

220 केवी और उससे अधिक वोल्टेज वर्ग सबस्टेशन उपकरणों की विफलता पर विशेषज्ञों की स्थायी समिति की रिपोर्ट (अप्रैल 2019 - दिसंबर 2021)

REPORT OF STANDING COMMITTEE OF EXPERTS ON FAILURE OF 220 kV & ABOVE VOLTAGE CLASS SUBSTATION EQUIPMENT (APRIL 2019 - DECEMBER 2021)



Government of India Central Electricity Authority Ministry of Power New Delhi

(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 whole.

As part of this report, the failure of substation equipment for the period of 1st April 2019 and 31st December 2021 was analysed by the committee for which meeting was conducted on 02nd August 2022. Total fifteen (15) Utilities reported the failure of equipment. Total 117 failure incidences of Transformers, Reactors, Instrument Transformers, Surge Arresters, Circuit Breakers, XLPE cable, Wave trap and Coupling Capacitors of 220 kV and above voltage rating were reported between 1st April 2019 and 31st December 2021 to CEA.

Out of these equipment failure, total 24 cases of Transformer failure were reported. These 24 Transformers constitutes of 2 nos. of 765 kV class Transformers, 12 nos, of 400 kV class Transformers and 10 nos. of 220 kV class Transformers. Failures of Reactors which were reported during the period are total 9 out of which 2 were 765 kV class and 7 were 500 kV class.

It is found that cause of failures of around 50% of failed transformers is winding insulation failure. 9% transformer failure of total failed transformer pertains to ageing and 8% failures pertains to Fault in phase winding. In reactor 34% failure of total failed reactor pertains to Winding failure, 22% to bushing failures, 11% to insulation failures.

Total 22 nos. of Current Transformers failures cases were reported during the period out which 18 were of 220 kV class, 4 were of 400 kV class and none were of 765 kV class. Reported failures of Potential Transformers/ CVT failures constitutes total 11 nos. out of which 10 were of 220 kV class, 1 were of 400 kV class and none were of 765 kV class.

Total 40 no. of failure cases of Surge arrestors were reported out of which 33 were of 220 kV class, 7 were of 400 kV class and none were of 765 kV class. Failures of Circuit breakers which were reported to CEA were 6, out of which 4 were of 220 kV class, 2 were of 400 kV class and none were of 765 kV class.

Other equipment for which failures were reported include 3 nos. of 220 kV XLPE cables, 1 nos. of wave trap and 1 nos. of Coupling Capacitors.

Out of total 117 failures of the equipment occurred, 24 nos. of equipment failed within five years, 29 nos of equipment failed in 5-10 years of period. 45 nos of equipment failed during 10-20 years of their operation. 19 nos of equipment failed who had operation of more than 20 years.

It is suggested 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 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.

In case of Surge Arrestor, 3rd harmonic resistive component of leakage current is a very good method for assessing healthiness of SA and therefore it should be regularly monitored. In case of Circuit breaker, Dynamic Contact Resistance Measurement (DCRM) test should be conducted once in two years. Measurement of resistance of disconnector main contacts should be carried out and it should not exceed 300 micro ohms.



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 (1) 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 a 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 02nd August 2022 to investigate the failure of substation equipment between 1st April 2019 and 31st December 2021 as reported to CEA by various utilities. Minutes of the meeting are enclosed at **Annexure–IV**.

Previous report on failure of substation equipment was published in June 2020 which contained the information regarding failure of substation equipment reported to CEA between 1st April 2018 and 31st March 2019.

2. Brief details of the failure of substation equipment failed between 1st April 2019 and 31st December 2021 as reported to CEA

The Committee investigates failures of 220 kV and above voltage class equipment only. A total of 117 failure incidences of of Transformers, Reactors, Instrument Transformers, Surge Arresters, Circuit Breakers, XLPE cable, Wave trap and Coupling Capacitors of 220 kV and above voltage rating were reported between 1st April 2019 and 31st December 2021 to CEA. The voltage wise quantity of each equipment has been indicated in the Table-1 below:



Equipment	Voltage Class			Quantity
	220 kV	400 kV	765 kV	(Nos.)
	Quantity (Nos.)			
Transformers	10	12	2	24
Reactors	-	7	2	9
Current	18	4	-	22
Transformers				
Potential	10	1	-	11
Transformers/				
CVT				
Surge Arresters	33	7	-	40
Circuit Breakers	4	2	-	6
XLPE Cables	3	-	-	3
Wave trap	1	-	-	1
Coupling	1	-	-	1
Capacitors				
Grand Total				117

TABLE-1

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

TABLE-2

Years of	No. of ed	quipment	failed						
Service	Transf	React	CT	CVT/	Surge	Circuit	XLPE	Wav	Coupli
	ormers	ors		РТ	Arreste	Breaker	Cable	e	ng
					r			trap	Capacit
									or
0-5	10	3	5	2	2	1	1	0	0
5-10	6	1	8	2	9	1	2	0	0
10-15	2	1	6		12	3	0	0	0
15-20	1	2	3	5	9	1	0	0	0
>20	5	2	0	2	8	0	0	1	1

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

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



2.3 Failure of Transformers:

- i. 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.
- ii. Summary of Inter Connecting Transformers/Generator Transformers (GTs) reported to CEA that have failed between April 2019 and Dec 2021 is detailed below (Table 3):

S.	Utility	Substation	Make	Rating	Year	Date of failure	Probable Cause
No)				of		of Failure*
•					comm		
					ssioni		
1		NT 11	EN(CO	215	ng	12.04.2010	XX7' 1'
1.	APIRANSC	Nellore	EMCO	315 MUA	2016	13.04.2019	Winding
	0			MVA,			insulation
				400 /220	,		Tanure
2	POWERGRI	Allahahad	CGI	315	2014	07 07 2019	Winding
2.	D	Ananaoad	COL	MVA	2014	07.07.2017	insulation
				400/220			failure
				kV			1411410
3.	POWERGRI	Magarwada	EMCO	500	2014	08.08.2019	Dielectric
	D	U		MVA,			Failure
				400/220			
				kV			
4.	DTL	Tikrikalan	TELK	315	2014	29.09.2019	Winding
				MVA, 3	5		insulation
				Phase,			failure
				400/220/			
_	DOWED OD I			33 kV	0.01.6		
5.	POWERGRI	Bhadrawatı	ALSTOM	234 MVA	,2016	15.12.2019	Winding
	D			400/93 kV	, ,		insulation
				Pole-1, Y-	-		Tallure
6	DTI	RK Purom	IMP	pn 160	2018	06.03.2020	High
0.			11/11	MVA	2010	00.03.2020	Acetylene
				220/66/1			Fault near
				1 kV			winding

Table 3



7.	KPTCL	Shivamogg a	General Electric, USA	100 MVA, 220/110/ 11 kV	1967	23.03.2020	No information available
8.	POWERGRI D / BBMB	Panipat	TELK	150 MVA, 400/220 kV	1985	12.07.2020	Sludge Formation throughout the coil.
9.	MSETCL	Babhaleshw ar	CGL	167 MVA, 400/220/ 33 kV 1- Ph ICT	2010	24.07.2020	Winding insulation failure
10.	WUPPTCL	Greater Noida	BHEL	500 MVA, 765/400/ 220 kV 1- Ph ICT	2018	13.12.2020	Winding insulation failure
11.	POWERGRI D	Hyderabad	ABB	3 x 156.33 MVA, 400/37 kV, 1-Ph Coupling Transfor mer	2019	30.01.2021	Oil splashed, which resulted in transformer damage.
12.	DTL	Bawana	BHEL	315 MVA, 400/220/ 33 kV, 3- Ph	1998	30.03.2021	Winding insulation failure
13.	POWERGRI D	New Wanpoh	Vijai Electric (Toshiba)	105 MVA, 400/220 kV, 1-Ph	2013	05.05.2021	Not known
14.	DTL	Sarita Vihar	TELK	100 MVA, 220/66/1 1 kV, 3- Ph	1982	09.06.2021	Ageing, Winding insulation failure
15.	HVPNL	IMT Bawal	Bharat Bijlee Limited	100 MVA, 220/33	2016	17.06.2021	Bulging of Tank



			(BBL)	kV, 3-Ph			
16.	DTL	Peeragarhi GIS	IMP Power	100 MVA, 220/33/1 1 kV, 3- Ph	2016	10.07.2021	Winding inter-turn shorting
17.	TANTRANS CO	Alamathy	Transform ers and Rectifiers India Limited	105 MVA, 400/230 kV – R phase unit of ICT3	2014	05.11.2021	Winding insulation failure
18.	WUPPTCL	765kVGreat er Noida	BHEL	3x500 MVA	2016	12.11.2021	Winding insulation failure
19.	DTL	Tikrikalan	EMCO	315 MVA, 3 Phase, 400/220/ 33 kV	2011	13.11.2021	Winding insulation failure
20.	MSETCL	Nagewadi	Vijay Electricals	220/132 kV, 100 MVA, 3- Phase	2018	10.06.2019	Fault in Y phase winding
21.	MSETCL	Partur	Areva	50 MVA, 220/33 kV	2008	06.10.2019	Fault in B- phase winding
22.	MSETCL	GCR Parli- V	EMCO	100 MVA, 220/132 kV, 3-Ph	1994	24.03.2020	Internal fault due to ageing
23.	MSETCL	Umred	Bharat Bijlee	25 MVA, 220/33 kV	2007	04.04.2020	Winding insulation failure
24.	MSETCL	Manjarsum ba	CGL	220/33 kV, 25 MVA, 3- Ph	2017	15.10.2020	Winding 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, twenty-four (24) transformer failure cases from April 2019 to December 2021 have been reported by eight (8) 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 10 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 2017-2021: The number of different transformer failures as reported in the last 5 years to CEA has been shown in the graph below:



2.4 Failure of Reactor:

i. Failure of following Reactors has been reported to CEA during the period from April 2019 and December 2021 by four (4) utilities which is of 400/420 kV class. Cause of failure is based on information, data and reports furnished by the utility.



S. No.	Utility	Substation	Make	Rating	Year of commi- ssioning	Date of failure	Probable Cause of failure*
1.	PGCIL	Bina	BTW	80 MVAR, 765 kV, 1-ph	2014	22.09.2019	Internal insulation failure.
2.	PGCIL	Agra	CGL	16.67 MVAR, 400 kV, 1-ph	2019	31.05.2019	Heavy Carbonization (Weakening of Bushing)
3.	PGCIL	Nelamangala	CGL	50 MVAR, 400 kV, 3-ph	2005	29.05.2020	HV Bushing failure
4.	PGCIL	Balipara	BHEL	50 MVAR, 420 kV, 3-ph	2000	23.05.2020	Winding failure
5.	PGCIL	Gajuwaka (Vizag)	BHEL	63 MVAR, 400 kV, 3-ph	1991	03.09.2020	Ageing led to deterioration of insulation
6.	PGCIL	Aurangabad	CGL	765 kV, 80 MVAr, Single phase	2014	03.04.2021	Winding failure
7.	SJVNL	Jhakri	BHEL	3-ph, 80 MVAR, 400 kV	2019	17.10.2019	Bushing failure
8.	KPTCL	Nelamangala	CGL	50 MVAR, 400 kV, 3-ph	2003	09.06.2020	Winding failure
9.	MSETCL	Kharghar	BHEL	80 MVAr, 400 kV, 3-Phase	2009	04.06.2020	Information not available

Table 4

ii. Failures of reactors during 2017-2021: The number of different reactor failures as reported in the last 5 years to CEA has been shown in the graph below.





2.5 <u>Failure of Instrument Transformers (CT/PT/CVT)</u>, <u>Surge Arresters (SA)</u>, <u>Coupling</u> <u>Capacitors (CC) and Disconnectors:</u>

i. Summary of failure of CTs, PTs, CVTs, SAs, CCs, and Disconnector occurred between April 2019 and December 2021 as reported to CEA is detailed below (Table 5):

Utility	Make	Rating	Year of commiss ioning	Date of failure				
Current Transf	Current Transformer: Total 22 Nos.							
APTRANSCO	SCT	400 kV, 3000-2000-500/1-1-1-1-1	2016	05.07.2020				
		А						
APTRANSCO	AREVA	220 kV, 800-600-400/1-1-1,0.5-	2009	25.06.2020				
		1,0.5-1A						
APTRANSCO	BHEL	220 kV, 1600-800/1-1-2-2-1 A	2017	30.07.2020				
APTRANSCO	SCT	220 kV, 500-300/1A	2011	16.06.2019				
TANTRANSCO	SCT	230 kV	2015	29.03.2020				
TANTRANSCO	SCT	230 kV	2015	29.03.2020				
TANTRANSCO	SCT	230 kV	2014	29.03.2020				
KSEB	TELK	220 kV, 40kA,3sec	2009	03.03.2020				
KSEB	MEHRU	220 kV, 800-400/1-1-1-1,	2009	03.09.2020				
		40kA,1sec						

Table 5

KSEB	MEHRU	220 kV, 800-400/1-1-1-1,	2009	03.09.2020
		40kA,1sec		
DVC	AREVA	245 kV, 800-400/1-1-1-1-1A	2011	01.07.2019
DVC	AREVA	245 kV, 800-400/1-1-1-1A	2015	16.08.2020
MSETCL	AREVA	400kV Ratio- 2000/1000/500:1	2007	26.07.2020
MSETCL	SCT	220kV	2020	01.11.2020
		Ratio- 2400/1200:1A (5C), VA		
		Burden-20		
MSETCL	MEHRU	220kV	2016	30.06.2020
		Ratio: 800-400-200/1A		
MSETCL	ABB	245 kV, 2400-1200/1 A	2016	09.06.2019
MSETCL	Universal	220 kV	2012	14.02.2020
	Magnoflux	800-400-200/1A		
MSETCL	ITC	245 kV, 800-400/1-1-1-1-1	2013	20.04.2020
MSETCL	Indian	220 kV	2018	08.08.2020
	Transform			
	ers Ltd.			
MSETCL	ABB	245 kV	2002	09.08.2020
MSETCL		220 kV, 2400-1200-600 A, 5 core		28.08.2020
NPCIL	BHEL	Rated voltage: 420 kV, Rated	2005	21.08.2021
		current:2000 A		
		No of cores: 5		
CVT/PT: Total 1	1 Nos.			
APTRANSCO	WS	420 kV	NA	12.11.2020
APTRANSCO	SCT	245 kV	2011	20.06.2019
APTRANSCO	CGL	220 kV	2000	19.11.2019
APTRANSCO	CGL	220 kV	2000	28.05.2020
TANTRANSCO	CGL	230 kV	2006	10.10.2020
MSETCL	CGL	220/√3 kV/ 110/√3 V	2006	09.04.2019
MSETCL	BHEL	220/√3 kV/ 110/√3 V	1999	25.07.2019
MSETCL	CGL	220/√3 kV/ 110/√3 V	2003	24.05.2019
MSETCL	Toshiba	220/√3 kV/ 110/√3 V	2020	19.04.2020
	T&D			
	Systems			
	Pvt. Ltd.	,		
MSETCL	CGL	220/√3 kV/ 110/√3 V	2003	01.09.2020
Adani	CGL	Voltage Class - 245 kV, Type -	2021	26.01.2021
		VEOT245/1050/50		
Surge Arrestor	: Total 40 No	98.		
APTRANSCO	CGL	400 kV	NA	05.08.2019
APTRANSCO	OBLUM	400 kV	NA	12.11.2019
APTRANSCO	OBLUM	400 kV	2000	20.11.2020

APTRANSCO	CGL	390 kV		14.06.2019
APTRANSCO	CGL	400 kV	2016	22.05.2019
APTRANSCO	LAMCO	220 kV	2004	08.08.2019
APTRANSCO	LAMCO	245 kV	2003	24.10.2019
APTRANSCO	LAMCO	216 kV	2007	12.10.2019
APTRANSCO	CGL	220 kV	2005	13.04.2019
APTRANSCO	CGL	220 kV	2005	25.02.2020
APTRANSCO	WSI India	220 kV	1991	22.03.2020
	ltd.			
APTRANSCO	WSI India	220 kV	1997	20.07.2020
	ltd.			
APTRANSCO	OBLUM	220 kV	NA	30.06.2020
APTRANSCO	WSI	220 kV	1991	07.11.2020
APTRANSCO	CGL	220 kV	2005	26.12.2020
TANTRANSCO	CGL	390 kV	2006	29.04.2020
TANTRANSCO	CGL	230 kV	2003	06.11.2019
TANTRANSCO	CGL	230 kV	2006	16.01.2020
TANTRANSCO	CGL	230 kV	2006	10.10.2020
WBSETCL	OBLUM	198 kV	NA	24.08.2019
WBSETCL	OBLUM	198 kV	2015	08.08.2019
WBSETCL	OBLUM	198 kV	NA	10.08.2019
DVC	CGL	198 kV	2006	12.11.2019
KPTCL	CGL	220 kV	2008	29.01.2020
MSETCL	OBLUM	198 kV	2010	08.07.2020
MSETCL	LAMCO	198 kV	2010	17.08.2020
MSETCL	OBLUM	198 kV	2013	07.08.2020
MSETCL	OBLUM	198 kV	2011	20.08.2020
MSETCL	OBLUM	198 kV	2011	10.08.2020
MSETCL	CGL	198 kV	2001	25.10.2020
MSETCL	CGL	198 kV	2001	15.11.2020
MSETCL	LAMCO	198 kV	2011	19.07.2020
MSETCL	METOVA	198 kV	2008	30.08.2020
	R			
MSETCL	OBLUM	198 kV	2011	23.08.2020
MSETCL	ELPRO	198 kV	2004	30.07.2019
MSETCL	CGL	198 kV	2005	02.10.2019
MSETCL	WS	198 kV	1992	11.07.2020
	Industries			
MSETCL	LAMCO	198 kV	2010	18.07.2020
MSETCL	CGL	198 kV	1996	15.09.2020
MSETCL	LAMCO	198 kV	2011	19.10.2020

XLPE Cables T	XLPE Cables Total 3 Nos.						
DTL	LS Cables	220 kV	2011	19.06.2019			
DTL	TBEA	220 kV	NA	19.06.2019			
Adani Electricity	Cable Joint	220 kV	2020	07.01.2022			
Mumbai Ltd.	- M/s						
(AEML)	NKT,						
	Germany						
	XLPE						
	Cable -						
	M/s SFC,						
	China						
Circuit Breaker Total 6 Nos.							
KPTCL	CGL	420 kV, 2500A, 40kA for 3 sec	2002	21.08.2020			
KPTCL	SIEMENS	420 kV, 4000 A	2018	18.04.2019			
KPTCL	SIEMENS	220 kV	2008	01.07.2019			
APTRANSCO	CGL	245 kV	2011	20.06.2019			
APTRANSCO	ABBB	245 kV, 3150 A	2008	02.08.2020			
TANTRANSCO	ALSTOM	245 kV	2006	01.11.2019			
Wave Trap Tot	al 1 Nos.						
APTRANSCO	WSI	Inductance: 1 mH,	1992	27.08.2020			
		800 A, Blocking band:85-450 kHz,					
		20 kA for 1sec					
Coupling Capa	citor: Total 1	Nos.					
MSETCL	WS	245 kV, 8000 pF	1985	01.06.2020			

- ii. It is observed that twenty two (22) Nos. of cases of CT failure that occurred during the period from April, 2019 to December, 2021 have been reported to CEA by six (6) utilities.
- iii. In the case of PT/CVT, eleven (11) Nos. of failure occurred during the period from April 2019 to December 2021 have been reported to CEA by four (4) Utilities. However, it may be noted that due to a handful of utilities reporting the failure, it is not possible to successfully capture the statistics of service life of key electrical equipment in the substations across various utilities in India.
- iv. In most of the cases of failure of CT/ CVT/ PT/ SA, the equipment had blasted or flashed over. In such cases, it becomes difficult to pin point the cause of failure. However, such failures may be attributed to deterioration of internal insulation and moisture ingress. Some of the failures of equipment could be due to ageing.

v. Failures of CTs/PTs/CVTs during 2017-2021: The number of different CT/PT/CVT failures as reported in last 5 years to CEA has been shown in the graph below:



- vi. As per the reports received by CEA, forty (40) Nos. of cases of SA failure that occurred during the period from April 2019 to December 2021 have been reported to CEA by six (6) utilities. Out of these, fourteen (14) Nos. of SAs are of 220/230/245 kV class, five (5) Nos. of SAs are of 400/390 kV class and rest twenty one (21) are 198 kV class.
- vii. Failures of SAs during 2017-2021: The number of different SA failures as reported in the last 5 years to CEA has been shown in the graph below.



viii. It is observed that six (6) Nos. of cases of CB failure occurred during the period from April 2019 to December 2021 have been reported to CEA by three (3) utilities

3. OBSERVATIONS:

- i. It is observed that reported failures are primarily due to following reasons:
 - a) Normal Ageing
 - b) Failure of Insulation system for CB/CT/PT/CVT/SA.
 - c) Failure of Insulation system & Bushing for Transformers & Reactors.
 - d) Lack of prudent maintenance practices
 - e) Frequent System Faults and transient over voltages generated by the system.
- ii. In most of the failure cases of CT/PT/CVT/SA, equipment blasted or got completely damaged making it impossible to carry out any test after failure. Without tests, internal condition of the failed equipment cannot be assessed and cause of failure cannot be determined. However, in most of the cases it is assumed that degradation of insulation due to ingress of moisture and transient system voltages might be the reason of failure of these equipment.
- iii. 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.
- iv. Adequate modern Diagnostic tools are not available with most of the State Utilities.
- v. Most of the utilities are facing problem due to shortage of technical staff for operation & maintenance of sub-station equipment. Sometimes interpretation of test results becomes difficult in absence of experts / experienced O&M staff.
- vi. 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.
- vii. In most of the cases of failures, utilities do not furnish factory test reports, precommissioning test reports, history of O&M & repairs, relay settings, environmental & system conditions at the time of failure etc. which makes it very difficult to analyze the cause of failure.
- viii. 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. Some of the recommendations are being repeated from the previous report with the objective to remind the actions required to be taken by utilities to improve performance of equipment and to use 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, precommissioning 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 regulation which can be used for one substation or a pool of substations depending upon requirement.
- 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 best practices for maintenance of each equipment. All the equipment which have reached/approaching 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 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 actions 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 major equipment (CB/LA/CT/CVT) and bushings of transformer may be protected by providing Room Temperature Vulcanisation (RTV) coating. RTV coating over porcelain housing of equipment (CB/LA/CT/CVT) / 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 & 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. 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. na The reduction in number of taps/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. While measuring tan delta of transformer bushing/CT/PT/CVT, apart from absolute value, rate of rise of tan delta should also be monitored and it should not be more than 0.1% per year. Frequency of measurement should be increased in case tan delta value is approaching 0.7%. Following tables can be referred while measuring tan δ and capacitance of CVTs:

Change in Tanð	Monitoring Frequency
Upto +0.002	Three yearly
+0.002 to +0.003	Yearly
Above +0.003	Alarming

Change in Capacitance	Monitoring Frequency
upto ±2%	Three yearly
$\pm 2\%$ to $\pm 3\%$	Yearly
Above ±6%	Alarming

(Source: - CBIP Manual on EHV Substation Equipment Maintenance)



xix.

xviii. The change in secondary voltage of CVTs is a very good indicator of the condition/health of CVTs. Following table may be referred to for monitoring of secondary voltage:

Drift in secondary Voltage (to be measured by 0.2 / 0.5 class multimeter)	Condition	Monitoring Frequency
Upto ± 0.5 volts	Healthy	Six monthly
\pm 0.5 to \pm 0.8 volts	To be monitored	03 monthly
+0.8 to +1.2 volts	Close monitoring	Monthly
+1.2 to +2.0 volts	Close monitoring	15 days
above +2.0 volts	Alarming	replacement
-0.8 to -4.0 volts	Close monitoring	15 days
less than -4.0 volts	Alarming	replacement

(Source: - CBIP Manual on EHV Substation Equipment Maintenance) Following table can be referred while measuring tan δ of CTs:

Value of Tanð	Monitoring Frequency
Upto 0.007 (annual rise@0.001)	Yearly
0.007 to 0.011	Half Yearly
Above 0.011	Replace the CT

(Source: - CBIP Manual on EHV Substation Equipment Maintenance

Oil level in CTs should be checked before charging. For CTs with metallic bellows, the oil should be present up to the top of the bellow for proper functioning. The oil leakage needs to be checked periodically. Bellow level should be closely watched. The level of bellows of all CTs in one bay should be same at any point of time. Different bellow level may be an indicator of oil leakage, gassing or fault.

Similarly, Capacitor units & EMU of CVTs in one bay should have same oil level indication at any point of time.

- xxi. Varistors protect the CVT from over voltage due to Ferro-resonance (FR) oscillations. They may fail in service due to sustained FR or if the energy to be handled exceeds designed limit. If a varistor fails, it should be replaced by the varistor of the same voltage rating.
- xxii. 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.

4.4 Recommendations for Surge Arrester:

- i. Measurement of the 3rd harmonic resistive component of leakage current is a very good method for assessing healthiness of SA. If 3rd harmonic component of resistive current is more than 150 μ A, then Insulation Resistance (IR) value test should also be conducted and if current exceeds 350 μ A, then SA should be removed from service and replaced. The measurement of leakage current before and after the monsoon should be carried out so as to ascertain the effect of moisture.
- ii. Before erection, the condition of the Arrester unit should be checked and it should be ensured that there is no damage during erection. If SA is kept on an uneven surface, it is likely to damage the pressure relief diaphragm. Any damage to this thin & sensitive material while handling & erecting will result into moisture entry into Surge Arrester, which will lead to its failure.
- iii. Thermal scanning is another simple on-line check often used on SAs to locate hot spot due to improper/defective terminations/excessive watt loss.
- iv. The specification of SA should include Dip test/Sealing Test which can be carried out at manufacturer's works to ensure proper sealing against ingress of moisture.

4.4 Recommendations for Circuit Breaker:

Dynamic Contact Resistance Measurement (DCRM) test kit is a very important tool to assess the healthiness of circuit breaker. This test may be carried out once in two years. Moreover, while formulating the specification for procurement of CB for new substation, provision for procurement of Operational Analyzer along with Dynamic Contact Resistance Measurement (DCRM) test kit should be included for one substation or a group of nearby



substations depending upon the requirement.

4.5 Recommendations for disconnectors:

- i. Disconnectors used for transferring load currents from one bus system to another should be designed and tested for bus transfer current switching duty.
- ii. Measurement of resistance of disconnector main contacts should be carried out and it should not exceed 300 micro ohms.

Annexure-I



Detailed Information of All Failed Equipment Reported to CEA between April 2019 and December 2021



Detailed Information of All Failed Equipment Reported to CEA between April 2019 and December 2021

Detailed information in respect of following failures is given in subsequent pages of this annexure:

S. No.	Failure report	Utility	S/S Equipment	Serial no.	Date of Failure
TRA	NSFORMERS				
1.	Failure of 315 MVA,	APTRANSCO	Power	HT2037/136	13.04.2019
	400/220 kV Power		Transformer	42	
	Transformer at Nellore				
	Substation				
2.	Failure of 315 MVA,	POWERGRID	Power	T10319/1	07.07.2019
	420/220 kV, ICT-III at		Transformer		
	Allahabad Substation				
3.	Failure of 500 MVA	POWERGRID	Power	13444	08.08.2019
	400/230 kV ICT-II at		Transformer		
<u> </u>	Magarwada Substation	5.77			
4.	Failure of 315 MVA,	DTL	Power	140155-1	29.09.2019
	400/220/33 kV Power		Transformer		
	Transformer at				
-	Tikrikalan Substation	DOWEDODD			15 12 2010
э.	Failure of 234 MVA,	POWERGRID	Converter	PID1659/06	15.12.2019
	234/93 KV Pole-1, Y-Ph		Transformer		
	Converter Transformer				
	at Bhadrawati				
6	Substation Eciliare of 160 MVA	DTI	Douvon	DT7071	06.02.2020
0.	Failure of 100 MVA, $220/66/11$ kV Bower	DIL	Transformer	P1/9/1	00.03.2020
	Z20/00/11 KV Power Transformer at PK		Transformer		
	Puram Substation				
7	Fulling of 100 MVA	KDTCI	Dower	D566535	23 03 2020
/.	220/110/11 kV Power	KITCL	Transformer	D300333	23.03.2020
	Transformer at		Transformer		
	Shivamogga Substation				
8	Failure of 150 MVA	POWERGRID /	Power	140053-2	12 07 2020
0.	400/220 kV ICT at	BBMB	Transformer	110033 2	12.07.2020
	Panipat Substation	DDIVID	Tunstonner		
9	Failure of 167 MVA	MSETCL	Power	T09735/4	24.07.2020
<i>.</i>	400/220/33 kV 1-Ph		Transformer	10970071	2
	ICT at 400 kV				
	Babhaleshwar				
	Substation				



10.	Failure of 765/400 kV, 500 MVA 1-Ph ICT at 765/400/220 kV Greater Noida Substation	WUPPTCL	Power Transformer	6007319	13.12.2020
11.	Failureof3x156.33MVACouplingTransformers at 400 kVHyderabad	POWERGRID	Coupling Transformer	14073-10, 14073-11, 14073-12	30.01.2021
12.	Failure of 315 MVA, ICT-II at 400 kV Bawana Substation	DTL	Power Transformer	6005260	30.03.2021
13.	Failure of 400/220 kV 105 MVA ICT-2 at New Wanpoh Substation	POWERGRID	Power Transformer	90093A02	05.05.2021
14.	Failure of 100 MVA-II, 220/66/11 kV Power Transformer installed at 220 kV Sarita Vihar Sub-station	DTL	Power Transformer	130067	09.06.2021
15.	Failure of 100 MVA 220/33 kV Power Transformer at 220 kV IMT Bawal Substation	HVPNL	Power Transformer	5358/1	17.06.2021
16.	Failure of 100 MVA220/33 kVPowerTransformer at 220 kVPeeragarhiGISSubstation	DTL	Power Transformer	PT-7776	10.07.2021
17.	Failure of 400/230 kV, 105 MVA, 1-Ph ICT-III unit at 400 kV Alamathy Substation	TANTRANSCO	Power Transformer	PM0300101	05.11.2021
18.	Tripping of 765/400 kV, 3x500MVA ICT-II at 765kVGreater Noida S/stn	WUPPTCL	Power Transformer	6007312 6007313 6007314	12.11.2021
19.	Tripping of 315MVA 400/220/33 kV ICT 4 AutoTransformer at Tikrikalan	DTL	Power Transformer	HT- 1798/13001	13.11.2021
20.	Tripping of 100 MVA, 220/132 kV ICT at 220 kV Nagewadi	MSETCL	Power Transformer	90075B06	10.06.2019



21.	Tripping of 50 MVA, 220/33 kV, Power Transformer at 220 kV Partur substation	MSETCL	Power Transformer	B30018	06.10.2019
22.	Tripping of 100 MVA, 220/132 kV, ICT at 220 kV old GCR Parli-V	MSETCL	Power Transformer	HT/1286/114 37	24.03.2020
23.	Tripping of 25 MVA, 220/33 kV power Transformer at 220 kV Umred substation	MSETCL	Power Transformer	4921/1	04.04.2020
24.	Tripping of 25 MVA 220/33 kV Power Transformer at 220 kV Manjarsumba substation	MSETCL	Power Transformer	T8297/1	15.10.2020
REA	CTORS				
25.	Failure of 765 kV, 80 MVAR, 1-Ph reactor at Bina substation	PGCIL	Reactor	20122K09	22.09.2019
26.	Failure of 400 kV, 16.67 MVAR, 1-Ph reactor at Agra substation	PGCIL	Reactor	24473	31.05.2019
27.	Failure of 400 kV, 50 MVAR, 3-Ph reactor at Nelamangala substation	PGCIL	Reactor	T9049/1	29.05.2020
28.	Failure of 420 kV, 50 MVAR, 3-Ph reactor at Balipara substation	PGCIL	Reactor	6005364	23.05.2020
29.	Failure of 400 kV, 63 MVAR, 3-Ph reactor at Gajuwaka (Vizag) substation	PGCIL	Reactor	6005069	03.09.2020
30.	Failure of 765 kV, 80 MVAr, 1-Ph Line Reactor at Aurangabad Substation	PGCIL	Reactor	BH10223/07	03.04.2021
31.	Failure of 400 kV, 80 MVAR, 3-Ph reactor at Jhakri substation	SJVNL	Reactor	6007310	17.10.2019



32.	Failure of 400 kV, 50 MVAR, 3-Ph reactor at Nelamangala substation	KPTCL	Reactor	T8716/2	09.06.2020
33.	Failure of 80 MVAr, 400 kV, 3 Phase Bus reactor at 400 kV Kharghar Substation	MSETCL	Reactor	6006584	04.06.2020
CUR	RENT TRANSFORMER	S	-	•	
34.	Failure of 220kV CT at Jammalamadugu Substation	APTRANSCO	СТ	54159	05.07.2020
35.	Failure of 220kV CT at Pulivendula Substation	APTRANSCO	СТ	200808153	25.06.2020
36.	Failure of 220kV CT at Visakhapatnam Substation	APTRANSCO	СТ	224167	30.07.2020
37.	Failure of 220kV CT at Nunna Substation	APTRANSCO	СТ	2011/409R	16.06.2019
38.	Failure of 420kV R-Ph CT at Kadaperi Substation	TANTRANSCO	СТ	251/2012	29.03.2020
39.	Failure of 420kV Y-Ph CT at Kadaperi Substation	TANTRANSCO	СТ	253/2012	29.03.2020
40.	Failure of 420kV B-Ph CT at Kadaperi Substation	TANTRANSCO	СТ	765/2013	29.03.2020
41.	Failure of 220kV CT at Edappon Substation	KSEB	СТ	230264-8	03.03.2020
42.	Failure of 220kV B-Ph CT at Orkatteri Substation	KSEB	СТ	OC 2183/3/2/07	03.09.2020
43.	Failure of 220kV Y-Ph CT at Orkatteri Substation	KSEB	СТ	OC 2183/3/9/07	03.09.2020
44.	Failureof150MVA,220kVatCTPSDhanbadSubstation	DVC	СТ	200806101/2 008	01.07.2019
45.	Failure of 220kV CT at Jamshedpur Substation	DVC	CT	42091001594	16.08.2020



