Consumers Energy

A CMS Energy Company

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September 2, 1998

U.S. Nuclear Regulatory Commission
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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT
LICENSEE EVENT REPORT 96-014-01 - CLASS 1E RAYCHEM CABLE SPLICES INSTALLED INCORRECTLY - SUPPLEMENTAL REPORT

Licensee Event Report (LER) 96-014 was submitted on December 23, 1996. This event was reported in accordance with 10 CFR 50.73(a)(2)(ii)(B) as a condition outside of the design basis of the plant. The LER reported the discovery of Class 1E electrical cable splices that were installed incorrectly as a result of an inadequate procedure. Testing of a representative sample of splices like those found in containment was completed to assess their capability to meet postulated accident conditions. The testing successfully demonstrated past operability of the splices. The attached supplement to LER 96-014 includes this information.

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SUMMARY OF COMMITMENTS

This letter contains no new commitments and no revisions to existing commitments. This supplement serves to complete the following commitment made in the December 23, 1996, submittal:

> An investigation will continue to evaluate the unqualified Raychem cable splice over a PVC conductor jacket to determine its capability to meet the postulated accident conditions within containment during prior operation. The results of this investigation will be provided in a supplement to this LER.

Thomas J. Palmisano
Site Vice President

CC Administrator, Region III, USNRC
Project Manager, NRR, USNRC
NRC Resident Inspector - Palisades

Attachment

NRC FORM 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

Estimated burden per response to comply with this mandatory information collection request: 50 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Forward comments regarding burden estimate to the Records Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and to the Paperwork Reduction Project (3150-0104), Office of Management and Budget, Washington, DC 20503. If 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.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
CONSUMERS ENERGY COMPANY - PALISADES NUCLEAR PLANT	05000255	1 OF 5

TITLE (4)

CLASS 1E RAYCHEM CABLE SPLICES INSTALLED INCORRECTLY - SUPPLEMENTAL REPORT

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
11	24	1996	1996	-- 014	-- 01	09	02	1998	FACILITY NAME	DOCKET NUMBER
										05000

OPERATING MODE (9)	N
POWER LEVEL (10)	0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)		50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)	x	50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Philip D. Flenner, Sr. Licensing Engineer	(616) 764-2544

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	ZZ	ELECON	R098	N						

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	x	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On November 24, 1996, during a routine refueling outage maintenance activity, a Class 1E electrical cable splice was discovered to be installed incorrectly due to an inadequate procedure. This installation could not be considered qualified for the Class 1E service. Subsequent investigation for similar cable splices within containment resulted in the identification of 381 potentially susceptible cable splices. These splices were either confirmed to be acceptable by field inspection or were replaced with correctly installed splices. A total of 270 cable splices were replaced. An evaluation of the potentially susceptible cable splices was also done in areas where a postulated high energy line break outside of containment would present a harsh environment. These cable splices were found acceptable based on an evaluation in accordance with 10 CFR Part 50.49.

An evaluation of the unqualified Raychem cable splice over a PVC conductor jacket was completed to determine the capability of the cable splice configuration to meet the postulated accident conditions within containment during prior operation. The results of this evaluation have determined that the incorrectly installed splices would have performed their required safety function during any Design Basis Accident. The affected equipment was therefore operable during prior operation.

EVENT DESCRIPTION

On November 24, 1996, during a routine refueling outage maintenance activity, a Class 1E electrical cable splice was discovered to be installed incorrectly due to an inadequate procedure. This installation could not be considered qualified for the Class 1E service.

The splice was made in a manner that included the polyvinyl chloride (PVC) jacket on a Rome cable conductor within the Raychem splice. The PVC conductor jacket is required to be peeled back prior to installing the Raychem splice so the splice adhesion occurs against the environmentally qualified cross-linked polyethylene (XLPE) insulation rather than the PVC conductor jacket. The inclusion of the PVC conductor jacket within the splice resulted in a configuration which had not been qualified by test.

CAUSE OF THE EVENT

The original installation of the affected Raychem electrical splices were made incorrectly due to an inadequate procedure.

ANALYSIS OF THE EVENT

In response to the original discovery of the unqualified cable splice configuration, a review of the cables in the Equipment Qualification (EQ) Program was completed. This resulted in the determination that only Rome and Essex power and control cables have a PVC conductor jacket. The PVC conductor jacket configuration was not adequately addressed in the applicable procedure. Review of qualified circuits identified 381 splices within containment that could have been affected. These splices were either confirmed to be acceptable by field walkdown or were replaced with correctly installed splices. Some splices were replaced without inspection because the splice would have been destroyed in order to do the inspection.

Additionally, two locations outside of containment were determined to contain susceptible splices in a potentially harsh environment during a postulated high energy line break (HELB) accident. The environment during HELB conditions outside of containment is considerably less severe than that in containment. The identified cable splices in these locations were qualified by analysis, in accordance with 10 CFR Part 50.49.

SAFETY SIGNIFICANCE

Evaluations of the splices removed from the plant have determined that this event did not affect operability of any of the associated equipment. The event, therefore, was not significant to safety.

