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Facility: Hope Creek Nuclear Generating Station

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Inspection Summary: This inspection was a special reactive safety inspection conducted to review the circumstances surrounding, and licensee actions and evaluations associated with an unplanned release of radioactive material from the Hope Creek Station south plant vent which occurred on the early morning hours of April 5, 1995.

Areas Reviewed: The following Executive Summary delineates the inspection findings and conclusions.

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EXECUTIVE SUMMARY

Hope Creek Inspection Report 50-354/95-05

April 6-21, 1995

A. Description of Event

An unplanned release of radioactive material, from the Hope Creek station's south plant vent (SPV), occurred on the early morning hours of April 5, 1995. The radioactive material released originated from the decontamination solution evaporator (DSE) and travelled through the unmonitored DSE effluent vent pipe to the SPV. The SPV effluent monitoring system did not detect the release due to its liquid mist/droplet form. The release contaminated portions of the site protected area downwind of the release point. The release was not discovered until the afternoon of April 5, 1995. A contaminated vehicle left the site before the contamination was identified.

B. General Findings and Conclusions

1. Licensee Response to Event

The licensee's response to the initial alarm was appropriate. However, incorrect diagnoses were made to explain conflicting indications. Operations and radiation protection personnel relied on the readings of the SPV monitor and samples of the DSE effluent and SPV effluent and incorrectly concluded that a release had not occurred.

The licensee was slow to identify the occurrence of a release due to weaknesses in communications and integrated assessment of incoming information. As a result, the licensee was slow to take actions to secure potential sources of additional releases and to take appropriate actions to prevent potential further spread of contamination, and mitigate exposure pathways.

The licensee's procedures provided limited guidance for response to an onsite contamination event.

2. Engineering

The licensee did not have an adequate understanding of the design basis of the DSE and did not perform an adequate design review of the DSE and the SPV effluent monitoring system to support operation of the DSE.

The radiation effluent monitoring system was not capable of detecting effluent releases (in the form released) from the DSE.

3. Operations and Operations Procedures

The DSE was not operated in accordance with design basis or Final Safety Analysis Report commitments. The inspection identified that, among other findings, the DSE's operating level set points/limits/alarms were set non-conservatively, the DSE was operated in "semi-continuous" mode versus "batch" mode, the processing of floor drain water was not evaluated, and automatic control functions were overridden to establish flow paths.

In addition, operating procedures for the DSE were inadequate, there was a lack of clear understanding of system operation by system operating personnel, and operating personnel did not have a clear understanding of system interlocks and automatic functions.

Lastly, there was a belief that the DSE could not cause a radioactive release and there was minimal monitoring of system operations.

C. Safety Significance

Although about 25 gallons of steam and water, that contained about 85 millicuries of mixed radioactive corrosion products were released from the SPV, the release of radioactive contamination from the DSE had little radiological impact on the public and environment. No release limits were exceeded and a reasonable worst case analysis did not identify any significant potential impacts.

The safe operation of the reactor was not affected and the release did not significantly impact on shift licensee personnel. In addition, although workers worked in areas later determined to have low levels of contamination, no intake of radioactive materials occurred and no significant personnel contaminations occurred.

After it was identified that a release had occurred, there was excellent evaluation of the impact of the release on the environment and on continued reactor operations by the licensee.

D. Summary of Areas for NRC Followup and Apparent Violations

The inspectors identified a number of areas for followup and four apparent violations as follows.

1. The design review of the DSE was inadequate. As discussed in Section 4.0 of the inspection report, the licensee's design reviews did not identify DSE design weaknesses.

2. There were no adequate approved operating procedures for the DSE. As discussed in Section 4.6 of the inspection report, as of April 5, 1995, the operating procedures for the DSE, a liquid radwaste system component, were inadequate to limit uncontrolled releases to the environment and provide for proper operation of the DSE.

This is an apparent violation of Technical Specification 6.8.1 requires, in part, that applicable procedures recommended in Appendix A of Regulatory Guide 1.33, Revision 2, be established, implemented and maintained. Appendix A of Regulatory Guide 1.33 recommends procedures for limiting release of radioactive materials to the environment including operation of liquid radioactive waste systems.

3. The surveying and monitoring of DSE effluents was not adequate to detect the release. As discussed in Section 7.2 of the inspection report, as of April 5, 1995, the licensee's surveys and evaluations of the effluent released from the DSE exhaust to the south plant vent were inadequate to ensure compliance with the requirements of 10 CFR 20.1302. This is an apparent violation of 10 CFR 20.1501(a).

4. Alarm set point changes were not made in accordance with approved procedures. As discussed in Section 5 of the inspection report, on April 12, 1995, alarm setpoints were increased on both the reactor building ventilation exhaust system and radwaste exhaust system ventilation duct radiation monitors without appropriate operating shift approval, independent review, or technical document room notification. This is an apparent violation of Technical Specification 6.8.1 which requires, in part, that applicable procedures recommended in Appendix A of Regulatory Guide 1.33, Revision 2, be established, implemented and maintained. Appendix A of Regulatory Guide 1.33 recommends procedures for control of temporary modifications.

5. Workers were not informed of the release and onsite contamination once it was identified. As discussed in Section 6.5 of the inspection report, onsite workers and drivers of vehicles that traversed and worked in contaminated areas on April 5, 1995, were not informed until April 6, 1995, that they had potentially entered contaminated areas and should perform enhanced personnel monitoring to detect contamination. This is an apparent violation of 10 CFR 19.12.

6. A contaminated vehicle left the site. (See Section 6.5 of the inspection report.)

7. The development by the licensee of a plan for disposal of contaminated soil and maintenance of records relative to 10 CFR 50.75(g). (See Section 6.3 of the inspection report.)

8. The verification by the licensee that apparent previous Hope Creek turbine building roof contamination and other site contamination (as appropriate) has been properly evaluated from an offsite impact perspective. (See Section 3.2 of the inspection report.)

The NRC will review the above matters for follow-up and potential enforcement, as appropriate, and will review the event to determine if generic communications regarding the unmonitored release (e.g., an NRC Information Notice) are needed.

DETAILS

1.0 INDIVIDUALS CONTACTED

Attachment 1 to this report identifies the individuals contacted.

2.0 PURPOSE AND SCOPE OF INSPECTION

The inspection was a special reactive NRC inspection conducted to review the circumstances surrounding, licensee evaluations made, and corrective actions taken following an unplanned release of radioactive material from the Hope Creek station's south plant vent (SPV) on the early morning hours of April 5, 1995.

The inspectors reviewed the circumstances surrounding the event and the licensee's actions and evaluations associated with it. The inspectors interviewed individuals directly involved in the event and response to it. The personnel involved in the design review of the liquid radwaste system were also interviewed. In addition, the licensee's root cause analysis of the event was reviewed.

The following matters were reviewed during the inspection.

- Sequence of Events
- Station Response to Event
- Radiological Release
- Decontamination Solution Evaporator Design and Testing
- Decontamination Solution Evaporator Operation and Operating Procedures
- Radiological Controls and Contamination Controls

The documents reviewed during the inspection are identified in Attachment 2 to this report.

A event time line is included as Attachment 3 of this report.

3.0 EVENT DESCRIPTION, EVENT RESPONSE, ROOT CAUSE ANALYSIS, AND NRC EVALUATION OF EVENT RESPONSE

3.1 Event Description

On the evening of April 4, 1995, a radwaste (RW) operator was processing waste liquid from the chemical waste tank (CWT) via evaporation by use of the decontamination solution evaporator (DSE). Feed to the DSE was secured about 11:07 p.m. on April 4, 1995. Shortly before midnight on April 4, 1995, the RW operator restarted feed flow to the DSE from the CWT. Feed to the DSE had been secured in order to refill the CWT from a floor drain collection tank (FDCT).

Between midnight and 1:00 a.m. on April 5, 1995, the RW operator responded to several alarms, due to high differential pressure (dp) across the demister in the vapor body of the DSE, by spraying the demister with water from the condensate system. In two instances the operator left the spray valve open for an extended period of time (6 minutes and 13 minutes, respectively) while attending to other operations in the RW control room. The DSE is discussed in Section 4.0 of this report and is depicted in Attachment 4.

The prolonged spraying of the demister, combined with a continuous supply of heating steam to the evaporator, caused a buildup of steam in the vapor body of the DSE. This resulted in an increased evaporator pressure that was suddenly relieved when the spray flow was secured. Unknown to the operator, the depressurization caused a momentary high steam flow condition in the six-inch diameter DSE evaporator effluent exhaust pipe that ejected approximately 43 and 15 gallons on two occasions of a water and steam mixture to the south plant vent (SPV). Portions of the steam and water mixture (an estimated 25 gallons) was released to the environment from the SPV, while the remainder was deposited in the SPV duct work on the 155' elevation of the services radwaste (SRW) building.

The radioactive liquid in the SPV duct work caused a limited increase in general area radiation levels, which were detected by three radiation monitors in the area. Two of the radiation monitors, on the reactor building ventilation system exhaust (RBVSE) and the radwaste area exhaust (RWE), alarmed at about 12:30 a.m. Both monitors indicated two distinct increases in radiation levels occurring approximately 7 minutes after each of the two prolonged sprays of the DSE demister. Increased radiation levels were also indicated on the filtered ventilation recirculation system (FRVS) area radiation monitor (ARM), but no alarm was received on this monitor due to the low radiation levels detected by this ARM. There were no increases in radiation levels detected by the SPV effluent monitor. Attachment 5 depicts the general arrangement of the duct work and radiation detectors affected by the release.

3.2 Licensee Event Response and Sequence of Events

In response to the radiation monitor alarms, control room (CR) operators entered abnormal procedure HC.OP-AB.ZZ-0126 (AB-126), "Abnormal Releases of Gaseous Activity". Concurrently, a radiation protection (RP) technician initiated a review of the alarms in accordance with HC.RP-AR.SP.0001, "Radiation Monitoring System Alarm Response". These procedures direct personnel to review other radiation monitors for indications of radiation. The procedures also inform personnel to review SPV monitor readings for indications of radioactive releases. The operators and RP technician (technician A) independently checked multiple indications and determined that the RBVSE and RWE monitors were the only alarms that were received.

Both the CR and radiation protection personnel contacted the RW control room and were told that the DSE was operating, but that no activities were in progress that could have caused the radiation alarms. No indications of a previous or in progress release was noted by review of the SPV monitor.

The senior nuclear shift supervisor (SNSS), the work control supervisor, an instrumentation and controls (I&C) technician, and two RP technicians (technicians A and B) went to the area of the alarms to investigate the cause of the alarms. They identified a hot spot in the SPV duct work that measured approximately 120 mR/hr on contact and 15 mR/hr at approximately one foot. (See Attachment 5 for location of hot spot.)

After surveying the area and duct work, the radiation protection technicians and senior reactor operators (SROs) believed that the hot spot was caused by a piece of solid material (possibly a piece of a filter) that had been deposited in the duct. The operations personnel inspected the ventilation filter trains, but could not detect any damage. Liquid was observed dripping from the duct work into a previously installed drip bag. The liquid was reddish brown in color and was assumed to be a pre-existing condition. Personnel believed that, because no increase had been seen on the SPV effluent monitor, no release had occurred or was in progress.

An RP technician (technician B) and the I&C technician attempted to go onto the SRW building roof in proximity to the SPV discharge point, to check the SPV duct work, but the attempt was aborted when they identified that their clean booties (worn in the radiologically controlled area for housekeeping purposes) were contaminated. Consequently, the technicians could not exit onto the normally non-contaminated roof area.

At approximately 2:00 a.m., as a result of the contaminations, the drip bag and the area under the drip bag were surveyed. The survey identified up to 80,000 dpm/100 cm^2 on the floor, and up to 220,000 dpm/100 cm^2 in the drip bag. The RP technicians initiated action to enhance the drip bags to collect the leaking fluid and post and control the area as a contamination area.

(Inspectors' Note: The above contamination survey results were determined by the licensee using a 10% detection efficiency for the thin window GM contamination survey detector used to analyze the smear surveys. Subsequent licensee evaluations determined that the efficiency of the GM contamination survey detector was approximately 2%. Consequently contamination values potentially ranged from 400,000 dpm/100 cm^2 to 1,100,000 dpm/100 cm^2 removable contamination. The licensee was not aware initially of the reduced detector efficiency for the radionuclide mix encountered.)

Several hours after the high radiation alarms were received, the CR operators exited (@ 3:00 a.m.) procedure AB-126 because it was believed that no release had occurred and the procedure did not provide any applicable instructions for addressing the hot spot and contamination in the plant. The SNSS requested that the DSE be secured, but the RW operator suggested that the evaporator be left in service so that an effluent sample could be taken. The SNSS agreed to the suggestion and the DSE was left in operation.

The RW operator also informed the CR that he had sprayed the DSE demister and caused a high level in the evaporator around the time that the radiation alarms were received.

A sample of the process stream from the DSE effluent pipe was collected at approximately 4:00 a.m. that morning. The sample analysis results (provided about 5:00 a.m.) indicated that no unusual radiological releases were occurring from the DSE.

A nuclear incident report (IR) and a radiological occurrence report (ROR) were initiated to address the radiation alarms and the hot spot found on the duct work. RORs were also written to address the personnel contaminations. At the morning managers' meeting, the RP manager was assigned to investigate the incident report and Operations was assigned to assist in determining if the DSE was the cause.

After the meeting, the senior shift support (radwaste) supervisor reviewed the DSE recorder traces and concluded that, in spite of the problems with evaporator level control on the previous shift, the DSE was operating normally and could not have caused the hot spot in the SPV duct work. At the time of the meeting, the day shift SNSS incorrectly believed that the DSE was secured and relayed the incorrect information to plant management. CR operators and shift supervision focused their efforts on preparing for a future release due to the fluid in the duct work drying out. They reviewed abnormal response procedures and closely monitored radiation monitor indications.

Throughout the morning of April 5, RP personnel continued to try to determine the cause and extent of contamination associated with the hot spot and liquid found in the duct work. As part of the weekly routine sampling program, the continuous samples (particulate and iodine) from the SPV were pulled for analysis at about 8:00 a.m.

A smear sample from the SPV enclosure was collected at approximately 9:15 a.m. This sample, analyzed at approximately 11:00 a.m. indicated the presence of short-lived radionuclides.

At approximately 10:00 a.m. on April 5, 1995, an RP supervisor (RP supervisor A) and an RP technician (technician C) together exited from the turbine building roof top area near the south plant vent and identified contamination levels of up to about 8,000 dpm on their clean booties coming into the building from the roof top.

Although they informed their supervisor, no further evaluation was performed of the cause of their bootie contamination. The RP personnel had collected some roof top rock (gravel) samples which were counted in a high sensitivity tool monitor. The rocks alarmed the tool monitor. (The turbine building roof was not posted as a contaminated area. The turbine building roof access hatch is normally locked due to the presence of radiation on the roof from steam passing through the turbine.)

The rocks were analyzed and determined around noon to contain longer-lived radionuclides (e.g., Mn-54 and Zn-65). These results were also provided to the individual's supervisor; however, the contamination was believed to be from a pre-existing condition on the roof and no further evaluation was made of the rocks. The licensee's RP personnel indicated a previous release of low level contamination of portions of the turbine building roof had occurred. Chemistry personnel, who counted the rock samples, noted unusual radionuclide contents indicative of reactor coolant and informed RP personnel of these observations. However, this information was not effectively communicated in that RP management was not made aware of the information.

