23	24.01.23	
	Start Current (A)	0.1xIn	0.2xIn	24.01.23	24.01.23	
	Operate Time(s)	0.05	0.05	24.01.23	24.01.23	
c	**NOC3 High**					
	Operation mode	Inst.	Inst.	24.01.23	24.01.23	
	Start Current (A)	4.0xIn	10.0xIn	24.01.23	24.01.23	
	Operate Time(s)	0.05	0.05	24.01.23	24.01.23	
d	**NOC3 Inst**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	1.10xIn	1.10xIn	24.01.23	24.01.23	
	Operate Time(s)	5.5	5.5	24.01.23	24.01.23	
e	**NOC3 Low**					

	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	1.10xIn	1.10xIn	24.01.23	24.01.23	
	Operate Time(s)	25	25	24.01.23	24.01.23	
f	**NPS3 High**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	0.2xIn	0.2xIn	24.01.23	24.01.23	
	Operate Time(s)	2	2	24.01.23	24.01.23	
	k	5	5	24.01.23	24.01.23	
	Start delay (s)	1	1	24.01.23	24.01.23	
	Minimum Time (s)	0.1	0.1	24.01.23	24.01.23	
	Maximum Time (s)	1000	1000	24.01.23	24.01.23	
	Cooline Time (s)	50	50	24.01.23	24.01.23	
g	**NPS3 Low**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Current (A)	0.15xIn	0.15xIn	24.01.23	24.01.23	
	Operate Time(s)	3	3	24.01.23	24.01.23	
	k	5	5	24.01.23	24.01.23	
	Start delay (s)	0.1	0.1	24.01.23	24.01.23	
	Minimum Time (s)	1	1	24.01.23	24.01.23	
	Maximum Time (s)	1000	1000	24.01.23	24.01.23	
	Cooline Time (s)	50	50	24.01.23	24.01.23	
h	**PREV3**					
	Operation mode	3-Phase	3-Phase	24.01.23	24.01.23	
	Operate Time(s)	1	1	24.01.23	24.01.23	
	Rotating Direction	forward	forward	24.01.23	24.01.23	
i	**PSV3St1**					
	Operation mode	V2>	V2>	24.01.23	24.01.23	
	Start Value	0.1xVn	0.1xVn	24.01.23	24.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	24.01.23	24.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	24.01.23	24.01.23	
	Operate Time(s)	V2>=0.5	V2>=0.5	24.01.23	24.01.23	
	Operate Time(s)	V1<=1.0	V1<=1.0	24.01.23	24.01.23	
	Operate Time(s)	V1>=1.0	V1>=1.0	24.01.23	24.01.23	
j	**PSV3St2**					
	Operation mode	V2	V2	24.01.23	24.01.23	
	Start Value	0.1xVn	0.1xVn	24.01.23	24.01.23	
	Start Value	V1<=0.75xVn	V1<=0.75xVn	24.01.23	24.01.23	
	Start Value	V2>=1.10xVn	V2>=1.10xVn	24.01.23	24.01.23	

	Operate Time(s)	V2>=0.5	V2>=0.5	24.01.23	24.01.23	
	Operate Time(s)	V1<=0.04	V1<=0.04	24.01.23	24.01.23	
	Operate Time(s)	V1>=0.04	V1>=0.04	24.01.23	24.01.23	
k	**TOL3 Dev**					
	Start Current (A)	6.0xIn	6.0xIn	24.01.23	24.01.23	
	Start Time (s)	2.5	2.5	24.01.23	24.01.23	
	No. of starts	1	1	24.01.23	24.01.23	
	Device Type	Motor	I	24.01.23	24.01.23	
	Trip Temp.°C	100	100	24.01.23	24.01.23	
	Prior Alarm °C	90	90	24.01.23	24.01.23	
	Restart Inhibit °C	60	60	24.01.23	24.01.23	
	Ambient Temp. °C	50	50	24.01.23	24.01.23	
l	**UV3 Low**					
	Operation mode	D.T.	D.T.	24.01.23	24.01.23	
	Start Value	0.8xVn	0.8xVn	24.01.23	24.01.23	
	Operate Time(s)	1	1	24.01.23	24.01.23	
	Time Multiplier	0.1	0.1	24.01.23	24.01.23	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	220/6.6kV Station Transformer CT Ratio-2500/1, NCT-300/1				
a	**NEF1 Inst**	0.2xIn (60A), 1.0sec	25.01.23	25.01.23	
b	**NEF1 Low**	0.2xIn (500A), 1.0sec	25.01.23	25.01.23	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	I/C from ST 8 CT Ratio-2500/1				
1	**Inrush3**	0.1xIn, I12/I1f: 15%	25.01.23	25.01.23	
2	**Motor Start**	NA	25.01.23	25.01.23	
3	**NEF**				
	NEF1 High	NA	25.01.23	25.01.23	
	NEF1 Inst	NA	25.01.23	25.01.23	
	NEF1 Low	0.25xIn (625A), 0.8 sec	25.01.23	25.01.23	

4	**NOC**				
	NOC3 High	3xIn, 0.05 sec	25.01.23	25.01.23	
	NOC3 Inst	NA	25.01.23	25.01.23	
	NOC3 Low	NA	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	NA	--------	-------	
	NPS3 Low	NA	-------	-------	
6	**PREV3**				
	PSV	NA	-------	-------	
	PSV3St1	NA	-------	-------	
	PSV3St2	NA	-------	-------	
7	**TOL3Dev**	NA	-------	-------	
8	**UV3Low**	0.2xVn, 0.5 sec	25.01.23	25.01.23	

Sr. No.	**Particulars**	**Setting Group**	**Date of testing**		**Remark**
			Unit-08	**Unit-09**	
	AWRS Service transformer CT Ratio-300/1A, NCT-50/1A				
1	**Inrush3**	0.15xIn, 0.02sec	25.01.23	25.01.23	
2	**Motor Start**	NA			
3	**NEF**				
	NEF1 High	0.13xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Inst	0.3xIn, 0.1 sec	25.01.23	25.01.23	
	NEF1 Low	0.1xIn, 0.5 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	1.8xIn, 0.5 sec	25.01.23	25.01.23	
	NOC3 Inst	3.6xIn, 0.02 sec	25.01.23	25.01.23	
	NOC3 Low	1.95xIn, 11.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	0.3xIn,0.04 sec	25.01.23	25.01.23	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	-------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	-------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	Raw water transformer CT Ratio-100/1A				
1	**Inrush3**	0.15xIn, 0.02sec	25.01.23	25.01.23	
2	Motor Start	NA	--------	-------	
3	NEF				
	NEF1 High	0.1xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Inst	0.3xIn, 0.04 sec	25.01.23	25.01.23	
	NEF1 Low	0.1xIn, 1.0 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	1.5xIn,1.0 sec	25.01.23	25.01.23	
	NOC3 Inst	3.0xIn, 0.02 sec	25.01.23	25.01.23	
	NOC3 Low	0.95xIn, 11.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	0.3xIn,0.04 sec	25.01.23	25.01.23	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	-------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	-------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	CHP Switchgear 1 CT Ratio-1250/1A				
1	**Inrush3**				
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	0.3xIn, 0.8 sec	25.01.23	25.01.23	
	NEF1 Inst	2xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Low	NA	--------	-------	
4	**NOC**				
	NOC3 High	2xIn,1.0 sec	25.01.23	25.01.23	
	NOC3 Inst	3.0xIn, 0.02 sec	25.01.23	25.01.23	

	NOC3 Low	0.95xIn, 11.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	0.3xIn,0.04 sec	25.01.23	25.01.23	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	**Particulars**	**Setting Group**	**Date of testing**		**Remark**
			Unit-08	**Unit-09**	
	AHP Transformer CT Ratio-300/1A				
1	**Inrush3**	NA			
2	**Motor Start**	0.15xIn, 0.02sec	25.01.23	25.01.23	
3	**NEF**	NA	--------	-------	
	NEF1 High	0.2xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Inst	0.1xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Low	0.1xIn, 0.5 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	1.1xIn,5.0 sec	25.01.23	25.01.23	
	NOC3 Inst	3.0xIn, 0.02 sec	25.01.23	25.01.23	
	NOC3 Low	0.8xIn, 11.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	0.3xIn,0.04 sec	25.01.23	25.01.23	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	**Particulars**	**Setting Group**	**Date of testing**		**Remark**
			Unit-08	**Unit-09**	
	SAC				

	CT Ratio-50/1A				
1	**Inrush3**				
2	**Motor Start**	4.4xIn, 6 sec	25.01.23	25.01.23	
3	**NEF**				
	NEF1 High	0.1xIn, 0.05 sec	25.01.23	25.01.23	
	NEF1 Inst	NA	--------	-------	
	NEF1 Low	1.1xIn, 25 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	4.0xIn, 0.05 sec	25.01.23	25.01.23	
	NOC3 Inst	1.1xIn, 8 sec	25.01.23	25.01.23	
	NOC3 Low	1.1xIn, 25 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.2xIn, 2 sec	25.01.23	25.01.23	
	NPS3 Low	0.15xIn, 2 sec	25.01.23	25.01.23	
6	**PREV3**	1sec	25.01.23	25.01.23	
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	6xIn, 4.6 sec	25.01.23	25.01.23	
8	**UV3Low**	0.8xVn, 1sec	25.01.23	25.01.23	

Sr. No.	**Particulars**	**Setting Group**	**Date of testing**		**Remark**
			Unit-08	**Unit-09**	
	IAC CT Ratio-50/1A				
1	**Inrush3**				
2	**Motor Start**	4.4xIn, 6 sec	25.01.23	25.01.23	
3	**NEF**				
	NEF1 High	0.1xIn, 0.05 sec	25.01.23	25.01.23	
	NEF1 Inst	NA	--------	-------	
	NEF1 Low	NA	--------	-------	
4	**NOC**				
	NOC3 High	0.1xIn, 0.05 sec	25.01.23	25.01.23	
	NOC3 Inst	1.1xIn, 8 sec	25.01.23	25.01.23	
	NOC3 Low	1.1xIn, 25 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.2xIn, 2 sec	25.01.23	25.01.23	
	NPS3 Low	0.15xIn, 2 sec	25.01.23	25.01.23	

6	**PREV3**	1sec	25.01.23	25.01.23	
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	6xIn, 4.6 sec	25.01.23	25.01.23	
8	**UV3Low**	0.8xVn, 1sec	25.01.23	25.01.23	

Sr. No.	**Particulars**	**Setting Group**	**Date of testing**		**Remark**
			Unit-08	**Unit-09**	
	Fire Water/ Compressor Transformer CT Ratio-200/1A				
1	**Inrush3**	0.15xIn, 0.02 sec	25.01.23	25.01.23	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	0.1xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Inst	0.1xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Low	0.1xIn, 1.0 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	2xIn,1.0 sec	25.01.23	25.01.23	
	NOC3 Inst	3.0xIn, 0.02 sec	25.01.23	25.01.23	
	NOC3 Low	0.95xIn, 11.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	0.3xIn,0.04 sec	25.01.23	25.01.23	
6	**PREV3**	1sec	25.01.23	25.01.23	
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	**Particulars**	**Setting Group**	**Date of testing**		**Remark**
			Unit-08	**Unit-09**	
	Tie to 9S CT Ratio-200/1A				
1	**Inrush3**	0.1xIn, I12/I1f: 15%	25.01.23	25.01.23	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				

	NEF1 High	NA	--------	-------	
	NEF1 Inst	NA	--------	-------	
	NEF1 Low	0.25xIn, 0.5 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	3xIn, 0.05 sec	25.01.23	25.01.23	
	NOC3 Inst	NA	--------	-------	
	NOC3 Low	NA	--------	-------	
5	**NPS**				
	NPS3 High	NA	--------	-------	
	NPS3 Low	NA	--------	-------	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	0.8xVn, 1sec	25.01.23	25.01.23	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	SST 9B CT Ratio-200/1A				
1	**Inrush3**	0.15xIn, 0.02 sec	25.01.23	25.01.23	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	0.1xIn, 0.1 sec	25.01.23	25.01.23	
	NEF1 Inst	0.2xIn, 0.1 sec	25.01.23	25.01.23	
	NEF1 Low	0.1xIn, 0.1 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	1.5xIn,1.0 sec	25.01.23	25.01.23	
	NOC3 Inst	3.5xIn, 0.02 sec	25.01.23	25.01.23	
	NOC3 Low	1.1xIn, 10.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	NA	--------	-------	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	

7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	Tie to 8U CT Ratio-1600/1A				
1	**Inrush3**	0.1xIn, I12/I1f: 15%	25.01.23	25.01.23	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	NA	--------	-------	
	NEF1 Inst	NA	--------	-------	
	NEF1 Low	0.35xIn, 0.55 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	3xIn, 0.05 sec	25.01.23	25.01.23	
	NOC3 Inst	NA	--------	-------	
	NOC3 Low	NA	--------	-------	
5	**NPS**				
	NPS3 High	NA	--------	-------	
	NPS3 Low	NA	--------	-------	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	Tie from 8S CT Ratio-1600/1A				
1	**Inrush3**	0.1xIn, I12/I1f: 15%	25.01.23	25.01.23	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	NA	--------	-------	
	NEF1 Inst	NA	--------	-------	
	NEF1 Low	0.35xIn, 0.55 sec	25.01.23	25.01.23	

4	**NOC**				
	NOC3 High	3.5xIn, 0.05 sec	25.01.23	25.01.23	
	NOC3 Inst	NA	--------	-------	
	NOC3 Low	NA	--------	-------	
5	**NPS**				
	NPS3 High	NA	--------	-------	
	NPS3 Low	NA	--------	-------	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	**Particulars**	**Setting Group**	**Date of testing**		**Remark**
			Unit-08	**Unit-09**	
	Tie from IDCT Transformer 8A CT Ratio-200/1A				
1	**Inrush3**	0.1xIn, I12/I1f: 15%	25.01.23	25.01.23	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	0.1xIn, 0.5 sec	25.01.23	25.01.23	
	NEF1 Inst	0.3xIn, 0.04 sec	25.01.23	25.01.23	
	NEF1 Low	0.1xIn, 1.0 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	1.5xIn,1.0 sec	25.01.23	25.01.23	
	NOC3 Inst	3.0xIn, 0.02 sec	25.01.23	25.01.23	
	NOC3 Low	0.95xIn, 11.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	0.3xIn,0.04 sec	25.01.23	25.01.23	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	ESP Transformer. 8A CT Ratio-300/1A				
1	**Inrush3**	NA	--------	-------	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	0.1xIn, 0.07 sec	25.01.23	25.01.23	
	NEF1 Inst	0.2xIn, 2.0 sec	25.01.23	25.01.23	
	NEF1 Low	NA	--------	-------	
4	**NOC**				
	NOC3 High	2xIn, 5.0 sec	25.01.23	25.01.23	
	NOC3 Inst	NA	--------	-------	
	NOC3 Low	2xIn, 6.0 sec	25.01.23	25.01.23	
5	**NPS**				
	NPS3 High	NA	--------	-------	
	NPS3 Low	NA	--------	-------	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

Sr. No.	Particulars	Setting Group	Date of testing		Remark
			Unit-08	Unit-09	
	UST CT Ratio-200/1A				
1	**Inrush3**	0.1xIn, I12/I1f: 15%	25.01.23	25.01.23	
2	**Motor Start**	NA	--------	-------	
3	**NEF**				
	NEF1 High	0.1xIn, 0.1 sec	25.01.23	25.01.23	
	NEF1 Inst	0.1xIn, 0.1 sec	25.01.23	25.01.23	
	NEF1 Low	0.1xIn, 0.1 sec	25.01.23	25.01.23	
4	**NOC**				
	NOC3 High	1.5xIn, 6.0 sec	25.01.23	25.01.23	
	NOC3 Inst	4xIn,0.02sec	25.01.23	25.01.23	
	NOC3 Low	0.95xIn, 11.0 sec	25.01.23	25.01.23	

5	**NPS**				
	NPS3 High	0.3xIn,0.04 sec	25.01.23	25.01.23	
	NPS3 Low	0.3xIn,0.04 sec	25.01.23	25.01.23	
6	**PREV3**				
	PSV	NA	--------	-------	
	PSV3St1	NA	--------	-------	
	PSV3St2	NA	--------	-------	
7	**TOL3Dev**	NA	--------	-------	
8	**UV3Low**	NA	--------	-------	

OBSERVATIONS

As a general finding from this audit, it is observed that:

1. Generator & GT are well protected as per Northern region Power Committee recommendation.
2. GRP has independent main-1 and main-2 functional Numerical protection.
3. Both UATs are well protected as per guidelines.
4. The state of DC & EDG supply at 1X250MW Unit checked and found in order.
5. Time Functionality of GPS/TSU, circuit breaker, relay testing reports is also checked, and all are found in satisfactory state.

RECOMMENDATIONS:

Various recommendations in order to improve the reliability of power system and to avoid unwanted outages in 2X250 MW Unit-08 & 09 are as follows: -

1) Refurbishment of M/s Siemens make SCADA system of 2X250 MW Unit-08 & 09, DTPS, HTPP, Aligarh.
2) Refurbishment of M/s ABB make SCADA system of 6.6 kV switchgear system, 2X250 MW Unit-08 & 09, DTPS, HTPP, Aligarh.

Electrical Maintenance Division-I
DTPS, HTPP, Kasimpur, Aligarh

Internal Protection Audit Data

1x660 MW

EMD-I,
ETPS, HTPS

Generator, ET, GT, UT, EDG, 220V DC System, 11kV System

‘E’ Thermal power station,
Harduaganj Thermal Power Plant,
Kasimpur, Aligarh

GENERATOR
780MVA, 50HZ, 23.5kV, 0.85PF LAG

Make	**UoM**	**TOSHIBA**
Type		TAKS
Model number		THDF 115/67
Maximum continuous rating		663 MW / 780 MVA
VWO Rating (Continuous)		693.0MW / 816 MVA
Rated terminal voltage	kV	23.5
Rated stator current	Amps	19164
Rated frequency	Hz	50
Rated power factor		0.85(Lagging)
Rotor current at MCR	Amps	4640
Rotor voltage at MCR	Volts	492
Number of phases	No.	3
Type of Stator Winding Connection		Star Star
Type of Cooling		
Stator Core		Hydrogen Cooled
Stator Winding		Water Cooled
Rotor		Hydrogen Cooled
Synchronous speed	rpm	3000
Rated H2 Gas pressure	Bar(g)	5.3
Critical speed	rpm	1st : 1010
		2nd : > 2848
		3rd : >3600

Excitation Transformer
23.5 / 0.66 kV, 5 MVA

Object	**23.5 / 0.66 kV, 5 MVA Excitation Transformer**			
Winding	HV		LV	
Voltage	23.5	kV	0.66	kV
Capacity	5	MVA	5	MVA
Line Current	122.8	A	4373.8	A
Tap changer	--		--	
% Impedance @ 5 MVA Base	Nominal Tap			
	15% ± 7.5%			
Vector Group	Yd1			

NEUTRAL EARTHING TRANSFORMER

23.5kV/240V, 80kVA

Object	Neutral Earthing Transformer			
	HV		LV	
Voltage	23.5	kV	240	V
Capacity	80	kVA	80	kVA
Earthing resistor	0.25 Ohms			

Unit Transformer-A & B
23.5 / 11.5 kV, 35 MVA

Object	23.5 / 11.5 kV, 35 MVA Unit Transformer-A & B			
Winding	HV		LV	
Voltage	23.5	kV	11.5	kV
Capacity	35	MVA	35	MVA
Line Current	859.8	A	1757.1	A
Tap changer	±10% at 1.25% per tap			
% Impedance @ 35 MVA Base		Nominal Tap		
	NA	9±10%	NA	
Vector Group	Dyn1			

Generating Transformer
420 / 23.5 kV, 825 MVA

Object	420 / 23.5 kV, 825 MVA Generating Transformer			
Winding	HV		LV	
Voltage	$420/\sqrt{3}$	kV	23.5	kV
Capacity	275	MVA	275	MVA
Line Current	1134.08	A	11702.13	A
Tap changer	±5% at 2.5% per tap			
% Impedance @ 275 MVA Base		Nominal Tap		
	NA	15%	NA	
Vector Group	YNd11			

CT/PT (VT) DETAILS
CURRENT TRANSFORMER

Description	Side	CT No.	Details
CT details for 87G	Terminal	CT – 4 (M1), CT – 3 (M2)	25000 / 5 A
CT details for 87G and other protections	Neutral	CT – 7 (M1), CT – 5 (M2)	25000 / 5 A
CT details for 87UAT-A	HV	CT – 10	2500 / 1 A
	LV		2500 / 1 A
CT details for UT-A HV 50/51	HV	CT – 11	2500 / 1 A
CT details for UT-A LV 51NS	LV	NCT	300 / 1 A
CT details for 87UT-B	HV	CT – 13	2500 / 1 A
	LV		2500 / 1 A
CT details for UT-B HV 50/51	HV	CT – 11	2500 / 1 A
CT details for UT-B LV 51NS	LV	NCT	300 / 1 A
VT details for 32, 21, 60, 40, 78, 27, 59, 81	Terminal	-	23500 / √3 / 110 V / √3
VT details for 64G1	NGT	-	23500 / 240 V

Protection relay / IED Details:

Sr. No	Protection Type	ANSI Code	IED	
			REG670-M1	**REG670-M2**
1	Generator Differential Protection	87 G	X	X
2	Loss of Excitation Protection	40 G	X	X
3	Under Voltage Protection	27 G	X	X
4	Over – Voltage Protection	59 G	X	X
5	Back – up Impedance Protection	21 G	X	X
6	Reverse Power Protection (2 stages)	32 G	X	X
7	Under Frequency Protection	81 U	X	X
8	Over Frequency Protection	81 O	X	X
9	Pole Slip Protection	78 G	X	X
10	PT Fuse Fail	60 G	X	X
11	Negative Phase Sequence Protection	46 G	X	X
12	95 % Stator Earth Fault Protection (NGT Voltage)	64 G1	X	X
13	Dead Machine Protection	27/50G	X	X
14	Rotor Earth Fault Protection – RXTTE Based	64 R	X	--

X – Protection is included in the relay

Sr. No	Protection Type	ANSI Code	IED
15	100% Stator Earth Fault Protection (Injection)	64 G2	P345
16	Excitation Transformer Differential Protection	87 ET	
17	ET Overcurrent Protection	50/51ET	
18	Overall Differential Protection	87 OA	RET670-3
19	UT-A Differential Protection	87UTA	RET615-UTA
20	UT-A REF Protection	64R	
21	UT-A Over – Current Protection	50/51UT-A	REF615-UTA
22	UT-A Stand-by Earth – Fault Protection	51NS	
23	UT-B Differential Protection	87UTB	RET615-UTB
24	UT-B REF Protection	64R	
25	UT-B Over – Current Protection	50/51UT-B	REF615-UTB
26	UT-B Stand-by Earth – Fault Protection	51NS	

Sl No	Protection	CT Details	VT/PT Details	Relay	Approved Settings	Installed Settings	Remark
1	**Generator Differential Protection (87 G) GENDIFF_PROT**	PHASE SIDE CT-4 25000/5A, CL:PS, NEUTRAL SIDE CT-7 25000/5A, CL:PS,		REG670-M1	Idmin is set to 10% (0.10 times) of IBase 19164.0 A.	Idmin is set to 10% (0.10 times) of IBase 19164.0 A.	
					EndSection1 1.25 IB	EndSection1 1.25 IB	
					EndSection2 3.00 IB	EndSection2 3.00 IB	
					SlopeSection2 40.0 %	SlopeSection2 40.0 %	
					SlopeSection3 80.0 %	SlopeSection3 80.0 %	
		PHASE SIDE CT-3 25000/5A, CL:PS, NEUTRAL SIDE CT-5 25000/5A, CL:PS,		REG670-M2	Idmin is set to 10% (0.10 times) of IBase 19164.0 A.	Idmin is set to 10% (0.10 times) of IBase 19164.0 A.	
					EndSection1 1.25 IB	EndSection1 1.25 IB	
					EndSection2 3.00 IB	EndSection2 3.00 IB	
					SlopeSection2 40.0 %	SlopeSection2 40.0 %	
					SlopeSection3 80.0 %	SlopeSection3 80.0 %	
2	**Loss of Excitation (With and without under voltage) Protection (40 G) (Field Failure)**	CT-7 25000/5A, CL:PS	VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M1	Xoffsetz1 - -13.40 %	Xoffsetz1 - - 13.40 %	
					Z1diameter 100.00 %	Z1diameter 100.00 %	
					tZ1 0.10 s	tZ1 0.10 s	
					OperationZ2 On	OperationZ2 On	
					Xoffsetz2 - 13.40 %	Xoffsetz2 - 13.40 %	
					Z2diameter 181.00 %	Z2diameter 181.00 %	
					tZ2 2.00 s	tZ2 2.00 s	
		CT-5 25000/5A, CL:PS	VT-1, 23.5KV/ √3 / 110V/√3	REG670-M2	Xoffsetz1 - -13.40 %	Xoffsetz1 - - 13.40 %	
					Z1diameter 100.00 %	Z1diameter 100.00 %	

			100VA, CL:0.2/3P		tZ1 0.10 s	tZ1 0.10 s	
					OperationZ2 On	OperationZ2 On	
					Xoffsetz2 - 13.40 %	Xoffsetz2 - 13.40 %	
					Z2diameter 181.00 %	Z2diameter 181.00 %	
					tZ2 2.00 s	tZ2 2.00 s	
3	**Under – Voltage Protection (27G)** **UNDER_VOLTAGE_27G Voltage protection UnderVoltage2Step(PTUV,27)**	NA	VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M1	Step 1	Step 1	
					U1< 70 %UB	U1< 70 %UB	
					t1 2.00 s	t1 2.00 s	
					Step 2	Step 2	
					U2< 70 %UB	U2< 70 %UB	
					t2 0 .000 s	t2 0 .000 s	
		NA	VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M2	Step 1	Step 1	
					U1< 70 %UB	U1< 70 %UB	
					t1 2.00 s	t1 2.00 s	
					Step 2	Step 2	
					U2< 70 %UB	U2< 70 %UB	
					t2 0.000 s	t2 0.000 s	
4	**Over – Voltage Protection (59)** **OVER_VOLTAGE_59G Voltage protection OverVoltage**		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M1	Step 1	Step 1	
					U1> 110 %UB	U1> 110 %UB	
					t1 3.00 s	t1 3.00 s	
					Step 2	Step 2	
					U2> 120 %UB	U2> 120 %UB	
					t2 1.500 s	t2 1.500 s	
					Step 1	Step 1	

	2Step(PTOV, 59)		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M2	U1> 110 %UB	U1> 110 %UB	
					t1 3.00 s	t1 3.00 s	
					Step 2	Step 2	
					U2> 120 %UB	U2> 120 %UB	
					t2 1.500 s	t2 1.500 s	
5	**Over Fluxing Protection (24)** **OVER_FLUX _99G Voltage protection Overexcitati on(PVPH,24)**		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M1	V/Hz> 105.0 %UB/f	V/Hz> 105.0 %UB/f	
					V/Hz>> 120.0 %UB/f	V/Hz>> 120.0 %UB/f	
					Xleak 0.000 ohm	Xleak 0.000 ohm	
					TrPulse 0.100 s	TrPulse 0.100 s	
					tMin 1.000 s	tMin 1.000 s	
					tMax 3600.00 s	tMax 3600.00 s	
					tCooling 1200.00 s	tCooling 1200.00 s	
					CurveType Tailor made	CurveType Tailor made	
					t1Tailor 3600.00 s	t1Tailor 3600.00 s	
					t2Tailor 95.00 s	t2Tailor 95.00 s	
					t3Tailor 54.00 s	t3Tailor 54.00 s	
					t4Tailor 38.00 s	t4Tailor 38.00 s	
					t5Tailor 28.00 s	t5Tailor 28.00 s	
					t6Tailor 20.00 s	t6Tailor 20.00 s	
					AlarmLevel 98.0 %	AlarmLevel 98.0 %	
					tAlarm 5.00 s	tAlarm 5.00 s	
				REG670-M2	V/Hz> 105.0 %UB/f	V/Hz> 105.0 %UB/f	

			VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P		V/Hz>> 120.0 %UB/f	V/Hz>> 120.0 %UB/f	
					Xleak 0.000 ohm	Xleak 0.000 ohm	
					TrPulse 0.100 s	TrPulse 0.100 s	
					tMin 1.000 s	tMin 1.000 s	
					tMax 3600.00 s	tMax 3600.00 s	
					tCooling 1200.00 s	tCooling 1200.00 s	
					CurveType Tailor made	CurveType Tailor made	
					t1Tailor 3600.00 s	t1Tailor 3600.00 s	
					t2Tailor 95.00 s	t2Tailor 95.00 s	
					t3Tailor 54.00 s	t3Tailor 54.00 s	
					t4Tailor 38.00 s	t4Tailor 38.00 s	
					t5Tailor 28.00 s	t5Tailor 28.00 s	
					t6Tailor 20.00 s	t6Tailor 20.00 s	
					AlarmLevel 98.0 %	AlarmLevel 98.0 %	
					tAlarm 5.00 s	tAlarm 5.00 s	
6	**Back-up Impedance Protection (21)** **BACKUP_IMP_21G Impedance protection**	CT-7 25000/5A, CL:PS,	VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M1	Zone – 1	Zone – 1	
					Z1 in % of ZTrf = 70% = 0.0703 Ω	Z1 in % of ZTrf = 70% = 0.0703 Ω	
					Time delay for Zone1 = 0.5 Sec	Time delay for Zone1 = 0.5 Sec	
					Zone – 2	Zone – 2	
					Z1 in % of ZTrf = 120% = 0.12 Ω	Z1 in % of ZTrf = 120% = 0.12 Ω	
					Time delay for Zone2 = 2 Sec	Time delay for Zone2 = 2 Sec	

	MhoDistance(PDIS,21)	CT-5 25000/5A, CL:PS	VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M2	Zone – 1	Zone – 1	
					Z1 in % of ZTrf = 70% = 0.0703 Ω	Z1 in % of ZTrf = 70% = 0.0703 Ω	
					Time delay for Zone1 = 0.5 Sec	Time delay for Zone1 = 0.5 Sec	
					Zone – 2	Zone – 2	
					Z1 in % of ZTrf = 120% = 0.12 Ω	Z1 in % of ZTrf = 120% = 0.12 Ω	
					Time delay for Zone2 = 2 Sec	Time delay for Zone2 = 2 Sec	
7	**Reverse Power Protection (32 G)** **REV_POWER_32G Current protection DirOverPowerProtection (PDOP,32)**	CT-7 25000/5A, CL:PS,	VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M1	operating angle setting Ө = Өi = 180°	operating angle setting Ө = Өi = 180°	
					Step1 Over Power Pickup S1> = 0.5 % Sbase	Step1 Over Power Pickup S1> = 0.5 % Sbase	
					S1> = 3.3 MW	S1> = 3.3 MW	
					Operating time delay t1 = 15.0 Sec	Operating time delay t1 = 15.0 Sec	
					Step 2 Over Power Pickup S2> = 0.5 % Sbase	Step 2 Over Power Pickup S2> = 0.5 % Sbase	
					S2> = 3.3 MW	S2> = 3.3 MW	
					Operating time delay t2 = 2.0 Sec	Operating time delay t2 = 2.0 Sec	
		CT-5 25000/5A, CL:PS	VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M2	operating angle setting Ө = Өi = 180°	operating angle setting Ө = Өi = 180°	
					Step1 Over Power Pickup S1> = 0.5 % Sbase	Step1 Over Power Pickup S1> = 0.5 % Sbase	
					S1> = 3.3 MW	S1> = 3.3 MW	
					Operating time delay t1 = 15.0 Sec	Operating time delay t1 = 15.0 Sec	
					Step 2 Over Power Pickup S2> = 0.5 % Sbase	Step 2 Over Power Pickup S2> = 0.5 % Sbase	
					S2> = 3.3 MW	S2> = 3.3 MW	
					Operating time delay t2 = 2.0 Sec	Operating time delay t2 = 2.0 Sec	

8	**Under-Frequency (81 U) 81GL UnderFrequency (PTUF,81)**		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M1	Stage – 1 of under frequency settings is set to 48.5 Hz, with a time delay of 2 s.	Stage – 1 of under frequency settings is set to 48.5 Hz, with a time delay of 2 s.	
			VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M2	Stage – 2 of under frequency settings is set 48.0 Hz with a time delay of 1 s.	Stage – 2 of under frequency settings is set 48.0 Hz with a time delay of 1 s.	
9	**Over – Frequency (81 O) 81GH OverFrequency (PTOF,81)**		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M1	Stage – 1 of over frequency settings is set to 52 Hz with a time delay of 2.5 s.	Stage – 1 of over frequency settings is set to 52 Hz with a time delay of 2.5 s.	
					Stage – 2 of over frequency settings is set to 52.5 Hz with a time delay of 1 s.	Stage – 2 of over frequency settings is set to 52.5 Hz with a time delay of 1 s.	
			VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M2	Stage – 1 of over frequency settings is set to 52 Hz with a time delay of 2.5 s.	Stage – 1 of over frequency settings is set to 52 Hz with a time delay of 2.5 s.	
					Stage – 2 of over frequency settings is set to 52.5 Hz with a time delay of 1 s.	Stage – 2 of over frequency settings is set to 52.5 Hz with a time delay of 1 s.	
10	**Pole Slip Protection (78 G) GEN_POLESLIP _78G Impedance protection**	CT-7 25000/5A, CL:PS,	VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M1	ZA = (Ztrf + ZN) (0.1 + 0.0159) = 0.1159 Ω	ZA = (Ztrf + ZN) (0.1 + 0.0159) = 0.1159 Ω	
					ZB = -Xd' = - 0.189 Ω	ZB = -Xd' = - 0.189 Ω	
					ZC = Xtrf = 85% of Ztrf 0.85 * 0.1 = 0.085 Ω	ZC = Xtrf = 85% of Ztrf 0.85 * 0.1 = 0.085 Ω	
					Angle Phi (Φ) = 85°	Angle Phi (Φ) = 85°	
					Start Angle = 110°	Start Angle = 110°	

	PoleSlip (PPAM,78)				Trip Angle = 90°	Trip Angle = 90°	
					No of counts for zone1 trip = 1	No of counts for zone1 trip = 1	
					No of counts for zone2 trip = 2	No of counts for zone2 trip = 2	
		CT-5 25000/5A, CL:PS	VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M2	ZA = (Ztrf + ZN) (0.1 + 0.0159) = 0.1159 Ω	ZA = (Ztrf + ZN) (0.1 + 0.0159) = 0.1159 Ω	
					ZB = -Xd' = - 0.189 Ω	ZB = -Xd' = - 0.189 Ω	
					ZC = Xtrf = 85% of Ztrf 0.85 * 0.1 = 0.085 Ω	ZC = Xtrf = 85% of Ztrf 0.85 * 0.1 = 0.085 Ω	
					Angle Phi (Φ) = 85°	Angle Phi (Φ) = 85°	
					Start Angle = 110°	Start Angle = 110°	
					Trip Angle = 90°	Trip Angle = 90°	
					No of counts for zone1 trip = 1	No of counts for zone1 trip = 1	
					No of counts for zone2 trip = 2	No of counts for zone2 trip = 2	
11	**Negative Sequence Protection (46 G)** **NEG_SEQ_46G Current protection NegSeqOverCurr2Step (PTOC,46I2)**	CT-7 25000/5A, CL:PS,	VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG-670M1	Step1: (only for alarm)	Step1: (only for alarm)	
					Negative sequence current pickup Istart-1> = 4.0% Ibase	Negative sequence current pickup Istart-1> = 4.0% Ibase	
					Operating characteristics setting = Definite	Operating characteristics setting = Definite	
					Operating time for alarm = 5 s	Operating time for alarm = 5 s	
					Step2:	Step2:	
					Negative sequence current pickup Istart-2> = 6% Ibase	Negative sequence current pickup Istart-2> = 6% Ibase	
					Operating characteristics setting = Inverse	Operating characteristics setting = Inverse	
					Operating Time (I2t = K) (set to 90% of generator capability	Operating Time (I2t = K) (set to 90% of generator capability	

					curve) K = 5.04*	curve) K = 5.04*	
		CT-5 25000/5A, CL:PS	VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG- 670M2	Step1: (only for alarm)	Step1: (only for alarm)	
					Negative sequence current pickup Istart-1> = 4.0% Ibase	Negative sequence current pickup Istart-1> = 4.0% Ibase	
					Operating characteristics setting = Definite	Operating characteristics setting = Definite	
					Operating time for alarm = 5 s	Operating time for alarm = 5 s	
					Step2:	Step2:	
					Negative sequence current pickup Istart-2> = 6% Ibase	Negative sequence current pickup Istart-2> = 6% Ibase	
					Operating characteristics setting = Inverse	Operating characteristics setting = Inverse	
					Operating Time (I2t = K) (set to 90% of generator capability curve) K = 5.04*	Operating Time (I2t = K) (set to 90% of generator capability curve) K = 5.04*	
12	**95% Stator Earth – Fault and (64 G1) (95% SEF) STATOR_95_EF_64G1 Voltage protection ResidualOverVoltage2Step (PTOV,59N)**		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670- M1	Stage 1	Stage 1	
					Un> Pick up (phase to earth) = 8% of Ubase / √3	Un> Pick up (phase to earth) = 8% of Ubase / √3	
					Un> Pick up (in terms of Ubase) = 4.62% of Ubase	Un> Pick up (in terms of Ubase) = 4.62% of Ubase	
					Un> Pick up (in terms of Up) = 5% of Ubase i.e. pick up Voltage = 1.175 kV	Un> Pick up (in terms of Up) = 5% of Ubase i.e. pick up Voltage = 1.175 kV	
					Pick – up (secondary voltage) = 5.5 V	Pick – up (secondary voltage) = 5.5 V	
					Operating time delay = 1.5 Sec	Operating time delay = 1.5 Sec	

					Stage 2	Stage 2	
					Un> Pick up (phase to earth) = 17% of Ubase / √3	Un> Pick up (phase to earth) = 17% of Ubase / √3	
					Un> Pick up (in terms of Ubase) = 10.00% of Ubase	Un> Pick up (in terms of Ubase) = 10.00% of Ubase	
					Un> Pick up (in terms of Up) = 10% of Ubase i.e. pick up Voltage = 2.35 kV	Un> Pick up (in terms of Up) = 10% of Ubase i.e. pick up Voltage = 2.35 kV	
					Pick – up (secondary voltage) = 11 V	Pick – up (secondary voltage) = 11 V	
					Operating time delay = 0.5 Sec	Operating time delay = 0.5 Sec	
			VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M2	Stage 1	Stage 1	
					Un> Pick up (phase to earth) = 8% of Ubase / √3	Un> Pick up (phase to earth) = 8% of Ubase / √3	
					Un> Pick up (in terms of Ubase) = 4.62% of Ubase	Un> Pick up (in terms of Ubase) = 4.62% of Ubase	
					Un> Pick up (in terms of Up) = 5% of Ubase i.e. pick up Voltage = 1.175 kV	Un> Pick up (in terms of Up) = 5% of Ubase i.e. pick up Voltage = 1.175 kV	
					Pick – up (secondary voltage) = 5.5 V	Pick – up (secondary voltage) = 5.5 V	
					Operating time delay = 1.5 Sec	Operating time delay = 1.5 Sec	
					Stage 2	Stage 2	
					Un> Pick up (phase to earth) = 17% of Ubase / √3	Un> Pick up (phase to earth) = 17% of Ubase / √3	
					Un> Pick up (in terms of Ubase) = 10.00% of Ubase	Un> Pick up (in terms of Ubase) = 10.00% of Ubase	
					Un> Pick up (in terms of Up) = 10% of Ubase i.e. pick up Voltage = 2.35 kV	Un> Pick up (in terms of Up) = 10% of Ubase i.e. pick up Voltage = 2.35 kV	

					Pick – up (secondary voltage) = 11 V	Pick – up (secondary voltage) = 11 V	
					Operating time delay = 0.5 Sec	Operating time delay = 0.5 Sec	
13	**Dead Machine Protection (GAPC/50AE)** **DEAD_MACHINE_50DGM Current protection AccEnerGen Prot (GAPC,50AE)**		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M1	Under Voltage Pick-up for dead machine detect U< = 70% Ubase i.e. U< = 16.45 kV	Under Voltage Pick-up for dead machine detect U< = 70% Ubase i.e. U< = 16.45 kV	
					Dead machine detection time tu< = 5 Sec	Dead machine detection time tu< = 5 Sec	
					Over Voltage Pickup for machine live detect U> = 90% Ubase i.e. U> = 21.15 kV	Over Voltage Pickup for machine live detect U> = 90% Ubase i.e. U> = 21.15 kV	
					Machine live detection time tu> = 1 Sec	Machine live detection time tu> = 1 Sec	
			VT-2, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M2	Under Voltage Pick-up for dead machine detect U< = 70% Ubase i.e. U< = 16.45 kV	Under Voltage Pick-up for dead machine detect U< = 70% Ubase i.e. U< = 16.45 kV	
					Dead machine detection time tu< = 5 Sec	Dead machine detection time tu< = 5 Sec	
					Over Voltage Pickup for machine live detect U> = 90% Ubase i.e. U> = 21.15 kV	Over Voltage Pickup for machine live detect U> = 90% Ubase i.e. U> = 21.15 kV	
					Machine live detection time tu> = 1 Sec	Machine live detection time tu> = 1 Sec	

14	**Rotor Earth Fault Protection (64 R) ROTOR_EF_ 64F Analog modules 3PhaseAnal ogGroup**			REG670-M1	The COMBIFLEX injection unit RXTTE4 is used	The COMBIFLEX injection unit RXTTE4 is used	
					Pickup 4.9 kOhm	Pickup 4.9 kOhm	
					Time Delay 05 sec	Time Delay 05 sec	
					Pickup 1.9 kOhm	Pickup 1.9 kOhm	
					Time Delay 2 sec	Time Delay 2 sec	
15	**100% Stator Earth Fault Protection (Injection) (64G2) / P345**	NGT-CT Turns ratio: 400:5A Rating factor (RF): 3.0 Frequency: 20 Hz Voltage insulation: 600 V Basic impulse level (BIL): 10 Kv	NEUTRAL EARTHING TRANSFORMER 23.5kV/240V, 80kVA	MICOM-P345	R Factor: 6.670	R Factor: 6.670	
					R<l Alarm: Enabled	R<l Alarm: Enabled	
					R<l Alm Set: 700.0 Ohm	R<l Alm Set: 700.0 Ohm	
					R<l Alm Dly: 10.00 s	R<l Alm Dly: 10.00 s	
					R<2 Trip: Enabled	R<2 Trip: Enabled	
					Series R: 281.0 Ohm	Series R: 281.0 Ohm	
					Parallel G : 0 S	Parallel G : 0 S	
					Overcurrent: Enabled	Overcurrent: Enabled	
					I> 1 Trip Set: 500.0 mA	I> 1 Trip Set: 500.0 mA	
					I> 1 Trip Dly: 1.000 s	I> 1 Trip Dly: 1.000 s	
					Supervision: Enabled	Supervision: Enabled	
					V< Set: 1.000 V	V< Set: 1.000 V	
					I< Set: 10.00 mA	I< Set: 10.00 mA	
					Superv'n Dly: 1.000 s	Superv'n Dly: 1.000 s	
		N/A	NEUTRAL EARTHING TRANSFORMER 23.5kV/240V, 80kVA	REG670-M1	64G4 (100% SEF 3RD HARMONIC) DISABLED	64G4 (100% SEF 3RD HARMONIC) DISABLED	

16	**EXCITATION TRAFO. DIFF. PROTECTION ET Differential Protection (87 ET)**	CT-16, 200/5A, CL:5P20	N/A	MICOM-P345	Xform Diff Fune: Enabled	Xform Diff Fune: Enabled	
					Set Mode: Simple	Set Mode: Simple	
					Xform Isl: 200.0e-3 PU	Xform Isl: 200.0e-3 PU	
					Xform Kl: 30.00 %	Xform Kl: 30.00 %	
					Xform Is2: 1.000 PU	Xform Is2: 1.000 PU	
					Xform K2: 80.00 %	Xform K2: 80.00 %	
					Xform tDIFF: 0 s	Xform tDIFF: 0 s	
					Xform ls-CTS: 1.500 PU	Xform ls-CTS: 1.500 PU	
					Xform HSl Status: Enabled	Xform HSl Status: Enabled	
					Xform ls-HSl: 6.700 PU	Xform ls-HSl: 6.700 PU	
					Xform HS2 Status: Enabled	Xform HS2 Status: Enabled	
					Xform ls-HS2: 16.00 PU	Xform ls-HS2: 16.00 PU	
					Zero seq filt HV: Enabled	Zero seq filt HV: Enabled	
					Zero seq filt LV: Disabled	Zero seq filt LV: Disabled	
					2nd harm blocked: Enabled	2nd harm blocked: Enabled	
					Xform Ih(2)%>: 20.00 %	Xform Ih(2)%>: 20.00 %	
					Cross blocking: Disabled	Cross blocking: Disabled	
					5th harm blocked: Disabled 37.60: Circuitry Fail: Enabled	5th harm blocked: Disabled 37.60: Circuitry Fail: Enabled	
					ls-cctfail: 100.0e-3 PU	ls-cctfail: 100.0e-3 PU	
					K-cctfail: 10.00 %	K-cctfail: 10.00 %	
					CctFail Delay: 5.000 s	CctFail Delay: 5.000 s	

17	**EXCITATION TRAFO ET Overcurrent Protection (50/51 ET)**	CT-16, 200/5A, CL:5P20 CT * 3, 6000/5A, CL : 5P20	N/A	MICOM-P345	CT Source: IA-1 IB-1 IC-1	CT Source: IA-1 IB-1 IC-1	
					Function: IEC S Inverse	Function: IEC S Inverse	
					I> 1 Direction: Non-Directional	I> 1 Direction: Non-Directional	
					I> 1 Current Set: 3.750 A	I> 1 Current Set: 3.750 A	
					I> 1 TMS: 250.0e-3	I> 1 TMS: 250.0e-3	
					I> 1 tRESET: 0 s	I> 1 tRESET: 0 s	
					I>2 Function: Disabled	I>2 Function: Disabled	
					I>3 Status: Enabled	I>3 Status: Enabled	
					I>3 Direction: Non-Directional	I>3 Direction: Non-Directional	
					I>3 Current Set: 24.55 A	I>3 Current Set: 24.55 A	
					I>3 Time Delay: 100.0 ms	I>3 Time Delay: 100.0 ms	
					I>4 Status: Disabled	I>4 Status: Disabled	
					I> Char Angle: 30.00 deg	I> Char Angle: 30.00 deg	
18	**Overall Differential Protection (87 OA) RET670-3**	CT-8, 25000/5A, CL:PS CT-12., 5000/5A, CL:PS CT-15, 25000/5A, CL:PS Core 4 of 402-CTA (CT-CORE-4 3000-2000-1000-500/1A,CL:PS) Core 5 of 403-CT (CT-CORE-5 3000-2000-1000-500/1A, CL:PS)	N/A	RET670-3	Setting Group1	Setting Group1	
					Operation On	Operation On	
					SOTFMode Off	SOTFMode Off	
					IDiffAlarm 0.05 IB	IDiffAlarm 0.05 IB	
					tAlarmDelay 10.000 s	tAlarmDelay 10.000 s	
					ldMin 0.20 IB	ldMin 0.20 IB	
					EndSection1 1.25 IB	EndSection1 1.25 IB	
					EndSection2 3.00 IB	EndSection2 3.00 IB	
					SlopeSection2 40.0 %	SlopeSection2 40.0 %	
					SlopeSection3 80.0 %	SlopeSection3 80.0 %	

					ldUnre 10.00 IB	ldUnre 10.00 IB	
					12/11Ratio 15.0 %	12/11Ratio 15.0 %	
					15/11Ratio 25.0 %	15/11Ratio 25.0 %	
					CrossBlockEn On	CrossBlockEn On	
					NegSeqDiffEn On	NegSeqDiffEn On	
					IMinNegSeq 0.20 IB	IMinNegSeq 0.20 IB	
					NegSeqROA 60.0 Deg	NegSeqROA 60.0 Deg	
					OpenCTEnable Off	OpenCTEnable Off	
19 A	**UT Differential Protection (87UTA)**	CT-10, 2500/1A, CL:PS	N/A	RET615-UTA	Operation on	Operation on	
					CT connection type Type 1	CT connection type Type 1	
					Winding 1 type D	Winding 1 type D	
					Winding 2 type yn	Winding 2 type yn	
					Clock number Clk Num 1	Clock number Clk Num 1	
					Zro A elimination Winding 2	Zro A elimination Winding 2	
					Tapped winding Not in use	Tapped winding Not in use	
					CT ratio Cor Wnd 1 2.91	CT ratio Cor Wnd 1 2.91	
					CT ratio Cor Wnd 2 1.42	CT ratio Cor Wnd 2 1.42	
					Setting groups	Setting groups	
					High operate value 1330 %Ir	High operate value 1330 %Ir	
					Enable high set True	Enable high set True	
					Low operate value 20 %Ir	Low operate value 20 %Ir	
					Slope section 2 40 %	Slope section 2 40 %	
					End section 2 300 %Ir	End section 2 300 %Ir	

					Restraint mode 2.h + 5.h + wav	Restraint mode 2.h + 5.h + wav	
					Harmonic deblock 2. True	Harmonic deblock 2. True	
					Start value 2.H 15 %	Start value 2.H 15 %	
					Start value 5.H 35 %	Start value 5.H 35 %	
					Stop value 5.H 35 %	Stop value 5.H 35 %	
					Harmonic deblock 5. False	Harmonic deblock 5. False	
19 B	**UT Differential Protection (87UTB)**	CT-13, 2500/1A, CL:PS	N/A	RET615-UTB	Operation on	Operation on	
					CT connection type Type 1	CT connection type Type 1	
					Winding 1 type D	Winding 1 type D	
					Winding 2 type yn	Winding 2 type yn	
					Clock number Clk Num 1	Clock number Clk Num 1	
					Zro A elimination Winding 2	Zro A elimination Winding 2	
					Tapped winding Not in use	Tapped winding Not in use	
					CT ratio Cor Wnd 1 2.91	CT ratio Cor Wnd 1 2.91	
					CT ratio Cor Wnd 2 1.42	CT ratio Cor Wnd 2 1.42	
					Setting groups	Setting groups	
					High operate value 1330 %Ir	High operate value 1330 %Ir	
					Enable high set True	Enable high set True	
					Low operate value 20 %Ir	Low operate value 20 %Ir	
					Slope section 2 40 %	Slope section 2 40 %	
					End section 2 300 %Ir	End section 2 300 %Ir	
					Restraint mode 2.h + 5.h + wav	Restraint mode 2.h + 5.h + wav	
					Harmonic deblock 2. True	Harmonic deblock 2. True	
					Start value 2.H 15 %	Start value 2.H 15 %	

					Start value 5.H 35 %	Start value 5.H 35 %	
					Stop value 5.H 35 %	Stop value 5.H 35 %	
					Harmonic deblock 5. False	Harmonic deblock 5. False	
20 A	**UT A REF Protection (64R)**	2500/1A, CL:PS Neutral CT 2500/1A, CL:PS		RET615-UTA	Operation on	Operation on	
					Reset delay time 20 ms	Reset delay time 20 ms	
					Setting groups	Setting groups	
					Operate value 7.0 %In	Operate value 7.0 %In	
					Minimum operate time 40 ms	Minimum operate time 40 ms	
20 B	**UT B REF Protection (64R)**	2500/1A, CL:PS Neutral CT 2500/1A, CL:PS		RET615-UTB	Operation on	Operation on	
					Reset delay time 20 ms	Reset delay time 20 ms	
					Setting groups	Setting groups	
					Operate value 7.0 %In	Operate value 7.0 %In	
					Minimum operate time 40 ms	Minimum operate time 40 ms	
21 A	**UT Overcurrent Protection (50/51 UT) / REF615 UT A**	CT-11, 2500/1A, CL:5P20, 30VA	N/A	REF615-UTA	Operation ON	Operation ON	
					Num of start phases 1out of 3	Num of start phases 1out of 3	
					Minimum operate time 20 ms	Minimum operate time 20 ms	
					Reset delay time 20 ms	Reset delay time 20 ms	
					Measurement mode OFT	Measurement mode OFT	
					Allow Non Dir TRUE	Allow Non Dir TRUE	
					Min operate current 0.01 xIn	Min operate current 0.01 xIn	
					Min operate voltage 0.01 xUn	Min operate voltage 0.01 xUn	
					Setting groups	Setting groups	
					Start value 0.42xIn	Start value 0.42xIn	

					Start value Mult 1.0	Start value Mult 1.0		
					Time multiplier 0.25	Time multiplier 0.25		
					Operate delay time 40ms	Operate delay time 40ms		
					Operating curve type IEC Normal Inverse	Operating curve type IEC Normal Inverse		
					Type of reset curve Immediate	Type of reset curve Immediate		
					Voltage Mem time 40ms	Voltage Mem time 40ms		
					Directional mode Non Directional	Directional mode Non Directional		
					Characteristic angle 60 degree	Characteristic angle 60 degree		
					Max forward angle 80 degree	Max forward angle 80 degree		
					Max reverse angle 80 degree	Max reverse angle 80 degree		
					Min forward angle 80 degree	Min forward angle 80 degree		
					Min reverse angle 80 degree	Min reverse angle 80 degree		
					Pol quantity cross pole	Pol quantity cross pole		
					PHIPTOC1: 1	PHIPTOC1: 1		
					31»>(1)	31»>(1)		
					Operation on	Operation on		
					Num of start phases 1 out of 3	Num of start phases 1 out of 3		
					Reset delay time 20 ms	Reset delay time 20 ms		
					Setting groups	Setting groups		
					Start value 4.58 xln	Start value 4.58 xln		
					Start value Mult 1.0	Start value Mult 1.0		
					Operate delay time 100 ms	Operate delay time 100 ms		
2IB					Operation ON	Operation ON		

	UT Overcurrent Protection (50/51 UT) / REF615 UT B	CT-14, 2500/1A, CL:5P20, 30VA			REF615-UTB	Num of start phases 1out of 3	Num of start phases 1out of 3	
						Minimum operate time 20 ms	Minimum operate time 20 ms	
						Reset delay time 20 ms	Reset delay time 20 ms	
						Measurement mode OFT	Measurement mode OFT	
						Allow Non Dir TRUE	Allow Non Dir TRUE	
						Min operate current 0.01 xIn	Min operate current 0.01 xIn	
						Min operate voltage 0.01 xUn	Min operate voltage 0.01 xUn	
						Setting groups	Setting groups	
						Start value 0.42xIn	Start value 0.42xIn	
						Start value Mult 1.0	Start value Mult 1.0	
						Time multiplier 0.25	Time multiplier 0.25	
						Operate delay time 40ms	Operate delay time 40ms	
						Operating curve type IEC Normal Inverse	Operating curve type IEC Normal Inverse	
						Type of reset curve Immediate	Type of reset curve Immediate	
						Voltage Mem time 40ms	Voltage Mem time 40ms	
						Directional mode Non Directional	Directional mode Non Directional	
						Characteristic angle 60 degree	Characteristic angle 60 degree	
						Max forward angle 80 degree	Max forward angle 80 degree	
						Max reverse angle 80 degree	Max reverse angle 80 degree	
						Min forward angle 80 degree	Min forward angle 80 degree	
						Min reverse angle 80 degree	Min reverse angle 80 degree	
						Pol quantity cross pole	Pol quantity cross pole	
						PHIPTOC1: 1	PHIPTOC1: 1	

					31»>(1)	31»>(1)	
					Operation on	Operation on	
					Num of start phases 1 out of 3	Num of start phases 1 out of 3	
					Reset delay time 20 ms	Reset delay time 20 ms	
					Setting groups	Setting groups	
					Start value 4.58 xln	Start value 4.58 xln	
					Start value Mult 1.0	Start value Mult 1.0	
					Operate delay time 100 ms	Operate delay time 100 ms	
22 A	**UT Standby Earth Fault Protection (51 NUT) / REF615 UT A**	Neutral CT 300/1A, CL:PS		REF615-UTA	Base current, Ibase = 300 A	Base current, Ibase = 300 A	
					Pick-up set, 25% of maximum fault Current = 75 A	Pick-up set, 25% of maximum fault Current = 75 A	
					Operating value in primary = 75 A	Operating value in primary = 75 A	
					Pickup set, in % of Ibase = 25 % of Ibase	Pickup set, in % of Ibase = 25 % of Ibase	
					Pickup set, in In = 0.25 x In	Pickup set, in In = 0.25 x In	
					Curve = IEC Extremely inverse	Curve = IEC Extremely inverse	
					Direction = Non	Direction = Non	
					TMS[1] (k), = 0.1	TMS[1] (k), = 0.1	
22 B	**UT Standby Earth Fault Protection (51 NUT) / REF615 UT B**	Neutral CT 300/1A, CL:PS		REF615-UTB	Base current, Ibase = 300 A	Base current, Ibase = 300 A	
					Pick-up set, 25% of maximum fault Current = 75 A	Pick-up set, 25% of maximum fault Current = 75 A	
					Operating value in primary = 75 A	Operating value in primary = 75 A	
					Pickup set, in % of Ibase = 25 % of Ibase	Pickup set, in % of Ibase = 25 % of Ibase	
					Pickup set, in In = 0.25 x In	Pickup set, in In = 0.25 x In	

					Curve = IEC Extremely inverse	Curve = IEC Extremely inverse	
					Direction = Non	Direction = Non	
					TMS[1] (k), = 0.1	TMS[1] (k), = 0.1	
23	**GT OVER FLUXING PROTECTION 99GT**		VT-1, 23.5KV/ √3 / 110V/√3 100VA, CL:0.2/3P	REG670-M1	Low operate value 20 %Ir	Low operate value 20 %Ir	
					Setting Group1	Setting Group1	
					Operation On	Operation On	
					Ibase 19164A	Ibase 19164A	
					Ubase 23.5kV	Ubase 23.5kV	
					V/Hz> 105.0 %UB/f	V/Hz> 105.0 %UB/f	
					V/Hz>> 120.0 %UB/f	V/Hz>> 120.0 %UB/f	
					Xleak 0.000 ohm	Xleak 0.000 ohm	
					TrPulse 0.100 s	TrPulse 0.100 s	
					tMin 1.000 s	tMin 1.000 s	
					tMax 200.00 s	tMax 200.00 s	
					tCooling 1.00 s	tCooling 1.00 s	
					CurveType Tailor made	CurveType Tailor made	
					kForIEEE 1	kForIEEE 1	
					t1Tailor 150.00 s	t1Tailor 150.00 s	
					t2Tailor 95.00 s	t2Tailor 95.00 s	
					t3Tailor 54.00 s	t3Tailor 54.00 s	
					t4Tailor 38.00 s	t4Tailor 38.00 s	
					t5Tailor 28.00 s	t5Tailor 28.00 s	
					t6Tailor 20.00 s	t6Tailor 20.00 s	
					AlarmLevel 98.0 %	AlarmLevel 98.0 %	
					tAlarm 5.00 s	tAlarm 5.00 s	
24	**GT DIFF. PROTECTION. 87GT**	CT-20: 1500/5A, CL:PSCT 21A: 15000/5A, CL:PSCT 2IB: 15000/5A, CL:PS		RET670-1	Setting Group1	Setting Group1	
					Operation On	Operation On	
					SOTFMode Off	SOTFMode Off	
					IDiffAlarm 0.15 IB	IDiffAlarm 0.15 IB	
					tAlarmDelay 10.000 s	tAlarmDelay 10.000 s	
					ldMin 0.20 IB	ldMin 0.20 IB	
					EndSection1 1.25 IB	EndSection1 1.25 IB	

					EndSection2 3.00 IB	EndSection2 3.00 IB	
					SlopeSection2 40.0 %	SlopeSection2 40.0 %	
					SlopeSection3 80.0 %	SlopeSection3 80.0 %	
					ldUnre 8.00 IB	ldUnre 8.00 IB	
					I2/I1Ratio 15.0 %	I2/I1Ratio 15.0 %	
					I5/I1Ratio 25.0 %	I5/I1Ratio 25.0 %	
					CrossBlockEn On	CrossBlockEn On	
					NegSeqDiffEn Off	NegSeqDiffEn Off	
					OpenCTEnable Off	OpenCTEnable Off	
					tOCTAlarmDelay 3.000 s	tOCTAlarmDelay 3.000 s	
					tOCTResetDelay 0.250 s	tOCTResetDelay 0.250 s	
					tOCTUnrstDelay 10.00 s	tOCTUnrstDelay 10.00 s	
25	**GT STANDBY E/F PROTECTION 51 N GT 51NS**	CT-23: 1500/1A, CL:5P20		RET670-1	Setting Group1	Setting Group1	
					Operation On	Operation On	
					IBase 1134 A	IBase 1134 A	
					UBase 420.00 kV	UBase 420.00 kV	
					AngleRCA 65 Deg	AngleRCA 65 Deg	
					polMethod Voltage	polMethod Voltage	
					UPolMin 1 %UB	UPolMin 1 %UB	
					IPolMin 2 %IB	IPolMin 2 %IB	
					RNPol 5.00 ohm	RNPol 5.00 ohm	
					XNPol 40.00 ohm	XNPol 40.00 ohm	
					IN>Dir 10 %IB	IN>Dir 10 %IB	
					2ndHarmStab 20 %	2ndHarmStab 20 %	
					BlkParTransf Off	BlkParTransf Off	
					UseStartValue IN4>	UseStartValue IN4>	
					SOTF Off	SOTF Off	
					ActivationSOTF Open	ActivationSOTF Open	
					StepForSOTF Step 2	StepForSOTF Step 2	
					HarmResSOTF Off	HarmResSOTF Off	

					tSOTF 0.200 s	tSOTF 0.200 s	
					t4U 1.000 s	t4U 1.000 s	
					ActUnderTime CB position	ActUnderTime CB position	
					tUnderTime 0.300 s	tUnderTime 0.300 s	
					Step 1	Step 1	
					Setting Group1	Setting Group1	
					DirMode1 Non-directional	DirMode1 Non-directional	
					Characterist1 IEC Norm. inv.	Characterist1 IEC Norm. inv.	
					IN1> 20 %IB	IN1> 20 %IB	
					t1 0.000 s	t1 0.000 s	
					k1 0.05	k1 0.05	
					IMin1 20.00 %IB	IMin1 20.00 %IB	
					t1Min 0.000 s	t1Min 0.000 s	
					IN1Mult 2.0	IN1Mult 2.0	
					ResetTypeCrv1 Instantaneous	ResetTypeCrv1 Instantaneous	
					tReset1 0.020 s	tReset1 0.020 s	
					HarmRestrain1 On	HarmRestrain1 On	
					tPCrv1 1.000	tPCrv1 1.000	
					tACrv1 13.500	tACrv1 13.500	
					tBCrv1 0.00	tBCrv1 0.00	
					tCCrv1 1.0	tCCrv1 1.0	
					tPRCrv1 0.500	tPRCrv1 0.500	
					tTRCrv1 13.500	tTRCrv1 13.500	
					tCRCrv1 1.0	tCRCrv1 1.0	
					Step 2/3/4 Setting Group1 DirMode2/3/4 Off	Step 2/3/4 Setting Group1 DirMode2/3/4 Off	
26	**GT OVER HEAD DIFF. PROTECTIO N 87OH**	Bus II CB Side CT CT-18: 2000/1A, CL:PS Tie CB Side CT CT-18: 2000/1A, CL:PS Transformer Bushing		RET670-2	Setting Group1	Setting Group1	
					Operation On	Operation On	
					U>Alarm 65 V	U>Alarm 65 V	
					tAlarm 5.000 s	tAlarm 5.000 s	
					U>Trip 162 V	U>Trip 162 V	

		Side CT CT-18: 2000/1A, CL:PS			SeriesResistor 1620 ohm	SeriesResistor 1620 ohm	
					HZPDIF: 2	HZPDIF: 2	
					Setting Group1	Setting Group1	
					Operation On	Operation On	
					U>Alarm 65 V	U>Alarm 65 V	
					tAlarm 5.000 s	tAlarm 5.000 s	
					U>Trip 162 V	U>Trip 162 V	
					SeriesResistor 1620 ohm	SeriesResistor 1620 ohm	
					HZPDIF: 3	HZPDIF: 3	
					Setting Group1	Setting Group1	
					Operation On	Operation On	
					U>Alarm 65 V	U>Alarm 65 V	
					tAlarm 5.000 s	tAlarm 5.000 s	
					U>Trip 162 V	U>Trip 162 V	
					SeriesResistor 1620 ohm	SeriesResistor 1620 ohm	
27	**GT HV REF PROTECTION HV High Impedance Restricted Earth Fault Protection: 64RGT 64GT**	HV Side CT CT-19: 1500/1A, CL:PS HV Neutral Side CT CT-22: 1500/1A, CL:PS		RET670-2	Setting Group1	Setting Group1	
					Operation On	Operation On	
					U>Alarm 28 V	U>Alarm 28 V	
					tAlarm 5.000 s	tAlarm 5.000 s	
					U>Trip 69 V	U>Trip 69 V	
					SeriesResistor 690 ohm	SeriesResistor 690 ohm	
28	**GT O/C PROTECTION50/51 GT**	CT-23: 1500/1A, CL:5P20		RET670-1	InstPhaseOverCurrent (PIOC_50)	InstPhaseOverCurrent (PIOC_50)	
					Setting Group1	Setting Group1	
					Operation OFF	Operation OFF	
					IBase 1500 A	IBase 1500 A	
					OpMode 1 out of 3	OpMode 1 out of 3	
					IP>> 200 %IB	IP>> 200 %IB	
					StValMult 1.0	StValMult 1.0	

					PhaseOverCurrent 4Step(PTOC_51_67)	PhaseOverCurrent 4Step(PTOC_51_67)	
					Setting Group1	Setting Group1	
					Operation On	Operation On	
					IBase 1134 A	IBase 1134 A	
					UBase 400.00 kV	UBase 400.00 kV	
					AngleRCA 55 Deg	AngleRCA 55 Deg	
					AngleROA 80 Deg	AngleROA 80 Deg	
					IMinOpPhSel 7 %IB	IMinOpPhSel 7 %IB	
					2ndHarmStab 20 %	2ndHarmStab 20 %	
					STEP1	STEP1	
					Setting Group1	Setting Group1	
					DirMode1 Non-directional	DirMode1 Non-directional	
					Characterist1 IEC Norm. inv.	Characterist1 IEC Norm. inv.	
					I1> 150 %IB	I1> 150 %IB	
					t1 0.000 s	t1 0.000 s	
					k1 0.50	k1 0.50	
					IMin1 150.00 %IB	IMin1 150.00 %IB	
					t1Min 0.000 s	t1Min 0.000 s	
					I1Mult 2.0	I1Mult 2.0	
					ResetTypeCrv1 Instantaneous	ResetTypeCrv1 Instantaneous	
					tReset1 0.020 s	tReset1 0.020 s	
					tPCrv1 1.000	tPCrv1 1.000	
					tACrv1 13.500	tACrv1 13.500	
					tBCrv1 0.00	tBCrv1 0.00	
					tCCrv1 1.0	tCCrv1 1.0	
					tPRCrv1 0.500	tPRCrv1 0.500	
					tTRCrv1 13.500	tTRCrv1 13.500	
					tCRCrv1 1.0	tCRCrv1 1.0	
					HarmRestrain1 Off	HarmRestrain1 Off	
					STEP2	STEP2	
					Setting Group1	Setting Group1	
					DirMode2 Non-directional	DirMode2 Non-directional	

					Characterist2 IEC Def Time	Characterist2 IEC Def Time	
					I2> 800 %IB	I2> 800 %IB	
					t2 0.100 s	t2 0.100 s	
					k2 0.050	k2 0.050	
					IMin2 800.00 %IB	IMin2 800.00 %IB	
					t2Min 0.000 s	t2Min 0.000 s	
					I2Mult 2.0	I2Mult 2.0	
					ResetTypeCrv2 Instantaneous	ResetTypeCrv2 Instantaneous	
					tReset2 0.020 s	tReset2 0.020 s	
					tPCrv2 1.000	tPCrv2 1.000	
					tACrv2 13.500	tACrv2 13.500	
					tBCrv2 0.00	tBCrv2 0.00	
					tCCrv2 1.0	tCCrv2 1.0	
					tPRCrv2 0.500	tPRCrv2 0.500	
					tTRCrv2 13.500	tTRCrv2 13.500	
					tCRCrv2 1.0	tCRCrv2 1.0	
					HarmRestrain2 Off	HarmRestrain2 Off	
					STEP3	STEP3	
					Setting Group1	Setting Group1	
					DirMode3 OFF	DirMode3 OFF	
					Characterist3 ANSI Def Time	Characterist3 ANSI Def Time	
					I3> 250 %IB	I3> 250 %IB	
					t3 0.800 s	t3 0.800 s	
					k3 0.050	k3 0.050	
					IMin3 33.00 %IB	IMin3 33.00 %IB	
					t3Min 0.000 s	t3Min 0.000 s	
					I3Mult 2.0	I3Mult 2.0	
					ResetTypeCrv3 Instantaneous	ResetTypeCrv3 Instantaneous	
					tReset3 0.020 s	tReset3 0.020 s	
					tPCrv3 1.000	tPCrv3 1.000	
					tACrv3 13.500	tACrv3 13.500	
					tBCrv3 0.00	tBCrv3 0.00	
					tCCrv3 1.0	tCCrv3 1.0	

						tPRCrv3 0.500	tPRCrv3 0.500	
						tTRCrv3 13.500	tTRCrv3 13.500	
						tCRCrv3 1.0	tCRCrv3 1.0	
						HarmRestrain3 Off	HarmRestrain3 Off	
						STEP4	STEP4	
						Setting Group1	Setting Group1	
						DirMode4 OFF	DirMode4 OFF	
						Characterist4 ANSI Def Time	Characterist4 ANSI Def Time	
						I4> 175 %IB	I4> 175 %IB	
						t4 2.000 s	t4 2.000 s	
						k4 0.050	k4 0.050	
						IMin4 17.00 %IB	IMin4 17.00 %IB	
						t4Min 0.000 s	t4Min 0.000 s	
						I4Mult 2.0	I4Mult 2.0	
						ResetTypeCrv4 Instantaneous	ResetTypeCrv4 Instantaneous	
						tReset4 0.020 s	tReset4 0.020 s	
						tPCrv4 1.000	tPCrv4 1.000	
						tACrv4 13.500	tACrv4 13.500	
						tBCrv4 0.00	tBCrv4 0.00	
						tCCrv4 1.0	tCCrv4 1.0	
						tPRCrv4 0.500	tPRCrv4 0.500	
						tTRCrv4 13.500	tTRCrv4 13.500	
						tCRCrv4 1.0	tCRCrv4 1.0	
						HarmRestrain4 Off	HarmRestrain4 Off	

EDG 2000KVA

- **Standard Power Rating** at 415 V, 50 Hz, 1500 rpm & 0.8pf (NAME PLATE) -2000 kVA std. M/C with Class H insulation to Class H temp. Rise @40 deg C ambt temp., 1220KW(PF:0.8) , 3Φ 3W 50HZ, Xd : 1.845PU, Xd" : 0.072PU
- **Derated Power Rating** at 415 V, 50 Hz, 1500 rpm & 0.8pf (Tender Requirement) -1525kVA / 1220KW with Class H insulation to temp. Rise limited to Class B @50 deg C ambient.

Particulars	UoM	Specifications
Nos	NO	2
Make		PERKINS
Model Number		Perkins-4016-61TRG2 (16 Cylinders, V-Configuration)
Rating	kW	2000 KVA
Speed	RPM	1500
Mechanical Efficiency	%	94
Thermal Efficiency	%	39.3
Nos of Cylinder		16
DOR (from radiator end)		Clock wise from Drive End
Nos. of Stroke		4
Piston Speed	m/sec	9.5
Type of Cooling		Engine is radiator cooled.
Turbo/Super Charger		
Make		MAHAMAI ENGINEER
Nos.		4
Speed	RPM	1500
Fuel Oil Tank Size	liters	990
Fuel Oil Consumption at 50% / 75%/100% load	g/kw-hr	25% - 188 g/kWh 50% - 192 g/kWh 75% - 195 g/kWh
Jacket Water		(engine and radiator) 252 litres
Starting System		
Type		Electric Start
Battery Capacity @ 0 °C		24 Vdc, 4 no. of 180Ah (2 set per DG)
Generator and Accessories		
Make		Leroy Somer - LSC74L
Design Output Continuous Rating	kW	1220KW / 1525KVA (Class H to B @ 50deg C)
P.F		0.8
Voltage, Frequency	V	415 V,50 Hz
Current	Amps	2121.6 A
Speed	RPM	1500
Main Exciter		
Voltage	V	40
Current	Amps	4.2

A. GEN AMF PANEL

1) Relay Type : MICOM P343 (AREVA)
2) CT Data : 3200/1A
3) PT Data : 415/√3 / 110/√3 V

EDG PROTECTION (Mechanical).

SR. No.	PROTECTION DETAILS	ANSI CODE	SET VALUE	UNIT	TIME DELAY	ALARM	GB TRIP	ENGINE STOP
1	Emergency Stop	1	-	-	Inst.	√	√	√
2	Low oil Pressure Alarm	NA	2.5	Bar	5 Sec	√		
3	High Coolant Temp Trip (switch)	NA	102	°c	5 sec	√	√	√
4	Over Speed Shutdown	12	1620	RPM	1sec	√	√	√
5	Governor Alarm	NA	-	-	Inst.	√	√	√

EDG PROTECTION (Electrical).

RELAY		Setting Range	Setting Value	Adopted Value	Remark
50/51					
I>1	Function	Disabled, DT, IEC S, IEC V…	IEC VI		TRIP
	Direction	Non-direction, Direction Fwd,Rev	Non-direction		
	Current set	0.08~4.0 In (0.01 In step)	0.95In		
	TMS	0.025~1.2 (0.025 step)	0.25		
	TD	(0.01-100)	0.24		
I>3	Status	Enabled, Disabled	Enabled		TRIP
	Direction	Non-direction, Direction Fwd,Rev	Non-direction		
	Current set	0.08~100 In (0.01 In step)	2.4In		
	Time delay	0~100s (0.01 step)	0.1s		
49					
Ith	Thermal	Disabled/Enabled	Enabled		
	Thermal I>	0.50 ~ 2.50In	0.95In		
	Thermal Alarm	20 ~ 100%	60%		
	T-heating	1 ~ 200minutes	16 min		
	T-cooling	1 ~ 200minutes	12 min		
	M factor	0 ~ 10	3		
27					
V<	Measure Mode	Phase to Phase, Phase to Neutral	Phase to Phase		-
	Operate Mode	Any Phase, Three Phase	Three Phase		-
LEVEL-1 V<1	Function	Disabled, DT, IDMT	DT		ALARM
	Voltage Set	10~120V (1V Step)	82.5V		
	Time delay	0~100s (0.01s Step)	3.0s		
LEVEL-2 V<1	Function	Disabled, DT, IDMT	DT		TRIP
	Voltage Set	10~120V (1V Step)	77V		
	Time delay	0~100s (0.01s Step)	1.0s		
59					
V <	Measure Mode	Phase to Phase, Phase to Neutral	Phase to Phase		
	Operate Mode	Any Phase, Three Phase	Three Phase		
LEVEL-1 V>1	Function	Disabled, DT, IDMT	DT		ALARM
	Time Dial	60~185V (1V Step)	121V		
	Time Delay	0~100s (0.01s Step)	3.0s		
LEVEL-2 V>1	Function	Disabled, DT, IDMT	DT		TRIP
	Time Dial	60~185V (1V Step)	1V		
	Time Delay	0~100s (0.01s Step)	1.0s		
32					
P>1	Operation Mode	Generating/Motoring	Generating		TRIP
	Power 1 Function	Reverse/Low forward/Over	Reverse		
	P>1 Setting	1~300.0W (1A 100/120V)	6 W		

	Power1 Time Delay	0.00 ~ 100.0s	3s		
81 O/U					
F>1	Status	Disabled/Enabled	Enabled		
	Setting	45.00 ~ 65.00Hz	51.5Hz		
	Time Delay	0.1 ~ 100.0s	2s		
F<1	Status	Disabled/Enabled	Enabled		
	Setting	45.00 ~ 68.00Hz	48.5Hz		
	Time Delay	0.1 ~ 100.0s	4s		
46					
In>1	Function	Disabled, DT, IEC S, IEC V…	DT		
	Direction	Non-direction, Direction Fwd,Rev	Non-direction		
	Current set	0.08~4.0 In (0.01 In step)	0.132In		
	Time Delay	0.025~1.2 (0.025 step)	5 sec		
40					
ϕ<	Ffail Aim Status	Disabled/Enabled	Enabled		
	Ffail Angle	15^0 ~ 75^0	60^0		
	Ffail Delay	0.00 ~ 100.0s	10s		
	Ffail Status	Disabled/Enabled	Enabled		
	Ffail- Xa1	0.0 ~ 40.0Ω (1A 100/120V)	15.0Ω		
	Ffail- Xb1	25 ~ 325.0Ω (1A 100/120V)	175.0Ω		
	Ffail1 time delay	0.00 ~ 100.0s	0.5 sec		
V/Hz					
F>1	V/Hz Alarm Status	Disabled/Enabled	Enabled		ALARM
	V/Hz Alarm Set	1.50~3.50 V/Hz (100/120V)	2.156 V/Hz		
	V/Hz Alarm Delay	0~100s (0.01s Step)	25s		
F<1	V/Hz>1 Trip Set	1.50~3.50 V/Hz (100/120V)	2.42 V/Hz		TRIP
	V/Hz>1 Delay	0.00 ~ 600sec	10s		
	V/Hz>2 Trip Set	1.50 ~ 3.50 V/Hz	3.3 V/Hz		
	V/Hz>2 Delay	0 ~ 600 sec	2.0s		
	V/Hz Trip Function	DT, IDMT	DT		
87G					
I>1	Status	Disabled/Enabled	Enabled		TRIP
	Direction	Non-direction, Direction Fwd,Rev	Non-direction		
	Current set	0.08~100 In (0.01 In step)	0.1In		
	Time delay	0~100s (0.01 step)	40msec		
51V					
51V	Backup Function	Disabled/Voltage Controlled/Voltage Restrained/Under Impedance	Under Impedance		
	Z<1 Setting	8…480Ω(380/440 V, 1A)	8 Ω		
	Z<1 Time Delay	0~100s (0.01s Step)	0.5 sec		
	Z<2	8…480Ω(380/440 V, 1A)	95 Ω		
	Z<2 Time Delay	0~100s (0.01s Step)	0.6 sec		

220V DC BATTERY BANK SYSTEM

S. NO.	DESCRIPTION	SPECIFICATIONS
1.00.00	***BATTERY***	
1.01.00	***General***	
	a. Make	Exide Industries Ltd
	b. Type	YHP29
	c. Reference Standard	IS 1652 / BS6290
	d. Quantity	108 nos cell per 220V 1500 Ah Battery Bank
1.02.00	***Rating***	
	a. Rated Voltage	2 Volt (Nominal)
	b. 10-hour rating at 27 Deg.C to end cell voltage	1500AH@1.85 ECV
	c. 2-hour discharge rate to end cell voltage	553.5Amp@1.78 ECV
	d. 1 –hour discharge rate to end cell voltage	900Amp@1.75 ECV
	e. 1 -minute discharge rate to end cell voltage	2777.78Amp@1.70 ECV
1.03.00	***Performance***	
	a. Battery duty cycle curve furnished	No
	b. Cell voltage characteristics during duty cycle furnished	No
	c. Minimum cell voltage during duty cycle	(Reffer sizing calculation)Volt
	d. AH efficiency at 10-hour discharge rate	Not less than 92%
	e. Expected life of Battery	15 - 20 years (under normal operation & maintainence conditions)
1.04.00	***Battery Characteristics***	
	a. Recommended charging rate for	
	i) Float charging	300Amp (limit current)
	ii) Equalising Charge	75Amp
	iii) Boost charging in 10 hrs.	Amp
	Start	210Amp
	Finish	100.5Amp
	b. Recommend specific gravity at 27	
	i) For first filling	1.205 +/- 0.005
	ii) At full charge	1.215 +/- 0.005
	iii) At end of 10-hour discharge	1.120 - 1.130
	c. Short-circuit current for a dead- short	
	across battery terminals, when	
	i) Float charge at 2.25 V/Cell	40.50 KA
	ii) Boost charge at 2.75 V/Cell	49.50 KA
	d. Battery internal resistance	0.006 Ohm (2 string in parallel connections)

	e. Cell voltage characteristics during charging furnished	Yes
1.05.00	Mounting details	This is free standing type stand. So no mounting arrangement required.
1.06.00	Terminal connection	Bolton
1.07.00	Maximum and Minimum ambient temperature	50 deg C & 3.7 deg C

11kV SWITCHGEAR

Details of Protection Relays:

1	FEEDER PROTECTION RELAY	P127
2	MOTOR PROTECTION RELAY	P225
3	MOTOR PROTECTION RELAY	P220
4	MOTOR DIFFERENTIAL PROTECTION RELAY	P122
5	VOLTAGE PROTECTION RELAY	P922
6	TRANSFORMER DIFFERENTIAL PROTECTION RELAY	P642
7	TRAFO FAULT RELAY	CV2
8	LOCKOUT RELAY	PQ8

PROTECTION SETTINGS:

1. MDBFP MOTOR

MOTOR DETAILS

1	NAME OF MOTOR	MDBFP	
2	VOLTAGE LEVEL	11KV	
3	SERVICE FACTOR	1	
4	RATED CURRENT	1063	
5	STARTING CURRENT	450	
6	MOTOR STARTING CURRENT AT 100% RATED VOLTAGE	7.9	
7	RELAY TYPE	MICOM P225	

PARAMETER CONFIGRATION:

PARAMETER CONFIGURATION	RELAY SETTING RANGE	STEP	RECOMMENDED SETTING	REMARKS
CT RATIO				
Prim Ph	1-3000A	1A	1250	
Sec Ph	1 or 5		1	

PROTECTION FUNCTIONS

1.Too long start-up protection (Start-Up criteria) MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Start-up detection criteria	(closing 52) or (closing 52 + current threshold) optional	(closing 52 + current threshold)	
Current threshold IUTIL	0.5 to 5 In by steps of 0.01 In	1.8In	
Time-Delay tIstart	1 to 200 s by steps of 1 s	18	

2. Thermal replica [ANSI 49] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.85In	
Negative sequence current recognition factor Ke	0 to 10 by steps of 1	3	
Overload time-constant Te1	1 to 180 min by steps of 1min	40min	
Start-up time-constant Te2	1 to 360 min by steps of 1min	6min	
Cooling time-constant Tr	1 to 999 min by steps of 1min	55min	
Trip thermal threshold	Set to 100%	100	
Thermal alarm threshold	20 to 100% by steps of 1%	90	
Start-up inhibition	20 to 100% by steps of 1%	58	
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.85In	

3. Short-circuit protection [ANSI 50/51] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold I>	0.1 to 25 In by steps of 0.05 In	6.8In	Other stages to be disabled
Delay type:	DT, IDMT or RI	DT	
Time delay tI> (DMT)	0 to 150 s by steps of 0,01 s	0.1s	

4. Earth fault protection [ANSI 50/51N] MICOM P225 50/1A

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold Io>, Io>>	0,002 to 1 In by steps of 0,001 Ion	Io>> = 0.60 In	
Time-delays tIo>, tIo>>	0,002 to 1 In by steps of 0,001 Ion	0.10s	

5. Unbalance protection [ANSI 46] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Negative sequence current threshold I2>	0,04 to 0,8 In by steps of 0,01 In	0.06In	
Time-delay for Alarm tI2>	0 to 200 s by steps of 0,01 s	10s	
Negative sequence current threshold I2>>	0,04 to 0,8 In by steps of 0,01 In	0.09In	
Time Multiplier Setting TMS I2>>	0.2 to 2 by steps of 0.001	1	
IDMT time-delay	t = TMS x 1,2/(I2/In)	14s	

6. Undervoltage Protection [ANSI 27]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Voltage threshold V<	5 to 130 V by steps of 0.1 V	82.5 V	
Time dealt tV<	0 to 600 s by steps of 0.01 s	1.0 s	
V< inhibition during start-up	Yes/No	Yes	

7. Locked rotor protection [ANSI 51LR/50S] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current Threshold Istall	0.5 to 5 In by steps of 0.01 In	1.8In	
Time-delay tIstall	0,1 to 60 s by steps of 0,1 s	18.0s	

Locked rotor at start-up detection	No/Input/Power Factor	No	

AUTOMATIC FUNCTIONS Micom P225

1. Limitation of the number of start-ups [ANSI 66]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Reference period Treference	10 to 120 min by steps of 5 min	60	
Number of cold starts	1 to 5 by steps of 1	183.0s	
Number of hot starts	0 to 5 by steps of 1	2	
Restart inhibition time Tinterdiction	1 to 120 min by steps of 1 min	30min	3 equally spaced starts

TIME BETWEEN TWO START

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Inhibition time T betw 2 start	1 to 120 min by steps of 1min	30min	

2. CWP MOTOR

MOTOR DETAILS

1	NAME OF MOTOR	CWP (3710kW)	
2	VOLTAGE LEVEL	11 kV	
3	SERVICE FACTOR	1	
4	RATED CURRENT	2253.0 A	
5	STARTING CURRENT	600	
6	MOTOR STARTING CURRENT AT 100% RATED VOLTAGE	4.0s	
7	RELAY TYPE	Mi COM P225	

PARAMETER CONFIGRATION:

PARAMETER CONFIGURATION	RELAY SETTING RANGE	STEP	RECOMMENDED SETTING	REMARKS
CT RATIO				
Prim Ph	1-3000A	1A	350	
Sec Ph	1 or 5		1	

PROTECTION FUNCTIONS

PROTECTION G1

1.Too long start-up protection (Start-Up criteria) MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Start-up detection criteria	(closing 52) or (closing 52 + current threshold) optional	(closing 52 + current threshold)	
Current threshold IUTIL	0.5 to 5 In by steps of 0.01 In	1.5In	
Time-Delay tIstart	1 to 200 s by steps of 1 s	9	

2. Thermal replica [ANSI 49] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.76In	
Negative sequence current recognition factor Ke	0 to 10 by steps of 1	3	
Overload time-constant Te1	1 to 180 min by steps of 1min	50min	
Start-up time-constant Te2	1 to 360 min by steps of 1min	8min	
Cooling time-constant Tr	1 to 999 min by steps of 1min	90min	
Trip thermal threshold	Set to 100%	100	
Thermal alarm threshold	20 to 100% by steps of 1%	90	
Start-up inhibition	20 to 100% by steps of 1%	74	
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.76In	

3. Short-circuit protection [ANSI 50/51] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold I>	0.1 to 25 In by steps of 0.05 In	5.8In	Other stages to be disabled
Delay type:	DT, IDMT or RI	DT	
Time delay tI> (DMT)	0 to 150 s by steps of 0,01 s	0.1s	

4. Earth fault protection [ANSI 50/51N] MICOM P225 50/1A

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold Io>, Io>>	0,002 to 1 In by steps of 0,001 Ion	Io>> = 0.60 In	
Time-delays tIo>, tIo>>	0 to 100 s by steps of 0,01 s	0.10s	

5**. Unbalance protection [ANSI 46] MICOM P225**

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Negative sequence current threshold I2>	0,04 to 0,8 In by steps of 0,01 In	0.05In	
Time-delay for Alarm tI2>	0 to 200 s by steps of 0,01 s	10s	
Negative sequence current threshold I2>>	0,04 to 0,8 In by steps of 0,01 In	0.07In	
Time Multiplier Setting TMS I2>>	0.2 to 2 by steps of 0.001	1	
IDMT time-delay	t = TMS x 1,2/(I2/In)	17s	

6. Undervoltage Protection [ANSI 27]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Voltage threshold V<	5 to 130 V by steps of 0.1 V	82.5 V	
Time dealt tV<	0 to 600 s by steps of 0.01 s	1.0 s	
V< inhibition during start-up	Yes/No	Yes	

7. Locked rotor protection [ANSI 51LR/50S] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current Threshold Istall	0.5 to 5 In by steps of 0.01 In	1.5In	
Time-delay tIstall	0,1 to 60 s by steps of 0,1 s	9.0s	
Locked rotor at start-up detection	No/Input/Power Factor	No	

AUTOMATIC FUNCTIONS Micom P225

Limitation of the number of start-ups [ANSI 66]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Reference period Treference	10 to 120 min by steps of 5 min	60	
Number of cold starts	1 to 5 by steps of 1	183.0s	
Number of hot starts	0 to 5 by steps of 1	2	
Restart inhibition time Tinterdiction	1 to 120 min by steps of 1 min	30min	3 equally spaced starts

TIME BETWEEN TWO START

PARAMETER	RELAY SETTING	RECOMMENDED	REMARKS

	RANGE	SETTING	
Inhibition time T betw 2 start	1 to 120 min by steps of 1min	30min	

4. PA FAN

MOTOR DETAILS

1	NAME OF MOTOR	PA FAN (3150kW)	
2	VOLTAGE LEVEL	11 kV	
3	SERVICE FACTOR	1	
4	RATED CURRENT	189.8A	
5	STARTING CURRENT	600	
6	MOTOR STARTING CURRENT AT 100% RATED VOLTAGE	3.6s	
7	RELAY TYPE	Mi COM P225	

PARAMETER CONFIGRATION:

PARAMETER CONFIGURATION	RELAY SETTING RANGE	STEP	RECOMMENDED SETTING	REMARKS
CT RATIO				
Prim Ph	1-3000A	1A	350	
Sec Ph	1 or 5		1	

PROTECTION FUNCTIONS

PROTECTION G1

1.Too long start-up protection (Start-Up criteria) MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Start-up detection criteria	(closing 52) or (closing 52 + current threshold) optional	(closing 52 + current threshold)	
Current threshold IUTIL	0.5 to 5 In by steps of 0.01 In	1.1In	
Time-Delay tIstart	1 to 200 s by steps of 1 s	9	

2. Thermal replica [ANSI 49] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.57In	
Negative sequence current recognition factor Ke	0 to 10 by steps of 1	3	
Overload time-constant Te1	1 to 180 min by steps of 1min	24min	

Start-up time-constant Te2	1 to 360 min by steps of 1min	5min	
Cooling time-constant Tr	1 to 999 min by steps of 1min	-	
Trip thermal threshold	Set to 100%	100	
Thermal alarm threshold	20 to 100% by steps of 1%	90	
Start-up inhibition	20 to 100% by steps of 1%	62	
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.57In	

3. Short-circuit protection [ANSI 50/51] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold I>	0.1 to 25 In by steps of 0.05 In	4.3In	Other stages to be disabled
Delay type:	DT, IDMT or RI	DT	
Time delay tI> (DMT)	0 to 150 s by steps of 0,01 s	0.1s	

4. Earth fault protection [ANSI 50/51N] MICOM P225 50/1A

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold Io>, Io>>	0,002 to 1 In by steps of 0,001 Ion	Io>> = 0.60 In	
Time-delays tIo>, tIo>>	0 to 100 s by steps of 0,01 s	0.10s	

5. Unbalance protection [ANSI 46] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Negative sequence current threshold I2>	0,04 to 0,8 In by steps of 0,01 In	0.04In	
Time-delay for Alarm tI2>	0 to 200 s by steps of 0,01 s	10s	
Negative sequence current threshold I2>>	0,04 to 0,8 In by steps of 0,01 In	0.05In	
Time Multiplier Setting TMS I2>>	0.2 to 2 by steps of 0.001	1	
IDMT time-delay	t = TMS x 1,2/(I2/In)	22s	

6. Undervoltage Protection [ANSI 27]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Voltage threshold V<	5 to 130 V by steps of 0.1 V	82.5 V	
Time dealt tV<	0 to 600 s by steps of 0.01 s	1.0 s	

V< inhibition during start-up	Yes/No	Yes	

7. Locked rotor protection [ANSI 51LR/50S] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current Threshold Istall	0.5 to 5 In by steps of 0.01 In	1.1In	
Time-delay tIstall	0,1 to 60 s by steps of 0,1 s	9.0s	
Locked rotor at start-up detection	No/Input/Power Factor	No	

AUTOMATIC FUNCTIONS Micom P225

Limitation of the number of start-ups [ANSI 66]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Reference period Treference	10 to 120 min by steps of 5 min	60	
Number of cold starts	1 to 5 by steps of 1	183.0s	
Number of hot starts	0 to 5 by steps of 1	2	
Restart inhibition time Tinterdiction	1 to 120 min by steps of 1 min	30min	3 equally spaced starts

TIME BETWEEN TWO START

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Inhibition time T betw 2 start	1 to 120 min by steps of 1min	30min	

6. CID FAN

MOTOR DETAILS

1	NAME OF MOTOR	CID FAN (11300kW)	
2	VOLTAGE LEVEL	11 kV	
3	SERVICE FACTOR	1	
4	RATED CURRENT	691.3	
5	STARTING CURRENT	450	

6	MOTOR STARTING CURRENT AT 100% RATED VOLTAGE	12.4s	
7	RELAY TYPE	Mi COM P225	

PARAMETER CONFIGRATION:

PARAMETER CONFIGURATION	RELAY SETTING RANGE	STEP	RECOMMENDED SETTING	REMARKS
CT RATIO				
Prim Ph	1-3000A	1A	1000	
Sec Ph	1 or 5		1	

PROTECTION FUNCTIONS

PROTECTION G1

1.Too long start-up protection (Start-Up criteria) MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Start-up detection criteria	(closing 52) or (closing 52 + current threshold) optional	(closing 52 + current threshold)	
Current threshold IUTIL	0.5 to 5 In by steps of 0.01 In	1.5In	
Time-Delay tIstart	1 to 200 s by steps of 1 s	34	

2. Thermal replica [ANSI 49] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.73In	
Negative sequence current recognition factor Ke	0 to 10 by steps of 1	3	
Overload time-constant Te1	1 to 180 min by steps of 1min	27min	
Start-up time-constant Te2	1 to 360 min by steps of 1min	9min	
Cooling time-constant Tr	1 to 999 min by steps of 1min	137min	
Trip thermal threshold	Set to 100%	100	
Thermal alarm threshold	20 to 100% by steps of 1%	90	
Start-up inhibition	20 to 100% by steps of 1%	67	
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.73In	

3. Short-circuit protection [ANSI 50/51] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold I>	0.1 to 25 In by steps of 0.05 In	5.55In	Other stages to be disabled
Delay type:	DT, IDMT or RI	DT	
Time delay tI> (DMT)	0 to 150 s by steps of 0,01 s	0.1s	

4. Earth fault protection [ANSI 50/51N] MICOM P225 50/1A

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold Io>, Io>>	0,002 to 1 In by steps of 0,001 Ion	Io>> = 0.60 In	
Time-delays tIo>, tIo>>	0 to 100 s by steps of 0,01 s	0.10s	

5. Unbalance protection [ANSI 46] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Negative sequence current threshold I2>	0,04 to 0,8 In by steps of 0,01 In	0.05In	
Time-delay for Alarm tI2>	0 to 200 s by steps of 0,01 s	10s	
Negative sequence current threshold I2>>	0,04 to 0,8 In by steps of 0,01 In	0.07In	
Time Multiplier Setting TMS I2>>	0.2 to 2 by steps of 0.001	1	
IDMT time-delay	t = TMS x 1,2/(I2/In)	17s	

6. Undervoltage Protection [ANSI 27]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Voltage threshold V<	5 to 130 V by steps of 0.1 V	82.5 V	
Time dealt tV<	0 to 600 s by steps of 0.01 s	1.0 s	
V< inhibition during start-up	Yes/No	Yes	

7. Locked rotor protection [ANSI 51LR/50S] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current Threshold Istall	0.5 to 5 In by steps of 0.01 In	1.5In	
Time-delay tIstall	0,1 to 60 s by steps of 0,1 s	34s	

Locked rotor at start-up detection	No/Input/Power Factor	No	

AUTOMATIC FUNCTIONS Micom P225

2. Limitation of the number of start-ups [ANSI 66]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Reference period Treference	10 to 120 min by steps of 5 min	60	
Number of cold starts	1 to 5 by steps of 1	183.0s	
Number of hot starts	0 to 5 by steps of 1	2	
Restart inhibition time Tinterdiction	1 to 120 min by steps of 1 min	30min	3 equally spaced starts

TIME BETWEEN TWO START

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Inhibition time T betw 2 start	1 to 120 min by steps of 1min	30min	

7. FD FAN

MOTOR DETAILS

1	NAME OF MOTOR	FD FAN (1750kW)	
2	VOLTAGE LEVEL	11 kV	
3	SERVICE FACTOR	1	
4	RATED CURRENT	108.1	
5	STARTING CURRENT	600	
6	MOTOR STARTING CURRENT AT 100% RATED VOLTAGE	2.9s	
7	RELAY TYPE	Mi COM P225 / P220	

PARAMETER CONFIGURATION:

PARAMETER CONFIGURATION	RELAY SETTING RANGE	STEP	RECOMMENDED SETTING	REMARKS
CT RATIO				
Prim Ph	1-3000A	1A	150	
Sec Ph	1 or 5		1	

PROTECTION FUNCTIONS

PROTECTION G1

1.Too long start-up protection (Start-Up criteria) MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Start-up detection criteria	(closing 52) or (closing 52 + current threshold) optional	(closing 52 + current threshold)	
Current threshold IUTIL	0.5 to 5 In by steps of 0.01 In	1.5In	
Time-Delay tIstart	1 to 200 s by steps of 1 s	8	

2. Thermal replica [ANSI 49] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.76In	
Negative sequence current recognition factor Ke	0 to 10 by steps of 1	3	
Overload time-constant Te1	1 to 180 min by steps of 1min	43min	
Start-up time-constant Te2	1 to 360 min by steps of 1min	6min	
Cooling time-constant Tr	1 to 999 min by steps of 1min	-	
Trip thermal threshold	Set to 100%	100	
Thermal alarm threshold	20 to 100% by steps of 1%	90	
Start-up inhibition	20 to 100% by steps of 1%	75	
Thermal current threshold I	0,2 to 1,5 In by steps of 0,01 In	0.76In	

3. Short-circuit protection [ANSI 50/51] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold I>	0.1 to 25 In by steps of 0.05 In	5.8In	Other stages to be disabled
Delay type:	DT, IDMT or RI	DT	
Time delay tI> (DMT)	0 to 150 s by steps of 0,01 s	0.1s	

4.Short-circuit protection [ANSI 50SC] MICOM P220 400/1 A CT RATIO

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold I>	0.1 to 25 In by steps of 0.05 In	2.7In	Other stages to be disabled
Delay type:	DT, IDMT or RI	DT	
Time delay tI> (DMT)	0 to 150 s by steps of 0,01 s	0.05s	

3. Earth fault protection [ANSI 50/51N] MICOM P225 50/1A

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current threshold Io>, Io>>	0,002 to 1 In by steps of 0,001 Ion	Io>> = 0.60 In	
Time-delays tIo>, tIo>>	0 to 100 s by steps of 0,01 s	0.10s	

5. Unbalance protection [ANSI 46] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Negative sequence current threshold I2>	0,04 to 0,8 In by steps of 0,01 In	0.05In	
Time-delay for Alarm tI2>	0 to 200 s by steps of 0,01 s	10s	
Negative sequence current threshold I2>>	0,04 to 0,8 In by steps of 0,01 In	0.07In	
Time Multiplier Setting TMS I2>>	0.2 to 2 by steps of 0.001	1	
IDMT time-delay	t = TMS x 1,2/(I2/In)	17s	

6. Undervoltage Protection [ANSI 27]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Voltage threshold V<	5 to 130 V by steps of 0.1 V	82.5 V	
Time dealt tV<	0 to 600 s by steps of 0.01 s	1.0 s	
V< inhibition during start-up	Yes/No	Yes	

7. Locked rotor protection [ANSI 51LR/50S] MICOM P225

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Current Threshold Istall	0.5 to 5 In by steps of 0.01 In	1.5In	
Time-delay tIstall	0,1 to 60 s by steps of 0,1 s	8.0s	
Locked rotor at start-up detection	No/Input/Power Factor	No	

AUTOMATIC FUNCTIONS Micom P225

8.Limitation of the number of start-ups [ANSI 66]

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Reference period Treference	10 to 120 min by steps of 5 min	60	
Number of cold starts	1 to 5 by steps of 1	183.0s	
Number of hot starts	0 to 5 by steps of 1	2	
Restart inhibition time Tinterdiction	1 to 120 min by steps of 1 min	30min	3 equally spaced starts

TIME BETWEEN TWO START

PARAMETER	RELAY SETTING RANGE	RECOMMENDED SETTING	REMARKS
Inhibition time T betw 2 start	1 to 120 min by steps of 1min	30min	

OBSERVATION:-

As a general finding from this audit, it is observed that:

1. Generator & GT are well protected as per Northern region Power Committee recommendation.
2. GRP has independent main-1 and main-2 functional Numerical protection.
3. Both UTs & UATs are well protected as per guidelines.
4. The state of DC & EDG supply at 1X660MW Unit checked and found in order.
5. Time Functionality of GPS/TSU, circuit breaker, relay testing reports is also checked, and all are found in satisfactory state.

