U. S. NUCLEAR REGULATORY COMMISSION

REGION V

Report No. 50-344/87-15

Docket No. 50-344

License No. NPF-1

Licensee: Portland General Electric Company
121 S. W. Salmon Street
Portland, Oregon 97204

Facility Name: Trojan Nuclear Plant

Inspection at: Rainier, Oregon

Inspection Conducted: April 15-24, 1987

Inspector: C. A. Hooker 5/8/87
C. A. Hooker, Radiation Specialist Date Signed

Approved by: G. P. Yuhas 5/8/87
G. P. Yuhas, Chief Date Signed
Facilities Radiological Protection Section

Summary:

Inspection on April 15-24, 1987 (Report No. 50-344/87-15)

Areas Inspected: This was a special inspection in response to the licensee's April 10, 1987, report of high contamination levels in the reactor building and a subsequent report on April 17, 1987, of a potential exposure to the right foot of an individual in excess of the regulatory limits. The purpose of this inspection was to evaluate the adequacy of the radiation protection controls being implemented by the licensee to minimize the potential for unplanned exposures to workers from small particulate sources of radioactive material. Inspection procedures addressed were 30703, 90713, 83729, and 93702.

Results: Of the areas inspected, apparent violations involving failure to establish and implement radiation protection procedures, Technical Specification 6.11, paragraph 4.A.; failure to provide instructions to workers, 10 CFR 19.12, paragraph 4.B.; failure to perform surveys and/or evaluations, 10 CFR 20.201, paragraph 4.C.; and failure to maintain records of surveys, 10 CFR 20.401, paragraph 4.D., were identified.

DETAILS

1. Persons Contacted

a. Portland General Electric (PGE)

*D. W. Cockfield, Vice President, Nuclear
*C. A. Olmstead, General Manager, Trojan
*C. P. Yundt, General Manager, Technical Functions
*D. R. Keuter, Manager, Technical Services
*J. D. Reid, Manager, Plant Services
*T. D. Walt, Manager, Nuclear Safety and Regulation Department (NSRD)
*R. C. Jarman, Manager, Nuclear Quality Assurance Department
*N. C. Dyer, Manager, Radiological Safety Branch (RSB)
*T. O. Meek, Supervisor, Radiation Protection (RP)
*A. R. Ankrum, Nuclear Regulation Branch Engineer
J. C. Wiles, Unit Supervisor, RP
P. B. Chadley, RP Engineer
L. F. Price, RP Technician (RPT)
O. A. Peterson, RPT

b. Contract Personnel

Power Systems Energy Services

J. W. Leonard, Shift Supervisor
E. Jones, RPT
K. S. Estaque, RPT
R. P. Troffer, RPT
M. L. Butts, RPT

Quadrex

R. Faller, Field Services Engineer

c. NRC Contacts

*R. C. Barr, Senior Resident Inspector
*G. Y. Suh, Resident Inspector

*Denotes those present at the exit interview on April 24, 1987.

In addition to the individuals identified above, the inspector met and held discussions with other members of the licensee's and contractor's staffs.

2. Background

During 1980 the licensee experienced fuel pin cladding failures resulting in increased concentrations of fission products in the primary coolant system. During the 1981 fuel cycle, the licensee experienced baffle jetting problems that resulted in actual fuel rod separations as observed during their spring 1982 refueling outage. After clean up and retrieval

operations, the licensee conservatively estimated that about 376 fuel pellets may have fallen out of the fuel rods. The licensee recovered 232 pellets with a maximum of 144 that were not accounted for. About 12 pellets were observed to be under the core support plate and could not be retrieved. Since July 1982 the licensee has recovered 32 pellets, leaving 112 unaccounted for. Due to the failed fuel problem and loose unclad fuel pellets in the primary system, the licensee experienced increased levels of radioactive material in plant systems and numerous instances of personnel contamination.

In 1986 the NRC issued IE Information Notice No. 86-23, Excessive Skin Exposures Due to Contamination With Hot Particles, dated April 9, 1986. The licensee received the notice on April 16, 1986, and set a target date of June 20, 1986, for completion of their evaluation. The evaluation was completed on May 14, 1986, by a member of the RSB, reviewed and approved on June 25, 1986, and proposed corrective actions approved on June 27, 1986, by plant management. The inspector noted from the evaluation that the licensee had determined that this problem demanded continuous vigilance by Trojan RP staff and plant workers to control personnel contaminations by proper surveys, work practices, and use of protective clothing (PC). The evaluation further noted that an automatic laundry monitor would be budgeted for 1987, and that training of radiation workers and RPTs should include training on highly radioactive particles because of Trojan's failed fuel experience.

