



220 केवी और उससे अधिक वोल्टेज वर्ग सबस्टेशन उपकरणों की विफलता पर विशेषज्ञों
की स्थायी समिति की रिपोर्ट (जनवरी 2022 - जून 2023)

REPORT OF STANDING COMMITTEE OF EXPERTS ON FAILURE OF 220 kV &
ABOVE VOLTAGE CLASS SUBSTATION EQUIPMENT
(JANUARY 2022 - JUNE 2023)
(Part-I)



Government of India
Central Electricity Authority
Ministry of Power
New Delhi
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(In fulfillment of CEA's obligation under Section 73(1) of the Electricity Act, 2003)

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EXECUTIVE SUMMARY

As per mandate of Standing Committee to investigate the failure of 220 kV and above voltage Class substation/ switchyard equipment and recommend measures to avert recurrence of such failures in future, CEA receives reports of failures of various substation/ switchyard equipment from power utilities, investigates the failures and brings out the report for benefit of Power Sector as a whole.

As part of this report, the failure of substation equipment for the period from 1st January 2022 to 31st June 2023 was analyzed by the Committee for which meetings were conducted on 21.11.2023 and 22.11.2023. Total Twenty one (21) Utilities reported the failure of equipment. Total 49 failure incidences of Transformers and Reactors of 220 kV and above voltage rating were reported between 1st January 2022 and 31st Jun 2023 to CEA. Part-1 of the Report covers the failures of the Transformers and Reactors.

Out of the total equipment failures, 45 cases of Transformer failure were reported. These 45 Transformers constitute 2 Nos. of 765 kV Class Transformers, 16 Nos, of 400 kV Class Transformers and 27 Nos. of 220 kV Class Transformers. Failures of Reactors which were reported during the period are total 4 out of which 1 was 765 kV Class and 3 were 400 kV Class.

From the analysis of the failed transformers, it is found that around 23% failures is due to internal fault, 16% failures pertains to winding insulation failure, and 14% failures pertains to fault in Phase winding.

It is suggested that to prevent the failure of the equipment especially Transformers and Reactors, the practice of Condition Based Monitoring using online modern diagnostic tools should be followed. In case Transformers/ Reactors are reaching their end of Service of life, then close monitoring of these Equipment should be carried out. The frequency/periodicity of measurement should be changed depending on the condition/healthiness of the equipment in operation. The trend of test results should be monitored rather than the absolute values of test results. The regular cleaning of dust deposited on the housings of major equipment and bushings of transformer in Thermal Power Plant or area with heavy pollution are essential to avoid flash over across the insulators as frequent flashovers may lead to failure of the equipment.

A single electrical asset monitoring system shall be installed that can monitor all Medium voltage and high voltage electrical assets like GIS, AIS, Breakers, Power Cables including Transformers for condition based maintenance. All FAT, SAT and Periodic testing data for all electrical equipment shall be stored in this system for performing health assessment. The system shall have advanced health index models that utilizes analytics and threshold limits as prescribed by latest IS, IEEE, IEC, and CIGRE standards / recommendations. This system shall also be capable of integrating online monitoring of sensors installed at electrical assets, and inspection records/reports from the visual inspection of assets. It shall have the capabilities to monitor DGA, Partial discharge – Electrical & UHF, bushing, fan control, fiber optic monitoring and other monitoring parameters. This system shall be installed for transformers, including existing and new transformers; shall support cloud and on-premise installation and provide access to electrical asset health dashboards at engineer's PC, Mobile, Laptops or tablets.

1. INTRODUCTION

A Standing Committee of Experts in the field of design and operation of EHV Substations from CEA, various power utilities and research/academic institutes was constituted under Section 73, Clause (l) of the Electricity Act, 2003, to investigate the failure of 220 kV and above voltage class substation/ switchyard equipment such as Power/Generator Transformer, Circuit Breaker (CB), Instrument Transformer [i.e. Current Transformer (CT), Potential Transformer (PT) and Capacitor Voltage Transformer (CVT)], Surge Arrester (SA), Isolator etc. and recommend measures to avert recurrence of such failures in future. As part of this activity, CEA has been receiving reports of failures of various substation/ switchyard equipment from power utilities. Office order vide which Standing Committee was constituted is enclosed at **Annexure-III**.

The intent behind formation of this Standing Committee was to investigate the causes of failures, deliberate the failures of various substation/ switchyard equipment of Power utilities, suggest remedial measures to prevent recurrence of such events in future and prepare a report which would serve as a repository of case studies of failures and suggested remedial measures for future.

All the utilities are required to report any event of failure of substation equipment at the earliest in the specified format for reporting the incident (available on CEA website and attached as **Annexure- II**) along with all the additional information [like Disturbance Recorder (DR)/ Event Logger (EL) report], SLD, Test reports, O&M history, Photographs etc.) to be submitted by the utilities while reporting the incident. The information about many events are received in CEA with some delay, due to which site visit by the members of the committee could not materialize.

A meeting of the Standing Committee of experts was held in CEA on 21.11.2023 and 22.11.2023 to investigate the failure of substation equipment between 1st January 2022 and 30th June 2023 as reported to CEA by various utilities. Minutes of the meeting are enclosed at **Annexure-IV**.

2. Brief details of the failure of substation equipment failed between 1st January 2022 and 30th June 2023 as reported to CEA

The Committee investigates failures of 220 kV and above voltage class equipment only. A total of 49 failure incidences of Transformers and Reactors of 220 kV and above voltage rating were reported between 1st January 2022 and 30th June 2023 to CEA. This report covers the failure of Transformers and Reactors occurred and reported to CEA between 1st January 2022 and 30th June 2023. The voltage wise quantity of each equipment has been indicated in the Table-1 below:

TABLE-1

Equipment	Voltage Class			Quantity (Nos.)
	220 kV	400 kV	765 kV	
	Quantity (Nos.)			
Transformers	27	16	2	45
Reactors	0	3	1	4
			Total	49

2.1 Quantity of failed equipment and years of service put in by this equipment before failures is given in Table-2.

TABLE-2

Years of Service	Nos. of equipment failed	
	Transformers	Reactors
0-5	12	0
5-10	9	2
10-15	7	2
15-20	6	0
>20	11	0

Note: In some cases, years of service have been considered taking the difference between Re-Commissioning and failure date.

Complete detail of all the above-mentioned failures is provided in **Annexure-I**.

2.2 **Failures of Transformers:**

- Transformer, the costliest equipment in a switchyard/substation, is expected to serve the entire life of a substation which is considered to be 35 years. However, it has been observed that many transformers installed in Indian utilities have failed within first few years of service which is a matter of concern.
- Summary of Inter Connecting Transformers/Generator Transformers (GTs) reported to CEA that have failed between 1st January 2022 and 30th June 2023 is detailed below (Table 3):

Table 3

Sl.No	Utility	Substation	Make	Rating	Year of Commissioning	Date of failure	Probable Cause of Failure*
1	UPRVUNL	Anpara Thermal Power Plant	BHEL	250 MVA, 15.75/400 kV, 3-PHASE	21-06-2012	18-04-2023	No information available
2	NTPL	NTPL	ABB	200 MVA, 21/400/√3 kV 1Phase	19-08-2014	02-09-2022	Failure of OCTC
3	NTPC	Ramagundam	TELK	200 MVA/3-Phase	28-03-2018	17-02-2023	Due to Ageing
4	GSECL	Kadana Hydro Electric Project	Atlanta Electricals Pvt. Ltd	25 MVA, 220/11 kV, 3-Phase	28-03-2018	10-10-2022	Due to hydrogen gas continually increasing in Substationue
5	GSECL	Wanakbori TPS	BHEL	315 MVA, 27/420 kV 1 Phase	03-03-2019	18-02-2023	due to Internal fault
6	DTL	Tikrikalan	TELK	315 MVA, 400/220/33 kV, Three Phase	2005	05-09-2022	due to Internal fault
7	POWERGRID	Khetri	T&R	500 MVA, 765/220 kV, 1-Phase	2021	10-02-2023	due to Internal fault
8	POWERGRID	Rourkela	BHEL	315 MVA, 400/220 kV, 3-Phase	2021	09-04-2023	due to insulation failure of Y-Phase HV series winding
9	NPCIL	TAPS-3&4	TELK	210 MVA, 1-PHASE, 420 kV/√3/21 kV	2005	01-01-2022	Inadequate design of Tank and Core leading to Higher Dissolved gas concentration, hot spots were observed on transformer tank body



Sl.No	Utility	Substation	Make	Rating	Year of Commissioning	Date of failure	Probable Cause of Failure*
10	NPCIL	TAPS-3&4	MERLIN GERIN	210 MVA, 1-PHASE, 420 kV/ $\sqrt{3}$ /21 kV	2004	12-12-2022	SEAL FAILURE
11	NPCIL	TAPS-3&4	TELK	210 MVA, 1-PHASE, 420 kV/ $\sqrt{3}$ /21 kV	01-06-2017	15-06-2023	Not known
12	NPCIL	Kaiga	M/s CGL	167 MVA 400/220 kV ,1 PHASE	1989	02-07-2022	Due to Bushing failure
13	PSTCL	AMLOH	EMCO	100 MVA, 220/66 kV, 3Phase	2000	23-05-2022	Nothing found
14	PSTCL	Malerkotla	BBL	100 MVA, 220/66 kV, 3Phase	25-04-2011	22-06-2022	Due to 66 kV Cap Bank No.1 circuit breaker damage
15	PSTCL	Malerkotla	CGL	100 MVA, 220/66 kV, 3Phase	12-12-1986	22-06-2022	Due to 66 kV Cap Bank No.1 circuit breaker damage
16	PSTCL	G2 MGG	(CGL)	100 MVA,220/66 kV,	11-06-1995	25-09-2022	After internal inspection at site, it was found that the lead of R Phase was flashed.
17	PSTCL	Nabha	BBL	100 MVA, 220/66 kV, 3-Phase	21-06-2011	06-06-2023	Due to falling of 66 kV Bakhopeer (DC) Towers
18	PSTCL	Nakodar	SIEMENS	315 MVA	23-05-2014	06-02-2023	Under Investigation OEM Siemens
19	PSTCL	Mohali	Crompton Greaves	1100 MVA	27-07-1996	30-03-2022	66 kV CHD-II Breaker damaged due to birdage
20	KPTCL	Anchepalya	CROMPTON GREAVES	100 MVA, 220/66/11 kV	01-04-2011	17-08-2022	Tertiary winding failure
21	KPTCL	Receiving station Bidadi	APEX	100 MVA,220 kV	31-12-1998	04-05-2022	Damage in B-Phase Winding



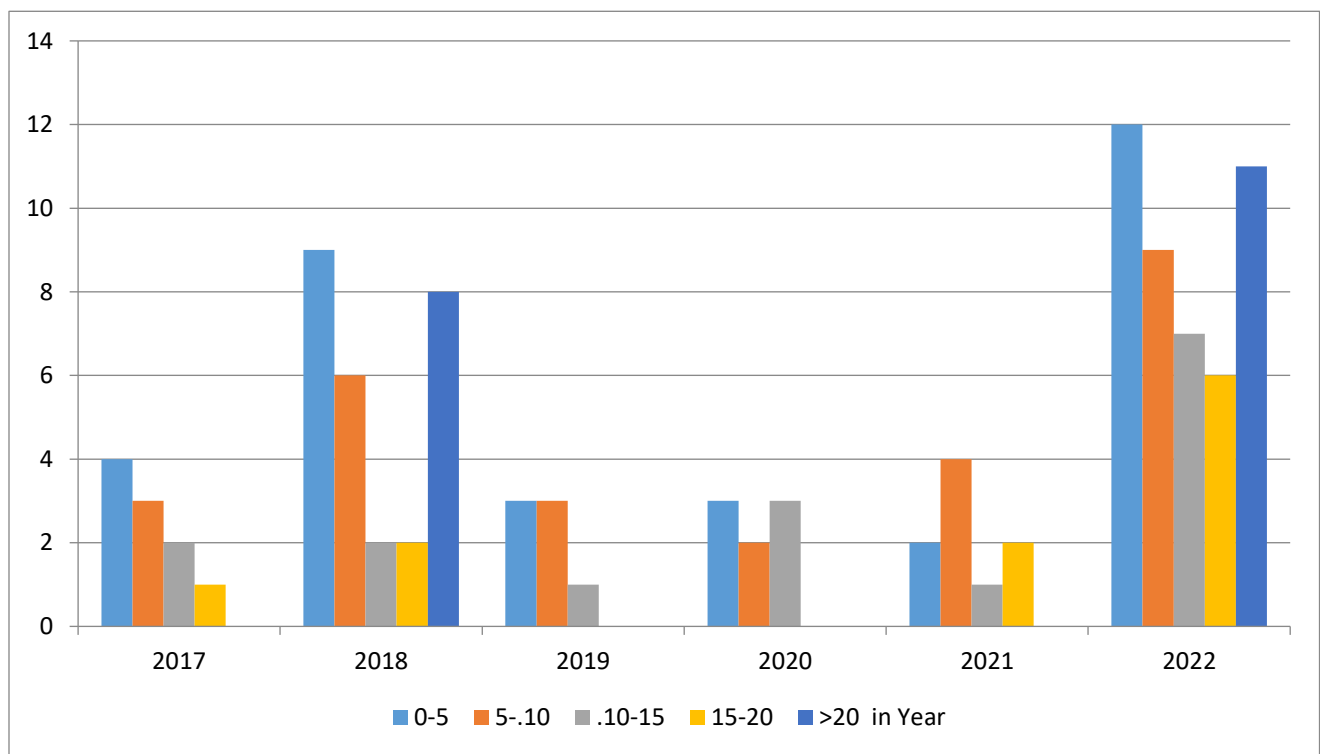
Sl.No	Utility	Substation	Make	Rating	Year of Commissioning	Date of failure	Probable Cause of Failure*
22	KPTCL	MADHUVAN HALLI	ALSTOM	100 MVA, 220/66/11 kV, 3 PHASE	16-03-2006	31-05-2022	Y Phase Winding Faulty
23	KPTCL	HIRIYUR	NGEF	100 MVA, 220/110KV	06-02-2020	06-10-2022	Tertiary LV RB Phase limb Faulty
24	KPTCL	Kavoor	NGEF	100 MVA, 220/110 kV	16-03-1990	30-04-2022	fault in R Phase winding
25	KPTCL	Peenya	CGL	150 MVA, 220/110 kV	07-07-2007	08-10-2022	Due to winding faulty
26	GETCO	DUDHREJ	VOLTAMP	50 MVA 220/11 kV 3 PHASE	24-10-2019	15-09-2022	Due to reflected fault of In 11 kV capacitor Bank bird is short circuited between two Phase
27	GETCO	Mokha	Prime Electric Ltd.	100 MVA, 220/66 kV, 3-Phase	07-03-2015	11-07-2022	Due to internal Fault
28	GETCO	Haladarwa	Crompton Parkinson (CGL)	50 MVA- 220/132 kV-3-Phase	25-09-2012	25-09-2022	Not known
29	GETCO	Timbdi Substation	Oshaka	100 MVA, 220/132 kV, 3-Phase	1978	22-11-2022	all 3 Nos diverter drum broken, LV wdg opened
30	MSETCL	Kharepatan	GEC ALSTHOM	100MVA, 220/132 kV, 3-Phase	03-06-1995	22-09-2022	cause of failure not predictable.
31	MSETCL	KANDALGAON	EMCO TRANSFORMERS	100 MVA, 220/100 kV, 3PHASE	28-06-2017	24-09-2022	Winding insulation failure
32	MSETCL	Lonikand-II	AVAL	100 MVA/220/132 kV	01-12-2021	01-03-2022	Due to insulation failure.
33	MSETCL	Bhosari-1	BHEL	100 MVA/220-22-22/3-Phase	12-08-2016	24-03-2022	due to isolator fault



Sl.No	Utility	Substation	Make	Rating	Year of Commissioning	Date of failure	Probable Cause of Failure*
34	MSETCL	Chakan Substation	EMCO	50 MVA, 220 kV/22 kV ,3-Phase	22-04-2019	18-10-2022	Internal insulation failure..
35	MSETCL	Hinjewadi-1	EMCO	50 MVA, 220/22 kV	10-10-2022	19-10-2022	Due to insulation failure.
36	MSETCL	Bhokardan SUBSTATION	GEC	25 MVA, 220/33 kV,3-Phase	26-07-2019	09-02-2022	Due to insulation failure
37	AEGCL	SONABIL	CGL	100 MVA 60/80/100 220/132/11 kV 3 PHASE	12-01-2016	21-02-2022	Mechanical Wear And Tear
38	WUPPTCL	Hapur	BHEL	500MVA, 765/400/33 kV 1 Ph.	14-08-2017	23-05-2022	Due to Internal fault
39	DTL	Delhi Transco Limited	BHEL	100 MVA 220/66-33/11 kV 3- Phase	1999	07-06-2023	B Phase winding burn
40	RVUNL	Chhabra	ABB	50 MVA, 400/6.9/6.9 kV, 3 Phase	2014	24-05-2023	Unknown
41	RVUNL	Suratgarh	BHEL	275 MVA, 420 /21 kV,1-Phase	14-02-2017	15-03-2022	Due to Failure of HV bushing of transformer.
42	RRVPNL	BIKANER	BHEL	160 MVA 220/132/11 kV)	01-06-2018	07-01-2023	Due to realizing of gas from Buchhloz Relay
43	RVPN	JODHPUR	BHEL	315 MVA , 400/220 kV, 3-Phase	14-03-2005	29-05-2023	Internal fault
44	MPPTCL	Narmadapurm	AREVA	160 MVA 220/132/33 kV 3 PHASE	31-01-2009	27-06-2022	Internal fault
45	MPPTCL	Nagada	BHEL	315 MVA(400/220 /33 kV)	15-11-1997	27-08-2022	Due to insulation failure

The probable cause of failure is based on information, data, and reports furnished by the utility

- iii. As can be seen from Table 3 above, forty-five (45) transformer failure cases from 1st January 2022 and 30th June 2023 have been reported by sixteen (16) Utilities to CEA. It is a matter of concern that more than 50% of the reported failed transformers were in operation/service for less than 15 years. It is highlighted that a large number of transformer failure cases remain unreported as many of power utilities [State Transmission Utilities, Private Utilities/Licensees, Central Transmission Utilities, Public Sector Power Utilities] in the Country have not reported the failures.
- iv. Failures of transformers during 2017-2022: The number of different transformer failures as reported in the last 5 years to CEA has been shown in the graph. below:



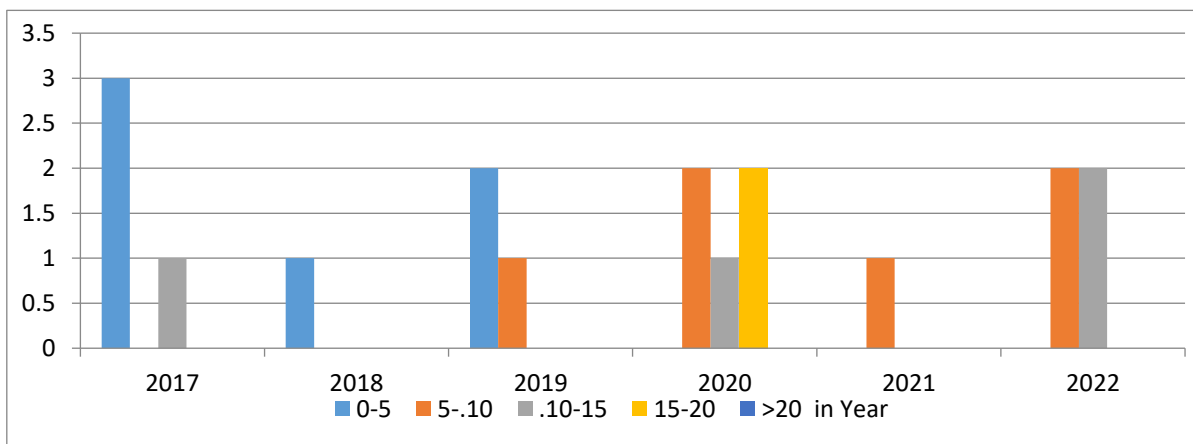
2.3 Failures of Reactor:

- i. Failure of following Reactors has been reported to CEA during the period from 1st January 2022 and 30th June 2023 by four (4) utilities which is of 400/220 kV and 765kV class. Cause of failure is based on information, data and reports furnished by the utility.

Table 4

S.No	Utility	Substation	Make	Rating	Year of commi-Substationi oning	Date of failure	Probable Cause of failure*
1	DVC	Koderma	BHEL	50 MVAR, 420 kV, 3-Phase	04-04-2013	20-04-2023	Insulation Failure
2	POWERGRID	Raipur	Alstom	125 MVAR ,3-Phase	2014	30-09-2022	Failure of HV bushings
3	NPCIL	Kudankula n	ZAPO ROZH TRANSFOR MATO R	26667 kVA r	05-10-2012	27-11-2022	Winding part HV – N2 winding (one out of two parallel winding) was found electricall y open
4	RVPN	ANTA	NA	3X80 MVAR , 765 kV	05-01-2015	29-03-2023	Gradding capacitor failed.

- ii. Failures of reactors during 2017-2022: The number of different reactor failures as reported in the last 5 years to CEA has been shown in the graph below.



3. OBSERVATIONS:

- i. It is observed that reported failures are primarily due to following reasons:
 - a) Normal Ageing
 - b) Failure of Insulation system and Bushing for Transformers and Reactors.
 - c) Lack of prudent maintenance practices
 - d) Frequent System Faults and transient over voltages generated by the system.
- ii. Condition Based Maintenance (CBM) Practices using modern diagnostic tools is not being followed by most of the utilities and in general, periodic Time Based Maintenance (TBM) is still being practiced.
- iii. Adequate modern Diagnostic tools are not available with most of the State Utilities.
- iv. Most of the utilities are facing problem due to shortage of technical staff for operation and maintenance of sub-station equipment. Sometimes interpretation of test results becomes difficult in absence of experts / experienced O&M staff.
- v. Sometimes due to unavailability of shut down, maintenance of equipment is deferred which affects the efficient functioning of the equipment and further deteriorate the health of equipment.
- vi. In most of the cases of failures, utilities do not furnish factory test reports, pre-Commissioning test reports, history of O&M and repairs, relay settings, environmental and system conditions at the time of failure etc. which makes it very difficult to analyze the cause of failure.
- vii. In case of failure of transformers and reactors, report of detailed internal inspection carried out by the Original Equipment Manufacturer (OEM) at site or at its works are not provided.

4. RECOMMENDATIONS:

4.1 Recommended measures suggested by the Committee for the Utilities to improve the performance of the substation equipment are listed below. These are aimed at improving the performance of equipment and using modern diagnostic tools for condition assessment so as to keep substation equipment healthy for long trouble-free and reliable operation.

4.2 General Recommendations:

- i. All the utilities should furnish preliminary information of failure of substation equipment of 220 kV and above voltage class within 48 hours of the occurrence of the failure and detailed report within a Month in the prescribed format available at Annexure-III and also on CEA website. The report should accompany tests carried out after failure, test reports and details of previous maintenance, pre-Commissioning test reports, and Photographs of the failed equipment.
- ii. The utilities should report to the Original Equipment Manufacturer (OEM) about the failure of equipment, even if the warranty has expired, which may

help the manufacturers to take corrective action for improving the product design.

- iii. The practice of Condition Based Monitoring using online modern diagnostic tools should be followed instead of conventional Periodic / Time-Based Maintenance. A list of diagnostic tools is given in CEA Grid Standard Regulations which can be used for one substation or a pool of substations depending upon requirement.
- iv. A single electrical asset monitoring system shall be installed that can monitor all Medium voltage and high voltage electrical assets like GIS, AIS, Breakers, Power Cables including Transformers for condition based maintenance. All FAT, SAT and Periodic testing data for all electrical equipment shall be stored in this system for performing health assessment. The system shall have advanced health index models that utilizes analytics and threshold limits as prescribed by latest IEEE, IEC, and CIGRE standards / recommendations. This system shall also be capable of integrating online monitoring of sensors installed at electrical assets, and inspection records/reports from the visual inspection of assets. It shall have the capabilities to monitor DGA, Partial discharge – Electrical & UHF, bushing, fan control, fiber optic monitoring and other monitoring parameters. This system shall be installed for transformers, including existing and new transformers; shall support cloud and on-premise installation and provide access to electrical asset health dashboards at engineer's PC, Mobile, Laptops or tablets.
- v. Condition monitoring as mentioned in Standard specifications and technical parameters for transformers and reactors (66 kV & above voltage class) CEA standard may be adopted.
- vi. The frequency/periodicity of measurement should be changed depending on the condition/healthiness of the equipment in operation. The trend of test results should be monitored rather than the absolute values of test results.
- vii. Utilities should follow the practices for maintenance of each equipment. All the equipment which have reached/ approaching the end of service life need to be monitored closely and utility should plan and take action in advance for replacement of such equipment in a Phased manner.
- viii. The utilities should make it a practice to carry out various tests on major electrical equipment at sites one or two months prior to expiry of warranty period of respective equipment so that any abnormality observed in test results can be discussed with OEM for taking up further necessary action within the warranty period.

- ix. The utilities must be careful during installation of transformers at site and long hanging connecting leads which might touch with other parts of the transformer, should be avoided.
- x. The utilities must be careful while storing the equipment as spare or keeping transformer uncharged in the yard for long time before putting in to service. The OEM's recommendation for storage should be followed strictly. Spare equipment should be periodically tested as per OEM's recommendation.
- xi. Utilities should take appropriate action for repair/replacement of concerned equipment as soon as some abnormality is observed through visual inspection or diagnostic tests.
- xii. Frequent failures of equipment of any particular make should be thoroughly investigated in consultation with OEM and necessary action including design modification, if required, should be carried out by OEM.
- xiii. Most of the utilities are facing problem due to shortage of supporting staff for operation & maintenance of sub-station equipment. The manpower should be strengthened for efficient operation & maintenance.
- xiv. The regular cleaning of dust deposited on the housings of major equipment and bushings of transformer in Thermal Power Plant are essential to avoid flash over across the insulators, as such frequent flashover across the bushing / housing of equipment (due to operation in such dusty environment) may lead to failure of equipment. Wherever feasible, the porcelain housings of bushings of transformer may be protected by providing Room Temperature Vulcanisation (RTV) coating. RTV coating over porcelain housing of bushings of transformer & reactors may also be considered by utilities for substation equipment installed in pollution prone areas.
- xv. Utilities should create and maintain complete data base of equipment/transformers including previous test reports (reports of factory tests/pre-Commissioning tests/tests during O&M etc.), operation & maintenance history of equipment with make, model & year of Commissioning etc. for proper evaluation, interpretation of test results and for taking Run-Refurbish-Replacement decision.
- xvi. However, merely maintaining the history of O&M is not sufficient. Test results are not useful if correct method of testing is not followed. All tests and maintenance should be carried out as per best practices. The method of testing as well as the conditions while conducting the tests should be consistent / identical to previous testing condition as far as possible. For example, test voltage, tap position at which test is conducted etc should be maintained while measuring IR or Turns Ratio, or conducting SFRA and

other similar tests. Details of test kits, should be maintained so that the test results can be compared with subsequent test results. For variation in temperature, required correction factors could be incorporated. Calibration of the testing instruments should be ensured for reliability of the assessment.

- xvii. Utilities should explore the possibility of installation of CCTV cameras in the substation, covering transformer area so that transformers could be monitored from the control room and any mishap with the transformer could be recorded for further analysis. It would also help to determine the point of initiation and actual cause in case of fire in transformer.
- xviii. If any damaged equipment is sent to the manufacturer's works for repair, detailed investigation report including probable causes of failure should be submitted to the Standing Committee for benefit of the other utilities.