The Senior RP supervisor did have a technician on standby to perform surveys of the outdoor areas because of the indication of contamination on the roof, however, this was canceled at around noon because the results from the 8:00 a.m. samples from the SPV weekly samples were received about noon and the sample results indicated no release had occurred or was in progress. Neither the identification of short-lived radionuclides at 9:15 a.m., the occurrence of personnel contaminations at 10:00 a.m., or the concerns raised by radiochemistry personnel were effectively integrated into the assessment of whether a release to the environment had occurred.

The RP personnel conservatively posted the SPV event enclosures as a contaminated area at 12:10 p.m. A survey of the enclosure at 1:40 p.m. identified high levels of contamination (up to 25 millirad/hr as measured on wipe sample using an open window ion chamber) and water on the floor near the SPV duct work. The SPV was posted as high contamination area at that time.

At about 2:20 p.m. on April 5, 1995, RP technicians, informed of the potential contamination on the roof of the turbine building, questioned during shift turnover whether the roof-top area of the turbine building should be posted as a contaminated area.

At the 3:00 p.m. planning meeting, RP reported that they had not identified any new concerns related to the incident report. (Note: As he was leaving the site at the end of day shift, the senior radwaste supervisor was concerned that the source of the hot spot had not been identified. He called the RW control room and directed the operator to secure the DSE. The DSE was secured at 4:30 p.m.)

RP technicians were dispatched to the turbine building roof to survey the roof to determine the need for posting of the roof as a contaminated area. At 3:30 p.m., a survey of the roof indicated elevated levels of contamination of about 10,000 dpm for a large area smear sample. Also, short-lived radionuclides were identified during analysis of large area wipe samples at about 4:00 p.m. indicating a release to the roof had occurred. The technicians posted the roof area and informed their supervisors, who directed that surveys of the yard area be performed. The inspectors noted however, that based on previously known information as discussed above, the licensee should have been aware of the potential for a release to the environment.

A survey of the yard area at about 4:30 p.m., identified removable contamination of the yard area and on vehicles parked in the area in proximity to the south side of the turbine building. Levels ranging from less than 1000 dpm/100 cm^2 to 20,000 dpm/100 cm^2 removable contamination were identified. About 5,000 dpm/100 cm^2 was identified at the fence area near the hydrogen tankers. The RP technicians informed their supervisor. The inspector noted that the yard contamination could have been identified earlier if the reasons for shoe contaminations resulting from walking on the turbine building roof been pursued. Hope Creek RP personnel contacted the Salem station RP organization and informed them of the identified contamination and requested personnel to stand by to provide assistance.

(Inspectors' Note: The above contamination survey results were determined by the licensee using a 10% detection efficiency for the thin window GM contamination survey detector used to analyze the smear surveys. Subsequent licensee evaluations determined that the efficiency of the GM contamination survey detector was approximately 2%. Consequently contamination values actually ranged from less than 1000 dpm/100 cm^2 to 100,000 dpm/100 cm^2 removable contamination. In addition, the fence area exhibited about 25,000 dpm/100 cm^2. The licensee was not aware initially of the reduced detector efficiency for the radionuclide mix encountered.)

At approximately 5:15 p.m., the Hope Creek Senior Nuclear Shift Supervisor (SNSS) was notified of the yard contamination. The control room (CR) operators reentered the gaseous release abnormal procedure (AB-126). The filter recirculation ventilation system (FRVS) was placed in service and the major discharges through the south plant vent (reactor building ventilation, turbine building ventilation, and radwaste and services building ventilation) were secured at 5:50 p.m. in

accordance with AB-126. The licensee declared the SPV effluent monitor inoperable at 6:42 p.m. and initiated alternate sampling (@ 7:35 p.m.) of the SPV effluent.

Hope Creek RP personnel again contacted Salem RP personnel at about 6:45 p.m., to inform them that contamination was identified at higher elevations of the station and to have radiation protection personnel stand by. Hope Creek RP personnel later (@ 7:20 p.m.) notify Salem personnel to survey at higher elevations.

At approximately 8:00 p.m., the licensee informed the NRC senior resident inspector (SRI) of the presence of contamination in the protected area.

At about 11:30 p.m., Operations personnel informed RP personnel that a vehicle (an Air Products hydrogen tanker) had left the site at about 9:40 a.m. that morning. RP personnel were dispatched to survey the vehicle at its Delaware City terminal. At 11:30 p.m., RP personnel informed security personnel at the security building to prohibit exit of vehicles without RP permission.

Because the vehicle had to be located and RP technicians sent to the location, the vehicle was not surveyed until 4:30 a.m. The survey of the hydrogen tanker at 4:30 a.m. on April 6, 1995, identified removable contamination up to about 3,000 dpm/100 cm^2 (Actually 15,000 dpm/100 cm^2 when corrected for the reduced efficiency discussed above.). Decontamination was performed of the vehicle at the terminal with cleaning cloths returned to the licensee's HC station. Personnel involved with the tanker were surveyed and found to be free of contamination. At 6:30 a.m., a four-hour report in accordance with 10 CFR 50.72(b)(2)(vi) was made to the NRC for the inadvertent release of radioactively contaminated material.

At 6:30 a.m., NRC inspection personnel entering the station were directed by security personnel to avoid grassy areas and remain on walkways.

At about 8:00 a.m., radiation protection personnel were stationed at the security building to survey personnel leaving the protected area. Signs were also posted at the security area notifying personnel entering and exiting the protected area of the onsite contamination. Enhanced personnel monitoring, using hand and foot monitors, for personnel egressing the protected area, was initiated at approximately 10:30 a.m. that day.

3.3 Licensee Root Cause Analysis

The licensee established, appropriately staffed, and provided a specific charter to the root cause analysis (RCA) team directed to analyze the event. NRC review indicated the RCA team focused on the significant issues, including the mechanism by which the event occurred, and demonstrated good use of analytical tools to establish root causes. The

team used procedure NC NA-BP.ZZ-0002, "Root Cause," to guide the analytical process. The inspectors concluded that the team's final report was detailed and comprehensive; further, recommended corrective actions specifically addressed the identified root causes.

Ultimately the RCA team attributed the cause of the event to a design problem. Specifically, steam vapor leaving the DSE discharged directly into the SPV without any condensing or filtering unit. This allowed two short duration releases of a steam/water mixture (approximately 58 gallons total) to exit undetected from the DSE effluent vent pipe to the SPV after a high differential pressure condition inside the DSE was relieved by prolonged spraying of an internal demister element.

About 25 gallons of radioactive liquid, in a mist/droplet form, later was determined to have exited the SPV to the environment. The remainder was believed to have collected in the duct work, spilled to the floor, and returned to the DSE.

Contributing causes were also determined by the RCA team to be primarily design related (i.e., inadequate effluent radiation monitoring, no automatic effluent isolation function, excessive DSE vent piping length with "no-slope" sections). However, inadequate procedures, operator training and knowledge, and other operational concerns were concluded to have had direct impact on the event.

The release mechanism established by the RCA team was judged by the inspectors to be credible and consistent with NRC findings and observations. The inspectors concluded that the licensee's RCA team performed an excellent post-event analysis and review.

3.4 NRC Assessment of Event Response

The inspectors determined that the licensee's initial response to the high radiation alarms was appropriate. The inspectors concluded, however, that licensee personnel involved in the event and reviewing the event during the day on April 5, 1995, were slow to identify that a release had occurred. Multiple indications were evaluated and appropriate procedures were entered, however, an incorrect diagnosis was made to conflicting radiation monitor indications. Data and results being collected throughout the morning, which indicated that a release may have occurred, were not evaluated in an integrated fashion. Operations and radiation protection personnel believed that a release had not occurred due to: 1) the lack of any indication of a release on the SPV effluent monitor, 2) sample results for the DSE effluent indicated that no release was in progress, 3) sample results from the SPV weekly sample indicated a release had not occurred, and 4) information provided by RW operations personnel indicated that operation of the DSE could not result in a release of radioactive material.

Subsequent investigation and follow-up activities were hindered by misdiagnoses and communications problems. In addition, procedural weaknesses, involving limited guidance for control of radioactive

material outside the radiologically controlled area, contributed to the slow response to the event. The following examples are provided to support these conclusions.

- The SROs on the night shift incorrectly believed that the hot spot was caused by solid material lodged in duct work. The SROs and radwaste personnel did not believe that there was a mechanism that could have resulted in a release from the DSE into the SPV. As a result, the DSE was not secured until 16 hours after the event.

- Key information was identified throughout the investigation, but the information was not communicated and interpreted effectively, which delayed identification that a release had occurred. This included information, obtained before noon on April 5, that personnel had become contaminated while traversing the turbine building roof, indicating the presence of contamination in an unexpected location, and information provided by the chemistry group that they had identified unusual radioactivity on the turbine building roof

- The procedure for abnormal gaseous releases (AB-126) and the radiation monitor alarm response procedure (ARP) focused the licensee staff's attention on use of the SPV monitor readings to ascertain whether a release had occurred or was in progress. Since the SPV effluent monitor could not detect the release, this delayed actions to secure the SPV.

- Shift management and radiation protection personnel relied on radwaste personnel information that operation of the DSE could not have resulted in a release of radioactive material.

- The licensee was not initially aware of the reduced detection efficiency for radionuclide mix.

As a result of these problems, the licensee was slow to take actions to secure potential sources and to take appropriate actions to prevent potential further spread of contamination. Management attention and direction was focused on preventing a future release from liquid drying out in the duct, rather than on determining the cause and extent of the event, including whether a release had occurred.

The inspectors determined that the event was properly reported and that the required notification was made, when it was identified that a contaminated vehicle had left the site. No emergency action levels (EALs) were exceeded during this event.

4.0 LIQUID RADWASTE CHEMICAL WASTE SYSTEM DESIGN AND OPERATION

4.1 General

The inspectors reviewed the design basis, start-up testing, and applicable design change packages associated with start-up and operation of the DSE. The inspectors also evaluated the general and specific knowledge of the licensee's personnel involved with design review, start-up, and operation of the DSE.

4.2 Background

Hope Creek was originally constructed with an extensive solid and liquid radioactive waste handling system, however, the majority of the system was not placed in service when commercial operation of the plant began in 1987. The solid waste processing system was not placed into service until 1989, and the evaporation (volume reduction) portion of the Liquid Waste Management System (LWMS), including the chemical waste subsystem of which the DSE is part, was not placed in operation until 1994.

The DSE, located on the 54' elevation of the services radwaste (SRW) building, is a small capacity evaporator used to process chemical waste from the chemical waste tank. The evaporator was designed to process chemical wastes from laboratory drains, decontamination solutions, and sample rack drainage on a batch basis. The Final Safety Analysis Report (FSAR) indicates that the DSE is operated on a batch basis. However, at the time of the event, the DSE was being used to process liquid radioactive waste from the floor drain collection system in a semi-continuous mode.

In an effort to minimize the total volume of radioactive waste shipped offsite, the licensee developed a LWMS evaporator start-up plan. The plan was described in a project scope proposal drafted in 1992. This proposal included a plan to verify that the original LWMS installation was intact, and to conduct a phased approach to starting up the various components in the system.

In planning for the start-up and operation for the DSE, the licensee developed a "global" design change package (DCP 4EC-3348) to address minor deficiencies that may arise during the start-up of the system, and to control the necessary functional and operational testing. The DSE was in the final phase of this start-up testing at the time the release event occurred. The inspectors noted that the licensee's DCP did not evaluate the adequacy of the original design of the DSE, rather it served to provide a means to correct minor system operational issues which may be encountered during system start-up and operation. The licensee's personnel assumed that the design had been reviewed and was acceptable.

4.3 Licensee Understanding of Chemical Waste System Design Basis Before Event

The inspectors concluded that the licensee's personnel involved in the DCP discussed above, and the operations personnel starting up and operating the DSE, did not have an adequate understanding of the design basis of the DSE prior to the event, both in terms of its interconnection with the remainder of the LWMS and the SPV, and its functional operation.

This was evidenced by the following observations.

- In several instances, actual LWMS configuration and operation conflicted with Final Safety Analysis Report (FSAR) section 11.2, design bases and system descriptions. For example, LWMS effluents were described in the FSAR to be "processed, monitored, and diluted" prior to discharge to the environment. More specifically, DSE operations were intended to occur on a "batch processing" basis, with the effluent vapors then "sampled and discharged" through the DSE effluent vent to the SPV. These activities did not occur in practice.

- Responsible engineering personnel were not completely familiar with the commitments made in the FSAR. After the event, a team of licensee engineering personnel was assembled to research and understand the original design basis of the DSE and its effluent path. Insufficient design documentation existed at Hope Creek to establish the true basis for the system's design and operation, indicating that familiarity with the design of the system, including the design bases for the SPV radiation monitoring system (RMS), was weak. Only after several days of effort, which included consultations with the system's vendor (General Electric) and the plant architect (Bechtel), was the licensee able to completely understand the features of the system and the reasons for its installed configuration.

4.4 NRC Evaluation of Licensee Engineering Design Reviews and Safety Evaluations

4.4.1 Licensee Review of System Design

The inspectors concluded that the licensee did not identify significant DSE and SPV radiation monitoring system design concerns which, had they been noted and adequately addressed, likely would have prevented the April 5, 1995, inadvertent radioactive release.

The inspectors determined that the licensee had several opportunities prior to the event to identify the noted problems with the design of the DSE. Missed opportunities included: the original design and independent review of the DSE and the SPV radiation monitoring systems; the 10 CFR

50.59 safety evaluations performed to justify the LWMS start-up program under DCP 4EC-3348; and the Hope Creek Station Operations Review Committee (SORC) reviews of these same DCP safety evaluations.

As a result of weaknesses in the licensee's evaluation of the DSE, several key issues were not addressed which impacted the likelihood and significance of this event. The following examples are provided.

- FSAR section 11.2.3, "Radioactive Releases," did not address the potential for a release via the DSE effluent vent path, despite the fact that engineering drawings (Process and Instrument Drawings (P&IDs)), as well as General Electric and Bechtel design documents, indicated that the DSE was directly vented to the environment via the SPV.

- The DSE effluent path was not equipped with a radiation monitor (or an associated high radiation isolation function), contrary to FSAR section 11.2.1 and 10 CFR 50 Appendix A General Design Criteria (GDC) 60 and 64 requirements regarding control, monitoring, and sampling of radioactive releases.

- Although the FSAR states that the DSE effluent is vapor (without reference to a known "rainout" or "entrained liquid droplet" transport phenomenon), no assessment was made of the SPV effluent monitor's capability to detect such effluent in the FSAR RMS design bases (section 11.5). (Post-event analysis by the licensee determined that the SPV monitor was incapable of detecting contaminants in vapor form).

The inspectors noted that the licensee performed several 10 CFR 50.59 safety evaluations to assess the various phases of the DCP test plan, including the initial functional testing and the subsequent operational testing of the DSE. None of these evaluations addressed the potential for a radioactive release via the DSE process vent. Specifically, the evaluations did not consider the potential for unexpected DSE operational transients that could be encountered or the capability of the SPV RMS to detect any resultant releases. Opportunities to identify DSE and SPV RMS design problems during these safety evaluations may have been missed because of the nature of the DCP itself; that is, the DCP was drafted primarily to enable minor system deficiencies to be corrected during start-up testing, with the assumption that the safety of the DSE had been evaluated previously in the FSAR. The inspectors did note that the licensee had evaluated the DSE relative to NRC Information Notice No. 91-40 and had concluded that the concerns raised in the notice were adequately addressed.