A memorandum from T. O. Meek to D. R. Keuter, Review of NRC IE Information Notice 86-23, dated November 20, 1986, noted that "Trojan has experienced problems with particles in the past. We have not had high skin exposures, however, the possibility is very high that an excessive skin exposure may occur if we do not take action to prevent the spread of hot particles." Six items were identified to improve the contamination program:

- Purchase and installation of whole body friskers.
- Purchase of automatic laundry monitors.
- Improve protective clothing by discarding the 100% cotton coveralls and substituting other clothing with man-made fabrics simular to those being used at other facilities.
- Improve decontamination of plant surfaces.
- Expand the use of local containments to control contamination from hot particles at the source. Under this action, it was also noted that the RP plant staff does not include trained personnel to implement this program.
- Installation of permanent physical barriers in place of ropes to provide more positive contamination control.

The memorandum also noted that, except for the whole body friskers which were already being set up on-site, all other items would require plant and management support to implement.

It should be noted that in 1985 the licensee had implemented:

- Segregation of PCs used on high level contamination jobs.
- The use of disposable paper coveralls over cloth PCs to prevent hot particles from reaching cloth coveralls.
- Double washing of rubber gloves.
- Improved surveying of laundered clothing by the vendor.
- Spot check surveys of laundered clothing when received from the vendor.

On April 1, 1987, the licensee started their 1987 refueling outage. The licensee observed a significant increase in personnel contamination. The licensee partly attributed the discovery of these contamination instances to the installation of four new highly sensitive whole body friskers that had been put into operation about March 1, 1987. Personnel contamination incidents following January 1, 1987, were broken down as follows:

- January 1 to March 31, 1987 - 17 clothing and 3 personnel.
- April 1-3, 1987 - 8 clothing and 18 personnel.

On April 3, 1987, at the request of the Plant General Manager, the Performance Monitoring Event Analysis (PMEA) group initiated an investigation to determine the root cause(s) of the apparent significant increase in personnel clothing and skin contamination.

On April 10, 1987, as a result of a significant dispersal of highly radioactive material on April 9, 1987, in the reactor containment, the licensee notified the NRC and made a report pursuant to 10 CFR 50.72(b)(2)(vi). In response to this notification, a Region V inspector was dispatched to the site on April 15, 1987, to determine if the licensee was dedicating sufficient resources to evaluate the potential radiological consequences and to verify that the licensee was in the process of implementing adequate radiation protection measures to control potential exposures from suspected highly radioactive irradiated fuel fragments (IFF).

3. Annotated Chronology

This inspection, which began at 12:30 p.m. on April 15, 1987, included: interviews with plant, corporate and contractor staffs; reviews of selected RP surveys and air sample data, licensee evaluations, selected licensee procedures, personnel contamination reports; observations by the inspector including independent measurements of radiation using an NRC portable ionization chamber, Serial No. 837, due for calibration May 23, 1987.

At the start of this inspection, the licensee had not yet documented a sequence of events with respect to the dispersal of IFF in the reactor building.

NOTE: The licensee used an RO2A ion chamber survey instrument in most cases. Those readings reported in rad/hr as beta radiation were determined by the licensee by taking the difference between window open and closed readings and multiplying by factor of about five.

A. Initial Indication of the Contamination Problem

On April 2, 1987, initial refueling cavity surveys were made. Smears from the upper cavity floor indicated a maximum of 50,000 dpm/100 cm^2 while control rod drive seals smears indicated 75 mrad/hr beta, 2 mR/hr gamma and 500 dpm alpha. Dose rate measurements, taken at waist high, while standing on the cavity floor indicated a maximum of 100 mR/hr gamma. Survey records did not indicate that general area beta dose rate measurements were taken.

The lower cavity floor smears (100 cm^2) indicated a maximum of 75 mrad/hr beta, 5 mR/hr gamma, and 500 dpm alpha near the upender trench. The remaining cavity floor area indicated a maximum of 150,000 dpm/100 cm^2 and dose rates at about waist level ranged from 10 to 50 mR/hr gamma. Survey records did not indicate that beta dose rate measurements were made.

Following decontamination of the refueling cavity and shielding of the reactor head, on April 8, 1987, at 6:45 a.m. smears of the cavity floor ranged from 5,000 dpm/100 cm^2 to 30,000 dpm 100 cm^2. Dose rates around the reactor head area (about waist high) ranged from 50 mR/hr to 70 mR/hr gamma. The step-off pad (SOP) in the lower cavity on initial wipe (100 cm^2) indicated 25 mrad/hr beta and 500 dpm alpha. Post decontamination of the SOP indicated 20,000 dpm/100 cm^2 and no alpha activity. No survey records indicate that dose rate measurements were taken at the reactor vessel flange opening. The flange opening is about one to two inches above the cavity floor and about 3/8 inch wide.

Late evening on April 8, 1986, during reactor head stud removal, several of the contract refueling crew workers came out of the refueling cavity contaminated. Three workers indicated nasal contamination ranging from 8,000 dpm to 20,000 dpm. One worker showed hair contamination (30,000 dpm/probe area) and one worker had contamination on the back of his neck (20,000 dpm/probe area). Air sample data on April 8, 1987, taken from 9:50 p.m. to 11:00 p.m. (upper cavity) indicated 1.4 E-10 µCi/cc; and on April 9, 1987, 12:27 a.m. to 1:00 a.m. (lower cavity) 6.0 E-10 to µCi/cc.