4.3 Recommendations for Transformers (ICT and GT), Reactors and Instrument Transformers (CT/PT/CVT):

- i. The proper handling, loading, transportation, unloading, and storage at site before assembling play important role in satisfactory operation of equipment.
- ii. The erection of major equipment including transformers/reactors should always be carried out by experienced technical team under the close supervision of manufacturer.
- iii. Inordinate delay in Commissioning of equipment after reaching at site should be avoided.
- iv. When there is a wide gap between the year of manufacturing and year of Commissioning of the transformers/ reactors, proper care must be taken to ensure satisfactory operation of transformer/ reactor. Storage and periodic testing of transformer/ reactor should be done as per manufacturer's recommendations.
- v. Transformer/ reactors should not be kept for more than three (3) months with dry air/inert gas (Nitrogen) filling and all throughout the period, required Pressure needs to be maintained in order to avoid the exposure of active part to atmosphere. After three (3) months, transformer/ reactor should be filled with oil under vacuum and it should be provided with oil conservator including oil level indicator and breather. The oil parameters need to be monitored regularly.
- vi. As far as possible the transformer/ reactor should be transported filled with dry air. Use of nitrogen for this purpose should be avoided.

- vii. The height of the fire wall between two transformers/reactors should be at least 600 mm above the highest point of the transformer and fire wall should be rated for four-hour fire rating so that fire in one transformer/reactor does not affect adjacent transformers/ reactor.
- viii. Whenever there is movement of transformer either from manufacturing works or from one station to other, **Sweep frequency response analysis (SFRA)** should be carried out before movement and after shifting to new location and in case of any discrepancy, OEM may be contacted. SFRA signature would provide valuable information about deformation in winding /core during transportation.
- ix. On Load Tap Changer (OLTC) is one of the contributors to the failure of transformer. The possibility of eliminating OLTC from 400 kV & 765 kV class transformer should be considered (based on system studies) in consultation with Regional Power Committee (RPC) and Regional Load Despatch Centre (RLDC)/Grid-India and CEA. The reduction in number of tap steps can also be considered in case of OLTC of 220 kV and below voltage class transformers. The removal of OLTC will simplify the design and manufacturing of transformers.
- x. Tertiary winding should be avoided, wherever feasible, as it increases the probability of failure of the transformer. Tertiary terminals of transformer prone to short circuiting by external element such as bird or animal may be suitably insulated.
- xi. Transformer should be subjected to short circuit test as per CEA Regulations to verify its capability to withstand dynamic effect of short circuit. The design review of the transformers should be carried out properly before commencement of manufacturing. Stage inspection should also be carried out to check manufacturing process as well as quality of material used in subsequent transformers.
- xii. An internal inspection of the failed transformer on-site is warranted at times to locate fault inside the transformer and to assess the extent of damage. As far as possible, internal inspection should be carried out in association with OEM / in presence of representative of OEM. All safety precautions must be observed at all times. Internal inspection must be performed by experienced staff with proper training. The internal inspection should not cause any further damage to the transformer and precaution should be taken to prevent ingress of moisture and any foreign material into the transformer and hence internal inspection should be meticulously planned.
- xiii. As far as possible, LV test and SFRA should be conducted after through fault to check the integrity of the transformer.

- xiv. The capacitance and tan delta measurement of transformer bushing at variable frequency and **Dissolved gas analysis (DGA)** of bushing oil should be carried out for health assessment of bushings as this has been proved to be very effective in assessing the condition of in-service bushings.
- xv. Residual Life Assessment (RLA) should be conducted for old and aged transformers (approaching end of service life) for proper planning to replace them in stages.
- xvi. Periodic oil testing including DGA (wherever feasible) in the case of instrument transformers are recommended. Health of gaskets and bellows needs to be checked periodically for CTs. Thermo-vision scanning of CTs, CVTs and PTs should also be carried out regularly as a good maintenance practice.
- xvii. At the substations where fault level has increased beyond the design level, suitable corrective measures such as splitting of bus or employment of fault limiting devices should be adopted.



Annexure- I

**Detailed Information of Failure of Transformers and Reactors from 1st
January 2022 to 30th June 2023 as reported to CEA**

TRANSFORMERS

1. Failure of 250 MVA, 15.75/400 kV, 3-Phase at Anpara Thermal Power Plant

i.	Name of Substation	:	Anpara Thermal Power Plant
ii.	Utility	:	UPRVUNL
iii.	Faulty Equipment (ICT/Autotransformer/GT/Reactor etc.)	:	GT
iv.	Rating (MVA/MVAR, Voltage ratio/1-Phase/3-Phase)	:	250 MVA, 15.75/400 kV, 3-Phase
v.	Make (Original equipment manufacturer)	:	BHEL
vi.	Serial No.	:	6006863
Vii	Date and time of occurrence of fault	:	18.04.2023 at 8:48 hrs
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	Operation
ix.	Year of Manufacturing	:	2012
x.	Date of Commissioning	:	21.06.2012
xi.	Detail of Tests done after failure	:	DGA of burnet transformer oil of GT. No Electrical tests were performed because All HT Bushings along with tank were damaged. Hydrogen H₂ : 3261 ppm Water H₂O : 69 ppm Carbon Dioxide CO₂ : 3481 ppm Carbon Monoxide CO: 264 ppm Ethylene C₂H₄ : 390 ppm Ethane C₂H₆ : 58 ppm Methane CH₄ : 399 ppm Acetylene C₂H₂ : 353 ppm TDCG :4724 ppm
xii.	Observation (Visual observation e.g. bulging of tank, fire, any leakage of oil,	:	GT burnt and all oil leaked due to transformer tank damaged.

	damage to various components of transformer and nearby equipment /material etc.)		
xiii.	Probable cause of failure	:	DGA test results indicated incipient fault in the Transformer.
xiv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached	:	
xv.	Present condition of equipment (whether repairable or beyond repair)	:	Kept isolated for repairing.
xvi.	Details of any previous failure on the same unit.	:	GT was running smoothly before this incidence.
xvii.	Is tertiary winding provided (yes/No)	:	No.
Xviii	Whether relay time is synchronized with UTC.	:	No
xix.	Bushing details (OIP/RIP/RIS, Porcelain/Polymer housing)	:	OIP
xx.	On Load Tap Changer or off Circuit Tap Changer.	:	Off Circuit Tap Changer
xxi.	Tap position of OLTC at the time of failure	:	3
xxii.	Past record of Operation of OLTC	:	N.A.
Xxiii	Tap Range	:	1 to 5
xxiv.	Details of Protection provided for ICT/GT/Reactor	:	REF, Differential, Over Current
xxv.	Details of Protection operated	:	REF, Differential
xxvi.	Whether equipment is properly earthed	:	Yes
xxvii.	Earth Resistance of Substation and date of its measurement	:	0.3 Ohm (12.01.2021)

xxviii	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure.	:	Yes Yes R-Phase no change, Y-Phase 01 increase, B-Phase not available due to damage of surge counter
xxix.	Lightning Impulse and Switching Impulse withstand Voltage of the bushings of all voltage level	:	1550 kVp and 1180 kVp
xxx.	Lightning Impulse and Switching Impulse withstand Voltage of the winding of all voltage level.	:	1425 kVp and 1175 kVp
xxxi.	Type of Fire protection provided (Emulsifier system/N ₂ Injection based fire protection system/ foam based protection etc.)	:	Emulsifier System
xxxii.	Whether conditions at the time of failure (Clear sky/rainy/thunderstorm etc.)	:	Clear Sky
xxxiii	Storage Condition of equipment at site before Commissioning: a. Period of storage b. Idle charged or uncharged c. Dry air filled/Nitrogen filled/Oil filled	:	Idle Charged
xxxiv.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation ?	:	No
xxxv.	Number of through faults the equipment was subjected to before failure	:	Nil

2. Failure Report of 200 MVA, 21/400/ $\sqrt{3}$ kV GT at NLC Tamilnadu Power Limited

i.	Name of Substation	:	NTPL 400 KV GIS
ii.	Utility	:	NLC Tamilnadu Power Limited
iii.	Faculty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	GT
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	200 MVA, 21/400/ $\sqrt{3}$ kV 1-phase
v.	Make (Original equipment manufacturer)	:	ABB
vi.	Serial No	:	14030-002
vii.	Date and time of occurrence of fault	:	02/09/2022, 07:27 Hrs
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	Operation
ix.	Year of Manufacturing	:	2012
x.	Date of Commissioning	:	19/08/2014
xi.	Sequence of events/ Description of fault (SOE with time stamp, Protection operated during fault)	:	In NTPL, M/s. ABB make 200MVA, 21/400/$\sqrt{3}$ KV Unit-1 Single Phase 'Y' Phase Generator Transformer got failed on 02.09.2022 at 07.27 hrs. while in service with the indications viz., phase differential protection. WTI, HV and LV High, OTI High, PRV and Buchholz relay Trips protection. First up Protection Acted: • GT differential protection (87GT). • Differential trip Y phase ,Y phase PRV-1 operated. • Overall differential protection (87OA).



			- Differential trip R phase ,Differential trip Y phase PRV-2 operated. - Y phase Buchholz operated.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated)	:	IR value, Winding resistance HV and LV, HV side Winding Resistance could not be ascertained.
Fault Current recorded in GT Differential Relay:			
HV side (400 kV side)			
	Before Trip	During Trip	
R-Ph	661.03 A	706 A	
Y-Ph	685.5 A	3270 A	
B-Ph	694.1 A	961 A	
LV side (21 kV side)			
	Before Trip	During Trip	
R-Ph	12617 A	14700 A	
Y-Ph	13042 A	36400 A	
B-Ph	13249 A	20200 A	
xiii.	Observations (Visual observations e.g bulging of tank fire, any leakage of oil, damage to various components of transformer and nearby equipment/material etc.)	:	Fire and abnormal noise were observed. OCTC top cover got sheared into pieces. - Completed active part along with core and tank bottom found carbonized. - Bottom oil formed slurry due to contamination against carbon formed due to arcing burnt insulation, burnt contact, copper

			granules etc. physical inspection reveals damage at OCTC only. However, it is solely not sufficient generate quantum of carbon observed. The involvement of any of the winding during fault is suspected. The transformer is subjected to catastrophic failure which was caused severe damage to HV/regulating winding, OCTC and diverter. Since data collected not sufficient to establish the cause of exact failure and additional inspection recommended at their factory.
xiv.	Probable cause of failure	:	OCTC is main cause of the failure.
xv.	a. Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) b. Whether any abnormality observed in these tests. If yes, attach the test reports. c. What steps were taken to address the abnormality?	: : :	MRT testing of transformer was carried out Dec2020 during Unit-1 major Overhaul The HV winding resistance were measured in all the taps. Oil BDV and water PPM is being tested departmentally in every quarter and all oil parameter tested external agencies in every six month. DGA is being carried out on quarterly bass by M/s CPRI and external agency. The values are found normal. No NA
xvi.	Whether relay time is synchronized with UTC	:	No
xvii.	Bushing details	:	OIP

	(OIP/RIP/RIS, Porcelain/Polymer housing)		
xviii.	On Load Tap Changer or Off Circuit Tap Changer	:	OCTC
xix.	Tap position of OLTC at the time of failure	:	5
xx.	Past Record of Operation of OLTC	:	None
xxi.	Tap Range	:	1-9
xxii.	Details of Protection Provides for ICT/GT/Reactor	:	GT Differential, Overall Differential, Over Current, Earth Fault, PRV, Bucholz, WTI, OTI
xxiii.	Details of Protection Operated	:	81GT-Diff Trip, Y Phase, PRV1, 870A-Diff Trip R,Y, PRV2 Y Phase
xxiv.	Whether Equipment is Properly Earthed	:	Yes
xxv.	Surge arrestor: (a) Is SA Provided for protection (b) Whether Healthiness of SA is Monitored (c) Whether Reading of SA Counter Changed During Failure	: : :	Yes No
xxvi.	Lightning Impulse and Switching Impulse withstand Voltage of the Bushing of all Voltage Level	:	Lightning Impulse, HV-1675 kV, LV -170 kV, N-170 kV Switching Impulse - H.V – 1300 kV
xxvii.	Lightning Impulse and Switching Impulse withstand Voltage of the Winding of all Voltage Level	:	Lightning Impulse, HV-1425 kV, LV -125 kV, N-125 kV Switching Impulse- HV – 1050 kV
xxviii.	Type of fire Protection Provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier



xxix.	Whether condition at the time of failure (Clear Sky/ rainy/ thunderstorm etc.)	:	Clear Sky
xxx.	Storage condition of equipment at site before Commissioning: (a) Periods of Storage (b) Idle charged or uncharged (c) Dry air filled/ Nitrogen filled / Oil filled	: : :	 Uncharged Oil filled
xxxi.	Number of through faults the equipment was subjected to before failure.	:	None

3. Failure Report of 200 MVA, 3-Phase Auto Transformer-1 at Ramagundam substation of NTPC

i.	Name of Substation	:	400 kV NTPC Ramagundam
ii.	Utility	:	NTPC
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Auto Transformer-1
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	200 MVA, 3-Phase
v.	Make (Original equipment manufacturer)	:	TELK
vi.	Serial No.	:	140058-01
vii.	Date and time of occurrence of fault	:	17.02.2023, 00:37:43.378 Hrs.
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Tripped on Differential Protection
ix.	Year of Manufacturing	:	1983
x.	Date of Commissioning	:	1983
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Tripped on Differential protection,
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	

Following are the results of low voltage tests conducted after internal inspection without oil:
Test Voltage: 100 V

1. Ratio Test:
HV-IV

Tap No.	Design Ratio	U-Ph	V-Ph	W-Ph
1	3.3333	3.3269 (+0.18%)	3.3299 (+0.09%)	3.5643 (-6.49%)
9b	3.0303	3.0257 (+0.14%)	3.0263 (+0.12%)	3.2971 (-8.12%)
12	2.917	2.9081 (+0.31%)	2.9106 (+0.22%)	3.200 (-8.86%)
17	2.727	2.7196 (+0.27%)	2.7200 (+0.26%)	3.043 (>10%)

HV-LV

Tap No.	Design Ratio	U-Ph	V-Ph	W-Ph
9b	6.998	6.991 (+0.10%)	6.989 (+0.13%)	7.686 (-8.95%)

IV-LV

Tap No.	Design Ratio	U-Ph	V-Ph	W-Ph
9b	2.309	2.309 (0.00%)	2.308 (+0.05%)	2.3141 (-0.22%)

2. Single Phase Exciting Current:

Phase	HV	IV
U-Ph	1.94 mA	10.08 mA
V-Ph	1.97 mA	10.04 mA
W-Ph	82 mA	1.14 A

3. Three Phase Exciting Current:

Phase	HV	IV
U-Ph	16.16 mA	154.6 mA
V-Ph	15.42 mA	152.4 mA
W-Ph	31.30 mA	309.1 mA

4. Magnetic Balance Test:

HV	Applied Voltage Between (V)	Voltage Measured Between (V)		
		1U-N	1V-N	1W-N
	1U-N	100.8	99.2	1.02
	1V-N	98.4	100.3	1.72
	1W-N	17.84	74.1	100.6

IV	Applied Voltage Between (V)	Voltage Measured Between (V)		
		2U-N	2V-N	2W-N
	2U-N	101	100.2	0.78
	2V-N	99.7	100.5	0.95
	2W-N	20.67	80.2	100.9

5. Three Phase Low Voltage Impedance:

Phase	Voltage (V)	Current (A)	Impedance
U-Ph	100.1	0.533	13.52%
V-Ph	100.2	0.518	
W-Ph	100.1	0.522	

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of	:	Nil
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	transformer and nearby equipment / material etc.)		
xiv.	Probable cause of failure	:	Operation of Differential Protection indicates fault inside the transformer. From DGA test, physical inspection and low voltage test results, it is suspected that there is a chance for internal arcing in W phase coil. The root cause of inter-turn shorting could be the weakening of insulation due to ageing.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	From DGA values, physical inspection and low voltage test results, it is suspected that there is a chance for internal shorting in W Phase coil. The root cause of inter-turn shorting could be the weakening of insulation due to ageing, which can be explained after the disassembly of the transformer at the factory. The other two phases do not show any abnormalities in low-voltage tests. However, low voltage tests are inconclusive, and healthiness can only be confirmed after factory tests. The repair of the unit is not advisable at the site, as perfect assembly and clamping are difficult to achieve at the site. Further, the effectiveness of repair and healthiness-of the transformer cannot be ensured without a factory test. The transformer is more than 40 years old and the ageing of insulation is common for all three phases; hence to provide a healthy unit after repair works it is suggested to replace all the three coils, core insulation parts, transformer accessories that are found faulty during inspection at TELK factory and carryout OLTC overhauling.
xvi.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in	: :	(a) 30.10.2021 (b) Tests were normal. However, increasing

	these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	trend of C ₂ H ₄ (Ethylene) gas in DGA Test report was observed since March 2021 © Internal inspection of the transformer was carried out by OEM in October 2021 and clearance was obtained by OEM to take transformer into service. Continuous monitoring of DGA report was in place.
xvii.	Details of any previous failure on the same unit	:	Nil
xviii.	Is tertiary winding provided (Yes/No)	:	Yes
xix.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xx.	Whether tertiary terminals are bare/ insulated	:	Insulated
xxi.	Details of protection for Tertiary	:	Differential
xxii.	Whether relay time is synchronized with UTC	:	Yes
xxiii.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxiv.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC
xxv.	Tap position of OLTC at the time of failure	:	12
xxvi.	Past record of Operation of OLTC	:	Nil
xxvii.	Tap Range	:	1-17
xxviii.	Details of Protection provided for ICT/GT/Reactor	:	(i) Differential (ii) Directional Over Current (iii) Earth Fault, Restricted Earth Fault
xxix.	Details of Protection operated	:	Differential
xxx.	Whether equipment is properly earthed	:	Yes
xxxi.	Earth Resistance of Substation and date of	:	0.48 Ohm, 10.04.2023

	its measurement		
xxxii.	Surge arrestor: (a) Is SA provided for protection (b) Whether Healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	(a)Yes (b) Yes (c) No
xxxiii.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	Lightning Impulse 400 kV-1550, 132 kV-650 kVp, 33 kV-250 kVp Switching Impulse: 1175 kVp
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	Lightning Impulse 400 kV-1300 kVp, 132 kV- 550 kVp, 33 kV-250 kVp Switching Impulse: 1050 kVp
xxxv.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier System
xxxvi.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear sky
xxxvii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	It is in charged condition since 1983 and not a newly commissioned transformer.
xxxviii.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Yes
xxxix.	Number of through faults the equipment was subjected to before failure	:	8

4. Failure Report of 25 MVA, 220/11 kV, 3-Phase Station Transformer at Kadana Hydro Electric Project-GSECL

i.	Name of Substation	:	Kadana Hydro Electric Project-
ii.	Utility	:	GSECL
iii.	Faulty Equipment (ICT/Auto-transformer /GT/Reactor etc.)	:	25 MVA Station Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1 Phase /3-Phase)	:	25 MVA, 220/11 kV, 3-Phase
v.	Make (Original equipment manufacturer)	:	M/s Atlanta Electricals Pvt. Ltd.
vi.	Serial no.	:	AET 1253/6151
vii.	Date and Time of occurrence of fault	:	10/10/2022 , 4:20 AM
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	Operation
ix.	Year of Manufacturing	:	02/2018
x.	Date of Commissioning	:	28/03/2018
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	The hydrogen gas was continually increasing since commissioning as per DGA report of ERDA every three months. Protection operated (i) Master relay trip-86 (ii) Aux MPRV/OPRV Trip 30 (iii) E/F Aux Buchholz/OLTC Trip (iv) HV/LV REF Protection-87 (v) Differential protection (vi) OTI/WTI Trip (vii) NIFPS system operated
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	No test done after failure. Reason OEM representative has inspected the site immediately after failure and after opening of inspection window, the fault was occurred in the transformer and HV R-Phase main lead got burnt, All HV bushing base found crack
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	HV R-Phase main lead got burnt. All HV bushing base found crack. The oil was found completely black due to internal flashover/fault.

xiv.	Probable cause of failure	:	Operation of Differential relay along with operation of Buchholz and PRV relays indicates fault inside the transformer. Operation of REF indicates that fault involved ground. The increase in H ₂ gas indicates arcing in the oil.
xv.	Present condition of equipment (Whether repairable or beyond repair)	:	Beyond repair (Under Guarantee period) OEM has been completed the replacement along with erection and testing by new transformer against faulty transformer.
xvi.	a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) b) Whether any abnormality observed in these tests. If yes, attach the test reports. c) What steps were taken to address the abnormality?	: : :	a) Not applicable (New transformer under guarantee period) b) Yes, hydrogen gas was continually increasing in DGA report. c) Continually follow up with OEM regarding the said matter
xvii.	Details of any previous failure on the same unit	:	No previous failure occurred on the same unit
xviii.	Is tertiary winding provided (Yes/No)	:	No
xix.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xx.	Whether tertiary terminals are bare/insulated	:	NA
xxi.	Details of protection for Tertiary	:	NA
xxii.	Whether relay time is synchronized with UTC	:	NA
xxiii.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP porcelain bushing
xxiv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxv.	Tap position of OLTC at the time of failure	:	9
xxvi.	Past record of Operation of OLTC	:	No, OLTC Fix
xxvii.	Tap Range	:	1 to 17

xxviii.	Details of Protection provided for ICT/GT/Reactor	:	NA
xxix.	Details of Protection operated	:	Master relay trip-86 Aux MPRV/OPRV Trip 30E/F Aux Buchholz/OLTC Trip HV/LV REF Protection-87 Differential protection OTI/WTI Trip NIFPS system operated
xxx.	Whether equipment is properly earthed	:	Yes
xxxi.	Earth Resistance of Substation and date of its measurement	:	-
xxxii.	Surge arrester : a) Is SA provided for protection b) Whether healthiness of SA is monitored c) Whether reading of SA counter changed during failure	:	Yes
xxxiii.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	1050 kVp
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	Lighting Impulse Test BIL:1050 kVp Chopped Impulse Test BIL:1155 kVp Switching Impulse Test BIL: 850 kVp
xxxv.	Type of Fire protection provided (Emulsifier system/N2 Injection based fire protection system/foam based protection etc.)	:	N2 injection based fire protection system
xxxvi.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear sky
xxxvii.	Storage condition of equipment at site before Commissioning : a) Period of storage b) Idle charged or uncharged c) Dry air filled/Nitrogen filled/Oil filled	:	No Storage
xxxviii.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand: capability was verified on the basis of calculation?	:	Yes

5. Failure Report 322 MVA, 27/420 kV 1 Phase Generator Transformer at Wanakbori TPS of GSECL

i.	Name of Substation	:	400 kV Wanakbori TPS		
ii.	Utility	:	GSECL		
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	GT-8-B Phase		
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	322 MVA, 27/420 kV 1 Phase Gen. Transformer		
v.	Make (Original equipment manufacturer)	:	BHEL		
vi.	Serial No.	:	6007555		
vii.	Date and time of occurrence of fault	:	18/02/2023		
viii.	Fault discovered during (Operation or periodic testing / maintenance)	:	Operation		
ix.	Year of Manufacturing	:	2017		
x.	Date of Commissioning	:	3/3/2019		
xi.	Sequence of events/Description of fault(SOE with time stamp, Protection operated during fault)	:	18/02/2023 at 18.00 hrs Buchholz alarm appeared. It was decided to shut down GT-8 B Phase.		
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Due to Buchholz alarm oil, DGA test was carried out on top and bottom sample of transformer on 19-02-2023.		
			Name of Gas	Concentration of Gas (µl/l)	Specified Values as per IS 10593 (µl/l)
			H ₂	326	150 max
			C ₂ H ₂	111	20 max
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	No visual damage was found from outside.		
xiv.	Probable cause of failure	:	Increased concentration of H2 and C2H2 indicated towards arcing in oil. Failure may be in internal active part of transformer.		
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	M/s BHEL Engineer visited and inspected the faulty transformer.		
xvi.	Present condition of equipment(Whether repairable or beyond repair)	:	Yes, Repairable and taken up with OEM(M/S BHEL)		

xxvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	Routine Shut down was held on 11.07.2024. Tan delta testing was carried on 11-07-2022 and no abnormality was found.
xxviii.	Whether relay time is synchronized with UTC	:	Yes
xix.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xx.	On Load Tap Changer or Off Circuit Tap Changer	:	Off Circuit tap changer
xxi.	Tap position of OLTC at the time of failure	:	9
xxii.	Tap Range	:	1 to 17(HV Side-462 kV to 378 kV)
xxiii.	Details of Protection provided for ICT/GT/Reactor	:	(1) Differential Protection (2) Over Current (3) Earth Fault (4) Over Flux (5) Buchholz (6) Winding Temperature high (7) Oil Temperature high (8) PRV
xxiv.	Details of Protection operated	:	Buchholz alarm operated
xxv.	Whether equipment is properly earthed	:	Yes
xxvi.	Earth Resistance of Substation and date of its measurement	:	GT-8-B Phase Earth pit: 0.56 Ω and 0.6 Ω (20.03.2021)
xxvii.	Surge arrestor : (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	(a) Yes (b) Yes (c) Counter not changed
xxviii.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	630 kV
xxix.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	1550 kVp



xxx.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier System
xxxi.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	clear sky
xxii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	Storage is as per M/s BHEL (OEM) standard practice during the 2018-19 project work.
xxiii.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Yes

6. Failure Report of 315 MVA, 400/220/33 kV Power Transformer at Tikrikalan Substation of DTL

i.	Name of Substation	:	400 kV Substation. Tikrikalan
ii.	Utility	:	Delhi Transco Limited (DTL)
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Auto-transformer- ICT-III
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	315 MVA, 400/220/33 kV, Three Phase
v.	Make (Original equipment manufacturer)	:	TELK
vi.	Serial No.	:	140123-1R1
vii.	Date and time of occurrence of fault	:	05.09.2022 at 19:18 Hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2005
x.	Date of Commissioning	:	Originally commissioned in 2005 at 400 kV Bawana and tripped in 2008. The transformer was sent to M/s TELK Kerala for repair. Repaired in 2011 and commissioned at 400 kV Substation Tikrikalan on 12.07.2014
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	220 kV Tikrikalan to Peeragarhi Circuit 1 (Bay No. 219) got tripped at 19:18 Hrs. due to damage to the cable during piling work by DMRC near Peeragarhi Chowk. Internal fault developed in 315 MVA ICT-3 while feeding the fault. The transformer tripped on Differential, REF, Buchholz, PRV, OTI, WTI, OSR, 86A, 86B NIFPES system operated, Oil drained.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	No testing has been conducted as of now due to damage to bushings and the main tank.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage	:	All 400 kV and 220 kV Bushings got damaged along with main tank of the transformer. NIFPES system operated

	to various components of transformer and nearby equipment / material etc.)		and oil got drained. There was fire on Y Phase 220 kV bushing which was controlled by staff using fire extinguishers available near the transformer. Fire tender was also called. One number Foam Fire tender was utilized to extinguish the fire completely.
xiv.	Probable cause of failure	:	The cable of 220 kV Mundka-Peeragarhi Ckt-1 was damaged during the piling work of M/s DMRC and it leads to the failure of 315 MVA ICT-3 being the source for feeding through fault current causing huge damage to the Transformer. Operation of differential and REF protection indicates towards the internal fault in the Transformer. As per the records available in relays, initially fault was in Y phase, later it was converted into R and Y phase fault. Transformer fed the through-fault current for 80 ms and thereafter internal fault developed in the transformer showing fault current of 43.9 kA in R phase and 41.6 kA on Y phase on HV side, which was cleared within 48 ms.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	OEM M/s TELK has been requested to visit the site for analyzing the failure.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Transformer is likely to be beyond repair.
xvii.	Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) Whether any abnormality observed in these tests. If yes, attach the test reports. What steps were taken to address the abnormality?	: : :	PMS done on regular basis. Hydrogen content was high in the DGA results. Acetylene was observed in 2019 however no cause for generation of Acetylene observed during the internal inspection. Acetylene formation not observed after internal inspection in 2019. Abnormal DGA results were discussed in Transformer Expert Committee of DTL and DGA monitoring was being done on regular basis.

xviii.	Details of any previous failure on the same unit	:	This transformer was originally commissioned in 2005 at 400 kV Substation Bawana and tripped in 2008. Internal inspection carried out and carbon particles found by M/s TELK in winding. Transformer sent to M/s TELK Kerala for repair. Transformer repaired in 2011 and commissioned at 400 kV Substation Tikrikalan.
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/insulated	:	Insulated
xxii.	Details of protection for Tertiary	:	No
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain/ Polymer housing)	:	OIP Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	9 b (Normal)
xxvii.	Past record of Operation of OLTC	:	In working condition. No on load tap changed in last 4 years.
xxviii.	Tap Range	:	1-9b-17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, Overcurrent Relay, REF, Buchholz, PRV, OSR, Winding and Oil Temp.
xxx.	Details of Protection operated	:	Transformer tripped on Differential, REF, Buchholz, PRV, OTI, WTI, OSR, 86A, 86B NIFPES system operated, Oil drained.
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.08 ohm

xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxxiv.	Type of Fire protection provided (Emulsifier system/ N ₂ Injection based fire protection system/ foam based protection etc.)	:	N ₂ Injection based fire protection system (NIFPES)
xxxv.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear Sky
xxxvi	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	This transformer was originally commissioned in 2005 at 400 kV Bawana Substation. It got tripped in 2008. Internal inspection was carried out and carbon particles were found by M/s TELK in winding. Transformer was sent to M/s TELK Kerala for repair. Transformer got repaired in 2011 and commissioned at 400 kV Tikrikalan Substation.