Following the event, the licensee learned that a decision was made in the mid-1970's to remove a process vent effluent condenser incorporated in the original vendor DSE design.

This decision was based on concerns regarding the potential for organic chemical contamination of the distillate that would be returned to the demineralized water system. Justification for this pre-installation design modification was based on a radiological impact assessment performed by Bechtel and subsequently approved by the licensee, which concluded that any radioactive contaminants released via this pathway would be insignificant.

The licensee was not aware of this original design modification and its justification during the planning, evaluation, and conduct of the LWMS start-up testing. As a result, certain assumptions made in the Bechtel analysis were invalidated during the testing. For example, the analysis assumed that the DSE would be processing "batch" quantities of chemical waste. In contrast, the licensee was processing, in a semi-continuous manner, low purity floor drain collection tank waste. Further, Bechtel assumed that routine batch sampling of the DSE process influent and effluent would occur to continually validate radiological effluent conditions; however, the licensee did not perform such routine sampling in practice. The inspectors noted that, after the event, the licensee was not able to locate the original engineering change notice that authorized removal of the effluent condenser.

The inspectors concluded that the licensee did not perform an effective review of the LWMS design bases before initiating the operational testing phase of DCP 4EC-3348. This resulted in an inadequate justification for the conduct of the testing as it was ultimately performed and a failure to consider the impact of the DSE operation on effluent releases and the adequacy of installed radiation monitors.

4.[illegible].2 Licensee Review of Planned DSE Operations

The inspectors determined that the licensee did not adequately evaluate several DSE operational issues.

The following examples are provided.

- No evaluation was conducted to justify operation of the DSE in a semi-continuous mode. The system was designed to be operated in a batch mode as described in the FSAR. There was no evaluation to ensure that changing the mode of system operation did not have an effect on design assumptions for radwaste holdup times and sample requirements.

- There was no evaluation to justify processing of floor drain water in the DSE. (It was necessary to transfer floor drain water to the CWT to provide a semi-continuous supply of process fluid.) No consideration was given to evaluation of differences in the nature of the floor drain and chemical waste tank inputs to determine if there was any impact on the DSE. Automatic control functions

had to be bypassed to establish a flowpath from the FDCT to the CWT, but no evaluation was performed to justify the acceptability of bypassing the automatic control functions.

- The chemical waste system and DSE operating parameters were not well defined or evaluated during the design change process. No specifications were defined for evaporator pressure, temperature, operating level, or for steam or demister spray flow rates. The operational testing was intended to demonstrate acceptable operation of the system; however, the only testing acceptance criteria specified in the DCP was that the nominal evaporation rate of the DSE be at least 3 gallons per minute (gpm).

- During the design change process, DSE operating level setpoints, limits, and alarms were set non-conservatively due to an error in interpreting design documents. The evaporator vendor manual specified that a control system was required to prevent steam from being admitted to the evaporator shell unless tubes were flooded with liquid. As a result of the misinterpretation of design information, the automatic steam shutoff function was set at a level 24 inches below the top of the tubes.

- Actual operating level for the DSE was selected based on experience gained during the start-up testing. The normal operating level for the DSE was 6 inches below the top of the tubes; therefore, the DSE was operated routinely with the tubes not flooded. The normal operating level also was not within the operating level band specified in the system operating procedure (SOP). The level band in the SOP and the alarm setpoints in the system ARPs were appropriate with respect to the level of the tubes in the evaporator. However, the discrepancies between the setpoints in the existing procedures and the setpoints established in the design change process were not identified.

Overall, there was no indication that the operating characteristics of the evaporator were evaluated or that abnormal conditions were considered. As a result, it was not recognized that prolonged spraying of the demister or spraying while steaming could cause a pressure transient in the evaporator.

4.5 DSE Operations During Start-up Testing and Training of Personnel on DSE Operation

The inspectors' evaluations of actual DSE operations and training of personnel during start-up testing identified the following.

- No formal monitoring of system operation was performed during the operational testing phase of the start-up testing.

The DCP for the performance run stated that data would be gathered in accordance with the radwaste log procedure. This procedure contained a log sheet for the chemical waste system, but did not specify a frequency for completing the data sheet. Normally, the SOP specifies system logging requirements.

In this case, the SOP had not been revised for current operation of the system and did not specify any logging requirements. The log sheet was completed at system start-up, but no routine logs were taken during system operation.

- There was no indication that any concerted effort was made to ensure that the system was operating properly. In at least one instance, system mis-operation was not reported and investigated. On March 25, 1995, a high level occurred in the evaporator, apparently due to inadvertent closure of the steam inlet valve and failure of the evaporator feed inlet valve to fully close as designed. This abnormal condition was not identified until the DSE level recorder traces were reviewed in conjunction with investigation of the April 5 event.

- Radwaste personnel did not have a clear understanding of system interlocks and automatic functions. For example, both RW operators and supervisors had misconceptions about the automatic system response on high and low level evaporator level. This lack of understanding appeared to be due to failure to consolidate information from the design change process for incorporation into procedures and training material. Training had been conducted on the chemical waste system shortly before the event, but the system lesson plan had not been revised to reflect current information on system operation and contained many inaccuracies.

- Operators and radwaste supervision did not believe that the DSE could cause a radioactive release. They were not familiar with the design basis of the DSE and did not recognize its potential to release radioactive contaminants through an unfiltered, unmonitored effluent pathway. As a result, operation of the DSE was considered a lower priority when conflicting demands that required operator attention existed. The RW operator involved in the event indicated that he had clearly defined priorities and would only have been concerned about DSE operation if a radiation alarm was received on the steam supply for the DSE. On the night of the event, there were numerous evolutions in progress in the radwaste control room. When another operation, that was considered higher priority than the DSE high differential pressure (dp) alarm, required his attention, the operator was distracted and inadvertently left the demister spray valve open for an extended period of time.

4.6 Operating Procedures for the DSE

The inspectors' review of the operating procedures for the DSE identified the following.

- The chemical waste system operating procedure was not revised to support the operational testing of the DSE. A conscious decision was made to rely on operator experience gained during start-up testing rather than a formal procedure for system operation. However, accurate, reliable information concerning system operation was not readily available to the operators. The intent was to revise the procedure after start-up testing was complete so that experience gained during the operational testing could be incorporated. One of the activities that the RW operator was involved in on the night of the event was working on the revision to the procedure.

- The DSE operating procedure contained inaccurate information concerning system operation. For example, the procedure contained a note with incorrect information concerning automatic system response to high and low evaporator level.

- The existing system operating procedure did not address semi-continuous operation of the DSE. No procedural direction was provided for refill of the CWT or DSE operation during the refill. A draft procedure was provided by engineering during the start-up testing, but it also did not address operation of the DSE while refilling the CWT. Operators were given the option of securing steam to the evaporator when refilling the CWT, therefore, the evolution was not performed consistently from shift to shift. Failure to secure steam while refilling the CWT caused an unnecessary level transient in the DSE and unnecessarily challenged the automatic closure function of the steam valve on low level.

- The safety evaluation in the DCP stated that water transfers would be controlled by approved procedures. However, no procedural direction was provided for transfer of water from the FDCT to the CWT, even though automatic control functions and interlocks had to be overridden to establish the flowpath.

- There was inadequate procedural guidance for process sampling as required in the design specifications and the FSAR. The operating procedure required sampling of the CWT, but the procedural direction could not be implemented because the system was not operated in batch mode, as the SOP intended. Periodic CWT and FDCT samples were taken, but they were not analyzed for solids as specified in design specifications, and the sampling frequencies did not ensure that all DSE influent was sampled.

The procedure addressed, but did not require, sampling of the "vapors." It was not clear if "vapors" referred to the DSE effluent, because the sample point specified in the SOP was not on the DSE discharge line. No routine samples of DSE effluent were taken.

- The alarm response procedure for high differential pressure across the demister did not provide direction for spraying the demister. Operators were trained to spray for 30 seconds to 1 minute, but no cautions were provided in procedures or in training on the consequences of prolonged spraying of or spraying while heating steam was being supplied to the DSE. Prolonged spraying while heating steam was being supplied to the DSE resulted in the pressure transients that caused the release of radioactive material.

The inspectors noted that Technical Specification 6.8.1 requires, in part, that applicable procedures recommended in Appendix A of Regulatory Guide 1.33, Revision 2, be established, implemented and maintained. Appendix A of Regulatory Guide 1.33 recommends procedures for limiting release of radioactive materials to the environment, including operation of liquid radioactive waste systems.

Based on the above review, the inspectors concluded that as of April 5, 1995, the operating procedures for the Decontamination Solution Evaporator, a liquid radwaste system component, were inadequate to limit uncontrolled releases to the environment and provide for proper operation of the DSE. Specifically, on April 5, 1995, the DSE discharged about 85 millicuries of mixed radioactive corrosion products, in an uncontrolled manner to the environment, and the procedures and controls for operation of the DSE were inadequate to either preclude or detect the occurrence. This is an apparent violation of Technical Specifications. (VIO 50-354/95-05-01)

4.7 Overall Conclusions Regarding Cause of Event

The inspectors concluded that the primary root cause of the April 5, 1995, event was an inadequate system design. However, secondary causal factors were also identified. The inspectors also concluded that the licensee did not have an adequate understanding of the design basis of the DSE and did not perform adequate design reviews of the LWMS chemical waste subsystem and SPV radiation monitoring system prior to placing the DSE into operation. Several opportunities were missed in the original design and design change processes to identify a failure to meet General Design Criteria requirements regarding monitoring and control of radioactive effluents.

The inspectors further concluded that overall control of system operation was weak. Operating parameters were not clearly defined or evaluated prior to system start-up. There was minimal monitoring of system operation even though the system was in a testing mode.

Radwaste personnel did not have a clear understanding of system operation and system operating and alarm response procedures did not provide adequate direction for operation of the DSE. Existing procedures were not adhered to and the DSE was not operated in accordance with the design bases or FSAR commitments. Some of these weaknesses contributed directly to the event. For example, inadequate procedural direction and understanding of system operation resulted in prolonged spraying of the demister, which ultimately caused the release.

5.0 ADDITIONAL ISSUES (SYSTEM CONFIGURATION CONTROL)

Subsequent to the event, on April 12, 1995, temporary modifications (T-Mod's) were made to two non-Class 1E ventilation duct radiation monitors. Specifically, the RWE and RBVSE duct radiation monitor alarm setpoints were increased in order to clear locked-in high radiation alarms caused by elevated background radiation levels which resulted from the April 5, 1995 release. Although it was known that this change would reduce the sensitivity of the stated detectors, it was deemed necessary in order to provide control room operators some indication of a transient condition in the event of a subsequent release via the affected pathways.

Although the inspectors noted that the affected radiation monitors were not Technical Specification-required monitors, the inspectors were informed and noted that T-Mod's were not implemented in accordance with the established licensee procedure (NC.NA-AP.ZZ-0013(Q), "Control of Temporary Modifications"). Specifically, the alarm setpoint changes were made without appropriate operations shift acknowledgement, independent review, and technical document room notification. Further, the radiation protection database control procedure, HC.RP-GP.SP-0001, was not implemented because the appropriate radiation protection department personnel notifications were not made. This deficiency, attributed by the licensee to personnel error, was identified by the responsible licensee technical department supervisor and documented in an internal station incident report.

Technical Specification 6.8.1 requires in part that applicable procedures recommended in Appendix A of Regulatory Guide 1.33, Rev 2 be established, implemented and maintained. Appendix A of Regulatory Guide 1.33 recommends procedures for control of temporary modifications. The above failure to follow procedures is an apparent violation of Technical Specifications. (VIO 50-354/95-05-02)

6.0 EXTENT OF CONTAMINATION AND LICENSEE EVALUATION AND CONTROL OF CONTAMINATION

6.1 General

The inspectors reviewed the extent of onsite and offsite contamination resulting from the unplanned release of radioactive material from the SPV.

The inspector also evaluated the adequacy of the licensee's efforts to control the contamination once it was identified. In addition, the inspectors evaluated the licensee's measurements of offsite (outside protected area) contamination, and its potential impact on the public.

6.2 Licensee Response to Identification of Contamination

The licensee discovered removable contamination on the roof of the turbine building at approximately 3:30 p.m. on April 5, 1995. As a result, Hope Creek RP personnel were directed to perform surveys of the yard area south of the turbine building. The surveys of the yard area, performed at approximately 4:30 p.m. on April 5, 1995, indicated removable contamination.

Once the contamination was identified, Hope Creek RP personnel informed Salem station RP personnel of the onsite contamination. This notification prompted Salem RP personnel to survey and monitor normally accessible walkways and entrances to the Salem station. No contamination was detected at the Salem station. Hope Creek RP personnel later informed Salem station RP personnel that the contamination may have been deposited at higher elevations. This notification, at about 8:00 p.m. on April 5, 1995, prompted Salem station personnel to survey elevated areas in the wind direction provided by Hope Creek personnel. Salem RP personnel identified, using large area smear surveys, low levels of contamination on the Salem Unit 2 turbine building deck. The Salem turbine deck was posted to inform personnel of the contamination. Once the onsite contamination was identified, the licensee did send personnel to survey areas outside the protected area. The results of surveys performed outside the protected area are discussed in Section 6.4 of this report.

The licensee's corporate radiation protection services organization was informed of the contamination on the morning of April 6, 1995. The services group initiated offsite surveys and developed an enhanced environmental monitoring program. In addition, the licensee initiated action to retrieve and analyze airborne samples from fixed monitoring stations at offsite locations.

6.3 Description and Composition of Onsite Contamination

Attachment 6 to this report depicts the magnitude and extent of contamination of the Hope Creek and Salem stations. Note that the values for contamination levels given in Attachment 6 are in counts per minute per 100 cm^2. These values may be corrected to disintegrations per minute per 100 cm^2 (dpm/100cm^2) by dividing the value by .02 (the nominal detection efficiency for the handheld frisker for the radionuclide mixture).

The inspectors' review indicated that the majority of contamination was located on the roof area of the Hope Creek turbine building and the area immediately south of the Hope Creek turbine building. The contamination appeared to have exited the SPV in a droplet-like form as evidenced by reddish-brown spots observed by an inspector on the turbine building roof.

Contamination levels ranged from about 150,000 dpm/100cm^2 (corrected for radionuclide mix) at the SPV, to less than detectable at the extreme point of deposition within the protected area. Contamination surveys on the Salem Unit 2 station's turbine deck did not identify contamination with area surveys of 100 cm^2. Large area surveys, using cloth wipes, however, identified low levels of contamination. The identified areas of contamination were immediately posted and controlled. The licensee did not detect radioactive materials via surveys of areas outside of the area depicted in Attachment 6.

Based on the survey results, the majority of contamination fell directly south of and in close proximity to the Hope Creek turbine building, an area located within the protected area that was not accessible to the public. A number of licensee vehicles, located in the area south of the turbine building, were contaminated to levels averaging 100,000 dpm/100 cm^2 (corrected for radionuclide mix). These vehicles were decontaminated. No significant contamination was identified at the immediate area of the south exit point from the Hope Creek station, an area frequented by individuals taking breaks while smoking. In addition, no contamination was detected within the Salem or Hope Creek station building air intake systems or cafeterias.