46.	Failure of 400 kV CT at RS Kalwa substation	MSETCL	СТ	20070186/20 07	26.07.2020
47.	Failure of 220 kV CT at Chinchwad-1 substation	MSETCL	СТ	2013/1447	01.11.2020
48.	Failure of 220 kV CT at Talegaon Ambi substation	MSETCL	СТ	4763/1/1/13	30.06.2020
49.	Failure of 220 kV CT at 220 kV New GCR Parli substation	MSETCL	СТ	21060018	09.06.2019
50.	Failure of 220 kV CT at 220 kV Patoda substation	MSETCL	СТ	16347	14.02.2020
51.	Failure of 220 kV CT at220kVNerale(Panama) substation	MSETCL	СТ	3026-22	20.04.2020
52.	Failure of 220 kV CT at220kVWaghala(Nanded-2) substation	MSETCL	СТ	3094-05	08.08.2020
53.	Failure of 220 kV CT at 220 kV Dasturi substation	MSETCL	СТ	ID221143	09.08.2020
54.	Failure of 220 kV CT at 220 kV Girwali substation	MSETCL	СТ	2010/50	28.08.2020
55.	Failure of 220 kV CT at at Kaiga Generating Station 3 & 4	NPCIL	СТ	6167701	21.08.2021
POTI	ENTIAL TRANSFORME	CRS / CAPACITOR	VOLTAGE TR	ANSFORMER	S
56.	Failure of 400kV CVT at Kalapaka Substation	APTRANSCO	CVT	97101014	12.11.2020
57.	Failure of 220kV PT at Ragulapadu Substation	APTRANSCO	PT	200/230	20.06.2019
58.	Failure of 220kV CVT at Chinnakampalli Substation	APTRANSCO	CVT	13322	19.11.2019
59.	Failure of 220kV CVT at Chinnakampalli Substation	APTRANSCO	CVT	13325	28.05.2020
60.	Failure of 220kV CVT at Kilpauk Substation	TANTRANSCO	PT	11976	10.10.2020



61.	Failure of 220 kV PT at Bale Substation	MSETCL	РТ	10253	09.04.2019
62.	Failure of 220 kV PT at Kharghar Substation	MSETCL	РТ	2228704	25.07.2019
63.	Failure of 220 kV PT at 220 kV Kaulewda Substation	MSETCL	PT	13667	24.05.2019
64.	Failure of 220 kV PT at 220 kV Gadchandur Substation	MSETCL	PT	552977	19.04.2020
65.	Failure of 220 kV PT at 220 kV jalna Substation	MSETCL	РТ	R-15049	01.09.2020
66.	Failure of 220 kV IVT at Versova EHV Substation	Adani	PT	60097	26.01.2021
SURC	GE ARRESTER			-	•
67.	Failure of 400kV SA at Kalapakka Sub-Station	APTRANSCO	SA	34046	05.08.2019
68.	Failure of 400kV SA at Kalapakka Sub-Station	APTRANSCO	SA	-	12.11.2019
69.	Failure of 400kV SA at Kalapakka Sub-Station	APTRANSCO	SA	2813	20.11.2020
70.	Failure of 390kV SA at Vemagiri Sub-Station	APTRANSCO	SA	24810	14.06.2019
71.	Failure of 400kV SA at Jammalamadugu Sub- Station	APTRANSCO	SA	160299	22.05.2019
72.	Failure of 220kV SA at Parawada Sub-Station	APTRANSCO	SA	2308	08.08.2019
73.	Failure of 245kV SA at Anantapuramu Sub- Station	APTRANSCO	SA	150C	24.10.2019
74.	Failure of 220kV SA at Tallapalli Sub-Station	APTRANSCO	SA	-	12.10.2019
75.	Failure of 220kV SA at Nellore Sub-Station	APTRANSCO	SA	27390	13.04.2019
76.	Failure of 220kV SA at Manubolu Sub-Station	APTRANSCO	SA	27394	25.02.2020
77.	Failure of 220kV SA at Vishakapatnam Sub- Station	APTRANSCO	SA	330	22.03.2020



78.	Failure of 220kV SA at Vishakapatnam Sub-	APTRANSCO	SA	9010327	20.07.2020
79.	Failure of 220kV SA at Gajuwaka Sub-Station	APTRANSCO	SA	03	30.06.2020
80.	Failure of 220kV SA at Vishakapatnam Sub- Station	APTRANSCO	SA	9010319	07.11.2020
81.	Failure of 220kV SA at Manubolu Sub-Station	APTRANSCO	SA	27373	26.12.2020
82.	Failure of 390kV SA at Alamathy Sub-Station	TANTRANSCO	SA	26188	29.04.2020
83.	Failure of 230kV SA at Korattur Substation	TANTRANSCO	SA	4862	06.11.2019
84.	Failure of 230kV SA at Alamathy Substation	TANTRANSCO	SA	27198	16.01.2020
85.	Failure of 230kV SA at Kilpauk Substation	TANTRANSCO	SA	35157	10.10.2020
86.	Failure of 198kV SA at Gokarna Sub-Station	WBSETCL	SA	-	24.08.2019
87.	Failure of 198kV SA at Midnapore Sub-Station	WBSETCL	SA	-	08.08.2019
88.	Failure of 198kV SA at KGP Sub-Station	WBSETCL	SA	-	10.08.2019
89.	Failure of 198kV SA at Burnpur Sub-Station	DVC	SA	21955	12.11.2019
90.	Failure of 220kV SA atHALBengaluruSubstation	KPTCL	SA	51628	29.01.2020
91.	Failure of 220 kV Surge Arrestor at TSS Panvel substation	MSETCL	SA	117	08.07.2020
92.	Failure of 220 kV Surge Arrestor at ONGC Panvel substation	MSETCL	SA	1128	17.08.2020
93.	Failure of 220 kV Surge Arrestor at ONGC Panvel substation	MSETCL	SA	9/38/23	07.08.2020
94.	Failure of 220 kV Surge Arrestor at URAN substation	MSETCL	SA	NA	20.08.2020



95.	Failure of 220 kV Surge Arrestor at Talegaon	MSETCL	SA	1151	10.08.2020		
	Ambi substation						
96.	Failure of 220 kV Surge Arrestor at Ranjangaon substation	MSETCL	SA	2192	25.10.2020		
97.	Failure of 220 kV Surge Arrestor at Ranjangaon substation	MSETCL	SA	2191	15.11.2020		
98.	Failure of 400 kV Surge Arrestor at RS Kalwa substation	MSETCL	SA	888ABC	19.07.2020		
99.	Failure of 220 kV Surge Arrester at 220 kV Malegaon, Nashik	MSETCL	SA	123140124	30.08.2020		
100.	Failure of Surge arrester at 220 kV Malegaon, Nashik	MSETCL	SA	2	23.08.2020		
101.	Failure of 220 kV Surge arrester at 220 kV Warora substation	MSETCL	SA	NA	30.07.2019		
102.	Failure of 220 kV Surge arreter at 220 kV old GCR Parli-V	MSETCL	SA	9948	02.10.2019		
103.	Failure of 220 kV Surge arrester at 220 kV Lote Substation	MSETCL	SA	R-91-9-610	11.07.2020		
104.	Failure of 220 kV Surge arrester at 400 kV RS Karad Substation	MSETCL	SA	858	18.07.2020		
105.	Failure of 220 kV Surge arrester at 220/33 kV Halkarni Substation	MSETCL	SA	9510137	15.09.2020		
106.	Failure of 220 kV Surge arrester at 220 kV Virur substation	MSETCL	SA	263C	19.10.2020		
XLPH	XLPE CABLE						
107.	Failure of 220kV XLPECablebetweenMaharaniBaghandTraumaCentreSubstations	DTL	XPLE CABLE	-	19.06.2019		



108.	Failure of 220kV XLPE	DTL	XPLE CABLE	-	19.06.2019			
	Cable between							
	Maharani Bagh and							
	Masjid Moth							
	Substations							
109.	Failure of 220 kV cable	Adani Electricity	XLPE cable	-	07.01.2022			
	joint on Aarey –	Mumbai Ltd.	joint					
	MSETCL Borivali line	(AEML)						
Circu	Circuit Breaker							
110.	Failure of 420kV CB at	KPTCL	СВ	A12401	21.08.2020			
	Nelamangala							
	Substation							
111.	Failure of 420kV CB at	KPTCL	СВ	2017/IND/01	18.04.2019			
	Doni Cross, Gadag			/18411				
	Substation							
112.	Failure of 220kV CB at	KPTCL	СВ	IND/05/2510	01.07.2019			
	Hoody Receiving							
	Substation							
113.	Failure of 245kV CB at	APTRANSCO	CB	27827C	20.06.2019			
	Ragulapadu Substation							
114.	Failure of 245kV CB at	APTRANSCO	CB	24500179	02.08.2020			
	Chittoor Substation							
115.	Failure of 245kV CB at	TANTRANSCO	CB	150156	01.11.2019			
	Alamathy Substation							
Wave	trap							
116.	Failure of 220kV Wave	APTRANSCO	Wave trap	L5869	27.08.2020			
	trap at Nunna							
	Substation							
Coup	ling Capacitor							
117.	Failure of 220 kV CC at	MSETCL	CC	7002172	01.06.2020			
	Theur substation							



TRANSFORMERS 1. Failure of 400/220 kV ICT-3 at Nellore substation of APTRANSCO

А.	Name of Substation	:	Nellore
В.	Utility/Owner of substation	:	APTRANSCO
C.	Faulty Equipment	:	ICT
D.	Rating	:	315 MVA, 400/220 kV
E.	Make	:	ЕМСО
F.	Sr. No.	:	HT2037/13642
G.	Year of manufacturing	:	2015
H.	Year of commissioning	:	2016
I.	Date and time of	:	13.04.19 at 2259 hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	29.07.2019
	CEA		
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	To be replaced
	equipment		
M.	Details of previous	:	Information not available
	maintenance		
Ν.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	ICT-3 tripped on Buchholz, PRV and differential
	Description of failure		protection.
			Internal inspection was carried out and broken wood
			pieces were noticed on 400 kV Y-ph side. Carbon
			deposits at Y-ph limb and burned paper at the
D			bottom of main tank were found.
Ρ.	Details of Tests done after	:	DGA: High acetylene content (78.7 ppm –top, 798.9
	lanure		ppm- bollom) Magnetia halanaa taati na ahnammalityi
			IP values at Normal Tan: no abnormality
			Winding resistance: no abnormality
			winding resistance. no abnormanty
0	Observations and Probable	•	Operation of Buchholz PRV and differential
∼ ∙	cause of failure	.	protection indicates internal arcing which is also
			corroborated by higher concentration of acetylene
			and CO ₂ along with other gases. During internal
			inspection, broken wood pieces on 400 kV Y-ph
			side, Carbon deposits at Y-ph limb and burned paper
			at the bottom of main tank were noticed which
			indicates the problem in the Y-phase HV winding.
			Since details of previous maintenance is not known,


it is difficult to say if the fault was result of
development of <i>existing</i> incipient fault or it
developed suddenly. Thorough internal inspection
by OEM is recommended to assess the exact nature
of fault.

A.	Name of Substation	:	Allahabad
B.	Utility/Owner of substation	:	PGCIL
C.	Faulty Equipment	:	ICT
D.	Rating	:	315 MVA, 400/220 kV
E.	Make	:	CGL
F.	Sr. No.	:	T10319/1
G.	Year of manufacturing	:	2013
H.	Year of commissioning	:	2014
I.	Date and time of occurrence/discovery of fault	:	07.07.2019 at 0751 hrs
J.	Information received in CEA	:	04.09.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
M.	Details of previous maintenance	:	Carried out as per utility's norms and results were within permissible limits
N.	Details of previous failure	:	No previous failure
Ο.	Sequence of events/ Description of failure	:	On 07.07.2019 at 0751 hrs, the ICT tripped with the following indications and caught fire: 07:51:44:977: General trip 07:51:44:977: Differential trip operated 07:51:44:977: REF operated 07:51:45:028: PRD operated 07:51:45:036: Backup O/C operated 07:51:45:061: 400 kV and 220 kV CB tripped 07:51:45:071: Buchholz trip
Р.	Details of Tests done after failure	:	No tests could be conducted as the transformer caught fire.
Q.	Observations	:	Internal flashover resulted in bursting of main tank near bolted joints. OLTC, stiffeners etc. were completely burnt. Winding insulation was also burnt entirely. Prior to the failure, the transformer has endured approximately 14 Nos. through faults occurring on 220 kV lines in the past 18 months.
R.	Probable cause of failure	:	Operation of differential relay and buchholz alarm indicates internal fault. Due to regular faults on 220 kV lines, the transformer insulation might have been

2. Failure Report of 315 MVA, 400/220 kV ICT III at Allahabad Substation of PGCIL



	weakenee	d. A	s the tra	nsfo	rmer had	caught fire	it is	not
	possible	to	assess	the	internal	condition	of	the
	uansioni	ICI.						

A.	Name of Substation	:	Magarwada
B.	Utility/Owner of substation	:	PGCIL
C.	Faulty Equipment	:	ICT
D.	Rating	:	500 MVA, 400/220 kV
E.	Make	:	EMCO
F.	Sr. No.	:	13444
G.	Year of manufacturing	:	2013
H.	Year of commissioning	:	2014
I.	Date and time of occurrence/discovery of fault	:	08.08.19 at 0857 hrs
J.	Information received in CEA	:	04.09.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Repaired at site
M.	Details of previous maintenance	:	 i. Internal inspection done in the presence of OEM due to increasing trend of H₂. No abnormality could be found. However, extra paper insulation was wrapped on HV bushing leads ii. HV bushing replacement carried out in 2016 and 2018
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 08.08.19 at 0857 hrs, ICT tripped on:
	Description of failure		08:57:28:770: Buchholz operation
			08:57:28:801: 86 A/B
			08:57:28:817: CB opening
Р.	Details of Tests done after failure	:	DGA results indicated Acetylene content of 288 ppm.
Q.	Observations	:	Flash marks were observed on R-ph top ring and yoke clamp support. Flash mark and tree formation was observed on outer wrap of R-ph (IV) side. Y-ph OLTC connecting Copper rod of selector was touching IV lead support structure (wooden). Flash mark was observed on the point of contact. Rainy weather was observed at the time of failure.
R.	Probable cause of failure	:	Based on rising trend of H_2 in the oil, indicates slight deterioration of insulation. Humid weather may also have contributed to weakening of insulation during tripping. Dielectric failure could have been the probable cause of failure.

3. Failure of 400/230/33kV, 3 Ph, 315 MVA ICT-II at Magarwada Substation of PGCIL

A.	Name of Substation	:	Tikrikalan						
B.	Utility/Owner of substation	:	DTL						
С.	Faulty Equipment	:	Auto transformer						
D.	Rating	:	315 MVA, 3 Phase, 400/220/33 kV						
E.	Make	:	TELK						
F.	Sr. No.	:	140155-1						
G.	Year of manufacturing	:	2010						
H.	Year of commissioning	:	2012						
I.	Date and time of	:	29.09.19 at 00:19 hrs						
	occurrence/discovery of								
	fault								
J.	Information received in CEA	:	01.10.19						
Κ.	Fault discovered during	:	Operation						
L.	Present condition of	:	Not repairable						
	equipment								
М.	Details of previous	:							
	maintenance								

4. Failure of 315 MVA Auto transformer at 400 kV Tikrikalan Substation of Delhi Transco Ltd.(DTL)

From the earlier DGA reports (from October 2014 to September 2019), it is observed that higher generation of acetylene gas has been almost a consistent problem since August 2015. Other transformer test reports were found to be generally in order. An inspection of this transformer was conducted by TELK representatives and DTL officers on 27th October 2015. In this inspection, the exact reason of generation of acetylene gas was not found out. However as per advice of TELK representatives, transformer was cleaned with oil jets and vacuumed with equalization of OLTC with main tank.

After this inspection and cleaning, the generation of acetylene gas in DGA reports were found under the limits for some time. In July 2016, the generation of acetylene gas was above limits and there was continuous generation of acetylene gas, as observed in the DGA reports, of consecutive months. DTL officers again conducted inspection in presence of TELK representatives on 3rd December 2018 to 4th December 2018. During internal inspection, no visible cause for the formation of acetylene gas was found. TELK representatives again advised cleaning the transformer with oil jets and to perform other standard procedures. After this cleaning process, the values were in limits for some time and then, they started increasing again till the date of failure.

N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	
	Description of failure		

- 1.1 On 29.09.19, at 00:19 hrs, all the three 315 MVA, 400/220/33kV ICTs (ICT 2, ICT 3 & ICT 4) were running in parallel with load of 161 MW each. At that time, there was a fault on 220kV Tikrikalan-Najafgarh Overhead Circuit and it tripped on the Distance Protection Relay (Zone-1, B-Phase). The fault current in B phase of the line was 24.5 kA in magnitude and was cleared within 64ms.
- 1.2 Within 10 ms after clearing the fault in Najafgarh ckt., an internal fault having magnitude of 39.6 kA (400 kV side) was developed in TELK make 315 MVA, 400/220/33kV auto transformer (ICT-2, Sr. No. 140155-1) and the transformer got tripped on Circuit Breaker 409 (Tie Breaker) and Circuit Breaker 410-52 (Main Breaker) along with heavy sound and flame in transformer with following facia/relay indications:
 - a. Differential Protection
 - b. Restricted Earth Fault Relay
 - c. Buchholz Relay
 - d. Pressure Release Valve
 - e. Winding Temperature Indicator
 - f. Oil Temperature Indicator
 - g. Sudden Pressure Relay
 - h. Master Trip Relay (86A & 86B) of Main and Tie Bay (400kV) of ICT-2 operated due to internal fault in the transformer which gave inter-tripping command to its 220kV incomer, hence 220kV 86A and 86B operated and isolated transformer from 220kV side.
 - i. NIFPES indication showing oil drain valve open with Fire Detector Trip and Transformer Conservator Isolation Valve got closed.

After hearing the sound, staff present at substation rushed to the switchyard and found ICT 2 under fire. DTL submitted that Nitrogen Injection Fire Prevention & Extinguishing System (NIFPES) of CTR make operated but fire could not be controlled. Fire tenders reached the site and fire could be controlled in the morning.

			8
P.	Details of Tests done after	:	No tests could be conducted due to extensive
	failure		damage
Q.	Observations	:	

- i. During physical inspection of the failed transformer at site, it was observed that HV Bushings of Y & B-phase had completely damaged due to fire, and burnt insulation paper and connecting rods of bushings were visible. Further, B phase bushing connecting rod had bent due to excessive heating and porcelain housing was found scattered around transformer. R phase Bushing had less damage compared to Y & B phase bushings, however cracks on the ceramic housing could be observed.
- ii. MV bushing of R, Y & B phase were found damaged due to fire, and burnt insulation paper and connecting rods of the bushings were visible.

iii. Transformer tank was found bulged at MV and HV side and it had cracked at a number of places. Tertiary side bushing housing was observed burnt.

iv. Radiator Bank/ Cooling System of the transformer was found damaged due to fire.



- v. Marshalling Box, Control cables, auxiliary power cables near the transformer and CTR make NIFPES was completely damaged.
- vi. All the Lightening Arrestors on 400kV side were found damaged and grading ring of all the lightening arrestor were lying damaged on the floor.
- vii. Line Isolators on HV side of all the three phases were damaged due to the fire and parts of the isolator were found broken on the floor.
- viii. Transformer windings were found damaged due to fire and paper insulation was also observed burnt.
- ix. It was informed that there was no time synchronization between the disturbance recorders of the Distance relay of the 220kV Tikrikalan-Najafgarh Overhead Circuit and REF relay of the ICT-2 transformer

R. Probable cause of failure

i. The damage to the transformer due to fire was so severe that it was not possible to carry out any test on the failed transformer.

:

- ii. Operation of Differential relay along with operation of Buchholz, OSR (OLTC Buchholz) & PRV relays indicates fault inside the transformer. Operation of REF indicates that fault involved ground. The flow of heavy fault current in the transformer windings due to fault on 220 kV Tikrikalan-Najafgarh Overhead Circuit, might have led to rise in winding temperature and operation of WTI Trip and OTI Trip.
- iii. High energy arcing due to fault inside the transformer tank might have led to sudden pressure rise in tank and tripping of Buchholz & PRV. PRV being a slow operating device might not have been able to bring down the gas pressure inside the tank to safe value and high rate of rise of gas pressure might have resulted in cracks at weak areas of the transformer tank.
- iv. It was informed by DTL staff that at first fire was noticed on B-phase MV bushing only and later on it spread to other accessories and equipment. At the time of fault, Event Logger data showed 39.6kA fault current in B-phase. It is possible that damage to insulation of B-phase MV winding might have taken place as most of the damage could be observed on the B phase side.
- v. There has been continuous emission of the acetylene gas observed in the Dissolved Gas Analysis report since August 2015 (except for two brief intervals after TELK representatives visit and cleaning done by DTL). It is further observed from the MoMs of TELK and DTL dated 27.10.2015 and 04.12.2018 that no visible cause for the formation of acetylene could be found out during the internal inspection. Acetylene gas formation suggests sparking; the appropriate course for DTL should have been to get the transformer checked thoroughly in time and to found out the root cause of acetylene formation.

TELK Engineers visited 400kV S/Stn. Tikrikalan on dated 30.10.2019, and jointly inspected the failed transformer with DTL Engineers. After Inspection, it was informed by the TELK representatives that the transformer was not in repairable condition and no further inspection was needed.

5. Failure of 234 MVA, 440/93 kV Converter Transformer at Bhadrawati HVDC station of PGCIL

А.	Name of Substation	:	Bhadrawati
В.	Utility/Owner of substation	:	PGCIL
С.	Faulty Equipment	:	Converter transformer
D.	Rating	:	234 MVA, 400/93 kV, Pole-1, Y-ph
E.	Make	:	Alstom
F.	Sr. No.	:	PTD1659/06
G.	Year of manufacturing	:	1997
H.	Year of commissioning	:	2016
I.	Date and time of	:	15.12.2019 at 0958 hrs
	fault		
J.	Information received in CEA	:	04.09.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	Carried out as per utility's norms and results were
	maintenance		within permissible limits
N.	Details of previous failure	:	No previous failure
О.	The sequence of events/	:	On 15.12.2019 at 0958 hrs, the Y-ph converter
	Description of failure		Transformer tripped on
			09:58:36.736: Biased differential
			09:58:36.736: Instantaneous phase fault protection
			09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD
Р.	Details of Tests done after	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted:
Р.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm
Р.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm
P.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm
Р.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H6- 345 ppm
Р.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H6- 345 ppm C2H2-2327 ppm
Р.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H6- 345 ppm C2H2-2327 ppm C0- 2196 ppm
Р.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H4- 2629 ppm C2H6- 345 ppm C2H2-2327 ppm CO- 2196 ppm CO2- 10497ppm
P.	Details of Tests done after failure	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H6- 345 ppm C2H2-2327 ppm CO- 2196 ppm CO2- 10497ppm
P	Details of Tests done after failure Observations	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H4- 2629 ppm C2H6- 345 ppm C2H2-2327 ppm CO- 2196 ppm CO2- 10497ppm
Р. Q.	Details of Tests done after failure Observations	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H6- 345 ppm C2H2-2327 ppm CO- 2196 ppm CO2- 10497ppm Main tank body was bulged and cracks developed in the stiffeners. Oil-end porcelain portion of HV bushing was found displaced slightly. HV lead take
Р.	Details of Tests done after failure Observations	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H4- 2629 ppm C2H2-2327 ppm CO- 2196 ppm CO2- 10497ppm Main tank body was bulged and cracks developed in the stiffeners. Oil-end porcelain portion of HV bushing was found displaced slightly. HV lead take- off point had been mechanically moved. Outer
P. Q.	Details of Tests done after failure Observations	:	09:58:36.736: Instantaneous phase fault protection 09:58:36.736: PRD DGA was conducted: H2- 4338 ppm CH4- 2437 ppm C2H4- 2629 ppm C2H4- 2629 ppm C2H2-2327 ppm CO- 2196 ppm CO2- 10497ppm Main tank body was bulged and cracks developed in the stiffeners. Oil-end porcelain portion of HV bushing was found displaced slightly. HV lead take- off point had been mechanically moved. Outer winding had collapsed



R.	Probable cause of failure	:	From the observations as submitted by the utility,
			heavy fault current capable of mechanical
			displacement had passed through Y-ph HV end.
			Phase fault protection and differential operation also
			indicate the same. Delay in release of pressure by
			PRD, developed due to heavy gas generation, led to
			cracking and bulging of the main body. (Non
			operation of Buchholz, Delay operation of PRD and
			PGCIL's analysis for sudden fault in HV winding to
			be inform)

6. Failure of 160 MVA Power Transformer at RK Puram Substation of Delhi Transco Ltd.(DTL)

A.	Name of Substation	:	RK Puran	1						
В.	Utility/Owner of substation	:	DTL							
С.	Faulty Equipment	:	Power Tra	ansformer						
D.	Rating	:	160 MVA	, 220/66/1	1 kV					
E.	Make	:	M/s IMP							
F.	Sr. No.	:	PT7971	PT7971						
G.	Year of manufacturing	:	2017							
Н.	Year of commissioning	:	2018							
I.	Date and time of occurrence/discovery of fault	:	06.03.2020 at 10:58 hrs							
J.	Information received in CEA	:	20.03.202	0						
К.	Fault discovered during	:	Operation							
L.	Present condition of equipment	:	As per the of PT we inspection	e report sul ould be int	bmitted by the timated by C	ne utility, the status DEM after internal				
М.	Details of previous maintenance	:	Voltage ratio test, winding resistance test, IR test, tan delta, DGA of oil etc. were done as per utility's practice. No abnormality was observed.							
N.	Details of previous failure	:	No previo	ous failure						
Ο.	Sequence of events/ Description of failure	:	On 06.03.2020 at 1058 hrs, DMRC ckt-1 tripped on: i. Directional Overcurrent and E/F relay ii. All three phases tripped iii. LBB iv. 86.1 and 86.2 master trip Simultaneously, PT-II tripped on Y-ph differential, Buchholz trip and 86.1 and 86.2 master							
			trip with	incomer						
Р.	Details of Tests done after failure	:								
Folle	owing tests were conducted on	at sit	e after failu	ure:						
i. I	i. Magnetizing balance test:									
	HV side									
	V _{RN}	Vy	N V	V _{BN}	(mA)					
	246.3	2.9	2	43.1	I _{RN} = 11.7					

101	244.5	128.2	$I_{YN} = 520$
241.9	2.9	246.3	$I_{BN} = 12.2$
LV side			
V_{RN}	V_{YN}	V_{BN}	(mA)
252	1.3	250.7	I _{RN} = 80
84.9	250.2	165	I _{YN} =5.20
249.3	2.2	252.1	$I_{BN}=74$

Voltage induction in Y-ph is not normal when either R or B-ph are energized. Magnetizing current in Y-ph is upto 430-570 mA (for various taps) on HV side and 5.2 mA on LV side (NT).

ii. DGA before the date of failure showed no abnormality, while on 06.03.20, acetylene concentration was 8.0 ppm which increased to 53.8 ppm on 07.03.2020.

	H ₂	CO ₂	CO	C_2H_4	C_2H_6	CH ₄	C_2H_2	TDCG
31.01.20	17	1548	203	9	5	8	0.5	241
06.03.20	24	1574	214	18	6	14	8	283
07.03.20	43	1366	256	68	9	42	53.8	471

- iii. Results of Voltage ratio test, Winding resistance test, vector group test etc. were normal.
- iv. Internal inspection was done after draining the oil. Carbon particles were observed at lead part/ bottom end of Y-ph LV winding and paper insulation.

No cracks/ bulge could be observed from the photographs shared by DTL

Q.	Observations and Probable cause of failure	:	Some kind of internal fault has happened near Y-ph LV as can be deduced from the information. High acetylene also indicates internal flash-over which might have led to carbon deposition. Thorough internal inspection would be helpful to ascertain the
			cause of failure.

7.	Failure of 10	0 MVA,	220/110/11	kV	Power	Transformer	at	Shivamogga	substation	of
	KPTCL									

A.	Name of Substation	:	Shivamogga
B.	Utility/Owner of substation	:	KPTCL
C.	Faulty Equipment	:	Power Transformer
D.	Rating	:	100 MVA, 220/110/11 kV
E.	Make	:	General Electric, USA
F.	Sr. No.	:	D566535
G.	Year of manufacturing	:	1963
H.	Year of commissioning	:	1967
I.	Date and time of	:	23.03.2020 at 1803 hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	04.08.2020
	CEA		
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Repairable
	equipment		
М.	Details of previous	:	Last maintenance done on 20.11.2019
	maintenance		
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 23.03.2020 at 1803 hrs, the transformer tripped
	Description of failure		on differential relay in all three phases during tap
			changer operation
Р.	Details of Tests done after	:	NA
	failure		
Q.	Observations and Probable	:	The reason can be ascertained only after submission
	cause of failure		of detailed inspection report after disassembly of the
			windings and dismantling of the core respectively by
			the utility.



8. Failure of 400/220 kV, 1 Ph, 150 MVA ICT at Panipat Substation of BBMB (PGCIL)

A.	Name of Substation	:	Panipat
В.	Utility/Owner of substation	:	BBMB/PGCIL
C.	Faulty Equipment	:	ICT
D.	Rating		150 MVA, 400/220 kV
E.	Make	:	TELK
F.	Sr. No.	:	140053-2
G.	Year of manufacturing	:	1984
H.	Year of commissioning	:	1985
I.	Date and time of	:	12.07.2020 at 1458 hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	09.09.2020
	CEA		
К.	Fault discovered during	:	Operation
L.	Present condition of	:	Not Repairable
	equipment		
М.	Details of previous	:	As per information submitted by PGCIL, all
	maintenance		maintenance activities were carried out as per their
			norms and results were within acceptable limits.
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 12.07.2020 at 1458 hrs, ICT tripped on:
	Description of failure		10:31: Differential Operated
			14:58: Buchholz Operated
Р.	Details of Tests done after	:	i. DGA results indicated C2H2 content of 28 ppm
	failure		ii. Capacitance & Tan delta measurement of
			winding & Bushing, IR measurement,
			Magnetizing current, Voltage ratio, SFRA &
			Winding Resistance
Q.	Observations	:	Sludge deposition throughout the core coil assembly
	D 1 11 00.1		and at the bottom of the tank
К.	Probable cause of failure	:	As per the report submitted by the utility, the probable
			cause of the failure of this ICI was the failure of its LV
			winding during tertiary fault. Since the transformer had
			served for 35 years, ageing could be the reason of fault.