Electrical Maintenance Division-I
ETPS, HTPS, Kasimpur, Aligarh

Annexure-X

Consultancy Report on
“Protection Audit of PPS-III, Bawana-Delhi”

Client Ref. No.: 4020003977   Dated: 08/11/2018

CPRI Report No.: 2/9/PSD/RT55/2019

Client: M/s. Pragati Power Corporation Limited

Consultant: M/s. Central Power Research Institute (CPRI)

Power Systems Division
Central Power Research Institute
Sir. C. V. Raman Road,
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Bengaluru – 560 080
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December 2019

POWER SYSTEMS DIVISION
CENTRAL POWER RESEARCH INSTITUTE
Sir. C. V. RAMAN ROAD P.B.No.8066, BANGALORE 560080 (INDIA)

Consultancy Report

Ref. File No.:2/9/PSD/PPCL/PPS-III/TPPA/2019 - 2020

Title:	Protection Audit of PPS-III, Bawana - Delhi
Project Objectives	Review of Protection Schemes & Relay Settings of various equipment and associated systems of identified at PPS-III Generating Station Bawana, Delhi
Name and Address of the Customer:	M/s. Pragati Power Corporation Limited Sector-5, DSIIDC Industrial Area, Bawana, Delhi, 110039
CPRI's reference	2/9/PS/PPCL/TPPA/2018-2019
Name(s) of investigator(s) from CPRI	1. Mr. Kaliappan. P - JD (3). Mr. Jaiganesh R - Project Engg... 2. Mr. Ramesh Patil - EO-III (4). Mr. Shivakumar K - Project Engg...
Names of interacting persons from Customer's side:	1. Mr. Arif Rahman - Sr. Manager (Protection) 2. Mr. Shishir Jha - Sr. Manager (EM-III) 3. Mr. Manoj Goyal - Deputy Manager (Protection)
Report contains:	No of pages: 211

Report prepared by:	Report Approved by:
1. **Kaliappan.P** Joint Director Power Systems Division 2. **Ramesh Patil** Engineering Officer Gr-III Power Systems Division	**Meera K.S** Additional Director & HOD Power Systems Division

Acknowledgment

CPRI wishes to thank M/s. Pragati Power Corporation Limited, for placing this contract to CPRI. CPRI wishes to thank all the Officers/Engineers of M/s. Pragati Power Corporation Limited, who were associated in this work for their co-operation for providing the required data and support during the visit of PPS-III Bawana Generating Station and for their interactions. CPRI team specially wishes to thank the following personnel for their excellent cooperation without which this work would not have been possible:

1. Mr. Arif Rahman - Sr. Manager (Protection)
2. Mr. Shishir Jha - Sr. Manager (EM-III)
3. Mr. Manoj Goyal - Deputy Manager (Protection)

Client: M/s. Pragati Power Corporation Limited

EXECUTIVE SUMMARY

M/s. Pragati Power Corporation Limited awarded the "protection audit for 1500MW combined cycle generating units of PPS-III Bawana including generator transformer and 400 kV line", vide work order No. 4020003977 dated 08/11/2018 to CPRI, Bangalore. The Power plant has 4x222.1 MW (GTG) and 2x260 MW (STG) Generator Units, 16.5/420 kV Generator Transformers (GT), 400 kV Transmission lines and Station HT & LT Power system. The awarded protection audit works involves the review of protection schemes/setting for Generators Units, this includes review of generator protection, Generator Transformer, Station Auxiliary Transformer, Auxiliary Service Transformer, 400 kV switchyard (consisting of lines & Bus bar protection). The study also includes checking of adequacy and healthiness of auxiliary supply system, Relay co-ordination, inspecting the healthiness of DC system, availability/healthiness of fault recording instruments such as disturbance recorders, Event logger & Time synchronizing units with reference to standards, CBIP guidelines and report of the task force on power system analysis under contingencies.

1. **Generator Unit protection**

   The 16.5kV Generator Protection relay settings are reviewed for each type of protection and it is observed that the adopted relay settings are stable except a few cases. The protection schemes are in line with guidelines. The review of generator protection setting is given in **Chapter-2.**

2. **Generator Transformer Protection**

   The Generator transformer 16.5/420kV is protected by differential protection scheme. The stability of differential protection is checked for different transformer tap position. The adopted relays settings are found to be in order. The details setting is given in **Chapter-2**.

3. **Station Auxiliary Transformer Protection**

   The station auxiliary transformer is interconnected to the 16.5 kV bus on the HV side and the 6.9 kV on the LV side. The transformer is equipped with differential, V/f protection and backup protection. The stability of differential protection is checked for different transformer tap position. The differential, V/f protection and back up protection are found in order. The details are given in **Chapter-2**.

4. **Transmission lines and Busbar protections**

   The two 400 kV transmission lines are protected by Main-1 and Main-2 distance protection schemes. The distance protection settings adopted are in line with the guidelines. The 400 kV Busbar protection scheme is found to be in order. The details are given in **Chapter-3**.

5. **Auxiliary Service Transformer Protection**

   The auxiliary service transformer 6.6/0.433kV has protected by backup over current and earth fault protection schemes. The stability of transformer is checked. The adopted relays settings are found to be in order. The details are given in **Chapter-4**.

6. **DC batteries and Charging units**

   The healthiness of all the battery units and chargers are inspected for earth leakages. The battery units and the charging units are found to be in order without any leakages. The details of the batteries and chargers are given in the **Chapter-5**.

7. **Relay coordination on the HT and LT network**

   The short circuit studies are carried out by modeling the generating units and 400 kV High Voltage network in ETAP simulation package. Based on short circuit current values from the study, review of existing back-up relay settings are checked. The details are discussed in **Chapter-6** and Details of Load flow study and Short circuit study are discussed in **Annexure**.

8. **Time Synchronizing Unit, Event Loggers and Disturbance Recorders:**

   Time synchronizing units with 'GPS' receiver is provided and it is synchronized with all numerical relays. Numerical relays are synchronized to universal coordinated time (UTC), through GPS receiver based master clock unit. There is separate dedicated DR and EL are available.

DETAILED REPORT ON THIRD PARTY PROTECTION AUDIT OF

PPS-III, BAWANA-DELHI

CHAPTER 1

INTRODUCTION

Introduction

M/S. Pragati Power Corporation Limited Bawana-Delhi placed an order with CPRI vide Work Order No. 4020003977, to carry out the third-party protection audit of its plant with the following scope of work.

1. Review of all types of protective relays and their settings.
2. Review of the implemented protection schemes/philosophies and settings with reference to recommended guidelines and other best practices for followings.
    - Switchyard
    - Busbar
    - Generator
    - Generator transformer
    - Station auxiliary transformer
    - Auxiliary supply systems
3. Recommend corrective action for any additional protection and disabling/enabling of any unwanted/essential setting/protection schemes as per the guidelines.
4. To carry out relay co-ordination studies for the different protection.
5. Checking the healthiness of 220 V DC system available at the plant for protection and suggest corrective measures in case of any problem.
6. To check for the adequacy/healthiness of the primary and backup protection schemas and settings.
7. Review of availability/healthiness of time synchronization unit.
8. Conduct the training course.
9. Prepare a report on the protection review, which shall include the details of recommended protection philosophy setting calculation procedure for different protections, and suitable solution for rectification of identified problem.

The protection audit is carried out to validate the operational plant protection schemes and review of settings against the calculated protection settings. This involves the site visit by the protection audit team, downloading of operational relay setting, field measurements and healthiness check of the plant axillaries.

CHAPTER 2

REVIEW OF GENERATOR PROTECTION

GAS TURBINE GENERATOR (GTG)

Generator Ratings			Gen. Busduct CT data					
			Phase Side					
MVA	261.294	MVA		Primary	Secondary	CLASS	Vk	VA
MW	222.10	MW	CT-4	12500	5	0.2	-	50
kV	16.50	kV	CT-5	12500	5	0.2	-	50
Rated Stator Current	9143	Amps.	CT-6	12500	5	PS	1000	-
Field Current - IFN	2274	Amps.	CT-7	12500	**5**	PS	1000	-
Xd = Xq (Round Rot)	1.629	pu	CT-8	12500	5	PS	1000	-
Xd' (Sat)	0.203	pu	**Neutral side**					
Xd" (Sat)	0.138	pu	CT-1	12500	5	0.2	-	50
Xd' (Un-Sat)	0.2124	pu	CT-2	12500	5	PS	1000	-
Xd" (Un-Sat)	0.166	pu	CT-3	12500	5	PS	1000	-

Generator busduct VT parameter

VT REFERENCE:	VT1		VT2		VT3	
Ratio (kV/V)	(16.5/√3) / (110/√3)	(16.5/√3) / (110/√3)	(16.5/√3) / (110/√3)	(16.5/√3) / 110	(16.5/√3) / (110/√3)	(16.5/√3) / 110
Accuracy Class	3P/0.5	0.2	3P/0.5	0.2	3P/0.5	0.2
Rated Burden (VA)	100	100	100	100	100	100

Generator busduct IVT parameter

VT REFERENCE:	IVT1	IVT2	IVT3
Ratio(V/V)	(110V/√3)/(80 /√3)	(415V/√3)/(110 /√3)	(110V/√3)/(63.5 /√3)
Accuracy Class	3P	1	3P
Rated Burden (VA)	30	60	30

Neutral Groundging Transformer

DATA	Py	Sy
VOLTAGE RATIO(kV)	16.5	0.24
RATED -KVA	75	
R (On LV Side) Ω	0.277	
NGT LV (Sec.) CT Ratio	800	5

Generator Transformer Ratings		
GT Capacity in MVA	220.5	MVA
HV Voltage rating	420	kV
LV Voltage rating	16.5	kV
Transformer Impedance	13.5	%
HV Side CT (Primary)	500	A
HV Side CT (Secondary)	1	A
LV Side CT (Primary)	12500	A
LV Side CT (Secondary)	5	A
VT (Primary)	400000	V
VT (Secondary)	110	V
Frequency	50	Hz
Min tap	5	%
Max tap	-5	%

SAT Transformer Ratings		
SAT Capacity in MVA	31.5	MVA
HV Voltage rating	16.5	kV
LV Voltage rating	6.9	kV
Transformer Impedance	12	%
HV Side CT (Primary)	1250	A
HV Side CT (Secondary)	1	A
LV Side CT (Primary)	3000	A
LV Side CT (Secondary)	1	A
VT (Primary)	16500	V
VT (Secondary)	110	V
Frequency	50	Hz
Min tap	10	%
Max tap	-10	%

PROTECTION SETTINGS

Sl. No.	PROTECTION FUNCTION	ANSI Code	Relay Model	Setting adopted	Setting Recommended	Remarks	Adopted Trip Class	Comments
1	GENERATOR DIFFERENTIAL	87G	7UM622	2001 Differential protection ON 2031 Pick-up value of High Set Trip 5.00 I/InO 2041A Slope 1 of tripping characteristic 0.15A 2042A Base point for slope 1 0.20 I/InO 2043A Slope2 of tripping characteristic 0.50 2044A Base point for slope 2 of charact. 2.00 I/InO	2001 Differential protection ON 2031 Pick-up value of High Set Trip 4.9261 I/InO 2041A Slope 1 of tripping characteristic 0.15A 2042A Base point for slope 1 0.20 I/InO 2043A Slope2 of tripping characteristic 0.50 2044A Base point for slope 2 of charact. 2.00 I/InO	All Settings are in order.	Class-A2	All Settings are in order.
2	GENERATOR LOW FORWARD POWER PROTECTION	37G	7UM622	3100 REVERSE POWER PROTECTION 3201 Forward Power Supervision OFF 3202 P-forw.< Supervision Pickup 0.5 %	3100 REVERSE POWER PROTECTION 3201 Forward Power Supervision ON 3202 P-forw.< Supervision Pickup 0.311 %			Customer disabled this protection
3	GENERATOR REVERSE POWER PROTECTION	32G	7UM622	3100 REVERSE POWER PROTECTION 3101 State of the reverse power protection ON 3102 Pick-up value of reverse power -0.50 %	3100 REVERSE POWER PROTECTION 3101 State of the reverse power protection ON 3102 Pick-up value of reverse power -0.497 %	All Settings are in order.	Class-D	All Settings are in order.
4	GENERATOR NEGATIVE PHASE SEQUENCE	46G	7UM622	1701 unbalanced load protection ON 1702 Continously permissible neg. sequence current 6 % 1705 Time for Cooling down 1406 Sec 1706 I2>> Pick-up value 48%	1701 unbalanced load protection ON 1702 Continously permissible neg.seq current 5.85 % 1705 Time for Cooling down 1406 Sec 1706 I2>> Pick-up value 47.5%	All Settings are in order.	Class D	All Settings are in order.
5	SYSTEM BACKUP IMPEDANCE	21G	7UM622	3301 Impedance protection ON 3303 Undervoltage seal-in ON/OFF on 3304 Undervoltage value for seal-in 77 V 3306 Impedance Zone Z1 2.00 Ohm 3307 Impedance Zone Z1 Time Delay 1.00 S 3310 Impedance Zone Z2 2.80 Ohm 3311Impedance Zone Z2 Time delay 2.00 Sec 3313 Power Swing Blocking On 3314 Distance betw. Power Swing - Trip-Pol. 3.00 Ohm 3316A Power Swing block locks out Z1 & Z2 3317A Power Swing Action Time 3.0 Sec	3301 Impedance protection ON 3303 Undervoltage seal-in ON/OFF on 3304 Undervoltage value for seal-in 77 V 3306 Impedance Zone Z1 1.944 Ohm 3307 Impedance Zone Z1 Time Delay 1.00 S 3310 Impedance Zone Z2 2.78 Ohm 3311Impedance Zone Z2 Time delay 2.00 Sec 3313 Power Swing Blocking On 3314 Distance betw. Power Swing - Trip-Pol. 3.00 Ohm 3316A Power Swing block locks out Z1 & Z2 3317A Power Swing Action Time 3.0 Sec	All Settings are in order.	Class A1	All Settings are in order.
6	LOSS OF EXCITATION	40G	7UM622	3000 UNDEREXCITATION PROTECTION 3001 State of the underexcitation protection ON 3002 Susceptance Intersect Characteristic1(λ1) 0.54 3003 Inclination angle of char. 1 80 ° 3004 Characteristic 1 Time Delay 2.0 Sec 3005 Susceptance Intersect Characteristic2 (λ2) 0.49 3006 Inclination angle of char. 2 90 ° 3007 Characteristic 2 Time Delay 2.00 s 3008 Susceptance Intersect Characteristic3 (λ3) 1.10 3009 Inclination angle of char. 3 100 ° 3010 Characteristic 3 Time Delay 0.30 s	3000 UNDEREXCITATION PROTECTION 3001 State of the underexcitation protection ON 3002 Susceptance Intersect Characteristic1(λ1) 0.547 3003 Inclination angle of char. 1 80 ° 3004 Characteristic 1 Time Delay 2.0 Sec 3005 Susceptance Intersect Characteristic2 (λ2) 0.49 3006 Inclination angle of char. 2 90 ° 3007 Characteristic 2 Time Delay 2.00 s 3008 Susceptance Intersect Characteristic3 (λ3) 1.10 3009 Inclination angle of char. 3 100 ° 3010 Characteristic 3 Time Delay 0.30 s	All Settings are in order.	Class D	All Settings are in order.

7a	OVER VOLTAGE	59G	7UM622	4101 State of the Voltage protection ON 4102 Pick-up value of the U> stage 121.0 V 4103 Time delay for trip U> 3.00 s 4104 Pick-up value of the U>> stage 132.0 V 4105 Time delay for trip U>> 1.00 s	4101 State of the Voltage protection ON 4102 Pick-up value of the U> stage 121.0 V 4103 Time delay for trip U> 3.00 s 4104 Pick-up value of the U>> stage 132.0 V 4105 Time delay for trip U>> 1.00 s	All Settings are in order.	Class D	All Settings are in order.
7b	UNDER VOLTAGE	27G	7UM622	4001 STATE OF UNDER VOLTAGE OFF 4002 U< stage 77 V 4003 Time delay for trip U< ∞ s	4001 STATE OF UNDER VOLTAGE On 4002 U< stage 77 V 4003 Time delay for trip U< 0 s	Protection need to be Enabled	Class D	Settings need to be reviewed
8	STATOR GROUND FAULT PROT	59N	7UM622	5001 stator earth fault protection ON 5002 Pick-up value of displacement voltage U0> 4.8 V 5005 T S/E/F 0.20 Sec	5001 stator earth fault protection ON 5002 Pick-up value of displacement voltage U0> 5.5 V 5005 T S/E/F 0.20 Sec	All Settings are in order.	Class-A2	All Settings are in order.
9	100 % STATOR EARTH FAULT PROTECTION	64G2	7UM622	5301 100% stator earth fault protection ON 5302 Pick-up value of Alarm stage Rsef< 136 Ohm 5303 Pick-up value of Alarm stage Rsef<< 34 Ohm 5306 Pick-up value of I SEF>> Stage 0.65 A	5301 100% stator earth fault protection ON 5302 Pick-up value of Alarm stage Rsef< 135.4 Ohm 5303 Pick-up value of Alarm stage Rsef<< 33.9 Ohm 5306 Pick-up value of I SEF>> Stage 0.63 A	All Settings are in order.	Class-A2	All Settings are in order.
10	VOLT/HZ	99G	7UM622	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 20000 Sec 4308 U/f = 1.15 Time Delay 600 Sec 4309 U/f = 1.20 Time Delay 200 Sec 4310 U/f = 1.25 Time Delay 70 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 10 Sec 4313 U/f = 1.40 Time Delay 3 Sec	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 18000 Sec 4308 U/f = 1.15 Time Delay 600 Sec 4309 U/f = 1.20 Time Delay 200 Sec 4310 U/f = 1.25 Time Delay 70 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 10 Sec 4313 U/f = 1.40 Time Delay 3 Sec	All Settings are in order.		All Settings are in order.
11	GENERATOR OVER CURRENT PROTECTION	51V	7UM622	1201 State of overcurrent I> stage ON 1202 Pick-up value I> stage 4.00A 1203 Time delay for trip I> 2.00 S	1201 State of overcurrent I> stage ON 1202 Pick-up value I> stage 4.2A 1203 Time delay for trip I> 2.00 S	All Settings are in order.		All Settings are in order.
12	POLE SLIPPING	78G	7UM622	3501 State of the out-of-step protection ON 3504 Resistance Za of the polygon (width) 1.75 Ohm 3505 Reactance of the polygon Zb (reverse) 2.8 Ohm 3506 Reactance of the polygon Zc(forward char.1) 3.00 Ohm	3501 State of the out-of-step protection ON 3504 Resistance Za of the polygon (width) 1.75 Ohm 3505 Reactance of the polygon Zb(reverse) 2.756 Ohm 3506 Reactance of the polygon Zc(forward char.1) 2.92 Ohm	All Settings are in order.	Class-D	All Settings are in order.
13	DEAD MACHINE PROTECTION	50/27	7UM622	7101 Inadvertent Energisation ON 7102 I Stage pick-up 4.0 A 7103 Release Threshold U1< 77.0 V	7101 Inadvertent Energisation ON 7102 I Stage pick-up 3.660 A 7103 Release Threshold U1< 77.0 V	All Settings are in order.	Class-A	All Settings are in order.
14	Sensitive Rotor Earth Fault Protection	64R	7UM622	6101 Rotor earth fault protection (1-3hZ) ON 6102 Pick-up value of the warning stage Re< 80.0 kOhm 6103 Pick-up value of the tripping stage Re<< 5 kOhm 6104 Time delay for warning stage Re< 10.00 s 6105 Time delay for trip Re<< stage 3.00 s 6106Pick-up value of Open Rotor Circuit (Qc) 0.02 mA 6107A Testing Resistor 3.3 kOhm	The final setting of Qc has to be Determined During commissioning	All Settings are in order.	Class-A2	the final setting of Qc has to be Determined During commissioning

15	UNDER FREQUENCY PROTECTION	81UF	7UM622	4201 Over/Under frequency protection ON 4202 f1 Pick-up 48.50 Hz (95%) 4204 T f1 Time Delay 2.5 Sec 4205 f2 Pick-up 47.40 Hz(95%) 4207 T f2 Time Delay 2.00 Sec	4201 Over/Under frequency protection ON 4202 f1 Pick-up 48.50 Hz (95%) 4204 T f1 Time Delay 2.5 Sec 4205 f2 Pick-up 47.50 Hz(95%) 4207 T f2 Time Delay 2.00 Sec	All Settings are in order.	Class-C	All Settings are in order.
16	INTERTURN FAULT PROTECTION	64GIT	7SJ804	5202 Threshold Voltage sum 8.0V	5202 Threshold Voltage sum 8.01V	Settings are in order.		Settings are in order.
17	OVER ALL DIFFERENTIAL	87OA	7UT633	1001 Differential protection ON 1031 Pick-up value of High Set Trip 8.00 I/InO 1041A Slope 1 of tripping characteristic 0.2A 1042A Base point for slope 1 0.20 I/InO 1043A Slope2 of tripping characteristic 0.80 1044A Base point for slope 2 of charact. 2.00 I/InO	1001 Differential protection ON 1031 Pick-up value of High Set Trip 8.0515 I/InO 1041A Slope 1 of tripping characteristic 0.2A 1042A Base point for slope 1 0.20 I/InO 1043A Slope2 of tripping characteristic 0.80 1044A Base point for slope 2 of charact. 2.00 I/InO	All Settings are in order.		all Settings are in order.
18	GT DIFFERENTIAL	87GT	7UT613	1201 Differential protection ON 1231 Pick-up value of High Set Trip 8.00 I/InO 1241A Slope 1 of tripping characteristic 0.2A 1242A Base point for slope 1 0.20 I/InO 1243A Slope2 of tripping characteristic 0.80 1244A Base point for slope 2 of charact. 2.00 I/InO	1201 Differential protection ON 1231 Pick-up value of High Set Trip 7.41 I/InO 1241A Slope 1 of tripping characteristic 0.2A 1242A Base point for slope 1 0.20 I/InO 1243A Slope2 of tripping characteristic 0.80 1244A Base point for slope 2 of charact. 2.00 I/InO	All Settings are in order.		All Settings are in order.
19	GT V/F PROTECTION	99GT	7UT633	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 20000 Sec 4308 U/f = 1.15 Time Delay 120 Sec 4309 U/f = 1.20 Time Delay 75 Sec 4310 U/f = 1.25 Time Delay 50 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 18 Sec 4313 U/f = 1.40 Time Delay 3 Sec	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 18000 Sec 4308 U/f = 1.15 Time Delay 120 Sec 4309 U/f = 1.20 Time Delay 75 Sec 4310 U/f = 1.25 Time Delay 50 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 18 Sec 4313 U/f = 1.40 Time Delay 3 Sec	All Settings are in order.	--	All Settings are in order.
20	GT GROUND OVER CURRENT	51N GT	7UT633	IEp PICKUP 0.4A TMS 0.3 sec	IEp PICKUP 0.4A TMS 0.3 sec	Settings are in order.	--	Settings are in order.
21	SAT DIFFERENTIAL PROTECTION	87UAT	7UT613	1201 Differential protection ON 1231 Pick-up value of High Set Trip 10.00 I/InO 1236A T I-DIFF>> Time Delay 0.00 Sec 1241A Slope 1 of tripping characteristic 0.2A 1242A Base point for slope 1 0.20 I/InO 1243A Slope2 of tripping characteristic 0.80 1244A Base point for slope 2 of charact. 2.00 I/InO	1201 Differential protection ON 1231 Pick-up value of High Set Trip 8.33 I/InO 1236A T I-DIFF>> Time Delay 0.00 Sec 1241A Slope 1 of tripping characteristic 0.2A 1242A Base point for slope 1 0.20 I/InO 1243A Slope2 of tripping characteristic 0.80 1244A Base point for slope 2 of charact. 2.00 I/InO	1231 Pick-up value of High Set Trip Setting need to be review	--	All Settings are in order.Except 1231 Pick-up value of High Set Trip

22	SAT V/F PROTECTION		7UT613	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 20000 Sec 4308 U/f = 1.15 Time Delay 120 Sec 4309 U/f = 1.20 Time Delay 75 Sec 4310 U/f = 1.25 Time Delay 50 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 18 Sec 4313 U/f = 1.40 Time Delay 3 Sec	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 18000 Sec 4308 U/f = 1.15 Time Delay 120 Sec 4309 U/f = 1.20 Time Delay 75 Sec 4310 U/f = 1.25 Time Delay 50 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 18 Sec 4313 U/f = 1.40 Time Delay 3 Sec	All Settings are in order.	--	All Settings are in order.
23	SAT OVER CURRENT (HV SIDE)		7SJ802	Ip PICKUP 1A TMS 0.5 sec	Ip PICKUP 1A TMS 0.5 sec	Settings are in order	--	Settings are in order
24	SAT GROUND OVER CURRENT		7SJ802	IEp PICKUP 0.2A TMS 0.2 sec	IEp PICKUP 0.2A TMS 0.2 sec	Settings are in order	--	Settings are in order

STEAM TURBINE GENERATOR (STG)

Generator Ratings			Gen. Busduct CT data					
			Phase Side					
MVA	305.882	MVA		Primary	Secondary	CLASS	Vk	VA
MW	260.00	MW	CT-5	12500	5	PS	1000	-
kV	16.50	kV	CT-6	12500	5	PS	1000	-
Rated Stator Current	10703	Amps.	CT-7	12500	5	0.2	-	50
Field Current - IFN	2582	Amps.	CT-8	12500	5	0.2	-	50
Xd = Xq (Round Rot)	1.907	pu	Neutral side					
Xd' (Sat)	0.237	pu	CT-1	12500	5	PS	800	-
Xd" (Sat)	0.162	pu	CT-2	12500	5	0.2	-	50
Xd' (Un-Sat)	0.2486	pu	CT-3	12500	5	PS	1000	-
Xd" (Un-Sat)	0.194	pu	CT-4	12500	5	PS	1000	-

Generator busduct VT parameter						
VT REFERENCE:	VT1		VT2		VT3	
Ratio (kV/V)	(16.5/√3) / (110/√3)	(16.5/√3) / (110/√3)	(16.5/√3) / (110/√3)	(16.5/√3) / (110/√3	(16.5/√3) / (110/√3)	(16.5/√3) / (110/√3
Accuracy Class	3P/0.5	0.2	3P/0.5	0.2	3P/0.5	0.2
Rated Burden (VA)	100	100	100	100	100	100

Generator busduct IVT parameter		
VT REFERENCE:	IVT1	IVT2
Ratio(V/V)	(110V/√3)/(80 /√3)	(415V/√3)/(110 /√3)
Accuracy Class	3P	1
Rated Burden (VA)	30	60

Neutral Groundging Transformer		
DATA	Py	Sy
VOLTAGE RATIO kV	16.5	0.24
RATED -KVA	50	
R (On LV Side) Ω	0.326	
NGT LV (Sec.) CT Ratio	600	5

Generator Transformer Ratings		
GT Capacity in MVA	292.40	MVA
HV Voltage rating	420	kV
LV Voltage rating	16.5	kV
Transformer Impedance	13.5	%
HV Side CT (Primary)	500	A
HV Side CT (Secondary)	1	A
LV Side CT (Primary)	12500	A
LV Side CT (Secondary)	5	A
VT (Primary)	400000	V
VT (Secondary)	110	V
Frequency	50	Hz
Min tap	5	%
Max tap	-5	%

PROTECTION SETTINGS

SI. No.	PROTECTION FUNCTION	ASNI Code	Relay Model	Setting adopted	Setting Recommended	Remarks	Adopted Trip Class	Comments
1	GENERATOR DIFFERENTIAL	87G	7UM622	2001 Differential protection ON 2031 Pick-up value of High Set Trip 4.5 I/InO 2041A Slope 1 of tripping characteristic 0.15A 2042A Base point for slope 1 0.20 I/InO 2043A Slope2 of tripping characteristic 0.50 2044A Base point for slope 2 of charact. 2.00 I/InO	2001 Differential protection ON 2031 Pick-up value of High Set Trip 4.2194 I/InO 2041A Slope 1 of tripping characteristic 0.15A 2042A Base point for slope 1 0.20 I/InO 2043A Slope2 of tripping characteristic 0.50 2044A Base point for slope 2 of charact. 2.00 I/InO	All Settings are in order.	Class-A	All Settings are in order.
2	GENERATOR LOW FORWARD POWER PROTECTION	37G	7UM622	3100 REVERSE POWER PROTECTION 3201 Forward Power Supervision ON 3202 P-forw.< Supervision Pickup 0.5 **%**	3100 REVERSE POWER PROTECTION 3201 Forward Power Supervision ON 3202 P-forw.< Supervision Pickup 0.366 %	Settings are in order.	Class-B	Settings are in order.
3	GENERATOR REVERSE POWER PROTECTION	32G	7UM622	3100 REVERSE POWER PROTECTION 3101 State of the reverse power protection ON 3102 Pick-up value of reverse power -0.50 %	3100 REVERSE POWER PROTECTION 3101 State of the reverse power protection ON 3102 Pick-up value of reverse power -0.497 %	Settings are in order.	Class-B	Settings are in order.
4	GENERATOR NEGATIVE PHASE SEQUENCE	46G	7UM622	1701 unbalanced load protection ON 1702 Continously permissible neg. seq current 6.7 % 1705 Time for Cooling down 1406 Sec 1706 I2>> Pick-up value 54%	1701 unbalanced load protection ON 1702 Continously permissible neg.seq current 6.85 % 1705 Time for Cooling down 1406 Sec 1706 I2>> Pick-up value 55.6%	All Settings are in order.	Class A	All Settings are in order.
5	SYSTEM BACKUP IMPEDANCE	21G	7UM622	3301 Impedance protection ON 3303 Undervoltage seal-in ON/OFF on 3304 Undervoltage value for seal-in 77 V 3306 Impedance Zone Z1 1.50 Ohm 3307 Impedance Zone Z1 Time Delay 1.00 S 3310 Impedance Zone Z2 2.10 Ohm 3311Impedance Zone Z2 Time delay 2.00 Sec 3313 Power Swing Blocking On 3314 Distance betw. Power Swing - Trip-Pol. 3.00 Ohm 3316A Power Swing block locks out Z1 & Z2 3317A Power Swing Action Time 3.0 Sec	3301 Impedance protection ON 3303 Undervoltage seal-in ON/OFF on 3304 Undervoltage value for seal-in 77 V 3306 Impedance Zone Z1 1.466 Ohm 3307 Impedance Zone Z1 Time Delay 1.00 S 3310 Impedance Zone Z2 2.095 Ohm 3311Impedance Zone Z2 Time dela 2.00 Sec 3313 Power Swing Blocking On 3314 Distance betw. Power Swing - Trip-Pol. 3.00 Ohm 3316A Power Swing block locks out Z1 & Z2 3317A Power Swing Action Time 3.0 Sec	All Settings are in order.	Class A	All Settings are in order.
6	LOSS OF EXCITATION	40G	7UM622	3000 UNDEREXCITATION PROTECTION 3001 State of the underexcitation protection ON 3002 Susceptance Intersect Characteristic1(λ1) 0.55 3003 Inclination angle of char. 1 80 ° 3004 Characteristic 1 Time Delay 2.0 Sec 3005 Susceptance Intersect Characteristic2 (λ2) 0.49 3006 Inclination angle of char. 2 90 ° 3007 Characteristic 2 Time Delay 2.00 s 3008 Susceptance Intersect Characteristic3 (λ3) 1.10 3009 Inclination angle of char. 3 100 ° 3010 Characteristic 3 Time Delay 0.30 s	3000 UNDEREXCITATION PROTECTION 3001 State of the underexcitation protection ON 3002 Susceptance Intersect Characteristic1(λ1) 0.55 3003 Inclination angle of char. 1 80 ° 3004 Characteristic 1 Time Delay 2.0 Sec 3005 Susceptance Intersect Characteristic2 (λ2) 0.49 3006 Inclination angle of char. 2 90 ° 3007 Characteristic 2 Time Delay 2.00 s 3008 Susceptance Intersect Characteristic3 (λ3) 1.10 3009 Inclination angle of char. 3 100 ° 3010 Characteristic 3 Time Delay 0.30 s	All Settings are in order.	Class B	All Settings are in order.

7a	OVER VOLTAGE	59G	7UM622	4101 State of the Voltage protection ON 4102 Pick-up value of the U> stage 121.0 V 4103 Time delay for trip U> 3.00 s 4104 Pick-up value of the U>> stage 132.0 V 4105 Time delay for trip U>> 1.00 s	4101 State of the Voltage protection ON 4102 Pick-up value of the U> stage 121.0 V 4103 Time delay for trip U> 3.00 s 4104 Pick-up value of the U>> stage 132.0 V 4105 Time delay for trip U>> 1.00 s	All Settings are in order.	Class A	All Settings are in order.
7b	UNDER VOLTAGE	27G	7UM622	4001 STATE OF UNDER VOLTAGE OFF 4002 U< stage 77 V 4003 Time delay for trip U< 0 s	4001 STATE OF UNDER VOLTAGE ON 4002 U< stage 77 V 4003 Time delay for trip U< 0 s	Protection need to be Enabled	Class B	Settings need to be reviewed
8	STATOR GROUND FAULT PROT	59N	7UM622	5001 stator earth fault protection ON 5002 Pick-up value of displacement voltage U0> 4.8 V 5005 T S/E/F 0.20 Sec	5001 stator earth fault protection ON 5002 Pick-up value of displacement voltage U0> 5.5 V 5005 T S/E/F 0.20 Sec	All Settings are in order.	Class-A	All Settings are in order.
9	100 % STATOR EARTH FAULT PROTECTION	64G2	7UM622	5301 100% stator earth fault protection ON 5302 Pick-up value of Alarm stage Rsef< 102 Ohm 5303 Pick-up value of Alarm stage Rsef<< 25Ohm 5306 Pick-up value of I SEF>> Stage 0.71 A	5301 100% stator earth fault protection ON 5302 Pick-up value of Alarm stage Rsef< 101.6 Ohm 5303 Pick-up value of Alarm stage Rsef<< 25.4 Ohm 5306 Pick-up value of I SEF>> Stage 0.71 A	All Settings are in order.	Class-A	All Settings are in order.
10	VOLT/HZ	24/99G	7UM622	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 20000 Sec 4308 U/f = 1.15 Time Delay 600 Sec 4309 U/f = 1.20 Time Delay 200 Sec 4310 U/f = 1.25 Time Delay 70 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 10 Sec 4313 U/f = 1.40 Time Delay 3 Sec	4301 overexcitation protection ON 4306 U/f = 1.05 Time Delay 20000 Sec 4307 U/f = 1.10 Time Delay 18000 Sec 4308 U/f = 1.15 Time Delay 600 Sec 4309 U/f = 1.20 Time Delay 200 Sec 4310 U/f = 1.25 Time Delay 70 Sec 4311 U/f = 1.30 Time Delay 30 Sec 4312 U/f = 1.35 Time Delay 10 Sec 4313 U/f = 1.40 Time Delay 3 Sec	All Settings are in order.		All Settings are in order.
11	GENERATOR OVER CURRENT PROTECTION	51V	7UM622	1201 State of overcurrent I> stage ON 1202 Pick-up value I> stage 4.50A 1203 Time delay for trip I> 2.00 S	1201 State of overcurrent I> stage ON 1202 Pick-up value I> stage 4.67A 1203 Time delay for trip I> 2.00 S	All Settings are in order.		All Settings are in order.
12	POLE SLIPPING	78G	7UM622	3501 State of the out-of-step protection On 3504 Resistance Za of the polygon (width) 1.5 Ohm 3505 Reactance of the polygon (reverse) 2.8 Ohm 3506 Reactance of the polygon (forward char.1) 2.20 Ohm	3501 State of the out-of-step protection On 3504 Resistance Za of the polygon (width) 1.43 Ohm 3505 Reactance of the polygon (reverse) 2.76 Ohm 3506 Reactance of the polygon (forward char.1) 2.20 Ohm	All Settings are in order.	Class-C	All Settings are in order.
13	DEAD MACHINE PROTECTION	50/27	7UM622	7101 Inadvertent Energisation ON 7102 I Stage pick-up 4.2 A 7103 Release Threshold U1< 77.0 V	7101 Inadvertent Energisation ON 7102 I Stage pick-up 4.28 A 7103 Release Threshold U1< 77.0 V	All Settings are in order.	Class-A	All Settings are in order.
14	Sensitive Rotor Earth Fault Protection	64R	7UM622	6101 Rotor earth fault protection (1-3hZ) ON 6102 Pick-up value of the warning stage Re< 80.0 kOhm 6103 Pick-up value of the tripping stage Re<< 5 kOhm 6104 Time delay for warning stage Re< 10.00 s 6105 Time delay for trip Re<< stage 3.00 s 6106Pick-up of Open Rotor Circuit (Qc) 0.02 mA 6107A Testing Resistor 3.3 kOhm	The final setting of Qc has to be Determined During commissioning	All Settings are in order.	Class-A	the final setting of Qc has to be Determined During commissioning

15	UNDER FREQUENCY PROTECTION	81UF	7UM622	4201 Over/Under frequency protection ON 4202 f1 Pick-up 48.50 Hz (95%) 4204 T f1 Time Delay 2.5 Sec 4205 f2 Pick-up 47.40 Hz(95%) 4207 T f2 Time Delay 2.00 Sec	4201 Over/Under frequency protection ON 4202 f1 Pick-up 48.50 Hz (95%) 4204 T f1 Time Delay 2.5 Sec 4205 f2 Pick-up 47.50 Hz(95%) 4207 T f2 Time Delay 2.00 Sec	All Settings are in order.	Class-C	All Settings are in order.
16	INTERTURN FAULT PROTECTION	64GIT	7SJ804	5202 Threshold Voltage sum 8.0V	5202 Threshold Voltage sum 8.2V	Settings are in order.		Settings are in order.
17	OVER ALL DIFFERENTIAL	87OA	7UT633	1001 Differential protection ON 1031 Pick-up value of High Set Trip 8.00 I/InO 1041A Slope 1 of tripping characteristic 0.2A 1042A Base point for slope 1 0.20 I/InO 1043A Slope2 of tripping characteristic 0.80 1044A Base point for slope 2 of charact. 2.00 I/InO	1001 Differential protection ON 1031 Pick-up value of High Set Trip 8.23 I/InO 1041A Slope 1 of tripping characteristic 0.2A 1042A Base point for slope 1 0.20 I/InO 1043A Slope2 of tripping characteristic 0.80 1044A Base point for slope 2 of charact. 2.00 I/InO	All Settings are in order.		All Settings are in order.
18	GT DIFFERENTIAL	87GT	7UT633	1201 Differential protection ON 1231 Pick-up value of High Set Trip 8.00 I/InO 1241A Slope 1 of tripping characteristic 0.2A 1242A Base point for slope 1 0.20 I/InO 1243A Slope2 of tripping characteristic 0.80 1244A Base point for slope 2 of charact. 2.00 I/InO	1201 Differential protection ON 1231 Pick-up value of High Set Trip 7.41 I/InO 1241A Slope 1 of tripping characteristic 0.2A 1242A Base point for slope 1 0.20 I/InO 1243A Slope2 of tripping characteristic 0.80 1244A Base point for slope 2 of charact. 2.00 I/InO	All Settings are in order.		All Settings are in order.Except 1231 Pick-up value of High Set Trip
19	GT GROUND OVER CURRENT	51N GT	7UT633	IEp PICKUP 0.4A TMS oo sec	IEp PICKUP 0.4A TMS 0.3 sec		--	Setting need to be reviewed

CHAPTER 3

REVIEW OF SWITCHYARD PROTECTION

CHAPTER 3.1

REVIEW OF 400 kV TRANSMISSION LINES PROTECTION

RELAY SETTINGS				
400 kV BIWANI Line				
Description	**Setting Range**	**Setting Adopted**	**Setting Recommended**	**Comments**
MAIN-I & II / **Line Settings**	**SIEMENS SIPROTECH 7SA522 & 7SA611**			
Line Length	0.3 km to 1000 km in steps of 0.010 Km	97.415	**97.415**	
Zone Settings				
Z1 Operating Mode	Forward/ Reverse/ Inactive	Forward	**Forward**	
X (Z1)	0.05/In Ω to 600/In Ω	7.093	**7.092**	Settings are in order.
RG (Z1)	0.05/In Ω to 600/In Ω	33.872	**33.771**	
T1 delay	0.00 to 30.00 s , ∞	0.000	**0.000**	
Z2 Operating Mode	Forward/ Reverse/ Inactive	Forward	**Forward**	
X (Z2)	0.05/In Ω to 600/In Ω	10.633	**10.638**	Settings are in order.
RG (Z2)	0.05/In Ω to 600/In Ω	33.872	**33.771**	
T2 delay	0.00 to 30.00 s , ∞	0.300	**0.300**	
Z3 Operating Mode	Forward/ Reverse/ Inactive	Forward	**Forward**	
X (Z3)	0.05/In Ω to 600/In Ω	22.152	**19.657**	setting shall be adopted as recommended
RG (Z3)	0.05/In Ω to 600/In Ω	33.872	**33.771**	
T3 delay	0.00 to 30.00 s , ∞	1.000	**1.000**	
Z4 Operating Mode	Forward/ Reverse/ Inactive	Reverse	**Reverse**	
X (Z4)	0.05/In Ω to 600/In Ω	0.866	**1.773**	setting shall be adopted as recommended
RG (Z4)	0.05/In Ω to 600/In Ω	33.872	**33.771**	
T4 delay	0.00 to 30.00 s , ∞	1.000	**1.000**	
Power Swing Blocking Settings				
Power Swing Blocking function	Enabled/ Disabled	Enabled	**Enabled**	
Power Swing Trip	YES/ NO	NO	**NO**	Settings are in order.
Blocking zones	Z1, Z1B, Z2,Z3,Z4	Z2 and higher	**Z2 and higher**	
Power Swing Detection Delay	0.08s to 5.00s	0.08	**0.08**	
Backup Overcurrent and Earth Fault Relay Settings				
Earth fault Relay Settings	PSM	0.30	**0.30**	Settings are in order.
	TMS	1.50	**1.50**	
Over current Relay Settings	PSM	1.50	**1.50**	
	TMS	1.50	**1.50**	

RELAY SETTINGS				
400 kV BAHADURGARH Line				
Description	**Setting Range**	**Setting Adopted**	**Setting Recommended**	**Comments**
MAIN-I & II	**SIEMENS SIPROTECH 7SA522 & 7SA611**			
Line Settings				
Line Length	0.3 km to 1000 km in steps of 0.010 Km	49.000	**48.991**	
Zone Settings				
Z1 Operating Mode	Forward/ Reverse/ Inactive	Forward	**Forward**	
X (Z1)	0.05/In Ω to 600/In Ω	3.567	**3.567**	Settings are in order.
RG (Z1)	0.05/In Ω to 600/In Ω	9.633	**33.771**	
T1 delay	0.00 to 30.00 s , ∞	0.000	**0.000**	
Z2 Operating Mode	Forward/ Reverse/ Inactive	Forward	**Forward**	
X (Z2)	0.05/In Ω to 600/In Ω	5.350	**5.350**	Settings are in order.
RG (Z2)	0.05/In Ω to 600/In Ω	9.630	**33.771**	
T2 delay	0.00 to 30.00 s , ∞	0.300	**0.300**	
Z3 Operating Mode	Forward/ Reverse/ Inactive	Forward	**Forward**	
X (Z3)	0.05/In Ω to 600/In Ω	12.137	**14.609**	setting shall be adopted as recommended
RG (Z3)	0.05/In Ω to 600/In Ω	9.630	**33.771**	
T3 delay	0.00 to 30.00 s , ∞	1.000	**1.000**	
Z4 Operating Mode	Forward/ Reverse/ Inactive	Reverse	**Reverse**	
X (Z4)	0.05/In Ω to 600/In Ω	0.892	**0.892**	Settings are in order.
RG (Z4)	0.05/In Ω to 600/In Ω	9.630	**33.771**	
T4 delay	0.00 to 30.00 s , ∞	1.000	**1.000**	
Power Swing Blocking Settings				
Power Swing Blocking function	Enabled/ Disabled	Enabled	**Enabled**	
Power Swing Trip	YES/ NO	NO	**NO**	
Blocking zones	Z1, Z1B, Z2,Z3,Z4	Z2 and higher	**Z2 and higher**	Settings are in order.
Power Swing Detection Delay	0.08s to 5.00s	0.08	**0.08**	
Backup Overcurrent and Earth Fault Relay Settings				
Earth fault Relay Settings	PSM	0.3	**0.3**	Settings are in order.
	TMS	1.5	**1.5**	
Over current Relay Settings	PSM	1.5	**1.5**	
	TMS	1.5	**1.5**	

CHAPTER 3.2

REVIEW OF 400 kV BUSBAR PROTECTION

Bus Bar Differential Protection			
Relay 7SS525 (Main Unit)	**Settings**		
	Values		
Parameters	**Setting Adopted**	**Setting Recommended**	**Units**
Voltage rating	400	400	kV
Maximum load current	1250	1250	A
Minimum load current	60	60	A
Maximum short circuit current	40	40	kA
Minimum short circuit current	3.1	3.1	kA
CT ratio			
CT primary	2000	2000	A
CT secondary	1	1	A
Settings			
Phase slope KCZ	30	30	%
IDCZ>2 current	1625	1625	A
Phase slope K2	65	65	%
ID>2 current (recommended 60% of max CT ratio)	1200	1200	A
Phase slope K1	0	0	%
ID>1 current (>2% of Max CT ratio and less than the minimum load feeder current	110	110	A
ID>1 alarm Timer	5	5	sec

CHAPTER 4

REVIEW OF AUXILLIARY SERVICE TRANSFORMER PROTECTION

1DAT01, 1DAT02, 2DAT01, 2DAT02, 3DAT01, 3DAT02, 4DAT01, 4DAT02, 1DBT01, 1DBT02, 2DBT01, 2DBT02, 0DDT01 & 0DDT02				
Sl No.	**PARAMETERS**		**Setting Adopted**	**Setting Recommended**
1	**Capacity (KVA)**		**1600**	**1600**
2	**Voltage Ratio (kV)**		**6.6/0.433**	**6.6/0.433**
3	**% Impedance**		**8**	**8**
4	**Adopted CT Ratio**	**HV**	**200/1**	**200/1**
		LV	**2500/1**	**2500/1**
		NEUTRAL	**2500/1**	**2500/1**
5	**Over Current (HV SIDE)**	**Make & Model**	**SEL 751A**	
		Current Setting	***1.00***	***1.00***
		Time delay	***0.51***	***0.51***
6	**E/F (HV SIDE)**	**Make & Model**	**SEL 751A**	
		Current Setting	***0.10***	**0.10**
		Time delay	***1.00***	**1.00**
7	**Over Current (LV SIDE)**	**Make & Model**	**GE F650**	
		Current Setting	***3.50***	**3.50**
		Time delay	***0.00***	**0.00**
8	**E/F (LV SIDE)**	**Make & Model**	**GE F650**	
		Current Setting	***0.10***	**0.10**
		Time delay	***0.20***	**0.20**
The Settings are in order.				

0DAT01, 0DAT02, 0DBT01, 0DBT02, 0DBT03, 1DCT01 & 2DCT02				
Sl No.	**PARAMETERS**		**Setting Adopted**	**Setting Recommended**
1	**Capacity (KVA)**		**2000**	**2000**
2	**Voltage Ratio (kV)**		**6.6/0.433**	**6.6/0.433**
3	**% Impedance**		**10**	**10**
4	**Adopted CT Ratio**	**HV**	**200/1**	**200/1**
		LV	**2500/1**	**2500/1**
		NEUTRAL	**2500/1**	**2500/1**
5	**Over Current (HV SIDE)**	**Make & Model**	**SEL 751A**	
		Current Setting	***1.00***	***1.00***
		Time delay	***0.51***	***0.51***
6	**E/F (HV SIDE)**	**Make & Model**	**SEL 751A**	
		Current Setting	***0.10***	**0.10**
		Time delay	***1.00***	**1.00**
7	**Over Current (LV SIDE)**	**Make & Model**	**GE F650**	
		Current Setting	***3.50***	**3.50**
		Time delay	***0.00***	**0.00**
8	**E/F (LV SIDE)**	**Make & Model**	**GE F650**	
		Current Setting	***0.10***	**0.10**
		Time delay	***0.20***	**0.20**
The Settings are in order.				

CHAPTER 5

DC BATTERIES AND CHARGERS

DC BATTERIES AND CHARGERS

DC battery and Chargers are very important units as they are required to operate the protection relays. In this section, the details of the batteries and chargers are described. There are two sets of battery banks for each DC system with two separate chargers provided for each battery bank.

a) Battery banks are placed in separate rooms with good ventilation.
b) Periodic and comprehensive checkup of DC battery and chargers are to be carried out by engaging professionals.
c) No ‘DC Earth’ fault is present.
d) Cleanliness and Maintenance of Batteries, Battery Chargers and Battery room are satisfactory.

220 V DC Supply Systems Checking Healthiness of the DC system

220VBattery System (2 Nos. 220V Battery Banks and 2 Nos. Charger Units)		
220V BATTERY DETAILS	BANK 1	BANK 2
MAKE& Model	HBL Power Systems Ltd	
TYPE	Ni Cd	
NO OF CELLS	173*2=340	
CAPACITY	1780 Ah	
220V CHARGER DETAILS	CHARGER 1	CHARGER 2
MAKE	CALDYNE Automatics Ltd	
DC CHECKING	0FA	0FB
POSITVE-NEGATIVE(V)	237.2	238.1
POSITVE-EARTH(V)	143.5	143.8
NEGATIVE-EARTH(V)	91.7	92.1

220 V DC Supply Systems Checking Healthiness of the DC system

220VBattery System (2 Nos. 220V Battery Banks and 2 Nos. Charger Units)		
220V BATTERY DETAILS	BANK 1	BANK 2
MAKE& Model	AMCO saft India Ltd.	
TYPE	Ni Cd	
NO OF CELLS	173	
CAPACITY	410 Ah	
220V CHARGER DETAILS	CHARGER 1	CHARGER 2
MAKE	Chabbi Electricals	
DC CHECKING	1D	2D
POSITVE-NEGATIVE(V)	241.8	241.7
POSITVE-EARTH(V)	149.1	148.4
NEGATIVE-EARTH(V)	91.2	88.4

125 V DC Supply Systems Checking Healthiness of the DC system

125VBattery System (8 Nos. 125V Battery Banks and 8 Nos. Charger Units)								
220V BATTERY DETAILS	BANK 1	BANK 2	BANK 3	BANK 4	BANK 5	BANK 6	BANK 7	BANK 8
MAKE& Model	AMCO saft India Ltd.							
TYPE	Ni Cd							
NO OF CELLS	98				98*3			
CAPACITY	410 Ah				1780Ah			
220V CHARGER DETAILS	1	2	3	4	5	6	7	8
MAKE	HBL Power Systems Ltd							
DC CHECKING	1FA	1FB	2FA	2FB	3FA	3FB	4FA	4FB
POSITVE-NEGATIVE(V)	136.8	136.4	137	136.3	136.4	136.8	137.1	133.3
POSITVE-EARTH(V)	69.9	69.2	68.2	69.3	69.7	69.3	69.1	67.5
NEGATIVE-EARTH(V)	66.3	66.2	68.2	66.4	66.1	66.5	67.3	65.1

CHAPTER 6

BACKUP OVER CURRENT AND EARTH FAULT RELAY CO-ORDINATION

O/C Relay Co-ordination

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	PSM	**TMS**	**Operating Time**	**Sequence of tripping**
400kV BUS	GTG & STG (HV SIDE)	SIEMENS 7UT633	OC (Non Dir.)	NI	500	35376				0.4	**0.25**	**0.321**	**1**
	LINE 1	SIEMENS 7SA522	OC (Non Dir.)	NI	1000	53988	1.5	1.5	2.827	1.5	1.5	2.827	**2**
	LINE 2	SIEMENS 7SA522	OC (Non Dir.)	NI	1000	30255	1.5	1.5	3.391	1.5	1.5	3.391	**3**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
16.5 kV BUS	GTG STG (HV SIDE)	SIEMENS 7UT633	OC (Non Dir.)	NI	500	59950				0.4	0.25	0.290	**1**
	GCB (GTG & STG)	SIEMENS 7UM622	OC (Non Dir.)	NI	2500	59786	1	0.2	0.427	1	0.2	0.427	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
6.6 kV BUS	SAT	SIEMENS 7SJ802	OC (Non Dir.)	NI	1250	9072	1	0.5	1.731	1	0.5	1.731	**1**
	GT CB	SIEMENS 7SJ802	OC (Non Dir.)	NI	1250	9072	1	0.5	1.731	1	0.5	1.731	**2**
	GCB (GTG)	SIEMENS 7UM622	OC (Non Dir.)	NI	2500	5028	1	0.2	1.990	1	0.2	1.990	**3**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 1DA BUS	1DAT01 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	1DAT01 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 2DA BUS	2DAT01 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	2DAT01 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	Relay Location	Relay make and model		Characteristic	CT Ratio	Primary Fault current seen by relay (A)	PSM	TMS	Operating Time	PSM	TMS	Operating Time	Sequence of tripping
415V 1DB BUS	1DBT01 (LV SIDE)	GE F650	OC (Non Dir.)	DT	1000	32881	3.5	0	0.000	3.5	0	0.000	**1**
	1DBT01 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	Relay Location	Relay make and model		Characteristic	CT Ratio	Primary Fault current seen by relay (A)	PSM	TMS	Operating Time	PSM	TMS	Operating Time	Sequence of tripping
415V 1DA BUS	1DAT02 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	1DAT02 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	Relay Location	Relay make and model		Characteristic	CT Ratio	Primary Fault current seen by relay (A)	PSM	TMS	Operating Time	PSM	TMS	Operating Time	Sequence of tripping
415V 2DA BUS	2DAT02 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	2DAT02 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	Relay Location	Relay make and model		Characteristic	CT Ratio	Primary Fault current seen by relay (A)	PSM	TMS	Operating Time	PSM	TMS	Operating Time	Sequence of tripping
415V 1DB BUS	1DBT02 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	1DBT02 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	Relay Location	Relay make and model		Characteristic	CT Ratio	Primary Fault current seen by relay (A)	PSM	TMS	Operating Time	PSM	TMS	Operating Time	Sequence of tripping
415V 3DA BUS	3DAT01 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	3DAT01 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 4DA BUS	4DAT01 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	4DAT01 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 2DB BUS	2DBT01 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	2DBT01 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 3DA BUS	3DAT02 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	3DAT02 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 4DA BUS	4DAT02 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	4DAT02 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 2DB BUS	2DBT02 (LV SIDE)	GE F650	OC (Non Dir.)	DT	2500	32881	3.5	0	0.000	3.5	0	0.000	**1**
	2DBT02 (HV SIDE)	SEL751A	OC (Non Dir.)	VI	200	26251	1	0.51	0.049	1	0.51	0.049	**2**

EF O/C Relay Co-ordination

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	PSM	**TMS**	**Operating Time**	**Sequence of tripping**
400kV BUS	GTG & STG (HV SIDE)	SIEMENS 7UT633	E/F (Non Dir.)	NI	500	36890	0.4	0.3	0.382	0.4	**0.3**	**0.382**	**1**
	LINE 1	SIEMENS 7SA522	E/F (Non Dir.)	NI	1000	39785	0.3	1.5	2.045	0.3	1.5	2.045	**2**
	LINE 2	SIEMENS 7SA522	E/F (Non Dir.)	NI	1000	28089	0.3	1.5	2.210	0.3	1.5	2.210	**3**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
6.6 kV BUS	SAT	SIEMENS 7SJ802	E/F (Non Dir.)	NI	3000	22433	0.2	0.2	0.373	0.2	0.2	0.373	**1**
	GCB (GTG)	SIEMENS 7UM622	E/F (Non Dir.)	NI	2500	2724	0.65	1	13.480	0.65	1	13.480	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 1DA BUS	1DAT01 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	1DAT01 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 2DA BUS	2DAT01 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	2DAT01 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 1DB BUS	1DBT01 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	1DBT01 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 1DA BUS	1DAT02 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	1DAT02 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 2DA BUS	2DAT02 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	2DAT02 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 1DB BUS	1DBT02 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	1DBT02 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 3DA BUS	3DAT01 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	3DAT01 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 4DA BUS	4DAT01 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	4DAT01 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 2DB BUS	2DBT01 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	2DBT01 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 3DA BUS	3DAT02 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	3DAT02 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 4DA BUS	4DAT02 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	4DAT02 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

							Setting Adopted			Setting Recommended			
Fault Location and Type	**Relay Location**	**Relay make and model**		**Characteristic**	**CT Ratio**	**Primary Fault current seen by relay (A)**	**PSM**	**TMS**	**Operating Time**	**PSM**	**TMS**	**Operating Time**	**Sequence of tripping**
415V 2DB BUS	2DBT02 (LV SIDE)	GE F650	E/F (Non Dir.)	DT	2500	31179	0.1	0.2	0.200	0.1	0.2	0.200	**1**
	2DBT02 (HV SIDE)	SEL751A	E/F (Non Dir.)	NI	50	31179	0.1	1	0.733	0.1	1	0.733	**2**

CHAPTER 7

SAMPLE CALCULATION

RELAY SETTING CALCULATIONS FOR GENERATOR RELAY PANELS

Generator Ratings		
MVA	261.294	MVA
MW	222.10	MW
kV	16.50	kV
Rated Stator Current	9143	Amps.
Field Current - IFN	2274	Amps.
Xd = Xq (Round Rot)	1.629	pu
Xd' (Sat)	0.203	pu
Xd" (Sat)	0.138	pu
Xd' (Un-Sat)	0.2124	pu
Xd" (Un-Sat)	0.166	pu

Neutral Grounding Transformer		
DATA	Primary	Secondary
VOLTAGE RATIO (V)	16500.0	240
RATED KVA	75	
R (On LV Side) Ω	0.277	
NGT LV (Sec.) CT Ratio(A/A)	800	5

Generator Transformer Ratings		
ICT Capacity in MVA	220.5	MVA
HV Voltage rating	420	kV
LV Voltage rating	16.5	kV
Transformer Impedance	13.5	%
HV Side CT (Primary)	500	A
HV Side CT (Secondary)	1	A
LV Side CT (Primary)	12500	A
LV Side CT (Secondary)	5	A
VT (Primary)	400000	V
VT (Secondary)	110	V
Frequency	50	Hz
Min tap	5	%
Max tap	-5	%

SAT Transformer Ratings		
ICT Capacity in MVA	31.5	MVA
HV Voltage rating	16.5	kV
LV Voltage rating	6.9	kV
Transformer Impedance	12	%
HV Side CT (Primary)	1250	A
HV Side CT (Secondary)	1	A
LV Side CT (Primary)	3000	A
LV Side CT (Secondary)	1	A
VT (Primary)	16500	V
VT (Secondary)	110	V
Frequency	50	Hz
Min tap	10	%
Max tap	-10	%

TYPES OF PROTECTION PROVIDED AND RELAYS USED:

1) Generator Differential
2) Reverse Power protection
3) Low Forward Power
4) Over Voltage protection
5) Under Voltage protection
6) Loss of Excitation - SIEMENS SIPROTEC 7UM622
7) Negative Phase Sequence Thermal
8) System Backup Impedance
9) Pole slipping or Out of Step
10) Over flux
11) Dead Machine Protection
12) Under/Over Frequency Protection
13) GT Differential - SIEMENS SIPROTEC 7UT633
14) SAT AUX ICT Differential Protection - SIEMENS SIPROTEC 7SJ802
15) Distance Relay Main-I - SIEMENS SIPROTEC 7SA522
16) Distance Relay Main-II - SIEMENS SIPROTEC 7SA612

GENERATOR DIFFERENTAL: (BIASED TYPE DIFFERENTIAL)

Relay Used = SIPROTEC 7UM622

Generator Rating = 261.29 MVA

Generator full load current Neutral Side = $\frac{MVA}{(\sqrt{3}*V_L)}$

Generator full load current Neutral Side = $\frac{261.294}{(\sqrt{3}*16.5)}$

Generator full load current Neutral Side = 9.143 kA

CT Ratio = 12500/5A

CT current on Sy side = $\frac{9.143*10^3}{(12500/5)}$

CT current on Sy side = 3.6572 A

Generator full load current Generating Side = $\frac{MVA}{(\sqrt{3}*V_L)}$

Generator full load current Generating Side = $\frac{261.29}{(\sqrt{3}*16.5)}$

Generator full load current Generating Side = 9.143 kA

CT Ratio = 12500/5A

CT current on Sy side = $\frac{9.143*10^3}{(12500/5)}$

= 3.6572 A

Ratio of compensation on Neutral Side = $\frac{1}{3.6572}$

Ratio of compensation on Neutral Side = 0.2734

Ratio of compensation on Generating Side = $\frac{1}{3.6572}$

Ratio of compensation on Generating Side = 0.2734

Compensated Current Internally Neutral Side I_1 = 0.2734*3.65

Compensated Current Internally Neutral Side I_1 = 1A

Compensated Current Internally Generating Side I_2 = 0.2734*3.65

Compensated Current Internally Generating Side I_2 = 1A

Bias Setting:

Pickup Value Is = 0.1

Bias slope1 M1 = 0.15

Bias slope2 M2 = 0.5

Base Point for Slope2 = 2.0

Bias Current Ibias = (I_1+I_2)

Bias Current Ibias = (1+1) = 2A

Differential Current = (I_1-I_2) = 1-1 = 0

Operating Current = Is + M1*Ibias

Operating Current = 0.1+0.15*2 = 0.4A

Pickup Value of High set Differential = 1/ Xd' = (1/0.203) = 4.926

REVERSE POWER PROTECTION:

Relay used	= SIEMENS SIPROTECH 7UM622
Relay Setting Adopted	= 0.5 % to 1% (as per CBIP)
Apparent Output of Generator	= 261.294 MVA
Active Output of Generator	= 222.1MW
Rated Voltage of Generator	= 16.5 kV
Rated current	= 9143 A
CT Primary Adopted	= 12500 A
CT Secondary Adopted	= 5 A
PT Primary	=16.5 kV
PT Secondary	= 110 V

CALCULATION

Machine power corresponding to the setting value

$$= \frac{\text{Relay setting Adopted X Active Output of Generator}}{100} \quad \text{MW}$$

$$= \frac{0.8 \text{ X } 222.1 \text{ MW}}{100}$$

= 1.7768 MW

Minimum % Power setting to be adopted =

$$= \frac{P_{machine} \text{ X } V_{machine} \text{ X } I_{machine}}{PT_{primary} \text{ X } CT_{primary} \text{ X Apparent Output}}$$

$$= \frac{1.7768 \text{ X } 16500 \text{ X } 9143 \text{ X } 100}{16500 \text{ X } 12500 \text{ X } 261.294}$$

Minimum % Power setting to be adopted = 0.497%

UNDER VOLTAGE PROTECTION:

Relay Used = SIEMENS SIPROTECH 7UM622

Typical setting = 70% of secondary voltage

= 0.7*110V

Typical setting = 77V

Typical Time delay = Instantaneous or with a very short time delay

OVER VOLTAGE PROTECTION:

Relay Used = SIEMENS SIPROTECH 7UM622

First Stage Over voltage protection = 110% of secondary voltage

= 1.1*110 = **121 V**

Second Stage Over voltage protection = 130% of secondary voltage

= 1.2*110 = **132V**

Typical Time delay = Instantaneous or with a very short time delay

LOSS OF EXCITATION:

Relay Used = SIEMENS SIPROTECH 7UM622

Generator Rated Voltage = 16.5 kV

Generator Rated MVA = 261.294 MVA

Generator Rated Current = 9143 A

Synchronous D-Axis Reactance Xd = 140.2 % or 1.42 pu.

CT Primary = 12500 A

CT Secondary = 5A

PT Primary = 16.5 kV

PT Secondary = 110 V

CALCULATION

Direct Axis Synchronous Reactance = 1.42 p.u.

$$\text{Admittance} \quad \frac{1}{X_{dsec}} = \frac{1}{X_{dmach}} \times \frac{I_{N\,MACH}}{U_{N\,MACH}} \times \frac{U_{N\,VT\,PRIMARY}}{I_{N\,CT\,PRIMARY}}$$

Xdsec = Related synchronous Direct axis reactance, secondary

Xdmach = Related synchronous Direct axis reactance

INMACH = Full load current of the machine

IN CT PRIMARY = Primary rating of the Current Transformer

UNMACH = Nominal Voltage of the machine

UN VT PRIMARY = Primary rating of Voltage Transformer

$$\frac{1}{X_{dsec}} = \frac{1}{1.402} \times \frac{9143}{16500} \times \frac{16500}{12500}$$

$$= 0.5217 \text{ mho}$$

Safety factor = 1.05

$$\text{Characteristics 1} = \text{Safety factor X} \left[\frac{1}{X_{d\,sec}}\right]$$

= 1.05 x 0.5217

Characteristics 1 = 0.5477 mho

Angle = 80 °

Time delay = 2.0 sec

Characteristics 2 = 0.9* Characteristics 1

= 0.9* 0.5477

Characteristics 2 = 0.4930 mho

Angle = 90 °

Time delay = 2.0 sec.

Characteristics 3 = 2* Characteristics 2

= 2 * 0.4930

Characteristics 3 = 1.0962 mho

Angle = 90 °

Time delay = 0.3 s

SYSTEM BACKUP IMPEDANCE 21G

Relay Used	= SIEMENS SIPROTECH 7UM622
Generator MVA	= 261.294 MVA
Generator Rated Voltage	= 16.5 kV
Generator Transformer MVA	= 220.5 MVA
Generator Transformer Impedance	= 13.5 % or .135 pu
CT Primary of the Generator	= 12500 A
CT Secondary of Generator	= 5 A
PT Primary	= 16.5 kV / √3
PT Secondary	= 110 V / √3

$$\frac{\text{CT Ratio}}{\text{PT Ratio}} = 16.667$$

CALCULATION

Impedance of the Generator Transformer = % Impedance of Generator Transformer X

Base Impedance of the Generator Transformer on Generator Side

$$= \frac{0.135 \text{ X } (16.5*16.5)}{220.6}$$

Impedance of the Generator Transformer = 0.167 Ω

Zone 1 Impedance in Sy. (Limited to 70% of GT) = 0.7*0.167 *16.667

Zone 1 Impedance in Sy. (Limited to 70% of GT) = 1.94 Ω

Zone 2 Impedance in Sy. (Limited to 100 % of GT) = 0.167*16.667

Zone 2 Impedance in Sy. (Limited to 100 % of GT) = 2.78 Ω

NEGATIVE PHASE SEQUENCE PROTECTION

Relay Used = SIEMENS SIPROTECH 7UM622

Full load current of the machine = 9143 A

CT Primary = 12500

The i^2t curve for the machine is not available, hence

i^2t continuous withstand is assumed as = 8 %

with stand time constant = 20 sec

Alarm setting = i^2t continuous withstand X Current in Sy.

= 8 X (9143/12500)

Alarm setting = 5.85 %

Trip setting is with respect to 65 % of the full load current

= 0.65* (9143/12500)*100

= 47.54 %

K primary = 9

Therefore, the Negative sequence withstand of the Generator is

$$t = \frac{9}{(0.08)^2}$$

t = 1406.0 sec.

POLE SLIPPING:

Relay Used	=	SIEMENS SIPROTECH 7UM622
Generator rated MVA	=	261.294MVA
Terminal Voltage	=	16.5kV
Synchronous Reactance Xd	=	140.2 % or 1.402 pu
Transient Reactance X'd	=	20.3 % or 0.203 pu
Sub-Transient Reactance X"d	=	13.8 % or 0.138 pu
CT Ratio	=	12500/5A
PT Ratio	=	16.5 kV/110V
Generator Transformer rated MVA	=	220.5 MVA
Generator Transformer Impedance	=	13.5 % or 0.135 pu
Fault MVA	=	√3*400k*40k = 27712 MVA

CALCULATIONS

Source Impedance of the Generator $= \dfrac{kV^2}{\text{Fault MVA}}$

$= \dfrac{16.5*16.5}{27713}$

$= 0.0098\ \Omega$

$Zd - Zc = \dfrac{Zs \text{ X } \quad CT\ Ratio}{PT\ Ratio}$

$= 0.0098 \text{ X } \dfrac{12000/5}{16500/110}$

$= 0.164\ \Omega$

Generator Pole Slipping Impedance = 1.15 X Xd'' X kV^2 / MVA

$$Z_g = 1.15 \times 0.135 \times \frac{16.5*16.5}{261.29}$$

$Z_g = 0.1653\ \Omega$

$$Z_b = Z_G \times \frac{\text{CT Ratio}}{\text{PT Ratio}}$$

$$= 0.1653 \times \frac{12500/5}{16500/110}$$

$$\mathbf{Z_b = 2.755\ \Omega}$$

Generator Transformer Impedance = Generator Transformer Impedance X kV^2 / MVA

$$= 0.135 \times \frac{16.5*16.5}{220.5}$$

$Z_T = 0.168\ \Omega$

$$Z_c = Z_T \times \frac{\text{CT Ratio}}{\text{PT Ratio}}$$

$$= 0.168 \times \frac{12500/5}{16500/110}$$

$$\mathbf{Z_c = 2.92\ \Omega}$$

Ztot = Zb + Zc

= 2.755 + 2.92

Ztot = 5.67 Ω

Angle of Inclination of Polygon = 90 °

Za = (Ztot / 2) X $\tan^{-1}$ (90 /2)

Za = 1.75 Ω

OVER FLUX PROTECTION:

Relay Used = SIEMENS SIPROTECH 7UM622

V/f Setting		Time delay	Unit
U/f> Pickup	1.05	20000	Sec
U/f> Pickup	1.1	18000	Sec
U/f> Pickup	1.15	600	Sec
U/f> Pickup	1.2	200	Sec
U/f> Pickup	1.25	70	Sec
U/f> Pickup	1.3	30	Sec
U/f> Pickup	1.35	10	Sec
U/f> Pickup	1.4	3	Sec

DEAD MACHINE PROTECTION

The Dead Machine protection is generally Adopted based on the assumption that, when an accidental energization occurs a current of above 1 p.u. flows which is dangerous for the people working in maintenance as well as the Generator which does motoring action due to the non-availability of Field.

SETTING ADOPTED

@ Under voltage pick up (77 V)

Typical setting = Full load current Sy. Of the CT = (9143*5/12500)

Typical setting = 3.657 A

Time delay = 1 sec.

GENERATOR FREQUENCY PROTECTION:

Relay Used = SIEMENS SIPROTECH 7UM622.

Setting Adopted for two Stage under Frequency Protection

First Stage under Frequency Protection

Alarm Setting (f1) = 48.50 Hz => 97%

Time Delay = 2.5 sec.

Second Stage under Frequency Protection

Trip Setting (f2) = 47.5 Hz=> 95%

Time Delay = 2 sec.

GENERATOR OVER CURRENT PROTECTION:

Relay Used = SIEMENS SIPROTECH 7UM622

Current at 95 % of rated voltage = MVA*1000/ (1.732*0.95* Rated voltage)*1000.

= 261.294*1000/ (1.732 *0.95*16.5).

= 9624.125 A

Secondary current = Current at 95 % of rated voltage / (CT Ratio)

= 9624.125 / (12500/5)

=3.85 A

I> Pickup = 109% of secondary current

= 1.09* 3.85

Pickup =4.2 A

STATOR EARTH FAULT PROTECTION (95%):

Relay Used = SIEMENS SIPROTECH 7UM622

VT secondary Voltage = 110

CALCULATIONS:

Pick up value for E/F detection = ((100%-95%)* VT secondary Voltage)/100%

= (5 %*(110))/100%

Pick up value for E/F detection = 5.5V

STATOR EARTH FAULT PROTECTION (100%)

Relay Used = SIEMENS SIPROTECH 7UM622

NGT sec.. Voltage = (240/√3)

Intermediate CT = 800/5

Pick up value for E/F detection= (0.2* NGT Sec.. voltage)/(R* Intermediate CTR)

= (0.2*(240/√3)) / (0.277*800/5)

Pick up value for E/F detection = 0.63 A

ROTOR EARTH FAULT PROTECTION:

CHARGE Qc DURING POLARITY REVERSAL
BELOW WHICH THE MEASURING CIRCUIT IS
ASSUMED TO BE OPEN

THE FINAL SETTING OF CHARGE Qc HAS TO BE DETERMINED DURING COMMISSIONING.

Pickup value of warning stage: 80k Ω

Pickup value of Tripping stage: 5k Ω

QC value = 0.02 mAsec

GENERATOR INTERTURN FAULT PROTECTION

In case of single turn inter turn fault, unbalance produced in faulty phase leads to a voltage 0.908 p.u. in the faulty phase, with other two phase voltages being normal.

VOD = (VR+VYV+B) N

VOD = N [V(0.908) + VCos 120+ jVSin 120+ VCos 240+ jVSin240]

VOD= 4.249 v

Resistivity of copper wire = 0.0171

cable size =2.5mmsq

length of wire = 275

Lead Resistance = **($\mathscr{P}$L)/A** = 1.88 ohm

Voltage drop across lead resistance = 3.76 V

Total voltage = 4.249+3.76 = 8.09 V

GENERATOR TRANSFORMER: (BIASED TYPE DIFFERENTIAL)

Relay Type: SIEMENS 7UT613

MVA = 220.5 MVA

Voltage Ratio = 420/16.5 kV

Voltage in kV (HV Side) = 400

Voltage in kV (LV Side) = 16.5

CT Ratio (HV Side) = 500/1

CT Ratio (LV Side) = 12500/5

Minimum Tap = -5

Maximum Tap = +5

Rated Current (HV Side) = MVA / (√3*kV)

=220.5*10^6/ (√3*400*10^3)

=318.27 A

Current on CT Secondary (HV) = Rated Current (HV Side)/CT Ratio

= 318.27/500

=0.637 A

Required Ratio Compensation = 1/ 0.637 = 1.5698 A

Rated Current (LV Side) = MVA / (√3*kV)

=220.5*10^6/ (√3*16.5*10^3)

=7715.6 A

Current on CT Secondary (LV) = Rated Current (LV Side)/CT Ratio

=7719.2 / (12500/5) = 3.086 A

Required Ratio Compensation = 1/ 3.086 =0.324 A

Calculations for OLTC tap setting -5%

Full load Current for HV Side Winding at -5% = MVA / (√3*0.95*kV)

=220.5*10^6/ (√3*400*0.95*10^3)

=335.02 A

Current on CT Secondary (HV) = Rated Current (HV Side)/CT Ratio

= 335.02/500

=0.6700A

As the adopted ratio correction is 1.5698A the current to relay bias terminal

= 0.67 * 1.5698

=1.0517 A

Hence the differential current is = 1.0517 – 1

= 0. 0517 A

Bias current = $(I_1+I_2)/2$

= (1.0517+1)/2

= 1.0258 A

[Since the bias current is less than 1.5 A the slope will be within 20%]

Therefore the operating current of the relay will be = $I_s + (M1 * I_{bias})$

= 0.2 + (0.2 * 1.0258)

= 0.4052 A

Differential current should be less than operating current for stability,

Here for worst tap condition, Differential current is less than operating current, hence stable.

Calculations for OLTC tap setting +5%

Full load Current for 420 kV %(HV Side) Winding at **+5**% = MVA / (√3*1.05*kV)

=220.5*10^6/ (√3*400*1.05*10^3)

=302.43A

Current on CT Secondary (HV) = Rated Current (HV Side)/CT Ratio

= 288.03 /500

=0.605 A

As the adopted ratio correction is 1.5698 A the current to relay bias terminal

= 0.6048* 1.5698

=0.95A

Hence the differential current is = 1 - 0.95

= 0.05 A

Bias current = $(I_1+I_2)/2$

= (0.9501 +1)/2

= 0.97505 A

[Since the bias current is less than 1.5 A the slope will be within 20%]

Therefore the operating current of the relay will be = $I_s + (0.2* I_{bias})$

= 0.2 + (0.2 * 0.97505)

= 0.395 A

Differential current should be less than operating current for stability,
Here for worst tap condition, Differential current is less than operating current, hence stable.

Pick up value of high set trip = 1 / (% impedance)

= 1 / (0.135)

Pick up value of high set trip = 7.41

SAME FORMULAS ARE HOLDS GOOD FOR STG UNIT CALCULATION

STATION AUXILIARY TRANSFORMER: (BIASED TYPE DIFFERENTIAL)

Relay Type: SIEMENS 7UT613

MVA = 31.5 MVA

Voltage Ratio = 16.5/6.9 kV

CT Ratio (HV Side) = 1250/1

CT Ratio (LV Side) = 3000/1

Rated Current (HV Side) = MVA / (√3*kV)

=31.5*10^6/ (√3*16.5*10^3) =1102.205 A

Current on CT Secondary (HV) = Rated Current (HV Side)/CT Ratio

= 1102.205/1250 =0.882 A

Required Ratio Compensation = 1/ 0.674 = 1.134 A

As the adopted ratio correction is 1.134A the current to relay bias terminal

= 0.882 * 1.134 =1A

Hence the differential current is = 1 – 1 = 0

Bias current = (I1+I2)/2 = (1+1)/2 = 1A

[Since the bias current is less than 1.5 A the slope will be within 20%]

Therefore the operating current of the relay will be = Is + (0.2* I bias)

= 0.3 + (0.2 * 1) = 0.5 A

Differential current should be less than operating current for stability,

Here for worst tap condition, Differential current is less than operating current, hence stable.

Pick up value of high set trip = 1 / (X"d) = 1 / (0.12) = 8.33

DISTANCE PROTECTION MAIN-I

Relay Used: 7SA522

Data required

1. Positive sequence Line impedance = R_1+jX_1
2. Zero sequence Line impedance = R_0+JX_0
3. CT Ratio
4. PT Ratio
5. Protected Line Length in kms
6. Adjacent Shortest Line Length in kms
7. Adjacent Longest Line Length in kms
8. Voltage ratio of the transformer at the remote end if any
9. MVA of the transformer at the Remote end
10. % Impedance of the transformer at remote end
11. Maximum load on the feeder in Amperes

Calculation Procedure

The relay settings are in terms of impedance that is Z

Total Positive sequence impedance of protected line with reference to primary

ZPL = [ZPL (Ohms /km)*Protected Line Length (km)]

ZPL W.R.T Secondary = Z**PL** W.R.T Primary *(CT ratio/PT ratio)

Positive sequence impedance Angle = $\tan^{-1}(X_1/R_1)$

Similarly the Impedance for Adjacent Shortest Line **ZSL**, Adjacent Remote Long

Line **ZLL** and second Adjacent Long Line **Z2LL** can be calculated.

Transformer Impedance **ZT** = (% Transformer Impedance) *((KV) ^{2}/MVA)]

Zero sequence impedance $\mathbf{Z_0}$ = $\sqrt{R_0^2+X_0^2}$

Zero sequence impedance Angle $\mathbf{Z_0}$ = $\tan^{-1}(X_0/R_0)$

Loadability:

The Limiting conditions for setting the distance relay reach to avoid encroachment into loads. As per "Reliability Standard PRC-023", the manimum impedance for the distance relay characteristics along 30º on the impedance plane for 0.85 per unit rated voltage and the maximum specified current for each condition.