On April 9, 1987, at about 3:45 a.m., the licensee performed smear tests of the floor area and equipment in the upper cavity in an effort to determine the cause of the personnel contaminations. Floor smears ranged from 15,000 dpm/100 cm^2 to 400,000 dpm/100 cm^2, and equipment (ropes and chain falls) ranged from 3,000 dpm/100 cm^2 to 150,000 dpm/100 cm^2. Survey records did not indicate that dose rate measurements to identify the source of contamination were taken during these surveys.

The RP Supervisor, when informed of the personnel and refueling cavity contamination, stopped the work and requested additional wipe surveys of the work areas.

Records showed that at 7:30 a.m. large area smears of the 93' levels in the containment ranged from 20,000 dpm/wipe to 340,000 dpm/wipe and 30 mrad/hr beta/wipe in the area on the refueling floor where the workers exit from the refueling cavity.

At 8:00 a.m. more detailed wipe surveys of the upper refueling cavity area indicated that contamination levels on the floor area ranged from 20,000 dpm/100 cm^2 to 240,000 dpm/100 cm^2. The top of the flange near stud hole No. 48 indicated 260,000 dpm/100 cm^2. Stud holes Nos. 8, 52, 49, and 39 showed a maximum of 40,000 dpm/100 cm^2. Studs, Nos. 35, 29, 18, and 12 indicated a maximum of 4,000 dpm/100 cm^2. This survey record also stated that air flow was coming up through the cavity seal opening. Large area smears of the studs in their racks indicated a maximum of 25,000 dpm/wipe. No survey record showed that dose rate measurements were taken during these surveys to identify a source of contamination.

At 9:30 a.m. all survey data indicated the contamination had been cleaned to below 60,000 dpm/large area smears on the refueling floor.

Air samples collected from 7:20 a.m. to 9:26 a.m. in the upper cavity indicated less than or equal to 3.97 E-11 µCi/cc; while samples taken from 9:35 a.m. to 10:30 a.m. in the spent fuel pool area showed 1.52 E-10 µCi/cc.

According to the RP Supervisor, the licensee at this time believed that the contamination problems were associated with contaminated stud holes and/or studs. Air sample data did not indicate an airborne problem, therefore, they assumed that the contamination (personnel, equipment and floor areas) was caused by tracking and handling.

B. Dispersal of Radioactive Material

On April 9, 1987, at about 12:30 p.m., the cavity workers resumed stud removal operations. Due to the previous contamination problems, the RP Supervisor required the workers to wear respirators. Personnel dosimetry requirements included the use of a high and low range pocket ion chambers (PICs) and a TLD packet, worn on the chest area (same as previous requirements).

The following information was obtained through discussion with the RPT staff and had not been documented in the licensee's survey records:

- On April 9, 1987, at about 12:45 p.m., a RPT took a wipe on the refueling floor side of the step-off pad (SOP) leading to the cavity and noted what appeared to be a particle that measured 75 mrad/hr beta using an RO2A survey instrument. Nearby floor areas smears indicated 2,000 dpm/per three square feet.

- The air monitor on the refueling floor indicated no increase in air activity.

- 1:15 p.m. to 1:30 p.m. wipes sent up from the refueling cavity on the stud racks indicated 30 to 40 mrad/hr beta. The stud racks were then double wrapped in plastic and hoisted from the cavity to a location on the 93' elevation.

Routine large area smears of the spent fuel pool building, on the 93' elevation, taken between 2:30 p.m. and 3:00 p.m. ranged from 200,000 dpm to 60 mrad/hr beta. Based on this apparent spread of contamination from the reactor building to the spent fuel pool area, all cavity work was stopped and all personnel were evacuated from the area at about 3:30 p.m. on April 9, 1987.

A RPT informed the inspector that a smear from the outer layer of PC from the last worker out of the cavity at this time measured 4.1 rad/hr beta and 180 mR/hr gamma with an RO2A. The RPT also informed the inspector that this survey had not been documented. The RPT stated that no smear and/or direct radiation surveys of the other six workers' PCs were performed. The RPT stated that the PCs were not saved. The inspector learned from discussion with the RPT that no determination was made to establish if the 4.1 rad/hr dose rate measured was the result of a single point source of IFFs or a uniform distribution of radioactive material on the smear.