	Fanule of 107 101 vity, 400/220/	55 N	V 1-11 IC1 at 400 KV Dabhaicshwar Substation
А.	Name of Substation	:	400kV Babhaleshwar
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	ICT
D.	Rating	:	167 MVA, 400/220/33 kV 1-Ph ICT
E.	Make	:	CGL
F.	Sr. No.	:	T0973514
G.	Year of manufacturing	:	2010
H.	Year of commissioning	:	First time commissioning: 23.06.2014 (400kV
			Warora S/s)
			Second time commissioning: 27.11.2016
			(400kV Babhleshwar)
I.	Date and time of	:	24.07.2020 at 7:15 hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	21.01.2022
	CEA		1
К.	Fault discovered during	:	Operation
L.	Present condition of	:	Repairable and proposal under process
	equipment		
M.	Details of previous	:	Quarterly maintenance was done with all diagnostic
	maintenance		testing. No abnormality was observed.
Ν.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	(SoE with time not specified in the report)
	Description of failure		220kV B-Phase bushing burst.
			Protections:
			Differential Relay: Differential Rph Pickup, Yph
			Pickup, Bph Pickup
			KEF operated
			LV Backup Kelay: LED: Bph pickup
			PKV, B-ph auxiliary relay trip
D			1 rip relay operated
Ρ.	Details of rests done after	:	1. Open Circuit
	lanure		2. Shori Ulrcull 2. Tan Dalta
			7. IX 5. Ratio Test
			6 Tan continuity
			7 SFR A
			8 DGA of ICT Oil
L	l		

9. Failure of 167 MVA, 400/220/33 kV 1-Ph ICT at 400 kV Babhaleshwar Substation



Q. Probable cause of failure :	As per the report submitted by the utility, the probable cause of the failure of this ICT was B-phase Bushing failure.
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A.	Name of Substation	:	765/400/220kV WUPPTCL G. Noida
			Substation
В.	Utility/Owner of substation	:	Western U.P. Power Transmission Co. Ltd.
С.	Faulty Equipment	:	ICT
D.	Rating	:	500 MVA, 765/400/220 kV 1-Ph ICT
E.	Make	:	BHEL
F.	Sr. No.	:	6007319
G.	Year of manufacturing	:	2015
H.	Year of commissioning	:	2018
I.	Date and time of occurrence/discovery of fault	:	13-12-2020 (00:55 Hrs)
J.	Information received in CEA	:	21.01.2022
К.	Fault discovered during	:	Operation : Transformer was in Service and
			Tripped on fault & HV bushing busted
L.	Present condition of	:	Declared failed on 19-12-2020 by OEM (M/s
	equipment		BHEL)- 'R' phase of 765kV ICT has been
			charged with spare ICT
111.	maintenance		 I. Hall-yearly plained DOA test on 20-08-2018, 28-02-2019, 13-09-2019 and 25-05-2020, BDV and PPM on 31-10-2019 & 26-05-2020. DGA, BDV & PPM. (All reports enclosed as Ann-1) ii. Annually planned tests : Core Insulation, Tan Delta capacitance measurement for Winding & Bushing, Insulation Resistance on 15-02-2019 (Ann-2) and 9-05- 2020 (Ann-3) iii. Recently performed PD test on 7-03-2020 (Ann-4)
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	REF operated - 00.55.13.614 Hrs
	Description of failure		Diff R ph operated - 00.55.13.618 Hrs.
			PRV-1/2 operated - 00.55.13.667 Hrs.
			Buchcholz -1 operated - 00.55.13.719 Hrs.
Р.	Details of Tests done after	:	1. Tan Delta and Capacitance of winding
	failure		2. IR Measurement
			3. Turn Ratio
			4. Magnetizing Current
	1. Tan Delta and capacitanc	e of	Winding (at 20 ° C)
	Voltage		Canacitance Tan δ
	, shage		

10. Failure of 500 MVA, 765/400 kV 1-Ph ICT at 765/400/220 kV Greater Noida Substation

	Winding Combina	Test Mode	Site (pF)	Factory (pF)	Site (%)	Factory (%)
	tion					
2 kV	HV+IV+ N/ LV	UST	5217	-	14.82	
2 kV	HV+IV+ N/ LV+G	GST	7374	7753	10.94	0.18
2 kV	HV+IV+ N/LV with guard	GSTg	2158	3598	1.43	0.2

2. Insulation Resistance Measurement: (Winding & CC-CL)

Winding

2	At 2.5 kV	At 5kV
HV- Earth	6.9 MΩ	5.6 MΩ

CC-CL IR Test

Combination	IR Value 50 V	IR Value 100 V	IR Value 250 V	IR Value 500 V
Core-Yoke	7.9 MΩ	19 MΩ	7.23 MΩ	5.17 MΩ
Core-Tank	18 MΩ	9 MΩ	17.9 MΩ	19.9 MΩ
Yoke-Tank	15 MΩ	15 MΩ	14.1 MΩ	12.5 MΩ

3. Turn Ratio Test

HV/IV

Tap Position	Site Ratio	Specified Ratio	Factory
1(Min)	1.212	1.815	1.8145
2	1.2054	1.823	1.8222
3	1.2344	1.831	1.8298
4	1.211	1.839	1.8376
5	1.235	1.847	1.8465
6	1.208	1.855	1.8546
7	1.236	1.863	1.8613
8	1.2119	1.872	1.8691
9	1.213	1.881	1.8775
10	1.212	1.890	1.8878
11	1.215	1.899	1.8962
12(Nor.)	1.154	1.908	1.9066
13	1.206	1.917	1.9157



14	1.23	1.927	1.9254
15	1.237	1.937	1.9356
16	1.203	1.947	1.9460
17	1.239	1.958	1.9567
18	1.201	1.966	1.9671
19	1.207	1.978	1.9773
20	1.198	1.990	1.9873
21	1.208	2.001	1.9985
22	1.228	2.013	2.0100
23(Max.)	1.236	2.025	2.0222

HV/LV

Tap Position	Site Ratio	Specified Ratio	Factory
1(Min)	9.646	14.149	14.184
2	9.638	14.076	14.103
3	9.677	14.002	14.020
4	9.634	13.929	13.941
5	9.638	13.855	13.870
6	9.970	13.789	13.800
7	8.632	13.716	13.721
8	9.064	13.642	13.645
9	9.689	13.569	13.573
10	8.939	13.495	13.498
11	9.022	13.421	13.426
12(Nor.)	8.763	13.356	13.343
13	8.64	13.282	13.289
14	9.026	13.208	13.225
15	8.873	13.135	13.148
16	9.689	13.061	13.068
17	9.169	12.988	13.003
18	9.737	12.922	12.931
19	9.034	12.848	12.867
20	9.650	12.775	12.781
21	9.053	12.701	12.720
22	9.053	12.628	12.637
23(Max.)	9.166	12.554	12.564

IV/LV

Tap Position	Site Ratio	Specified Ratio	Factory
1(Min)	7.745	7.795	7.818



	2	7.80		7.722		7.741			
	3	7.70		7.648		7.665			
	4	7.828		7.575		7.594			
	5	7.762		7.501		7.516			
	6	7.775		7.435		7.442 7.376			
	7	7.737		7.362					
	8	7.794		7.288	7.296				
	9	7.820		7.215		7.223			
	10	7.996		7.141		7.154			
	11	7.732		7.067		7.080			
	12(Nor.)	7.707		6.001		7.000			
	13	7.786		6.928		6.935			
	14	7.667		6.854		6.864			
	15	7.786		6.781		6.795			
	16	7.736		6.707		6.720			
	17	7.651		6.634		6.646			
	18	7.756		6.568		6.568			
	19	7.732		6.4945		6.540			
	20	7.766		6.421		6.430			
	21	7.719		6.347		6.361			
	22	7.762		6.273		6.284			
	23(Max.)	7.707		6.200		6.212			
	4. Turn Ratio Test	4. Turn Ratio Test							
	Tap Position	Voltage	Applied	Voltage	Applied	Current			
		Between		(Volts)		Measure			
						d			
			~			(Amp)			
	12(Nor.)	HV (1.1-N)	240		11.2			
	12(Nor.)	IV (2.1-N)		240		10.1			
Q.	Observations	:	Test resul of the Tra	t indicate d nsformer.	amage of w	indings and insulation			
R.	Probable cause of failu	ire :	As per the the proba internal/ c	e preliminary report submitted by the utility, ible cause of the failure may be due to some design fault.					

11. Failure of 3 x 156.33 MVA,	400/37 kV, 1-Ph Co	oupling Transformer	at 400 kV Hyderah	oad
Substation of POWERGRII)		-	

A.	Name of Substation	:	400/220 kV Hyderabad
В.	Utility/Owner of substation	:	POWERGRID
C.	Faulty Equipment	:	Coupling Transformer
D.	Rating	:	3 x 156.33 MVA, 400/37 kV, 1-Ph Coupling
			Transformer
Е.	Make	:	ABB
F.	Sr. No.	:	14073-10 (B-Phase),
			14073-11 (Spare as Y-Phase)
			14073-12 (R-Phase)
G.	Year of manufacturing	:	2018
Н.	Year of commissioning	:	2019
I.	Date and time of	:	30-01-2021 @07:15 Hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	23.02.2021
	CEA		
К.	Fault discovered during	:	Operation
L.	Present condition of	:	Beyond Repair
	equipment		
М.	Details of previous	:	All maintenance carried out as per POWERGRID
	maintenance		norms and results were within acceptable limits
NI	Details of merrique failure		No mariona failuna
N.	Details of previous failure	:	No previous failure
0.	Sequence of events/	:	07:15:41 – MV Bus Bar K-N fault detected
	Description of failure		07:15:41 – MV Bus Bar Differential Protection trip
			Differential Protection trip
			07:15:41 STATCOM station 400 kV Main and Tie
			CR Open
			07:15:41 – WTI OTI PRD SPR and Buchholz
			protection operated in all three coupler transformer.
Р.	Details of Tests done after	:	DGA indicated 718, 335 & 1170 ppm C2h2 content in
	failure	·	R. Y and B phase respectively.
			No other tests could be performed as all the three
			transformer tanks bulged and oil was spilled out from
			the main body and units damaged extensively.
Q.	Observations	:	Tanks of all the three coupler transformers bulged out
			and oil spilled out. Oil splashed and all the
			transformers damaged extensively.



R.	Probable cause of failure	:	As per the preliminary report submitted by the utility R-Ph to earth fault occurred due to unidentified reasons in delta system. The fault converted into 3-Phase fault within 400 msec. Subsequent to 3-Phase fault in MV side, internal fault occurred in all the three coupler transformer units. Very high value of acetylene in all three units indicate very heavy arcing inside the transformer. This arcing increased pressure inside the tank leading to its bulging.
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А.	Name of Substation	:	400 kV Bawana
B.	Utility/Owner of substation	:	DTL
C.	Faulty Equipment	:	ICT
D.	Rating	:	315 MVA, 400/220/33 kV, 3-Ph
E.	Make	:	BHEL
F.	Sr. No.	:	6005260
G.	Year of manufacturing	:	1993
H.	Year of commissioning	:	1998
I.	Date and time of occurrence/discovery of fault	:	30-03-2021 (17:35 Hrs)
J.	Information received in CEA	:	31.02.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond Repair
M.	Details of previous maintenance	:	Capacitance & Tan Delta Test, DGA of oil, oil properties, LV Test.
N.	Details of previous failure	:	 2005: On 21.08.2005 ICT –II tripped on following: Differential relay 87B & 87C, Buchholz relay Over Current relay (C Ph) OLTC Trip (B Ph) Buchholz alarm Problem found in b Phase Tap winding and B Phase OLTC. Transformer revived after repairing on 28.02,2006 2017: On 30.11.2017, ICT-II tripped on following: Differential relay R, Y, B OLTC Buchholz relay PRV operated Buchholz alarm Problem found in R Phase bushing of 400 kV side and R & Y phase bushing of 220 kV side got damaged. Transformer revived after replacement of damaged bushing on 23.03.2018.

12. Failure of 315 MVA, 400/220/33 kV, ICT-II at 400 kV Bawana Substation of DTL



O.	Sequence of events/ Description of failure	:	On 30.03.2021, 315 MVA ICT-2 was operating in parallel with 315 MVA ICT-3. ICT-2 was carrying a load of 83 MW. At 17:35 Hrs ICT-2 tripped with heavy sound and was found to be engulfed with fire. The relays which operated were Differential R,Y,B Phase; REF, Buccholz, PRV, 186A & 186B, 86A. 220 kV incomer-2 tripped on inter-tripping.
Р.	Details of Tests done after failure	:	ICT completely damaged due to fire.
Q.	Observations	:	 Bulging of tank towards MV side. 400 kV B phase bushing with turret was dislocated from the main tank. Housing of R and B phase bushing was found scattered around the transformer and paper insulation was burnt in the fire. MV bushing of R, Y & B phase were found damaged due to fire
R.	Probable cause of failure	:	The damage to the transformer due to fire was so severe that it was not possible to carry out any test on the failed transformer.
			Operation of Differential relay along with operation of Buchholz & PRV relays indicates fault inside the transformer. Operation of REF indicates that fault involved ground. Local hotspots may have arisen in the tank that may have intiated the fire.
			High energy arcing due to fault inside the transformer tank might have led to sudden pressure rise in tank and tripping of Buchholz & PRV. PRV being a slow operating device might not have been able to bring down the gas pressure inside the tank to safe value and high rate of rise of gas pressure might have resulted in buckeling of the tank.

A.	Name of Substation	:	400/220 kV New Wanpoh Substation			
B.	Utility/Owner of substation	:	POWERGRID			
C.	Faulty Equipment	:	ICT			
D.	Rating	:	105 MVA, 400/220 kV, 1-Ph			
E.	Make	:	Vijai Electric (Toshiba)			
F.	Sr. No.	:	90093A02			
G.	Year of manufacturing	:	2012			
H.	Year of commissioning	:	2013			
I.	Date and time of	:	05-05-2021 (19:19 Hrs)			
	occurrence/discovery of					
	fault					
J.	Information received in	:	14.06.2021			
	CEA					
К.	Fault discovered during	:	Operation			
L.	Present condition of	:	Can be repaired at factory			
	equipment					
М.	Details of previous	:	All maintenance activities carried out as per			
	maintenance		POWERGRUD norms and there was some deviation			
			in DGA results which was taken up with the OEM.			
			However, the internal inspection & online PD were			
			unable to identify the cause of the problem and			
			transformer was kept under observation.			
N	Details of previous failure		NII			
0	Sequence of events/	•	REF PRV Differential & Buchholz relay operated at			
0.	Description of failure	•	19·19·10 268			
	Description of fundic		19.19.10.200			
Р	Details of Tests done after		DGA indicated high level of all fault gases			
1.	failure	•	SFRA test result also indicate that the winding is			
	Tullure		shorted.			
			During Core IR measurement, CC-CL was found to be			
			shorted.			
Q.	Observations	:	No bulging of tank or fire occurred during the said			
			failure.			
R.	Probable cause of failure	:	As reported by the utility, from internal inspection it			
			seems that the fault developed between IV winding			
			bottom end ring and side limb due to which fault			
			current was grounded through core thus resulting in			
			flashover.			

13. Failure of 105 MVA, 400/220 kV, ICT-II at 400 kV New Wanpoh Substation of POWERGRID

A.	Name of Substation	:	220 kV Sarita Vihar Substation
В.	Utility/Owner of substation	:	DTL
C.	Faulty Equipment	:	Power Transformer
D.	Rating	:	100 MVA, 220/66/11 kV, 3-Ph
E.	Make	:	TELK
F.	Sr. No.	:	130067
G.	Year of manufacturing	:	1982
H.	Year of commissioning	:	1982: Commissioned at 220 kV Najafgarh Substation
			2003: Recommissioned at Sarita Vihar after
L	Date and time of	•	09-06-2021 (05:27 Hrs)
1.	occurrence/discovery of	•	05 00 2021 (05.27 1115)
	fault		
J.	Information received in	:	05.07.2021
	CEA		
К.	Fault discovered during	:	Operation
L.	Present condition of	:	For repairing of transformer, it is required to send at
	equipment		works of manufacturer. Transformer has already
			completed more than 38 years of life and outlived
			as per DERC guidelines. DTL has decided to
			replace it with spare transformer. No decision has
			been taken for repairing.
М.	Details of previous	:	Not provided
	maintenance		
N	Details of merrique failure		One winding had failed in year 2001 2002. The
IN.	Details of previous failure	:	One winding had failed in year 2001-2002. The
			and recommissioned in 2003 at Sprite Viber
0	Sequence of events/		Transformer tripped on Buchholz and differential
0.	Description of failure	•	along with inter-trip to 66 kV I/C-II
	Description of fundic		
Р.	Details of Tests done after	:	Voltage ratio, SFRA, Magnetic Balance, Magnetizing
	failure	•	Current, Winding Resistance and Insulation resistance
			were conducted on 09.06.2021.
			Wide variation was observed in capacitance and tan
			delta values for MV-T and MV-E winding insulation.
			Insulation resistance for LV-E was found to be 1000
			ohm at 5 kV DC for 15 seconds. Magnetizing current
			for R-phase when voltage was applied on HV and MV

14. Failure of 100 MVA-II, 220/66/11 kV, Power Transformer installed at 220 kV Sarita Vihar Substation of DTL



			side was found to be very high as compared to values in other phases. When voltage was applied on LV side, magnetizing current could not be measured as fuse failed due to heavy current. During winding resistance measurement test, the current did not flow in LV winding. DGA indicated Acetylene value of 105 ppm which is very high from allowed limit of 1 ppm as per IEEE standard. Voltage could not be injected in 11 kV side during SFRA test.
Q.	Observations	:	A flash was observed at 66 kV R-Phase bushing. From internal inspection, no abnormality was observed.
R.	Probable cause of failure	:	From the test results, it appears that there might be internal fault in the LV (tertiary) winding. The transformer was very old and ageing might be the reason of failure.

15. Failure of	100 MVA,	220/33	kV,	Power	Transformer	installed	at	220	kV	IMT	Bawal
Substation (of HVPNL										

Name of Substation	:	220 kV Substation IMT Bawal		
Utility/Owner of substation	:	HVPNL		
Faulty Equipment	:	Power Transformer		
Rating	:	100 MVA, 220/33 kV, 3-Ph		
Make	:	Bharat Bijlee Limited (BBL)		
Sr. No.	:	5358/1		
Year of manufacturing	:	2014		
Year of commissioning	:	2016		
Date and time of occurrence/discovery of	:	17-06-2021 (05:27 Hrs)		
fault				
Information received in CEA	:	05.07.2021		
Fault discovered during	:	Operation		
Present condition of equipment		Beyond repair at site		
Details of previous maintenance	:	 Cleaning of marshalling box of T/f and OLTC. Tightening of termination box. Checking of contactors, space heaters and illumination. Checking of oil pumps and cooling fans auto starting. Maintenance of OLTC driving mechanism by oiling and greasing. Checking of all remote indication (WTI and tap position indicator) Electrical checking/ testing of PRV, Buchholz relay, OSR. Checking/ testing of Buchholz relay by oil draining. External cleaning of radiator and all bushings. Checking/ calibration of OTI and WTI. IR Measurement of windings and polarization index. Earthing resistance of HV, LV NCT and transformer. Oil test of main tank and OLTC for BDV, specific resistance, acidity, water content, dielectric dissipation factor and DGA. 		
Details of previous failure	:	NA		
	Name of Substation Utility/Owner of substation Faulty Equipment Rating Make Sr. No. Year of manufacturing Year of commissioning Date and Date and Information received Fault discovered during Present condition Of equipment Details of previous maintenance	Name of Substation:Utility/Owner of substation:Faulty Equipment:Rating:Make:Sr. No.:Year of manufacturing:Year of commissioning:Dateandimeofinformationreceivedrequipment:PresentconditionOf:Presentconditionof:petailsofprevious:maintenance:information:petailsofprevious:maintenance:		



О.	Sequence of events/	:	NA
	Description of failure		
Р.	Details of Tests done after	:	IR Test, Winding Resistance Test, Voltage ratio Test,
			Magnetic Balance Test, Magnetic Current Test.
Q.	Observations	:	Bulging of Tank and PRV operated
R.	Probable cause of failure	:	NA

16. Failure of 100 MVA, 220/33/11 kV, Power Transformer installed at 220 kV Peeragarhi GIS Substation of DTL

A.	Name of Substation	:	220 kV GIS Peeragarhi
B.	Utility/Owner of substation	:	DTL
C.	Faulty Equipment	:	Power Transformer
D.	Rating	:	100 MVA, 220/33/11 kV, 3-Ph
E.	Make	:	IMP Power
F.	Sr. No.	:	PT-7776
G.	Year of manufacturing	:	2016
H.	Year of commissioning	:	2017
7	Date and time of occurrence/ discovery of fault	:	10-07-2021 (09:58 Hrs)
I.	Information received in CEA	:	22.07.2021
J.	Fault discovered during	:	Operation
К.	Present condition of equipment	:	Repairable
L.	Details of previous maintenance	:	Capacitance and Tan Delta, LV Testing (Magnetic Balance, Magnetizing Current, Winding Resistance), IR Test, DGA Test.
М.	Details of previous failure	:	NA
N.	Sequence of events/ Description of failure	:	Transformer tripped on Differential Protection at 09:58 AM on 10.07.2021.
О.	Details of Tests done after failure	:	DGA, Tan Delta & Capacitance, SFRA, Magnetic Balance, Magnetizing Current, Winding Resistance, IR Test were carried out after failure. Very high magnetizing current was measure in R-phase on HV side at lowest, normal & highest taps. Acetylene was found to be 11.8 ppm in DGA which was very high as compared to previously measured (3 months ago) value of less than 0.5 ppm. Turns ratio also appeared out-of-tolerance, particularly for R-phase winding.
P.	Observations	:	Internal inspection of the transformer was carried out by OEM on 15.07.2021. Due to high magnetizing current measured in the testing done after failure, winding assembly, OLTC, bushing terminals, and core were visually examined but no defect, hot spot, burnt marks, damaged leads, or loosened nut/bolt found.
Q.	Probable cause of failure	•	Since no visual defect was observed during internal inspection at site by OEM, the exact cause of failure can be determined only at the OEM works after



untanking of core-coil assembly and the	thorough
inspection of the transformer. However, high	value of
magnetizing current and generation of A	cetylene
indicates towards possibility of inter-turn sho	orting in
R-phase HV winding.	-

A.	Name of Substation	:	400/230-110 kV Alamathy Substation	
B.	Utility/Owner of substation	:	TANTRANSCO	
C.	Faulty Equipment		ICT	
D.	Rating	:	105 MVA, 400/230 kV – R phase unit of ICT3	
E.	Make	:	Transformers and Rectifiers India Limited	
F.	Sr. No.	:	PMO300101 (R Phase)	
G.	Year of manufacturing	:	2013	
Н.	Year of commissioning	:	2014	
7	Date and time of	:	05-11-2021 (07:29 Hrs)	
	occurrence/discovery of			
	fault			
I.	Information received in	:	06.01.2022	
	CEA			
J.	Fault discovered during	:	Operation	
К.	Present condition of	:	Beyond repair	
	equipment			
L.	Details of previous	:	22.06.2021 : Maintenance	
	maintenance		09.02.2021: Annual relay test and Tan Delta Test	
			10.06.2021: DGA Test	
			No abnormality observed	
М.	Details of previous failure	:	NA	
N.	Sequence of events/	:		
	Description of failure			
О.	Details of Tests done after	:	Ratio measurement Test, Magnetizing Current, Short	
	failure		Circuit test, DC Winding Resistance Test, IR	
			measurement, SFRA, DGA Test for Y and B phase	
			units were carried out.	
			L	
Kat	<u>Katio measurement test (B Phase)</u>			

17. Failure of 105 MVA, 400/230 kV, 1-Ph, ICT-III unit at 400 kV Alamathy Substation of TANTRANSCO

a) Ratio measurement on: HV - IV (400/ $\sqrt{3}$ / 230/ \sqrt{kV})

Tap No	Specified ratio	Measured ratio	Deviation in %
1	1.913	2.241	17.15
2	1.891	2.217	17.24
3	1.870	2.192	17.22



4	1.848	2.168	17.32
5	1.826	2.143	17.36
6	1.804	2.119	17.46
7	1.783	2.093	17.39
8	1.761	2.069	17.49
9b	1.739	2.043	17.48
10	1.717	2.022	17.76
11	1.696	1.996	17.69
12	1.674	1.971	17.74
13	1.652	1.946	17.8
14	1.630	1.921	17.85
15	1.609	1.896	17.84
16	1.587	1.87	17.83
17	1.565	1.847	18.02
EQUIPMENT USED		RATIO METER Make : Sivananda	

b) Ratio measurement on: HV - LV $(400/\sqrt{3}/33 \text{ kV})$

Tap No	Specified ratio	Measured ratio	Deviation in %
1	7.6982	13.76	78.89
2	7.6107	13.59	78.58
3	7.5233	13.41	78.25
4	7.4358	13.27	78.48
5	7.3483	13.1	78.28
6	7.2608	12.93	78.1
7	7.1734	12.77	78.03



8	7.0859	12.62	78.12
9b	6.9984	12.55	79.34
10	6.9109	12.34	78.58
11	6.8234	12.23	79.25
12	6.7360	12.09	79.48
13	6.6485	11.91	79.15
14	6.5610	11.79	79.7
15	6.4735	11.14	82.91
16	6.3860	11.14	83.84
17	6.2986	11.46	81.96

c) Ratio measurement on: IV - LV (230/ $\sqrt{3}$ / 33 kV)

Tap No	Specified ratio	Measured ratio	Deviation in %
17	4.024	6.437	59.97

Short Circuit test (B Phase)

a) Voltage applied between HV and Neutral (IV and Neutral shorted)

Tap No	Applied voltage (V)	Current in HV (A)	Current in IV (A)	% Impedance
1	417.0	5.9	11.4	11.49 %
2	416.6	6.0	11.5	
3	416.8	6.1	11.7	
4	417.0	6.2	11.8	
5	416.7	6.4	11.9	
6	416.8	6.5	12.0	
7	416.6	6.7	12.1	



8	417.1	6.8	12.3	
9b	416.4	6.9	12.3	11.88 %
10	416.0	7.1	12.4	
11	415.7	7.2	12.5	
12	415.7	7.4	12.6	
13	416.2	7.5	12.7	
14	415.7	7.7	12.8	
15	416.4	7.8	12.9	
16	416.8	8.0	12.9	
17	416.3	8.1	13.0	12.49 %

b) Phase-phase voltage applied on HV side (LV side shorted.)

Tap No	Applied voltage (V)	Current in HV (A)	Current in LV (A)	% Impedance		
1	418.8	1.6	13.1	42.58		
2	418.8	1.6	13.3			
3	418.6	1.6	13.4			
4	418.4	1.7	13.6			
5	418.7	1.7	13.8			
6	419.2	1.8	14.0			
7	419.3	1.8	14.1			
8	418.3	1.8	14.3			
9b	417.7	1.9	14.4	43.28		
10	417.5	1.9	14.6			
11	417.9	2.0	14.8			
12	418.2	2.0	15.0			



13	417.9	2.1			15.2					
14	418.0	2.2	,		15.3					
15	418.0	2.2	,		15.5					
16	418.3	2.3			15.8					
17	17 418.8		2.3		15.9		44.2	44.25		
							·			
Р.	. Observations			Fire emer instantane	rged from ously and be	the R	phase f the ma	unit of in tank bro	ICT oker	3 1.
Q.	Q. Probable cause of failure			Inter-turn	fault					
А.	Name of Substation		:	765/400/2	220 kV Greater Noid	la Substation				
----	---	----------------	------	--------------------	-----------------------	------------------------				
В.	Utility/Owner of substa	ation	:	WUPPTC	CL					
С.	Faulty Equipment		:	3x500 M	VA ICT-II					
D.	Rating		:	3x500 M	VA					
E.	Make		:	BHEL						
F.	Sr. No.		:	6007312 -	- 500 MVA Y Phase	2				
				6007313 -	- 500 MVA B Phase	2				
				6007314 -	- 500 MVA R Phase	2				
G.	Year of manufacturing		:	2015						
Н.	Year of commissioning	5	:	2016						
7	Date and time	of	:	12.11.202	21 at 14:21 Hrs					
	occurrence/discovery	of								
	fault									
I.	Information received	l in	:	15.11.202	21					
	CEA									
J.	Fault discovered during	3	:							
К.	Present condition	of	:							
	equipment									
L.	Details of pre	vious	:	DGA was	done on 22.06.202	1 and the results were				
	maintenance			found to b	e generally in order.					
М.	Details of previous fail	ure	:							
N.	Sequence of ev	vents/	:							
	Description of failure									
	D 1 0 T 1	0								
О.	Details of Tests done	e after	:							
	failure									
	Tan Delta and capaci	<u>tance o</u>	f Bı	<u>ishing (R I</u>	<u>Ph ICT)</u>					
	Bushing Detail	Applic	ed	voltage	Tan Delta (%)	Capacitance (pF)				
	$\mathbf{U}\mathbf{V} (1 \ 1) (\mathbf{U}\mathbf{C}\mathbf{T})$	(KV)			0.2(1	1(5)				
	$ \begin{array}{c} HV (1.1) (US1) \\ Mode \end{array} $	2.0			0.201	403.0				
	wode)	3.0			0.203	403.0				
	Dushing Data:1	Annle	ad a	voltage	Tan Dalta (0/)	Conssitence (nF)				
	Dusning Detail	Аррио	eu	voltage	Tan Della (%)	Capacitance (pr)				
	IV (3.1) (UST	10			0 356	338.2				
	$\begin{bmatrix} D & (0.1) \\ Mode \end{bmatrix}$	2.0			0.354	338.2				
		5.0			When applied 5 1	V & above voltage test				
		5.0			kit getting trinned					
					Kit getting u ipped					

18. Failure of 3x500 MVA 765/400 kV ICT-II at 765 kV Greater Noida Substation of WUPPTCL



LV (3.2) (UST	1.0	0.358	343.9
Mode)	2.0	0.359	343.9
	5.0	When applied 5 kV	& above voltage, test
		kit getting tripped	
Tan Delta and Capac	itance of Winding Te	<u>est (R Ph ICT)</u>	
Winding	Applied Voltage (kV)	Tan Delta (%)	Capacitance (pF)
HV+N/ LV (UST	2.0	0.630	8213
Mode)			
HV+N/ LV (GST	2.0	0.146	2431
Mode)			
HV+N/ LV (GST-G	2.0	0.579	10600
Mode)			
LV/ HV+N (UST	2.0	0.686	8215
Mode)			
LV/ HV+N (GST	2.0	0.516	18030
Mode)			
LV/HV+N (GST-G	2.0	0.301	9835
Mode)			

Insulation Resistance Measurement (PI) R Ph ICT

Winding	Applied Voltage (kV)	Time	IR value (GΩ)
HV+IV+N to Earth	0.5	1 Min	128.4
(Tank)	1	1 Min	120.4
(LV1 + LV2) to	0.5	1 Min	10.48
Earth (Tank)	1	1 Min	7.54
	2.5	15 - 20 Sec	0
(LV1 + LV2) to	0.5	1 Min	104.3
HV+IV+N	1	1 Min	197.2
	2.5	1 Min	110.2

Winding Resistance Test (Applied current 1 Amp, Amb Temp = 21° C)

Tap Position	Applied Terminal	Wing resistance	Remarks
12	HV-N	537 mΩ	
12	IV-N	-	Value not measured
12	LV (3.1 to 3.2)	-	Value not measured



Tan nosition	Ann	lied	Annlie	h	Measured		Remarks
	Terr	minal	Voltage	e e	current		iveinai kš
12	HV/	N	239.3 V	T	1.57 A		IV & LV kept
12	LV/	N	239.6 V	7	7.94 A		open HV & LV kept
							open
	LV ((3.1 & 3.2) High c	urrent dr	awn (MCB	got	LV winding Shorted
Tan Dagitia 12	rn rat	<u>lo</u>					
Tap Position12	rn rat	<u>io</u> Ratio					
Tap Position12		<u>io</u> Ratio Measure	d	Calcula	ited	Err	ror (%)
Tap Position12		no Ratio Measure 1.906	d	Calcula 2.594	ited	Err 36.0	-or (%) 09
Tap Position12 HV/IV HV/LV		Ratio Measure 1.906 13.362	d	Calcula 2.594 112.85	ited	Err 36.0 744	
Transformer TuTap Position12HV/IVHV/LVIV/LV		Io Ratio Measure 1.906 13.362 7.002	d	Calcula 2.594 112.85 42.05	ited	Err 36.0 744 500	ror (%) 09
Tap Position12HV/IVHV/LVIV/LV		Io Ratio Measure 1.906 13.362 7.002	d	Calcula 2.594 112.85 42.05	ited	Err 36.0 744 500	ror (%) 09
Transformer TuTap Position12HV/IVHV/LVIV/LVObservations		Io Ratio Measure 1.906 13.362 7.002	d High leve	Calcula 2.594 112.85 42.05	ylene (C ₂ H ₂) 4	Err 36.0 744 500	opm was observed
Tap Position12 HV/IV HV/LV IV/LV Observations		IO Ratio Measure 1.906 13.362 7.002	d High leve in DGA	Calcula 2.594 112.85 42.05	ylene (C ₂ H ₂) 4 of oil samp	Err 36.0 744 500	ppm was observed which indicated
Tap Position12 HV/IV HV/LV IV/LV Observations		Ratio Measure 1.906 13.362 7.002	d High leve in DGA towards	Calcula 2.594 112.85 42.05 el of Acety analysis arcing in	ylene (C ₂ H ₂) 4 of oil samp n oil or paj	Err 36.0 744 500 0.7 p oled per	opm was observed which indicated at a very high
Tap Position12 HV/IV HV/LV IV/LV Observations		Ratio Measure 1.906 13.362 7.002	d High leve in DGA towards temperatu	Calcula 2.594 112.85 42.05 el of Acety analysis arcing in are.	ylene (C ₂ H ₂) 4 of oil samp n oil or paj	Err 36.0 744 500 0.7 p oled per	opm was observed which indicated at a very high

	Transco Liu. (DTL)				
А.	Name of Substation	:	Tikrikalan		
В.	Utility/Owner of substation	:	DTL		
С.	Faulty Equipment	:	Auto transformer		
D.	Rating	:	315 MVA, 3 Phase, 400/220/33 kV		
Е.	Make	:	ЕМСО		
F.	Sr. No.	:	HT- 1798/13001		
G.	Year of manufacturing	:	2009		
Н.	Year of commissioning	:	31.03.2011		
I.	Date and time of	:	13.11.2021 at 19:15 hrs		
	occurrence/discovery of				
	fault				
J.	Information received in CEA	:	25.11.2021		
Κ.	Fault discovered during	:	Operation		
L.	Present condition of	:	May be Repairable		
	equipment				
М.	Details of previous	:			
	maintenance				
prob mon test,	blem was discussed in Transfo itoring of DGA was done. Othe Winding Resistance test, Insula	ormen er tra ation	r Expert Committee of DTL and thereafter, regular nsformer test conducted on LV side like Voltage ratio Resistance test, Tan delta of winding and bushing test		
and	SFRA were found to be genera	lly ir	n order.		
N.	Details of previous failure	:	No previous failure		
О.	Sequence of events/ Description of failure	:			
315MVA EMCO make 400/220/33kV ICT 4 Auto Transformer S.No. HT- 1798/13001tripped on Differential, REF, Buchholz, PRV, 86A, 86B relays along with 220kV incomer no.4 showing indication 86A & 86B in the transformer on the date 13.11.2021 on 19.15 Hrs.Nitrogen Injection Fire Protection System (NIFPS) operated therefore no fire caught insidethe ICT-4 and oil drain from main tank to NIFPS connected tank. At the time of tripping, allthe three 315 MVA 400/220/33kV ICTs (ICT 1, ICT 3 and ICT-4) were running in parallelwith load of 90 MW each.P.Details of Tests done after:failure					
Afte	er tripping of 315MVA ICT 4 t	ranst	former on 13.11.2021, the following testing has been		
carri	ied out at Tap 9b, i.e. normal ta	p as	at the time of tripping:		

19. Failure of 315 MVA Auto transformer at 400/220/33 kV Tikrikalan Substation of Delhi Transco Ltd. (DTL)

1. Magnetic Balance check result: -



	HV			IV		
Rn	240.3 V	133.4 V	18.74 V	237.0 V	127 V	12.55 V
Yn	225 V	240.4 V	225.7 V	228.7 V	238.3 V	229.3 V
Bn	19.9 V	122 V	241 V	11.73 V	112.4 V	237.5 V
Ι	2.60mA	2.03mA	2.67mA	5.79mA	4.43mA	6.05mA

	LV		
RY	240 V	236.9 V	235.6 V
YB	111 V	238.9 V	19.92 V
BR	128.9 V	19.32 V	238.7 V
Ι	29.9mA	46.3mA	42mA

2. Voltage Ratio (3 Phase supply applied on HV side):

Phase Group	HV(Applied)	IV(measured)	LV(measured)
R1N/R2N/R3Y3	238.8	131.4	34.1
Y1N/Y2N/Y3B3	240.2	131.7	34.08
B1N/B2N/B3R3	237.0	130.8	34.20

3. Winding resistance was measured in $m\Omega$ and results are as under:

R1R2	Y1Y2	B1B2	R2N	Y2N	B2N	R3Y3	Y3B3	B3R3
279.9	318.4	279.2	348.8	348.8	348.8	16.1	15.9	15.7

Q. Observations

:

After Internal Inspection on the date 18.11.2021 of 315MVA 400/220/33kV ICT4 EMCO 2009 Make, S.No. HT1 798/13001, following are the observations:

- 1. It is observed that R phase 220kV side Tap winding leads found Burnt.
- 2. HV side, IV side, selector of OLTC and other parts of the transformer were checked thoroughly and no other visible damage could be seen.
- 3. Winding resistance results are showing higher resistance for Y Phase winding since Jan 2020. The winding resistance of Y phase winding is approx. 40 milli ohm higher than the R and B phase winding as noted from Jan 2020.

