APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-397/94-20

License: NPF-21

Licensee: Washington Public Power Supply System
3000 George Washington Way
P.O. Box 968, MD 1023
Richland, Washington

Facility Name: Washington Nuclear Project-2

Inspection At: Richland, Washington

Inspection Conducted: June 13-17, 1994

Inspector: C. J. Paulk, Reactor Inspector, Engineering Branch
Division of Reactor Safety

Accompanying
Inspector: K. R. Naidu, Senior Reactor Engineer
Office of Nuclear Reactor Regulation

Approved: T. F. Westerman 6-30-94
T. F. Westerman, Chief, Engineering Branch Date
Division of Reactor Safety

Inspection Summary

Areas Inspected: Nonroutine, announced inspection of licensee activities related to electrical containment penetrations.

Results:

- The licensee was actively pursuing resolution of the degraded electrical penetration modules (Section 2.1).
- The licensee's actions were considered to be appropriate once a probable cause was identified (Section 2.1).
- The licensee's storage, procurement, installation, and testing of the replacement electrical penetration modules were found to be in accordance with site procedures and regulatory requirements (Sections 2.3.1, 2.3.2, 2.3.3, and 2.3.4).

Summary of Inspection Findings:

- Inspection Followup Item 397/9402-02 was reviewed but not closed (Section 2.2).

Attachment:

- Attachment - Persons Contacted and Exit Meeting

DETAILS

1 PLANT STATUS

During this inspection period, the plant was shut down for its ninth refueling outage.

2 FOLLOWUP - ENGINEERING (92903)

On January 9, 1994, the licensee identified an erratic rod position indicator. The licensee's immediate actions were followed by the resident inspector staff and subsequently identified as Inspection Followup Item 397/9402-02. This inspection concerned the additional licensee activities related to the electrical penetrations.

2.1 Background

In February 1975, the licensee approved a waiver to the original electrical containment penetration purchase specification. This waiver allowed the replacement of cross-linked polyethylene rubber with silicone-impregnated rubber as an equivalent insulation material for instrumentation circuits.

The licensee has had a history of problems with electrical conductors routed through the electrical containment penetrations produced originally by Westinghouse Electric Company, and later by Imaging and Sensing Technical Corporation. The problems date back to 1987 when two conductors were found to be open, one each in Penetrations E-X-101B1 and E-X-101B3. In 1988, another conductor in Penetration E-X-101B3 was found open as was one conductor in Penetration E-X-101D3. In 1989, another conductor in Penetration E-X-101D3 was found open as well as two more conductors in E-X-101B3 and one conductor in Penetration E-X-101B2. The licensee's actions for each of these occurrences was to switch to spare conductors because the problems were considered to have been caused by manipulation of the conductors during maintenance activities.

In 1990, the licensee attributed ten open conductors as being the result of replacing the conductors in their connection boxes. The licensee's actions for these ten conductors was to switch to spare conductors. The ten conductors were located as follows: three conductors in Penetration E-X-101B1; two conductors in Penetration E-X-101B2; four conductors in Penetration E-X-101C3; and, one conductor in Penetration E-X-101D3.

In 1991, the licensee found three conductors open: two in Penetration E-X-101B2; and one in Penetration E-X-101B3. The licensee did not take any corrective actions at that time "for fear of breaking more." In 1992, seven conductors were found open: four in Penetration E-X-101B1; one each in Penetrations E-X-101B2 and E-X-101B3; and three in Penetration E-X-101C3. The licensee switched all ten of the 1991 and 1992 conductors to spares. The licensee also initiated Problem Event

Report 293-0106 to determine the failure mode. The licensee's preliminary conclusions indicated the failures were on the inboard (containment) side of the penetrations and were not likely to have been caused by manipulation.

In June 1993, two conductors were found open (location not specified). The licensee moved these conductors to spares and initiated Problem Event Report 293-0765 to address the failures.