On April 9, 1987, as a result of the contamination spread, about 21 workers were found to have skin and/or nasal contaminations. The licensee suspected that a majority of these contaminations were caused during removal of workers' PCs. Facial and nasal contamination ranged from 2,000 dpm to 40,000 dpm. Other areas of the skin or body ranged from 3,000 dpm to 150,000 dpm. Seven of the workers with positive nasal contaminations were given whole body counts (WBCs) with no positive indications of any uptakes of radioactive material. An air sample taken in the upper cavity from 2:25 p.m. to 2:45 p.m. showed an air concentration of 2.44 E-7 µCi/cc. A gamma scan of this sample, according to the licensee, indicated Zr-95, Nb-95, Cs-134, Cs-137, Ru-106, and Ce-144. The licensee could not locate the gamma scan analysis data. An air sample from the upper cavity taken from 2:45 p.m. to 3:20 p.m. indicated an air concentration of 4.0 E-9 µCi/cc. Air sample data on the refueling floor from 2:40 p.m. to 2:59 p.m. indicated 6.5 E-10 µCi/cc. The inspector was informed that none of the air sample filters had been saved for further analysis.

From survey records, contamination levels in the spent fuel pool area ranged from 200,000 dpm to 60 mrad/hr beta for large area smears. Outlying areas of the containment 93' level ranged from 60,000 dpm to 160,000 dpm. Stud racks on the SFP floor area, under their plastic wrapping ranged from 40,000 dpm to 350 mrad/hr beta. The refueling floor ranged from 50 mrad/hr beta and 8 mR/hr gamma to 825 mrad/hr beta to 15 mR/hr gamma. No survey data showed the 5 to 10 rad/hr beta smears on the refueling floor that the licensee had

reported to the Region V office and the Headquarters Duty Officer on April 10, 1987.

On April 9, 1987, at 5:00 p.m. a brief entry into the cavity area identified a spot on the floor of the upper cavity, near stud hole No. 48, that measured 35 rad/hr beta and 1.0 R/hr gamma. According to the RP Supervisor, this was the first dose rate measurement taken in the cavity since April 8, 1987, to identify the source of contamination problems.

The RP Supervisor stated that previous surveys to identify the source of contamination had been concentrating on wipe tests.

The licensee suspended work activities in the cavity area and spent fuel pool 93' elevation in order to pinpoint the source of contamination and develop plans for reentry.

C. Identification of the Source of Contamination

On April 10, 1987, at 12:00 a.m. licensee's survey data showed that a spot on the cavity floor near stud hole No. 48 measured >100 rad/hr beta and 30 R/hr gamma at contact, and 4 rad/hr beta and 1.0 R/hr gamma at 18 inches with an RO2A. Cavity floor smears ranged from 20 mrad/hr/ft^2 beta and 1 mR/hr/ft^2 gamma to 500 mrad/hr beta/ft^2 and 12 mR/hr/ft^2 gamma. A smear from the east cavity wall measured 50 mrad/hr/ft^2 beta and 2.0 mR/hr/ft^2 gamma. Dose rate measurements taken on the reactor head, above the stud plugs and below the insulation ranged from 25 mrad/hr beta and 1 mR/hr gamma to 1,600 mrad/hr beta and 30 mR/hr gamma (hole No. 48 area). No further cavity entries were made. Decontamination operations and more smear tests were underway for affected areas at the 93' level.

The licensee then made the initial 10 CFR 50.72 report to NRC as described in paragraph 2 above.

On April 10, 1987, at 10:45 a.m. to 3:30 p.m. pre-decontamination survey data showed that the 205' level also had higher than normal contamination levels. Smears showed activity that ranged from 25,000 dpm/ft^2 to 330,000 dpm/ft^2. By 4:30 p.m. the 93' levels had been cleaned to less than 100,000 dpm/ft^2. At 8:00 p.m. a subsequent cavity entry and more surveys using a Teletector survey instrument in the stud holes indicated that the flange area at stud hole No. 48 appeared to be the source of contamination problems.

On April 11, 1987, after no success in trying to vacuum the high reading source from between the flange, a RPT using a piece of wire, pulled some material out onto the cavity floor. The RPT measured the material that indicated greater than 50 R/hr at contact and 30 R/hr at 18 inches - RO2A window closed readings. According to the RPT, the material appeared to look like a fuel pellet cut in half. The RPT left the area. The flange opening is about 1 to 2 inches above the cavity floor and is about 3/8 inch wide at the edge. The licensee developed plans for removal of the material on April 12, 1987.

On April 12, 1987, at about 3:00 a.m., the suspect fuel pellet was retrieved with a sticky pliable material on the end of a stick, placed in a 500 ml bottle cut in half and remotely placed in a lead container. A plastic type paint was poured over the material in the bottle to seal it in place. Dose rate measurements from the material, prior to retrieval, indicated readings of 50 R/hr gamma at 8 inches, 30 R/hr gamma and 100 rad/hr beta at 18 inches using a RO2A survey instrument. Spots (smudges) on the cavity floor where the material had fallen were measured at 100 rad/hr beta and 30 R/hr gamma at contact.

The maximum dose to personnel who retrieved the material was 25 mrem measured from chest and thigh PICs. No personnel clothing or skin contaminations were encountered.

On April 12, 1987, an RPT cleaned the area by vacuuming and wet mopping. On April 21, 1987, the inspector was informed by this RPT that as he was leaving the cavity area, he took a measurement on the knees of his PCs and observed a reading of 1 R/hr gamma on each knee using a RO2A instrument. When asked, the RPT stated that he had not informed anyone of this reading nor had the survey been documented.