7. Failure Report of 100 MVA 220/66-33/11 kV 3- Phase at Park Street, Delhi Transco Limited

S.No	Information required	:	Status
i.	Name of substation utility/owner of substation	:	220 kV Substation Park Street, Delhi Transco Limited
ii.	Faulty Equipment (ICT, Auto-transformer/GT/ Reactor etc.	:	100 MVA Power Transformer
iii.	Rating	:	100 MVA 220/66-33/11 kV 3- Phase
iv.	Make	:	M/s BHEL
v.	Serial No-	:	2008101
vi.	Date and time of occurrence of fault	:	07.06.2023 14:45 hrs
vii.	Fault discovered during(Operation or Periodic testing/ maintenance)	:	During post tripping testing and Internal inspection.
viii.	Year of Manufacturing	:	1994
ix.	Year of Commissioning	:	1999
x.	Sequence of Events leading to failure/ Description of fault	:	On 07.06.2023 at 14:45 hrs 100 MVA Transformer tripped on Differential B Phase.
xi.	Tests conducted on failed transformer after fault along with test reports.	:	DGA, SFRA, Voltage ratio, Magnetizing balance, Tan delta and capacitance, IR, Winding resistance.

Dissolved Gas Analysis Test:

(ppm)	H ₂	CO ₂	CO	C ₂ H ₄	C ₂ H ₆	CH ₄	C ₂ H ₂	TDCG
29.05.2023	90	390	54	532	144	299	4.0	1122
07.06.2023	246	418	94	667	164	380	70.3	1620

Capitance and Tan delta Test:

Sr. No	Insulation Tested	Mode	Previous results of Dt.23.2022	Current Results 08.06.2023	Change from Previous Values

			Capacitance	Dissipation Factor		Capacitance	Dissipation Factor		Cap	Tan Delta
			(pF)	Meas	(pF)	(pF)	Meas	@20 °C		
1.	HV-LV	UST-R	27291.69	0.72	0.53	26504.68	0.52	0.38	-2.88%	-0.00146
2.	HV-E	GSTg-RB	5443.09	0.56	0.41	5394.74	0.43	0.31	-1.07%	-0.000949
3.	LV-T	UST-R	1260.23	0.56	0.41	1229.11	0.42	0.31	-02.47%	-0.001022
4.	LV-E	GSTg-RB	3792.09	0.82	0.60	3727.89	0.68	0.50	-1.69%	-0.001022
5.	T-HV	UST-R	14510.78	0.54	0.39	14113.71	0.45	0.33	-2.74%	-0.000657
6.	T-E	GSTg-RB	18681.98	0.76	0.55	18159.22	0.48	0.35	-2.80%	-0.002044
7.	220kVR-Ph Bushing	UST-R	365.23	0.28	-	364.62	0.28	-	-	-
8.	220kVY-Ph Bushing	UST-R	366.81	0.28	-	366.38	0.27	-	-	-
9.	220kVB-Ph Bushing	UST-R	-	-	-	367.75	0.41	-	-	-
10	66kV R – Ph Bushing	UST-R	-	-	-	357.88	0.42	-	-	--
11	66kV Y-Ph Bushing	UST-R	-	-	-	379.06	0.47	-	-	-
12	66kVB - Ph Bushing	UST-R	372.2	0.48	-	371.89	0.48	-	-	-
13-15	Excitation Current Test	27.43 mA	Y-ph	27.26 mA	-	B-ph	-	-	-	-

xii.	Visual observations during site visit [e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.]	:	During Internal inspection B Phase winding was found burnt.
xiii.	Probable cause of failure	:	Operation of Differential protection indicates internal fault in the Transformer. Ageing could be the reason of fault. DGA and Low voltage test results clearly indicate towards the problem in turn of the HV B-ph

			winding causing spark inside the Power Transformer.
xiv.	If OEM representative had inspected the equipment or visited the site after failure, their remark, MOM to be attached.	:	No
xv.	Details of previous maintenance activity carried out on equipment.	:	Complete over hauling of Transformer was carried out with all related testing from January to March 2023
xvi.	Present condition of equipment(whether repairable or beyond repair)	:	Will be addressed with higher officers.
xvii.	Is tertiary winding provided(Yes/No)	:	Yes
xviii.	Tertiary loaded (Yes/No). If yes , specify load on tertiary	:	No
xix.	Whether tertiary terminals are bare/ Insulated	:	Insulated
xx.	Details of Protection for tertiary.	:	CAP C: Carrier Current Protection A: Auxiliary Relay Protection P: Phase Comparison Protection
xxi.	Whether relay time is synchronized with UTC	:	Yes
xxii.	The type of bushing and housing: OIP/RIP, Porcelain / polymer housing	:	OIP, Porcelain
xxiii.	On load tap changer or Off circuit tap changer	:	On load tap changer
xxiv.	Tap position OLTC at the time of failure	:	2
xxv.	Past record of Operation of OLTC	:	Tap position lowered from 4 to 2 on 23.09.2022
xxvi.	Tap Range	:	1-17
xxvii.	Protection provided for transformer	:	PRV, SPR , Bucholz, Differential , MOG WTI (HV, MV, LV) Trip and alarm, OTI trip and alarm

xxviii.	Protection operated during fault	:	Differential B- Phase, 86 OPTD.
xxix.	Whether equipment is properly earthed.	:	Yes
xxx.	Surge Arrestor a) Is SA provided for protection b) Whether healthiness of SA is monitored c) Whether reading of SA Counter changed during failurer	: : :	Yes Yes No it did not change
xxxi.	Lighting Impulse and switching Impulse withstand voltage of bushings of all the voltage level.	:	HV- 1050 kVp LV- 325 kVp TV- 170 kVp
xxxii.	Lighting Impulse and switching Impulse withstand voltage of windings of all the voltage level.	:	HV- 1050 kVp LV- 325 kVp TV- 170 kVp
xxxiii.	Fire fighting provision [provision of soak pit / oil collecting pit, Emulsifier system/ N2 Injection based fire protection system / both]	:	No
xxxiv.	Weather condition at the time of failure.	:	Clear
xxxv.	Number of through fault equipment is subjected to before failure	:	5
xxxvi.	Maintenance record, last over haul carried out	:	Last over hauling done in January- March 2023
xxxvii.	Any major break down before this failure	:	No breakdown however there was high rise in the gases of transformer oil.
xxxviii.	Any test conducted prior to fault (DGA, capacitance & Tan-delta of bushing & winding resistance, turns ratio, SFRA, low voltage tests etc.)	:	DGA, Tran delta and capacitance, winding resistance, SFRA, Turn ratio, Magnetising balance.

8. Failure Report of 500 MVA, 765/400 kV, 1-Phase Power Transformer at Khetri Substation of Powergrid.

i.	Name of Substation	:	765/400 kV Khetri Substation
ii.	Utility	:	Power Grid Corporation Ltd.
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	ICT
iv.	Rating (MVA/MVAR, Voltage Ratio, 1 Phase/ 3 Phase)	:	765/220 kV, 500 MVA, 1-Phase
v.	Make (Original equipment manufacturer)	:	Transformer & Rectifier India Ltd
vi.	Serial No.	:	PM000148
vii.	Date and time of occurrence of fault	:	10.02.2023 at 03:25 Hrs
viii.	Fault discovered during (Operation or periodic testing/ Maintenance)	:	Operation
ix.	Year of Manufacturing	:	2020
x.	Year of Commissioning	:	2021
xi.	Sequence of events/Description of Fault (SOE with time stamp, Protection operated during fault)	:	Differential, Buchholz relay and PRD , OTI trip operated at 03:25 Hrs on 10.02.2023
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no test were conducted, reason for the same may be stated)	:	DGA and LV tests.
Dissolved Gas Analysis Test:			

Sample Date	H2	CH4	C2H4	C2H6	C2H2	CO	CO2
08.10.2021	0	1	1	0	0	27	188
10.02.2023	1211	1061	2211	219	1988	367	591
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment/ Material etc.)			:	The main tank of the unit bulged with cracks and oil spilled out. The main tank of the unit bulged from bell tank joint portion and stiffeners cracked due to build in pressure inside tank. All 03 PRD flags were found in operated condition indicating operation of all PRDs during fault. The HV, IV and tertiary bushings were found physically intact from outside.		
xiv.	Probable cause of failure			:	From the Disturbance recorder, Event logger, LV test results, SFRA, DGA history and internal inspection of the failed ICT, it was suspected that there is sudden turn to turn fault inside the transformer. Due to turn to turn fault, circulating current also flows through ICT-1. It is pertinent to mention here that REF protection did not operated as ground fault loop was not present. The differential protection of the above ICT operated as per scheme and fault has been isolated within 70 ms of fault inception and all protection works properly.		
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MOM etc. may be attached.			:	Yes		
xvi.	Present condition of equipment (Whether repairable or beyond repair)			:	Under Repair at Works		

xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	All maintenance activities were carried out as per PGCIL norms and results were within acceptable limits.
xviii.	Details of any previous failure on the same unit	:	NA
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/insulated	:	Insulated
xxii.	Details of protection of tertiary	:	NA
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain/Polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On load tap changer
xxvi.	Tap Position of OLTC at the time of failure	:	Nominal
xxvii.	Past record of Operation of OLTC	:	NA
xxviii.	Tap Range	:	23
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, REF, Backup Impedance, Buchholz, PRD, WTI Trip, OTI Trip

xxx.	Details of Protection Operated	:	Differential, Buchholz relay, PRD and OTI trip operated
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.64
xxxiii.	Surge arrestor : (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	(a) Yes (b) Yes (c) No
xxiv	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxv	Weather conditions at the time of Failure (Clear sky/rainy/thunderstorm etc.)	:	Clear

9. Failure Report of 315 MVA, 3-Phase, 400/220 kV Power Transformer at Rourkela Substation of PGCIL

i.	Name of Substation	:	400/220 kV Rourkela Substation
ii.	Utility	:	PGCIL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	ICT
iv.	Rating (MVA/MVAR, Voltage Ratio, 1 Phase/ 3 Phase)	:	315 MVA, 400/220 kV, 3-Phase
v.	Make (Original equipment manufacturer)	:	BHEL
vi.	Serial No.	:	6006128
vii.	Date and time of occurrence of fault	:	09-04-2023 at 07:12:53 Hrs
viii.	Fault discovered during (Operation or periodic testing/ Maintenance)	:	Operation
ix.	Year of Manufacturing	:	2003
x.	Year of Commissioning at Rourkela	:	2021
xi.	Sequence of events/Description of Fault (SOE with time stamp, Protection operated during fault)	:	Buchholz relay and PRD operated at 07:12 on 09.04.2023
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no test were conducted, reason for the same may be stated)	:	DGA was carried out. DGA indicated high level of fault gases including high C ₂ H ₂ . LV tests was also conducted.

LV test result:

Magnetising Current

Tap Position	Voltage Applied (Volt)		Current Measured (mA)	
LOWEST	R-N	242.1	R-Ph	1.7
	Y-N	242.1	Y-Ph	4.5

	B-N	242.1	B-Ph	2.8
NORMAL	R-B	242.	R-Ph	2.1
	Y-N	242.5	Y-Ph	5.6
	B-N	242.4	B-Ph	3.2
HIGHEST	R-N	243.1	R-Ph	2.3
	Y-N	243.7	Y-Ph	7.0
	B-N	242.9	B-Ph	3.6

Voltage Applied (Volt)		Current Measured (mA)	
2R-N	242.6	R-Ph	3.8
2Y-N	242.4	Y-Ph	19.7
2B-N	242.4	B-Ph	6.6

Resistance of Y phase winding (HV to IV) also showing deviation more than 70% from the previous value and winding resistance of R and B Phase was within acceptable limit.

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment/ Material etc.)	:	Carbon and metal powder observed on floor near Y-ph IV winding.
xiv.	Probable cause of failure	:	Increased value of C2H2 indicates towards arcing in the oil. Based on deviation in LV test results including huge deviation in Y-Ph winding resistance at different taps and burning of HV lead along with number of discs of the Y-Ph winding, it is suspected that said ICT failed due to failure of the inter-disc insulation of the HV series winding of the Y-Phase of the transformer.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MOM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Beyond Repair
xvii.	(d) Details of previous maintenance (Activities carried out in previous maintenance including the tests	:	All maintenance activities carried out as per M/s Power Grid Corporation Ltd

	conducted, periodicity of the maintenance activities) (e) Whether any abnormality observed in these tests. If yes, attach the test reports. (f) What steps were taken to address the abnormality?		norms and results were within acceptable limits.
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/ insulated	:	Insulated
xxii.	Whether relay time is synchronized with UTC	:	Yes
xxiii.	Bushing details (OIP/RIP/RIS, Porcelain/Polymer housing)	:	RIP
xxiv.	On Load Tap Changer or Off Circuit Tap Changer	:	On load tap changer
xxv.	Tap Position of OLTC at the time of failure	:	Nominal
xxvi.	Tap Range	:	17
xxvii.	Details of Protection provided for ICT/GT/Reactor	:	Differential , REF, Backup Impedance, Buchholz, PRD, WTI Trip, OTI Trip
xxviii.	Details of Protection Operated	:	Buchholz relay and PRD operated
xxix.	Whether equipment is properly earthed.	:	yes
xxx.	Earth Resistance of Substation and date of its measurement	:	0.5 ohm , 13.01.2023
xxxi.	Surge arrestor: (d) Is SA provided for protection	:	(a) Yes



	(e) Whether healthiness of SA is monitored (f) Whether reading of SA counter changed during failure	:	(b) Yes (c) No
xxxii.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxxiii.	Weather conditions at the time of Failure (Clear sky/rainy/thunderstorm etc.)	:	Clear

10.Failure Report of 210 MVA, 1-Phase, 21/400/ $\sqrt{3}$ kV Generator Transformer (GT-3) at TAPS-3 and TAPS- 4 of NPCIL

i.	Name of Substation	:	TAPS-3 and TAPS-4
ii.	Utility	:	NPCIL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Generator transformer-3 R-Phase
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	210 MVA, 21/400/ $\sqrt{3}$ kV, 1-Phase
v.	Make (Original equipment manufacturer)	:	TELK
vi.	Serial No.	:	140117-7
vii.	Date and time of occurrence of fault	:	Jan-2022
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	Corrective maintenance
ix.	Year of Manufacturing	:	2002
x.	Date of Commissioning	:	2005
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	No electrical fault occurred.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	The failed transformer is in process of repair at OEM.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Higher Dissolved gas concentration, hot spots were observed on transformer tank body.

xiv.	Probable cause of failure	:	Inadequate design of Tank and Core leading to Higher Dissolved gas concentration, hot spots were observed on transformer tank body.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	Yes, Transformer modified by OEM
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities)	:	Routine maintenance and Condition Monitoring tests on transformers during unit shutdowns on two year frequency basis.
	b) Whether any abnormality observed in these tests. If yes, attach the test reports.	:	Nil
	c) What steps were taken to address the abnormality?	:	NA
xviii.	Details of any previous failure on the same unit	:	Nil
xix.	Is tertiary winding provided (Yes/No)	:	No
xx.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxi.	On Load Tap Changer or Off Circuit Tap Changer	:	Off circuit tap changer
xxii.	Details of Protection provided for ICT/GT/Reactor	:	Differential protection, over fluxing, PRD, Buchholz. OTI, WTI
xxiii.	Details of Protection operated	:	-
xxiv.	Whether equipment is properly earthed	:	yes
xxv.	Earth Resistance of Substation and date of its measurement	:	0.22 Ω

xxvi.	Surge arrestor: a) Is SA provided for protection b) Whether healthiness of SA is monitored c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxvii.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	LIWV: 1425 kV SIWV: 630 kV
xxviii.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxix.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Not Applicable as the failure was not relevant to Ambient weather.
xxx.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand: capability was verified on the basis of calculation.	:	yes, capability was verified on the basis of calculation

11. Failure Report of 210 MVA, 1-Phase, 21/400/ $\sqrt{3}$ kV Generator Transformer (GT-4) at TAPS-3 and 4 of NPCIL

i.	Name of Substation	:	Taps-3 and 4
ii.	Utility	:	NPCIL
iii.	Faulty Equipment and the aSubstationociated feeder	:	Generator transformer-4
iv.	Rating (Voltage/ current/ current ratio/ capacitance/ MCOV etc., as applicable)	:	210 MVA, 1-Phase, 21/400/ $\sqrt{3}$ kV SF ₆ to Air Bushing 1250 A
v.	Make (Original equipment manufacturer)	:	Merlin gerin, france
vi.	Serial No.	:	-
vii.	Date and time of occurrence of fault	:	12/12/2022
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	During periodic testing, SF ₆ gas leakage was observed.
ix.	Weather conditions at the time of failure (clear sky/ rainy / thunderstorm etc.)	:	Clear sky
x.	Year of manufacturing	:	2002
xi.	Date of Commissioning	:	2004
xii.	Storage condition of equipment if the gap between delivery at site and Commissioning is over 6 months	:	NPCIL store
xiii.	Present condition of equipment (Repaired/ To be repaired / beyond repair)	:	Repaired
xiv.	Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities)	:	Yearly preventive maintenance

	Whether any abnormality observed in these tests. If yes, attach the test reports. What steps were taken to address the abnormality?	:	SF6 gas leak due to seal failure, no electrical fault.
xv.	Sequence of events/Description of fault (SOE with time stamp)	:	No electrical fault occurred.
xvi.	Details of protection operated :	:	Nil
xvii.	Details of tests done after failure	:	Leak test
xviii.	Observations (Any relevant observation made by the field staff or during visual inspection)	:	SF ₆ gas leak due to seal failure was observed.
xix.	Probable cause of failure	:	Seal failure (O'ring).
xx.	Attach reports of tests during pre-Commissioning, periodic maintenance and after failure; Photographs of the failed equipment etc.	:	Ir 3.8gΩ Mvdt - 279μΩ

12. Failure Report of 210 MVA, 1-Phase, 21/400/ $\sqrt{3}$ kV kV Generator Transformer- at TAPS-3 and 4 of NPCIL

i.	Name of Substation	:	TAPS-3 and 4
i.	Utility	:	NPCIL
ii.	Faulty Equipment (ICT/ Auto-transformer/ GT/ Reactor etc.)	:	Generator transformer-4 R-Phase
iii.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/ 3-Phase)	:	210 MVA, 1-Phase, 21/400/ $\sqrt{3}$ kV kV
iv.	Make (Original equipment manufacturer)	:	Telk
v.	Serial No.	:	140117-4R1
vi.	Date and time of occurrence of fault	:	15/06/2023, 09:30am
vii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
viii.	Year of Manufacturing	:	2017
ix.	Date of Commissioning	:	Jun-2017
x.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Transformer differential protection operated during hotline washing of GT-4 R-Phase.
xi.	Observations and Probable Cause of Failure (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	HV bushing flash over. Operation of Differential protection indicates fault inside the Transformer.
xii.	Present condition of equipment (Whether repairable or beyond repair)	:	Operation
xiii.	Is tertiary winding provided	:	No

	(Yes/No)		
xiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xv.	On Load Tap Changer or Off Circuit Tap Changer	:	Off circuit tap changer
xvi.	Details of Protection provided for ICT/GT/Reactor	:	E/F, REF, differential protection, over fluxing, PRD, Buccholz, High oil temperature, High winding temperature
xvii.	Details of Protection operated	:	Differential protection
xviii.	Whether equipment is properly earthed	:	Yes
xix.	Earth Resistance of Substation and date of its measurement	:	0.22Ω
xx.	Surge arrestor: a) Is SA provided for protection b) Whether healthiness of SA is monitored c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxi.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	LIWV: 1425 kV SIWV: 630 kV
xxii.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier System
xxiii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Thunder storm
xxiv.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Yes, the capability was verified on the basis of calculation

13. Failure Report of 167 MVA, 400/ 220 kV, 1-Phase Power Transformer at Kaiga Generating Station of NPCIL

i.	Name of Substation	:	Kaiga Generating Station
ii.	Utility	:	Nuclear Power Corporation of India Ltd
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	ICT -1 Y- Phase transformer
iv.	Rating(MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	167 MVA ,400/ 220 kV, 1-Phase
v.	Make (Original equipment manufacturer)	:	CGL make
vi.	Serial No.	:	24990
vii.	Date and time of occurrence of fault	:	02/07/2022
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	Operation
ix.	Year of Manufacturing	:	1989
x.	Date of Commissioning	:	As methane gas was developing in existing ICT, spare ICT of similar rating was identified at PGCIL, Bangalore. The spare transformer of M/s CGL make (year of manufacturing as 1989) was available with PGCIL and same was identified for replacement of existing ICT-1 Y Phase transformer at Kaiga. The transformer was removed from service in the year 2019 and stored in oil filled condition at PGCIL yard. The transformer was tested and transported to Kaiga and it was installed in the Y Phase location of the ICT-1. After carrying out necessary test and inspections, ICT -1 was taken into service on 01/06/2022. Its operation was found to be satisfactory.
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	On 02.07.2022 at 16:07 hrs., 167 MVA, 220 kV/ 400 kV Interconnecting transformer-1(ICT-1) tripped on Restricted earth fault (REF) followed by Differential protection

			operation and flashover took place at IV bushing of Y Phase. Both HV and LV CB got opened immediately and ICT -1 was isolated. All other switchyard equipment were ensured healthy.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Tests were not done after failure as equipment was damaged.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	In the field, flash over and smoke was observed in Y-Phase (Intermediate voltage – 220 kV) bushing area of ICT-1. It was observed that ICT-1 Y-Phase (Intermediate voltage-220 kV) bushing had failed and automatic Fire deluge system for the ICT-2 had operated.
xiv.	Probable cause of failure	:	Bushing failure. Operation of Differential relay indicates fault inside the transformer. Operation of REF relay indicates that fault involved ground. Ageing could be the reason of fault.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	beyond repair
xvii.	a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) b) Whether any abnormality observed in these tests. If yes, attach the test reports. c) What steps were taken to address the abnormality?	:	M/s CG make transformer was available with PGCIL. The Transformer was tested and transported to Kaiga. The transformer was installed, tested and commissioned at Kaiga switchyard. No abnormality was observed. The transformer was inspected by OEM and clearance was given for charging.
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided	:	Yes

	(Yes/No)		
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/insulated		Bare, connected through IPS tube
xxii.	Details of protection for Tertiary	:	No protection available
xxiii.	Whether relay time is synchronized with UTC	:	Yes with GPS
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP, Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC, Kept in Manual
xxvi.	Tap position of OLTC at the time of failure	:	11
xxvii.	Past record of Operation of OLTC	:	OLTC is not operated
xxviii.	Tap Range	:	1-17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	ICT Protection 1. Directional O/C, Earth fault protection (67N) 2. Overload-1 protection (50L1) 3. Overload-2 protection (50L2) 4. Differential protection(87T), 5. REF(64T), 6. Over Fluxing-1 protection (99) 7. Backup over current protection (67 A/B/C) 8. Over Fluxing-2 protection (99) Transformer body protections: 1. Buchholz relay protection (oil surge relay) 3. Winding temperature high trip (105⁰ C) 4. 4. Oil temperature high trip (95⁰ C) 5. 5. OLTC oil surge trip 6. 6. PRD trip (7 psi)

xxx.	Details of Protection operated	:	REF (64 T) protection operated.
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.385 ohm, 26.05.2022
xxiii.	Surge arrestor: a) Is SA provided for protection b) Whether healthiness of SA is monitored c) Whether reading of SA counter changed during failure	: : :	a) SA provided b) healthy
xxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	LIWV : 1425 SIWV: 1050
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	LIWV : 1300 SIWV: 1050
xxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Rainy
xxviii.	Storage condition of equipment at site before Commissioning: a) Period of storage b) Idle charged or uncharged c) Dry air filled/Nitrogen filled/ Oil filled	: : : :	Transformer was kept in oil filled condition a) 3 years b) Uncharged c) Oil filled
xxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Nil
xl.	Number of through faults the equipment was subjected to before failure.	:	Nil



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14. Failure Report of 100 MVA, 220/ 66 kV Power Transformer at Amloh Substation of PSTCL

i.	Name of Substation	:	220 kV Amloh Substation
li.	Utility	:	PSTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	220/66 kV 100 MVA PT
iv.	Rating (MVA/MVAR, Voltage ratio, I-Phase/3Phase)	:	100 MVA, 220/66 kV, 3-Phase
v.	Make (Original equipment manufacturer)	:	EMCO
vi.	Serial No.	:	HT1384/11729
vii.	Date and time of occurrence of fault	:	23.05.2022
vili.	Fault discovered during	:	-
	(Operation maintenance) or periodic testing/maintenance	:	Operation
ix.	Year of Manufacturing	:	1997
x.	Date of Commissioning	:	2000
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	AT 02:32 Transformer tripped on Over Current relay Indications.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	IR Testing of PTF, TTR, Magnetic balance, Charging current, Short Circuit Current.

