

March 7, 1996

NOTE TO: Ashok Thadani, ADT/NRR  
THRU: Gus C. Lainas, DE/NRR *RL*  
FROM: José Calvo, EELB/DE/NRR *JAC*  
SUBJECT: TRANSFORMER FAILURES

By a note dated February 6, 1996, you requested DE to investigate and report back findings/recommendations on transformer failures.

The Electrical Engineering Branch (EELB) has searched for events from 1980 through 1995 involving transformer failures through NUDOCS, LERs, preliminary notices, morning reports, event notifications, circulars, bulletins and Information Notices. The events are associated with all types of transformers including high-voltage (main, unit auxiliary and start-up) and low-voltage transformers. In addition, we investigated other information including NSAC-182 (March 1992), "Losses of Offsite Power in Nuclear Power Generating Stations," NUREG-1299 (March 1991), "Review of Licensee's Renewal, Nuclear Plant Aging Research (NPAR)," and NUREG-0933 Issue 107, "Main Transformer Failures." A Table of Events is attached.

The following is the summary by year of the number of transformer failures and consequential reactor trips.

<u>DATES</u>	<u>TRANSFORMER FAILURES</u>	<u>REACTOR TRIPS</u>
1996 thru 3/1/96	3	2
1995	5	3
1994	1	1
1993	1	1
1992	5	3
1991	8	5
1990	0	0
1989	1	1
1988	4	4
1987	2	1
1986	1	1
1985	0	0
1984	1	1
1983	1	0
1980	1	0

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The following findings were made regarding the transformer related events:

1. in the last 5 months there have been 6 events involving loss of high voltage transformers. (Note: The recent Catawba and Calvert Cliffs events were included in the attached table for information only, however, they did not involve transformer failures and were not counted in the above summary.)
2. In NUREG-1299, "Review of Licensee's Renewal, Nuclear Plant Aging Research (NPAR)," NPRDS showed that 13 percent of the transformer failures were age-related.
3. Transformer failure rates may not be changing when considering events back into the 80s.

SRP-UB  
Findings  
12-2-96

With respect to recommendations there is a Generic Issue (GSI-107, "Main Transformer Failures") that was ranked LOW; however it was borderline to MEDIUM. It appears that it was ranked LOW because of the perceived potential benefits of the SBO rule implementation. The prioritization was done around 1990/91. We are currently responding to the RES request to review low-priority generic safety issues. We will provide this information to RES for potential reprioritization of the issue.

Attachment: Transformer Failures Table

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NAME	NKTrehan:JC		DFThatcher		GCLaffas	JACalvo	JAL7	
E	3/6/96		3/7/96		3/7/96	3/7/96		

# 2  
3/7/96

TRANSFORMER FAILURES TABLE

DATE	PLANT	Transformer Fail/Rx Trip	DESCRIPTION
2/27/96	Calvert Cliffs 2	No/Yes	Trip occurred while troubleshooting on one of 500 kV breakers in the switchyard was in progress causing loss of all four RCPs. The unit responded as designed except that one of rupture discs on the main turbine ruptured. <u>This event did not involve transformer failure.</u>
2/25/96	Palo Verde 1	Yes/No	Lightning struck Phase C of the Main Power Transformer (MPT). Flames were observed in the bushings and were self extinguished. Turbine tripped and reactor runback to 8%. Two holes were observed in the Isophase bus duct.
2/6/96	Catawba 2	No/Rx T	Ground on phases X & Z of the 22 kV Isophase buses. Resister wall bushings for phases X & Z used to connect protective relaying Potential Transformers to Isophase buses were damaged. <u>This event did not involve transformer failure.</u>
2/6/96	Perry 1	No/Refuel Outage	Explosion in Start-up (SAT) transformer during refueling and maintenance. Deluge protection operated.
2/4/96	LaSalle 1	Yes/Refuel Outage	Loss of MPT oil cooling due to failure of cable feeding to cooling fans resulting in high oil temperature. A missing cap from conduit carrying cable was missing. Water had frozen resulting in cable failure.
1/18/96	Braidwood 2	Yes/No	One of two SATs as well as high voltage breaker damaged.
12/18/95	South Texas 1	Yes/Rx T	A phase of main power transformer (MPT) had a ground fault.
10/21/95	Diablo Canyon 1	Yes/No	During refueling, an explosion and fire occurred at UAT. A grounding breaker was accidentally left connected to bus causing a ground fault.