In order to confirm the source of the radioactive material deposited on site, and evaluate the release to determine if a chronic low-level release may have occurred, the licensee performed gamma spectroscopic analysis of representative surveys of various contamination samples collected throughout the site. The results of those analyses are depicted in Attachment 7. Attachment 7 provides percentage ratios of the radionuclides identified in the sample results, which confirm that the mix and ratios of radionuclides identified were similar to those identified in the DSE.

At the conclusion of the inspection, the licensee's root case analysis team and corporate radiological services group concluded that about 25 gallons of liquid, containing about 85 millicuries of mixed radioactive corrosion products, had been released from the SPV to the environment.

The 25 gallons was estimated to have been released from a total of 58 gallons which was released to the DSE effluent vent pipe.

Based on the data provided, the inspectors concluded that the radioactive materials deposited on portions of the station originated from the DSE. This was evidenced by the consistency of ratios for short-lived products and the lack of identification (in any compass direction) of any radioactive materials immediately outside the plume (contamination foot-print area) depicted in Attachment 6.

The inspectors' discussions with licensee personnel indicated a previous event apparently had resulted in very low levels of radioactive contamination being deposited on the turbine building roof. This matter was not included within the scope of this inspection. However, the licensee indicated the information on the previous event will be obtained and provided to the NRC during a subsequent inspection. The inspector indicated the matter will be evaluated relative to the need to include such a release in the licensee's decommissioning database file, as required by 10 CFR 50.75(g), and whether such a release required NRC approval to leave the previous contamination found on the turbine building roof in place.

Overall, the inspectors concluded that the licensee performed a comprehensive evaluation of the extent and composition of onsite contamination associated with the April 5, 1995, unplanned release, once the contamination was identified.

6.4 Offsite Contamination (Outside Protected Area)

As discussed above, the licensee performed surveys outside of the protected area. No contamination was detected using either smear surveys or monitoring with handheld survey meters.

The licensee retrieved offsite airborne radioactivity monitoring samples from various locations around the site out to about 10 miles. The licensee collected five air samples from stations that continuously collected airborne samples, four surface water samples, and nine grass samples. These included samples from sampling stations in Delaware and New Jersey. The licensee's sample analysis results did not identify any detectable activity attributable to the release.

The licensee also collected soil and grass samples from the shoreline directly downwind from the Hope Creek SPV. The samples were collected within the owner controlled area and were analyzed by high sensitivity gamma spectroscopy analysis to lower limits of detection recommended by the NRC. The samples were collected to evaluate the potential for contamination outside the protected area.

The licensee detected contamination in samples of soil. The samples collected were two-foot diameter circular areas 1.25 inches deep. The maximum sample result was about 577 picocuries per kilogram (pCi/kg) (corrected for hard-to-detect Fe-55) in location B-10, which is located on the shoreline within the owner controlled area south of the Salem station.

The levels detected in soil samples, as well as their location, are shown in Attachment 8. This maximum result indicated twice the concentration of normal activity seen in river sediment samples near the plant liquid effluent discharge point. The inspectors noted that the radioactive contamination detected would not result in any significant exposure of members of the public. The maximum offsite doses projected for the radioactive contamination released is discussed in Section 7.4 of this report.

The licensee also collected shoreline grass samples. The grass samples were grass clippings collected from a two-foot diameter area. The licensee detected a maximum of about 43,500 picocuries per kilogram (at location B-9) (corrected for hard-to-detect Fe-55) of grass. The levels detected, as well as their location, are shown in Attachment 9. The maximum projected offsite doses for the radioactive contamination released is discussed in Section 7.4 of this report.

The inspectors noted that the contamination was within the owner controlled area and did not represent a hazard to members of the public. The licensee estimated that about 2,000 linear feet of shoreline exhibited trace contamination not detectable by hand held monitoring instruments. The licensee will include the radioactivity released during the event in subsequent effluent release reports.

The dose assessments for members of the public potentially exposed to the contamination is discussed in Section 7.4 of this report.

6.5 Worker Notification of Contamination on Site

The licensee became aware of the onsite contamination in the area south of the Hope Creek turbine building at about 4:30 p.m. on April 5, 1995. Prior to the discovery, numerous contractor employees had worked during the day of April 5, 1995, on a new site services building located between the Salem and Hope Creek stations. At least two of the contractor workers also worked in grassy areas located in proximity

to the south side of the Hope Creek turbine building. The individuals worked in manholes 10 and 10A near the walkway from the Hope Creek station to the security processing area.

The inspectors' review indicated that essentially all of the workers left the site at the end of the work day at about 3:00 p.m. on April 5, 1995, prior to the discovery by the licensee that a release had occurred. A licensee contamination survey, documented at 5:00 p.m. on April 5, 1995, indicated removable contamination south of the Hope Creek turbine building ranging from less than 1000 dpm/100 cm^2 to 100,000 dpm/100cm^2 (corrected for radionuclide mix).

The average removable contamination in the area south of the turbine building indicated about 50,000 dpm/100cm^2 (corrected for radionuclide mix). The inspector also noted that the licensee identified about 25,000 dpm/100cm^2 (corrected for radionuclide mix) of contamination on the site services building on April 5, 1995. The licensee posted these areas as contamination areas.

The inspector questioned licensee personnel as to what information was provided to workers once the contamination was discovered. Licensee personnel indicated that once the contamination was discovered, the affected areas were posted immediately. In addition, security personnel later were informed to go to the Salem radiological control point and perform whole body frisking. Security vehicles were surveyed. No readily identifiable contamination was noted. The licensee also initiated, on April 6, 1995, periodic updates of personnel via separate information notes and via the licensee's onsite employee newspaper.

The licensee's RP personnel directed security personnel that workers should be informed that they were not to go to the new site services building, but to report to their muster areas. Security personnel informed workers coming into the station as early as 6:30 a.m. on April 6, 1995, that personnel were only to walk in designated areas and remain off of the grassy areas. The inspector noted that no posting or information was placed at the entrance or exit of the security building until about 8:00 a.m. on April 6, 1995, to indicate to personnel that an unplanned contamination release event had occurred.

The licensee's RP personnel indicated to the inspectors that they believed that it was not necessary to inform workers who had left the station of the contamination event because: 1) personnel were monitored by a portal monitor as they left the station; 2) personnel who had traversed the contaminated areas were not alarming portal monitors inside the security building or at the RP control points; and 3) surveys performed inside the security building and parking lot areas did not identify any contamination.

The inspectors evaluated the RP personnel's decision not to inform workers of the contamination event. The inspector reviewed the sensitivity of the portal monitor and noted that the portal monitor at the security building had a sensitivity of about 450,000 dpm. However, the monitor had previously identified personnel attempting to exit the station with lower levels of contamination, but the licensee was not able to qualify the minimum amount of contamination detectable.

The inspector noted that 10 CFR 19.12 requires that all individuals working in or frequenting a restricted area be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area and be instructed in the health protection problems associated with exposure to such radioactive material or radiation, and be instructed in precautions or procedures to minimize exposure.

The inspectors' noted that the extent of such instructions is required to be commensurate with the potential radiological health problems in the restricted area.

The licensee's RP personnel met with the construction workers on the morning of April 6, 1995, and briefed them on the extent of contamination, the potential radiological hazards, and the actions on-going to evaluate the release. The workers were informed to return to their home and bring back the clothes they had worn the previous day so that the clothing could be monitored for contamination. The workers returned clothing throughout the afternoon of April 6, 1995, but did not return to work on the site services building that day.

Notwithstanding the information that was provided to workers on the morning of April 6, 1995, the inspectors' believed that it was reasonable to have informed, on April 5, 1995, all construction workers who had worked in close proximity to the Hope Creek turbine building of the discovery of removable radioactive contamination in their work area, and to have requested at that time that they return to the station so that their person and clothes could be monitored. This was reasonable considering that: 1) the licensee did not know who had worked in the contaminated areas and what the nature of their tasks was; and 2) it was not apparent that the portal monitor could readily identify contamination that was less than high levels. In addition, the licensee did not post a notice at the security building once the site contamination was identified informing personnel of the event.

Such notification would have allowed workers exiting the station after the discovery of the contamination the option of requesting high sensitivity personnel monitoring before leaving the site.

In addition, licensee RP personnel did not take any action to locate any vehicles that may have left the site until approximately 11:30 p.m. on April 5, 1995, when it was brought to their attention that a vehicle (hydrogen tanker) had left the site at approximately 9:40 a.m. that day. The vehicle, when located at approximately 4:30 a.m. on April 6, 1995,

was determined to be contaminated. The contaminated vehicle was unknowingly removed from the site. The licensee's radiation protection program procedure (NC.NA-AP.ZZ-0029(Q) - Revision 2) prohibits release of materials with radioactive contamination as specified in Section 5.0 of the procedure.

The inspector noted that once it was brought to the RP group's attention that a vehicle had left the site, the licensee initiated a review to identify any other vehicles that may have left the site after the contamination event occurred. The licensee subsequently identified that 18 vehicles (including the above discussed hydrogen tanker) had left the site after the time of the release. These 18 vehicles were located and surveyed by radiation protection personnel. Vehicle handling personnel were also surveyed. Of the 18 vehicles, only one, the above discussed hydrogen tanker truck, was identified as contaminated. The tanker was decontaminated and returned to the station for further monitoring on April 6, 1995. Decontamination cloths were also returned to the site. No personnel who drove or worked with the vehicles was contaminated. The inspector noted that the contamination on the hydrogen truck was generally tenacious and was not easily dispersed. In addition, there was no precipitation in the area on April 5 and 6, 1995, that would have dispersed the contamination.

The inspectors noted that the failure to inform personnel of the contamination event was an apparent violation of 10 CFR 19.12. (VIO 50-354/95-05-03)

6.6 Worker Contaminations and Radiation Monitoring and Evaluation of Intakes of Radioactive Material

The inspector noted that, once the onsite contamination was identified on the afternoon of April 5, 1995, Salem station RP personnel initiated actions to monitor individuals who may have traversed the area during the time of release or thereafter. These individuals were primarily security personnel. Also, vehicles used by the security force were surveyed. No readily detectable contamination was identified. The licensee also initiated whole body counting of on-shift personnel who were present on the day of release and who could have been exposed to airborne radioactive material. These individuals, as indicated above, were primarily roving security personnel. No intakes of radioactive material were identified. At the end of the inspection, the licensee was reviewing the potential for any of the approximately 97 personnel who were on shift during the period of release to have traversed the contaminated area.

The licensee directed all construction workers to report to the Salem station radiological control point on the morning of April 6, 1995, at about 10:00 a.m. for frisking with high sensitivity whole body friskers. As noted previously, the licensee monitored about 32 individuals who worked for the contractor performing work on the new site services building. Of the 32 individuals monitored, the licensee determined that

11 individuals may have worked in contaminated areas. These 11 individuals were whole body counted on April 7, 1995. No intakes of radioactive material was identified by whole body counting.

The inspectors noted that trace amounts of contamination was identified on shoes of 13 of the 32 individuals. These individuals' vehicles were surveyed and no contamination was identified. Trace clothing contamination was identified on the outer layers of clothing worn on April 6, 1995, of five of the 13 individuals. The clothing was determined by the licensee to have been the same outer garments worn by these individuals on April 5. According to the licensee, none of the contamination was detectable by handheld monitoring with a frisker (thin window Geiger-Mueller (GM) pancake probe). The licensee decontaminated the clothing. Two of the five individuals, who were considered to have been the individuals who worked in closest proximity to the areas of maximum contamination, were interviewed by the inspectors. The inspectors noted that the two contractor workers had received radiation worker training. The two individuals had not been provided personnel radiation monitoring devices because of the expectation that the workers' tasks would not result in any measurable radiation exposure.

The inspectors' review indicated all individuals who exited the site on April 5, 1995, followed directions of security force personnel and re-monitored themselves if a portal monitor alarmed. The inspectors' interviews of workers and security force personnel indicated security personnel were familiar with requirements for monitoring personnel leaving the site.

The inspectors also noted that the licensee performed an exposure evaluation to determine the potential external radiation exposure for individuals who may have been standing or working near the ground contamination. The licensee assumed a maximum exposure time of 48 hours and concluded that the maximum calculated radiation exposure was less than 1 millirem. The inspector noted that the individuals worked in the area for no more than 8 hours following the contamination event.

The inspectors noted that the licensee performed skin dose assessments assuming workers were unknowingly contaminated to levels equal to the highest levels of ground contamination seen. The licensee's calculations, performed for skin density thicknesses of both 3 milligram per centimeter squared (mg/cm^2) and 7 mg/cm^2, indicated no significant skin exposure was sustained assuming an 8 hour exposure period. The inspector noted that no regulatory limit would be exceeded for a 24-hour exposure period. Further, no monitoring of personnel skin dose would be required. The licensee also estimated exposure of workers to radioactive material via inhalation, submersion in the plume, and exposure due to resuspended radioactive material. No significant exposure was estimated for these pathways. Exposure results were well within regulatory requirements.

Based on the above review, the inspectors concluded that no significant personnel contamination, external radiation exposure, or intake of radioactive material by personnel occurred. At the end of the inspection, the licensee was finalizing its dose assessments. These final assessments will be reviewed during a subsequent inspection.

7.0 ESTIMATE OF RADIOACTIVITY RELEASED AND EFFLUENT CONTROLS

7.1 General

The inspectors reviewed the licensee's estimates of radioactivity released from the SPV, its potential impact on members of the public, and the licensee's conformance with applicable regulatory requirements controlling the allowable quantities and release rates of radioactive material.

The following areas were reviewed during the inspection.

(1) Operability of SPV effluent monitoring system
(2) Quantification of the radioactive materials released to the environment
(3) Calculation of projected dose to the public, and
(4) Implementation of the radiological environmental monitoring program (REMP).

7.2 Operability of the SPV Effluent Monitoring System

The SPV effluent monitor provides continuous particulate, iodine, and noble gas monitoring of effluents discharged through the SPV. The monitor consists of isokinetic sampling probes installed in the duct work, a continuous particulate monitor, a continuous gaseous iodine monitor, and a continuous gaseous effluent monitor. The particulate channel and iodine channel of the monitor are equipped, respectively, with filters to collect samples of particulate and gaseous iodine effluent releases. Noble gas releases are monitored continuously and periodically verified by grab sampling and analysis. The general arrangement of the sampling station, as well as the locations for the reactor and radwaste building exhaust monitors, is shown in Attachment 5.

As shown in Attachment 5, isokinetic sampling probes are connected to the SPV sampling station. The isokinetic sampling probes installed in the SPV duct work are not designed to collect liquid mist or vapor. During the event on April 5, 1995, radioactive liquid in a mist/droplet form was released through the SPV. Accordingly, the SPV effluent monitoring system did not detect any unusual radioactivity in the effluents.

The inspector reviewed analytical results for SPV iodine and particulate samples and monitoring results for radwaste, turbine, and reactor building effluent RMS. Analytical data for the SPV iodine and particulate samples indicated normal activities.

During the event, however, reactor and radwaste building exhaust radiation monitoring systems (RMS) in the vicinity of the SPV alarmed. The locations of the reactor and radwaste building exhaust RMS are 6 feet and 10 feet away, respectively, from the SPV. Radioactive liquid found on the SPV floor and contained within duct work was believed to have caused these two exhaust RMS channels to alarm. The turbine building exhaust RMS did not alarm because this RMS is farther away from the SPV.