R. Probable cause of failure :				
	R.	Probable cause of failure	:	



- i. Operation of Differential relay along with operation of Buchholz & PRV relays indicates fault inside the transformer.
- ii. High energy arcing due to fault inside the transformer tank might have led to sudden pressure rise in tank and tripping of Buchholz & PRV.
- iii. Acetylene gas formation suggests sparking; the appropriate course for DTL should have been to get the transformer checked thoroughly in time and to found out the root cause of acetylene formation.

After Internal Inspection, it was suggested that the transformer is not repairable at site and if at all DTL intends to get this transformer repaired, then all the three winding limbs may be required to be considered for replacement.

А.	Name of Substation	:	220 kV Nagewadi
B.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	ICT
D.	Rating	••	220/132 kV, 100 MVA, 3-Phase
E.	Make	••	Vijay Electricals
F.	Sr. No.	:	90075B06
G.	Year of manufacturing	:	2011
H.	Year of commissioning	••	The said ICT was supplied against 220 kV
			Krishnoor substation & was lying idle for
			approximately 5 to 6 years.
			Commissioned at Nagewadi substation on
			17.09.2018.
			(Storage condition not provided)
7	Date and time of	:	10.06.2019 @ 21:59
	occurrence/discovery of		23.06.2019 @14:47
	fault		09.08.2019 @ 12:15
I.	Information received in	:	22.02.2022
	CEA		
J.	Fault discovered during	:	Operation
К.	Present condition of	:	Needs Repair
	equipment		
L.	Details of previous	:	Pre-monsoon maintenance carried out on dated
	maintenance		27.05.2019. No abnormality observed in these tests.
М.	Details of previous failure	:	NA
Ν.	Sequence of events/	:	1. Y- Phase Differential relay operated.
	Description of failure		2. Master trip relay 86
О.	Details of Tests done after	:	Open circuit & Short circuit test, Magnetic Imbalance
	failure		Test, Winding Tan Delta Test, Winding Resistance
			Test, Excitation Test, Partial Discharge Test

20. Failure of 100 MVA, 220/132 kV, 3-Ph ICT at 220 kV Nagewadi substation of MSETCL



Р.	Observations	:	After tripping on 10.06.2019, LV testing results had not shown any predictable abnormalities. So, trial was taken to charge the transformer on 11.06.2019 but it tripped again. Transformer again charged from 132 kV side and stood ok. It again tripped on 23.06.2019 on Y- phase differential protection. Joint inspection was carried by M/s Toshiba (erstwhile Vijay). No abnormality found on internal inspection and transformer was charged. It again tripped on 09.08.2019 on Y Phase differential protection. M/s Jain Electricals Aurangabad did internal inspection but no abnormality was found at site apart from zero IR value between frame & tank and increase in DGA values after every tripping.
Q.	Probable cause of failure	:	Even after various tests and internal inspections the exact cause of tripping could not be found. Since, every time Y-phase differential protection has operated, it seems there is some incipient fault in the Y-phase winding which cannot be detected at site. Further, the transformer was lying idle for approximately 5 to 6 years and information about how the transformer was stored during that time is not known. The transformer needs to be inspected in detail at the works.

21. Failure of 50	MVA,	220/33	kV, Power	Transformer	at 2	220 kV	Partur	substation	of
MSETCL									

А.	Name of Substation	:	220 kV Partur Substation
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	Power Transformer
D.	Rating	:	50 MVA, 220/33 kV
Е.	Make	:	Areva
F.	Sr. No.	:	B30118
G.	Year of manufacturing	:	2007
Н.	Year of commissioning	:	Earlier transformer was commissioned at 220 kV
			Jalna Substation on 12.01.2008 & was in service till
			22.02.2018.
			The transformer was removed in augmentation &
			then shifted to Partur on 19.05.2019.
7	Date and time of	:	06.10.2019 at 11:35 Hrs
	occurrence/discovery of		
	fault		
I.	Information received in	:	22.02.2022
T	CEA		
J.	Fault discovered during	:	Operation
K.	Present condition of	:	Transformer repaired
T	equipment		
L.	Details of previous	:	Pre-monsoon maintenance carried out on
	mointononoo		7/05/019 No abnormality was observed
	maintenance		27.00.2019.110 donomianty was observed.
	maintenance		
М.	Details of previous failure	:	NIL
M. N.	Details of previous failure Sequence of events/	:	NIL 1. Main Buchholz alarm window indication
<u>M.</u> N.	Details of previous failure Sequence of events/ Description of failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated
M. N.	Details of previous failure Sequence of events/ Description of failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated
M. N. O.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test
<u>M.</u> N. O.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test
<u>M.</u> N.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test
M. N. O.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV)
M. N. O.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test
M. N. O.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test 6. PT Test 7. Winding Ten Delte Test
M. N. O.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test 6. PT Test 7. Winding Tan Delta Test
M. N. O.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test 6. PT Test 7. Winding Tan Delta Test 8. Gas Flame Test
<u>М.</u> N. О.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	······································	 NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test 6. PT Test 7. Winding Tan Delta Test 8. Gas Flame Test Substation staff informed that some sound was heard in the word at the time of fault. Some sound was heard
<u>М.</u> N. О.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	 NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test 6. PT Test 7. Winding Tan Delta Test 8. Gas Flame Test Substation staff informed that some sound was heard in the yard at the time of fault. Some sparking signs are soon on T/f earth nit During viewel increasion D where
<u>М.</u> N. О.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	 NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test 6. PT Test 7. Winding Tan Delta Test 8. Gas Flame Test Substation staff informed that some sound was heard in the yard at the time of fault. Some sparking signs are seen on T/f earth pit. During visual inspection, B-phase winding was found to be out of share due to be set of set
<u>М.</u> N. О.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	·· · ·	 NIL 1. Main Buchholz alarm window indication 2. Directional relay B-Phase winding operated 3. 86 Master Trip relay operated 1. Excitation Current Test 2. Open circuit Test 3. Short circuit Test 4. Magnetic Balance Test(HV-LV) 5. Winding Resistance Test 6. PT Test 7. Winding Tan Delta Test 8. Gas Flame Test Substation staff informed that some sound was heard in the yard at the time of fault. Some sparking signs are seen on T/f earth pit. During visual inspection, B-phase winding was found to be out of shape due to mechanical force.



			supporting of B phase winding are disturbed/dislocated. Copper globules are seen near B-phase winding. As per DR data, fault current of 5300 A on T/f LV side was recorded.
Q.	Probable cause of failure	:	Test results of excitation current, magnetic balance and short circuit test found abnormality. The transformer had tripped 8 times on differential protection due to failure of LV cable while it was commissioned in Jalan S/s. Due to these faults and resulting mechanical forces, the winding support/packing might have weakened. In the present case, it appears from the data that B- Phase winding had internal fault.

A.	Name of Substation	:	220 kV old GCR Parli-V
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	ICT
D.	Rating	:	100 MVA, 220/132 kV, 3-Ph
E.	Make	:	EMCO
F.	Sr. No.	:	HT/1286/11437
G.	Year of manufacturing	:	1994
Н.	Year of commissioning	:	1994
7	Date and time of	:	24.03.2020 at 20:40 Hrs
	occurrence/discovery of fault		
I.	Information received in CEA	:	22.02.2022
J.	Fault discovered during	:	Operation
K.	Present condition of equipment	:	Beyond repair
L.	Details of previous maintenance	:	Tan Delta test was done. Results were satisfactory.
М.	Details of previous failure	:	NA
N.	Sequence of events/	:	1. Differential protection
	Description of failure		2. Buchholz Alarm
			3. Buchholz trip
			4. OTI Trip
			5. WTI Trip
О.	Details of Tests done after	:	Test could not be done as ICT got completely burnt.
	failure		
Р.	Observations	:	Transformer got completely burnt with damage to
			nearby equipment.
Q.	Probable cause of failure	:	Since the transformer got burnt, no test could be
			conducted after failure. Sufficient information is not
			available to arrive at any conclusion. However, it
			appears that internal fault might have taken place due
			to ageing effect.

22. Failure of 100 MVA, 220/132 kV, ICT at 220 kV old GCR Parli-V substation of MSETCL

A.	Nam	e of Substa	ation		:	220 kV Um	red				
B.	Utilit	v/Owner c	of substatio	n	:	MSETCL					
C.	Fault	y Equipme	ent		:	Power Tran	sformer				
D.	Ratin	<u>g</u>			:	25 MVA, 22	20/33 kV				
E.	Make	<u>e</u>			:	Bharat Bijle	e				
F.	Sr. N	0.			:	4921/1					
G.	Year	of manufa	cturing		:	2006					
H.	Year	of commis	ssioning		:	2007					
7	Date occur fault	and rrence/disc	time covery	of of	:	04.04.2020	at 17:45 H	rs			
I.	Infor CEA	mation 1	received	in	:	22.02.2022					
J.	Fault	discovere	d during		:	Operation					
K.	Prese equip	ent com ment	ndition	of	:	Sent for rep Services Pv	air to M/s t. Ltd.	Vishwas P	ower Engi	neering	
L. Details of previous maintenance				us	:	Diagnostic tests were carried on 30.10.2019 LV-HV Cap: 3198 pf, Tan Delta: 0.233% LV-E Cap: 3774 pf, Tan Delta: 0.356% HV-E Cap:11020 pf, Tan Delta: 0.257% HV R Ph bushing cap: 316.3 pf, Tan Delta: 0.306% HV Y Ph bushing cap: 367.1 pf, Tan Delta: 0.219% HV R Ph bushing cap: 314.3 pf, Tan Delta: 0.28%					
М.	Detai	ls of previ	ous failure		:	NA					
N.	Sequence of events/ Description of failure			ts/	:	 Transformer tripped on differential protection Buchholz trip & alarm operated Y phase surge arrester of 33 kV Tas (Korgaon) feeder burst. 					
О.	Detai	ls of Tes	ts done af	fter	:	Open Circuit, short circuit, magnetic balance, SFRA,					
	failu	e				Winding res	istance, IR	Test.			
Ope	n Circ	uit Test (Гар 9b):								
3-Ph	suppl	y given to	HV and LV	V kej	pt op	en					
V_{RY}	= 382	$V V_{YB} = 1$	$388V V_{BR}$	= 38	84 V						
V _{RN}	=220	$V_{\rm YN} = 22$	$22V V_{BN} =$	= 223	8 V						
Sho	rt Circ	<u>uit Test (</u>	<u>Tap 9b):</u>								
Tap	o No.	HV Curre	ent (A)	T		T	LV Curre	nt (A)	т	T	
01		I_R	Ιγ 0.72	I _B	4	I _N	I _r	ly	Ib	I _n	
9b		0.83	0.73	0.8	4	0	5./1	5.37	5.78	0	

23. Failure of 25 MVA, 220/33 kV power Transformer at 220 kV Umred substation of MSETCL

Magnetic Balance Test (Tap 9b):

1-Ph supply given to HV of each phase & LV kept open								
Phase	HV Voltag	e		LV Voltage				
	V _{RN}	VYN	VBN	Vrn	Vyn	Vbn		
R	222.9	9.3	203	33.3	1.2	30.5		
Y	102.9	224.8	95	15.2	29.03	14.11		
В	207.1	8.87	226	31	1.13	33.8		

Winding Resistance Test: Ambient Temp. 30° C Oil Temp. 44° C

Tap No.	RN (Ω)	ΥΝ (Ω)	BN (Ω)	rn (mΩ)	yn (mΩ)	bn (mΩ)
9b	3.301	3.297	3.3	67.330	64.940	67.160

IR Test:

Voltage applied 5 kV

HV-LV	20.1 GΩ
HV-E	18.6 GΩ
LV-E	Voltage couldn't stand at 5 kV

SFRA Test carried and SFRA plots found abnormal.

P.	Probable cause of failure	:	Abnormality was found in IR test and SFRA.
			Transformer might have failed due to internal fault
			probably line to ground fault on LV side of Y-phase winding
			winding.

24	4. Failure of 25 MVA,	, 220/33 kV power	r Transformer	at 220 kV	Manjarsumba	substation of
	MSETCL	-			-	

A.	Name of Substation	:	220/33 kV Manjarsumba
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	Power Transformer
D.	Rating	:	220/33 kV, 25 MVA, 3-Ph
E.	Make	:	CGL
F.	Sr. No.	:	T8297/1
G.	Year of manufacturing	:	1991
Н.	Year of commissioning	:	Earlier commissioned at 220 kV Manjarsumba on 08.03.16 which failed on 02.06.17. Transformer was repaired & recommissioned after this failure on 19.11.17.
7	Date and time of occurrence/discovery of fault	:	15.10.2020 at 16:31 Hrs
I.	Information received in CEA	:	22.02.22
J.	Fault discovered during	:	Operation
K.	Present condition of equipment	:	Repairable
L.	Details of previous maintenance	:	Pre-monsoon maintenance work done on 29.04.2020. Tan Delta tests of bushing and windings taken on 05.02.2020 and found to be normal. Maintenance activities were carried out quarterly.
М.	Details of previous failure	:	Failure date: 02.06.17 B- Ph Differential protection operated, Buchholz trip, 86 operated Relay indication:- Group 86A and 86B tripped
N.	Sequence of events/ Description of failure	:	 15.10.2020 16:31 Hrs: 33 kV Manjarsumba feeder tripped on O/C Y phase and B phase. 16:31 Hrs: 25 MVA, 220/33 kV Transformer-II tripped on differential protection Y phase, Buchholz trip
O.	Details of Tests done after failure	:	Open Circuit, short circuit, magnetic balance, Tan Delta of bushing and winding, SFRA, Winding resistance, Polarization Index, DGA of oil, Stability test, Continuity for Star.

Ope	n Cir	cuit 7	[est (]	Гар	9b):	T T 1									
3-Ph	suppl	ly giv	en to	HV	and L	N kept	open								
V _{RY}	$V_{RY} = 432$ V $V_{YB} = 430$ V $V_{BR} = 427$ V														
V _{RN}	=249.	41 V	V _{YN}	= 24	8.26	$V V_{BN}$	= 246	52 \	\checkmark		1		1		
Tap	o No.	V_R	V_{YE}	3	V_{BR}	V_{RN}	VYI	N VBN		1	V _{ry}	V_{yb}	V _{br}	V_{rn}	V_{yn}
		Y													
9b		430	431	4	426	248.8	249		261	.1	64.1	64.4	64.3	37.2	37.2
Shor	rt Cir	cuit]	l'est (l	Гар	9b):										
Tap	o No.	HV	Curre	ent (A	A)					LV	Curren	t(A)			
		IR		Iy		IB	Ι	N		Ir		Iy	Ib		In
9b		1.07	7	0.1	2	1.14	1	.15		7.7	5	0.00	8.0	09	7.93
Mag HV s	gnetic side	Bala	nce T	est (Tap 9	9b):		T.		X 7		X7		T (A)	
Pha	ase	V	RN	VY	'N	V BN		Vı	'n	V ₃	yn	Vbn		I (MA)	
	oned	2	40	240	0	210.90		27	/ 1	26	6	2.0		0.75	
K			+9	240	0	219.89		3/	.1	27	0.0 7	2.9	,	0.75	
T D		1	20.3	250	07	121.3		19	7.08 5.6	37		18.32	2	0.47	
		Z	+.0	230	0.7	230.0		э.,	30	57	.2	37.4		0.78	
	side:	nlind	T	7			V				V 7.			I (m A)	
P II2	ase ap	pneu	. \	$\frac{7 \text{ rn}}{17.6}$			V yn 2186				V bn 22.6			<u>1 (MA)</u> 20 4	
			1	$\frac{47.0}{20.2}$	2		210.0	, 7			1116			20.4	
D			2	<u>50.5</u> 6.6)		240.7				247			$\frac{14.09}{21.51}$	
D			5	0.0			213.4	ł			247			21.31	
Р.	Obse	ervati	ons			:	LV bro son	Y ken newl	phas duc nere	e: V e to whic	Vooden o inter ch was r	blocks nal L ot visit	s foun V w ole.	nd distur rinding	bing and damaged
Q. Probable cause of failure				:	Sho cle Fau hac life wh anc ins cau	ort o arly alt c l ser . Ag ich ich l fau ulati	circu indicurrer ved f geing could alt cu on a displ	it te cates it da for 3 mig mig no rren and acen	est resu s the pr ta was 0 years ght have t withst t throug due to ment of	It and oblem not pro and wa weake and fau gh the the excess wooder	magn with wided as repa ened v ilt on ransfo ssive n bloc	etic bal Y-phase . The tra aired in i vinding i the 33 k ormer dan forces ks.	ance test winding. unsformer ts service nsulation CV feeder maged its generated		



REACTORS

25. Failure of 80 MVAR, 765 kV, 1-ph reactor at Bina substation of PGCIL

A.	Name of Substation	:	Bina
В.	Utility/Owner of substation	:	PGCIL
C.	Faulty Equipment	:	Line reactor
D.	Rating	:	80 MVAR, 765 kV, 1-ph
E.	Make	:	BTW
F.	Sr. No.	:	20122K09
G.	Year of manufacturing	:	Information not available
Н.	Year of commissioning	:	2014
I.	Date and time of	:	22.09.2019 at 1708 hrs
	occurrence/discovery of		
T	Information received in		07 00 2020
J.	CEA	•	07.09.2020
К.	Fault discovered during	:	
L.	Present condition of	:	Sent to vendor for detailed analysis
	equipment		
М.	Details of previous	:	Information not available
	maintenance		
N.	Details of previous failure	:	
О.	Sequence of events/	:	On 22.09.2019 at 1708 hrs, LR tripped with following
	Description of failure		indications:
	-		17:08:03 CB open
			17:08:04 REF operated
			17:08:05 Buchholz operated
			17:08:05 PRD operated
Р.	Details of Tests done after	:	i. DGA: C2H2- 597 ppm
	failure		ii. Winding tan delta increased with increase in test
			voltage from 2 kV to 10 kV
			iii. Magnetization current increased by 20.81%
			iv. Fall in PI value which has been recorded as 1.16
Q.	Observations and Probable	:	Operation of buchholz alarm and high concentration
	cause of failure		of acetylene gas indicates internal fault. However, the
			reason can be ascertained only after detailed
			inspection after disassembly of the windings and
			dismantling of the core respectively.



26. Failure of 16.67 MVAR, 400 kV Reactor of Agra substation of PGCIL

A.	Name of Substation	:	Agra
В.	Utility/Owner of substation	:	PGCIL
C.	Faulty Equipment	:	Line Reactor
D.	Rating	:	16.67 MVAR, 400 kV, 1-ph
E.	Make	:	CGL
F.	Sr. No.	:	24473
G.	Year of manufacturing	:	1984
H.	Year of commissioning	:	2019 (recommissioned at Agra)
I.	Date and time of occurrence/discovery of fault	:	31.05.19 at 2052 hrs
J.	Information received in CEA	:	07.09.2020
K.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not Repairable, scraped
M.	Details of previous maintenance	:	All maintenance tests done as per utility's norms. No abnormalities were observed.
N.	Details of previous failure	:	No previous failure
O.	Sequence of events/ Description of failure	:	On 31.05.19 at 2052 hrs, 16.67 MVAR, 400 kV, 1-ph line Reactor failed and caught fire while in operation. 20:52:56 CB close 20:52:59 Diff. and REF operated 20:52:59 86 A and B operated 20:52:59 PRD trip 20:52:59 CB open 20:52:59 Buchholz operated
Р.	Details of Tests done after failure	:	No tests could be conducted due to extensive damage
Q.	Observations and Probable cause of failure	:	The reactor failed with following protection operations: Differential, REF, PRD and Buchholz. Top cover got unbolted and the main tank was bulged at two places. HV bushing and lead were completely damaged. Heavy carbonization in oil and tank was observed upon inspection. The reactor has served



	nearly 35 years and the gradual deterioration in the quality due to ageing may have led to the failure
	quality due to ageing may have led to the failure.

۸	Name of Substation	•	100/220kV Nelamangala
A. D	Italic of Substation	•	400/220K V INclainaligata
В.	Utility/Owner of substation	:	KPICL Orange of December 100 CU
C	E 14 E		Owner of Reactor : PGCIL
C.	Faulty Equipment	:	
D.	Rating	:	50 MVAR, 400 kV, 3-ph
Е.	Make	:	CGL
F.	Sr. No.	:	T9049/1
G.	Year of manufacturing	:	Information not available
H.	Year of commissioning	:	2005
I.	Date and time of	:	29.05.2020 at 0031 hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	09.09.2020
	CEA		
К.	Fault discovered during	:	Operation
L.	Present condition of	:	Repairable
	equipment		1
M.	Details of previous	:	As per information submitted by PGCIL, all
	maintenance		maintenance activities were carried out as per their
			norms and results were within acceptable limits.
N.	Details of previous failure	:	NA
0.	Sequence of events/	:	On 29.05.2020 at 0031 hrs. LR tripped on:
	Description of failure	-	Differential Operated. Backup impedance Operated.
	1		Buchholz & PRD trip, OTI
Р.	Details of Tests done after	:	DGA testing of bottom sample. Magnetizing current.
	failure	-	Winding Resistance, IR and SFRA tests were carried
			out.
0.	Observations and Probable	:	As per utility report:
•	cause of failure	-	i. HV bushing was completely damaged
			ii Bulging of tank resulted into oil leakage from
			tank
			iii. Reactor MB was completely burnt
			iv LA & CT was also damaged
			Based on the limited information provided by the
			utility the probable cause of the failure of this reactor
			may be attributed to the failure of HV bushing
			may be attributed to the failure of HV bushing.

27. Failure of 50 MVAR, 420 kV of line reactor at Nelamangala substation of KPTCL (PGCIL)

20.10	mare of 50 mi (mar, 120 k) of		reactor at Danpara substation of r Gerl
А.	Name of Substation	:	400/220kV Balipara
B.	Utility/Owner of substation	:	PGCIL
С.	Faulty Equipment	:	Line reactor
D.	Rating	:	50 MVAR, 420 kV, 3-ph
E.	Make	:	BHEL
F.	Sr. No.	••	6005364
G.	Year of manufacturing	•••	1995
Н.	Year of commissioning	:	2000
I.	Date and time of occurrence/discovery of fault	:	23.05.2020 at 1014 hrs
J.	Information received in CEA	:	09.09.2020
К.	Fault discovered during	•••	Operation
L.	Present condition of equipment	:	Not Repairable
М.	Details of previous maintenance	:	Gasket replacement work carried out in Jan 2020.
N.	Details of previous failure	:	NA
О.	Sequence of events/	:	On 23.05.2020 at 1014 hrs, LR tripped on:
	Description of failure		Buchholz & PRD Operated
Р.	Details of Tests done after failure	:	DGA testing of main tank oil, Capacitance & Tan delta testing of winding & Bushing Magnetizing current
	Tullulo		Winding Resistance and SFRA tests were carried out.
Q.	Observations and Probable cause of failure	:	 As per utility report: i. Burning marks on lead guide tube near Y-phase bushing ii. Y-phase lead takes off and snout found burnt iii. Outer layer turns of winding found burnt Based on the limited information provided by the utility, the probable cause of the failure of this reactor may be attributed to winding failure

28. Failure of 50 MVAR, 420 kV of line reactor at Balipara substation of PGCIL

-/- 1 (inuic of 05 101 0 min, 400 K 0 0		reactor at Gajuwaka substation of 1 GC11
А.	Name of Substation	:	400/220kV Gajuwaka (Vizag)
B.	Utility/Owner of substation	:	PGCIL
С.	Faulty Equipment	:	Reactor
D.	Rating	:	63 MVAR, 400 kV, 3-ph
E.	Make	:	BHEL
F.	Sr. No.	:	6005069
G.	Year of manufacturing	:	NA
H.	Year of commissioning	:	1991
I.	Date and time of occurrence/discovery of fault	:	03.09.2020 at 0434 hrs
J.	Information received in CEA	:	24.02.2021
К.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not Repairable
М.	Details of previous maintenance	:	As informed by the utility, all maintenance activities carried out as per their norms and results were within acceptable limits.
N.	Details of previous failure	:	NA
О.	Sequence of events/ Description of failure	:	On 03.09.2020 at 0434 hrs, Reactor tripped on: REF, Differential, Buchholz & PRD
Р.	Details of Tests done after failure	:	DGA results indicate H2 value of 3977ppm & C2H2 value of 2100ppm.
			Magnetizing current & Winding Resistance results indicate damage in R-ph winding.
Q.	Observations and Probable cause of failure	:	 As per utility report: i. R-Ph & Y-Ph bushings were damaged ii. Cracks observed over Y-Ph bushing flange iii. Carbon deposition found below expansion chamber iv. Cracks & bulging in main tank body was observed
			Results of winding resistance and very high value of acetylene indicate arcing due to inter-turn fault in the R-phase winding. The reactor had served for around 30 years. Ageing could be the cause of deterioration of insulation which led to inter-turn fault.

29. Failure of 63 MVAR, 400 kV of line reactor at Gajuwaka substation of PGCIL



equipment Details

of

M.

	Aurangabad Substation of PGCIL					
А.	Name of Substation	:	765/400 kV Aurangabad Substation			
В.	Utility/Owner of substation	:	PGCIL			
C.	Faulty Equipment	:	Reactor			
D.	Rating	:	765 kV, 80 MVAr, Single phase			
E.	Make	:	CGL			
F.	Sr. No.	:	BH10223/07			
G.	Year of manufacturing	:	2014			
Н.	Year of commissioning	:	2014			
I.	Date and time of	:	03.04.2021 at 07:24 Hrs			
	occurrence/discovery of					
	fault					
J.	Information received in CEA	:	14.06.2021			
Κ.	Fault discovered during	:	Operation			
L.	Present condition of	:	Reactor can be repaired at factory			

All maintenance activities carried out as per

30. Failure of 80 MVAr, 765 kV, Wardha-2 Line reactor R-phase unit at 765/400 kV Aurangabad Substation of PGCIL

	maintenance		POWERGRID norms and results were within acceptable limits
N.	Details of previous failure	••	NA
0.	Sequence of events/ Description of failure	:	REF, Differential & Buchholz relay operated at 07:24 Hrs.
Р.	Details of Tests done after failure	:	DGA indicates high level of all fault gases. SFRA indicates significant damages to winding
Q.	Observations	:	Main tank has bulged and HV & neutral bushings were damaged.
R.	Probable cause of failure	:	Flashover between HV lead exit and neutral lead coming from top

:

previous

A.	Name of Substation	:	Jhakri
B.	Utility/Owner of substation	:	SJVN
C.	Faulty Equipment	:	Reactor
D.	Rating	:	3-ph, 80 MVAR, 400 kV
E.	Make	:	BHEL
F.	Sr. No.	:	6007310
G.	Year of manufacturing	:	2013
H.	Year of commissioning	:	2019 (22.04.19)
I.	Date and time of	:	17.10.19 at 1258 hrs
	occurrence/discovery of		
	fault		
J.	Information received in CEA	:	02.12.19
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Based on the utility's report, Matter was pending
	equipment		with OEM
М.	Details of previous	:	During last maintenance following tests was
	maintenance		conducted (date unavailable)
			i. Dehydration of oil done
			ii. Air released from all vents
			iii. BDV test
			iv. DGA test
			No abnormality was observed
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 17.10.19 at 1258 hrs, LG fault occurred in B
	Description of failure		phase with following protection operations:
			Bus bar Protection-I
			• PRV
_			Buccholz relay
Р.	Details of Tests done after	:	i. BDV test
	failure		ii. DGA test
			iii. Core insulation
			iv. IR of winding
	<u></u>		
Q.	Observations	:	Following observations were provided by the field
			personnel:
			1. Tank was bulged
			11. All 3-pn busnings (OIP) of HV side were
			111. Oll leakage
			iv. Neutral bushing and its turret was also

31. Failure of 80 MVAR, 400 kV of line reactor at Jhakri substation of SJVNL



			 v. On internal inspection, B-ph winding was damaged. Carbon deposition on other two windings as well vi. No change in surge counter reading after failure The reactor was in storage from 11.03.2014 to 22.01.2019: N2 filled: 11.03.14 to 24.11.18; Oil filled: 25.11.18 to 22.01.19; and was kept uncharged for clearance purposed from 23.01.09 to 22.04.19.
R.	Probable cause of failure	:	OEM during its inspection found all three phase bushings at HV side totally damaged while neutral bushing and its turret was damaged. B-ph winding was also entirely damaged which makes it the source of fault. Due to the internal flashover, small carbon particles may also have been deposited in R and Y phase insulation and caused bulges in the tank at various locations. Previous BDV shows no abnormality. As per OEM's report, the flashover might have been due to grid network condition.

52.17	$\frac{1}{1000} = \frac{1}{1000} = 1$		
A.	Name of Substation	:	400/220kV Nelamangala
B.	Utility/Owner of substation	:	KPTCL
С.	Faulty Equipment	:	Line reactor
D.	Rating	:	50 MVAR, 400 kV, 3-ph
E.	Make	:	CGL
F.	Sr. No.	:	T8716/2
G.	Year of manufacturing	:	2000
H.	Year of commissioning	:	2003
I.	Dateandtimeofoccurrence/discoveryoffault	:	09.06.2020 at 0553 hrs
J.	Information received in CEA	:	04.08.2020
K.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Faulty
М.	Details of previous maintenance	:	 After replacing the faulty 400kV Bushings of all the 3 phases, the following tests have been conducted: Capacitance and tan delta tests on bushings and winding Winding Resistance Magnetizing current Insulation Diagnostics Oil DGA and BDV Turret CTs, Knee point voltage, polarity and ratio tests.
N.	Details of previous failure	:	 i. On 27.05.2017 at 22:13 hrs, Reactor tripped on fault due to failure of 400kV R-ph Bushing which was replaced on 15.06.2017. ii. On 23.09.2018 at 16:27 hrs, Reactor tripped on fault due to failure of 400kV B-ph Bushing which was replaced on 23.01.2019. iii. On 23.01.2019 at 14:28 hrs, Reactor tripped due to failure of 400kV, Y-ph Bushing which was replaced on 08.06.2020.
0.	Sequence of events/ Description of failure	:	On 09.06.2020 at 05:53 hrs, the reactor tripped on fault with Differential, Backup impedance, REF, PRV 1&2,

32. Failure of 50 MVAR, 420 kV of line reactor at Nelamangala substation of KPTCL



			Buchholz and WTI trip relays followed with oil spilling from bell tank gasket.
			NIFPES system installed, has drained 10% of reactor oil to the sump.
Р.	Details of Tests done after failure	:	Magnetizing current and Winding Resistance tests were conducted on 10.06.2020.
Q.	Observations and Probable cause of failure	:	OEM during its inspection found problem in Y-ph winding.

А.	Name of Substation		400 kV Kharghar
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	••	Bus reactor
D.	Rating	:	80 MVAr, 400 kV, 3-Phase
E.	Make	:	BHEL
F.	Sr. No.	:	6006584
G.	Year of manufacturing	:	2008
H.	Year of commissioning	:	2009
I.	Date and time of	:	04.06.2020 at 13:10 Hrs
	occurrence/discovery of		
	fault		
J.	Information received in CEA	:	21.01.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Beyond repair
	equipment		
М.	Details of previous	:	i) Last relay testing on 11.02.2020
	maintenance		ii) PI & Bushing Tan Delta on 06.01.2022
			iii) Winding Tan Delta & Excitation on
			27.12.2018
N.	Details of previous failure	:	NA
О.	Sequence of events/	:	It was observed that there was heavy rain on
	Description of failure		03.06.2020. Reactor was taken into service on
			04.06.2020. After charging of said Reactor, it
			tripped on differential protection and caught fire and
			burnt at 13:10Hrs. REF and bucholz alarm also
_			operated.
Р.	Details of Tests done after	:	It was not possible to conduct test after failure as
	tailure		Reactor was badly damage and tank bulged.
Q.	Observations	:	Reactor caught fire. Y-phase Bushings failed and
			burst. Reactor tank bulged.
R.	Probable cause of failure	:	Sufficient information is not available.