On April 12, 1987, at 11:30 p.m. after decontamination, contact dose rates at the flange opening near hole NO. 48 were 13 rad/hr beta and 600 mR/hr gamma with 12 R/hr gamma in hole No. 48, and a 3.0 R/hr gamma spot on the wet floor. Dose rates ranged from 20 to 60 mR/hr gamma at the flange opening for the remaining head area. After placing plastic wrapped plywood on the cavity floor area at hole No. 48, contact dose rates were 1.0 R/hr gamma from the spot on the floor and 250 mR/hr gamma at the flange.

The licensee was keeping the cavity walls wet in order to minimize any further contamination spreads.

D. Resumption of Work

From April 13, 1987, through April 14, 1987, the refueling crew worked on the refueling floor and in the cavity area removing equipment and making preparations for reactor head removal. The licensee had changed from single dosimetry to multiple dosimetry packets. Workers in the cavity were required to wear plastic outer PCs and air supplied hoods. The licensee started experiencing contamination problems on the 93' refueling floor area when the [illegible]ne was being used. The licensee concluded this occurred because [illegible] crane, crane rails and other associated equipment had not been decontaminated. The licensee instituted respirator requirements for the 93' levels. The inspector was informed by the RPT staff, contract refueling crew and the RP Supervisor that during April 13 through April 14, 1987, prior to exiting the cavity area, the outer PC and rubber shoe covers were being wiped off; however, surveys of the workers' clothing during work in the cavity and/or upon exiting were not instituted until April 15, 1987. In addition, the inspector was informed by the RP Supervisor and the contract

refueling crew that no special training and/or instructions were provided the refueling crew concerning the contamination problems associated with IFFs in the cavity area and the 93' level in the containment, until April 15, 1987, after the contract workers expressed concerns in regard to the additional radiological controls being employed in their work areas.

The inspector noted that no special instructions or changes had been made on the RWP No. 701, Refueling Preparation and Reactor Disassembly, dated April 1, 1987. This RWP only noted requirements for single TLD personnel dosimetry packets instead of the multiple TLDs being used as of April 13, 1987. The RWP also noted respirators were required for respiratory protection instead of the supplied air hoods being used during cavity work. No special precautions were added to the RWP in regard to IFF contamination problems.

On April 14, 1987, the licensee initiated a bioassay program to have urine samples from selected individuals sent to a contract vendor for beta and alpha analysis.

On April 15, 1987, the licensee's daily update, posted and distributed site-wide, Morning Update from Plant Manager, item 1, in regard to the containment contamination problems stated: "Major problem is the very small fuel particles that became airborne from the refueling cavity work. These particles were very light and were carried above the refueling cavity to the 205' elevation and areas between. Work in the Containment from the 93' elevation and above is delayed while we decontaminate these areas."

E. Extremity Exposure

At about 12:30 p.m. on April 17, 1987, the RP supervisor informed the inspector that earlier in the day a contract RPT had picked up a radioactive particle on his PC rubber shoe cover after exiting the upender trench. The particle measured greater than 50 R/hr gamma with a RO2A and 300 R/hr gamma with a PIC6A, both contact readings. The RP Supervisor estimated that the foot could have received a dose of 200 rem. Shortly thereafter, the RP Supervisor informed the inspector that after reevaluation a conservative dose of 83 rem had been estimated. The RPTs low range PIC was off scale and the high range PIC read 180 mrem. The licensee informed the NRC Headquarters Duty Officer and made a report in accordance with 10 CFR 50.72.

On April 17, 1987, at 2:00 p.m. the Plant Manager issued a plant wide notification of the suspected extremity exposure. The notification also stated, in part, that all containment work had been stopped to ensure that adequate measures to protect people working in all containment areas could be developed, and that work would not resume in the containment until a review had been completed.

On April 17, 1987, at 2:00 p.m., the inspector attended a corporate and plant management meeting in regard to the contamination and

potential overexposure incidents. The meeting was presided by the Plant General Manager with the Vice President, Nuclear providing oversight. Brief details of the sequence of events during April 8-17, 1987, were presented by the RP Supervisor. The RP Supervisor also discussed the need to evaluate the radiation exposure to the hands and whole body of the RPT who had received the potential 83 rem foot dose. The Vice President, Nuclear requested that this individual be given a medical examination. The licensee outlined 14 action items to be addressed in regard to the facilities IFF and other sources of radioactive particle problems. The Outage Coordinator questioned as to when containment work could begin again. The Vice President, Nuclear stated, in part, that no containment work would restart until the contamination problem was under control and had management's approval. The licensee also discussed the need for onsite assistance from other facilities and contract professionals.

Following the meeting, the inspector was informed by the Manager, NSRD that he had been assigned the responsibility to take charge of and ensure that the containment contamination problem was properly investigated and evaluated.