Based on the reviews of analytical results and RMS monitoring results, the inspector determined that the SPV sampling station and RMS were operable at the time of the event and were also operable during the investigation. However, because of the nature of the release (i.e., liquid mist/droplet form) the release was not detected by the SPV.

The inspectors believe that the monitor was unlikely to detect the release because: 1) the release was not in a form easily sampled by the SPV isokinetic probes; and 2) the DSE effluent (@ 700 cubic feet per minute (CFM)) discharged from a vent pipe into the SPV, which had a discharge flow of about 400,000 CFM. Consequently, the DSE effluent released would be highly diluted before it reached the isokinetic probe.

The inspector noted that 10 CFR 20.1501(a) requires that each licensee make or cause to be made surveys that may be necessary and reasonable to comply with the regulations in this part and are reasonable under the circumstances. Also, 10 CFR 20.1103 defines a survey as an evaluation of the radiological conditions incident to, among other matters, the release, disposal or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive materials and measurement or calculations of levels of radiation or concentrations or quantities of radioactive material present.

10 CFR 20.1302(a) requires that the licensee make or cause to be made, as appropriate, surveys of radiation levels in unrestricted areas and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in 20.1301. The licensee must show compliance with the dose limits of 10 CFR 20.1301 by the methods outlined in 10 CFR 20.1302(b).

The inspector noted that, as of April 5, 1995, and since initial start-up of the system (at least since October 1994), the licensee's surveys and evaluations of the effluent released from the decontamination solution evaporator exhaust to the south plant vent were inadequate to ensure compliance with the requirements of 10 CFR 20.1302. Specifically, the inspector noted that the licensee had not evaluated

the physical characteristics of the effluent released from the DSE when the DSE was operating in 1) the continuous or semi-continuous mode of operation, or 2) during periods when DSE demister spraying was performed to reduce high differential pressure conditions. As a result, the licensee was unable to detect the release of an estimated 85 millicuries of radioactive material that was released from the DSE to the environment via the SPV on April 5, 1995. This is an apparent violation of 10 CFR 20.1501(a). (VIO 50-354/95-05-04)

7.3 Total Amount of Radioactive Materials Released

The inspectors reviewed the licensee's methods used to estimate the total amount of radioactive material released from the SPV. The inspectors also performed independent calculations to estimate the quantities of radioactive materials released.

The licensee estimated the amount of radioactive material released by three different methods. The first method involved use of a computer code (MIDAS) and concentrations of radioactive material found in soil samples outside the protected area.

The licensee back-calculated the release assuming deposition velocities contained in NRC regulatory guides. The licensee calculated about 1 curie of mixed corrosion products was released. This was considered a very conservative calculation (i.e., likely to overestimate the release) in that the licensee assumed the release was a particulate release when in fact the release was liquid.

The licensee performed a second estimate of radioactive material released by using comprehensive measurements of radioactivity levels in the protected area with a thin window GM probe. The licensee concluded that about 10 millicuries of mixed corrosion products had been released from the south plant vent using this second method.

The licensee subsequently performed a release calculation using the volume of liquid that was estimated, by the licensee's root case analysis group, to have been released from the SPV and the liquid radioactivity concentrations in the DSE. The licensee concluded that 25 gallons of liquid may have been released from the SPV which contained a total of 85 millicuries of mixed corrosion products. This calculation appeared to be reasonable. The licensee also performed a reasonable worst case estimate of radioactive contamination that could have been released. The calculation is discussed in Section 7.5 of this report.

The inspectors estimated the amount of radioactive material released by using radioactive material concentrations obtained from the licensee's analysis of liquid samples obtained from the SPV floor (likely released liquids). The inspector assumed 100 gallons (3.8E+5 milliliters) of liquid was released and concluded the total amount of radioactive materials released to the licensee's property was 268 millicuries of mixed corrosion products. Correcting the amount of radioactivity released for hard-to-detect iron-55 (Fe-55) results in a total estimated

amount of radioactivity released of about 346 millicuries. If 25 gallons was released (using the licensee's estimate of liquid volume released), it is expected that about 86 millicuries would be released. This estimate compares favorably with the licensee's estimate. The inspectors noted that, based on reviews of surveys and tours of the areas, the majority of the released radioactive materials landed on the grass of the protected area close to the south side of the Hope Creek turbine building and on the turbine building roof.

The inspectors noted that the licensee included into the dose calculations, the total amount of tritium (H-3) potentially released to the environment. The licensee used H-3 activity measured in the evaporator water and/or evaporator feed water rather than tritium sampling at the SPV stack. The average H-3 activity in the evaporator water was 1.32E-3 μCi/ml. Therefore, the total amount of H-3 released during this event was 5.02E+2 μCi (0.502 millicuries).

The projected dose to the public and licensee conformance with applicable release limits are discussed in Section 7.4 of this report.

7.4 Projected Dose to the Public and Conformance with Technical Specification Limits

7.4.1 General

The inspectors evaluated the potential doses that could be received by members of the public attributable to the radioactivity released from the SPV on April 5, 1995. The inspectors reviewed liquid and airborne release pathways. The inspectors interviewed and discussed dose results with cognizant licensee personnel. The inspectors evaluated the licensee's calculations and methods to determine projected potential offsite doses to members of the public. The inspectors noted that the licensee conservatively assumed (for the purpose of dose calculations) that the total estimated volume of liquid released (25 gallons) from the SPV was discharged offsite. Such a calculation would significantly overestimate the offsite dose, since the majority of the liquid released would have settled on the onsite building roofs and grounds.

7.4.2 Liquid Release Pathway Analysis

Due to rain on April 8 and 9, 1995, the licensee analyzed storm drain samples. The storm drains catch runoff from roofs and the ground before release to the environment. The licensee, in anticipation of rain, applied a commercial sealer to the site walkways and driveways that indicated contamination. Landscape rock was also sealed with a commercial sealer. The licensee also applied a sealer to roof tops. Consequently runoff of radioactive contamination was expected to be minimal. Also, the licensee cut and bagged contaminated grass before any rain occurred. These methods were considered very good licensee contingencies to minimize releases to offsite environs. The inspector noted that the majority of radionuclides in the SPV release were short-lived, and would decay away quickly.

The inspectors' review indicated the analytical results of the storm drain samples were very low and near the environmental lower limits of detection (LLDs). The inspectors determined that there was no dose consequence to the public relative to storm drain runoff. In addition, the inspector noted that the licensee's calculations, using NRC-approved methods, indicated the licensee did not exceed either the Technical Specification 3.11.1.1 liquid effluent concentration limit or the Technical Specification 3.11.1.2 liquid effluent offsite dose limits. Maximum concentrations of radioactivity in liquids contained in outfalls were below 1% of maximum permissible limits. In addition, maximum projected organ doses and total body doses were well below limits, assuming the entire estimated 25 gallons of liquid was released to the river.

Based on the above review, the inspectors concluded that the liquid release had no significant offsite dose impact on personnel.

7.4.3 Airborne Release Pathway Analysis

The inspectors reviewed the licensee's airborne release pathway analyses and compliance with Technical Specification release limits. The inspector reviewed and discussed the Technical Specification 3.11.2.1.b gaseous effluent dose values, Technical Specification 3.11.2.3 iodine, tritium and radionuclides in particulate form dose limits and values, and also discussed Technical Specification 3.12.1.b environmental monitoring program results.

The inspectors' review of the licensee's data and methods indicated the licensee used offsite dose calculation manual methodologies and actual meteorological conditions. The review indicated all dose values were well within Technical Specification limits using, as a source term, the radioactivity contained in the 25 gallons estimated to have been released from the SPV. As noted above, the licensee, in performing the calculations, assumed that all radioactivity contained within the 25 gallons was released offsite.

The inspectors noted that the licensee calculated the potential exposure (due to inhalation and direct exposure to deposited activity) to a hypothetical member of the public who may have been at the Delaware River shoreline during and following the event. Based on review of assumptions used in the calculation, the inspectors agreed that no significant exposure would have occurred.

Based on the above review, the inspectors concluded that the airborne release had no significant offsite dose impact on personnel.

7.5 Assessments and Conclusions

Based on the above reviews, the inspectors concluded that there were no radiological impacts on either the public or the offsite environment.

Attachment 10 to this report provides a Technical Specification compliance matrix developed by the licensee to show applicable limits, maximum calculated doses for the event, and comparison of doses (or quantities) from releases during calendar year 1994 and the April 5, 1995, event.

The inspectors further noted that the licensee performed a reasonable worst case analysis for offsite dose consequences. The analysis assumed that a quantity of radioactive material, equal to five times that released on April 5, 1995, was released in the direction of the closest site boundary (901 meters north). The licensee's calculations indicated the potential doses would be well within the dose limits for individual members of the public outlined in 10 CFR 20.1301.

8.0 EXIT MEETING

The inspectors held a public exit meeting on April 21, 1995, at the licensee's combined Salem/Hope Creek station processing center. Members of the public including members of the media, attended the meeting. The inspectors summarized the purpose, scope, and findings of the inspection. Attachment 11 to this report provides the information discussed at the exit meeting. The licensee acknowledged the inspection findings.

Attachment 1

INDIVIDUALS CONTACTED

1. Public Service Electric and Gas Company, Inc.

*J. Benjamin, General Manager, Quality Assurance and Nuclear Safety Review
D. Branham, Chemistry Support
M. Champ, Manager, Nuclear Communication
V. Cirlante, Senior Radiation Protection Supervisor, ALARA
*J. Clancy, Technical Manager, Hope Creek Operations
T. DiGuiseppi, Manager, Emergency Preparedness and Radiological Support
R. Dolan, Principal Engineer, Chemistry Services
*L. Eliason, Chief Nuclear Officer and President, Nuclear Business Unit
R. Gary, Senior RP Supervisor, Operations
J. Hagan, Vice-President Nuclear Operations
F. Higgins, Planning Manager
R. Hovey, General Manager, Hope Creek Operations
M. Ivanick, Senior Security Regulatory Coordinator
P. Kordziel, Senior Planner
*S. LaBruna, V. P. Nuclear Engineering
*C. Lambert, Manager, Nuclear Engineering Design
J. Molner, Senior RP Supervisor
*W. O'Malley, Operations Manager
*P. Opsal, Chemistry Manager
J. Priest, Engineer, Licensing and Regulation
*M. Prystupa, RP Manager
D. Smith, Principal Engineer, Nuclear Licensing
*F. Thomson, Manager Nuclear Licensing
G. Trotter, Supervisor, Testing
*M. Trum, Maintenance Manager
J. Nichols, Manager, Assessment
J. Wray, Principal Engineer, Radiological Support

2. Others

C. Mummert, Site Superintendent, Ratheon
M. Sesok, Hope Creek site representative, Atlantic Electric
K. Tosch, Nuclear Engineer, New Jersey Bureau of Nuclear Engineering
D. Vann, Nuclear Engineer, New Jersey Bureau of Nuclear Engineering

3. U. S. Nuclear Regulatory Commission

* S. Shankman, Deputy Director, Division of Radiation Safety and Safeguards (DRSS)
* J. White, Chief, Reactor Projects Section 2A, Division of Reactor Projects
* R. Bores, Chief, Facilities Radiation Protection Section, DRSS
* R. Summers, Senior Resident Inspector, Hope Creek Station

* Indicates attendance at exit meeting on April 21, 1995.

Attachment 2

DOCUMENTS REVIEWED

- Memorandum from M. Prystupa to M. Trum dated 4/18/95, "Root Cause Investigation of IR # 95-083 South Plant Vent Radioactive Material Release of April 5, 1995"
- Nuclear Incident Report 95-083, RX BLDG EXHAUST HI RAD
- Hope Creek Significant Event Review Team (SERT) Report 95-02, Inadvertent Release, dated April 5, 1995
- HC.OP-SO.HB-0003(R) - Rev. 2, "Liquid Radwaste - Chemical Waste System Operation" (and draft Rev. 3)
- HC.OP-AR.HB-0007(R), Rev. 4, "Radwaste Annunciator Panel 00C300 CN-3"
- HC.OP-SO.HB-0002(R), Rev. 6, "Liquid Radwaste - Floor Drain System Operation"
- HC.OP-AB.ZZ-0126(Q), Rev. 4, "Abnormal Release of Gaseous Radioactivity"
- HC.OP-DL.ZZ-0030(R), Rev. 6, "Radwaste Management Log"
- Student Handout No. 300H-000.00H-00HB05-02, Chemical Drains System
- Instruction Manual Detergent Evaporator Waste Evaporator System
- General Employee Lesson Plans
- HP.RP-GP.SP-0001(Q), Rev. 7, "Control of Radiation Monitoring System Setpoints"
- HC.RP-AR.SP-0001(Q), Rev. 10, "Radiation Monitoring System Alarm Response"
- HP.RP-TI.ZZ-1001(Q), Rev. 5, "Radiological Occurrence Investigations"
- HP.RP-TI.ZZ-0804(Q), Rev. 5, "Labelling and Control of Radioactive Material"
- HC.RP-TI.ZZ-0201(Q), Rev. 5, "Access Control Point Management"
- HC.SA-AP.ZZ-0046(Q), Rev. 6, "Radiological Access Control Program"
- HC.RP-TI.ZZ-024 (Q), Rev. 6, "Posting of Radiological Signs and Barriers"
- HC.RP-TI.ZZ-062(Q), Rev. 7, Radiation and Contamination Surveys
- HC.RP-TI.ZZ-0205(Q), Rev. 6, "Decontamination of Personnel and Skin Dose Assessment"

- HC.RP-TI.ZZ-0602(Q), Rev. 7, "Radiation and Contamination Surveys"

- NC.NA-AP.ZZ-0013(Q), Rev. 2, "Control of Temporary Modifications"

- NC.NA-AP.ZZ-0024(Q), Rev. 4, "Radiation Protection Program"

- NC.NA-AP.ZZ-0059 (Q), Rev.3, "10 CFR 50.59 Reviews and Safety Evaluations"

- NC.DE-WB.ZZ-0001(Q), "Standard Design Change Workbook One"

- NC.NA-AP.ZZ-0008(Q), "Control of Design and Configuration Changes"

- Process and Instrumentation Drawings (P&IDs)
  - M-26-1, Radiation Monitoring System
  - M-62-0 Equipment Drain
  - M-63-0 Floor Drain
  - M-64-0 Chemical Waste
  - M-65-0 Waste Evaporator
  - O-P-HB-11 Isometric for DSE Vent to SPV

- Hope Creek Design Change Package 4EC-3348 (LWMS Startup Program)

- Hope Creek Project Scope Proposal H92-007 (LWMS Startup Program)

- Hope Creek Final Safety Analysis Report (FSAR) Sections 11.2, 11.5, 14.2, 15.7

- PNO-G14-4010 GE Design Specification for Radioactive Waste Disposal System

- GEK-90351 GE Design Document for LWMS 10855-D3.43 Design, Installation and Test Specification for Hope Creek LWMS

- May 17, 1995 Memorandum (Bechtel Corp. to PSE&G) regarding Decontamination Solution Evaporator

- May 17, 1995 memorandum (GE to PSE&G) answering PSE&G questions regarding Decontamination Solution Evaporator

- NRC Information Notice 91-40, "Contamination of a Nonradioactive System and Resulting Possibility for Unmonitored, Uncontrolled Release to the Environment,", dated June 19, 1991

- NRC Circular No. 79-21, "Prevention of Unplanned Releases of Radioactivity," dated October 19, 1979

- NRC Circular No. 80-18, , "10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems," dated August 22, 1980

- NRC Bulletin 80-10, "Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release to Environment," dated May 6, 1980

- NRC NUREG 1048 and Supplements, "Hope Creek Safety Evaluation Report," dated October 1984

- Various NRC Regulatory Guides including Regulatory Guides 1.21, 1.26. 1.143

Attachment 3

EVENT TIME LINE

Times are approximate:

April 4, 1995

11:07 p.m. A radwaste (RW) operator secures feed to the decontamination solution evaporator (DSE) and initiates refill of chemical waste tank (CWT) from a floor drain collection tank.

