U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-352/92-13 and 50-353/92-13

Docket No. 50-352 and 50-353

License No. NPF-39 and NPF-85

Licensee: Philadelphia Electric Company
Correspondence Control Desk
P. O. Box 195
Wayne, Pennsylvania 19087-0195

Facility Name: Limerick Generating Station, Units 1 and 2

Inspection At: Limerick, Pennsylvania

Inspection Conducted: March 26 - 27, 1992

Inspector: _____ 4-2-92
S. Sherbini, Senior Radiation Specialist — date
Facilities Radiation Protection Section

Approved by: _____ 4-2-92
W. Pasciak, Chief, Facilities Radiation Protection Section — date

Areas Inspected: A special, reactive, inspection to review the circumstances connected with the inhalation of radioactive material by a worker while working in the Unit 1 reactor cavity.

Results: The amount of radioactive material inhaled by the worker apparently was below the regulatory limit, and has cleared rapidly from the worker's body. However, poor radiological work practices and an apparent failure of communication between Health Physics personnel and the work crew apparently contributed to the incident. An apparent violation, involving two examples of failure to follow procedures, was identified. This apparent violation is described in more detail in Section 4.0 of the enclosed inspection report.

DETAILS

1.0 Personnel Contacted

1.1 Licensee Personnel

* M. Belinski, HP Supervisor
R. Bryan, Nuclear Maintenance Division
* M. Christinziano, Supervisor, HP Technical Support
* J. Doering, Plant Manager
* R. Dubiel, Superintendent, Plant Services
* J. Fongheiser, Senior Health Physicist
R. Keskela, Nuclear Maintenance Division
B. Landis, Senior Health Physics Technician
J. Mallon, Dosimetry Physicist
T. Mscisz, Assistant Senior Health Physicist
* D. Neff, Licensing Engineer

1.2 NRC Personnel

T. Kenny, Senior Resident Inspector
* L. Scholl, Resident Inspector
B. Whitacre, Resident Inspector

* Denotes attendance at the exit meeting on March 27, 1992.

2.0 Purpose of the Inspection

This inspection was conducted in response to an incident in which a worker inhaled a relatively large quantity of radioactive material while working in the reactor cavity of the Unit 1 reactor. The inspection was conducted on the day following the incident, and the licensee had not completed its investigation at that time. Therefore, assessment of the quality of the licensee's investigation of the root causes of the incident and its identification of any contributing programmatic weaknesses will be performed during a future inspection.

3.0 Description of the Event

The incident occurred on the morning of Wednesday, March 25, 1992, and involved a technician in the licensee's site Nuclear Maintenance Department. The individual will be referred to as the Technician in this report. At 6:30 a.m. on March 25, the Technician and a group of other personnel attended a shift turnover meeting with the outgoing shift. The meeting was attended by a Health Physics (HP) representative. At 8:40 a.m., the Technician and a crew of three workers signed in on Radiation Work Permit (RWP) 920704, Rev 2, to enter the reactor cavity. The scope of their work in the cavity was to inspect the reactor flange, remove all loose articles and

equipment from the cavity, including the service platform, and also perform general housekeeping work in preparation for flooding the cavity. The reactor head had been removed, but the moisture separator and dryer were still in the vessel. Both of these components are removed under water after flooding the cavity. Access to the cavity was via a ladder hung on the side of the cavity, and the cavity area was posted as a contamination area. A person was stationed at the railing at the top of the cavity; he served as the "outside man" since the cavity was considered to be a confined space.

RWP 920704, Rev 2, was a job specific RWP written for the Unit 1 352' elevation of the Reactor Building, Refuel Floor, to "Perform Survey/Disassemble Reactor". It had been initiated on 3/24/92. Because reactor disassembly involves a wide variety of different tasks with different radiological controls requirements, the RWP is revised whenever radiological conditions for the current work require a change in protective clothing, dosimetry, or other radiological controls measures. Rev 2 of the RWP required the following protective clothing: 1 coverall, 1 disposable suit, 1 pair glove liners, 1 pair plastic gloves, 1 pair rubber gloves, 2 pair shoe covers, 1 pair boots, and 1 hood. A 0-200 mrem self reading dosimeter (SRD) and a thermoluminescent dosimeter (TLD) were also required and were to be placed just above the ankles because most of the radiation dose was expected to be due to radiation coming from underfoot. No respirators were required, and no unusual HP coverage was specified.