The minimums Load w.r.t Secondary $\mathbf{Z}_{min} = 0.8*\mathbf{V_{L-L}}/(\sqrt{3}*1.2*.\mathbf{I_L})$

The Resistance reach corresponding to $\mathbf{Z}_{min}$ w.r.t Secondary

$\mathbf{R} = Z_{min} * COS (30)$ The

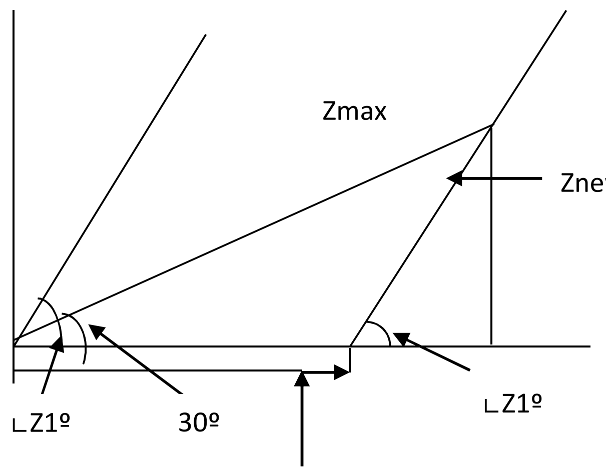
Reactance reach corresponding to $\mathbf{Z}_{min}$ w.r.t Secondary

$\mathbf{X} = Z_{min} * SIN (30)$

The New impedance for Parallel line drawn parallel to the Line impedance passing through Zmax to the point at which the parallel line cuts

The Resistance axis is **Z new**=X **(at Z_{min})** /SIN (Line angle)

The New Resistance from Known Reactance **Rnew**= Znew* COS (Line angle)



Resistive Reach R Resistance reach of Relay Characteristics obtained from maximum loadability condition Resistive Reach R = (R correspond to Z_{min} – Rnew)

Zone Settings

Zone 1

Zone 1 = 80 % of Protection Line

Kz 1 Zero sequence compensation

Kz1 = $(Z_0 - Z_1 / 3 * Z_1)$

Kz1 angle = angle of Kz1

As per manufacturer's specification the maximum X/R ratio allowed is 10, hence considering this limitation and the maximum loadability limit the minimum of the two is considered

Resistive reach

R1G= MIN of **[**(10 times of Zone1 Impedance) and Resistance at maximum load)**]**

R1PH= MIN of **[**(10 times of Zone1 Impedance) and Resistance at maximum load)**]**

Zone 2

Zone 2 = MIN OF {[MAX OF ((Protection line+ (0.5*Adjacent shortest line)) AND (1.2*Protection line)], (Protection line+ (0.5*Remote End transformer impedance)))}

tz2 = if [ZONE 2 > 80 % of Next shortest line then t=0.6sec else t=0.3 sec

Kz2 = (Z0-Z1/3*Z1)

Kz2 angle = angle of Kz2

R2G = Minimum [15 times of Zone 2 Impedance and 0.8*Resistive Reach at Max load]

R2PH = Minimum [15 times of Zone 2 Impedance and 0.8*Resistive Reach at Max load]

Zone 3

Zone3 = [MIN OF (1.2*Protection line + Adjacent Long line) & (Protection line + Adjacent Long line +0.25* Adjacent Second Long Line) & (Protection line + (0.8*Transformer impedance))]

R3G-R4G = Minimum [(15 times of Zone 3 Reactance) and 0.8* Resistance at Maximum load]

R3PH-R4PH = Minimum [(15 times of Zone 3 Reactance) and 0.8* Resistance at Maximum load]

tz3 = 0.8 sec

Zone 4

Zone4 = 0.25 *Zone 1

tz4 = 1 sec

Substation : 400kV PPCL

Line : BAWANA - BAHADURGARH

Relay Name : M1-7SA522 M2-7SA612

Data

Positive sequence Line impedance = 0.0267+j0.3309

Zero sequence Line impedance = 0.2281+j1.0314

Positive sequence Line impedance (LONGEST LINE REMOTE END) = 0.0267+j0.3309

Zero sequence Line impedance (LONGEST LINE REMOTE END) = 0.2281+j1.0314

Positive sequence Line impedance (SHORTEST LINE REMOTE END) = 0.0267+j0.3309

Zero sequence Line impedance (SHORTEST LINE REMOTE END) = 0.2281+j1.0314

CT Ratio = 1000A/1A

PT Ratio = 400kV/110V

Protected Line Length = 48.99 Km

Adjacent Shortest Line Length (SHORTEST LINE REMOTE END) = 54 Km

Adjacent Longest Line Length (LONGEST LINE REMOTE END) = 84.387 Km

CT/PT ratio = 0.275

Calculation

Positive sequence impedance of Protected line ZPL = $\sqrt{R^2+X^2}$

ZPL = 0.3320 Ohms/Km

Total Positive sequence impedance of Protected line ZPL=

= [ZPL (Ohms /Km)*Protected Line Length (km)]

ZPL W.R.T Primary = 16.2652 Ω

ZPL W.R.T Secondary = ZPL W.R.T Primary *(CT/PT ratio)

ZPL= 4.47 Ω

Positive sequence impedance of Adjacent Shortest line ZS = $\sqrt{R^2+X^2}$

ZS = 0.3320 Ohms/Km

Total Positive sequence impedance Adjacent Shortest ZSL=

= [Z (Ohms /Km)*Protected Line Length (km)] ZSL W.R.T Primary

= 17.928 Ω

ZSL W.R.T Secondary= ZSL W.R.T Primary * (CT/PT ratio) ZSL W.R.T

Secondary= 4.9302 Ω

Total Positive sequence impedance of Adjacent Longest line ZLL=

= [ZLL (Ohms /Km)*Longest Line Length (km)] ZLL W.R.T Primary =

28.0164 Ω

ZLL W.R.T Secondary= ZLL W.R.T Primary * (CT/PT ratio) ZLL W.R.T Secondary=

7.7045Ω

Zone Settings

<u>Zone 1</u>

Zone 1= 80 % of Protection Line

=0.8* 4.47

Zone 1 = 3.576 Ω

Tz1 = 0 sec

Zone 2 = 1.2(Protection line)

Zone 2 = 5.35 Ω

tz2 = 0.3sec

<u>Zone 3</u>

Zone3 = 1.2*(Protection line + Adjacent Long line)

Zone3 = 14.6094 Ω

tz3 = **1 sec**

<u>Zone 4</u>

Zone4 = 0.25 *Zone1

Zone4 = 0.894Ω **tz4 = 1 sec**

Substation : 400kV PPCL

Line : BAWANA - BHIWANI

Relay Name : M1-7SA522 M2-7SA612

Data

Positive sequence Line impedance = 0.0267+j0.3309

Zero sequence Line impedance = 0.2281+j1.0314

Positive sequence Line impedance (LONGEST LINE REMOTE END) = 0.0267+j0.3309

Zero sequence Line impedance (LONGEST LINE REMOTE END) = 0.2281+j1.0314

Positive sequence Line impedance (SHORTEST LINE REMOTE END) = 0.0267+j0.3309

Zero sequence Line impedance (SHORTEST LINE REMOTE END) = 0.2281+j1.0314

CT Ratio = 1000A/1A

PT Ratio = 400kV/110V

Protected Line Length = 97.415 Km

Adjacent Shortest Line Length (SHORTEST LINE REMOTE END) = 34 Km

Adjacent Longest Line Length (LONGEST LINE REMOTE END) = 82 Km

CT/PT ratio = 0.275

Calculation

Positive sequence impedance of Protected line ZPL = $\sqrt{R^2+X^2}$

ZPL = 0.3320 Ohms/Km

Total Positive sequence impedance of Protected line ZPL=

= [ZPL (Ohms /Km)*Protected Line Length (km)]

ZPL W.R.T Primary = 32.3417Ω

ZPL W.R.T Secondary = ZPL W.R.T Primary *(CT/PT ratio)

ZPL= 8.894 Ω

Positive sequence impedance of Adjacent Shortest line ZS = $\sqrt{R^2+X^2}$

ZS = 0.3320 Ohms/Km

Total Positive sequence impedance Adjacent Shortest ZSL=

= [Z (Ohms /Km)*Protected Line Length (km)] ZSL W.R.T Primary

= 9.96 Ω

ZSL W.R.T Secondary= ZSL W.R.T Primary * (CT/PT ratio) ZSL W.R.T

Secondary= 2.739Ω

Total Positive sequence impedance of Adjacent Longest line ZLL=

= [ZLL (Ohms /Km)*Longest Line Length (km)] ZLL W.R.T Primary =

27.224Ω

ZLL W.R.T Secondary= ZLL W.R.T Primary * (CT/PT ratio) ZLL W.R.T Secondary=

7.4866Ω

Zone Settings

Zone 1

Zone 1= 80 % of Protection Line

=0.8* 8.894

Zone 1 = 7.10 Ω

Tz1 = 0 sec

Zone 2 = 1.2(Protection line)

Zone 2 = 10.638 Ω

tz2 = 0.3sec

Zone 3

Zone3 = 1.2*(Protection line + Adjacent Long line)

Zone3 = 1*9.656* Ω

tz3 = **1 sec**

Zone 4

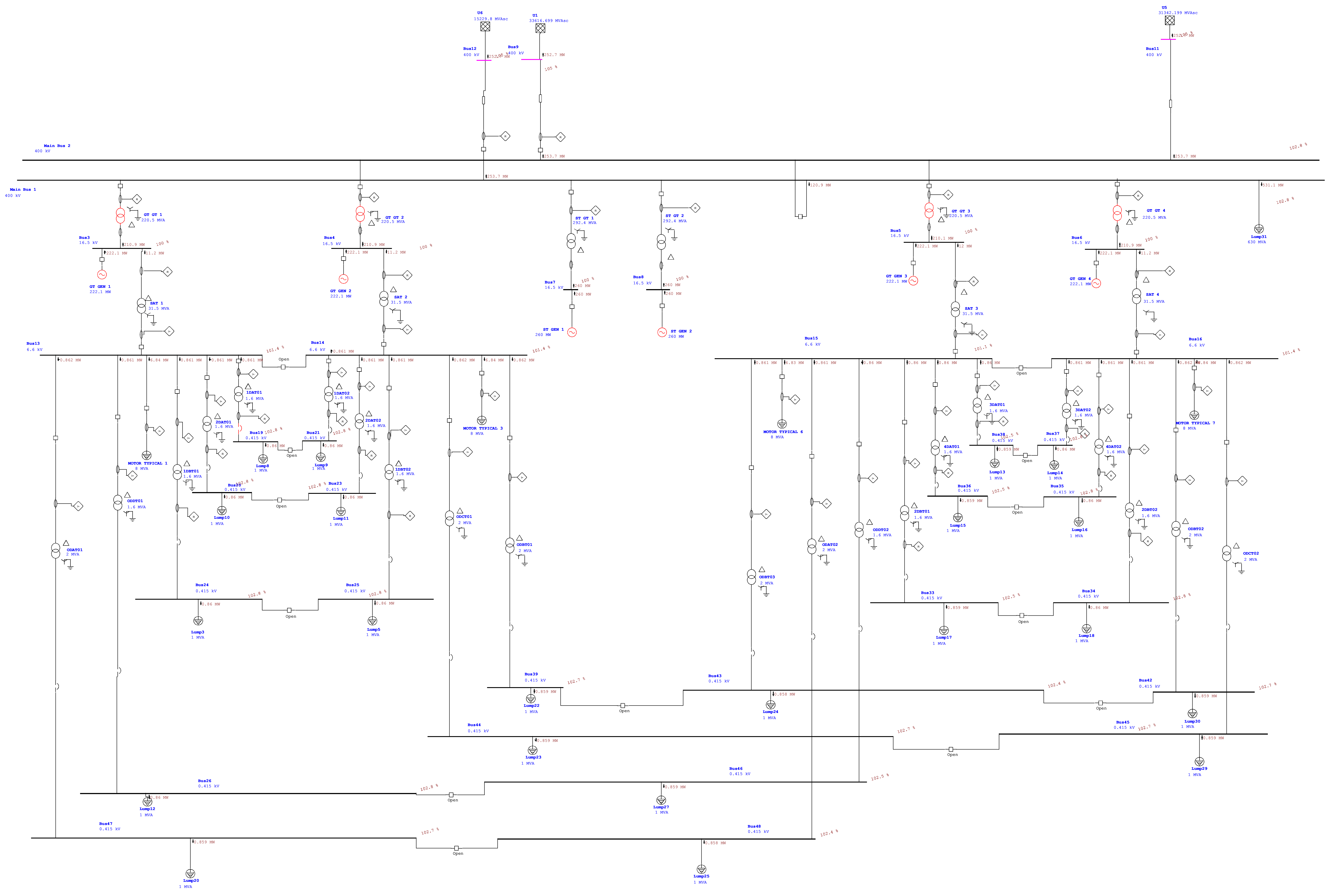
Zone4 = 0.25 *Zone1

Zone4 = 1.7775Ω **tz4 = 1 sec**

CHAPTER 8

ANNEXURE

LOAD FLOW STUDY WITH DTL LINE


U6
15229.8 MVAsc
U1
33616.699 MVAsc
U5
31342.199 MVAsc
Bus12
400 kV
Bus9
400 kV
Bus11
400 kV
Main Bus 2
400 kV
Main Bus 1
400 kV
GT GT 1
220.5 MVA
GT GT 2
220.5 MVA
ST GT 1
292.4 MVA
ST GT 2
292.4 MVA
GT GT 3
220.5 MVA
GT GT 4
220.5 MVA
Lump31
630 MVA
Bus3
16.5 kV
Bus4
16.5 kV
Bus5
16.5 kV
Bus6
16.5 kV
Bus7
16.5 kV
Bus8
16.5 kV
GT GEN 1
222.1 MW
GT GEN 2
222.1 MW
GT GEN 3
222.1 MW
GT GEN 4
222.1 MW
ST GEN 1
260 MW
ST GEN 2
260 MW
SAT 1
31.5 MVA
SAT 2
31.5 MVA
SAT 3
31.5 MVA
SAT 4
31.5 MVA
Bus13
6.6 kV
Bus14
6.6 kV
Bus15
6.6 kV
Bus16
6.6 kV
MOTOR TYPICAL 1
8 MVA
MOTOR TYPICAL 3
8 MVA
MOTOR TYPICAL 6
8 MVA
MOTOR TYPICAL 7
8 MVA
Bus24
0.415 kV
Bus25
0.415 kV
Bus26
0.415 kV
Bus47
0.415 kV
Bus39
0.415 kV
Bus43
0.415 kV
Bus44
0.415 kV
Bus46
0.415 kV
Bus48
0.415 kV
Bus42
0.415 kV
Bus45
0.415 kV
Bus33
0.415 kV
Bus34
0.415 kV
Lump3
1 MVA
Lump5
1 MVA
Lump12
1 MVA
Lump20
1 MVA
Lump22
1 MVA
Lump23
1 MVA
Lump24
1 MVA
Lump25
1 MVA
Lump27
1 MVA
Lump29
1 MVA
Lump30
1 MVA
Lump17
1 MVA
Lump18
1 MVA
Open

Electrical Transient Analyzer Program

Load Flow Analysis

Loading Category (1): Design

Generation Category (1): Design

Load Diversity Factor: None

	Swing	V-Control	Load	Total
Number of Buses:	3	6	27	36

	XFMR2	XFMR3	Reactor	Line/Cable	Impedance	Tie PD	Total
Number of Branches:	31	0	0	3	0	1	35

Method of Solution:	Adaptive Newton-Raphson Method
Maximum No. of Iteration:	99
Precision of Solution:	0.0001000
System Frequency:	50.00 Hz
Unit System:	Metric
Project Filename:	bawana project 29-08
Output Filename:	G:\BAWANA FINAL\etap with coupler\29.08.2019\Untitled.lfr

Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable Length:	No		

Temperature Correction	Apply Adjustments	Individual /Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable Resistance:	Yes	Individual	

Bus Input Data

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus3	16.500	1	100.0	0.0								
Bus4	16.500	1	100.0	0.0								
Bus5	16.500	1	100.0	0.0								
Bus6	16.500	1	100.0	0.0								
Bus7	16.500	1	100.0	0.0								
Bus8	16.500	1	100.0	0.0								
Bus9	400.000	1	105.0	0.0								
Bus11	400.000	1	105.0	0.0								
Bus12	400.000	1	105.0	0.0								
Bus13	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus14	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus15	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus16	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus19	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus20	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus21	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus23	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus24	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus25	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus26	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus33	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus34	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus35	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus36	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus37	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus38	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus39	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus42	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus43	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus44	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus45	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus46	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus47	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus48	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Main Bus 1	400.000	1	95.2	0.0	428.400	265.499	97.143	60.204				
Main Bus 2	400.000	1	100.0	0.0								
Total Number of Buses: 36					464.440	287.834	106.153	65.788	0.000	0.000	0.000	0.000

Generation Bus				Voltage		Generation			Mvar Limits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Min
Bus3	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus4	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus5	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus6	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus7	16.500	Voltage Control	1	100.0	0.0	260.000			161.134	0.000
Bus8	16.500	Voltage Control	1	100.0	0.0	260.000			161.134	0.000
Bus9	400.000	Swing	1	105.0	0.0					
Bus11	400.000	Swing	1	105.0	0.0					
Bus12	400.000	Swing	1	105.0	0.0					
						1408.400	0.000			

Line/Cable Input Data

ohms or siemens/1000 m per Conductor (Cable) or per Phase (Line)

Line/Cable ID	Library	Size	Length Adj. (m)	Length % Tol.	#/Phase	T (°C)	R	X	Y
Bhaadurgarh		484.	48991.0	0.0	1	75	0.026660	0.330930	
Bhiwani		484.	48991.0	0.0	1	75	0.026660	0.330930	
Line3		484.	48991.0	0.0	1	75	0.026660	0.330930	

Line / Cable resistances are listed at the specified temperatures.

2-Winding Transformer Input Data

Transformer		Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
1DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
1DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
1DBT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
1DBT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DBT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DBT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
3DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
3DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
4DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
4DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
GT GT 1	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
GT GT 2	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
GT GT 3	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
GT GT 4	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
ODAT01	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODAT02	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODBT01	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODBT02	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODBT03	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODCT01	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODCT02	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODDT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
ODDT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
SAT 1	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
SAT 2	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
SAT 3	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
SAT 4	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
ST GT 1	3-Phase	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.5000	YNd	0.000
ST GT 2	3-Phase	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.5000	YNd	0.000

2-Winding Transformer Load Tap Changer (LTC) Settings

Transformer	Connected Buses ("*" LTC Side)		Transformer Load Tap Changer Setting					
ID	Primary Bus ID	Secondary Bus ID	% Min. Tap	% Max. Tap	% Step	Regulated Bus ID	% V	kV
1DAT01	* Bus13	Bus19	-5.00	5.00	2.500	Bus13	100.00	6.600
1DAT02	* Bus14	Bus21	-5.00	5.00	2.500	Bus21	100.00	0.415
1DBT01	* Bus13	Bus24	-5.00	5.00	2.500	Bus13	100.00	6.600
1DBT02	* Bus14	Bus25	-5.00	5.00	2.500	Bus14	100.00	6.600
2DAT01	* Bus13	Bus20	-5.00	5.00	2.500	Bus13	100.00	6.600
2DAT02	* Bus14	Bus23	-5.00	5.00	2.500	Bus14	100.00	6.600
2DBT01	* Bus15	Bus33	-5.00	5.00	2.500	Bus15	100.00	6.600
2DBT02	* Bus16	Bus34	-5.00	5.00	2.500	Bus34	100.00	0.415
3DAT01	* Bus15	Bus38	-5.00	5.00	2.500	Bus15	100.00	6.600
3DAT02	* Bus16	Bus37	-5.00	5.00	2.500	Bus37	100.00	0.415
4DAT01	* Bus15	Bus36	-5.00	5.00	2.500	Bus15	100.00	6.600
4DAT02	* Bus16	Bus35	-5.00	5.00	2.500	Bus35	100.00	0.415
GT GT 1	* Main Bus 1	Bus3	-5.00	5.00	2.500	Main Bus 1	100.00	400.000
GT GT 2	* Main Bus 2	Bus4	-5.00	5.00	2.500	Main Bus 2	100.00	400.000
GT GT 3	* Main Bus 2	Bus5	-5.00	5.00	2.500	Main Bus 1	100.00	400.000
GT GT 4	* Main Bus 1	Bus6	-5.00	5.00	2.500	Main Bus 2	100.00	400.000
ODAT01	* Bus13	Bus47	-5.00	5.00	2.500	Bus13	100.00	6.600
ODAT02	* Bus15	Bus48	-5.00	5.00	2.500	Bus15	100.00	6.600
ODBT01	* Bus14	Bus39	-5.00	5.00	2.500	Bus14	100.00	6.600
ODBT02	* Bus16	Bus42	-5.00	5.00	2.500	Bus16	100.00	6.600
ODBT03	* Bus15	Bus43	-5.00	5.00	2.500	Bus43	100.00	0.415
ODCT01	* Bus14	Bus44	-5.00	5.00	2.500	Bus14	100.00	6.600
ODCT02	* Bus16	Bus45	-5.00	5.00	2.500	Bus16	100.00	6.600
ODDT01	* Bus13	Bus26	-5.00	5.00	2.500	Bus13	100.00	6.600
ODDT02	* Bus15	Bus46	-5.00	5.00	2.500	Bus15	100.00	6.600
SAT 1	* Bus3	Bus13	-5.00	5.00	2.500	Bus3	100.00	16.500
SAT 2	* Bus4	Bus14	-5.00	5.00	2.500	Bus4	100.00	16.500
SAT 3	* Bus5	Bus15	-5.00	5.00	2.500	Bus5	100.00	16.500
SAT 4	* Bus6	Bus16	-5.00	5.00	2.500	Bus6	100.00	16.500
ST GT 1	* Main Bus 1	Bus7	-5.00	5.00	2.500	Main Bus 1	100.00	400.000
ST GT 2	* Main Bus 1	Bus8	-5.00	5.00	2.500	Main Bus 1	100.00	400.000

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Bas			
ID	Type	From Bus	To Bus	R	X	Z	Y
1DAT01	2W XFMR	Bus13	Bus19	10.16	457.35	457.47	
1DAT02	2W XFMR	Bus14	Bus21	10.16	457.35	457.47	
1DBT01	2W XFMR	Bus13	Bus24	10.16	457.35	457.47	
1DBT02	2W XFMR	Bus14	Bus25	10.16	457.35	457.47	
2DAT01	2W XFMR	Bus13	Bus20	10.16	457.35	457.47	
2DAT02	2W XFMR	Bus14	Bus23	10.16	457.35	457.47	
2DBT01	2W XFMR	Bus15	Bus33	10.16	457.35	457.47	
2DBT02	2W XFMR	Bus16	Bus34	10.16	457.35	457.47	
3DAT01	2W XFMR	Bus15	Bus38	10.16	457.35	457.47	
3DAT02	2W XFMR	Bus16	Bus37	10.16	457.35	457.47	
4DAT01	2W XFMR	Bus15	Bus36	10.16	457.35	457.47	
4DAT02	2W XFMR	Bus16	Bus35	10.16	457.35	457.47	
GT GT 1	2W XFMR	Main Bus 1	Bus3	3.39	5.09	6.12	
GT GT 2	2W XFMR	Main Bus 2	Bus4	3.39	5.09	6.12	
GT GT 3	2W XFMR	Main Bus 2	Bus5	3.39	5.09	6.12	
GT GT 4	2W XFMR	Main Bus 1	Bus6	3.39	5.09	6.12	
ODAT01	2W XFMR	Bus13	Bus47	22.84	456.90	457.47	
ODAT02	2W XFMR	Bus15	Bus48	22.84	456.90	457.47	
ODBT01	2W XFMR	Bus14	Bus39	22.84	456.90	457.47	
ODBT02	2W XFMR	Bus16	Bus42	22.84	456.90	457.47	
ODBT03	2W XFMR	Bus15	Bus43	22.84	456.90	457.47	
ODCT01	2W XFMR	Bus14	Bus44	22.84	456.90	457.47	
ODCT02	2W XFMR	Bus16	Bus45	22.84	456.90	457.47	
ODDT01	2W XFMR	Bus13	Bus26	10.16	457.35	457.47	
ODDT02	2W XFMR	Bus15	Bus46	10.16	457.35	457.47	
SAT 1	2W XFMR	Bus3	Bus13	0.85	38.09	38.10	
SAT 2	2W XFMR	Bus4	Bus14	0.85	38.09	38.10	
SAT 3	2W XFMR	Bus5	Bus15	0.85	38.09	38.10	
SAT 4	2W XFMR	Bus6	Bus16	0.85	38.09	38.10	
ST GT 1	2W XFMR	Main Bus 1	Bus7	0.10	4.62	4.62	
ST GT 2	2W XFMR	Main Bus 1	Bus8	0.10	4.62	4.62	
Bhaadurgarh	Line	Bus12	Main Bus 1	0.07	0.92	0.92	
Bhiwani	Line	Bus9	Main Bus 2	0.07	0.92	0.92	
Line3	Line	Bus11	Main Bus 2	0.07	0.92	0.92	
CB94	Tie Breakr	Main Bus 2	Main Bus 1				

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
* Bus3	16.500	100.000	9.4	222.100	-73.629	0	0	Main Bus 1	210.941	-81.505	7912.8	-93.3	
								Bus13	11.159	7.875	477.9	81.7	
* Bus4	16.500	100.000	9.4	222.100	-73.629	0	0	Main Bus 2	210.940	-81.504	7912.8	-93.3	
								Bus14	11.160	7.875	477.9	81.7	
* Bus5	16.500	100.000	9.4	222.100	-72.521	0	0	Main Bus 2	210.090	-81.094	7879.9	-93.3	
								Bus15	12.010	8.572	516.3	81.4	
* Bus6	16.500	100.000	9.4	222.100	-73.629	0	0	Main Bus 1	210.940	-81.504	7912.8	-93.3	
								Bus16	11.160	7.875	477.9	81.7	
* Bus7	16.500	100.000	8.5	260.000	55.004	0	0	Main Bus 1	260.000	55.004	9299.0	97.8	
* Bus8	16.500	100.000	8.5	260.000	55.004	0	0	Main Bus 1	260.000	55.004	9299.0	97.8	
* Bus9	400.000	105.000	0.0	-252.754	249.557	0	0	Main Bus 2	-252.754	249.557	488.3	-71.2	
* Bus11	400.000	105.000	0.0	-252.754	249.557	0	0	Main Bus 2	-252.754	249.557	488.3	-71.2	
* Bus12	400.000	105.000	0.0	-252.754	249.557	0	0	Main Bus 1	-252.754	249.557	488.3	-71.2	
Bus13	6.600	101.405	6.9	0	0	6.838	4.238	Bus19	0.861	0.585	89.8	82.7	
								Bus24	0.861	0.585	89.8	82.7	
								Bus20	0.861	0.585	89.8	82.7	
								Bus47	0.862	0.585	89.9	82.7	
								Bus26	0.861	0.585	89.8	82.7	
								Bus3	-11.143	-7.165	1142.8	84.1	
Bus14	6.600	101.405	6.9	0	0	6.838	4.238	Bus21	0.861	0.585	89.8	82.7	
								Bus25	0.861	0.585	89.8	82.7	
								Bus23	0.861	0.585	89.8	82.7	
								Bus39	0.862	0.585	89.9	82.7	
								Bus44	0.862	0.585	89.9	82.7	
								Bus4	-11.144	-7.165	1142.9	84.1	
Bus15	6.600	101.136	6.7	0	0	6.831	4.234	Bus33	0.860	0.585	89.9	82.7	
								Bus38	0.860	0.585	89.9	82.7	
								Bus36	0.860	0.585	89.9	82.7	
								Bus48	0.861	0.585	90.0	82.7	
								Bus43	0.861	0.585	90.0	82.7	
								Bus46	0.860	0.585	89.9	82.7	
								Bus5	-11.992	-7.743	1234.7	84.0	
Bus16	6.600	101.405	6.9	0	0	6.838	4.238	Bus34	0.861	0.585	89.8	82.7	
								Bus37	0.861	0.585	89.8	82.7	
								Bus35	0.861	0.585	89.8	82.7	
								Bus42	0.862	0.585	89.9	82.7	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
								Bus45	0.862	0.585	89.9	82.7	
								Bus6	-11.144	-7.165	1142.9	84.1	
Bus19	0.415	102.787	4.5	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus20	0.415	102.787	4.5	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus21	0.415	102.787	4.5	0	0	0.860	0.533	Bus14	-0.860	-0.533	1368.8	85.0	
Bus23	0.415	102.787	4.5	0	0	0.860	0.533	Bus14	-0.860	-0.533	1368.8	85.0	
Bus24	0.415	102.787	4.5	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus25	0.415	102.787	4.5	0	0	0.860	0.533	Bus14	-0.860	-0.533	1368.8	85.0	
Bus26	0.415	102.787	4.5	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus33	0.415	102.500	4.3	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus34	0.415	102.787	4.5	0	0	0.860	0.533	Bus16	-0.860	-0.533	1368.8	85.0	
Bus35	0.415	102.787	4.5	0	0	0.860	0.533	Bus16	-0.860	-0.533	1368.8	85.0	
Bus36	0.415	102.500	4.3	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus37	0.415	102.787	4.5	0	0	0.860	0.533	Bus16	-0.860	-0.533	1368.8	85.0	
Bus38	0.415	102.500	4.3	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus39	0.415	102.665	4.5	0	0	0.859	0.532	Bus14	-0.859	-0.532	1369.7	85.0	
Bus42	0.415	102.665	4.5	0	0	0.859	0.532	Bus16	-0.859	-0.532	1369.7	85.0	
Bus43	0.415	102.378	4.3	0	0	0.858	0.532	Bus15	-0.858	-0.532	1372.0	85.0	
Bus44	0.415	102.665	4.5	0	0	0.859	0.532	Bus14	-0.859	-0.532	1369.7	85.0	
Bus45	0.415	102.665	4.5	0	0	0.859	0.532	Bus16	-0.859	-0.532	1369.7	85.0	
Bus46	0.415	102.500	4.3	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus47	0.415	102.665	4.5	0	0	0.859	0.532	Bus13	-0.859	-0.532	1369.7	85.0	
Bus48	0.415	102.378	4.3	0	0	0.858	0.532	Bus15	-0.858	-0.532	1372.0	85.0	
Main Bus 1	400.000	102.822	1.5	0	0	531.103	329.148	Bus12	253.688	-237.962	488.3	-72.9	
								Bus3	-193.581	107.544	310.9	-87.4	
								Bus6	-193.580	107.543	310.9	-87.4	
								Bus7	-259.276	-22.405	365.3	99.6	
								Bus8	-259.276	-22.405	365.3	99.6	
								Main Bus 2	120.922	-261.464	404.4	-42.0	
Main Bus 2	400.000	102.822	1.5	0	0	0	0	Bus9	253.688	-237.962	488.3	-72.9	
								Bus11	253.688	-237.962	488.3	-72.9	
								Bus4	-193.580	107.543	310.9	-87.4	
								Bus5	-192.875	106.916	309.6	-87.5	
								Main Bus 1	-120.922	261.464	404.4	-42.0	

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

# Indicates a bus with a load mismatch of more than 0.1 MVA

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus3	16.500										236.583	93.9	8278.3	
Bus4	16.500										236.583	93.9	8278.2	
Bus5	16.500										236.442	93.9	8273.3	
Bus6	16.500										236.583	93.9	8278.2	
Bus7	16.500										265.755	97.8	9299.0	
Bus8	16.500										265.755	97.8	9299.0	
Bus9	400.000										355.195	71.2	488.3	
Bus11	400.000										355.195	71.2	488.3	
Bus12	400.000										355.195	71.2	488.3	
Bus13	6.600		5.440	3.371	1.398	0.867					13.248	84.1	1142.8	
Bus14	6.600		5.440	3.371	1.398	0.867					13.249	84.1	1142.9	
Bus15	6.600		5.440	3.371	1.391	0.862					14.274	84.0	1234.7	
Bus16	6.600		5.440	3.371	1.398	0.867					13.249	84.1	1142.9	
Bus19	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus20	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus21	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus23	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus24	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus25	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus26	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus33	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus34	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus35	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus36	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus37	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus38	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus39	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus42	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus43	0.415		0.680	0.421	0.178	0.110					1.010	85.0	1372.0	
Bus44	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus45	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus46	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus47	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus48	0.415		0.680	0.421	0.178	0.110					1.010	85.0	1372.0	
Main Bus 1	400.000		428.400	265.499	102.703	63.649					1056.649	85.7	1483.3	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Main Bus 2	400.000										695.653	72.9	976.5	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
					Capability	Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	(MVA)	MVA	%	MVA	%
1DAT01	Transformer				1.600	1.041	65.1	1.011	63.2
1DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
1DBT01	Transformer				1.600	1.041	65.1	1.011	63.2
1DBT02	Transformer				1.600	1.041	65.1	1.011	63.2
2DAT01	Transformer				1.600	1.041	65.1	1.011	63.2
2DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
2DBT01	Transformer				1.600	1.040	65.0	1.010	63.1
2DBT02	Transformer				1.600	1.041	65.1	1.011	63.2
3DAT01	Transformer				1.600	1.040	65.0	1.010	63.1
3DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
4DAT01	Transformer				1.600	1.040	65.0	1.010	63.1
4DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
* GT GT 1	Transformer				220.600	226.139	102.5	221.448	100.4
* GT GT 2	Transformer				220.600	226.138	102.5	221.447	100.4
* GT GT 3	Transformer				220.600	225.197	102.1	220.526	100.0
* GT GT 4	Transformer				220.600	226.138	102.5	221.447	100.4
ODAT01	Transformer				2.000	1.042	52.1	1.011	50.5
ODAT02	Transformer				2.000	1.041	52.0	1.010	50.5
ODBT01	Transformer				2.000	1.042	52.1	1.011	50.5
ODBT02	Transformer				2.000	1.042	52.1	1.011	50.5
ODBT03	Transformer				2.000	1.041	52.0	1.010	50.5
ODCT01	Transformer				2.000	1.042	52.1	1.011	50.5
ODCT02	Transformer				2.000	1.042	52.1	1.011	50.5
ODDT01	Transformer				1.600	1.041	65.1	1.011	63.2
ODDT02	Transformer				1.600	1.040	65.0	1.010	63.1
SAT 1	Transformer				31.500	13.658	43.4	13.248	42.1
SAT 2	Transformer				31.500	13.659	43.4	13.249	42.1
SAT 3	Transformer				31.500	14.756	46.8	14.274	45.3
SAT 4	Transformer				31.500	13.659	43.4	13.249	42.1
ST GT 1	Transformer				292.400	265.755	90.9	260.242	89.0
ST GT 2	Transformer				292.400	265.755	90.9	260.242	89.0

* Indicates a branch with operating load exceeding the branch capability.

Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
GT GT 1	210.941	-81.505	-193.581	107.544	17359.6	26039.4	100.0	102.8	2.07
SAT 1	11.159	7.875	-11.143	-7.165	15.8	710.5	100.0	101.4	3.00
GT GT 2	210.940	-81.504	-193.580	107.543	17359.4	26039.1	100.0	102.8	2.07
SAT 2	11.160	7.875	-11.144	-7.165	15.8	710.6	100.0	101.4	3.00
GT GT 3	210.090	-81.094	-192.875	106.916	17215.3	25822.9	100.0	102.8	2.07
SAT 3	12.010	8.572	-11.992	-7.743	18.4	829.2	100.0	101.1	3.26
GT GT 4	210.940	-81.504	-193.580	107.543	17359.4	26039.1	100.0	102.8	2.07
SAT 4	11.160	7.875	-11.144	-7.165	15.8	710.6	100.0	101.4	3.00
ST GT 1	260.000	55.004	-259.276	-22.405	724.4	32599.5	100.0	102.8	2.07
ST GT 2	260.000	55.004	-259.276	-22.405	724.4	32599.5	100.0	102.8	2.07
Bhiwani	-252.754	249.557	253.688	-237.962	934.1	11595.4	105.0	102.8	2.18
Line3	-252.754	249.557	253.688	-237.962	934.1	11595.4	105.0	102.8	2.18
Bhaadurgarh	-252.754	249.557	253.688	-237.962	934.1	11595.4	105.0	102.8	2.18
1DAT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
1DBT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
2DAT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
ODAT01	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
ODDT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
1DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
1DBT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
2DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
ODBT01	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
ODCT01	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
2DBT01	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
3DAT01	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
4DAT01	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
ODAT02	0.861	0.585	-0.858	-0.532	2.6	52.9	101.1	102.4	3.01
ODBT03	0.861	0.585	-0.858	-0.532	2.6	52.9	101.1	102.4	3.01
ODDT02	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
2DBT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
3DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
4DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
ODBT02	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
ODCT02	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01

73645.5	207994.0

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	108.0	105.0
UnderVoltage	95.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
CB72	LV CB	Overload	3.000	Amp	1368.784	45626.1	3-Phase
GT GEN 1	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GEN 2	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GEN 3	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GEN 4	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GT 1	Transformer	Overload	220.600	MVA	226.14	102.5	3-Phase
GT GT 2	Transformer	Overload	220.600	MVA	226.14	102.5	3-Phase
GT GT 3	Transformer	Overload	220.600	MVA	225.20	102.1	3-Phase
GT GT 4	Transformer	Overload	220.600	MVA	226.14	102.5	3-Phase
ST GEN 1	Generator	Overload	260.000	MW	260.00	100.0	3-Phase
ST GEN 2	Generator	Overload	260.000	MW	260.00	100.0	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus11	Bus	Over Voltage	400.000	kV	420.000	105.0	3-Phase

Marginal Report

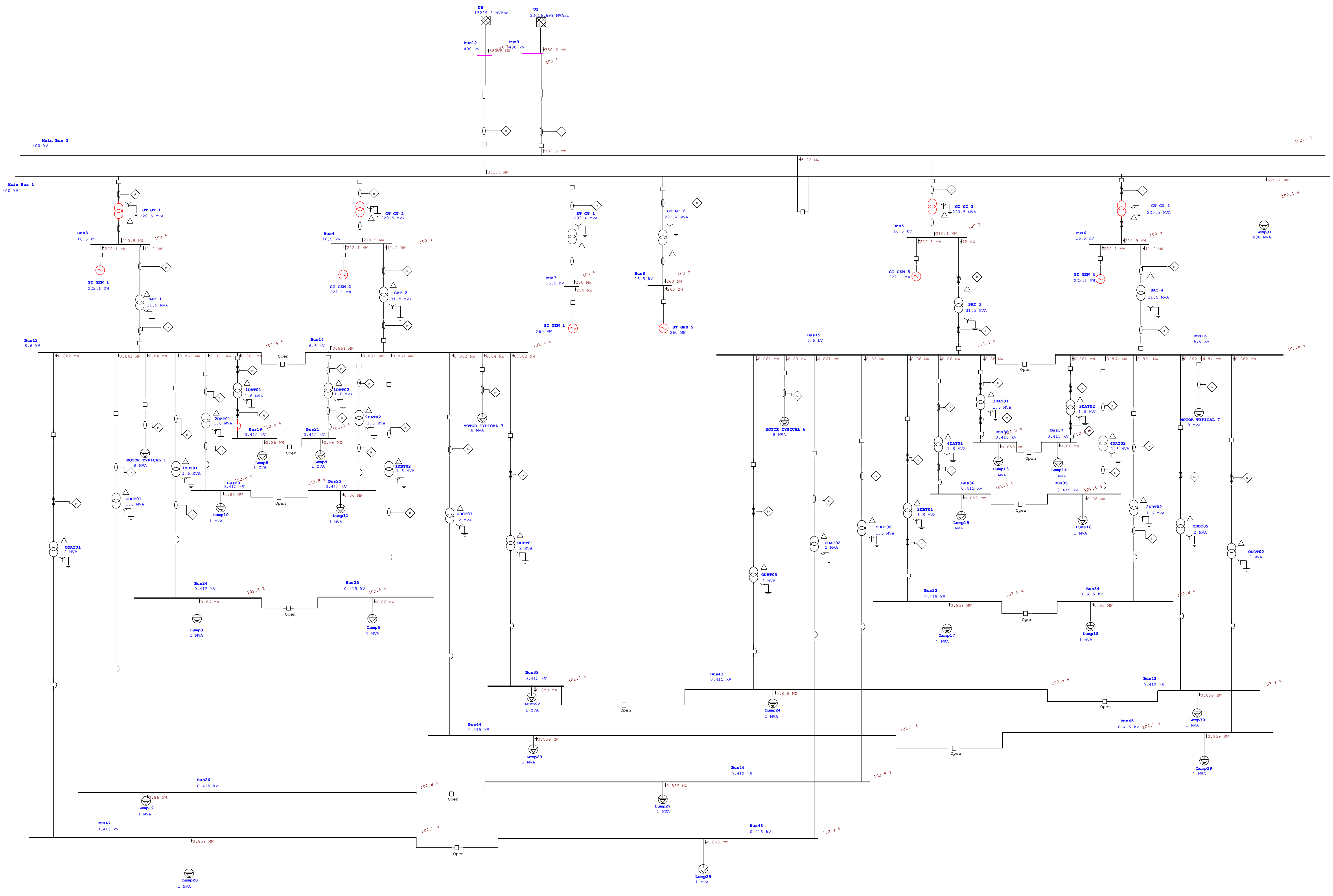
Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus12	Bus	Over Voltage	400.000	kV	420.000	105.0	3-Phase
Bus9	Bus	Over Voltage	400.000	kV	420.00	105.0	3-Phase

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	-758.262	748.671	1065.584	71.16 Leading
Source (Non-Swing Buses):	1408.400	-183.399	1420.291	99.16 Leading
Total Demand:	650.138	565.272	861.517	75.46 Lagging
Total Motor Load:	464.440	287.834	546.400	85.00 Lagging
Total Static Load:	112.052	69.444	131.826	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	73.646	207.994		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

LOAD FLOW STUDY WITHOUT DTL LINE


U6
15229.8 MVAsc
U1
33616.699 MVAsc
Bus12
400 kV
Bus9
400 kV
Main Bus 2
400 kV
Main Bus 1
400 kV
GT GT 1
220.5 MVA
GT GT 2
220.5 MVA
ST GT 1
292.4 MVA
ST GT 2
292.4 MVA
GT GT 3
220.5 MVA
GT GT 4
220.5 MVA
Lump31
630 MVA
Bus3
16.5 kV
Bus4
16.5 kV
Bus5
16.5 kV
Bus6
16.5 kV
Bus7
16.5 kV
Bus8
16.5 kV
GT GEN 1
222.1 MW
GT GEN 2
222.1 MW
GT GEN 3
222.1 MW
GT GEN 4
222.1 MW
ST GEN 1
260 MW
ST GEN 2
260 MW
SAT 1
31.5 MVA
SAT 2
31.5 MVA
SAT 3
31.5 MVA
SAT 4
31.5 MVA
Bus13
6.6 kV
Bus14
6.6 kV
Bus15
6.6 kV
Bus16
6.6 kV
MOTOR TYPICAL 1
8 MVA
MOTOR TYPICAL 3
8 MVA
MOTOR TYPICAL 6
8 MVA
MOTOR TYPICAL 7
8 MVA
Open
Lump3
1 MVA
Lump5
1 MVA
Lump8
1 MVA
Lump9
1 MVA
Lump10
1 MVA
Lump11
1 MVA
Lump12
1 MVA
Lump20
1 MVA
Lump25
1 MVA
Bus24
0.415 kV
Bus25
0.415 kV
Bus26
0.415 kV
Bus47
0.415 kV
Bus48
0.415 kV
Bus39
0.415 kV
Bus43
0.415 kV
Bus42
0.415 kV
Bus44
0.415 kV
Bus45
0.415 kV
Bus46
0.415 kV
Bus33
0.415 kV
Bus34
0.415 kV

Electrical Transient Analyzer Program

Load Flow Analysis

Loading Category (1): Design

Generation Category (1): Design

Load Diversity Factor: None

	Swing	V-Control	Load	Total
Number of Buses:	3	6	27	36

	XFMR2	XFMR3	Reactor	Line/Cable	Impedance	Tie PD	Total
Number of Branches:	31	0	0	2	0	1	34

Method of Solution:	Adaptive Newton-Raphson Method
Maximum No. of Iteration:	99
Precision of Solution:	0.0001000
System Frequency:	50.00 Hz
Unit System:	Metric
Project Filename:	bawana project 29-08
Output Filename:	G:\BAWANA FINAL\etap with coupler\29.08.2019\Untitled.lfr

Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable Length:	No		

Temperature Correction	Apply Adjustments	Individual /Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable Resistance:	Yes	Individual	

Bus Input Data

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus3	16.500	1	100.0	0.0								
Bus4	16.500	1	100.0	0.0								
Bus5	16.500	1	100.0	0.0								
Bus6	16.500	1	100.0	0.0								
Bus7	16.500	1	100.0	0.0								
Bus8	16.500	1	100.0	0.0								
Bus9	400.000	1	105.0	0.0								
Bus11	400.000	2	105.0	0.0								
Bus12	400.000	1	105.0	0.0								
Bus13	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus14	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus15	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus16	6.600	1	100.0	0.0	5.440	3.371	1.360	0.843				
Bus19	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus20	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus21	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus23	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus24	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus25	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus26	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus33	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus34	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus35	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus36	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus37	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus38	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus39	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus42	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus43	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus44	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus45	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus46	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Bus47	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus48	0.415	1	100.0	0.0	0.680	0.421	0.170	0.105				
Main Bus 1	400.000	1	95.2	0.0	428.400	265.499	97.143	60.204				
Main Bus 2	400.000	1	100.0	0.0								
Total Number of Buses: 36					464.440	287.834	106.153	65.788	0.000	0.000	0.000	0.000

Generation Bus				Voltage		Generation			Mvar Limits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Min
Bus3	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus4	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus5	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus6	16.500	Voltage Control	1	100.0	0.0	222.100			125.000	-125.000
Bus7	16.500	Voltage Control	1	100.0	0.0	260.000			161.134	0.000
Bus8	16.500	Voltage Control	1	100.0	0.0	260.000			161.134	0.000
Bus9	400.000	Swing	1	105.0	0.0					
Bus11	400.000	Swing	2	105.0	0.0					
Bus12	400.000	Swing	1	105.0	0.0					
						1408.400	0.000			

Line/Cable Input Data

ohms or siemens/1000 m per Conductor (Cable) or per Phase (Line)

Line/Cable			Length						
ID	Library	Size	Adj. (m)	% Tol.	#/Phase	T (°C)	R	X	Y
Bhaadurgarh		484.	48991.0	0.0	1	75	0.026660	0.330930	
Bhiwani		484.	48991.0	0.0	1	75	0.026660	0.330930	

Line / Cable resistances are listed at the specified temperatures.

2-Winding Transformer Input Data

Transformer		Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
1DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
1DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
1DBT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
1DBT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DBT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
2DBT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
3DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
3DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
4DAT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
4DAT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
GT GT 1	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
GT GT 2	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
GT GT 3	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
GT GT 4	3-Phase	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.5000	YNd	0.000
ODAT01	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODAT02	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODBT01	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODBT02	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODBT03	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODCT01	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODCT02	3-Phase	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.0000	Dyn	0.000
ODDT01	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
ODDT02	3-Phase	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.0000	Dyn	0.000
SAT 1	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
SAT 2	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
SAT 3	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
SAT 4	3-Phase	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.0000	Dyn	0.000
ST GT 1	3-Phase	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.5000	YNd	0.000
ST GT 2	3-Phase	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.5000	YNd	0.000

2-Winding Transformer Load Tap Changer (LTC) Settings

Transformer	Connected Buses ("*" LTC Side)		Transformer Load Tap Changer Setting					
ID	Primary Bus ID	Secondary Bus ID	% Min. Tap	% Max. Tap	% Step	Regulated Bus ID	% V	kV
1DAT01	* Bus13	Bus19	-5.00	5.00	2.500	Bus13	100.00	6.600
1DAT02	* Bus14	Bus21	-5.00	5.00	2.500	Bus21	100.00	0.415
1DBT01	* Bus13	Bus24	-5.00	5.00	2.500	Bus13	100.00	6.600
1DBT02	* Bus14	Bus25	-5.00	5.00	2.500	Bus14	100.00	6.600
2DAT01	* Bus13	Bus20	-5.00	5.00	2.500	Bus13	100.00	6.600
2DAT02	* Bus14	Bus23	-5.00	5.00	2.500	Bus14	100.00	6.600
2DBT01	* Bus15	Bus33	-5.00	5.00	2.500	Bus15	100.00	6.600
2DBT02	* Bus16	Bus34	-5.00	5.00	2.500	Bus34	100.00	0.415
3DAT01	* Bus15	Bus38	-5.00	5.00	2.500	Bus15	100.00	6.600
3DAT02	* Bus16	Bus37	-5.00	5.00	2.500	Bus37	100.00	0.415
4DAT01	* Bus15	Bus36	-5.00	5.00	2.500	Bus15	100.00	6.600
4DAT02	* Bus16	Bus35	-5.00	5.00	2.500	Bus35	100.00	0.415
GT GT 1	* Main Bus 1	Bus3	-5.00	5.00	2.500	Main Bus 1	100.00	400.000
GT GT 2	* Main Bus 2	Bus4	-5.00	5.00	2.500	Main Bus 2	100.00	400.000
GT GT 3	* Main Bus 2	Bus5	-5.00	5.00	2.500	Main Bus 1	100.00	400.000
GT GT 4	* Main Bus 1	Bus6	-5.00	5.00	2.500	Main Bus 2	100.00	400.000
ODAT01	* Bus13	Bus47	-5.00	5.00	2.500	Bus13	100.00	6.600
ODAT02	* Bus15	Bus48	-5.00	5.00	2.500	Bus15	100.00	6.600
ODBT01	* Bus14	Bus39	-5.00	5.00	2.500	Bus14	100.00	6.600
ODBT02	* Bus16	Bus42	-5.00	5.00	2.500	Bus16	100.00	6.600
ODBT03	* Bus15	Bus43	-5.00	5.00	2.500	Bus43	100.00	0.415
ODCT01	* Bus14	Bus44	-5.00	5.00	2.500	Bus14	100.00	6.600
ODCT02	* Bus16	Bus45	-5.00	5.00	2.500	Bus16	100.00	6.600
ODDT01	* Bus13	Bus26	-5.00	5.00	2.500	Bus13	100.00	6.600
ODDT02	* Bus15	Bus46	-5.00	5.00	2.500	Bus15	100.00	6.600
SAT 1	* Bus3	Bus13	-5.00	5.00	2.500	Bus3	100.00	16.500
SAT 2	* Bus4	Bus14	-5.00	5.00	2.500	Bus4	100.00	16.500
SAT 3	* Bus5	Bus15	-5.00	5.00	2.500	Bus5	100.00	16.500
SAT 4	* Bus6	Bus16	-5.00	5.00	2.500	Bus6	100.00	16.500
ST GT 1	* Main Bus 1	Bus7	-5.00	5.00	2.500	Main Bus 1	100.00	400.000
ST GT 2	* Main Bus 1	Bus8	-5.00	5.00	2.500	Main Bus 1	100.00	400.000

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA Bas			
ID	Type	From Bus	To Bus	R	X	Z	Y
1DAT01	2W XFMR	Bus13	Bus19	10.16	457.35	457.47	
1DAT02	2W XFMR	Bus14	Bus21	10.16	457.35	457.47	
1DBT01	2W XFMR	Bus13	Bus24	10.16	457.35	457.47	
1DBT02	2W XFMR	Bus14	Bus25	10.16	457.35	457.47	
2DAT01	2W XFMR	Bus13	Bus20	10.16	457.35	457.47	
2DAT02	2W XFMR	Bus14	Bus23	10.16	457.35	457.47	
2DBT01	2W XFMR	Bus15	Bus33	10.16	457.35	457.47	
2DBT02	2W XFMR	Bus16	Bus34	10.16	457.35	457.47	
3DAT01	2W XFMR	Bus15	Bus38	10.16	457.35	457.47	
3DAT02	2W XFMR	Bus16	Bus37	10.16	457.35	457.47	
4DAT01	2W XFMR	Bus15	Bus36	10.16	457.35	457.47	
4DAT02	2W XFMR	Bus16	Bus35	10.16	457.35	457.47	
GT GT 1	2W XFMR	Main Bus 1	Bus3	3.39	5.09	6.12	
GT GT 2	2W XFMR	Main Bus 2	Bus4	3.39	5.09	6.12	
GT GT 3	2W XFMR	Main Bus 2	Bus5	3.39	5.09	6.12	
GT GT 4	2W XFMR	Main Bus 1	Bus6	3.39	5.09	6.12	
ODAT01	2W XFMR	Bus13	Bus47	22.84	456.90	457.47	
ODAT02	2W XFMR	Bus15	Bus48	22.84	456.90	457.47	
ODBT01	2W XFMR	Bus14	Bus39	22.84	456.90	457.47	
ODBT02	2W XFMR	Bus16	Bus42	22.84	456.90	457.47	
ODBT03	2W XFMR	Bus15	Bus43	22.84	456.90	457.47	
ODCT01	2W XFMR	Bus14	Bus44	22.84	456.90	457.47	
ODCT02	2W XFMR	Bus16	Bus45	22.84	456.90	457.47	
ODDT01	2W XFMR	Bus13	Bus26	10.16	457.35	457.47	
ODDT02	2W XFMR	Bus15	Bus46	10.16	457.35	457.47	
SAT 1	2W XFMR	Bus3	Bus13	0.85	38.09	38.10	
SAT 2	2W XFMR	Bus4	Bus14	0.85	38.09	38.10	
SAT 3	2W XFMR	Bus5	Bus15	0.85	38.09	38.10	
SAT 4	2W XFMR	Bus6	Bus16	0.85	38.09	38.10	
ST GT 1	2W XFMR	Main Bus 1	Bus7	0.10	4.62	4.62	
ST GT 2	2W XFMR	Main Bus 1	Bus8	0.10	4.62	4.62	
Bhaadurgarh	Line	Bus12	Main Bus 1	0.07	0.92	0.92	
Bhiwani	Line	Bus9	Main Bus 2	0.07	0.92	0.92	
CB94	Tie Breakr	Main Bus 2	Main Bus 1				

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
* Bus3	16.500	100.000	9.9	222.100	-61.105	0	0	Main Bus 1	210.941	-68.980	7765.6	-95.0	
								Bus13	11.159	7.875	477.9	81.7	
* Bus4	16.500	100.000	9.9	222.100	-61.104	0	0	Main Bus 2	210.940	-68.980	7765.6	-95.0	
								Bus14	11.160	7.875	477.9	81.7	
* Bus5	16.500	100.000	9.9	222.100	-59.993	0	0	Main Bus 2	210.090	-68.565	7732.8	-95.1	
								Bus15	12.010	8.572	516.3	81.4	
* Bus6	16.500	100.000	9.9	222.100	-61.104	0	0	Main Bus 1	210.940	-68.980	7765.6	-95.0	
								Bus16	11.160	7.875	477.9	81.7	
* Bus7	16.500	100.000	9.3	260.000	70.019	0	0	Main Bus 1	260.000	70.019	9421.8	96.6	
* Bus8	16.500	100.000	9.3	260.000	70.019	0	0	Main Bus 1	260.000	70.019	9421.8	96.6	
* Bus9	400.000	105.000	0.0	-380.587	339.272	0	0	Main Bus 2	-380.587	339.272	700.9	-74.6	
* Bus12	400.000	105.000	0.0	-380.587	339.272	0	0	Main Bus 1	-380.587	339.272	700.9	-74.6	
Bus13	6.600	101.405	7.5	0	0	6.838	4.238	Bus19	0.861	0.585	89.8	82.7	
								Bus24	0.861	0.585	89.8	82.7	
								Bus20	0.861	0.585	89.8	82.7	
								Bus47	0.862	0.585	89.9	82.7	
								Bus26	0.861	0.585	89.8	82.7	
								Bus3	-11.143	-7.165	1142.8	84.1	
Bus14	6.600	101.405	7.5	0	0	6.838	4.238	Bus21	0.861	0.585	89.8	82.7	
								Bus25	0.861	0.585	89.8	82.7	
								Bus23	0.861	0.585	89.8	82.7	
								Bus39	0.862	0.585	89.9	82.7	
								Bus44	0.862	0.585	89.9	82.7	
								Bus4	-11.144	-7.165	1142.9	84.1	
Bus15	6.600	101.136	7.2	0	0	6.831	4.234	Bus33	0.860	0.585	89.9	82.7	
								Bus38	0.860	0.585	89.9	82.7	
								Bus36	0.860	0.585	89.9	82.7	
								Bus48	0.861	0.585	90.0	82.7	
								Bus43	0.861	0.585	90.0	82.7	
								Bus46	0.860	0.585	89.9	82.7	
								Bus5	-11.992	-7.743	1234.7	84.0	
Bus16	6.600	101.405	7.5	0	0	6.838	4.238	Bus34	0.861	0.585	89.8	82.7	
								Bus37	0.861	0.585	89.8	82.7	
								Bus35	0.861	0.585	89.8	82.7	
								Bus42	0.862	0.585	89.9	82.7	
								Bus45	0.862	0.585	89.9	82.7	

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
								Bus6	-11.144	-7.165	1142.9	84.1	
Bus19	0.415	102.787	5.0	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus20	0.415	102.787	5.0	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus21	0.415	102.787	5.0	0	0	0.860	0.533	Bus14	-0.860	-0.533	1368.8	85.0	
Bus23	0.415	102.787	5.0	0	0	0.860	0.533	Bus14	-0.860	-0.533	1368.8	85.0	
Bus24	0.415	102.787	5.0	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus25	0.415	102.787	5.0	0	0	0.860	0.533	Bus14	-0.860	-0.533	1368.8	85.0	
Bus26	0.415	102.787	5.0	0	0	0.860	0.533	Bus13	-0.860	-0.533	1368.8	85.0	
Bus33	0.415	102.500	4.8	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus34	0.415	102.787	5.0	0	0	0.860	0.533	Bus16	-0.860	-0.533	1368.8	85.0	
Bus35	0.415	102.787	5.0	0	0	0.860	0.533	Bus16	-0.860	-0.533	1368.8	85.0	
Bus36	0.415	102.500	4.8	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus37	0.415	102.787	5.0	0	0	0.860	0.533	Bus16	-0.860	-0.533	1368.8	85.0	
Bus38	0.415	102.500	4.8	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus39	0.415	102.665	5.1	0	0	0.859	0.532	Bus14	-0.859	-0.532	1369.7	85.0	
Bus42	0.415	102.665	5.1	0	0	0.859	0.532	Bus16	-0.859	-0.532	1369.7	85.0	
Bus43	0.415	102.378	4.8	0	0	0.858	0.532	Bus15	-0.858	-0.532	1372.0	85.0	
Bus44	0.415	102.665	5.1	0	0	0.859	0.532	Bus14	-0.859	-0.532	1369.7	85.0	
Bus45	0.415	102.665	5.1	0	0	0.859	0.532	Bus16	-0.859	-0.532	1369.7	85.0	
Bus46	0.415	102.500	4.8	0	0	0.859	0.532	Bus15	-0.859	-0.532	1371.0	85.0	
Bus47	0.415	102.665	5.1	0	0	0.859	0.532	Bus13	-0.859	-0.532	1369.7	85.0	
Bus48	0.415	102.378	4.8	0	0	0.858	0.532	Bus15	-0.858	-0.532	1372.0	85.0	
Main Bus 1	400.000	102.098	2.2	0	0	529.661	328.255	Bus12	382.512	-315.380	700.9	-77.2	
								Bus3	-194.221	94.060	305.1	-90.0	
								Bus6	-194.220	94.059	305.1	-90.0	
								Bus7	-259.256	-36.553	370.1	99.0	
								Bus8	-259.256	-36.553	370.1	99.0	
								Main Bus 2	-5.219	-127.888	180.9	4.1	
Main Bus 2	400.000	102.098	2.2	0	0	0	0	Bus9	382.512	-315.380	700.9	-77.2	
								Bus4	-194.220	94.059	305.1	-90.0	
								Bus5	-193.511	93.434	303.8	-90.1	
								Main Bus 1	5.219	127.888	180.9	4.1	

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Bus11	400.000													
Bus3	16.500										232.565	95.5	8137.7	
Bus4	16.500										232.565	95.5	8137.7	
Bus5	16.500										232.443	95.6	8133.4	
Bus6	16.500										232.565	95.5	8137.7	
Bus7	16.500										269.263	96.6	9421.8	
Bus8	16.500										269.263	96.6	9421.8	
Bus9	400.000										509.855	74.6	700.9	
Bus12	400.000										509.855	74.6	700.9	
Bus13	6.600		5.440	3.371	1.398	0.867					13.248	84.1	1142.8	
Bus14	6.600		5.440	3.371	1.398	0.867					13.249	84.1	1142.9	
Bus15	6.600		5.440	3.371	1.391	0.862					14.274	84.0	1234.7	
Bus16	6.600		5.440	3.371	1.398	0.867					13.249	84.1	1142.9	
Bus19	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus20	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus21	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus23	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus24	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus25	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus26	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus33	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus34	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus35	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus36	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus37	0.415		0.680	0.421	0.180	0.111					1.011	85.0	1368.8	
Bus38	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus39	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus42	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus43	0.415		0.680	0.421	0.178	0.110					1.010	85.0	1372.0	
Bus44	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus45	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus46	0.415		0.680	0.421	0.179	0.111					1.010	85.0	1371.0	
Bus47	0.415		0.680	0.421	0.179	0.111					1.011	85.0	1369.7	
Bus48	0.415		0.680	0.421	0.178	0.110					1.010	85.0	1372.0	
Main Bus 1	400.000		428.400	265.499	101.261	62.756					1048.189	87.0	1481.8	

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Percent Loading
Main Bus 2	400.000										499.800	77.6	706.6	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).

\# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
					Capability (MVA)	Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%		MVA	%	MVA	%
1DAT01	Transformer				1.600	1.041	65.1	1.011	63.2
1DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
1DBT01	Transformer				1.600	1.041	65.1	1.011	63.2
1DBT02	Transformer				1.600	1.041	65.1	1.011	63.2
2DAT01	Transformer				1.600	1.041	65.1	1.011	63.2
2DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
2DBT01	Transformer				1.600	1.040	65.0	1.010	63.1
2DBT02	Transformer				1.600	1.041	65.1	1.011	63.2
3DAT01	Transformer				1.600	1.040	65.0	1.010	63.1
3DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
4DAT01	Transformer				1.600	1.040	65.0	1.010	63.1
4DAT02	Transformer				1.600	1.041	65.1	1.011	63.2
* GT GT 1	Transformer				220.600	221.933	100.6	215.799	97.8
* GT GT 2	Transformer				220.600	221.932	100.6	215.798	97.8
* GT GT 3	Transformer				220.600	220.995	100.2	214.887	97.4
* GT GT 4	Transformer				220.600	221.932	100.6	215.798	97.8
ODAT01	Transformer				2.000	1.042	52.1	1.011	50.5
ODAT02	Transformer				2.000	1.041	52.0	1.010	50.5
ODBT01	Transformer				2.000	1.042	52.1	1.011	50.5
ODBT02	Transformer				2.000	1.042	52.1	1.011	50.5
ODBT03	Transformer				2.000	1.041	52.0	1.010	50.5
ODCT01	Transformer				2.000	1.042	52.1	1.011	50.5
ODCT02	Transformer				2.000	1.042	52.1	1.011	50.5
ODDT01	Transformer				1.600	1.041	65.1	1.011	63.2
ODDT02	Transformer				1.600	1.040	65.0	1.010	63.1
SAT 1	Transformer				31.500	13.658	43.4	13.248	42.1
SAT 2	Transformer				31.500	13.659	43.4	13.249	42.1
SAT 3	Transformer				31.500	14.756	46.8	14.274	45.3
SAT 4	Transformer				31.500	13.659	43.4	13.249	42.1
ST GT 1	Transformer				292.400	269.263	92.1	261.820	89.5
ST GT 2	Transformer				292.400	269.263	92.1	261.820	89.5

* Indicates a branch with operating load exceeding the branch capability.

Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
GT GT 1	210.941	-68.980	-194.221	94.060	16719.8	25079.7	100.0	102.1	2.76
SAT 1	11.159	7.875	-11.143	-7.165	15.8	710.5	100.0	101.4	3.00
GT GT 2	210.940	-68.980	-194.220	94.059	16719.6	25079.4	100.0	102.1	2.76
SAT 2	11.160	7.875	-11.144	-7.165	15.8	710.6	100.0	101.4	3.00
GT GT 3	210.090	-68.565	-193.511	93.434	16578.8	24868.2	100.0	102.1	2.76
SAT 3	12.010	8.572	-11.992	-7.743	18.4	829.2	100.0	101.1	3.26
GT GT 4	210.940	-68.980	-194.220	94.059	16719.6	25079.4	100.0	102.1	2.76
SAT 4	11.160	7.875	-11.144	-7.165	15.8	710.6	100.0	101.4	3.00
ST GT 1	260.000	70.019	-259.256	-36.553	743.7	33465.9	100.0	102.1	2.76
ST GT 2	260.000	70.019	-259.256	-36.553	743.7	33465.9	100.0	102.1	2.76
Bhiwani	-380.587	339.272	382.512	-315.380	1924.7	23891.7	105.0	102.1	2.90
Bhaadurgarh	-380.587	339.272	382.512	-315.380	1924.7	23891.7	105.0	102.1	2.90
1DAT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
1DBT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
2DAT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
ODAT01	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
ODDT01	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
1DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
1DBT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
2DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
ODBT01	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
ODCT01	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
2DBT01	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
3DAT01	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
4DAT01	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
ODAT02	0.861	0.585	-0.858	-0.532	2.6	52.9	101.1	102.4	3.01
ODBT03	0.861	0.585	-0.858	-0.532	2.6	52.9	101.1	102.4	3.01
ODDT02	0.860	0.585	-0.859	-0.532	1.2	52.8	101.1	102.5	2.90
2DBT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
3DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
4DAT02	0.861	0.585	-0.860	-0.533	1.2	52.7	101.4	102.8	2.89
ODBT02	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
ODCT02	0.862	0.585	-0.859	-0.532	2.6	52.7	101.4	102.7	3.01
					72175.3	218890.1			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	108.0	105.0
UnderVoltage	95.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
CB72	LV CB	Overload	3.000	Amp	1368.784	45626.1	3-Phase
GT GEN 1	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GEN 2	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GEN 3	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GEN 4	Generator	Overload	222.100	MW	222.10	100.0	3-Phase
GT GT 1	Transformer	Overload	220.600	MVA	221.93	100.6	3-Phase
GT GT 2	Transformer	Overload	220.600	MVA	221.93	100.6	3-Phase
GT GT 3	Transformer	Overload	220.600	MVA	221.00	100.2	3-Phase
GT GT 4	Transformer	Overload	220.600	MVA	221.93	100.6	3-Phase
ST GEN 1	Generator	Overload	260.000	MW	260.00	100.0	3-Phase
ST GEN 2	Generator	Overload	260.000	MW	260.00	100.0	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus11	Bus	Over Voltage	400.000	kV	420.000	105.0	3-Phase

Marginal Report

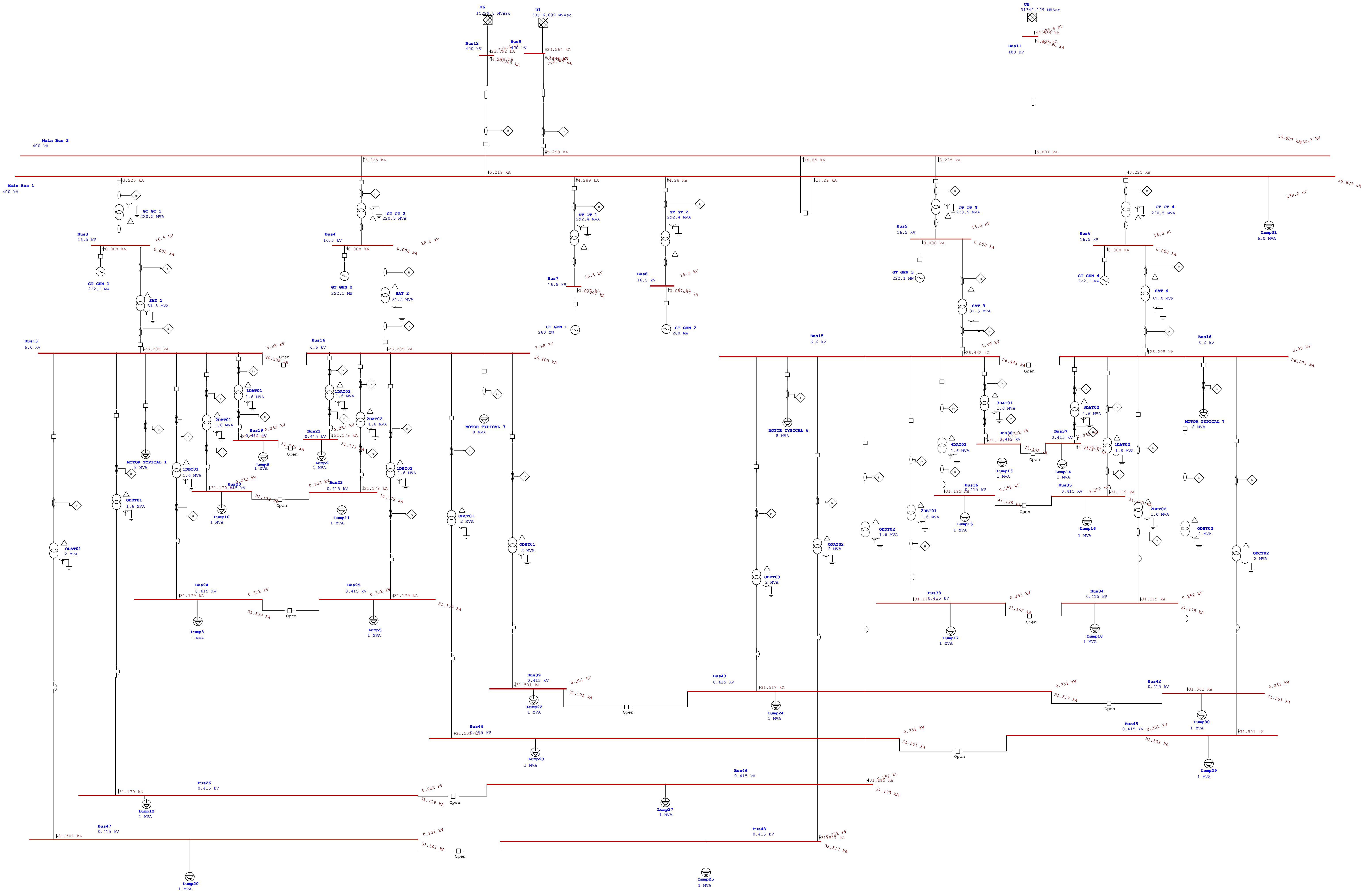
Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus12	Bus	Over Voltage	400.000	kV	420.000	105.0	3-Phase
Bus9	Bus	Over Voltage	400.000	kV	420.00	105.0	3-Phase

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	-761.174	678.543	1019.709	74.65 Leading
Source (Non-Swing Buses):	1408.400	-103.269	1412.181	99.73 Leading
Total Demand:	647.226	575.274	865.934	74.74 Lagging
Total Motor Load:	464.440	287.834	546.400	85.00 Lagging
Total Static Load:	110.611	68.550	130.130	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	72.175	218.890		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

SHORT CIRCUIT STUDY WITH DTL LINE



Electrical Transient Analyzer Program

Short-Circuit Analysis

IEC 60909 Standard

3-Phase, LG, LL, & LLG Fault Currents

	Swing	V-Control	Load	Total
Number of Buses:	3	6	27	36

	XFMR2	XFMR3	Reactor	Line/Cable	Impedance	Tie PD	Total
Number of Branches:	31	0	0	3	0	1	35

	Synchronous Generator	Power Grid	Synchronous Motor	Induction Machines	Lumped Load	Total
Number of Machines:	6	3	0	0	26	35

System Frequency:	50.00
Unit System:	Metric
Project Filename:	bawana project 29-08
Output Filename:	G:\BAWANA FINAL\etap with coupler\29.08.2019\Untitled.SI2S

Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable Length:	No		

Temperature Correction	Apply Adjustments	Individual /Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable Resistance:	Yes	Individual	

Bus Input Data

Bus					Initial Voltage	
ID	Type	Nom. kV	Base kV	Sub-sys	%Mag.	Ang.
Bus3	Gen.	16.500	16.500	1	100.00	30.00
Bus4	Gen.	16.500	16.500	1	100.00	30.00
Bus5	Gen.	16.500	16.500	1	100.00	30.00
Bus6	Gen.	16.500	16.500	1	100.00	30.00
Bus7	Gen.	16.500	16.500	1	100.00	30.00
Bus8	Gen.	16.500	16.500	1	100.00	30.00
Bus9	SWNG	400.000	420.000	1	105.00	0.00
Bus11	SWNG	400.000	420.000	1	105.00	0.00
Bus12	SWNG	400.000	420.000	1	105.00	0.00
Bus13	Load	6.600	6.900	1	100.00	0.00
Bus14	Load	6.600	6.900	1	100.00	0.00
Bus15	Load	6.600	6.900	1	100.00	0.00
Bus16	Load	6.600	6.900	1	100.00	0.00
Bus19	Load	0.415	0.453	1	100.00	-30.00
Bus20	Load	0.415	0.453	1	100.00	-30.00
Bus21	Load	0.415	0.453	1	100.00	-30.00
Bus23	Load	0.415	0.453	1	100.00	-30.00
Bus24	Load	0.415	0.453	1	100.00	-30.00
Bus25	Load	0.415	0.453	1	100.00	-30.00
Bus26	Load	0.415	0.453	1	100.00	-30.00
Bus33	Load	0.415	0.453	1	100.00	-30.00
Bus34	Load	0.415	0.453	1	100.00	-30.00
Bus35	Load	0.415	0.453	1	100.00	-30.00
Bus36	Load	0.415	0.453	1	100.00	-30.00
Bus37	Load	0.415	0.453	1	100.00	-30.00
Bus38	Load	0.415	0.453	1	100.00	-30.00
Bus39	Load	0.415	0.453	1	100.00	-30.00
Bus42	Load	0.415	0.453	1	100.00	-30.00
Bus43	Load	0.415	0.453	1	100.00	-30.00
Bus44	Load	0.415	0.453	1	100.00	-30.00
Bus45	Load	0.415	0.453	1	100.00	-30.00
Bus46	Load	0.415	0.453	1	100.00	-30.00
Bus47	Load	0.415	0.453	1	100.00	-30.00
Bus48	Load	0.415	0.453	1	100.00	-30.00
Main Bus 1	Load	400.000	420.000	1	95.24	0.00
Main Bus 2	Load	400.000	420.000	1	100.00	0.00

36 Buses Total

All voltages reported by ETAP are in % of bus Nominal kV.
Base kV values of buses are calculated and used internally by ETAP.

Line/Cable Input Data

Line/Cable			Length				ohms or siemens per 1000 m per Conductor (Cable) or per Phase (Line)					
ID	Library	Size	Adj. (m)	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
Bhaadurgarh		484.	48991.0	0.0	1	75	0.02666	0.33093		0.26118	1.03144	
Bhiwani		484.	48991.0	0.0	1	75	0.02666	0.33093		0.26118	1.03144	
Line3		484.	48991.0	0.0	1	75	0.02666	0.33093		0.26118	1.03144	

Line / Cable resistances are listed at the specified temperatures.

2-Winding Transformer Input Data

Transformer	Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	MVA	Prim. kV	Sec. kV	% Z	X/R	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
1DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
1DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
1DBT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
1DBT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DBT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DBT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
3DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
3DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
4DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
4DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
GT GT 1	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
GT GT 2	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
GT GT 3	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
GT GT 4	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
ODAT01	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODAT02	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODBT01	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODBT02	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODBT03	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODCT01	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODCT02	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODDT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
ODDT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
SAT 1	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
SAT 2	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
SAT 3	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
SAT 4	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
ST GT 1	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.50	YNd	-30.00
ST GT 2	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.50	YNd	-30.00

2-Winding Transformer Grounding Input Data

Transformer	Rating			Conn.	Grounding							
					Primary				Secondary			
ID	MVA	Prim. kV	Sec. kV	Type	Type	kV	Amp	ohm	Type	kV	Amp	ohm
1DAT01	1.600	6.600	0.433	D/Y					Solid			
1DAT02	1.600	6.600	0.433	D/Y					Solid			
1DBT01	1.600	6.600	0.433	D/Y					Solid			
1DBT02	1.600	6.600	0.433	D/Y					Solid			
2DAT01	1.600	6.600	0.433	D/Y					Solid			
2DAT02	1.600	6.600	0.433	D/Y					Solid			
2DBT01	1.600	6.600	0.433	D/Y					Solid			
2DBT02	1.600	6.600	0.433	D/Y					Solid			
3DAT01	1.600	6.600	0.433	D/Y					Solid			
3DAT02	1.600	6.600	0.433	D/Y					Solid			
4DAT01	1.600	6.600	0.433	D/Y					Solid			
4DAT02	1.600	6.600	0.433	D/Y					Solid			
GT GT 1	220.600	420.000	16.500	Y/D	Solid							
GT GT 2	220.600	420.000	16.500	Y/D	Solid							
GT GT 3	220.600	420.000	16.500	Y/D	Solid							
GT GT 4	220.600	420.000	16.500	Y/D	Solid							
ODAT01	2.000	6.600	0.433	D/Y					Solid			
ODAT02	2.000	6.600	0.433	D/Y					Solid			
ODBT01	2.000	6.600	0.433	D/Y					Solid			
ODBT02	2.000	6.600	0.433	D/Y					Solid			
ODBT03	2.000	6.600	0.433	D/Y					Solid			
ODCT01	2.000	6.600	0.433	D/Y					Solid			
ODCT02	2.000	6.600	0.433	D/Y					Solid			
ODDT01	1.600	6.600	0.433	D/Y					Solid			
ODDT02	1.600	6.600	0.433	D/Y					Solid			
SAT 1	31.500	16.500	6.900	D/Y					Solid			
SAT 2	31.500	16.500	6.900	D/Y					Solid			
SAT 3	31.500	16.500	6.900	D/Y					Solid			
SAT 4	31.500	16.500	6.900	D/Y					Solid			
ST GT 1	292.400	420.000	16.500	Y/D	Solid							
ST GT 2	292.400	420.000	16.500	Y/D	Solid							

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVAb			
ID	Type	From Bus	To Bus	R	X	Z	Y
1DAT01	2W XFMR	Bus13	Bus19	9.67	435.32	435.43	
1DAT02	2W XFMR	Bus14	Bus21	9.67	435.32	435.43	
1DBT01	2W XFMR	Bus13	Bus24	9.67	435.32	435.43	
1DBT02	2W XFMR	Bus14	Bus25	9.67	435.32	435.43	
2DAT01	2W XFMR	Bus13	Bus20	9.67	435.32	435.43	
2DAT02	2W XFMR	Bus14	Bus23	9.67	435.32	435.43	
2DBT01	2W XFMR	Bus15	Bus33	9.67	435.32	435.43	
2DBT02	2W XFMR	Bus16	Bus34	9.67	435.32	435.43	
3DAT01	2W XFMR	Bus15	Bus38	9.67	435.32	435.43	
3DAT02	2W XFMR	Bus16	Bus37	9.67	435.32	435.43	
4DAT01	2W XFMR	Bus15	Bus36	9.67	435.32	435.43	
4DAT02	2W XFMR	Bus16	Bus35	9.67	435.32	435.43	
GT GT 1	2W XFMR	Main Bus 1	Bus3	3.29	4.94	5.94	
GT GT 2	2W XFMR	Main Bus 2	Bus4	3.29	4.94	5.94	
GT GT 3	2W XFMR	Main Bus 2	Bus5	3.29	4.94	5.94	
GT GT 4	2W XFMR	Main Bus 1	Bus6	3.29	4.94	5.94	
ODAT01	2W XFMR	Bus13	Bus47	21.50	429.99	430.52	
ODAT02	2W XFMR	Bus15	Bus48	21.50	429.99	430.52	
ODBT01	2W XFMR	Bus14	Bus39	21.50	429.99	430.52	
ODBT02	2W XFMR	Bus16	Bus42	21.50	429.99	430.52	
ODBT03	2W XFMR	Bus15	Bus43	21.50	429.99	430.52	
ODCT01	2W XFMR	Bus14	Bus44	21.50	429.99	430.52	
ODCT02	2W XFMR	Bus16	Bus45	21.50	429.99	430.52	
ODDT01	2W XFMR	Bus13	Bus26	9.67	435.32	435.43	
ODDT02	2W XFMR	Bus15	Bus46	9.67	435.32	435.43	
SAT 1	2W XFMR	Bus3	Bus13	0.83	37.13	37.14	
SAT 2	2W XFMR	Bus4	Bus14	0.83	37.13	37.14	
SAT 3	2W XFMR	Bus5	Bus15	0.83	37.13	37.14	
SAT 4	2W XFMR	Bus6	Bus16	0.83	37.13	37.14	
ST GT 1	2W XFMR	Main Bus 1	Bus7	0.10	4.47	4.47	
ST GT 2	2W XFMR	Main Bus 1	Bus8	0.10	4.48	4.48	
Bhaadurgarh	Line	Bus12	Main Bus 1	0.07	0.92	0.92	
Bhiwani	Line	Bus9	Main Bus 2	0.07	0.92	0.92	
Line3	Line	Bus11	Main Bus 2	0.07	0.92	0.92	
CB94	Tie Breakr	Main Bus 2	Main Bus 1				

Power Grid Input Data

		Rating		% Impedance 100 MVA Base			Grounding
Power Grid ID	Connected Bus ID	MVASC	kV	R	X"	R/X"	Type
U1	Bus9	33616.700	420.000	0.02960	0.29599	0.10	Wye - Solid
U5	Bus11	31342.200	420.000	0.03175	0.31748	0.10	Wye - Solid
U6	Bus12	15229.800	420.000	0.06533	0.65335	0.10	Wye - Solid

Total Connected Power Grids (= 3): 80188.700 MVA

Synchronous Generator Input Data

Synchronous Generator		Rating				% Impedance in Machine Base					Grounding			Excitation
							Xd"							
ID	Type	MVA	kV	RPM	% PF	R	Adj.	Tol.	R/X	Xd, sat	Conn.	Type	Amp	Type
GT GEN 1		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
GT GEN 2		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
GT GEN 3		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
GT GEN 4		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
ST GEN 1	Turbo	305.882	16.500	1500	85.00	1.000	19.40	0.0	0.05	190.70	Wye		6.18	Turbine 130%
ST GEN 2	Turbo	305.882	16.500	1500	85.00	1.000	19.00	0.0	0.05	155.00	Wye		6.18	Turbine 130%

Total Connected Synchronous Generators (= 6.00) : 1,656.941 MVA

Lumped Load Input Data

	Lumped Load						Motor Loads								
	Rating				% Load		Loading		% Impedance (Machine Base)			Grounding			mFact.
Lumped Load ID	kVA	kV	Amp	% PF	MTR	STAT	kW	kvar	R	X"	R/X"	Conn.	Type	Amp	MW/PP
Lump3	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump5	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump8	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump9	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump10	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump11	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump12	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump13	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump14	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump15	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump16	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump17	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump18	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump20	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump22	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump23	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump24	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump25	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump27	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump29	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump30	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump31	630000.0	420.000	866.03	85.00	80	20	428400.00	265498.50	1.53		0.10	Delta			428.40
MOTOR TYPICAL 1	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44
MOTOR TYPICAL 3	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44
MOTOR TYPICAL 6	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44
MOTOR TYPICAL 7	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44

Total Connected Lumped Loads (= 26): 683000.0 kVA

SHORT- CIRCUIT REPORT

Fault at bus: **Bus9**
Nominal kV = 400.000
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus9	Total	0.00	54.551	0.00	113.71	118.26	39.785	39.785	2.60E-002	2.63E-001	1.00E-001	5.50E-001
Main Bus 2	Bus9	67.49	10.540	75.43	99.63	101.22	7.198	6.244	1.28E-001	1.36E+000	9.14E-001	3.44E+000
U1	Bus9	95.24	44.010	95.24	95.24	95.24	32.589	33.564	3.26E-002	3.26E-001	1.09E-001	6.53E-001
Bus11	Main Bus 2	91.04	3.680	94.70	99.42	99.35	2.175	1.146	1.09E-001	1.27E+000	7.60E-001	3.21E+000
Bus4	Main Bus 2	79.67	0.407	88.73	95.36	90.49	0.407	0.637 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus5	Main Bus 2	79.69	0.408	88.73	95.36	90.50	0.407	0.637 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus12	Main Bus 1	85.72	2.849	91.31	99.18	99.11	1.732	1.031	1.46E-001	1.64E+000	7.97E-001	3.58E+000
Bus3	Main Bus 1	79.67	0.407	88.73	95.36	90.49	0.407	0.637 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus6	Main Bus 1	79.67	0.407	88.73	95.36	90.49	0.407	0.637 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus7	Main Bus 1	77.31	0.441	88.80	95.36	88.64	0.493	0.847 *	4.16E-001	1.06E+001	9.93E-002	4.47E+000
Bus8	Main Bus 1	77.47	0.446	88.97	95.17	88.76	0.501	0.845 *	4.16E-001	1.05E+001	9.95E-002	4.48E+000
Lump31	Main Bus 1	95.24	1.535	95.24	95.24	95.24	0.748	0.000	3.04E-001	3.04E+000		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	54.551	39.785	47.235	50.725
Peak Current (kA), Method C	:	135.004	98.461	116.898	125.536
Breaking Current (kA, rms, symm)	:		39.785	47.235	50.725
Steady State Current (kA, rms)	:	53.988	39.785	47.235	50.725

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus11**
Nominal kV = 400.000
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Bus11	Total	0.00	51.595	0.00	101.96	102.85	49.196	49.196	2.74E-002	2.78E-001	3.64E-002	3.18E-001
Main Bus 2	Bus11	67.63	10.563	73.11	97.93	98.22	8.166	4.409	1.27E-001	1.36E+000	9.18E-001	3.45E+000
U5	Bus11	95.24	41.033	95.24	95.24	95.24	41.033	44.839	3.49E-002	3.49E-001	3.49E-002	3.49E-001
Bus9	Main Bus 2	91.52	3.734	93.45	99.34	99.15	2.627	0.751	1.07E-001	1.24E+000	8.34E-001	3.52E+000
Bus4	Main Bus 2	79.74	0.405	86.87	95.39	88.87	0.404	0.457 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus5	Main Bus 2	79.76	0.406	86.88	95.39	88.88	0.405	0.457 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus12	Main Bus 1	85.79	2.837	89.71	98.61	98.21	2.052	0.740	1.46E-001	1.64E+000	7.97E-001	3.58E+000
Bus3	Main Bus 1	79.74	0.405	86.87	95.39	88.87	0.404	0.457 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus6	Main Bus 1	79.74	0.405	86.87	95.39	88.87	0.404	0.457 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus7	Main Bus 1	77.39	0.440	87.10	95.39	86.50	0.478	0.608 *	4.16E-001	1.06E+001	9.93E-002	4.47E+000
Bus8	Main Bus 1	77.55	0.444	87.31	95.14	86.66	0.489	0.606 *	4.16E-001	1.05E+001	9.95E-002	4.48E+000
Lump31	Main Bus 1	95.24	1.528	95.24	95.24	95.24	0.973	0.000	3.04E-001	3.04E+000		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	51.595	49.196	44.675	50.707
Peak Current (kA), Method C	:	127.712	121.773	110.583	125.513
Breaking Current (kA, rms, symm)	:		49.196	44.675	50.707
Steady State Current (kA, rms)	:	51.038	49.196	44.675	50.707

# Indicates a fault current contribution from a three-winding transformer.

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus12**

Nominal kV = 400.000

Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Bus12	Total	0.00	30.755	0.00	103.74	105.47	28.089	28.089	4.53E-002	4.66E-001	7.60E-002	5.97E-001
Main Bus 1	Bus12	69.26	10.817	74.62	98.38	98.98	8.154	4.748	1.22E-001	1.33E+000	9.14E-001	3.44E+000
U6	Bus12	95.24	19.939	95.24	95.24	95.24	19.939	23.392	7.19E-002	7.19E-001	7.19E-002	7.19E-001
Bus3	Main Bus 1	80.52	0.385	87.60	95.38	89.48	0.391	0.483 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus6	Main Bus 1	80.52	0.385	87.60	95.38	89.48	0.391	0.483 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus7	Main Bus 1	78.29	0.417	87.78	95.37	87.31	0.464	0.642 *	4.16E-001	1.06E+001	9.93E-002	4.47E+000
Bus8	Main Bus 1	78.44	0.422	87.97	95.15	87.46	0.474	0.641 *	4.16E-001	1.05E+001	9.95E-002	4.48E+000
Lump31	Main Bus 1	95.24	1.451	95.24	95.24	95.24	0.885	0.000	3.04E-001	3.04E+000		
Bus9	Main Bus 2	91.95	3.546	93.87	99.45	99.33	2.427	0.794	1.07E-001	1.24E+000	8.34E-001	3.52E+000
Bus11	Main Bus 2	91.53	3.480	94.12	99.19	98.97	2.412	0.869	1.09E-001	1.27E+000	7.60E-001	3.21E+000
Bus4	Main Bus 2	80.52	0.385	87.60	95.38	89.48	0.391	0.483 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus5	Main Bus 2	80.54	0.385	87.61	95.38	89.48	0.391	0.483 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	30.755	28.089	26.628	29.846
Peak Current (kA), Method C	:	76.307	69.693	66.067	74.053
Breaking Current (kA, rms, symm)	:		28.089	26.628	29.846
Steady State Current (kA, rms)	:	30.255	28.089	26.628	29.846

\# Indicates a fault current contribution from a three-winding transformer.

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Main Bus 1**
Nominal kV = 400.000
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Main Bus 1	Total	0.00	43.922	0.00	103.57	114.71	36.890	36.890	3.66E-002	3.26E-001	1.55E-001	4.96E-001
Bus12	Main Bus 1	56.08	8.758	66.72	97.63	98.99	6.651	5.219	1.46E-001	1.64E+000	7.97E-001	3.58E+000
Bus3	Main Bus 1	49.16	1.252	71.88	95.69	81.39	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus6	Main Bus 1	49.16	1.252	71.88	95.69	81.39	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus7	Main Bus 1	40.10	1.357	72.24	95.68	74.21	2.167	4.288 *	4.16E-001	1.06E+001	9.93E-002	4.47E+000
Bus8	Main Bus 1	40.58	1.371	72.81	95.01	74.44	2.194	4.280 *	4.16E-001	1.05E+001	9.95E-002	4.48E+000
Lump31	Main Bus 1	95.24	4.718	95.24	95.24	95.24	2.647	0.000	3.04E-001	3.04E+000		
Bus9	Main Bus 2	73.81	11.528	77.23	99.72	101.12	8.233	5.299	1.07E-001	1.24E+000	8.34E-001	3.52E+000
Bus11	Main Bus 2	72.43	11.313	79.87	98.20	98.91	8.279	5.801	1.09E-001	1.27E+000	7.60E-001	3.21E+000
Bus4	Main Bus 2	49.16	1.252	71.88	95.69	81.39	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus5	Main Bus 2	49.20	1.253	71.90	95.69	81.40	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
U6	Bus12	95.24	8.758	95.24	95.24	95.24	6.651	5.219	7.19E-002	7.19E-001	7.19E-002	7.19E-001
Bus13	Bus3	60.07	1.038	77.51	91.75	97.81	0.504	0.000	1.70E+002	6.82E+001		
GT GEN 1	Bus3	95.24	30.828	95.24	95.24	95.24	14.808	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000
Bus16	Bus6	60.07	1.038	77.51	91.75	97.81	0.504	0.000	1.70E+002	6.82E+001		
GT GEN 4	Bus6	95.24	30.828	95.24	95.24	95.24	14.808	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000
ST GEN 1	Bus7	95.24	34.544	95.24	95.24	95.24	16.644	0.000	3.16E-001	6.14E+000	1.70E+005	2.21E+000
ST GEN 2	Bus8	95.24	34.889	95.24	95.24	95.24	17.343	0.000	3.17E-001	6.02E+000	1.70E+005	2.22E+000
U1	Bus9	95.24	11.528	95.24	95.24	95.24	8.233	5.299	3.26E-002	3.26E-001	1.09E-001	6.53E-001
U5	Bus11	95.24	11.313	95.24	95.24	95.24	8.279	5.801	3.49E-002	3.49E-001	3.49E-002	3.49E-001
Bus14	Bus4	60.07	1.038	77.51	91.75	97.81	0.504	0.000	1.70E+002	6.82E+001		
GT GEN 2	Bus4	95.24	30.828	95.24	95.24	95.24	14.808	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000
Bus15	Bus5	60.55	1.092	77.78	91.88	97.78	0.530	0.000	1.62E+002	6.37E+001		
GT GEN 3	Bus5	95.24	30.801	95.24	95.24	95.24	14.795	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000

(Cont.)

Fault at bus: **Main Bus 1**
Nominal kV = 400.000
Voltage c Factor = 1.10 (User-Defined)

Contribution		**3-Phase Fault**		**Line-To-Ground Fault**					**Positive & Zero Sequence Impedances Looking into "From Bus"**			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	43.922	36.890	37.963	43.214
Peak Current (kA), Method C	:	107.911	90.635	93.270	106.172
Breaking Current (kA, rms, symm)	:		36.890	37.963	43.214
Steady State Current (kA, rms)	:	35.376	36.890	37.963	43.214

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Main Bus 2**
Nominal kV = 400.000
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Main Bus 2	Total	0.00	43.922	0.00	103.57	114.71	36.890	36.890	3.66E-002	3.26E-001	1.55E-001	4.96E-001
Bus9	Main Bus 2	73.81	11.528	77.23	99.72	101.12	8.233	5.299	1.07E-001	1.24E+000	8.34E-001	3.52E+000
Bus11	Main Bus 2	72.43	11.313	79.87	98.20	98.91	8.279	5.801	1.09E-001	1.27E+000	7.60E-001	3.21E+000
Bus4	Main Bus 2	49.16	1.252	71.88	95.69	81.39	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus5	Main Bus 2	49.20	1.253	71.90	95.69	81.40	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus12	Main Bus 1	56.08	8.758	66.72	97.63	98.99	6.651	5.219	1.46E-001	1.64E+000	7.97E-001	3.58E+000
Bus3	Main Bus 1	49.16	1.252	71.88	95.69	81.39	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus6	Main Bus 1	49.16	1.252	71.88	95.69	81.39	1.766	3.226 *	3.67E+000	1.09E+001	3.29E+000	4.94E+000
Bus7	Main Bus 1	40.10	1.357	72.24	95.68	74.21	2.167	4.288 *	4.16E-001	1.06E+001	9.93E-002	4.47E+000
Bus8	Main Bus 1	40.58	1.371	72.81	95.01	74.44	2.194	4.280 *	4.16E-001	1.05E+001	9.95E-002	4.48E+000
Lump31	Main Bus 1	95.24	4.718	95.24	95.24	95.24	2.647	0.000	3.04E-001	3.04E+000		
U1	Bus9	95.24	11.528	95.24	95.24	95.24	8.233	5.299	3.26E-002	3.26E-001	1.09E-001	6.53E-001
U5	Bus11	95.24	11.313	95.24	95.24	95.24	8.279	5.801	3.49E-002	3.49E-001	3.49E-002	3.49E-001
Bus14	Bus4	60.07	1.038	77.51	91.75	97.81	0.504	0.000	1.70E+002	6.82E+001		
GT GEN 2	Bus4	95.24	30.828	95.24	95.24	95.24	14.808	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000
Bus15	Bus5	60.55	1.092	77.78	91.88	97.78	0.530	0.000	1.62E+002	6.37E+001		
GT GEN 3	Bus5	95.24	30.801	95.24	95.24	95.24	14.795	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000
U6	Bus12	95.24	8.758	95.24	95.24	95.24	6.651	5.219	7.19E-002	7.19E-001	7.19E-002	7.19E-001
Bus13	Bus3	60.07	1.038	77.51	91.75	97.81	0.504	0.000	1.70E+002	6.82E+001		
GT GEN 1	Bus3	95.24	30.828	95.24	95.24	95.24	14.808	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000
Bus16	Bus6	60.07	1.038	77.51	91.75	97.81	0.504	0.000	1.70E+002	6.82E+001		
GT GEN 4	Bus6	95.24	30.828	95.24	95.24	95.24	14.808	0.000	3.71E-001	6.16E+000	1.44E+005	2.60E+000
ST GEN 1	Bus7	95.24	34.544	95.24	95.24	95.24	16.644	0.000	3.16E-001	6.14E+000	1.70E+005	2.21E+000
ST GEN 2	Bus8	95.24	34.889	95.24	95.24	95.24	17.343	0.000	3.17E-001	6.02E+000	1.70E+005	2.22E+000

(Cont.)