11:45 p.m. RW operator completes fill of CWT and restarts feed to DSE.

April 5, 1995

12:07 a.m. High differential pressure alarm on DSE demister. RW operator sprays demister and leaves spray valve open for 6 minutes.

12:19 a.m. Radiation levels on reactor building ventilation system exhaust (RBVSE) and radwaste exhaust (RWE) radiation monitors start to increase.

12:23 a.m. Radiation alarms received in control room and radiation protection alarm monitoring station.

12:24 a.m. High differential pressure alarm on DSE demister. RW operator sprays demister and closes spray valve in < 1 minute.

12:28 a.m. High differential pressure alarm on DSE demister. RW operator sprays demister and leaves spray valve open for 13 minutes.

12:30 a.m. Control room operators and radiation protection technician (technician A) investigate radiation alarms.

Radiation protection technician A goes to the area of the detectors in alarm condition (services radwaste (SRW) building elevation 155') and performs a radiation survey with a hand held ion chamber. The technician does not identify an apparent cause of the alarm.

12:35 a.m. A second radiation protection technician (technician B) and an I&C technician go to the location of the detectors in alarm condition. Technician B takes additional radiation survey instruments to perform comprehensive surveys in the overhead areas near the detectors. The senior nuclear shift supervisor (SNSS) and work control supervisor go to area to investigate.

12:48 a.m. Radiation levels on RBVSE and RWE radiation monitors increase again.

1:30 a.m. Radiation protection technician B discovers a spot in the duct work near the reactor building vent exhaust monitor that measures about 120 mR/hr on contact and 15 mR/hr at one foot. The RP and I&C technicians attempt to go on to the roof to check the south plant ventilation (SPV) duct work. However, upon surveying themselves to exit onto the roof, the individuals identify that they are contaminated. The technicians' booties read 6,000 dpm and 4,000 dpm respectively (uncorrected for hard-to detect-radionuclides). The radiation protection technician initiates radiological occurrence reports to document the contamination events.

2:00 a.m As a result of becoming contaminated, the technician (Technician B) surveys the area under a drip bag that was not containing all liquid leaking from the duct work. The survey identified up to 80,000 dpm/100 cm^2 on the floor and up to 220,000 dpm/100 cm^2 in the drip bag (Values uncorrected for hard-to-detect radionuclides).

The radiation protection technicians confer with the senior reactor operators (SROs) at the area of alarming effluent monitor (155' elevation service radwaste). They believe that the hot spot is from a piece of solid material (possibly a piece of a filter) that has become lodged in the duct.

A station incident report is initiated to document the hot spot found on the duct work.

3:00 a.m. Control room (CR) operators exit procedure AB-126. SNSS requests RW operator to secure DSE. RW operator suggests sampling DSE vapor instead. RW operator informs CR of DSE level perturbation.

4:00 a.m. RW operator assists chemistry technician in obtaining a sample of DSE vapor.

5:00 a.m. DSE effluent sample results are received. Results indicate no significant activity (1E-7 uCi/ml).

7:30 a.m. The radiation protection manager is assigned to determine the cause of the alarms of the reactor building exhaust monitor and radwaste exhaust monitor and hot spot in the duct work. Operations is assigned to assist in determining if the DSE was the cause.

Senior RW supervisor investigates and determines that DSE is operating normally.

8:00 a.m. Weekly samples of SPV collected.

9:15 a.m. A smear sample is taken of the SPV enclosure. The sample (analyzed at about 11:00 a.m.) indicates short lived radionuclides.

9:40 a.m. An Air Products hydrogen tanker trailer, later determined to be contaminated, leaves the station.

10:00 a.m. An RP supervisor and an RP technician go to the turbine roof to perform surveys. Rocks are collected. The individuals find that their shoes are contaminated when they leave the roof. The roof area access is normally locked and controlled by RP.

11:30 a.m. Rock sample results indicate presence of long lived radionuclides. Chemistry personnel indicate results are unusual.

noon The senior RP supervisor cancels outside yard survey due to no unusual radionuclides identified on the SPV weekly sample.

12:10 p.m. Roof surveys are initiated. The south plant vent is posted as a Contamination Area.

1:40 p.m. While looking for the source of radioactive contamination found in the south plant vent exhaust duct work, a survey of the south plant vent enclosure identifies high levels of contamination leaking from the duct work. The SPV is posted as a High Contamination Area.

2:20 p.m. RP technicians question how the turbine building roof is posted. The roof was then posted no access pending detailed survey.

3:00 p.m. The senior RW supervisor learned that the source of the hot spot had not been identified during the planning meeting.

3:30 p.m. A survey of the turbine building (TB) roof identified elevated contamination levels and short-lived radionuclides.

Radiation protection personnel determine that contamination found on TB roof is not from an earlier release as was previously believed.

4:00 p.m. The Hope Creek turbine building roof is posted as a contaminated area.

4:30 p.m. Radiation protection personnel initiate surveys of the machine shop. No contamination is found.

The DSE is secured at the direction of the senior RW supervisor.

4:45 p.m. Radiation protection surveys of the vehicles parked south of the turbine building identify gross removable contamination of about 20,000 dpm (uncorrected for hard-to-detect-radionuclides).

5:15 p.m. SNSS notified of yard contamination. CR operators enter procedure AB-126.

5:50 p.m. The filter recirculation ventilation system (FRVS) is placed in service. The major discharges through the south plant vent are secured.

6:20 p.m Radiation protection surveys of the north side of the new site services building identify about 5,000 dpm/100 cm^2 (uncorrected for hard-to-detect radionuclides) on vertical surfaces of the building.

6:30 p.m. The radiation protection personnel initiate surveys of the site.

6:42 p.m. The licensee declares the south plant vent effluent monitor inoperable.

6:45 p.m A Hope Creek radiation protection supervisor notifies the Salem radiation protection of the contamination event.

7:20 p.m. Hope Creek RP personnel notify Salem RP personnel that contamination was found at higher elevations. Salem RP personnel initiate confirmatory surveys of upper elevations of the station.

7:35 p.m. Radiation protection personnel initiate alternate sampling of the south plant vent monitor.

8:00 p.m. The licensee informs the NRC senior resident inspector (SRI) of the presence of contamination in the protected area.

8:10 p.m. Salem radiation protection personnel identify contamination on the Unit 2 turbine deck railing of about 5,000 dpm/large area smear (uncorrected for hard-to-detect radionuclides).

11:10 p.m. A decontamination crew finds approximately 2 gallons of red/brown liquid in SPV duct.

11:30 p.m. The licensee's senior radiation protection supervisor directs that no vehicles leave the protected area. The directive is issued after it was determined that a vehicle left the site.

April 6, 1995

4:30 a.m. The licensee decides to issue a press release concerning the contaminated Air Products vehicle.

6:30 a.m. A four-hour report is made to the NRC for an event of media interest.

7:30 a.m. Contractor personnel begin arriving at the station. The personnel gather at change areas. Personnel are informed of the contamination found in the protected area and are directed to go

to the Salem health physics control point and perform personnel frisking. Personnel remain in the change areas until about 10:00 a.m. Personnel are also requested to go home and return with clothes that they wore to the site the previous day.

8:30 a.m. The licensee is informed by a contractor supervisor that several workers who had been working outside the site services building the previous day alarmed the portal monitor in the security building when attempting to exit the station. The workers were directed to re-check themselves and were found to be free of contamination. The workers are identified and directed to obtain whole body counts.

9:15 a.m. All personnel are requested to come to the Salem Station health physics control point to perform whole body frisking.

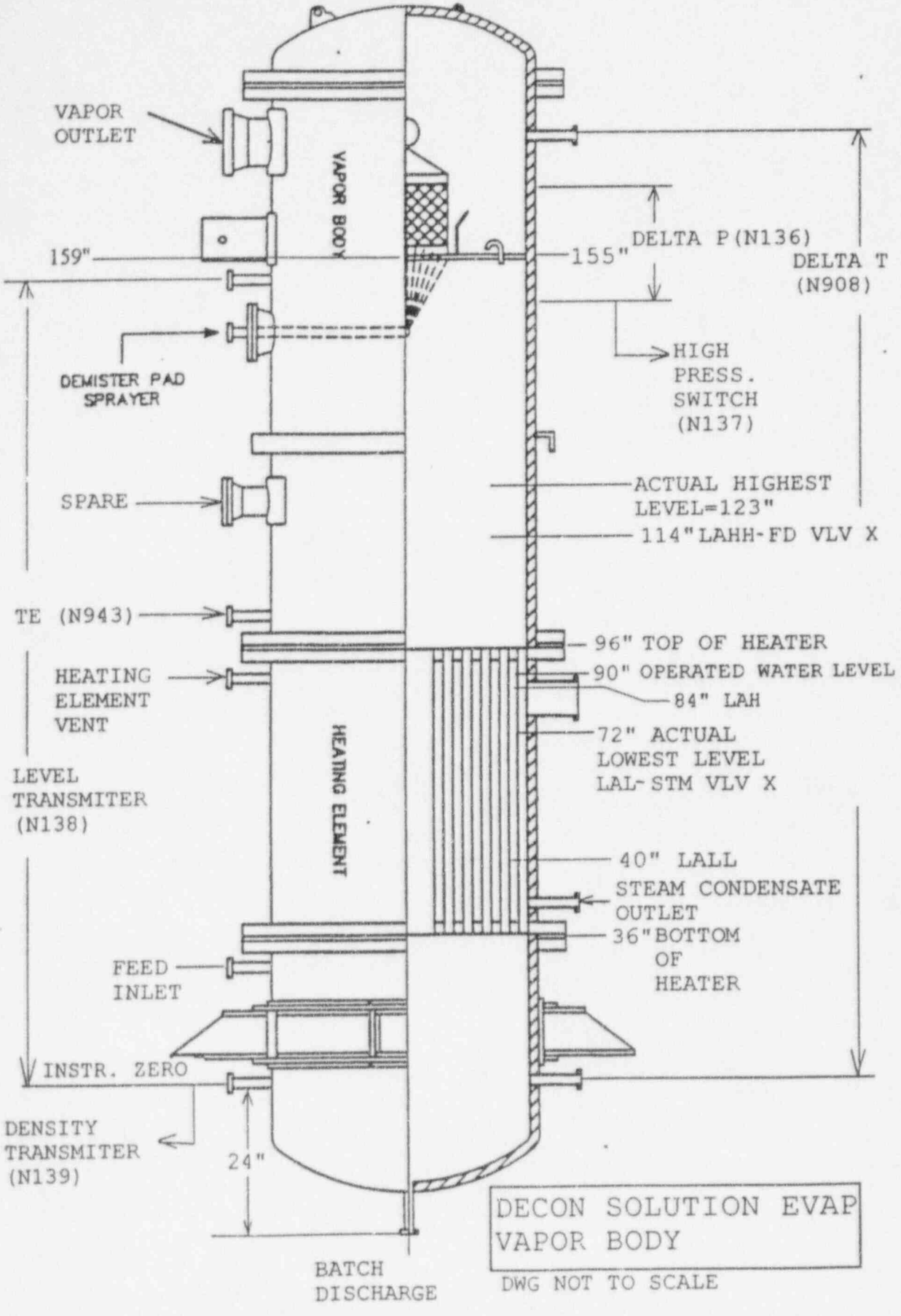
9:35 a.m. The licensee places signs at the security building to alert personnel coming into the station of the presence of contamination within the protected area. The licensee also places signs to alert personnel exiting the site that additional frisking was required to exit the station. The licensee initiates frisking using hand held friskers.

10:00 a.m. Workers report to the Salem radiation protection control point to perform personnel monitoring. A number of individuals alarm the high sensitivity personnel contamination monitors at the RP control point. Subsequent surveys of the individuals do not indicate any contamination using a hand held frisker.

10:30 a.m. The licensee implements enhanced monitoring of personnel exiting the protected area. The licensee requires personnel to use a hand and foot monitor prior to leaving the station. Individuals that are identified as contaminated were decontaminated.

2:00 p.m. The licensee continues to perform surveys for contamination outside the protected area. None are identified.

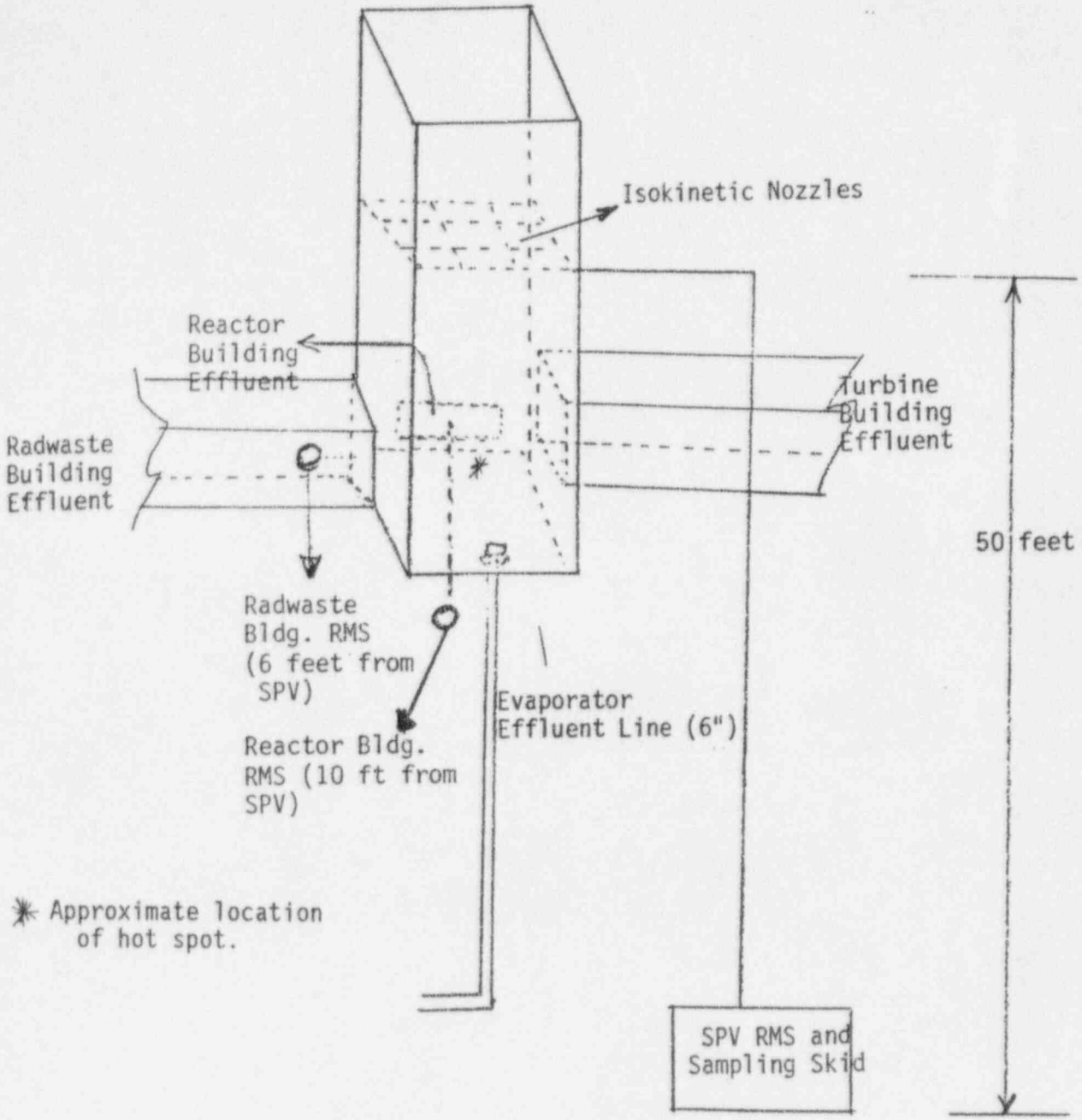
Attachment 4. Schematic of Decontamination Solution Evaporator



SOURCE: Public Service Electric and Gas Company, Inc.

