



**Entergy Nuclear Northeast**

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June 14, 2005  
BVY 05-064

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555

**Subject: Vermont Yankee Nuclear Power Station  
License No. DPR-28 (Docket No. 50-271)  
Reportable Occurrence No. LER 2004-003-01**

As defined by 10 CFR 50.73(a)(2)(iv)(A), we are submitting the attached revision for a Reportable Occurrence that occurred on June 18, 2004 as LER 2004-003-01 to report a change to the root cause of the event based upon the results of laboratory analysis.

Sincerely,

**Entergy Nuclear Operations, Inc.  
Vermont Yankee**

A handwritten signature in black ink, appearing to read "W. Maguire".

William F. Maguire  
General Manager/ Plant Operations

cc: USNRC Region I Administrator  
USNRC Resident Inspector - VYNPS  
USNRC Project Manager - VYNPS  
Vermont Department of Public Service

*JE22*

# LICENSEE EVENT REPORT (LER)

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to [infocollects@nrc.gov](mailto:infocollects@nrc.gov), and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

<b>1. FACILITY NAME</b> VERMONT YANKEE NUCLEAR POWER STATION (VY)	<b>2. DOCKET NUMBER</b> 05000 271	<b>3. PAGE</b> 1 OF 5
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**4. TITLE**  
Automatic Reactor Scram due to a Main Generator Trip as a result of an Iso-Phase Bus Duct Two-Phase Electrical Fault

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
06	18	2004	2004	003	01	06	14	2005	N/A	05000
									FACILITY NAME	DOCKET NUMBER
									N/A	05000

<b>9. OPERATING MODE</b>  N	<b>11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)</b>									
	<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> 50.73(a)(2)(vii)						
<b>10. POWER LEVEL</b>  100	<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)						
	<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)						
	<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)						
	<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)						
	<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)						
	<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)						
<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input type="checkbox"/> OTHER							
<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A							

**12. LICENSEE CONTACT FOR THIS LER**

FACILITY NAME William F. Maguire, General Manager Plant Operations	TELEPHONE NUMBER (Include Area Code) (802) 257-7711
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**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
E	EL	FCON	P295	Yes	E	EL	IPBU	P295	Yes
E	EL	BDUC	P295	Yes	E	EL	LAR	G066	Yes

<b>14. SUPPLEMENTAL REPORT EXPECTED</b>				<b>15. EXPECTED SUBMISSION DATE</b>		
<input type="radio"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE) <input checked="" type="radio"/> NO				MONTH	DAY	YEAR

**ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)**

On 06/18/04 at 0640, with the plant at full power, a turbine load reject scram occurred due to a two phase electrical fault to ground on the 22 kV iso-phase bus. All safety systems responded as designed and the reactor was shutdown without incident. Off-site power transmission lines and station emergency power sources were available throughout the event. Arcing and heat generated during the fault damaged an area around the iso-phase bus ducts and Main Transformer low voltage bushings. The electrical faults disrupted an oil line flange between the Main Transformer oil conservator (expansion tank) and the "C" phase low voltage bushing box, and the leaking oil ignited. Fire suppression systems activated automatically. An Unusual Event was declared at 0650 for a fire lasting greater than 10 minutes. The VY fire brigade and local community fire departments declared the fire under control at 0717. At 1245, the Unusual Event was terminated. The electrical grounds that initiated the event were caused by loose material in the "B" iso-phase bus duct as a result of the failure of a flexible connector. The grounds raised the voltage on the "A" and "C" iso-phase busses contributing to the failure of the "A" phase surge arrester. The root causes of the event were determined to be the result of a flexible connector fabrication deficiency and preventative maintenance not being performed on the surge arresters located in the Main Generator Potential Transformer (PT) Cabinet. There was no release of radioactivity, breach of secondary containment or personnel injury during this event.

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VERMONT YANKEE NUCLEAR POWER STATION (VY)	05000 271	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	2 OF 5
		2004	-- 003	-- 01	

**17. NARRATIVE** (If more space is required, use additional copies of NRC Form 366A)

**DESCRIPTION:**

On 06/18/04 at 0640, with the plant operating at full power, a two-phase electrical fault-to-ground occurred on the 22kV System (EIS=IPBU, BDU). The "B" phase faulted to ground in the low voltage bushing box on top of the Main Transformer (EIS=XFMR), and the "A" phase faulted to ground in the surge arrester cubicle of the Main Generator Potential Transformer (PT) Cabinet through the "A" phase surge arrester (EIS=LAR).