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	The DC winding resistance of the R-Phase HV winding and the charging current of the R- Phase HV and LV were not found to be in order.
xiv.	Probable cause of failure	:	Internal Fault as while testing DC winding resistance of R phase HV winding and charging current of R phase HV and LV both was not found in order.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Beyond Repair
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity maintenance activities)	:	The Half yearly maintenance and protection testing with Tan-Delta was done at Substation in march 2022.
	(b) Whether any abnormality observed in these tests. If yes, attach the test reports.	:	None
	(c) What steps were taken to address the abnormality?	:	None
xviii.	Details of any previous failure on the same unit	:	Nothing
xix.	Is tertiary winding provided (Yes/No)	:	No
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/ RIP/ RIS, Porcelain / polymer housing)	:	Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer.

xxvi.	Tap position of OLTC at the time of failure	:	3
xxviii.	Tap Range	:	02 to 17
xxx.	Details of Protection operated	:	After try Differential relay operated
xxxix.	Whether equipment is properly earthed	:	Yes
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	N2 injection based fire protections system
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Thunder Storm
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	No

15. Failure Report of 100 MVA 220/66/11 kV Power Transformer at Botian Wala of PSTCL

i	Name of Substation	:	220 kV Substation Botian Wala
ii.	Utility	:	PSTCL
iii.	Faulty Equipment	:	Power Transformer
iv.	Rating (MVA, Voltage ratio, 1-Ph./3-Phase)	:	70/85/100 MVA 220/66/11 kV 3- Phase
v.	Make (Original equipment manufacturer)	:	Bharat Bijlee Ltd.
vi.	Serial No.	:	T/05205/6
vii.	Date and time of occurrence of fault	:	03.12.2021/ 08:10
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2010
x.	Date of Commissioning	:	09.06.2011
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	On HV Side: Differential Relay, B-Phase Over current High Set Main Buchholz Alarm operated On LV Side: REF Operated
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure? If no tests were conducted, reasons for the same may be stated.)	:	Complete Testing of Power transformer was done. LV Side B Phase DC Resistance was found more as compared to R and Y Phase.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Main Buchholz alarm operated during this tripping and flammable gas was found trapped in Buchholz relay

xiv.	Probable cause of failure	:	66 kV of Bus Bar B- Phase LA got damaged. Operation of Differential relay, Overcurrent relay along with operation of Buchholz relay indicated heavy current flow. The abnormal value of B-ph DC winding resistance indicates damage in B-ph winding.
xxvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	Maintenance was done as per P&M Manual on 12.10.2021
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/ insulated	:	Bare
xxiii.	Whether relay time is synchronized with UTC	:	No
xxiv.	Bushing details (OIP/ RIP/ RIS, Porcelain/ Polymer housing)	:	Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer (OLTC)
xxvi.	Tap position of OLTC at the time of failure	:	5
xxvii.	Past record of Operation of OLTC	:	5
xxviii.	Tap Range	:	1 to 17

xxix.	Details of Protection Provided for ICT/ GT/ Reactor	:	Differential Relay, Restricted Earth fault, Backup Over Current, Over Fluxing Protection, Over Voltage, under Voltage, Oil Temperature Indicator, Winding Temperature Indicator, Oil Pressure Relief-PRV, Gas Accumulation using Gas Accumulation Relay (Buchholz Relay)
xxx.	Details of Protection operated	:	HV Side: Differential Relay, B- Phase Over Current High Set, Main Buchholz Alarm operated LV Side: REF Operated
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	T/F - 0.28 ohm, HV NCT - 0.39 ohm, LV NCT - 0.36 ohm on 12.10.2021
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxxvi.	Type of Fire protection provided (Emulsifier system/ N ₂ Injection based fire protection system/foam based protection etc.)	:	NIFPS i.e. N ₂ Injection based fire protection system
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.	:	Foggy

16. Failure Report of 100 MVA, 220/66 kV, 3 Phase Power Transformer of Malerkotla at PSTCL

i.	Name of Substation	:	220 kV SUBSTATION Malerkotla
ii.	Utility	:	PSTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating (MVA/MVAR, Voltage ratio,	:	100 MVA, 220/66 kV, 3 Phase
v.	Make (Original equipment manufacturer)	:	Bharat Bijlee Ltd.
vi.	Serial No.	:	T-05205/3
vii.	Date and time of occurrence of fault	:	22.06.2022 at 07:14 Hrs
viii.	The Sequence of Events/ Description of Fault		At 07:14 Hrs: 66 kV Cap Bank No.1 (C-14) tripped through NDR-1 and IDMT O/C E/F Protection operated. 220/66 kV 100 MVA transformer T-3 tripped through operation of Differential relay and Buchholz trip stage-1.
ix.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
x.	Year of Manufacturing	:	2010
xi.	Date of Commissioning	:	25.04.2011
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated)	:	T.T.R., No Load Current and Magnetic Balance

xiii.	Probable cause of failure	:	Due to damage of 66 kV Cap Bank No.1 circuit breaker fault current was traveled to P/T/F. Operation of Differential relay and Buchholz relay indicates fault inside the transformer.
xiv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No
xv.	Present condition of equipment (Whether repairable or beyond repair)	:	Under Observation
xvi.	Details of previous maintenance (Activities carried out in previous maintenance conducted, maintenance activities)	:	Jumper checking/tightening, Checking of oil level, Cleaning of HV bushing/ LV bushing/ CT, checking & tightening of terminals, cleaning of body/ radiators, cleaning of marshalling box terminals, Checking & replacement of Silica Gel, Recording of IR Values of Bushings/ CT's.
xvii.	Details of any previous failure on the same unit	:	NIL
xviii.	Is tertiary winding provided (Yes/No)	:	Yes
xix.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xx.	Whether tertiary terminals are bare/ insulated	:	Bare
xxi.	Whether relay time is synchronized with UTC	:	Yes
xxii.	Bushing details (OIP/ RIP/ RIS, Porcelain/polymer housing)	:	OIP
xxiii.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxiv.	Tap position of OLTC at the time of failure	:	4

xxv.	Past record of Operation of OLTC	:	Tap Change from 5 to 4 on Dt. 04.05.2022
xxvi.	Tap Range	:	1-17
xxvii.	Details of Protection provided for ICT/GT/Reactor	:	Over Current, Differential, HV/LV REF, LBB, BBP, Buccholz, Winding/ Oil Temperature Trip, PRV etc.
xxviii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxix.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	NA
xxx.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	NA
xxxi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based/ fire protection system/ foam based protection etc.)	:	NIFPES
xxxii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear

17. Failure Report of 100 MVA, 220/66 kV, 3 Phase Power Transformer at Malerkotla Substation of PSTCL

i.	Name of Substation	:	220 kV Malerkotla Substation
ii.	Utility	:	PSTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	100 MVA, 220/66 kV, 3 Phase
v.	Make (Original equipment manufacturer)	:	CGL
vi.	Serial No.	:	24586
vii.	Date and time of occurrence of fault	:	22.06.2022 (07:14 Hrs and 08:12 Hrs.)
viii.	The Sequence of Events/ Description of Fault		At 07:14 hrs: 66kV Cap Bank No.1 (C-14) tripped through Unbalance Prot. Acted Bank-1 and IDMT O/C E/F Protection operated. 220/66 kV 100 MVA transformer T-2 tripped through HSU of O/C relay showing current as 710%. At 08:12 hrs: The 220/66 kV 100 MVA transformer T-2 was attempted to be energized which did not hold and tripped with the operation of HSU of O/C relay showing current as 610% and REF , OLTC Buchholz , Buchholz Stage-1, Differential relay , T/F oil temp high alarm and T/F winding temp high alarm operated.
ix.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
x.	Year of Manufacturing	:	1986
xi.	Date of Commissioning	:	12.12.1986

xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated)	:	TTR, No-Load Current, Magnetic Balance, Vector Group, DC Resistance
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Leakage of oil
xiv.	Probable cause of failure	:	Due to damage of 66 kV Cap Bank No.1 circuit breaker fault current was traveled to P/T/F.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Beyond Repair
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance conducted, maintenance activities) (b) Whether any abnormality observed in these tests If yes, attach the test reports. (c) What steps were taken to address the abnormality?	: : :	Jumper checking/ tightening, Checking of oil level, Cleaning of HV bushing/ LV bushing/ CT, checking and tightening of terminals, cleaning of body/ radiators, Cleaning of marshalling box terminals, Checking and replacement of Silica Gel, Recording of IR No NA
xviii.	Details of any previous failure on the same unit	:	NIL
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No

xxi.	Whether tertiary terminals are bare/ insulated	:	Bare
xxii.	Whether relay time is synchronized with UTC	:	Yes
xxiii.	Bushing details (OIP/RIP/RIS, Porcelain/ polymer housing)	:	OIP
xxiv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxv.	Tap position of OLTC at the time of failure	:	4
xxvi.	Past record of Operation of OLTC	:	Tap Change from 5 to 4 on 04.05.2022
xxvii.	Tap Range	:	1-17
xxviii.	Details of Protection provided for ICT/GT/Reactor	:	Over Current, Differential, HV/LV REF, LBB, BBP, Bucholz, Winding/Oil Temperature Trip, PRV, Etc.
xxix.	Whether equipment is properly earthed	:	Yes
xxx.	Earth Resistance of Substation and date of its measurement	:	On Dated. 15.06.2023 {0.79ohm (HV-NCT) & 0.78ohm (LV-NCT)}
xxxi.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxxii.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	NA
xxxiii.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	NA

xxxiv.	Type of Fire protection provided (Emulsifier system/ N2 Injection based/ fire protection system/ foam based protection etc.)	:	NIFPES
xxxv.	Weather conditions at the time of failure (clear sky/ rainy/ thunderstorm etc.)	:	Clear
xxxvi.	Storage condition of equipment at site before Commissioning	:	
xxxvii	(a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	: : :	NA NA NA
xxxviii.	Number of through faults the equipment was subjected to before failure	:	14-trippings in last 5years



18. Failure Report of 100 MVA, 220/66 kV, Power Transformer at G2 MGG Substation of PSTCL

i.	Name of Substation	:	220 kV Substation G2 MGG
ii.	Utility	:	PSTCL
iii.	Faulty Equipment (ICT/ Auto-Transformer/ GT/ Reactor etc)	:	Power Transformer
iv.	Rating(MVA/MVAr,Voltage ratio, 1-Phase/ 3-Phase)	:	100 MVA, 220/66 kV
v.	Make (Original Equipment Manufacturing)	:	Crompton Greaves Limited
vi.	Serial No.	:	T-8434/2
vii.	Date and time of occurrence of Fault	:	Date:-25.09.2022 Time:- 21:15
viii.	Fault Discovered During (Operation or Periodic Testing/Maintenance)	:	Operation
ix.	Year of Manufacturing	:	1994
x.	Date of Commissioning	:	11/6/1995
xi.	Sequence of events/Description of Fault (SOE with time stamp, Protection Operated during fault)	:	At 21:15 hrs, 100 MVA Power Transformer T-1 tripped on Differential relay, Buchholz main trip relay with NIFPES operated indications. It is pertinent to mention here that no tripping of any other 220/66 kV Transformer, 66/11 kV Transformer, 66 kV lines and 11 kV feeders occurred at that time in 220 kV Substation G2 Mandi Gobindgarh.
xii.	Details of Tests done after failure, (what test were conducted after the discovery of failure .if no test were conducted,reasons for the same may be stated)	:	After protection testing, results of R Phase was found out of order as R Phase charging current and R Phase DC winding resistance was found to be higher than other two Phases. After internal inspection at site, it was found that the lead of R Phase was flashed.

1. DC winding resistance:

Tap	R-ph (MΩ)	Y-ph (MΩ)	B-ph (MΩ)
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1 HV	1493	754	748
4 HV	1425	720	715
5 HV	1395	710.8	706
6 HV	1362	702	697
7 HV	1220	595	590
LV	50.4	50.2	49.9

2. Charging Current

Tap 5	R-ph	Y-ph	B-ph
HV	15 mA	3.90 mA	4.09 mA
LV	160 mA	27.12 mA	27.52 mA
S.C. HV	1.34 mA	3.50 mA	3.60 mA

Tap 6	R-ph	Y-ph	B-ph
HV	15.26 mA	3.80 mA	4.1 mA
LV	160 mA	26.97 mA	27.5 mA
S.C. HV	1.35 mA	3.55 mA	3.66 mA

Tap 4	R-ph	Y-ph	B-ph
HV	14.66 mA	3.65 mA	3.87 mA
LV	160 mA	26.40 mA	27.5 mA
S.C. HV	1.35 mA	3.46 mA	3.55 mA

xiii.	Observations (Visual observation e.g.bulging of tank,fire any leakage of oil ,damage to various. component of transformer and Near by equipment/material etc.)	:	On Dated 20.10.2022 the core and winding assembly of Power Transformer was inspected by the officers of Grid Construction, Protection and P&M Organisation. The following points were observed:
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			1. Large number of copper granules was noticed on the bottom side of R Phase Winding. 2. Some of the wooden packing of the bottom side of the R Phase winding was found displaced. 3. Heavy flash was found on R Phase winding lead.
xiv.	Probable cause of failure	:	After protection testing, results of R Phase was found out of order as R Phase charging current and R Phase DC winding resistance was found to be higher than other two Phases. After internal inspection at site, it was found that the lead of R Phase was flashed. The test done after failure shows high and abnormal charging current of R-ph of HV and LV winding. DC winding resistance of R-ph winding is also high. A high DC winding resistance and charging current in the R-phase of a transformer indicates damage in the R-ph winding of the Transformer.
xv.	If OEM representative had inspected the equipment or visited the site after failure their remarks, MoM etc. may be attached	:	No OEM representative had inspected the equipment or visited the site after failure
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	beyond repair
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormally observed in these test reports. (c) What steps were taken to address the abnormality?	:	As per history of T/F- T1, R Phase HV bushing of T1 had got damaged on Dated 20.06.2005 due to bursting of LV side B Phase CT and was replaced from Dated 06.07.2005 to 08.07.2005 LV side R,Y,B Phase bushings and 2 No. Tertiary bushings were replaced due to bursting of circuit breaker and high TAN-DELTA values. Also, Capital maintenance of T1 OLTC was done on Dated 10.07.2005
xviii.	Details of any previous failure on the same unit	:	TF T-1 HV side R-Phase bushing, LV side R,Y,B Phase bushings and 2 no. tertiary bushings were replaced due to damage and high TAN-DELTA values in 2005.



xix.	Is tertiary winding provided (Yes/No)	:	YES
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19. Failure Report of 100 MVA, 220/66 kV, 3-Phase Power Transformer at Nabha of PSTCL

i.	Name of Substation	:	220 kV Substation Nabha
ii.	Utility	:	PSTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	100 MVA, 220/66 kV, 3-Phase
v.	Make (Original equipment manufacturer)	:	BBL
vi.	Serial No.	:	T/05149/6
vii.	Date and time of occurrence of fault	:	06.06.2023 at 18:59 Hrs.
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2010
x.	Date of Commissioning	:	21.06.2011
	Sequence of events/Description of Fault	:	1) Time 18:58 hrs a) 66 kV Bakhopeer Ckt-1 : Master Trip, O/C R phase H-Set, E/F H-Set, (DPR Z1, L = 2.266 km, Phase ABN, X = 0.5938 ohm, R = 0.3301 ohm) b) 66 kV Bakhopeer Ckt-2 : Master Trip, O/C R phase H-Set, E/F H-Set 2) A few moments later the (time was 18:59) a) 66 kV Ablowal/Hiana-Kalan: Master trip, directional O/C, R Phase H-Set, E/F H-Set. b) 66 kV Incomer-2 : Master trip, Numerical non directional O/C, R Phase H-Set, E/F 610% c) 66 kV Incomer-1 : Backup O/C R,Y,B Phase H-Set, E/F Ia = 256A, Ib = 131A, Ic = 2064A, In = 117A d) P/T/F 220/66 kV 100 MVA T-3 : Master Trip, Buckle Stage-1 and differential relay

			L1 = 0.61 (I/In), L2 = 0.30 (I/In), L3 = 0.30 (I/In)
xi.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Visual observation found ok
xii.	Probable cause of failure	:	The falling of 66 kV Bakhopeer (DC) Towers might have caused an abnormal increase in current or loading on the transformer, which lead to overheating of the windings and imbalance in the currents entering and leaving the transformer windings.
xiii.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	NA
xiv.	Present condition of equipment (Whether repairable or beyond repair)	:	Under Observation
xv.	(a) Details of previous maintenance (Activities carried out in previous maintenance conducted, maintenance activities) (b) Whether any abnormality observed in these tests If yes, attach the test reports. (c) What steps were taken to address the abnormality?	: : :	Cleaning of bushings, checking and tightening of terminals, cleaning of body/radiators, cleaning of marshalling box terminals, checking & replacement of Silica Gel, Recording of IR Values. No NA
xvi.	Details of any previous failure on the same unit	:	NIL
xvii.	Is tertiary winding provided (Yes/No)	:	Yes
xviii.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xix.	Whether tertiary terminals are bare/insulated	:	Bare
xx.	Details of protection for Tertiary	:	Earth
xxi.	Whether relay time is synchronized with UTC	:	Yes

xxii.	Bushing details (OIP/RIP/RIS, Porcelain/polymer housing)	:	Porcelain
xxiii.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxiv.	Tap position of OLTC at the time of failure	:	03
xxv.	Past record of Operation of OLTC	:	Tap Change from 05 to 03 on 24.05.2023 Time: 03:30 Hrs.
xxvi.	Tap Range	:	1-17
xxvii.	Details of Protection provided for ICT/GT/Reactor	:	Over Current, Differential, HV/LV REF, LBB, BBP, Bucchoz, Winding/Oil Temperature Trip, PRV, Etc.
xxviii.	Whether equipment is properly earthed	:	Yes
xxix.	Earth Resistance of Substation and date of its measurement	:	On 28.12.2021 {0.15ohm (HV) and 0.16ohm (LV)}
xxx.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: : :	Yes Yes No
xxxi.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	NA
xxxii.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	NA
xxxiii.	Type of Fire protection provided (Emulsifier system/ N2 Injection based/ fire protection system/ foam based protection etc.)	:	NIFPES
xxxiv.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Rainy & Stormy

xxxv.	Storage condition of equipment at site before Commissioning (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	: : :	NA NA NA
xxxvi.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Data Not available
xxxvii.	Number of through faults the equipment was subjected to before failure	:	10-trippings in last five (5) years
xxxviii.	Protection schematic diagram	:	In the scope of Protection

20. Failure report of 315 MVA 400/ 220/ 33 kV ICT at Nakodar substation of PSTCL

i.	Name of Substation	:	400 kV substation PSTCL Nakodar
ii.	Utility	:	PSTCL
iii.	Faulty Equipment (ICT/Auto transformer/GT/Reactor etc.)	:	ICT
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3 Phase)	:	315 MVA 400/220/33 kV
v.	Make(Original equipment manufacturer)	:	SIEMENS
vi.	Serial No.	:	I130049/04
vii.	Date and time of occurrence of fault	:	06/02/2023 at 22:15 hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Running Condition
ix.	Year of Manufacturing	:	2011
x.	Date of Commissioning	:	23-05-2014
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Differential Failure
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Complete Testing as per manual
xiii.	Observations (Visual observations e .g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment/ material etc.)	:	NIL
xiv.	Probable cause of failure	:	The reason can be ascertained only after submission of detailed inspection report by the utility.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Under Investigation OEM Siemens Mumbai

xvii.	(a) Details of previous maintenance (Activities carried out in Previous maintenance including the tests conducted, periodicity Of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	: : :	Periodical Testing as per PSTCL manual Nil --
xviii.	Details of any previous failure on the same unit	:	Nil
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxii.	Details of protection for Tertiary	:	-
xxiii.	Whether relay time is synchronized with UTC	:	Synchronized
xxiv.	Bushing details (OIP/RIP/RIS, housing) Porcelain		OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	10
xxviii	Tap Range	:	1-17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, Overcurrent, Earth Fault, REF, Buchholz, PRV, OSR, MOG
xxx.	Details of Protection operated	:	Differential
xxxi.	Whether equipment is properly earthed	:	Earthed
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.524
xxxiii.	Surge arrestor: (a) Is SA provided for protection	: :	 Yes



	(b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	: :	Yes Yes
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	N2 Injection Base
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear Sky



21. Failure Report of 100 MVA 220 kV Power Transformer Mohali Substation of PSTCL

i.	Name of Substation	:	220 kV Substation Mohali 1
ii.	Utility	:	PSTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	100 MVA
v.	Make (Original equipment manufacturer)	:	Crompton Greaves
vi.	Serial No.	:	T-8474/1
vii.	Date and time of occurrence of fault	:	30.03.2022
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	
ix.	Year of Manufacturing	:	1996
x.	Date of Commissioning	:	7/27/1996
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	66 kV CHD-II Breaker damaged, Differential relay operated.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated)	:	TTR, Charging Current, Magnetic Balance Test, IR, D.C Winding resistance.

Transformer turns ratio (TTR) test:

Sr.No.	R- Ph	B- Ph	B- Ph
1	3.429	4.183	3.425

Charging Current (mA):-

Winding	R- Ph	B- Ph	B- Ph
HV	3.3	598	3.3
LV	25.7	8.48 A	25.8

Magnetic Balance :-



Winding	R- Ph	B- Ph	B- Ph
HV (V)	219.5	0.567	218.6
	78.4	219.8	80.2
	219.4	0.550	219.8
LV (V)	220.3	0.433	220
	93.8	220.5	90.3
	220.1	0.410	220.4

Winding	R-Ph	B- Ph	B- Ph
HV	3.07	3.09	3.10
LV	10.56	10.58	10.6

Insulation Resistance (IR) with 5 kV Megger (in GΩ):- (Oil Temp: -42 °C)

Winding	15 sec	20 sec	60 sec	120 sec	600 sec	P.I
HV-E	4.50	4.52	5.65	6.35	8.53	1.51
HV-LV	5.95	5.99	7.31	8.26	10.7	1.47
LV-E	1.90	2.08	3.10	3.86	6.34	2.04
TR-E	-	0	-	0	-	-
HV-TR	-	3.41	-	5.35	-	-
LV-TR	-	2.50	-	4.45	-	-

DC winding resistance (in $\mu \Omega$):-

HV Winding	R-Ph	B-Ph	B-Ph
Tap No. 3	731	731	731
LV Winding	R-Ph	B-Ph	B-Ph
	0045	0045	0045

The test result of TTR, Charging Current Test, Magnetic Balance Test show abnormal values. Also the IR values of Tertiary winding – Earth is Zero. Hence, this transformer is not for energization.

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	66 kV CHD-II Breaker damaged due to birdage. On dated 18.04.2022 the core and winding assembly of Power Transformer was inspected by the officers of Grid Construction, Protection and P&M Organisation. The following points were observed:- 1. Large numbers of Copper granules were noticed on the top and bottom side of Yellow phase and Blue Phase winding.
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			2. Some of the wooden packing of upper end of Yellow and Blue Phase winding were found displaced and broken pieces found littered at the base. 3. Broken pieces of card board insulation material of the Yellow and Blue phases windings found littered at the base. 4. As per protection testing report, the I.R. value of tertiary winding to earth found zero.
xiv.	Probable cause of failure	:	Due to damage of 66 kV CHD-II line breaker fault current was traveled to P/T/F.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Not economical to repair.
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	Short Circuit
xxi.	Whether tertiary terminals are bare/ insulated	:	Bare
xxii.	Details of protection for Tertiary	:	No protection Tertiary
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain/polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC
xxvi.	Tap position of OLTC at the time of failure	:	3
xxvii.	Past record of Operation of OLTC	:	Tap position 2 to3 on 04.03.2022
xxviii	Tap Range	:	1-17

xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, Buchholz, O/C, REF, PRV
xxx.	Details of Protection operated	:	Differential
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.2 Ohm, 04.08.2022
xxxiii	Surge arrestor:	:	
	(a) Is SA provided for protection	:	Yes
	(b) Whether healthiness of SA is monitored	:	OK
	(c) Whether reading of SA counter changed during failure	:	No
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based/ fire protection system/ foam based protection etc.)	:	N2 Injection based
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear
xxxviii.	Storage condition of equipment at site before Commissioning		
	(a) Period of storage	:	NA
	(b) Idle charged or uncharged	:	Uncharged
	(c) Dry air filled/Nitrogen filled/ Oil filled	:	NA
xxxix	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	NA
xl.	Number of through faults the equipment was subjected to before failure	:	66 kV Breaker damaged due to Birdage

22. Failure Report of 100 MVA, 220/66 kV at Anchepalya substation of KPTCL

i.	Name of Substation	:	220/66 kV Anchepalya
ii.	Utility	:	KPTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating : (MVA/MVAR, Voltage ratio, 1Phase/3Phase)	:	100 MVA, 220/66/11 kV
v.	Make (Original equipment manufacturer)	:	CROMPTON GREAVES
vi.	Serial No.	:	BH8859/1
vii.	Date and time of occurrence of fault	:	17.08.2022 @ 13:48 hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2002
x.	Date of Commissioning	:	01.04.2011
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Load on transformer was 18 MW and at 13:22 Hrs Transformer tripped on OCR EFR, then test charged at 13:48 tripped on Buccholtz relay
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	HV, LV, IV with all combinations including to Ground- Insulation Resistance test, LV Tests, Excitation test, Magnetic Balance test.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Nil
xiv.	Probable cause of failure	:	Tertiary winding failure
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	Nil



xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activity). (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	Periodic maintenance of Transformer carried out on 12.08.2022
xviii.	Details of any previous failure on the same unit	:	Previous Failure: 23.10.2007 at 220 kV Honnalli Substation
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/ insulated	:	Insulated
xxii.	Details of protection for Tertiary	:	-
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	8 at 13:22 Hrs 6 at 13:48 Hrs
xxvii.	Past record of Operation of OLTC	:	30302
xxviii.	Tap Range	:	1 TO 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential Relay, Transformer Aux function(BZ,OSR,WT High, OT High)
xxx.	Details of Protection operated	:	Bucholtz relay

xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	1 ohms 12.08.2022
	Surge arrestor: (a) Is SA provided for protection	:	Provided
	(b) Whether healthiness of SA is monitored	:	Healthy
	(c) Whether reading of SA counter changed during failure	:	No
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	-
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	220 kV – 950 kVp 66kV – 325 kVp 11kV – 95 kVp
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	NIFPS to Transformer, ABC Type Fire extinguishers around the transformer
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear
xxxviii.	Storage condition of equipment at site before Commissioning:	:	NA
	(a) Period of storage	:	-
	(b) Idle charged or uncharged	:	-
	(c) Dry air filled/Nitrogen filled/ Oil filled	:	-
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Verified on the basis of calculation
xl.	Number of through faults the equipment was subjected to before failure	:	Nil



xli.	Attach the following:	:	
	(a) Single Line Diagram of the substation	:	Attached
	(b) Ph.otograPh.s of the failed equipment	:	Attached
	(c) Disturbance Recorder/Even Logger Data	:	NA
	(d) Reports of tests conducted after failure	:	Attached
	(e) Factory test results	:	NA
	(f) Pre-Commissioning test results	:	NA
	(g) Protection schematic diagram	:	NA