During April 17-19, 1987, the licensee aggressively worked on developing monitoring procedures, training programs (workers and RP staff), mockups to evaluate the exposure to the RPT's foot, and reconstructed the RPT's activities in the refueling cavity and upender trench for a time and motion study in order to evaluate the individual's exposures. This time and motion study was video taped by the licensee.

On April 18, 1987, the licensee, remotely, gamma scanned the rubber shoe contaminated with the highly radioactive particle. The scan was performed using their Nuclear Data ND6 PASS gamma analyzer. The licensee was able to obtain a spectrum from the analyzer screen; however a printout of the counting data could not be obtained due to system failure. The licensee observed peaks of Zr-95, Nb-95, Ru-106, Cs-134, Cs-137 and Ce-144 from the screen display. The licensee contacted the Nuclear Data vendor for repair services. The inspector expressed concerns regarding availability of their analytical capabilities with licensee representatives. This matter was also discussed at the exit interview on April 24, 1987. The licensee acknowledged the inspector's concern.

4. Inspector Observations

A. Technical Specification 6.11 requires that procedures for personnel radiation protection shall be prepared consistent with the requirements of 10 CFR Part 20 and shall be approved, maintained, and adhered to for all operations involving personnel radiation exposure.

The licensee had been cognizant of radiological problems associated with highly radioactive particles as of May 14, 1986, based on

review of IE Information Notice 86-23. In their review, the licensee noted that this problem demanded continuous vigilance of the RP department and workers to control personnel contamination by proper surveys and work practices. As of April 17, 1987, the licensee had not developed radiation protection procedures to ensure that survey methods and control techniques could limit the exposure to workers from highly radioactive particles such that compliance with the general provisions expressed in 10 CFR 20.1(c) and specific dose limits of 10 CFR 20.101(a) would be met. Failure to prepare such procedures was identified as an apparent violation of T.S. 6.11 (50-344/87/15-01).

B. 10 CFR 19.12 requires, in part, that all individuals working in or frequenting any portion of a restricted area, shall be instructed in the health protection problems associated with exposure to radioactive materials and precautions or procedures to minimize exposure. The extent of these instructions shall be commensurate with potential radiological health problems in the restricted area.

The licensee being aware of the increased radiological health hazards associated with the contamination incident that occurred on April 9, 1987, and continued through April 17, 1987, permitted about ten contract refueling crew workers to enter the refueling cavity and refueling floor areas during April 13 and 14, 1987, without instructing them in the potential radiological health protection problems associated with exposure to highly radioactive IFFs. On April 15, 1987, such instructions were provided, only after the contract workers brought their concerns to the licensee's attention and the inspector informed the licensee representative that failure to provide these instructions to workers involved in refueling cavity and 93' level containment activities during April 13 through 14, 1987, was an apparent violation of 10 CFR 19.12.

In addition, after being aware of the potential radiological consequences due to IFFs during April 9-17, 1987, contract and facility RPT's providing coverage for reactor cavity and refueling floor work had not been instructed in precautions or procedures to minimize their exposure and that of their co-workers from the small highly radioactive IFFs present. Specifically the worker who entered the cavity on April 17, 1987 and handled his shoe cover contaminated with a highly radioactive IFF stated to the inspector that he had not been instructed in precaution or procedures to detect and limit his exposure from this type of radiological hazard. His statements were echoed by many other RPTs. Failure to instruct workers in the health protection problems and precautions and procedures to minimize their exposure from IFFs represents an apparent violation of 10 CFR 19.12 (50-344/87-15-02).

C. 10 CFR 20 states, under Precautionary Procedures in 20.201, Surveys, that:

> "As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or

other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

"(b) Each licensee shall make or cause to be made such surveys as (1) may be necessary for the licensee to comply with the regulations in this part, and (2) are reasonable under the circumstances to evaluate the extent of radiation hazards that may be present."

(1) On April 9, 1987, seven workers engaged in reactor vessel stud removal and plugging operations were exposed to highly radioactive loose surface contamination (a smear from the outer layer of protective clothing from one worker purportedly indicated a level of 4.1 rad/hr beta and 180 mR/hr gamma) and no survey or evaluation was made to determine the extent of radiation hazard to portions of their bodies resulting from the presence of highly radioactive material on their clothing. These workers were also permitted to reenter the refueling cavity and refueling floor area on April 13 and 14, 1987, prior to any dose evaluations. Failure to perform the required surveys and/or evaluations of their dose prior to allowing these workers to incur more radiation exposure during cavity and refueling floor work on April 13 and 14, 1987, represents an apparent violation of 10 CFR 20.201(b) (50-344/87-15-03).