33. Failure of 80 MVAR, 400 kV, 3- Phase Bus reactor at 400 kV Kharghar substation



CURRENT TRANSFORMERS

34. Failure of 400 kV Current Transformer at Jammalamadugu substation of APTRANSCO

А.	Name of Substation	:	Jammalamadugu					
В.	Utility/Owner of substation	:	APTRANSCO					
С.	Faulty Equipment	:	B-ph CT					
D.	Rating	:	400 kV, 3000-2000-500/1-1-1-1 A					
E.	Make	••	SCT					
F.	Sr. No.		54159					
G.	Year of manufacturing	:	2015					
Η.	Year of commissioning	:	2016 (29.06.2016)					
I.	Date and time of	:	05.07.2020 at 1745 hrs					
	occurrence/discovery of							
	fault							
J.	Information received in	:	19.08.2020					
	CEA							
К.	Fault discovered during	:	Operation					
L.	Present condition of	:	Information not available					
	equipment							
М.	Details of previous	:	Information not available					
	maintenance							
Ν.	Details of previous failure	:	Information not available					
О.	Sequence of events/	:	Secondary terminals of CT are burned due to					
	Description of failure		internal fault.					
Р.	Details of Tests done after	:	Information not available					
	failure							
Q.	Observations and Probable	:	As per the information submitted by the utility, the					
	cause of failure		CT's live tank blasted towards P1 side					
			simultaneously by catching fire due to internal fault.					



Α.	Name of Substation	:	Pulivendula
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	СТ
D.	Rating	:	220 kV, 800-600-400/1-1-1,0.5-1,0.5-1A
E.	Make	:	AREVA
F.	Sr. No.		200808153
G.	Year of manufacturing	•••	2008
Η.	Year of commissioning	:	2009 (19.11.2009)
I.	Date and time of	:	25.06.2020 at 1132 hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	16.09.19
	CEA		
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Information not available
	equipment		
М.	Details of previous	:	Information not available
	maintenance		
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	Information not available
	Description of failure		
Р.	Details of Tests done after	:	Information not available
	failure		
Q.	Observations and Probable	:	Based on the information provided by the utility, CT
	cause of failure		blasted due to internal fault.

35. Failure of 220 kV Current Transformer at Pulivendula substation of APTRANSCO



A.	Name of Substation	:	Visakhapatnam					
В.	Utility/Owner of substation	••	APTRANSCO					
C.	Faulty Equipment	:	Rph CT of 220kV Bus coupler tow	ards Bus-II				
D.	Rating	••	220 kV, 1600-800/1-1-2-2-1 A					
E.	Make	:	BHEL					
F.	Sr. No.	:	2241267					
G.	Year of manufacturing	:	2003					
Н.	Year of commissioning	:	2017 (25.03.2017)					
I.	Date and time of occurrence/discovery of fault	:	30.07.2020 at 1100 hrs					
J.	Information received in CEA	•	16.10.2020					
Κ.	Fault discovered during	:	Operation					
L.	Present condition of equipment	:	Information not available					
M.	Details of previous maintenance	:	Raising trend is observed in tan detesting. The details of tan delta valR-Ph of 220kV Bus-II CT are as forS.Test done on dateNo.Tan delta value (%)1.24.07.20170.000972.15.09.20191.9773.23.06.20202.941	elta values during lues measured on ollows: Capacitance (in pF) 803 813.34 810.75				
N.	Details of previous failure	:	nformation not available					
О.	Sequence of events/ Description of failure	:	Information not available					
Р.	Details of Tests done after failure	:	nformation not available					
Q.	Observations and Probable cause of failure	:	Based on utility's information, the of high tan delta values due to nsulation resistance.	CTs had a trend deterioration of				

36. Failure of 220 kV Current Transformer at Visakhapatnam substation of APTRANSCO



J7. Famile of 220 KV Current Fransformer at Numma substation of AT FRANSCO	37.	Failure of 2	220 kV (Current '	Transformer	at Nunna	substation	of Al	PTRAN	NSC	D
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Α.	Name of Substation	:	Nunna
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	HV side B-ph CT of 100 MVA Power Transformer-
			I
D.	Rating	:	220 kV, 500-300/1A
Е.	Make	:	SCT
F.	Sr. No.	:	2011/409R
G.	Year of manufacturing	:	2011
Н.	Year of commissioning	:	2011
I.	Date and time of	:	16.06.19 at 0616 hrs
	occurrence/discovery of		
	fault		
J.	Information received in	:	30.09.19
	CEA		
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Not reparable
	equipment		
М.	Details of previous	:	Information not available.
	maintenance		Details of test results before failure not provided.
N.		1	No marriana failuna
	Details of previous failure	:	No previous failure
О.	Details of previous failure Sequence of events/	:	On 16.06.19 at 0616 hrs , 220 kV CT in B-ph HV
О.	Details of previous failure Sequence of events/ Description of failure	:	On 16.06.19 at 0616 hrs , 220 kV CT in B-ph HV side of 100 MVA PTR-I blasted and caught fire. Oil
О.	Details of previous failure Sequence of events/ Description of failure	:	On 16.06.19 at 0616 hrs , 220 kV CT in B-ph HV side of 100 MVA PTR-I blasted and caught fire. Oil gushed out
О. Р.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after	:	On 16.06.19 at 0616 hrs , 220 kV CT in B-ph HV side of 100 MVA PTR-I blasted and caught fire. Oil gushed out No tests could be conducted as the damage was
О. Р.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure	:	On 16.06.19 at 0616 hrs , 220 kV CT in B-ph HV side of 100 MVA PTR-I blasted and caught fire. Oil gushed out No tests could be conducted as the damage was extensive
O. P. Q.	Details of previous failure Sequence of events/ Description of failure Details of Tests done after failure Observations and Probable	:	On 16.06.19 at 0616 hrs , 220 kV CT in B-ph HV side of 100 MVA PTR-I blasted and caught fire. Oil gushed out No tests could be conducted as the damage was extensive Based on the information provided by the utility, it



38. Failure of 220 kV B-ph Current Transformer at Kada	aperi substation of TANTRANSCO
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А.	Name of Substation	:	Kadaperi
В.	Utility/Owner of substation	:	TANTRANSCO
C.	Faulty Equipment	:	B-ph CT of Alandur feeder
D.	Rating	:	230 kV
E.	Make	:	SCT Ltd.
F.	Sr. No.	:	251/2012(B-ph CT of Alandur feeder)
G.	Year of manufacturing	:	Information not available
H.	Year of commissioning	:	2015(B-ph CT of Alandur feeder)
I.	Date and time of	:	29.03.2020 at 0403 hrs.
	occurrence/discovery of fault		
J.	Information received in CEA	:	27.07.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	CT replaced
	equipment		
M.	Details of previous	:	Regular monthly maintenance (cleaning, visual
	maintenance		check) was done. Annual relay test conducted on
			Alandur feeder in December 2019 and SPD feeder in
			June 2019. Quarterly maintenance of all feeders also
			conducted.
N.	Details of previous failure	:	Information not available
О.	Sequence of events/	:	On 29.03.2020 at 0403 hrs., loud explosive noise was
	Description of failure		observed and 230 kV busbar main zone and check
			zone operated. Busbar protection relay acted in all
			230 kV feeders at the substation. Following relay
			indication were observed:
			<u>Alandur end</u> :
			Main I: No indication
			Main II: R-ph trip, Y-ph trip, earth fault, Zone II
			separated, $I_b=15.09$ kA, fault duration 462.2 msec,
			Fault location= 13.25 km
			On yard inspection, it was found that the B-ph CT of
			Alandur feeder had exploded with oil splashed out
			and had caught fire.
Р.	Details of Tests done after	:	High tan delta values observed
	failure		
Q.	Observations and Probable	:	Based on utility's information, the CTs had a trend of
	cause of failure		high tan delta values. However, in the absence of
			maintenance test values the CTs, it is difficult to
			ascertain the cause of failure. As reported, frequent
			failure of CTs of this make have happened in



	TANTRANSCO, the failed CT may be sent to OEM to identify any defect, if present, so that any required
	corrective measure may be taken in other equipment of the same make.



39.	Failure	of 220 kV	Y-ph	Current	Transfo	ormer at	Kadaper	i substation	of TANTR	ANSCO
			-						-	

Α.	Name of Substation	:	Kadaperi
В.	Utility/Owner of substation	:	TANTRANSCO
С.	Faulty Equipment	:	Y-ph CT of Alandur feeder
D.	Rating	:	230 kV
E.	Make	:	SCT Ltd.
F.	Sr. No.	:	253/2012(Y-ph CT of Alandur feeder)
G.	Year of manufacturing	:	Information not available
H.	Year of commissioning	:	2015(Y-ph CT of Alandur feeder)
I.	Date and time of	:	29.03.2020 at 0403 hrs.
	occurrence/discovery of fault		
J.	Information received in CEA	:	27.07.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	CT replaced
	equipment		
М.	Details of previous	:	Regular monthly maintenance (cleaning, visual
	maintenance		check) was done. Annual relay test conducted on
			Alandur feeder in December 2019 and SPD feeder in
			June 2019. Quarterly maintenance of all feeders also
			conducted.
N.	Details of previous failure	:	Information not available
О.	Sequence of events/	:	On yard inspection, it was found that the B-ph of
	Description of failure		Alandur feeder had exploded with oil splashed out
			and had caught fire. The adjacent CT, in Y-ph
			Alandur feeder had been damaged due to flying
			debris from the explosion in B-ph Alandur feeder.
P.	Details of Tests done after	:	No tests could be conducted due to extensive damage
	failure		
Q.	Observations and Probable	:	Based on utility's information, the Y-ph CT of
	cause of failure		Alandur feeder had been damaged due to flying
			debris from the explosion in B-ph CT of Alandur
			feeder.

A.	Name of Substation	:	Kadaperi
В.	Utility/Owner of substation	:	TANTRANSCO
С.	Faulty Equipment	:	R-ph CT of Sriperumpudur feeder
D.	Rating	:	230 kV
E.	Make	:	SCT Ltd.
F.	Sr. No.	:	765/2013(R-ph CT of Sriperumpudur feeder)
G.	Year of manufacturing	:	Information not available
H.	Year of commissioning	:	2014(R-ph CT of Sriperumpudur feeder)
I.	Date and time of occurrence/discovery of fault	:	29.03.2020 at 0403 hrs.
J.	Information received in CEA	:	27.07.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	CT replaced
	equipment		
M.	Details of previous maintenance	:	Regular monthly maintenance (cleaning, visual check) was done. Annual relay test conducted on Alandur feeder in December 2019 and SPD feeder in June 2019. Quarterly maintenance of all feeders also conducted.
N.	Details of previous failure	:	Information not available
О.	Sequence of events/ Description of failure	:	On yard inspection, it was found that the B-ph of Alandur feeder had exploded with oil splashed out and had caught fire. The adjacent CT, in R-ph Sriperumpudur feeder had been damaged due to flying debris from the explosion in B-ph Alandur feeder.
Р.	Details of Tests done after failure	:	No tests could be conducted due to extensive damage
Q.	Observations and Probable cause of failure	:	Based on utility's information, the in R-ph CT of Sriperumpudur feeder had been damaged due to flying debris from the explosion in B-ph CT of Alandur feeder.

40. Failure of 220 kV R-ph Current Transformer at Kadaperi substation of TANTRANSCO



A.	Name of Substation	:	Edappon
В.	Utility/Owner of substation	:	KSEB Ltd.
С.	Faulty Equipment	:	CT of 220 kV bus coupler
D.	Rating	:	220 kV, 40 kA,3 sec
E.	Make	:	TELK
F.	Sr. No.	:	230264-8
G.	Year of manufacturing	:	2001
Η.	Year of commissioning	:	2009
I.	Date and time of	:	03.03.2020, 0745 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.06.2020
Κ.	Fault discovered during	:	operation
L.	Present condition of	:	Not reparable
	equipment		
М.	Details of previous	:	a) Last Routine maintenance done on 04.12.2019.
	maintenance		b) PET testing conducted on 03.05.2018.
			c) No abnormality observed
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	At 0745 hrs on 03.03.2020, CT flashed along with
	Description of failure		tripping 2 EMEP, 2 KYEP, 220 kV bus coupler,
			IEPKY, IEPMV feeder.
			Following relay indications were observed:
			Directional O/C and E/F relay
			220 kV busbar protection: subrack zone 1U, subrack
			zone 2W, subrack check differential zone T
Р.	Details of Tests done after	:	No tests could be conducted as the damage was
	failure		extensive
Q.	Observations and Probable	:	Internal fault
	cause of failure		

41. Failure of 220 kV Current Transformer of Edappon substation of KSEB


Α.	Name of Substation	:	Orkatteri			
В.	Utility/Owner of substation	:	KSEB Ltd.	KSEB Ltd.		
С.	Faulty Equipment	:	B-Ph CT of 2	ORKH feede	er	
D.	Rating	:	220 kV, 800-400/1-1-1-1, 40 kA, 1sec			c
E.	Make	:	MEHRU			
F.	Sr. No.	:	OC 2183/3/2	/07		
G.	Year of manufacturing	:	2007			
Н.	Year of commissioning	:	2009 (06.01.2	2009)		
I.	Date and time of	:	03.09.2020, 2	2112 hrs		
	occurrence/discovery of fault					
J.	Information received in CEA	:	22.11.2020			
Κ.	Fault discovered during	:	Operation			
L.	Present condition of	:	Not repairabl	e		
	equipment					
M.	Details of previous	:	On 03.03.20	20, IR test	and Tan delt	ta tests were
	maintenance		carried out ar	nd the results	of which are	as follows:
			Phase	IR value (M	lohm)	Tan delta
				15 sec	60 sec	
			R	289000	396000	0.15
			Y	101000	208000	0.17
			В	9910	20700	0.92
			On 04.06.2	020, CT I	nsulators w	ere cleaned,
			connections t	ightened, oil	leak detected	was fixed.
				0		
N.	Details of previous failure	:	No previous	failure		
О.	Sequence of events/	:	On 03.09.202	20 at 21:12	hrs, B-Ph C	Г of 2ORKH
	Description of failure		feeder blasted	d with follow	ing indicatior	ı:
	_		Busbar protec	ction operate	d	
Р.	Details of Tests done after	:	No tests coul	d be conduct	ed as the CT	was damaged
	failure		physically			÷
<u>O.</u>	Observations and Probable	:	As deduced f	from the result	lts of IR test r	esults, the IR
×.	cause of failure	.	value of B-F	Ph was foun	d to be on l	ower side as
			compared to	the IR value	s of R-Ph& Y	-Ph. Further.
			the tan delta	value obtaine	d during the t	est was found
			to be on high	er side. There	efore, the prob	bable cause of

42. Failure of 220 kV B-Ph Current Transformer of Orkatteri substation of KSEB



	this failure may be attributed to deterioration of	f
	insulation resistance.	



	43. F	ailure of	220 kV Y	-Ph Curre	nt Transformer	of Orkatteri	substation	of KSEB
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Α.	Name of Substation	:	Orkatteri
В.	Utility/Owner of substation	:	KSEB Ltd.
С.	Faulty Equipment	:	Y-Ph CT of 2ORKH feeder
D.	Rating	:	220 kV, 800-400/1-1-1-1, 40 kA, 1 sec
E.	Make	:	MEHRU
F.	Sr. No.	:	OC 2183/3/9/07
G.	Year of manufacturing	:	2007
Н.	Year of commissioning	:	2009 (06.01.2009)
I.	Date and time of	:	03.09.2020, 2112 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.11.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Not repairable
	equipment		
М.	Details of previous	:	On 04.06.2020, CT Insulators was cleaned,
	maintenance		connections tightened, oil leak detected was fixed
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 03.09.2020 at 21:12 hrs, B-Ph CT of 2ORKH
	Description of failure		feeder blasted which caused damaged to Y-Ph CT of
			2ORKH feeder
Р.	Details of Tests done after	:	No tests could be conducted as the CT was damaged
	failure		physically
Q.	Observations and Probable	:	Damaged due to blast in nearby B-Ph CT of 2ORKH
	cause of failure		feeder



44.	Failure of 220 kV	Current Transf	ormer at CTPS	Dhanbad s	substation of	DVC
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А.	Name of Substation	:	CTPS Dhanbad
В.	Utility/Owner of substation	:	DVC
С.	Faulty Equipment	:	B-ph CT of Line#204
D.	Rating	:	245 kV, 800-400/1-1-1-1A
E.	Make	:	AREVA
F.	Sr. No.	:	200806101/2008
G.	Year of manufacturing	:	2008
H.	Year of commissioning	:	2011
I.	Date and time of	:	01.07.19 at 0855 hrs
	occurrence/discovery of fault		
J.	Fault discovered during	:	operation
Κ.	Present condition of	:	Not reparable
	equipment		-
L.	Details of previous	:	During last maintenance (date not available)
	maintenance		IR value-P-E: $80.2 \text{ G}\Omega$
			P1-1s1-86.2 GΩ
			P1-2s1-80.2 GΩ
			P1-3s1-86.2 GΩ
			P1-4s1-83.2 GΩ
			P1-5s1-81.2 GΩ
М.	Details of previous failure	:	No previous failure
N.	Sequence of events/	:	On 01.07.19 at 0855 hrs., 220 kV B-ph CT of
	Description of failure		Line#204 burst with heavy smoke at Dhanbad S/s
			end. Line#204 tripped at both ends with following
			relay indications:
			Dhanbad end :
			Facia, M1, M2, Grp A&B, carrier channel received
			Relay-M1- B-ph, Z1, fault location 0.24 km, fault
			current- 5.27 kA, trip time- 80 msec
			Relay-M2- B-ph, Z1, fault location 0.24 km, fault
			current- 4.77 kA, pre-fault current- 43 A
			At UTPS end: M1 21 distance 1-D
			M1-21 distance IXB
			W12-21 distance 2XB
			Auto mologymo E/E and accuricy trip signal
			Auto reclosure, E/F and carrier trip signal



			Partially cloudy weather
О.	Details of Tests done after failure		No tests could be conducted as the damage was extensive. OEM was contacted for investigation.
Р.	P. Observations and Probable cause of failure		Based on the information provided by the utility, it is difficult to ascertain the cause of failure.



45. Failure of 220 k	V Current Transformer	• at CTPS Jamshedpu	r substation of DVC

Α.	Name of Substation	:	CTPS Dhanbad			
В.	Utility/Owner of substation	:	DVC			
С.	Faulty Equipment	:	Y-ph CT of	L#214 (DVC	C Jameshedp	ur S/S- DVC
			BTPS "B")			
D.	Rating	:	245 kV, 800-400/1-1-1-1A			
E.	Make	:	AREVA			
F.	Sr. No.	:	42091001594	4		
G.	Year of manufacturing	:	2008			
Η.	Year of commissioning	:	2015			
I.	Date and time of	:	16.08.2020 a	t 0152 hrs		
	occurrence/discovery of fault					
J.	Information received in CEA	:	15.09.2020			
Κ.	Fault discovered during	:	Operation			
L.	Present condition of	:	Completely of	lamaged. The	erefore, Not r	repairable
	equipment		0 15 10 00		1 / 1 1	
М.	Details of previous	:	On 15.12.20	19, IR test	and tan delt	ta tests were
	maintenance		carried out a	and results (of the same	are attached
			herewith:			
			<u>IR test report</u>			
			IR test	R (Gohm)	Y (Gohm)	B (Gohm)
			values			D (Collini)
			P-E	136	13.2	197
			P-core1	165.7	14.15	181.2
			P-core2	169.7	15.55	253
			P-core3	134.6	16.07	155.7
			P-core4	120.3	14.39	170.7
			P-core5	123.8	17.69	166.1
			Tan delta val	ue: 0.813		
N.	Details of previous failure	:	No previous	failure		
О.	Sequence of events/	:	On 16.08.20	20 at 0152 l	hrs., 220 kV	Y-ph CT of
	Description of failure		Line#214(DV	VC Jameshed	lpur S/S- DV	C BTPS "B")
	-		tripped at bo	th ends due t	o burst out o	f Y-Ph CT at
			JSR end with	n following re	elay indicatio	ns:
				_		
		L	At JSR end			



			Distance protection Operated, 860perated, realy-dist prot. R-Ph, Z1 trip, 186(R,Y,B), 186(RT,YT,BT), Fault distance:94.594 km <u>At BTPS "B" end</u> Distance protection "R" & "Y"-ph, Z1, Z2, Z3, B/U- D/E/F,86 (R,Y,B)
Р.	Details of Tests done after failure	:	No tests could be conducted as the equipment was completely damaged.
Q.	Observations and Probable cause of failure	:	As deduced from the results of IR test results carried out on 15.12.2019, the IR value of Y-Ph was found to be on lower side as compared to the IR values of R-Ph & B-Ph. Further, the tan delta value obtained during the test was found to be on higher side. Therefore, the probable cause of this failure may be attributed to deterioration of insulation resistance.

A.	Name of Substation	:	400kV RS Kalwa
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	Y-ph CT of 400 kV Bus Coupler Bay
D.	Rating	:	400 kV Ratio- 2000/1000/500:1
E.	Make	:	Areva
F.	Sr. No.	:	20070186/2007
G.	Year of manufacturing	:	2007
Н.	Year of commissioning	:	2007
I.	Date and time of	:	26.07.2020
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Not repairable
	equipment		
М.	Details of previous	:	During last annual maintenance, Capacitance and tan
	maintenance		delta test were carried out on 17.05.2020 and test
			results are as follows:
			Capacitance (pF): 1110
			Tan delta: 0.209%
			IR: 8.2 Gohm
N.	Details of previous failure	:	No Previous failures
О.	Sequence of events/	:	On 26.07.2020, Y-ph CT burst and caught fire which
	Description of failure		resulted in the operation of Bus bar protection.
Р.	Details of Tests done after	:	No tests could be conducted as CT busted
	failure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.
		I	6

46. Failure of 400 kV CT at RS Kalwa substation of MSETCL



А.	Name of Substation	:	220kV Chinchwad-1
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	B-ph CT of 220 kV Chinchwad-Urse line
D.	Rating	:	220kV
			Ratio- 2400/1200:1A (5C), VA Burden-20
E.	Make	:	SCT
F.	Sr. No.	:	2013/1447
G.	Year of manufacturing	:	2012
Η.	Year of commissioning	:	23.04.2020 (The said CT was previously erected (not
			commissioned) at spare bay of 220 kV Chinchwad-
			II S/S. In 2020, this CT was removed from 220 kV
			Chinchwad-II S/S & commissioned at B-ph of 220
			kV Urse Line bay at 220 kV Chinchwad-I S/S.)
I.	Date and time of	:	01.11.2020 at 0854 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	On 30.05.2020, tan delta test were carried out and
	maintenance		the value obtained during the test was found to be
			0.76% which seems to be on higher side.
			On 01.01.2020, IR test was conducted and the value
			obtained during the test was 65.3 Gohm.
Ν.	Details of previous failure	:	No Previous failures
О.	Sequence of events/	:	On 01.11.2020, B-ph CT failed and busted which
	Description of failure		resulted in operation of Bus bar protection.
Р.	Details of Tests done after	:	No tests could be conducted as CT busted
	Tallure		
Q.	Observations and Probable	:	Higher Tan Delta value indicates degradation of
	cause of failure		insulation. Hence, CT might have failed because of
			insulation failure.

47. Failure of 220 kV CT at Chinchwad-1 substation of MSETCL

Δ	Name of Substation		Talagaan Ambi
A.		•	
В.	Utility/Owner of substation	:	MSEICL
С.	Faulty Equipment	:	Y-ph CT of 220/22kV, 50 MVA Transformer
D.	Rating	:	220kV
			Ratio: 800-400-200/1A
Ε.	Make	:	MEHRU ELECTRICALS
F.	Sr. No.	:	4763/1/1/13
G.	Year of manufacturing	:	2013
Η.	Year of commissioning	:	02.12.2016 (kept as spare from 2013 at 220 kV
			Bridgestone S/S)
I.	Date and time of	:	30.06.2020 at 2151hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
M.	Details of previous	:	During last annual maintenance, tan delta test and
	maintenance		capacitance test were carried out on 19.05.2019 and
			following are the observations:
			Tan delta the value obtained appears to be on higher
			side.
			Capacitance value obtained: 538.6 (pF)
N.	Details of previous failure	:	No Previous failures
	1		
О.	Sequence of events/	:	On 30.06.2020, HV Y-Ph CT of 220/22kV, 50 MVA
	Description of failure		Transformer was busted which resulted in the tripping
	I		of bays connected to main bus-1(i.e. 220kV PGCIL-1.
			Urse-1. GM along with Bus coupler) resulting into the
			operation of Differential protection. Busbar protection.
P.	Details of Tests done after	•	No tests could be conducted as CT blasted
1.	failure		
	Observations 1 D 1 11	<u> </u>	III al an Tan Dalla andrea ' l' (1 1 1 1' C
Q.	Observations and Probable	:	Higher Ian Delta value indicates degradation of
	cause of failure		insulation. Hence, CI might have failed because of
			insulation failure.

48. Failure of 220 kV CT at Talegaon Ambi substation of MSETCL



Α.	Name of Substation	:	220 kV New GCR Parli
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	220 kV Y-Ph CT of main Bus coupler
D.	Rating	:	245 kV, 2400-1200/1 A
E.	Make	:	ABB
F.	Sr. No.	:	21060018
G.	Year of manufacturing	:	2001
Η.	Year of commissioning	:	2016 (From 2001 to 2016, it was kept at 220 kV
			Girwali switchyard in well & good condition.)
I.	Date and time of	:	09.06.2019 at 19:48 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation (Weather was rainy and stormy)
L.	Present condition of equipment	:	Beyond repair
М.	Details of previous	:	Maintenance done on 12.02.2019
	maintenance		
N.	Details of previous failure	:	NIL
О.	Sequence of events/	:	Main bus coupler CT failed and caught fire.
	Description of failure		Bus bar protection of both the buses operated.
	-		
Р.	Details of Tests done after	:	NA
	failure		
Q.	Observations and Probable	:	The through current was very low but, the occurrence
	cause of failure		might have taken place due some internal problem
			because of ageing and insulation failure.

49. Failure of 220 kV CT at 220 kV New GCR Parli substation of MSETCL

A.	Name of Substation	:	220 kV Patoda Substation
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	220 kV R-Ph CT of 220/33 kV 50 MVA Transformer-
			Ι
D.	Rating	:	220 kV
			800-400-200/1 A
Ε.	Make	:	Universal Magnoflux
F.	Sr. No.	:	16347
G.	Year of manufacturing	:	2009-10
Η.	Year of commissioning	:	2012
I.	Date and time of	:	14.02.2020 @ 21:10 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repairs
М.	Details of previous	:	Tan Delta test done on 08.01.2020 : Tan Delta=
	maintenance		0.75417 %
			Capacitance@10 kV = 221 pF.
			No abnormality absorbed.
Ν.	Details of previous failure	:	NIL
О.	Sequence of events/	:	CT burst in running condition at 21:10 Hrs
	Description of failure		
D			N7/1
Ρ.	Details of Tests done after	:	Nıl
	Tailure		
Q.	Observations and Probable	:	Failure may be due to insulation failure. (As reported
	cause of failure		by MSETCL, failure rate of Universal Magnoflux CTs
			is high even after having desirable values of Tan Delta
			and Capacitance).

50. Failure of 220 kV CT at 220 kV Patoda substation of MSETCL

	Name of Substation		220 IV Nevels (Denema) Substation
A.		1:	220 KV INErale (Panama) Substation
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	220 kV B-Ph CT of 220 kV bus sectionaliser
D.	Rating	:	245 kV, 800-400/1-1-1-1
E.	Make	:	ITC
F.	Sr. No.	:	3026-22
G.	Year of manufacturing	:	2011
Η.	Year of commissioning	:	2013 (Information regarding storage condition not
			available as substation was under M/s Panama
			renewable energy Ltd.)
I.	Date and time of	:	20.04.2020 at 21:22 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair
M.	Details of previous	:	Not available as substation was under M/s Panama
	maintenance		
N			
N.	Details of previous failure	:	
О.	Sequence of events/	:	Bus bar protection operated successfully tripping all
	Description of failure		220 kV CB connected to the bus including bus
			sectionaliser and Transformer -2 HV/LV CBs and
			Transformer-1 HV CB as it was already on humming
			from HV.
P.	Details of Tests done after	:	Test could not be done as CT was completely
	failure		damaged.
Q.	Observations and Probable	:	Insulation failure due to ageing may be a probable
	cause of failure		cause of failure.
L		1	

51. Failure of 220 kV CT at 220 kV Nerale (Panama) substation of MSETCL

34.	Fallule of 220 KV CI at 220 KV		agnala (Nanded-2) substation of MISETCE
A.	Name of Substation	:	220 kV Waghala (Nanded-2)
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	Y Ph CT, 220 kV Waghala – Kumbhargaon ckt-1
D.	Rating	:	220 kV
E.	Make		Indian Transformers Ltd.
F.	Sr. No.	:	3094-05
G.	Year of manufacturing	:	2017
Η.	Year of commissioning	:	2018
I.	Date and time of occurrence/discovery of fault	:	08.08.2020 at 1100 Hrs
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair
M.	Details of previous maintenance	:	Tan Delta results 1. 0.2416 % (477.08 pf) [12.12.2019] 2. 0.24% (475.35 pf) [17.04.2018]
N.	Details of previous failure	:	Nil
O.	Sequence of events/ Description of failure	:	220 kV Waghala- Kumbhargaon ckt 1 A/R operated successfully at Kumbhargaon substation end only and A/R lockout at 220 kV Waghala end. Line was charged from Kumbhargaon end up to Waghala end. Y ph CT burst at 220 kV Waghala substation At 11:12 Hrs 220 kV Waghala-Kumbhargaon ckt 1 tripped from 400 kV Kumbhargaon end. As per patrolling report of AEE 400 kV line maintenance, R Ph jumper was found broken and fell on Y Ph conductor at Location No. 50.
Р.	Details of Tests done after failure	:	Test could not be done as CT burst during failure
Q.	Observations and Probable cause of failure	:	NA

52. Failure of 220 kV CT at 220 kV Waghala (Nanded-2) substation of MSETCL

		Du	
Α.	Name of Substation	:	220/33 kV Dasturi Substation
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	220 kV R Ph CT of 220 kV Dasturi - Kandalgaon line
			at 220 kV Dasturi end
D.	Rating	:	245 kV
E.	Make	:	ABB
F.	Sr. No.	:	ID221143
G.	Year of manufacturing	:	2000
Η.	Year of commissioning	:	2002
I.	Date and time of		09.08.2020 at 17:40 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair
M.	Details of previous	:	Tan Delta test done on 27.01.2020
	maintenance		Tan Delta = 0.55%
			Capacitance = 1130 pF
			Thermoscanning done on 31.07.2020 & Temperature
			found 39.7 Deg C
N.	Details of previous failure	:	Nil
О.	Sequence of events/	:	220 kV Dasturi – Kandalgaon line R ph CT failed at
	Description of failure		dasturi S/s. Distance protection operated and line
	_		tripped.
Р.	Details of Tests done after	:	Tests could not be done as CT was completely
	failure		damaged.
			-
Q.	Observations and Probable	:	CT might have failed due to ageing.
	cause of failure		
-			

53. Failure of 220 kV CT at 220 kV Dasturi substation of MSETCL



Α.	Name of Substation	:	220 kV Girwali Substation
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	220 kV B-Ph CT of Girwali Parli Ckt-2
D.	Rating	:	220 kV, 2400-1200-600 A, 5 core
E.	Make	:	SCT
F.	Sr. No.	:	2010/50
G.	Year of manufacturing	:	2010
Η.	Year of commissioning	:	201933
I.	Date and time of occurrence/discovery of fault	:	28.08.2020 at 09:08 Hrs
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair and replaced
M.	Details of previous	:	Tan Delta test done on 20.01.2020. Tan Delta = 2.13%
	maintenance		Tan Delta value was above acceptable limit
N.	Details of previous failure	:	NIL
О.	Sequence of events/	:	At 09:08 Hrs B-Ph CT of 220 kV Girwali Parli ckt-2
	Description of failure		failed.
Р.	Details of Tests done after	:	Test could not be done as CT was completely
	failure		damaged.
Q.	Observations and Probable	:	Insulation failure seems to be the probable reason for
	cause of failure		failure which may be due to manufacturing defect.
			As reported by MSETCL, failure rate of SCT make
			CI's has been observed to be high. The said
			manufacturer has been debarred from MSETCL and
			vendor registration cancelled.