The most recent survey of the area had been done at 6:30 a.m. on March 25. It showed a general area exposure rate in the cavity of 4-90 mR/hr, 10-50 mR/hr contact with the reactor vessel flange, and 300 mR/hr contact at the outer ledge. Removable contamination levels were in the range of about 10,000 - 50,000 dpm/100 sq. cm. The highest contamination levels were on the flange and reached about 250,000 dpm/100 sq. cm. The survey did not indicate radiation or contamination levels in the transfer canal. The transfer canal is a relatively narrow passageway, approximately 4' wide, that connects the cavity with the spent fuel pool (SFP) and is used to transfer fuel between the two areas. At the time of the incident, access to the transfer canal was roped off and posted "Caution Do Not Enter". The RWP also specified that "Entry Into The Transfer Canal Prohibited Under This RWP". A survey taken on Sunday, March 22 showed that the general area exposure rates in the transfer canal were 10-40 mR/hr and the contamination levels were about 24 mrad/hr smearable. The licensee stated that the cavity had been decontaminated since that survey was taken but that the transfer canal had not. The licensee also stated that they did not expect the readings in the transfer canal to have changed from the 22nd to the 25th of March because nothing had been done that would cause them to change.

During the morning of March 25th, two low volume air samples were taken in the cavity. The samples were taken by suspending the air sampling head from the top of the cavity down into the cavity. Although this does not constitute a breathing zone sample, it does give an indication of any unusual airborne conditions in the general

work area. The first sample was started at 6:45 a.m. and stopped at 11:00 a.m., and the second was started at 11:00 a.m. and stopped at 2:15 p.m., the flow rate in both cases was 1 cfm. The results showed air concentrations of about 0.04 and 0.1 MPC fraction, respectively. The MPC fraction is defined by the licensee as the ratio of the measured concentration to the maximum permissible concentration (MPC). In this situation, since the identities of the nuclides in the air sample were not known, and the licensee had determined from other sources that alpha emitters were not present, the MPC specified in 10 CFR Part 20 is 3E-9 uCi/cc.

The Technician and his crew entered the cavity after signing in on the RWP. The Technician proceeded to inspect the reactor vessel flange and his crew started work on the service platform and various housekeeping functions, including vacuum cleaning the cavity area. Inspection of the flange revealed a possible surface defect. The Technician asked for engineers to be called to inspect this findings, and in the meantime he joined the ongoing housekeeping work. Two engineers arrived a little later and inspected the flange. After the service platform was removed and most of the housekeeping was completed, the Technician removed the rope and caution sign at the entrance to the transfer canal, and work proceeded to remove Stop Log #15 at about 11:00 a.m. Stop Log #15 is a large gate made of concrete blocks encased in steel that is installed between the SFP and the reactor cavity, at the end of the transfer canal near the SFP. It fits in guides and is equipped with inflatable seals, and serves two functions: it is part of secondary containment and it serves as a radiation shield for radiation from the SFP. The stop log is removed by lifting it vertically with a crane. Two other gates between the SFP and the cavity keep the water in the SFP from flowing into the cavity when the stop log is removed.

While the stop log was being lifted, some sealant material broke off and fell on the floor of the transfer canal. At that time, the vacuum cleaner had been removed from the cavity, and the Technician asked the outside man to send down a brush and dust pan. He then entered the transfer canal and, using the brush and dust pan, cleaned the area. While in the transfer canal, he noticed some gouging in the stop log guides, and he called for engineers to inspect the guides. Two engineers then entered the transfer canal with the Technician to perform the inspection. They then all exited the area and left the cavity, the last person to leave being the Technician. He signed out on the RWP sheet at 1:00 p.m. The self-reading dosimeter (SRD) readings showed that the Technician's exposure for the 4.25-hour stay in the cavity was 35 mR; the exposures for all other personnel who entered the cavity between 8:30 a.m. and 1:00 p.m. were less than that.