Within less than one cycle (11 milliseconds) of the initial electrical fault, the Main Generator protective relaying sensed the condition and isolated the generator from the grid within the following 5 cycles (80 milliseconds). A generator load rejection reactor scram then occurred. Approximately 400 milliseconds following the initial electrical faults to ground from "A" and "B" phases, arcing and ionization in the "B" phase low voltage bushing box carried over to the "C" phase low voltage bushing box on top of the Main Transformer. The electrical faults disrupted a flange in the oil piping between the Main Transformer oil conservator (expansion tank) and the "C" phase low voltage bushing box. The arcing or heat from the fault ignited the oil, resulting in a fire. Fire suppression systems activated automatically as expected.

The plant response following the scram was as expected, with the exception that both Recirculation pumps tripped and other AC voltage effects were observed as a result of the voltage transient associated with the high fault current. All safety systems functioned as designed and the reactor was shutdown without incident. There was no release of radioactivity and no personnel injuries.

The VY fire brigade was dispatched at 0641. An Unusual Event was declared at 0650 due to "Any unplanned on-site or in-plant fire not extinguished within 10 minutes". The VY fire brigade initiated fire hose spray from a nearby hydrant and quenched the fire. Local fire departments began arriving at 0705. The fire was declared under control at approximately 0717 and re-flash watches were established. Off-site power transmission lines and station emergency power sources were available at all times throughout the event.

The States of Vermont, New Hampshire and Massachusetts were provided with initial notification of the event at 0721. The NRC Operations Center was notified of the event at 0748, recorded as NRC Event Number 40827. In addition to the declaration of the emergency classification, a 4-Hour NRC Non-Emergency Notification was completed due to an RPS actuation with the reactor critical, pursuant to 10CFR50.72(b)(2)(iv)(B). At 1245, the Unusual Event was terminated.

The iso-phase bus flexible connector (EIS=FCON) that failed (expansion joints) was part of the original bus supplied and designed by H. K. Porter, Drawing Numbers G-191144 & G-191146. All flexible connectors were replaced with an upgraded design supplied by Delta-Unibus. The surge arresters were GE Alugard Station Arrestors, Model Number 9L11LAB, installed as original plant equipment. All of the surge arresters were replaced.

**CAUSES:**

The root causes of the event were determined to be the result of a flexible connector fabrication deficiency and preventative maintenance not being performed on the surge arresters located in the Generator Potential Transformer (PT) Cabinet.

The electrical grounds that initiated the event were caused by loose material in the "B" iso-phase bus duct as a result of the failed flexible connector that allows the iso-phase bus to thermally expand and contract. The grounds raised the voltage on the "A" and "C" iso-phase busses, contributing to the failure of the "A" phase surge arrester.

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Although the iso-phase bus is subjected to preventative maintenance cleaning and Doble Testing each refueling outage, the cleaning and inspection is limited to the stand-off insulators. Additional inspections to evaluate the condition of the bus (including its flexible connectors) would have detected the degraded flexible connectors.

A detailed equipment failure evaluation was conducted on the flexible connectors associated with the Main Generator 22 kV Electrical System. The cause of the "B" phase flexible connector failure was that weld porosity and excessive weld grinding (reinforcement removal) during original fabrication weakened the laminate weld.

During approximately 32 years of plant operation, differential thermal expansion and contraction caused thermally induced stress at the flexible connector attachment welds. These thermally induced stresses caused the propagation of fatigue cracks at the attachment welds. The fatigue cracks grew and, combined with voids in the weld metal and lack of edge welds, resulted in over stressing the remaining weld metal that failed due to tensile and shear over load ultimately leading to the failure and separation of the outer laminate from the bus. The end closest to the generator on the "B" phase flexible connector failed first allowing the outer laminate to be lifted into the cooling air flow, thereby placing additional stresses on the undersized weld ligaments at the transformer end.

There was no sign of cracking at any other flexible connector weld, indicating that the increased air flow/velocity in the bus duct did not result in flow induced vibration of the outer laminates and contribute to the failure. The increased air flow within the bus duct following the refueling outage modifications may have accelerated the failure timetable for the laminate; however, the failure would have occurred at some time in the near future at the original flow rates.

The need for inspecting the flexible connectors was identified during a recent review of industry operating experience (OE). This OE is being included as recommended preventative maintenance for future outages; however, it was not included in the preventative maintenance inspection performed during RFO-24.

