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IN 86-53

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

June 26, 1986

IE INFORMATION NOTICE NO. 86-53: IMPROPER INSTALLATION OF HEAT SHRINKABLE TUBING

Addressees:

All nuclear power reactor facilities holding an operating license or a construction permit.

Purpose:

This notice is to alert licensees to a potentially generic safety problem involving improper installation of heat shrinkable tubing over electrical splices and terminations.

It is expected that recipients will review this information for applicability to their facilities and consider actions, if applicable, to prevent or identify this and similar problems at their facilities. Suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required. The NRC staff is continuing to evaluate this matter. If specific action is determined to be necessary, a separate notification will be issued.

Description of Circumstances:

Problems involving improper installation of heat shrinkable tubing manufactured by Raychem have been identified at a number of plants as described below.

Davis-Besse

On May 14, 1986, the licensee for the Davis-Besse plant reported pursuant to 10 CFR 50.72 that it had been discovered that over the past several years terminations and splices may have been incorrectly installed. Plant operation in this configuration constituted an unanalyzed condition outside the licensing basis (i.e., potential common-mode failures). The licensee had recently contracted with Raychem to present training sessions to their electricians and I&C technicians. During the training, the licensee realized that heat shrinkable tubing used to cover electrical terminations and splices had not been installed according to the manufacturer's instructions and acceptance criteria. A sample of 71 wire splices was subsequently inspected; 67 were found to be nonconforming in one or more of the following ways:

1. improper diameters
2. improper overlap onto wire insulation (i.e., length)
3. use of tubing directly over fabric cover of wire
4. improper bending of tubing/wires inside junction boxes

The licensee has stated that the potential problem involves wiring, ranging from small I&C signal wire up through large 4160-volt power cables and probably includes all plant systems, safety related and not safety related. One estimate suggests that 1500 cables with 2-4 splices each (total of 3000-6000 splices) may be involved, of which 1000-2000 splices may be safety-related.

The licensee plans to locate and rework or requalify all suspect uses of the heat shrinkable tubing before restarting the plant.

Dresden

During a Safety System Outage Modification Inspection by the NRC at Dresden Unit 3, deficiencies on Raychem heat shrinkable tubing involving valve solenoids, valve motor operators, pressure transmitters, and HVAC fan motors were found to be of the following types:

1. Insulation damage on several in-line splices apparently caused by manipulation before the heat shrinkable tubing had cooled completely and set. The degree of damage varied from minor abrasion to exposure of bare conductors.

2. Severe bends apparently to fit into small compartments, but tight bends also were found inside larger valve operator compartments.

3. Less than the minimum total tubing length (6 inches) and absence of inner tubing; in some cases the tubing did not extend over the cable jacket and in one case the bare conductor was exposed.

4. Heat shrinkable tubing directly over braided cable jackets.

The licensee is evaluating corrective actions.

Comanche Peak

Certain Bunker Ramo Corporation electrical containment penetrations were found to have improper pigtail splices. The Raychem heat shrinkable tubing over the splices did not have the sufficient length and, in some cases, bare conductors were exposed. Numerous instances were found where the heat shrinkable tubing was not adhering to the cable jacket. In addition, the splices were not staggered. As a result of these and other penetration related deficiencies, the affected electrical penetrations are being replaced.

Watts Bar

On April 2, 1986, the applicant for the Watts Bar plant provided an initial notification of several problems with Raychem heat shrinkable tubing associated with Conax electrical penetrations including:

1. heat shrinkable tubing not heat shrunk properly
2. heat shrinkable tubing sleeves taped improperly
3. incorrect heat shrinkable materials used on cable splices
4. bare conductors exposed

The applicant characterized the situation as a potential that circuit malfunctions (shorts, grounds, or opens) could occur and cause associated equipment or instrumentation failure and adversely affect safe operations of the plant. The applicant is evaluating alternate corrective actions.

In addition, installation discrepancies with Raychem heat shrinkable tubing have been reported at Surry, Bellefonte, and Shearon Harris plants.

Discussion:

The fundamental purpose of applying heat shrinkable tubing over electrical terminations and splices is to provide electrical insulation. If the tubing has not been installed according to the manufacturer's instructions, electrical failures may occur during a range of conditions including off-normal non-accident conditions, mild-environment accident conditions, and harsh-environment accident conditions.

The problems described above appear to arise in a wide variety of situations. The degree that Bechtel installers or Bechtel installation instructions have contributed to the problem is unknown. In some cases, the manufacturer's installation instructions were apparently used directly and problems arose.

The existence of improperly installed heat shrinkable tubing could result in multiple equipment failures in safety-related systems. Potential common-mode failure of safety-related systems which could prevent the fulfillment of a safety function is an unanalyzed condition outside the licensing basis of the plant.

The degree to which this potential problem will manifest itself in actual equipment or system failures is not well known. Our review of operating experience revealed that there were no reported failures during normal plant operation that were attributed to improper installation of heat shrinkable tubing. Operating experience does provide at least one data point regarding harsh environments. The Davis-Besse plant experienced a blowdown inside containment in 1977; no failures attributed to heat shrinkable tubing were identified.

The Raychem heat shrinkable tubing was tested in certain configurations for equipment qualification for postulated harsh-environment accident conditions. These configurations are included in the manufacturer's installation instructions and identified as "LOCA/HELB accident" or simply "Accident" specifications. For example, the minimum total length of the tubing for a 0.7-1.2 inch connection length is specified as 6 inches minimum for the LOCA/HELB accident case and as 4 inches minimum for the non-accident case. If actual installation configurations are not those specified as having been qualified by type testing, the status of the equipment qualification is indeterminate.

10 CFR 50.49 requires that safety-related electrical equipment that may be exposed to a harsh environment during an accident, be qualified to be able to perform the safety functions. If a licensee finds that the qualification may not be valid because heat shrinkable tubing was improperly installed, action would become necessary to establish compliance regarding system operability and reporting.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the Regional Administrator of the appropriate regional office or this office.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contact: J. T. Beard, NRR
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Attachment: List of Recently Issued IE Information Notices

Attachment 1
IN 86-53
June 26, 1986

LIST OF RECENTLY ISSUED
IE INFORMATION NOTICES

Information Notice No.	Subject	Date of Issue	Issued to
86-52	Conductor Insulation Degradation On Foxboro Model E Controllers	6/26/86	All power reactor facilities holding an OL or CP
86-51	Excessive Pneumatic Leakage In The Automatic Depressurization System	6/18/86	All BWR facilities holding an OL or CP
86-50	Inadequate Testing To Detect Failures Of Safety-Related Pneumatic Components Or Systems	6/18/86	All power reactor facilities holding an OL or CP
86-49	Age/Environment Induced Electrical Cable Failues	6/16/86	All power reactor facilities holding an OL or CP
86-48	Inadequate Testing Of Boron Solution Concentration In The Standby Liquid Control System	6/13/86	All BWR facilities holding an OL or CP
86-47	Feedwater Transient With Partial Failure Of The Reactor Scram System	6/9/86	All BWRs and PWRs facilities holding an OL or CP
86-46	Improper Cleaning And Decontamination Of Respiratory Protection Equipment	6/12/86	All power reactor facilities holding an OL or CP and fuel fabrication facilities
86-45	Potential Falsification Of Test Reports On Flanges Manufactured By Golden Gate Forge And Flange, Inc.	6/10/86	All power reactor facilities holding an OL or CP and research and test facilities

OL = Operating License
CP = Construction Permit