(2) On April 9, 1987, a radiation protection technician, following the dispersal of significant quantities of radioactive material in and around the refueling cavity, measured a spot on the floor in the upper cavity near stud hole No. 48 that indicated an exposure rate of 30 rads/hr beta and 1.0 R/hr gamma; and on April 10, 1987, a different radiation protection technician measured another spot on the floor near the reactor vessel flange, near stud hole No. 48, which indicated an exposure rate of greater than 100 rad/hr beta and 30 R/hr gamma at contact and no evaluations were made in either case to determine the radiation hazard to individuals who had previously worked in the area on April 9, 1987. Failure to perform the required evaluation in this case was also identified as an apparent violation of 10 CFR 20.201(b) (50-344/87-15-04).

(3) On April 12, 1987, a RPT, while vacuuming around the reactor upper cavity area, measured radioactive contamination levels on the knees of his outer layer of PC that indicated a level of 1.0 R/hr gamma. If this dose rate were due to an IFF the beta dose rate could have been at least of 44 rad/hr (based on beta to gamma ratios recorded on licensee's survey forms) if a measurement had been made.

Failure to perform a survey necessary to evaluate the dose to the worker represents an apparent violation of 10 CFR 20.201b (50-344/87-15-05).

The licensee was not aware of the dose rate from contamination levels this individual measured on his PC, until it was brought to their attention by the inspector. The individual being a senior RPT, should have been aware of the need to identify the source of radioactive material present and initiate an evaluation of the dose to his body.

(4) On April 17, 1987, a senior contract RPT entered the reactor cavity area and upender trench to obtain dose rate measurements for planned electrical work. The RPT was suited in one pair of cloth coveralls, paper coveralls and plastic outer suit; foot gear of plastic, rubber shoes, plastic and another outer rubber shoe cover; for hands, cotton with 2 pairs of rubber gloves; and respirator and hood. Upon exiting the lower cavity area the individual surveyed his feet and noted that his right shoe cover, indicated an exposure rate of greater than 50 R/hr gamma at contact. During an interview with this individual the inspector was informed that he removed the shoe cover with his left hand. He picked up and held the shoe cover with his left hand on two more occasions to obtain dose rate measurements. He then picked up the shoe cover a third time and attempted to wipe off the hot spot with a masslin cloth with his right hand. Shortly thereafter he picked up the shoe cover again, took another reading and placed it in two plastic bags toe end down (hot spot on heel). He held the double bag in his left hand and between his knees and upper legs while sealing the bag ends with tape. Handling the shoe cover without performing an evaluation of the radiation hazard to his hands and other portions of his body was also identified as an apparent violation of 10 CFR 20.201(b), (50-344/87-15-06).

The licensee's Radiation Protection Manual specifies the radiation dosimetry requirements for personnel. Radiation Protection Procedure RP 109, Personnel Dosimetry Program, provides the details to ensure implementation of these requirements. Section III.C.1.b. states, in part, that extremity TLDs will be required when the extremity dose is expected to be five times greater than the whole body dose and the dose to the extremities is expected to exceed 1 rem for the quarter.

The RPT had prior knowledge from previous surveys that a 10 R/hr gamma hot spot, 22 R/hr gamma hot spot and other hot spots existed on the floor area of the trench. Since whole body dose rates ranged from 300 mR/hr gamma to about 1000 mR/hr gamma and since no specified stay times had been calculated, the failure to wear lower extremity monitoring devices in these adverse conditions represents an apparent violation of TS 6.11 (50-344/87-15-07).

The licensee initially estimated, and reported to the NRC that the above individual could have received a dose of 83 rem to the right foot.

10 CFR 20.101(a) limits the radiation dose to the hands and forearms; feet and ankles to 18.75 rem/quarter, and the skin of the whole body to 7.5 rem/quarter. Under the provisions of 10 CFR 20.101(b) an individual may receive a whole body dose of 3.0 rem/quarter.

On the evening of April 17, 1987, the RPT was sent to visit a physician, who is a specialist in Therapeutic Radiology for base line observations.

On April 18, 1987, the inspector observed the licensee processing the RPT's TLDs. The TLD results indicated a whole body dose of 350 mrem and no indication of a beta dose to the skin for the period April 1-17, 1987. A licensee QA representative also observed the TLD processing operation.

On April 18, 1987, the licensee, with the RPT, reconstructed the reactor cavity and upender trench entry, using mockups and video equipment in order to aid them in a time and motion study. On April 22, 1987, the inspector observed the licensee verifying the location of the source on the rubber shoe cover while in double plastic bags. Through manipulation and dose rate measurements using a Teletector survey instrument it was determined that the source was on the heel of the rubber. Using window open and window closed readings with a R02A, it appeared that the source was on the outside of the rubber. Through the double plastic bags the inspector measured a reading of 1200 mrad/hr window open and 250 mR/hr window closed with a R02 at three feet. The licensee observed similar readings using a R02A. A maximum reading of about 300 R/hr with the Teletector was noted by the licensee. After verification of the source on the rubber, the licensee, by placing a water leg and foot phantom and TLDs on the source, performed a series of tests in order to better evaluate the dose to the RPT's foot. In addition, a series of tests using a chest phantom and TLDs at different distances were used to determine the deep and shallow doses in order to further evaluate the exposure to the skin, whole body and hands. A licensee QA representative also observed the licensee's mockup tests. The inspector had no concerns in regard to the method and types of tests being conducted.