23. Failure Report of 100 MVA 220 kV Power Transformer at Bidad of KPTCL

i.	Name of Sub station	:	220 kV Receiving station Bidadi
ii.	Utility	:	KPTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Ph.se/3-Phase)	:	100 MVA
v.	Make (Original equipment manufacturer)	:	APEX
vi.	Serial No.	:	T-1035/01
vii.	Date and time of occurrence of fault	:	04.05.2022 @ 17:02
viii.	Fault discovered during (Operation or periodic testing maintenance)	:	During Operation
ix.	Year of Manufacturing	:	1998
x.	Date of Commissioning	:	31.12.1998
xi.	Sequence of events/ Description of fault (SOE with time stamp, Protection operated during fault)	:	66 kV Line named Hejjala line tripped on DPR simultaneously 100 MVA APEX make tripped on Differential Y&B Phase, HV & LV EFR?OCR, LV REFR, PRV & Bucholtz and at the time Oil Drawn valve opened.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated)	:	1. IR Test 2. Winding Resistance test 3.Short circuit Test 4. Magnetic balance test(HV/LV) In short circuit test it was found that Y-Phase LV winding open circuit) All test was carried out in Tap-3
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment /material etc.)	:	During test it was found that LV B-Phase Winding get damaged.
xiv.	Probable cause of failure	:	Damage in B-Phase Winding
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MOM etc. may be attached.	:	No

xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Declared as faulty
xvii.	a) Details of previous Maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) b) Whether any abnormality observed in these tests. If yes, attach the test reports. C) What steps were taken to address the abnormality?	:	Previous maintenance was carried out before faulty on 1. IR values measured between HV-LV- 121 M ohms, HV-Gnd- 132 Mohms, LV-Gnd- 125 Ohms. Oil leakages was completely arrested. PI value measured and found to be more than 2 b) .No abnormalities observed during operation of Power Transformer and during any maintenance.
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided (Yes/ No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare / insulated	:	Insulated
xxii.	Details of protection for Tertiary	:	Non Directional OCR protection for R,Y,B Phase
xxiii.	Whether relay time is synchronized with UTC	:	Synchronized
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxv.	On Load Tap Charger or Off Circuit Tap Charger	:	OLTC
xxvi.	Tap position of OLTC at the time of failure	:	4
xxvii.	Past record of Operation of OLTC	:	NA
xxviii.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT / GT /Reactor	:	Differential, REF, Back up protection, Buchotz, OSR and PRV
xxx.	Details of Protection operated	:	Differential, REFR, EFR/OCR, Buchotz and PRV



xxxi.	Whether equipment is properly earthed	:	properly earthed
xxxii.	Earth Resistance of sub station and date of its measurement	:	less than 1 Ohm Dtd:23.06.2022
xxxiii.	Surge arrestor: a) Is SA provided for protection b) Whether healthiness of SA is monitored c) Whether reading of SA counter changed during failure	:	a) Provided b) Continuously monitored c) No
xxiv.	Lightning Impulse and switching impulse withstand voltage of the bushings of all voltage level	:	-
xxxv.	Lightning Impulse and Switching Impulse withstand voltage of the winding of all voltage level	:	220 kV-950kVp 66kV-325kVp 11kV - 95kVp
xxxvi.	Type of Fire protection provided (Emulsifier system /N2 Injection based fire protection system / foam based protection etc.)	:	Nitrogen injection fire protection system
xxxvii.	Weather conditions at the time of failure (Clear sky / rainy / thunderstorm etc.)	:	Clear
xxxviii.	Storage condition of equipment at site before Commissioning: a) Period of storage b) Idle charged or uncharged c) Dry air filled / Nitrogen filled / Oil filled	:	NA
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Verified on the basis of calculation
xl.	Number of through faults the equipment was subjected to before failure	:	NIL

24. Failure Report of 100 MVA, 220/66/11 kV, 3 Phase at Madhuvanhalli of KPTCL

i.	Name of Substation	:	220 kV Substation madhuvanhalli
ii.	Utility	:	KPTCL
iii.	Faulty Equipment (ICT/Auto-transformer/ GT/ Reactor etc.)	:	100 MVA Power Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	100 MVA, 220/66/11 kV, 3 Phase
v.	Make (Original equipment manufacturer)	:	Alstom
vi.	Serial No.	:	B-29797
vii.	Date and time of occurrence of fault	:	31.05.2022
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2004
x.	Date of Commissioning	:	16.03.2006
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	87,86,buccloz relay,oltc surge relay trip,tr bucczz alarm,circulating current protection for tertiary wdg ,30 abcde,50/51 num directional with highset, over fluxing relay -99, oil through prv spilled out..
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Ir test, sc test, ratio test, magnetic balance test,bdv test etc
xiii.	Observations:(Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Oil leakage from prv
xiv	Probable cause of failure	:	Y- Phase winding faulty

xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	No abnormalities found
xviii.	Details of any previous failure on the same unit	:	Nil
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/ insulated		Insulated
xxii.	Details of protection for Tertiary	:	-
xxiii.	Whether relay time is synchronized with UTC	:	-
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain/polymer housing)	:	Oip/porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On load tap changer
xxvi.	Tap position of OLTC at the time of failure	:	6
xxvii.	Past record of Operation of OLTC	:	80464



xxvii.	Tap Range	:	0-21
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential protection ref relay buchholz, prv, diverter trip, wt & ot high functional trip relays. Nifes
xxx.	Details of Protection operated	:	87,86,buccloz relay,oltc surge relay trip,tr bucczz alarm,circulating current protection for tertiary wdg ,30abcde,50/51 num directional with highset, over fluxing relay -99
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	1 ohm
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	Good
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	-
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	220 kV-950 kVp 66 kV-325 kVp 11 kV – 95 kVp
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Nitrogen injection fire protection system
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear sky
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Verified on the basis of calculation



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xl.	Number of through faults the equipment was subjected to before failure	:	NIL
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25. Failure Report of 100 MVA, 220 kV Power Transformer at Hiriypur Substation of KPTCL

i.	Name of Substation	:	220 kV Hiriypur Substation
ii.	Utility	:	KPTCL
iii.	Faulty Equipment	:	Power Transformer
	(ICT/Auto-transformer/GT/Reactor etc.)	:	
iv.	Rating : (MVA/MVAr, Voltage ratio, 1Phase/3Phase)	:	100 MVA
v.	Make (Original equipment manufacturer)	:	NGEF
vi.	Serial No.	:	6800000137
vii.	Date and time of occurrence of fault	:	Date: 06.10.2022 Time: 13:45 /REFR Relay operated.
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Normal loading.
ix.	Year of Manufacturing	:	1995
x.	Date of Commissioning	:	Repaired good Power Transformer was commissioned on 06.02.2020 at 220 kV Hiriypur. R/S
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	On 06.10.2022 Time: 13:45 /REFR Relay operated after preliminary inspection Transformer test Charged at Transformer Bocholt Alarm in C&R panel immediately Hand tripped and informed RT, as per RT suggestion Transformer Kept Open.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	On 07.10.2022 1) Ratio Test 2) Magnetic balance Test. 3) Short circuit (LV) test. 4)IR 5) On 10.10.2022 Oil DGA test (Higher Concentration of Acetylene) 6) HV Excitation Test
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various	:	No Abnormalities found



	components of transformer and nearby equipment / material etc.)		
xiv.	Probable cause of failure	:	Tertiary LV RB Phase limb Faulty
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Failed
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activity). (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	a) Oil Test - 8.07.2022 Tan Delta - 23.02.2022 IDAX - 23.02.2022 b) No abnormalities found c) Nil
xviii.	Details of any previous failure on the same unit	:	Nil
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/ insulated	:	Insulated
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load
xxvi.	Tap position of OLTC at the time of failure	:	8
xxvii.	Past record of Operation of OLTC	:	Approximately 5800 operations after Commissioning at Hiriyur SUBSTATION
xxviii.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	NA
xxx.	Details of Protection operated	:	REFR Operated
xxxi.	Whether equipment is properly earthed	:	Yes

xxxii.	Earth Resistance of Substation and date of its measurement	:	Below 2 ohms
	Surge arrestor: (a) Is SA provided for protection	:	Yes
	(b) Whether healthiness of SA is monitored	:	Working good
	(c) Whether reading of SA counter changed during failure	:	Not changed
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Nitrogen Injection fire protection system
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear sky
xxxviii.	Storage condition of equipment at site before Commissioning:	:	
	(a) Period of storage	:	One year
	(b) Idle charged or uncharged	:	Uncharged
	(c) Dry air filled/Nitrogen filled/ Oil filled	:	Oil filled
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Verified on the basis of calculation
xl.	Number of through faults the equipment was subjected to before failure	:	NIL

26. Failure Report of 100 MVA, 220/110 kV Auto transformer at Kavoor Substation of KPTCL

i.	Name of Substation	:	220 kV Kavoor Substation
ii.	Utility	:	KPTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Auto transformer
iv.	Rating (MVA/MVAr, Voltage ratio, 1-Phase/3- Phase)	:	100 MVA, 220/110 kV
v.	Make (Original equipment manufacturer)	:	NGEF
vi.	Serial No.	:	6800000058
vii.	Date and time of occurrence of fault	:	30.04.2022 @ 19:55 Hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	1989
x.	Date of Commissioning	:	16.03.1990
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	* Transformer tripped on buchholz relay at 19:55hrs on 30.04.2022. * No visual defect found except accumulated gas in buchholz relay * After consulting to RT staff & releasing the accumulated gas transformer once again test charged at 20:45 hrs but immediately tripped on buchholz & differential relay (R&Y). * After inspection once again accumulation of gas found in buchholz relay.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Open circuit test : RPh. excitation current was found significantly higher than YPh. & BPh. MBT HV & LV test : HV RPh. excitation current was found abnormally high and voltage sharing was also uneven.

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	None
xiv.	Probable cause of failure	:	Suspected fault in RPh. winding
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	NO. FIRM not existing as of now.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	a) Quarterly maintenance used to carried out in which all the prescribed maintenance points are carried out. Relay operations were also tested. b) High water content and low BDV were indicated in the yearly oil sample report. c) Subsequently to improve these values oil filtration & sludge removal process was carried out on 19.01.2022.
xviii.	Details of any previous failure on the same unit	:	On 20.07.2005 the tap lead of BPh. inside the main tank got burnt which was reinsulated and taken back into service on 14.09.2005.
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/ insulated	:	Two Terminals were insulated and the other one solidly grounded.
xxiii.	Whether relay time is synchronized with UTC	:	No Numerical relay existed. All were electromechanical and static type.
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP, Porcelain housing
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer

xxvi.	Tap position of OLTC at the time of failure	:	6
xxviii	Tap Range	:	1-17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential Protection Back up protection for HV & LV DIR IDMT REF Relay Over fluxing Relay Buchholz, PRV, Diverter Trip, WT & OT High functional trip relays. NIFES fire prevention system
xxx.	Details of Protection operated	:	Buchhloz & differential relay
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.54 -0.83 Ohms on 05.12.2018
xxxiii.	Surge arrestor:(a) Is SA provided for protection(b) Whether healthiness of SA is monitored(c) Whether reading of SA counter changed during failure	:	a) Yes b) Yes, all the SAs were healthy c) No
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	Not available
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	HV BIL 395 kV/900 kVp LV BIL 185 kV/450 kVp
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	N2 injection based fire protection system
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear sky
xxxviii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	Not available
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand	:	Verified on the basis of calculation



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	capability was verified on the basis of calculation?		
xl.	Number of through faults the equipment was subjected to before failure	:	NIL

27. Failure Report of 150 MVA 220 /66/11 kV at Peenya substation of KPTCL

i.	Name of Substation	:	220 kV Peenya
ii.	Utility	:	KPTCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating (MVA/MVAr, Voltage ratio, 1-Ph.se/3-Phase)	:	150 MVA
v.	Make (Original equipment manufacturer)	:	CGL
vi.	Serial No.	:	BEH - 9196/ 4
vii.	Date and time of occurrence of fault	:	08.10.2022, 16:08 Hrs
viii.	Fault discovered during (Operation or periodic testing maintenance)	:	Operation
ix.	Year of Manufacturing	:	2006
x.	Date of Commissioning	:	07.07.2007
xi.	Sequence of events/ Description of fault (SOE with time stamp, Protection operated during fault)	:	HV side REFR relay and Buccholz relay operated.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated)	:	Magnetic balance on HV and LV side tested, IR test, HV excitation test, DGA.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment /material etc.)	:	On Physical observation of power transformer no abnormalities found
xiv.	Probable cause of failure	:	Y- Phase IV winding faulty
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MOM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable (Repair work is under tendering stage)

xvii.	a) Details of previous Maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) b) Whether any abnormality observed in these tests. If yes, attach the test reports. C) What steps were taken to address the abnormality?	:	a) Quarterly maintenance on 26.08.2022. Tan delta - 26.12.2021 IDAX - 26.12.2021 Oil Testing - 13.09.2021 b) not observed any abnormality. c) NA
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided (Yes/ No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare / insulated	:	Insulated
xxii.	Details of protection for Tertiary	:	Insulation sleeves provided
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxv.	On Load Tap Charger or Off Circuit Tap Charger	:	OLTC
xxvi.	Tap position of OLTC at the time of failure	:	6
xxvii.	Past record of Operation of OLTC	:	36247 (as on 2019)
xxviii	Tap Range	:	0-17
xxix.	Details of Protection provided for ICT / GT /Reactor	:	Differential Protection REF Relay Buchholz, PRV, OSR, WT & OT High functional trip relays. NIFPES
xxx.	Details of Protection operated	:	HV side REFR relay and Bulcholz relay operated.
xxxi.	Whether equipment is properly earthed	:	Yes



xxxii.	Earth Resistance of sub station and date of its measurement		0.3 ohms, 13.09.2022
xxxiii.	Surge arrestor: a) Is SA provided for protection b) Whether healthiness of SA is monitored c) Whether reading of SA counter changed during failure		a) Yes b) Yes c) No
xxxv.	Lightning Impulse and Switching Impulse withstand voltage of the winding of all voltage level		220 kV – 950 kVp 66 kV – 325 kVp 11 kV – 95 kVp
xxxvi.	Type of Fire protection provided (Emulsifier system /N2 Injection based fire protection system / foam based protection etc.)		Nitrogen injection fire protection system
xxxvii.	Weather conditions at the time of failure (Clear sky / rainy / thunderstorm etc.)		Rainy
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?		Verified on the basis of calculation
xl.	Number of through faults the equipment was subjected to before failure		NIL

28.Failure Report of 50 MVA 220/11 kV 3 Phase Auto transformer at Dudhrej of GETCO

i.	Name of Substation	:	220 kV Dudhrej
ii.	Utility	:	GETCO
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Auto transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	50 MVA 220/11 kV 3 Phase
v.	Make (Original equipment manufacturer)	:	Voltamp
vi.	Serial No.	:	Jn 22800/4
vii.	Date and time of occurrence of fault	:	15/09/2022 7:50 Hrs
viii.	Fault discovered during (Operation or periodi testing/maintenance)	:	Operation
ix.	Year of Manufacturing	:	2018
x.	Date of Commissioning	:	24.10.2019
xi.	Sequence of events/Description of fault (SOE with tim stamp, Protectionoperated during fault)	:	At 220 kV Dudhrej Substation on 15-09-2022 at 07:50 Hrs, bird electrocuted between two Phase in outdoor 11 kV Capacitor bank which resulted Phase to Phase fault. Simultaneously, 11 kV Bus fault also taken place in incomer Bus PT riser compartment. In Reflection of both above fault 220/11 kV 50 MVA Tr-3 tripped on Buchholz and PRV Trip..
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests wer conducted, reasons for the same may be stated.)	:	(1) Routine tests of Transformer was carried out after the failure. [turn ratio, magnetic balance hv , open circuit, vector group, insulation resistance, transformer oil, short circuit, magnetic balance lv , lv charging current, winding resistance hv/lv]

			(2) tan delta , sfra , idax
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Internal inspection was carried out with OEM M/S Voltamp transformer , Vadodara and following observations was carried out 1] Transformer top side inspection window opened and found flash over on R-Phase of Pressure ring on HV side 2] Inspection window of Tank wall on LV side opened , flash over found on Pressure ring of Y-Phase. Copper particles were also observed. 3] Carbon particles observed below the Pressure ring of Y-Phase.
xiv.	Probable cause of failure	:	Due to reflected fault of In 11 kV capacitor Bank bird is short circuited between two Phase. Note : - After flaming test, it is confirmed that Buchholz relay is actually operated. All Low voltage testing & SFRA & Oil DGA Result found abnormal.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	The Faulty [50 MVA 220/11 kV Power Transformer Sr No: Jn 22800/4] Of [Voltamp] Make Has Been Replaced With [50mva 220/11 kV Power Transformer Sr No: Jn 22800/2r] Of [Voltamp] Make By [Getco] On [13.02.2023].
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	Last maintenance was carried out on dated 09.04.2022 for yearly testing and Bay cleaning work.
xviii.	Details of any previous failure on the same unit	:	NO
xix.	Is tertiary winding provided (Yes/No)	:	No

xxiii.	Whether relay time is synchronized with UTC	:	No
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP , Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	9
xxvii i.	Tap Range	:	1 TO 17
xxx.	Details of Protection operated	:	LV Side(At PS-5 11kV): OC / EF relay Operated 86(Master) Trip. HV Side: 3-Ph. 864/868 optd Bucholz Alarm Bucholz Trip, PRV Trip
xxxi.	Whether equipment is properly earthed	:	YES
xxxii .	Earth Resistance of Substation and date of its measurement	:	0.85 OHM / 13.04.2022
xxxii i.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	(a) Yes (b) Yes it is being monitored (c) No
xxxv i.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Nitrogen (N2) Injection based fire protection system (NIFPS)
xxxv ii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Rainy
xxxv iii.	Storage condition of equipment at site before Commissioning: (a) Period of storage	:	TR-3 was charged on 24-10-2019.



	(b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled		
xxxi x.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand	:	Short circuit test was carried out.
	capability was verified on the basis of calculation?		Yes
xl.	Number of through faults the equipment was subjected to before failure	:	None

29.Failure Report of 100 MVA, 220/66 kV, 3-Phase Transformer at Mokha of GETCO

i.	Name of Substation	:	220 kV Mokha SUBSTATION
ii.	Utility	:	NA
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Transformer
iv.	Rating(MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	100 MVA,220/66 KV,3-Phase
v.	Make (Original equipment manufacturer)	:	Prime Electric Ltd.
vi.	Serial No.	:	WOD-00501/13/13/00064
vii.	Date and time of occurrence of fault	:	11/07/2022 & 19:30 hrs.
viii.	Fault discovered during (Operation or periodic testing / maintenance)	:	Operation
ix.	Year of Manufacturing	:	2013
x.	Date of Commissioning	:	07/03/2015
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Transformer tripped on date 11.07.22 at 19.30 hrs HV side facia- Diff prot trip, Bucholz Alarm, Buch Trip, OLTC OSR trip, PRD trip LV side- Inter trip, During investigation YPh. jumper bushing found open, Welding joint of one stiffener at top Plate broken & deshaped, R,Y,B Bushings found cracked from BOTTOM Flange
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Routine test, SFRA, DGA, Tan-delta test

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Oil leaked from Top and Bushing Damaged
xiv.	Probable cause of failure	:	Due to internal Fault
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	Yes
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Beyond Repair
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	Hot point attended and Routine maintenance carried out of x mer on dt:03.06.2022 NA NA
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided (Yes/No)	:	No
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain/polymer housing)	:	Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC



xxvi.	Tap position of OLTC at the time of failure	:	11
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xxvii.	Past record of Operation of OLTC	:	NA
xxviii.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, OC,EF, REF, Buchholz, oil temp ind, PRV,OSR
xxx.	Details of Protection operated	:	Differential, Buchholz, OLTC OSR,
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	<1 ohm, 07/06/2022
xxxiii.	Surge arrestor: (a) Is SA provided fo protection (b) Whether healthiness of SA ismonitored (c) Whether reading of SA counterchanged during failure	:	Yes Yes No
xxxiv.	Type of Fire protection provided (Emulsifier system/ N2 Injection basedfire protecti system/ foam based protection etc.)	:	No fire protection provided
xxxv.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Rainy
xxxvi.	Whether short circuit test was carried outon this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Yes
xxxvii.	Number of through faults the equipment was subjected to before failure	:	No

30.Failure Report of 50 MVA- 220/132-3 Phase at Haldarwa Substation of GETCO

i.	Name of Substation	:	220 kV Haldarwa SUBSTATION
ii.	Utility	:	GETCO
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Power Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	50 MVA- 220/132- 3 Phase
v.	Make (Original equipment manufacturer)	:	Crompton Parkinson(CGL)
vi.	Serial No	:	23287
vii.	Date and time of occurrence of fault	:	25.09.2022 @ 13:42 hrs.
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Reflected fault of 132 kV Haldarwa DFCC line
ix	Year of Manufacturing	:	1971
x.	Date of Commissioning	:	25.09.2012
xi	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	On dt.25.09.22 132 kV Haldarwa -DFCCline No.2 metering CT & PT Tandelta testing carried out by CMS team. And flyong patrolling for tension Location carried out from loc.no.1 to 40. On Loc.No.17(DT) B Phase Jumper found open and same Location Nut Bolt provided and jumer made normal .At 13.42 Hrs.132 kV Haldarwa-DFCC line no-2 while charging Tripped and 220 kV Bus "B" operated. Haldarwa End-Zone-1,B Ph., SOTF operate, Dist-95.10 Mtr,R Phase-6.1A,Y Ph.-3.8A,B Ph.-11.94 KA.Opp end No any Substation Line will be remain on shock charge

			Hence zero power of 220 kV Bus.B & at 220 kV Haldarwa Substation.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Low Voltage test, Winding resistance, TTR, SFRA, DGA of oil, Tan delta of Winding and Bushing
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Abnormalities noticed in Low voltage test results as under: - For B Phase, Turns ratio test results are beyond permiSubstationible limits - Magnetising current values are high - In MB Test, leSubstation volts are induced in B Phase, when supply is given to R Phase / Y Phase; When supply is given to B Phase, sum of volts induced in R Ph. and Y Phase is leSubstation than supply volts. During internal inspection on Dtd.18.10.2022, B Phase winding –few(2- 3 nos) copper granules at the bottom part of the B Phase Winding.
xiv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached	:	NO
xv.	Present condition of equipment (Wether repairable or beyond repair)	:	During internal inspection on Dtd.18.10.2022 , MOM mentioned that further detail investigation the said transformer may be sent to the workshop of the repairer.
xvi.	a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?		Low Voltage test, Winding resistance, TTR, Tan delta of Winding and Bushing on dtd 04.03.2022 & DGA of oil on Dtd 30.03.2022.

xvii.	Is tertiary winding provided (Yes/No)		NO
xviii	Whether relay time is synchronized with UTC		Yes
xix	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)		OIP
xx	On Load Tap Changer or Off Circuit Tap Changer		On Load Tap Changer
xxi	Tap position of OLTC at the time of failure		11
xxii	Past record of Operation of OLTC		Not Changed since long time as not required in System
xxiii	Tap Range		1-17
xxiv	Details of Protection provided for ICT/GT/Reactor		Differential protection, WTI OTI TRIP, Bucholz trip, REF Trip.PRV Trip, OC & EF Protection
xxv	Details of Protection operated		220/132 kV TRF-3. HV Side:-Ph.asia-Gen tripp, Differential B- Ph. Relay R- Ph. E/F-128.70A, Y- Ph. E/F-102.77 A, B- Ph. E/F-1.36kA .LV Side Iter Trip.
xxvi	Whether equipment is properly earthed		Yes
xxvii	Earth Resistance of Substation and date of its measurement		02.03.2022
xxviii	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure		HV Side & LV Side Provided.
xxix	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)		Clear



xxx	Number of through faults the equipment was subjected to before failure		No
xxxi	Attach the following: (a) Single Line Diagram of the substation (b) Photographs of the failed equipment (c) Disturbance Recorder/Even Logger Data (d) Reports of tests conducted after failure (e) Factory test results (f) Pre-Commissioning test results (g) Protection schematic diagram		Yes

31.Failure Report of 100MVA, 220/132 kV at Timbdi Substation of GETCO

i.	Name of Substation	:	220 kV Timbdi Substation
ii.	Utility	:	GETCO
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Auto-Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	100MVA,220/132 kV ,3-Phase
v.	Make (Original equipment manufacturer)	:	Oshaka
vi.	Serial No.	:	5BA192901
vii.	Date and time of occurrence of fault	:	22/11/2022 & 07:20 hrs.
viii.	Fault discovered during (Operation or periodic testing /maintenance)	:	Operation
ix.	Year of Manufacturing	:	1978
x.	Date of Commissioning	:	1978
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Transformer tripped on date 22.11.22 at 07.20 hrs on Diff, Main PRV 1&2, OLTC OSR, all 3nos LV bushing lift up from bottom portion, some oil drained out and partial inspection carried out it is observed that all 3nos diverter drum broken , LV wdg opened from common connection
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	SFRA, Tan Delta, Insulation Test, Magnetizing Current, Magnetizing balance, Short Circuit Test, Winding Resistance

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	LV Bhushing lift up from bottom portion and oil leakage from that part.
xiv.	Probable cause of failure	:	all 3nos diverter drum broken , LV wdg opened from common connection
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Beyond Repair
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	Routine maintenance carried out of x mer on dt:10.11.2022 NA NA
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided (Yes/No)	:	No
xxi ii	Whether relay time is synchronized with UTC	:	Yes
xxi v.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xx v.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC
xx vi.	Tap position of OLTC at the time of failure	:	4
xxvii i.	Tap Range	:	1 to 17

xxi x.	Details of Protection provided for ICT/GT/Reactor	:	Differential,OC,EF,Over Flux, Bucholz, oil temp ind, trip ckt faulty,PRV,OSR
xx x.	Details of Protection operated	:	Diff, Main PRV 1&2, OLTC OSR
xx xi	Whether equipment is properly earthed	:	Yes
xxxii	Earth Resistance of Substation and date of its measurement	:	0.65 & 02.02.2023
xx xiii .	Surge arrestor: (d) Is SA provided for protection (e) Whether healthiness of SA is monitored (f) Whether reading of SA counter changed during failure	:	Yes Yes No
xx xvi .	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	No fire protection provided
xx xvi i.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear sky
xx xvi ii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	10 Month Uncharged Oil filled
xx xix .	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Yes
xl.	Number of through faults the equipment was subjected to before failure	:	No

32.Failure Report of 100 MVA 220/132/33 kV ICT at Kharepatan Substation of MSETCL

i.	Name of Substation	:	220/132/33 kV Kharepatan Substation
ii.	Utility	:	MSETCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	ICT
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	220/132 kV,
v.	Make(Original equipment manufacturer)	:	GEC ALSTHOM
vi.	Serial No.	:	B-28215
vii.	Date and time of occurrence of fault	:	22.09.2022, 16:35 Hrs.
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	NIL
ix.	Year of Manufacturing	:	1994
x.	Date of Commissioning	:	03.06.1995
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	On 22.09.2022 at 16:35hours, 220/132 kV, 100 MVA GEC Make (ICT-1) damaged and caught fire due to blasting of LV Side R-Phase bushing. Thus, the said ICT Tripped with having Window indication of Differential protection operated and Transformer internal fault. CTR Make NIFPS operated successfully, oil got drained out and nitrogen injected into transformer tank. Then also fire not quenched. After some time LV Y-Phase bushing and R-Phase side radiator bank collapsed. HV side R-Phase bushing got damaged. Transformer Fire was extinguished completely with the help of Fire brigade team from Kankavli and Rajapur.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	As heavy smoke was coming through ICT after 10th day of occurrence. Thus detailed inspection and testing is not feasible.