Fault at bus: **Main Bus 2**
Nominal kV = 400.000
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	43.922	36.890	37.963	43.214
Peak Current (kA), Method C	:	107.911	90.635	93.270	106.172
Breaking Current (kA, rms, symm)	:		36.890	37.963	43.214
Steady State Current (kA, rms)	:	35.376	36.890	37.963	43.214

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus3**
Nominal kV = 16.500
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus3	Total	0.00	118.032	0.00	173.20	173.21	0.008	0.008	9.93E-001	3.11E+000	1.44E+005	2.71E+000
Main Bus 1	Bus3	100.08	59.950	105.00	105.00	105.00	0.003	0.000	3.43E+000	5.43E+000		
Bus13	Bus3	21.17	2.099	104.55	104.54	104.55	0.000	0.000	2.64E+001	1.81E+002		
GT GEN 1	Bus3	100.00	59.786	100.00	100.00	100.00	0.005	0.008	3.87E-001	6.43E+000	1.44E+005	2.71E+000
Bus12	Main Bus 1	102.82	0.483	105.00	105.00	105.00	0.000	0.000	1.54E+001	6.19E+000		
Bus6	Main Bus 1	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus7	Main Bus 1	97.26	0.075	100.00	100.00	100.00	0.000	0.000 *	1.01E+002	3.50E+001		
Bus8	Main Bus 1	97.29	0.076	100.00	100.00	100.00	0.000	0.000 *	1.00E+002	3.47E+001		
Lump31	Main Bus 1	100.00	0.260	100.00	100.00	100.00	0.000	0.000	3.04E-001	3.04E+000		
Bus9	Main Bus 2	103.70	0.636	105.00	105.00	105.00	0.000	0.000	1.17E+001	4.67E+000		
Bus11	Main Bus 2	103.63	0.624	105.00	105.00	105.00	0.000	0.000	1.19E+001	4.76E+000		
Bus4	Main Bus 2	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus5	Main Bus 2	97.97	0.069	100.00	100.00	100.00	0.000	0.000 *	9.46E+001	6.73E+001		
Bus19	Bus13	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus24	Bus13	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus20	Bus13	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus47	Bus13	39.38	0.341	109.08	109.08	109.08	0.000	0.000	6.98E+002	2.10E+003		
Bus26	Bus13	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
MOTOR TYPICAL 1	Bus13	104.55	3.345	104.55	104.55	104.55	0.000	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	118.032	0.008	101.270	101.272
Peak Current (kA), Method C	:	293.294	0.020	251.643	251.648
Breaking Current (kA, rms, symm)	:		0.008	101.270	101.272
Steady State Current (kA, rms)	:	74.868	0.008	101.270	101.272

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus13**
Nominal kV = 6.600
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
				% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus13	Total	0.00	27.659	0.00	104.34	101.13	26.206	26.206	2.35E+000	3.17E+001	8.25E-001	3.71E+001
Bus19	Bus13	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus24	Bus13	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus20	Bus13	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus47	Bus13	20.79	0.407	65.37	71.58	104.35	0.257	0.000	7.00E+002	2.04E+003		
Bus26	Bus13	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus3	Bus13	87.53	21.693	92.55	95.68	91.11	22.433	26.206 *	1.86E+000	4.05E+001	8.25E-001	3.71E+001
MOTOR TYPICAL 1	Bus13	100.00	4.003	100.00	100.00	100.00	2.529	0.000	2.19E+001	2.19E+002		
Lump8	Bus19	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump3	Bus24	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump10	Bus20	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump20	Bus47	104.34	6.211	104.34	104.34	104.34	3.401	0.000	6.78E+002	1.61E+003		
Lump12	Bus26	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Main Bus 1	Bus3	100.04	4.342	100.18	100.36	100.39	2.375	0.000	4.07E+001	1.78E+001		
GT GEN 1	Bus3	95.65	5.028	95.65	95.65	95.65	2.724	0.000	3.87E-001	6.43E+000	1.44E+005	2.71E+000

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	27.659	26.206	23.945	27.409
Peak Current (kA), Method C	:	70.114	66.430	60.699	69.482
Breaking Current (kA, rms, symm)	:		26.206	23.945	27.409
Steady State Current (kA, rms)	:	21.688	26.206	23.945	27.409

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus19**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Bus19	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus13	Bus19	89.23	26.251	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump8	Bus19	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus24	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus20	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus47	Bus13	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus26	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus3	Bus13	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 1	Bus13	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

	3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms) :	32.881	31.179	28.476	32.834
Peak Current (kA), Method C :	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm) :		31.179	28.476	32.834
Steady State Current (kA, rms) :	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus20**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus20	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus13	Bus20	89.23	26.251	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump10	Bus20	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus19	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus24	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus47	Bus13	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus26	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus3	Bus13	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 1	Bus13	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.881	31.179	28.476	32.834
Peak Current (kA), Method C	:	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm)	:		31.179	28.476	32.834
Steady State Current (kA, rms)	:	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus24**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus24	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus13	Bus24	89.23	26.251	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump3	Bus24	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus19	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus20	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus47	Bus13	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus26	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus3	Bus13	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 1	Bus13	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.881	31.179	28.476	32.834
Peak Current (kA), Method C	:	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm)	:		31.179	28.476	32.834
Steady State Current (kA, rms)	:	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus26**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus26	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus13	Bus26	89.23	26.251	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump12	Bus26	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus19	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus24	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus20	Bus13	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus47	Bus13	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus3	Bus13	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 1	Bus13	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.881	31.179	28.476	32.834
Peak Current (kA), Method C	:	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm)	:		31.179	28.476	32.834
Steady State Current (kA, rms)	:	25.791	31.179	28.476	32.834

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus47**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus47	Total	0.00	33.208	0.00	104.85	100.54	31.501	31.501	4.54E+001	3.67E+002	2.15E+001	4.30E+002
Bus13	Bus47	89.16	26.527	92.78	95.84	92.60	27.259	31.501 *	2.38E+001	4.62E+002	2.15E+001	4.30E+002
Lump20	Bus47	100.00	7.012	100.00	100.00	100.00	4.434	0.000	6.78E+002	1.61E+003		
Bus19	Bus13	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus24	Bus13	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus20	Bus13	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus26	Bus13	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus3	Bus13	91.13	1.385	91.64	91.54	91.33	0.758	0.000 *	2.90E+002	4.52E+001		
MOTOR TYPICAL 1	Bus13	95.84	0.256	95.84	95.84	95.84	0.140	0.000	2.19E+001	2.19E+002		

	3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms) :	33.208	31.501	28.758	33.096
Peak Current (kA), Method C :	78.731	74.684	68.182	78.466
Breaking Current (kA, rms, symm) :		31.501	28.758	33.096
Steady State Current (kA, rms) :	26.059	31.501	28.758	33.096

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus4**
Nominal kV = 16.500
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus4	Total	0.00	118.032	0.00	173.20	173.21	0.008	0.008	9.93E-001	3.11E+000	1.44E+005	2.71E+000
Main Bus 2	Bus4	100.08	59.950	105.00	105.00	105.00	0.003	0.000	3.43E+000	5.43E+000		
Bus14	Bus4	21.17	2.099	104.55	104.54	104.55	0.000	0.000	2.65E+001	1.81E+002		
GT GEN 2	Bus4	100.00	59.786	100.00	100.00	100.00	0.005	0.008	3.87E-001	6.43E+000	1.44E+005	2.71E+000
Bus9	Main Bus 2	103.70	0.636	105.00	105.00	105.00	0.000	0.000	1.17E+001	4.67E+000		
Bus11	Main Bus 2	103.63	0.624	105.00	105.00	105.00	0.000	0.000	1.19E+001	4.76E+000		
Bus5	Main Bus 2	97.97	0.069	100.00	100.00	100.00	0.000	0.000 *	9.46E+001	6.73E+001		
Bus12	Main Bus 1	102.82	0.483	105.00	105.00	105.00	0.000	0.000	1.54E+001	6.19E+000		
Bus3	Main Bus 1	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus6	Main Bus 1	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus7	Main Bus 1	97.26	0.075	100.00	100.00	100.00	0.000	0.000 *	1.01E+002	3.50E+001		
Bus8	Main Bus 1	97.29	0.076	100.00	100.00	100.00	0.000	0.000 *	1.00E+002	3.47E+001		
Lump31	Main Bus 1	100.00	0.260	100.00	100.00	100.00	0.000	0.000	3.04E-001	3.04E+000		
Bus21	Bus14	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus25	Bus14	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus23	Bus14	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus39	Bus14	39.39	0.341	109.08	109.08	109.08	0.000	0.000	6.98E+002	2.10E+003		
Bus44	Bus14	39.39	0.341	109.08	109.08	109.08	0.000	0.000	6.98E+002	2.10E+003		
MOTOR TYPICAL 3	Bus14	104.55	3.345	104.55	104.55	104.55	0.000	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	118.032	0.008	101.270	101.272
Peak Current (kA), Method C	:	293.294	0.020	251.643	251.648
Breaking Current (kA, rms, symm)	:		0.008	101.270	101.272
Steady State Current (kA, rms)	:	74.868	0.008	101.270	101.272

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus14**
Nominal kV = 6.600
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
				% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus14	Total	0.00	27.658	0.00	104.34	101.13	26.205	26.205	2.35E+000	3.17E+001	8.25E-001	3.71E+001
Bus21	Bus14	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus25	Bus14	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus23	Bus14	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus39	Bus14	20.79	0.407	65.37	71.58	104.35	0.257	0.000	7.00E+002	2.04E+003		
Bus44	Bus14	20.79	0.407	65.37	71.58	104.35	0.257	0.000	7.00E+002	2.04E+003		
Bus4	Bus14	87.53	21.693	92.55	95.68	91.11	22.433	26.205 *	1.86E+000	4.05E+001	8.25E-001	3.71E+001
MOTOR TYPICAL 3	Bus14	100.00	4.003	100.00	100.00	100.00	2.529	0.000	2.19E+001	2.19E+002		
Lump9	Bus21	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump5	Bus25	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump11	Bus23	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump22	Bus39	104.34	6.211	104.34	104.34	104.34	3.401	0.000	6.78E+002	1.61E+003		
Lump23	Bus44	104.34	6.211	104.34	104.34	104.34	3.401	0.000	6.78E+002	1.61E+003		
Main Bus 2	Bus4	100.04	4.342	100.18	100.36	100.39	2.375	0.000	4.07E+001	1.78E+001		
GT GEN 2	Bus4	95.65	5.028	95.65	95.65	95.65	2.724	0.000	3.87E-001	6.43E+000	1.44E+005	2.71E+000

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	27.658	26.205	23.944	27.410
Peak Current (kA), Method C	:	70.108	66.425	60.694	69.478
Breaking Current (kA, rms, symm)	:		26.205	23.944	27.410
Steady State Current (kA, rms)	:	21.688	26.205	23.944	27.410

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus21**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Bus21	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus14	Bus21	89.23	26.250	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump9	Bus21	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus25	Bus14	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus23	Bus14	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus39	Bus14	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus44	Bus14	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus4	Bus14	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 3	Bus14	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

	3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms) :	32.881	31.179	28.476	32.834
Peak Current (kA), Method C :	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm) :		31.179	28.476	32.834
Steady State Current (kA, rms) :	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus23**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus23	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus14	Bus23	89.23	26.250	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump11	Bus23	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus21	Bus14	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus25	Bus14	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus39	Bus14	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus44	Bus14	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus4	Bus14	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 3	Bus14	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

	3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms) :	32.881	31.179	28.476	32.834
Peak Current (kA), Method C :	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm) :		31.179	28.476	32.834
Steady State Current (kA, rms) :	25.791	31.179	28.476	32.834

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus25**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus25	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus14	Bus25	89.23	26.250	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump5	Bus25	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus21	Bus14	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus23	Bus14	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus39	Bus14	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus44	Bus14	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus4	Bus14	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 3	Bus14	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.881	31.179	28.476	32.834
Peak Current (kA), Method C	:	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm)	:		31.179	28.476	32.834
Steady State Current (kA, rms)	:	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus39**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus39	Total	0.00	33.208	0.00	104.85	100.54	31.501	31.501	4.54E+001	3.67E+002	2.15E+001	4.30E+002
Bus14	Bus39	89.16	26.527	92.78	95.84	92.60	27.259	31.501 *	2.38E+001	4.62E+002	2.15E+001	4.30E+002
Lump22	Bus39	100.00	7.012	100.00	100.00	100.00	4.434	0.000	6.78E+002	1.61E+003		
Bus21	Bus14	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus25	Bus14	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus23	Bus14	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus44	Bus14	94.37	0.026	96.45	99.31	98.94	0.014	0.000	1.42E+004	6.64E+003		
Bus4	Bus14	91.13	1.385	91.64	91.54	91.33	0.758	0.000 *	2.90E+002	4.52E+001		
MOTOR TYPICAL 3	Bus14	95.84	0.256	95.84	95.84	95.84	0.140	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	33.208	31.501	28.758	33.096
Peak Current (kA), Method C	:	78.731	74.684	68.182	78.466
Breaking Current (kA, rms, symm)	:		31.501	28.758	33.096
Steady State Current (kA, rms)	:	26.059	31.501	28.758	33.096

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus44**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus44	Total	0.00	33.208	0.00	104.85	100.54	31.501	31.501	4.54E+001	3.67E+002	2.15E+001	4.30E+002
Bus14	Bus44	89.16	26.527	92.78	95.84	92.60	27.259	31.501 *	2.38E+001	4.62E+002	2.15E+001	4.30E+002
Lump23	Bus44	100.00	7.012	100.00	100.00	100.00	4.434	0.000	6.78E+002	1.61E+003		
Bus21	Bus14	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus25	Bus14	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus23	Bus14	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus39	Bus14	94.37	0.026	96.45	99.31	98.94	0.014	0.000	1.42E+004	6.64E+003		
Bus4	Bus14	91.13	1.385	91.64	91.54	91.33	0.758	0.000 *	2.90E+002	4.52E+001		
MOTOR TYPICAL 3	Bus14	95.84	0.256	95.84	95.84	95.84	0.140	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	33.208	31.501	28.758	33.096
Peak Current (kA), Method C	:	78.731	74.684	68.182	78.466
Breaking Current (kA, rms, symm)	:		31.501	28.758	33.096
Steady State Current (kA, rms)	:	26.059	31.501	28.758	33.096

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus5**
Nominal kV = 16.500
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Bus5	Total	0.00	118.144	0.00	173.20	173.21	0.008	0.008	9.92E-001	3.10E+000	1.44E+005	2.71E+000
Main Bus 2	Bus5	100.08	59.950	105.00	105.00	105.00	0.003	0.000	3.43E+000	5.43E+000		
Bus15	Bus5	22.30	2.210	104.55	104.54	104.55	0.000	0.000	2.61E+001	1.72E+002		
GT GEN 3	Bus5	100.00	59.786	100.00	100.00	100.00	0.005	0.008	3.87E-001	6.43E+000	1.44E+005	2.71E+000
Bus9	Main Bus 2	103.70	0.636	105.00	105.00	105.00	0.000	0.000	1.17E+001	4.67E+000		
Bus11	Main Bus 2	103.63	0.624	105.00	105.00	105.00	0.000	0.000	1.19E+001	4.76E+000		
Bus4	Main Bus 2	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus12	Main Bus 1	102.82	0.483	105.00	105.00	105.00	0.000	0.000	1.54E+001	6.19E+000		
Bus3	Main Bus 1	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus6	Main Bus 1	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus7	Main Bus 1	97.26	0.075	100.00	100.00	100.00	0.000	0.000 *	1.01E+002	3.50E+001		
Bus8	Main Bus 1	97.29	0.076	100.00	100.00	100.00	0.000	0.000 *	1.00E+002	3.47E+001		
Lump31	Main Bus 1	100.00	0.260	100.00	100.00	100.00	0.000	0.000	3.04E-001	3.04E+000		
Bus33	Bus15	40.50	0.336	109.08	109.08	109.08	0.000	0.000	7.30E+002	2.09E+003		
Bus38	Bus15	40.50	0.336	109.08	109.08	109.08	0.000	0.000	7.30E+002	2.09E+003		
Bus36	Bus15	40.50	0.336	109.08	109.08	109.08	0.000	0.000	7.30E+002	2.09E+003		
Bus48	Bus15	40.34	0.336	109.08	109.08	109.08	0.000	0.000	7.17E+002	2.09E+003		
Bus43	Bus15	40.34	0.336	109.08	109.08	109.08	0.000	0.000	7.17E+002	2.09E+003		
Bus46	Bus15	40.50	0.336	109.08	109.08	109.08	0.000	0.000	7.30E+002	2.09E+003		
MOTOR TYPICAL 6	Bus15	104.55	3.302	104.55	104.55	104.55	0.000	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	118.144	0.008	101.367	101.369
Peak Current (kA), Method C	:	293.523	0.020	251.841	251.846
Breaking Current (kA, rms, symm)	:		0.008	101.367	101.369
Steady State Current (kA, rms)	:	74.868	0.008	101.367	101.369

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus15**
Nominal kV = 6.600
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Bus15	Total	0.00	28.053	0.00	104.72	101.29	26.442	26.442	2.43E+000	3.13E+001	8.25E-001	3.71E+001
Bus33	Bus15	21.01	0.407	65.33	72.01	104.35	0.256	0.000	6.88E+002	2.05E+003		
Bus38	Bus15	21.01	0.407	65.33	72.01	104.35	0.256	0.000	6.88E+002	2.05E+003		
Bus36	Bus15	21.01	0.407	65.33	72.01	104.35	0.256	0.000	6.88E+002	2.05E+003		
Bus48	Bus15	20.79	0.407	65.50	71.77	104.35	0.256	0.000	7.00E+002	2.04E+003		
Bus43	Bus15	20.79	0.407	65.50	71.77	104.35	0.256	0.000	7.00E+002	2.04E+003		
Bus46	Bus15	21.01	0.407	65.33	72.01	104.35	0.256	0.000	6.88E+002	2.05E+003		
Bus5	Bus15	87.53	21.693	92.57	95.68	91.13	22.441	26.442 *	1.86E+000	4.05E+001	8.25E-001	3.71E+001
MOTOR TYPICAL 6	Bus15	100.00	4.003	100.00	100.00	100.00	2.516	0.000	2.19E+001	2.19E+002		
Lump17	Bus33	104.34	6.207	104.34	104.34	104.34	3.382	0.000	6.78E+002	1.61E+003		
Lump13	Bus38	104.34	6.207	104.34	104.34	104.34	3.382	0.000	6.78E+002	1.61E+003		
Lump15	Bus36	104.34	6.207	104.34	104.34	104.34	3.382	0.000	6.78E+002	1.61E+003		
Lump25	Bus48	104.34	6.211	104.34	104.34	104.34	3.384	0.000	6.78E+002	1.61E+003		
Lump24	Bus43	104.34	6.211	104.34	104.34	104.34	3.384	0.000	6.78E+002	1.61E+003		
Lump27	Bus46	104.34	6.207	104.34	104.34	104.34	3.382	0.000	6.78E+002	1.61E+003		
Main Bus 2	Bus5	100.04	4.342	100.18	100.36	100.39	2.363	0.000	4.07E+001	1.78E+001		
GT GEN 3	Bus5	95.65	5.028	95.65	95.65	95.65	2.710	0.000	3.87E-001	6.43E+000	1.44E+005	2.71E+000

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	28.053	26.442	24.286	27.770
Peak Current (kA), Method C	:	70.708	66.647	61.215	69.994
Breaking Current (kA, rms, symm)	:		26.442	24.286	27.770
Steady State Current (kA, rms)	:	21.688	26.442	24.286	27.770

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus33**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus33	Total	0.00	32.908	0.00	105.13	100.34	31.195	31.195	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus15	Bus33	89.32	26.277	92.92	95.84	92.63	26.985	31.195 *	1.20E+001	4.67E+002	9.67E+000	4.35E+002
Lump17	Bus33	100.00	7.012	100.00	100.00	100.00	4.431	0.000	6.78E+002	1.61E+003		
Bus38	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus36	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus48	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus43	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus46	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus5	Bus15	91.15	1.352	91.65	91.54	91.35	0.740	0.000 *	3.00E+002	3.85E+001		
MOTOR TYPICAL 6	Bus15	95.84	0.249	95.84	95.84	95.84	0.136	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.908	31.195	28.498	32.858
Peak Current (kA), Method C	:	80.028	75.862	69.305	79.906
Breaking Current (kA, rms, symm)	:		31.195	28.498	32.858
Steady State Current (kA, rms)	:	25.791	31.195	28.498	32.858

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus36**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus36	Total	0.00	32.908	0.00	105.13	100.34	31.195	31.195	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus15	Bus36	89.32	26.277	92.92	95.84	92.63	26.985	31.195 *	1.20E+001	4.67E+002	9.67E+000	4.35E+002
Lump15	Bus36	100.00	7.012	100.00	100.00	100.00	4.431	0.000	6.78E+002	1.61E+003		
Bus33	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus38	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus48	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus43	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus46	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus5	Bus15	91.15	1.352	91.65	91.54	91.35	0.740	0.000 *	3.00E+002	3.85E+001		
MOTOR TYPICAL 6	Bus15	95.84	0.249	95.84	95.84	95.84	0.136	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.908	31.195	28.498	32.858
Peak Current (kA), Method C	:	80.028	75.862	69.305	79.906
Breaking Current (kA, rms, symm)	:		31.195	28.498	32.858
Steady State Current (kA, rms)	:	25.791	31.195	28.498	32.858

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus38**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus Va	Vb	Vc	kA Symm. rms Ia	3I0	% Impedance on 100 MVA base R1	X1	R0	X0
Bus38	Total	0.00	32.908	0.00	105.13	100.34	31.195	31.195	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus15	Bus38	89.32	26.277	92.92	95.84	92.63	26.985	31.195 *	1.20E+001	4.67E+002	9.67E+000	4.35E+002
Lump13	Bus38	100.00	7.012	100.00	100.00	100.00	4.431	0.000	6.78E+002	1.61E+003		
Bus33	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus36	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus48	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus43	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus46	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus5	Bus15	91.15	1.352	91.65	91.54	91.35	0.740	0.000 *	3.00E+002	3.85E+001		
MOTOR TYPICAL 6	Bus15	95.84	0.249	95.84	95.84	95.84	0.136	0.000	2.19E+001	2.19E+002		

	3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms) :	32.908	31.195	28.498	32.858
Peak Current (kA), Method C :	80.028	75.862	69.305	79.906
Breaking Current (kA, rms, symm) :		31.195	28.498	32.858
Steady State Current (kA, rms) :	25.791	31.195	28.498	32.858

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus43**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
				% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus43	Total	0.00	33.235	0.00	104.87	100.55	31.517	31.517	4.54E+001	3.67E+002	2.15E+001	4.30E+002
Bus15	Bus43	89.25	26.554	92.83	95.84	92.64	27.276	31.517 *	2.39E+001	4.62E+002	2.15E+001	4.30E+002
Lump24	Bus43	100.00	7.012	100.00	100.00	100.00	4.433	0.000	6.78E+002	1.61E+003		
Bus33	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus38	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus36	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus48	Bus15	94.45	0.026	96.50	99.32	98.95	0.014	0.000	1.44E+004	6.71E+003		
Bus46	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus5	Bus15	91.14	1.366	91.64	91.54	91.34	0.748	0.000 *	2.95E+002	4.54E+001		
MOTOR TYPICAL 6	Bus15	95.84	0.252	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	33.235	31.517	28.782	33.120
Peak Current (kA), Method C	:	78.786	74.714	68.230	78.514
Breaking Current (kA, rms, symm)	:		31.517	28.782	33.120
Steady State Current (kA, rms)	:	26.059	31.517	28.782	33.120

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus46**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus46	Total	0.00	32.908	0.00	105.13	100.34	31.195	31.195	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus15	Bus46	89.32	26.277	92.92	95.84	92.63	26.985	31.195 *	1.20E+001	4.67E+002	9.67E+000	4.35E+002
Lump27	Bus46	100.00	7.012	100.00	100.00	100.00	4.431	0.000	6.78E+002	1.61E+003		
Bus33	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus38	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus36	Bus15	94.53	0.025	96.55	99.38	98.91	0.014	0.000	1.48E+004	6.36E+003		
Bus48	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus43	Bus15	94.52	0.025	96.55	99.37	98.92	0.014	0.000	1.48E+004	6.44E+003		
Bus5	Bus15	91.15	1.352	91.65	91.54	91.35	0.740	0.000 *	3.00E+002	3.85E+001		
MOTOR TYPICAL 6	Bus15	95.84	0.249	95.84	95.84	95.84	0.136	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.908	31.195	28.498	32.858
Peak Current (kA), Method C	:	80.028	75.862	69.305	79.906
Breaking Current (kA, rms, symm)	:		31.195	28.498	32.858
Steady State Current (kA, rms)	:	25.791	31.195	28.498	32.858

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus48**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus48	Total	0.00	33.235	0.00	104.87	100.55	31.517	31.517	4.54E+001	3.67E+002	2.15E+001	4.30E+002
Bus15	Bus48	89.25	26.554	92.83	95.84	92.64	27.276	31.517 *	2.39E+001	4.62E+002	2.15E+001	4.30E+002
Lump25	Bus48	100.00	7.012	100.00	100.00	100.00	4.433	0.000	6.78E+002	1.61E+003		
Bus33	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus38	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus36	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus43	Bus15	94.45	0.026	96.50	99.32	98.95	0.014	0.000	1.44E+004	6.71E+003		
Bus46	Bus15	94.45	0.026	96.50	99.33	98.94	0.014	0.000	1.44E+004	6.63E+003		
Bus5	Bus15	91.14	1.366	91.64	91.54	91.34	0.748	0.000 *	2.95E+002	4.54E+001		
MOTOR TYPICAL 6	Bus15	95.84	0.252	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	33.235	31.517	28.782	33.120
Peak Current (kA), Method C	:	78.786	74.714	68.230	78.514
Breaking Current (kA, rms, symm)	:		31.517	28.782	33.120
Steady State Current (kA, rms)	:	26.059	31.517	28.782	33.120

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus6**
Nominal kV = 16.500
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus6	Total	0.00	118.032	0.00	173.20	173.21	0.008	0.008	9.93E-001	3.11E+000	1.44E+005	2.71E+000
Main Bus 1	Bus6	100.08	59.950	105.00	105.00	105.00	0.003	0.000	3.43E+000	5.43E+000		
Bus16	Bus6	21.17	2.099	104.55	104.54	104.55	0.000	0.000	2.65E+001	1.81E+002		
GT GEN 4	Bus6	100.00	59.786	100.00	100.00	100.00	0.005	0.008	3.87E-001	6.43E+000	1.44E+005	2.71E+000
Bus12	Main Bus 1	102.82	0.483	105.00	105.00	105.00	0.000	0.000	1.54E+001	6.19E+000		
Bus3	Main Bus 1	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus7	Main Bus 1	97.26	0.075	100.00	100.00	100.00	0.000	0.000 *	1.01E+002	3.50E+001		
Bus8	Main Bus 1	97.29	0.076	100.00	100.00	100.00	0.000	0.000 *	1.00E+002	3.47E+001		
Lump31	Main Bus 1	100.00	0.260	100.00	100.00	100.00	0.000	0.000	3.04E-001	3.04E+000		
Bus9	Main Bus 2	103.70	0.636	105.00	105.00	105.00	0.000	0.000	1.17E+001	4.67E+000		
Bus11	Main Bus 2	103.63	0.624	105.00	105.00	105.00	0.000	0.000	1.19E+001	4.76E+000		
Bus4	Main Bus 2	97.96	0.069	100.00	100.00	100.00	0.000	0.000 *	9.47E+001	6.73E+001		
Bus5	Main Bus 2	97.97	0.069	100.00	100.00	100.00	0.000	0.000 *	9.46E+001	6.73E+001		
Bus34	Bus16	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus37	Bus16	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus35	Bus16	39.54	0.340	109.08	109.08	109.08	0.000	0.000	7.11E+002	2.09E+003		
Bus42	Bus16	39.39	0.341	109.08	109.08	109.08	0.000	0.000	6.98E+002	2.10E+003		
Bus45	Bus16	39.39	0.341	109.08	109.08	109.08	0.000	0.000	6.98E+002	2.10E+003		
MOTOR TYPICAL 7	Bus16	104.55	3.345	104.55	104.55	104.55	0.000	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	118.032	0.008	101.270	101.272
Peak Current (kA), Method C	:	293.294	0.020	251.643	251.648
Breaking Current (kA, rms, symm)	:		0.008	101.270	101.272
Steady State Current (kA, rms)	:	74.868	0.008	101.270	101.272

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus16**
Nominal kV = 6.600
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus16	Total	0.00	27.658	0.00	104.34	101.13	26.205	26.205	2.35E+000	3.17E+001	8.25E-001	3.71E+001
Bus34	Bus16	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus37	Bus16	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus35	Bus16	21.01	0.407	65.20	71.83	104.35	0.257	0.000	6.88E+002	2.05E+003		
Bus42	Bus16	20.79	0.407	65.37	71.58	104.35	0.257	0.000	7.00E+002	2.04E+003		
Bus45	Bus16	20.79	0.407	65.37	71.58	104.35	0.257	0.000	7.00E+002	2.04E+003		
Bus6	Bus16	87.53	21.693	92.55	95.68	91.11	22.433	26.205 *	1.86E+000	4.05E+001	8.25E-001	3.71E+001
MOTOR TYPICAL 7	Bus16	100.00	4.003	100.00	100.00	100.00	2.529	0.000	2.19E+001	2.19E+002		
Lump18	Bus34	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump14	Bus37	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump16	Bus35	104.34	6.207	104.34	104.34	104.34	3.399	0.000	6.78E+002	1.61E+003		
Lump30	Bus42	104.34	6.211	104.34	104.34	104.34	3.401	0.000	6.78E+002	1.61E+003		
Lump29	Bus45	104.34	6.211	104.34	104.34	104.34	3.401	0.000	6.78E+002	1.61E+003		
Main Bus 1	Bus6	100.04	4.342	100.18	100.36	100.39	2.375	0.000	4.07E+001	1.78E+001		
GT GEN 4	Bus6	95.65	5.028	95.65	95.65	95.65	2.724	0.000	3.87E-001	6.43E+000	1.44E+005	2.71E+000

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	27.658	26.205	23.944	27.410
Peak Current (kA), Method C	:	70.108	66.425	60.694	69.478
Breaking Current (kA, rms, symm)	:		26.205	23.944	27.410
Steady State Current (kA, rms)	:	21.688	26.205	23.944	27.410

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus34**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus34	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus16	Bus34	89.23	26.250	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump18	Bus34	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus37	Bus16	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus35	Bus16	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus42	Bus16	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus45	Bus16	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus6	Bus16	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 7	Bus16	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

	3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms) :	32.881	31.179	28.476	32.834
Peak Current (kA), Method C :	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm) :		31.179	28.476	32.834
Steady State Current (kA, rms) :	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus35**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		**3-Phase Fault**		**Line-To-Ground Fault**					**Positive & Zero Sequence Impedances Looking into "From Bus"**			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus35	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus16	Bus35	89.23	26.250	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump16	Bus35	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus34	Bus16	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus37	Bus16	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus42	Bus16	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus45	Bus16	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus6	Bus16	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 7	Bus16	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.881	31.179	28.476	32.834
Peak Current (kA), Method C	:	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm)	:		31.179	28.476	32.834
Steady State Current (kA, rms)	:	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus37**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus37	Total	0.00	32.881	0.00	105.11	100.33	31.179	31.179	3.85E+001	3.71E+002	9.67E+000	4.35E+002
Bus16	Bus37	89.23	26.250	92.88	95.84	92.59	26.968	31.179 *	1.19E+001	4.68E+002	9.67E+000	4.35E+002
Lump14	Bus37	100.00	7.012	100.00	100.00	100.00	4.432	0.000	6.78E+002	1.61E+003		
Bus34	Bus16	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus35	Bus16	94.45	0.026	96.50	99.37	98.91	0.014	0.000	1.46E+004	6.30E+003		
Bus42	Bus16	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus45	Bus16	94.44	0.026	96.50	99.36	98.91	0.014	0.000	1.45E+004	6.38E+003		
Bus6	Bus16	91.14	1.370	91.65	91.54	91.34	0.750	0.000 *	2.96E+002	3.85E+001		
MOTOR TYPICAL 7	Bus16	95.84	0.253	95.84	95.84	95.84	0.138	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	32.881	31.179	28.476	32.834
Peak Current (kA), Method C	:	79.970	75.830	69.255	79.856
Breaking Current (kA, rms, symm)	:		31.179	28.476	32.834
Steady State Current (kA, rms)	:	25.791	31.179	28.476	32.834

# Indicates a fault current contribution from a three-winding transformer.

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus42**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus42	Total	0.00	33.208	0.00	104.85	100.54	31.501	31.501	4.54E+001	3.67E+002	2.15E+001	4.30E+002
Bus16	Bus42	89.16	26.527	92.78	95.84	92.60	27.259	31.501 *	2.38E+001	4.62E+002	2.15E+001	4.30E+002
Lump30	Bus42	100.00	7.012	100.00	100.00	100.00	4.434	0.000	6.78E+002	1.61E+003		
Bus34	Bus16	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus37	Bus16	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus35	Bus16	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus45	Bus16	94.37	0.026	96.45	99.31	98.94	0.014	0.000	1.42E+004	6.64E+003		
Bus6	Bus16	91.13	1.385	91.64	91.54	91.33	0.758	0.000 *	2.90E+002	4.52E+001		
MOTOR TYPICAL 7	Bus16	95.84	0.256	95.84	95.84	95.84	0.140	0.000	2.19E+001	2.19E+002		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	33.208	31.501	28.758	33.096
Peak Current (kA), Method C	:	78.731	74.684	68.182	78.466
Breaking Current (kA, rms, symm)	:		31.501	28.758	33.096
Steady State Current (kA, rms)	:	26.059	31.501	28.758	33.096

\# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus45**
Nominal kV = 0.415
Voltage c Factor = 1.05 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus45	Total	0.00	33.208	0.00	104.85	100.54	31.501	31.501	4.54E+001	3.67E+002	2.15E+001	4.30E+002
Bus16	Bus45	89.16	26.527	92.78	95.84	92.60	27.259	31.501 *	2.38E+001	4.62E+002	2.15E+001	4.30E+002
Lump29	Bus45	100.00	7.012	100.00	100.00	100.00	4.434	0.000	6.78E+002	1.61E+003		
Bus34	Bus16	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus37	Bus16	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus35	Bus16	94.37	0.026	96.45	99.32	98.93	0.014	0.000	1.42E+004	6.56E+003		
Bus42	Bus16	94.37	0.026	96.45	99.31	98.94	0.014	0.000	1.42E+004	6.64E+003		
Bus6	Bus16	91.13	1.385	91.64	91.54	91.33	0.758	0.000 *	2.90E+002	4.52E+001		
MOTOR TYPICAL 7	Bus16	95.84	0.256	95.84	95.84	95.84	0.140	0.000	2.19E+001	2.19E+002		

	3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms) :	33.208	31.501	28.758	33.096
Peak Current (kA), Method C :	78.731	74.684	68.182	78.466
Breaking Current (kA, rms, symm) :		31.501	28.758	33.096
Steady State Current (kA, rms) :	26.059	31.501	28.758	33.096

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus7**
Nominal kV = 16.500
Voltage c Factor = 1.10 (User-Defined)

Contribution		**3-Phase Fault**		**Line-To-Ground Fault**					**Positive & Zero Sequence Impedances Looking into "From Bus"**			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus7	Total	0.00	138.415	0.00	173.20	173.21	0.007	0.007	1.07E-001	2.78E+000	1.70E+005	2.28E+000
Main Bus 1	Bus7	97.86	77.696	105.00	105.00	105.00	0.003	0.000	1.41E-001	4.95E+000		
ST GEN 1	Bus7	100.00	60.728	100.00	100.00	100.00	0.004	0.007	3.26E-001	6.33E+000	1.70E+005	2.28E+000
Bus12	Main Bus 1	101.87	0.628	105.00	105.00	105.00	0.000	0.000	1.19E+001	1.55E+000		
Bus3	Main Bus 1	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.35E+001	8.91E+000		
Bus6	Main Bus 1	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.35E+001	8.91E+000		
Bus8	Main Bus 1	96.10	0.098	100.00	100.00	100.00	0.000	0.000 *	7.55E+001	1.36E+001		
Lump31	Main Bus 1	100.00	0.338	100.00	100.00	100.00	0.000	0.000	3.04E-001	3.04E+000		
Bus9	Main Bus 2	103.13	0.827	105.00	105.00	105.00	0.000	0.000	9.04E+000	1.21E+000		
Bus11	Main Bus 2	103.03	0.811	105.00	105.00	105.00	0.000	0.000	9.21E+000	1.23E+000		
Bus4	Main Bus 2	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.35E+001	8.91E+000		
Bus5	Main Bus 2	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.34E+001	8.93E+000		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	138.415	0.007	118.448	118.449
Peak Current (kA), Method C	:	368.082	0.018	314.983	314.988
Breaking Current (kA, rms, symm)	:		0.007	118.448	118.449
Steady State Current (kA, rms)	:	95.835	0.007	118.448	118.449

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Fault at bus: **Bus8**
Nominal kV = 16.500
Voltage c Factor = 1.10 (User-Defined)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus	To Bus	% V	kA	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
ID	ID	From Bus	Symm. rms	Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
Bus8	Total	0.00	139.569	0.00	173.20	173.21	0.007	0.007	1.08E-001	2.76E+000	1.70E+005	2.29E+000
Main Bus 1	Bus8	97.86	77.694	105.00	105.00	105.00	0.002	0.000	1.41E-001	4.95E+000		
ST GEN 2	Bus8	100.00	61.885	100.00	100.00	100.00	0.004	0.007	3.27E-001	6.21E+000	1.70E+005	2.29E+000
Bus12	Main Bus 1	101.86	0.628	105.00	105.00	105.00	0.000	0.000	1.19E+001	1.55E+000		
Bus3	Main Bus 1	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.35E+001	8.91E+000		
Bus6	Main Bus 1	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.35E+001	8.91E+000		
Bus7	Main Bus 1	96.06	0.097	100.00	100.00	100.00	0.000	0.000 *	7.62E+001	1.38E+001		
Lump31	Main Bus 1	100.00	0.338	100.00	100.00	100.00	0.000	0.000	3.04E-001	3.04E+000		
Bus9	Main Bus 2	103.13	0.827	105.00	105.00	105.00	0.000	0.000	9.04E+000	1.21E+000		
Bus11	Main Bus 2	103.03	0.811	105.00	105.00	105.00	0.000	0.000	9.21E+000	1.23E+000		
Bus4	Main Bus 2	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.35E+001	8.91E+000		
Bus5	Main Bus 2	96.51	0.090	100.00	100.00	100.00	0.000	0.000 *	8.34E+001	8.93E+000		

		3-Phase	L-G	L-L	L-L-G
Initial Symmetrical Current (kA, rms)	:	139.569	0.007	122.164	122.166
Peak Current (kA), Method C	:	370.956	0.018	324.695	324.700
Breaking Current (kA, rms, symm)	:		0.007	122.164	122.166
Steady State Current (kA, rms)	:	97.165	0.007	122.164	122.166

# Indicates a fault current contribution from a three-winding transformer.
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer.

Short-Circuit Summary Report

3-Phase, LG, LL, LLG Fault Currents

Bus		3-Phase Fault			Line-to-Ground Fault				Line-to-Line Fault				*Line-to-Line-to-Ground			
ID	kV	I"k	ip	Ik	I"k	ip	Ib	Ik	I"k	ip	Ib	Ik	I"k	ip	Ib	Ik
Bus9	400.000	54.551	135.004	53.988	39.785	98.461	39.785	39.785	47.235	116.898	47.235	47.235	50.725	125.536	50.725	50.725
Bus11	400.000	51.595	127.712	51.038	49.196	121.773	49.196	49.196	44.675	110.583	44.675	44.675	50.707	125.513	50.707	50.707
Bus12	400.000	30.755	76.307	30.255	28.089	69.693	28.089	28.089	26.628	66.067	26.628	26.628	29.846	74.053	29.846	29.846
Main Bus 1	400.000	43.922	107.911	35.376	36.890	90.635	36.890	36.890	37.963	93.270	37.963	37.963	43.214	106.172	43.214	43.214
Main Bus 2	400.000	43.922	107.911	35.376	36.890	90.635	36.890	36.890	37.963	93.270	37.963	37.963	43.214	106.172	43.214	43.214
Bus3	16.500	118.032	293.294	74.868	0.008	0.020	0.008	0.008	101.270	251.643	101.270	101.270	101.272	251.648	101.272	101.272
Bus13	6.600	27.659	70.114	21.688	26.206	66.430	26.206	26.206	23.945	60.699	23.945	23.945	27.409	69.482	27.409	27.409
Bus19	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus20	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus24	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus26	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus47	0.415	33.208	78.731	26.059	31.501	74.684	31.501	31.501	28.758	68.182	28.758	28.758	33.096	78.466	33.096	33.096
Bus4	16.500	118.032	293.294	74.868	0.008	0.020	0.008	0.008	101.270	251.643	101.270	101.270	101.272	251.648	101.272	101.272
Bus14	6.600	27.658	70.108	21.688	26.205	66.425	26.205	26.205	23.944	60.694	23.944	23.944	27.410	69.478	27.410	27.410
Bus21	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus23	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus25	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus39	0.415	33.208	78.731	26.059	31.501	74.684	31.501	31.501	28.758	68.182	28.758	28.758	33.096	78.466	33.096	33.096
Bus44	0.415	33.208	78.731	26.059	31.501	74.684	31.501	31.501	28.758	68.182	28.758	28.758	33.096	78.466	33.096	33.096
Bus5	16.500	118.144	293.523	74.868	0.008	0.020	0.008	0.008	101.367	251.841	101.367	101.367	101.369	251.846	101.369	101.369
Bus15	6.600	28.053	70.708	21.688	26.442	66.647	26.442	26.442	24.286	61.215	24.286	24.286	27.770	69.994	27.770	27.770
Bus33	0.415	32.908	80.028	25.791	31.195	75.862	31.195	31.195	28.498	69.305	28.498	28.498	32.858	79.906	32.858	32.858
Bus36	0.415	32.908	80.028	25.791	31.195	75.862	31.195	31.195	28.498	69.305	28.498	28.498	32.858	79.906	32.858	32.858
Bus38	0.415	32.908	80.028	25.791	31.195	75.862	31.195	31.195	28.498	69.305	28.498	28.498	32.858	79.906	32.858	32.858
Bus43	0.415	33.235	78.786	26.059	31.517	74.714	31.517	31.517	28.782	68.230	28.782	28.782	33.120	78.514	33.120	33.120
Bus46	0.415	32.908	80.028	25.791	31.195	75.862	31.195	31.195	28.498	69.305	28.498	28.498	32.858	79.906	32.858	32.858
Bus48	0.415	33.235	78.786	26.059	31.517	74.714	31.517	31.517	28.782	68.230	28.782	28.782	33.120	78.514	33.120	33.120
Bus6	16.500	118.032	293.294	74.868	0.008	0.020	0.008	0.008	101.270	251.643	101.270	101.270	101.272	251.648	101.272	101.272
Bus16	6.600	27.658	70.108	21.688	26.205	66.425	26.205	26.205	23.944	60.694	23.944	23.944	27.410	69.478	27.410	27.410
Bus34	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus35	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus37	0.415	32.881	79.970	25.791	31.179	75.830	31.179	31.179	28.476	69.255	28.476	28.476	32.834	79.856	32.834	32.834
Bus42	0.415	33.208	78.731	26.059	31.501	74.684	31.501	31.501	28.758	68.182	28.758	28.758	33.096	78.466	33.096	33.096
Bus45	0.415	33.208	78.731	26.059	31.501	74.684	31.501	31.501	28.758	68.182	28.758	28.758	33.096	78.466	33.096	33.096
Bus7	16.500	138.415	368.082	95.835	0.007	0.018	0.007	0.007	118.448	314.983	118.448	118.448	118.449	314.988	118.449	118.449
Bus8	16.500	139.569	370.956	97.165	0.007	0.018	0.007	0.007	122.164	324.695	122.164	122.164	122.166	324.700	122.166	122.166

All fault currents are in rms kA. Current ip is calculated using Method C.

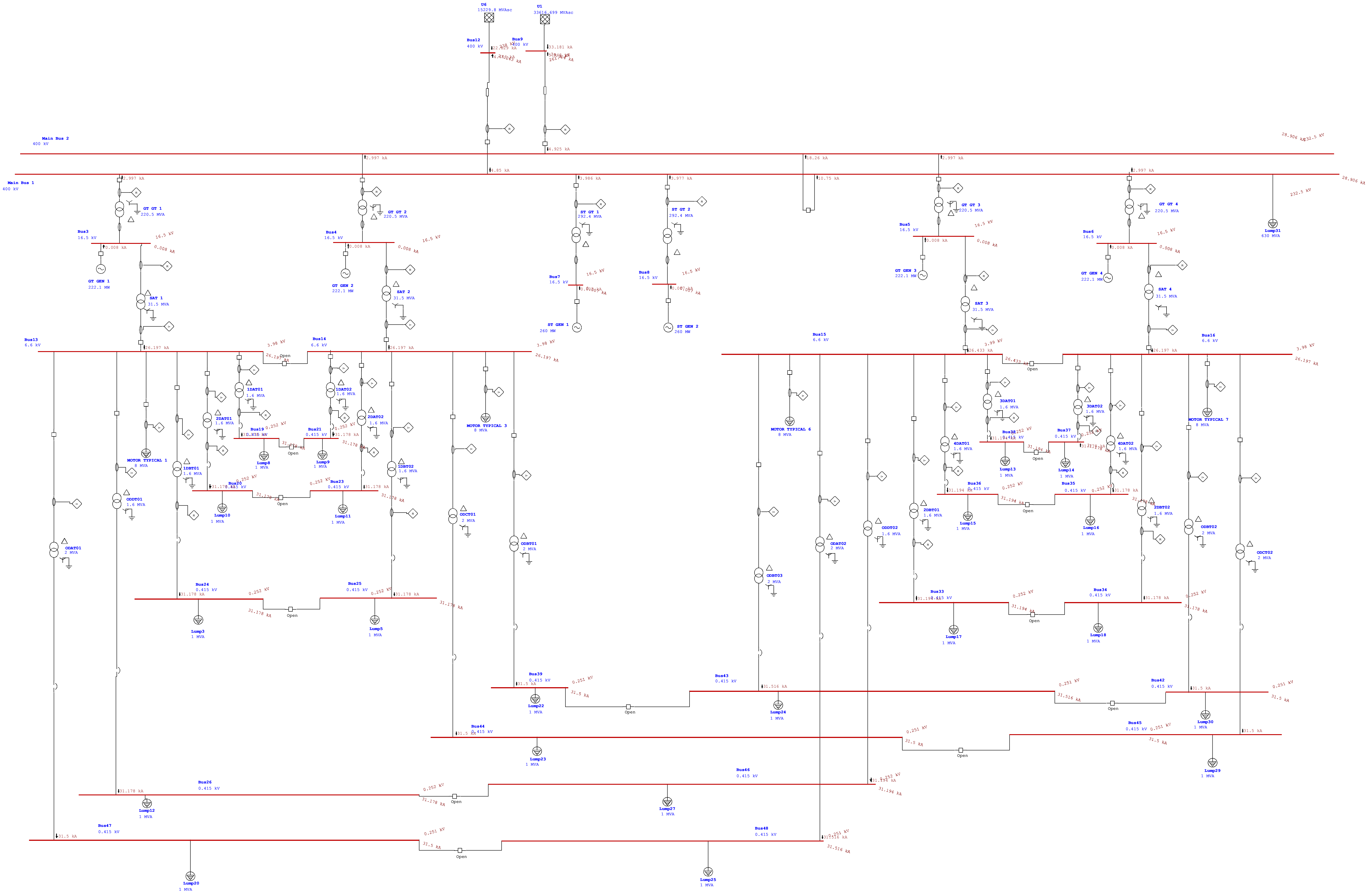
* LLG fault current is the larger of the two faulted line currents.

Sequence Impedance Summary Report

Bus		Positive Seq. Imp. (ohm)			Negative Seq. Imp. (ohm)			Zero Seq. Imp. (ohm)			Fault Zf (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
Bus9	400.000	0.45802	4.63428	4.65686	0.45955	4.63564	4.65836	1.76401	9.69711	9.85626	0.00000	0.00000	0.00000
Bus11	400.000	0.48375	4.89976	4.92358	0.48544	4.90127	4.92525	0.64171	5.60610	5.64271	0.00000	0.00000	0.00000
Bus12	400.000	0.79925	8.22115	8.25991	0.80351	8.22501	8.26417	1.34004	10.52512	10.61008	0.00000	0.00000	0.00000
Main Bus 1	400.000	0.64577	5.74759	5.78376	0.66741	5.76808	5.80657	2.74173	8.74101	9.16092	0.00000	0.00000	0.00000
Main Bus 2	400.000	0.64577	5.74759	5.78376	0.66741	5.76808	5.80657	2.74173	8.74101	9.16092	0.00000	0.00000	0.00000
Bus3	16.500	0.02702	0.08457	0.08878	0.03031	0.08524	0.09047	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus13	6.600	0.01120	0.15113	0.15155	0.01162	0.15121	0.15165	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus19	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus20	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus24	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus26	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus47	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus4	16.500	0.02702	0.08457	0.08878	0.03031	0.08524	0.09047	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus14	6.600	0.01121	0.15113	0.15155	0.01164	0.15121	0.15165	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus21	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus23	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus25	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus39	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus44	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus5	16.500	0.02699	0.08449	0.08870	0.03028	0.08516	0.09038	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus15	6.600	0.01159	0.14897	0.14942	0.01200	0.14903	0.14952	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus33	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus36	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus38	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus43	0.415	0.00093	0.00751	0.00757	0.00093	0.00751	0.00757	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus46	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus48	0.415	0.00093	0.00751	0.00757	0.00093	0.00751	0.00757	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus6	16.500	0.02702	0.08457	0.08878	0.03031	0.08524	0.09047	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus16	6.600	0.01121	0.15113	0.15155	0.01164	0.15121	0.15165	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus34	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus35	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus37	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus42	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus45	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000

Bus		Positive Seq. Imp. (ohm)			Negative Seq. Imp. (ohm)			Zero Seq. Imp. (ohm)			Fault Zf (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
Bus7	16.500	0.00292	0.07565	0.07571	0.00450	0.07740	0.07753	4622.58700	0.06218	4622.58700	0.00000	0.00000	0.00000
Bus8	16.500	0.00294	0.07502	0.07508	0.00485	0.07334	0.07350	4622.58400	0.06230	4622.58400	0.00000	0.00000	0.00000

SHORT CIRCUIT STUDY WITHOUT DTL LINE


U6
15229.8 MVAsc
U1
33616.699 MVAsc
Bus12
400 kV
Bus9
400 kV
Main Bus 2
400 kV
Main Bus 1
400 kV
GT GT 1
220.5 MVA
GT GT 2
220.5 MVA
ST GT 1
292.4 MVA
ST GT 2
292.4 MVA
GT GT 3
220.5 MVA
GT GT 4
220.5 MVA
Bus3
16.5 kV
Bus4
16.5 kV
Bus5
16.5 kV
Bus6
16.5 kV
Bus7
16.5 kV
Bus8
16.5 kV
GT GEN 1
222.1 MW
GT GEN 2
222.1 MW
GT GEN 3
222.1 MW
GT GEN 4
222.1 MW
ST GEN 1
260 MW
ST GEN 2
260 MW
SAT 1
31.5 MVA
SAT 2
31.5 MVA
SAT 3
31.5 MVA
SAT 4
31.5 MVA
Lump31
630 MVA
Bus13
6.6 kV
Bus14
6.6 kV
Bus15
6.6 kV
Bus16
6.6 kV
MOTOR TYPICAL 1
8 MVA
MOTOR TYPICAL 3
8 MVA
MOTOR TYPICAL 6
8 MVA
MOTOR TYPICAL 7
8 MVA
Bus39
0.415 kV
Bus43
0.415 kV
Bus42
0.415 kV
Bus44
0.415 kV
Bus45
0.415 kV
Bus46
0.415 kV
Bus26
0.415 kV
Bus47
0.415 kV
Bus48
0.415 kV
Open

Electrical Transient Analyzer Program

Short-Circuit Analysis

IEC 60909 Standard

3-Phase, LG, LL, & LLG Fault Currents

	Swing	V-Control	Load	Total
Number of Buses:	3	6	27	36

	XFMR2	XFMR3	Reactor	Line/Cable	Impedance	Tie PD	Total
Number of Branches:	31	0	0	2	0	1	34

	Synchronous Generator	Power Grid	Synchronous Motor	Induction Machines	Lumped Load	Total
Number of Machines:	6	3	0	0	26	35

System Frequency:	50.00
Unit System:	Metric
Project Filename:	bawana project 29-08
Output Filename:	G:\BAWANA FINAL\etap with coupler\29.08.2019\Untitled.SI2S

Adjustments

Tolerance	Apply Adjustments	Individual /Global	Percent
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	Yes	Individual	
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable Length:	No		

Temperature Correction	Apply Adjustments	Individual /Global	Degree C
Transmission Line Resistance:	Yes	Individual	
Cable Resistance:	Yes	Individual	

Bus Input Data

Bus					Initial Voltage	
ID	Type	Nom. kV	Base kV	Sub-sys	%Mag.	Ang.
Bus3	Gen.	16.500	16.500	1	100.00	30.00
Bus4	Gen.	16.500	16.500	1	100.00	30.00
Bus5	Gen.	16.500	16.500	1	100.00	30.00
Bus6	Gen.	16.500	16.500	1	100.00	30.00
Bus7	Gen.	16.500	16.500	1	100.00	30.00
Bus8	Gen.	16.500	16.500	1	100.00	30.00
Bus9	SWNG	400.000	420.000	1	105.00	0.00
Bus11	SWNG	400.000	420.000	2	105.00	0.00
Bus12	SWNG	400.000	420.000	1	105.00	0.00
Bus13	Load	6.600	6.900	1	100.00	0.00
Bus14	Load	6.600	6.900	1	100.00	0.00
Bus15	Load	6.600	6.900	1	100.00	0.00
Bus16	Load	6.600	6.900	1	100.00	0.00
Bus19	Load	0.415	0.453	1	100.00	-30.00
Bus20	Load	0.415	0.453	1	100.00	-30.00
Bus21	Load	0.415	0.453	1	100.00	-30.00
Bus23	Load	0.415	0.453	1	100.00	-30.00
Bus24	Load	0.415	0.453	1	100.00	-30.00
Bus25	Load	0.415	0.453	1	100.00	-30.00
Bus26	Load	0.415	0.453	1	100.00	-30.00
Bus33	Load	0.415	0.453	1	100.00	-30.00
Bus34	Load	0.415	0.453	1	100.00	-30.00
Bus35	Load	0.415	0.453	1	100.00	-30.00
Bus36	Load	0.415	0.453	1	100.00	-30.00
Bus37	Load	0.415	0.453	1	100.00	-30.00
Bus38	Load	0.415	0.453	1	100.00	-30.00
Bus39	Load	0.415	0.453	1	100.00	-30.00
Bus42	Load	0.415	0.453	1	100.00	-30.00
Bus43	Load	0.415	0.453	1	100.00	-30.00
Bus44	Load	0.415	0.453	1	100.00	-30.00
Bus45	Load	0.415	0.453	1	100.00	-30.00
Bus46	Load	0.415	0.453	1	100.00	-30.00
Bus47	Load	0.415	0.453	1	100.00	-30.00
Bus48	Load	0.415	0.453	1	100.00	-30.00
Main Bus 1	Load	400.000	420.000	1	95.24	0.00
Main Bus 2	Load	400.000	420.000	1	100.00	0.00

36 Buses Total

All voltages reported by ETAP are in % of bus Nominal kV.
Base kV values of buses are calculated and used internally by ETAP.

Line/Cable Input Data

ohms or siemens per 1000 m per Conductor (Cable) or per Phase (Line)

Line/Cable			Length									
ID	Library	Size	Adj. (m)	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
Bhaadurgarh		484.	48991.0	0.0	1	75	0.02666	0.33093		0.26118	1.03144	
Bhiwani		484.	48991.0	0.0	1	75	0.02666	0.33093		0.26118	1.03144	

Line / Cable resistances are listed at the specified temperatures.

2-Winding Transformer Input Data

Transformer	Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	MVA	Prim. kV	Sec. kV	% Z	X/R	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
1DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
1DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
1DBT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
1DBT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DBT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
2DBT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
3DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
3DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
4DAT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
4DAT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
GT GT 1	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
GT GT 2	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
GT GT 3	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
GT GT 4	220.600	420.000	16.500	13.50	1.50	0	0	0	0	0	13.50	YNd	-30.00
ODAT01	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODAT02	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODBT01	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODBT02	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODBT03	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODCT01	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODCT02	2.000	6.600	0.433	10.00	20.00	0	0	0	0	0	10.00	Dyn	30.00
ODDT01	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
ODDT02	1.600	6.600	0.433	8.00	45.00	0	0	0	0	0	8.00	Dyn	30.00
SAT 1	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
SAT 2	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
SAT 3	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
SAT 4	31.500	16.500	6.900	12.00	45.00	0	0	0	0	0	12.00	Dyn	30.00
ST GT 1	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.50	YNd	-30.00
ST GT 2	292.400	420.000	16.500	13.50	45.00	0	0	0	0	0	13.50	YNd	-30.00

2-Winding Transformer Grounding Input Data

Transformer	Rating			Conn.	Grounding Primary				Grounding Secondary			
ID	MVA	Prim. kV	Sec. kV	Type	Type	kV	Amp	ohm	Type	kV	Amp	ohm
1DAT01	1.600	6.600	0.433	D/Y					Solid			
1DAT02	1.600	6.600	0.433	D/Y					Solid			
1DBT01	1.600	6.600	0.433	D/Y					Solid			
1DBT02	1.600	6.600	0.433	D/Y					Solid			
2DAT01	1.600	6.600	0.433	D/Y					Solid			
2DAT02	1.600	6.600	0.433	D/Y					Solid			
2DBT01	1.600	6.600	0.433	D/Y					Solid			
2DBT02	1.600	6.600	0.433	D/Y					Solid			
3DAT01	1.600	6.600	0.433	D/Y					Solid			
3DAT02	1.600	6.600	0.433	D/Y					Solid			
4DAT01	1.600	6.600	0.433	D/Y					Solid			
4DAT02	1.600	6.600	0.433	D/Y					Solid			
GT GT 1	220.600	420.000	16.500	Y/D	Solid							
GT GT 2	220.600	420.000	16.500	Y/D	Solid							
GT GT 3	220.600	420.000	16.500	Y/D	Solid							
GT GT 4	220.600	420.000	16.500	Y/D	Solid							
ODAT01	2.000	6.600	0.433	D/Y					Solid			
ODAT02	2.000	6.600	0.433	D/Y					Solid			
ODBT01	2.000	6.600	0.433	D/Y					Solid			
ODBT02	2.000	6.600	0.433	D/Y					Solid			
ODBT03	2.000	6.600	0.433	D/Y					Solid			
ODCT01	2.000	6.600	0.433	D/Y					Solid			
ODCT02	2.000	6.600	0.433	D/Y					Solid			
ODDT01	1.600	6.600	0.433	D/Y					Solid			
ODDT02	1.600	6.600	0.433	D/Y					Solid			
SAT 1	31.500	16.500	6.900	D/Y					Solid			
SAT 2	31.500	16.500	6.900	D/Y					Solid			
SAT 3	31.500	16.500	6.900	D/Y					Solid			
SAT 4	31.500	16.500	6.900	D/Y					Solid			
ST GT 1	292.400	420.000	16.500	Y/D	Solid							
ST GT 2	292.400	420.000	16.500	Y/D	Solid							

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVAb			
ID	Type	From Bus	To Bus	R	X	Z	Y
1DAT01	2W XFMR	Bus13	Bus19	9.67	435.32	435.43	
1DAT02	2W XFMR	Bus14	Bus21	9.67	435.32	435.43	
1DBT01	2W XFMR	Bus13	Bus24	9.67	435.32	435.43	
1DBT02	2W XFMR	Bus14	Bus25	9.67	435.32	435.43	
2DAT01	2W XFMR	Bus13	Bus20	9.67	435.32	435.43	
2DAT02	2W XFMR	Bus14	Bus23	9.67	435.32	435.43	
2DBT01	2W XFMR	Bus15	Bus33	9.67	435.32	435.43	
2DBT02	2W XFMR	Bus16	Bus34	9.67	435.32	435.43	
3DAT01	2W XFMR	Bus15	Bus38	9.67	435.32	435.43	
3DAT02	2W XFMR	Bus16	Bus37	9.67	435.32	435.43	
4DAT01	2W XFMR	Bus15	Bus36	9.67	435.32	435.43	
4DAT02	2W XFMR	Bus16	Bus35	9.67	435.32	435.43	
GT GT 1	2W XFMR	Main Bus 1	Bus3	3.29	4.94	5.94	
GT GT 2	2W XFMR	Main Bus 2	Bus4	3.29	4.94	5.94	
GT GT 3	2W XFMR	Main Bus 2	Bus5	3.29	4.94	5.94	
GT GT 4	2W XFMR	Main Bus 1	Bus6	3.29	4.94	5.94	
ODAT01	2W XFMR	Bus13	Bus47	21.50	429.99	430.52	
ODAT02	2W XFMR	Bus15	Bus48	21.50	429.99	430.52	
ODBT01	2W XFMR	Bus14	Bus39	21.50	429.99	430.52	
ODBT02	2W XFMR	Bus16	Bus42	21.50	429.99	430.52	
ODBT03	2W XFMR	Bus15	Bus43	21.50	429.99	430.52	
ODCT01	2W XFMR	Bus14	Bus44	21.50	429.99	430.52	
ODCT02	2W XFMR	Bus16	Bus45	21.50	429.99	430.52	
ODDT01	2W XFMR	Bus13	Bus26	9.67	435.32	435.43	
ODDT02	2W XFMR	Bus15	Bus46	9.67	435.32	435.43	
SAT 1	2W XFMR	Bus3	Bus13	0.83	37.13	37.14	
SAT 2	2W XFMR	Bus4	Bus14	0.83	37.13	37.14	
SAT 3	2W XFMR	Bus5	Bus15	0.83	37.13	37.14	
SAT 4	2W XFMR	Bus6	Bus16	0.83	37.13	37.14	
ST GT 1	2W XFMR	Main Bus 1	Bus7	0.10	4.47	4.47	
ST GT 2	2W XFMR	Main Bus 1	Bus8	0.10	4.48	4.48	
Bhaadurgarh	Line	Bus12	Main Bus 1	0.07	0.92	0.92	
Bhiwani	Line	Bus9	Main Bus 2	0.07	0.92	0.92	
CB94	Tie Breakr	Main Bus 2	Main Bus 1				

Power Grid Input Data

		Rating		% Impedance 100 MVA Base			Grounding
Power Grid ID	Connected Bus ID	MVASC	kV	R	X"	R/X"	Type
U1	Bus9	33616.700	420.000	0.02960	0.29599	0.10	Wye - Solid
U5	Bus11	31342.200	420.000	0.03175	0.31748	0.10	Wye - Solid
U6	Bus12	15229.800	420.000	0.06533	0.65335	0.10	Wye - Solid

Total Connected Power Grids (= 3): 80188.700 MVA

Synchronous Generator Input Data

Synchronous Generator		Rating				% Impedance in Machine Base					Grounding			Excitation
							Xd"							
ID	Type	MVA	kV	RPM	% PF	R	Adj.	Tol.	R/X	Xd, sat	Conn.	Type	Amp	Type
GT GEN 1		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
GT GEN 2		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
GT GEN 3		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
GT GEN 4		261.294	16.500	1500	85.00	1.000	16.60	0.0	0.06	162.90	Wye		7.28	Turbine 130%
ST GEN 1	Turbo	305.882	16.500	1500	85.00	1.000	19.40	0.0	0.05	190.70	Wye		6.18	Turbine 130%
ST GEN 2	Turbo	305.882	16.500	1500	85.00	1.000	19.00	0.0	0.05	155.00	Wye		6.18	Turbine 130%

Total Connected Synchronous Generators (= 6.00) : 1,656.941 MVA

Lumped Load Input Data

Lumped Load							Motor Loads								
	Rating				% Load		Loading		% Impedance (Machine Base)			Grounding			mFact.
Lumped Load ID	kVA	kV	Amp	% PF	MTR	STAT	kW	kvar	R	X"	R/X"	Conn.	Type	Amp	MW/PP
Lump3	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump5	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump8	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump9	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump10	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump11	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump12	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump13	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump14	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump15	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump16	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump17	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump18	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump20	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump22	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump23	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump24	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump25	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump27	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump29	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump30	1000.0	0.415	1391.21	85.00	80	20	680.00	421.43	6.46		0.42	Delta			0.68
Lump31	630000.0	420.000	866.03	85.00	80	20	428400.00	265498.50	1.53		0.10	Delta			428.40
MOTOR TYPICAL 1	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44
MOTOR TYPICAL 3	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44
MOTOR TYPICAL 6	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44
MOTOR TYPICAL 7	8000.0	6.600	699.82	85.00	80	20	5440.00	3371.41	1.53		0.10	Delta			5.44

Total Connected Lumped Loads (= 26): 683000.0 kVA

SHORT- CIRCUIT REPORT

Fault at bus : **Bus9**
Nominal kV = 400.000 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus9	Total	100.03	0.0	50.01	180.0	50.01	180.0	0.000	0.0	45.877	-174.2	45.877	5.8	26.487	26.487	0.000
Main Bus 2	Bus9	100.11	-0.1	69.54	-134.5	71.52	135.9	0.017	-127.8	7.757	-173.9	7.769	6.2	4.488	4.476	0.000
U1	Bus9	95.24	0.0	95.24	-120.0	95.24	120.0	0.017	52.2	38.120	-174.3	38.108	5.7	21.999	22.011	0.000
Bus4	Main Bus 2	92.64	23.5	74.55	-93.4	88.85	155.0	0.008	-103.5	0.453	-163.4	0.457	17.5	0.266	0.259	0.000
Bus5	Main Bus 2	92.64	23.5	74.56	-93.4	88.85	155.0	0.008	-103.4	0.453	-163.3	0.458	17.5	0.266	0.259	0.000
Bus12	Main Bus 1	100.05	0.0	85.90	-125.0	86.82	125.8	0.013	52.4	3.240	-176.9	3.231	2.9	1.863	1.873	0.000
Bus3	Main Bus 1	92.64	23.5	74.55	-93.4	88.85	155.0	0.008	-103.5	0.453	-163.4	0.457	17.5	0.266	0.259	0.000
Bus6	Main Bus 1	92.64	23.5	74.55	-93.4	88.85	155.0	0.008	-103.5	0.453	-163.4	0.457	17.5	0.266	0.259	0.000
Bus7	Main Bus 1	89.41	23.4	71.49	-88.9	90.88	156.7	0.010	-131.3	0.490	-179.5	0.497	1.4	0.289	0.281	0.000
Bus8	Main Bus 1	89.10	23.7	72.22	-88.9	90.65	156.3	0.013	130.2	0.510	-178.3	0.518	0.6	0.292	0.302	0.000
Lump31	Main Bus 1	95.24	0.0	95.24	-120.0	95.24	120.0	0.007	53.0	1.745	-176.3	1.741	3.5	1.004	1.009	0.000

\# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus12**

Nominal kV = 400.000 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus12	Total	100.04	0.0	50.02	180.0	50.02	180.0	0.000	0.0	25.434	-174.2	25.434	5.8	14.684	14.684	0.000
Main Bus 1	Bus12	100.10	-0.1	71.55	-133.1	73.21	134.4	0.012	-127.4	8.162	-174.2	8.171	5.9	4.719	4.711	0.000
U6	Bus12	95.24	0.0	95.24	-120.0	95.24	120.0	0.012	52.6	17.271	-174.3	17.263	5.7	9.965	9.974	0.000
Bus3	Main Bus 1	92.81	24.0	76.00	-93.1	89.25	154.7	0.008	-103.3	0.421	-163.2	0.425	17.7	0.248	0.241	0.000
Bus6	Main Bus 1	92.81	24.0	76.00	-93.1	89.25	154.7	0.008	-103.3	0.421	-163.2	0.425	17.7	0.248	0.241	0.000
Bus7	Main Bus 1	89.81	23.9	73.16	-89.0	91.11	156.2	0.009	-131.1	0.456	-179.3	0.462	1.5	0.268	0.262	0.000
Bus8	Main Bus 1	89.53	24.2	73.83	-89.0	90.91	155.9	0.012	130.4	0.474	-178.1	0.481	0.7	0.271	0.280	0.000
Lump31	Main Bus 1	95.24	0.0	95.24	-120.0	95.24	120.0	0.006	53.2	1.622	-176.1	1.618	3.7	0.933	0.938	0.000
Bus9	Main Bus 2	100.03	0.0	92.09	-122.6	92.58	123.0	0.016	52.4	3.965	-176.9	3.954	2.9	2.280	2.292	0.000
Bus4	Main Bus 2	92.81	24.0	76.00	-93.1	89.25	154.7	0.008	-103.3	0.421	-163.2	0.425	17.7	0.248	0.241	0.000
Bus5	Main Bus 2	92.81	24.0	76.02	-93.1	89.26	154.6	0.008	-103.3	0.422	-163.2	0.425	17.7	0.248	0.241	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Main Bus 1**

Nominal kV = 400.000 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Main Bus 1	Total	100.26	-0.1	50.13	179.9	50.13	179.9	0.000	0.0	28.171	-172.9	28.171	7.1	16.264	16.264	0.000
Bus12	Main Bus 1	100.11	-0.1	69.41	-135.7	70.07	136.1	0.030	54.5	7.595	-174.8	7.575	5.0	4.368	4.391	0.000
Bus3	Main Bus 1	92.08	14.3	48.38	-104.5	80.76	162.7	0.019	-101.4	1.062	-161.3	1.072	19.6	0.624	0.608	0.000
Bus6	Main Bus 1	92.08	14.3	48.38	-104.5	80.76	162.7	0.019	-101.4	1.062	-161.3	1.072	19.6	0.624	0.608	0.000
Bus7	Main Bus 1	84.73	13.1	39.48	-88.2	86.18	166.4	0.023	-129.2	1.150	-177.4	1.165	3.5	0.677	0.660	0.000
Bus8	Main Bus 1	83.80	13.7	41.17	-88.1	85.49	165.6	0.031	132.3	1.195	-176.2	1.214	2.6	0.684	0.707	0.000
Lump31	Main Bus 1	95.24	0.0	95.24	-120.0	95.24	120.0	0.016	55.1	4.091	-174.2	4.080	5.6	2.353	2.365	0.000
Bus9	Main Bus 2	100.07	0.0	80.95	-127.9	81.40	128.2	0.040	54.3	9.996	-175.0	9.970	4.8	5.749	5.779	0.000
Bus4	Main Bus 2	92.08	14.3	48.38	-104.5	80.76	162.7	0.019	-101.4	1.062	-161.3	1.072	19.6	0.624	0.608	0.000
Bus5	Main Bus 2	92.08	14.3	48.42	-104.5	80.77	162.7	0.019	-101.4	1.063	-161.2	1.073	19.6	0.625	0.608	0.000
U6	Bus12	95.24	0.0	95.24	-120.0	95.24	120.0	0.030	54.5	7.595	-174.8	7.575	5.0	4.368	4.391	0.000
Bus13	Bus3	100.20	-0.4	76.82	-138.8	66.53	129.6	0.540	23.5	1.047	-157.7	0.507	21.2	0.518	0.530	0.000
GT GEN 1	Bus3	95.24	30.0	95.24	-90.0	95.24	150.0	14.930	17.6	30.312	-160.9	15.391	20.5	15.374	14.939	0.000
Bus16	Bus6	100.20	-0.4	76.82	-138.8	66.53	129.6	0.540	23.5	1.047	-157.6	0.507	21.2	0.518	0.530	0.000
GT GEN 4	Bus6	95.24	30.0	95.24	-90.0	95.24	150.0	14.930	17.6	30.312	-160.9	15.391	20.5	15.374	14.939	0.000
ST GEN 1	Bus7	95.24	30.0	95.24	-90.0	95.24	150.0	16.670	1.7	34.016	-177.0	17.354	4.3	17.227	16.791	0.000
ST GEN 2	Bus8	95.24	30.0	95.24	-90.0	95.24	150.0	17.282	4.9	35.398	-176.8	18.132	1.6	17.399	18.003	0.000
U1	Bus9	95.24	0.0	95.24	-120.0	95.24	120.0	0.040	54.3	9.996	-175.0	9.970	4.8	5.749	5.779	0.000
Bus14	Bus4	100.20	-0.4	76.82	-138.8	66.53	129.6	0.540	23.5	1.047	-157.6	0.507	21.2	0.518	0.530	0.000
GT GEN 2	Bus4	95.24	30.0	95.24	-90.0	95.24	150.0	14.930	17.6	30.312	-160.9	15.391	20.5	15.374	14.939	0.000
Bus15	Bus5	100.19	-0.4	76.95	-138.4	67.03	129.5	0.569	23.8	1.102	-157.3	0.534	21.5	0.545	0.557	0.000
GT GEN 3	Bus5	95.24	30.0	95.24	-90.0	95.24	150.0	14.916	17.6	30.284	-160.9	15.377	20.5	15.360	14.926	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Main Bus 2**

Nominal kV = 400.000 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Main Bus 2	Total	100.26	-0.1	50.13	179.9	50.13	179.9	0.000	0.0	28.171	-172.9	28.171	7.1	16.264	16.264	0.000
Bus9	Main Bus 2	100.07	0.0	80.95	-127.9	81.40	128.2	0.040	54.3	9.996	-175.0	9.970	4.8	5.749	5.779	0.000
Bus4	Main Bus 2	92.08	14.3	48.38	-104.5	80.76	162.7	0.019	-101.4	1.062	-161.3	1.072	19.6	0.624	0.608	0.000
Bus5	Main Bus 2	92.08	14.3	48.42	-104.5	80.77	162.7	0.019	-101.4	1.063	-161.2	1.073	19.6	0.625	0.608	0.000
Bus12	Main Bus 1	100.11	-0.1	69.41	-135.7	70.07	136.1	0.030	54.5	7.595	-174.8	7.575	5.0	4.368	4.391	0.000
Bus3	Main Bus 1	92.08	14.3	48.38	-104.5	80.76	162.7	0.019	-101.4	1.062	-161.3	1.072	19.6	0.624	0.608	0.000
Bus6	Main Bus 1	92.08	14.3	48.38	-104.5	80.76	162.7	0.019	-101.4	1.062	-161.3	1.072	19.6	0.624	0.608	0.000
Bus7	Main Bus 1	84.73	13.1	39.48	-88.2	86.18	166.4	0.023	-129.2	1.150	-177.4	1.165	3.5	0.677	0.660	0.000
Bus8	Main Bus 1	83.80	13.7	41.17	-88.1	85.49	165.6	0.031	132.3	1.195	-176.2	1.214	2.6	0.684	0.707	0.000
Lump31	Main Bus 1	95.24	0.0	95.24	-120.0	95.24	120.0	0.016	55.1	4.091	-174.2	4.080	5.6	2.353	2.365	0.000
U1	Bus9	95.24	0.0	95.24	-120.0	95.24	120.0	0.040	54.3	9.996	-175.0	9.970	4.8	5.749	5.779	0.000
Bus14	Bus4	100.20	-0.4	76.82	-138.8	66.53	129.6	0.540	23.5	1.047	-157.6	0.507	21.2	0.518	0.530	0.000
GT GEN 2	Bus4	95.24	30.0	95.24	-90.0	95.24	150.0	14.930	17.6	30.312	-160.9	15.391	20.5	15.374	14.939	0.000
Bus15	Bus5	100.19	-0.4	76.95	-138.4	67.03	129.5	0.569	23.8	1.102	-157.3	0.534	21.5	0.545	0.557	0.000
GT GEN 3	Bus5	95.24	30.0	95.24	-90.0	95.24	150.0	14.916	17.6	30.284	-160.9	15.377	20.5	15.360	14.926	0.000
U6	Bus12	95.24	0.0	95.24	-120.0	95.24	120.0	0.030	54.5	7.595	-174.8	7.575	5.0	4.368	4.391	0.000
Bus13	Bus3	100.20	-0.4	76.82	-138.8	66.53	129.6	0.540	23.5	1.047	-157.7	0.507	21.2	0.518	0.530	0.000
GT GEN 1	Bus3	95.24	30.0	95.24	-90.0	95.24	150.0	14.930	17.6	30.312	-160.9	15.391	20.5	15.374	14.939	0.000
Bus16	Bus6	100.20	-0.4	76.82	-138.8	66.53	129.6	0.540	23.5	1.047	-157.6	0.507	21.2	0.518	0.530	0.000
GT GEN 4	Bus6	95.24	30.0	95.24	-90.0	95.24	150.0	14.930	17.6	30.312	-160.9	15.391	20.5	15.374	14.939	0.000
ST GEN 1	Bus7	95.24	30.0	95.24	-90.0	95.24	150.0	16.670	1.7	34.016	-177.0	17.354	4.3	17.227	16.791	0.000
ST GEN 2	Bus8	95.24	30.0	95.24	-90.0	95.24	150.0	17.282	4.9	35.398	-176.8	18.132	1.6	17.399	18.003	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus3**
Nominal kV = 16.500 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus3	Total	100.98	-0.9	50.49	179.1	50.49	179.1	0.000	0.0	100.504	-161.7	100.504	18.3	58.026	58.026	0.000
Main Bus 1	Bus3	102.12	-28.8	104.83	-152.1	98.37	88.2	1.104	62.1	51.507	-147.8	50.552	31.5	29.187	29.743	0.000
Bus13	Bus3	93.23	-7.2	90.39	-174.1	21.17	97.0	0.040	38.9	1.835	-171.4	1.801	8.0	1.039	1.060	0.000
GT GEN 1	Bus3	100.00	0.0	100.00	-120.0	100.00	120.0	1.141	-118.7	50.145	-175.5	50.779	5.5	29.609	28.660	0.000
Bus12	Main Bus 1	103.74	-29.5	104.89	-150.9	102.06	89.2	0.313	-150.8	0.334	-148.5	0.647	30.4	0.320	0.327	0.000
Bus6	Main Bus 1	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus7	Main Bus 1	100.13	0.0	97.95	-121.7	96.51	120.2	0.049	-151.3	0.050	-152.1	0.099	28.3	0.050	0.049	0.000
Bus8	Main Bus 1	100.05	-0.1	97.96	-121.7	96.62	120.2	0.051	-154.1	0.052	-149.0	0.103	28.5	0.050	0.053	0.000
Lump31	Main Bus 1	100.00	-30.0	100.00	-150.0	100.00	90.0	0.169	-150.2	0.180	-147.9	0.349	31.0	0.172	0.176	0.000
Bus9	Main Bus 2	104.25	-29.7	104.93	-150.5	103.24	89.6	0.413	-151.0	0.439	-148.7	0.852	30.2	0.421	0.431	0.000
Bus4	Main Bus 2	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus5	Main Bus 2	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus19	Bus13	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus24	Bus13	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus20	Bus13	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus47	Bus13	69.80	-29.3	109.65	179.4	58.87	34.0	0.165	-163.9	0.175	-161.9	0.341	17.1	0.169	0.172	0.000
Bus26	Bus13	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
MOTOR TYPICAL 1	Bus13	104.55	-30.0	104.55	-150.0	104.55	90.0	1.626	-177.0	1.720	-175.1	3.345	3.9	1.657	1.689	0.000

# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus13**

Nominal kV = 6.600 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus13	Total	100.04	-0.1	50.02	179.9	50.02	179.9	0.000	0.0	23.933	-175.7	23.933	4.3	13.818	13.818	0.000
Bus19	Bus13	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus24	Bus13	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus20	Bus13	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus47	Bus13	93.79	-6.2	88.06	-173.6	20.79	106.0	0.001	33.7	0.353	-161.1	0.353	18.9	0.204	0.204	0.000
Bus26	Bus13	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus3	Bus13	92.66	28.0	87.43	-88.6	94.73	152.4	0.009	-155.2	18.762	-177.3	18.770	2.7	10.836	10.833	0.000
MOTOR TYPICAL 1	Bus13	100.00	0.0	100.00	-120.0	100.00	120.0	0.006	20.5	3.469	-174.3	3.464	5.7	2.001	2.002	0.000
Lump8	Bus19	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump3	Bus24	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump10	Bus20	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump20	Bus47	104.34	-30.0	104.34	-150.0	104.34	90.0	3.098	-161.1	3.113	-161.1	6.211	18.9	3.104	3.107	0.000
Lump12	Bus26	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Main Bus 1	Bus3	100.44	0.0	100.08	-120.2	100.00	120.1	2.237	18.2	4.344	-162.8	2.107	16.1	2.150	2.195	0.000
GT GEN 1	Bus3	95.65	30.0	95.65	-90.0	95.65	150.0	2.446	-11.5	4.976	170.1	2.531	-8.4	2.526	2.450	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus19**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus19	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus13	Bus19	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump8	Bus19	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus24	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus20	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus47	Bus13	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus26	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus3	Bus13	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 1	Bus13	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus20**
Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)								
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic		Sequence Current (kA)		
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus20	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus13	Bus20	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump10	Bus20	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus19	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus24	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus47	Bus13	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus26	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus3	Bus13	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 1	Bus13	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

\# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus24**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus24	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus13	Bus24	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump3	Bus24	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus19	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus20	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus47	Bus13	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus26	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus3	Bus13	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 1	Bus13	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus26**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus26	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus13	Bus26	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump12	Bus26	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus19	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus24	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus20	Bus13	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus47	Bus13	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus3	Bus13	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 1	Bus13	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus47**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus47	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.757	-172.9	28.757	7.1	16.603	16.603	0.000
Bus13	Bus47	94.15	28.3	89.15	-89.9	94.28	151.8	0.001	-147.5	22.972	-177.1	22.972	2.9	13.263	13.263	0.000
Lump20	Bus47	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	32.5	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus19	Bus13	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.5	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus24	Bus13	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.5	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus20	Bus13	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.5	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus26	Bus13	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.5	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus3	Bus13	91.19	59.9	91.34	-59.8	91.68	180.0	0.692	1.6	1.384	-178.4	0.693	1.6	0.692	0.692	0.000
MOTOR TYPICAL 1	Bus13	95.84	30.0	95.84	-90.0	95.84	150.0	0.128	4.6	0.256	-175.4	0.128	4.5	0.128	0.128	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus4**

Nominal kV = 16.500 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)								
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic		Sequence Current (kA)		
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus4	Total	100.98	-0.9	50.49	179.1	50.49	179.1	0.000	0.0	100.504	-161.7	100.504	18.3	58.026	58.026	0.000
Main Bus 2	Bus4	102.12	-28.8	104.83	-152.1	98.37	88.2	1.104	62.1	51.507	-147.8	50.552	31.5	29.187	29.743	0.000
Bus14	Bus4	93.23	-7.2	90.38	-174.1	21.17	97.0	0.040	38.9	1.835	-171.4	1.801	8.0	1.039	1.060	0.000
GT GEN 2	Bus4	100.00	0.0	100.00	-120.0	100.00	120.0	1.141	-118.7	50.145	-175.5	50.779	5.5	29.609	28.660	0.000
Bus9	Main Bus 2	104.25	-29.7	104.93	-150.5	103.24	89.6	0.413	-151.0	0.439	-148.7	0.852	30.2	0.421	0.431	0.000
Bus5	Main Bus 2	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus12	Main Bus 1	103.74	-29.5	104.89	-150.9	102.06	89.2	0.313	-150.8	0.334	-148.5	0.647	30.4	0.320	0.327	0.000
Bus3	Main Bus 1	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus6	Main Bus 1	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus7	Main Bus 1	100.13	0.0	97.95	-121.7	96.51	120.2	0.049	-151.3	0.050	-152.1	0.099	28.3	0.050	0.049	0.000
Bus8	Main Bus 1	100.05	-0.1	97.96	-121.7	96.62	120.2	0.051	-154.1	0.052	-149.0	0.103	28.5	0.050	0.053	0.000
Lump31	Main Bus 1	100.00	-30.0	100.00	-150.0	100.00	90.0	0.169	-150.2	0.180	-147.9	0.349	31.0	0.172	0.176	0.000
Bus21	Bus14	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus25	Bus14	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus23	Bus14	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus39	Bus14	69.81	-29.3	109.65	179.4	58.87	34.1	0.165	-163.9	0.175	-162.0	0.341	17.1	0.169	0.172	0.000
Bus44	Bus14	69.81	-29.3	109.65	179.4	58.87	34.1	0.165	-163.9	0.175	-162.0	0.341	17.1	0.169	0.172	0.000
MOTOR TYPICAL 3	Bus14	104.55	-30.0	104.55	-150.0	104.55	90.0	1.626	-177.0	1.720	-175.1	3.345	3.9	1.657	1.689	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus14**

Nominal kV = 6.600 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus14	Total	100.04	-0.1	50.02	179.9	50.02	179.9	0.000	0.0	23.932	-175.7	23.932	4.3	13.817	13.817	0.000
Bus21	Bus14	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus25	Bus14	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus23	Bus14	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus39	Bus14	93.79	-6.2	88.06	-173.6	20.79	106.0	0.001	33.7	0.353	-161.1	0.353	18.9	0.204	0.204	0.000
Bus44	Bus14	93.79	-6.2	88.06	-173.6	20.79	106.0	0.001	33.7	0.353	-161.1	0.353	18.9	0.204	0.204	0.000
Bus4	Bus14	92.66	28.0	87.43	-88.6	94.73	152.4	0.009	-155.2	18.762	-177.3	18.770	2.7	10.836	10.833	0.000
MOTOR TYPICAL 3	Bus14	100.00	0.0	100.00	-120.0	100.00	120.0	0.006	20.5	3.469	-174.3	3.464	5.7	2.001	2.002	0.000
Lump9	Bus21	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump5	Bus25	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump11	Bus23	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump22	Bus39	104.34	-30.0	104.34	-150.0	104.34	90.0	3.098	-161.1	3.113	-161.1	6.211	18.9	3.104	3.107	0.000
Lump23	Bus44	104.34	-30.0	104.34	-150.0	104.34	90.0	3.098	-161.1	3.113	-161.1	6.211	18.9	3.104	3.107	0.000
Main Bus 2	Bus4	100.44	0.0	100.08	-120.2	100.00	120.1	2.237	18.2	4.344	-162.8	2.107	16.1	2.150	2.195	0.000
GT GEN 2	Bus4	95.65	30.0	95.65	-90.0	95.65	150.0	2.446	-11.5	4.976	170.1	2.531	-8.4	2.526	2.450	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus21**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus21	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus14	Bus21	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump9	Bus21	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus25	Bus14	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus23	Bus14	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus39	Bus14	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus44	Bus14	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus4	Bus14	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 3	Bus14	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus23**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus23	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus14	Bus23	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump11	Bus23	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus21	Bus14	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus25	Bus14	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus39	Bus14	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus44	Bus14	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus4	Bus14	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 3	Bus14	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus25**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus25	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus14	Bus25	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump5	Bus25	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus21	Bus14	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus23	Bus14	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus39	Bus14	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus44	Bus14	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus4	Bus14	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 3	Bus14	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus39**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)								
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic		Sequence Current (kA)		
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus39	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.757	-172.9	28.757	7.1	16.603	16.603	0.000
Bus14	Bus39	94.15	28.3	89.15	-89.9	94.28	151.8	0.001	-147.5	22.971	-177.1	22.972	2.9	13.263	13.263	0.000
Lump22	Bus39	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	32.5	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus21	Bus14	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus25	Bus14	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus23	Bus14	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus44	Bus14	100.00	0.0	95.58	-121.2	96.03	121.7	0.013	17.8	0.026	-162.2	0.013	17.7	0.013	0.013	0.000
Bus4	Bus14	91.19	59.9	91.34	-59.8	91.68	180.0	0.692	1.6	1.384	-178.4	0.693	1.6	0.692	0.692	0.000
MOTOR TYPICAL 3	Bus14	95.84	30.0	95.84	-90.0	95.84	150.0	0.128	4.6	0.256	-175.4	0.128	4.5	0.128	0.128	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus44**
Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus44	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.757	-172.9	28.757	7.1	16.603	16.603	0.000
Bus14	Bus44	94.15	28.3	89.15	-89.9	94.28	151.8	0.001	-147.5	22.971	-177.1	22.972	2.9	13.263	13.263	0.000
Lump23	Bus44	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	32.5	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus21	Bus14	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus25	Bus14	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus23	Bus14	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus39	Bus14	100.00	0.0	95.58	-121.2	96.03	121.7	0.013	17.8	0.026	-162.2	0.013	17.7	0.013	0.013	0.000
Bus4	Bus14	91.19	59.9	91.34	-59.8	91.68	180.0	0.692	1.6	1.384	-178.4	0.693	1.6	0.692	0.692	0.000
MOTOR TYPICAL 3	Bus14	95.84	30.0	95.84	-90.0	95.84	150.0	0.128	4.6	0.256	-175.4	0.128	4.5	0.128	0.128	0.000

# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus5**

Nominal kV = 16.500 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus5	Total	100.97	-0.9	50.49	179.1	50.49	179.1	0.000	0.0	100.601	-161.7	100.601	18.3	58.082	58.082	0.000
Main Bus 2	Bus5	102.12	-28.8	104.83	-152.1	98.37	88.2	1.103	62.1	51.506	-147.8	50.553	31.5	29.188	29.743	0.000
Bus15	Bus5	93.42	-7.5	90.30	-173.7	22.30	97.4	0.042	39.3	1.932	-171.1	1.896	8.3	1.095	1.116	0.000
GT GEN 3	Bus5	100.00	0.0	100.00	-120.0	100.00	120.0	1.142	-118.7	50.145	-175.5	50.779	5.5	29.609	28.660	0.000
Bus9	Main Bus 2	104.25	-29.7	104.93	-150.5	103.24	89.6	0.413	-151.0	0.439	-148.7	0.852	30.2	0.421	0.431	0.000
Bus4	Main Bus 2	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus12	Main Bus 1	103.74	-29.5	104.89	-150.9	102.06	89.2	0.313	-150.8	0.334	-148.5	0.647	30.4	0.320	0.327	0.000
Bus3	Main Bus 1	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus6	Main Bus 1	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus7	Main Bus 1	100.13	0.0	97.95	-121.7	96.51	120.2	0.049	-151.3	0.050	-152.1	0.099	28.3	0.050	0.049	0.000
Bus8	Main Bus 1	100.05	-0.1	97.96	-121.7	96.62	120.2	0.051	-154.1	0.052	-149.0	0.103	28.5	0.050	0.053	0.000
Lump31	Main Bus 1	100.00	-30.0	100.00	-150.0	100.00	90.0	0.169	-150.2	0.180	-147.9	0.349	31.0	0.172	0.176	0.000
Bus33	Bus15	70.66	-29.7	109.63	179.4	58.96	35.0	0.163	-164.4	0.173	-162.5	0.336	16.6	0.166	0.170	0.000
Bus38	Bus15	70.66	-29.7	109.63	179.4	58.96	35.0	0.163	-164.4	0.173	-162.5	0.336	16.6	0.166	0.170	0.000
Bus36	Bus15	70.66	-29.7	109.63	179.4	58.96	35.0	0.163	-164.4	0.173	-162.5	0.336	16.6	0.166	0.170	0.000
Bus48	Bus15	70.32	-29.8	109.64	179.4	59.22	34.8	0.163	-164.1	0.173	-162.2	0.336	16.9	0.166	0.170	0.000
Bus43	Bus15	70.32	-29.8	109.64	179.4	59.22	34.8	0.163	-164.1	0.173	-162.2	0.336	16.9	0.166	0.170	0.000
Bus46	Bus15	70.66	-29.7	109.63	179.4	58.96	35.0	0.163	-164.4	0.173	-162.5	0.336	16.6	0.166	0.170	0.000
MOTOR TYPICAL 6	Bus15	104.55	-30.0	104.55	-150.0	104.55	90.0	1.605	-177.3	1.698	-175.3	3.302	3.7	1.635	1.667	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus15**
Nominal kV = 6.600 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus15	Total	100.04	-0.1	50.02	179.9	50.02	179.9	0.000	0.0	24.274	-175.5	24.274	4.5	14.015	14.015	0.000
Bus33	Bus15	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.1	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus38	Bus15	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.1	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus36	Bus15	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.1	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus48	Bus15	93.79	-6.2	88.06	-173.6	20.79	106.0	0.001	33.4	0.353	-161.1	0.353	18.9	0.204	0.204	0.000
Bus43	Bus15	93.79	-6.2	88.06	-173.6	20.79	106.0	0.001	33.4	0.353	-161.1	0.353	18.9	0.204	0.204	0.000
Bus46	Bus15	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.1	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus5	Bus15	92.66	28.0	87.43	-88.6	94.73	152.4	0.009	-154.8	18.761	-177.3	18.770	2.7	10.836	10.833	0.000
MOTOR TYPICAL 6	Bus15	100.00	0.0	100.00	-120.0	100.00	120.0	0.006	20.3	3.469	-174.3	3.464	5.7	2.001	2.002	0.000
Lump17	Bus33	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump13	Bus38	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump15	Bus36	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump25	Bus48	104.34	-30.0	104.34	-150.0	104.34	90.0	3.098	-161.1	3.113	-161.1	6.211	18.9	3.104	3.107	0.000
Lump24	Bus43	104.34	-30.0	104.34	-150.0	104.34	90.0	3.098	-161.1	3.113	-161.1	6.211	18.9	3.104	3.107	0.000
Lump27	Bus46	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Main Bus 2	Bus5	100.44	0.0	100.08	-120.2	100.00	120.1	2.237	18.2	4.344	-162.8	2.108	16.1	2.150	2.195	0.000
GT GEN 3	Bus5	95.65	30.0	95.65	-90.0	95.65	150.0	2.446	-11.5	4.976	170.1	2.531	-8.4	2.526	2.450	0.000

# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus33**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus33	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.498	-174.1	28.498	5.9	16.453	16.453	0.000
Bus15	Bus33	94.11	28.3	89.32	-89.8	94.40	151.8	0.001	-149.7	22.755	-178.5	22.755	1.5	13.138	13.137	0.000
Lump17	Bus33	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.3	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus38	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus36	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus48	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus43	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus46	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus5	Bus15	91.20	59.9	91.36	-59.8	91.68	180.0	0.675	-0.1	1.352	179.9	0.676	-0.1	0.676	0.676	0.000
MOTOR TYPICAL 6	Bus15	95.84	30.0	95.84	-90.0	95.84	150.0	0.125	2.9	0.250	-177.1	0.125	2.8	0.125	0.125	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus36**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus36	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.498	-174.1	28.498	5.9	16.453	16.453	0.000
Bus15	Bus36	94.11	28.3	89.32	-89.8	94.40	151.8	0.001	-149.7	22.755	-178.5	22.755	1.5	13.138	13.137	0.000
Lump15	Bus36	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.3	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus33	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus38	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus48	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus43	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus46	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus5	Bus15	91.20	59.9	91.36	-59.8	91.68	180.0	0.675	-0.1	1.352	179.9	0.676	-0.1	0.676	0.676	0.000
MOTOR TYPICAL 6	Bus15	95.84	30.0	95.84	-90.0	95.84	150.0	0.125	2.9	0.250	-177.1	0.125	2.8	0.125	0.125	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus38**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus38	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.498	-174.1	28.498	5.9	16.453	16.453	0.000
Bus15	Bus38	94.11	28.3	89.32	-89.8	94.40	151.8	0.001	-149.7	22.755	-178.5	22.755	1.5	13.138	13.137	0.000
Lump13	Bus38	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.3	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus33	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus36	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus48	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus43	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus46	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus5	Bus15	91.20	59.9	91.36	-59.8	91.68	180.0	0.675	-0.1	1.352	179.9	0.676	-0.1	0.676	0.676	0.000
MOTOR TYPICAL 6	Bus15	95.84	30.0	95.84	-90.0	95.84	150.0	0.125	2.9	0.250	-177.1	0.125	2.8	0.125	0.125	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus43**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus43	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.781	-172.9	28.781	7.1	16.617	16.617	0.000
Bus15	Bus43	94.17	28.3	89.24	-89.9	94.31	151.8	0.001	-147.9	22.995	-177.0	22.995	3.0	13.276	13.276	0.000
Lump24	Bus43	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	32.1	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus33	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus38	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus36	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus48	Bus15	100.00	0.0	95.63	-121.2	96.09	121.7	0.013	17.6	0.026	-162.4	0.013	17.5	0.013	0.013	0.000
Bus46	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus5	Bus15	91.20	59.9	91.34	-59.8	91.68	180.0	0.682	1.4	1.366	-178.6	0.683	1.4	0.683	0.683	0.000
MOTOR TYPICAL 6	Bus15	95.84	30.0	95.84	-90.0	95.84	150.0	0.126	4.4	0.252	-175.6	0.126	4.3	0.126	0.126	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus46**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus46	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.498	-174.1	28.498	5.9	16.453	16.453	0.000
Bus15	Bus46	94.11	28.3	89.32	-89.8	94.40	151.8	0.001	-149.7	22.755	-178.5	22.755	1.5	13.138	13.137	0.000
Lump27	Bus46	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.3	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus33	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus38	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus36	Bus15	100.00	0.0	95.61	-121.1	96.23	121.7	0.013	15.8	0.025	-164.3	0.013	15.7	0.013	0.013	0.000
Bus48	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus43	Bus15	100.00	0.0	95.62	-121.1	96.21	121.7	0.013	16.1	0.025	-163.9	0.013	16.0	0.013	0.013	0.000
Bus5	Bus15	91.20	59.9	91.36	-59.8	91.68	180.0	0.675	-0.1	1.352	179.9	0.676	-0.1	0.676	0.676	0.000
MOTOR TYPICAL 6	Bus15	95.84	30.0	95.84	-90.0	95.84	150.0	0.125	2.9	0.250	-177.1	0.125	2.8	0.125	0.125	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus48**
Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus48	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.781	-172.9	28.781	7.1	16.617	16.617	0.000
Bus15	Bus48	94.17	28.3	89.24	-89.9	94.31	151.8	0.001	-147.9	22.995	-177.0	22.995	3.0	13.276	13.276	0.000
Lump25	Bus48	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	32.1	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus33	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus38	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus36	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus43	Bus15	100.00	0.0	95.63	-121.2	96.09	121.7	0.013	17.6	0.026	-162.4	0.013	17.5	0.013	0.013	0.000
Bus46	Bus15	100.00	0.0	95.62	-121.2	96.11	121.7	0.013	17.2	0.026	-162.8	0.013	17.2	0.013	0.013	0.000
Bus5	Bus15	91.20	59.9	91.34	-59.8	91.68	180.0	0.682	1.4	1.366	-178.6	0.683	1.4	0.683	0.683	0.000
MOTOR TYPICAL 6	Bus15	95.84	30.0	95.84	-90.0	95.84	150.0	0.126	4.4	0.252	-175.6	0.126	4.3	0.126	0.126	0.000

\# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus6**
Nominal kV = 16.500 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus6	Total	100.98	-0.9	50.49	179.1	50.49	179.1	0.000	0.0	100.504	-161.7	100.504	18.3	58.026	58.026	0.000
Main Bus 1	Bus6	102.12	-28.8	104.83	-152.1	98.37	88.2	1.104	62.1	51.507	-147.8	50.552	31.5	29.187	29.743	0.000
Bus16	Bus6	93.23	-7.2	90.38	-174.1	21.17	97.0	0.040	38.9	1.835	-171.4	1.801	8.0	1.039	1.060	0.000
GT GEN 4	Bus6	100.00	0.0	100.00	-120.0	100.00	120.0	1.141	-118.7	50.145	-175.5	50.779	5.5	29.609	28.660	0.000
Bus12	Main Bus 1	103.74	-29.5	104.89	-150.9	102.06	89.2	0.313	-150.8	0.334	-148.5	0.647	30.4	0.320	0.327	0.000
Bus3	Main Bus 1	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus7	Main Bus 1	100.13	0.0	97.95	-121.7	96.51	120.2	0.049	-151.3	0.050	-152.1	0.099	28.3	0.050	0.049	0.000
Bus8	Main Bus 1	100.05	-0.1	97.96	-121.7	96.62	120.2	0.051	-154.1	0.052	-149.0	0.103	28.5	0.050	0.053	0.000
Lump31	Main Bus 1	100.00	-30.0	100.00	-150.0	100.00	90.0	0.169	-150.2	0.180	-147.9	0.349	31.0	0.172	0.176	0.000
Bus9	Main Bus 2	104.25	-29.7	104.93	-150.5	103.24	89.6	0.413	-151.0	0.439	-148.7	0.852	30.2	0.421	0.431	0.000
Bus4	Main Bus 2	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus5	Main Bus 2	100.14	0.0	98.93	-121.8	96.91	119.7	0.045	-135.1	0.046	-136.0	0.091	44.5	0.046	0.045	0.000
Bus34	Bus16	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus37	Bus16	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus35	Bus16	70.15	-29.2	109.64	179.4	58.61	34.3	0.165	-164.2	0.175	-162.3	0.340	16.8	0.169	0.172	0.000
Bus42	Bus16	69.81	-29.3	109.65	179.4	58.87	34.1	0.165	-163.9	0.175	-162.0	0.341	17.1	0.169	0.172	0.000
Bus45	Bus16	69.81	-29.3	109.65	179.4	58.87	34.1	0.165	-163.9	0.175	-162.0	0.341	17.1	0.169	0.172	0.000
MOTOR TYPICAL 7	Bus16	104.55	-30.0	104.55	-150.0	104.55	90.0	1.626	-177.0	1.720	-175.1	3.345	3.9	1.657	1.689	0.000

\# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus16**

Nominal kV = 6.600 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus16	Total	100.04	-0.1	50.02	179.9	50.02	179.9	0.000	0.0	23.932	-175.7	23.932	4.3	13.817	13.817	0.000
Bus34	Bus16	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus37	Bus16	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus35	Bus16	94.05	-6.2	87.82	-173.5	21.01	107.3	0.001	33.3	0.353	-161.4	0.352	18.5	0.204	0.204	0.000
Bus42	Bus16	93.79	-6.2	88.06	-173.6	20.79	106.0	0.001	33.7	0.353	-161.1	0.353	18.9	0.204	0.204	0.000
Bus45	Bus16	93.79	-6.2	88.06	-173.6	20.79	106.0	0.001	33.7	0.353	-161.1	0.353	18.9	0.204	0.204	0.000
Bus6	Bus16	92.66	28.0	87.43	-88.6	94.73	152.4	0.009	-155.2	18.762	-177.3	18.770	2.7	10.836	10.833	0.000
MOTOR TYPICAL 7	Bus16	100.00	0.0	100.00	-120.0	100.00	120.0	0.006	20.5	3.469	-174.3	3.464	5.7	2.001	2.002	0.000
Lump18	Bus34	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump14	Bus37	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump16	Bus35	104.34	-30.0	104.34	-150.0	104.34	90.0	3.096	-161.5	3.111	-161.4	6.207	18.6	3.102	3.105	0.000
Lump30	Bus42	104.34	-30.0	104.34	-150.0	104.34	90.0	3.098	-161.1	3.113	-161.1	6.211	18.9	3.104	3.107	0.000
Lump29	Bus45	104.34	-30.0	104.34	-150.0	104.34	90.0	3.098	-161.1	3.113	-161.1	6.211	18.9	3.104	3.107	0.000
Main Bus 1	Bus6	100.44	0.0	100.08	-120.2	100.00	120.1	2.237	18.2	4.344	-162.8	2.107	16.1	2.150	2.195	0.000
GT GEN 4	Bus6	95.65	30.0	95.65	-90.0	95.65	150.0	2.446	-11.5	4.976	170.1	2.531	-8.4	2.526	2.450	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus34**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus34	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus16	Bus34	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump18	Bus34	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus37	Bus16	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus35	Bus16	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus42	Bus16	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus45	Bus16	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus6	Bus16	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 7	Bus16	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus35**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus35	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus16	Bus35	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump16	Bus35	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus34	Bus16	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus37	Bus16	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus42	Bus16	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus45	Bus16	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus6	Bus16	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 7	Bus16	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus37**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus37	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.475	-174.1	28.475	5.9	16.440	16.440	0.000
Bus16	Bus37	94.10	28.3	89.23	-89.8	94.37	151.8	0.001	-149.3	22.732	-178.5	22.733	1.5	13.125	13.124	0.000
Lump14	Bus37	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	30.7	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus34	Bus16	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus35	Bus16	100.00	0.0	95.56	-121.1	96.17	121.7	0.013	16.0	0.026	-164.1	0.013	15.9	0.013	0.013	0.000
Bus42	Bus16	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus45	Bus16	100.00	0.0	95.57	-121.2	96.15	121.7	0.013	16.3	0.026	-163.7	0.013	16.2	0.013	0.013	0.000
Bus6	Bus16	91.19	59.9	91.35	-59.8	91.68	180.0	0.684	0.1	1.370	-179.9	0.685	0.1	0.685	0.685	0.000
MOTOR TYPICAL 7	Bus16	95.84	30.0	95.84	-90.0	95.84	150.0	0.127	3.1	0.253	-176.9	0.126	3.0	0.126	0.127	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus42**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus42	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.757	-172.9	28.757	7.1	16.603	16.603	0.000
Bus16	Bus42	94.15	28.3	89.15	-89.9	94.28	151.8	0.001	-147.5	22.971	-177.1	22.972	2.9	13.263	13.263	0.000
Lump30	Bus42	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	32.5	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus34	Bus16	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus37	Bus16	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus35	Bus16	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus45	Bus16	100.00	0.0	95.58	-121.2	96.03	121.7	0.013	17.8	0.026	-162.2	0.013	17.7	0.013	0.013	0.000
Bus6	Bus16	91.19	59.9	91.34	-59.8	91.68	180.0	0.692	1.6	1.384	-178.4	0.693	1.6	0.692	0.692	0.000
MOTOR TYPICAL 7	Bus16	95.84	30.0	95.84	-90.0	95.84	150.0	0.128	4.6	0.256	-175.4	0.128	4.5	0.128	0.128	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus45**

Nominal kV = 0.415 Voltage c Factor = 1.05 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus45	Total	100.00	0.0	50.00	180.0	50.00	180.0	0.000	0.0	28.757	-172.9	28.757	7.1	16.603	16.603	0.000
Bus16	Bus45	94.15	28.3	89.15	-89.9	94.28	151.8	0.001	-147.5	22.971	-177.1	22.972	2.9	13.263	13.263	0.000
Lump29	Bus45	100.00	0.0	100.00	-120.0	100.00	120.0	0.001	32.5	6.073	-157.2	6.072	22.8	3.506	3.506	0.000
Bus34	Bus16	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus37	Bus16	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus35	Bus16	100.00	0.0	95.57	-121.2	96.05	121.7	0.013	17.4	0.026	-162.6	0.013	17.4	0.013	0.013	0.000
Bus42	Bus16	100.00	0.0	95.58	-121.2	96.03	121.7	0.013	17.8	0.026	-162.2	0.013	17.7	0.013	0.013	0.000
Bus6	Bus16	91.19	59.9	91.34	-59.8	91.68	180.0	0.692	1.6	1.384	-178.4	0.693	1.6	0.692	0.692	0.000
MOTOR TYPICAL 7	Bus16	95.84	30.0	95.84	-90.0	95.84	150.0	0.128	4.6	0.256	-175.4	0.128	4.5	0.128	0.128	0.000

# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus7**

Nominal kV = 16.500   Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus7	Total	101.22	-0.6	50.61	179.4	50.61	179.4	0.000	0.0	116.836	-177.1	116.836	2.9	67.455	67.455	0.000
Main Bus 1	Bus7	103.25	-27.6	102.35	-152.3	95.50	90.5	1.169	52.5	66.036	-177.8	65.296	1.4	37.461	38.365	0.000
ST GEN 1	Bus7	100.00	0.0	100.00	-120.0	100.00	120.0	1.169	-127.5	50.811	-176.2	51.589	4.8	29.998	29.126	0.000
Bus12	Main Bus 1	104.23	-29.0	103.80	-151.0	100.83	90.3	0.410	178.2	0.427	-179.0	0.836	-0.3	0.412	0.424	0.000
Bus3	Main Bus 1	100.13	-0.1	96.80	-121.6	96.25	120.9	0.059	-166.0	0.059	-166.4	0.118	13.8	0.059	0.059	0.000
Bus6	Main Bus 1	100.13	-0.1	96.80	-121.6	96.25	120.9	0.059	-166.0	0.059	-166.4	0.118	13.8	0.059	0.059	0.000
Bus8	Main Bus 1	100.00	-0.1	95.85	-121.1	96.52	121.6	0.067	175.0	0.066	-179.4	0.133	-2.2	0.065	0.068	0.000
Lump31	Main Bus 1	100.00	-30.0	100.00	-150.0	100.00	90.0	0.221	178.9	0.230	-178.3	0.450	0.3	0.222	0.228	0.000
Bus9	Main Bus 2	104.54	-29.4	104.28	-150.6	102.51	90.2	0.540	178.1	0.561	-179.2	1.101	-0.5	0.543	0.558	0.000
Bus4	Main Bus 2	100.13	-0.1	96.80	-121.6	96.25	120.9	0.059	-166.0	0.059	-166.4	0.118	13.8	0.059	0.059	0.000
Bus5	Main Bus 2	100.13	-0.1	96.80	-121.6	96.25	120.9	0.059	-166.0	0.059	-166.4	0.118	13.8	0.059	0.059	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Fault at bus : **Bus8**

Nominal kV = 16.500 Voltage c Factor = 1.10 (User-Defined)

Line-To-Line Fault

Contribution		% Voltage at From Bus						Current at From Bus (kA)						Sequence Current (kA)		
From Bus	To Bus	Va		Vb		Vc		Ia		Ib		Ic				
ID	ID	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	I1	I2	I0
Bus8	Total	98.94	-0.8	49.47	179.2	49.47	179.2	0.000	0.0	120.549	-176.9	120.549	3.1	69.599	69.599	0.000
Main Bus 1	Bus8	103.09	-27.7	102.18	-152.2	95.48	90.5	1.318	-37.5	66.165	-178.5	65.146	2.2	38.326	37.492	0.000
ST GEN 2	Bus8	100.00	0.0	100.00	-120.0	100.00	120.0	1.318	142.5	54.446	-174.9	55.423	4.2	31.277	32.161	0.000
Bus12	Main Bus 1	104.16	-29.0	103.72	-151.0	100.82	90.3	0.408	-179.6	0.430	178.9	0.838	-0.3	0.422	0.416	0.000
Bus3	Main Bus 1	100.03	-0.1	96.75	-121.6	96.23	120.9	0.058	-163.9	0.059	-168.6	0.118	13.8	0.060	0.058	0.000
Bus6	Main Bus 1	100.03	-0.1	96.75	-121.6	96.23	120.9	0.058	-163.9	0.059	-168.6	0.118	13.8	0.060	0.058	0.000
Bus7	Main Bus 1	100.01	-0.1	95.72	-121.1	96.39	121.6	0.064	179.9	0.064	175.3	0.128	-2.4	0.065	0.062	0.000
Lump31	Main Bus 1	100.00	-30.0	100.00	-150.0	100.00	90.0	0.220	-178.9	0.232	179.6	0.451	0.3	0.227	0.224	0.000
Bus9	Main Bus 2	104.50	-29.4	104.23	-150.6	102.51	90.2	0.537	-179.8	0.566	178.7	1.102	-0.5	0.555	0.547	0.000
Bus4	Main Bus 2	100.03	-0.1	96.75	-121.6	96.23	120.9	0.058	-163.9	0.059	-168.6	0.118	13.8	0.060	0.058	0.000
Bus5	Main Bus 2	100.03	-0.1	96.76	-121.6	96.24	120.9	0.059	-163.9	0.060	-168.5	0.118	13.8	0.060	0.058	0.000

\# Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta-Y transformer

Short-Circuit Summary Report

3-Phase, LG, LL, LLG Fault Currents

Bus		3-Phase Fault			Line-to-Ground Fault				Line-to-Line Fault				*Line-to-Line-to-Ground			
ID	kV	I"k	ip	Ik	I"k	ip	Ib	Ik	I"k	ip	Ib	Ik	I"k	ip	Ib	Ik
Bus9	400.000	52.989	130.840	51.993	39.104	96.556	39.104	39.104	45.877	113.279	45.877	45.877	49.349	121.851	49.349	49.349
Bus12	400.000	29.381	72.662	28.529	27.244	67.375	27.244	27.244	25.434	62.900	25.434	25.434	28.643	70.835	28.643	28.643
Main Bus 1	400.000	32.614	79.478	24.064	28.908	70.447	28.908	28.908	28.171	68.650	28.171	28.171	32.654	79.576	32.654	32.654
Main Bus 2	400.000	32.614	79.478	24.064	28.908	70.447	28.908	28.908	28.171	68.650	28.171	28.171	32.654	79.576	32.654	32.654
Bus3	16.500	117.164	291.437	73.612	0.008	0.020	0.008	0.008	100.504	249.997	100.504	100.504	100.506	250.001	100.506	100.506
Bus13	6.600	27.645	70.089	21.671	26.197	66.418	26.197	26.197	23.933	60.677	23.933	23.933	27.396	69.459	27.396	27.396
Bus19	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus20	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus24	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus26	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus47	0.415	33.207	78.730	26.057	31.500	74.683	31.500	31.500	28.757	68.181	28.757	28.757	33.095	78.465	33.095	33.095
Bus4	16.500	117.164	291.437	73.612	0.008	0.020	0.008	0.008	100.504	249.997	100.504	100.504	100.506	250.001	100.506	100.506
Bus14	6.600	27.645	70.084	21.671	26.197	66.413	26.197	26.197	23.932	60.672	23.932	23.932	27.397	69.455	27.397	27.397
Bus21	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus23	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus25	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus39	0.415	33.207	78.729	26.057	31.500	74.683	31.500	31.500	28.757	68.181	28.757	28.757	33.095	78.465	33.095	33.095
Bus44	0.415	33.207	78.729	26.057	31.500	74.683	31.500	31.500	28.757	68.181	28.757	28.757	33.095	78.465	33.095	33.095
Bus5	16.500	117.277	291.667	73.612	0.008	0.020	0.008	0.008	100.601	250.196	100.601	100.601	100.603	250.200	100.603	100.603
Bus15	6.600	28.040	70.684	21.671	26.434	66.635	26.434	26.434	24.274	61.192	24.274	24.274	27.757	69.971	27.757	27.757
Bus33	0.415	32.907	80.026	25.790	31.194	75.861	31.194	31.194	28.498	69.304	28.498	28.498	32.857	79.905	32.857	32.857
Bus36	0.415	32.907	80.026	25.790	31.194	75.861	31.194	31.194	28.498	69.304	28.498	28.498	32.857	79.905	32.857	32.857
Bus38	0.415	32.907	80.026	25.790	31.194	75.861	31.194	31.194	28.498	69.304	28.498	28.498	32.857	79.905	32.857	32.857
Bus43	0.415	33.234	78.785	26.057	31.516	74.713	31.516	31.516	28.781	68.229	28.781	28.781	33.119	78.513	33.119	33.119
Bus46	0.415	32.907	80.026	25.790	31.194	75.861	31.194	31.194	28.498	69.304	28.498	28.498	32.857	79.905	32.857	32.857
Bus48	0.415	33.234	78.785	26.057	31.516	74.713	31.516	31.516	28.781	68.229	28.781	28.781	33.119	78.513	33.119	33.119
Bus6	16.500	117.164	291.437	73.612	0.008	0.020	0.008	0.008	100.504	249.997	100.504	100.504	100.506	250.001	100.506	100.506
Bus16	6.600	27.645	70.084	21.671	26.197	66.413	26.197	26.197	23.932	60.672	23.932	23.932	27.397	69.455	27.397	27.397
Bus34	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus35	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus37	0.415	32.880	79.968	25.790	31.178	75.829	31.178	31.178	28.475	69.254	28.475	28.475	32.833	79.855	32.833	32.833
Bus42	0.415	33.207	78.729	26.057	31.500	74.683	31.500	31.500	28.757	68.181	28.757	28.757	33.095	78.465	33.095	33.095
Bus45	0.415	33.207	78.729	26.057	31.500	74.683	31.500	31.500	28.757	68.181	28.757	28.757	33.095	78.465	33.095	33.095
Bus7	16.500	136.558	362.630	93.422	0.007	0.018	0.007	0.007	116.836	310.260	116.836	116.836	116.838	310.264	116.838	116.838
Bus8	16.500	137.710	365.508	94.751	0.007	0.018	0.007	0.007	120.549	319.959	120.549	120.549	120.551	319.964	120.551	120.551

All fault currents are in rms kA. Current ip is calculated using Method C.

* LLG fault current is the larger of the two faulted line currents.

Sequence Impedance Summary Report

Bus		Positive Seq. Imp. (ohm)			Negative Seq. Imp. (ohm)			Zero Seq. Imp. (ohm)			Fault Zf (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
Bus9	400.000	0.48207	4.76981	4.79411	0.48489	4.77223	4.79680	1.77840	9.75261	9.91343	0.00000	0.00000	0.00000
Bus12	400.000	0.86428	8.60276	8.64606	0.87215	8.60962	8.65368	1.34995	10.59051	10.67620	0.00000	0.00000	0.00000
Main Bus 1	400.000	0.93992	7.73211	7.78903	0.97994	7.76855	7.83012	3.38957	10.32182	10.86412	0.00000	0.00000	0.00000
Main Bus 2	400.000	0.93992	7.73211	7.78903	0.97994	7.76855	7.83012	3.38957	10.32182	10.86412	0.00000	0.00000	0.00000
Bus3	16.500	0.02671	0.08535	0.08944	0.03005	0.08608	0.09118	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus13	6.600	0.01117	0.15121	0.15162	0.01160	0.15129	0.15173	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus19	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus20	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus24	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus26	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus47	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus4	16.500	0.02671	0.08535	0.08944	0.03005	0.08608	0.09118	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus14	6.600	0.01118	0.15121	0.15162	0.01161	0.15129	0.15173	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus21	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus23	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus25	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus39	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus44	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus5	16.500	0.02669	0.08527	0.08935	0.03001	0.08600	0.09109	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus15	6.600	0.01156	0.14904	0.14949	0.01198	0.14911	0.14959	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus33	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus36	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus38	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus43	0.415	0.00093	0.00751	0.00757	0.00093	0.00751	0.00757	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus46	0.415	0.00079	0.00760	0.00765	0.00079	0.00760	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus48	0.415	0.00093	0.00751	0.00757	0.00093	0.00751	0.00757	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus6	16.500	0.02671	0.08535	0.08944	0.03005	0.08608	0.09118	3927.78500	0.07378	3927.78500	0.00000	0.00000	0.00000
Bus16	6.600	0.01118	0.15121	0.15162	0.01161	0.15129	0.15173	0.00393	0.17676	0.17681	0.00000	0.00000	0.00000
Bus34	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus35	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus37	0.415	0.00079	0.00761	0.00765	0.00079	0.00761	0.00765	0.00020	0.00892	0.00892	0.00000	0.00000	0.00000
Bus42	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus45	0.415	0.00093	0.00752	0.00758	0.00093	0.00752	0.00758	0.00044	0.00881	0.00882	0.00000	0.00000	0.00000
Bus7	16.500	0.00310	0.07667	0.07674	0.00474	0.07847	0.07862	4622.58700	0.06218	4622.58700	0.00000	0.00000	0.00000

Bus		Positive Seq. Imp. (ohm)			Negative Seq. Imp. (ohm)			Zero Seq. Imp. (ohm)			Fault Zf (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
Bus8	16.500	0.00312	0.07603	0.07609	0.00508	0.07431	0.07448	4622.58400	0.06230	4622.58400	0.00000	0.00000	0.00000

STUDY AND THIRD PARTY AUDIT OF

400/132kV SUBSTATION AT ANPARA – BTPS

REPORT

SUBMITTED TO:

400/132kV SUBSTATION AT ANPARA –BTPS

SUBMITTED BY:

POWER SYSTEMS DIVISION
CENTRAL POWER RESEARCH INSTITUTE
P.B. NO. 8066, SADASHIVANAGAR P.O
BANGALORE – 560 080
website: http://www.cpri.in

POWER SYSTEMS DIVISION
CENTRAL POWER RESEARCH INSTITUTE
Sir. C.V. RAMAN ROAD P.B.No.8066, BANGALORE 560080 (INDIA)

CONSULTANCY REPORT

Date: 12/02/2021

Title	**PROTECTION AUDIT OF 400/132 KV SUBSTATION AT ANPARA ,BTPS**
Objectives	Review of implemented Protection Schemes & Relay Settings in the 400 and 132 kV feeders of BTPS which includes transmission lines, transformers, bus reactor, bus bars etc., This includes main and backup protection Relay. Checking healthiness of DC /PLCC system.
Name and Address of the client	Shri Anil Kumar Nigam. Executive Engineer, EMD-III,BTPS, Anpara-231225
Client reference	2/9/PS/Anpara/2020- dated 01.06.2020
Name (s) of investigator(s) from CPRI	Dr Mahohar Singh , EO-III Er.Siripurapu Saikumar, Project Engineer
Names of Interacting persons from Customer's side	1.Er.A.K.Vaishya, EE EMD-III 2.Er A.K.Verma,AE EMD-III
Report contains	
Number of pages:	88
Number of Tables:	21

Report prepared by:

Signature: 12 . 02 . 2021

Name: Dr. Manohar Singh
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EXECUTIVE SUMMARY

Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVNL). Has awarded the “third party protection audit of 400/132 kV Substation at Anpara, BTPS “to CPRI vides work order No. 2/9/PS/Anpara/2020 dated 01.05.2020 .This Protection Audit covers the review of protection of Generator Transformers, ICT, Station Transformers, CW’S, Transmission lines (400 &132 kV) and other protection infrastructure installed at Anpara, BTPS. The power is evacuated through seven 400 kV and three 132 kV lines to Northern region grid.

The scope of this Protection involves the Review of the implemented protection schemes/philosophy & review of main & backup Protection setting & coordination in the switchyard which includes protection of Generator Transformers, ICT, Station Transformers, CW’S, Transmission lines (400 &132 kV), reactors, circuit breakers, bus bar etc. as per CBIP/NRLDC/NRP etc. guidelines. This also involves Reviewing of availability/healthiness of communication links like PLCC, optical fiber used for protection, healthiness/ adequacy of 110/ 48/ 24 V DC, GPS/TSU, and circuit breaker report.

In view of this work order, CPRI Protection audit team carried out the onsite Protection audit from 10/12/2020 and 11/12/2020 and have a compressive review of switchyard Projection schemes and setting has been carried out as per Northern region Power Committee Protection Guidelines.

The major equipment for which protection audit has been carried out are as under:

- Generator Transformer (2X 500 MVA & 3*210 MVA)
- ICT (3X100 MVA)
- Station Transformer (2 X 40MVA & 2*60 MVA)
- CW’S (3*40 MVA)
- Transmission Lines (7*400 kV & 3*132 kV)
- Bus Reactor (63 MVAR)
- 400 & 132 kV Bus bars.

As a general finding from this audit, it is observed that the 400/132 kV substation equipment is also well protection as per Northern region Power Committee recommendation. 400 kV and 132 kV lines, GT'S, ST'S, and CW'S have independent main-1 and main-2 functional protection. Bus bar, bus reactor are also well protected as per NRPC defined Protection. Operational protection setting is in order.

The state of DC supply at substation inspected and found in order. Time. Functionality of GPS/TSU, circuit breaker reports is also inspected and all are found in satisfactory state.

Details of protection schemes and review of protection setting and necessary recommendation of setting wherever needed are listed in the audit report.

CONTENTS

DETAILED REPORT ON THIRD PARTY PROTECTION AUDIT OF 400/132kV SUBSTATION AT ANPARA –BTPS

1.0 Introduction

Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVNL). Has awarded the third party protection audit of 400/132 kV at Anpara, BTPS to CPRI vides work order No. 2/9/PS/Anpara/2020 dated 01.06.2020 with the following scope of work:

1) Review of implemented protection schemes/philosophy & setting in the generating station and switchyard which includes Protection of transmission lines, transformers, bus bar reactors, review of relay & circuit breaker test reports with reference to CBIP /NRLDC/NRPC guidelines
2) To check the adequacy for the adequacy/ healthiness of the primary & backup protection scheme & Settings, Suggest corrective measures in case of any problems.
3) Review of availability/healthiness of communication links like PLCC, optical fiber used for protection.
4) To check the healthiness/adequacy of 220 V/48 V /24 V DC systems at Substation for protection and suggest corrective measures in the case of any problem.
5) Review of availability/Healthiness of GPS system and ensure time synchronization of different relays / devices etc.
6) Review of DR/EL
7) Review of test report of circuit breaker s for assessing their healthiness -healthiness of trip and close coil, Breaker close & open timings, SF6& operational media pressure setting of alarm, auto reclose lock out and breaker operational lock out and pole discrepancy operation.
8) Field collection of technical data for audit work from BTPS.
9) Field inspection of protection device for obsolescence of technology, suitability and healthiness.

2.1 General Observation and Philosophy adopted in substations

2.1.1 Philosophy used for Distance protection:

The philosophy adopted for 400/132 kV lines Distance protection relay settings is given below which is generally in accordance with CBIP guidelines, given below

Distance protection settings:

Zone-1 Reach : Set to 80% of the Protection line

Zone-1 Time : Instantaneous

Zone-2 Reach: 100% of the protected line + 50% of the shortest line emanating from the far end bus bar, or, 120% of the Protected line, whichever is higher

Zone-2 Time : 350ms for short lines (<100km) and 500ms for long lines >100km

Zone-3 Reach : 120% of the protected line + 100% of the longest line emanating from the far end bus bar, or 100% of the Protected line + 100% of the longest line emanating from the far end bus bar + 25% of the longest line emanating from the far end of the second line considered, whichever is lower.

The zone setting to be limited such that it will not reach into the next voltage level

Zone-3 Time : 1000ms

Zone-3R or Zone 4: 25% of the Zone-1 reaches

Zone-3R or Zone 4 Time: 1000ms

2.1 .2 Philosophies used for Transformer protection:

The philosophy adopted for Transformer protection relay settings is given below which is generally in accordance with CBIP guidelines, given below

Group-A			Group-B	
Differential Protection	**HV Back Up Over Current and Earth Fault**	**Over Fluxing Protection**	**LV Back Up Over Current and Earth Fault**	**Restricted Earth Fault**

2.2 General protections in 400/132 kV switchyard:

400/132 kV substation Anpara-BTPS Protection System		
DATE OF REVIEW BY CPRI TEAM : 08-12-2020		
SLNO	**Description**	**400/132 KV**
1	**Name Of Grid Substation**	400/132 kV Anpara-BTPS
2	**Highest Voltage Level**	400
3	**Year Of Installation**	--
4	**No Of Feeders**	10 -3(132KV),7(400KV)
5	**No of Units**	2
6	**No of Transformers, Make and Capacity**	GT'S: 2*500MVA (400/21)kV ,3*210 (400/15.75) ICT'S:3*100MVA(400/132)kV ST'S:2*60 MVA (132/6.9)kV,2*40MVA(132/6.9 kV) CW'S:3*40MVA(132/6,9 Kv)
7	**Busbar Arrangement**	(400 kV buses)and (132kV buses)
8	**Present Busbar Switching Status**	Fully Commissioned. bays are connected to different buses
9	**Busbar Protection**	Provided
10	**Relay System Status**	In Service
11	**DC Supply System**	Transmission Unit i)Four Nos of Battery Bank with 110 V DC,400AH Capacity and Four no's of battery Chargers for 110V System (Float cum Boost) are in service at ATPS, BTPS. ii) Four Nos of Battery Bank with 48 V DC,400AH Capacity and Four no's of battery Chargers for 48 V System (Float cum Boost) are in service at ATPS, BTPS.
12	**DC Supply Capacity And Adequacy**	DC system is adequate for the station load
13	**DC System Earth Fault Status**	Both the systems are Healthy
14	**PLCC**	
15	**GPS Clock Receiver & Synchronization Of Relay Status**	Provided
16	**Common Event Logger Status**	Not-Provided
17	**Line Disturbance Recorder**	Not-Provided
18	**Breaker Failure Relay Status**	Not-Provided
19	**General Observation of Relay And Protection System**	System is working satisfactorily.

2.3 Relays used for transmission line, Transformer, Bus bar, and Reactor:

Table-1 Relay used for Transmission Line Protection:-

Sl No	**Name of Line**	Main I (Distance, Diff, Backup earth fault)	Main II (Distance, Diff, Backup O/C earth fault)	Backup OC/Earth fault
1	ANPARA SINGRAULI L1	AVERA P-442	SIEMENS,SIPROTECH 7SA52	EE& CTIG
2	ANPARA SULTANPUR L2	SIEMENS,SIPROTECH 7SA52	ABB REL-670	EE& CTIG
3	ANPARA SARNATH L3	SIEMENS,SIPROTECH 7SA52	ABB REL-670	EE& CTIG
4	ANPARA SARNATH L5	SIEMENS,SIPROTECH 7SA52	ABB REL-670	HITACHI,3E81766
5	ANPARA MAU L6	SIEMENS,SIPROTECH 7SA52	ABB REL-670	HITACHI,3E81766
6	ANPARA B TO ANPARA D L8	ALSTOM,MICOM P-543	ABB REL-670	HITACHI,3E81766
7	ANPARA B TO ANPARA D L9	ALSTOM,MICOM P-543	ABB REL-670	HITACHI,3E81766
8	ANPARA BINA LINE L1	ABB REL-670	MICOM P-142	–
9	ANPARA PIPRI II L34	ABB REL-670	MICOM P-142	–
10	ANPARA PIPRI II L4	ABB REL-670	MICOM P-142	–

Table-2 Relays used for Transformer Protection:

Sl. No.	**Transformer Details**	Group-A			Group-B	
		Differential Protection	HV Back Up Over Current and Earth Fault	Over Fluxing Protection	LV Back Up Over Current and Earth Fault	Restricted Earth Fault
1	ICT 1 400/132kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P-142	MICOM P-645
2	ICT 2 400/132kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P-142	MICOM P-645
3	ICT 3 400/132kV	MICOM P-645	MICOM P-645	MICOM P-645	MICOM P-142	MICOM P-645
4	ST-1 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
5	ST-2 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
6	ST-3 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
7	ST-4 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
8	CW-1 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
9	CW-2 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
10	CW-3 132/6.9kV	MICOM P-645	MICOM P-645	MICOM P-645	EE CAG-37	MICOM P-645
11	GT-1 400/15.75 kV	ASEA RADSE	ER TJM-10	-	-	-
12	GT-2 400/15.75 kV	ASEA RADSE	ER TJM-10	-	-	-
13	GT-3 400/15.75 kV	ASEA RADSE	ER TJM-10	-	-	-

14	GT-4 420/21 kV	TOSHIBA	TOSHIBA	TOSHIBA	-	TOSHIBA
15	GT-5 420/21 kV	ABB RET-650	ABB RET-650	ABB RET-650	-	ABB RET-650

Table-3 Relay used for Bus bar Protection:-

Sl.No.	**Name of Bay**	Main-I	Main-II
1	Bus selector-1	MICOM,P-142	MICOM,P-141
2	Bus Selector-2	MICOM,P-142	EE,MCAG
3	400 kV Bus Bar	HITACHI-P 34964	-
4	132 kV Bus Bar	EE,CAG	-
5	132 kV Bus Coupler	EE,CDA	-
6	ATPS Bus Bar	EE,CAG	-
7	ATPS Bus Coupler	MICOM,P-142	-

Table-4 Relay used for Reactor Protection:

Sl. No.	**Name of Reactor**	**Differential Protection (Make & Model)**	**REF Protection (Make & Model)**	**Back-Up Impedance Protection (Make & Model)**
1	Bus Reactor	ALSTOM, P-645	-	-

2.4 INPUT DATA FOR TRANSMISSION LINE PROTECTION

Table-5 Input Data for Transmission Line Protection:

S. No.	Description	Units	Line	Line	Line	Line	Line
0	**Station Name**		ANPARA -BTPS	ANPARA -BTPS	ANPARA - BTPS	ANPARA - BTPS	ANPARA - BTPS
1	**Line Reference**		ANPARA- SINGURAULI LINE	ANPRA – SULTHANPU R LINE	ANPARA- SARNATH LINE	ANPARA- SARNATH LINE	ANPARA- MAU LINE
1.1	Line voltage level	kV	400	400	400	400	400
1.2	Name of remote substation		SINGURALI	SULTHANPUR	SARNATH	SARNATH	MAU
2	**Main 1**		YES	YES	YES	YES	YES
2.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
2.2	Model & Make		MICOM P-442	SIEMENS, SIPROTECH 7SA52	SIEMENS, SIPROTECH 7SA52	SIEMENS, SIPROTECH 7SA52	SIEMENS, SIPROTECH 7SA52
3	**Main 2 protection**		YES	YES	YES	YES	YES
3.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
3.2	Model & Make		SIEMENS, SIPROTECH 7SA52	ABB REL-670	ABB REL-670	ABB REL-670	ABB REL-670
4	**LBB Protection**		YES	YES	YES	YES	YES
4.1	Protection Type		ELECTRO MECHNICAL	ELECTRO MECHNICAL	ELECTRO MECHNICA	ELECTRO MECHNICAL	ELECTRO MECHNICA
4.2	Model & Make		EE,CTIG	EE,CTIG	EE,CTIG	HITACHI, 3E81766	HITACHI, 3E81766
5	**CT data for Main 1**						
5.1	Ratio	A/A	1000/1	1000/1	1000/1	1000/1	1000/1
6	**CT data for Main 2**						
6.1	Ratio	A/A	1000/1	1000/1	3000/1	3000/1	1000/1
7	PT Ratio	kV/V	400/110	400/110	400/110	400/110	400/110
8	**PROTECTED LINE DATA**						

8.1	Line Length	Km	27.2	267	156.7	156.7	262
8.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.0275	0.0275	0.0275
8.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.331	0.331	0.331
8.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.261	0.261	0.261
8.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.031	1.031	1.031
9	**ADJECENT SHORTEST LINE**		SINRAULI-VINDHYACHAL	SULTHANPUR - TANDA	SARNATH-AZAMGARH	SARNATH-AZAMGARH	MAU-AZAMGRAH
9.1	Line Length	Km	3.34	103	101.9	101.9	9.24
9.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.0275	0.0275	0.0275
9.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.331	0.331	0.331
9.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.261	0.261	0.261
9.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.031	1.031	1.031
10	**ADJECENT LONGEST LINE**		SINRAULI-LUCKNOW	SINRAULI-LUCKNOW	SARNATH L5	SARNATHL6	MAU
10.1	Line Length	Km	408.6	163.8	156	156	48.2
10.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.0275	0.0275	0.0275
10.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.331	0.331	0.331
10.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.261	0.261	0.261
10.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.031	1.031	1.031
10	**ADJECENT SECOND LONGEST LINE**		SINRAULI-FATEHPUR	-	SARNATHL-VARNASI	SARNATHL-VARNASI	MAU-IBRAHIMPATTI BALLA
10.1	Line Length	Km	331	-	107	107	9.24
10.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	-	0.0275	0.0275	0.0275
10.3	Positive seq. REACTANCE	Ohms/Km	0.331	-	0.331	0.331	0.331
10.4	Zero seq. RESISTANCE	Ohms/Km	0.261	-	0.261	0.261	0.261
10.5	Zero seq. REACTANCE	Ohms/Km	1.031	-	1.031	1.031	1.031
11	Arc Resistance(Assumed for all lines)	Ohm	5	5	5	5	5
11.1	Typical earth fault coverage (Assumed for all lines)	Ohm	10	10	10	10	10
11.2	Fault current local end	kA	39	39	39	39	39
11.3	Fault current Remote end	kA	37	37	37	37	37

S. No.	Description	Units	Line	Line	Line	Line	Line
0	**Station Name**		ANPARA -BTPS	ANPARA -BTPS	ANPARA - BTPS	ANPARA - BTPS	ANPARA - BTPS
1	**Line Reference**		ANPARA D- ANPARA B L8	ANPARA D- ANPARA B L9	ANPARA - BINA	ANPARA- PIPRI-I	ANPARA- PIPRI-II
1.1	Line voltage level	kV	400	400	132	132	132
1.2	Name of remote substation		ANPARA-D	ANPARA-D	BINA	PIPRI	PIPRI
2	**Main 1**		YES	YES	YES	YES	YES
2.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
2.2	Model & Make		MICOM P-543	MICOM P-543	ABB REL-670	ABB REL-670	ABB REL-670
3	**Main 2 protection**		YES	YES	YES	YES	YES
3.1	Protection Type		Numerical	Numerical	Numerical	Numerical	Numerical
3.2	Model & Make		ABB REL-670	ABB REL-670	MICOM P-142	MICOM P-142	MICOM P-142
4	**LBB Protection**		NO	NO	NO	NO	NO
4.1	Protection Type		-	-	-	-	-
4.2	Model & Make		-		-		-
5	**CT data for Main 1**						
5.1	Ratio	A/A	1000/1	1000/1	600/1	600/1	600/1
6	**CT data for Main 2**						
6.1	Ratio	A/A	1000/1	1000/1	600/1	600/1	600/1

7	PT Ratio	kV/V	400/110	400/110	132/110	132/110	132/110
8	**PROTECTED LINE DATA**						
8.1	Line Length	Km	5.02	5.02	28	28	28
8.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	0.162	0.162	0.162
8.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	0.3861	0.3861	0.3861
8.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	0.4056	0.4056	0.4056
8.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	1.622	1.622	1.622
9	**ADJECENT SHORTEST LINE**		ANPARA D-ANPARA B L9	ANPARA D-ANPARA B L8	-	PIPRI-KANAURIYA	PIPRI-KANAURIY
9.1	Line Length	Km	5.02	5.02	-	6.5	6.5
9.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	-	0.162	0.162
9.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	-	0.3861	0.3861
9.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	-	0.4056	0.4056
9.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	-	1.622	1.622
10	**ADJECENT LONGEST LINE**		ANPARA D-ANPARA B L9	ANPARA D-ANPARA B L8	-	PIPRI-SONENAGAR	PIPRI-SONENAGAR
10.1	Line Length	Km	5.02	5.02	-	186	186
10.2	Positive seq. RESISTANCE	Ohms/Km	0.0275	0.0275	-	0.162	0.162
10.3	Positive seq. REACTANCE	Ohms/Km	0.331	0.331	-	0.3861	0.3861
10.4	Zero seq. RESISTANCE	Ohms/Km	0.261	0.261	-	0.4056	0.4056
10.5	Zero seq. REACTANCE	Ohms/Km	1.031	1.031	-	1.622	1.622
10	**ADJECENT SECOND LONGEST LINE**		-	-	-	PIPRI -GARWA	PIPRI -GARWA
10.1	Line Length	Km	-	-	-	102	102
10.2	Positive seq. RESISTANCE	Ohms/Km	-	-	-	0.162	0.162
10.3	Positive seq. REACTANCE	Ohms/Km	-	-	-	0.3861	0.3861
10.4	Zero seq. RESISTANCE	Ohms/Km	-	-	-	0.4056	0.4056
10.5	Zero seq. REACTANCE	Ohms/Km	-	-	-	1.622	1.622
11	Remote End Transformers						
11.1	MVA		-	-	3*20	-	-
11.2	Voltage ratio	kV/kV	-	-	132/33	-	-
11.1	% Impedance	%	-	-	10	-	-

2.5 Review of 400/132 kV TRANSMISSION LINE PROTECTION SETTINGS:

2.5.1 REVIEW OF ANPARA- SINGRAULI LINE L1:

Table-5 Review of Anpara Singrauli Line:

Name of Transmission Line	ANPARA SINGRAULI L1									
Main I	Alstom P442									
	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach-phase (Ω)	**8.300**	**17.274**	-	-	**16.50**	**21.594**	**27.50**	**26.992**	**27.50**	**26.992**
Resistive reach-ground (Ω)	**27.200**	**23.033**	-	-	**34.70**	**28.791**	**42.08**	**35.989**	**42.08**	**35.989**
Impedance -phase resistive reach (Ω)	1.989	1.989	-	-	2.983	2.984	**9.470**	**40.3055**	0.497	0.497
Time delay (ms)	0	0	-	-	350	350	1000	1000	400	1000
Main II	**Siemens 7SA52**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**4.125**	**4.163**	**8.250**	**4.212**	**8.250**	**4.212**	**13.750**	**7.330**	**4.130**	**1.0408**
Reactance Reach (Ω)	1.980	1.98289	**2.970**	**2.4786**	**2.970**	**2.5546**	**9.440**	**40.1671**	**0.500**	0.4957
Resistive reach for ph- E faults (Ω)	**15.125**	**23.163**	**19.250**	**23.212**	**19.250**	**23.212**	**23.375**	**18.33**	**15.130**	**5.7908**

Time delay (ms)	0	0	0	0	350	350	1000	1000	1000	1000
LBB	**EE,CTIG**									
Over current protection										
Pick up	0.2	0.2								
delay	0.4	0.4								

2.5.2 REVIEW OF ANPARA- SULTANPUR LINE L2:

Table-6 Review of Anpara - Sultanpur line L2:

Name of Transmission Line			ANPARA SULTANPUR L2							
Main I	**Siemens 7SA52**		**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings
	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**4.380**	**5.5998**	2.850	5.998	**5.200**	**6.192**	**6.690**	**7.6265**	**2.77**	**1.400**
Reactance Reach (Ω)	19.430	19.442	**4.040**	**24.303**	**29.150**	**26.647**	**47.010**	**44.074**	**0.240**	**4.860**
Resistive reach for ph- E faults (Ω)	**8.510**	**24.599**	**1.670**	**24.998**	**9.320**	**25.292**	**10.820**	**26.6265**	**6.890**	**6.150**
Time delay (ms)	0	0	0	0	300	350	1000	1000	500	1000
Main II	**ABB REL670**									

Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	70.67	70.702	-	-	106.1	105.424	**170.94**	**160.270**	**0.86**	**14.140**
R1PP/PE (Ω)	5.93	5.874	-	-	8.89	8.759	**14.34**	**13.316**	**0.1**	**1.175**
X0PE (Ω)	**203.77**	**220.222**	-	-	**305.66**	**328.374**	**492.88**	**499.210**	**2.48**	**44.044**
R0PE (Ω)	**64.08**	**55.750**	-	-	**96.12**	**83.129**	**154.99**	**126.376**	**0.78**	**11.150**
RFPP (Ω)	**133.59**	**30.000**	-	-	**150.29**	**60.000**	**166.99**	**75.000**	**166.99**	**42.421**
RFPE (Ω)	**44.09**	**40.000**	-	-	**66.66**	**60.000**	**74.06**	100.000	**74.06**	**63.631**
tPP (ms)	0	0	-	-	300	350	1000	1000	500	1000
tPE (ms)	0	0	-	-	300	350	1000	1000	500	1000
LBB	**EE,CTIG**									
Over current protection										
Pick up	0.2	0.2								
delay	0.4	0.4								

2.5.3 REVIEW OF ANPARA SARNATH L3:

Table-6 Review of Anpara-Sarnath line L3:

Name of Transmission Line			ANPARA SARNATH L3							
Main I	Siemens 7SA52		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**10.045**	**4.938**	**12.050**	**5.173**	**12.050**	**5.364**	**20.050**	**6.576**	**2.770**	**1.234**
Reactance Reach (Ω)	11.410	11.410	**17.120**	**14.263**	**17.120**	**16.582**	**28.470**	**31.316**	**0.240**	**2.852**
Resistive reach for ph- E faults (Ω)	**6.170**	**23.938**	**8.890**	**24.173**	**8.890**	**24.364**	**14.790**	**25.576**	**6.890**	**5.984**
Time delay (ms)	0	0	0	0	350	350	1000	1000	500	1000
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	41.51	41.494	-	-	68.75	68.732	**66.38**	**113.877**	**0.86**	**10.374**
R1PP/PE (Ω)	3.45	3.447	-	-	5.71	5.710	**7.17**	**9.461**	**0.10**	**0.862**
X0PE (Ω)	129.30	129.246	-	-	214.15	214.087	**268.82**	**354.705**	**2.48**	**32.312**

R0PE (Ω)	32.73	32.719	-	-	54.21	54.197	**63.05**	**89.794**	**0.78**	**8.180**
RFPP (Ω)	**100**	**30**	-	-	**150.29**	**60**	**116.99**	**75**	**166.99**	**31.121**
RFPE (Ω)	**100**	**40**	-	-	**66.66**	**60**	**74.05**	**100**	**74.06**	**46.681**
tPP (ms)	0	0	-	-	**350**	**350**	1000	1000	**500**	**1000**
tPE (ms)	0	0	-	-	**350**	**350**	1000	1000	**500**	**1000**
LBB	**EE,CTIG**									
Over current protection										
Pick up	0.2	0.2								
delay	0.4	0.4								

2.5.4 REVIEW OF ANPARA SARNATH L5:

Table-7 Review of Anpara-Sarnath line L5:

Name of Transmission Line			ANPARA SARNATH L5							
Main I	Siemens 7SA52		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**10.045**	**4.938**	**12.050**	**5.173**	**12.050**	**5.364**	**20.050**	**6.576**	**2.770**	**1.234**
Reactance Reach (Ω)	**11.410**	**11.410**	**17.120**	**14.263**	**17.120**	**16.582**	**28.470**	**31.316**	**0.240**	**2.852**

Resistive reach for ph- E faults (Ω)	**6.170**	**23.938**	**8.890**	**24.173**	**8.890**	**24.364**	**14.790**	**25.576**	**6.890**	**5.984**
Time delay (ms)	0	0	0	0	350	350	1000	1000	**500**	**1000**
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**30**	**41.494**	-	-	**30**	**68.732**	**30**	**113.877**	**30**	**10.374**
R1PP/PE (Ω)	**5**	**3.447**	-	-	**5**	**5.710**	**5**	**9.461**	**5**	**0.862**
X0PE (Ω)	**100**	**129.246**	-	-	**100**	**214.087**	**100**	**354.705**	**100**	**32.312**
R0PE (Ω)	**47**	**32.719**	-	-	**47**	**54.197**	**47**	**89.794**	**47**	**8.180**
RFPP (Ω)	**100**	**30**	-	-	**30**	**60**	**30**	**75**	**30**	**31.121**
RFPE (Ω)	**100**	**40**	-	-	**100**	**60**	**100**	**100**	**100**	**46.681**
tPP (ms)	0	0	-	-	350	350	1000	1000	**500**	**1000**
tPE (ms)	0	0	-	-	350	350	1000	1000	**500**	**1000**
LBB	**EE,CTIG**									
Over current protection										
Pick up	0.2	0.2								
delay	0.4	0.4								

2.5.5 REVIEW OF ANPARA MAU L6:

Table-7 Review of Anpara-Mau line L6:

Name of Transmission Line			ANPARA MAU L6							
Main I	Siemens 7SA52		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**16.798**	**5.569**	**20.500**	**5.962**	**20.500**	**11.198**	**22.250**	**6.717**	**2.770**	**1.392**
Reactance Reach (Ω)	19.080	19.078	**28.620**	**23.848**	**28.620**	**24.058**	**31.600**	**33.023**	**0.240**	**4.769**
Resistive reach for ph- E faults (Ω)	**15.450**	**24.569**	**22.250**	**24.962**	**22.250**	**30.198**	**24.570**	**25.713**	**6.890**	**6.142**
Time delay (ms)	0	0	0	0	350	350	1000	1000	**500**	**1000**
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	69.38	69.378	-	-	88.24	88.24	**102.83**	**120.087**	**0.86**	**17.344**
R1PP/PE (Ω)	5.76	5.764	-	-	7.33	7.33	**8.54**	**9.977**	**0.10**	**1.441**
X0PE (Ω)	216.10	216.098	-	-	274.86	274.86	**320.28**	**374.047**	**2.48**	**54.024**

R0PE (Ω)	54.71	54.706	-	-	69.58	69.58	**81.09**	**94.691**	**0.78**	**13.676**
RFPP (Ω)	30	30	-	-	**150.29**	**60**	**166.99**	**75**	**166.99**	**52.033**
RFPE (Ω)	40	40	-	-	**66.66**	**55.6**	**74.06**	**55**	**74.06**	**55.630**
tPP (ms)	0	0	-	-	**500**	**350**	1000	1000	**500**	**1000**
tPE (ms)	0	0	-	-	**500**	**350**	1000	1000	**500**	**1000**
LBB	**EE,CTIG**									
Over current protection										
Pick up	0.2	0.2								
delay	0.4	0.4								

2.5.6 REVIEW OF ANPARA B TO ANPARA D L8:

Table-8 Review of Anpara B-Anpara D line L8:

Name of Transmission Line			ANPARA B TO ANPARA D L8							
Main I	**Alstom MICOM P-543**									
Settings	**Existing Settings**	Reviewed Settings								
Phase Differential	Enable	Enable								
IS1(mA)	200	200								
IS2(A)	2	2								
K1 slope (%)	30	30								
K2 slope (%)	100	100								

Delay (ms)	0	0								
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**30**	**1.329**	**-**	**-**	**40**	**2.492**	**40**	**3.656**	**40**	**0.332**
R1PP/PE (Ω)	**5**	**0.110**	**-**	**-**	**5**	**0.207**	**5**	**0.304**	**5**	**0.028**
X0PE (Ω)	**100**	**4.140**	**-**	**-**	**120**	**7.763**	**120**	**16.776**	**120**	**1.035**
R0PE (Ω)	**15**	**1.048**	**-**	**-**	**15**	**1.965**	**15**	**2.882**	**15**	**0.262**
RFPP (Ω)	**30**	**3.988**	**-**	**-**	**30**	**7.477**	**30**	**10.967**	**30**	**0.997**
RFPE (Ω)	**100**	**5.982**	**-**	**-**	**100**	**11.216**	**100**	**16.450**	**100**	**1.495**
tPP (ms)	**0**	**0**	**-**	**-**	350	350	1000	1000	**500**	**1000**
tPE (ms)	**0**	**0**	**-**	**-**	350	350	1000	1000	**500**	**1000**
LBB	**EE, HITACHI,3 E81766**									
Over current protection										
Pick up	0.8	0.8								
delay	0.5	0.5								

2.5.7REVIEW OF ANPARA B TO ANPARA D L9:

Table-9 Review of Anpara B-Anpara D line L9:

Name of Transmission Line			ANPARA B TO ANPARA D L9							
Main I	**Alstom MICOM P-543**									
Settings	**Existing Settings**	Reviewed Settings								
Phase Differential	Enable	Enable								
IS1(mA)	200	200								
IS2(A)	2	2								
K1 slope (%)	30	30								
K2 slope (%)	100	100								
Delay (ms)	0	0								
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**30**	**1.329**	**-**	**-**	**40**	**2.492**	**40**	**3.656**	**40**	**0.332**
R1PP/PE (Ω)	**5**	**0.110**	**-**	**-**	**5**	**0.207**	**5**	**0.304**	**5**	**0.028**
X0PE (Ω)	**100**	**4.140**	**-**	**-**	**120**	**7.763**	**120**	**16.776**	**120**	**1.035**
R0PE (Ω)	**15**	**1.048**	**-**	**-**	**15**	**1.965**	**15**	**2.882**	**15**	**0.262**

RFPP (Ω)	**30**	**3.988**	**-**	**-**	**30**	**7.477**	**30**	**10.967**	**30**	**0.997**
RFPE (Ω)	**100**	**5.982**	**-**	**-**	**100**	**11.216**	**100**	**16.450**	**100**	**1.495**
tPP (ms)	**0**	**0**	**-**	**-**	350	350	1000	1000	**500**	**1000**
tPE (ms)	**0**	**0**	**-**	**-**	350	350	1000	1000	**500**	**1000**
LBB	**EE, HITACHI,3 E81766**									
Over current protection										
Pick up	0.8	0.8								
delay	0.5	0.5								

2.5.8 REVIEW OF 132 KV ANPARA B TO BINA LINE:

Table-10 Review of 132kV Anpara B-Bina line:

Name of Transmission Line			ANPARA B TO BINA LINE							
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**2.61**	**8.649**	-	-	**3.91**	**18.071**	**7.33**	**25.331**	**4.48**	**1.730**
R1PP/PE (Ω)	**0.99**	**3.633**	-	-	**1.49**	**11.802**	**2.79**	**19.062**	**1.43**	**0.727**
X0PE (Ω)	**8.57**	**36.333**	-	-	**12.85**	**52.676**	**24.09**	**59.936**	**14.72**	**7.267**
R0PE (Ω)	**2.21**	**9.085**	-	-	**3.31**	**18.617**	**6.20**	**25.877**	**3.79**	**1.817**

RFPP (Ω)	**8**	**25.946**	-	-	**8**	**46.622**	**8**	**42.330**	**8**	**5.189**
RFPE (Ω)	**10**	**30.826**	-	-	**10**	**27.147**	**10**	**24.917**	**10**	**7.784**
tPP (ms)	**0**	**0**	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
tPE (ms)	**0**	**0**	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
Back up Over Current and Earth Fault										
Over Current										
Pick up	204	204								
Time delay	0.25	0.25								
Earth Fault										
Pick up	120	120								
Time Delay	**0.12**	**0.2**								

2.5.9 REVIEW OF 132 KV ANPARA B TO PIPRI LINE I&II:

Table-11 Review of 132kV Anpara B-Pipri Line I&II:

Name of Transmission Line			ANPARA B TO PIPRI LINE I&II							
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**9.12**	**8.649**	-	-	**13.67**	**12.066**	**87.08**	**84.788**	**2.28**	**2.162**
R1PP/PE (Ω)	**3.47**	**3.629**	-	-	**5.21**	**5.063**	**33.19**	**35.575**	**0.87**	**0.907**

X0PE (Ω)	**29.98**	**36.333**	-	-	**44.97**	**50.688**	**286.42**	**356.191**	**7.50**	**9.083**
R0PE (Ω)	**7.72**	**9.085**	-	-	**11.58**	**12.675**	**73.74**	**92.477**	**1.93**	**2.271**
RFPP (Ω)	**14.95**	**25.946**	-	-	**18.42**	**36.197**	**74.38**	**75.000**	**9.74**	**6.486**
RFPE (Ω)	**13.47**	**38.919**	-	-	**15.21**	**51.383**	**43.38**	**51.149**	**10.25**	**9.730**
tPP (ms)	0	0	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
tPE (ms)	0	0	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
Back up Over Current and Earth Fault										
Over Current										
Pick up(A)	300	300								
Time delay(S)	**0.01**	**0.2**								
Earth Fault										
Pick up(A)	120	120								
Time Delay(S)	**0.01**	**0.25**								

REVIEW NOTES TRANSMISSION LINES:

Distance based Main-1 and Main-2 protection is provided to all 400 kV lines. All 132 kV lines are protected by main distance and current based backup protection. However it is observed that relay setting operational relay setting are different that reviewed setting. A complied summary of reviewed relay setting is given in Tables.

2.6 INPUT DATA FOR TARNSFORMER PROTECTION:

Table-12 Input Data for Transformer Protection**:**

S. No.	Description	Units	Value	Value	Value	Value	Value
0	**Substation Name**		ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS
1	**Transformer Name**		ICT 1	ICT 2	ICT 3	ST-1	ST-2
2	**Rating**						
2.1	MVA	MVA	100	100	100	40	40
2.2	Voltage Ratio	kV / kV	400/132	400/132	400/132	132/6.9	132/6.9
3	**Impedance**	%	10	10	10	14.08	14.08
4	**Vector Group**		YNa0d11	YNa0d11	YNa0d11	YNd11	YNd11
5	**OLTC Data**						
5.1	Min Tap (%)	% (-)	10	10	10	10	10
5.2	Max Tap (%)	% (+)	10	10	10	10.15	10.15
5.3	No. of Steps		17	17	17	17	17
6	**Differential Protection**		YES	YES	YES	YES	YES
6.1	Differential CT Ratio						
6.2	HV CT Ratio (Main & ICT)	A/A	500/1	500/1	500/1	300/1	300/1
6.3	LV1 CT Ratio (Main & ICT)	A/A	600/1	600/1	600/1	3000/1	3000/1
6.4	Differential Relay						
6.5	Make		MICOM	MICOM	MICOM	MICOM	MICOM
6.6	Model		P-645	P-645	P-645	P-645	P-645
7	**REF Protection**		YES	YES	YES	YES	YES

7.1	REF Protection CTs						
7.2	CT Ratio	A/A	600/1	600/1	600/1	300/1	300/1
7.6	REF Relay						
7.7	Make		MICOM	MICOM	MICOM	MICOM	MICOM
7.8	Model		P-645	P-645	P-645	P-645	P-645
7.9	Rstab Range (Ω)	Ohms	-	-	-	-	-
8	**Over Fluxing Protection**		YES	YES	YES	YES	YES
8.1	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.2	Model		P-645	P-645	P-645	P-645	P-645
8	**HV Back-up Protection**		YES	YES	YES	YES	YES
8.1	HV Back-up Protection Relay		Numerical	Numerical	Numerical	Numerical	Numerical
8.2	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.3	Model		P-645	P-645	P-645	P-645	P-645
8.4	HV Back-up Protection CTs						
8.5	Ratio	A/A	500/1	500/1	500/1	300/1	300/1
9	**LV Back-up Protection**		YES	YES	YES	YES	YES
9.1	LV Back-up Protection Relay		Numerical	Numerical	Numerical	Electro mechanical	Electro mechanical
9.2	Make		MICOM	MICOM	MICOM	EE	EE
9.3	Model		P-142	P-142	P-142	CAG-37	CAG-37
9.4	LV Back-up Protection CTs						
9.5	Ratio	A/A	600/1	600/1	600/1	3000/1	3000/1
S. No.	**Description**	**Units**	**Value**	**Value**	**Value**	**Value**	**Value**
0	**Substation Name**		ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS

1	**Transformer Name**		ST-3	ST-4	CW-1	CW-2	CW-3
2	**Rating**						
2.1	MVA	MVA	60	60	40	40	40
2.2	Voltage Ratio	kV/kV	132/6.9	132/6.9	132/6.9	132/6.9	132/6.9
3	**Impedance**	%	10	10	16.94	16.94	16.94
4	**Vector Group**		YN.d11.d11	YN.d11.d11	YNd11	YNd11	YNd11
5	**OLTC Data**						
5.1	Min Tap (%)	% (-)	10	10	12.27	12.27	12.27
5.2	Max Tap (%)	% (+)	10	10	10	10	10
5.3	No. of Steps		17	17	17	17	17
6	**Differential Protection**		YES	YES	YES	YES	YES
6.1	Differential CT Ratio						
6.2	HV CT Ratio (Main & ICT)	A/A	300/1	300/1	300/1	300/1	300/5
6.3	LV1 CT Ratio (Main & ICT)	A/A	3000/1	3000/1	4000/1	4000/1	2000/5
6.3	LV2 CT Ratio(Main & ICT)	A/A	-	-	-	-	-
6.4	Differential Relay						
6.5	Make		MICOM	MICOM	MICOM	MICOM	MICOM
6.6	Model		P-645	P-645	P-645	P-645	P-645
7	**REF Protection**		YES	YES	YES	YES	NO
7.1	REF Protection CTs						
7.2	CT Ratio	A/A	300/1	300/1	300/1	300/1	-
7.6	REF Relay						

7.7	Make		MICOM	MICOM	MICOM	MICOM	-
7.8	Model		P-645	P-645	P-645	P-645	-
7.9	Rstab Range (Ω)	Ohms	-	-	-	-	
8	**Over Fluxing Protection**		YES	YES	NO	NO	NO
8.1	Make		MICOM	MICOM	-	-	-
8.2	Model		P-645	P-645	-	-	-
8	**HV Back-up Protection**		YES	YES	YES	YES	YES
8.1	HV Back-up Protection Relay		Numerical	Numerical	Numerical	Numerical	Numerical
8.2	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.3	Model		P-645	P-645	P-645	P-645	P-645
8.4	HV Back-up Protection CTs						
8.5	Ratio	A/A	300/1	300/1	300/1	300/1	300/5
9	**LV Back-up Protection**		YES	YES	YES	YES	YES
9.1	LV Back-up Protection Relay		Electro mechanical	Electro mechanical	Electro mechanical	Electro mechanical	Electro mechanical
9.2	Make		CAG-37	CAG-37	CAG-37	CAG-37	CAG-37
9.3	Model						
9.4	Ratio	A/A	3000/1	3000/1	4000/1	4000/1	2000/5
S. No.	**Description**	**Units**	**Value**	**Value**	**Value**	**Value**	**Value**
0	**Substation Name**		ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS	ANPARA BTPS
1	**Transformer Name**		GT-1	GT-2	GT-3	GT-4	GT-5
2	**Rating**						
2.1	MVA	MVA	250	250	250	600	600

2.2	Voltage Ratio	kV/kV	15.75/400	15.75/400	15.75/400	21/420	21/420
3	**Impedance**	%	10	10	16.94	16.94	16.94
4	**Vector Group**		YNd11	YNd11	YNd11	YNd11	YNd11
5	**OLTC Data**						
5.1	Min Tap (%)	% (-)	10.25	10.25	10.25	5.17	10
5.2	Max Tap (%)	% (+)	0.25	0.25	0.25	5	10
5.3	No. of Steps		5	5	5	5	9
6	**Differential Protection**		YES(Over all differential)	YES(Over all differential)	YES(Over all differential)	YES	YES
6.1	Differential CT Ratio						
6.2	HV CT Ratio (Main & ICT)	A/A	500/1	500/1	500/1	1000/1	1000/1
6.3	LV1 CT Ratio (Main & ICT)	A/A	10000/5	10000/5	10000/5	12000/5	12000/5
6.4	Differential Relay		Electro Mechanical	Electro Mechanical	Electro Mechanical	Electro Mechanical	Numerical
6.5	Make		ASEA	ASEA	ASEA	Toshiba	ABB
6.6	Model		RADSE	RADSE	RADSE	D1938731M X:3L	RET-650
7	**REF Protection**		YES	YES	YES	YES	NO
7.1	REF Protection CTs						
7.2	CT Ratio	A/A	500/1	500/1	500/1	1000/1	-
7.6	REF Relay		Electro Mechanical	Electro Mechanical	Electro Mechanical	Electro Mechanical	-
7.7	Make		ASEA	ASEA	ASEA	Toshiba	-
7.8	Model		RADSE	RADSE	RADSE	IBX164	-

7.9	Rstab Range (Ω)	Ohms				164	-
8	**Over Fluxing Protection**		-	-	-	YES	YES
8.1	Make		-	-	-	Toshiba	ABB
8.2	Model		-	-	-	OFX 132	RET-650
8	**HV Back-up Protection**		YES	YES	YES	YES	YES
8.1	HV Back-up Protection Relay		Electro Mechanical	Electro Mechanical	Electro Mechanical	Electro Mechanical	Numerical
8.2	Make		ER	ER	ER	Toshiba	ABB
8.3	Model		TJM-10	TJM-10	TJM-10	IKC	RET-650
8.4	HV Back-up Protection CTs						
8.5	Ratio	A/A	500/1	500/1	500/1	1000/1	1000/1
9	**LV Back-up Protection**		-	-	-	-	-
9.1	LV Back-up Protection Relay		-	-	-	-	-
9.2	Make		-	-	-	-	-
9.3	Model		-	-	-	-	-
9.4	LV Back-up Protection CTs		-	-	-	-	-

2.7 REVIEW OF TRANSFORMER PROTECTION RELAY SETTINGS:

Table-13 Review of Transformer Protection Relay Settings**:**

Main-I	**ICT1**		**ICT2**		**ICT3**		**ST-1**		**ST-2**					
Relay make	**MICOM P-645**		**MICOM P-645**		**MICOM P-645**		**MICOM P-645**		**MICOM P-645**					
Differential Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Unit		CT ratio	
diff Id	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	A	Iref	ICTs 1,2&3	HV-500/1
Diff I>>	-	-	-	-	-	-	-	-	-	-	A	Iref		LV-600/1
Diff I>>>	-	-	-	-	-	-	-	-	-	-	A	Iref	ST-1&2	LV-3000/1
slope 1	30	30	30	30	30	30	30	30	30	30		%		
slope 2	70	70	70	70	70	70	80	80	80	80		%		HV-300/1
Over Fluxing Protection													Neutral CT ratios	
V/f	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	V/Hz		ICTs 1,2&3	600/1
Time delay	5	5	5	5	5	5	5	5	5	5	sec			
V/f	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	V/Hz		ST-1&2	300/1
Time delay	18	18	18	18	18	18	18	18	18	18	sec			
REF Protection HV side														
High Impedance Type														
Pickup	0.09	0.09	0.09	0.09	0.09	0.09	0.1	0.1	0.1	0.1	A			
Stabilizing Resistor	-	97.05	-	97.05	-	97.05	-	126.84	-	126.84	ohm			
BACK UP HV SIDE OVER CURRENT AND EARTH FAULT PROTECTION														

Relay Make	MICOM P-142		MICOM P-142		MICOM P-142		MICOM P-142		MICOM P-142				
Over Current	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	DT	DT	DT	DT	DT	DT	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	150	150	150	150	150	150	225	225	225	225			
Time Delay (Sec)	0.5	0.5	0. 5	0.5	0.5	0.5	0.35	0.35	0.35	0.35			
Earth Fault	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	50	50	50	50	50	50	30	30	30	30			
Time Delay (Sec)	0.35	0.35	0.35	0.35	0.35	0.35	0.1	0.1	0.1	0.1			
LV side Over current and Earth fault protection													
Relay Make	MICOM P-142		MICOM P-142		MICOM P-142		MICOM P-142		MICOM P-142				
Over Current	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	0.75	0.75	0.75	0.75	0.75	0.75	15	15	15	15			
Time Delay	**0.35**	**0.17**	**0.35**	**0.17**	**0.35**	**0.17**	0.5	0.5	0.5	0.5			

(Sec)													
Function	-	-	-	-	-	-	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	-	-	-	-	-	-	30	30	30	30			
Time Delay (Sec)	-	-	-	-	-	-	0.5	0.5	0.5	0.5			
Earth Fault	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Pick up (A)	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-			
Time Delay (Sec)	0.35	0.35	0.35	0.35	0.35	0.35	-	-	-	-			

Main-I	ST-3		ST-4		CW-1		CW-2		CW-3					
Relay make	**MICOM P-645**		**MICOM P-645**		**MICOM P-645**		**MICOM P-645**		**MICOM P-645**					
Differential Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Unit		CT ratio	
diff Id	0.2	0.2	0.2	0.2	0.17	0.17	0.17	0.17	0.17	0.17	A	Iref	ST-3&4	HV-500/1
Diff I>>	-	-	-	-	5	5	5	5	-	-	A	Iref		LV-600/1
Diff I>>>	-	-	-	-	8	8	8	8	-	-	A	Iref	CW-1&2	LV-4000/1 HV-300/1
slope 1	30	30	30	30	15	15	15	15	15	15		%	CW-3	LV-2000/5 HV-300/5
slope 2	80	80	80	80	80	80	80	80	80	80		%		
Over Fluxing Protection														
V/f	2.42	2.42	2.42	2.42	-	-	-	-	-	-	-		Neutral CT ratios	
Time delay	5	5	5	5	-	-	-	-	-	-	-		ST-3&4	3000/1
V/f	2.64	2.64	2.64	2.64	-	-	-	-	-	-	-		CW-1&2	300/1
Time delay	18	18	18	18	-	-	-	-	-	-	-		CW-3	300/1
REF Protection HV side														

High Impedance Type													
Pickup	0.1	0.1	0.1	0.1	30	30	30	30	-	-	A		
Stabilizing Resistor	-	108.48	-	108.48	-	125.9	-	125.9	-	-	ohm		
Back up	ST-3		ST-4		CW-1		CW-2		CW-3				
Relay make	**MICOM P-645 & EE CAG-37**		**MICOM P-645 & EE CAG-37**		**MICOM P-645 & EE CAG-37**		**MICOM-P-645 & EE CAG-37**		**MICOM-P-645 & EE CAG-37**				
HV side Over current and Earth fault protection													
Over Current	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	1	1	1	1	0.75	0.75	0.75	0.75	1.25	1.25			
Time Delay (Sec)	0.4	0.4	0.4	0.4	0.35	0.35	0.35	0.35	0.3	0.3			
Function	DT	DT	DT	DT	-	-	-	-	-	-			
Pick up (A)	1	1	1	1	-	-	-	-	-	-			
Time Delay (Sec)	5	5	5	5	-	-	-	-	-	-			
Earth Fault	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	0.1	0.1	0.1	0.1	-	-	-	-	0.1	0.1			
Time Delay	0.1	0.1	0.1	0.1	-	-	-	-	0.1	0.1			

(Sec)													
LV side Over current and Earth fault protection													
Over Current	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	8	8	8	8	15	15	15	15	5	5			
Time Delay (Sec)	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	10	10			
Function	-	-	-	-	-	-	-	-	-	-			
Pick up (A)	-	-	-	-	-	-	-	-	-	-			
Time Delay (Sec)	-	-	-	-	-	-	-	-	-	-			
Earth Fault	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Pick up (V)	-	-	-	-	-	-	-	-	3	3			
Time Delay (Sec)	-	-	-	-	-	-	-	-	0.5	0.5			

Main-I	GT-1		GT-2		GT-3		GT-4		GT-5					
Relay make	**ASEA-RADSE**		**ASEA-RADSE**		**ASEA-RADSE**		**TOSHIBA**		**ABB,RET-650**					
Differential Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Unit		CT ratio	
diff Id	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	A	Iref	GT-1,2,3	HV-500/1
slope 1	-	-	-	-	-	-	-	-	40	40		%	GT-4,5	HV-1000/1 LV-12000/5
slope 2		-	-	-	-	-	-	-	80	80		%		
Over Fluxing Protection														
V/f	-	-	-	-	-	-	2.3	2.3	1.13	1.13	V/Hz			
Time delay	-	-	-	-	-	-	2	2	2	2	sec			
V/f	-	-	-	-	-	-	2.5	2.5	1.4	1.4	V/Hz			
Time delay	-	-	-	-	-	-	2	2	2	2	sec			
REF Protection HV side														
High Impedance Type														
Pickup	-	-	-	-	-	-	0.01	0.01	-	-	mA			
Stabilizing Resistor	-	-	-	-	-	-	163	163	-	-	ohm			
Back up HV side Over current and Earth fault protection														
Over Current	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings				
Pick up (A)	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.1	0.1				
Time	0.1	0.1	0.1	0.1	0.1	0.1	1	1	1	1				

Delay (Sec)													
Earth Fault	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	-	-	-	-	-	-	-	-	0.5	0.5			
Time Delay (Sec)	-	-	-	-	-	-	-	-	1	1			

2.8 REVIEW NOTES TRANSFORMER PROTECTION:

400/132 kV Substation of BTPS was audited and it is observed that Transformer main -I, main-II, and Back up protection settings are in order. Based on the review the necessary suggestions in the operational relay setting are listed in the below table

Note	• For ST-1, 2, 3, 4 - LV side earth fault protection is not provided. This Protection may be considered. • For CW-1, 2, 3, - HV & LV side earth fault protection is not provided. This Protection may be considered. • GT-1, 2, 3 – Over fluxing protection is not provided. This Protection may be considered. • For CW- 3&GT-5 – REF protection is not provided. This Protection may be considered. • For GT-1, 2, 3, 4&5 LV side over current and earth fault protection is provided in generators relay panels.

2.9 INPUT DATA FOR BUS REACTOR PROTECTION:

Table-14 Input Data for Bus Reactor Protection**:**

Sl. No	Description	Unit	Value
	Substation Name		
1	**Name**		Bus Reactor
2	**Rating**		
2.1	MVA	MVAR	63
2.2	Voltage Level	kV	420
3	**Impedance**	%	2304
4	**Differential Protection**		YES
4.1	Differential CT Ratio		
4.2	HV CT Ratio (Main & ICT)	A/A	100/1
4.3	LV CT Ratio (Main & ICT)	A/A	100/1
4.4	Differential Relay		Numerical
4.5	Make		MICOM
4.6	Model		P-645
5	**REF Protection**		NO
5.1	REF Protection neutral side		-
5.2	CT Ratio	A/A	-
5.3	REF Relay		-
5.4	Make		-
5.5	Model		-
5.6	Rstab Range (Ω)	Ohms	-
6	**Back-up Protection**		YES
6.1	Back-up Protection Relay		ELECTRO MEXHINICAL
6.2	Make		EE
6.3	Model		MCAG
6.4	Back-up Protection CTs Ratio	A/A	100/1

2.10 REVIEW OF BUS REACTOR PROTECTION SETTINGS:

Table-15 Review of Bus Reactor Protection Settings**:**

Sl No.	Description			BUS REACTOR Adopted Settings	BUS REACTOR Recommended Settings
1	**Make**			ALSTOM	
2	**Capacity(MVAR)**			63	
3	**Voltage Level (KV)**			420	
4	**% Impedance**			2304	
5	**MAIN**			**MAIN-I**	**MAIN-I**
6	**Differential**	**Relay Model &make**		MICOM P-645	
		Adopted CT Ratio	**HV**	100/1	100/1
			LV	100/1	100/1
		Biased	**M1 (%)**	20	20
			M2 (%)	60	60
			Is/Id min	0.2	0.2
7	**Back Up Over Current**	**Relay Model &make**			
		CT Ratio	**HV**	100/1	100/1
			LV	100/1	100/1
		Settings			
		Over current	**Pick up (A)**	1.4	1.4
			Time delay(Sec)	0.4	0.4
		Earth fault	**Pick up (A)**	0.5	0.5
			Time delay(Sec)	0.4	0.4

2.11 REVIEW NOTES OF BUS REACTOR PROTECTION

400/132 kV Substation of BTPS was audited and it is observed that Bus Reactor protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table

Note	• For Bus Reactor as per NRPC guide lines REF protection should be given.

2.12 REVIEW OF BUS BAR PROTECTION:

400/132 kV Substation of BTPS was audited and it is observed that Bus Bar protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table

Table-16 Review of Bus Bar Protection Settings**:**

Sl. No.	BAY	PROTECTION	Main-I		Main-II	
			Existing settings	**Recommended Settings**	**Existing settings**	**Recommended Settings**
1	Bus selector-1	Over Current	Pick up I=2400 A Time delay=1.0 sec	Pick up I=2400 A Time delay=1.0 sec	Pick up I=8000 A Time delay=0sec	Pick up I=8000 A Time delay=0sec
		Earth Fault	Pick up I=300A Time delay=1.2sec	Pick up I=300A Time delay=1.2sec	Pick up I=300A Time delay=1.2 sec	Pick up I=300A Time delay=1.2 sec
2	Bus selector -2	Over Current	Pick up I=2400 A Time delay=1.0 sec	Pick up I=2400 A Time delay=1.0 sec	Pick up I=1200 Time delay=0 sec	Pick up I=1200 Time delay=0 sec
		Earth Fault	Pick up I=300A Time delay=1.2sec	Pick up I=300A Time delay=1.2sec	Pick up I=1200 Time delay=0 sec	Pick up I=1200 Time delay=0 sec
		CB Fail	I<40 A IN<40 A I sef<20 mA	I<40 A IN<40 A I sef<20 mA	-	-
3	400 kV BUS BAR	Voltage differential	Check Zone=200 V Zone A=200 V Zone B=200 V Zone C =200 V	Check Zone=200 V Zone A=200 V Zone B=200 V Zone C =200 V	-	-
		95 Wire supervision relay	Pick up VS=14 V	Pick up VS=14 V	-	-
4	132 KV BUS BAR	Differential	Check Zone=0.75 A Zone A=0.75 A Zone B=0.75 A Zone C =0.75 A	Check Zone=0.75 A Zone A=0.75 A Zone B=0.75 A Zone C =0.75 A	-	-
		Bus wire supervision	Pick up=5 V	Pick up=5 V	-	-

5	132 BUS COUPLER	Over Current	Pick up=1.25 A Delay =0.8 Sec	Pick up=1.25 A Delay =0.8 Sec	-	-
		Earth Fault	Pick up=0.8A Delay =0.8 Sec	Pick up=0.8A Delay =0.8 Sec	-	-
6	ATPS BUS BAR	Differential	Check Zone=0.75 A Zone A=0.75 A Zone B=0.75 A Zone C =0.75 A	Check Zone=0.75 A Zone A=0.75 A Zone B=0.75 A Zone C =0.75 A	-	-
		Bus wire supervision	Pick up=5 V	Pick up=5 V	-	- -
7	ATPS BUSCOUPLER	Over Current	Pick up=1.25 A Delay =1 Sec	Pick up=1.25 A Delay =1 Sec	-	-
		Earth Fault	Pick up=0.8A Delay =0.8 Sec	Pick up=0.8A Delay =0.8 Sec	-	-

2.13 Review of Auxiliary Protection Infrastructure:-

In this section, the details of the batteries and chargers are described. There are four sets of battery banks of 220 V in Substation and three set of 48 V. The DC system in DTPS is adequate for the station and it is satisfactory.
Details of DC system data noted by CPRI team during field audit are given below:-

Table-17 Review of 220 V battery bank for ATPS

DC BATTER SYSTEM OF 220 V (2 Battery Banks) IN ATPS		
Bank	Bank-1	Bank-2
Make	EXIDE	HBL
Type	OPZS400PSTBS400	T-420 H-HOP
Year of Commissioning	2019	2017
No Of Cells	110*2.02V	110*2.02V
Capacity	400Ah	420Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	CHHABI	CHLORIDE
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	232 V	227.4V
Positive-Earth	160 V	160 V
Negative-Earth	72 V	72 V

Table-18 Review of 220 V battery bank for BTPS

DC BATTER SYSTEM OF 220 V (2 Battery Banks) IN BTPS		
Bank	Bank-1	Bank-2
Make	EXIDE	HBL
Type	OPZS1450P	T1500SHDP
No Of Cells	110*2.02V	110*2.02V
Year of Commissioning	2018	2018
Capacity	1450Ah	1500Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	YUASA	CHLORIDE
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	235 V	232 V
Positive-Earth	116.0 V	116V
Negative-Earth	115.5 V	115.5 V

Table-19 Review of 40 V battery bank for ATPS

DC BATTER SYSTEM OF 48 V (2 Battery Banks) IN ATPS		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	T-200 H-HDD	T-200 H-HDD
No Of Cells	24*2.24V	24*2.24V
Year of Commissioning	2018	2018
Capacity	200Ah	200Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	ADOR POWER	ADOR POWER
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	53.98 V	54 V
Positive-Earth	51.4V	35V
Negative-Earth	-53.3 V	-53.5 V

Table-20 Review of 48 V battery bank for BTPS

DC BATTER SYSTEM OF 48 V (2 Battery Banks) IN BTPS		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	T-500 H-HDD	T-500 H-HDD
No Of Cells	24*2.24V	24*2.24V
Year of Commissioning	2018	2018
Capacity	500Ah	500Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	AFCO INDUSTRIAL	AFCO INDUSTRIAL
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	53.9 V	53.9 V
Positive-Earth	31.3 V	31.3 V
Negative-Earth	-51V	-51V

III. Review of Circuit Breaker Test Reports

3.0 Review of Circuit Breaker Test Reports:

Circuit breaker test reports were collected in the field from Switchyard by the CPRI audit team and verified that all the lines closing time is less than 120ms and are in order. The Overall performance of all the circuit breaker is satisfactory as per testing reports collected at site.

Table-21 Review of Circuit Breaker Test Reports:

Breaker Name	Close coil (milli seconds)	Trip Coil-I (milli seconds)	Trip Coil-II (milli seconds)	Remark (as per CBIP guide lines)
L2	97.0	19.0	18.6	ok
L3	83.2	19.0	19.8	ok
L4	48.9	19.2	19.2	ok
L5	115.4	21.8	22.2	ok
L8	88.7	18.4	18.4	ok
L9	90	18.2	18.5	ok
BINA(L-1)	3.4	3.6	3.4	ok
PIPRI LINE(L-3&4)	49.9	19.3	19.0	ok
G-1	96.7	17.5	17.0	ok
G-2	93.6	20.4	20.1	ok
G-3	91.4	19.0	17.3	ok
G-4	116.6	22.6	22.6	ok
G-5	114.4	22.5	22.2	ok
ICT-1	97	17	17	ok
ICT-II	89.4	19.0	19.4	ok
CW-II	74.2	36.8	36.0	ok
ST-I	70.6	37.0	36.0	ok
ST-II	67.3	35.1	34.3	ok
ATPS BC	72	36	37	ok
BTPS BC	94.1	17	18.4	ok

IV. Audit finding and observation

4.0Audit finding and observations:

CPRI audit team carried out the site visit filed inspection and following are a few observation

1. A few Lines, Generator transformer, station transformer are protected by electro-mechanical so these relays may be replaced by numerical relays for better performance in terms of Synchronizing and disturbance/event recording facility.
2. 400kV Lines are protected as main-1 and main-2 distance protection. All 132 kV lines are also protected as main distance and backup over current protection. But their operational relay setting are observable variation with respect to calculated relay setting obtained based on the provided line parameters.
3. All GT, ICTs and station transformer are well protected only earth fault backup protection and V/F is nor provided
4. The 132 kV substation section of 400 kV BTPS is not properly fenced to stop movement of cattle/animals coming to 132 KV section of yard. This may result in hazard and safety issues to manpower, animal and damage to the Equipment's installed in substation.
5. The isolator, switchbox, panels used for powering the breakers and other switching equipment having ageing effect and a few of them are damaged by corrosion.
6. Regular maintenance of substation in terms of cleanliness, painting of panels and protection against waterlogging.
7. The substation Power equipment Earthing is measured a few sample locations. It is found that Earthing of power equipment with substation ground mat is proper and its value is less than 1 ohm.
8. The D C bank supply is measured and it is observed that they are well maintained. Station-1, 48 V bank -2 are non-functional.
9. Synchronizing facility is available at substation but most of good no. of relays are electro-mechanical so these relays are not time synchronized.
10. The periodic test reports of Circuit breakers and relays are reviewed and it is found that their performance is satisfactory in terms of breaker opening, closing times,
11. Wherever the change in relay settings and additional protection is required is suggested as under:

400/132 kV switchyard were audited and it is observed that GT, station transformers, CW'S, Bus reactor and line unit protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table.