On the evening of April 23, 1987, the inspector and licensee QA representative observed the licensee reading the TLDs from the mockup tests. The licensee had used 22 TLD finger ring TLDs for each of the three timed tests (66 TLDs total) with the foot phantom and a set of three chest TLD badges at 50, 20, 14 and 10 inches to assess the deep and shallow doses. The licensee used the National Voluntary Laboratory Accreditation Program algorithium of 1.0 so that the dose due to high energy beta would not be overestimated.

On April 28, 1987, the licensee notified the Region V office by telephone that they had completed their evaluation of the doses

to the RPT. The licensee evaluation concluded that during April 17, 1987, this individual had received a whole body dose of 1210 mrem, a skin dose of 4620 mrem and extremity dose of 9570 mrem. Doses received from the incident on April 17, 1987, would be about 9220 mrem (right hand due wiping the shoe cover), 5450 mrem (left hand for the times the shoe was picked up) 1660 mrem (right foot) and 4270 mrem (skin at knee area when holding the bag between the knees). It should be noted that the major factor in the low dose to the foot was that the RPT's shoe was of very dense rubber material with a thickness of 2.5 cm and the additional 1.0 cm of rubber shoe (2 pair) coverings he was wearing during the incident. Based on the inspectors observations of the licensee's time and motion video, mockup TLD tests and interviews of the individual involved,the inspector could see no reason to dispute the licensee's dose results in this case. Since no regulatory limits were exceeded no apparent violation was identified for this specific case. However, the inspector will review other evaluations, when completed by the licensee, as described in the above paragraphs (50-344/87-15-08).

D. 10 CFR 20.401(b) requires, in part, that each licensee shall maintain records showing the results of surveys required by 10 CFR 20.201(b), "Surveys". 10 CFR 20.201(b) requires that each licensee make or cause to be made surveys as: (1) may be necessary for the licensee to comply with the regulations in 10 CFR 20, and (2) are reasonable under the circumstances to evaluate the extent of radiation hazards that may be present.

(1) During discussions with the RPT on April 20, 1987, the inspector was informed that the measured 4.1 rad/hr beta and 180 mR/hr gamma on a wipe from the outer layer of PC of a worker exiting the reactor cavity on April 9, 1987, had not been documented. Failure to document this survey data was identified as an apparent violation of 10 CFR 20.401(b), (50-344/87-15-08).

(2) During discussions with the RPT staff on April 21, 1987, the inspector was informed by the RPT who was vacuuming and decontaminating the upper cavity floor area on April 12, 1987, after the retrieval of a suspected irradiated fuel pellet, that he measured a reading of 1.0 R/hr gamma from the knees of this outer PC prior to exiting and did not document the reading. Failure to document this survey was also identified as an apparent violation of 10 CFR 20.401(b), (50-344/87-15-09).

E. Based on the above and other observations made during the inspection, the following items were presented to the licensee representatives for consideration.

(1) The corporate Health Physics department provided limited on-site support in the period between April 8 and 17, 1987.

The RSB Manager was on-site April 11-12, 1987 to support retrieval of the suspected partial fuel pellet. The corporate organization was slow to recognize the reporting requirements pursuant to 10 CFR 20.403(b)(4). The report was made on April 16, 1987.

Detail involvement and oversight improved after April 17, 1987.

(2) RWPs were general in nature, covered a wide range of work scope and did not provide adequate special instructions to radiation workers. When work conditions changed the RWPs were not being updated. The licensee allowed RPT's to exercise broad authority to prescribe protection measures with minimum management oversight.

(3) The RP Supervisor stated that he was not staffed to handle major contamination problems.

(4) The RP staff and plant workers had not been adequately trained on the radiological hazards and survey techniques, with regard to irradiated fuel fragments.

(5) The RP Supervisor reports to the Manager, Technical Services. The Manager, Technical Services is also responsible for on-site engineering and training.

The RP Supervisor informed the inspector that during April 6-9, 1987, he had not entered the containment; however, he had discussed refueling cavity contamination problems with the RP Unit Supervisor and reviewed contamination survey reports.

Considering the known presence of IFFs at the facility; the long delay in developing training and procedures; the time involved in aggressively responding to the April 8, 9, 1987 dispersal incident, the time to recognize the IFF hazard and to identify the need to perform dose evaluations for workers appears to indicate a lack of management involvement in ensuring a high quality radiation protection program.

These observations were discussed at the exit interview.

5. Exit Interview

The inspector met with the licensee representatives denoted in paragraph 1 at the conclusion of the inspection on April 24, 1987. The scope and findings of the inspection were summarized. The licensee representatives were informed of the apparent violations of NRC requirements discussed in this report.

In regard to the apparent violations noted, the licensee presented very little comment. However, the inspector was informed that all precautions

as necessary would be taken to ensure radiological safety for continued outage activities.