After leaving the cavity and removing his protective clothing, the Technician went to the whole body frisker on the refueling floor to check for contamination before leaving the area. The frisker alarmed, and a survey with a hand-held frisker showed about 450 cpm around the neck and upper torso area. Attempts were made at decontamination, but the count rate did not change. He was then escorted by HP to

the personnel decontamination facility in the radwaste building, where more extensive decontamination efforts were undertaken. However, no change in activity was noted. He was then taken to the whole body counting facility and counted on a bed counter at 2:30 p.m. The counter showed a total activity of about 840 nCi, including 110 nCi Mn-54, 90 nCi Zn-65, and 640 nCi Co-60. Suspecting that much of the activity was in the throat area, the licensee gave the Technician two cans of soda to drink, and the Technician was counted again at 3:00 p.m. There were minor increases in the activity of all three isotopes, probably because of a change in source geometry in the body. It was also noted that the peak of the activity distribution in the body had shifted slightly away from the upper part of the body toward the lower regions. However, the plot of linear activity distribution from head to foot produced by the whole body counter did not permit a determination of a correspondence between the peak of the distribution and a specific body region, other than that it was somewhere in the upper part of the body.

The licensee's procedures require excreta bioassay to be started if the measured activity exceeded 5% of the maximum permissible body burden (MPBB), which it did in this case. Urine and fecal excreta collection was therefore started and continued up to the time of this inspection, and the samples were sent to an outside vendor for analysis. The licensee also consulted the company physician, who advised the use of a laxative. The technician took the laxative that night, and the fecal sample brought in the next day showed activity as measured by a frisker. A third whole body count was made at 6:20 a.m. on March 26 and showed a decrease in total activity from 840 nCi to 180 nCi. Both the Mn-54 and the Co-60 activities dropped by the same fraction, and the Zn-65 activity had dropped below the system's minimum detectable activity limit (20.5 nCi for Zn-65). A second count at 3:50 p.m. on March 26 showed a further drop to about 70 nCi. The last available count during this inspection was made on March 27 at 9:10 a.m. and it showed about 40 nCi, most of which was Co-60.

The licensee's preliminary estimate of the intake was about 1350 nCi, corresponding to approximately 100 MPCH (maximum permissible concentration-hour, a unit for the quantity of radioactive material). This assessment was based on the use of an intake retention fraction of 0.62 obtained from NRC NUREG/CR-4884, "Interpretation of Bioassay Measurements", assuming Class Y chemical compound classification and also assuming that the intake occurred between 2-3 hours before the first whole body count. The licensee stated that they were confident that there were no significant amounts of isotopes other than the three identified in the whole body count. This conclusion is based on Ge(Li) analysis of some of the fecal samples obtained from the technician, as well as on data from waste stream analysis. The licensee also stated that the excreta analyses should confirm these conclusions.

It should be noted that there is no direct evidence that the internal contamination resulted from the use of the brush and dust-pan in the transfer canal. However, much circumstantial evidence supports this conclusion. The Technician himself feels that he did not perform any other work that could have resulted in such an intake. In addition, the contamination levels in the work areas entered during that period, other than the transfer canal, were relatively much lower than those in the canal. Finally, the licensee counted the other personnel who entered the cavity during the period in question on the whole body counter and found all to be clean with the exception of one person, who showed about 1% MPBB (maximum permissible body burden), which is quite low compared to the activity found in the Technician. This person was one of the three people who entered the transfer canal area to inspect the gouges in the stop log guides. The licensee stated that they were not sure whether this 1.1% MPBB was an actual intake or external contamination. The licensee's conclusion that the intake occurred while using the brush and dust-pan therefore appears reasonable.

The Technician involved in the incident has been with the licensee for many years. He is a boilermaker by trade and has been with the Nuclear Maintenance Division for several years. His group is charged with outage work on the refueling floor and under the vessel, including control rod drive work and reactor disassembly and assembly. He has been doing this type of work at the licensee's two nuclear power plant sites for several years.