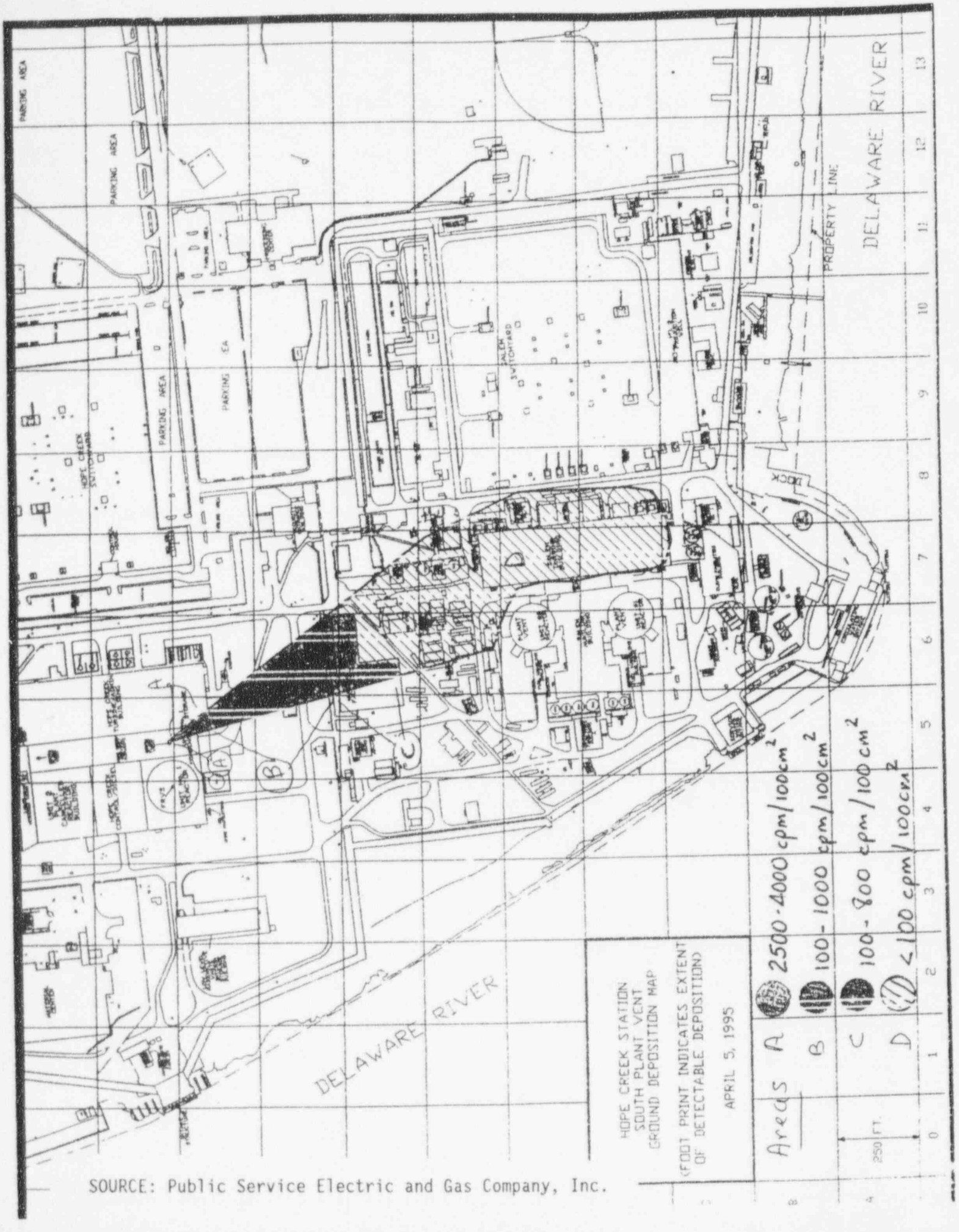
Attachmnet 5. General Arrangemnet of Duct Work Affected by Release

South Plant Vent (SPV)



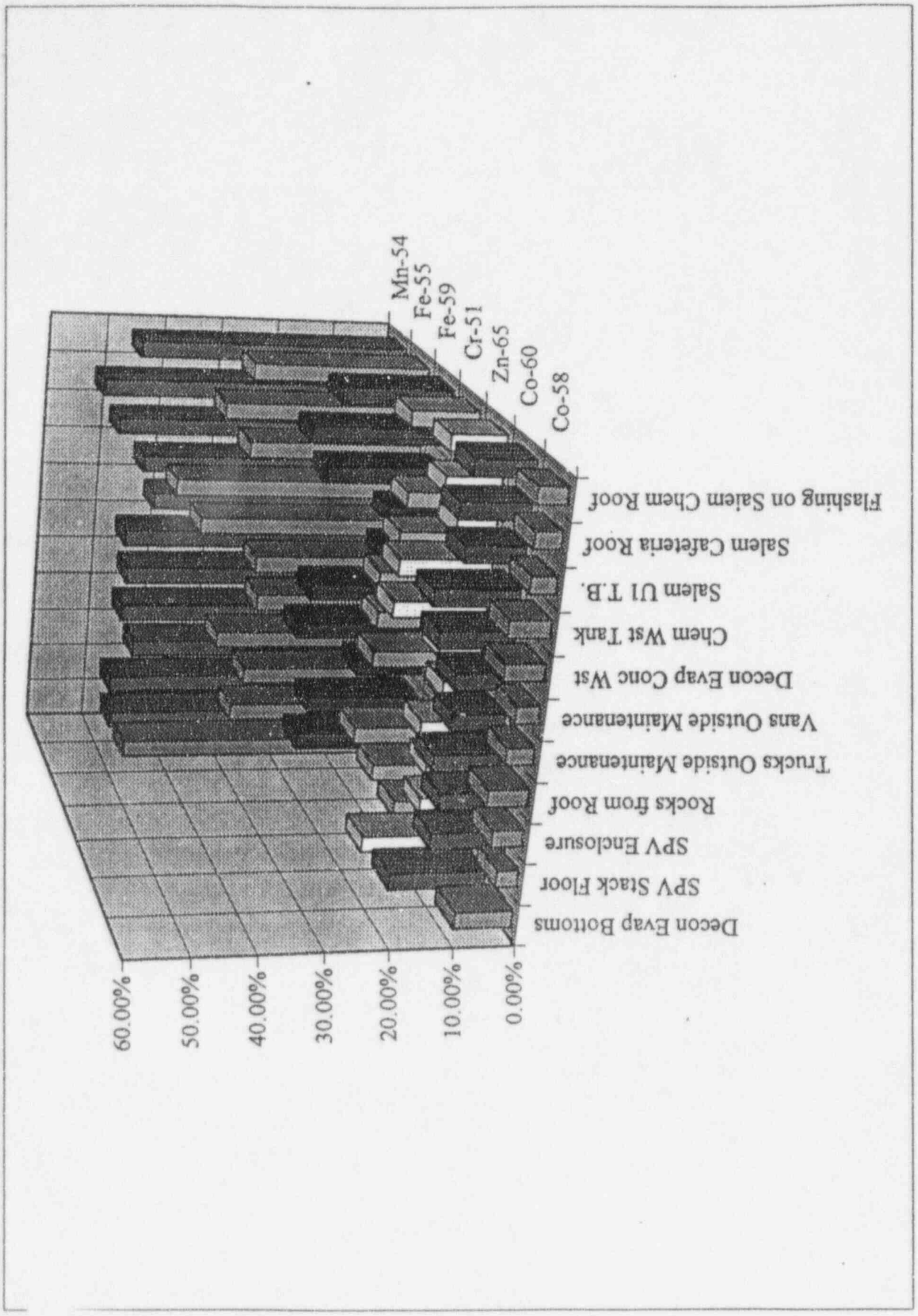
Sampling Skid and RMS for the SPV

Attachment 6, Extent of Onsite Contamination within the Protected Area



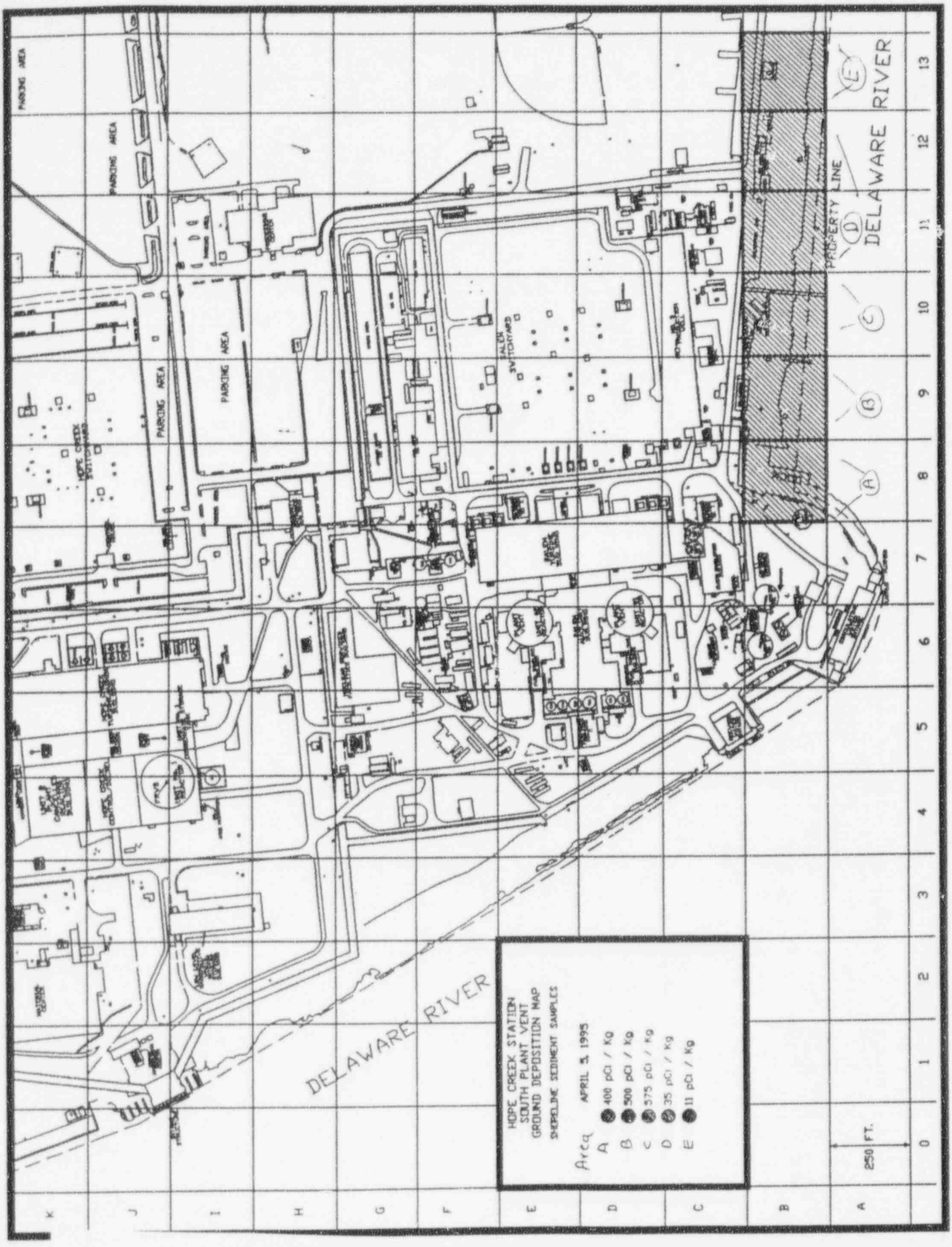
SOURCE: Public Service Electric and Gas Company, Inc.

Attachment 7, Radionuclide Analysis and Intercomparison of Ratios



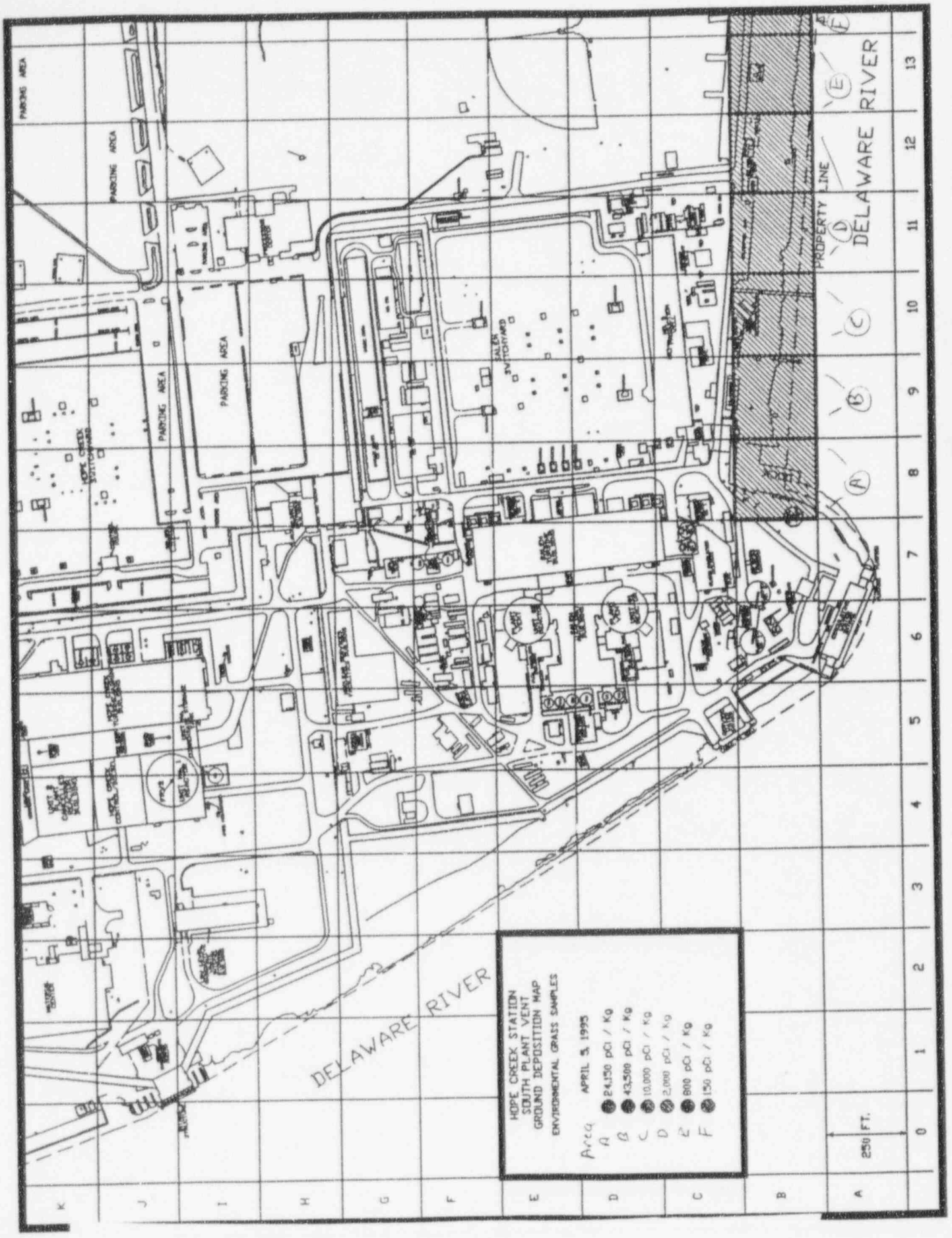
SOURCE: Public Service Electric and Gas Company, Inc.