DATE	PLANT	Transformer Fail/Rx Trip	DESCRIPTION
8/22/95	Cook 1	Yes/No	Output bushing for Phase 2 on MPT failed. MPT has been installed to replace a previously damaged MPT and was being tested prior to service. A crack in the bushing was found and was replaced.
7/30/95	Grand Gulf	Yes/Rx T	MPT and main generator trip due to failure of CT on A phase of generator output breaker. CT replaced.
6/25/95	South Texas 2	No/Rx T	MPT locked out due to pilot wire relay trouble (failure of capacitor)
8/18/95	Seabrook	Yes/No	13.8 kV non-safety transformer failed due to inadequate design
4/5/94	Braidwood 2	Yes/Rx T	Reactor trip due to a fault on B phase of MPT. Extensive damage. Replaced with spare. Oil sample done every 6 months.
4/3/94	Zion 1	No/No	Replaced MPT and replaced main generator Isophase Bus duct fire.
6/13/93	Quad Cities 2	Yes/Rx T	Internal arcing in MPT - initiated deluge system. Oil was black. MPT replaced.
9/22/92	Fitzpatrick	No/No	Load Center transformer - ground fault. Loss of UPS.
7/4/92	Peach Bottom	Yes/No	230 kV auto transformer failed due to arcing.
9/22/92	Zion	Yes/Rx T	Phase C of MPT, transformer failure with oil fire - Deluge system oper. MPT significantly damaged, isophase bus was significantly damaged from explosion of MPT - bus duct flash over, main gen Phase C bushings were damaged. MPT replaced.
4/24/92	San Onofre 2	Yes/No	Failure of transformer 2B13X. Replaced.
1/9/92	Clinton	Yes/Rx T	Failure of MPT on B phase due to internal fault.
1/4/92	Vogtle	Yes/Rx T	Failure of MPT on B phase due to internal fault. MPT was found smoking heavily. Replaced.
6/16/91	Salem 1	Yes/Rx T	Lightning struck on B phase of MPT.

DATE	PLANT	Transformer Fail/Rx Trip	DESCRIPTION
4/29/91	Maine Yankee	Yes/Rx T	One of two MPTs had internal fault - fault current caused arcing between neutral bus & neutral bus enclosure - <u>damaged neutral bushing</u> - fire activated deluge system. MPT replaced.
3/20/91	Indian Point 2	Yes/No	Loss of power to all 6.9 kV caused by <u>PT failure</u> - 138 kV normal power lost.
10/11/91	Peach Bottom	Yes/No	Failed static inverter transformer.
8/13/91	Nine Mile Point 2	Yes/Rx T	Reactor scram due to transformer failure, and loss of UPS.
3/13/91	Vermont Yankee	Yes/Rx T	One phase of MPT failed due to short.
2/15/91	Peach Bottom	Yes/Rx T	Failure of MPT due to failure of cooling system which caused transformer overheat, causing sudden pres. trip. Deluge system did not activate. No cooling fans were available due to loss of power. MPT was found smoking. Deluge system was manually started.
8/28/91	Crystal River 3	Yes/No	480 V ESF transformer failed, replaced.
6/25/89	Oyster Creek	Yes/Rx T	Fault in MPT - spare installed.
12/26/88	Nine Mile Point 2	No/No	Explosion of CT in offsite switchyard
10/16/88	Braidwood 1	Yes/Rx T	PT failure on 138 kV offsite line. Reactor tripped on RCP low flow.
8/13/88	Maine Yankee	Yes/Rx T	Fault in MPT.
7/6/88	Palo Verde	Yes/Rx T	138 kV UAT explosion and fire caused by brittle and cracked insulation.
3/29/88	Oconee 2	No/No	SAT CT fault.
1/10/88	Grand Gulf 1	Yes/Rx T	HV WDG. fault on MPT - MPT replaced.
7/20/87	Wolf Creek	Yes/Rx T	PT failure caused partial LOOP.
7/4/87	Palisades	Yes/No	Fault on SAT 1-2.
5/31/86	NA2	Yes/Rx T	Failure of 120-V Vital ac bus transformer, reactor tripped.

DATE	PLANT	Transformer Fail/Rx Trip	DESCRIPTION
12/2/85	Wolf Creek	No/No	Loss of ESF transformer due to PT failure.
6/20/83	Salem 2	No/No	460V transformer fault and fire due to failure of transformer neutral wdg.
11/4/84	Duane Arnold	Yes/Rx T	UAT fault caused by short in the HV wdg.
7/3/83	Three Mile Island 2	Yes/No	Medium Voltage transformer failure due to insulation failure.
1/17/80	Kewaunee	Yes/No	Reserve Aux. Transformer failed. No cause given.