54. Failure of 220 kV CT at 220 kV Girwali substation of MSETCL

55.	Fallult of 200 KV C1 at Raiga (JUI	
Α.	Name of Substation	:	400 kV switchyard Kaiga Generating Station-3&4
В.	Utility/Owner of substation	:	NPCIL- Kaiga Generating Station-3&4
С.	Faulty Equipment	:	Kaiga-ICT-1, R-phase CT#1 (of R, Y, B)
D.	Rating	:	Rated voltage: 420 kV, Rated current:2000 A
			No of cores: 5
Ε.	Make	:	BHEL
F.	Sr. No.	:	6167701
G.	Year of manufacturing	:	2003
Η.	Year of commissioning	:	2005
I.	Date and time of	:	21.08.2021 at 18:22 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	25.08.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Faulty CT being replaced
М.	Details of previous	:	Regular preventive maintenance (PM) checks like CT
	maintenance		terminal tightness checks, insulator cleaning, checks
			for any oil leaks, oil level and Nitrogen pressure,
			Insulation Resistance measurement, Capacitance &
			Tan delta measurement, are being done biennially.
			Condition monitoring (CM) checks like oil level
			monitoring, Porcelain insulator cleanliness checks,
			Thermography on power connections are being carried
			out once in 6 months.
			DV (1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
			PM checks on this equipment was carried out on
			observed during DM
N	Details of previous failure		Nil
N.	Sequence of avental	•	$\frac{1111}{(2000)} = \frac{1100}{100} + \frac{1000}{100} + \frac$
0.	Description of failure	•	tripped on TEE_1 differential protection and 400kV
			Bus-1 deenergized on actuation of bus differential
			protection. In field it was observed that Kaiga-ICT-1
			R-phase CT#1 (of R V B) failed and resulted in
			tripping of ICT.
P .	Details of Tests done after	:	No test could be performed as CT was in failed
	failure		condition.
0	Observations and Probable	•	CT was in service for 16 years. Previous test data in
\v.	cause of failure	•	the month of Dec-2020 were observed to be within

55. Failure of 200 kV CT at Kaiga Generating Station 3 & 4 of NPCIL



	acceptable investigated	limits.	Cause	of	failure	is	being
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POTENTIAL TRANSFORMERS / CAPACITOR VOLTAGE TRANSFORMERS 56. Failure of 400 kV CVT at Kalapaka substation of APTRANSCO

А.	Name of Substation	:	Kalapaka
В.	Utility/Owner of substation	:	APTRANSCO
C.	Faulty Equipment	:	B phase CVT in Kalapaka-PGCIL circuit-2 at PGCIL
			end
D.	Rating	:	420kV
E.	Make	:	WS
F.	Sr. No.	:	97101014
G.	Year of manufacturing	:	2001
Н.	Year of commissioning	:	NA
I.	Date and time of	:	12.11.2020
	occurrence/discovery of fault		
J.	Information received in CEA	:	21.02.2021
Κ.	Fault discovered during	:	Testing
L.	Present condition of	:	Replaced
	equipment		
М.	Details of previous	:	Information Not available
	maintenance		
N.	Details of previous failure	:	Information Not available
О.	Sequence of events/	:	As per the information submitted by the utility, a drift
	Description of failure		of around '-6 Volts' in secondary voltages in all the 3
			cores of B-ph CVT was observed. The CVT was in
			service for more than 18 years.
P.	Details of Tests done after	:	Not available
	failure		
Q.	Observations and Probable	:	Based on the information provided by the utility, it is
_	cause of failure		difficult to ascertain the cause of failure.



Α.	Name of Substation	:	Ragulapadu
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	B phase PT
D.	Rating	:	245kV
E.	Make	:	SCT
F.	Sr. No.	:	2009/230
G.	Year of manufacturing	••	2009
Н.	Year of commissioning	:	2011
I.	Date and time of	:	20.06.2019 at 02:55 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	20.08.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Replaced
	equipment		
М.	Details of previous	:	Information Not available
	maintenance		
Ν.	Details of previous failure	:	Information Not available
Ο.	Sequence of events/	:	On 20.06.2019 at 02:55 hrs the 220 kV GCB Metering
	Description of failure		B-phase Potential Transformer blasted with loud noise
			and caught fire.
Р.	Details of Tests done after	:	Not available
	failure		
Q.	Observations and Probable	:	Based on the information provided by the utility, it is
	cause of failure		difficult to ascertain the cause of failure.

57. Failure of 220 kV PT at Ragulapadu substation of APTRANSCO

Α.	Name of Substation	:	Chinnakampalli
В.	Utility/Owner of substation	:	APTRANSCO
C.	Faulty Equipment	:	B phase CVT
D.	Rating	:	220 kV
E.	Make	:	CGL
F.	Sr. No.	:	13322
G.	Year of manufacturing	:	1999
Η.	Year of commissioning	:	2000
I.	Date and time of	:	19.11.19 at 04:42 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	04.08.2020
Κ.	Fault discovered during	:	Feeder of subject CVT was under idle charge
L.	Present condition of	:	Replaced
	equipment		
М.	Details of previous	:	Information Not available
	maintenance		
N.	Details of previous failure	:	Information Not available
О.	Sequence of events/	:	High temperature was observed near CVT base during
	Description of failure		thermo-vision scanning. It was observed that CVT was
			emitting a humming sound and not producing normal
			secondary voltage during testing
Р.	Details of Tests done after	:	Not available
	failure		
Q.	Observations and Probable	:	It is difficult to deduce anything as no information on
	cause of failure		previous performance is available and SOE is also
			unclear.

58. Failure of 220 kV B-ph CVT at Chinnakampalli substation of APTRANSCO

A.	Name of Substation	:	Chinnakampalli
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	Y phase CVT
D.	Rating	:	220 kV
E.	Make	:	CGL
F.	Sr. No.	:	13325
G.	Year of manufacturing	:	1999
H.	Year of commissioning	:	2000 (21.03.2000)
I.	Date and time of	:	28.05.2020 at 11:30 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	04.08.2020
Κ.	Fault discovered during	:	Feeder of subject CVT was under idle charge
L.	Present condition of	:	Replaced
	equipment		
М.	Details of previous	:	Information Not available
	maintenance		
N.	Details of previous failure	:	Information Not available
О.	Sequence of events/	:	High temperature was observed near CVT base during
	Description of failure		thermo-vision scanning. Further, the ratio test results of
			the CVT are not satisfactory, CVT was also defective
			and suggested for replacement by MRT wing, Kadapa.
P.	Details of Tests done after	:	Not available
	failure		
Q.	Observations and Probable	:	It is difficult to deduce anything as no information on
	cause of failure		previous performance is available and SOE is also
			unclear.

59. Failure of 220 kV Y-ph CVT at Chinnakampalli substation of APTRANSCO

A.	Name of Substation	:	Kilpauk
В.	Utility/Owner of substation	:	TANTRANSCO
С.	Faulty Equipment	:	Y phase CVT
D.	Rating	:	230 kV
E.	Make	:	CGL
F.	Sr. No.	:	11976
G.	Year of manufacturing	:	1998
Н.	Year of commissioning	:	2006 (27.01.2006)
I.	Date and time of	:	10.10.2020 at 0339 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	28.01.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Not repairable
	equipment		
М.	Details of previous	:	Information Not available
	maintenance		
N.	Details of previous failure	:	Information Not available
О.	Sequence of events/	:	On 10.10.2020 at 0339 hrs, 230kV Y-Ph Bus PT failed
	Description of failure		with following protection:
			Bus bar protection.
			NCTPS feeder Distance protection relays M1 & M2
			operated.
Р.	Details of Tests done after	:	Information Not available
	failure		
Q.	Observations and Probable	:	It is difficult to deduce anything as no information on
-	cause of failure		previous performance and SOE is available and SOE is
			also unclear.

60. Failure of 220 kV CVT at Kilpauk substation of TANTRANSCO



01.	1. Fanule of 220 KV 1 1 at Date substation of MSETCE				
А.	Name of Substation	:	220 kV Bale		
В.	Utility/Owner of substation	:	MSETCL		
С.	Faulty Equipment	:	220 kV B-Ph PT		
D.	Rating	:	220/√3 kV/ 110/√3 V		
E.	Make	:	CGL		
F.	Sr. No.	:	10253		
G.	Year of manufacturing	:	1997		
Н.	Year of commissioning	:	2006		
I.	Date and time of	:	09.04.2019		
	occurrence/discovery of fault				
J.	Information received in CEA	:	21.01.2022		
Κ.	Fault discovered during	:	Operation		
L.	Present condition of	:	Beyond repair		
	equipment				
М.	Details of previous	:	Test was conducted on 28.12.2018 and IR value was		
	maintenance		56.4 GΩ		
N.	Details of previous failure	:	NIL		
Ο.	Sequence of events/	:	PT burst at 06:25 Hrs		
	Description of failure				
P.	Details of Tests done after	:	No test could be done as PT was completely damaged		
	failure				
Q.	Observations and Probable	:	Ageing may be factor responsible for failure.		
	cause of failure				

61. Failure of 220 kV PT at Bale substation of MSETCL



		-	8
A.	Name of Substation	:	400 kV Kharghar
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	220 kV Main Bus-I, B-Ph PT
D.	Rating	:	220/√3 kV/ 110/√3 V
E.	Make	:	BHEL
F.	Sr. No.	:	2228704
G.	Year of manufacturing	:	1998
Η.	Year of commissioning	:	1999
I.	Date and time of	:	25.07.2019 at 03:50 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	21.01.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Beyond repair
	equipment		
М.	Details of previous	:	IR value taken on 16.03.2019
	maintenance		
N.	Details of previous failure	:	NA
О.	Sequence of events/	:	-
	Description of failure		
Р.	Details of Tests done after	:	-
	failure		
0	Observations and Probable	•	Insulation failure due to ageing may be the probable
∀ .	cause of failure	•	cause of failure
L			euroe of future.

62. Failure of 220 kV PT at 400 kV Kharghar substation of MSETCL

A.	Name of Substation	:	220 kV Kaulweda
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	R Ph 220 kV R-Ph PT of Bus section
D.	Rating	:	220/√3 kV/ 110/√3 V
E.	Make	:	CGL
F.	Sr. No.	:	13667
G.	Year of manufacturing	:	1999
H.	Year of commissioning	:	2003 (Storage condition: Data not available)
I.	Date and time of	:	24.05.2019 at 05:25 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Beyond repair
	equipment		
М.	Details of previous	:	Diagnostic testing could not be carried out due to single
	maintenance		PT set as outage was not possible.
N.	Details of previous failure	:	NA
О.	Sequence of events/	:	On 24.05.2019 at 05:25 Hrs, 220 kV Bus bar protection
	Description of failure		operated due to failure of 220 kV R Ph Bu sPT. All
			feeders connected to 220 kV Main Bus tripped affecting
			the supply to 33 kV Bus. However, power flow on 132
			kV Bus remained affected.
Р.	Details of Tests done after	:	No test could be done as PT was completely damaged.
	failure		
Q.	Observations and Probable	:	As reported by the utility no maintenance is being done
-	cause of failure		at the substation, due to which the unwarranted failure
			of the equipment may have occurred.

63. Failure of 220 kV PT at 220 kV Kaulewda Substation of MSETCL

01.	VI I andre VI 220 KV I I at 220 KV Gauchandul Substation of Mishi Ch					
Α.	Name of Substation	:	220 kV Gadchandur			
В.	Utility/Owner of substation	:	MSETCL			
С.	Faulty Equipment	:	220 kV R-Ph PT of Bus section-II			
D.	Rating	:	220/√3 kV/ 110/√3 V			
E.	Make	:	Toshiba T&D Systems Pvt. Ltd.			
F.	Sr. No.	:	552977			
G.	Year of manufacturing	:	2017			
Н.	Year of commissioning	:	2020 (Was mounted on structure since 05.12.2017 and was taken in service on 05.02.2020)			
I.	Date and time of	:	19.04.2020 at 20:43 Hrs			
	occurrence/discovery of fault					
J.	Information received in CEA	:	22.02.2022			
Κ.	Fault discovered during	:	Operation			
L.	Present condition of	:	Beyond repair (Burst)			
	equipment					
М.	Details of previous	:	Capacitance and Tan Delta & IR test was done on			
	maintenance		26.02.2020 and result was found to be normal.			
N.	Details of previous failure	:	NA			
О.	Sequence of events/	:	R-Ph PT of 220 kV Pt Section-II burst & Bus bar			
	Description of failure		protection operated.			
Р.	Details of Tests done after	:	No test could be done as PT was completely damaged.			
	failure					
Q.	Observations and Probable	:	Insulation failure may have led to failure. (As reported			
	cause of failure		by utility, Tan Delta values of the replacement provided			
			by Toshiba also increased within short service period of			
			the 03 months.)			

64. Failure of 220 kV PT at 220 kV Gadchandur Substation of MSETCL



0.5.					
А.	Name of Substation	:	220 kV Jalna		
В.	Utility/Owner of substation	:	MSETCL		
С.	Faulty Equipment	:	220 kV R-Ph PT		
D.	Rating	:	220/√3 kV/ 110/√3 V		
E.	Make	:	CG		
F.	Sr. No.	:	R-15049		
G.	Year of manufacturing	:	2000		
Η.	Year of commissioning	:	2003		
I.	Date and time of	:	01.09.2020 at 21:30 Hrs		
	occurrence/discovery of fault				
J.	Information received in CEA	:	22.02.2022		
Κ.	Fault discovered during	:	Operation		
L.	Present condition of	:	Beyond repair		
	equipment				
М.	Details of previous	:	Tan Delta & IR test was done on 22.01.2018.		
	maintenance		Tan Delta: 0.305 %, Cap: 422.748 pf, IR value: 3.5 GΩ		
N.	Details of previous failure	:	NA		
Ο.	Sequence of events/	:	220 kV R Ph PT burst at 21:30 Hrs. Bus bar protection		
	Description of failure		operated. Normalcy restored at 22:10 Hrs		
Р.	Details of Tests done after	:	No test could be done as PT was completely damaged.		
	failure				
Q.	Observations and Probable	:	Ageing may have led to failure of PT.		
_	cause of failure				

65. Failure of 220 kV PT at 220 kV Jalna Substation of MSETCL

00.	vv. i anui v vi 22v K v i v i at v ci svva Eii v Substativii vi AENIE					
A.	Name of Substation	:	Versova EHV Substation			
B.	Utility/Owner of substation	:	Adani Electricity Mumbai Ltd – Transmission			
С.	Faulty Equipment	:	220kV IVT (Bay-12, 220kV Versova- Goregaon Line-			
			2)			
D.	Rating	:	Voltage Class - 245 kV, Type - VEOT245/1050/50			
E.	Make	:	M/s Crompton Greaves Limited, India			
F.	Sr. No.	:	60097			
G.	Year of manufacturing	:	2016			
Н.	Year of commissioning	:	2021			
I.	Date and time of	:	26/01/2021 at 01:24 Hrs			
	occurrence/discovery of fault					
J.	Information received in CEA	:	10.02.2021			
Κ.	Fault discovered during	:	Operation			
L.	Present condition of	:	Beyond repair			
	equipment					
М.	Details of previous	:	Pre-commissioning testing carried out on 08/01/2021			
	maintenance					
N.	Details of previous failure	:	NA			
О.	Sequence of events/	:	SoE of 26.01.2021 not provided			
	Description of failure					
Р.	Details of Tests done after	:	NA			
	failure					
Q.	Observations and Probable	:	Visual & Physical Inspection of failed equipment was			
	cause of failure		done under supervision of OEM representative. IVT			
			tank along with its active parts are completely damaged.			
			Failed equipment is taken by OEM to factory for			
			detailed investigation.			
			Investigation report awaited.			

66. Failure of 220 kV IVT at Versova EHV Substation of AEML



SURGE ARRESTER 67. Failure of 400 kV Surge Arrestor of Kalapakka substation of APTRANSCO

Α.	Name of Substation	•••	Kalapakka
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	R-ph Surge Arrestor of Asupaka bay reactor
D.	Rating	•••	400 kV
Е.	Make	:	CGL
F.	Sr. No.	:	34046
G.	Year of manufacturing	•••	2004
Н.	Year of commissioning	:	Information Not available
I.	Date and time of	:	05.08.2019
	occurrence/discovery of fault		
T	Information received in CEA	•	
5.		•	
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	••	Not repairable, Replaced
М.	Details of previous	:	Information Not available
	maintenance		
Ν.	Details of previous failure	:	Information Not available
Ο.	Sequence of events/	•••	On 05.08.2019, R-ph Surge Arrestor of Asupaka bay
	Description of failure		reactor flashed over during operation
Р.	Details of Tests done after	:	Information Not available
	failure		
Q.	Observations and Probable	:	It is difficult to ascertain the cause of failure on the
	cause of failure		information gathered from the utility's report.

Α.	Name of Substation	:	Kalapakka
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	R-ph Surge Arrestor of HV side of ICT-II
D.	Rating	:	400 kV
E.	Make	:	OBLUM
F.	Sr. No.	:	Information Not available
G.	Year of manufacturing	:	2001
Η.	Year of commissioning	:	Information Not available
I.	Date and time of occurrence/discovery of fault	:	12.11.2019
J.	Information received in CEA	:	-
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable, Replaced
M.	Details of previous maintenance	:	Information Not available
N.	Details of previous failure	:	Information Not available
О.	Sequence of events/	:	On 12.11.2019, R-ph Surge Arrestor of HV side of
	Description of failure		ICT-II flashed over during operation
P.	Details of Tests done after		Information Not available
1.	failure	•	
Q.	Observations and Probable	:	It is difficult to ascertain the cause of failure on the
	cause of failure		information gathered from the utility's report.

68. Failure of 400 kV Surge Arrestor of Kalapakka substation of APTRANSCO

Α.	Name of Substation	:	Kalapakka
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	R-ph SA
D.	Rating	:	400 kV
E.	Make	:	OBLUM
F.	Sr. No.	:	2813
G.	Year of manufacturing	:	2000
Η.	Year of commissioning	:	Information Not available
I.	Date and time of	:	20.11.2020
	occurrence/discovery of fault		
J.	Information received in CEA	:	21.02.2021
К.	Fault discovered during	:	Testing
L.	Present condition of equipment	:	Replaced
M.	Details of previous	:	Leakage current monitoring test was carried out and
	maintenance		measured 3 rd harmonic resistive current was found to
			be greater than 350µA. During Insulation resistance
			test, IR value was found to be less than 1 G Ω .
N.	Details of previous failure	:	Information Not available
Ο.	Sequence of events/	:	The SA was in service for more than 18 years.
	Description of failure		
Р.	Details of Tests done after	:	Information Not available
	failure		
Q.	Observations and Probable	:	It is difficult to ascertain the cause of failure on the
	cause of failure		information gathered from the utility's report.

69. Failure of 400 kV Surge Arrestor of Kalapakka substation of APTRANSCO



Α.	Name of Substation	:	Vemagiri
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	Y-ph Surge Arrestor of Vemagiri-GMR-1 feeder
D.	Rating	:	390 kV
E.	Make	:	Crompton Greaves Ltd.
F.	Sr. No.	:	24810
G.	Year of manufacturing	:	2003
Η.	Year of commissioning	:	2005 (11.09.2005)
I.	Date and time of	:	14.06.2019 at 09:33 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	18.07.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Replaced
M.	Details of previous	:	Information Not available
	maintenance		
N.	Details of previous failure	:	Information Not available
	_		
О.	Sequence of events/	:	On 14.06.2019 at 09:33 hrs, Y-ph Surge Arrestor of
	Description of failure		Vemagiri-GMR-1 feeder blasted and caught fire.
Р.	Details of Tests done after	:	No tests could be conducted as SA blasted
	failure		
Q.	Observations and Probable	:	As no tests could be conducted, and no previous test
	cause of failure		records are available, it is difficult to ascertain the
			cause of failure. However it could have failed due to
			ageing leading to internal fault

70. Failure of 390 kV Surge Arrestor at Vemagiri substation of APTRANSCO

A.	Name of Substation	:	Jammalamadugu
В.	Utility/Owner of substation	:	APTRANSCO
C.	Faulty Equipment	:	R-ph Surge Arrestor of Talaricheruvu-I feeder
D.	Rating	:	400kV
E.	Make	:	CGL
F.	Sr. No.	:	160299
G.	Year of manufacturing	:	2015
Η.	Year of commissioning	:	2016 (29.06.2016)
I.	Date and time of	:	22.05.2019 at 19:46 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	18.07.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Replaced
М.	Details of previous	:	Information Not available
	maintenance		
N.	Details of previous failure	:	Information Not available
О.	Sequence of events/	:	On 22.05.2019 at 19:46 hrs, R-ph Surge Arrestor of
	Description of failure		Talaricheruvu-I feeder blasted while in operation.
Р.	Details of Tests done after	:	No tests could be conducted as SA blasted
	failure		
Q.	Observations and Probable	:	As no tests could be conducted, and no previous test
	cause of failure		records are available, it is difficult to ascertain the
			cause of failure. However it could have failed due to
			internal fault

71. Failure of 400 kV Surge Arrestor at Jammalamadugu substation of APTRANSCO

A.	Name of Substation	••	Parawada
В.	Utility/Owner of substation	:	APTRANSO
С.	Faulty Equipment	:	Y Phase Surge Arrestor of 220 kV VSS feeder
D.	Rating	:	220 kV
E.	Make	:	LAMCO
F.	Sr. No.	:	2308
G.	Year of manufacturing	:	2001
H.	Year of commissioning	:	2004
I.	Date and time of	:	08.08.2019 at 1134 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	28.10.2019
Κ.	Fault discovered during	••	Operation
L.	Present condition of	:	Replaced
	equipment		
М.	Details of previous	:	Information not available
	maintenance		
N.	Details of previous failure	••	Information not available
О.	Sequence of events/	:	On 08.08.2019 at 1134 hrs, 220 kV feeder tripped on
	Description of failure		distance protection at 220 kV VSS substation end.
			After inspection of the switch yard, it was observed
			that the SA had blasted.
P.	Details of Tests done after	:	No test could be conducted as SA had blasted.
	failure		
Q.	Observations and Probable	:	Internal fault
	cause of failure		

72. Failure of 220 kV Surge Arrestor of Parawada substation of APTRANSCO

Α.	Name of Substation	:	Anantapuramu
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	HV side R Phase Surge Arrestor of 100MVA PTR-
			III
D.	Rating	:	245 kV
E.	Make	•••	LAMCO
F.	Sr. No.	•••	150 C
G.	Year of manufacturing	:	2000
H.	Year of commissioning	:	2003
I.	Date and time of	:	24.10.2019 at 1535 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	23.12.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of	•••	Replaced
	equipment		
M.	Details of previous		Information not available
	maintenance		
N.	Details of previous failure	•••	Information not available
Ο.	Sequence of events/		On 24.10.2019 at 1535 hrs, 100 MVA PTR-III
	Description of failure		tripped on HV overcurrent. Trip relay and
			differential relay operated. R-ph SA had blasted/
			flashed over
Р.	Details of Tests done after	:	No tests could be conducted
	failure		
Q.	Observations and Probable	:	Internal fault could be the probable cause
	cause of failure		

73. Failure of 245 kV Surge Arrestor at Anantapuramu substation of APTRANSCO


Α.	Name of Substation	:	Tallapalli
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	B Phase Surge Arrestor of 220kV Tallapalli
			Srisailam feeder-I
D.	Rating	:	216 kV
E.	Make	:	LAMCO
F.	Sr. No.	:	Information not available
G.	Year of manufacturing	:	Information not available
H.	Year of commissioning	:	2007
I.	Date and time of	:	12.10.2019 at 1750 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	29.11.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of	:	Replaced
	equipment		
M.	Details of previous	:	Information not available
	maintenance		
N.	Details of previous failure	:	Information not available
О.	Sequence of events/	:	On 12.10.2019 at 1750 hrs , amidst rain and
	Description of failure		thunderstorms, B Phase Surge Arrestor of 220kV
			Tallapalli Srisailam feeder-I flashed over and the
			monitor was burnt
Р.	Details of Tests done after	:	No tests could be conducted
	failure		
Q.	Observations and Probable	:	Internal flashover/ fault could be the probable cause
	cause of failure		

74. Failure of 220 kV Surge Arrestor at Tallapalli substation of APTRANSCO



75.	Failure of 220 kV	Surge Arrestor	at Nellore substation of APTRANSCO
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Α.	Name of Substation	:	Nellore
В.	Utility/Owner of substation	•••	APTRANSCO
C.	Faulty Equipment	••	Surge Arrestor
D.	Rating	:	220kV
E.	Make	•••	CGL
F.	Sr. No.	•••	27390
G.	Year of manufacturing	:	2004
Η.	Year of commissioning	:	2005 (25.12.2005)
I.	Date and time of	:	13.04.2019 at 12:17 hrs
	occurrence/discovery of fault		
T	Information received in CEA	•	29.07.2019
••		•	27.07.2017
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	Last maintenance done on 13.02.2019. No
	maintenance		abnormality was observed
N.	Details of previous failure	:	Nil
О.	Sequence of events/	:	On 13.04.2019 at 12:17 hrs, Y-ph SA of 220 kV
	Description of failure		Sullurpet-1 feeder flashed over while in operation
Р.	Details of Tests done after	:	No tests could be conducted due to flashover
	failure		
Q.	Observations and Probable	:	As informed by utility, no abnormality was observed
	cause of failure		during regular maintenance two months prior to the
			incident. Ageing could have resulted in the
			deterioration of insulation of SA which may have led
			to flashover.

Α.	Name of Substation	:	Manubolu
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	B-ph Surge Arrestor of Manubolu-Nellore-3 feeder
D.	Rating	:	220kV
Е.	Make	:	CGL
F.	Sr. No.	:	27394
G.	Year of manufacturing	:	2004
Η.	Year of commissioning	:	2005
I.	Date and time of	:	25.02.2020 at 1409 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	13.03.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	Last annual maintenance done on 01.06.2019.
	maintenance		Following IR values were found:
			R-ph to body: 158 Gohm
			Y-ph to body: 168 Gohm
			B-ph to body: 180 Gohm
Ν.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 25.02.2020 at 14:09 hrs, Manubolu- Nellore-3
	Description of failure		feeder breaker tripped with following indications:
			Manubolu end:
			$\frac{\text{Main I}}{\text{Main I}}$
			80 A, 80 B1, 80 B2 trip
			Zone-I SOIF, B-pn, C-N, L3-N Polov L. 227.6A
			$\begin{array}{c} \text{Kelay I}_{\text{A}} = 227.0\text{A} \\ \text{I}_{\text{B}} = 224.2\text{ A} \end{array}$
			$I_B = 354.5 \text{ A}$ $I_c = 23.5 \text{ b} \text{ A}$
			$V_{-2}337.3 kV$
			$V_{an} = 37.3 \text{ kV}$
			V_{cn} - 245.1 kV
			Fault location 2.284 km
			AR operated. AR lockout
			Main 2:
			<u>L3-N</u>
			Zone-1 SOTF B-ph, AR operated, AR lockout
			Nellore end:
			<u>Main 1:</u>
			B-ph-Grnd, zone-1, fault location-16.7 km
			<u>Main 1:</u>

76. Failure of 220 kV Surge Arrestor at Manubolu substation of APTRANSCO



			zone-1, fault location-20.73 km Upon inspection of the yard, it was found that B-ph SA had failed due to internal flash over.
Р.	Details of Tests done after failure	:	No tests could be conducted as SA blasted
Q.	Observations and Probable cause of failure	:	No abnormality was observed during last periodic maintenance. Ageing could have resulted in the deterioration of insulation of SA which may have led to flashover.



А.	Name of Substation	:	Vishakhapatnam
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	B-ph Surge Arrestor of Kakinada feeder
D.	Rating	:	220 kV
E.	Make	:	WSI India ltd.
F.	Sr. No.	:	330
G.	Year of manufacturing	:	1990
Н.	Year of commissioning	:	1991
I.	Date and time of	:	22.03.2020 at 1545 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.07.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	Information not available
	maintenance		
N.	Details of previous failure	:	Information not available
О.	Sequence of events/	:	On 22.03.2020 at 1545 hrs, B-ph SA of Kanikada
	Description of failure		feeder blasted while in operation and a fault current
			was generated. B-ph Bus-II sectionalizer isolator
			(Failure Details of this isolator is not submitted) also
D	Dataila of Tosta dans offer	+-	you damaged and 220 KV Bus-II protection operated
г.	failure	:	no tests could be conducted as SA diasted
	lanure		
Q.	Observations and Probable	:	As no tests could be conducted, and no previous test
	cause of failure		records are available, it is difficult to ascertain the
			internal fault as the SA had sorted for 20 years and
			significant againg might have deteriorated its health
		1	significant ageing inight have deteriorated its fleath.

77. Failure of 220 kV Surge Arrestor at Vishakhapatnam substation of APTRANSCO

А.	Name of Substation	:	Vishakhapatnam
В.	Utility/Owner of substation	:	APTRANSCO
C.	Faulty Equipment	:	Y-ph Surge Arrestor of Kakinada feeder
D.	Rating	:	220 kV
E.	Make	:	WSI India ltd.
F.	Sr. No.	:	9010327
G.	Year of manufacturing	:	1990
Н.	Year of commissioning	:	1997(18.12.1997)
I.	Date and time of occurrence/discovery of fault	:	20.07.2020 at 1305 hrs
J.	Information received in CEA	:	22.09.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous maintenance	:	Information not available
N.	Details of previous failure	:	Information not available
0.	Sequence of events/ Description of failure	•	220kV VSS-Pendurthy-I feeder breakers tripped at both ends due to blasting of Y-Ph LA along with tripping of 220kV VSS-Pendurthy-II feeder at 220kV Pendurthy end. At the same time, 220kV VSS-MRS-I & 220kV VSS-MRS-II feeders tripped at 220kV VSS end showing Y phase to ground fault in zone-3 (Reverse zone) with fault location 2.1 km (for MRS-I) & 2.34 km (for MRS-II).
Р.	Details of Tests done after failure	:	No tests could be conducted as SA blasted
Q.	Observations and Probable cause of failure	:	It is difficult to ascertain the cause of failure. However, it could have failed due to ageing as the SA had served for 30 years, even though the leakage current is 2.6 mA (less than 6 mA) under healthy zone.

78. Failure of 220 kV Surge Arrestor at Vishakhapatnam substation of APTRANSCO

А.	Name of Substation	:	Gajuwaka
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	B-ph Surge Arrestor of HV side of 220/132 kV, 160
			MVA power transformer-1
D.	Rating	:	220 kV
E.	Make	:	OBLUM
F.	Sr. No.	:	03
G.	Year of manufacturing	:	2009
Н.	Year of commissioning	:	Information not available
I.	Date and time of	:	30.06.2020 at 1700 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	09.09.2020
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	Information not available
	maintenance		
N.	Details of previous failure	:	Information not available
О.	Sequence of events/	:	The 220/132kV, 160MVA, Power Transformer-1
	Description of failure		tripped with heavy sound with relay indications HV-
			O/C and Differential protection
Р.	Details of Tests done after	:	Information not available
	failure		
Q.	Observations and Probable	:	As no previous test records are available, it is difficult
	cause of failure		to ascertain the cause of failure.

79. Failure of 220 kV Surge Arrestor at Gajuwaka substation of APTRANSCO



Α.	Name of Substation	:	Visakhapatnam
В.	Utility/Owner of substation	:	APTRANSCO
C.	Faulty Equipment	:	R-ph SA of 220kV VSS-Gajuwaka feeder
D.	Rating	:	22 kV
E.	Make	:	WSI
F.	Sr. No.	:	9010319
G.	Year of manufacturing	:	1990
Н.	Year of commissioning	:	1991 (14.07.1991)
I.	Date and time of occurrence/discovery of fault	:	07.11.2020 at 1610 hrs
J.	Information received in CEA	:	28.01.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
M.	Details of previous maintenance	:	Information not available
N.	Details of previous failure	:	Information not available
О.	Sequence of events/ Description of failure	:	Information not available
Р.	Details of Tests done after failure	:	Information not available
Q.	Observations and Probable cause of failure	:	As no previous test records are available, it is difficult to ascertain the cause of failure. However, it could have failed due to ageing as the SA had served for 30 years, even though the leakage current is 1mA (less than 4mA) under healthy zone.

80. Failure of 220 kV Surge Arrestor at Visakhapatnam substation of APTRANSCO



А.	Name of Substation	:	Manubolu
В.	Utility/Owner of substation	:	APTRANSCO
С.	Faulty Equipment	:	B-ph Surge Arrestor of LV side of 315MVA ICT-1
D.	Rating	:	220Kv
Е.	Make	:	CGL
F.	Sr. No.	:	27373
G.	Year of manufacturing	:	2004
Η.	Year of commissioning	:	2005(18.12.2005)
I.	Date and time of occurrence/discovery of fault	:	26.12.2020 at 0620 hrs
J.	Information received in CEA	:	09.02.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
M.	Details of previous maintenance	:	Last annual maintenance done on 18.12.2020. Following IR values were found: R-ph to body: 224 Gohm Y-ph to body: 229 Gohm B-ph to body: 204 Gohm
N.	Details of previous failure	:	No previous failure
0.	Sequence of events/ Description of failure	:	On 26.12.2020 at 06:20hrs, B-ph Surge Arrestor of LV side of 315MVA ICT-1 failed with following indications: <u>Manubolu end:</u> Differential protection trip, Group A&B protection trip, CB auto trip HV panel: 86GA, 87T differential relay
			Tie panel: 86GA LV panel: 86GA
Р.	Details of Tests done after failure	:	Information not available
Q.	Observations and Probable cause of failure	:	As no previous test records are available, it is difficult to ascertain the cause of failure. However, it could have failed due to internal flashover.