The licensee stated that they will continue to monitor the Technician until the activity is eliminated from his body, and will also supplement their preliminary assessments with results from the excreta analyses when they become available. The licensee has also started an investigation to identify the causes of the incident and any contributing programmatic weaknesses. The results of this assessment will be reviewed during a future inspection. The Technician was barred from radiological work pending evaluation of his uptake.

4.0 Assessment of the Event

A review of the sequence of events described above showed that there were violations of the requirements for work in a radiological controls area, as well as some poor radiological controls practices. These included the following.

RPW 9207074 stated in the "Special Instructions/Remarks" section

"Entry Into The Transfer Canal Prohibited On This RWP".

Contrary to this requirement, the Technician entered the transfer canal to clean up the debris from the stop log, and other personnel entered the area to inspect the gouges on the stop log guide. These gouges could only be seen from inside the transfer canal and not from the cavity. The RWP program, as described in Procedure A-C-107,

"Radiation Work Permit Program and radiological Controlled Area Access Requirements", states that signing in on an RWP means that the requirements specified in the RWP were understood and that the person will comply with these requirements. Entry into the transfer canal therefore constitutes an example of an apparent failure to follow procedures (50-352/92-13-01).

- Procedure M-041-011, "Maintenance Procedure For Reactor Vessel Disassembly", Section 5.4 states,

  "Do not remove items from the spent fuel pool, reactor cavity, steam dryer/separator pool, or cask washdown/storage area unless Health Physics is present".

Contrary to this requirement, several items were removed from the cavity during the morning of March 25, including the service platform, tools, and other items, without the presence of HP at the work location. This constitutes another example of an apparent failure to follow procedures (50-352/92-13-01).

- According to Procedure HP-215, "Establishing and Posting Controlled Areas", Section 6.2.2 "General Requirements for Posting a Controlled Area", Subsection (b),

  "Radiation warning signs .... shall contain the conventional radiation caution symbol in magenta (purple) on a yellow background. The sign shall contain the following information:

  1. The classification of the area

  2. Minimum requirements for entry if applicable.

Contrary to the above requirements, the sign posted between the reactor cavity and the transfer canal did not contain a classification of the area. The sign only said "Caution Do Not Enter" and, although it was a radiological sign, it did not identify the radiological hazard, i.e., high radiation fields, high contamination, etc. The licensee stated that they did not concur with this assessment because they felt that indicating the nature of the hazard would have constituted double posting, that is, posting the same area twice. Their reasoning was that the cavity was already posted as a contamination area and that identifying the transfer canal, which is within the cavity, as a contamination area would have been redundant and possibly confusing. The inspector stated that the Technician indicated that he was confused regarding the nature of the hazard in the transfer canal. Discussions with the Technician had indicated that he believed the transfer canal was posted because it was closer to the SFP and would therefore be expected to have a higher radiation field than that in the rest of the cavity. He stated that he did not think that the canal was more contaminated than the general cavity area. It was agreed

that the matter of double posting was a matter that required careful review by the licensee because of its safety implications. This item will therefore be reviewed during a future inspection.

- The Technician stated that he believed that his work in the cavity was the final step before flooding in preparation for refueling. In particular, he believed that he had to remove all loose items from the cavity and that nobody was going to go in there after he left the area. This being the case, he believed that he had to remove the caution sign at the entrance to the transfer canal as part of his housekeeping duties. Health Physics, however, felt that he was in error in removing the sign because they felt that it was standard policy that only HP may remove any radiological sign, and that included the sign in the cavity. There was no communication between HP and the Technician regarding this matter.

- The use of a brush and dustpan in a highly contaminated area was poor radiological practice. However, the contamination status of the transfer canal was unknown to the Technician, which may have contributed to his decision to use the brush to remove the debris from the stop log. Nevertheless, he did know that the whole area was posted as a contamination area, and this should have been sufficient information to prevent such an activity.

The radiological training program for maintenance personnel was not reviewed during the inspection, and it was not determined during this inspection whether training was a contributing factor in this event. This item will therefore be reviewed during a future inspection.

5.0 Exit Meeting

The inspector met with licensee representatives at the end of this inspection on March 27, 1992. The inspector reviewed the purpose and scope of the inspection and discussed the inspection findings.