Table-1 Review of 400/132 kV Transmission lines

Name of Transmission Line			ANPARA SINGRAULI L1							
Main I	**Alstom P442**									
	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings

Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach-phase (Ω)	**8.300**	**17.274**	-	-	**16.50**	**21.594**	**27.50**	**26.992**	**27.50**	**26.992**
Resistive reach-ground (Ω)	**27.200**	**19.89**	-	-	**34.70**	**28.791**	**42.08**	**35.989**	**42.08**	**35.989**
Impedance -phase resistive reach (Ω)	-	-	-	-	-	-	**9.470**	**40.3055**	-	-
Time delay (ms)	-		-	-	-	-	-	-	400	1000
Main II	**Siemens 7SA52**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**4.125**	**4.163**	**8.250**	**4.212**	**8.250**	**4.212**	**13.750**	**7.330**	**4.130**	**1.0408**
Reactance Reach (Ω)	-	-	**2.970**	**2.4786**	**2.970**	**2.5546**	**9.440**	**40.1671**	**-**	-
Resistive reach for ph- E faults (Ω)	**15.125**	**23.163**	**19.250**	**23.212**	**19.250**	**23.212**	**23.375**	**18.33**	**15.130**	**5.7908**
Name of Transmission Line			ANPARA SULTANPUR L2							
Main I	Siemens 7SA52		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**4.380**	**5.599**	**-**	**-**	**5.200**	**6.192**	**6.690**	**7.6265**	**2.77**	**1.400**
Reactance Reach	-	-	**4.040**	**24.303**	**29.150**	**26.64**	**47.010**	**44.074**	**0.240**	**4.860**

(Ω)										
Resistive reach for ph- E faults (Ω)	**8.510**	**24.599**	**1.670**	**24.998**	**9.320**	**25.292**	**10.820**	**26.6265**	**6.890**	**6.150**
Time delay (ms)	-	-	-	-	-	-	-	-	500	1000
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**-**	**-**	**-**	**-**	**-**	**-**	**170.94**	**160.270**	**0.86**	**14.140**
R1PP/PE (Ω)	**-**	**-**	**-**	**-**	**-**	**-**	**14.34**	**13.316**	**0.1**	**1.175**
X0PE (Ω)	**203.77**	**220.222**	**-**	**-**	**305.66**	**328.374**	**492.88**	**499.210**	**2.48**	**44.044**
R0PE (Ω)	**64.08**	**55.750**	**-**	**-**	**96.12**	**83.129**	**154.99**	**126.376**	**0.78**	**11.150**
RFPP (Ω)	**133.59**	**30.000**	**-**	**-**	**150.29**	**60**	**166.99**	**75.000**	**166.99**	**42.421**
RFPE (Ω)	**44.09**	**40.000**	**-**	**-**	**66.66**	**60**	**74.06**	**100.000**	**74.06**	**63.631**
Name of Transmission Line			ANPARA SARNATH L3							
Main I	Siemens 7SA52		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forwar	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse

			d							
Resistive reach for ph-ph faults (Ω)	**10.045**	**4.938**	**12.050**	**5.173**	**12.050**	**5.364**	**20.050**	**6.576**	**2.770**	**1.234**
Reactance Reach (Ω)	-	-	**17.120**	**14.263**	**17.120**	**16.582**	**28.470**	**31.316**	**0.240**	**2.852**
Resistive reach for ph- E faults (Ω)	**6.170**	**23.938**	**8.890**	**24.173**	**8.890**	**24.364**	**14.790**	**25.576**	**6.890**	**5.984**
Time delay (ms)	-	-	-	-	-	-	-	-	**500**	**1000**
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**-**	**-**	**-**	**-**	**-**	**-**	**66.38**	**113.877**	**0.86**	**10.374**
R1PP/PE (Ω)	**-**	**-**	**-**	**-**	**-**	**-**	**7.17**	**9.461**	**0.10**	**0.862**
X0PE (Ω)	**-**	**-**	**-**	**-**	**-**	**-**	**268.82**	**354.705**	**2.48**	**32.312**
R0PE (Ω)	**-**	**-**	**-**	**-**	**-**	**-**	**63.05**	**89.794**	**0.78**	**8.180**
RFPP (Ω)	**100**	**30**	**-**	**-**	**150.29**	**60**	**116.99**	**75**	**166.99**	**31.121**
RFPE (Ω)	**100**	**40**	**-**	**-**	**66.66**	**60**	**74.05**	**100**	**74.06**	**46.681**
tPP (ms)	-	-	**-**	**-**	**-**	**-**	**-**	**-**	**500**	**1000**
tPE (ms)	-	-	**-**	**-**	**-**	**-**	**-**	**-**	**500**	**1000**

Name of Transmission Line			ANPARA SARNATH L5							
Main I	**Siemens 7SA52**									
	Existing Settings	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**10.045**	**4.938**	**12.050**	**5.173**	**12.050**	**5.364**	**20.050**	**6.576**	**2.770**	**1.234**
Reactance Reach (Ω)	-	-	**17.120**	**14.263**	**17.120**	**16.582**	**28.470**	**28.463**	**0.240**	**2.852**
Resistive reach for ph- E faults (Ω)	**6.170**	**23.938**	**8.890**	**24.173**	**8.890**	**24.364**	**14.790**	**25.576**	**6.890**	**5.984**
Time delay (ms)	-	-	-	-	-	-	-	-	**500**	**1000**
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**30**	**41.494**	-	-	**30**	**68.732**	**30**	**113.877**	**30**	**10.374**
R1PP/PE (Ω)	**5**	**3.447**	-	-	**5**	**5.710**	**5**	**9.461**	**5**	**0.862**
X0PE (Ω)	**100**	**129.246**	-	-	**100**	**214.087**	**100**	**354.705**	**100**	**32.312**
R0PE (Ω)	**47**	**32.719**	-	-	**47**	**54.197**	**47**	**89.794**	**47**	**8.180**
RFPP (Ω)	**100**	**30**	-	-	**30**	**60**	**30**	**75**	**30**	**31.121**
RFPE (Ω)	**100**	**40**	-	-	**100**	**60**	**100**	**100**	**100**	**46.681**

tPP (ms)	-	-	-	-	-	-	-	-	**500**	**1000**
tPE (ms)	-	-	-	-	-	-	-	-	**500**	**1000**

Name of Transmission Line			ANPARA MAU L6							
Main I	**Siemens 7SA52**		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach for ph-ph faults (Ω)	**16.798**	**5.569**	**20.500**	**5.962**	**20.500**	**11.198**	**22.250**	**6.717**	**2.770**	**1.392**
Reactance Reach (Ω)	-	-	**28.620**	**23.848**	**28.620**	**24.058**	**31.600**	**33.023**	**0.240**	**4.769**
Resistive reach for ph- E faults (Ω)	**15.450**	**24.569**	**22.250**	**24.962**	**22.250**	**30.198**	**24.570**	**25.713**	**6.890**	**6.142**
Time delay (ms)	-	-	-	-	-	-	-	-	**500**	**1000**
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	-	-	-	-	-	-	**102.83**	**120.087**	**0.86**	**17.344**
R1PP/PE (Ω)	-	-	-	-	-	-	**8.54**	**9.977**	**0.10**	**1.441**
X0PE (Ω)	-	-	-	-	-	-	**320.28**	**374.047**	**2.48**	**54.024**

R0PE (Ω)	-	-	-	-	-	-	**81.09**	**94.691**	**0.78**	**13.676**
RFPP (Ω)	-	-	-	-	**150.29**	**60**	**166.99**	**75**	**166.99**	**52.033**
RFPE (Ω)	-	-	-	-	**66.66**	**55.6**	**74.06**	**55**	**74.06**	**55.630**
tPP (ms)	-	-	-	-	**500**	**350**	**-**	**-**	**500**	**1000**
tPE (ms)	-	-	-	-	**500**	**350**	**-**	**-**	**500**	**1000**

Name of Transmission Line			ANPARA B TO ANPARA D L8							
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**30**	**1.329**	**-**	**-**	**40**	**2.492**	**40**	**3.656**	**40**	**0.332**
R1PP/PE (Ω)	**5**	**0.110**	**-**	**-**	**5**	**0.207**	**5**	**0.304**	**5**	**0.028**
X0PE (Ω)	**100**	**4.140**	**-**	**-**	**120**	**7.763**	**120**	**16.776**	**120**	**1.035**
R0PE (Ω)	**15**	**1.048**	**-**	**-**	**15**	**1.965**	**15**	**2.882**	**15**	**0.262**
RFPP (Ω)	**30**	**3.988**	**-**	**-**	**30**	**7.477**	**30**	**10.967**	**30**	**0.997**
RFPE (Ω)	**100**	**5.982**	**-**	**-**	**100**	**11.216**	**100**	**16.450**	**100**	**1.495**
tPP (ms)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**500**	**1000**
tPE (ms)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**500**	**1000**

Name of Transmission Line	ANPARA B TO ANPARA D L9			

Main II	ABB REL670									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**30**	**1.329**	-	-	**40**	**2.492**	**40**	**3.656**	**40**	**0.332**
R1PP/PE (Ω)	**5**	**0.110**	-	-	**5**	**0.207**	**5**	**0.304**	**5**	**0.028**
X0PE (Ω)	**100**	**4.140**	-	-	**120**	**7.763**	**120**	**16.776**	**120**	**1.035**
R0PE (Ω)	**15**	**1.048**	-	-	**15**	**1.965**	**15**	**2.882**	**15**	**0.262**
RFPP (Ω)	**30**	**3.988**	-	-	**30**	**7.477**	**30**	**10.967**	**30**	**0.997**
RFPE (Ω)	**100**	**5.982**	-	-	**100**	**11.216**	**100**	**16.450**	**100**	**1.495**
tPP (ms)	-	-	-	-	-	-	-	-	**500**	**1000**
tPE (ms)	-	-	-	-	-	-	-	-	**500**	**1000**

Name of Transmission Line			ANPARA B TO BINA LINE							
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**2.61**	**8.649**	-	-	**3.91**	**18.071**	**7.33**	**25.331**	**4.48**	**1.730**
R1PP/PE (Ω)	**0.99**	**3.633**	-	-	**1.49**	**11.802**	**2.79**	**19.062**	**1.43**	**0.727**
X0PE (Ω)	**8.57**	**36.333**	-	-	**12.85**	**52.676**	**24.09**	**59.936**	**14.72**	**7.267**
R0PE (Ω)	**2.21**	**9.085**	-	-	**3.31**	**18.617**	**6.20**	**25.877**	**3.79**	**1.817**

RFPP (Ω)	**8**	**25.946**	-	-	**8**	**46.622**	**8**	**42.330**	**8**	**5.189**
RFPE (Ω)	**10**	**30.826**	-	-	**10**	**27.147**	**10**	**24.917**	**10**	**7.784**
tPP (ms)	**-**	**-**	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
tPE (ms)	**-**	**-**	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
Back up Over Current and Earth Fault										
Earth Fault										
Pick up	120	120								
Time Delay	**0.12**	**0.2**								

Name of Transmission Line			ANPARA B TO PIPRI LINE I&II							
Main II	**ABB REL670**									
Distance Protection	Zone 1		Zone IB		Zone 2		Zone 3		Zone 4	
Settings										
Direction	Forward	Forward	-	-	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	**9.12**	**8.649**	-	-	**13.67**	**12.066**	**87.08**	**84.788**	**2.28**	**2.162**
R1PP/PE (Ω)	**3.47**	**3.629**	-	-	**5.21**	**5.063**	**33.19**	**35.575**	**0.87**	**0.907**
X0PE (Ω)	**29.98**	**36.333**	-	-	**44.97**	**50.688**	**286.42**	**356.191**	**7.50**	**9.083**
R0PE (Ω)	**7.72**	**9.085**	-	-	**11.58**	**12.675**	**73.74**	**92.477**	**1.93**	**2.271**
RFPP (Ω)	**14.95**	**25.946**	-	-	**18.42**	**36.197**	**74.38**	**75.000**	**9.74**	**6.486**
RFPE (Ω)	**13.47**	**38.919**	-	-	**15.21**	**51.383**	**43.38**	**51.149**	**10.25**	**9.730**

tPP (ms)	**-**	**-**	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
tPE (ms)	**-**	**-**	-	-	**600**	**350**	**1200**	**1000**	**2400**	**1000**
Back up Over Current and Earth Fault										
Over Current										
Pick up(A)	300	300								
Time delay(S)	**0.01**	**0.2**								
Earth Fault										
Pick up(A)	120	120								
Time Delay(S)	**0.01**	**0.25**								

Table-2 Review of Transformer Protection settings

- For ST-1, 2, 3, 4 - LV side earth fault protection is not provided. This Protection may be considered.
- For CW-1, 2, 3, - HV & LV side earth fault protection is not provided. This Protection may be considered.
- For CW-1, 2, 3and GT-1, 2, 3 – Over fluxing protection is not provided. This Protection may be considered.
- For CW- 3&GT-5 – REF protection is not provided. This Protection may be considered.
- For GT-1, 2, 3, 4&5 LV side over current and earth fault protection is provided in generators relay panels

Table-3 Review of Bus reactor Protection settings

- For Bus Reactor as per NRPC guide lines REF protection should be given.

V.SAMPLE CALCULATION

5.1 SAMPLE CALCULATION FOR ANPARA B –SINGURALI LINE MAIN-I: MICOM, P-442

Line Distance Protection					
Name of 400kV EHV substation:-		**Anpara-BTPS**			
Name of 400kV Line:-		**Anpara B –Singurali Line**			
Voltage Level in kV		**400**			
Double circuit		**No**			
Protection		**Main I – Distance**			
Relay Name and Model Number		**Micom ,P-442**			
Series Compensated Line		**NO**			
CT & PT DETAILS					
CT ratio		1000/1	A		
CTR		100			
PT ratio		400/0.110	kV		
PTR		3636.36			
LINE DETAILS					
Line	Designation	Length (in km)	Type of conductor		
Protected Line (PL)	Anpara-Singurauli Line	27.1	moose		
Adjacent Shortest Line (ASL)	Sinrauli-Vindhyachal	3.34	moose		
Adjacent Longest Line (ALL)	Sinrauli-Lucknow	408	moose		
Adjacent 2nd Longest Line (A2LL)	Sinrauli-Fatehpur	331	moose		
LINE PARAMETERS					
Parameters		Ohms /km	Ohms		
Protected Line					
Positive sequence resistance, R1		0.0275	0.0745		
Positive sequence reactance, X1		0.331	8.970		
Positive sequence Impedence, Z1		0.3321	8.999		

Zero sequence resistance , R0	0.261	7.073		
Zero sequence reactance ,X0	1.031	27.9401		
Zero sequence Impedence, Z0	1.063	28.807		
Adjacent Longest Line				
Positive sequence resistance, R1	0.0275	1.122		
Positive sequence reactance, X1	0.331	135.048		
Positive sequence Impedence, Z1	0.3321	135.496		
Zero sequence resistance , R0	0.261	106.488		
Zero sequence reactance ,X0	1.031	420.648		
Zero sequence Impedence, Z0	1.063	433.704		
Adjacent 2nd Longest Line				
Positive sequence resistance, R1	0.0275	0.910		
Positive sequence reactance, X1	0.331	109.561		
Positive sequence Impedence, Z1	0.3321	109.925		
Adjacent Shortest Line				
Positive sequence resistance, R1	0.0275	0.0918		
Positive sequence reactance, X1	0.331	1.105		
Positive sequence Impedence, Z1	0.3321	1.109		
OTHER DATA INPUTS				
Distance characteristics	Quadrilateral			
Arc Resistance	5	Ohm		
Typical earth fault coverage	10	Ohm		
RELAY SETTING CALCULATIONS				
CTR/PTR RATIO	:CTR/PTR	0.275		
Minimum load Impedance on sec. side	:(0.85*110)/(1.732*1.2)	44.98	ohm	
Rph_max	:(0.6*Minimum load Impedance on sec. side)	26.99	ohm	
RG_max	:(0.8*Minimum load Impedance on sec. side)	35.98	ohm	

Rph_min	:Arc Resistance*CTR/PTR	1.375	ohm	
RG_min	:Typical earth fault coverage*CTR/PTR RATIO	2.75	ohm	
Zero sequence compensation factor				
kZ0 Res. Comp , IkZ0I	:(Z0 - Z1)/(3* Z1)	0.734		
kZ0 angle	:(ATAN((X0 in Ω/km -X1 in Ω/km)/(R0 in Ω/km-R1 in Ω/km))-ATAN(X1 in Ω/km/R1 in Ω/km))*180/3.14 , X0,R0,x1&R1 of protected line Parameter	-13.704		
Zone setting calculations				Existing Settings
Distance protection settings : Zone 1				
Zone 1 reach		80	%	
Direction		Forward		
kZ1 Res. Comp	:kZ0 Res. Comp ,IkZ0I	0.734		
kZ1 angle	:kZ0 angle	-13.704	deg	
Zone1 Impedance Reach	: Z1 in Ω *0.8*CTR/PTR RATIO	1.9897	ohm	1.989
R1G	:(0.8*R2G))	23.0331	ohm	27.2
R1ph	:(0.8*R2ph)	17.2748	ohm	8.300
tZ1	:Zone1 Tripping time	0	sec	0
Distance protection settings : Zone 2				
120% PL or 150% PL (DC)	:IF(Double circuit ="YES",150,120)	120	%	
100% PL + 50% ASL at remote end bus	:100*(Z1 in Ω of protected line Parameter + 0.5*(Z1 in Ω of adjacent Shortest Line)/ Z1 in Ω of protected line Parameter	2.9845	ohm	
Zone 2 reach considering lower voltage level encroachment	:MAX(120% PL or 150% PL (DC),100% PL + 50% ASL at remote end bus)	2.6396	ohm	
Direction		Forward		
kZ2 Res. Comp	:kZ0 Res. Comp , IkZ0I	0.734		
kZ2 angle	:kZ0 angle	-13.704	degree	
Zone2 Impedance Reach	:Z1 in Ω of protected line Parameter* (Zone 2 reach considering lower voltage level encroachment/100)*CTR/PTR RATIO	**2.9845**	ohm	2.983
R2G	:(0.8*R3G))	28.791	ohm	34.7

R2ph	: (0.8*R3PH)	21.594	ohm	16.50
tZ2	0 to 350 m sec	0.35	sec	0.35
Distance protection settings : Zone 3				
120% PL + 100% ALL at remote end bus	:100*(1.2*Z1 in Ω of protected line Parameter + Z1 in Ω of adjacent Longest Line)/ Z1 in Ω of protected line Parameter	40.30553732	ohm	
100% PL + 100% ALL at remote end bus+25%ALL at remote end bus	:100*(Z1 in Ω of protected line Parameter + Z1 in Ω of adjacent Longest Line+0.25* Z1 in Ω of adjacent 2nd Longest Line)/Z1 in Ω of protected line Parameter	47.36637738	ohm	
Zone 3 reach	:MIN((120% PL + 100% ALL at remote end bus, 100% PL + 100% ALL at remote end bus+25%ALL at remote end bus)	**40.30553732**	ohm	9.47
Direction		Forward		
kZ3 Res. Comp	:kZ0 Res. Comp, IkZ0I	0.734		
kZ3 angle	:kZ0 angle	-13.704	degree	
R3G	:RG_max	35.989	ohm	42.08
R3ph	:Rph_max	26.992	ohm	27.50
tZ3	0 to 1 sec	1	sec	1
Distance protection settings : Zone 4				
Zone 4 reach		25	**%**	
Direction		Reverse		
kZ4 Res. Comp	:kZ0 Res. Comp,IkZ0I	0.734		
kZ4 angle	:kZ0 angle	-13.704	degree	
Zone4 Impedance Reach	:Z1 in Ω of protected line Parameter*(25/100)*CTR/PTR RATIO	**0.4668**	ohm	0.497
R4G	:R3G	35.989	ohm	42.08
R4ph	:R3ph	26.992	ohm	27.50
tZ4	: Zone 4 Tripping time	1	sec	1

5.2 SAMPLE CALCULATION FOR ANPARA B –SINGURALI LINE MAIN-II: SIEMENS, 7SA52

Line Distance Protection					
Name of 220kV EHV substation:-	**Anpara-BTPS**				
Name of 220kV Line:-	**Anpara B –Singurali Line**				
Voltage Level in kV	**400**				
Double circuit	**NO**				
Protection	**Main II - Distance**				
Relay Name and Model Number	**Siemens 7SA52**				
Series Compensated Line	**NO**				
CT & PT DETAILS					
CT ratio		1000/1	A		
CTR		100			
PT ratio		440/0.110	kV		
PTR		3636.363			
LINE DETAILS					
Line	Designation	Length (in km)	Type of conductor		
Protected Line (PL)	Anpara-Singurauli Line	27.1	moose		
Adjacent Shortest Line (ASL)	Sinrauli-Vindhyachal	3.34	moose		
Adjacent Longest Line (ALL)	Sinrauli-Lucknow	408	moose		
Adjacent second Longest Line(ASLL)	Sinrauli-Fatehpur	331	moose		
LINE PARAMETERS					
Parameters		Ohms /km	Ohms		
Protected Line					
Positive sequence resistance, R1		0.0275	0.0745		
Positive sequence reactance, X1		0.331	8.970		
Positive sequence Impedance, Z1		0.3321	8.999		
Zero sequence resistance , R0		0.261	7.073		

Zero sequence reactance ,X0	1.031	27.9401		
Zero sequence Impedance, Z0	1.063	28.807		
Adjacent Longest Line				
Positive sequence resistance, R1	0.0275	1.122		
Positive sequence reactance, X1	0.331	135.048		
Positive sequence Impedance, Z1	0.3321	135.496		
Zero sequence resistance , R0	0.261	106.488		
Zero sequence reactance ,X0	1.031	420.648		
Zero sequence Impedance, Z0	1.063	433.704		
Adjacent Shortest Line				
Positive sequence resistance, R1	0.0275	0.910		
Positive sequence reactance, X1	0.331	109.561		
Positive sequence Impedance, Z1	0.3321	109.925		
Adjacent Second Longest Line				
Positive sequence resistance, R1	0.0275	9.1025		
Positive sequence reactance, X1	0.331	109.561		
Zero sequence reactance ,X0	1.031	341.261		
Zero sequence Impedance, Z0	1.063	351.853		
OTHER DATA INPUTS				
Distance characteristics	Quadrilateral			
Arc Resistance	8	ohm		
Tower footing resistance	15	ohm		
I2/I1 ratio	0.954			
I2 - Single phase to ground fault level at remote end bus,I1 - Single phase to ground fault level at local end bus if data not available I2/I1 is taken as 3				
Safety margin	20	%		
RELAY SETTING CALCULATIONS				

CTR/PTR	0.275			
Zero sequence compensation factor				
RE/RL =(R0-R1)/3R1	:(R0 in Ω of Protected Line - R1 in Ω of Protected Line)/(3*R1 in Ω of Protected Line)	2.830303		
XE/XL =(X0-X1)/3X1	:(X0 in Ω of Protected Line - X1 in Ω of Protected Line)/(3*X1 in Ω of Protected Line)	0.704935		
k0 = (Z0-Z1)/3Z1	:(Z0 in Ω of Protected Line - Z1 in Ω of Protected Line)/(3*Z1 in Ω of Protected Line)	0.73401		
Resistive Reach calculations				
Rph -E Tolerance	:(1+(I2/I1 ratio))*(Arc Resistance + Tower footing resistance)*(1+(Safety margin/100))/(1+RE/RL)			
Rph -E Tolerance on secondary	:Rph -E Tolerance *(CTR/PTR)	2.654		
Rph -ph Tolerance	:(Arc Resistance/2)*(1+(Safety margin/100))			
Rph -ph Tolerance on secondary	:Rph -ph Tolerance *(CTR/PTR)	0.825		
Effective Transformer Impedance				
Zone setting calculations				
Distance protection settings : Zone 1				
Zone 1 reach		80	%	Existing Setting
Direction		Forward		
R(Z1), Resistance for ph-ph faults	:MAX(((R1 in Ω of Protected Line*0.8) + Rph -ph Tolerance)*(CTR/PTR),(R1 in Ω of Protected Line*0.8*Line angle * CTR/PTR)+Rarc/2)	4.163	ohm	4.125
X(Z1), Reactance	:(X1 in Ω of Protected Line)*0.8*(CTR/PTR)	1.98289	ohm	1.980
RE(Z1), Resistance for ph -e faults	:(MAX((R1 in Ω of Protected Line*0.8) + Rph -E Tolerance)*(CTR/PTR),(R1 in Ω of Protected Line*0.8*Line angle * CTR/PTR+ Rarc +Rtower footing))	23.163	ohm	15.125
T1- 1phase	Zone 1 Tripping time	0	sec	0
T1- multi phase	Zone 1 Tripping time	0	sec	0
Distance protection settings : Zone 1B				
Zone 1B reach		100	%	
Direction		Forward		
R(Z1), Resistance for ph-ph faults	:((R1 in Ω of Protected Line)+Rph -ph Tolerance)*(CTR/PTR), R1 in Ω of Protected Line*Line angle * CTR/PTR)+Rarc/2)	4.20	ohm	8.250
X(Z1), Reactance	:X1 in Ω of Protected Line*(CTR/PTR)	2.4786	ohm	2.970

RE(Z1), Resistance for ph -e faults	:(MAX((R1 in Ω of Protected Line)+ Rph -E Tolerance)*(CTR/PTR), R1 in Ω of Protected Line*Line angle* CTR/PTR) +Rarc +Rtower footing)))	23.212	ohm	19.250
T1- 1phase	Zone 1B Tripping time	0	sec	0
T1- multi phase	Zone 1B Tripping time	0	sec	0
Distance protection settings : Zone				
100% PL + 50% ASL at remote bus	:(X 1in Ω of Protected Line + (0.5 * X1 in Ω of adjacent Shortest Line))	2.5544	ohm	
Zone 2 reach	:(100% PL + 50% ASL at remote bus)	2.5546	ohm	
Direction		Forward		
R(Z1), Resistance for ph-ph faults	:(MAX((R1 in Ω of Protected Line+0.5*R1 in Shortest line)+Rph -ph Tolerance)*(CTR/PTR), ((R1 in Ω of Protected Line+0.5*R1 in Shortest line *Line angle * CTR/PTR)+Rarc/2))	4.212	ohm	8.250
X(Z1), Reactance	:(X 1in Ω of Protected Line + (0.5 * X1 in Ω of adjacent Shortest Line))	2.5546	ohm	2.970
RE(Z1), Resistance for ph -e faults	:(MAX((R1 in Ω of Protected Line+0.5*R1 in Shortest line)+Rph -ph Tolerance)*(CTR/PTR), R1 in Ω of Protected Line+0.5*R1 in Shortest line *Line angle * CTR/PTR)+Rarc + R tower footing)	23.212	ohm	19.250
T1- 1phase	:IF((Z1 in Ω of Protected Line*((Zone 2 reach/100)-1))< (0.6*Z1 in Ω of adjacent Shortest Line),0.35,0.5)	0.35	sec	0.35
T1- multi phase	:IF((Z1 in Ω of Protected Line*((Zone 2 reach/100)-1))< (0.6*Z1 in Ω of adjacent Shortest Line),0.35,0.5)	0.35	sec	0.35
Distance protection settings : Zone				
120% PL + 100% ALL	:(1.2*X1 in Ω of Protected Line + X1 in Ω of adjacent Longest Line)	40.167		
100% PL + 100% ALL+25%ASLL	:(1*X1 in Ω of Protected Line + X1 in Ω of adjacent Longest Line+0.25*X1in Ω of adjacent second longest line)	171.6500		
Zone 3 reach	:MIN((100% PL + 100% ALL),(100% PL+100% ALL+25% ASLL))	40.1671		
Direction		Forward		
R(Z1), Resistance for ph-ph faults	:(MAX((1.2*R1 in Ω of Protected Line+R1 in Ω of adjacent Longest Line +Rph -ph Tolerance)*(CTR/PTR), ((1.2*R1 in Ω of Protected Line+R1 in Ω of adjacent Longest)* (CTR/PTR)+(R arc/2))	7.330	ohm	13.750
X(Z1), Reactance	MIN(120% PL + 100% ALL, 100% PL + 100% ALL+25%ASLL)	40.1671	ohm	9.440
RE(Z1), Resistance for ph -e faults	:(MAX((1.2*R1 in Ω of Protected Line+R1 in Ω of adjacent Longest Line +Rph -ph Tolerance)*(CTR/PTR), ((1.2*R1 in Ω of Protected Line+R1 in Ω of adjacent Longest)* (CTR/PTR)+(R arc +R tower footing))	26.33	ohm	23.375

T1- 1phase	:IF(100% PL + 80% of ETI at remote bus<120% PL + 100% ALL,1,0.8)	1	sec	**1**
T1- multi phase	:IF(100% PL + 80% of ETI at remote bus<120% PL + 100% ALL,1,0.8)	1		
Distance protection settings : Zone 4				
Zone 4 reach		20	**%**	
Direction		Reverse		
R(Z1), Resistance for ph-ph faults	: ((R1 in Ω of Protected Line*Zone 4 reach/100)+Rph -ph Tolerance) *(CTR/PTR)	0.2474	ohm	4.130
X(Z1), Reactance	: (Zone 4 reach/100)*X1 in Ω of Protected Line*(CTR/PTR)	0.4957	ohm	0.500
RE(Z1), Resistance for ph -e faults	: ((R1 in Ω of Protected Line*Zone 4 reach/100)+Rph -E Tolerance) *(CTR/PTR)	0.7048	ohm	15.130
T1- 1phase	: Zone 4 Tripping time	1	sec	1
T1- multi phase	: Zone 4 Tripping time	1	sec	1

5.3 SAMPLE CALCULATION FOR ANPARA B –SULTHANPUR MAIN-II: ABB, REL-670

Line Distance Protection					
Name of 220kV EHV substation:-		**Anpara BTPS**			
Name of 220kV Line:-		**Anpara B- Sulthanpur Line**			
Voltage Level in kV		**400**			
Double circuit		**NO**			
Protection		**Main II - Distance**			
Series Compensated Line		**NO**			
CT & PT DETAILS					
CTR		1000			
PTR		3636.36			
LINE DETAILS					
Line	Designation	Length (in km)			
Protected Line (PL)	Anpra –Sulthanpur Line	267			
Adjacent Shortest Line (ASL)	sulthanpur -tanda	103			
Adjacent Longest Line (ALL)	Sinrauli-Lucknow	163.8			
LINE PARAMETERS					

Parameters	Ohms /km	Ohms		
Protected Line				
Positive sequence resistance, R1	0.0275	7.343		
Positive sequence reactance, X1	0.331	88.377		
Positive sequence Impedance, Z1	0.3321	88.681		
Zero sequence resistance , R0	0.261	69.687		
Zero sequence reactance ,X0	1.031	275.277		
Zero sequence Impedance, Z0	1.064	283.961		
Adjacent Longest Line				
Positive sequence resistance, R1	0.0275	4.505		
Positive sequence reactance, X1	0.331	54.218		
Positive sequence Impedance, Z1	0.3321	54.405		
Zero sequence resistance , R0	0.261	42.752		
Zero sequence reactance ,X0	1.031	168.878		
Zero sequence Impedance, Z0	1.064	174.205		
Adjacent Shortest Line				
Positive sequence resistance, R1	0.0275	2.8325		
Positive sequence reactance, X1	0.331	34.093		
Zero sequence resistance , R0	0.261	26.883		
Zero sequence reactance ,X0	1.031	106.193		
Positive sequence Impedance, Z1	0.3321	34.210		
RELAY SETTING CALCULATIONS				
CTR/PTR		0.275		
Thermal rating of conductor		800	A	

Minimum load impedance	: (0.85*Voltage Level in kV)/(1.732*Thermal rating of conductor*1.5/1000)	163.59	ohm	
Zone setting calculations			Downloaded Settings	Existing Settings
Distance protection settings : Zone 1				
Direction		Forward		
X1FwPP/PE	: X1 in Ω of Protected Line*0.8	70.702	ohm	70.67
R1PP/PE	: R1 in Ω of Protected Line*0.8	5.874	ohm	5.93
Z1	: SQRT(X1FwPP/PE^2+R1PP/PE^2)	70.945	ohm	
X0PE	: X0 in Ω of Protected Line*0.8	220.222	ohm	203.77
R0PE	: R0 in Ω of Protected Line*0.8	55.750	ohm	64.08
RFfwPP/RFRvPP	: MIN(3*(X1FwPP/PE),1.6*Minimum load impedance*(COS(30*3.14/180)-((R1PP/PE)/(X1FwPP/PE))*SIN(30*3.14/180)),30)	30.000	ohm	133.59
RFfwPE/RFRvPE	:MIN(4.5*(X1FwPP/PE),0.8*Minimum load impedance*(COS(30*3.14/180)-((2*(R1PP/PE)+R0PE)/(2*(X1FwPP/PE)+X0PE))*SIN(30*3.14/180)),40)	40.000	ohm	44.09
tPP	: Zone 1 Tripping Time	0	ms	0
tPE	: Zone 1 Tripping Time	0	ms	0
Distance protection settings : Zone 2				
Direction		Forward		
X1FwPP/PE	: X1 in Ω of Protected Line+(0.5*X1 in Ω of adjacent Shortest Line)	105.424	ohm	106.01
R1PP/PE	: R1 in Ω of Protected Line+(0.5*R1 in Ω of adjacent Shortest Line)	8.759	ohm	8.89
Z2	: SQRT((X1FwPP/PE)^2+(R1PP/PE)^2)	105.36	ohm	
X0PE	: X0 in Ω of Protected Line+(0.5*X0 in Ω of adjacent Shortest Line)	328.374	ohm	305.66
R0PE	: R0 in Ω of Protected Line+(0.5*R0 in Ω of adjacent Shortest Line)	83.129	ohm	96.12
RFfwPP/RFRvPP	: MIN(3*(X1FwPP/PE),1.6*Minimum load impedance*(COS(30*3.14/180)-((R1PP/PE)/(X1FwPP/PE))*SIN(30*3.14/180)),60)	60.000	ohm	150.29

RFfwPE/RFRvPE	: MIN(4.5*(X1FwPP/PE),0.8*Minimum load impedance*(COS(30*3.14/180)-((2*(R1PP/PE)+E60)/(2*(X1FwPP/PE)+X0PE))*SIN(30*3.14/180)),60)	60.000	ohm	66.66
tPP	: Zone 2 Tripping Time	400	ms	300
tPE	: Zone 2 Tripping Time	400	ms	300
Distance protection settings : Zone 3				
Direction		Forward		
X1FwPP/PE	: (X1 in Ω of Protected Line + X1 in Ω of adjacent Longest Line*0.5)	115.486	ohm	170.94
R1PP/PE	: (R1 in Ω of Protected Line + R1 in Ω of adjacent Longest Line*0.5)	9.595	ohm	14.34
Z3	: SQRT((X1FwPP/PE)^2+(R1PP/PE)^2)	115.88	ohm	
X0PE	: X0 in Ω of Protected Line+X0 in Ω of adjacent Longest Line*0.5)	359.716	ohm	492.88
R0PE	: (R0 in Ω of Protected Line+R0 in Ω of adjacent Longest Line*0.5)	91.063	ohm	154.99
RFfwPP/RFRvPP	: MIN(3*(X1FwPP/PE),1.6*Minimum load impedance*(COS(30*3.14/180)-((R1PP/PE)/(X1FwPP/PE))*SIN(30*3.14/180)),60)	75.000	ohm	166.99
RFfwPE/RFRvPE	: MIN(4.5*(X1FwPP/PE),0.8*Minimum load impedance*(COS(30*3.14/180)-((2*(R1PP/PE)+E60)/(2*(X1FwPP/PE)+X0PE))*SIN(30*3.14/180)),60)	100.000	ohm	74.06
tPP	: Zone 3 Tripping Time	1000	ms	1000
tPE	: Zone 3 Tripping Time	1000	ms	1000
Distance protection settings : Zone 4				
Zone 4 reach		20	**%**	
Direction		Reverse		
X1FwPP/PE	: (20/100)*X1 in Ω of Protected Line	14.140	ohm	0.86
R1PP/PE	:R1 in Ω of Protected Line *20/100	1.175	ohm	0.1
Z4	: SQRT((X1FwPP/PE)^2+(R1PP/PE)^2)	14.188	ohm	
X0PE	: X0 in Ω of Protected Line*20/100	44.044	ohm	2.48

R0PE	: R0 in Ω of Protected Line*20/100	11.150	ohm	0.78
RFfwPP/RFRvPP	: MIN(3*(X1FwPP/PE),1.6*Minimum load impedance*(COS(30*3.14/180)-((R1PP/PE)/(X1FwPP/PE))*SIN(30*3.14/180)),60)	42.421	ohm	166.99
RFfwPE/RFRvPE	: MIN(4.5*(X1FwPP/PE),0.8*Minimum load impedance*(COS(30*3.14/180)-((2*(R1PP/PE)+E60)/(2*(X1FwPP/PE)+X0PE))*SIN(30*3.14/180)),60)	63.631	ohm	74.06
tPP	: Zone 4 Tripping Time	1000.0	ms	500
tPE	: Zone 4 Tripping Time	1000.0	ms	500

5.4 Sample calculations for line back up Over Current and Earth Fault for Anpara B- Bina 132 kV line: MICOM, P-142

FAULT CONTRIBUTION IN kA FOR REMOTE END BUS FAULT (3 ph)	3.183
FAULT CONTRIBUTION IN kA FOR REMOTE END BUS FAULT (1 ph)	2.8647
CT Ratio =	600
Over current protection	
Choose plug setting to be =	0.34
The primary operating current (POC) =PS*CT Ratio	204
Fault current current consiered for setting calculation, If (Amp) =	3183
PSM = If/POC	15.603
The relay is coordinated with Zone-2 distance protection + 100ms with Op.Time (in sec)of =	0.5
Choosing a normal inverse characteristics, operating time at TMS=1, T = 0.14/ I^(0.02)-1	2.48
The Time required TMS = Required Op.Time / Op.time = 1	0.202
Set TMS =	0.21
Operating time achieved @ Set TMS	0.520
Earth fault protection	
Choose plug setting to be =	0.2
The primary operating current (POC) =PS*CT Ratio	120
Fault current current consiered for setting calculation, If (Amp) =	2864.7
PSM = If/POC	23.873
The relay is coordinated with Zone-2 distance protection + 100ms with Op.Time (in sec)of =	0.5
Choosing a normal inverse characteristics, operating time at TMS=1, T = 0.14/ I^(0.02)-1	2.14
The Time required TMS = Required Op.Time / Op.time = 1	0.20
Set TMS =	0.25
Operating time achieved @ Set TMS	0.534

5.5 Sample calculations for Transformer Differential for MICOM P-645:

	SUB STATION	Anpara-BTPS			
	DIFFERENTIAL PROTECTION FOR TRANSFORMER	87T	TR1		
	Relay used	Micom,P-645			
	Settings Value	Secondary side			
Sl. No.	**Parameters**	**Value**	**Units**		
1	Transformer MVA rating	100	MVA		
2	Voltage rating	400/132	kV		
3	Vector Group	YNa0d11			
4	Rectance (HV- LV)	10	%		
5	Voltage at HV nominal	400	kV		
6	Voltage LV nominal	132	kV		
	CT Ratio				
	HV Side				
7	CT ratio on the HV side	500/1			
8	CT primary current on the HV side	500	A		
9	CT secondary current on the HV side	1	A		
	LV Side				
10	CT 1 ratio on the LV side	600/1			
11	CT 1 primary current on the LV side	600	A		
12	CT 1 secondary current on the LV side	1	A		
	OLTC				
16	Min Tap	-10	%		
17	Max Tap	10	%		

	CALCULATIONS				
18	HV side rated current	: Transformer MVA rating*1000/((3^0.5)*Voltage at HV nominal)	144.34	A	
19	HV Side CT current	: (HV side rated current)/ (CT primary current on the HV side/CT secondary current on the HV side)	0.29	A	
20	LV side rated current	: Transformer MVA rating*1000/((3^0.5)*Voltage LV nominal)	437.39	A	
21	LV Side CT current	: (LV side rated current)/ (CT 1 primary current on the LV side/CT 1 secondary current on the LV side)	0.73		
23	Compensation factor				
24	Compensation factor on HV CT (Kma)	: 1/HV Side CT current	3.464	-	
25	Compensation factor on LV CT (Kmb)	: 1/LV Side CT current	1.372	-	
26	Compensated current on CT Sec HV Side	: HV Side CT current*Compensation factor on HV CT (Kma)	1.000	-	
27	Compensated current on CT Sec LV Side	: (LV Side CT current)*Compensation factor on LV CT (Kmb)	1.000	-	
	For Min Tap of OLTC				
	LV SIDE				
28	Full load current	: Transformer MVA rating*1000/((3^0.5)*Voltage at LV nominal*(1+(Min Tap/100)))	160.38	A	
29	Full load current on CT sec.	: Full load current/(CT primary current on the HV side/CT primary current on the LV side)	0.321	A	
30	Compensated current on CT Sec.	: Full load current on CT sec.*Compensation factor on LV CT (Kma)	1.111	A	
	For MAX Tap of OLTC				
	HV SIDE				
31	Full load current	: Transformer MVA rating*1000/((3^0.5)*Voltage at HV nominal*(1+(Max Tap/100)))	131.22	A	
32	Full load current seen by CT sec	: Full load current/(CT primary current on the HV side/CT primary current on the LV side)	0.262	A	
33	Compensated current on CT Sec	: Full load current seen by CT sec*Compensation factor on HV CT (Kma)	0.909	A	
	BIAS SETTING	**Existing**	**Recommended**	**Unit**	
34	Idiff>	Relay Settings	0.2	0.2	
	Stability check performed by for the following cases				

A.	The transformer is fully loaded at minimum tap				
B.	The transformer is fully loaded at maximum tap				
C.	Through Fault stability at normal tap				
D.	Through Fault stability at minimum tap				
E.	Through Fault stability at maximum tap				
A.	**Stability of transformer at full load and under operation at minimum tap**				
1	Transformer HV side current in Iref, PU, I1	: Compensated current on CT Sec.	1.111	A	
2	Transformer LV side current , Iref	: (LV Side CT current)*Compensation factor on LV CT (Kmb)	1	A	
3	Transformer LV side current , Iref, PU, I2	: (Transformer LV side current , Iref)/(CT 1 secondary current on the LV side)	1	A	
4	Differential current, Idiff (I1-I2)	: ABS((Transformer HV side current in Iref, PU, I1)-(Transformer LV side current , Iref, PU, I2))	0.111	A	
5	Restraining current, Istab (I1+I2)	: ((Transformer HV side current in Iref, PU, I1)+(Transformer LV side current , Iref, PU, I2))/2	1.06	A	
	The operating point is in the stable region				
B.	**Stability of transformer at full load and under operation at maximum tap**				
1	Transformer HV side current in Iref, PU, I1	: Compensated current on CT Sec	0.9091	A	
2	Transformer LV side current , Iref	: (LV Side CT current)*Compensation factor on LV CT (Kmb)	1	A	
3	Transformer LV side current , Iref, PU, I2	: (Transformer LV side current , Iref)/(CT 1 secondary current on the LV side)	1	A	
4	Differential current, Idiff (I1-I2)	: (Transformer LV side current , Iref, PU, I2)-(Transformer HV side current in Iref, PU, I1)	0.09	A	
5	Restraining current, Istab (I1+I2)	: ((Transformer LV side current , Iref, PU, I2)+(Transformer HV side current in Iref, PU, I1))/2	0.95	A	
	The operating point is in the stable region				
C.	**Stability of transformer at through fault and under operation at normal tap**				
1	The fault MVA =MVA/%Z	: (Transformer MVA rating)/((Reactance (HV- LV))/100)	1000.000	MVA	
2	Through fault current on the HV side	: (The fault MVA*1000)/(SQRT(3)*Voltage at HV nominal)	1443.38	A	

3	Through fault current on HV side seen by relay (CT sec)	: (Through fault current on the HV side)/ (CT primary current on the HV side/CT primary current on the HV side)	2.89	A	
5	Compensated Through fault current at HV side seen by relay., I1	: Through fault current on HV side seen by relay (CT sec)*Compensation factor on HV CT (Kma)	10.00	A	
6	Through fault current on the LV side	: (The fault MVA*1000)/(SQRT(3)*Voltage LV nominal)	4373.87	A	
7	Through fault current on the LV side seen by relay (CT sec)	: (Through fault current on the LV side/CT 1 primary current on the LV side)	7.29	A	
8	Compensated Through fault current on LV side	: (Through fault current on the LV side seen by relay (CT sec)) *Compensation factor on LV CT (Kmb)	10.00	A	
9	Transformer LV side current in Iref, PU Iref/CT sec, I2	: Compensated Through fault current on LV side/CT 1 secondary current on the LV side	10.00	A	
10	Differential current, Idiff (I1-I2)	: Transformer LV side current, I2-Compensated Through fault current at HV side seen by relay, I1	0.00	A	
11	Restraining current, Istab (I1+I2)	: (Transformer LV side current, I2+Compensated Through fault current at HV side seen by relay, I1)/2	10.00	A	
	The operating point is in the stable region				
D.	**Stability of transformer for through fault under operation at minimum tap**				
1	Through fault current on the HV side at minimum tap position	: (Through fault current on the HV side)/(1+(Min Tap)/100)	1603.75	A	
2	Through fault current on the HV side seen by relay (CT sec)	: (Through fault current on the HV side at minimum tap position)* (CT primary current on the HV side/CT primary current on the HV side)	3.21	A	
3	Compensated Through fault current on HV side	: Through fault current on the HV side seen by relay (CT sec)*Compensation factor on HV CT (Kma)	11.11	A	
4	Transformer HV side current in Iref, PU Iref/CT sec, I1	: Compensated Through fault current on HV side/CT secondary current on the HV side	11.11	A	
5	Transformer LV side current in Iref, PU Iref/CT sec, I2	: Transformer LV side current, I2	10.00	A	
6	Differential current, Idiff (I1-I2)	: (Transformer HV side current, I1)-(Transformer LV side current, I2)	1.11	A	stabl e

7	Restraining current, Istab (I1+I2)	: ((Transformer HV side current, I1)+(Transformer LV side current, I2))/2	10.56	A	
	The operating point is in the stable region				

E.	**Stability of transformer for through fault under operation at maximum tap**				
1	Through fault current on the HV side at maximum tap position	: (Through fault current on the HV side)/(1+Max Tap/100)	1312.16	A	
2	Through fault current on the HV side seen by relay (CT sec.)	: (Through fault current on the HV side at maximum tap position)*(CT primary current on the HV side/CT primary current on the HV side)	2.62	A	
3	Compensated Through fault current on HV side	: (Through fault current on the HV side seen by relay (CT sec.))*Compensation factor on HV CT (Kma)	9.09	A	
4	Transformer HV side current in Iref, PU Iref/CT sec,I1	Compensated Through fault current on HV side/CT secondary current on the HV side	9.09	A	
5	Transformer LV side current in Iref, PU Iref/CT sec, I2	Transformer LV side current, I2	10.00	A	
6	Differential current, Idiff (I1-I2)	(Transformer HV side current sec,I1) - (Transformer LV side current, I2)	0.91	A	stabl e
7	Restraining current, Istab (I1+I2)	((Transformer HV side current sec,I1) + (Transformer LV side current, I2))/2	9.55	A	
	The operating point is in the stable region				

5.6 Sample calculations Transformer REF Protection: MICOM, P-645

	Relay used	MICOM		P-141
Sl. No.	**Parameters**	Value		Unit
1	T/F Capacity	100		MVA
2	Voltage Ratio	400/132		kV
3	REF, Phase Side CT ratio	500/1		
4	Phase Side CT primary	500		
5	Phase Side CT secondary	1		
6	REF, Neutral Side CT ratio	500/1		
7	Neutral Side CT primary	500		
8	Neutral Side CT secondary	1		
9	Reactor Impedance	10		%
CALCULATION				
12	Maximum fault current on the HV side = (fault at that bus /impedance)	4604.07		A
13	Current seen by the relay = (max fault current /CT ratio)	7.67		
If		7.67		
Rstab Calculation				
14	Rct value in CT in ohms (assumed), Rct	3		ohm
15	Lead wire resistance RL	0.6		ohm
16	Total Lead wire resistance	1.498		ohm
17	voltage developed during fault across the relay , Vs (= Fault current* (Rct + 2RL))	26.47		Volt
	Settings	Calculated	Existing	
18	Ipickup	0.10	0.1	A
19	stabilizing resistor value, Rstab (min) (Rstab = Vs/Is)	264.69	-	ohm

5.7 Sample calculations of Bus reactor Differential Protection: MICOM, P-645

	Relay used	MICOM	P-643
Sl. No.	Parameter	Value	Unit
1	Reactor capacity	63	MVAR
2	Voltage Level	420	kV
3	Phase Side CT Ratio	100/1	
4	CT (Phase Side)-Primary	100	
5	CT (Phase Side)-Secondary	1	
6	Neutral Side Side CT Ratio	100/1	
7	CT (Neutral Side)-Primary	100	
8	CT (Neutral Side)-Secondary	1	
9	Full Load Current of Reactor(A)=(reactor capacity/(√3*kv)*1000)	86.61	A
10	Inrush Current in Primary (A) assumed=(6*full load current) (6 times of normal current-assumed)	519.63	A
11	Inrush Current in Secondary (If) (winding a and c)= (full load current /ct ratio)	5.20	A

12	Compensation ratio = (1/inrush current in secondary)	0.19	
13	Inrush Current in Secondary (If) (winding b) =)= (full load current /ct ratio)	5.20	A
14	Compensation ratio= (1/inrush current in secondary)	0.19	
15	Full load current of Reactor(winding a and c)	86.61	A
16	Current seen by relay = (full load current/ CT ratio)	0.87	A
17	Compensation ratio = (1/current seen by relay)	1.15	
18	Full load current of Reactor(winding b)	86.61	A
19	Current seen by relay= (full load current/ CT ratio)	0.87	A
20	Compensation ratio= (1/current seen by relay)	1.15	
Differential Protection Settings			
15	Idiff>	0.2	A
16	m1	20	%
17	m2	60	%
18	IR,m2	1	A
19	Idiff>>	10	A
20	Idiff>>>	32	

VI Sample field inspection Photograph

The 132 kV substation section of 400 kV BTPS is not properly fenced to stop movement of cattle/animals coming to 132 KV section of yard. This may result in hazard and safety issues to manpower, animal and damage to the Equipment's installed in substation. A few sample Photograph collected for from sit for a quick reference. Replacement of damaged, regular maintenance of substation in terms of cleanliness, painting of panels and protection against waterlogging is suggested.

STUDY AND THIRD PARTY AUDIT OF

765/400kV SWITCHYARD AT

ANPARA –DTPS

REPORT

SUBMITTED TO:

765/400kV SWITCHYARD AT ANPARA –DTPS

SUBMITTED BY:

POWER SYSTEMS DIVISION
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POWER SYSTEMS DIVISION
CENTRAL POWER RESEARCH INSTITUTE
Sir. C.V. RAMAN ROAD P.B.No.8066, BANGALORE 560080 (INDIA)

CONSULTANCY REPORT

Date: 29/01/2021

Title:	PROTECTION AUDIT OF 765/400 KV SWITCHYARD AT ANPARA ,DTPS
Objectives:	Review of implemented Protection Schemes & Relay Settings in the 765 and 400 kV feeders of DTPS which includes transmission lines, transformers, bus reactor ,line reactor, bus bars etc., This includes main and backup protection Relay. Checking healthiness of DC/PLCC system.
Name and Address of the client:	Shri Manoj Prasad. Executive Engineer, E&MCD-VII,DTPP, Anpara-231225
Client reference :	2/9/PS/UPRVNL/2020-2021 dated 05.02.2020
Name (s) of investigator(s) from CPRI	Dr Mahohar Singh , EO-III Er.Siripurapu Sai Kumar, Project Engineer
Names of Interacting persons from Customer's side:	1.Er.Manoj Prasad, EE EMD-III 2.Er Ajay Prasad, EE EMD-III
Report contains:	
Number of pages:	43
Number of Tables:	19

Report prepared by:	Report Approved by:
Signature: 29.01.2021	Signature: Amit Jain 29/01/2021
Name: Dr. Manohar Singh	Name: Dr. Amit Jain
Engineering Officer	Joint Director & HOD ,
	Power System Division, CPRI
Date:	Date:

EXECUTIVE SUMMARY

Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVNL) has awarded the "third party protection audit of 756/400kV Switchyard at Anpara, DTPS," to CPRI vide work order No. 2/9/PS/UPRVNL/2020-2021 dated 05.02.2020. This Protection Audit covers the review of protection of Generator Transformers banks, ICT Bank, Station Transformers, Transmission lines and other protection infrastructure installed at Anpara, DTPS. The pooled power from D_TPS and B_TPS is evocated through two 765 kV lines to Northern Grid.

The scope of this Protection involves the Review of the implemented protection schemes/philosophy & review of main & backup Protection setting & coordination in the switchyard which includes protection of generator transformer , transmission lines, ICT Bank, Station transformer, reactors, circuit breakers, bus bar etc. as per CBIP/NRLDC/NRP etc. guidelines. This also involves Reviewing of availability/healthiness of communication links like PLCC, healthiness/ adequacy of 110/ 48/ 24 V DC, GPS/TSU, and circuit breaker report.

In view of this work order, CPRI Protection audit team carried out the onsite Protection audit from 08/12/2020 and 09/12/2020 and have a compressive review of switchyard Projection schemes and setting has been carried out as per Northern region Power Committee Protection Guidelines.

The major equipment for which protection audit has been carried out are as under:

- Generator Transformer bank (2X 600 MVA)
- ICT Bank (1X1000 MVA)
- Station Transformer (2 X 80MVA)
- 765 & 400kV Transmission Lines
- Bus Reactor (189 MVAR) and Line Reactor (330 MVAR)
- 765 &400kV Bus bar and LBB protection system.

As a general finding from this audit, it is observed that the 765 /400 kV D_TPS substation equipment is also well protected as per Northern region Power Committee recommendation. Both 765 kV and 400 kV lines have independent main-1 and main-2 functional Numerical protection. Bus bar, line reactor and bus reactor are also well protected as per NRPC defined

Protection schemes. Operational protection settings are in order and some setting medication for 765 kV Unnao lines are recommend as outcome of this audit.

The state of DC supply at substation inspected and found in order. Time Functionality of GPS/TSU, circuit breaker, relay resting reports is also inspected and all are found in satisfactory state.

Details of protection schemes and review of protection setting and necessary recommendation of setting wherever needed are listed in the audit report.

CONTENTS

DETAILED REPORT ON THIRD PARTY PROTECTION AUDIT OF 765/400kV SWITCHYARD AT ANPARA –DTPS

1.0 Introduction

Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVNL). Has awarded the third party protection audit of 756/400kV SWITCHYARD at Anpara, DTPS to CPRI vides work order No. 2/9/PS/UPRVNL/2020-2021 dated 05.02.2020 with the following scope of work:

1) Review of implemented protection schemes/philosophy & setting in the generating station and switchyard which includes Protection of transmission lines, transformers, bus bar reactors, review of relay & circuit breaker test reports with reference to CBIP /NRLDC/NRPC guidelines
2) To check the adequacy for the adequacy/ healthiness of the primary & backup protection scheme & Settings, Suggest corrective measures in case of any problems.
3) Review of availability/healthiness of communication links like PLCC, optical fiber used for protection.
4) To check the healthiness/adequacy of 220 V/48 V /24 V DC systems at Substation for protection and suggest corrective measures in the case of any problem.
5) Review of availability/Healthiness of GPS system and ensure time synchronization of different relays / devices etc.
6) Review of DR/EL
7) Review of test report of circuit breaker s for assessing their healthiness -healthiness of trip and close coil, Breaker close & open timings, SF6& operational media pressure setting of alarm, auto reclose lock out and breaker operational lock out and pole discrepancy operation.
8) Field collection of technical data for audit work from DTPS.
9) Field inspection of protection device for obsolescence of technology, suitability and healthiness

2.1 General Observation and Philosophy adopted in substations

2.1.1 Philosophy used for Distance protection:

The philosophy adopted for 765/400kV lines Distance protection relay settings is given below which is generally in accordance with CBIP guidelines, given below

Distance protection settings:

Zone-1 Reach: Set to 80% of the Protection line

Zone-1 Time : Instantaneous

Zone-2 Reach: 100% of the protected line + 50% of the shortest line emanating from the far end bus bar, or, 120% of the Protected line, whichever is higher

Zone-2 Time : 300ms for short lines (<100km) and 550ms for long lines >100km

Zone-3 Reach : 120% of the protected line + 100% of the longest line emanating from the far end bus bar, or 100% of the Protected line + 100% of the longest line emanating from the far end bus bar + 25% of the longest line emanating from the far end of the second line considered, whichever is lower.

The zone setting to be limited such that it will not reach into the next voltage level

Zone-3 Time : 1000ms

Zone-3R or Zone 4: 20% of the Zone-1 reaches

Zone-3R or Zone 4 Time: 1000ms

2.1 .2 Philosophy used for Transformer protection:

The philosophy adopted for Transformer protection relay settings is given below which is generally in accordance with CBIP guidelines, given below

Group-A			Group-B	
Differential Protection	HV Back Up Over Current and Earth Fault	Over Fluxing Protection	LV Back Up Over Current and Earth Fault	Restricted Earth Fault

2.2 General protections in 765/400kV switchyard:

765/400kV Switchyard-DTPS Protection System Review		
DATE OF REVIEW BY CPRI TEAM : 08-12-2020		
SLNO	**Description**	**765/400KV**
1	**Name Of Grid Substation**	765/400 kV Switchyard-DTPS
2	**Highest Voltage Level**	765kV
3	**Year Of Installation**	
4	**No Of Feeders**	4 -2(765KV),2(400KV)
5	**No of Units**	2
6	**No of Transformers, Make and Capacity**	GT'S: 2*600MVA(765/21)kV - AREVA ICT'S:1*1000MVA(765/400/33)kV – AREVA ST'S:2*80 MVA (400/11.5-11.5)kV-BHEL
7	**Busbar Arrangement**	2 (765kV buses)and 2 (400kV buses)
8	**Present Busbar Switching Status**	Fully Commissioned. bays are connected to different buses
9	**Busbar Protection**	Provided
10	**Relay System Status**	In Service
11	**DC Supply System**	Transmission Unit i)Eight Nos of Battery Bank with 110 V DC,400AH Capacity in service ii)Eight no's of bttery Chargers for 110V System (Float cum Boost) are in service
12	**DC Supply Capacity And Adequacy**	DC system is adequate for the station load
13	**DC System Earth Fault Status**	Both the systems are Healthy
14	**PLCC**	Not provided Provided to Unnao line but not commissioned
15	**GPS Clock Receiver & Synchronization Of Relay Status**	Provided and Synchronized
16	**Common Event Logger Status**	Provided
17	**Line Disturbance Recorder**	Provided
18	**Breaker Failure Relay Status**	Provided
19	**General Observation of Relay And Protection System**	System is working satisfactorily.

2.3 Relays used for transmission line, Transformer, Bus bar, and Reactor:

Table-1 Relay used for Transmission Line Protection:-

Sl.no	Name of the Feeder	Main-I	Main-II	Backup
1	765kV Anpara-Lanco line	ABB REL-670	MICOM P-543	MICOM P-821
2	765kV Anpara –Unnao line	ABB REL-670	MICOM P-543	-
3	400kV Anpara D- Anpara B line-1&2	ABB REL-670	MICOM P-543	MICOM P-921

Table-2 Relays used for Transformer Protection:

Sl. No.	Transformer Details	Group-A			Group-B	
		Differential Protection	HV Back Up Over Current and Earth Fault	Over Fluxing Protection	LV Back Up Over Current and Earth Fault	Restricted Earth Fault
1	ICT Bank 765/400kV	MICOM P-633,P-643, (TEE2:P-633)	MICOM P-141, (TEE1:P-122)	MICOM P-633,P-643	MICOM P-141, (TEE1:P-122) (TEE2:P-633)	MICOM P-643,P-633
2	GT-6 Bank 765/21kV	MICOM P-633,P-643, (TEE2:P-633)	MICOM P-141, (TEE1:P-122)	MICOM P-633,P-643	-	MICOM P-643,P-633
3	GT-7 Bank 765/21kV	MICOM P-633,P-643, (TEE2:P-633)	MICOM P-141, (TEE1:P-122)	MICOM P-633,P-643	-	MICOM P-643,P-633
4	ST-1 400/11.5-11.5kV	MICOM P-633,P-643, (TEE2:P-633)	MICOM P-141, (TEE1:P-122)	MICOM P-633,P-643	MICOM P-141, (TEE1:P-122)	MICOM P-633
5	ST-2 400/11.5-11.5kV	MICOM P-633,P-643, (TEE2:P-633)	MICOM P-141, (TEE1:P-122)	MICOM P-633,P-643	MICOM P-141, (TEE1:P-122)	MICOM P-633

Table-3 Relay used for Busbar Protection:-

Sl.No.	**Name of Bay**	Main-I	Main-II	BACK UP
1	765kV Bus-1	MICOM P-743	MICOM P-746	MICOM P-921
2	765kV Bus-2	MICOM P-743	MICOM P-746	MICOM P-921
3	400kV Bus-1	MICOM P-743	MICOM P-746	MICOM P-921
4	400kV Bus-2	MICOM P-743	MICOM P-746	MICOM P-921

Table-3 Relay used for Reactor Protection:

Sl. No.	**Name of Reactor**	**Differential Protection (Make & Model)**	**REF Protection (Make & Model)**	**Back-Up Impedance Protection (Make & Model)**
1	Bus Reactor	ALSTOM, P-632	-	ALSTOM P141
2	Line Reactor	ALSTOM, P-632	SEF MICOM P-141	MICOM P-141

2.4 INPUT DATA FOR 765kV TRANSMISSION LINE PROTECTION

Table-4 INPUT DATA FOR 765kV TRANSMISSION LINE PROTECTION

S. No.	Description	Units	Value	Value
0	**Station Name**		765kV Line-I	765kV Line-II
1	**Line Reference**		Anpara-Lanco line	Anpara –Unnao line
1.1	Line voltage level	kV	765	765
1.2	Name of remote substation		765kV Lanco	765kV Unnao
2	**Main 1**			
2.1	Protection Type		Numerical	Numerical
2.2	Model & Make		ABB REL-670	ABB REL-670
3	**Main 2 protection**		YES	YES
3.1	Protection Type		Numerical	Numerical
3.2	Model & Make		MICOM P-543	MICOM P-543
4	**LBB Protection**		YES	NO
4.1	Protection Type		Numerical	-
4.2	Model & Make		MiCOM P-821	-
5	**CT data for Main 1**			
5.1	Ratio	A/A	2000/1	2000/1
5.2	Class		PS	PS
5.3	Vk / VA burden	V / VA	2000	2000
5.4	Rct	Ohms	-	-
5.5	Imag @ Vk/2 or Vk/4	mA	60	60
6	**CT data for Main 2**			
6.1	Ratio	A/A	2000/1	2000/1
6.2	Class		PS	PS
6.3	Vk / VA burden	V / VA	2000	2000
6.4	Rct	Ohms	-	-
6.5	Imag @ Vk/2 or Vk/4	mA	60	60
7	**CT data for LBB**			
7.1	Ratio	A/A	3000/1	-
7.2	Class		PS	-
7.3	Vk / VA burden	V / VA	2000	-
7.4	Rct	Ohms	-	-
7.5	Imag @ Vk/2 or Vk/4	mA	60	-
8	PT Ratio	kV/V	765kV/110V	765kV/110V

Sl. No.	Description	Units	Value	Value
9	PROTECTED LINE DATA		Anpara-Lanco line	Anpara –Unnao line
9.1	Line Length	Km	2.63	426.149
9.2	Positive seq. RESISTANCE	Ohms/Km	0.0114	0.0114
9.3	Positive seq. REACTANCE	Ohms/Km	0.2853	0.2853
9.4	Zero seq. RESISTANCE	Ohms/Km	0.2399	0.2399
9.5	Zero seq. REACTANCE	Ohms/Km	0.938073	0.938073
10	Transformers details (from remote bus)		765kV Lanco	765kV Unnao
10.1	Transformer connected to the remote bus		YES	YES
10.2	Voltage ratio of the transformer	kV/kV	765 /400	765/400
10.3	MVA of the transformer	MVA	2*1000	3*1000
10.4	Impedance of the transformer	%	15	14.20

2.5 Review of 765kV TRANSMISSION LINE PROTECTION SETTINGS:

Table-5 Review of Anpara D-Lanco Line settings:

Name of Transmission Line	Anpara D- Lanco line									
Main I	**ABB REL-670**									
Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 5	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	0.6	0.6	-	-	**10.99**	**59.094**	**21.23**	**117.438**	**0.15**	**0.150**
R1PP/PE (Ω)	0.02	0.02	-	-	**10.27**	**2.3613**	**20.51**	**4.693**	**0.006**	**0.006**
X0PE (Ω)	1.97	1.97	-	-	**12.705**	**194.039**	**22.95**	**385.615**	**0.49**	**0.493**
R0PE (Ω)	0.5	0.5	-	-	**10.87**	**49.690**	**21.11**	**98.750**	**0.13**	**0.126**
RFPP (Ω)	**55**	**1.801**	-	-	**65**	**60**	**80**	**75.000**	**0.9**	**0.450**
RFPE (Ω)	**110**	**2.701**	-	-	**125**	**60**	**145**	**100.000**	**1.35**	**0.675**
tPP (ms)	0	0	-	-	**400**	**550**	1000	1000	1000	1000
tPE (ms)	0	0	-	-	**400**	**550**	1000	1000	1000	1000
Main II	**MICOM P-543**									
Line Differential	ON	ON								
87-1 Pickup(A)	0.2	0.2								
Slope k1(%)	30	30								
Slope k2(%)	150	150								

time delay (ms)	0	0									
Over Current and Earth Fault											
Over current	ON	ON									
Function	DT	DT									
Pick up (A)	1.5	1.5									
Time delay (S)	1.5	1.5									
Earth Fault											
Function	DT	DT									
Pick up (A)	0.2	0.2									
Time delay (A)	1.5	1.5									
Broken conductor											
Pick up (A)	0.2	0.2									
Time delay(S)	2	2									
LBB	MICOM P-821										
Name of Line	Anpara-D Lanco line										
Protection	Over voltage										
Function	DMT	DMT									
Pickup U>	121	121	V	U ref							
Time dial	3	3	Sec								
Pickup U>>	154	154	V	U ref							
Time dial	0.1	0.1	Sec								

2.5.2 Review of Anpara D-Unnao Line settings:

Table-6 Review of Anpara D- Unnao Line settings:

Name of Transmission Line	Anpara D –Unnao line									
Main I	**ABB REL-670**									
Setting	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	97.26	97.26	-	-	**127.47**	**179.924**	**133.36**	**238.268**	**9.73**	**24.316**
R1PP/PE (Ω)	3.89	3.89	-	-	**14.97**	**7.189**	**25.21**	**9.521**	**0.38**	**0.972**
X0PE (Ω)	319.37	319.37	-	-	**405.10**	**590.791**	**410.99**	**782.368**	**31.94**	**79.843**
R0PE (Ω)	81.79	81.79	-	-	**102.23**	**151.292**	**102.23**	**200.352**	**8.18**	**20.447**
REPP (Ω)	55	30	-	-	**65**	**60.000**	**80**	**75.000**	**20**	**72.948**
REPE (Ω)	110	40	-	-	**125**	**60.000**	**145**	**100.000**	**85.25**	**100.000**
tPP (ms)	0	0	-	-	500	550	1000	1000	1000	1000.0
tPE (ms)	0	0	-	-	500	550	1000	1000	1000	1000.0
Main II	**Alstom P4543**									
	Existing Settings	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings	**Existing Settings**	Reviewed Settings
Distance Protection Settings	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach-phase (Ω)	**33.66**	**17.24**	-	-	**33.66**	**21.59**	**33.66**	**26.99**	**33.66**	**26.99**

Resistive reach-ground (Ω)	**44.88**	**23.30**	-	-	**44.88**	**28.79**	**44.88**	**35.98**	**44.88**	**35.98**
Impedance -phase resistive reach (Ω)	**27.99**	**27.99**	-	-	**36.93**	**43.388**	**38.88**	**75.57**	**2.800**	**6.99**
Time delay (ms)	0	0	-	-	500	500	1000	1000	1000	1000

2.6 INPUT DATA FOR 400kV TRANSMISSION LINE PROTECTION

Table-7 Input Data for 400 kV Transmission Line Protection

S. No.	Description	Units	Value
0	**Station Name**		400kV Line-I &II
1	**Line Reference**		Anpara D –Anpara B
1.1	Line voltage level	kV	400
1.2	Name of remote substation		400kV Obra
2	**Main 1**		
2.1	Protection Type		Numerical
2.2	Model & Make		ABB REL-670
3	**Main 2 protection**		YES
3.1	Protection Type		Numerical
3.2	Model & Make		MICOM P-543
4	**LBB Protection**		-
4.1	Protection Type		-
4.2	Model & Make		-
5	**CT data for Main 1**		
5.1	Ratio	A/A	2000/1
5.2	Class		PS
5.3	Vk / VA burden	V / VA	2000
5.4	Rct	Ohms	-
5.5	Imag @ Vk/2 or Vk/4	mA	60
6	**CT data for Main 2**		
6.1	Ratio	A/A	2000/1
6.2	Class		PS
6.3	Vk / VA burden	V / VA	2000
6.4	Rct	Ohms	-
6.5	Imag @ Vk/2 or Vk/4	mA	60
7	**CT data for LBB**		
7.1	Ratio	A/A	3000/1
7.2	Class		PS
7.3	Vk / VA burden	V / VA	2000
7.4	Rct	Ohms	-
7.5	Imag @ Vk/2 or Vk/4	mA	60
8	**PT Ratio**	kV/V	400kV/110V
9	**PROTECTED LINE DATA**		**Anpara D-Anpara B Line**
9.1	Line Length	Km	5.03

SL. No.	Description	Units	Value
9.2	Positive seq. RESISTANCE	Ohms/Km	0.014612
9.3	Positive seq. REACTANCE	Ohms/Km	0.2509
9.4	Zero seq. RESISTANCE	Ohms/Km	0.189595
9.5	Zero seq. REACTANCE	Ohms/Km	0.83347
10	Transformers details (from remote bus)		
10.1	Transformer connected to the remote bus		
10.2	Voltage of the transformer		2*400
10.3	MVA of the transformer		600
10.4	Impedance of the transformer		15%

2.7 Review of 400kV TRANSMISSION LINE PROTECTION SETTINGS:

Table-8 Review of 400kV Transmission Line Protection Settings:

Name of Transmission Line	**Anpara D –Anpara B Line I&II**									
Main I	**ABB REL-670**									
Settings	**Existing Settings**	**Reviewed Settings**	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 5	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	1.01	1.010	-	-	**6.26**	**5.764**	**11.26**	**89.63903**	**0.10**	**0.252**
R1PP/PE (Ω)	**0.10**	**0.059**	-	-	**5.07**	**4.575**	**10.07**	**7.415998**	**0.10**	**0.015**
X0PE (Ω)	3.35	3.354	-	-	**9.19**	**3.532155**	**14.19**	**226.7288**	**0.05**	**0.838**
R0PE (Ω)	0.76	0.763	-	-	**5.95**	**15.52755**	**20.95**	**51.57553**	**0.1**	**0.191**
RFPP (Ω)	**55**	**3.029**	-	-	**65**	**18.786**	**80**	**33.786**	**1**	**0.757**
RFPE (Ω)	**110**	**4.543**	-	-	**125**	**28.179**	**145**	**50.679**	**1**	**1.136**
tPP (ms)	0	0	-	-	300	350	1000	1000	1000	1000
tPE (ms)	0	0	-	-	300	350	1000	1000	1000	1000
Main II	**MICOM P-543**									
Line Differential	ON	ON								
87-1 Pickup(A)	0.2	0.2								
Slope k1(%)	30	30								
Slope k2(%)	150	150								
time delay (ms)	0	0								

Over Current and Earth Fault										
Over current	ON	ON								
Function	DT	DT								
Pick up (A)	1.5	1.5								
Time delay (S)	1.5	1.5								
Earth Fault										
Function	DT	DT								
Pick up (A)	0.2	0.2								
Time delay (A)	1.5	1.5								
Broken conductor										
Pick up (A)	0.2	0.2								
Time delay(mS)	100	100								

2.8 Review notes of 765kV &400kV Transmission lines:

765/400KV Switchyard of DTPS was audited and it is observed that Transmission Line protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below tables

2.8.1 Review note of line distance protection:

Note	• Reverse zone Protection for 765 kV lines Zone-4 can be enabled instead of Zone-5.

2.8.2 Review of Transmission Line Settings:

Table-9 Review of Transmission Line Protection Settings:

Name of Transmission Line			**Anpara D –Lanco line**							
Main I	**ABB REL-670**		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Setting	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	-	-	-	-	**10.99**	**59.094**	**21.23**	**117.438**	**0.15**	**0.150**
R1PP/PE (Ω)	-	-	-	-	**10.27**	**2.3613**	**20.51**	**4.693**	**0.006**	**0.006**
X0PE (Ω)	-	-	-	-	**12.705**	**194.039**	**22.95**	**385.615**	**0.49**	**0.493**
R0PE (Ω)	-	-	-	-	**10.87**	**49.690**	**21.11**	**98.750**	**0.13**	**0.126**
RFPP (Ω)	**55**	**1.801**	-	-	**65**	**60**	**80**	**75.000**	**0.9**	**0.450**
RFPE (Ω)	**110**	**2.701**	-	-	**125**	**60**	**145**	**100.000**	**1.35**	**0.675**

Name of Transmission Line			**Anpara D –Unnao line**							
Main I	**ABB REL-670**							
Setting	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	-	-	**127.47**	**179.924**	**133.36**	**238.268**	**9.73**	**24.316**
R1PP/PE (Ω)	-	-	**14.97**	**7.189**	**25.21**	**9.521**	**0.38**	**0.972**
X0PE (Ω)	-	-	**405.10**	**590.791**	**410.99**	**782.368**	**31.94**	**79.843**
R0PE (Ω)	-	-	**102.23**	**151.292**	**102.23**	**200.352**	**8.18**	**20.447**
RFPP (Ω)	55	30	**65**	**60.000**	**80**	**75.000**	**20**	**72.948**
RFPE (Ω)	110	40	**125**	**60.000**	**145**	**100.000**	**85.25**	**100.000**
Setting	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach-phase (Ω)	**33.66**	**17.24**	**33.66**	**21.59**	**33.66**	**26.99**	**33.66**	**26.99**
Resistive reach-ground (Ω)	**44.88**	**23.30**	**44.88**	**28.79**	**44.88**	**35.98**	**44.88**	**35.98**
Impedance - phase resistive	**27.99**	**27.99**	**36.93**	**43.388**	**38.88**	**75.57**	**2.800**	**6.99**
400 kV Anpara D-Anpara B line I&II								
X1PP/PE (Ω)	-	-	**6.26**	**5.764**	**11.26**	**89.63903**	**0.10**	**0.252**
R1PP/PE (Ω)	**0.10**	**0.059**	**5.07**	**4.575**	**10.07**	**7.415998**	**0.10**	**0.015**
X0PE (Ω)			**9.19**	**3.532155**	**14.19**	**226.7288**	**0.05**	**0.838**
R0PE (Ω)			**5.95**	**15.52755**	**20.95**	**51.57553**	**0.1**	**0.191**
RFPP (Ω)	**55**	**3.029**	**65**	**18.786**	**80**	**33.786**	**1**	**0.757**
RFPE (Ω)	**110**	**4.543**	**125**	**28.179**	**145**	**50.679**	**1**	**1.136**

2.9 INPUT DATA FOR TARNSFORMER PROTECTION:

Table-10 Input Data for Transformer Protection:

S. No.	Description	Units	Value	Value	Value	Value	Value
0	**Substation Name**		765 bay	765 bay	765 bay	400 bay	400 bay
1	**Transformer Name**		ICT Bank	GT-6 Bank	GT-7 Bank	ST-1	ST-2
2	**Rating**						
2.1	MVA	KVA	1000	600	600	80	80
2.2	Voltage Ratio	kV/kV	765/400/33	765/21	765/21	400/11.5-11.5	400/11.5-11.5
3	**Impedance**	%	14	15	15	18.5	18.5
4	**Vector Group**		YNynd11	YNd11	YNd11	YNyn0	YNyn0
5	**OLTC Data**						
5.1	Min Tap (%)	% (-)	5	5	5	10	10
5.2	Max Tap (%)	% (+)	5	5	5	10	10
5.3	No. of Steps		23	5	5	17	17
6	**Differential Protection**		YES	YES	YES	YES	YES
6.1	Differential CT Ratio						
6.2	HV CT Ratio (Main & ICT)	A/A	1000/1	800/1	800/1	600/1	600/1
6.3	LV1 CT Ratio (Main & ICT)	A/A	1600/1	20000/1	20000/1	2500/1	2500/1
6.3	LV2 CT Ratio(Main & ICT)	A/A	800/1	-	-	2500/1	2500/1
6.4	Differential Relay						

6.5	Make		MICOM	MICOM	MICOM	MICOM	MICOM
6.6	Model		P-633,P-643 (TEE-1 P-122) (TEE-2 P-633)	P-633,P-643 (TEE-1 P-122) (TEE-2 P-633)	P-633,P-643 (TEE-1 P-122) (TEE-2 P-633)	P-633,P-643 (TEE-1 P-122) (TEE-2 P633)	P-633,P-643 (TEE-1 P-122) (TEE-2 P-633)
7	**REF Protection**		YES	YES	YES	YES	YES
7.1	REF Protection CTs						
7.2	CT Ratio	A/A	800/1	800/1	800/1	200/1	200/1
7.6	REF Relay						
7.7	Make		MICOM	MICOM	MICOM	MICOM	MICOM
7.8	Model		P-633.P-643	P-633,P-643	P-633,P-643	P-633	P-633
7.9	Rstab Range (Ω)	Ohms	-	-	-	-	-
8	**Over Fluxing Protection**		YES	YES	YES	YES	YES
8.1	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.2	Model		P-633,P-643	P-633,P-643	P-633,P-643	P-633,P-643	P-633,P-643
8	**HV Back-up Protection**		YES	YES	YES	YES	YES
8.1	HV Back-up Protection Relay		Numerical	Numerical	Numerical	Numerical	Numerical
8.2	Make		MICOM	MICOM	MICOM	MICOM	MICOM
8.3	Model		P-141	P-141	P-141	P-141	P-141
8.4	HV Back-up Protection CTs						
8.5	Ratio	A/A	800/1	800/1	800/1	600/1	600/1
9	**LV Back-up Protection**		YES	NO	NO	YES	YES
9.1	LV Back-up Protection Relay		Numerical	-	-	Numerical	Numerical
9.2	Make		MICOM	-	-	SEL	SEL

9.3	Model		P-141	-	-	751A IC	751A IC
9.4	LV Back-up Protection CTs			-	-		
9.5	Ratio	A/A	1600/1	-	-	2500/1	2500/1

2.10 REVIEW OF TRANSFORMER PROTECTION RALAY SETTINGS

Table-11 Review of Transformer Protection Relay Settings:

Main-I	ICT		GT-6		GT-7		S T-1		S T-2					
Relay make	**MICOM P-633**		**MICOM P-633**		**MICOM P-633**		**MICOM P-633**		**MICOM P-633**					
Differential Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Unit		CT ratio	
diff Id	0.15	0.15	0.15	0.15	0.15	0.15	0.2	0.2	0.2	0.2	A	Iref		HV-1000/1
Diff I>>	8	8	10	10	10	10	10	10	10	10	A	Iref	ICT	LV-1600/1
Diff I>>>	12	12	12	12	12	12	12	12	12	12	A	Iref	GT-6	HV-800/1
slope 1	20	20	20	20	20	20	20	20	20	20		%		LV-20000/5
slope 2	80	80	80	80	80	80	80	80	80	80		%	GT-7	HV-800/1
Over Fluxing Protection														LV-20000/5
V/f	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	V/Hz			HV-600/1
Time delay	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	sec		ST-1	LV-2500/1
V/f	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	V/Hz			HV-600/1
Time delay	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	sec		ST-2	LV-2500/1
V/f	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	V/Hz		Neutral CT ratios	
Time delay	120	120	120	120	120	120	120	120	120	120	sec		ICT	800/1
V/f	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	V/Hz		GT-6	600/1
Time delay	70	70	70	70	70	70	70	70	70	70	sec		GT-7	600/1
V/f	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	V/Hz		ST-1	200/1
Time delay	50	50	50	50	50	50	50	50	50	50	sec		ST-2	200/1
V/f	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	V/Hz			
Time delay	30	30	30	30	30	30	30	30	30	30	sec			

V/f	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	V/Hz		
Time delay	10	10	10	10	10	10	10	10	10	10	sec		
V/f	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	V/Hz		
Time delay	4	4	4	4	4	4	4	4	4	4	sec		
V/f	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	V/Hz		
Time delay	2	2	2	2	2	2	2	2	2	2	sec		
V/f	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	V/Hz		
Time delay	1	1	1	1	1	1	1	1	1	1	sec		
V/f	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	V/Hz		
Time delay	1	1	1	1	1	1	1	1	1	1	sec		
V/f	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	V/Hz		
Time delay	1	1	1	1	1	1	1	1	1	1	sec		
V/f													
Time delay													
REF Protection HV side													
High Impedance Type													
Pickup	-	-	-	-	-	-	0.2	0.2	0.2	0.2	A		
Stabilizing Resistor	-	-	-	-	-	-	121.60	73.91	121.60	73.91	ohm		
Low Impedance Type													
Idiff	0.22	0.22	0.15	0.15	0.15	0.15	-	-	-	-	A Iref		
M1 slope	20	20	100	100	100	100	-	-	-	-	%		
M2 slope	150	150	101	101	101	101	-	-	-	-	%		

MAIN-II	ICT		GT-6		GT-7		S T-1		S T-2					
Relay make	**MICOM P-643**		**MICOM P-643**		**MICOM P-643**		**MICOM P-643**		**MICOM P-643**					
Differential Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Unit			CT Ratio
IS1	0.15	0.15	0.15	0.15	0.15	0.15	0.2	0.2	0.2	0.2	A	ref	ICT	HV-1000/1
HS1	8	8	10	10	10	10	10	10	10	10	A	Iref		LV-1600/1
HS2	12	12	12	12	12	12	12	12	12	12	A	Iref	Gt-6	HV-800/1
slope 1	20	20	20	20	20	20	20	20	20	20	%			LV-20000/5
slope 2	80	80	80	80	80	80	80	80	80	80	%			
Over Fluxing Protection														
V/f	2.530	2.530	2.530	2.530	2.530	2.530	2.530	2.530	2.530	2.530	V/Hz		Gt-7	HV-800/1
Time delay	120	120	120	120	120	120	120	120	120	120	V/Hz			LV-20000/5
V/f	2.640	2.640	3.080	3.080	3.080	3.080	2.530	2.530	2.530	2.530	V/Hz		ST-1	HV-600/1
Time delay	70	70	4	4	4	4	60	60	60	60	V/Hz			LV-2500/1
V/f	2.860	2.860	-	-	-	-	3.080	3.080	3.080	3.080	V/Hz		ST-2	HV-600/1
Time delay	30	30	-	-	-	-	4	4	4	4	V/Hz			LV-2500/1
V/f	3.080	3.080	-	-	-	-	-	-	-	-	V/Hz			
Time delay	4	4	-	-	-	-	-	-	-	-	V/Hz			
V/f	3.300	3.300	-	-	-	-	-	-	-	-	V/Hz			
Time delay	1	1	-	-	-	-	-	-	-	-	V/Hz			
REF Protection													Neutral CT ratios	
Pickup (mA)	0.2	0.2	0.2	0.2	0.2	0.2								
K1 (%)	105	105	105	105	105	105	-	-	-	-	A		GT-6	600/1
K2 (%)	105	105	105	105	105	105	-	-	-	-	ohm		GT-7	600/1
Over current and Earth fault protection														
HV side														

Over current													
function	-	-	IEC S Inverse	IEC S Inverse	-	-	-	-	-	-			
Pick up (A)	-	-	1	1	-	-	-	-	-	-			
Time delay(s)	-	-	1	1	-	-	-	-	-	-			
Earth Fault Protection													
function	-	-	IEC S Inverse	IEC S Inverse	-	-	-	-	-	-			
Pickup(mA)	-	-	0.2	0.2	-	-	-	-	-	-			
Time delay(S)	-	-	1	1	-	-	-	-	-	-			
LV side													
Over current													
function	-	-	IEC S Inverse	IEC S Inverse	-	-	-	-	-	-			
Pick up (A)	-	-	5	5	-	-	-	-	-	-			
Time delay(s)	-	-	1	1	-	-	-	-	-	-			
Earth Fault Protection													
function	-	-	IEC S Inverse	IEC S Inverse	-	-	-	-	-	-			
Pickup(A)	-	-	1	1	-	-	-	-	-	-			
Time delay(S)	-	-	1.5	1.5	-	-	-	-	-	-			
Back up	ICT		GT-6		GT-7		S T-1		S T-2				
Relay make	MICOM-P-141		MICOM-P-141		MICOM-P-141		MICOM-P-141		MICOM-P-141				
HV side Over current and Earth fault protection													
Over Current	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			

Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	DT	DT			
Pick up (A)	0.87	0.87	0.66	0.66	0.66	0.66	0.26	0.26	0.26	0.26			
Time Delay (Sec)	0.6	0.6	0.55	0.55	0.55	0.55	0.25	0.25	1	1			
TV Side													
Function	IEC S Inverse	IEC S Inverse	-	-	-	-	-	-	-	-			
Pick up	0.37	0.37	-	-	-	-	-	-	-	-			
Time delay	0.5	0.5	-	-	-	-	-	-	-	-			
Earth Fault	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	0.8	0.8	0.12	0.12	0.12	0.12	0.08	0.08	0.08	0.08			
Time Delay (Sec)	0.1	0.1	0.55	0.55	0.55	0.55	0.78	0.78	0.78	0.78			
LV side Over current and Earth fault protection													
Over Current	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Function	IEC S Inverse	IEC S Inverse	-	-	-	-	IEC S Inverse	IEC S Inverse	IEC S Inverse	IEC S Inverse			
Pick up (A)	1.040	1.040	-	-	-	-	0.3	0.3	0.3	0.3			
Time Delay (Sec)	0.49	0.49	-	-	-	-	0.0	0.05	0.05	0.05			
Earth Fault	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings			
Pick up (A)	-	-	-	-	-	-	-	-	-	-			
Time Delay (Sec)	-	-	-	-	-	-	-	-	-	-			
TV side													
Pick up (A)	0.8	0.8											
Time Delay (Sec)	0.1	0.1											

TEE2	765 Anpara –C line+GT-7 Tie+765kV Bus-1		Bus Reactor+765 Unnao line Tie+765kV Bus- 2		765kV Bus -2+GT-7+765kV Anpara -C Line Tie		GT-6+ICT765kV HV Tie+765kV Bus-2		ICT-400kV -LV+4-2-CT Tie Bay+400KVBUS-1					
Relay make	**MICOM P-633**		**MICOM P-633**		**MICOM P-633**		**MICOM P-633**		**MICOM P-633**					
Differential Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	UNIT		CT Ratio	
IS1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	A	Iref	ICT	3000/1
HS1	10	10	10	10	10	10	10	10	8	8	A	Iref	GT-6	3000/1
HS2	12	12	12	12	12	12	12	12	12	12	A	Iref	GT-7	3000/1
slope 1	20	20	20	20	20	20	20	20	20	20	%		ST-1	3000/1
slope 2	80	80	80	80	80	80	80	80	80	80	%		ST-2	3000/1

TEE2	400kV LINE-1 Tie +ST-2+400KVBUS-2		Line Reactor+765 Unnao line+765Bus 1		400KV Bus 1+ST-2 Tie+400kV LINE-1		400kV Line-2+400kV BUS-1+ST-1 Tie		400kV Line-2 Tie +400kV BUS-1+ST-1		ICT765kV HV + GT-6 Tie + 765kV Bus-2			
Relay make	**MICOM P-633**		**MICOM P-634**		**MICOM P-633**		**MICOM P-633**		**MICOM P-633**		**MICOM P-633**			
Differential Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	UNIT	
IS1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	A	ref
HS1	10	10	10	10	8	8	8	8	10	10	8	8	A	Iref
HS2	12	12	12	12	12	12	12	12	12	12	12	12	A	Iref
slope 1	20	20	20	20	20	20	20	20	20	20	20	20	%	
slope 2	80	80	80	80	80	80	80	80	80	80	80	80	%	

TEE1	765 Anpara –C line+GT-7 Tie+765kV Bus-1		Bus Reactor+765 Unnao line Tie+765kV Bus- 2		765kV Bus -2+GT-7+765kV Anpara -C Line Tie		GT-6+ICT765kV HV Tie+765kV Bus-2		ICT-400kV -LV+4-2-CT Tie Bay+400KVBUS-1				
Relay make	**MICOM P-122**		**MICOM P-122**		**MICOM P-122**		**MICOM P-122**		**MICOM P-122**				
Over Current Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	**UNIT**		
Pick up	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	**A**	ref	
Time Delay	0	0	0	0	0	0	0	0	0	0	**sec**		

TEE1	400kV LINE-1 Tie +ST-2+400KVBUS-2		Line Reactor+765 Unnao line+765Bus 1		400KV Bus 1+ST-2 Tie+400kV LINE-1		400kV Line-2+400kV BUS-1+ST-1 Tie		400kV Line-2 Tie +400kV BUS-1+ST-1		ICT765kV HV + GT-6 Tie + 765kV Bus-2			
Relay make	**MICOM P-122**		**MICOM P-122**		**MICOM P-122**		**MICOM P-122**		**MICOM P-122**		**MICOM P-122**			
Over Current Protection	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing settings	Reviewed Settings	Existing setting	Reviewed Settings	UNIT	
Pick up	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	A	Iref
Time Delay	0	0	0	0	0	0	0	0	0	0	0	0	A	Iref

2.11 REVIEW NOTES TRANSFORMER PROTECTION:

765/400KV Switchyard of DTPS was audited and it is observed that Transformer main -I, main-II, and Back up protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table

Note	• For GT-6, 7 LV side over current and earth fault protection is provided in generators relay panels. • For ICTS Bank, LV side earth fault protection is not provided. This Protection may be considered.

2.12 INPUT DATA FOR BUS REACTOR AND LINE REACTOR PROTECTION:

Table-12 Input Data for Bus Reactor and Line Reactor Protection:

Sl. No	Description	Unit	Value	Value
	Substation Name			
1	**Name**		Bus Reactor	Line Reactor
2	**Rating**			
2.1	MVA	MVAR	189	330
2.2	Voltage Level	kV	765	765
3	**Impedance**	%	3092.70	1775.64
4	**Differential Protection**		YES	YES
4.1	Differential CT Ratio			
4.2	HV CT Ratio (Main & ICT)	A/A	200/1	300/1
4.3	LV CT Ratio (Main & ICT)	A/A	600/1	600/1
4.4	Differential Relay		Numerical	Numerical
4.5	Make		MICOM	MICOM
4.6	Model		P-632	P-632
5	**REF Protection**		NO	YES
5.1	REF Protection neutral side		-	
5.2	CT Ratio	A/A	-	200/1
5.3	REF Relay		-	Numerical
5.4	Make		-	MICOM
5.5	Model		-	P-141
5.6	Rstab Range (Ω)	Ohms	-	
6	**Back-up Protection**		YES	YES
6.1	Back-up Protection Relay		Numerical	Numerical
6.2	Make		MICOM	MICOM
6.3	Model		P-141	P-141
6.4	Back-up Protection CTs Ratio	A/A	600/1	600/1

2.13 REVIEW OF BUS REACTOR AND LINE REACTOR PROTECTION SETTINGS:

Table-13 Review of Bus Reactor and Line Reactor Protection Settings:

Sl No.	Description			BUS REACTOR		LINE REACTOR	
				Adopted Settings	**Recommended Settings**	**Adopted Settings**	**Recommended Settings**
1	**Make**			ALSTOM		ALSTOM	
2	**Capacity(MVAR)**			189		330	
3	**Voltage Level (KV)**			765		765	
4	**% Impedance**			3092.70		1775.64	
5	**MAIN**			**MAIN-I**	**MAIN-I**	**MAIN-I**	**MAIN-I**
6	**Differential**	**Relay Model &make**		MICOM P-632		MICOM P-632	
		Adopted CT Ratio	**HV**	200/1	200/1	300/1	300/1
			LV	600/1	600/1	600/1	600/1
		Biased	**M1 (%)**	20	20	2	20
			M2 (%)	80	80	8	80
			Is/Id min	0.10	0.10	0.	0.10
	MAIN			**MAIN-II**	**MAIN-II**	**MAIN-**	**MAIN-II**
7	**Over current**	**Relay Model &make**		MICOM P-141	MICOM P-141	MICOM P-141	MICOM P-141
		Pick up (A)		0.10	0.1	0.	0.17
		Time delay(Sec)		0	0	0.5	0.5
8	**Back Up Over Current**	**Relay Model &make**					
		CT Ratio	**HV**	200/1	200/1	300/1	300/1
			LV	600/1	600/1	600/1	600/1
		Settings					
		Over curren	**Pick up (A)**	0.28	0.28	0.	0.49
			Time delay(Sec)	0.5	0.5	0 .	0.5
		Earth fault	**Pick up (A)**	0.13	0.13	0.	0.22
			Time delay(Sec)	1	1	1	1
9	**REF**	**Relay Model &make**		-			
		CT RATIO	**HV**	-	-	300/1	300/1
			LV	-	-	600/1	600/1
			NEUTRAL	-	-	200/1	200/1
		Setting	**Pick up (A)**	-	-	0.1	0.1
			Time delay (Sec)	-	-	0.5	0.5
			R Stab(ohm) Rct=5Ω(assumed)	-	-	-	326.78

2.14 REVIEW NOTES OF BUS REACTOR AND LINE REACTOR PROTECTION

765/400KV Switchyard of DTPS was audited and it is observed that Bus Reactor and Line Reactor protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table

Note	• For Bus Reactor as per NRPC guide lines REF protection should be given. • For Line Reactor REF protection stabilizing value is around 330 ohms.

2.15 REVIEW OF BUS BAR PROTECTION:

765/400KV Switchyard of DTPS was audited and it is observed that Bus Bar protection settings are in order.

Table-14 Review of Bus Bar Protection Settings:

Sl. No.	BAY	PROTECTION	Main-I		Main-II	
			Existing settings	Recommended	Existing settings	Recommended Settings
1	765 kV BUS-1	Dead Zone	Pick up I=2490 A Time delay=0.05 sec	Pick up I=2490 A Time delay=0.05 sec	Pick up I> 83% Time delay=0.5 sec	Pick up I> 83% Time delay=0.5 sec
		Over Current	Pick up I=3480 A Time delay=0.3 sec	Pick up I=3480A Time delay=0.3 sec	Pick up I=3480 A Time delay=0.3 sec	Pick up I=3480 A Time delay=0.3 sec
		Differential	-	-	I pick up = 2500 A K1=0% K2=60% T diff=0 sec	I pick up = 2500 A K1=0% K2=60% T diff=0 sec
2	765 kV BUS-2	Dead Zone	Pick up I=2490 A Time delay=0.05 sec	Pick up I=2490 A Time delay=0.05 sec	Pick up I> 83% Time delay=0.05 sec	Pick up I> 83% Time delay=0.05 sec
		Over Current	Pick up I=3480 A Time delay=0.3 sec	Pick up I=3480A Time delay=0.3 sec	Pick up I=3480 A Time delay=0.3 sec	Pick up I=3480 A Time delay=0.3 sec
		Differential	-	-	I pick up = 2500 A K1=0% K2=60% T diff=0 sec	I pick up = 2500 A K1=0% K2=60% T diff=0 sec
3	400 kV BUS-1	Dead Zone	Pick up I=2010 A Time delay=0.05 sec	Pick up I=2010 A Time delay=0.05 sec	-	-
		Over Current	Pick up I=3480 A Time delay=0.35 sec	Pick up I=3480A Time delay=0.35 sec	Pick up I=3480 A Time delay=0.35 sec	Pick up I=3480 A Time delay=0.35 sec
		Differential	-	-	I pick up = 2000 A K1=0% K2=60% T diff=0 sec	I pick up = 2000 A K1=0% K2=60% T diff=0 sec

4	400 kV BUS-2	Dead Zone	Pick up I=2010 A Time delay=0.05 sec	Pick up I=2010 A Time delay=0.05 sec	-	-
		Over Current	Pick up I=3480 A Time delay=0.35 sec	Pick up I=3480A Time delay=0.35 sec	Pick up I=3480 A Time delay=0.35 sec	Pick up I=3480 A Time delay=0.35 sec
		Differential	-	-	I pick up = 2000 A K1=0% K2=60% T diff=0 sec	I pick up = 2000 A K1=0% K2=60% T diff=0 sec

2.16 Review of Auxiliary Protection Infrastructure:-

In this section, the details of the batteries and chargers are described. There are two sets of battery banks of 110 V for one CRB in switchyard. In total eight banks for four CRB's. The DC system in DTPS is adequate for the station and it is satisfactory.