81. Failure of 220 kV Surge Arrestor at Manubolu substation of APTRANSCO



82. Failure of 390 kV Surge Arrestor at Alamthy substation of TANTRANSCO

А.	Name of Substation	:	Alamathy
В.	Utility/Owner of substation	:	TANTRANSCO
C.	Faulty Equipment	:	B-ph Surge Arrestor of 400kV Thiruvalam-II feeder
D.	Rating	:	390 kV
E.	Make	:	CGL
F.	Sr. No.	:	26188
G.	Year of manufacturing	:	2003
Η.	Year of commissioning	:	2006
I.	Date and time of occurrence/discovery of fault	:	29.04.2020 at 0706 hrs
J.	Information received in CEA	:	09.09.2020
К.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Removed from service
М.	Details of previous maintenance	:	Hi-pot test was conducted. No abnormality observed
N.	Details of previous failure	:	No previous failure
0.	Sequence of events/ Description of failure	:	On 29.04.2020 at 0706 hrs, B-ph Surge Arrestor of 400kV Thiruvalam-II feeder flashed over during operation with loud noise and heavy smoke.
Р.	Details of Tests done after failure	:	No tests could be conducted as SA flashed over
Q.	Observations and Probable cause of failure	:	Ageing might be the cause of failure



A.	Name of Substation	:	Korattur
В.	Utility/Owner of substation	:	TANTRANSO
С.	Faulty Equipment	:	R Phase Surge Arrestor of 100 MVA AT-II
D.	Rating	:	230 kV
Ε.	Make	:	CGL
F.	Sr. No.	:	4862
G.	Year of manufacturing	:	1999
H.	Year of commissioning	:	2003
I.	Date and time of	:	06.11.2019 at 1208 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	05.12.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Replaced
M.	Details of previous	:	Hi-pot test conducted and reported in healthy
	maintenance		condition.
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 06.11.2019 at 1208 hrs, heavy dip in voltage
	Description of failure		and sound was observed in the station yard. Upon
			inspecting the relay panel, it was noticed that 100
			MVA Auto Transformer No. II – HV&LV
			breakers got tripped on differential protection. In
			station yard inspection, it was found that 230kV
			HV SA of R phase of 100 MVA Auto Transformer
			No. II had flashed over
Р.	Details of Tests done after	:	No test could be conducted due to flash over
	failure		
Q.	Observations and Probable	:	Ageing could be the probable cause
	cause of failure		

83. Failure of 230 kV Surge Arrestor of Korattur substation of TANTRANSCO



84. Failure of 230 kV Surge Arrestor at Alamthy substation of TANTRANSCO

A.	Name of Substation	:	Alamathy
В.	Utility/Owner of substation	:	TANTRANSCO
C.	Faulty Equipment	:	B-ph Surge Arrestor of LV side of 315 MVA, 400/230 kV ICT
D.	Rating	:	230 kV
E.	Make	:	CGL
F.	Sr. No.	:	27198
G.	Year of manufacturing	:	2003
Η.	Year of commissioning	:	2006
I.	Date and time of occurrence/discovery of fault	:	16.01.2020 at 1531 hrs
J.	Information received in CEA	:	10.02.2020
К.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable, Replaced
M.	Details of previous maintenance	:	Hipot test conducted on 19.08.19. No abnormality observed
N.	Details of previous failure	:	No previous failure
0.	Sequence of events/ Description of failure	:	On 16.01.2020 at 1531 hrs, B-ph Surge Arrestor of LV side of 315 MVA, 400/230 kV ICT flashed over during operation with loud noise and heavy smoke.
Р.	Details of Tests done after failure	:	No tests could be conducted as SA flashed over
Q.	Observations and Probable cause of failure	:	Ageing might be the cause of failure



85. Failure of 230 kV Surge Arrestor at Kilpauk substation of TANTRANSCO

A.	Name of Substation	:	Kilpauk
В.	Utility/Owner of substation	:	TANTRANSCO
C.	Faulty Equipment	:	R-ph Surge Arrestor of HV side of Auto transformer-1
D.	Rating	:	230 kV
E.	Make	:	CGL
F.	Sr. No.	:	35157
G.	Year of manufacturing	:	2004
Η.	Year of commissioning	:	2006 (27.01.2006)
I.	Date and time of occurrence/discovery of fault	:	10.10.2020 at 0920 hrs
J.	Information received in CEA	:	28.01.2021
К.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous maintenance	:	Information not available
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/ Description of failure	:	Information not available
Р.	Details of Tests done after failure	:	Information not available
Q.	Observations and Probable cause of failure	:	Heavy noise observed & smoke emanated from 'R' Phase SA. However, since no previous test records are available, it is difficult to ascertain the cause of failure

А.	Name of Substation	:	Gokarna
В.	Utility/Owner of substation	:	WBSETCL
С.	Faulty Equipment	:	Y Phase Surge Arrestor of 220 kV Krishnanagar ckt-
			2
D.	Rating	:	198 kV
E.	Make	••	OBLUM
F.	Sr. No.	••	Information not available
G.	Year of manufacturing	••	2009
Η.	Year of commissioning	••	Information not available
I.	Date and time of	:	24.08.2019 at 0644 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	24.09.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Replaced
М.	Details of previous	:	Last annual maintenance done in <u>2017</u> . No
	maintenance		abnormalities were observed
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 24.08.2019 at 0644 hrs, the SA failed. No further
	Description of failure		information available from the utility
Р.	Details of Tests done after	:	Done as per standard procedure of the utility. No
	failure		further information available.
Q.	Observations and Probable	:	Could not be concluded due to lack of information.
	cause of failure		Frequency of maintenance could be increased

86. Failure of 198 kV Surge Arrestor at Gokarna substation of WBSETCL



Α.	Name of Substation	:	Midnapore
В.	Utility/Owner of substation	:	WBSETCL
С.	Faulty Equipment	:	B Phase Surge Arrestor of 220 kV Midnapore-
			Arambag ckt-1
D.	Rating	:	198 kV
Е.	Make	:	OBLUM
F.	Sr. No.	:	Information not available
G.	Year of manufacturing	:	2014
Н.	Year of commissioning	:	2015
I.	Date and time of	:	08.08.2019 at 0949 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	24.09.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	••	Replaced
M.	Details of previous	•••	Last annual maintenance done in 2018. No
	maintenance		abnormalities were observed
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 08.08.2019 at 0949 hrs, the SA failed.
	Description of failure		
P .	Details of Tests done after	:	Done as per standard procedure of the utility. No
	failure		further information available.
Q.	Observations and Probable	:	Could not be concluded due to lack of information.
	cause of failure		

87. Failure of 198 kV Surge Arrestor of Midnapore substation of WBSETCL



A.	Name of Substation	:	KGP
В.	Utility/Owner of substation	:	WBSETCL
С.	Faulty Equipment	:	B Phase Surge Arrestor of 220 kV Vidyasagar-
			KGP ckt-2
D.	Rating	:	198 kV
E.	Make	:	OBLUM
F.	Sr. No.	:	Information not available
G.	Year of manufacturing	:	2009
Н.	Year of commissioning	:	Information not available
I.	Date and time of	:	10.08.2019 at 1426 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	24.09.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Replaced
M.	Details of previous	:	Last annual maintenance done in 2018. No
	maintenance		abnormalities were observed
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 10.08.2019 at 1426 hrs , the SA failed. No
	Description of failure		further information available from the utility
Р.	Details of Tests done after	:	Done as per standard procedure of the utility. No
	failure		further information available.
Q.	Observations and Probable	:	Could not be concluded due to lack of information.
	cause of failure		

88. Failure of 198 kV Surge Arrestor of KGP substation of WBSETCL



Α.	Name of Substation	:	Burnpur
В.	Utility/Owner of substation	:	DVC
С.	Faulty Equipment	:	B- Phase Surge Arrestor of 220 kV L#229
D.	Rating	:	198 kV
Е.	Make	:	CGL
F.	Sr. No.	:	21955
G.	Year of manufacturing	:	2003
Н.	Year of commissioning	:	2006
I.	Date and time of	:	12.11.2019 at 2127 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	10.12.2019
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
M.	Details of previous	:	Last maintenance done on 07.11.18
	maintenance		
			IR values:
			Stack 1: 3.3 GΩ
			Stack 2: 22.3 GΩ
			Stack 3: NA
			Overall: 5.6 G Ω
			THLC: 23 μA
			Surge counter reading: 23 (at previous
			maintenance)
			Surge counter reading: 29 (just before bursting)
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/	:	On 12.11.2019 at 2127 hrs, the B- Phase Surge
	Description of failure		Arrestor of 220 kV L#229 burst while in operation
P .	Details of Tests done after	:	No tests could be conducted as the SA burst
	failure		
Q.	Observations and Probable	:	Indicative Parameters are within limits. Ageing
	cause of failure		could be the probable cause of failure



А.	Name of Substation	:	HAL Bengaluru
В.	Utility/Owner of substation	:	KPTCL
С.	Faulty Equipment	:	Surge Arrestor
D.	Rating	:	220 kV
E.	Make	:	CGL
F.	Sr. No.	:	51628
G.	Year of manufacturing	:	2006
Η.	Year of commissioning	:	2008
I.	Date and time of	:	29.01.20 at 1634 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	04.08.20
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Replaced
М.	Details of previous maintenance	:	Last maintenance done on 11.05.2019
N.	Details of previous failure	:	No previous failure
О.	Sequence of events/ Description	:	On 29.01.20 at 1634 hrs, 220 kV HAL-Hoody line
	of failure		1 tripped on DPR, 86A, 86 B and 67 B with
			following fault currents:
			R-ph 2.23 kA
			Y-ph 12.25 kA
			B-ph 1.2 kA
			SA had flash over
Р.	Details of Tests done after failure	:	No test could be conducted
Q.	Observations and Probable cause	:	As no previous test records are available, it is
	of failure		difficult to ascertain the cause of failure.

90. Failure of 220 kV Surge Arrestor at HAL, Bengaluru substation of KPTCL

А.	Name of Substation	:	TSS Panvel
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	B-ph Surge Arrestor of 220kV ONGC-TSS Line
D.	Rating	:	198Kv
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
E.	Make	:	OBLUM ELECTRICALS
F.	Sr. No.	:	117
G.	Year of manufacturing	:	2009
Η.	Year of commissioning	:	27.12.2010
I.	Date and time of	:	08.07.2020 at 1330 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	During last maintenance, LCM test was carried out on
	maintenance		18.04.2020 and test results are as follows:
			Ir = 143 micro Amp; It = 1.361 mA; Ic = 209 micro
			Amp
			Also, IR test was carried on 18.03.2020 and the value
			during the test was found to be 1.02 Gohm.
Ν.	Details of previous failure	:	No Previous failures
О.	Sequence of events/	:	On 08.07.2020, 220kV ONGC-TSS Line tripped on
	Description of failure		Line Differential protection at both ends.
Р.	Details of Tests done after	:	No tests could be conducted as SA blasted
	Tanure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.

91. Failure of 220 kV Surge Arrestor at TSS Panvel substation of MSETCL

	Name of Substation		ONGC Panyal
A.		•	
В.	Utility/Owner of substation	:	MISEIUL
С.	Faulty Equipment	:	Y-ph Surge Arrestor of 220/33-22kV PTR-2
D.	Rating	:	198kV
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
E.	Make	:	LAMCO IND LTD
F.	Sr. No.		1128
G.	Year of manufacturing	:	NA
Н.	Year of commissioning	:	24.02.2010
I.	Date and time of	•••	17.08.2020 at 0555 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during		Operation
L.	Present condition of equipment	:	Not repairable
			_
М.	Details of previous	:	During last maintenance, LCM test was carried out on
	maintenance		18.04.2020 and test results are as follows:
			Ir = 75 micro Amp; It = 1 mA; Ic = 110 micro Amp
			Also, IR test was carried on 04.03.2020 and the value
			during the test was found to be 658 Mohm.
Ν.	Details of previous failure	:	No Previous failures
O.	Sequence of events/	:	On 17.08.2020, PTR-2 tripped from HV and LV side
	Description of failure		on differential protection.
Р.	Details of Tests done after	:	No tests could be conducted as SA blasted
	failure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.
		•	-

92. Failure of 220 kV Surge Arrestor at ONGC Panvel substation of MSETCL

А.	Name of Substation	:	ONGC Panvel
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	R-ph Surge Arrestor of 220kV ONGC-TSS Line
D.	Rating	:	198kV
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
E.	Make	:	OBLUM ELECTRICALS
F.	Sr. No.	:	9/38/23
G.	Year of manufacturing	:	NA
Η.	Year of commissioning	:	2013
I.	Date and time of	:	07.08.2020 at 2315 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	During last maintenance, LCM test was carried out on
	maintenance		18.04.2020 and test results are as follows:
			Ir = 130 micro Amp; It = 1.07 mA; Ic = 190 micro Amp
			Also, IR test was carried on 18.03.2020 and the value
			during the test was found to be 1.37 Gohm.
N.	Details of previous failure	:	No Previous failures
О.	Sequence of events/	:	On 07.08.2020, 220kV ONGC-TSS Line tripped on
	Description of failure		Line Differential protection at both ends.
Ρ.	Details of lests done after	:	No tests could be conducted as SA blasted
	lanure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.

93. Failure of 220 kV Surge Arrestor at ONGC Panvel substation of MSETCL

Α.	Name of Substation	:	URAN
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment		R-ph Surge Arrestor of GT UNIT-5
D.	Rating	:	198kV
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
E.	Make	:	OBLUM ELECTRICALS
F.	Sr. No.	:	NA
G.	Year of manufacturing	:	2010
Н.	Year of commissioning		12.08.2011
I.	Date and time of	:	20.08.2020 at 0317 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
			-
М.	Details of previous	:	During last maintenance, LCM test was carried out on
	maintenance		15.05.2019 and test results are as follows:
			Ir = 174 micro Amp; $It = 1.731$ mA; $Ic = 39$ micro Amp
			Also, IR test was carried on 18.03.2020 and the values
			obtained during the test are as follows:
			For Top = 685Mohm; Middlle = 780 Mohm; Bottom
			= 1.3 Gohm; Top-Bottom $= 2.7$ Gohm
N.	Details of previous failure	:	No Previous failures
О.	Sequence of events/	:	On 20.08.2020, GT-5 tripped due to busting of R-ph
	Description of failure		SA.
Р.	Details of Tests done after	:	No tests could be conducted as SA blasted
	failure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.

94. Failure of 220 kV Surge Arrestor at URAN substation of MSETCL

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Α.	Name of Substation	:	Talegaon Ambi
B.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	Y-ph Surge Arrestor of Talegaon-Urse-1 Line
D.	Rating	:	198kV
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
E.	Make	••	OBLUM ELECTRICALS
F.	Sr. No.	••	1151
G.	Year of manufacturing	•••	2010
Н.	Year of commissioning	•••	21.04.2011
I.	Date and time of	:	10.08.2020 at 1140 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
			-
M.	Details of previous	:	During last annual maintenance, LCM test was carried
	maintenance		out on 19.05.2020 and the value of current obtained
			was 177 microAmp.
N.	Details of previous failure	:	No Previous failures
	-		
Ο.	Sequence of events/	:	On 10.08.2020, Talegaon-Urse-1 Line tripped on
	Description of failure		distance protection.
Р.	Details of Tests done after	:	No tests could be conducted as SA blasted
	failure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.
L			\sim

95. Failure of 220 kV Surge Arrestor at Talegaon Ambi substation of MSETCL

А.	Name of Substation	:	220kV Ranjangaon
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	Y-ph Surge Arrestor of 220/132kV, 200 MVA ICT-1
D.	Rating	:	198kV
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
E.	Make	:	CGL
F.	Sr. No.	:	2192
G.	Year of manufacturing	:	1998
H.	Year of commissioning	:	28.03.2001
I.	Date and time of	:	25.10.2020 at 1830 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous	:	During last annual maintenance, LCM test was carried
	maintenance		out on 02.05.2020 and the value of current obtained
			was 57.8 microAmp
N.	Details of previous failure	:	No Previous failures
Ο.	Sequence of events/	:	On 25.10.2020, HV & LV CB of ICT-1 tripped on
	Description of failure		differential protection.
P.	Details of Tests done after	:	No tests could be conducted as SA blasted
	failure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.

96. Failure of 220 kV Surge Arrestor at Ranjangaon substation of MSETCL

Α.	Name of Substation	:	220kV Ranjangaon
В.	Utility/Owner of substation		MSETCL
C.	Faulty Equipment		Y-ph Surge Arrestor of 220 kV, Utech-Ranjangaon
			line
D.	Rating	:	198kV
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
E.	Make	:	CGL
F.	Sr. No.	:	2191
G.	Year of manufacturing	:	1999
Н.	Year of commissioning	:	28.03.2001
I.	Date and time of	:	15.11.2020 at 1745 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
М.	Details of previous		During last annual maintenance, LCM test was carried
	maintenance		out on 02.05.2020 and the value of current obtained
			was 25.5 microAmp
N.	Details of previous failure	:	No Previous failures
О.	Sequence of events/	:	On 15.11.2020, Distance Protection operated on Y-Ph
	Description of failure		to Earth fault at distance 0.4km with fault current
			5800A, at 220kV Ranjangaon SS.
Р.	Details of Tests done after	:	No tests could be conducted as SA blasted
	failure		
Q.	Observations and Probable	:	As no tests were conducted after the failure, it is
-	cause of failure		difficult to ascertain the cause of failure. However,
			insulation failure might be the reason of failure.

97. Failure of 220 kV Surge Arrestor at Ranjangaon substation of MSETCL

	Name of Substation		
A.		:	400KV KS Kalwa
<u>В</u> .	Utility/Owner of substation	:	MSEICL
С.	Faulty Equipment	:	R-ph Surge Arrestor of 220 kV Bapgaon line
D.	Rating	:	198kV
			Nominal Discharge Current = 10kA
			Pressure Relief Current = 40 kA
			Long Duration Discharge CLASS 3
Е.	Make	:	LAMCO Industries
F.	Sr. No.	:	888ABC
G.	Year of manufacturing	:	2009
Н.	Year of commissioning	:	27.12.2011
I.	Date and time of	:	19.07.2020
	occurrence/discovery of fault		
J.	Information received in CEA	:	07.12.2021
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Not repairable
	1 1		
M.	Details of previous maintenance	:	During last annual maintenance, LCM test was carried out R-ph SA on 15.04.2020 and test results are as follows: Ir = 349 micro Amp; It = 1343 mA; Ic = 239 microAmp Also, IR test was carried on 04.05.2020 and the values obtained during the test are as follows: For Top = 137Mohm; Middlle = 178.5 Mohm; Bottom = 180.1Mohm; Top-Bottom = 121.5 Kohm
N.	Details of previous failure	:	No Previous failures
О.	Sequence of events/ Description of failure	:	On 19.07.2020, 220kV Bapgaon line was tripped on distance protection due to failure of SA.
Р.	Details of Tests done after failure	:	No tests could be conducted as SA blasted
Q.	Observations and Probable cause of failure	:	As no tests were conducted after the failure, it is difficult to ascertain the cause of failure. However, insulation failure might be the reason of failure.

98. Failure of 400 kV Surge Arrestor at RS Kalwa substation of MSETCL

Α.	Name of Substation	:	220 kV Malegaon, Nashik
В.	Utility/Owner of substation	:	MSETCL
C.	Faulty Equipment	:	Y-phase Lightning Arrestor of 220/33 kV 50 MVA
			Kanohar make PTR
D.	Rating	:	Rated Voltage 198 kV
E.	Make	:	METOVAR
F.	Sr. No.	:	123140124
G.	Year of manufacturing	:	2006
Н.	Year of commissioning	:	2008
I.	Date and time of	:	30.08.2020 at 04:22 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	21.01.2022
Κ.	Fault discovered during	:	Operaion
L.	Present condition of equipment	:	Beyond repair
М.	Details of previous	:	Maintenance done on 07.05.2020, 13.06.2019,
	maintenance		20.03.2018, 26.05.2017
N.	Details of previous failure	:	NA
О.	Sequence of events/	:	PTR tripped on differential protection. During
	Description of failure		inspection, smoke was observed from all stacks of the
			LA
Р.	Details of Tests done after	:	Damaged and beyond repair
	failure		
Q.	Observations and Probable	:	May be due to ageing and consistently high voltage to
	cause of failure		which these equipments have been subjected. Voltage
			especially during the last 10 days was above 240 kV
			almost 10 hrs daily. This is causing excessive stress on
			all equipment.

99. Failure of 220 kV Surge Arrester at 220 kV Malegaon, Nashik



Α.	Name of Substation	:	220 kV Malegaon, Nashik
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	•••	Y-phase Lightning Arrestor of 220kV Shivajinagar
			line
D.	Rating	:	Rated voltage: 198 kV
Е.	Make	:	OBLUM
F.	Sr. No.	:	2
G.	Year of manufacturing	:	-
Н.	Year of commissioning	:	2011
I.	Date and time of	:	23/8/2020 at 01:44 hrs.
	occurrence/discovery of fault		
J.	Information received in CEA	:	21.01.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair
М.	Details of previous maintenance	:	Maintenance done on 07.05.2020, 13.06.2019,
			20.03.2018, 26.05.2017
N.	Details of previous failure	:	NA
О.	Sequence of events/ Description	:	At 01:19 hrs Malegaon end CB tripped while
	of failure		Shivajinagar end CB remained on. Line currents
			were unbalanced. At 01:44 hrs loud noise and
			sparks were observed from Y phase LA at
			Malegaon and simultaneously Shivajimagar CB
			also tripped.
Р.	Details of Tests done after failure	:	Damaged beyond repair
Q.	Observations and Probable cause	•••	Y phase jump of line at loc. No. 204 was found
	of failure		disconnected. It appears to have remained hanging
			and line remained charged.
			Later the jump might have got earthed/touched
			other phase leading to tripping and damage to LA.
			Also this pocket has issue of consistently high
			voltage many times more than 245kV. This has
			caused stress on many equipment.

100. Failure of Surge arrester at 220 kV Malegaon, Nashik



Α.	Name of Substation	:	220 kV Warora
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	R-Ph HV Surge Arrestor of 220/66 kV PTR
D.	Rating	:	Rated voltage: 198 kV
E.	Make	:	ELPRO
F.	Sr. No.	:	NA
G.	Year of manufacturing	:	2004
Н.	Year of commissioning	:	2004
I.	Date and time of	:	30.07.2019 at 13:50 Hrs.
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair (Flash mark on LA)
М.	Details of previous maintenance	:	LCM could not be taken as LA bottom is directly
			earthed. Hence, IR values were taken on 07.07.2019
			and result was $8G\Omega$.
N.	Details of previous failure	:	NA
О.	Sequence of events/ Description	:	Transformer tripped on differential protection.
	of failure		After inspection, flashover marks observed on HV
			side of R-Ph SA. Testing team declared HV side R-
			Ph SA faulty as IR values of Transformer with R-
			Ph LA found zero M Ω . Replaced with healthy SA.
Р.	Details of Tests done after failure	:	IR values taken and found $0 \text{ M}\Omega$.
Q.	Observations and Probable cause	:	LA might have failed due to ageing and heavy
	of failure		lightning.

101. Failure of Surge arrester at 220 kV Warora Substation of MSETCL



102. Failure of Surge arrester at 220 kV Old GCR Parli-V Substation of MSETCL

Α.	Name of Substation	:	220 kV Old GCR Parli-V
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	B-Ph Surge Arrestor of 220 kV Parli-Harangul Ckt
			Ι
D.	Rating	:	Rated voltage: 198 kV
E.	Make	:	CGL
F.	Sr. No.	:	9948
G.	Year of manufacturing	:	2000
Н.	Year of commissioning	:	2005
I.	Date and time of	:	02.10.2019 at 11:19 Hrs.
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair
М.	Details of previous maintenance	:	LCM taken on 21.05.2019
			$I_r = 2 \mu A$
			$I_{rcorr} = 3 \mu A$
			$I_{rt}=29 \ \mu A$
N.	Details of previous failure	:	NA
О.	Sequence of events/ Description	:	Distance protection operated: Very small distance
	of failure		sensed by the relay.
			220 kV Bus coupler bay tripped – Heavy current
			flow from bus coupler.
Р.	Details of Tests done after failure	:	No test could be done as completely damaged.
Q.	Observations and Probable cause	:	LA might have failed due to heavy storm and
	of failure		lightning.



tility/Owner of substation	••	MSETCL
ulty Equipment	:	220 kV R-Ph SA of 220 kV Lote-Dasturi Line
ating		198 kV
ake	:	W S Industries
: No.	:	R-91-9-610
ear of manufacturing	:	1991
ear of commissioning	:	1992
ate and time of	:	11.07.2020 at 03:43 Hrs
currence/discovery of fault		
formation received in CEA	:	22.02.2022
ult discovered during	:	Operation
resent condition of equipment	:	LA Burst and beyond repair
etails of previous maintenance	:	LCM test conducted twice in a year. LCM test done
		on 23.05.2020
		$I_{r.corre} = 1019 \ \mu A$
		$I_t = 1019 \ \mu A$
		$I_r = 205 \ \mu A$
		Insulator part cleaned & other maintenance done
		during pre-monsoon maintenance work.
etails of previous failure	:	NA
equence of events/ Description	:	Lote – Dasturi line tripped from both end due to
failure		failure of R Phase SA at Lote S/s.
etails of Tests done after failure	:	Tests could not be done as SA completely damaged.
bservations and Probable cause	:	SA might have failed due to ageing.
failure		
	ulty Equipment ting ake No. ear of manufacturing ear of commissioning tte and time of currence/discovery of fault formation received in CEA ult discovered during esent condition of equipment etails of previous failure quence of events/ Description failure etails of Tests done after failure oservations and Probable cause failure	ulty Equipment : ting : ake : ake : No. : ear of manufacturing : ear of commissioning : currence/discovery of fault : formation received in CEA : ult discovered during : esent condition of equipment : etails of previous failure : etails of previous failure : etails of Tests done after failure : oservations and Probable cause : failure :

103. Failure of Surge arrester at 220 kV Lote Substation of MSETCL



Α.	Name of Substation	:	400 kV Karad
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	220 kV B-Ph SA of ICT-III
D.	Rating	:	198 kV
E.	Make		LAMCO
F.	Sr. No.	•••	858
G.	Year of manufacturing	•••	2009
Η.	Year of commissioning	:	2010
I.	Date and time of	:	18.07.2020 at 21:40 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	•••	22.02.2022
Κ.	Fault discovered during	•••	Operation
L.	Present condition of equipment	:	Beyond repair
М.	Details of previous maintenance	:	LCM test done on 30.04.2020
			$I_{r.corre} = 40 \ \mu A$
			$I_t = 977 \ \mu A$
			$I_r = 34 \ \mu A$
N.	Details of previous failure	:	NA
О.	Sequence of events/ Description	:	400/220 kV, 315 MVA ICT-III tripped on
	of failure		differential protection. During inspection it was
			observed that LV side B-Ph SA has got burst.
Р.	Details of Tests done after failure	:	Tests could not be done as SA completely damaged.
Q.	Observations and Probable cause	:	SA might have failed due to heavy rain and
_	of failure		lightning.

104. Failure of Surge arrester at 400 kV Karad Substation of MSETCL



Α.	Name of Substation	:	220/33 kV Halkarni Substation
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	Y Ph LA of 25 MVA Transformer
D.	Rating	:	198 kV
E.	Make	:	CGL
F.	Sr. No.	:	9510137
G.	Year of manufacturing	:	1995
Н.	Year of commissioning	:	1996
I.	Date and time of	:	15.09.2020 at 03:27 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair
М.	Details of previous maintenance	:	LCM test done on 28.05.2020
			$I_{r.corre} = 65 \ \mu A$
			$I_t = 805 \ \mu A$
			$I_r = 60 \ \mu A$
N.	Details of previous failure	:	NA
О.	Sequence of events/ Description	:	25 MVA, 220/33 kV Transformer tripped due to
	of failure		bursting of Y Ph LA.
Р.	Details of Tests done after failure	:	Tests could not be done as SA completely damaged.
Q.	Observations and Probable cause	:	SA might have failed due to ageing aggravated by
	of failure		rainy weather.

105. Failure of Surge arrester at 220 kV Halkarni Substation of MSETCL



А.	Name of Substation	:	220kV Virur Substation
В.	Utility/Owner of substation	:	MSETCL
С.	Faulty Equipment	:	220 kV Y-Ph LA of 220 kV Virur TSS Ckt-2
D.	Rating	:	198 kV
E.	Make	:	LAMCO
F.	Sr. No.	:	263C
G.	Year of manufacturing	:	2007
Н.	Year of commissioning	:	2011
I.	Date and time of	:	19.10.2020 at 10:50 Hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	22.02.2022
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Beyond repair
М.	Details of previous maintenance	:	LCM test done on 16.05.2020
			$I_{r.corre} = 21 \ \mu A$
			IR (Top to Earth)= $6 G\Omega$
N.	Details of previous failure	:	NA
О.	Sequence of events/ Description	:	Y Ph LA burst on 19.10.2020 at 10:50 Hrs while
	of failure		shifting on TBC due to problem in main CB.
Р.	Details of Tests done after failure	:	Tests could not be done as SA completely damaged.
Q.	Observations and Probable cause	:	
	of failure		

106. Failure of Surge arrester at 220 kV Virur Substation of MSETCL



XLPE CABLE

107. Failure of 220 kV XLPE cable between Maharani Bagh and Trauma Centre Substation of Delhi Transco Ltd.(DTL)

Α.	Name of Substation	:	Between Maharani Bagh and Trauma Centre
В.	Utility/Owner of substation	:	DTL
С.	Faulty Equipment	:	XLPE cable
D.	Rating	:	220 kV
Е.	Make	:	LS cables
F.	Sr. No.	:	NA
G.	Year of manufacturing	•••	2010
Н.	Year of commissioning	:	2011
I.	Date and time of	:	19.06.19 at 1130 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	21.06.19
Κ.	Fault discovered during	•••	Operation
L.	Present condition of equipment	:	Damaged, not repairable
М.	Details of previous maintenance	:	As per utility's Maintenance schedule. No further
			information available
N.	Details of previous failure	:	No information available
О.	Sequence of events/ Description	:	On 19.06.19 at 1154 hrs both Circuits J and D of M.
	of failure		bagh- Trauma centre tripped and the cable caught
			fire.
Р.	Details of Tests done after failure	:	No tests could be conducted as the cable was burnt
Q.	Observations and Probable cause	:	It is difficult to ascertain the cause of failure as the
	of failure		only information that can be gathered from the
			utility's report suggests that the circuit tripped and
			cable caught fire.

А.	Name of Substation	:	Masjid Moth
В.	Utility/Owner of substation	:	DTL
С.	Faulty Equipment	:	XLPE cable
D.	Rating	:	220 kV
E.	Make	:	TBEA
F.	Sr. No.	:	NA
G.	Year of manufacturing	:	Information not available
Н.	Year of commissioning	:	Information not available
I.	Date and time of	:	19.06.19 at 1100 hrs
	occurrence/discovery of fault		
J.	Information received in CEA	:	21.06.19
Κ.	Fault discovered during	:	Operation
L.	Present condition of equipment	:	Damaged, not repairable
М.	Details of previous maintenance	:	As per utility's Maintenance schedule. No further
			information available
N.	Details of previous failure	:	Cable joining work was done near New friends
			colony in March 2018
О.	Sequence of events/ Description	:	On 19.06.19 at 1100 hrs 220 kV underground cable
	of failure		under Barapula flyover caught fire while in
_			operation, damaging both sources of Masjid Moth
Р.	Details of Tests done after failure	:	No tests could be conducted as the cable was burnt
Q.	Observations and Probable cause	:	It is difficult to ascertain the cause of failure as the
	of failure		only information that can be gathered from the
			utility's report suggests that the circuit tripped and
			cable caught fire.

108. Failure of 220 kV XLPE cable between Maharani Bagh and Masjid Moth Substation of Delhi Transco Ltd.(DTL)


109. Failure of 220 kV cable joint on Aarey – MSETCL Borivali line

A.	Name of Substation	:	220kV Aarey EHV Substation			
В.	Utility/Owner of substation	:	Adani Electricity Mumbai Ltd –			
			Transmission			
С.	Faulty Equipment	:	220kV Cable Joint at JC-06			
			(220kV Aarey - MSETCL Borivali			
			Line-1)			
D.	Rating	:	Joint suitable for 220 kV 1C X 1200 Sq.mm. XLPE			
			Cable, Copper conductor, Capacitance equivalent to			
			cable i.e 0.191pF i.e , Current			
			Rating – 800A			
E.	Make	:	Cable Joint - M/s NKT, Germany			
			XLPE Cable - M/s SFC, China			
F.	Sr. No.	:	NA			
G.	Year of manufacturing	:	2018			
Н.	Year of commissioning	:	2020			
I.	Date and time of	:	07/01/2022 at 11:58 Hrs.			
	occurrence/discovery of fault					
J.	Information received in CEA	:	21.01.22			
К.	Fault discovered during	:	Operation: Tripping of 220kV Aarey – MSETCL			
			Borivali Line-1			
L.	Present condition of equipment	:	Repaired (Cable Joint replaced)			
М.	Details of previous maintenance	:	Pre-commissioning Cable testing carried out on			
			04/03/2020. No abnormality observed in this test			
N.	Details of previous failure	:	NA			
О.	Sequence of events/ Description	:	2022 01 07 11:58:47:560- Differential Trip			
	of failure		2022 01 07 11:58:45:561- CB opened			
Р.	Details of Tests done after failure	:	1. Fault Pinpointing by TDR & Surging method			
			2. Cable Sheath testing & Insulation Resistance test			
			after fault rectification work			
Q.	Observations and Probable cause	:	Fault Pre-location & Pinpointing carried out from			
-	of failure		MSETCL Borivali substation.			
			Fault pinpointed @3.6Km distance from MSETCL			
			Borivali Substation at JC-06			



CIRCUIT BREAKER

110. Failure of 420 kV Circuit Breaker at Nelamangala Station of KPTCL

Α.	Name of Substation	:	Nelamangala			
В.	Utility/Owner of substation	:	KPTCL			
С.	Faulty Equipment	:	Circuit Breaker			
D.	Rating	:	420kV, 2500A, 40kA for 3 sec			
E.	Make	:	CGL			
F.	Sr. No.	:	A12401			
G.	Year of manufacturing	:	2000			
H.	Year of commissioning	:	2002(02.02.2002)			
I.	Date and time of occurrence/discovery of fault	:	21.08.2020 at 2232 hrs			
J.	Information received in CEA	:	10.12.2020			
Κ.	Fault discovered during	:	Operation			
L.	Present condition of equipment	:	Not repairable			
M.	Details of previous	:	Last maintenance was done on 18.08.2020. No			
NI	Details of growing failure		Abhormanty observed			
IN.	Details of previous failure	:	No previous failure			
0.	Description of failure	:	On 21.08.2020, the line opening code was iss by SLDC to open 400kV Nelamangala-Talagu line, to maintain the system voltage. At 22:32 the line tie breaker was first opened Nelamangala end & main breaker was ope later. The direct trip sent to Talaguppa end brea Further, line was de-energized. After opening of main breaker i.e. after 10 to sec, heavy sound and huge arcing due to he discharge arc at the R-ph interrupter of 411 (400kV Talaguppa-Hiriyur-1 Tie breaker) towa 400kV Bus side was observed. One of the double break interrupters (towards B side) had flashed over causing damages to and Grading capacitor.			
P.	Details of Tests done after failure	:	No tests could be conducted			
Q.	Observations and Probable	:	Based on the information submitted by the utility,			
	cause of failure		and frequent operations which is subjected to severe surge conditions.			