Unqualified splices could result in moisture intrusion into the areas of the electrical conductor during LOCA or HELB events. The conductivity of the moisture would then allow for increased leakage current between the conductors or to ground. This leakage current, if of sufficient magnitude, could affect the operation of the connected equipment and trip the associated protective device. The splices in question, however, were all associated with control and power circuits. For these types of circuits, leakage current would have to increase significantly to affect circuit operation. Qualification reports for similar configurations indicate that leakage currents would not increase to a point that would affect the operation of control and power circuits. This assumption has been verified by further evaluations of splices removed from the plant.

The following components could have been affected:

- Low Pressure Safety Injection Valves
- High Pressure Safety Injection Valves
- Containment Air Cooler Fan Motors
- Service Water Valves to the Containment Air Coolers
- Position Indications for the Above Valves

Evaluation of the splices was done by testing several configurations which simulate all of the incorrect or potentially incorrect splices found in the plant. The results of the testing successfully demonstrated past operability.

Eight samples were tested, simulating all of the configurations found in containment. Seven of the samples were fabricated using cable removed from the lowest elevation in containment during the 1996 refueling outage. Four of these were in-line splices, laid in grounded trays, and subjected to voltages and currents during the testing which simulated containment electrical penetration connector splices for position switches, solenoid valves, power and control for motor operated valves (MOV), and containment air cooler fan motors. Three of these were V-splices, in grounded junction boxes or condulets, simulating splices at the devices listed above, except for the power and control for MOVs. The MOV splices did not require testing because MOV circuits are terminated on terminal blocks inside the MOV junction boxes. Therefore, no new failure modes are introduced by inadequate splices in those boxes. The remaining sample was an actual containment electrical penetration splice, removed for this testing. It was included in the test program without first cutting it open to see if the splices were indeed incorrect. It was dissected after the test and found to have been made incorrectly, as expected, with the conductor jackets going all the way to the butt splice.

Functional testing, thermal aging, radiation aging, accident radiation, and accident simulation were all done in accordance with IEEE-323-74 for environmental qualification testing of cables and splices. Thermal aging was sufficient to simulate the condition of the cable and the Raychem materials up to the point in time that the splices were found and removed. The cable required thermal aging to account for heat rise considerations on the containment air cooler fans, and for the difference between the lower normal temperatures at the elevation in the plant where the cable came from and the higher temperatures at the higher elevations where some of the incorrectly prepared splices were found. Radiation exposure was sufficient to simulate lifetime normal dose plus accident dose. The accident simulation consisted of high pressure steam injected into a sealed chamber where the samples were energized with appropriate voltages and currents. The test temperature, pressure, and humidity enveloped the Palisades requirements, with the exception of duration. The required accident exposure duration of 30 days plus margin was simulated by a 5½ day test at a high enough temperature to compensate for the difference, using Arrhenius methods. Chemical spray similar to that expected at Palisades was also included in the testing. Due to test chamber limitations, the flow density used was less than the expected Palisades accident flow density, but that is insignificant due to the protected nature of the splices. The as-installed cable splices all were protected from direct impingement by junction boxes, condulets, or an overall Raychem heat shrink sleeve. The acceptance criteria for the splices were that they maintain expected voltage and current throughout the accident test. Leakage current was monitored during the test. Post-test insulation resistance tests were done for information only. Leakage current was found to be very low. Post-test insulation resistance tests at 500 VDC revealed low insulation resistance on two of the samples, but that is not significant, since they adequately maintained appropriate voltages and currents throughout the accident simulation.

CORRECTIVE ACTION

During the 1996 refueling outage, a review of qualified circuits identified 381 splices within containment that could have been affected. These splices were either confirmed to be acceptable by field inspection or were replaced with correctly installed splices. A total of 270 splices were replaced within containment. The remaining 111 were determined to be acceptable since it could be confirmed that the PVC conductor jacket was not included within the Raychem splice.

A review was performed of potentially susceptible cable splices in areas outside of containment that could experience a harsh environment. This harsh environment would only exist during postulated HELB accident conditions. The identified cable splices outside of containment were qualified by analysis, in accordance with 10 CFR Part 50.49.

An investigation has evaluated the unqualified Raychem cable splice over a PVC conductor jacket to determine the capability of the cable splice configuration to meet the postulated accident conditions within containment during prior operation. The

results of this investigation have determined that the incorrectly installed splices would have performed their required safety function during any Design Basis Accident. Operability was not impaired for any of the affected equipment.

No further corrective actions are required.

PREVIOUS EVENTS

Problems with cable splices/connections have been reported previously in the following LERs:

- LER 91-002 - Non-Qualified Cable Splices Inside Containment
- LER 92-019 - Electrical Connections Not Environmentally Qualified In Position Switch Circuits Requiring Environment Qualification
- LER 95-007 - Exposed Kapton Cable Insulation Results In Unqualified EQ Cable Splice
- LER 95-012 - Unqualified Electrical Connection In Containment Service Water Outlet Valve Controller

In addition, a previous problem with cable that had not been environmentally qualified was reported in LER 94-015 - Unqualified Cable Found Being Used In An Application Requiring Environmentally Qualified Cable.