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	1. R & Y-Phase bushing of 220 & 132 kV Side found burnt. 2. R-Phase side radiator cooling bank found burnt and collapsed 3. B-Phase HV & LV bushing found intact Physically but healthiness will be decided after only electrical testing. 4. All protection and control cables (PRVs, Main Buchholz, OSRs etc.) found burnt along with cooling fans. 5. No any bulging of tank shown from the outside. 6. R & Y Phase HV LA are found damaged. 7. Gantry beam is found damaged. 8. 220/132 kV, 100MVA Vijay ICT-2 control cables burnt.
xiv.	Probable cause of failure	:	All diagnostic results are normal, hence cause of failure not predictable.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	NO, OEM had not visited the site as of now.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	1.R & Y-Phase bushing of 220 & 132 kV Side found burnt. 2.R-Phase side radiator cooling bank found burnt and collapsed 3.B-Phase HV & LV bushing found intact Physically but healthiness will be decided after only electrical testing. 4.All protection and control cables (PRVs, Main Buchholz, OSRs etc.) found burnt along with cooling fans. 5.As heavy smoke was coming through ICT after 10th day of occurrence, thus detailed inspection and testing is not feasible.

xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities)(b) Whether any abnormality observed in these tests. If yes, attach the test reports.(c) What steps were taken to address the abnormality?	:	(a) 1. Outage was taken on 30.05.2022 under permit no 11685/117. During this outage the following works has been carried out. Bay washing and cleaning of HV & LV side bushing, Plastic paper wrapping around PRV Relay & Buchholz relay done. IR of HV & LV winding is measured and found ok. 2. Outage taken on 29.01.2022 under permit no 12793/128. During this outage 1 barrel oil top up was done by external agency.4. C & Tan delta testing carried out on dt. 16.12.2021 & results found normal for windings & bushings.5. Outage taken on 18.11.2021 under permit no 12738/128. During this outage oil leakage attending work done by external agency.6. Outage taken on 02.06.2021 under permit no 14928/150. During this outage oil filtration work done by external agency.7. Outage taken on 16.02.2021 under permit no 14520/146. During this outage oil leakage attending work from LV side bushing CT was carried out by external agency.8. Outage taken on 25.01.2021 under permit no 10898/109. During this outage Y-Ph. LV bushing hotspot attended & HV-LV bushing washing done.9. Outage taken on 03.12.2020 under permit no 10867/109. During this outage SFRA & DFRA were carried out by Mobile testing unit Karad and results found ok. 10. Outage taken on 28.11.2020 under permit no 10860/109. During this outage work of OLTC overhauling carried out by external agency. 11. Outage taken on 21.01.2019 under permit no 6964/70. During this outage work oil leakage attending work done by external agency with chemical treatment.(b) No(c) NA
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/ insulated		Insulated
xxii.	Details of protection for Tertiary	:	No
xxiii.	Whether relay time is synchronized with UTC	:	No



xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	1.245 kV OIP Condenser Bushing 2.145 kV OIP Condenser Bushing	
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On load tap changer	
xxvi.	Tap position of OLTC at the time of failure	:	15	
xxvii.	Past record of Operation of OLTC	:	1. 21.09.2022, 20:25 HRS, Tap position changed from 14 to 15 and voltages were 137.6 and 135.52. 2. 21.09.2022, 13:52 HRS, Tap position changed from 13 to 14 and voltages were 137.2 and 135.7 3. 21.09.2022, 10:50 HRS, Tap position changed from 15 to 13 and voltages were 130.8 and 133.8 4. 02.07.2022, 10:07 HRS, Tap position changed from 13 to 15 and voltages were 135.1 and 134.5 5. 16.06.2022, 13:25 HRS, Tap position changed from 11 to 13 and voltages were 135.0 and 134.4 6. 31.05.2022, 11:37 HRS, Tap position changed from 12 to 11 and voltages were 131.5 and 134.0 7. 19.05.2022, 09:14 HRS, Tap position changed from 13 to 12 and voltages were 129.5 and 131.9 8. 18.05.2022, 20:48 HRS, Tap position changed from 11 to 13 and voltages were 139.0 and 137.0 9. 22.04.2022, 10:10 HRS, Tap position changed from 12 to 11 and voltages were 132.0 and 132.6 10. 19.04.2022, 19:50 HRS, Tap position changed from 11 to 12 and voltages were 139.1 and 137.1	
xxviii.	Tap Range	:	Tap No	IV Voltage (kV)
			1 MAX	151.8
			2	150.15
			3	148.5

			4	146.85
			5	145.2
			6	143.56
			7	141.9
			8	140.25
			9a	138.6
			9b	138.6
			9c	138.6
			10	136.95
			11	135.3
			12	133.65
			13 NOR	132
			14	130.35
			15	128.7
			16	127.05
			17 MIN	125.4
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Buchholz Relay, PRV Relay, OLTC OSR Relay, Differential Protection, Back up protection, REF Protection, WTI/OTI, MOG	
xxx.	Details of Protection operated	:	<u>WINDOW INDICATION</u> 1)Differential Protection operated 2)Transformer Internal fault <u>RELAY INDICATION</u> HV 1)Master trip operated(86.1), 2)Relay 87: LED- Diff Optd, Diff R-Ph., Diff Y-Ph., Diff B-Ph., Diff Hs>>; Current- G1 87 BD 87 HS ABC, 87 Ia op=4.11xIn, Ib op=2.066xIn, Ic op=2.042xIn, Ia res=2.055xIn, Ia res=1.033xIn, Ia res=1.32In; W1 Ia=1.432kA, Ib=0.086kA, Ic=0.223kA; W2 Ia=0.323kA, Ib=0.149kA, Ic=0.372kA; Ig-1=1.176kA, Ig-	

			2=0.735kA+86optd. LV Master trip 86.2, 87x operated, Buchholz trip
xxxii.	Whether equipment is properly earthed	:	YES
xxxiii.	Earth Resistance of Substation and date of its measurement	:	Earth resistance of substation was 0.95ohm, Date: 16.06.2022
xxxiiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	1. Yes, SA provided for protection 2. Yes, healthiness of SA monitored (LCM test taken half yearly) 3. Reading of SA counter not changed during failure
xxxv.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	N2 injection based fire protection system
xxxvi.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear
xxxvii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	Not available (ICT commissioned in the year 1995 & records not available)
xxxviii.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Short circuit test results with Low voltage conducted during pre-Commissioning are attached



xl.	Number of through faults the equipment was subjected to before failure	:	Total 13 Nos of through faults occurred from 01.10.2017 to 22.04.2022 .
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33.Failure Report of 100 MVA, 220/100 kV at Kandalgaon Substation of MSETCL

i.	Name of Substation	:	220 kV Kandalgaon Substation
ii.	Utility	:	MSETCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	220/100 kV ICT 1
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	100 MVA,220/100 kV,3PHASE
v.	Make (Original equipment manufacturer)	:	EMCO TRANSFORMERS LTD. (EMCO)
vi.	Serial No.	:	HT-1517/12104
vii.	Date and time of occurrence of fault	:	24.09.2022 @18:10
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2002
x.	Date of Commissioning	:	28.06.2017 Commissioned at 220 kV Talaja Substation in 2004. Failed in 2008 then repaired & commissioned at 220 kV Talaja Substation in 2009. In-service at Talaja Substation till 2013. In 2013, removed against augmentation scheme from Talaja Substation & commissioned at 220 kV Kandalgaon Substation in 2017 & in service till September 2022.
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	1.differential protection 2.main protection alarm 3.transformer internal fault 4.master relay 86g1-grp.a-h.v. 5.master relay 86g2-grp.b-lv.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	1.open circuit & short circuit test 2.internal resistance test 3.turns ratio test 4.tan-delta of bushing & winding 5.excitation test

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	1. B-Ph. la failure of 100 kV k'gaon-mhasala line 1 2.ctr operated and oil was drained in tank.
xiv.	Probable cause of failure	:	Winding displaced (mechanical failure)
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	1.Tan-Delta Test of winding was taken on 17.12.2018 & 29.10.2020 and all result was in permissible limit. 2. Tan-Delta Test of all Phase of h.v. & l.v. Bushing was taken on 17.12.2018 & 29.10.2020 and all result was in permissible limit.
xviii .	Details of any previous failure on the same unit	:	09.09.2008
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No.
xxi.	Whether tertiary terminals are bare/ insulated	:	Insulated
xxiii .	Whether relay time is synchronized with UTC	:	Yes.
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP/ Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On load tap changer
xxvi.	Tap position of OLTC at the time of failure	:	13
xxvii .	Past record of Operation of OLTC	:	It was operated on 25.05.2022 tap postion no.15 to tap position no.13

xxvii i.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential protection, buchholz, ctr, osr, winding & oil temperature protection, restricted earth fault
xxx.	Details of Protection operated	:	1.differential protection 2.main protection alarm 3.transformer internal fault 4.master relay 86g1-grp.a-h.v. 5.master relay 86g2-grp.b-lv.
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii .	Earth Resistance of Substation and date of its measurement	:	3.75 ohm on dtd.05.06.2022
xxxii i.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	1. yes, SA was provided for protection. 2.yes, SA was monitored. 3.yes, SA counter reading was changed during failure.
xxxv i.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Nitrogen injection fire protection system.
xxxv ii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Cloudy
xxxi x.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand	:	Open circuit and short circuit test conducted on dtd.25.09.2022 at tap 1, 13 & 17 and results are found ok.
	capability was verified on the basis of calculation?		Yes.
xl.	Number of through faults the equipment was subjected to before failure	:	There were no any faults before failure.

34. Failure Report of 100 MVA 220/132 kV at Lonikand-II Substation of MSETCL

i.	Name of Substation	:	400 kV Lonikand-II Substation
ii.	Utility	:	MSETCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	ICT
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	100 MVA 220/132 kV
v.	Make (Original equipment manufacturer)	:	AVAL make (MAHATI repaired)
vi.	Serial No.	:	M60/2
vii.	Date and time of occurrence of fault	:	Dt 01.03.2022 at 17:44 Hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2011
x.	Date of Commissioning	:	01.12.2021 Commissioned on Dtd.11.10.2013 at 220 kV Shivajinagar Substation, Dhule. Failed on 13.06.2020. After repairs, commissioned at Lonikand -II Substation.
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Tripped on Differential protection, Buchholz protection, master trip thereby satisfying all the conditions for NIFPS operation and operating the NIFPS.
xii.	Details of Tests done after failure(What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	HV excitation, LV excitation, Winding resistance measurement, Short circuit, Open circuit, Magnetic balance test, Vector group test, Ratio test, Turret CT testing, Bushing Capacitance and tan delta, SFRA.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Nil

xiv	Probable cause of failure	:	Failure may be due to insulation failure.
xvi	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvi i.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	ICT was commissioned on dt.01.12.2021 and all the pre Commissioning tests were carried out and no abnormality was observed.
xvi ii.	Details of any previous failure on the same unit	:	ICT was previously at Dhule substation and failed on 13.06.2020 and sent to M/s MAHATI for repairs.
xxi ii.	Whether relay time is synchronized with UTC	:	Yes
xxi v.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP Condensor bushing
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	13
xxvii.	Past record of Operation of OLTC	:	Healthy.
xxviii	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, OC Backup, REF, Buchholz, Temperature trip, PRV, OSR, Fire protection
xxx.	Details of Protection operated	:	Differential protection, Buchholz Trip, Buchholz alarm and CTR operated.
xx xi.	Whether equipment is properly earthed	:	Yes

xx xii.	Earth Resistance of Substation and date of its measurement	:	HV (Pit No 233) =0.33 Ω LV1(Pit No.235)=0.51 Ω
xx xiii .	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	a)Yes b)Yes-LCM tested. Dtd :30.05.2021 (R Ph.s = 25 μ A, Y Ph.s=26 μ A,B Ph.s= 23 μ A) c)No
xx xvi .	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	N2 injection based fire protection system (CTR)
xx xvi i.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	clear
xx xvi ii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	(a) Period of storage - NA (b) Idle charged or uncharged- NA (c) Dry air filled/Nitrogen filled/ Oil filled- Nitrogen Filled
xx xix	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand.	:	Yes

35. Failure Report of 100 MVA/ 220 kV at Bhosari-1 Substation of MSETCL

i.	Name of Substation	:	220 kV Bhosari-1 Substation
ii.	Utility	:	MSETCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	100 MVA/220-22-22/3-Phase Dual LV
v.	Make (Original equipment manufacturer)	:	BHEL Make (AVAL Repaired)
vi.	Serial No.	:	6003977
vii.	Date and time of occurrence of fault	:	Dt 24.03.2022 at 05:48 Hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2012
x.	Date of Commissioning	:	12.08.2016 The 220/132 kV, 100 MVA Transformer of 400 kV Khadka Substation, Jalgoan was converted into 100 MVA,220/22-22 by M/s. AVAL. The T/F was commissioned at 220 kV Bhosari I Substation on dtd: 13.12.2013 & failed on 22.04.2014 under GP. After Repair ,The T/F was commissioned at 220 kV Bhosari I Substation on dtd: 12.08.2016 & failed on 21.03.2022 & sent to M/s Mahati Electricals for repair.
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Near 22 kV bus section isolator No 4, 22 kV bus fault occured due to cat. Simultaneously transformer tripped on differential protection, Bucholz trip.

xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Transformer LV1 CB tripped on backup relay due to fault on 22 kV bus section isolator (due to cat). Simultaneously transformer tripped on differential protection, Bucholz trip. Transformer tested for low voltage test & magnetising currents for R Phase HV (100 mA), LV1 & LV2 R Phase (4.5 & 3.0 Amp) found beyond acceptable limits . R Phase found disturbed/scattered in SFRA also.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Nil
xiv.	Probable cause of failure	:	Testing Remark:- Transformer tripped on LV1 backup relay with 22kV bus section isolator fault (due to cat). Simultaneously transformer tripped on differential protection, Bucholz trip. Master trip 86 failed to operate causing HV LBB to trip. LBB selective trip appeared. Transformer tested for low voltage test & magnetising currents for R Phase HV (100mA), LV1 & LV2 R Phase (4.5 & 3.0 Amp)found beyond acceptable limits . R Phase found disturbed/scattered in SFRA also.Due to dead short circuit on LV side bus section, winding displacement occurred.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No. MSETCL Testing remarks enclosed
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable



xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	SFRA yearly , winding tan delta two yearly , Bushing tan delta yearly , Transformer Testing yearly (Test results are attached herewith)
xviii .	Details of any previous failure on the same unit	:	The TF was failed under GP on dtd: 22.04.2014 at 7:45 Hrs at 220 kV Bhosari I Substation. The TF tripped along with feeder no 14 22kV Bhosarigaon feeder. The TF was shifted to M/s AVAL factory for repair.
xix.	Whether relay time is synchronized with UTC	:	Yes
xx.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	Porcelain
xxi.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxii.	Tap position of OLTC at the time of failure	:	10
xxiii .	Past record of Operation of OLTC	:	Healthy , Diverter switch overhauling done on 23.12.2020
xxiv.	Tap Range	:	1 to 17
xxv.	Details of Protection provided for ICT/GT/Reactor	:	Differential, OC Backup, REF, Buchholz, Temperature trip, PRV, OSR, Fire protection
xxvi.	Details of Protection operated	:	Differential protection, Buchholz Trip ,Buchholz alarm and LV 1 backup optd.
xxvii .	Whether equipment is properly earthed	:	Yes
xxviii i.	Earth Resistance of Substation and date of its measurement	:	09.12.21 HV (Pit No 86) =0.38 Ω LV1(Pit No.83)=0.30 Ω LV2 (Pit No 81) =0.25 Ω TF 1(Pit No 82)=0.32 Ω (Pit No.84)= 0.31 Ω (Pit No

			=85)= 0.37 Ω LA (HV) = (0.40 Ω , 0.48 Ω , 0.51 Ω)
xxix.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	a)Yes b)Yes-LCM tested. Dtd :30.05.2021 (R Ph.s = 42 μ A, Y Ph.s=39 μ A,B Ph.s= 36 μ A) c)No
xxxii .	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	N2 injection based fire protection system (CTR)
xxxii i.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	clear sky early morning.
xxxv .	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	(a) Period of storage - NIL (b) Idle charged or uncharged- NA (c) Dry air filled/Nitrogen filled/ Oil filled-Nitrogen Filled
xxxv .	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Yes
xxxv i	Number of through faults the equipment was subjected to before failure	:	HV side tripping=4

36. Failure Report of 50 MVA, 220 kV/22 kV at Chakan Substation of MSETCL

i.	Name of Substation	:	400 kV Chakan Substation
ii.	Utility	:	MSETCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	50 MVA, 220 kV/22 kV ,3 Phase
v.	Make (Original equipment manufacturer)	:	EMCO TRANSFORMERS LTD. (EMCO) repaired by M/s SET ON SITE Electricals Pvt. Ltd.in March-2019
vi.	Serial No.	:	HT1778/12950
vii.	Date and time of occurrence of fault	:	18.10.2022 at 10:08 hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2008
x.	Date of Commissioning	:	22.04.2019 History of TF: On dt.01.03.2011 commissioned at 400 kV Chakan Substation and Failed on Dt.05.12.2011 Being in Guarantee Period sent to M/s EMCO Thane for repairs and after repairs allotted to 220 kV Telco Substation and commissioned to 220 kV Telco Substation on Dt.02.05.2012 and failed on dt.21.08.2017 and sent to factory for repairs at M/s SET ON SITE Electricals Pvt. Ltd. and after repairs re-commissioned at 400 kV Chakan Substation on dt.22.04.2019
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	50 MVA, 220/22 kV T/F No. -2 tripped on 18.10.2022 at 10:08 Hrs on differential and main Buchholz along with 22 kV feeders fault i.e. tripped simultaneously 22 kV Mercedes Benz (Ia- 9.1kA,Ib- 8.7kA,Ic- 9.74kA,3Ph.); 22 kV SPICER(Ia- 4.67kA); 22kV Chimbli (Ia- 8.4kA,Ib-5.62kA,Ic- 8.84kA,3 Ph.)

xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Transformer was tested for IR values, low voltage tests on existing tap(Tap no.12) such as O.C test, S. C. test, magnetization current, vector group. Also Winding Capacitance and tan delta ,Excitation current measurement and SFRA were carried out on dated:18.10.2022
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Internal inspection is carried out on dt.19.10.22 by draining oil and observations are noted:- 1. LV Y-Ph. Permali wood ring found broken 2. LV Y-Ph. Frame nut-bolts found displaced .
xiv.	Probable cause of failure	:	Simultaneous tripping of 22 kV Mercedes-Benz Feeder, 22kV Spicer Feeder and 22 kV Chimbli Feeder on Ph.-Ph. fault. Internal inspection is carried out on dtd.19.10.22 by draining oil and observations are noted:- 1. LV Y-Ph. Permali wood ring found broken 2. LV Y-Ph. Frame nut-bolts found displaced. Due to 22 kV Feeders fault (Ph. to Ph.), Transformer insulation got damaged.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	Testing work, 1. Bushing Capacitance and Tan-delta carried out. 2. Auxiliary relay protection Trial carried out. 3. IR and PI Values measured

xxviii.	Details of any previous failure on the same unit	:	On dt.01.03.2011 commissioned at 400 kV Chakan Substation and Failed on Dt.05.12.2011 Being in G.P. sent to M/s EMCO Thane for repairs and after repairs allotted to 220 kV Telco Substation and commissioned to 220 kV Telco Substation on Dt.02.05.2012 and failed on dt.21.08.2017 and sent to factory for repairs at M/s SET ON SITE Electricals Pvt. Ltd. and after repairs re-commissioned at 400 kV Chakan Substation on dt.22.04.2019
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	12
xxvii.	Past record of Operation of OLTC	:	Healthy
xxviii.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential Protection, OC and EF protection, REF, Buchholz, Winding and oil temperature trip, PRV, OSR
xxx.	Details of Protection operated	:	Differential protection optd & Main Buchholz alarm and trip
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	Test Dt: 08-04-2022 TF HV=0.44 Ω , 0.27 Ω . TF LV =0.40 Ω TF LV Neutral -0.43 Ω Body Earthing: 0.28 Ω , 0.47 Ω
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	a) Yes b) Yes-LCM tested on dtd: 03.05.2022. 3rd Harmonics R Ph. = 0.5, Y Ph.s=0.4, B Ph. = 0.7. Icorre:- R Ph. = 68 μ A, Y Ph.=58 μ A, B Ph.= 73 μ A. c) No



xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Cloudy
xxxviii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	a) TF transported from M/s Set On Site to 400 kV Chakan on dtd: 02.04.2019 & commissioned on dtd: 26.04.2019. Hence period of storage is 24 days. b) NA c) Nitrogen filled.
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand	:	Yes
	capability was verified on the basis of calculation?		Yes
xl.	Number of through faults the equipment was subjected to before failure	:	3

37. Failure Report of 50 MVA, 220/22 kV at Hinjewadi Substation of MSETCL

i.	Name of Substation	:	220 kV Hinjewadi-1 Substation
ii.	Utility	:	MSETCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	50 MVA, 220/22 kV
v.	Make (Original equipment manufacturer)	:	EMCO(repaired by Jain Electricals Pvt Ltd)
vi.	Serial No.	:	HT/1778/12951
vii.	Date and time of occurrence of fault	:	19-10-2022 at 18:29 Hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	operation
ix.	Year of Manufacturing	:	2008-2009. Repaired in 2022 by M/s Jain Electricals Pvt Ltd.
x.	Date of Commissioning	:	10.10.2022 • The T/F was commissioned at 400 kV Chakan Substation on dtd: 09.07.2010 & failed on 14.06.2012 under GP. • After repair, the T/F was commissioned at 400 kV Chakan Substation on dtd: 28.12.2012 & failed on 10.05.2021. • The T/F was sent to M/s Jain Electrical , Aurangabad for repair. • After repair, the T/F was commissioned at 220 kV Hinjewadi I Substation on dtd: 10.10.2022 & failed on 19.10.2022 under GP. & T/F sent to M/s Jain Electrical, Aurangabad for repair.

xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	After T/F humming sound gets changed on dt 17.10.2022,DGA testing of the TF oil carried out by M/s Power Electronical Nashik. The DGA report received on dtd: 19.10.2022 showing Abnormal values of Acetylene, methane, ethylene than preCommissioning values. 50MVA 220/22KV TF-1 Kept off on dtd: 19.10.22 at 18.29 Hrs. The internal inspection carried out on dtd:01.11.2022 INTERNAL INSPECTION FINDINGS:- 1. Top permali wooden ring Y Ph. & B Ph. is found broken. 2. Y Ph. common block decoupled. With reference to the testing results already conveyed to M/s. Jain Electricals and the internal inspection findings,T/F 50MVA, 220/22KV TF (Sr.no-HT-1778/12951) declared FAULTY and on site repair is not possible, so it is needed to be shifted to the factory for the repairs which is under the warranty period.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Transformer was tested for open circuit currents on HV/LV sides, short circuit currents, magnetic balance HV/LV and IR values. Also SFRA & Tan delta was taken by TCC mobile unit. On dtd.20.10.2022
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	NIL
xiv.	Probable cause of failure	:	Testing Remark 1) Winding resistance Test variation in resistance from 9 to 10 for R & Y- Ph. is comparatively greater than the values at other taps. LV B- Ph. takes longer time to stabilise. 2) LV magnetization current found increased compared to pre- commissioning result. 3) Excitation current values are increased as compared to previous values 4) Top permali wooden ring Y- Ph. & B- Ph. is found broken.

			5) Y- Ph. common block decoupled. 6) Due to insulation failure.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	No Maintenance carried out as TF was commissioned on dtd: 10.10.2022
xviii.	Details of any previous failure on the same unit	:	After repair, the T/F was commissioned at 400 kV Chakan Substation on dtd: 09.07.2010 then failed on 14.06.2012 under G.P. Again failed on 28.12.2012. Again Transformer failed on 10.05.2021 & then repaired By M/s Jain Electrical Pvt Ltd.
xxi.	Whether tertiary terminals are bare/ insulated		NA
xxii.	Details of protection for Tertiary	:	NA
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	Porcelain

xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	9
xxvii.	Past record of Operation of OLTC	:	Healthy
xxviii.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, OC Backup, REF, Buchholz, temperature trip, PRV, OSR,
xxx.	Details of Protection operated	:	NA (TF 2 is Hand trip)
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	Test Dt: 19.02.2022 TF HV =0.26 Ω TF LV =0.16 Ω HV Netural-0.19 Ω ,LV Neutral-0.16 Ω LA (HV) = (0.36 Ω , 0.24 Ω , 0.21 Ω)
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	a)Yes b)Yes-LCM tested. Dtd :15.11.2021 (R Ph.s = 10 μ A, Y Ph.s=09 μ A,B Ph.s= 16 μ A) c)No
xxxiv.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	clear
xxxv.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	Nitrogen filled



xxxi x.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand	:	Yes
	capability was verified on the basis of calculation?		Yes
xl.	Number of through faults the equipment was subjected to before failure	:	HV along with LV side tripping=19; LV side tripping=5

38. Failure Report of 25 MVA, 220/33 kV At Bhokardan Substation of MSETCL

i.	Name of Substation	:	220 kV Bhokardan Substation
ii.	Utility	:	MSETCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	220/33 kV, 25MVA GEC TF-I
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	25 MVA, 220/33 kV, 3 Phase
v.	Make (Original equipment manufacturer)	:	GEC
vi.	Serial No.	:	B-28242
vii.	Date and time of occurrence of fault	:	09.02.2022 at 08:42
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	1993 (Repaired at 2019)
x.	Date of Commissioning	:	26.07.2019 _Power Transformer Sr. No. B-28242 (Mfg. Yr. 1993) was previously commissioned at 220 kV Yavatmal Substation on Dt.28.08.1993. The said Transformer was in operation upto 2012. Under augmentation scheme said TF was removed from 220 kV Yavataml, under EHV O&M Division, Yavatmal. Further the same was allotted to 220 kV Balapur Substation, under EHV O&M, Division, Akola in year 2012 and commissioned on Dt.31.02.2012 at 220 kV Balapur Substation. Further, same transformer was removed from 220 kV Balapur Substation on Dt.22.09.2016 and sent to M/s Mahati Industries Pvt. Ltd, Pune for overhauling and re-insulation due to heavy oil leakage from top plates & OLTC problem (non-working of OLTC). After overhauling said TF was kept as spare at 220 kV Balapur substation, under EHV O&M Division, Akola.