А.	Name of Substation	:	Doni Cross, Gadag substation			
В.	Utility/Owner of substation	:	KPTCL			
С.	Faulty Equipment		Circuit Breaker			
D.	Rating	:	420kV, 4000 A			
E.	Make	:	Siemens			
F.	Sr. No.	:	2017/IND/01/18411			
G.	Year of manufacturing	:	2017			
Η.	Year of commissioning	:	2018 (16.10.2018)			
I.	Date and time of		18.04.2019 at 19:03 hrs			
	occurrence/discovery of fault					
J.	Information received in CEA	:	06.08.2019			
<u>К</u> .	Fault discovered during	:	Operation			
L.	Present condition of equipment	:	Sent to OEM for further inspection			
М.	Details of previous	:	Information Not available			
	maintenance					
N.	Details of previous failure	:	Information Not available			
О.	Sequence of events/	:	On 18.04.2019 at 19:03 hrs, #403 Bay 400 kV side			
	Description of failure		of bus-1 Main CB, B-ph pole limb of Guttur line			
			flashed over while in service with following			
			indications:			
			Main 2(DPR) If =3.177 kA			
			Busbar prot. Operated			
			#404 bay Breaker failure relay operated			
			Tie breaker tripped			
Р.	Details of Tests done after	:	Siemens representative visited the site and taken			
	failure		damaged failed equipment to their factory for RCA			
			for further investigation. Detailed			
Q.	Observations and Probable	:	As no previous test records are available, it is			
	cause of failure		difficult to ascertain the cause of failure.			

111. Failure of 420 kV Circuit Breaker at Doni Cross, Gadag substation of KPTCL

R. Traine of substation 1 Hody Receiving Station B. Utility/Owner of substation 1 KPTCL C. Faulty Equipment 220kV E. Make 1 ND/05/2510 G. Year of manufacturing 2006 H. Year of commissioning 2006 I. Date and time of occurrence/discovery of fault 01.07.2019 at 0920 hrs J. Information received in CEA 20.11.2019 K. Fault discovered during 0peration L. Present condition of equipment Not repairable. To be replaced M. Details of previous failure 1 No previous failure O. Sequence of events/ 10 n01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure No tests could be conducted		Name of Substation		Hoody Receiving Station		
B. Utility/Owner of substation : KPTCL C. Faulty Equipment : Circuit Breaker D. Rating : 220kV E. Make : Siemens F. Sr. No. : IND/05/2510 G. Year of manufacturing : 2006 H. Year of commissioning : 2008 I. Date and time of occurrence/discovery of fault : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous failure : No previous failure O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR Description of failure : No previous failure O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR Description of failure : No previous failure Period at the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. <td>A.</td> <td colspan="2"></td> <td colspan="3"></td>	A.					
C. Faulty Equipment : Curcuit Breaker D. Rating : 220kV E. Make : Siemens F. Sr. No. : IND/05/2510 G. Year of manufacturing : 2006 H. Year of commissioning : 2008 I. Date and time of occurrence/discovery of fault : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous : Last maintenance : No previous failure : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR Description of failure : No previous failure : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR Description of failure : : No previous failure : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR Ine tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P44	B.	Utility/Owner of substation	:	KPICL		
D. Rating : 220kV E. Make : Siemens F. Sr. No. : IND/05/2510 G. Year of manufacturing : 2006 H. Year of commissioning : 2008 I. Date and time of occurrence/discovery of fault : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : 0peration L. Present condition of equipment : Not repairable. To be replaced M. Details of previous failure : Last maintenance was done on 18.05.2019. No abnormality observed N. Details of previous failure : No previous failure O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure : No tests could be conducted	<u>C.</u>	Faulty Equipment	:	Circuit Breaker		
E. Make : Siemens F. Sr. No. : IND/05/2510 G. Year of manufacturing : 2006 H. Year of commissioning : 2008 I. Date and time of occurrence/discovery of fault : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous failure : No previous failure O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure : No tests could be conducted	D.	Rating	:	220kV		
F. Sr. No. : IND/05/2510 G. Year of manufacturing : 2006 H. Year of commissioning : 2008 I. Date and time of occurrence/discovery of fault : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous failure : Last maintenance was done on 18.05.2019. No abnormality observed N. Details of previous failure : No previous failure O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure : No tests could be conducted	Е.	Make	:	Siemens		
G. Year of manufacturing : 2006 H. Year of commissioning : 2008 I. Date and time of occurrence/discovery of fault : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous maintenance : Last maintenance was done on 18.05.2019. No abnormality observed N. Details of previous failure : No previous failure : O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure : No tests could be conducted	F.	Sr. No.	:	IND/05/2510		
H. Year of commissioning : 2008 I. Date and time of : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous : Last maintenance was done on 18.05.2019. No abnormality observed N. Details of previous failure : No previous failure : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure : No tests could be conducted	G.	Year of manufacturing	:	2006		
I. Date and time of occurrence/discovery of fault : 01.07.2019 at 0920 hrs J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous failure : Last maintenance was done on 18.05.2019. No abnormality observed N. Details of previous failure : No previous failure O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure : No tests could be conducted	H.	Year of commissioning	:	2008		
J. Information received in CEA : 20.11.2019 K. Fault discovered during : Operation L. Present condition of equipment : Not repairable. To be replaced M. Details of previous failure : Last maintenance was done on 18.05.2019. No abnormality observed N. Details of previous failure : No previous failure O. Sequence of events/ : On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion. P. Details of Tests done after failure : No tests could be conducted	I.	Date and time of occurrence/discovery of fault	:	01.07.2019 at 0920 hrs		
K.Fault discovered during:OperationL.Present condition of equipment:Not repairable. To be replacedM.Detailsofprevious:maintenance:Last maintenance was done on 18.05.2019. No abnormality observedN.Details of previous failure:O.Sequence ofevents/Description of failure:On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR line tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion.P.Details of Tests done after failure:No tests could be conducted	J.	Information received in CEA	:	20.11.2019		
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Description of failureline tripped on Main I (SIFANG-CSC101) and Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion.P.Details of Tests done after failure:No tests could be conducted	Ο.	Sequence of events/		On 01.07.2019 at 0920 hrs, 220kV Hoody-HSR		
P.Details of Tests done after:Main II (ALSTOM-P442) Relay. Loud sound was observed in the station yard and it was found that Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion.P.Details of Tests done after failure:	Description of failure			line tripped on Main I (SIFANG-CSC101) and		
P.Details of Tests done after:No tests could be conductedP.Details of Tests done after:No tests could be conducted		Ĩ		Main II (ALSTOM-P442) Relay. Loud sound was		
P.Details of Tests done after failure:Y phase limb of circuit breaker Interrupter portion (upper) had flashed over. Simultaneously ICT-1 and ICT-3 got tripped. During flash-over the porcelain insulator pieces damaged the adjacent R and B phase breaker limb upper portion.				observed in the station yard and it was found that		
P.Details of Tests done after failure:iiiP.Details of Tests done after failure:No tests could be conducted				Y phase limb of circuit breaker Interrupter portion		
P. Details of Tests done after failure : No tests could be conducted				(upper) had flashed over. Simultaneously ICT-1		
P. Details of Tests done after failure No tests could be conducted				and ICT-3 got tripped. During flash-over the		
P. Details of Tests done after failure No tests could be conducted				porcelain insulator pieces damaged the adjacent R		
P. Details of Tests done after : No tests could be conducted				and B phase breaker limb upper portion.		
failure	Р.	. Details of Tests done after		No tests could be conducted		
		failure				
Q. Observations and Probable : As no previous test records are available, it is	Q.	Observations and Probable	:	As no previous test records are available, it is		
cause of failure difficult to ascertain the cause of failure.		cause of failure		difficult to ascertain the cause of failure.		
cause of failure difficult to ascertain the cause of failure		cause of failure		difficult to ascertain the cause of failure.		

112. Failure of 220 kV Circuit Breaker at Hoody Receiving Station of KPTCL

A.	Name of Substation	:	Ragulapadu			
В.	. Utility/Owner of substation		APTRANSCO			
С.	Faulty Equipment	:	B phase limb of Gr. Control Circuit Breaker			
D.	Rating	:	245kV			
E.	Make	:	CGL			
F.	Sr. No.	:	27827C			
G.	Year of manufacturing	:	2009			
Н.	Year of commissioning	:	2011			
I.	Date and time of	:	20.06.2019 at 02:55 hrs			
	occurrence/discovery of fault					
J.	Information received in CEA	:	20.08.2019			
К.	K. Fault discovered during		Operation			
L.	Present condition of equipment		Replaced			
M.	M. Details of previous maintenance		Information not available			
N.	N. Details of previous failure		Information not available			
О.	Sequence of events/ Description	:	On 20.06.2019 at 02:55 hrs the 220kV GCB			
of failure			Metering B-phase Potential Transformer was			
			blasted. At the same time parts of the potential			
			transformer hit the B phase limb of Circuit Breaker			
			which damaged the circuit breaker and became			
			beyond repair.			
P. Details of Tests done after failure		:	Information not available			
Q.	Observations and Probable cause	:	The damage was of collateral with no problem in the			
	of failure		CB			

<u>113.</u> Failure of 245 kV Circuit Breaker at Ragulapadu substation of APTRANSCO



А.	. Name of Substation		Chittoor	
В.	. Utility/Owner of substation		APTRANSCO	
С.	Faulty Equipment	:	Y-ph limb of Kalikiri feeder Circuit Breaker limbs	
D.	Rating	:	245kV, 3150A	
E.	Make	:	ABB	
F.	Sr. No.	:	24500179	
G.	Year of manufacturing	:	2005	
Η.	Year of commissioning	••	2008	
I.	Date and time of	:	02.08.2020 at 02:55 hrs	
	occurrence/discovery of fault			
J.	. Information received in CEA		16.10.2020	
Κ.	K. Fault discovered during		Operation	
L.	. Present condition of equipment		Replaced	
М.	M. Details of previous maintenance		Information not available	
N.	Details of previous failure	:	Information not available	
О.	Sequence of events/ Description	••	Information not available	
	of failure			
Р.	P. Details of Tests done after failure		Information not available	
Q.	Q. Observations and Probable cause		As no previous test records are available, it is	
	of failure		difficult to ascertain the cause of failure.	

114. Failure of 245 kV Circuit Breaker at Chittoor substation of APTRANSCO

Α.	Name of Substation	:	Alamathy				
В.	Utility/Owner of substation	:	TANTRANSCO (TNEB)				
С.	Faulty Equipment	:	R Phase Limb of CB of Manali-II feeder				
D.	Rating	:	245 kV				
E.	Make	:	ALSTOM				
F.	Sr. No.	:	150156				
G.	Year of manufacturing	:	2004				
Η.	Year of commissioning	:	2006				
I.	Date and time of	:	01.11.2019 at 1423 hrs				
	occurrence/discovery of fault						
J.	Information received in CEA	:	25.11.19				
Κ.	Fault discovered during	:	Operation				
L.	Present condition of equipment	:	Replaced				
M.	Details of previous	:	Last Routine Maintenance works done on				
	maintenance		01.11.2019.				
			Details not available.				
N.	Details of previous failure	:	No previous failure				
Ο.	Sequence of events/	:	On 01.11.2019 at 14.23 hrs, heavy sound was				
	Description of failure		observed from CB of 230kV BUS A and the				
			connected feeder with this CB tripped. R phase				
			diaphragm punctured. Local Breaker Break-u				
			protection acted.				
Р.	Details of Tests done after	:	No test could be conducted as R phase diaphragm				
	failure		punctured.				
Q.	Observations and Probable	:	As no previous test records are available, it is				
	cause of failure		difficult to ascertain the cause of failure.				

115. Failure of 245 kV Circuit Breaker at Alamathy substation of TANTRANSCO



WAVE TRAP

116. Failure of 220 kV Wave trap at Nunna substation of APTRANSCO

Α.	Name of Substation	:	Nunna					
В.	Utility/Owner of substation	:	APTRANSCO (TNEB)					
C.	Faulty Equipment	:	B Phase Wave trap of 220kV Nunna-Gunadala					
			feeder					
D.	Rating	:	Inductance: 1mH,					
			800A, Blocking band:85-450kHz,					
			20kA for 1sec					
Е.	Make	:	WSI					
F.	Sr. No.	:	L5869					
G.	Year of manufacturing	:	1991					
H.	Year of commissioning	:	1992 (20.01.1992)					
I.	Date and time of	:	27.08.2020 at 0856 hrs					
	occurrence/discovery of fault							
J.	Information received in CEA	:	30.09.2020					
Κ.	Fault discovered during	:	Operation					
L.	Present condition of equipment	:	Not Repairable					
M.	Details of previous	:	Last periodical maintenance works done on					
	maintenance		31.03.2020.					
			No abnormality was observed.					
N.	Details of previous failure	:	No previous failure					
О.	Sequence of events/	:	On 27.08.2020 at 0856 hrs, B-ph Wave trap					
	Description of failure		structural assembly was damaged.					
Ρ.	Details of Tests done after	:	Information not available					
	failure							
Q.	Observations and Probable	:	As no previous test records are available, it is					
	cause of failure		difficult to ascertain the cause of failure.					



11/.	Failure of 220 KV CC at Theur	30			
Α.	Name of Substation	••	220kV Theur Substation		
В.	Utility/Owner of substation	•••	MSETCL		
C.	Faulty Equipment	•••	R-ph CC of 220kV Jejuri Bay		
D.	Rating	••	245kV, 8000pF		
E.	Make	••	WS		
F.	Sr. No.	••	7002172		
G.	Year of manufacturing	•••	1985		
Н.	Year of commissioning	•••	07.06.1985		
I.	Date and time of	:	01.06.2020 at 0950hrs		
	occurrence/discovery of fault				
J.	Information received in CEA	:	07.12.2021		
Κ.	Fault discovered during	•••	Operation		
L.	Present condition of equipment	•••	Not repairable		
М.	Details of previous	:	During last half yearly maintenance, cleaning and		
	maintenance		connection tightening of 220kV Jejuri Line Bay was		
			done on 10.10.2019.		
Ν.	Details of previous failure	:	No Previous failures		
О.	Sequence of events/	:	On 01.06.2020, failure of R-ph CC of 220kV Jejuri bay		
	Description of failure		takes place which resulted into the tripping of 220kV		
			Theur-Jejuri line on distance protection.		
Р.	Details of Tests done after	:	No tests could be conducted as CC completely burnt.		
	failure				
Q.	Observations and Probable	:	Ageing might be the reason for the failure of CC.		
-	cause of failure				

<u>Coupling Capacitor</u> 117. Failure of 220 kV CC at Theur substation of MSETCL



Annexure – II Format for report of failure of the Transformer/Reactors or Other equipment

Proforma for failure report of other substation equipment

[Circuit Breaker, Instrument Transformers (CT/PT/CVT), Wave Trap, Isolator, Surge Arrester, Coupling Capacitor, Cable]

i.	Name of Substation	•	
ii.	Utility	:	
iii.	Faulty Equipment and the associated feeder	:	
iv.	Rating (Voltage/ current/ current ratio/ capacitance/ MCOV etc., as applicable)	••	
v.	Short circuit withstand current and duration	:	
vi.	Make (Original equipment manufacturer)	•	
vii.	Serial No.	:	
viii.	Date and time of occurrence of fault	:	
ix.	Fault discovered during (Operation or periodic testing/ maintenance)	•	
х.	Weather conditions at the time of failure (clear sky/ rainy / thunderstorm etc.)		
xi.	Year of manufacturing	:	
xii.	Date of commissioning	:	
xiii.	Storage condition of equipment if the gap between delivery at site and commissioningis over 6 months	:	
xiv.	If OEM was contacted after failure, its recommendation/remark/ report/ MoM	:	
XV.	Present condition of equipment (Repaired/ To be repaired / beyond repair)	:	



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?							
xvii.	Details of previous failure	:						
	(Any failure which has led to a major repair of the equipment in the							
	past since its commissioning)							
xviii.	Sequence of events/Description of fault (SOE with time stamp)	:						
xix.	Details of protection operated	:						
xx.	Details of tests done after failure	:						
xxi.	Observations	:						
	(Any relevant observation made by the field staff or during visual							
	inspection)							
xxii.	Probable cause of failure	:						
xxiii.	Attach reports of tests during pre-commissioning,	:						
	periodic maintenance and after failure; Photographs of							
	the failed equipment etc.							

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	:	
х.	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 (OIP/RIP/RIS, Porcelain / polymer 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 arrestor: (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/ N2 Injection based fire protection system/ foam 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 	
XXX1X.	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?
xl.	Number of through faults the equipment was subjected to before failure
xli.	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



Annexure-III Office Order Constituting the Standing Committee

Report on failure of 220 kV and above voltage class substation equipment196





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



No. CEA/SETD/220-0/2012/ / -80

1. I

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	-Member
		Companies/Transmission Companies where Substation	
		Equipment failure has taken place	
~	(v)	Member Secretary of concerned RPC	-Member
	(vi)	Director (SETD), CEA -Mem	ber Secretary

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

(a) To investigate the causes of failure of substation equipment in service(b) 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.



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.

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.

4. Member Secretaries, Regional Power Committees:

- a) NRPC, New Delhib) WRPC, Mumbai
- SRPC, Bangalore c)
- d) ERPC, Kolkata e) NERPC, Shillong
- 5. Chief Engineer (SETD), CEA

6. Director (SETD), CEA.

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

Puri

Report on failure of 220 kV and above voltage class substation equipment 198



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 2nd August 2022 in CEA



File No.CEA-PS-14-97/3/2018-PSETD Division-Part(5)







भारत सरकार Government of India विद्युत मंत्रालय Ministry of Power केन्द्रीय विद्युत प्राधिकरण Central Electricity Authority विद्युत प्रणाली अभियांत्रिकी एवं प्रौद्योगिकी विकास प्रभाग Power System Engineering & Technology Development Division

To,

<As per attached List>

विषय: Minutes of the meeting of Standing Committee of Experts to investigate the failure of equipment at 220 kV & above sub-stations held on 02.08.2022.

महोदया/ महोदय,

The meeting of the Standing Committee of experts to investigate failure of 220 kV and above substation equipment was held on 02.08.2022 at 10:30 PM through video conferencing under the chairmanship of Chief Engineer (PSE&TD), CEA. The minutes of the meeting are attached for information and necessary action.

भवदीय

21pl S

(योगेन्द्र कुमार स्वर्णकार/Y.K.Swarnkar) निदेशक/Director Director, CEA & Member Sectretary of the Committee

सेवा भवन, रामाकृष्ण पुरम, सेक्टर -1, नई दिल्ली -110 066, ई-मेल: <u>ce-psetd@gov.in</u>, फ़ोन: 011 26732342 Sewa Bhawan, R. K. Puram, Sector-1, New Delhi-110 066, E-mail: <u>ce-psetd@gov.in</u>. Tel: 011 26732342 15



List of Addressees

1	Member-Secretary Northern Regional Power Committee, 18-A, Qutab Institutional Area, Shaheed Jeet Singh Marg, Katwaria Sarai, New Delhi110016	ms-nrpc@nic.in.
2	Member-Secretary Southern Regional Power Committee No. 29, Race Course Cross Road, Bengaluru- 560009	mssrpc-ka@nic.in,
3	Member-Secretary Western Regional Power Committee F-3, MIDC Area, Marol, Opposite SEEPZ, Central Road, Andheri (East), Mumbai-400093	ms-wrpc@nic.in.
4	Member-Secretary Eastern Regional Power Committee 14, Golf Club Rd, Golf Gardens, Tollygunge, Kolkata, West Bengal- 700033	mserpc-power@nic.in.
5	Director, IIT, Hauz Khas, New Delhi	director@admin.iitd.ac.in
6	Chairman & Managing Director, Power Grid Corporation of India Ltd., Saudamini, Plot No. 2, Sector-29, Gurgaon-122001 (Harvana)	cmd@powergrid.in.
7	Director General, Central Power Research Institute, P B No.8066, Sadashivnagar PO, Prof. Sir C V Raman Road, Bangalore - 560 080	dgcpri@cpri.in, mchandra@cpri.in,
8	Chairman & Managing Director, Power Grid Corporation of India Ltd., Saudamini, Plot No. 2, Sector-29, Gurgaon-122001 (Haryana)	cmd@powergrid.in,
9	Chairman & Managing Director, Delhi Transco. Ltd., Shakti Sadan, Kotla Marg, New Delhi- 110002	md@dtl.gov.in, gmom1.dtl@gmail.com,
1	 Chairman Haryana Vidyut Prasaran Nigam Ltd. Shakti Bhawan, Sector No. 6 Panchkula 134 109, Haryana 	chairman@hvpn.org.in.

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11.	Chairman Kerala State Electricity Board Board Secretariat Vidyuthi Bhavanam Pattom Thiruvananthapuram- 695 004	cmdkseb@kseb.in,
12.	Chairman & Managing Director Maharashtra State Electricity Transmission Company Ltd., C-19, E-Block, Prakashganga, Bandra- Kurla Complex Bandra(E), Mumbai 400 051	md@mahatransco.in.
13.	Chairman West Bengal State Electricity Transmission Company Ltd (WBSETCL) Vidyut Bhawan, Block-DJ, Sector-II, Bidhan Nagar, Kolkata- 700 091.	md@wbsetcl.in.
14.	Managing Director Karnataka Power Transmission Corporation Ltd., Kaveri Bhawan Bangalore -560009	md@kptcl.com,
15.	Chairman Damodar Valley Corporation, DVC Towers, VIP Road, Kolkata – 700 054	chairman@dvc.gov.in,
16.	Chairman & Managing Director SJVN Ltd. Himfed Building, New Shimla – 171 009	sectt.cmd@sjvn.nic.in.
17.	Head – Transmission Business Adani Transmission (India) Ltd. Sambhav House, Judges Bungalow Road, Bodakdev Ahmedabad – 380 015 (Gujarat)	sameer.ganju@adani.com,
18.	Chief General Manager Western UP Power Transmission Co. Ltd. 400/300/33KV Sub Station, Indirapuram Kalapatthar Ghaziabad- 201010	swapnil.wupptcl@gmail.com,



Minutes of the Meeting of Standing Committee of experts to investigate the failure of substation equipment at 220 kV & above voltage class (April 2019 to December 2021) held on 02.08.2022 through video conferencing.

A meeting of Standing Committee of experts to investigate the failure of substation equipment at 220 kV & above voltage class (April 2019 to December 2021) was held through video conferencing on 02.08.2022 under the chairmanship of Sh. Ashok Kumar Thakur, Chief Engineer, PSETD, CEA, and Chairman of the committee.

List of participants is attached as Annexure.

- 1. Chief Engineer, PSETD, welcomed all the participants of the meeting and highlighted a brief background about the formation and mandates of the committee. It was highlighted that for the period of April 2019 to December 2021, a total of 119 incidents of failure of substation equipment were reported to CEA by 14 utilities (PGCIL, MSETCL, DTL, WUPPTCL, HVPNL, TANTRANSCO, APTRANSCO, KPTCL, SJVNL, KSEB, DVC, NPCIL, Adani and WBSETCL). Out of the 119 incidents there have been failures of 26 Nos. Transformers, 9 Nos. Reactors, 22 Nos. Current Transformers (CT), 11 Nos. Potential Transformer/ capacitive Voltage Transformer (CVT), 40 Nos. Surge Arrester, 6 Nos. Circuit Breaker (CB), 3 Nos. XLPE cable, 1 No. Wavetrap and 1 No. Coupling Capacitor during the aforementioned period. He requested all the members to ensure timely maintenance and monitoring of substation equipment to reduce their failures. He also stressed upon timely intimation of incidents of failure to CEA 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.
- 2. 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.

- 3. 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.
- 4. PGCIL stated that during internal inspection of one of the transformers, OLTC lead was found to be touching IV side support structure. As there was no built-up of any gases in past DGA results this problem could not be anticipated. DTL also attributed one of the failure of its transformer to such long leads installed by the manufacturer. Considering the above, the committee members advised all the utilities to be extra careful during installation of transformers at site and long hanging connecting leads which might touch with other parts of the transformer, should be avoided.
- 5. On a query on POWERGRID's standard practice for DGA analysis, POWERGRID informed that they follow categorization of DGA results based on IEC C.57.104-2019 into Status 1, Status 2 and Status 3 considering mainly the age of equipment and O₂/N₂ ratio. Further investigation is carried based upon Duval triangle, Duval Pentagon and Normative Energy Intensity Index. It was further informed that for normal Transformer DGA analysis is done once in six months, Oil parameter test is done once in a year and Furan test is done once in 4 years to check for healthiness. If moisture content is found to be more than 20 ppm in oil and 2.5 ppm in the winding, filtration of oil is carried out.
- 6. POWERGRID informed that it has developed an in-house diagnosis software which categorizes Transformer/ Reactor based on their health as Excellent, Very Good, Low Severity, Medium Severity and High severity. For equipment under Medium and High severity category, DGA frequency is increased and DGA is done on monthly basis. DGA is done on 3 monthly basis for equipment under Low severity category. Further, if the rate of rise of gases is increasing in these results and equipment is in high severity category internal inspection is carried out. POWERGRID further informed that no adverse action is taken based only on one gas reported in DGA and quoted an example of 125 MVAr reactor wherein there



was an issue in Bushing leading to formation of acetylene (C₂H₂). Even after replacement of bushing, acetylene was still reported in DGA (residual gas) but the reactor was healthy. Sh. Dilip Devasthale (Adani Power) was of the view such practice of running a transformer and reactor with acetylene shall not be promoted. Sh. I.S. Bajwa, BBMB recommended for carrying out de-gassing of the equipment so as to avoid any residual C₂H₂, as it is an inflammable gas. In response to the above suggestions, POWERGRID stated that de-gassing is carried out only in some rare cases as proper monitoring could not be ascertained and track record of gases in DGA is lost. Also, they focus on rate of rise of gases in DGA results for better monitoring rather than residual gases. Regarding monitoring of healthiness of Bushings, POWERGRID informed that apart from carrying out capacitance and Tan Delta of bushing on yearly basis, they also carry out Variable Frequency Tan Delta for identification of failure in initial stages.

- 7. Director, PSETD informed all members that CEA had prepared "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV & above)" after detailed deliberations amongst all the major stakeholders and is available on its website. He advised all the utilities to follow the document as the adoption of the document would help the utilities in procuring high quality Transformers/ Reactors with specified losses. Further, the document also contains chapter on "Condition Monitoring:" which could be very helpful to utilities for adopting best maintenance practices. He further advised all the utilities to make it a practice to carry out SFRA test before and after transportation of Transformer/ Reactor and compare the two results and in case of any discrepancy, OEM may be contacted.
- 8. Regarding the storage condition of uncharged Transformer/Reactor at site, Director, PSETD, advised all the utilities that transformer should not be kept in storage filled with nitrogen or dry air for very long time and the instructions of OEM should be followed for ensuring its healthiness.
- 9. MSETCL representative informed that they encountered 9 failures of CTs during the period under consideration. Out of 9 failures, 4 CTs belong to one manufacturer. Considering the poor workmanship and quality, MSETCL has blacklisted the manufacturer. Further, since 2020, MSETCL has adopted Live Tank type CTs which has led to drastic reduction in failure of CTs in MSETCL. It was further informed by MSETCL that in order to ensure good quality by manufacturer, MSETCL has increased the warranty period to 60 months and during warranty any drastic increase in Tan δ value is observed, manufacturer is bound to replace it.





- 10. Observing multiple failures of transformers in DTL network, Director, PSETD stated that DTL shall carry out proper investigation so as to figure out reasons for multiple failures of Transformers in previous few years at Bawana, Tikri Kalan, Geeta Colony and other substations of DTL.
- 11. DTL representative replied that they are regularly carrying out proper maintenance and detailed investigation of failures but there have not been any common cause for failure of these transformers. Different transformers have failed due to multiple different reasons. However, the issue of multiple tripping of lines and High voltage during winters in the grid may be some common causes leading to build-up of stress in Transformers. In response, Director, PSETD, stated that problems are there in the network, but we shall work to reduce these failures in future for resilient operation of grid.
- 12. During the deliberation of failure of 100 MVA 220kV/33 kV ICT at Bawal Substation of HVPNL, it was informed that there has been 1356 through faults for the concerned ICTs due to multiple tripping of 33 kV feeders being maintained by DISCOMs.
- 13. Director, PSETD, suggested that wherever frequent tripping of the lines take place which deteriorates the transformer condition, the utility should keep a close watch on such lines, identify the possible causes of tripping and rectify the problem. If lines are owned by other utility the matter should be taken up with that utility and ask it to take necessary action so as to reduce such huge number of through faults which lead to failure of transformers.
- 14. During the deliberation of failure of 100 MVA, 220/110/11 kV ICT at Shivamogga substation of KPTCL, it was stated that the said transformer has been in operation since past 53 years without any failure. Director, PSETD appreciated KPTCL for this achievement.
- 15. On a query on maintenance practice of CT and CVT, POWERGRID stated that they perform DGA within 1 month of charging of equipment and before 1 year of expiry of warranty. Apart from this, Capacitance and Tan δ is also performed on yearly basis. In case of any deviation in value of Capacitance and Tan δ , Variable Frequency Tan δ is performed. POWERGRID stated that they carry out hotspot measurement using thermos-vision camera quarterly and if among different phases of same equipment deviation of more than 3-4° C is found, further analysis



is done. Director, PSETD advised all the utilities for utilizing thermos-vision camera for measuring any rise in temperature of CT and CVT for identification of any abnormality.

- 16. POWERGRID informed that, for Surge Arresters, Third harmonic resistive current measurement is being done twice a year, before and after monsoon. 150 μ A current is the limit for Third Harmonic current, however rate of rise of current is also monitored and if found to be risen more than 20 μ A from previous value monthly monitoring is done. For Third Harmonic current value between 150-350 μ A, IR measurement is done and the decision to replace it is taken based on IR value if found below 1000M Ω . For Third Harmonic current beyond 350 μ A, immediate replacement of LA is carried out.
- 17. Director, PSETD advised all the utilities to enhance monitoring of Transmission Lines as many failure of Transformers have been observed due to through faults caused by tripping the lines. Also, all utilities were advised to ensure proper 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.
- 18. Chief Engineer, PSETD and Chairman of the meeting, 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. He appreciated KPTCL for good maintenance practice which led to operation of Shivamogga ICT for 53 years. DTL was advised to increase vigilance so as to reduce multiple failures of ICT in their system. POWERGRID was also advised to try and reduce number of failure so as to set a benchmark in Indian power sector. He further informed that all suggestions received during the meeting shall be incorporated appropriately in the final report of the Committee.

The meeting ended with vote of thanks to the Chair.



Annexure

List of Participants

Central Electricity Authority (CEA)

- 1. Sh. A K Thakur, CE
- 2. Sh. Y K Swarnkar, Director
- 3. Sh. Bhanwar Singh Meena, DD
- 4. Sh. Akshay Dubey, DD
- 5. Sh. Nishant Chohla, AD
- 6. Sh. Anshul Kumar, AD

Central Power Research Institute (CPRI)

1. Sh S S Reddy, Addl. Director

Southern Regional Power Committee (SRPC)

1. Sh. Harsha, AEE

Power Grid Corporation of India (PGCIL)

- 1. Sh. Pradeep Kumar, CGM
- 2. Sh. PRS Yadav, GM
- 3. Sh. Rohit Jain, DGM
- 4. Sh. Dheeraj Singh, CM

Maharashtra State Electricity Transmission Corporation (MSETCL)

- 1. Sh. Ajay Patel, SE
- 2. Sh Rohidas Maske

Delhi Transco Ltd (DTL)

- 1. Sh. B Prasad, GM
- 2. Sh. Ashish Malik, AM
- 3. Sh. Devendra Singh

Karnataka Power Transmission Corporation (KPTCL)

- 1. Sh. Girish, CE
- 2. Sh. Nagaraj

Kerala State Electricity Board (KSEB)

- 1. Sh. Pradeep Kumar, CE
- 2. Sh. Biju M T, EE

State Load Dispatch Centre, Kerala

1. Smt. Reshmi S, AEE

Adani Electricity Mumbai Limited (AEML)

- 1. Sh. Dillip Devasthale
- 2. Sh. Mahesh Dange
- 3. Sh. Mohan Vegankar

Bhakra Beas Management Board (BBMB)

1. Sh. Kuldeep Singh



- 2. Sh. Sujit Singh
- 3. Sh. Indrajeet Singh Bajwa
- 4. Sh. Satish Pahal, SE

Damodar Valley Corporation (DVC)

- 1. Sh. Jayant Datta, CE
- 2. Sh. S Pal
- 3. Sh. Somu Chaudhary, SE

Western UP Power Transmission Limited (WUPPTCL)

1. Sh. S N Raju

Haryana Vidyut Prasaran Nigam Limited (HVPNL)

- 1. Sh. M L Garg, EE
- 2. Sh. Mohit Ahiwal
- 3. Sh. R N Mishra, EE

West Bengal State Electricity Transmission Company Limited (WBSETCL)

1. Sh. Ranjan Das, CE

Satluj Jal Vidyut Nigam (SJVN)

- 1. Sh. Sanjeev Sharma
- 2. Sh. Vaibhav Vivek

Tamil Nadu Transmission Corporation (TANTRANSCO)

1. Sh. Raghu Narayan, EE



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