Details of DC system data noted by CPRI team during field audit are given below:-

Table-15 Review of 110 V battery bank for CRB-1

DC BATTER SYSTEM OF 765 kV SWITCH YARD 110 V (2 Battery Banks) IN CRB-1		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	Nickel–cadmium battery	Nickel–cadmium battery
Year of Commissioning	2013	2013
No Of Cells	87*1.38V	87*1.39V
Capacity	400Ah	400Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	HBL	HBL
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	116 V	114 V
Positive-Earth	58 V	58 V
Negative-Earth	56 V	56 V

Table-16 Review of 110 V battery bank for CRB-2

DC BATTER SYSTEM OF 765 kV SWITCH YARD 110 V (2 Battery Banks) IN CRB-2		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	Nickel–cadmium battery	Nickel–cadmium battery
No Of Cells	87*1.44V	87*1.43V
Year of Commissioning	2013	2013
Capacity	400Ah	400Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	HBL	HBL
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	118 V	114 V
Positive-Earth	60 V	58 V
Negative-Earth	58 V	58 V

Table-17 Review of 110 V battery bank for CRB-3

DC BATTER SYSTEM OF 765 kV SWITCH YARD 110 V (2 Battery Banks) IN CRB-3		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	Nickel–cadmium battery	Nickel–cadmium battery
No Of Cells	87*1.42V	87*1.41V
Year of Commissioning	2013	2013
Capacity	400Ah	400Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	HBL	HBL
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	116 V	114 V
Positive-Earth	58V	60 V
Negative-Earth	56 V	58 V

Table-18 Review of 110 V battery bank for CRB-4

DC BATTER SYSTEM OF 765 kV SWITCH YARD 110 V (2 Battery Banks) IN CRB-4		
Bank	Bank-1	Bank-2
Make	HBL	HBL
Type	Nickel–cadmium battery	Nickel–cadmium battery
No Of Cells	87*1.41V	87*1.41V
Year of Commissioning	2013	2013
Capacity	400Ah	400Ah
Charger Details	CHARGER DETAILS	CHARGER DETAILS
Make	HBL	HBL
Style	FLOATCUM BOOST CHARGER	FLOATCUM BOOST CHARGER
Dc Checking		
Positive-Negative	125 V	116 V
Positive-Earth	62 V	58 V
Negative-Earth	62 V	58 V

III. Review of Circuit Breaker Test Reports

3.0 Review of Circuit Breaker Test Reports:
Circuit breaker test reports were collected in the field from Switchyard by the CPRI audit team and verified that all the lines closing time is less than 110ms and are in order. The Overall performance of all the circuit breaker is satisfactory as per testing reports collected at site.

765 KV BREAKER TEST REPORT

S.N.	Breaker Description	Date of Testing	Timing Test Report																					
			Close Timing Report							Trip Timing Report (TC-1)							Trip Timing Report (TC-2)							
						Pole Mismatch (ms)	Break Mismatch (ms)			Trip Time			Pole Mismatch (ms)	Break Mismatch (ms)			Trip Time			Pole Mismatch (ms)	Break Mismatch (ms)		
1			R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)		R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)	R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)		R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)	R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)		R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)
	701-52	27.10.2020	107.2	107	107.8	0.8	4	0.6	0.6	24.4	23.8	24.4	0.6	0.6	0.2	0.8							
2	702-52	28.10.2020	107.2	108	107.2	0.8	1	1.6	1.2	24	23.6	24.6	1	0.8	0.4	1	23	23.2	23.4	0.4	0.4	0.6	0.4
3	703-52	27.11.2019	105.2	106.6	107.2	2	3.4	0	1.2	23.6	22.4	23.2	1.2	0.4	0	0.4	24.4	24	23.6	0.8	0.2	0	0.2
4	704-52	12.04.2020	118.6	115.4	116.6	3.2	5.4	5.8	0.2	25.6	24.8	24.4	1.2	1.8	0.8	2	23.2	23.4	22.6	0.8	1.2	0.6	0.4
5	705-52	16.10.2020	113.6	112.2	111.6	0.8	1	0.8	1.6	24.8	24.8	24	0.8	1.4	1	0	23.4	24	23.2	0.8	0.4	0.8	0.2
6	706-52	13.10.2020	107.2	110.2	108.6	0.6	2.2	0.8	1.6	23.2	22.6	23	0.6	0.8	0.2	0.6	23.2	22.6	23.2	0.6	0.8	0.2	0.8
7	707-52	22.11.2019	105.4	108.3	106.8	2.9	3.8	0.7	1.3	23.4	23.6	23.5	0.2	0.6	0.8	0.7	24.3	23.8	25.1	1.3	0.6	0.6	1.7
8	708-52	21.01.2020	106.8	107.6	106.8	0.8	2.6	0.6	1.6	23.8	24	23.6	0.4	0.6	0.8	0.2	22.8	23.2	23.4	0.6	0.4	0.4	1
9	709-52	29.06.2019	107.4	107.2	107.9	0.7	2.2	2.8	0.1	24	23.6	23	1	1.2	0.2	0.2	23	22.6	22.4	0.6	1	0.4	0.4

400 KV BREAKER TEST REPORT

S.N.	Breaker Description	Date of Testing	Timing Test Report																					
			Close Timing Report							Trip Timing Report (TC-1)							Trip Timing Report (TC-2)							
			Close Time			Pole	Break Mismatch			Trip Time			Pole	Break Mismatch			Trip Time			Pole	Break Mismatch		
1.			R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)	Mismatch (ms)	R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)	R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)	Mismatch	R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)	R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)	Mismatch	R-Phase (ms)	Y-Phase (ms)	B-Phase (ms)
	401-52	08.11.2019	106.8	105.8	107.2	1.4	0	0	0	22.2	22.2	22.2	0	0	0	0	22.8	22.4	22.6	0.4	0	0	0
2	402-52	08.11.2019	106.6	108.8	107.2	2.2	0	0	0	21.8	22	22.2	0.4	0	0	0	22	21.8	23	1.2	0	0	0
3	403-52																						
4	404-52																						
5	405-52	20.10.2019	107.2	107.8	107.6	0.6	0	0	0	23.2	23.4	20.8	2.6	0	0	0	22.4	22.6	22.4	0.2	0	0	0
6	406-52																						
7	407-52	20.10.2019	105.8	105.8	106.6	0.8	0	0	0	22.2	21.4	22	0.8	0.2	0	0	22.4	21.6	22.2	0.8	0	0	0
8	408-52																						
9	409-52	28.06.2019	107	107	107	0	0	0	0	22	23	22	1	0	0	0	22	22		0		0	0

IV. Audit finding and observation

4.0Audit finding and observations:

CPRI audit team carried out the site visit filed inspection and following are a few observation

1. 765 kV Lines are protected as main differential and distance protection..400 kV lines are also protected as main differential and distance protection. But some of operational relay setting is observable variation with respect to calculated relay setting obtained based on the provided line parameters.
2. All GT Banks, ICT Bank and station transformers are well protected only earth fault backup protection is not provided.
3. Bus Reactors and Line Reactor are well protected only REF Protection is not provided.
4. The substation Power equipment Earthing is measured a few sample locations. It is found that Earthing of power equipment with substation ground mat is proper and its value is 0.5 ohm.
5. The D C bank supply is measured and it is observed that they are well maintained.
6. The periodic test reports of Circuit breakers and relays are reviewed and it is found that their performance is satisfactory in terms of breaker opening, closing times
7. Wherever the change in relay settings and additional protection is required is suggested as under:

765 /400kV switchyard were audited and it is observed that GT, station transformers, unit auxiliary transformer and line unit protection settings are in order. Based on the review the necessary changes in the operational relay setting are listed in the below table.

Table-19 Review of 765 kV **Anpara D –Lanco line** ,Anpara D-Unnao line & 400 kV Anpara D-Anpara B line I&II

Name of Transmission Line	**Anpara D –Lanco line**									
Main I	**ABB REL-670**		Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Setting	Existing Settings	Reviewed Settings								
Distance Protection	Zone 1		Zone 1B		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	-	-	-	-	**10.99**	**59.094**	**21.23**	**117.438**	**0.15**	**0.150**
R1PP/PE (Ω)	-	-	-	-	**10.27**	**2.3613**	**20.51**	**4.693**	**0.006**	**0.006**
X0PE (Ω)	-	-	-	-	**12.705**	**194.039**	**22.95**	**385.615**	**0.49**	**0.493**
R0PE (Ω)	-	-	-	-	**10.87**	**49.690**	**21.11**	**98.750**	**0.13**	**0.126**
RFPP (Ω)	**55**	**1.801**	-	-	**65**	**60**	**80**	**75.000**	**0.9**	**0.450**
RFPE (Ω)	**110**	**2.701**	-	-	**125**	**60**	**145**	**100.000**	**1.35**	**0.675**

Name of Transmission Line			**Anpara D –Unnao line**					
Main I	**ABB REL-670**							
Setting	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
X1PP/PE (Ω)	-	-	**127.47**	**179.924**	**133.36**	**238.268**	**9.73**	**24.316**
R1PP/PE (Ω)	-	-	**14.97**	**7.189**	**25.21**	**9.521**	**0.38**	**0.972**
X0PE (Ω)	-	-	**405.10**	**590.791**	**410.99**	**782.368**	**31.94**	**79.843**
R0PE (Ω)	-	-	**102.23**	**151.292**	**102.23**	**200.352**	**8.18**	**20.447**
RFPP (Ω)	55	30	**65**	**60.000**	**80**	**75.000**	**20**	**72.948**
RFPE (Ω)	110	40	**125**	**60.000**	**145**	**100.000**	**85.25**	**100.000**
Setting	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings	Existing Settings	Reviewed Settings
Distance Protection	Zone 1		Zone 2		Zone 3		Zone 4	
Direction	Forward	Forward	Forward	Forward	Forward	Forward	Reverse	Reverse
Resistive reach-phase (Ω)	**33.66**	**17.24**	**33.66**	**21.59**	**33.66**	**26.99**	**33.66**	**26.99**
Resistive reach-ground (Ω)	**44.88**	**23.30**	**44.88**	**28.79**	**44.88**	**35.98**	**44.88**	**35.98**
Impedance - phase resistive	**27.99**	**27.99**	**36.93**	**43.388**	**38.88**	**75.57**	**2.800**	**6.99**
400 kV Anpara D-Anpara B line I&II								
X1PP/PE (Ω)	-	-	**6.26**	**5.764**	**11.26**	**89.63903**	**0.10**	**0.252**
R1PP/PE (Ω)	**0.10**	**0.059**	**5.07**	**4.575**	**10.07**	**7.415998**	**0.10**	**0.015**
X0PE (Ω)			**9.19**	**3.532155**	**14.19**	**226.7288**	**0.05**	**0.838**
R0PE (Ω)			**5.95**	**15.52755**	**20.95**	**51.57553**	**0.1**	**0.191**
RFPP (Ω)	**55**	**3.029**	**65**	**18.786**	**80**	**33.786**	**1**	**0.757**
RFPE (Ω)	**110**	**4.543**	**125**	**28.179**	**145**	**50.679**	**1**	**1.136**

Table-2 Review of Transformer, Line Reactor and Bus Reactor Protection:

Note	• For GT-6, 7 LV side over current and earth fault protection is provided in generators relay panels. • For ICTS Bank, LV side earth fault protection is not provided. This Protection may be considered. • For Bus Reactor as per NRPC guide lines REF protection should be given. • For Line Reactor REF protection stabilizing value is around 330 ohms.

Annexure-XI

कार्यालय
अधिशासीअभियन्ता,
विद्युतपरीक्षण एंवपरिचालन खण्ड,
ग्रेटरनोएडा
उत्तरप्रदेशपावरट्रांसमिशनकारपोरेशनलि
दूरभाष–7290091978

U.P. POWER TRANSMISSION CORPORATION LIMITED
UPPTCL

Office Of The
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Electricity Test.&Comm.Division
Greater Noida
U.P. Power Transmission
Corporation Ltd.
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Phone no. 7290091978

पत्रांक/No.- 352 /ET&CD/Gr.Noida/ दिनांक/Dated- 17.08.2024

Sub- Regarding Submitting the Action taken on internal protection Audit report 2023-24.

Superintending Engineer,
ET&CC, Meerut.

Kindly take the reference of above cited subject. In this regard, Here we are submitting the Action taken on Internal protection Audit report 2023-24 for information and further necessary action.

(Divya Budiyal)
Executive Engineer

पत्रांक/No.- 352 /ET&CD/Gr.Noida/ दिनांक/Dated- 17.08.2024
Copy-
1. Superintending Engineer, ETC, Gr.Noida

(Divya Budiyal)
Executive Engineer

220 के0वी0 विमव एवं उच्चतर विभव के उपकेन्द्रो के प्रोटेक्शन ऑडिट में इंगित कमियों पर कार्यवाही के सम्बन्ध में।

विद्युत परीक्षण एवं परिचालन खण्ड, Gr.Noida

दिनांक 17.08.2024

S. No.	Sub-Station Name	Found Discrepancies	Action Taken By TnC	Action Taken By Transmission	Remark
1	400KV Gr.Noida	1.There is no Main-2 on any of the 220KV lines.	Requirement for MAIN-1/MAIN-2 CRP already sent by Transmission.	1.Action Required	
		2.TMS setting on both HV & LV back up relay of both 315MVA and both 500MVA ICTs are not as per UPPTCL protection setti ng SOP.	Setting are as per the guidelines received from T&C Circle office.	settings as per Letter no 213/ETCC-MT/ Dated 07/04/18.(attached)	
		3.TMS setting on HV back up relay of both 200MVA and 160MVA ICTs are not as per UPPTCL protection setti ng SOP	Setting are as per the guidelines received from T&C Circle office.		
2	220KV IITGNL	1.CB testing has been done only at the time of commissioning,since than no CB testing done till date.	Information for the CB timing test conveyed to Transmission.	1.Action Required	
		2.Routine testing Pending,its in the scope of M/S Elite Power.	Letter have issued to M/S Elite power,SDO(Transmission) is persuing the matter.	2.Action Required.	
3	220 KV Debai	1- Busbar protection on 220KV is unhealthy.There is comunication error in CU of busbar panel.		Action required.	
		2- Z2 & Z4 setting of both 220KV Napp and 220KV khurja line are not as per latest NRPC guidelines.	Zone settings of 220 KV line has been calculated as per NRPC guidelines.Corrective measure taken as per internal audit report.		
		3- There is no Main-II(Distance relay) on both 220KV Napp and 220KV Khurja lines.As per latest NRPC guidelines here should be Main-II of different make/principle on all 220KV and abobe transmission lines.		Action required.	
		4- LV backup relay on 100 MVA TF-1 is defective.		Action required.	
		5- TMS setting on both HV & LV backup relays of both 100 MVA TFs is not as per UPPTCL protection setting SOP.	Downstream transformer of 63MVA and 40MVA at 132KV is also set at 0.20.It was earlier obseved that on heavy fault current both LV of 220KV /132KV TFR and HV of 132KV/33KV transformer was issuing trip signal.Hence direction needed on this issue.		
		6- Positive of both 110V battery sets is earthed somewgwre.		Action required.	
		7- Relays are not synchronised as per GPS clock available at s/s.		Action required.	
		8- SOTF is not configured in M1 of 220KV Khurja line.	SOTF/TOR has been configured for Z-1 and Z-2 in the relay		
		9- PLCC on 220KV Khurja line is unhealthy.	Issue at PLCC Chanel at khurja end post fire hazard.		
		10- There is a continuous oil leakege from both 100MVA TFs which is dangerous from fire protection view point.		Action required	
		11- As per SDO (Trans.), CB testing has not been done after commissioning till date		Action required	
		1- There is minor variation in zone 1 & zone 2 settings of all 220KV line as compared with calculation done on the basis of latest NRPC guideline	1- Zone-1 & zone-2 settings of 220 KV line has been calculated as per NRPC guidelines.Corrective measure taken as per internal audit report.		
		2- Z 4 setting of all 220KV line are not as per UPPTCL protection setting SOP.	2- Zone-4 settings of 220 KV line has been calculated as per NRPC guidelines.Corrective measure taken as per internal audit report.		

4	220 KV Jahangirabad	3- There is no Main-II(Distance relay) on both 220KV Khurja lines.As per NRPC guidelines here should be Main-II of different make/principle on all 220KV and abobe transmission lines		Action required.	
		4- PLCC on 220KV Khurja and 220KV Harduaganj line is umhealthy	4- Issue at PLCC Chanel at khurja end and Harduaganj end,	4- Issue at PLCC Chanel at khurja end and Harduaganj end. Action required by transmission end.	
		5- TMS setting on both HV & LV backup relays of both 160MVA TFs is not as per UPPTCL protection setting SOP.	Downstream transformer of 63MVA and 40MVA at 132KV is also set at 0.20.It was earlier obseved that on heavy fault current both LV of 220KV /132KV TFR and HV of 132KV/33KV transformer was issuing trip signal.Hence direction needed on this issue.		
		6- Present GPS clock (SANDS make) is defective. new GPS clock (MESIBUS make) is available at s/s but its installation is pending hence relays are not synchronised as per GPS clock.		Action required.	
		7- Positive of 110V battery set 2 is earthed somewhere.		Action required.	
		8- As per SDO (Trans.), CB testing has not been done after commissioning till date		Action required.	
5	220 KV Hybrid Hapur	1- Zone settings of 220 KV Simbhaoli lines are not found as per NRPC guidelines.	1- Zone settings of 220 KV line has been calculated as per NRPC guidelines.Corrective measure taken as per internal audit report.		
		2- TMS settings on HV backup relay of all 60 MVA TF is not as per UPPTCL protection SOP.	Few years ago, many 33 kv passes damaged at 220 kv Hybrid Hapur substation, a joint meeting attended by firm engineer and UPPTCL representatives regarding the same issue, so that time these settings were one of the outcomes of meeting. (HV Side TMS is 0.20 and LV side TMS is 0.15). so that HV side TMS Settings will be changed after discussion with higher officials.		
		3-As per SDO (trans) CB testing has not been done as HYBRID passes are installed in place of conventional CBs.		Action required	
		4-NIFPS OF 60 MVA TF-I & 60 MVA TF-II is not working because of reduced pressure due to leakage issue. As per SDO(TRANS), approvel for rectifying the problem is under process		Action required	
6	220 KV Simbhaoli	1- There is a minor variation in zone-1 and zone-2 settings of 220 KV Simbhaoli line from 400 KV GIS as compared with calculations done on the basis of latest NRPC guidelines.	1- 220 KV Simbhaoli - 400 KV GIS line settings of Z-1& Z-2 rechecked & calculated, corrective measures taken as per internal audit report.		
		2- Z-4 settings of all 220 KV lines are not as per UPPTCL protection settings SOP.	2- Corrective measure taken as per internal audit report. Z-4 settings of all 220 KV lines are identical now		
		3- There is no Main-II(distance relay) on both 220 KV Hapur(765 KV) ckt-II and 220 KV Matore PGCIL lines. As per latest NRPC guidelines there should be Main-II of different make/ principle on all 220 KV and above transmission lines.		Action required.	
		4- Negative of 110 V battery set 1 is earthed somewhere.		Action required.	
		5- All relays are not synchronised as per GPS clock available at S/S.		Action required.	
		6- Testing of almost all the CBs has not been done since many (CB Testing status attached)		Action required.	
		1- There is minor variation in zone 1 & zone 2 settings of all 220KV line as compared with calculation done on the basis of latest NRPC guideline	1- Zone 1&2 settings of 220 KV line has been calculated as per NRPC guidelines.Corrective measure taken as per internal audit report.		

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7	220 KV SS SIKANDRABAD	2- TMS setting on both H.V.&L.V.backup relays of 160MVA, both 100MVA & both 60MVA T/Fs are not as per UPPTCL protection setting SOP.	2- Regarding TMS settings Corrective measure taken as per latest NRPC guideline.	-	
		3- Negative of 110V battery set 1is earthed some where.		Action required.	
		4- Relays are not synchronised as per GPS clock available at S/S		Action required.	
		5- PLCC on 220KV Khurja line is unhealthy.		Action required.	
		6- As per SDO(trans),CB testing has not been done after commissioning till date.		Action required.	
		7- NIFPS of 100MVA T/F-I & 60 MVA T/F -3is not working because of reducced pressure due to leakage issue.Asper SDO (trans),approval for rectifying the problem is under process.		Action required.	
8	220 KV S/S RUKHI	1- Busbsr protection on 220KV is partially healthy. Y Phase relay on busbar panel is defective.	1-Due work card /relay replacement by Related Transmission wing.	Action required.	
		2- Z1 & Z2 setting of 220KV Jahangirabad line are not as per latest NRPC guidelines.	2- Zone 1&2 settings of 220 KV line has been calculated as per NRPC guidelines.Corrective measure taken as per internal audit report.		
		3- Z4 setting of all 220KV lines are not as per UPPTCL protection setting SOP/latest NRPC guidelines.	3- Zone 4 settings of 220 KV line has been calculated as per NRPC guidelines.Corrective measure taken as per internal audit report.		
		4-TMS setting on both HV & LV backup relays of both 160 MVA &both 60MVA T/Fs is not as per UPPTCL protection setting SOP.	4- Regarding TMS settings Corrective measure taken as per latest NRPC guideline.		
		5-.There is continuous oil leakege from one 160 MVA T/F which is dangerous from fire protection vie point.		Action required.	
		6-As per SDO (trans),CB testing has not been done after commissioning till date.		Action required.	

अधि. GM
17.8.24

220 d0oh0 foHko ,o mPprj foHko d midUnk d ikVD'ku vkfMV e bfxr dfe;k ij dk;okgh d lEcU/k e

fo|r ijh{k.k ,o ifjpkyu [k.M] xkft;kckn fnukd 20-08-2024

S. No.	Sub-Station Name	Found Discrepancies	Action Taken By TnC	Action Taken By Transmission	Remark
1	400kV Muradnagar-1st	1. Common Event Logger Desktop software not functional.		1. विद्युत 400 के0वी0 उपकेन्द्र–प्रथम, मुरादनगर पर M/s GE T&D India Ltd, Pallavaram, Chennai-43, Tamil Nadu द्वारा स्थापित Event Logger (Alstom Make SL No.3269034608/11/EL MFG 2014) क्रियाशील नही है। जिसके अनुरक्षण हेतु मूल उपकरण निर्माता से अनुरक्षण हेतु प्राक्लन लेकर (R.e.f. No. 3161-CE(TW) M Dated-18.09.2023) एवं कार्यालय पत्रांक 813 दिनांक 05.10.2023 के द्वारा मुख्य अभियन्ता महोदय को Single Quotation हेतु वित्तीय एवं प्रशासनिक अनुमोदन हेतु प्रेषित किया गया था। तत्पश्चात निदेशक (ऑपरेशन) महादेय से वित्तीय एवं प्रशासनिक अनुमोदन प्राप्त कर ई–निविदा T–23/2023–24 से दिनांक 06.02.2024 के माध्यम से कार्यालय अधीक्षण अभियन्ता, विद्युत पारेषण मण्डल, गाजियाबाद द्वारा निविदा आमंत्रित की गई जिसमें कोई भी Bid प्राप्त न होने के कारण निविदा खोलने की तिथि को विस्तारित कर 08.04.2024 किया गया। जिसमें कोई Bid प्राप्त नही हुई जिस कारण निविदा खोलने की तिथि को पुनः विस्तारित कर 19.04.2024 किया गया परन्तु कोई भी Bid प्राप्त न होने के कारण निविदा को दिनांक 07.05.2024 को निरस्त कर दिया गया। तदोपरान्त OEM द्वारा Single Quotation के माध्यम से अनुरक्षण कार्य हेतु Note Sheet इस खण्ड कार्यालय के पत्रांक 257/वि0400के0वी0उ0ख0–। (मु0) दिनांक 06.06.2024 द्वारा पूनः भेजी गई है। जिसका वित्तीय एवं प्रशासनिक अनुमोदन प्रतिक्षित है।	
		2. Status of ICT-2 not configured in SPS system.		2. SPS के वार्षिक अनुरक्षण हेतु अनुबंध दिनांक 31.08.2023 को समाप्त हो गया था। जिसके पुनः वार्षिक अनुरक्षण हेतु पत्रांक संख्या–767/वि0400के0वी0उ0ख0–। (मु0) दिनांक 18.09.2023 के माध्यम से वित्तीय एवं प्रशासनिक अनुमोदन हेतु प्रस्ताव प्रेषित कर कार्यालय मुख्य अभियन्ता (पा0प0), मेरठ के पत्रांक संख्या–3748/CE(TW) MRT/ दिनांक 10.11.2023 द्वारा वित्तीय एवं प्रशासनिक अनुमोदन प्राप्त कर ई–निविदा टी0–24/2023–24 के माध्यम से निविदा आमंत्रित की गई जिसमें निविदा खोलने की तिथि 14.02.2024 थी परन्तु कोई Bid प्राप्त न होने के कारण निविदा खोलने की तिथि को विस्तारित कर 20.02.2024 किया गया परन्तु निविदा में पुनः कोई बोली प्राप्त नही हुई तदोपरान्त OEM द्वारा Single Quotation के माध्यम से वार्षिक अनुरक्षण हेतु Note Sheet इस खण्ड कार्यालय के पत्रांक 153/वि0400के0वी0उ0ख0–। (मु0) दिनांक 18.04.2024 द्वारा पूनः भेजी गई है। जिसका वित्तीय एवं प्रशासनिक अनुमोदन प्रतिक्षित है।	
		3. Carrier for all 220kV lines except 220kV Sahibabad line not operational.		1- 220 KV Muradnagar Interconnector-I&II लाईन हेतु दोनों उपकेन्द्र पर PLCC Cabinet उपलब्ध नही है। 2. 220 KV Muradnagar Faridnagar, Pratap Vihar लाईन हेतु other end पर PLCC Cabinet उपलब्ध नही है। 3. 220 KV Muradnagar Loni लाईन हेतु PLCC Cabinet उपलब्ध नही है।	
		4. All 220kV lines have E.M. relays for B/U protection.		उक्त Electromechanical Relays को Numerical Relays से बदलने हेतु Requirment पत्रांक 339/वि0400के0वी0उ0ख0–। (मु0) दिनांक 26.07.2024 के द्वारा अधीक्षण अभियन्ता कार्यालय को आवश्यक कार्यवाही हेतु प्रेषित कर दी गई है।	
2	400kV Muradnagar-2nd	1. Carrier for all 220kV lines not operational for 220kV Baraut & Morta line. 2. Dead time of Baraut & Morta line not as per SOP. 3. Only single Over Flux setting available for 400 kV ICT.	2.Dead time has been corrected to 1 sec for both 220kv Baraut and Morta Line as per SOP. 3.Overflux setting has been revised to pickup=110%,Dial=3.0,Curve= Inverse.	1. Requirement for 03 DTPC bas been raised aginst the PR No. 1030000556 on dt. 03.05.2023	
		1. Battery set voltage not found in order. 2. All T/F's high set time not as per SOP.	2.T/F high set setting have been changed as per SOP.	1. After properly charging the concerned battery set, the Battery Voltage is found to be in order.	

3	**220kV Muradnagar**	3. Bus Bar relay out of service due to 02 no. bays not configured.		3. 02 no. new bays Work of Relay Configuration approval has been submitted. (Report by Transmission)	
		4. 110V charger-1st float defective.		4. Approval for new Charger submitted. (Report by Transmission)	
4	**220kV Faridnagar**	1. Bus Bar relay faulty.		1. Relay reparing quotation has been sent to concerned firm, response awaited. (Report by Transmission)	
		2. All 220kV lines have E.M. relays for B/U protection.	2.All lines have numerical realy protection (wrongly included as E.M. relay for B/U protection).		
		3. 160 & 100 MVA T/F's high set time not as per SOP.	3.T/F high set setting have been changed as per SOP.		
5	**220kV Loni**	1. No PLCC/Carrier on 220kV Loni-Muradnagar line.		1. Data of 220kV loni is going through 400kV Ataur. FOTE Requirement given from MRD-I, as soon as FOTE installed at MRD I DTPC will be installed at 220kV Loni.	
		2. Zone-4 settings of 220kV Loni-Muradanagar line and 220kV Loni-Ataur line not found as per SOP.	2. Zone -4 change of both lines as per SOP (Zone -4-1.797 ohm, 450 ms).		
		3. Circuit breaker testing report not available except 220kV Muaradnagar line.		3. Remaining Circuit breaker CRM & Timing testing will be carried out in the upcoming winter season.	
6	**220kV Sahibabad**	1. Zone-4 settings of 220kV Sahibabad-Pratap Vihar line, 220kV Sahibabad-Indirapuram lien not found as per SOP.	1. Zone -4 change of both lines as per SOP (Zone -4-0.475 ohm, 450 ms)		
		2. 220kV Sahibabad-Pratap Vihar line carrier/PLCC not healthy.	2. 220kV Sahibabad-Pratap Vihar line carrier/PLCC not healthy because PLCC not Available at Pratap Vihar end.		
		3. No carrier/PLCC on 220kV Sahibabad-Indirapuram line.		3. Reqirement has been raised.	
		4. D.C. earth of Battery Set-2.		4. DC earth fault problem has been rectified.	
		5. **220kV Sahibabad-Ghazipur line** – Line under break-down sue to Tower bending. Protection relay not working {informed to SDO (M)} ar per information provided by AE (T&C) Sahibabad.		5. Note sheet has been sent to HQ for approval. Line distance relay has been arranged & will be commissioned in due time.	
		6. Circuit breaker testing report not available.		6. Circuit breaker CRM & Timing testing will be carried out in the upcoming winter season.	
7	**220kV Morti**	1. Circuit breaker testing report not available.		1. Circuit breaker CRM & Timing testing will be carried out in the upcoming winter season.	
		2. 160 MVA -1 & 2 T/F high set setting not as per SOP.	2.High set setting not change due to safty reason.		
		3. Battery set voltage not found in order.		3. Problem has been identified and rectified.	
8	**220kV Mandola Vihar**	1. There is One Battery Set of 110V (D.C.).		1. There is only 01 No. 110V, 300AH battery charger available at 220kV substation Mandola Vihar. One battery set was in idle state from substation energization. Battery set at 132kV subtsation Teela Mode gone dead in sept. 2023 so 01 No. battery set was moved to Teela Mode. As soon as 01 No. 110V, 200AH battery set will have received at Teela Mode this battery set will be shifted back to 220kV substation Mandola Vihar mentioning that 01 No. 110V, 300AH battery charger is also required at 220kV substation Mandola Vihar for which requirement have sent earlier.	
		2. Zone-4 settings of 220kV Mandola Vihar-Ataur line and 220kV Mandola Vihar-Baghpat (P.G.) line not found as per SOP.	2.Zone -4 change of both lines as per SOP (Zone -4-1.396 ohm, 450 ms)		
		3. Circuit breaker testing report not available.		3. Circuit breaker CRM & Timing testing will be carried out in the upcoming winter season.	
9	**220kV Pratap Vihar**	1. Circuit breaker testing report not available.		1.Circuit breaker CRM & Timing will be carried out in the upcoming winter season.	
		2. Dead time of all lines not as per SOP.	2. Dead time change of all lines as per SOP.		
		3. Carrier for all 220kV lines not operational.	3. PLCC/DTPC not Installed		
		4. Battery set voltage not found in order.	4. Battery set voltage found in order.		
10	**220kV Madhuban, Bapudham**	1. Circuit breaker testing report not available.		1. Circuit breaker CRM & Timing will be carried out in the upcoming winter season.	
		2. Dead time of all lines not as per SOP.	2. Dead time change of all lines as per SOP.		

(Umesh Jain)
Exicutive Engineer

220 के0वी0 विभव एवं उच्चतर विभव के उपकेन्द्रो के प्रोटेक्शन ऑडिट में इंगित कमियों पर कार्यवाही के सम्बन्ध में।

विद्युत परीक्षण एवं परिचालन खण्ड–द्वितीय, मुरादाबाद दिनांक 09.08.2024

S. No.	Sub-Station Name	Found Discrepancies	Action Taken By TnC	Action Taken By Transmission	Remark
1	220KV S/S Amroha	1-GPS clock not available.	Not Required	SAS Panel esa Sands Maks GPS Clock Install करा दी गयी है।	विद्युत पारेषण खण्ड–अमरोहा ने अपने पत्रांक 1818, दिनांक 05.08. 2024 द्वारा अवगत कराया है
		2-Relays are not synchronized.	Not Required	220के0वी0 उपकेन्द्र अमरोहा से निर्गत 220के0वी0 नहटौर लाईन, 160 एमवीए परिवर्तक –द्वितीय, 132के0वी0 कांठ रोड,132के0वी0 अगवानपुर, 132के0वी0 कोठी खिदमतपुर, 132के0वी0 बछरायूं, 132के0वी0 धनौरा प्रथम एवं द्वितीय, 63एमवीए परिवर्तक–द्वितीय पर स्थापित BCU, Main protection Relay, Backup relay Synchronize कर दिये गये है। शेष 220के0वी0 मुरादाबाद लाईन, मेरठ लाईन तथा चांदपुर लाईन पर M2 Relay, 160 एमवीए परिवर्तक–प्रथम पर Difference तथा LV Backup relay, 220kv Bus Bar Protection, 40 एमवीए परिवर्तक–प्रथम पर LV Backup relay, को Synchronize किये जाने हेतु कार्यवाही की जा रही है।	
		3-Healthy carrier protection in lines are not available	Not Required	220के0वी0 अमरोहा चांदपुर लाईन पर Carrier Protection Healthy है। 220के0वी0 अमरोहा–मुरादाबाद लाईन पर उपकरणों की उपलब्धता 220के0वी0 अमरोहा पर सुनिश्चित कर ली गयी है। शटडाउन की उपलब्धता के अनुसार Microwave तथा T&C के सहयोग से संयोजन कर दिया जायेगा। 220के0वी0 अमरोहा–नहटौर लाईन पर Carrier Protection Healthy करने हेतु कार्यवाही की जा रही है।	

(Rajeev Kumar)
Exicutive Engineer

Executive Engineer
Elecly. Test & Comm Division-I
400KV S/S Complex
Majhola Moradabad

कार्यालय
अधिशासी अभियन्ता
विद्युत परी0 एवं परि0 खण्ड,
400 के वी उपस्थान परिसर,
मझोला, मुरादाबाद
Mob. No. 9412749936

U.P. POWER TRANSMISSION CORPORATION LIMITED
UPPTCL

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EXECUTIVE ENGINEER
ELECTRICITY TEST & COMM. DIVISION
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पत्रांक 436 / वि0प0प0ख0–प्र0 / मु0 दिनांक– 28/8/24

विषयः– 220 के0वी0 विषय एवं उच्चतर विभव के उपकेन्द्रों पर प्रोटेक्शन आडिट के सम्बन्ध में।

अधीक्षण अभियन्ता
विद्युत परीक्षण एवं परिचालन मण्डल
उ0प्र0 पावर ट्रांस0 एवं कारपो0 लि0
पारेषण भवन विक्टोरिया पार्क,
मेरठ।

उपरोक्त विषयक विद्युत परीक्षण एवं परिचालन, खण्ड, मुजफ्फरनगर कार्यालय के पत्रांक–753, दिनांक 12.04.2024 के सन्दर्भ में आपको अवगत कराना है कि उक्त 220 के0वी0 विभव एवं उच्चतर के उपकेन्द्रों प्रोटेक्शन आडिट को दिनांक 31.03.2024 तक सम्पादित किये गये जिसमें उक्त में उपकेन्द्रों के सम्मुख पायी गयी कमियों को इस कार्यालय पत्रांक– 383 दिनांक 31.07.2024 से विद्युत पारेषण खण्ड–द्वितीय मुरादाबाद, विद्युत पारेषण खण्ड रामपुर, विद्युत पारेषण खण्ड सम्भल एवं विद्युत पारेषण खण्ड 400 के0वी0 मुरादाबाद को प्रेषित किया गया था इसके प्रति उत्तर में सभी विद्युत पारेषण खण्डों द्वारा कृत कार्यवाही से अवगत कराया गया है।

अतः उनके द्वारा प्रेषित कृत कार्यवाही को निर्धारित प्रारूप में भरकर अग्रिम एवं उचित कार्यवाही हेतु प्रेषित है।

संलग्नकः– यथोपरि।

(राजीव कुमार)
अधिशासी अभियन्ता

220 के0वी0 विभव एवं उच्चतर विभव के उपकेन्द्रो के प्रोटेक्शन ऑडिट में इंगित कमियों पर कार्यवाही के सम्बन्ध में।

विद्युत परीक्षण एवं परिचालन खण्ड–प्रथम, मुरादाबाद दिनांक 28.08.2024

S. No.	Sub-Station Name	Found Discrepancies	Action By TnC	Action By Transmission	Remark
1	220 KV S/S Moradabad-II	1-Synchronization of relay are partially done.	Not Required	220 के0वी0 विद्युत उपकेन्द्र मुरादाबाद पर 06 नग 33 के0वी0 पोष्को पर इलेक्ट्रों मेग्नेटिक रिले लगे हुए है, उक्त रिले को नुमेरिकल रिले से बदलने हेतु टेण्डर प्रक्रियाधीन है। नुमेरिकल रिले बदलनें के उपरान्त Sychronization कर दिया जायेगा।	विद्युत पारेषण खण्ड– द्वितीय, मुरादाबाद के कार्यालय पत्रांक–751 दिनांक 21.08.2024 के द्वारा अवगत कराया है।
		2-Main to relay of CB 83 is Faulty from 19,12,22.	Not Required	220 के0वी0 विद्युत उपकेन्द्र मुरादाबाद से निर्गत 220 के0वी0 मुरादाबाद–सी0बी0 गन्ज लाईन के M2 रिले क्षतिग्रस्त है उक्त पारेषण लाईन के लाईन डिस्टेंस प्रोटेक्शन पैनल मुख्यालय स्तर से क्रय करने हेतु मांग पत्र प्रेषित किया गया है।(टेक्नीकल कमेटी रिपोर्ट संलग्न है)	
2	400 KV S/S Moradabad	1-Synchronization of relay are partially done.	Not Required	सभी Main Relay Sychronization है।	विद्युत पारेषण खण्ड 400 के0वी0 मुरादाबाद के कार्यालय पत्रांक–606 दिनांक 27.08.2024 के द्वारा अवगत कराया है।
		2-Event Logger is Ungealthy.	Not Required	Event Logger बदल दिया गाया है वर्तमान में कार्यशील है।	
		3-Line Disturbance recorder not available.	Not Required	उपकेन्द्र पर स्थापित Numerical Relay में Disturbance Recorder व्यवस्था है।	
		4-Setting of relay of line are as per PGCIL norms.	Not Required	रिले की Setting PGCIL Norms अनुसार ही है।	
3	220 KV S/S Rampur	1-Auto reclosed in lines not working	Not Required	220 के0वी0 उपकेन्द्र रामपुर पर मौजूद 220 के0वी0 रामपुर (765)– रामपुर सर्किट–प्रथम एवं 220 के0वी0 रामपुर (765)– रामपुर सर्किट–द्वितीय का लाइन ऑटो रिक्लोज के टेस्टिंग हेतु उक्त लाइन का शटडाउन दिनांक 03.09.2024 एवं 04.09.2024 को प्रस्तावित है।	विद्युत पारेषण खण्ड– द्वितीय, मुरादाबाद के कार्यालय पत्रांक–1005 दिनांक 28.08.2024 के द्वारा अवगत कराया है।
4	220 KV S/S Sambhal	1-Relays are not synchronized.	Not Required	कार्यवाही करायी जा रही है।	विद्युत पारेषण खण्ड, सम्भल के अधिशासी अभियन्ता द्वारा अवगत कराया गया की कार्यवाही करायी जा रही है।
		2-M2 relay is defective in CB 82 Line	Not Required	कार्यवाही करायी जा रही है।	
		3-CB81, CB83, CB84 lines has main Backup scheme in place of M1-M2 Scheme.	Not Required	कार्यवाही करायी जा रही है।	

(Rajeev Kumar)
Exicutive Engineer

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GSTIN - 09AAACU8823E1Z9

पत्रांक 751 वि0पा0ख0–द्वितीय(मु0) दिनांक:– 21/08/2024

विषय :– 220 के0वी0 उपकेन्द्र मझोला, मुरादाबाद पर हुए प्रोटेक्शन ऑडिट के सम्बन्ध में।

अधिशासी अभियन्ता,
विद्युत परीक्षण एवं परिचालन खण्ड–प्रथम,
मुरादाबाद।

उपरोक्त विषयक आपके कार्यालय पत्रांक–383/वि0प0प0ख0–प्र0/मु0 दिनांक–31.07.2024 का संदर्भ ग्रहण करने का कष्ट करें जिसके माध्यम से आपके द्वारा 220 के0वी0 विद्युत उपकेन्द्र मुरादाबाद पर हुए प्रोटेक्शन ऑडिट में पाये गये कमियों के निराकरण के सम्बन्ध में कहा गया है। उक्त के सम्बन्ध में सूचना निम्नवत है–

1. Sychronization relays are partially done - 220 के0वी0 विद्युत उपकेन्द्र मुरादाबाद पर 06 नग 33 के0वी0 पोषकों पर इलेक्ट्रो मेग्नेटिक रिले लगे हुए है, उक्त रिले को नुमेरिकल रिले से बदलने हेतु टेण्डर प्रक्रियाधीन है। नुमेरिकल रिले बदलने के उपरान्त Sychronization कर दिया जायेगा।
2. Main 02 Relay of C.B.-83 is faulty from 19.12.2022. - 220 के0वी0 विद्युत उपकेन्द्र मुरादाबाद से निर्गत 220 के0वी0 मुरादाबाद–सी0बी0 गन्ज लाईन के M2 रिले क्षतिग्रस्त है। उक्त पारेषण लाईन के लाईन डिस्टेंस प्रोटेक्शन पैनल मुख्यालय स्तर से क्रय करने हेतु मांग पत्र प्रेषित किया गया है (टेक्नीकल कमेटी रिपोर्ट संलग्न है)।

संलग्नक–यथोपरि।

(अनीश मलिक)
अधिशासी अभियन्ता

पत्रांक .... वि0पा0ख0–द्वितीय(मु0) दिनांक:–

प्रतिलिपि निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित है–
1. अधीक्षण अभियन्ता, विद्युत पारेषण मंडल–प्रथम, मुरादाबाद।
2. उपखण्ड अधिकारी, विद्युत पारेषण उपखण्ड–प्रथम/द्वितीय, मुरादाबाद।
3. सहायक अभियन्ता, विद्युत परीक्षण एवं परिचालन उपखण्ड–द्वितीय, मुरादाबाद।

(अनीश मलिक)
अधिशासी अभियन्ता

Electricity Transmission Division, Rampur

Indent for Shutdown **220 KV Rampur-Rampur(765KV) CKT-I at 220 KV S/S Rampur**

NOTIFICATION NO ON SAP/ERP-		Particular of Work
Sl. No.	Particulars	
1	Name & Designation of Indenting Officer	Er. SHUBHAM KHARAYAT, Executive Engineer, Electricity Transmission Division, Rampur
2	Equipment/Line for which shutdown are required	220 KV Rampur-Rampur(765KV) CKT-I at 220 KV S/S Rampur
3	Will the shutdown cause any dislocation of supply to consumers. If yes, please mention the affected areas/ Location and anticipated load	There is no Supply Interruption as Load of 220 KV S/S Rampur will be fed from 220 KV Rampur(765KV) CKT-II
4	If there any possibility of reducting/ eliminating of supply	N/A
5	Period for which shutdown	From 06:00 hrs to 10:00 hrs on dated 03.09.2024
6	Purpose of shutdown	For Testing of auto Reclosing Relay By T&C wing and other maintenance work.
7	Date on which shutdown of this line/equipment was last availed	12.03.2024
8	Have you taken the approval of competent authority	Yes, Consent has been obtained from CE (T.W) Meerut.
9	Have you arrange spares, T&P and other things for availing shutdown reply Yes/No	Yes
10(a)	Whenever dislocation of supply is involed the concent of concerned C.E.(D)/S.E.(D) should be taken in advance, state Yes/No. whether consent taken	N/A
10(b)	In case the system will run in limiting condition, the information to concerning C.E./S.E.(D) is essential. Have you informed to them. If Yes, designation of the officer to whom information given to be specified	N/A
11	Any other information on which you consider relevant to this shutdown	Shutdown is essential for Testing of auto Reclosing Relay By T&C wing and other maintenance work.

(AKASH RAJ)
SDO, (T&C)
ET&CSD, Rampur
Mob. No- 9412749922

(SANJOY KUMAR)
SDO
ETSD-II & III, Rampur
Mob. No- 9412756776

22.8.24

(SANTOSH KUMAR)
Superintending Engineer
E.T.C.-I, Moradabad
Mob. No.9412749917

(SHUBHAM KHARAYAT)
Executive Engine
E.T.D., Rampur
Mob. No. 9412749951

कार्यालय
अधिशासी अभियन्ता
विद्युत 400 के0वी0 उप संस्थान खण्ड,
उ0प्र0 पावर ट्रान्समिशन कारपोरेशन लि0
मझोला, मुरादाबाद।
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GSTIN-09AAACU8823E1Z9

U.P. POWER TRANSMISSION CORPORATION LIMITED
UPPTCL

OFFICE OF THE
EXECUTIVE ENGINEER
ELECTY 400 K.V. SUB STATION DIVISION
U.P. POWER TRANSMISSION
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पत्रांक– 606 वि0 400 के0वी0 / उ0 / स0 / ख0 / (मु0) दिनाँक– 27/08/2024

विषय:– 220 के0वी0 विषय एंव उच्चतर विभव के उपकेन्द्रों प्रोटेक्सन आडिट के सम्बन्ध में।

अधिशासी अभियन्ता
विद्युत परिक्षण एवं परिचालन खण्ड
मझोला, मुरादाबाद।

उपरोक्त विषयक आपके कार्यालय पत्रांक सं0 383 दिनांक 31.07.2024 के सन्दर्भ में विद्युत 400 के0वी0 उपकेन्द्र पर दिनांक 31.03.2024 को सम्पादित किये गये Protaction Audit की आख्या निम्नवत् है–

क्र0सं0	Found Discrepancis	
1	Synchronization relays are partially done.	सभी Main Relay Synchronized है।
2	Even logger ins unhealthy.	Event Logger बदल दिया गया है वर्तमान में कार्यशील है।
3	Line disturbance recorder not available	उपकेन्द्र पर स्थापित Numerical Relay में disturbance recorder व्यवस्था है।
4	Setting of relay of line are as per PGCIL norms.	रिले की के Setting PGCIL norms अनुसार ही है।

संलग्नक:– यथोपरि।

(रजनीश कुमार)
e/c अधिशासी अभियन्ता

कार्यालय
अधिशासी अभियन्ता
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Email : eeetdmpr@upptcl.org
eeetdrmpr@gmail.com

पत्रांक:– 1005 – वि.पा.ख. / रा /

दिनॉक:– 28-08-2024

विषय :– 220 के.वी. विषय एवं उच्चतर विभव के उपकेन्द्रों प्रोटेक्शन आडिट के सम्बन्ध में।

अधिशासी अभियन्ता
विद्युत परीक्षण एवं परिचालन,
खण्ड–प्रथम, मुरादाबाद।
E-mail. ID- eetncmbd@upptcl.org

ई0मेल द्वारा

उपरोक्त विषयक आपके कार्यलय पत्रांक संख्या– 383 / दिनांक– 31.072024 एवं कार्यालय अधिशासी अभियन्ता, विद्युत परिक्षण एवं परिचालन खण्ड–मुजफ्फनगर के पत्रांक संख्या– 753 / दिनांक– 12.04.2024 में अंकित कम संख्या–7 के अनुपालन में आपको अवगत कराना है कि (220 के.वी. उपकेन्द्र, रामपुर पर मौजूद 220 के.वी. रामपुर(765)–रामपुर सर्किट–प्रथम एवं 220 के.वी. रामपुर(765)–रामपुर सर्किट–द्वितीय का लाइन ऑटो रिक्लोज के टेस्टिंग हेतु उक्त लाइन का शटडाउन दिनांक 03.09.2024 एवं 04.09.2024 को प्रस्थावित है।)

सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

संलग्नक:– शटडाउन इनडेन्ट।

अधिशासी अभियन्ता
विद्युत पारेषण खण्ड
रामपुर

पत्रांक:–.......................वि.पा.ख. / रा / दिनॉक:.......................

प्रतिलिपि निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित–

1. अधीक्षण अभियन्ता, विद्युत पारेषण मण्डल–प्रथम, उ0प्र0पा0ट्राँ0का0लि0, मुरादाबाद।

अधिशासी अभियन्ता
विद्युत पारेषण खण्ड
रामपुर

Protection Audit of Electricity Test & Commissioning Division, Meerut

S. No.	Sub-Station Name	Found Discrepancies	Complience by T&C Wing	Complience by O&M Wing
1	220 KV S/S Baghpat	H/S settings in 160MVA T/F-I and 100MVA not found as per SOP.	Action not required	-------------------------
		160MVA T/F –I LV O/C & E/F Relay found Electromechenical.	Action need to be taken by O&M, SDO(M) has been informed already.	PR Created & send requirement
		Shamli & Baraut line Zone setting & A/R dead time not found as per SOP.	Setting updated as per SOP.	-------------------------
		C.B testing record not provided by Transmission Wing.	Action need to be taken by O&M.	Shall be attended soon
		Relays not Synchronized.	Action need to be taken by O&M.	Shall be attended soon
		In Baghpat PG-I line M2 Relay not available.	Action need to be taken by O&M, SDO(M) has been informed already.	requirement send
2	220 KV S/S Nirpura	H/S settings in 160MVA T/F-I&II not found as per SOP.	Action Not required	-------------------------
		Relays not Synchronized.	GPS clock faulty. O&M wing are already aware of the fact and are in the process of correcting the GPS clock.	GPS Clock repairing in process
		Shamli & Baraut line Zone setting & A/R dead time not found as per SOP.	Setting updated as per SOP.	-------------------------
		C.B testing record not provided by Transmission Wing.	Action need to be taken by O&M.	Shall be attended soon
3	220 KV S/S Baraut	H/S settings in 200MVA ,160MVA T/F-I&II not found as per SOP.	Action Not required	-------------------------
		Murad Nagar, Baghpat PG-I&II and Nirpura line Zone setting & A/R dead time not found as per SOP	Setting have been updated as per sop	setting setright by T&C Wing
		110 V Battery set 1 found Negative Earth &110 V Battery set-II found positive Ground.	Action need to be taken by O&M, SDO(M) has been informed already.	Shall be attended soon
		C.B testing record not provided by Transmission Wing.	Action need to be taken by O&M	Shall be attended soon
		200MVA T/F HVCT (R,Y,B Phase) found accuracy class 0.5.	Action need to be taken by O&M, SDO(M) has been informed already.	Shall be attended soon
		160MVA T/F –I HVCT (R,Y,B Phase) found accuracy class 0.5.	Action need to be taken by O&M, SDO(M) has been informed already.	Shall be attended soon
		Murad Nagar line B Phase CT found accuracy class0.5 & Relay not Synchronized .	Action need to be taken by O&M, SDO(M) has been informed already.	Shall be attended soon
		In Baghpat PG-I line M2 Relay found defective.	Action need to be taken by O&M, SDO(M) has been informed already.	Shall be attended soon
		Nirpura line Relay not Synchronized Main - 2 Relay not available.	Action need to be taken by O&M, SDO(M) has been informed already.	requirement send
		Nirpura line Y&B Phase PT found accuracy class 0.5.	Action need to be taken by O&M, SDO(M) has been informed already.	in process
4	220 KV S/S Charla	H/S & IDMT setting in 160MVA T/F–I,II&III not found as per SOP.	H/S & IDMT setting in 160MVA T/F–I,II&III has been changed as per SOP.	-------------------------
		Muzaffarnagar line and Mator line Zone setting & dead time A/R not found as per SOP	Muzaffarnagar line and Mator line Zone setting & dead time A/R has been changed as per SOP	-------------------------
5	220 KV S/S Gheja	H/S & IDMT setting in 160MVA T/F –I&II not found as per SOP.	H/S & IDMT setting in 160MVA T/F –I&II has been changed as per SOP.	-------------------------
		Faridnagar, Modipuram& Baghpat PG-I &II line Zone setting not found as per SOP.	Faridnagar, Modipuram& Baghpat PG-I &II line Zone setting has been changed as per SOP.	-------------------------
		C.B testing record not provided by Transmission Wing.	Action need to be taken by O&M, SDO(M) has been informed already.	report available
6	220 KV S/S Modipuram	H/S setting in 200MVA T/F –I&II not found as per SOP.	H/S setting in 200MVA T/F –I&II has been changed as per SOP.	-------------------------
		Khatauli line, Modipuram-II (Gheja), Shatabdinagar & Mator-I&II line Zone setting & A/R dead time not found as per SOP.	Khatauli line, Modipuram-II (Gheja), Shatabdinagar & Mator-I&II line Zone setting & A/R dead time has been changed as per SOP.	-------------------------
		110 V Battery set-I&II found positive Ground.	Action need to be taken by O&M, SDO(M) has been informed already.	Shall be attended soon
		C.B testing record not provided by Transmission Wing.	Action need to be taken by O&M, SDO(M) has been informed already.	shall be tested soon
7	220 KV S/S Partapur (Jagriti Vihar)	H/S settings in 160MVA T/F-I,II&III not found as per SOP.	Action not required	-------------------------
		Hapur line-I&II and Matur line Zone setting & A/R dead time not found as per SOP.	Setting updated as per SOP.	-------------------------
		110V Battery Set –I&II Voltage not found in order.	Battery voltage corrected as informed by O&M, SDO(M).	Set right
		C.B testing record not provided by Transmission Wing.	Action need to be taken by O&M, SDO(M) has been informed already.	shall be tested soon
8	220 KV S/S Shatabdinagar	H/s settings in 200MVA ,160MVA T/F-I&II not found as per SOP.	Action not required	-------------------------
		Relays not Synchronized with GPS.	Action need to be taken by O&M, SDO(M) has been informed already.	relays has already been synchronised
		Modipuram, Hapur & Matur line Zone setting & A/R dead time not found as per SOP.	Setting updated as per SOP.	-------------------------
		110 V Battery set 1&2 found positive Earth.	Action need to be taken by O&M, SDO(M) has been informed already.	Shall be attended soon
		C.B testing record not provided by Transmission Wing.	Action need to be taken by O&M, SDO(M) has been informed already.	shall be tested soon

Executive Engineer
Electy. Test & Commissioning Division

U.P. POWER TRANSMISSION CORPORATION LTD.
Electricity Test & Commissioning Division, Muzaffarnagar
Transmission West, Meerut
Audit Compliance And Action Report August-2024

S. No.	Sub-Station Name	Found Discrepancies	Action Taken By TnC	Action Taken By Transmission	Remark
1	220KV NANAUTA	DC earth, CB testing pending, AR Problem, GPS unhealthy	Relay AR testing has been done again and some settings are modified and relay is now on monitoring, 220KV Shamli line AR problem still there during testing about which REPAIR/REPLACEMENT work has been forwarded to transmssion wing	DC earth yet to be rectified, CB testing Yet to be done, GPS case yet to be done	
2	220KV DEOBAND	AR not working and impedence not found as per SOP	Relay impedence has corrected in relay, Auto reclose problem has been corrected and tested now relay is on monitoring	NA	
3	220KV BEHAT	CB testing pending, AR problem	Relay AR testing has been completed, For which Repair/Replacement work has been forwarded to transmission wing	CB testing yet to be done	
4	220KV SARSAWA	CB testing pending,AR problem, Bus bar unhealthy, Impedence not found as per SOP	Relay impedence has corrected in relay, Auto reclose false carrier flag has been rectified and is now on monitoring	CB testing yet to be done, Bus bar case has been sent to company manufacturer yet the work has to be done	
5	220KV SAHARANPUR	DC earth,CB testing pending, Bus bar problem,Impedence not found as per SOP, GPS unhealthy	Relay impedence has corrected in relay, Bus bar is in healthy condition, Isolator status wire to bus bar relay yet to be lay down by transmission wing	DC earth yet to be rectified, CB testing Yet to be done, GPS case yet to be done	
6	220kV Nara	1. Testing of circuit breaker is not completed 2. Impedance of relay is not found as per SOP	Impedance is correct	As per transmission wring testing of CB will be completed within 2 month	
7	220kV Jansath	1. Testing of circuit breaker is not completed 2. Impedance of relay is not found as per SOP	Impedance is correct		
8	220kV Badhaikalan	1. Testing of circuit breaker is not completed 2. Impedance of relay is not found as per SOP	Impedance is correct		
9	220kV Khatouli	1. Testing of circuit breaker is not completed 2. Impedance of relay is not found as per SOP	Impedance is correct		

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10	400KV S/S Muzaffarnagar	1. DC Earth problem	–	1.DC earth problem will be rectified as soon as possible.	
		2. Circuit Breaker Testing Pending	–	2.Circuit Breaker testing kit is defectiveat 400kv S/S Muzaffarnagar.As per Transmission wing, Circuit Breaker testing work will be completed by october 2024.	
		3. CT Installed with 0.5 Accuracy class	–	3. 0.2/0.2s class accuracy CT are not available, transmission wing Is trying to arrange the required CT as they have informed the design circle lucknow for the same.	
11	220KV SHAMLI	1. GPS CLOCK UNHEALTHY		GPS CLOCK UNHEALTHY .SENT FOR REPAIR	
		2. DC EARTH PROBLEM		DC EARTHING PROBLEM WILL BE RECTIFY AS SOON AS POSSIBLE AS INFORMED BY TRANS WING	
		3. Circuit Breaker Testing Pending		Breaker testing work will be completed AS soon as possible as informed by trans wing	
12	400 KV GIS SHAMLI	1.Impedance of relay is not found as per SOP	IMPEDANCE IN RELAY UPDATED ACCORDING TO SOP	BREAKER TESTING HAS BEEN COMPLETED	
		2. Circuit Breaker Testing Pending			

(Vipin Kumar)
Executive Engineer

COMPLIANCE REPORT OF PROTECTION AUDIT

S. No.	Sub-Station Name	Found Discrepancies	Action Taken By T&C	Action Taken By Transmission	Remark
1	220 kV Sec 20 Noida	**All Battery set 2 gravity Is very low arround (1290). As per discussion with the SDO and JE of Substation, battery set 2 is on no load and request for replacement of battery set 2 has been sent.**		Requirement for Battery Set sent to Zonal Office	
2		**Main 2 relay of Sec 20-Pali Ckt II is defective**		Requirement of Relay Sent to Zonal Office	
3		**REF RELAY OF 160 MVA TF 2 IS DEFECTIVE**		Requirement of Relay Sent to Zonal Office	
4		**220KV SEC 20 - botanical garden line i.e. zone 2 setting Is more than 120%, which is not as per NRPC guidelines. As per discussion with the transmission team, previously multiple tripping happened with the improper settings. Due to this, zone 2 setting of the line is increased by more than 120%.**	220KV Sec 20 to Botanical line Zone-2 setting has been updated as per NRPC guidelines		
5		**220KV sec 20 to Ghazipur line zone 2 setting is more than 190 % which is not as per NRPC guidelines. As per discussion with transmission team, previously multiple tripping happened in this line due to some issues with the other lines. Due to this, zone 2 setting of the line is increased by more than 120%.**	220KV Sec 20 to Ghazipur line Zone-2 setting has been updated as per NRPC guidelines.		
6	220 KV BOTANICAL GARDEN	**No Bus Bar Protection ,only LBB is there.**		Allotment of Bus-Bar Panel awaited from Design Circle	
7		**MAIN 2 REALY OF 220 KV BTPS CKT IS DEFECTIVE**		Requirement of Relay Sent to Zonal Office	
8		**Differential setting slope M2% and TMS of HV (overcurrent and earth fault) settings OF ALL 3 no. 60 MVA TF are not as per UPPTCL protection setting SOP.**	Differential slope and TMS of HV O/C & E/F settings of all 3 Nos 60 MVA TF has been updated as per UPPTCL protection setting SOP.		

9	**220 KV BOTANICAL GARDEN**	**220KV BTPS line, TMS of zone 2 setting of main relay is zero because the line is open from the other end & AR is off due to the line going through the dense population area.**	As 200KV BTPS line is normally open from other end therefore Zone-2 time is zero and AR is off because line going through dense area.		
10		**AR of 220KV sec 20 line is off due to the line going through the dense population area.**	AR of 220KV Sec 20 is off because line going through dense area.		
11	**220 KV SEC 129 NOIDA**	**Main 2 relay of 220KV sec 148 line is faulty.**		Requirement of Relay Sent to Zonal Office	
12		**There is minor variation in main 1 relay of zone 2 settings of 220KV sec 129 to sec 148 line compared with the calculations done on the basis of latest NRPC guidelines**	All zone settings variation of 200KV Sec 129 to Sec 148 and 200KV Sec 129 to Pali in M1 & M2 has been corrected.		
13		**There is variation in zone 4 setting of main 1&2 relay of 220KV sec 129 to GR Noida line as compared with the calculations done on the basis of latest NRPC guidelines.**	All zone settings variation of 200KV Sec 129 to Sec 148 and 200KV Sec 129 to Pali in M1 & M2 has been corrected.		
14		**DC earth fault in set 1(12V +ve.,110 V -ve)**		Under rectification	
15	**400 KV S/S Sec-148**	**Zone 4 settings of 220 KV Sec148 (400) - Sec129 (220) Line updated on site as per NRPC guidelines**	Settings updated as per guidelines		
16		**Zone 4 settings of 400 KV Jehangirpur (765) - Sec148 (400) Ckt 1 & 2 updated on site as per NRPC guidelines**	Settings updated as per guidelines		
17		**Zone 4 settings of 220 KV Sec148 (400) - KP5 (220) Line updated on site as per NRPC guidelines**	Settings updated as per guidelines		
18		**DC Voltage (146V+ve, 93V-ve), need to attend**		Attended	
19	**220KV S/S Jewar**	**Some Battery cell of set 1st Battery is showing very low Gravity. Need urgent replacement**		M/s Salasar has been asked to replace the faulty battery cells, under process will be replaced by 15th Sepetember,2024.	

20	220KV S/S Jewar	**DC earth fault in set 1st –(46.7+ve,74.4-ve)**		Rectified, Presently +ve to E-63.6 V -ve to E- 58.5 V	
21		**Differential setting slope (M1%&M2%) of all 2 Nos 60 MVA T/fs are not as per UPPTCL protection setting SOP.**	Settings has been updated as per SOP of UPPTCL.		
22	220KV S/S RC Green	**Carrier protection is not installed at 220 KV Lines(220 KV Gr.Noida I & 220 KV Gr Noida 2 and line 3)**		TWC for installation of Differential relay and OPGW has been sent. Differential protection has been installed & commissioned on Line 3	
23		**Bus Bar & LBB is out of service due to fiber communication error**		Fiber com error of 05 Nos bay has been resolved. -Splicing of Fiber required for remaining 04 Bays which will be completed by 15th Aug 2024	
24		**GPS clock is not synchronized due to the fiber com error**		Correspondence with M/s SANDS was done regarding GPS clock synchronization. -Relay re-configuration required for SNTP to synchronize relays. -Relay reconfiguration included in proposal of SCADA repair work of RC green.	
25		**Main 2 Relay is not available at 220 KV Line 1 & Line 2**		Requirement of panel sent	
26		**Differential setting slope (M1%&M2%) of all 2 Nos 160 MVA T/fs are not as per UPPTCL protection setting SOP.**	Settings has been updated as per SOP of UPPTCL		
27	220KV S/S Dadri	**PLCC of 220 KV Muradnagar line is defective.**		Healthy at 220 KV Substation Dadri end.	
28		**Main-2 Relay of 220 KV Dadri-Khurja Ckt is faulty**		ZIV make relay has been arranged which can be retrofitted in the panel, same will be completed by 30th August,2024	

29	**220KV S/S Dadri**	**GPS clock is not synchronized**		Correspondence done with M/s SANDS, survey to be done for relay synchronization	
30		**Bus bar protection is not available.**	Bus bar protection has been commissioned.		
31		**Breaker failure relay status is under commissioned**	Commissioned.		
32	**220KV S/S Sec 62 Noida**	**NIFS System Indicates some low pressure indication**		NIFPS sytem inspection has been done by CTR representative and Requirement sent for approval to CE office	
33		**Carrier protection is not installed at 220KV Lines(220KV Indirapuram & 220KV Gr. Noida**		OPGW received at substation and will be changed by December 2024	
34		**There is DC Earth fault , Which is need to resolve(+ve 15V, -ve 99V)**		Under rectification +ve 65V , -ve 45 V	
35	**400 KV S/S Sec-123**	**LV O/C & E/F TMS settings of 200MVA TF 1st & 2nd are not as per NRPC guideline.**	Settings has been updated as per guidelines		
36		**DC earth fault in set 1(150V +ve.,89 V -ve), DC earth fault in set 1(151V +ve.,85V -ve)**		DC earth fault of both sets will be resolved within a week.	

EE(T&C)

ग्रिड-इंडिया
GRID-INDIA

ग्रिड कंट्रोलर ऑफ इंडिया लिमिटेड
(भारत सरकार का उद्यम)
GRID CONTROLLER OF INDIA LIMITED
(A Government of India Enterprise)
[formerly Power System Operation Corporation Limited (POSOCO)]
राष्ट्रीय भार प्रेषण केन्द्र / National Load Despatch Centre

आज़ादी का अमृत महोत्सव

कार्यालय : बी-9, प्रथम एवं द्वितीय तल, कुतुब इंस्टीट्यूशनल एरिया, कटवारिया सराय, नई दिल्ली - 110016
Office : 1st and 2nd Floor, B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi -110016
CIN : U40105DL2009GOI188682, Website : www.grid-india.in, E-mail : gridindiacc@grid-india.in, Tel.: 011- 42785855

संदर्भ: Grid-India/NLDC/2024/September/ **दिनाँक:** 20.09.2024

सेवा मे,

[1] Member Secretary, Northern Regional Power Committee,18-A, Qutab Institutional Area, Shaheed Jeet Singh Marg, Katwaria Sarai, New Delhi-110 016
[2] Member Secretary, Eastern Regional Power Committee, 14 Golf Club Road, Tollygunje, Kolkata-700033

महोदय/महोदया,

विषय/Subject: 220 केवी और उससे अधिक वोल्टेज वर्ग की अंतर-क्षेत्रीय लाइनों की ट्रिपिंग में सुरक्षा मानक के उल्लंघन की अधिसूचना

Notifying violation of protection standard in case of tripping of the Inter-Regional lines of voltage class 220 kV and above

220 केवी और उससे अधिक वोल्टेज वर्ग की अंतर क्षेत्रीय लाइनों की ट्रिपिंग के मामले में, केंद्रीय विद्युत प्राधिकरण, 2010 के ग्रिड मानक नियमन की धारा 3.ई के अनुसार फ़ाल्ट निम्नलिखित समय सीमा मे निर्बाधित किया जाना है:

This has reference to violation of protection standard in case of tripping of Inter Regional Lines of voltage class 220 kV and above. As per section 3.e of Grid Standards Regulation of CEA, 2010, fault is to be cleared within the following time:

क्र.स./ Sl. No.	मामूली प्रणाली वोल्टेज (केवी आरएमएस)/ Nominal System Voltage in kV rms	फ़ाल्ट निर्बाधन का अधिकतम समय (मिली सेकंड)/ Maximum time of fault clearing in msec
1	400	100
2	220	160

अगस्त 2024 माह के दौरान 220 केवी और उससे अधिक वोल्टेज वर्ग की अंतर-क्षेत्रीय लाइनों की ट्रिपिंग की सूची संलग्न है, जिनमें उल्लंघन पाए गए हैं। यह देखा गया है कि इन घटनाओं के दौरान निर्दिष्ट समय के भीतर फ़ाल्ट को निर्बाधित नहीं किया गया था। चूंकि, ये घटनाएं चिंता का विषय हैं, यह अनुरोध किया जाता है कि उल्लिखित लाइनों/सबस्टेशनों के संबंधित स्वामियों को उपयुक्त कार्रवाई करने की सलाह दी जाए।

The list of tripping of Inter Regional Lines of voltage class 220 kV and above, during the month of **August 2024** in which violations have been observed is enclosed. It has been observed that fault had not cleared within specified time during these incidents. Since, these events are matter of concern, it is requested that the corresponding owners of mentioned lines/substations may be advised to take suitable actions.

सधन्यवाद,

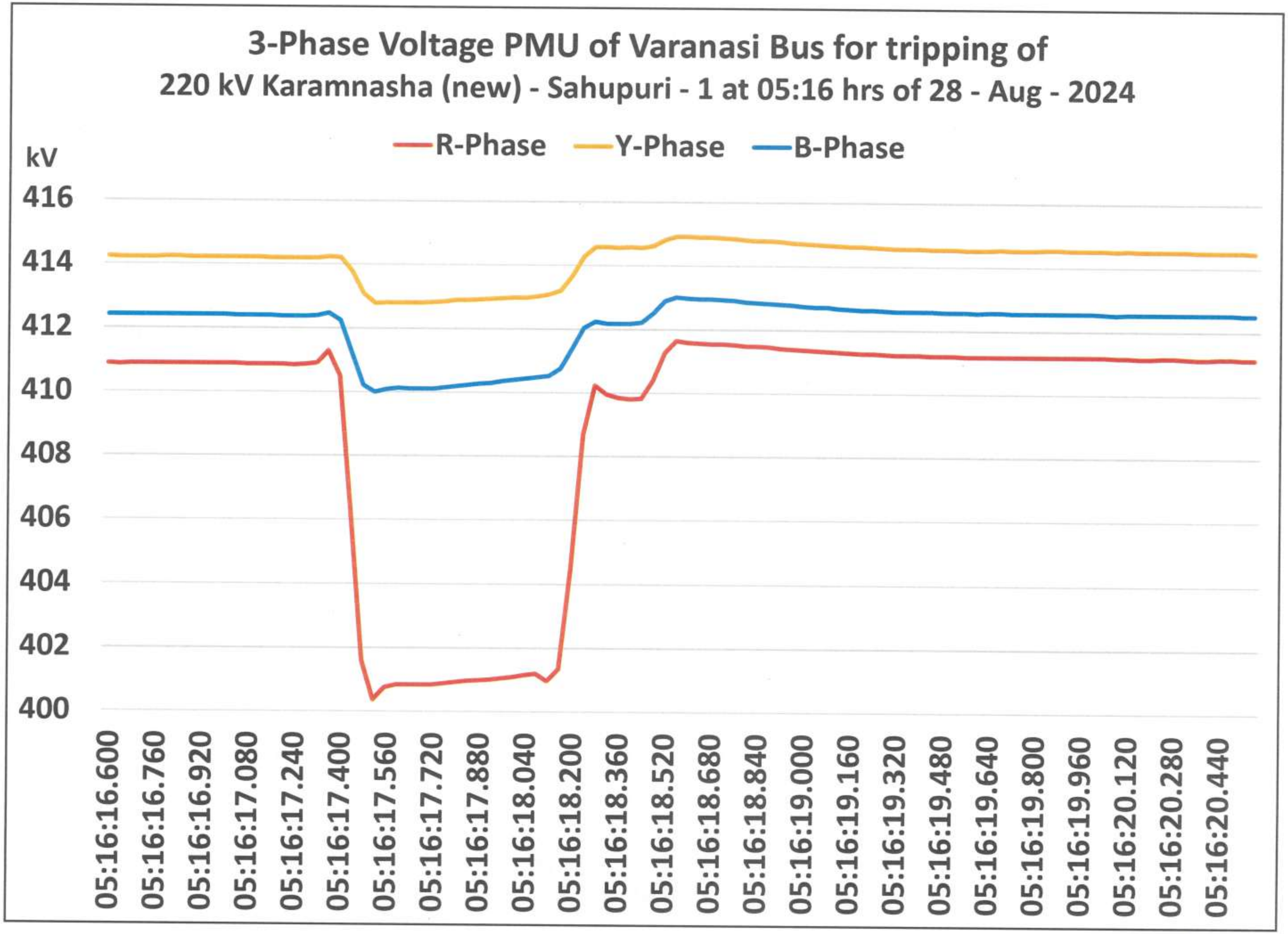
भवदीय,

(मानस रंजन चंद)
उप महाप्रबंधक, रा.भा.प्रे.कें.

प्रतिलिपि सूचनार्थ :

1. कार्यपालक निदेशक, ऊतरी क्षेत्रीय भार प्रेषण केंद्र / पूर्वी क्षेत्रीय भार प्रेषण केंद्र

Violation of Standards in case of tripping of Inter-Regional lines for August 2024						
S.No.	Name of Transmission Line	Regions Involved	Tripping Date and Time	Brief Reason/ Relay Indication	Restoration Date and Time	Fault Clearing Time (in msec as per nearest PMU)
1	220KV-Karamnasha (new)-Sahupuri - 1	ER/NR	28-Aug-2024 05:16	R-N Phase	28-Aug-2024 07:54	1000
Note: Fault clearing time calculated as per nearest PMU voltage						


3-Phase Voltage PMU of Varanasi Bus for tripping of
220 kV Karamnasha (new) - Sahupuri - 1 at 05:16 hrs of 28 - Aug - 2024
R-Phase
Y-Phase
B-Phase
kV
416
414
412
410
408
406
404
402
400
05:16:16.600
05:16:16.760
05:16:16.920
05:16:17.080
05:16:17.240
05:16:17.400
05:16:17.560
05:16:17.720
05:16:17.880
05:16:18.040
05:16:18.200
05:16:18.360
05:16:18.520
05:16:18.680
05:16:18.840
05:16:19.000
05:16:19.160
05:16:19.320
05:16:19.480
05:16:19.640
05:16:19.800
05:16:19.960
05:16:20.120
05:16:20.280
05:16:20.440

Annexure-XIII

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
उत्तर क्षेत्रीय विद्युत समिति
Northern Regional Power Committee

दिनांक: 08.10.2024

सेवामें/To,

As per List attached

विषय: **Minutes of the Meeting to discuss regarding Protection philosophy for Power Transformer and Reactor in Northern Region - reg**

Kindly find attached minutes of the meeting held on 27.09.2024 at 11:00 hrs at NRPC, New Delhi to discuss and finalize Protection philosophy for Power Transformer and Reactor in Northern Region. The finalized philosophy shall be discussed in 53rd PSC meeting scheduled on 22.10.2024.

Comments, if any, may be submitted within 3 days.

Signed by Dharmendra Kumar Meena
Date: 08-10-2024 13:57:58

(डी. के. मीना)
अधीक्षण अभियंता (संरक्षण)

Minutes of Meeting to discuss regarding Protection philosophy for Power Transformer and Reactor in Northern Region

Member Secretary, NRPC welcomed all participants.

AEE (P) apprised members that Protection philosophy for Power Transformer and Reactor of Northern Region was deliberated in 50th Protection sub-committee wherein utilities were requested to submit comments on draft protection philosophy of ICT and Reactor. Further, vide meeting notice letter dated 13.09.2024 utilities were again requested to submit comments on draft protection philosophy of ICT and Reactor. The comments have been received from IndiGrid, RVPNL, BBMB, NLDC, Adani Green, and HPPTCL.

The deliberation regarding individual settings of Power Transformer and Reactor of Northern Region is as below;

1. Individual Settings of Power Transformer:

1.1 Differential Protection;

1.1.1 Id min (sensitivity);

AEE (P) informed members that setting of Id min (sensitivity) was deliberated in 50th PSC meeting wherein members opined that setting may be kept as 0.2 pu. Further, IndiGrid and NLDC has also proposed setting as 0.2 pu or 20%. Members agreed for the same.

***Decision of the Committee**:* Setting may be kept as 0.2 pu.

1.1.2 First Slope;

It was discussed that few relays have provision of only 02 slopes. Further, end section calculation for slopes of relay also varies for different OEM. Hence, the setting proposed were as 0 – 10 % first slope and in case of differential relay with only two slopes, this slope is considered as zero. Members agreed for the same.

Decision of the Committee: 0 – 10 % first slope and in case of differential relay with only two slopes, this slope is considered as zero.

1.1.2 Second Slope;

The settings were proposed as 20 – 40 %. Members agreed for the same.

Decision of the Committee: Second Slope may be kept as 20 – 40 %.

1.1.3 Third Slope;

The settings were proposed as 60 – 80 %. Members agreed for the same.

Decision of the Committee: Third Slope may be kept as 60 – 80 %.

1.1.4 Unrestrained operation level;

Members deliberated that 10 pu is very high current for ICT and this protection is last resort which must be operated before damage to ICT. Further, exact value may not be defined as impedance for 400 kV and 765 kV transformers will be different. It was agreed that maximum Unrestrained operation level may be kept as 1/(% impedance at nominal tap). Members agreed for the same.

Decision of the committee: maximum Unrestrained operation level may be kept as 1/(% impedance at nominal tap).

1.1.5 Max. ratio of 2nd harm. To fundamental harm dif. curr. in %;

RVPNL submitted that they have observed tripping at 12 %. Hence it was proposed that setting may be kept as 10 – 15 %. Members agreed for the same.

Decision of the committee: setting may be kept as 10 – 15 %.

1.1.6 Max. ratio of 5th harm. To fundamental harm dif. curr. in %;

Members agreed for 25 % setting for Max. ratio of 5th harm. to fundamental harm dif. curr. in %,.

Decision of the committee: setting may be kept as 25 %.

1.1.7 Second and fifth harmonics restrain feature;

Members agreed for enabling of Second and fifth harmonics restrain feature.

Decision of the committee: Second and fifth harmonics restrain feature may be enabled.

1.1.8 Cross block feature;

Adani Green proposed that Cross block feature may be kept disabled for single tank ICT and enabled for banks of three phase. IndiGrid stated that during the fault fundamental component will be dominant event though inrush current behaviour will be different for three tank ICT. Adani Green stated that this setting will come in picture if fault comes only during charging and tripping may be delayed due to this setting. Members discussed that such instances of delayed tripping due to enabling of this setting is a rare occurrence and presently setting may be kept as enabled. Members agreed for the same.

NLDC stated Transient bias setting may be enabled to take care of sudden increase in mean bias current. Members deliberated that this setting may not be included in philosophy as this feature is available in few OEMs only, however utilities may decide as per their requirement and practical scenarios.

***Decision of the committee**:* Cross block feature may be enabled.

1.2 Restricted earth fault (REF) protection;

1.1.1 Pick up current (IREF);

IndiGrid proposed setting as 10 – 15% of full load current as CTs of 765/400 kV ICT have inherent inaccuracy hence they may not operate at 10 % setting of full load current. Members agreed for Pick up current (IREF) for REF as 10 – 15% of full load current.

***Decision of the committee**:* Pick up current (IREF) for REF as 10 – 15% of full load current may be kept.

1.1.2 Stabilizing resistor (RSTAB);

For stabilizing resistor (RSTAB), members discussed that multiplying factor of 1-1.5 may be given to accommodate CT errors. Members agreed for the same.

***Decision of the committee**:* multiplying factor of 1-1.5 may be given to accommodate CT errors.

1.3 Over Current Protection;

1.3.1 Scheme;

Decision of the committee: *To be implemented on both sides of ICT.*

1.3.2 Low Set Directional;

Utilities stated that proposed setting of 125-150% is very high and transformer will get damaged due to overload. However, it was highlighted that overload scenario and overcurrent protection are different and should not be considered as same. HPPTCL proposed pickup of 110 - 120 % of full load current with 1-3 sec delay (Trip). Finally, members agreed that pickup of 110 - 130 % of full load current may be kept with IDMT characteristics.

Decision of the committee*:* pickup of 110 - 130 % of full load current may be kept with IDMT characteristics.

1.3.3 High set non-Directional;

Utilities stated that proposed setting of 110-130% is very high and transformer will get damaged due to high through fault current. HPPTCL proposed two stage pickup of 90-100% and 110 - 130 % of through fault current. It was deliberated that setting may be lowered and time delay may be decreased as such high fault current should not be allowed through ICT. Members agreed that pickup of 100 - 110 % of through fault current may be kept with DT 0-50 msec.

Decision of the committee*:* Pickup of 100 - 110 % of through fault current may be kept with DT 0-50 msec.

1.4 Earth Fault Protection;

1.4.1 Low Set Directional ;

Utilities deliberated that Pickup: 20-80% of rated full load current Characteristics: IDMT, Co-ordination: to be coordinated with earth fault relay setting of outgoing feeders. Members agreed for proposed Low set Directional Earth Fault Protection.

Decision of the committee*:* pickup of 20 -80 % of rated full load current with IDMT characteristics.

1.4.2 High set non-Directional ;

Utilities deliberated that High Set Non-Directional may be kept as 100 - 110 % of through fault current with DT 0-50 msec.

Decision of the committee: pickup of 100 - 110 % of through fault current with DT 0-50 msec.

1.5 Overexcitation protection:

Adani Green Energy stated that Overexcitation setting curve should be as per capability curve provided by OEM. The setting should be well below capability curve and continuous operating limit. Members agreed for the same, however utilities should ensure that Overexcitation setting provided by OEM should not be over-sensitive. In case of non-availability of capability curve by OEM, proposed Overexcitation protection setting may be followed. Members agreed for the same.

Decision of the committee: Overexcitation setting curve should be as per capability curve provided by OEM., however utilities should ensure that Over excitation setting provided by OEM should not be over-sensitive. In case of non-availability of capability curve by OEM, proposed overexcitation protection setting may be followed.

2 Individual Settings of Reactor:

2.1 Differential Protection;

2.1.1 Id min (sensitivity);

Members agreed that Id min (sensitivity) and Slopes may be kept same as Transformer.

Decision of the committee: Setting may be kept as 0.2 pu.

2.1.2 First Slope;

Decision of the committee: 0 – 10 % first slope and in case of differential relay with only two slopes, this slope is considered as zero.

2.1.3 Second Slope;

Decision of the committee: Second Slope 20 – 40 %.

2.1.4 Third Slope;

Decision of the committee: Third Slope 60 – 80 %.

2.1.5 Unrestrained operation level;

Members deliberated that setting may be kept above in-rush current to avoid maloperation. RVPNL proposed of 2 pu setting, however this value will be well below in-rush current and current in case of CT saturations. Hence, members agreed that setting may be kept as 6-8 pu. Remaining differential protection settings were agreed as proposed.

Decision of the committee: setting may be kept as 6-8 pu.

2.1.6 Max. ratio of 2nd harm. To fundamental harm dif. curr. in %;

Decision of the committee: setting may be kept as 15 %.

2.1.7 Max. ratio of 5th harm. To fundamental harm dif. curr. in %;

Decision of the committee: setting may be kept as 25 %.

2.1.8 Second and fifth harmonics restrain feature;

Decision of the committee: Second and fifth harmonics restrain feature may be enabled.

2.1.9 Cross block feature;

Decision of the committee: Cross block feature may be enabled.

2.2 Impedance/Zone protection;

2.2.1 Setting;

Decision of the committee: 60% of reactor impedance.

2.2.2 Time setting;

IndiGrid Regarding impedance protection scheme, members agreed that Time setting may be revised to 1.2 sec to provide adequate margin with Auto-reclose dead time.

Decision of the committee: Time setting may be kept as 1.2 sec.

2.3 Phase overcurrent protection;

2.3.1 DT;

IndiGrid stated that over current setting is generally applicable only for Bus Reactor and there is no need of IDMT setting as IDMT is generally used when there is connecting feeder. He informed that it is a backup of differential protection. Further, rated current of reactor is already less and fault current is generally higher compared to rated current of reactor. Hence, DT may be kept as 6-10 times of rated current with 0.1s delay.

Decision of the committee: setting of 6-10 times rated current with a time delay of 0.1s. IDMT setting may be deleted.

NRLDC informed that back up impedance protection is also being implemented by POWERGRID for ICTs. NRLDC was requested to propose back up impedance protection setting which may be deliberated in upcoming PSC meetings. As this is additional setting which may be kept as optional for other utilities.

Decision taken:

The updated Protection philosophy (Enclosed as **Annexure**) for Power Transformer and Reactor will be taken up in upcoming PSC meeting for approval. Utilities were again requested to submit comments/inputs, if any on Protection philosophy of Power Transformer and Reactor.

Meeting ended with vote of thanks to the Chair

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List of Participants:

S. No.	Name (Sh/Smt)	Designation	Organization
1	V.K. Singh	Member Secretary	NRPC
2	D. K. Meena	Suprintending Engineer (O&P)	NRPC
3	Reeturaj Pandey	Executive Engineer (Protection)	NRPC
4	Kaushik Panditrao	Assistant Executive Engineer (Protection)	NRPC
5	Lokesh Agarwal	Assistant Executive Engineer (Protection)	NRPC
6	Manvendra Singh Hada	Senior Manager	INDIGRID
7	Vivek Karthikeyan	Assistant General Manager	INDIGRID
8	Nisha Kulshreshtha	S DOCC	BBMB
9	Hunny Kalia	Manager	JSWHEL
10	Amit Maan	Executive Engineer	HVPN
11	Vijayata	Assistant Executive Engineer	HVPNL
12	Vijay Pal	Suprintending Executive Engineer	RVPNL
13	D. K. Jain	Suprintending Engineer (Protection)	RVPN
14	A. K. Bissa	Suprintending Engineer	RVPN
15	Arif Rahman	Deputy General Manager (Protection)	CCGT, Bawana
16	Sudhir Kumar	Deputy General Manager (T) Protection	P.P.S-I, PPCL-IPGCL
17	Aman Gautam	Manager, NLDC	Grid-India
18	Mahavir Prasad Singh	Senior Deputy General Manager	Grid-India
19	Manas R. Chand	Deputy General Manager	Grid-India
20	Deepak Kumar	Deputy Manager	Grid-India
21	Raman Jain	Executive Engineer	RVUNL

22	Sujata Bhattacharya	Deputy Manager	NRLDC
23	Sanjay Bhatt	Assistant Vise President	Adani Green
24	Sunil Desai	Assistant General Manager	Adani Green (AGEL)
25	Sagar Bhavsar	Associate Manager	Adani Green
26	Nirbhay Kumar	Senior Manager	APCPL
27	Rajat Sharma	Senior Manager	HPPTCL
28	Vinay Painuly	Manager (E)	SJVN, RNPS
29	Ramneet Chanana	Deputy Manager	DTL
30	Paritosh Joshi	Senior Manager	DTL
31	Faraz	DD, CEA	CEA on deputation to GCIL

Annexure

सत्यमेव जयते

उत्तर क्षेत्रीय विद्युत समिति

NORTHERN REGIONAL POWER COMMITTEE

Protection Philosophy/Protocol of Northern Region

(Developed in compliance of IEGC 2023)

~~**Version: 2.0**~~

~~*(approved in 71st NRPC meeting held on 29.01.2024)*~~

~~**January 2024**~~

~~*Protection Philosophy/Protocol of Northern Region*~~

~~*(approved in 71st NRPC meeting held on 29.01.2024)*~~

Contents

1. Transmission line & Cable

S.N.	Protection Setting/ Protocol	Mandated Setting for transmission lines
1	**Protection Scheme**	**220kV and above:** Independent Main-I and Main-II protection (of different make OR different type/different algorithm) of non-switched numerical type is to be provided withcarrier aided scheme. **132kV and below:** One non-switched distance protection scheme and, directional over current and earth fault relays, should be provided as back up.
2	**Distance Protection Zone-1**	Reach: 80% of the protected line; 110% of the protected line (In case of radial lines)Time Setting: Instantaneous.
3	**Distance Protection Zone-2**	Reach: Single Circuit Line: 120% of length of principle line section. Double circuit line: 150% coverage of line totake care of under reaching due to mutual coupling effect. Time setting: i. 0.35 second *(considering LBB time of 200mSec, CB open time of 60ms, resetting time of 30ms and safety margin of 60ms)* ii. 0.5-0.6 second *(For a long line followed by a short line)*

4	**Distance Protection Zone-3**	Reach: Zone-3 should overreach the remote terminal of the longest adjacent line by an acceptable margin (typically 20% of highest impedance seen) for all fault conditions. Time Setting: 800-1000 msec If zone-3 reach transcends to other voltage level, time may be taken upto 1.5 sec.
5	**Distance Protection Zone- 4**	The Zone-4 reverse reach must adequately cover expected levels of apparent bus bar fault resistance.Time may be coordinated accordingly. Where Bus Bar protection is not available, time setting: 160 msec.
6	**Power Swing Blocking**	Block tripping in all zones, all lines. Out of Step tripping to be applied on all inter-regionaltie lines. Deblock time delay = 2s
7	**Protection for broken conductor**	Negative Sequence current to Positive Sequencecurrent ratio more than 0.2 (i.e. $I2/I1 \geq 0.2$) Alarm Time delay: 3-20 sec. Tripping may be considered for radial lines to protectsingle phasing of transformers.
8	**Switch on to fault (SOTF)**	Switch on to fault (SOTF) function to be provided in distance relay to take care of line energization onfault.
9	**VT fuse fail detection function**	VT fuse fail detection function shall be correctly setto block the distance function operation on VT fuse failure.
10	**Carrier Protection**	To be applied on all 220kV and above lines with the only exception of radial feeders.

<table>
<tr><td>11</td><td>Back up Protection</td><td>1. On 220kV and above lines with 2 Main Protections:
• Back up Earth Fault protections alone to beprovided.
• No Over current protection to be applied.
2. At 132kV and below lines with only one Main protection:
• Back up protection by IDMT O/C and E/F to be applied.</td></tr>
<tr><td>12</td><td>Auto Reclosing with dead time.</td><td>AR shall be enabled for 220 kV and above lines forsingle pole trip and re-closing.
Dead time = 1.0s. Reclaim time = 25.0s

Auto-recloser shall be blocked for following:
i. faults in cables
ii. Breaker Fail Relay
iii. Line Reactor Protections
iv. O/V Protection
v. Received Direct Transfer trip signals
vi. Busbar Protection
vii. Zone 2/3 of Distance Protection
viii. Circuit Breaker Problems.

CB Pole discrepancy relay time:1.5 sec;for tie breaker: 2.5 sec</td></tr>
</table>

13	Line Differential	For cables and composite lines, line differential protection with built in distance back up shall be applied as Main-I protection and distance relay as Main-II protection. For very short line (less than 10 km), line differential protection with distance protection as backup (built- in Main relay or standalone) shall be provided mandatorily as Main-I and Main-II. Differential protection may be done using dark fiber (preferably), or using bandwidth.

14	**Over Voltage Protection**	FOR 765kV LINES/CABLE: Low set stage (Stage-I): 106% - 109% (typically 108%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. 400kV LINES/CABLE: Low set stage (Stage-I): 110% - 112% (typically 110%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. FOR 220 KV LINES: No over-voltage protection shall be used. FOR 220 KV CABLE: Low set stage (Stage-I): 110% - 112% (typically 110%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. Drop-off to pick-up ratio of overvoltage relay: better than 97% Grading: Voltage as well as time grading may be done for multi circuit lines/cable.
15	**Resistive reach setting to prevent load point encroachment**	Following criteria may be considered for deciding load point encroachment: • Maximum load current (Imax) may be considered as 1.5 times the thermal rating of the line or 1.5 times the associated bay equipment current

		rating (the minimum of the bay equipment individual rating) whichever is lower. (Caution: The rating considered is approximately 15minutes rating of the transmission facility). • Minimum voltage (Vmin) to be considered as 0.85pu (85%).
16	**Direct Inter-trip**	To be sent on operation of following: i. Overvoltage Protection ii. LBB Protection iii. Busbar Protection iv. Reactor Protection v. Manual Trip (400 kV and above) vi. Cable Fault (in composite lines)
17	**Permissive Inter-trip**	To be sent on operation of Distance Protection

2. Series Compensated lines

1	**Lines with Series and other compensations inthe vicinity of Substation**	• Zone-1:FSC end: 60% of the protected line. Time: Instantaneous; Remoted end: 60% of the protected line with 100ms-time delay. POR Communication scheme logic is modified suchthat relay trips instantaneously in Zone-1 on carrierreceive. • Zone-2: 120 % of uncompensated line impedance for single circuit line. For Double circuit line, settings may be decided on basis of dynamic study in view of zero sequence mutual coupling. • Phase locked voltage memory is used to copewith the voltage inversion. Alternatively, an intentional time delay may be applied to overcome directionality problems related to voltage inversion. • over-voltage stage-I setting for series compensated double circuit lines may be kept higher at 113%.