In 1994, the number of failures escalated. In January, while at power, intermittent operation of a control rod was observed and determined to be the result of low insulation resistance, most likely as the result of moisture in the penetration terminal box. The licensee initiated four problem event reports (294-0025, 294-0040, 294-0063, and 294-0064) to address these problems. In March, position indication was lost to Control Rod 46-15 twice. Problem Event Reports 294-0166 and 294-0167 were initiated. The licensee installed a newly designed multiplexer card to allow operation at lower insulation resistances and installed heat tracing on Penetration E-X-101B. The licensee noted improved insulation resistance readings after the installation of the heat tracing.

On March 10, 1994, the licensee formed a team to define additional testing; perform a root cause evaluation; determine which electrical penetration modules were to be replaced; what the vendor involvement should be; and, develop contingency plans. The licensee commenced testing in April. This testing included electrical tests, as well as destructive tests, on the problematic electrical penetration modules. The licensee presented the vendor with questions related to the materials in May. On the basis of the vendor's responses to the material questions, the licensee initiated Problem Event Report 294-0505 to determine the qualification of the penetrations because of insufficient information related to the materials of construction in the qualification documents. The licensee sent representatives to the vendor's offices to review environmental qualification test data and to verify the traceability of the materials in the Washington Nuclear Project-1 and Washington Nuclear Project-2 electrical penetration modules.

The inspectors considered the licensee's actions to have been appropriate once a probable cause was identified.

2.2 (Open) Inspection Followup Item 397/9402-02: Electrical Containment Penetrations

During this inspection, the inspectors reviewed information related to the qualification of the original electrical penetration modules, the licensee's information obtained during destructive examination of removed electrical penetration modules, and the licensee's plans for ensuring the electrical penetration modules were, and would remain, operable.

The inspectors found that the material, an epoxy-type compound, was installed for strain relief for the conductors passing through the penetrations. This material was never meant to be a moisture barrier, just a mechanical support.

From the documentation available, the inspectors found that the vendor performed all required testing to demonstrate the electrical penetration modules would be capable of performing their design basis functions for 40 years, plus 1 year post-accident. The inspectors concluded that the failure mechanism (moisture intrusion and absorption) of the epoxy compound was not identified, nor considered, during the development of this type electrical penetration module; however, once the failure mechanism was identified, it was the licensee's responsibility to prevent it from affecting safety-related components.

The inspectors reviewed information obtained by the licensee during destructive testing of removed electrical penetration modules, as well as electrical test results. The inspectors found that extrusion of the epoxy compound was indicative of moisture intrusion and absorption. The extrusion was limited to one type of epoxy compound and corrosion was evident only in extruded samples that utilized silicone-impregnated fiber-glass insulated conductors with low direct current voltage applied. This was the first indication of corrosion related to the conductor failures. The licensee reached this conclusion by not finding any corrosion or electrical deficiencies in any electrical penetration module with cross-linked polyethylene insulated conductors, or in electrical penetration modules that did not exhibit extrusion, or in electrical penetration modules with higher voltages, or in electrical penetration modules with no voltage at all.

The inspectors noted that the licensee had developed plans to replace all electrical penetration modules with this epoxy compound and had identified a priority for their replacement. Additionally, the licensee was developing justification for operation until replacement should they not be able to meet their schedule during the on-going outage. The inspectors found that the licensee had divided the electrical penetration modules into five phases or groups. The electrical penetration modules identified in Phase 1 were those needed for the performance of environmental qualification testing (subsequently cancelled); in Phase 2 were those needed prior to startup; in Phase 3 were those required to maintain electrical integrity (safety-related), but that did not exhibit any extrusion; in Phase 4 were those without the requirement for electrical integrity (nonsafety-related), and exhibited extrusion; and, in Phase 5 were those without the requirement for electrical integrity and without evidence of extrusion. The licensee is performing destructive examination on selected removed electrical penetrations in order to further evaluate the moisture intrusion and absorption, the epoxy extrusion, and conductor corrosion. In addition to replacing electrical penetration modules, the licensee would relocate individual conductors from an electrical penetration module with the suspect epoxy compound. Those electrical penetration modules without the suspect epoxy compound were of a newer design that has not exhibited any electrical or mechanical (extrusion or moisture absorption) problems.