			Tf was released from 220 kV Balapur Substation to 220 kV Bhokardan Substation for replacement of 25 MVA, 220/33 kV EMCO Make Transformer bearing Sr. No. 1057C/10924, which was failed due to internal fault. At 220 kV Bhokardan substation said transformer is successfully commissioned on Dt. 26.07.2019. Power Transformer Sr. No. B-28242 is tripped on Dt.09.02.2022 on differential protection along with 33 kV Hasnabad feeder.
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	T/F Tripped on Differential Protection and also Main Buccolz Alarm Indication appeared. T/F Tripped along with 33 kV Hasnabad Feeder.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	1) Main Buchholz relay Flame test 2) Open Circuit 3) Short Circuit 4) Winding Tan-Delta & Capacitance 5) Oil DGA 6) HV and LV Magnetic Balance 7) HV and LV Excitation Current at 10kV 8) PI 9) HV and LV Winding resistance
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Internal visual inspection carried out and representative from M/S SETONSITE Electricals Pvt. Ltd, Aurangabad. Observations found in internal visual inspection are enlisted in attached MOM h/w.
xiv.	Probable cause of failure	:	As copper granules observed nearby inside of Y-Phase HV bushing, probable cause may be insulation failure.
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	OEM (Original Equipment Manufacturer) not visited.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	cannot be repaired at site.

xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	a) The routine testing of said TF was carried out on dt.12.07.2021. C & Tan delta of winding, bushing current excavation at 10kV etc. carried out during routine testing. B) No any abnormalities found during routine testing c) Not applicable
xviii.	Details of any previous failure on the same unit	:	NO
xix.	Is tertiary winding provided (Yes/No)	:	No
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC
xxvi.	Tap position of OLTC at the time of failure	:	12
xxvii i.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, REF, HV Bup, LV Bup Directional, LV Bup Non-Directional, MBA, MBT, OSR, PRV, WTA, WTT, OTA, OTT.
xxx.	Details of Protection operated	:	Differential
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii .	Earth Resistance of Substation and date of its measurement	:	0.27Ohm to 1.98Ohm on 2018 as informed by SUBSTATION I/C.
xxxii i.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	(a) Provided (b) SA LCM test carried out as per frequency, results were in order. C) No change in SA counter on the date of occurrence. As informed by SUBSTATION I/C.



xxxv i	Type of Fire protection provided (Emulsifier system/ N ₂ Injection based fire protection system/ foam based protection etc.)	:	Foam based External manual fire protection system
xxxv ii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear Sky
xxxv iii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	Nitrogen Filled
xxxv x.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand	:	440V SC test carried out
xxxv xi	capability was verified on the basis of calculation?		Yes

**39. Failure Report of 100 MVA, 220/132/11 kV 3 Phase At Sonabil GSS of AEGCL**

i.	Name of Substation	:	220/132 kV SONABIL GSS, AEGCL
ii.	Utility	:	AEGCL
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Auto-transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	60/80/100 220/132/11 kV 3 Phase
v.	Make (Original equipment manufacturer)	:	Cgl
vi.	Serial No.	:	T10201/4
vii.	Date and time of occurrence of fault	:	21/02/2022
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	2013
x.	Date of Commissioning	:	12/01/2016
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Trafo trip: 04:51 hrs (21/02/2022) Indications: relay 87-87 pickup Relay 50/51n: general trip, non dir e/f trip 1st attempt to charge: 05:08 hrs (unsuccessful)---declared faulty 2nd attempt after lv side test: 16:42 hrs Trip: 18:01 hrs Indications: relay 50/51n, general trip, non dir e/f trip B-Phase oltc bevel gear teeth found broken. 3rd attempt: 17:25 (successful)

xii.	Details of Tests done after : failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Lv side equipments' ir testing done. Found ok
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	B-Phase oltc bevel gear teeth found broken.
xiv.	Probable cause of failure	:	Mechanical wear and tear
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repaired (gear replaced)
xvii.	Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) Whether any abnormality observed in these tests. If yes, attach the test reports. What steps were taken to address the abnormality?	:	Routine testing: 01/12/2021
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	Yes



xxi.	Whether tertiary terminals are bare/insulated		Insulated
xxv.	On Load Tap Changer or Off Circuit TapChanger	:	Oltc
xxvi.	Tap position of OLTC at the time of failure	:	13
xxvii i.	Tap Range	:	1-17
xxx.	Details of Protection operated	:	87 pickup, Relay 50/51n, general trip, non dir e/f trip
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii i.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA ismonitored (c) Whether reading of SA counter changed during failure	:	a) Yes b) Yes c) No
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fireprotection system/ foam based protection etc.)	:	N2
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.	:	Clear sky

40. Failure Report of 500 MVA 765/400/220 kV AT Hapur Substation of WUPPTCL

i.	Name of Substation	:	765/400/220 kV Hapur
ii.	Utility	:	Western U.P. Power Transmission Co.Ltd.
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	ICT
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	500 MVA, 765/400/33 kV 1 Ph..
v.	Make (Original equipment manufacturer)	:	Bharat Heavy Electrical Ltd. (BHEL)
vi.	Serial No.	:	6007316
vii.	Date and time of occurrence of fault	:	23-05-2022, 5:31 hrs.
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	No fault discovered during operation / maintenance and periodic testing
ix.	Year of Manufacturing	:	2015
x.	Date of Commissioning	:	14-08-2017
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	1) IR & CC - CL 2) Turn Ratio 3) Magnetizing current test 4) Polarity 5) WRM 6) SFRA Test
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Flash over observed on CC-CL link, All other things are observed in order from external.
xiv.	Probable cause of failure	:	Internal fault

xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached	:	Suspected internal failure and need to be send back to BHEL, Factory for repair- MoM attached
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Beyond repair at site / station
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	A. (a) Core insulation test, (b) SFRA, (c) Tan delta of Bushing, (d) WTI & OTI setting verification, (e) Alarm / Trip test, (f) Earth resistance, (g) Tan delta of winding, (h) IR measurement B. C-CL - IR Value was low C. Communicated to OEM. OEM suggested equipment can be kept in service.
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	Yes – 118 kW
xxi.	Whether tertiary terminals are bare/ insulated	:	Bare Phase - R & B Insulated Phase - Y
xxii.	Details of protection for Tertiary	:	Over current, earth fault, open delta
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP / Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	12
xxvii.	Past record of Operation of OLTC	:	No

xxviii.	Tap Range	:	±5.5% (1 to 23)	
xxix.	Details of Protection provided for ICT/GT/Reactor	:	REF, Differential, HV O/C, E/F, LV O/C E/F, Over flux, PRV-I&II, OSR, Buchholz, OLTC - OSR, WTI - HV/LV/IV, OTT	
xxx.	Details of Protection operated	:	REF, Differential, Buchholz, OLTC - OSR, PRV-1 & 2	
xxxi	Whether equipment is properly earthed	:	Yes	
xxxii.	Earth Resistance of Substation and date of its measurement	:	23-03-2022, 0.2 ohms	
xxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	a) Yes b) Yes c) No	
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	LI 2400 kVp-HV 1425kVp-IV 325kVp-LV 170kVp-HVN	SI 1550kV-HV 1050kV-IV
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	LI 2100kVp-HV 1300kVp-IV 250kVp-LV 19kVp5-HVN	SI 1550kV-HV 1050kV-IV
xxxvi.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system	
xxxvii .	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Rainy / Thunderstorm	
xxxvii i.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	(a) Negligible (b) Back charge 21-06-2017 to 14-08-2017 (c) Nitrogen Filled	



xxxix .	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	No
xl	Number of through faults the equipment was subjected to before failure	:	Transient fault in 400 kV Transmission line connected to Hapur Substation

41. Failure Report of 50 MVA, 400/6.9/6.9 kV, 3 Phase at Chhabra Station of RVUNL

i.	Name of Substation	:	Chhabra Thermal Power Plant (4X250 MW), Chhabra, RVUNL
ii.	Utility	:	RVUNL, Energy Department(Raj)
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Station Transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	50 MVA, 400/6.9/6.9 kV, 3 Phase
v.	Make (Original equipment manufacturer)	:	ABB
vi.	Serial No.	:	12072-001
vii.	Date and time of occurrence of fault	:	24.05.2023 at 04:01 hrs.
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	NIL
ix.	Year of Manufacturing	:	2009
x.	Date of Commissioning	:	2014
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	Flashover occurred at 400 kV Y-Phase bushing
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	1. Measurement of capacitance and Tan delta of bushings 2. Turns ratio test 3. IR & PI measurement 4. Insulation resistance test between core, frame & tank 5. Measurement of capacitance and Tan delta of winding 6. Magnetic balance test 7. Magnetizing current test 8. Short circuit impedance test 9. DGA of oil samples 10. Measurement of winding resistance

xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Flashover marks at top & bottom part of 400 kV Y-Phase bushing (Images attached)
xiv	Probable cause of failure	:	Unknown
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	NO
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Transformer is under shutdown till damaged bushing is to be replaced by new bushing
xvii	a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) b) Whether any abnormality observed in these tests. If yes, attach the test reports. c) What steps were taken to address the abnormality?	:	a) Test report are attached of month July 2022 b) No abnormality observed
xviii .	Details of any previous failure on the same unit	:	Flashover occurred on same 400 kV Y-Phase bushing on dated 16.06.2020 at 19:23 hrs.
xix.	Is tertiary winding provided (Yes/No)	:	NO
xxiii .	Whether relay time is synchronized with UTC	:	Time sync with GPS
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	Tap No. 5
xxvii .	Past record of Operation of OLTC	:	No Operation since July 2022

xxvii i.	Tap Range	:	1 to 17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	1. Differential protection 2. Overhung(Differential protection) 3. Stand by earth fault protection 4. Over excitation protection 5. Restricted earth fault
xxx.	Details of Protection operated	:	Differential protection (Overhung)
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii .	Earth Resistance of Substation and date of its measurement	:	2.67 Ohm Date 08.06.2023
xxxii i.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	(a) Yes (b) Yes (c) No
xxxv i.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxxv ii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear Sky
xxxv iii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	NA
xl.	Number of through faults the equipment was subjected to before failure	:	Flashover occurred at 400 kV Y-Phase bushing

42.Failure Report of 275 MVA, 420 /21 kV,1-Phase at Suratgarh Station of RVUNL

i.	Name of Substation	:	2X660MW Suratgarh Super Critical Thermal Power Station
ii.	Utility	:	Generating Station
iii.	Faulty Equipment (	:	Generator Transformer #7A(R- Phase
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	275MVA, 420 /21 kV, 1-Phase.
v.	Make (Original equipment manufacturer)	:	Bhel Bhopal
vi.	Serial No.	:	6007474
vii.	Date and time of occurrence of fault	:	15-03-2022,01:32 Hrs.
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	During operating (Charged) condition.
ix.	Year of Manufacturing	:	2015
x.	Date of Commissioning	:	14.02.17
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure? If no tests were conducted, reasons for the same may be stated.)	:	Following test were conducted after failure:- Meggering of HV to Earth, HV to LV, LV to Earth, Core to Tank& Tank to Limb & Core to Limb and Magnetic Balance test were conducted.
xiii.	Observations (Visual observations e.g. bulging of tank,fire, any leakage of oil, damage to various components of transformer andnearby equipment / material etc.)	:	HV bushing Got damaged, Main tank Body deformed/damaged due internal fault. complete oil was drained
xiv.	Probable cause of failure	:	Failure of HV bushing of transformer.
xv.	If OEM representative had inspected theequipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	BHEL Bhopal (OEM) representative visited the site on 17/03/22.

xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Damaged GT was Charged on Dt. 12.10.2022 after repair and running successfully since then.
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	(a) GT oil sample testing was done in June-2021 and Tan delta measurement of HV Bushing was done in Nov- 2019 (b) No (c) Not Applicable
xviii.	Details of any previous failure on the same unit	:	No previous failure on this GT
xix.	Is tertiary winding provided(Yes/No)	:	No
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	NA
xxi.	Whether tertiary terminals are bare/insulated	:	NA
xxii.	Details of protection for Tertiary	:	NA
xxiii.	Whether relay time is synchronized with UTC	:	Relay time was synchronized with UTC but there is time drift in some of the relays
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain/polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit TapChanger	:	Off Load Tap Changer
xxvi.	Tap position of OLTC at the time of failure	:	3

xl.	Number of through faults the equipment was subjected to before failure	:	No
xxvii.	Past record of Operation of OLTC	:	Tap Position never changed
xxviii. i.	Tap Range	:	1 to 9
xxix.	Details of Protection provided for GT	:	Differential, REF, HV Overcurrent, Earth fault, Over flux, WTI, OTI, Buchholz, PRV-A & B, SPR etc.
xxx.	Details of Protection operated	:	Differential, REF, WTI, Buchholz, PRV-A & B, SPR
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	1 Ohm on dated 12.01.2017
xxxiii. i.	Surge arrester: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counterchanged during failure	:	(a) Yes (b) Yes (c) No
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	Lightning Impulse withstand Voltage = 1550 kVp Switching Impulse withstand Voltage = 1180 kVp
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	Switching Impulse Withstand Voltage of the winding HV = 1175 kVp Lightning Impulse Withstand Voltage of the winding HV/LV/HVN = 1425/125/95 kVp
xxxvi. .	Type of Fire protection provided (Emulsifier system/ N ₂ Injection based fire protection system/foam based protection etc.)	:	Emulsifier system
xxxvi. i.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.	:	clear sky

43. Failure Report of 160 MVA, 220 kV at GSS BIKANER of RRVPN

i.	Name of Substation	:	220 kV GSS BIKANER
ii.	Utility	:	Power Transformer
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	220/132 kV, 160 MVA TRF MAKE BHEL
iv.	Rating(MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	160 MVA.....(220/132/11 kV)
v.	Make(Original equipment manufacturer)	:	BHEL
vi.	Serial No.	:	2040808
vii.	Date and time of occurrence of fault	:	07.01.2023 AT 22:25 HRS
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Atom-sealing of transformer conservator tank was found failed & there is continuous oil leakage from silica gel breather of OLTC attended by BHEL representative from 02.01.2020 to 04.01.2020 but failed again on 05.01.2020 , Oil drainage from NIPES dtd 01.04.2020 attended by CTR Manufacturer, NIPES
ix.	Year of Manufacturing	:	2017
x.	Date of Commissioning	:	01.06.2018
xi.	Sequence of events/Description of fault (SOE withtime stamp, Protection operated during fault)	:	Above said transformer was tripped on dated 07.01.2023 at 08:00 hrs with indication as Buchholz trip-2 with oil level was found at 1/4th level. Oil top up was done by filtered oil Drum – 02 with releasing gases from Buchholz Relay. Transformer charged at 12:36 hrs and tripped again at 13:34 hrs with indication Buchholz trip-2, Master 86 then again closed at 15:05 hrs. Transformer again tripped at 22:25 hrs dtd 07.01.2023 Buchholz trip-2, Master 86 relay. While releasing trapped air from both Buchholz relays it was found that gases formation is in Buchholz relay (Main tank side) and there is no trapped gas found in Buchholz relay (Conservator side)

xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Oil testing done on dtd 08.01.2023 , Protection tests done by MPT&S dtd 08.01.2023 , Internal Inspection by AEN (Tr. Workshop), Heerapura, Jaipur 12.01.2023 & 13.01.2023
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	Shunt (wall mounted core at tertiary winding) of transformer are multiple shorted with tank body
xiv.	Probable cause of failure	:	86 master trip relay, buchholz relay optd
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	E file moved for repair of trf from bhel
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	A. Date of last routine maintenance:- 12.08.2022 , last oil testing:-15.11.2022 Last trf tan delta testing:- 26.05.2022 B. Nil C. Nil
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxi.	Whether tertiary terminals are bare/insulated	:	Yes
xxii.	Details of protection for Tertiary	:	Nil
xxiv.	Bushing details	:	Porcelain



	(OIP/RIP/RIS, Porcelain polymer housing)		
xv	On Load Tap Changer or Off Circuit Tap Changer	:	ON LOAD TAP CHANGER
xxvi.	Tap position of OLTC at the time of failure	:	TAP No 15
xxvii.	Past record of Operation of OLTC	:	06.01.2023 AT 18:00HRS
xxviii.	Tap Range	:	Tap No 01 to 21
xxx.	Details of Protection operated	:	BUCHHLOZ RELAY OPTD
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.30 ohms (Date- 29.09.2022)
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	a) Yes b) Healthy c) Internal Fault (No reading change)
xxxvi.	Type of Fire protection provided (Emulsifier system/ N ₂ Injection based fire protection system/ foam based protection etc.)	:	N ₂ Injection based fire protection system
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	WINTER SEASON WITH FOG & MIST
xxxviii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	Laying at Switchyard after dismantle
xxxix.	Whether short circuit test was carried out on this transformer or same design	:	Pre commissioning SC Test on dtd 25.05.2018 (All Values in order)



	transformer or short circuit withstand capability was		SC Test on dated 08.01.2023 after fault occurred (All Values in order)
xl.	Number of through faults the equipment was subjected to before failure	:	6

44. Failure Report of 315 MVA 400/200 KV at GSS JODHPUR of RVPN

i.	Name of Substation	:	400 KV GSS RVPN JODHPUR
ii.	Utility	:	step up/down of voltage
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	400/220 KV, 315 MVA ICT/AUTOTRANSFORMER
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	400/220 KV, 315 MVA ILT TRANSFORMER, 3-Phase
v.	Make (Original equipment manufacturer)	:	M/s BHEL
vi.	Serial No.	:	600603
vii.	Date and time of occurrence of fault	:	29.05.2023, 04:30 Hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	operation
ix.	Year of Manufacturing	:	2003
x.	Date of Commissioning	:	14.03.2005
xi.	Sequence of events/Description of fault (SOE with timestamp, Protection operated during fault)	:	transformer tripped with all relay indication (PRV, Buchholz, Differential, 86, OSR, ETC.) & R-Ph. HV side bushing burst, remaining all HV & LV bushings cracked.
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	testing has been done by MPT&S Wing Jodhpur. Core has been earthed and one Phase found abnormal during testing.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage)	:	(1) Found top- bottom rim bend cooling bank side. (2) Total Seven nos. HV-3, LV-3, Neutral- 1 bushing damaged/ cracked.



	of oil, damage to various components of transformer and nearby equipment / material etc.)		(3) Cooling bank side main body stiffener welding broken. (4) LV side B-Ph. OLTC top cover cracked. (5) Core packing found loose and alignment shifted. (6) LV bushing B-Ph. bottom side complete porcelain part found damaged.
xiv.	Probable cause of failure	:	Internal fault
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	Internal inspection of said transformer has been carried out from 21.07.2023 to 23.07.2023. MOM between M/s BHEL and RVPN
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable, said transformer will be repair at factory site of M/s BHEL Bhopal.
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	(a) Last Quarterly maintenance dt. 09.02.2023. Last testing carried out on dt. 25.10.2021. (b) Nil (c) Nil
xviii.	Details of any previous failure on the same unit	:	Yes, On Oct-2016 and Dec-2017
xix.	Is tertiary winding provided (Yes/No)	:	Yes
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	no
xxi.	Whether tertiary terminals are bare/ insulated		insulated

xxii.	Details of protection for Tertiary	:	NDR
xxiii.	Whether relay time is synchronized with UTC	:	No
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain polymer housing)	:	Condensor type OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC
xxvi.	Tap position of OLTC at the time of failure	:	11
xxvii.	Past record of Operation of OLTC	:	On dated tap position of transformer changed from 9b to 11.
xxviii.	Tap Range	:	17
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Buchholz relay PRD relay Differential protection 87 relay 86A&B relay, Ref relay 64R Back up O/C & E/F 67 relay C.B. Trouble relay 52XA/B Overflux protection relay NDR
xxx.	Details of Protection operated	:	HV side : 30AB(Buchholz Trip), 30EF(PRD 1&2 Trip), OLTC U,V,W Phase trip, OFL A/B alarm, 30UV relay operated. Differential protection 87 relay operated: LED 1,2,3,8,9 86A&B relay, Ref relay 64R CB 552B Panel: Differential protection 87-2, 87C relay operated. LV side : Back up O/C & E/F 67 relay C.B. Trouble relay 52XA/B 86 Relay optd.
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.16 ohm, 01.06.2022 to 12.06.2022

xxxiii.	Surge arrestor: (a) Is SA provided for protection Whether healthiness of SA is monitored Whether reading of SA counter changed during failure	:	(a) Yes (b) yes (c) No
xxxiv.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxxv.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Rainy / Thunderstorm
xxxvi.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	(a) 25.05.2003 to 06.03.2004 (b) uncharged (c) Nitrogen filled
xxvii.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand	:	short circuit test was carried out on this transformer
xxviii.	capability was verified on the basis of calculation?		yes
xxxix.	Number of through faults the equipment was subjected to before failure	:	02 Times



45. Failure Report of 160 MVA 220/132/33 KV at Narmadapurm substation of MPPTCL

i.	Name of Substation	:	220 kV Substation Narmadapurm
ii.	Utility	:	M.P. Power transmission co. Ltd.
iii.	Faulty Equipment (ICT/Autotransformer/GT/Reactor etc.)	:	Auto transformer
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	160 MVA 220/132/33 kV 3 PHASE
v.	Make (Original equipment manufacturer)	:	AREVA
vi.	Serial No.	:	B-30235
vii.	Date and time of occurrence of fault	:	Date 27/06/2022 Time 14:27 hrs.
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Fault discovered during operation of equipment. R&Y Phase Diff relay optd. Alongwith the operation of 03 PRV& Bucholz relay
ix.	Year of Manufacturing	:	2008
x.	Date of Commissioning	:	31/01/2009
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	1. Percentage Differential APh.. Pkp. 23:12:53.409822 2. Percentage Differential BPh.. Pkp. 23:12:53.409822 3. Inst. Differential A Ph.. Op. 23:12:53.417327 4. Inst.Differential BPh.. Op. 23:12:53.417327 5. Differential Operate 23:12:53.417327 6. Gen Trip ON 23:12:53.417327 7. OSG Trig. 23:12:53.417327 8. Percentage Differential CPh.. Pkp. 23:12:53.419826 9. Fault report Trig. 23:12:53.427327



			10. HV 86 B Operate 23:12:53.441620 11. HV 86 A Operate 23:12:53.452123 12. LV 86 Operate 23:12:53.456623 13. PRV 2 Operate 23:12:53.458127 14. PRV 1 Operate 23:12:53.461623
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Low voltage AC test and IR Values measurement done after failure
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	On dated 27.06.2022 at about 14:00 Hrs, at 220 kV Substaion Narmadapuram, system was running normal & relatively lightly loaded. NO system operation was being carried out at this time. At about 14:27Hrs, 160 MVA Transformer Make-AREVA bearing S.No. B-30235, tripped with heavy sound on R Y & B Phase Percentage Differential & R&Y Phase Instantaneous Differential operated along with the tripping of all 03no. PRVs relay & Bucholz Alarm / Trip relay & HV / LV Master Trip relay, and transformer HV & LV CBs tripped from both 220 kV & 132 kV side. No other occurrence of any other element at this substation and the adjacent EHV SUBSTATION were reported. It is evident from Disturbance Recorder/Event Recorder that after Inst. Differential operation the HV & LV Master Trip relay operates. Then other protection like PRV 1, 2 & 3 & Main Buch Alarm & Trip operating subsequently. Due to operation of all three PRVs, Oil came out of 160MVA Transformer with heavy Pressure. Due to heavy Pressure, many nuts & bolts of main tank broke and welding joints of 03no.s Stiffeners found broken at bottom side of Main tank (near 33 kV Bushings) and Main tank body also inflated near 33 kV Bushings.



			03nos. 220 kV Bushings cracked from bottom side. During internal inspection of transformer R-Phase Tap Changer complete Selector housing assembly along with selector rod(female contact housing) found damaged & 132 kV side Y-Phase tapping leads coming from winding tapings(3,5,7&9 taps) also get damaged. Some core winding assembly permawood support found damaged and its clamps also found broken.
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xiv.	Probable cause of failure	:	yes
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	Not inspection done by OEM
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	(A) Details of previous maintenance (1) LT & IR value measurement done on date 14/06/2022 (2) Tan delta measurement done on dated. 24/06/2020 (3) Winding resistance measured on dated. 21/09/2020 (B) There was no abnormality observed in this result
xviii.	Details of any previous failure on the same unit	:	NO
xix.	Is tertiary winding provided (Yes/No)	:	YES
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	NO
xxi.	Whether tertiary terminals are bare/insulated	:	Bare
xxii.	Details of protection for Tertiary	:	NILL
xxiii.	Whether relay time is synchronized with UTC	:	NO
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP Porcelain
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	On Load Tap changer
xxvi.	Tap position of OLTC at the time of failure	:	9

xxvii.	Past record of Operation of OLTC	:	21/09/2020
xxviii.	Tap Range	:	17
xxix.	Details of Protection provided for CT /GT / Reactor	:	Diff protection, O/C & E/F PRV protection, PRV, Bucholz relay, OSR, oil temperature and winding temperature protection
xxx.	Details of Protection operated	:	R&Y Phase Diff relay optd. Alongwith the tripping of 03 PRV & Bucholz
xxxi.	Whether equipment is properly earthed	:	YES
xxxii.	Earth Resistance of Substation and date of its measurement	:	Date of testing 17/05/2022 Measurement of earth resistance (1) Toward tertiary - 0.22Ω (2) Near cooling fan- 0.21Ω (3) 220 kV LA Side- 0.22Ω
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	(A)–YES (B) YES (C) NO
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	clear
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit withstand capability was verified on the basis of calculation?	:	Short circuit test did not carried out and short circuit withstand capability were tested at Factory.
xl.	Number of through faults the equipment was subjected to before failure since 01/06/2021		21 Nos.