3. Busbar protection

1	**Busbar protection**	To be applied on all 220kV and above sub stations with the only exception of 220kV radial fed bus bars.

4. Local Breaker Back-up

1	**Local Breaker Backup (LBB)**	For 220 kV and above level substations as well as generating stations switchyards, LBB shall be provided for each circuit breaker. LBB Current sensor I > 20% In LBB time delay = 200ms In case of variation in CT ratio, setting may be done accordingly.

5. Power Transformer

5.1 Differential Protection

1	Id min (sensitivity) i.e. multiple of trans. HV side rated current	Default: 0.2 pu Or If tap range is -X% to +Y%, then (X+Y)% may be kept as setting.
2	First Slope	0 - 10%. In case of differential relay with only two slopes, this slope is considered as zero.
3	Second Slope	20% to 40%
4	Third Slope	60% to 80%
5	Unrestrained operation level	Unrestrained differential current ≤ 1/(% impedance at nominal tap)
6	Max. ratio of 2nd harm. to fundamental harm dif. curr. in %	I2/I1Ratio = 10 - 15%
7	Max. ratio of 5th harm. to fundamental harm dif. curr. in %	I5/I1Ratio = 25%
8	Second and fifth harmonics restrain feature	Enabled
9	Cross block feature	Enabled

5.2 Restricted earth fault (REF) protection

1	Pick up current (IREF)	10 – 15 % of Full load current (IFL).
2	Stabilizing resistor (RSTAB)	stabilizing resistor (RSTAB) is obtained by dividing stabilizing voltage (VSTAB) by pick-up current. Stabilizing voltage VSTAB = IF x (RCT + 2RL) RSTAB = (VSTAB / IREF)*k Where: IF = Maximum through fault current, RCT = CT resistance, RL = CT circuit lead resistance, k = Multiplying factor (1-1.5)

5.3 Over Current Protection

1	Scheme	To be implemented on both sides of ICT
2	Low set Directional	Pick up: 110-130% of full load currentCharacteristics: IDMT Co-ordination: to be coordinated with distance relay zone 3 settings of outgoing feeders.
3	High Set Non-Directional	Pick Up: 100-110% of the through fault level of the transformer Characteristics: DT; 0 to 50 msec

5.4 Earth Fault Protection

1	Scheme	To be implemented on both sides of ICT
2	Low set Directional	Pickup: 20-80% of rated full load current Characteristics: IDMT Co-ordination: to be coordinated with earth fault relay setting of outgoing feeders.
3	High Set Non-Directional	Pick Up: 100-110% of the through fault level of the transformer Characteristics: DT; 0 to 50 msec

5.5 Overexcitation protection:

In case of non-availability capability curve by OEM, Shall be provided on both HV and LV sides as below:

U/F %	Time set (s)
110	9000
118	90
126	49.5
134	18
142	4
150	1

***Over excitation setting curve should be as per capability curve provided by OEM. The setting should be well below capability curve and continuous operating limit. However, it must be ensured that Over excitation setting provided by OEM are not be over-sensitive.

6. Shunt Reactor protection

6.1 Differential Protection

1	Id min (sensitivity)	Default: 0.2 pu
2	First Slope	0 - 10%. In case of differential relay with only two slopes, this slope is considered as zero.
3	Second Slope	20% to 40%
4	Third Slope	60% to 80%
5	Unrestrained operation level	6 - 8 pu
6	Max. ratio of 2nd harm. to fundamental harm dif. curr. in %	I2/I1Ratio = 15%
7	Max. ratio of 5th harm. to fundamental harm dif. curr. in %	I5/I1Ratio = 25%
8	Second and fifth harmonics restrain feature	Enabled
9	Cross block feature	Enabled

6.2 Impedance/ Zone protection

1	Setting	60% of reactor impedance
2	Time setting	1.2 sec

6.3 Phase overcurrent

1	DT	setting of 6-10 times rated current with a time delay of 0.1s

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Status of actions points recommended during previous PSC meetings (to be discussed in 53rd PSC meeting)

Annexure-XIV

S. No	Agenda	Remdial actions recommended during PSC meeting	Status of remdial action taken (to be updated by respective constituents)	
			52nd PSC	53rd PSC
1	Frequent multiple elements tripping at 220kV Kunihar, Baddi, Upperla Nangal complex and load loss event in HP control area	PSC Forum requested HP to complete the protection audit as per mentioned timelines (protection audit of 220kV Kunihar has been awarded and it would be completed within next 15-20 days. In next phase, by 15th September, protection audit of substations in downstream and upstream of 220kV Kunihar S/s would be completed.) and resolve the protection related issues. HP was also requested to share the reports of protection audit to NRPC & NRLDC after completion of audits.	1. Protection audit of 220kV Kunihar has been awarded to POWERGRID on 09th July 2024 and it would be completed by October 2024. 2. In next phase, protection audit of substations in downstream and upstream of 220kV Kunihar S/s would be completed, tender process of rest of the stations is in process.	
2	Multiple elements tripping at 220kV Hissar(BBMB) 07th May 2024, 11:16 hrs	a) Expedite the implementation of differential protection in short lines to avoid undesired operation of distance protection.	HVPNL representative informed that clearance related to OPGW received from POWERGRID. Matter was forwarded to design team and is pending at that stage.	
3	Multiple elements tripping at 400/220kV Akal (RS) on 08th Jun 2024, 19:53 hrs	a) Bus bar protection at 220kV bus at 400/220kV Akal shall be made operational at the earliest. b) Time synchronization of recording instruments (DR/EL) need to be ensured.	Rajasthan representative stated that three faulty PU were replaced from the future bay and one PU is still unhealthy which is in warranty period. Process is getting delayed due to lack of response from the OEM. Process will be expedited and will try to resolve the bus bar protection issue on priority.	
4	Multiple elements tripping at 400kV Sainj (HP), 400kV Parbati2 & Parbti3 (NHPC) Stations on 07th May 2024, 16:17 hrs	a) NHPC shall follow up with the relay engineer and taken necessary remedial actions to ensure proper operation of A/R scheme at Parbati2 end. b) NHPC and HPPTCL shall review the healthiness of PLCC at Parbati3 and Sainj end and take necessary actions to ensure their proper operation. c) Expedite the implementation of differential protection in 400kV Parbati2-Sainj line. d) Standardisation of recording instruments (DR/EL) need to be ensured.	1.Shutdown has been planned in 1st week of November 2024, testing of A/R scheme and implementation of differential protection will be done during that period. 2. PLCC card at Parabti3 end will be replaced by the end of September 2024. For dual test of PLCC operation, PLCC at Sianj end also need to be healthy.	
5	Multiple elements tripping at 400kV Khedar(RGTPS) Station at 10th May 2024, 19:35 hrs	a) Revised corrected protection settings of Main-2 Micome P4442 distance protection relay and A/R scheme at Khedar(RGTPS) end need to implemented at the earliest.	HVPNL representative informed that Khedar(RGTPS) have conducted 3rd party protection audit. Status of corrective action taken yet to be confirmed.	
6	Multiple elements tripping at 400kV Koteshwar(PG) on 17th May 2024, 17:21 hrs	a) In view of short line length of 400KV Koteshwar(PG)-Tehri D/C, POWERGRID shall plan for the differential protection in the line on priority in near future to avoid overreach of distance protection.	Update yet to be received	
7	Multiple elements tripping at 220kV Sarna (PS) on 04th May 2024, 07:10 hrs	a) Punjab shall expedite the commissioning of new bus scheme. B) POWERGRID shall revise the Z-4 time delay setting of Kishenpur lines at Sarna (PS) end as 160msec till bus bar get operational.	Punjab representative informed that tender of bus bar protection has been processed, bus bar protection at 220kV Sarna will be commissioned within 4-5 months tentatively.	
8	Multiple elements tripping at 400/132kV Masoli(UP) on 29th May 2024, 15:57 hrs	a) Up shall implement the bus bar protection at 132kv level at 400/132kV Masoli S/s.	UP representative informed that this case has been communicated to design team. In response, they have asked the list of all such stations in UP control area. Further follow up actions is expected in due time course.	
9	Multiple elements tripping at 220kV KTPS (RVUN) on 21st June 2024, 11:37 hrs	a) Commissioning of bus coupler between 220kV Bus-3 & 5 need to be expedited.	KTPS representaitve informed that tender for the same has been floated.	
10	Frequent tripping of 220 KV Anta(NT)-Sakatpura(RS) (RS) Ckt-1		Regarding non-operation of A/R, Rajasthan representative informed that relay penal is old, same is planned to be replaced with new within one month.	
11	Frequent tripping of 220 KV Saharanpur(PG)-Shamli(UP) (UP) Ckt-1		POWERGRID representaitve stated that they will review the status of A/R operation at Shahranpur(PG) and shall ensure its proper operation in future.	
12	Frequent tripping of 400 KV Dadri(NT)-Panipat(BB) (PG) Ckt-1		NTPC representative stated that they will look into the issue and share the updated on the same.	
13	Frequent tripping of 220 KV Khara(UP)-Saharanpur(PG) (UP) Ckt-1		UP representative informed that new relay is available at site. Relay will be replaced during lean season as per the shutdown opportunity.	
14	Multiple elements tripping event at Baghpat(PG) & Baghpat(UP)		POWERGRID representaitve stated that they will review the status of A/R operation at Shahranpur(PG) and shall ensure its proper operation in future.	
15	Multiple elements tripping event at Patiala(PG)		Continuous follow ups are being done for expeditious delivery of material. Thereafter, new bus bar protection will be implemented.	

16	Multiple elements tripping at 400/220kV Bhadla(RS)	Commissioning of Bus bar protection at 220kV bus at 400/220kV Bhadla(RS) need to be expedited.		
17	Multiple elements tripping at 400/220kV Lucknow(UP)	Replacement of bus bar relay with numerical bus bar relay need to be expedited.		
18	Multiple elements tripping at 400/220kV Muzaffarnagar(UP)	Necessary changes in logic of bay assignment may be done to ensure reliable operation of LBB and bus bar protection.		
19	Multiple elements tripping at 220kV Shahbad(HR) and 220kV Rajokheri(HR)	Review of protection system need to be done to avoid such undesired operation and proper operation of protection system need to be ensured.	Haryana representative agreed to share the revised details analysis of the event.	

~~Annex V~~

Annexure-XV

Status of Recording Instruments (220kV & above stations)						
Sr. No	Station Name	Voltage Level	Disturbance Recorder/Station Event logger healthy (Yes or No)	Standardisation (Yes or No)	Time Sync (Yes or No)	Remarks

Sr No	Element Name	Outage Date	Outage Time	Reason
1	220 KV Khara(UP)-Saharanpur(PG) (UP) Ckt-1	10-Sep-24	20:57	Phase to earth fault B-N
		16-Sep-24	18:10	Phase to earth fault Y-N
		28-Sep-24	08:17	Phase to earth fault B-N
		28-Sep-24	21:41	Phase to earth fault R-N
		29-Sep-24	09:53	Phase to earth fault Y-N
		29-Sep-24	17:12	Insulator flashover
2	220 KV Nara(UP)-Roorkee(UK) (UP) Ckt-1	03-Sep-24	20:17	Phase to earth fault R-N
		10-Sep-24	13:10	Bus bar protection operated at Nara(UP).
		12-Sep-24	21:32	Phase to earth fault R-N
		13-Sep-24	22:14	Phase to earth fault R-N
		14-Sep-24	10:28	Phase to earth fault R-N
		19-Sep-24	15:32	Phase to earth fault R-N
3	220 KV Saharanpur(PG)-Shamli(UP) (UP) Ckt-1	08-Sep-24	20:54	Phase to earth fault B-N
		11-Sep-24	04:55	Phase to earth fault B-N
		12-Sep-24	23:29	Phase to earth fault B-N
		26-Sep-24	19:45	Phase to earth fault Y-N
		28-Sep-24	08:05	Phase to earth fault Y-N
		29-Sep-24	02:24	Phase to earth fault Y-N
		29-Sep-24	16:34	Insulator flashover
		30-Sep-24	01:04	Phase to earth fault B-N
4	220 KV Sarna(PS)-Udhampur(PDD) (PDD) Ckt-1	18-Sep-24	00:15	Phase to earth fault R-N
		23-Sep-24	12:31	Phase to earth fault R-N
		24-Sep-24	10:45	Phase to earth fault Y-N
		27-Sep-24	08:54	Transient fault
		28-Sep-24	13:57	Phase to earth fault B-N
5	400 KV Agra-Unnao (UP) Ckt-1	11-Sep-24	03:19	Phase to earth fault B-N
		15-Sep-24	00:07	Phase to earth fault Y-N
		16-Sep-24	04:34	Phase to earth fault Y-N
		17-Sep-24	20:08	LBB operated
		23-Sep-24	19:52	Bus Bar Protection Operated
6	400 KV Anpara_B(UPUN)-Sarnath(UP) (UP) Ckt-2	06-Sep-24	16:41	Phase to earth fault R-N
		12-Sep-24	16:44	Phase to earth fault Y-N
		14-Sep-24	12:53	Phase to Phase Fault R-Y
7	400 KV Bareilly-Unnao (UP) Ckt-1	05-Sep-24	01:06	Earth fault
		17-Sep-24	20:33	Phase to earth fault Y-N
		23-Sep-24	19:52	Bus Bar Protection Operated
		28-Sep-24	12:05	Three phase fault
8	400 KV Jaunpur -Obra_C_TPS (UP) Ckt-1	11-Sep-24	10:03	Phase to earth fault R-N
		25-Sep-24	12:41	DT received at Jaunpur end.
		28-Sep-24	00:04	Phase to earth fault Y-N

Annexure-XVII

Grid Event to be discussed in 53rd PSC Meeting

S.No.	Category of Grid Incident/ Disturbance (GI-I to GD-V)	Name of Elements (Tripped/Manually opened)	Affected Area	Owner/ Agency	Outage		Event (As reported)	Loss of generation / loss of load during the Grid Disturbance		Fault Clearance time (in ms)	Points of discussion
					Date	Time		Generation Loss(MW)	Load Loss (MW)		
Utilities are requested to prepare detailed analysis report and present the event details during 53rd PSC meeting of following grid events (Events involving more than one utility may be jointly prepared and presented):											
1	GD-1	1)220 KV Khodri(UK)-Majri/Giri(HP) (UK) Ckt-1 2)220 KV Khodri(UK)-Majri/Giri(HP) (UK) Ckt-2 3)220 KV Khodri(UK)-Sarsawan(UP) (UP) Ckt 4)220 KV Khodri – Jhajra (UK) Ckt 5)30 MW Khodri Unit-1 6)30 MW Khodri Unit-2 7)30 MW Khodri Unit-3 8)30 MW Khodri Unit-4 9)60 MW Chhibro Unit-1 10)60 MW Chhibro Unit-2 11)60 MW Chhibro Unit-3 12)60 MW Chhibro Unit-4 13)11.25 MW Dhakrani Unit-2 14)11.25 MW Dhakrani Unit-3 15)30 MW Giri – Unit-1	Uttarakhand & Himachal Pradesh	HPPTCL, PTCUL	5-Sep-24	11:54	i)During antecedent condition, all the four 30MW units of Khodri HEP, all four 60 MW units of Chhibro HEP, 11.25MW Unit-2 & Unit-3 of Dhakrani HEP and both 30 MW units of Giri HEP were running and total active power generation of Khodri HEP, Chhibro HEP, Dhakrani HEP & Giri HEP were approx. 90 MW, 200 MW, 19 MW & 58 MW (as per SCADA). Total generation of Chhibro HEP was evacuating through 220 KV Khodri-Chhibro (UK) Ckt-1 & 2. 11.25 MW Unit-1 of Dhakrani HEP and 220 KV Saharanpur(UP)-Khodri(UK) (UP) Ckt were not in service during the event. ii)As reported, at 11:54 hrs, 220 KV Khodri(UK)-Sarsawan(UP) (UP) Ckt tripped on R-N phase to earth fault with fault distance of 44 km & 61 km and fault current of 2.5 kA & 2 kA from Khodri(UK) and Sarsawan(UP) end respectively. Line tripped on zone-1 distance protection from both ends. iii)At the same time, 220 KV Khodri(UK)-Majri/Giri(HP) (UK) D/C tripped on over voltage protection from both the ends and 30 MW Giri – Unit-1 & 220 KV Khodri – Jhajra (UK) Ckt also tripped (exact reason of tripping is yet to be received). iv)Due to tripping of 220kV lines from Khodri(UK) end, all the four 30MW units of Khodri(UK), all four 60 MW units of Chhibro(UK) and 11.25MW Unit-2 & Unit-3 of Dhakrani(UK) tripped due to loss of evacuation path. v)As per PMU at Saharanpur(PG), R-N phase to earth fault with fault clearing time of 80msec is observed. vi)Due to tripping all 220kV lines at Khodri(UK) and all generating Units at Khodri HEP(UK), Chhibro HEP(UK) and Dhakrani HEP(UK), blackout occurred at 220kV Khodri(UK), 220kV Chhibro(UK) & 132kV Dhakrani(UK). vii) As per SCADA, change in demand and generation of approx. 50 MW and 308 MW respectively in Uttarakhand control area. However, SLDC-Uttarakhand reported generation loss of approx. 307 MW and load loss of approx. 29 MW in Uttarakhand control area. viii)As per SCADA, change in demand and generation of approx. 140 MW and 28 MW in HP control area. However, SLDC-HP reported load loss of approx. 160 MW in HP control area.	335	189	80	Details analysis of the event
2	GD-1	1)220 KV Khodri(UK)-Majri/Giri(HP) (UK) Ckt-2 2)220 KV Khodri(UK)-Majri/Giri(HP) (UK) Ckt-1 3)220 KV Khodri(UK)-Sarsawan(UP) (UP) Ckt 4)220 KV Khodri – Jhajra (UK) Ckt 5)220 KV Khodri(UK)-Saharanpur(UP) (UP) Ckt 6)30 MW Khodri Unit-1 7)30 MW Khodri Unit-2 8)30 MW Khodri Unit-3 9)30 MW Khodri Unit-4 10)60 MW Chhibro Unit-1 11)60 MW Chhibro Unit-2 12)60 MW Chhibro Unit-3 13)60 MW Chhibro Unit-4 14)11.25 MW Dhakrani Unit-2 15)11.25 MW Dhakrani Unit-3 16)220kV Khodri-Chibro (UK) Ckt-1 17)220kV Khodri-Chibro (UK) Ckt-2	Uttarakhand, Himachal Pradesh & Uttar Pradesh	HPPTCL, PTCUL, UPPTCL	11-Sep-24	08:17	i)During antecedent condition, all the four 30MW units of Khodri HEP, all four 60 MW units of Chhibro HEP, 11.25MW Unit-2 & Unit-3 of Dhakrani HEP and both 30 MW units of Giri HEP were running and total active power generation of Khodri HEP, Chhibro HEP, Dhakrani HEP & Giri HEP were approx. 90 MW, 200 MW, 19 MW & 58 MW (as per SCADA). Total generation of Chhibro HEP was evacuating through 220 KV Khodri-Chhibro (UK) Ckt-1 & 2. 11.25 MW Unit-1 of Dhakrani HEP was not in service during the event. ii)As reported, at 08:17 hrs, B-phase LA of HV side of 220/132kV 100 MVA ICT burst which caused B-N phase to earth fault. On this fault, 220/132kV 100 MVA ICT didn't trip (exact reason yet to be received). iii)On this fault, all four 30MW units of Khodri HEP & all four 60 MW units of Chhibro HEP tripped on over current protection. 220 KV Khodri(UK)-Giri(HP) (UK) Ckt-2 tripped on directional earth fault protection from Giri(HP) end. iv)220kV lines from Khodri(UK) to Giri(HP) ckt-1, Sarsawan(UP), Jhajra(UK), Chibro(UK) ckt-1 & 2 and Saharanpur(UP) ckt tripped on zone-2 distance protection operation from remote end. It is reported that, at Khodri(UK) end, time setting in zone-4 distance protection is kept at 1000msec. Due to more time delay in zone-4 distance protection at Khodri(UK) end as compared to time delay of zone-2 distance protection of remote ends, all 220kV lines (except 220 KV Khodri(UK)-Giri(HP) (UK) Ckt-2) from Khodri(UK) S/s tripped from remote ends. v)At the same time, 11.25 MW Dhakrani Unit-2 & Unit-3 also tripped (exact reason of tripping is yet to be received). vi)As per PMU at Saharanpur(PG), B-N phase to earth fault with delayed fault clearing time of 440 msec is observed. vii) Due to tripping all 220kV lines at Khodri(UK) and all generating Units at Khodri HEP(UK), Chhibro HEP(UK) and Dhakrani HEP(UK), blackout occurred at 220kV Khodri(UK), 220kV Chhibro(UK) & 132kV Dhakrani(UK). viii)As per SCADA, change in demand and generation of approx. 50 MW and 310 MW respectively in Uttarakhand control area. However, SLDC-Uttarakhand reported generation loss of approx. 308 MW and load loss of approx. 38 MW in Uttarakhand control area. ix)As per SCADA, change in demand of approx. 195 MW in HP control area.	308	233	440	Details analysis of the event
3	GI-2	1)400/220 kV 500 MVA ICT 1 at Akal(RS) 2)400/220 kV 500 MVA ICT 2 at Akal(RS) 3)400/220 kV 315 MVA ICT 3 at Akal(RS) 4)400/220 kV 500 MVA ICT 4 at Akal(RS) 5)220 KV Akal-Giral Ckt 6)220 KV Akal-Amarsagar Ckt 7)220kV Akal-Bhensara Ckt-1 8)220kV Akal-Bhensara Ckt-2	Rajasthan	RRVPNL	13-Sep-24	02:49	i)400/220kV Akal(RS) has one and half breaker scheme at 400kV level and double main and transfer bus scheme at 220kV level. ii)During antecedent condition, 400/220 kV 500 MVA ICT-1 & ICT-2 were connected to 400kV bus-1 and 400/220 kV 315 MVA ICT-3 & 500 MVA ICT-4 were connected to 400kV bus-2. iii)As reported, at 02:49 hrs, Y-phase jumper of 220kV bus-1 of 220kV Akal-Bhensara Ckt-1 and R-phase jumper of 220kV bus-2 of 220kV Akal-Bhensara Ckt-2 snapped which created bus fault on both 220kV buses at Akal(RS). iv)On this fault, 400/220 kV 500 MVA ICT-1, ICT-2 tripped on earth fault protection and 400/220 kV 315 MVA ICT-3 & 500 MVA ICT-4 tripped on over current protection at Akal(RS) S/s. 220kV lines from Akal(RS) to Giral & Amarsagar tripped on zone-4 distance protection from Akal(RS) end. v)220kV Akal-Bhensara Ckt-1 tripped only from Bhensara end on zone-2 distance protection on R-Y phase to phase fault with fault distance of 53.2km and with fault current of Ir=~2.87kA & Iy=~2.88kA. vi) 220kV Akal-Bhensara Ckt-2 tripped only from Bhensara end on zone-1 distance protection on R-Y-B three phase fault with fault current of Ir=~1.6kA, Iy=~1.2kA & Ib=~5.9kA. vii) As per PMU at Bhadla(PG), R-B phase to phase fault converted into R-Y-B three phase fault with delayed fault clearance time of 1120 msec is observed. viii)Due to tripping of all four ICTs at Akal(RS), evacuation path lost for all the wind power plants connected at 220kV bus-1 & bus-2 at Akal(RS). On this, both 220kV buses became dead at Akal(RS) S/s. ix)During this event, dip in Rajasthan wind generation of approx. 1295 MW is observed out of which approx. 170 MW recovered within 13 minutes. (As per SCADA). x)As per SCADA, no change in demand is observed in Rajasthan control area.	1125	0	1120	Details analysis of the event
4	GI-1	1)220 KV Khodri(UK)-Majri/Giri(HP) (UK) Ckt-2 2)220 KV Khodri(UK)-Majri/Giri(HP) (UK) Ckt-1 3)220kV Khodri-Chibro (UK) Ckt-2 4)30 MW Khodri Unit-1 5)30 MW Khodri Unit-2 6)30 MW Khodri Unit-3	Uttarakhand & Himachal Pradesh	PTCUL, HPPTCL	19-Sep-24	11:53	i)During antecedent condition, all the four 30MW units of Khodri HEP & all four 60 MW units of Chhibro HEP were running and total active power generation of Khodri HEP & Chhibro HEP were approx. 90 MW & 200 MW (as per SCADA). Total generation of Chhibro HEP was evacuating through 220 KV Khodri-Chhibro (UK) Ckt-1 & 2. Loading of 220 KV Khodri(UK)-Majri(HP) (UK) D/C was approx. 145 MW. 30 MW Khodri Unit-3, 220 KV Khodri(UK)-Majri(HP) (UK) Ckt-1 & 220kV Khodri-Chibro (UK) Ckt-2 connected to 220kV bus-1 and other elements connected to 220kV bus-2 at Khodri HEP. ii)As reported, at 11:53 hrs, 220 KV Khodri(UK)-Majri(HP) (UK) Ckt-2 tripped on R-N phase to earth fault with fault current of Ir=~7kA & Ir=~1.7kA and fault distance of approx. 15.7km & 25.4km from Khodri HEP(UK) & Giri(HP) end respectively. iii)On this fault, 30MW Unit-1, 2 & 3 of Khodri HEP tripped on over current protection. Due to tandem connection of Khodri HEP and Chibro HEP, generation at Chibro HEP backed down by approx. 160 MW within 8 minutes. iv)As reported, CB of 30 MW Unit-3 of Khodri HEP took approx. 210 msec in opening process which led to LBB operation of 30 MW Unit-3 bay at Khodri HEP. On LBB operation, 220 KV Khodri(UK)-Majri(HP) (UK) Ckt-1 and 220kV Khodri-Chibro (UK) Ckt-2 also tripped from Khodri HEP end. v)As per PMU at Saharanpur(PG), R-N phase to earth fault with fault clearing time of 80 msec is observed. vi)As per SCADA, generation loss of approx. 70 MW in Uttarakhand control area. vii) As per SCADA and SLDC-HP, load loss of approx. 160 MW in HP control area.	70	160	80	Details analysis of the event

5	GI-2	1)400/220 kV 500 MVA ICT 1 at Jaisalmer(RS) 2)400/220 kV 500 MVA ICT 2 at Jaisalmer(RS) 3)220kV Jaisalmer(RS)-Renew Solar Ckt 4)220kV Jaisalmer(RS)-Fortum Solar Ckt 5)220kV Jaisalmer(RS)-Akal Ckt-1 6)220kV Jaisalmer(RS)-Akal Ckt-2 7)220kV Jaisalmer(RS)-ACME Aklera Ckt 8)220kV Jaisalmer(RS)-Clean Solar Ckt 9)220kV Jaisalmer(RS)-NTPC Renewable Ckt	Rajasthan	RRVPNL, NTPC	20-Sep-24	12:00	i)400/220kV Jaisalmer(RS) has one and half breaker scheme at 400kV level and double main and transfer bus scheme at 220kV level. ii)During antecedent condition, Renew Solar, Fortum Solar, NTPC Renewable, ACME Aklera and Clean solar was injecting approx. 107 MW, 240 MW, 160 MW, 260 MW and 250 MW respectively to Jaislamer(RS) at 220kV level. Active power was going out to Akal(RS) through 220kV Jaisalmer(RS)-Akal Ckt-1 & 2 carrying approx. 235 MW each. 400/220 kV 500 MVA ICT 1 & 2 at Jaisalmer(RS) were carrying approx. 282 MW and 268 MW respectively from 220kV level to 400kV level. iii)As reported, at 12:00 hrs, Y-phase jumper of 220kV Jaisalmer -Akal Ckt-2 broke at Jaisalmer end. iv)At the same time, bus bar protection operated at 220kV level of Jaisalmer and all the elements connected at 220kV level of Jaisalmer tripped and both the 220kV buses became dead. v)As per PMU at Fatehgarh3(PG), Y-N phase to earth fault with delayed fault clearance time of 600 msec is observed. vi)During this event, as per SCADA, solar generation loss of approx. 1070 MW is observed in Rajasthan control area. Dip in total solar generation of approx. 1790 MW is observed in NR control area out of which 980 MW is recovered within 3 minutes. vii)As per SCADA, no change in demand is observed in Rajasthan control area.	1790	0	600	Details analysis of the event
6	GD-1	1) 400 KV Bareilly-Unnao (UP) Ckt-1 2) 400 KV Bareilly-Unnao (UP) Ckt-2 3) 400 KV Mohanlalganj (PGYTL)-Unnao(UP) (PGYTL) Ckt 4) 400 KV Agra-Unnao (UP) Ckt 5) 400 KV Unnao-Panki (UP) Ckt 6) 400 KV Unnao(UP)-Jehta_Hardoi Road (UP) (PG) Ckt-1 7) 400 KV Unnao(UP)-Jehta_Hardoi Road (UP) (PG) Ckt-2 8) 400/220 kV 315 MVA ICT 1 at Unnao(UP) 9) 400/220 kV 500 MVA ICT 2 at Unnao(UP) 10) 400/220 kV 315 MVA ICT 3 at Unnao(UP) 11) 765/400 kV 1000 MVA ICT 1 at Unnao 765(UP) 12) 765/400 kV 1000 MVA ICT 2 at Unnao 765(UP) 13) 765/400 kV 1000 MVA ICT 3 at Unnao 765(UP) 14) 765 KV Obra_C TPS-Unnao 765(UP) Ckt 15) 765 KV Anpara_C(LAN)-Unnao 765(UP) (UP) Ckt	Uttar Pradesh	UPPTCL, PGCIL, LANCO	23-Sep-24	19:52	i)During antecedent condition, 400 kV Unnao-Agra(UP) Ckt was charged through transfer bus coupler at Unnao end which was coupled to 400kV Bus-1. ii)As reported, at 19:52 hrs, due to blast in B-phase circuit breaker of transfer bus coupler, bus fault occurred at Unnao, but bus bar protection didn't operate (exact reason yet to be shared and bus bar relay is of static type). iii)As per DR, distance protection relay in most of the lines sensed fault in zone-4 at Unnao end and in 400 KV Unnao(UP)-Jehta_Hardoi Road (UP) (PG) Ckt-1 remote end sensed fault in zone-2. 400 KV Unnao-Panki (UP) Ckt, line tripped on SOTF after unsuccessful A/R from Panki end (reason of the same not identified yet, suspected due to overreach of Z-1 DPR at Panki end as per DR). iv)400/220 kV 315 MVA ICT 1 & 3 and 500 MVA ICT-2 at Unnao(UP) and 765/400 kV 1000 MVA ICT 1, 2 & 3 at Unnao 765(UP) tripped on O/C E/F protection operation (after 700 ms to 900 ms). v)As all the elements connected at both the buses tripped, complete blackout occurred at 400/220kV Unnao(UP) S/s. vi)During the same time, 765kV Unnao-Anpara-C Ckt and 765kV Unnao-Obra-C Ckt tripped on over-voltage protection operation and complete blackout occurred at 765/400kV Unnao 765(UP) S/s. As per DR and event logger details, DT received at Anpara-C and Obra-C end. vii)As per PMU at Abdullapur(PG), B-N phase to earth fault with delayed fault clearing time of 560 ms is observed. Maximum MW loading of 400 kV Anpara-TH-Obra-B Ckt reached upto ~1042 MW as per PMU at Anpara-TH end. viii)Due to contingency related to overloading of 400 kV Anpara-Obra B line, "SPS for safe evacuation of Generation of Anpara Complex" operated and thermal backing of approximately 1200 MW imposed on Anpara-TH, C & D. As per SPS log received from Anpara-D: At 19:52:39:100 hrs: Case-1 of SPS operated, At 19:52:44:100 hrs: Case-2 of SPS operated, At 19:52:45:100 hrs: Again Case-1 of SPS operated. ix)As per information received from Anpara-D, at 19:53:11 hrs, 200 MW backdown started at Unit-7 however, it was not executed as observed from SCADA data (exact reason yet to be received). As per event logger details received, at 19:53:15 hrs, Unit-7 switched to manual mode from Auto mode. x)As reported by Anpara-D, SPS backing command could not be executed in Unit-6 as machine was already kept in manual mode due to disturbance in parameters. During SPS Case-2 execution, Anpara-C GT-1 or GT-2 didn't trip though SPS command was sent (exact reason yet to be received from Anpara-C). xi)As per SCADA, change in demand of approx. 700 MW is observed in UP control area and generation backdown of ~510MW at Anpara C (between 19:52 hrs-20:00 hrs) and ~325MW at Anpara-TH & ~75MW at Anpara-D (between 20:00 hrs-20:15 hrs) are also observed.	0	700	560	Details analysis of the event
7	GD-1	1)220 KV Meerut(PG)-Nara(UP) (PG) Ckt 2)220 KV Nara(UP)-Roorkee(UK) (UP) Ckt 3)220 KV Nara-Jansath (UP) Ckt 4)220 KV Nara-Muzaffarnagar (UP) Ckt 5)200/132kV 160MVA ICT-1 at Nara(UP) 6)200/132kV 200MVA ICT-2 at Nara(UP)	Uttar Pradesh	PGCIL, UPPTCL, PTCUL	10-Sep-24	13:18	i)220kV Nara(UP) has main and transfer bus scheme at 220kV level. ii)As reported, at 13:18 hrs, due to lightning and inclement weather conditions, R-N phase to earth fault occurred on 220kV main bus which led to bus bar protection operation at Nara(UP) S/s. iii)Due to bus bar protection operation, all elements connected to 220kV main bus i.e. 220 KV Meerut(PG)-Nara(UP) (PG) Ckt, 220 KV Nara(UP)-Roorkee(UK) (UP) Ckt, 220 KV Nara-Jansath (UP) Ckt, 220 KV Nara-Muzaffarnagar (UP) Ckt, 200/132kV 160MVA ICT-1 & 200MVA ICT-2 tripped at Nara(UP) S/s which led to blackout at 220kV Nara(UP) S/s. iv)As per PMU at Roorkee(PG), R-N phase to earth fault with delayed fault clearance time of 320msec is observed. v)As per SCADA, change in demand of approx. 120 MW & 60 MW in UP and Uttarakhand control area respectively. However, SLDC-UP has reported load loss of approx. 208 MW in UP control area.	0	268	320	Reason for delayed clearance of fault
8	GI-2	1)400 KV Obra_C_TPS-Obra_B (UP) Ckt 2)400 KV Jaunpur -Obra_C_TPS (UP) Ckt 3)660MW OBRA C_TPS(UP) - UNIT 1	Uttar Pradesh	UPPTCL	11-Sep-24	10:03	i)765/400kV Obra-C TPS(UP) has one and half breaker bus scheme at 400kV & 765kV level. ii)During antecedent condition, 660 MW Unit-1 at Obra-C TPS was generating approx. 350 MW and 400 KV Jaunpur -Obra_C_TPS (UP) Ckt was anti-theft charged from Obra-C end. iii)As reported, at 10:03 hrs, 400 KV Jaunpur -Obra_C_TPS (UP) Ckt tripped on R-N phase to earth fault with fault current of Ir=~6.8kA and fault distance of approx. 35.49km from Obra-C TPS(UP) end. Line tripped on zone-1 distance protection from Obra-C end. iv)At the same time, 400 KV Obra_C_TPS-Obra_B (UP) Ckt tripped on over current protection from Obra-B end. During the event, the current recorded was approx. Ir=~7.5kA at Obra-B end. It is reported that over current protection is enabled with current setting of 2kA and time setting of definite time characteristic without any time delay at Obra-B end for 400 KV Obra_C_TPS-Obra_B (UP) Ckt. v) Due to tripping of 400 KV Obra_C_TPS-Obra_B (UP) Ckt, both 100MVA station transformers became dead with led to tripping of 660 MW Obra C_TPS(UP) – Unit-1 due to disruption in auxiliary supply of Unit-1. It is reported that, auxiliary supply of 660 MW Unit-1 at Obra-C TPS is tapped from both 100 MVA STFs(station transformer) and 40 MVA UAT(Unit auxiliary transformer) which does not provide the redundancy in the auxiliary supply of 660 MW Unit-1 at Obra-C TPS. vi)As per PMU at Anpara(UP), R-N phase to earth fault with fault clearance time of 80 msec is observed. vii)As per DR of Obra-B end of 400 KV Obra_C_TPS-Obra_B (UP) Ckt, line tripped on over current protection with max current observed was approx. Ir=~7.5kA. viii) As per SCADA, no change in demand of UP control area. However, SLDC-UP has reported generation loss of approx. 350 MW at Obra-C TPS (as per SCADA also).	350	0	80	As per general protection philosophy, over current protection should be disabled in 400kV lines. Reason for enabling over current protection in 400 KV Obra_C_TPS-Obra_B (UP) Ckt at Obra-B (UP) end need to be shared

9	GI-2	1)400 KV Agra-Unnao (UP) Ckt 2)400 KV Unnao(UP)-Jehta_Hardoi Road (UP) (PG) Ckt-1 3)400/220 kV 315 MVA ICT 3 at Unnao(UP) 4)400 KV Bareilly-Unnao (UP) Ckt-2 5)765/400 kV 1000 MVA ICT 1 at Unnao(UP) 6)400KV Bus 2 at Unnao(UP) 7)406 BUS COUPLER BAY - 400KV BUS 1 AT UNNAO(UP) AND 400KV BUS 2 AT UNNAO(UP)	Uttar Pradesh	UPPTCL	17-Sep-24	20:09	i)765/400/220kV Unnao(UP) has double main and transfer bus scheme at 400kV level. ii)During antecedent condition, 400kV lines from Unnao(UP) to Agra(UP), Jehta_Hardoi Road(UP) & Bareilly Ckt-1 and 765/400 kV 1000 MVA ICT-1 & 400/220kV 315 MVA ICT-3 were connected to 400kV bus-2 at unnao(UP) S/s. iii)As reported, at 20:09 hrs, B-N phase to earth fault occurred on 400 KV Agra-Unnao (UP) Ckt with fault distance of approx. 174km & 86km from Agra(UP) and Unnao(UP) end respectively. Line tripped from Agra(UP) end on receiving DT from Unnao(UP) end but B-phase pole of line CB could not properly open from Unnao(UP) end which led to LBB operation in bay of 400 KV Agra-Unnao (UP) Ckt at Unnao(UP) end. iv)On LBB operation at Unnao(UP) S/s, all elements connected to 400kV bus-2 (400kV lines from Unnao(UP) to Agra(UP), Jehta_Hardoi Road(UP) & Bareilly Ckt-1 and 765/400 kV 1000 MVA ICT-1 & 400/220 kV 315 MVA ICT-3) tripped at Unnao(UP) S/s. v)As per PMU at Unnao(UP), B-N phase to earth fault with delayed fault clearance time of 520msec is observed. vi)As per SCADA, no change in demand of UP control area.	0	0	520	Reason for delayed clearance of fault and reason of breaker failure
10	GI-1	1) 220 KV Hissar(BB)-Hissar IA(HV) (HVPNL) Ckt-1 2) 220 KV Hissar(BB)-Hissar IA(HV) (HVPNL) Ckt-2 3) 220 KV Hissar-Sangrur (BB) Ckt-1 4) 220 KV Hissar-Sangrur (BB) Ckt-2 5) 220kV Bus-1 at Hissar(BB)	Haryana	BBMB, HVPNL	23-Sep-24	09:44	i)220/132/33kV Hissar(BB) S/s has double main bus scheme at 220kV level. ii)As reported, at 09:44hrs, Y-phase clamp of 220 KV Hissar-Sangrur (BB) Ckt-2 burnt and jumper snapped. iii)During the same time, all the lines connected at 220kV Bus-1 at Hissar(BB) also tripped (Exact reason yet to be shared). iv)As per DR and details received, 220 KV Hissar-Sangrur (BB) Ckt-1 & 2 tripped from Sangrur end only sensing the fault in zone-2. Fault current was 966.2A and 1.036kA respectively and fault distance was 169.2km and 167.1km respectively from Sangrur end. v)220 KV Hissar(BB)-Hissar IA(HV) (HVPNL) Ckt-1 tripped from Hissar(BB) end only sensing the fault in zone-4. Fault current was 4.984kA and fault distance was 468.2m from Hissar(BB) end. vi)220 KV Hissar(BB)-Hissar IA(HV) (HVPNL) Ckt-2 tripped from both the ends sensing the fault in zone-4 at Hissar(BB) end and zone-2 at Hissar IA(HV) end. Fault current was 3.676kA and 4.392 kA and fault distance was 0m and 5.022km from Hissar(BB) and Hissar IA(HV) end respectively. vii)Due to tripping of all the elements connected to bus-1, 220kV Bus-1 at Hissar(BB) became dead. viii)As per PMU at Hissar(PG), R-N phase to earth fault (phase sequence issue observed) with delayed fault clearing time of 360ms is observed. ix)As per SCADA, change in demand of approx. 75MW is observed in Haryana control area.	0	75	360	i)Exact reason of tripping of all the elements connected to bus-1 need to be shared. It is suspected that bus fault occurred, but bus bar protection didn't operate which resulted in fault clearance in zone-4 from Hissar(BB) end and zone-2 from remote ends. ii)Reason of delayed clearance of fault need to be shared.
11	GD-1	1) 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-1 2) 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-2	Delhi	DTL, PGCIL	24-Sep-24	12:52	i)220kV Narela(DTL) S/s has double main bus arrangement at 220kV level. ii)During antecedent condition, incoming power at Narela(DTL) through 220 KV Mandola(PG)-Narela(DV) (DTL) D/C was approx. 330MW. 220 KV Mandola(PG)-Narela(DV) (DTL) D/C was feeding load of 220kV Narela(DTL) and 220kV DSIDC(DTL). 220 KV Mandola(PG)-Narela(DV) (DTL) D/C, 220kV Narela-DSIDC (DTL) D/C, 220/66kV 100MVA ICT-1, ICT-2 & ICT-3 were connected to 220kV bus-2 at Narela(DTL) S/s. 220kV DSIDC-Bawana (DTL) D/C was not in service. 220kV bus coupler was in open condition at Narela(DTL) S/s. iii)As reported, at 12:52hrs, 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-2 tripped on B-N phase to earth fault with fault distance of 8.47km from Narela end. As per DR, 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-2 tripped on B-N phase to earth fault with fault current of Ib=~7.9kA & Ib=~8.9kA from Narela(DTL) and Mandaula(PG) end respectively. Line tripped on zone-1 distance protection from both ends. A/R operation not observed from both ends (exact reason of fault is yet to be received). iv)Due to tripping of 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-2, complete load shifted on 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-1. 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-1 also tripped approx. 75 seconds after the tripping of 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-2 on Y-B-N double phase to earth fault. (exact reason and location of fault is yet to be received). v)As per DR of 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-1, B-N phase to earth fault converted into Y-B-N double phase to earth fault is observed with fault current of Ib=~3.7kA & Iy=~2.8kA and Ib=~9.4kA & Iy=~10.6kA from Narela(DTL) and Mandaula(PG) end respectively. Line tripped on zone-1 distance protection from Narela(DTL) end and on zone-2 distance protection from mandaula(PG) end. A/R initiated at Narela(DTL) end. vi)As per PMU at Maharani Bagh(PG), B-N phase to earth fault followed by B-N phase to earth fault converted into Y-B phase to phase fault with fault clearing time of 120msec and 240msec is observed. vii)Due to tripping of 220 KV Mandola(PG)-Narela(DV) (DTL) D/C, 220/66kV 100MVA ICT-1, ICT-2 & ICT-3 at 220kV Narela(DTL) S/s and complete 220kV DSIDC(DTL) S/s became dead which led to blackout of 220kV DSIDC(DTL) S/s. viii)As per SCADA, change in demand of approx. 300 MW is observed in Delhi control area. However, SLDC-Delhi has reported load loss of approx. 338 MW. ix)During the tripping event, 220MW load of 220kV DSIDC Bawana(DTL) and 118MW load of 220kV Narela(DTL) got affected. At 13:01 hrs, 220kV DSIDC-Bawana (DTL) D/C closed and load of 220kV DSIDC(DTL) S/s normalized (as per SLDC-Delhi).	0	338	240	Reason of non operation of A/R in 220 KV Mandola(PG)-Narela(DV) (DTL) Ckt-2 on B-N fault.

Annexure-XVIII

RE: Mock testing of SPS of 500kV HVDC Mundra-Mahindergarh link

Thu 8/29/2024 7:29 PM

To:NRLDC SO 2 <nrldcso2@grid-india.in>; CPCC1 <rtamc.nr1@powergrid.in>;

Cc:seo-nrpc <seo-nrpc@nic.in>; Somara Lakra (सोमारा लाकरा) <somara.lakra@grid-india.in>; Mahavir Prasad Singh (महावीर प्रसाद सिंह) <mahavir@grid-india.in>; Arunkumar P <Arunkumar.P@adani.com>; Sugata Bhattacharya (सुगाता भट्टाचार्या) <sugata@grid-india.in>; Deepak Kumar <deepak.kr@grid-india.in>; AMIT SHARMA <amsharma@grid-india.in>; Bikas Kumar Jha (बिकास कुमार झा) <bikaskjha@grid-india.in>; Manas Ranjan Chand (मानस रंजन चंद) <manas@grid-india.in>; Aman Gautam (अमन गौतम) <amangautam@grid-india.in>; Gnanaguru . <Gnanaguru.1@adani.com>; Sumeet Sharma <Sumeet.Sharma@adani.com>; Naman Vyas <Namany.Vyas@adani.com>; Milan Popat <Milan.Popat@adani.com>; Nihar Raj <nihar.raj@adani.com>; Abhishek Kukreja <Abhishek.Kukreja@adani.com>;

5 attachments (9 MB)

Counter (2).jpg; Counter.jpg; TPS (2).jpg; TPS.jpg; 220KV Alwar ss.jpg;

****Warning****
This email has not originated from Grid-India. Do not click on attachment or links unless sender is reliable. Malware/ Viruses can be easily transmitted via email.

Dear Sir,

Please find the attached Photos. on 28-08-2024, a representative from M/s. Commtel Networks visited the Mahendragarh site and confirmed the healthiness of the SDH and TPS, along with their associated cards.

All SPS System equipment are functioning properly. The 15 TPS installed in the remote substation.

The details and status of TPS and Counter at Mahendragarh End.

S.No	TPS	TPS Status	Counter	Counter Status
1	PG Hissar	ON	17	OKAY
2	Bhiwani	ON	17	OKAY
3	Dadari	ON	17	OKAY
4	Alwar	ON	-	OFF
5	Bhilwara	ON	12	OKAY
6	Merta	ON	14	OKAY
7	Ratangarh	ON	-	OFF
8	Gobinugarg	ON	-	OFF
9	Malerkotla	ON	-	OFF
10	Laton Kalan	ON	6	OKAY
11	Mandula	ON	12	OKAY
12	Bamnauli	ON	-	OFF
13	Shamli	ON	-	OFF
14	Bahadurgarh	ON	10	OKAY

15	Dhanonda	ON	-	OFF

There alarms on the system are due to the following reasons.

1. Equipment Failure/ card failure/ power failure at Remote Sites.
2. Cable connectivity break between the remote System and cable coming from Field.
3. E1 connectivity outage at remote Sites.

Our team, with support from Commtel Networks, visited the nearest TPS installed at the 220/132 kV Alwar Substation to check its healthiness. However, during the inspection, the panel was found to be de-energized, necessitating an end-to-end test. (Photo Attached) Similarly, each substation needs to be ensured the healthiness of the TPS by respective Substation owner.

We request you to please confirm the healthiness of the Sr no 1 and 2 .

Thanks and Regards,

Kalicharan Sahu
(O&M) HVDC & EHV Substations,
Adani Energy Solutions Limited
| ±500kV HVDC Mahendragarh Terminal Sub Station I
Village-Kheri- Aghiyar, Taluka- Kanina, Mahendragarh 123 029, Haryana, India
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/AdaniOnline

From: NRLDC SO 2 <nrldcso2@grid-india.in>
Sent: Tuesday, August 27, 2024 10:07 AM
To: SLDC Punjab <se-sldcprojects@pstcl.org>; PC PSTCL SLDC PUNJAB <pcpstcl@gmail.com>; Haryana <sldcharyanacr@gmail.com>; Delhi <sldcmintoroad@gmail.com>; UP <sera@upsldc.org>; Rajasthan <SE.LDRVPNL@RVPN.CO.IN>; ce.ld@rvpn.co.in; CPCC1 <rtamc.nr1@powergrid.in>; neerajk@powergrid.in; setncmrt@upptcl.org; bharatlalgujar@gmail.com; akashdeep3433786@gmail.com; xenemtcbhpp2@bbmb.nic.in; PC Control Room <pccont@bbmb.nic.in>; se.prot.engg@rvpn.co.in; Arunkumar P <Arunkumar.P@adani.com>; Kali Charan Sahu <Kalicharan.Sahu@adani.com>; rajbir-walia79@yahoo.com; ase-sldcop@pstcl.org; sesldcop@hvpn.org.in; cepso@upsldc.org; se-sldcop <se-sldcop@pstcl.org>; SICHVDC Controlroom <SICHVDC.Controlroom@adani.com>
Cc: seo-nrpc <seo-nrpc@nic.in>; somara.lakra <somara.lakra@grid-india.in>; Mahavir Prasad Singh (महावीर प्रसाद सिंह) <mahavir@grid-india.in>; Sugata Bhattacharya (सुगाता भट्टाचार्या) <sugata@grid-india.in>; deepak.kr <deepak.kr@grid-india.in>; AMIT SHARMA <amsharma@grid-india.in>; bikaskjha <bikaskjha@grid-india.in>; Manas Ranjan Chand (मानस रंजन चंद) <manas@grid-india.in>; Aman Gautam (अमन गौतम) <amangautam@grid-india.in>
Subject: Re: Mock testing of SPS of 500kV HVDC Mundra-Mahindergarh link

***CAUTION**: This mail has originated from outside Adani. Please exercise caution with links and attachments.*

Sir,

उत्तर प्रदेश राज्य भार प्रेषण केन्द्र लि०
यू०पी०एस०एल०डी०सी०परिसर, विभूति खण्ड II,गोमती नगर, लखनऊ–226010
ई मेल : sera@upsldc.org

U.P. State Load Despatch Centre Ltd.
UPSLDC Complex, Vibhuti Khand – II
Gomti Nagar, Lucknow- 226010
E-mail: sera@upsldc.org

No: - 2661 /SE(R&A)/EE-II/SPS Dated:- 07/08/ 2024

General Manager, NRLDC18-A,
SJSS Marg, Katwaria Sarai,
New Delhi – 110016

Subject- Regarding SPS of HVDC Mundra-Mahendargarh line

Kindly refer to SE (ETC) Muzaffarnagar letter no/062/E.T.C./MZN/400 kV S/S Shamli dated 05.05.2024. (copy enclosed) regarding feeder wise load of Shamli area. As per the letter, at present complete load relief (i.e. 300MW) may not be provided by 220 kV Shamli, so that alternatively feeder and load details of 400 kV Shamli has also been provided. Also it is informed that at present SPS system at 220 kV Shamli is not healthy which is being maintained by PGCIL.

It is therefore requested to kindly instruct the concerned to incorporate 132 kV feeders of 220 kV Shamli & 400 kV Shamli in SPS of HVDC Mundra-Mahendargarh line so that appropriated load relief may be provided from UP Control area and take necessary action regarding healthiness of SPS system

Sangeeta
(Sangeeta)
Superintending Engineer (R&A)

No: - /SE(R&A)/EE-II/SPS Dated: - 2024

Copy forwarded to following via e-mail for kind information and necessary action:-

1. Director, UPSLDC, Vibhuti Khand – II, Gomti Nagar, Lucknow.
2. Director (Operation), UPPTCL, 11th Floor, Shakti Bhawan Extn., Lucknow.
3. Chief Engineer (PSO), Vibhuti Khand – II, Gomti Nagar, Lucknow.
4. Chief Engineer (Trans. West),PareshanBhawan, 130D, Hydel Colony, Victoria Park, Meerut 250001.
5. SE (Operations), 18 – A SJSS Marg, Katwaria Sarai, New Delhi, 110016.

(Sangeeta)
Superintending Engineer (R&A)

कार्यालय
अधीक्षण अभियन्ता
विद्युत पारेषण मण्डल
उ०प्र०पावर ट्रांसमिशन कारपोरेशन लि०
132 के०वी० भोपारोड उपकेन्द्र
मुजफ्फरनगर-251001

OFFICE OF THE
SUPERINTENDING ENGINEER
Electricity Transmission Circle
U.P. Power Transmission Corporation Ltd.
132 KV Bhopa Road Sub-station
Muzaffarnagar-251001

दूरभाष (0131-2608038

Ph. (0131-2608038
E-mail : seetcmzn@upptcl.org, seetcmzn@gmail.com

संख्या / No. 1062 /E.T.C./MZN/400 KV S/S Shamli

दिनांक / DATED 05/08/24

Subject: - Regarding SPS of HVDC Mundra-Mahendargarh.

Superintending Engineer (R & A)
U.P State Load Despatch Centre Ltd.
UPSLDC Complex, Vibhuti Khand-II
Gomti Nagar, Lucknow.
Email. sera@upsldc.org

Please refer to your office letter no. 2187 dt. 01.07.2024, forwarded to this office by SE (T&C), Meerut vide endorsement no. 2237/CE(TW)/MT/SPS dt. 23.07.2024 vide which it has been requested to provide details of 132 KV feeders for planned relief to HVDC Mundra-Mahendargarh SPS.

In this reference, it is to apprise that following is the details of 132 KV feeders being fed from 220 KV Sub-Station Shamli.

S.No.	Name of feeder	Connected Load (MVA)	Maximum Load (MW)	Average Load (MW)
1	132 KV Lalukheri	63+63	72	47
2	132 KV Jhinjhana	63+40+40	80	52
3	132 KV Kairana-I/II	63+63	41	27
4	132 KV Jasala	63+40	58	38
	Total		251	164

1. Following Case wise Trippings of 132 KV Feeders at 220 KV Sub-Station, Shamli for tripping of HVDC Mundra-Mahendergarh Line may be used.

(A) In Maximum Load Condition:-

S. No.	State.L.S quantum	Name of feeding substation	Feeder/line/ equipment	MW	Case-1 50 MW	Case-2 100 MW	Case-3 200MW	Case-4 300 MW
1	Uttar Pradesh Case-1 =50 MW Case-2 =100 MW Case-3 =200 MW Case-4 300 MW	220 KV Subsatation, Shamli	132 KV Jasala	58	1	1	1	1
2			132 KV Kairana-I	20.5		1		1
3			132 KV Kairana-II	20.5	-	1		1
4			132 KV Lalukheri	72	-	-	1	1
5			132 KV Jinjhana	80	-		1	1
			Total Relief	251	58	99	210	251

(B) In Average Load Condition :-

S. No.	State.L.S quantum	Name of feeding substation	Feeder/line/ equipment	MW	Case-1 50 MW	Case-2 100 MW	Case-3 200MW	Case-4 300 MW
1	Uttar Pradesh Case-1 =50 MW Case-2 =100 MW Case-3 =200 MW Case-4 =300 MW	220 KV Subsatation, Shamli	132 KV Jasala	38	1		1	1
2			132 KV Kairana-I	13.5	1		1	1
3			132 KV Kairana-II	13.5	-		1	1
4			132 KV Lalukheri	47	-	1	1	1
5			132 KV Jinjhana	52	-	1	1	1
			Total Relief	164	51.5	99	164	164

Alternatively HVDC Mundra-Mahendargarh SPS may be shifted to 400 KV Sub-Station Shamli, details of 132 KV feeders from 400 KV Sub-Station Shamli with its Maximum and Average load is as follows :

S.No.	Name of feeder	Connected Load (MVA)	Maximum Load (MW)	Average Load (MW)
1	132 KV Budhana	63+40	82	53
2	132 KV Kharad	63+40	78	51
3	132 KV Jalalpur	40+40	41	27
4	132 KV Thanabhawan	63+63+40	74	48
5	132 KV Kaniyan	40+40	35	23
	Total		310	202

2. Following Case wise Trippings of 132 KV Feeders at 400 KV Sub-Station, Shamli for tripping of HVDC Mundra-Mahendergarh Line is hereby recommended

(A). In Maximum Load Condition :-

S. No.	State.L.S quantum	Name of feeding substation	Feeder/line/ equipment	MW	Case-1 50 MW	Case-2 100 MW	Case-3 200MW	Case-4 300 MW
1	Uttar Pradesh Case-1 =50 MW Case-2 =100 MW Case-3 =200 MW Case-4 =300 MW	400 KV Subsatation, Shamli	132 KV Budhana	82	-	-	1	1
2			132 KV Kharad	78	-	-	1	1
3			132 KV Jalalpur	41	1	-	1	1
4			132 KV Thanabhawan	74	-	1	-	1
5			132 KV Kaniyan	35	1	1	-	1
			Total Relief	310	76	109	201	310

(B). In Average Load Condition :-

S. No.	State.L.S quantum	Name of feeding substation	Feeder/line/ equipment	MW	Case-1 50 MW	Case-2 100 MW	Case-3 200MW	Case-4 300 MW
1	Uttar Pradesh Case-1 =50 MW Case-2 =100 MW Case-3 =200 MW Case-4 =300 MW	400 KV Subsatation, Shamli	132 KV Budhana	53	-	1	1	1
2			132 KV Kharad	51	1	1	1	1
3			132 KV Jalalpur	27	-	-	1	1
4			132 KV Thanabhawan	48	-	-	1	1
5			132 KV Kaniyan	23	-		1	1
			Total Relief	202	51	104	202	202

Submitted for information and necessary action

(Nikhil Kumar)
Superintending Engineer

संख्या / No. /E.T.C./MZN/ दिनांक / DATED

Copy forwarded to the following for information and necessary action :

1. Chief Engineer (TW) UPPTCL Meerut.
2. Superintending Engineer, Electricity (T&C) Circle, UPPTCL Meerut.
3. Executive Engineer Electricity Transmission Division, Shamli

(Nikhil Kumar)
Superintending Engineer

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अधीक्षण अभियन्ता
विद्युत परीक्षण एवं परिचालन मण्डल
उ0प्र0 पावर ट्रांसमिशन कारपोरेशन लि0
प्रथम तल पारेषण भवन, 130–डी, विक्टोरिया पार्क
मेरठ– 250 003
मोबाइल: 9412749817

U.P. POWER TRANSMISSION CORPORATION LIMITED
UPPTCL

OFFICE OF THE
SUPERINTENDING ENGINEER
Electricity Test & Commissioning Circle
U.P. POWER TRANSMISSION CORPORATION LTD.
1st Floor Pareshan Bhawan, 130-D, Victoria Park,
Meerut 250 003
Mobile: 9412749817

No. 82 / ETCC-MT / **Dated- 30/05/24**

Sub :- SPS related to HVDC Mundra-Mahendargarh.

Superintending Engineer (R&A) **(By e-mail)**
UPSLDC Vibhuti Khand ,
Gomti Nagar,
Lucknow.

In reference to the above cited subject, UPSLDC via email on 22.05.2024 informed that on 17.05.2024 at 16:20 hrs, Case-3 of SPS related to HVDC Mundra - Mahendergarh operated. As per action in case-3 operation of this line SPS, 200MW load relief at 220kV Shamli (UP) is desired. However, no load relief at 220kV Shamli was observed at given date and time. It is to bring in your notice that due to commissioning of 400kV Shamli S/s entire power flow scenario has been changed. Current situation is summarized as below.

At 220kV Shamli S/s feeders shown in the list	Planned load relief (MW)	Current situation
Thana Bhawan -1	25	The only line cateting Thana Bhawan has been made LILO at 132kV Jalalpur. Now Jalalpur is fed from 220kV Shamli S/s while load of Thana Bhawan is fed from 400kV Shamli S/s.
Thana Bhawan -2	25	
Jasala-1	25	Only one line exists.
Jasala-2	25	
Kharad-1	50	Only one line exists which is normally kept open at Kharad and load of Kharad is normally fed from 400kV Shamli S/s.
Kharad-2	50	
Baraut-1	150 (case-4)	No such line exist at 220kV Shamli S/s.
Baraut-2	150 (case-4)	

In view of the above facts, entire load relief strategy needs to be reviewed and redesigned for SPS. On 17.05.2024 at 16:20 hrs, no tripping observed at 220kV S/S Shamli as SPS system is unhealthy, which is being maintained by M/s PGCIL.

Hence it is requested to you to kindly coordinate with M/s PGCIL for modification of the scheme and rectification of the fault in SPS.

(Pramod Kumar Mishra)
Superintending Engineer

No. 82 /ETCC-MT/ **Dated/- 30/05/24**

Copy forwarded to the following for information & necessary action:-

1. Chief Engineer (TW), UPPTCL Victoria Park, Meerut.
2. Executive Engineer, Electricity Test & Commissioning Div., Muzaffarnagar.

(Pramod Kumar Mishra)
Superintending Engineer

SK/SENew/NewEngLetter01

Rajasthan Details

Revised updated feeder details (radial) along with expected average Load Relief

S.No.	Name of Sub- Station	Feeder name as per existing detail	Revised name of Existing Feeder /Line/Equipment	Average Load relief (MW)	Remark
1	220 kV GSS Alwar	132 kV GSS Mundawar	132 kV GSS Pinan	25	
		132 kv GSS Bansoor	132 kV GSS Telco	45	
		132 kV GSS Ramgarh	132 kV GSS Ramgarh	65	
		132 kV GSS Malakhera	132 kV GSS Malakhera	50	
		132 kV Alwar (LOCAL)	132 kV GSS Alwar (LOCAL)	120	
2	220 kV GSS Ratangarh	132 kV Sardar Sher			Generally Feed from 220 kV Halasar
3	220 kV GSSV Bhilwara	132 kV GSS Gangapur	132 kv GSS Karoi	15	
		132 kV GSS Danta	132 kV GSS Danta	30	
		132 kV GSS Devgarh	132 kV GSS Bankali	18	
		132 kV GSS Kareda			
4	400 kV GSS Merta	132 kV GSS Kuchera	132 kV GSS Dhawa	25	
		132 kV GSS Lamba	132 kV GSS Lamba jatan	55	
		132 kV GSS Gotan			

Email **Control Room CONTROL ROOM SLDC**

Re: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

From : Executive Engineer TS Rewari <xentsrwr@hvpn.org.in> Thu, Aug 29, 2024 01:20 PM

Subject : Re: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

To : Control Room CONTROL ROOM SLDC <controlroomsldc@hvpn.org.in>

Cc : SE TS GGN <setsggn@hvpn.org.in>, Executive Engineer Executive Engineer <xen400kvdhanoda@hvpn.org.in>, Substation Engineer <sse220kvlulaahir@hvpn.org.in>

In continuation of trailing email and discussion held today telephonically, it is gathered that desired load relief shall not get as load of 220 kV Lula Ahir shall be fed through 220 kV Dadri-Lula Ahir line being synchronized. Therefore, it is proposed that in the existing scheme SPS, the tripping of 220 kV D/C Lula Ahir line at 400 kV Dhanonda end may be removed and tripping of all incomers (2 no. 132 kV Incomers of 100 MVA 220/132 kV TFs and one no. 33 kV incomer of 100 MVA 220/33 kV TF) at 220 kV Lula Ahir substation may be added.

The maximum load (for FY 2023-24) on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 53.46 MVA, 86.26 MVA and 87.02 MVA

The average load on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 50 MVA, 70 MVA and 70 MVA

From: "Executive Engineer TS Rewari" <xentsrwr@hvpn.org.in>
To: "Control Room CONTROL ROOM SLDC" <controlroomsldc@hvpn.org.in>
Cc: "SE TS GGN" <setsggn@hvpn.org.in>, "Executive Engineer Executive Engineer" <xen400kvdhanoda@hvpn.org.in>, "Substation Engineer" <sse220kvnarnaul@hvpn.org.in>
Sent: Wednesday, August 28, 2024 12:46:13 PM
Subject: Re: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

In reference of trailing email it is submitted that 220 kV Lula Ahir is connected with 400 kV Dhanonda through 220kV D/C line and with 220 kV Dadri through 220kV S/C line and with 220 kV Rewari with 220kV S/C line.
In general circuits of 400 kV Dhanonda and 220 kV Dadri runs in synchronization. The maximum load (for FY 2023-24) on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 53.46 MVA, 86.26 MVA and 87.02 MVA. It is further added that in general 220 kV Dadri takes load from 220 kV Lula Ahir substation and thus act as sink.

In case of operation of SPS at 400 kV Dhanonda, the desired load relief as mentioned in trailing email (90+95 MW) can be achieved through existing scheme (by outage of three no. 100 MVA TFs and 220 kV Dadri (acting as sink)).

Regards
XEN/TS Division
HVPNL Rewari.

From: "Control Room CONTROL ROOM SLDC" <controlroomsldc@hvpn.org.in>
To: "Executive Engineer TS Rewari" <xentsrwr@hvpn.org.in>, "Executive Engineer TS Rohtak" <xentsrtk@hvpn.org.in>, "Executive Engineer Ts Bhiwani" <xentsbhw@hvpn.org.in>, "Executive Engineer Executive Engineer" <xen400kvdhanoda@hvpn.org.in>, xendhanonda@gmail.com
Cc: "Chief Engineer SO Commercial" <cesocomml@hvpn.org.in>, "Chief Engineer TS Panchkula" <cetspkl@hvpn.org.in>, "Chief Engineer TS Hisar" <cetshsr@hvpn.org.in>, "Superintending Engineer SLDC OP" <sesldcop@hvpn.org.in>, "SE TS Rohtak" <setsrtk@hvpn.org.in>, "SE TS GGN" <setsggn@hvpn.org.in>, "Superintending Engineer TS Hisar" <setshsr@hvpn.org.in>, "Superintending Engineer MP CC Dhulkote" <sempccdkt@hvpn.org.in>, "Superintending Engineer MP CC Delhi" <sempccdelhi@hvpn.org.in>, "Executive Engineer MP Rohtak" <xenmpccrtk@hvpn.org.in>, "XEN MP Hisar" <xenmpcchsr@hvpn.org.in>, "XEN MP CC" <xenmpccggn@hvpn.org.in>
Sent: Wednesday, August 21, 2024 11:57:59 AM
Subject: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

Sir,

Please see the attachments.

--
Regards,
SCE (पाली प्रभारी अभियंता)/SLDC Control room,
HVPNL Panipat
Contact No- 9053090722,9053090721,0180-2664095

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Fwd: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

Control Room CONTROL ROOM SLDC <controlroomsldc@hvpn.org.in>

Fri 8/30/2024 12:44 PM

To:NRLDC SO 2 <nrldcso2@grid-india.in>; NRLDC SO-II <nrldcso2@gmail.com>; Deepak Kumar <deepak.kr@grid-india.in>;

Cc:Superintending Engineer SLDC OP <sesldcop@hvpn.org.in>;

2 attachments (209 KB)

Email SPS Rewari.pdf; Regarding SPS Bhiwani.pdf;

Sir,

In reference to the SPS installed for 500kV HVDC Munda - Mahindergarh link the information received from TS wing (copy attached) is as under:

1. At 400kV Dhanonda through Lula Ahir substation:- It is proposed that in the existing scheme SPS, the tripping of 220 kV D/C Lula Ahir line at 400 kV Dhanonda end may be removed and tripping of all incomers (2 no. 132 kV Incomers of 100 MVA 220/132 kV TFs and one no. 33 kV incomer of 100 MVA 220/33 kV TF) at 220 kV Lula Ahir substation may be added. The maximum load (for FY 2023-24) on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 53.46 MVA, 86.26 MVA and 87.02 MVA. The average load on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 50 MVA, 70 MVA and 70 MVA.

2. At 400/220kV Bhiwani BBMB: It is proposed that in the existing scheme SPS, the tripping of 220 kV Bapora (Bhiwani HVPNL) D/C line at Bhiwani BBMB end may be removed and tripping of all incomers (2 no. 132 kV Incomers of 100 MVA 220/132 kV T-1 & T-2 TFs) at 220 kV Bapora (Bhiwani HVPNL) substation may be added. The maximum load on two no. 100 MVA TFs installed at 220kV Bhiwani HVPNL is 80 MW and 85 MW respectively. The average load on two no. 100 MVA TFs installed at 220kV Bhiwani HVPNL is 70 MW and 70 MW respectively.

3. **At 132kV Charkhi Dadri**: It is proposed that in the existing scheme SPS, the tripping of 132kV Kalanaur line at Dadri BBMB end may be removed and tripping of 132kV Haluwas & 132kV Dadri old at Dadri BBMB may be added. The maximum load on 132kV Haluwas & 132kV Dadri old line is 45 MW and 50 MW respectively. The average load on 132kV Haluwas & 132kV Dadri old line is 40 MW and 40 MW respectively.

Rest information kept unchanged. It is also added here that the fiber connectivity is also available on all the above substations.
It is also pertinent to mention here that 700 MW load relief is expected from Haryana. Rest of the states have been allotted with a relative less amount of relief as compared to Haryana for 500kV HVDC Mundra - Mahendargarh link. The Haryana share from APL Mundra has also been reduced now. In view of the above, the expected load relief from the NR states is required to be reviewed accordingly. The same was also pointed out by this office during the online meeting held on dated 20.08.2024.

This is for information & further necessary action please.

From: "Executive Engineer TS Rewari" <xentsrwr@hvpn.org.in>
To: "Control Room CONTROL ROOM SLDC" <controlroomsldc@hvpn.org.in>
Cc: "SE TS GGN" <setsggn@hvpn.org.in>, "Executive Engineer Executive Engineer" <xen400kvdhanoda@hvpn.org.in>, "Substation Engineer" <sse220kvlulaahir@hvpn.org.in>
Sent: Thursday, August 29, 2024 1:20:08 PM
Subject: Re: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

In continuation of trailing email and discussion held today telephonically, it is gathered that desired load relief shall not get as load of 220 kV Lula Ahir shall be fed through 220 kV Dadri-Lula Ahir line being synchronized. Therefore, it is proposed that in the existing scheme SPS, the tripping of 220 kV D/C Lula Ahir line at 400 kV Dhanonda end may be removed and tripping of all incomers (2 no. 132 kV Incomers of 100 MVA 220/132 kV TFs and one no. 33 kV incomer of 100 MVA 220/33 kV TF) at 220 kV Lula Ahir substation may be added.

The maximum load (for FY 2023-24) on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 53.46 MVA, 86.26 MVA and 87.02 MVA
The average load on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 50 MVA, 70 MVA and 70 MVA

From: "Executive Engineer TS Rewari" <xentsrwr@hvpn.org.in>
To: "Control Room CONTROL ROOM SLDC" <controlroomsldc@hvpn.org.in>
Cc: "SE TS GGN" <setsggn@hvpn.org.in>, "Executive Engineer Executive Engineer" <xen400kvdhanoda@hvpn.org.in>, "Substation Engineer" <sse220kvnarnaul@hvpn.org.in>
Sent: Wednesday, August 28, 2024 12:46:13 PM
Subject: Re: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

In reference of trailing email it is submitted that 220 kV Lula Ahir is connected with 400 kV Dhanonda through 220kV D/C line and with 220 kV Dadri through 220kV S/C line and with 220 kV Rewari with 220kV S/C line.
In general circuits of 400 kV Dhanonda and 220 kV Dadri runs in synchronization. The maximum load (for FY 2023-24) on three no. 100 MVA TFs installed at 220 kV Lula Ahir is 53.46 MVA, 86.26 MVA and 87.02 MVA. It is further added that in general 220 kV Dadri takes load from 220 kV Lula Ahir substation and thus act as sink.

In case of operation of SPS at 400 kV Dhanonda, the desired load relief as mentioned in trailing email (90+95 MW) can be achieved through existing scheme (by outage of three no. 100 MVA TFs and 220 kV Dadri (acting as sink)).

Regards
XEN/TS Division
HVPNL Rewari.

From: "Control Room CONTROL ROOM SLDC" <controlroomsldc@hvpn.org.in>
To: "Executive Engineer TS Rewari" <xentsrwr@hvpn.org.in>, "Executive Engineer TS Rohtak" <xentsrtk@hvpn.org.in>, "Executive Engineer Ts Bhiwani" <xentsbhw@hvpn.org.in>, "Executive Engineer Executive Engineer" <xen400kvdhanoda@hvpn.org.in>, xendhanonda@gmail.com
Cc: "Chief Engineer SO Commercial" <cesocomml@hvpn.org.in>, "Chief Engineer TS Panchkula" <cetspkl@hvpn.org.in>, "Chief Engineer TS Hisar" <cetshsr@hvpn.org.in>, "Superintending Engineer SLDC OP" <sesldcop@hvpn.org.in>, "SE TS Rohtak" <setsrtk@hvpn.org.in>, "SE TS GGN" <setsggn@hvpn.org.in>, "Superintending Engineer TS Hisar" <setshsr@hvpn.org.in>, "Superintending Engineer MP CC Dhulkote" <sempccdkt@hvpn.org.in>, "Superintending Engineer MP CC Delhi" <sempccdelhi@hvpn.org.in>, "Executive Engineer MP Rohtak" <xenmpccrtk@hvpn.org.in>, "XEN MP Hisar" <xenmpcchsr@hvpn.org.in>, "XEN MP CC" <xenmpccggn@hvpn.org.in>
Sent: Wednesday, August 21, 2024 11:57:59 AM
Subject: Review of SPS installed for 500kV HVDC Mundra - Mahindergarh.

Sir,

Please see the attachments.

--
Regards,
SCE (पाली प्रभारी अभियंता)/SLDC Control room,
HVPNL Panipat
Contact No- 9053090722,9053090721,0180-2664095

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Regards,
SCE (पाली प्रभारी अभियंता)/SLDC Control room,
HVPNL Panipat
Contact No- 9053090722,9053090721,0180-2664095

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HARYANA VIDYUT PRASARAN NIGAM LIMITED

Regd. Office: Shakti Bhawan, Plot No. C-4, Sector-6, Panchkula, 134109.
Corporate Identity Number: U40101HR1997SGC033683
Website: www.hvpn.org.in, E-mail - xentsbhw@hvpn.org.in
Phone No: 01664-242797(O)

To

The Executive Engineer,
LDPC, HVPNL,
Panipat.

Memo No.Ch-116/OMBE-7 Dated: 29.08.2024

Subject: SPS scheme at HVPNL substations for getting load relief due to tripping of 500Kv HVDC Mundra – Mahendargarh

Please refer to this O/Memo No. 108/OMBE-7 dated 27.08.2024 and O/Email dated 09.08.2024 on the subject cited matter.

In this continuation to above, the details of SPS under TS division, HVPNL, Bhiwani is as under:

S No.	Name of feeding S/Stn	Feeder/Line/Equipment	SPS Installed	Max. Load	Load Relief (Avg Load)	Remarks
1	220KV S/Stn Bhiwani	132KV IA Bhiwani Line	UFR	50MW	40 MW	SPS (UFR)Installed and healthy
2	220KV S/Stn Bhiwani	132KV Bhiwani Ckt 2	UFR	50MW	40 MW	SPS (UFR)Installed and healthy
3	220KV S/Stn Bhiwani	132KV Tosham	UFR	-	-	SPS (UFR) Installed and healthy but line is running on No load as 2nd source to 132KV Tosham
4	220KV S/Stn Bhiwani	132KV Incomer of Transformer 100MVA Transformer T2	-	85MW	70 MW	SPS may be provided for load relief as mentioned on subject above.
5	220KV S/Stn Bhiwani	132KV Incomer of 100MVA Transformer T1	-	80MW	70 MW	SPS may be provided for load relief as mentioned on subject above.
6	132kV substation Dadri-2	132kV Dadri-kalanaur ckt	Yes		Nil	SPS Installed and healthy but line is running on No load as 2nd source to 132KV Kalanaur
7	132kV substation Dadri-2	132kV Dadri-Makrani ckt	Yes		Nil	SPS Installed and healthy but line is running on No load as 2nd source to 132KV Makrani
8	132kV substation Dadri-2	132kV Dadri-Haluwas ckt	-	45MW	40MW	SPS may be provided for load relief as mentioned on subject above.
9	132kV substation Dadri-2	132kV Dadri-Dadri old	-	50MW	40MW	SPS may be provided for load relief as mentioned on subject above.

This is for kind information and necessary action please.

Executive Engineer,
Transmission System Division,
HVPNL, Bhiwani

CC to:

1. SE/TS Circle, HVPNL, Hisar for kind information, please.

Delhi Details

Re: Mock testing of SPS of 500kV HVDC Mundra-Mahindergarh link

SLDC, DELHI <sldcmintoroad@gmail.com>

Wed 8/28/2024 3:48 PM

To:NRLDC SO 2 <nrldcso2@grid-india.in>;

Cc:sinha.surendra <sinha.surendra@yahoo.com>; dgmsodelhisldc@gmail.com <dgmsodelhisldc@gmail.com>; Manager (T) SO <managersogd@gmail.com>;

In reference to trailing mail, the maximum load on 220kV feeders covered under SPS of 500kV HVDC Mundra-Mahindergarh link are as under:

S. No.	Name of the Element	MW
1	220 KV BAMNAULI-PAPANKALAN-I CKT.-I	120
2	220 KV BAMNAULI-PAPANKALAN-I CKT.-II	120
3	220 KV MANDAULA- GOPALPUR CKT.-I	212
4	220 KV MANDAULA- GOPALPUR CKT.-II	214

Regards,
SLDC Delhi

On Tue, Aug 27, 2024 at 10:07 AM NRLDC SO 2 <nrldcso2@grid-india.in> wrote:

> Sir,
>
> In reference of the trailing mail, it is to be mentioned that inputs have received from Rajasthan only. Members agreed to shared the details by 22nd August 2024, however no further details received from Haryana, Punjab, Delhi, UP & ADANI.
>
> Kindly share the details as discussed during the meeting held on 20th August 2024, so that further remedial actions can be initiated on the basis of those details.
>
> सादर धन्यवाद/ Thanks & Regards
> प्रणाली संचालन-II/ System Operation-II
> उ०क्षे०भा०प्रे०के०/ NRLDC
> ग्रिड कंट्रोलर ऑफ इंडिया लिमिटेड/ Grid Controller of India Limited
> Formerly known as
> पोसोको / POSOCO

Punjab Details

	Name of S/S	66kV Feeders	Average Demand(Amp.)	Maximum Demand(Amp.)
Punjab Control Area	220/66kV Gobindgarh	66kV Talwara-19(ADANI SPS)	375	430
		66kV Talwara-2(ADANI SPS)	375	430
	220/66kV Lalton kalan	66kV Gill road-1(DADRI SPS)	543	610
		66kV Gill Road-2(DADRI SPS)	518	692
		66kV Dugri(DADRI SPS)	325	450
	220/66kV Malerkotla	66kV Malerkotla(ADANI SPS)	213	403
		66kV Amargarh(ADANI SPS)	238	405
		66kV Malaud ckt 1(DTPC SPS)	257	356

Note: 66kV Malaud at 220kV S/S Malerkotla was bifurcated into two circuits in the month of July 2024.

Nodal officers details

Control Area	Station Name	Nodal Person (SPS, communication system)	Contact details	Email Id
Rajasthan	220/132kV Alwar	Sh. Vijaypal Yadav XEN (Prot.) Ms. Pooja Verma AEN (Comm)	9413361407 9413375366	xen.prot.alwar@rvpn.co.in aen.comm.alwar@rvpn.co.in
	220/132kV Ratangarh	Sh. Mukesh Somra AEN (MPT&S) , Sh. Dharmender Singh (Comm.)	9414061442 9413383246	aen.mpt&s.rtg@rvpn.co.in aen.comm.ratangarh@rvpn.co.in
	220/132kV Bhilwara	Sh. Madhusudan Sharma, AEN (SLDC-comm Sh. Suresh Garg, XEN (MPT&S)	9413383176 9414061424	aen.subsldc.bhl@rvpn.co.in xen.mpts.bhl@rvpn.co.in
	220/132kV Merta	Mukesh Kumar (AEN Prot.) Mahip Singh (Aen) Comm)	7734806466 9413362995	aen.prot.mertacity@RVPN.CO.IN aen.comm.merta@RVPN.CO.IN
BBMB	400/220kV Bhiwani(BBMB)			
POWERGRID	400/220kV Hissar(PG)			
	Bhiwani(PG)			
	400/220kV Bahadurgarh(PG)			
Haryana	400/220kV Dhanonda	Gautam / SSE, 400kV Dhanonda	9313472669	dhanonda400kv@gmail.com
	220kV Lulahir	Er. Subhash Chander	9416373135	sse220kvlulaahir@hvpn.org.in
	220kV Rewari	Er. Kavinder Yadav	9315315649	sse220kvrwr@hvpn.org.in
	132kV Charkhi Dadri	Vivek Sangwan	9034459489	sse132kvdadri@hvpn.org.in
Punjab	220/66kV Gobindgarh	Er. Harwinder Singh	96461-18184	ae-220kvg1-mgg@pstcl.org
	220/66kV Laltokalan	Er. Supinder Singh	96461-24495	sse-pm-lalton@pstcl.org
	220/66kV Malerkotla	Er. Sanju Bala	96461-64007	sse-pm-mlrk@pstcl.org
UP	Shamli	Er. Krishna Nand	9412756631	eeetdshamli@upptcl.org,
	400kV Muradnagar	Er. D.S. Sengar	9412748666	ee400mrd2@upptcl.org
Delhi	400/220kV Bamnauli			
	400/220kV Mandola			

ANNEXURE-A

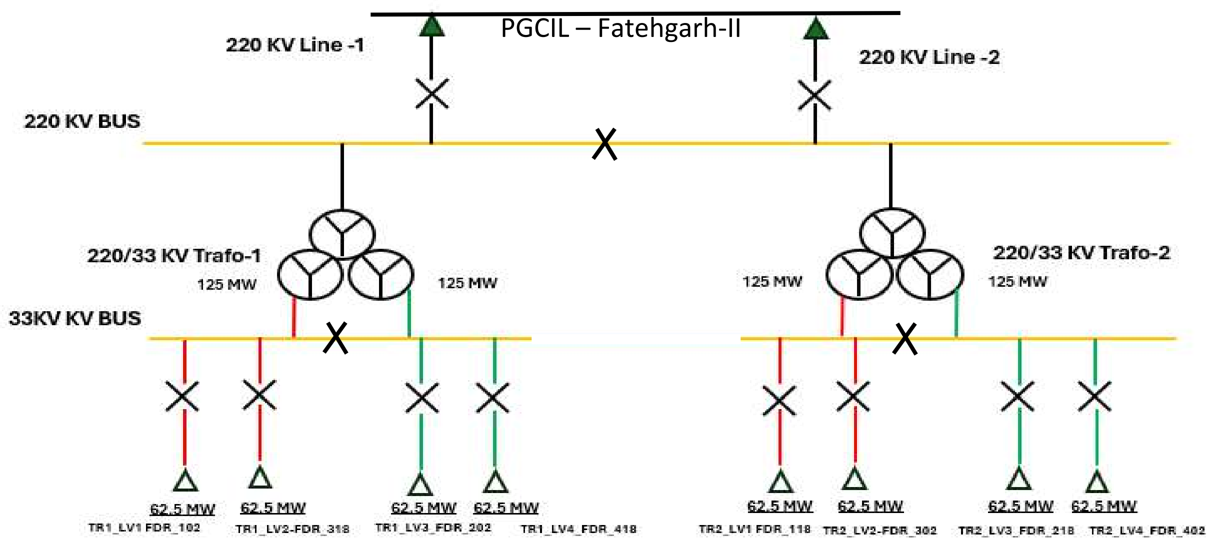
Proposal - Special Protection Scheme for Bhimsar 500 MW - AGEL

- **Plant Details:**

  - Plant Name : Bhimsar, Rajasthan – AGEL 24L
  - Plant Capacity : 500 MW
  - Switchyard Voltage : 220 kV
  - Switchgear Voltage : 33 kV
  - PPC Set Limit : 500 MW.
  - No of Lines : 2no's
  - No of Transformers : 2*250 MVA , 220/33/33 kV
  - No of 33 kV OG Feeders : 8no's

- **Plant SLD:**

220/33 KV 500 MW BHIMSAR Single Line Diagram



- **Pre-Condition:**

  In accordance with the approved scheme as per requirement of renewable plant, there are two transmission line configurations established for the evacuation of the entire plant capacity of 500 MW through double circuit transmission line (6kM OHL + 6kM Cable), connected with 220 kV PG-Fatehgarh-II substation.

  The cable having maximum current carrying capacity 820A per phase per circuit and conductor having maximum current carrying capacity 983A.

  Under normal conditions when the generation is at their peak, these transmission lines together capacity is to evacuate total Generation of 500 MW.

- **Need of Special Protection Scheme (SPS):**

  According to the approved evacuation arrangement as described above, In the tripping event of any one 220 kV line connected to the PGCIL Fatehgarh -II (Rajasthan) substation during peak generation, the total load will be shifted to other healthy line in service. The other line can be overloaded in such scenario. Subsequently there can be complete isolation and loss of total Generation.

  To prevent a blackout and safeguard our plant, it is necessary to limit the power/current within line capacity by implementing the SPS.

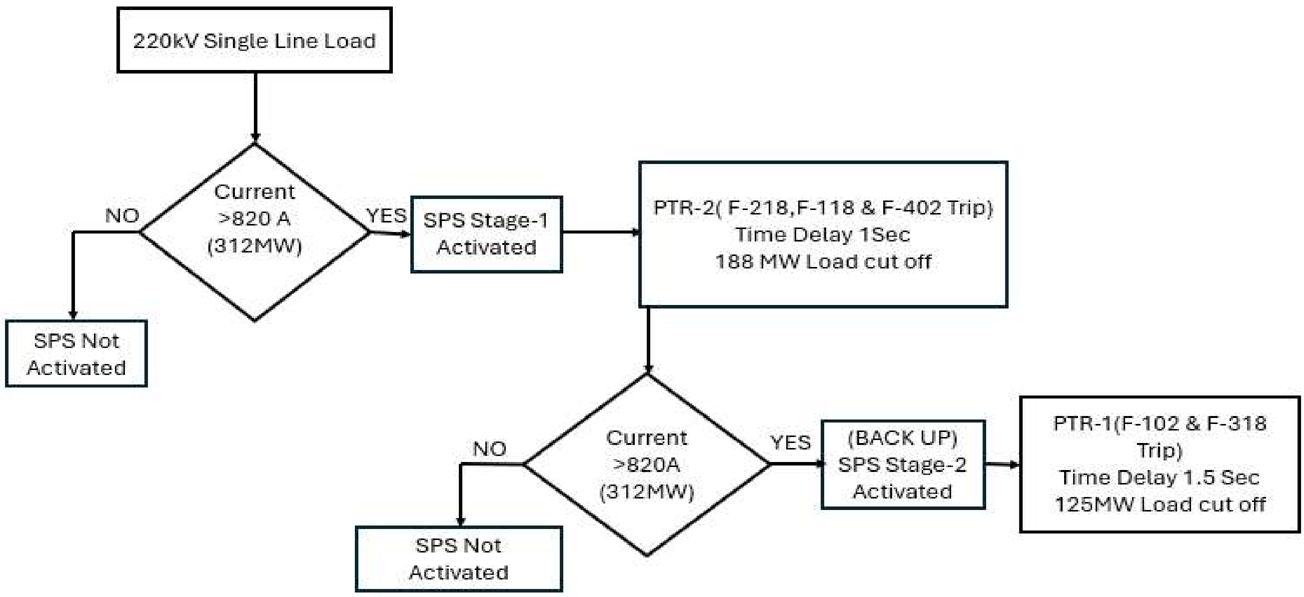
- **The philosophy of SPS is based on limiting the Generation to single Line current capacity.**

  - With a plant total set capacity of 500 MW, current is 1312.15 A at 220 kV Voltage.
  - One line maximum current carrying capacity is considered as 820 A as per cable maximum current carrying capacity at 220 kV which is equal to 312.46 MW. *(1-Core 2000 Sqmm /Phase)*
  - With the above scenario we have to backdown 188 MW (500 MW-312 MW=188 MW).
  - The curtailment of Generation by tripping of selected 33kV LV Feeders, 62.5 MW each.
  - Two stage SPS is proposed to ensure firm curtailment

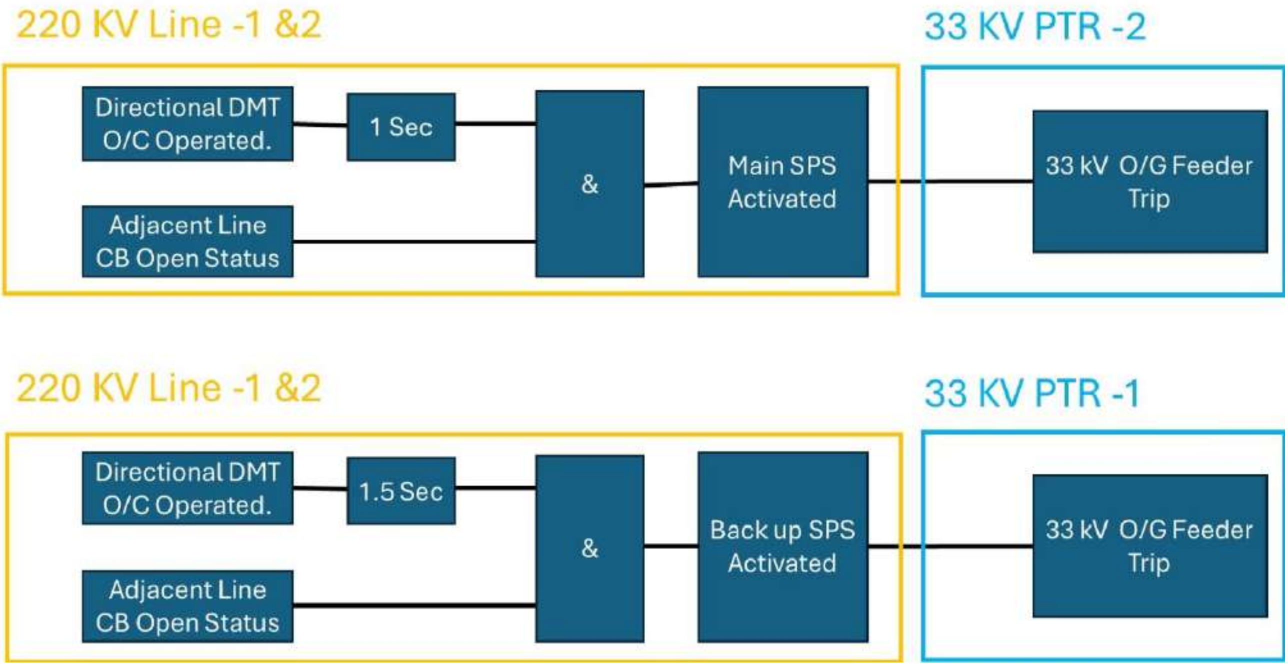
- **SPS configuration concept: -**

  - The SPS is proposed to have two stages of operation to ensure reliable curtailment action.
  - The Over current stages with DT characteristics, available in the Numerical Line Protection Relays, are used to detect and initiate action.
  - The P/U of O/C stage 1 and 2 is considered as 820 A, mentioned above, with time delay of 1 Sec. for Stage-1 and 1.5 Sec., for Stage-2.
  - In the event of failure of Stage-1 or not getting relief the current level may not reach below the threshold (820 A), the stage -2 will be initiated to trip other 33 kV Feeders to get the required evacuation curtailment.
  - The stage-1 is proposed to curtail feeders connected with PTR-2 and Stage-2 with PTR-1 respectively.
  - The functional flow chart and tripping logic are mentioned here under describing the two stage SPS proposed.
  - The over current functions to be used are 3 Phase elements, to avoid undue initiation on fault.

- **SPS Flow Chart:**



- **Relay Tripping Logic:**



Proposal :

With consideration of single line capacity to evacuate power from Bhimsar Plant, it is proposed to implement the proposed SPS to avoid total Generation loss and black out in the event of tripping of one line and overloading of other line.