The inspectors were informed that plant management intended to replace as many of the subject electrical penetration modules as possible prior to the end of the outage and that the parallel path to develop justification for operation

was continuing. The plan, as provided to the inspectors, would result in ten electrical penetration modules in Phase 1 and 2 being replaced and conductors in five electrical penetration modules relocated prior to the end of the outage. The licensee stated that, time permitting, the Phase 3 electrical penetration modules (three modules required for electrical integrity, one module that contained circuits to meet the licensee's commitments to Regulatory Guide 1.97, "Instrumentation for Light Water Cooled Nuclear Power Plants to Assess Plant and Environs During and Following an Accident," Revision 2, and one conductor relocation) would be performed prior to startup. This would leave the Phase 4 and 5 electrical penetration modules to be replaced during the next two refueling outages.

The inspectors reviewed the licensee's plans and found them to have been thorough and well thought out. This item will remain open pending further NRC evaluation of the licensee's destructive examination of removed electrical penetration modules and the completion of the justification of operations.

2.3 Electrical Penetration Module Replacement

The licensee was replacing some electrical penetration modules with modules from its unfinished plants at Washington Nuclear Project-1 and Washington Nuclear Project-4. Imaging and Sensing Technologies Corporation was manufacturing and supplying the new electrical penetration modules that were not available from the licensee's other facilities. The inspectors reviewed the procurement of the new electrical penetration modules, determined the acceptability of the electrical penetration modules from the licensee's other facilities assessed installation activities (including the local leak rate test) following the completion of an electrical penetration module installation, and reviewed the records of installation.

2.3.1 Procurement of Electrical Penetration Modules

The inspectors reviewed Purchase Order No. 238175, dated June 1, 1994. The inspectors found that the purchase order was for 9 Type D electrical penetration modules with 209 size 16 American wire gauge (AWG) copper conductors; 19 size 16 AWG Type KX shielded pair conductors; and, 9 O-ring kits for installing the electrical penetration modules. The licensee placed the following requirements on the vendor: compliance with licensee Contract No. 2808-55; fabrication of the electrical penetration modules to ASME Boiler Pressure Vessel Code, Section III, Class MC, 1971 Edition 1, with addenda to Summer 1972; tagging each electrical conductor with a unique identifier as shown on vendor Drawing No. E-41514, Revision A, at locations noted on vendor Drawing No. E-41513, Revision A. Additionally the vendor was to provide a certificate of conformance certifying the supplied items were covered by its Report No. PEN-TR-89-18, Revision 2; the items were qualified to the requirements of IEEE Standard 323-1974; and, the electrical penetration modules conformed to all the requirements of IEEE 317-1983.

The inspectors found that the vendor enclosed a copy of the licensee's "Purchase Order Clause Schedule" with the purchase order and noted the clauses that were pertinent to the supply of electrical penetration modules. The clauses contained the requirements for the vendor to implement a quality assurance program conforming to the requirements of Appendix B to 10 CFR Part 50 and to comply with 10 CFR Part 21.

The inspectors reviewed Revisions 1 through 6 of Evaluation 4724, "Procurement Evaluation Revision Record," in which the licensee's technical staff documented its evaluations to select the requirements that were imposed on the procurement of the electrical penetration modules.

The inspectors did not identify any problems in procurement of the replacement electrical penetration electrical penetration modules.

2.3.2 Storage of Electrical Penetration Modules

The inspectors toured the warehouse area in which electrical penetration modules were being stored. The electrical penetration modules were in their original crates in a temperature-controlled, clean area, free from rodents. The monitoring spaces of the electrical penetration modules were subjected to 13.8 Kpa (2 psi) of nitrogen pressure. The inboard and outboard areas in the Washington Nuclear Project-1 facility, where the electrical penetration modules had been installed, were clean, and free from debris and rodents. The inspectors observed that the cables in one penetration on the outboard side were landed on terminal blocks and that the pigtails on the inboard side rested in a cable tray. The monitoring spaces of the installed electrical penetration modules had also been connected to a header pressured with nitrogen at 13.8 Kpa.