46. Failure Report of 315 MVA ICT-II at Nagada Substation of MPPTCL

i.	Name of Substation	:	Nagada 400 kV Substation
ii.	Utility	:	MPPTCL
iii.	Faulty Equipment (ICT/Autotransformer/GT/Reactor etc.)	:	315MVA ICT-II (Transformer)
iv.	Rating (MVA/MVAR, Voltage ratio, 1- Phase/3-Phase)	:	315MVA(400/220/33 kV) Current-454/826/1837
v.	Make (Original equipment manufacturer)	:	BHEL
vi.	Serial No.	:	6005491
vii.	Date and time of occurrence of fault	:	27-08-2022 & 20 58Hrs
viii.	Fault discovered during (Operation or periodic testing/maintenance)	:	None
ix.	Year of Manufacturing	:	1956
x.	Date of Commissioning	:	15-11-1997
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	HV B & IV B-Phase bushing burst and displaced IV R-Phase bushing OLTC B Phase top plate cover broken & selector switch got damaged.
xiv.	Probable cause of failure	:	Due to insulation failure of HV B & IV B-Phase bushing.
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Transformer has completed its 25 years useful life and it is not repairable at site as per company Engineer M/s BHEL



xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	315MVA ICT-2 (BHEL) date of testing & maintenance on 01 04 2022 No any abnormality observed No any abnormality observed N/A
xviii.	Details of any previous failure on the same unit	:	
xix.	Is tertiary winding provided (Yes/No)	:	YES
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	50 KW
xxi.	Whether tertiary terminals are bare/ insulated	:	Bared
xxii.	Details of protection for Tertiary	:	Over current & NDR relay protection
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	OLTC (On load Tap changer)
xxvi.	Tap position of OLTC at the time of failure	:	11
xxvii.	Past record of Operation of OLTC	:	Tap operated on dtd 01.04.2022 during pre-monsoon maintenance
xxviii.	Tap Range	:	01-17- No.
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential, REF, O/C & E/F, V/F, Buchholz, PRV, OSR, NIFPS, WTI, OTI, LBB

**CENTRAL ELECTRICITY AUTHORITY**

xxx.	Details of Protection operated	:	Diff optd, REF protection Optd Bucolz trip, PRV-I&II Trip, NIFPS Optd.
xxxii.	Whether equipment is properly earthed	:	Yes
xxxiii.	Earth Resistance of Substation and date of its measurement	:	011 ohm & dtd 01-04-2022
xxxiii. i.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	Yes Yes No changed
xxxiv. i.	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	NIFPS & Fire extinguisher
xxxv. ii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Cloudy

REACTORS

47. Failure Report of 50MVAR,420 kV,3-Phase Switchyard, Koderma Thermal Power Station, DVC

i.	Name of Substation	:	400 kV Switchyard, Koderma Thermal Power Station
ii.	Utility	:	Damodar Valley Corporation
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Bus Reactor#2
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase /3-Phase)	:	50MVAR,420 kV,3-Phase
v.	Make (Original equipment manufacturer)	:	M/s BHEL, Bhopal
vi.	Serial No.	:	6006672
vii.	Date and time of occurrence of fault	:	20.04.2023 and 06:39 AM
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of manufacturing	:	2009
x.	Date of Commissioning	:	04.04.2013
xii.	Details of tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	Oil DGA has been conducted.
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil,	:	Bulging of tank, fire, leakage of oil, damage of all three Phase bushings have been occurred.

	damage to various components of transformer and nearby equipment / material etc.)		
xiv.	Probable cause of failure	:	Insulation Failure
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	As per OEM M/s BHEL, It is Beyond repair
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	(a) Activities carried out in previous maintenance schedule: - i) Tightness of all clamps & connectors ii) Cleaning of all bushings iii) Checking of healthiness of all protective devices (OTI, WTI, Bucholz, PRV etc.) iv) Preventive Maintenance of circuit breaker, isolators, LAs & other bay equipments. v) IR Test of Reactor and oil BDV & moisture content conducted. and Periodicity of the maintenance activity: - Annually (b) IR Test and oil BDV & moisture content were found ok. (c) NA

xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided (Yes/No)	:	No
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	No
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP
xxix.	Details of Protection provided for ICT/GT/Reactor	:	TEED, Differential, REF, Backup Overcurrent & Earth Fault, OTI,WTI, Buchholz, PRV etc.
xxx.	Details of Protection operated	:	TEED, Differential, REF, OTI,WTI, Buchholz, PRV
xxxi.	Whether equipment is properly earthed	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	Less than 0.5 ohm, D.O.M:-Jan,23
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	(a) Yes (b) Yes (c) No
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	BIL-1550 KVp SIL-1180 KVp

xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	1300 KVp and 1050 KVp respectively
xxxvi .	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxxvi i.	Weather conditions at the time of failure (clear sky/rainy /thunderstorm etc.)	:	clear sky
xxxvi ii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	Records are not available. However Commissioning was done by M/s BHEL.
xxxix .	Whether short circuit test was carried out on this transformer or same design transformer, or short circuit withstand capability was verified on the basis of calculation?	:	Not Available
xl.	Number of through faults the equipment was subjected to before failure	:	0

48. Failure Report of 400/220 kV Reactor at Raipur Substation of Power grid

i.	Name of Substation	:	400/220 kV Raipur Substation
ii.	Utility	:	POWERGRID
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Reactor
iv.	Rating (MVA/MVAR, Voltage Ratio, 1 Phase/ 3 Phase)	:	400 kV,125 MVAR ,3-Phase
v.	Make (Original equipment manufacturer)	:	Alstom
vi.	Serial No.	:	250361
vii.	Date and time of occurrence of fault	:	30.09.2022 at 22:16:19 Hrs
viii.	Fault discovered during (Operation or periodic testing/ Maintenance)	:	Operation
ix.	Year of Manufacturing	:	2014
x.	Year of Commissioning	:	2014
xi.	Sequence of events/Description of Fault (SOE with time stamp, Protection operated during fault)	:	REF operated at 22:16 on 30.09.2022
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no test were conducted, reason for the same may be stated)	:	All HV bushings got damaged
Xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment/ Material etc.)	:	HV bushings damaged

Xiv.	Probable cause of failure	:	Failure of HV bushings
Xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MOM etc. may be attached.	:	NO
Xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable
Xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	All maintenance activities carried out as per POWERGRID norms and results were within acceptable limits.
Xviii.	Details of any previous failure on the same unit	:	No
xxiii.	Whether relay time is synchronized with UTC	:	YES
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain/Polymer housing)	:	OIP
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Differential , REF, Backup Impedance, Buchholz, PRD, WTI Trip, OTI Trip
xxx.	Details of Protection Operated	:	REF
xxxi.	Whether equipment is properly earthed.	:	Yes
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.54
xxxiv.	Surge arrestor: (a) Is SA provided for protection	:	(a) Yes (b) Yes



	(b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure		(c) NO
xxxv	Type of Fire protection provided (Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)	:	Emulsifier system
xxxvi	Weather conditions at the time of Failure (Clear sky/rainy/thunderstorm etc.)	:	Clear

49. Failure Report of Rector at Kudankulan Nuclear power project 1&2 of NPCIL

i.	Name of Substation	:	Kudankulan Nuclear power project 1&2
ii.	Utility	:	Nuclear power corporation of India limited
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	Shunt reactor (00ACR40B Phase)
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3-Phase)	:	26667 KVAr
v.	Make(Original equipment manufacturer)	:	Zaporozh Transformator , Ukraine
vi.	Serial No.	:	15812
vii.	Date and time of occurrence of fault	:	27/11/2022, 18:00hrs
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation
ix.	Year of Manufacturing	:	06/2006
x.	Date of Commissioning	:	05/10/2012
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	87I inter turn differential protection along with Buchholz relay alarm
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be	:	The following tests were done in location 1) Active and magnetic part IR 2) Winding Insulation resistance 3) Winding resistance 4) Winding tan delta 5) Bushing tan delta

	stated.)		6) Oil test
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	No Physical damage is found
xiv	Probable cause of failure	:	Winding part HV –N2 winding (one out of two parallel winding) was found electrically open
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	No (Foreign OEM)
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	Repairable Contract is being processed for award of award for repair
xvii	a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	a) 2 Yearly PM checks done on 20/11/2022, all electrical parameters including IR, WR, tan delta etc. were checked, main oil hot oil circulation and oil test were done. b) No abnormality was found c) Measured values were within acceptable limit
xviii.	Details of any previous failure on the same unit	:	No
xix.	Is tertiary winding provided	:	No

	(Yes/No)		
xxiii.	Whether relay time is synchronized with UTC	:	Yes
xxiv.	Bushing details (OIP/RIP/RIS, Porcelain / polymer housing)	:	OIP (Oil impregnated paper insulation type)
xxix.	Details of Protection provided for ICT/GT/Reactor	:	Longitudinal reactor differential protection 87 Inter turn differential protection 87I
xxx.	Details of Protection operated	:	87 I Inter turn differential protection
xxxi.	Whether equipment is properly earthed	:	Yes.
xxxii.	Earth Resistance of Substation and date of its measurement	:	0.34 Ω dated 02/05/2023
xxxiii.	Surge arrestor: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	a) There is no SA in ACR-40 feeder, but ACR-40 connected to BUS-A , bus is having SA. b) PM checks are carried out during BUS-A shutdown time (31/05/2023). c) No change. Before and after ACR-40 event (28/11/2022) BUS-A SA counter
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	BIL: 1500KV
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	Lightning Impulse withstand Voltage -1425KV Switching Impulse withstand Voltage -1050 KV
xxxvi.	Type of Fire protection provided	:	Transformer internal protection based fire water spray type.



	(Emulsifier system/ N2 Injection based fire protection system/ foam based protection etc.)		
xxxvii .	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	Clear sky
xxxvii i.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	a) Three year b) Uncharged c) Oil filled
xl	Number of through faults the equipment was subjected to before failure	:	Nil

50. Failure Report of 765 kV Rector at Anta -Phagi Ckt 2 of RVPN

i.	Name of Substation	:	765 kV GSS ANTA
ii.	Utility	:	RVPN
iii.	Faulty Equipment and the associated feeder	:	765 kV Reactor Bank (3X80 MVAR) of 765 kV Anta -Phagi Ckt 2.
iv.	Rating (Voltage/ current/ current ratio/ capacitance/ MCOV etc., as applicable)	:	765 kV
v.	Short circuit withstand current and duration	:	50 KA
vi.	Make (Original equipment manufacturer)	:	3 Second
vi.	Serial No.	:	310009
vii	Date and time of occurrence of fault	:	29.03.2023 / 14:50Hrs.
ix.	Fault discovered during (Operation or periodic testing/ maintenance)	:	Operation.
x.	Weather conditions at the time of failure (clear sky/ rainy / thunderstorm etc.)	:	clear sky
xi	Year of manufacturing	:	2012
xii.	Date of Commissioning	:	05.01.2015
xiii.	Storage condition of equipment if the gap between delivery at site and Commissioning is over 6 months	:	12 month
xv.	Present condition of equipment (Repaired/ To be repaired / beyond repair)		To be repaired



xxii.	Probable cause of failure		Gradding capacitor failed.
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Annexure- II

Format for report of failure of the Transformer/Reactors

Proforma for reporting of failure of Transformer/Reactor

i.	Name of Substation	:	
ii.	Utility	:	
iii.	Faulty Equipment (ICT/Auto-transformer/GT/Reactor etc.)	:	
iv.	Rating (MVA/MVAR, Voltage ratio, 1-Phase/3- Phase)	:	
v.	Make (Original equipment manufacturer)	:	
vi.	Serial No.	:	
vii.	Date and time of occurrence of fault	:	
viii.	Fault discovered during (Operation or periodic testing/ maintenance)	:	
ix.	Year of Manufacturing	:	
x.	Date of Commissioning	:	
xi.	Sequence of events/Description of fault (SOE with time stamp, Protection operated during fault)	:	
xii.	Details of Tests done after failure (What tests were conducted after the discovery of failure. If no tests were conducted, reasons for the same may be stated.)	:	
xiii.	Observations (Visual observations e.g. bulging of tank, fire, any leakage of oil, damage to various components of transformer and nearby equipment / material etc.)	:	

xiv.	Probable cause of failure	:	
xv.	If OEM representative had inspected the equipment or visited the site after failure, their remarks, MoM etc. may be attached.	:	
xvi.	Present condition of equipment (Whether repairable or beyond repair)	:	
xvii.	(a) Details of previous maintenance (Activities carried out in previous maintenance including the tests conducted, periodicity of the maintenance activities) (b) Whether any abnormality observed in these tests. If yes, attach the test reports. (c) What steps were taken to address the abnormality?	:	
xviii.	Details of any previous failure on the same unit	:	
xix.	Is tertiary winding provided (Yes/No)	:	
xx.	Tertiary loaded (Yes/No) If yes, specify load on tertiary	:	
xxi.	Whether tertiary terminals are bare/insulated	:	
xxii.	Details of protection for Tertiary	:	
xxiii.	Whether relay time is synchronized with UTC	:	
xxiv.	Bushing details Porcelain /polymer (OIP/RIP/RIS, housing)	:	
xxv.	On Load Tap Changer or Off Circuit Tap Changer	:	
xxvi.	Tap position of OLTC at the time of failure	:	
xxvii.	Past record of Operation of OLTC	:	
xxviii.	Tap Range	:	
xxix.	Details of Protection provided for	:	

	ICT/GT/Reactor		
xxx.	Details of Protection operated	:	
xxxi.	Whether equipment is properly earthed	:	
xxxii.	Earth Resistance of Substation and date of its measurement	:	
xxxiii.	Surge arrester: (a) Is SA provided for protection (b) Whether healthiness of SA is monitored (c) Whether reading of SA counter changed during failure	:	
xxxiv.	Lightning Impulse and Switching Impulse Withstand Voltage of the bushings of all voltage level	:	
xxxv.	Lightning Impulse and Switching Impulse Withstand Voltage of the winding of all voltage level	:	
xxxvi.	Type of Fire protection provided (Emulsifier system Injection based fire Protection system/ for based protection etc.)	:	
xxxvii.	Weather conditions at the time of failure (clear sky/rainy/thunderstorm etc.)	:	
xxxviii.	Storage condition of equipment at site before Commissioning: (a) Period of storage (b) Idle charged or uncharged (c) Dry air filled/Nitrogen filled/ Oil filled	:	
xxxix.	Whether short circuit test was carried out on this transformer or same design transformer or short circuit with stand, capability was verified on the basis of calculation?	:	
xxxx.	Number of through faults the equipment was subjected to before failure	:	



xxxxi.	Attach the following: (a) Single Line Diagram of the substation (b) Photographs of the failed equipment (c) Disturbance Recorder/Even Logger Data (d) Reports of tests conducted after failure (e) Factory test results (f) Pre-Commissioning test results (g) Protection schematic diagram	:	
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Annexure- III

Office Order Constituting the Standing Committee



CENTRAL ELECTRICITY AUTHORITY



Government of India
Central Electricity Authority
Office of Secretary
Sewa Bhawan, R.K. Puram
New Delhi- 110 066
Fax No. 011-26108476
Tel.No. 011-26105619



(ISO :9001-2008)

No. CEA/SETD/220-O/2012/1-80

01.01.2013

Subject:- Constitution of a Standing Committee of Experts to investigate the failure of equipment at 220 kV & above sub-stations.

In order to investigate the failure of equipment at 220 kV & above sub-stations, it has been decided to constitute a Standing Committee comprising experts in the field of design and operation of EHV substation from Central Electricity Authority(CEA), various power utilities and research/academic institutes under section 73, clause(1) of the Electricity Act, 2003.

2. The Committee shall consist of the following members:

- | | | |
|-------|---|-------------------|
| (i) | Chief Engineer (SETD), CEA | -Chairperson |
| (ii) | A representative from CPRI, Bangalore | -Member |
| (iii) | A representative from IIT, Hauz Khas, New Delhi | -Member |
| (iv) | A representatives from concerned State Utility/Generating Companies/Transmission Companies where Substation Equipment failure has taken place | -Member |
| (v) | Member Secretary of concerned RPC | -Member |
| (vi) | Director (SETD), CEA | -Member Secretary |

3. The terms of reference of the Committee shall be as follows:

- To investigate the causes of failure of substation equipment in service
- To recommend remedial measures to avert recurrences of such failures in future.

4. Every incident of substation equipment failure needs to be immediately reported to Chairperson of the Standing Committee by a designated officer of the concerned organization.

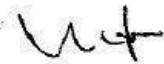
5. The Power Utility where failure of substation equipment has taken place will provide all assistance required by the Committee in carrying out the investigations.

6. The TA/DA and other expenses shall be borne by the respective organizations of the members of the Committee.



CENTRAL ELECTRICITY AUTHORITY

The Chairperson of the Committee will prepare compendium of the analysis of the failures and recommendations every six months and submit the same to the Authority and MoP.

o/c

(M.S. Puri)
Secretary, CEA

To:

1. Director General, Central Power Research Institute, Professor Sir C.V. Raman Road, P.O. Box- 8066, Bangalore- 560080.
2. Director, Indian Institute of Technology, Hauz Khas, New Delhi- 110016.
3. Chairman/CMDs of State Utility/ Generating Companies and Transmission Companies.

With a request to nominate their representative as member of the Committee along with an alternative member.

4. Member Secretaries, Regional Power Committees:

- a) NRPC, New Delhi
- b) WRPC, Mumbai
- c) SRPC, Bangalore
- d) ERPC, Kolkata
- e) NERPC, Shillong

5. Chief Engineer (SETD), CEA

6. Director (SETD), CEA.



Annexure- IV
Minutes of Meeting of the Standing Committee of
Experts to Investigate the Failure of 220 kV and
Above Voltage Class Substation Equipment Held on
21.11.2023 and 22.11.2023 in CEA

Minutes of the Meeting of Standing Committee of experts to investigate the failure of substation equipment at 220 kV and above voltage Class for the period of January 2022 to June 2023 held on 21.11.2023 and 22.11.2023.

A meeting of Standing Committee of experts to investigate the failure of substation equipment at 220 kV and above voltage Class for the period of January 2022 to June 2023 was held on 21.11.2023 and 22.11.2023 through Physical mode, under the chairmanship of Chief Engineer, PSE&TD, CEA, and Chairman of the committee. However link of the online meeting through video conferencing mode was provided to the participants who could not join Physically.

List of participants is attached as Annexure.

- 1 Chief Engineer, PSETD, welcomed all the participants and highlighted a brief background about the formation and mandates of the committee. He stated that a Standing Committee of experts in the field of design and operation of EHV Substations from CEA, various power utilities and research / academic institutes was constituted under Section 73, Clause (I) of the Electricity Act, 2003, to investigate the failure of 220 kV and above voltage Class substation / switchyard equipment such as Power/Generator Transformer and reactors vide which all the utilities are required to report any event of failure of transformers and reactors within 48 hours in the specified format for reporting the incident (available on CEA website) along with all the additional information (like Disturbance Recorder (DR)/ Event Logger (EL) report], SLD, Test reports, O&M history, Photographs etc.).
- 2 Further, he informed that for the period of January 2022 to June 2023, a total of 169 incidents of failure of substation equipment were reported to CEA by 21 utilities (NTPC, GSECL, AEGCL, KSEB, RRVUNL, DTL, DVC, NLCIL, MPPTCL, NTPL, KPTCL, Powergrid, UPPTCL, NPCIL, SJVN, PSTCL, HPPCL, GETCO, MSETCL, Puducherry Electricity Department, HTPS). Failure of thirty transformers, five Reactors, fifty four Current Transformers, twenty nine CVTs, twenty two Surge arresters, eighteen Circuit Breakers, two Wave traps and four Coupling Capacitors were reported.
- 3 He requested all the members to ensure timely maintenance and monitoring of substation equipment to reduce their failures. He also stressed upon intimation of incidents of failure to CEA within 48 hours by the utilities in order to arrange for site visit by CEA and other members of committee for investigation. He further stated that the objective of this committee was not finding faults in operation but rather to bring out the best practices being carried out by various utilities and extend them further to all the utilities. The findings of this committee would help in strengthening the Indian grid and avoid unwanted failure of substation equipment.
- 4 Director, PSETD, stated that sometimes the information provided by the utility is not sufficient to arrive at any conclusion. He informed that detailed Proforma for reporting of failure is available on CEA website and the same should be used by all utilities to report the incidents of failure of equipment so as to facilitate an investigation by CEA team and other members of committee. All utilities were advised to share the information in the provided format (word file shall also be included) along with all the relevant Photographs, reports of all pre-Commissioning tests and those carried out post fault. Director, PSETD, requested the utilities to present their failure incidents one by one to the expert members of the committee for investigation and opinions.

- 5 The presentation for their respective failure incidents were given by representatives of the utilities. The failure incidents and their subsequent findings were deliberated upon by the members of the committee, based on which suggestions were made to address the prevalent issues by members of the committee. Based on the deliberation in the meeting, the recommendations will be recorded in the final report of the Standing Committee.
- 6 KSEB representative presented 7 Nos. failure of CT, PT and Surge Arrester. In the reported CT, severe oil leak and the tan delta value were found high due to moisture ingress which causes failure. Chief Engineer, PSE&TD observed that the tests were done after oil leakage and moisture ingress. He advised to do the tests regularly so that deviation could be detected at early stage. Committee further advised that Capacitance variance should also be checked and the value of it should be within 5%. It was further recommended that the value of tan delta should be less than 0.07.
- 7 KPTCL representatives presented their six Power Transformers failure and two Current Transformers failure cases. The committee recommended that after severe fault, Dissolved Gas Analysis (DGA) and Sweep Frequency response Analysis (SFRA) tests should be carried out. KPTCL representatives also presented the fact that sometimes during end terminal fault in star connected transformers differential relay does not operate. The committee advised to carry out the variable frequency tan delta test starting from 1 Hz as this test provides earlier indication of a problem in the dielectric. Committee further recommended that Gasket should be changed after every 10 years so that proper seal is maintained to prevent the ingress of moisture.
- 8 SJVN representatives presented their one Generator Circuit Breaker (GCB) failure case. SJVN stated that they are doing the SF6 gas analysis test for circuit breakers every fortnightly by SF6 Gas Kit. It was observed that gas might have got contaminated due to over maintenance. Therefore, Committee recommended that over maintenance also leads to failure of the equipment. Utilities should carry out the maintenance as per standard practices. Committee further recommended that Dynamic contact resistance measurement (DCRM) is useful tool to prevent the failure of Circuit breaker. Therefore, DCRM should be regularly monitored.
- 9 AEGCL representatives presented their two 220 kV Circuit Breaker failure, one 100 MVA, 220 kV Autotransformer OLTC bevel gear teeth failure, one 220 kV Lightning Arrester failure, one surge arrestor failure and one isolator failure cases. For the failure of Surge arrestor, it was observed that the counter reading is not being monitored although they are monitoring the third harmonics frequently. It was informed that failed transformer faced frequent line faults that may deteriorate transformers life. Therefore, it becomes pertinent to monitor the number as well as severity of faults also. Further, Bad Quality of CRGO may also lead to the failure of transformer in due course of time. CPRI representative stated that in case of Transformer, CRGO testing can only be carried out in Lab.
- 10 PSTCL representatives presented the 22 Nos. failure cases. Out of the 8 numbers of Power Transformers damage cases of PSTCL presented, 7 no Transformers were 220/66KV, 100 MVA rated and 1 no. 400/220 kV, 315 MVA rated. Out of the 7 no 100MVA Transformers, 4 no, Transformers were old, having their Year of manufacturing (YOM) as 1986, 1994, 1996 and 1997 respectively. The remaining 3 no. damaged 100MVA Transformers were of M/s BBL make. The 400/220 kV, 315 MVA ICT, make M/s SIEMENS, YOM-2010 belonging to the same lot and procured without carrying out the short-circuit type test. The transformers got damaged due to tertiary winding insulation failure according to investigation report submitted

by supplier firm M/S SIEMENS. All the 8 no. Power Transformers got damaged due to winding insulation failure either during feeding of severe external through faults or during normal load running condition. The insulation failure during these events occurred either due to old age of transformers or design issues. During discussion committee remarked that it appears that protection setting are not proper. In response to this, PSPCL representative stated that they have carried out the protection audit recently and no such observation was provided by the Audit. The Committee recommended to recheck the protection coordination.

- 11 DTL representative presented their Failure of 315 MVA, 400/220/33 kV ICT-3 at 400 kV Substation Tikrikalan and Failure of 100 MVA, 220/66 kV Power Transformer at 220 kV substation Park Street.
- 12 GETCO representative presented their total four numbers of 220 kV and above transformer failure, fourteen numbers of current transformers failures, and twenty four numbers of lightening arresters failure, one CVT failure and two PT failure cases. He also added that due to coastal area their atmosphere has different salinity and moisture content which leads to change in various parameters of the devices. Committee recommends that Condition of equipment should be monitored before monsoon. Equipment should be tested for condition monitoring at the periodicity of annual for High Voltage equipment annually and on twice a year basis for EHV.
- 13 DVC representative presented their one 50 MVAR , 420 kV, 3- Phase Bus Reactor failure and 198 kV Lightning Arrestor failure. Committee recommended carrying out the variable frequency tan delta test on the equipment. Further tan delta value should be adjusted w.r.t. temperature so that values can be compared with base value.
- 14 MPPTCL representative presented their two transformer failure, four CT failure, two potential transformer/CVT failure and two Surge Arrester failure cases. It was observed that bushing failure was very frequent. PGCIL representative suggested for RIP Bushing which has very less Bushing failure rate and fault in that does not causes blasting. MPPTCL representative also asked for revision in Lightning Arresters standards. Chief Engineer (PSE&TD) and chairman of the committee suggested to follow the Standard Specification and technical parameters for transformer/Reactors(66 kV and above voltage Class) whereby use of RIP/RIS bushing for 145 kV and above Class except 765 kV Class transformers has been made mandatory.
- 15 NTPC representative presented their one 400 kV Ramagundam substation Autotransformer failure and one CVT failure of NTPC Kudgi STPP. The autotransformer was failed mainly due to aging and abnormality was observed during secondary voltage measurement of CVT. The committee recommended that in case the equipment is twenty years old then Furan test should be carried out to monitor the degree of degradation of the Transformer paper insulation.
- 16 RRVPNL representative presented their one Power Transformer failure, three Autotransformer failure, ten circuit breakers failure, twenty five current transformer failure, six CVT failure, thirteen Surge Arresters failure cases.
- 17 MSETCL representatives have attended the meeting through video conferencing mode. Total 22 number of failure cases was reported by MSETCL. Committee recommended to monitor the quality of SF6 gas in circuit breaker regularly because of impure SF6 gas may lead arcing between the contacts sustain during operation which deteriorates the life of CB.

- 18 MSETCL presented a case study whereby they have used Neutral Grounding Resistor (NGR) in the neutral connection of LV side resulting in reduction of ground fault currents to 40%. Earlier there were frequent faults as they have direct feeder to Distribution and the fault on discom feeders was directly fed by the Power Transformer. For a typical substation, the LV side short circuit current is in the range of 12 to 18 kA. For each fault, the transformers has to sustain axial and radial forces which causes displacement of LV windings over period of time. Out of 10 failed cases of power transformers in MSETCL, 9 Nos. cases of failures reported displacement of LV windings. Though SFRA test can determine the intactness of winding, however test cannot be conducted frequently owing to requirement of an outage. Therefore by using NGR of one ohm, the ground fault current has been reduced by 40% and therefore reducing the impact of the fault on the Transformer.
- 19 NPCIL representatives have not attended the meeting although they had sent their failure report.
- 20 Director, PSETD advised all the utilities to ensure proper O&M and storage conditions at site of the equipment and taking all precautions as per the advice of OEM. He thanked all the participants for their presence and healthy deliberations in the meeting.
- 21 Chief Engineer, PSE&TD and Chairman of the Committee, thanked all the participants for a healthy deliberations in the meeting and sharing their best practices with other utilities. He advised all the utilities to carry out maintenance activities as per schedule.
- 22 He further informed that all the suggestions received during the meeting shall be incorporated appropriately in the final report of the Committee and the main purpose of the meeting is knowledge and experience sharing so that every utility get benefitted and there will be less cases of failure.

The meeting ended with thanks to the Chair.

Annexure

List of Participants:

Central Electricity Authority (CEA):

- (i) Sh Ramesh Kumar, CE, PSE&TD & Chairperson of the Committee
- (ii) Sh Bhanwar Singh Meena, Director, PSE&TD & Member Secretary of the Committee
- (iii) Sh Pankaj Kumar Verma, Dy. Director, PSE&TD
- (iv) Sh Bhavesh Mahawar, AD, PSE&TD
- (v) Sh Amrendra Pratap Singh, AD, PSE&TD

AEGCL:

- (i) Sh Rituparna Khargharia, DGM
- (ii) Sh Bijoy Barman, AGM

MPPTCL:

- (i) Sh R.C. Sharma, SE (T&C)
- (ii) Sh Chandra Kant Shrivastava, EE

NTPL:

- (i) Sh N. Rengarajan, DGM

GETCO:

- (i) Sh N.J. Rathod, CE (TR)

KSEB:

- (i) Sh Biju M.T., EE RD Kannur

RRVUNL:

- (i) Sh V.K. Singh, SE

RVPN:

- (i) Sh A.K. BiSubstationa, SE
- (ii) Sh Neelesh Dharwad, SE
- (iii) Sh D.K. Jain, SE

PGCIL:

- (i) Sh Pradeep Kumar, CGM
- (ii) Sh Rajiv Ranjan, DGM

DVC:

- (i) Sh Sujeet Kumar, Dy. G.M.

DTL:

- (i) Sh R.S. Meena, GM
- (ii) Sh Ram Kumar, DGM

NRPC:

- (i) Sh Rituraj Pandey, Executive Engineer

NJHPS (SJVN Ltd.):

- (i) Sh M. Kumar, ED
- (ii) Sh Sanjeet S. Parmar, Dy. Manager

KPTCL:

- (i) Sh H.S. Shachi Kumar, SEE
- (ii) Sh B.V. Girish, CEE

PSTCL:

- (iii) Sh GS Sandhu, ASE
- (iv) Sh Sumit Moudgil, ASE

NTPC:

- (i) Sh Akhileshwar Maurya, Senior Manager

CPRI:

- (i) Sh L.N. Giri, EO
- (ii) Dr. J. Sreedevi, CPRI
- (iii) Sh T. Gurudev, CPRI
- (iv) Sh Chandra Shekhar, CPRI

Other Participants (Online):

- (i) Sh Animesh Meena
- (ii) Sh K.P. Meena
- (iii) Sh Rakesh Sharma
- (iv) ERPC
- (v) NERPC
- (vi) SRPC
- (vii) WRPC
- (viii) NRPC
- (ix) Sh Kura Ravi Kumar
- (x) MSETCL Corporate Office
- (xi) Sh Ganesh Deshmukh
- (xii) Sh Daulat Bhabad



CENTRAL ELECTRICITY AUTHORITY

- (xiii)** Sh Dilip Kumar Puhan
- (xiv)** Sh Maranani Sreekanth
- (xv)** Sh Ganesh Deshmukh
- (xvi)** Sh Vinayak Goad
- (xvii)** SE PAC AKOLA
- (xviii)** Dy. EE PAC KARAD
- (xix)** Executive Engineer, PAC Dn, Panvel
- (xx)** SE PAC Nagpur
- (xxi)** SE PAC Nashik
- (xxii)** Adee Testing
- (xxiii)** Protection unit Wardha
- (xxiv)** 400 kV Khadka
- (xxv)** Testing Bhandara
- (xxvi)** 400 kV testing, khaperkheds