The "A" surge arrester failure was the result of the combination of a ground occurring on the "B" iso-phase bus that caused an increase in voltage on the "A" and "C" iso-phase busses and not performing preventative maintenance necessary to monitor age related degradation of the "A" surge arrester. Industry experience has revealed that surge arresters degrade over time due to a combination of age, service environment and service conditions. Periodic inspection/testing could have detected degradation and allowed replacement prior to failure.

Three contributing causes were identified by the investigation: failure to effectively use industry OE to prevent similar events from occurring at VY, inadequate preventive maintenance of the generator iso-phase bus, and inadequate failure modes and effects evaluation. Specifically, it was noted that; the actions taken by VY in response to recommendations provided within the INPO Significant Operating Experience Report (SOER) 90-01 for "Ground Faults on AC Electrical Distribution" were inadequate. In addition to the SOER, guidance provided within EPRI's "Isolated Phase Bus Maintenance Guide" TR-112784 (1999) for the 22 kV flexible connectors and periodic inspections/testing was not utilized.

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**ASSESSMENT OF SAFETY CONSEQUENCES:**

All safety systems and fire suppression systems responded as designed. The reactor was shutdown without incident. Off-site power sources and station emergency power sources were available at all times throughout the event. Emergency response personnel acted promptly to prevent the fire from significantly damaging or breaching the adjacent turbine building. There was no release of radioactivity or personnel injury during this event. Therefore, this event did not significantly increase the risk to the health and safety of the public.

**CORRECTIVE ACTIONS:**

Immediate:

1. An Unusual Event was declared at 0650.
2. The station fire brigade on scene to combat the fire at 0652. Local fire departments arrived on-site at 0705 to provide assistance. The fire was under control at 0717.
3. Completed the initial notification to the States of Vermont, New Hampshire and Massachusetts at 0721.
4. Notified the NRC Operations Center of the Unusual Event at 0748.
5. Secured all affected site and plant areas for personnel safety and isolated affected equipment as necessary to maintain investigation integrity.
6. Condition Reports were generated for this event and potentially associated issues as appropriate for entry into the Corrective Actions Program.
7. A Root Cause Investigation team was established to assess damage and to secure the area.
8. Initial testing was completed on the main transformer, station auxiliary transformer, and main generator with no indication of damage that would affect the operation of the transformers or generator.
9. A Preliminary Nuclear Network Entry was completed to inform the industry of the initial findings and conditions of the event.

Prior to Plant Start Up:

1. The phase A, B, and C 22 kV surge arresters and capacitors were replaced prior to energizing the 22kV bus.
2. The phase A, B, and C 22 kV flexible connectors were replaced with an upgraded design supplied by Delta-Unibus prior to energizing the 22kV bus.
3. A cleanliness inspection was performed and documented as part of Iso-Phase Bus Duct Modification.
4. Maintenance department personnel inspected the cooler and leads fans for foreign material. Following operation of the fans, an additional inspection of the fans and coolers was performed.
5. Operator Alarm response sheets were revised to enhance operator actions in the event of future ground faults.
6. A preventative maintenance schedule was established for increased sampling of transformer oil for the main, auxiliary, and two startup transformers for four weeks after start-up.
7. The iso-phase bus duct system was monitored after assembly with the fans running to ensure that vibration levels were acceptable.
8. VY discussed this event and associated issues with the Entergy Fleet and industry experts as necessary to gather information pertinent to the root cause investigation and equipment recovery.

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**Long Term:**

1. The 22kV surge arresters and capacitors have been included in the preventative maintenance program with specifically defined periodic replacement requirements. With this change the cubicles containing these components have been assigned unique Preventative Maintenance identification numbers and the activities associated with the planned maintenance has been expanded to reflect lessons learned from this event.
2. The 22kV iso-phase bus preventative maintenance program was revised to provide periodic inspection requirements to prevent recurrence of this event. This revision provides direction for extensive iso-phase bus inspection, including the flexible connections.
3. Completed testing of the selected components involved in the event. The root cause analysis report has been revised to reflect the findings from the off-site lab analysis.

**ADDITIONAL INFORMATION:**

Approximately 350 Condition Reports generated since 06/01/1995 regarding the components and systems involved with this event were reviewed during the root cause investigation. No similar event with a related cause was identified to have occurred at Vermont Yankee during this period.