Quality control inspectors at Washington Nuclear Project-2 conducted receipt inspections on electrical penetration modules received from Washington Nuclear Project-1, or the vendor, and documented their findings on material receiving inspection reports. The instructions for the receipt inspection were described in Quality Assurance Instruction 10-3, "Receipt Instructions," Revision 11. The characteristics verified by the quality control inspectors during receipt inspections were identification and marking, workmanship, detection of fraudulence/malpractice, and the presence of an N-2 code data sheet. The inspectors observed that three electrical penetration modules (No. 252 1-PEN-HH3-C, No. 254 1-PEN-HI5, and No. 246 1-PEN-HE2 WNP-10) had been obtained by Intersite Transfer 01-94-009, dated May 25, 1994. Material Receiving Inspection Report 94-099, dated May 27, 1994, showed that Washington Nuclear Project-2 had received one electrical penetration module, Type N Serial No. 770817 (UF), from the vendor without any problems.

The inspectors did not identify any concerns related to the storage and receipt inspection of the electrical penetration modules.

2.3.3 Review of Installation Records

The inspectors reviewed work activities related to the installation of the electrical penetration modules. These activities consisted of determinating the cable connections, removing the old electrical penetration module, installing the replacement electrical penetration module, splicing the inboard cables, terminating or splicing the outboard cables, and performing the local leak rate test. The inspectors reviewed Work Order Task GW 15 09 for the work and inspection activities related to the installation of Module E-X-101A1 (control rod drive position indication). The inspectors did not identify any concerns related to the installation of the electrical penetration module inspected.

2.3.4 Local Leak Rate Test

The inspectors observed the local leak rate test performed on Module E-X-105B. The licensee used a pressure decay leakage method, used on both electrical and mechanical containment penetrations, to determine leakage through penetrations which were sealed by a series of four O-rings. Technicians applied nitrogen, at a pressure of 267.3 Kpa (38.77 psi), to the monitoring space of Module E-X-105B, and maintained it for 20 minutes. No drop in pressure was observed. The inspectors observed that all instruments used for the test bore valid calibration stickers. No concerns were identified in this area.

ATTACHMENT

1 PERSONS CONTACTED

1.1 Licensee Personnel

J. Benjamin, Manager, Quality Assessments
B. Boyum, Engineering Supervisor
D. Coleman, Manager, Regulatory Services
G. Cullen, Quality Assurance Engineer
W. Davison, Manager, Quality Assurance Plant Support Assessments
L. Fernandez, Licensing Engineer
M. Flasch, Director of Engineering
C. Foley, Licensing Engineer
J. Gearhart, Director, Quality Assurance
G. Gelhaus, Manager, Unit 2 Projects
R. Koenigs, Manager, Design Engineering
D. Larkin, Manager, Engineering Services
C. Noyes, Manager, Engineering Programs
J. Parish, Assistant Managing Director of Operations
S. Peck, Manager, Equipment Engineering
K. Pisarcik, Licensing Assistant
M. Reddemann, Technical Services Division Manager
W. Shaetter, Manager, Operations
G. Smith, Operations Division Manager
J. Swailes, Plant Manager
D. Swank, Compliance Manager

1.2 NRC Personnel

R. Barr, Senior Resident Inspector

The personnel listed above attended the exit meeting. In addition to the personnel listed above, the inspectors contacted other personnel during this inspection period.

2 EXIT MEETING

An exit meeting was conducted on June 17, 1994. During this meeting, the inspectors reviewed the scope and findings of the report. The licensee did not express a position on the findings documented in this report. The licensee did not identify as proprietary any information provided to, or reviewed by, the inspectors.