Attachment 8, Shoreline Sediment Sample Analysis Results Map



SOURCE: Public Service Electric and Gas Company, Inc.

Attachment 9, Shoreline Grass Sample Analysis Results Map



SOURCE: Public Service Electric and Gas Company, Inc.

Technical Specification Section	Limiting Condition for Operation	4/5/95 Event	1994 Values
3.11.1.1 Liquid Effluents Concentration	The concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table 2 for radionuclides other than dissolved or entrained noble gases.	Maximum measured activity in outfalls less than 1% MPC	All releases less than MPC
3.11.1.2 Liquid Effluents Dose	The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive effluents, from each reactor unit, to UNRESTRICTED AREAS shall be limited: a. During any calendar quarter to less than or equal to 1.5 mrems to the total body and to less than or equal to 5 mrems to any organ, and b. During any calendar year to less than or equal to 3 mrems to the total body and less than or equal to 10 mrems to any organ.	<u>ODCM Method</u> 0.07 mrem max organ (GI-LLI) and 0.03 mrem total body, assuming all 85 mCi released to river (exposure via fish/shellfish ingestion) <u>Actual</u> Will account for measured activity released via storm drains	<u>Annual Dose</u> Total Body 1.86E-1 mrem Highest Organ 4.44E-1 mrem (liver)
3.11.2.1.b Gaseous Effluents Dose Rate	The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the SITE BOUNDARY shall be limited to the following: b. From iodine-131, iodine-133, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrems/year to any organ	<u>ODCM Method</u> 90 mrem/year (6% of limit) based on limiting site boundary and annual average met. <u>Actual Met</u> 270 mrem/year (18% of limit) based on actual met during event	Evaluated on a per-release basis. All releases were a small fraction of the limit

ODCM=Offsite Dose Calculation Manual
GI-LLI=gastrointestinal-lower large intestine
MET.=meteorology

Technical Specification Section	Limiting Condition for Operation	4/5/95 Event	1994 Values
3.11.2.3 Dose - I-131, I-133, tritium and radionuclides in particulate form	The dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-live greater than 8 days in gaseous effluents released, from each reactor unit, to areas at or beyond the SITE BOUNDARY shall be limited to the following: a. During any calendar quarter: less than or equal to 7.5 mrems to any organ and, b. During any calendar year: less than or equal to 15 mrems to any organ.	<u>ODCM Method</u> 0.003 mrem max organ (GI-LLI) based on inhalation, ground plane and milk at 4.9 miles west <u>Actual Met</u> 4 mrem max organ (GI-LLI) based on hypothetical individual on site at south shoreline boundary - inhalation, ground plane exposure Less than 0.001 mrem to any real individual offsite	<u>Annual result</u> 1.25 E-3 mrem
3.12.1.b Radiological Environmental Monitoring Program	The radiological environmental monitoring program shall be conducted as specified in Table 3.12.1-1. b. With the level of radioactivity as a result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting level of Table 3.12.1-2 ...	No measurable levels offsite - low level deposition identified on site at south shoreline. No samples in excess of reporting level	No samples in excess of reporting level

NRC REVIEW FINDINGS
OF
HOPE CREEK
NUCLEAR STATION
APRIL 5, 1995
UNPLANNED RELEASE

PUBLIC PRESENTATION
APRIL 21, 1995

NRC INSPECTION NO. 50-354/95-05

April 6 - April 21, 1995

NRC Inspection Personnel

R. L. Nimitz, CHP, Senior Radiation Specialist (Team Leader)

T. E. Walker, Senior Operations Engineer

S. A. Morris, Resident Inspector

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TOPICS OF DISCUSSION

I. EVENT SUMMARY

II. INITIAL LICENSEE RESPONSE

III. SAFETY SIGNIFICANCE

IV. PROGRAMMATIC ISSUES

V. SUMMARY OF AREAS FOR NRC FOLLOWUP AND POTENTIAL ENFORCEMENT

I. EVENT SUMMARY

* Late on the evening of April 4, 1995, an operator was processing contaminated water from the Chemical Waste Tank via the installed station Decontamination Solution Evaporator (DSE) located on the 54' elevation Service Radwaste Building. The evaporator was designed to process chemical wastes from laboratory drains, decontamination solutions, and sample rack drainage on a batch basis. However, the DSE was being used to process liquid radioactive waste from the floor drain collection system in a semi-continuous mode. The operator experienced a high differential pressure on the evaporator's demister and initiated a spray cleaning of the demister to clear material clogging the demister.

* As a result of the spraying, and resultant pressure transient within the DSE, between about 12:15 a.m. and 1:00 a.m. on April 5, 1995, radioactive contamination, in the form of entrained liquid/mist was released from the DSE.

* The entrained liquid/mist travelled through the DSE's effluent discharge line to the South Plant Vent (SPV) exhaust duct located on the @ 155' elevation of the Service Radwaste Building.

Event Summary (Contd)

* The radioactive contaminated entrained liquid/mist was discharged from the SPV onto the Hope Creek turbine building (TB) roof and downwind in a southerly direction onto portions of the Hope Creek station's protected area and vehicles and buildings located near the TB. Portions of Salem station's protected area were also slightly contaminated.

* As a result of the release, the Reactor Building Ventilation Exhaust (RBVE) and Radwaste Exhaust (RWE) Radiation Monitors alarmed.

* Subsequent licensee review and follow-up resulted in discovery of onsite radioactive contamination on the afternoon of April 5, 1995.

Event Summary (Contd)

* As a result of the event, a special NRC review was conducted. Areas reviewed included the following.

  - The circumstances surrounding the event.

  - The licensee's initial response to the event including reporting.

  - The licensee's analysis of the event.

  - The evaporator and ventilation system design

  - Operations of the evaporator.

  - Effluent Releases and Public Impact

  - Onsite Radiological Controls

II. LICENSEE INITIAL RESPONSE

* The licensee immediately implemented alarm response procedures and initiated an investigation to determine the cause of the RBVE and RWE alarms.

* Licensee personnel quickly responded to the area where the detectors in alarm were located (@155' elevation Services Radwaste Building) and through surveys identified radioactive contaminated liquid leaking from duct work and a localized hot spot measuring about 100 mR/hr.

* Licensee personnel reviewed SPV radiation monitors and subsequently collected samples from the DSE effluent discharge line. The results indicated no release had occurred and no release was in progress.

Licensee Initial Response (Contd)

* The licensee believed material or filter debris had entered the duct work, no release to the environment had occurred, and initiated reviews to identify the cause of the hot spot and liquid. Action was taken to plan securing of ventilation systems to prevent release from the duct in the event the material could dry out and be released to the environment. The weekly samples of the SPV effluent, collected early on the morning of April 5, 1995, did not indicate any unusual releases had occurred.

* Licensee supervision and management were informed of the matter early on the morning of April 5, 1995. The licensee initiated actions to establish a Root Cause Analysis Team at 7:30 a.m. on April 5, 1995,

* Throughout the morning and afternoon of April 5, the licensee continued to perform surveys and evaluate the extent of contamination. Surveys of the turbine building roof identified contamination at about 2:00 p.m. The results prompted a survey of the yard area south of the TB which identified contamination about 3:00 p.m. that day. Based on the levels detected, and the nature of the event, the licensee concluded no reporting was required.

Licensee Initial Response (Contd)

* Contaminated areas were roped off and posted. An off site survey team performed surveys outside the protected area and did not detect contamination. The licensee established an Environmental Survey Plan in response to the event.

* As a result of the discovery of outdoor contamination, the licensee stopped major ventilation inputs to the SPV at about 6:00 p.m. on April 5, 1995. The licensee declared the SPV monitor inoperable at about 6:30 p.m. that day and initiated alternate sampling. The DSE had been shut down earlier that afternoon as a conservative action independent of the discovery of contamination.

* The NRC was notified of the onsite contamination at 8:00 p.m. on April 5, 1995.

* At about 11:30 p.m. on April 5, it was determined that a vehicle left the site earlier that day. A survey of the vehicle at 4:30 a.m. on April 6, identified low level contamination on the vehicle. The licensee initiated a formal report to the NRC.

Licensee Initial Response (Contd)

* The licensee established a Significant Event Review Team on April 6, 1995, and initiated special monitoring of personnel leaving the station. Contamination monitoring of personnel and vehicles that were on site on April 5 was also initiated.

* Licensee analysis of shoreline samples south of the station identified low levels of contamination via high sensitivity gamma spectroscopy analysis.

* Licensee analysis of offsite environmental air samples did not identify any releases.

* The licensee pulled onsite environmental dosimeters for analysis and is awaiting results.


HOPE CREEK STATION
SOUTH PLANT VENT
GROUND DEPOSITION MAP
(FOOT PRINT INDICATES EXTENT OF DETECTABLE DEPOSITION)
APRIL 5, 1995
2500 - 4000 cpm/100cm²
100 - 1000 cpm/100cm²
100 - 800 cpm/100 cm²
< 100 cpm/100cm²
250 FT.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
DELAWARE RIVER
PARKING AREA
PARKING AREA
PARKING AREA
PARKING AREA
HOPE CREEK SWITCHYARD
SALEM SWITCHYARD
PLANT VENT
PLANT VENT
DOCK
PROPERTY LINE
DELAWARE RIVER

III. SAFETY SIGNIFICANCE

* The licensee estimated that a maximum of 25 gallons of steam and water could have been released from the SPV. The liquid contained about 85 millicuries of mixed corrosion products.

* Although portions of the site's protected area exhibited detectable levels of contamination, whole body counting of potentially affected workers did not identify any instances of personnel intake of radioactive material.

* Use of high sensitivity portal monitoring did not identify any significant personnel contamination. One jacket, with low level contamination was identified. The jacket did not leave the site.

* Personnel exiting the station were monitored via portal monitors. Surveys of personnel vehicles and clothing returned to the station did not identify detectable contamination.

* On-site low level radioactive contamination, was promptly posted, secured and cleaned-up as appropriate and contingency plans were implemented to secure low level ground deposited contamination to prevent its release via rain.

Safety Significance (Contd)

* After it was identified that a release had occurred, there was excellent evaluation of the impact of the release on the environment and continued operations. The licensee also performed excellent post event analysis and review.

  - The Root Cause /Analysis and Significant Event Team compositions were appropriate.

  - The licensee focused on appropriate safety/programmatic issues.

  - There was good use of analytical tools

  - Preliminary NRC review indicates recommended corrective actions addressed roots causes.

* The DSE was shut down and re-start will not occur pending NRC review of licensee assessments and corrective actions. The licensee is also continuing to review other evaporators and operations onsite to preclude a similar occurrence.

OVERALL CONCLUSION

* **The safe operation of the reactor was not affected and the release did not significantly impact on shift licensee personnel.**

* **The release of radioactive contamination from the DSE had little radiological impact on the public and environment (off site). No release limits were exceeded. A reasonable worst case analyses did not identify any significant potential offsite impacts.**

IV. PROGRAMMATIC ISSUES

A. Event Response - General Conclusions

* Initial response was appropriate in that multiple indications were evaluated and appropriate procedures were entered, but incorrect diagnoses were made to explain conflicting indications. Operations and radiation protection personnel relied on the SPV monitor and samples and incorrectly concluded that a release had not occurred.

* Management attention and direction was focused on preventing a future release (liquid drying out in duct).

* The licensee was slow to identify the occurrence of a release due to weaknesses in communications and integrated assessment of incoming information. As a result the licensee was slow to take actions to secure potential sources and to take appropriate actions to prevent potential further spread of contamination.

* Procedures provided limited guidance for response to an onsite contamination event.

B. Engineering - General Conclusions

* The licensee did not have an adequate understanding of the design basis of the DSE.

* The licensee did not perform an adequate design review of the DSE and the South Plant Vent effluent monitoring system to support operation of the DSE.

* The Radiation Effluent Monitoring System was not capable of detecting effluent releases (in the form released) from the Decontamination Solution Evaporator.

C. Operations and Operations Procedures- General Conclusions

* The DSE was not operated in accordance with design basis or Final Safety Analysis Report commitments as follows.

- Established system operating level set points/limits/alarms were set non-conservatively.

- The system was operated in "semi-continuous" mode versus "batch" mode.

- No influent or effluent sampling performed on routine basis

- The processing of floor drain water was not evaluated.

- Automatic control functions were overridden to establish flow paths.

Operations and Operating Procedures (Contd)

* The operating procedures for DSE were inadequate. For example, the alarm response procedure (ARP) for high differential pressure across the demister provided no direction for spraying the demister.

* There was a lack of clear understanding of system operation by system operating personnel.

  - There was a belief that the DSE could not cause a radioactive release and it was not recognized that prolonged spraying, or spraying while steaming, could cause a pressure transient that could result in the release.

  - System operating personnel did not have a clear understanding of system interlocks and automatic functions.

* There was minimal monitoring of system operation

V. SUMMARY OF AREAS FOR NRC FOLLOWUP AND POTENTIAL ENFORCEMENT

1. The design review of the evaporator was inadequate.

2. There were no adequate approved operating procedures for the DSE.

3. The surveying and monitoring of DSE effluents was not adequate to detect the release.

4. Alarm set point changes were not made in accordance with approved procedures.

5. There is information that an individual may have alarmed the portal monitor and may have left the station without re-checking. This matter is continuing to be reviewed.

6. Workers were not informed of the release and on-site contamination once it was identified.

NRC Followup Areas (Contd)

7. A contaminated vehicle left the site.

8. Development of a plan for disposal of contaminated soil and maintenance of records relative to 10 CFR 50.75 g.

9. Verification that apparent previous Hope Creek turbine building roof contamination and other site contamination (as appropriate) has been properly evaluated from an offsite impact perspective.

The NRC will review the above matters for follow-up and potential enforcement as appropriate.

The NRC will review the event to determine if generic communications regarding it (e.g., an NRC Information Notice) are needed.