EA 98-472
Mr. R. A. Mellor
Vice President - Operations and Decommissioning
Connecticut Yankee Atomic Power Company
362 Injun Hollow Road
East Hampton, CT 06424-3099
SUBJECT: NRC SPECIAL INSPECTION REPORT 50-213/98-04

Dear Mr. Mellor:

This refers to the inspection conducted on July 20 - September 11, 1998, at the Haddam Neck Plant in Haddam, Connecticut. This purpose of this special inspection was to review the reactor coolant system (RCS) chemical decontamination that was completed to support plant decommissioning. The enclosed report presents the results of that inspection.

During the inspection period, your control of radiological work at Haddam Neck was generally characterized as careful and thorough, and the RCS chemical decontamination accomplished substantial dose reduction in reactor piping. However, the process was hampered and interrupted by several operational events that challenged plant personnel and the safe control of the radiological source term. These events included: two major leaks of decontamination fluid, the loss of control of demineralizer resins resulting in elevated radiation doses in plant piping, and the loss of control of a five-ton floor block due to improper rigging. None of the events resulted in personnel injury or overexposure to radiation, all leakage was contained, and there were no releases of radioactive water to the environment. However, the events were significant precursors that had the potential for worker injury, equipment damage, or radiological impacts. The events revealed weaknesses in the preparations and engineering support for the RCS decontamination, weaknesses in the corrective actions to address adverse conditions, and the failure to adequately assess and compensate for poor material conditions.

Based on the results of this inspection, four apparent violations of regulatory requirements were identified which involved the failure to provide adequate procedures for the RCS decontamination and related activities. The violations are identified in the enclosed inspection report and are being considered for escalated enforcement action in accordance with the "General Statement of Policy and Procedure for NRC Enforcement Action" (Enforcement Policy), NUREG-1600. Although your staff took appropriate actions to improve decontamination process controls and procedures following each event, the NRC determined that the corrective actions were not broadly-based to prevent subsequent events or problems. Also, credit for identification of the issues is not warranted, since they were primarily identified through unplanned events. The circumstances surrounding these apparent violations, the significance of the issues, and the need for effective corrective actions were discussed with you during a public meeting on August 3, 1998, and at the inspection exit meeting on September 11, 1998. As a result, it may not be necessary to conduct a predecisional enforcement conference in order to enable the NRC to make an enforcement decision.

Before the NRC makes its enforcement decision, we are providing you an opportunity to either (1) respond to the apparent violations addressed in this inspection report within 30 days of the date of this letter or (2) request a predecisional enforcement conference. If a conference is held, it will be open for public observation. The NRC will also issue a press release to announce the conference. Please contact Dr. Ronald Bellamy at 610-337-5200 within seven days of the date of this letter to notify the NRC of your intended response.

Your response should be clearly marked as a "Response to Apparent Violations in Inspection Report No. 50-213/98-04" and should include for each apparent violation: (1) the reason for the apparent
violation, or if contested, the basis for disputing the apparent violation, (2) the corrective steps that
have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further
violations, and (4) the date when full compliance will be achieved. Additionally, NRC reviews noted
several weaknesses in the control of plant activities (such as inadequate communications,
coordination, the integration of technical support, and the failure to make conservative decisions)
that must be addressed to assure the safe conduct of work. In response to the apparent violations,
in addition to the actions needed to correct the violations, you are requested to address these
matters and to describe the actions that will be taken to improve the integration of support during
critical evolutions, so that undue focus on time constraints is eliminated, and conservative decision-
making is consistently maintained for site decommissioning. We would expect that these actions
would be incorporated into your long-term corrective action plan.
Your response should be submitted under oath or affirmation and may reference or include previous
docketed correspondence, if the correspondence adequately addressed the required response. If an
adequate response is not received within the time specified or an extension of time had not been
granted by the NRC, the NRC will proceed with its enforcement decision or schedule a predecisional
enforcement conference. In addition, please be advised that the number and characterization of
apparent violations described in the enclosed inspection report may change as a result of further
NRC review. You will be advised by separate correspondence of the results of our deliberations in
this matter.
In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter, its
enclosure, and your response (if you choose to provide one) will be placed in the NRC Public
Document Room (PDR). To the extent possible, your response should not include any personal
privacy, proprietary, or safeguards information so that it can be placed in the PDR without
redaction.
Sincerely,

A. RANDOLPH BLOUGH
A. Randolph Blough, Director
Division of Nuclear Material Safety
Docket No. 50-213
License No. DPR-61
Enclosure:
NRC Inspection Report No. 50-213/98-04
cc w/encl:
D. Davis, Chairman, President and Chief Executive Officer
T. Bennet, Vice President and Chief Financial Officer
K. Heider, Decommissioning Director
G. Bouchard, Unit Director
J. Haseltine, Strategic Planning Director
G. van Noordennen, Regulatory Affairs Manager
J. Ritsher, CYAPCO Counsel
R. Bassilakis, Citizens Awareness Network
J. Block, Attorney for CAN
J. Brooks, CT Attorney General Office
K. Ainsworth, Town of Haddam
State of Connecticut SLO

U.S. NUCLEAR REGULATORY COMMISSION

· REGION I
Docket No.: 50-213
License No.: DPR-61
Report No.: 50-213/98-04
Licensee: Connecticut Yankee Atomic Power Company
EXECUTIVE SUMMARY
Haddam Neck Station
NRC Inspection Report No. 50-213/98-04

This special inspection included aspects of licensee preparations, planning and implementation of the reactor coolant system (RCS) chemical decontamination. The report covers a two-month period of inspection by resident, regional and NRC Headquarters personnel, and includes reviews and assessments of operations, engineering, maintenance, and plant support activities, and management effectiveness.

Decommissioning Operations and Support Activities:
The RCS chemical decontamination accomplished substantial dose reduction in reactor piping, but was hampered by several events that challenged plant personnel and the safe control of the radiological source term. Licensee preparations for and the conduct of the RCS decontamination were generally adequate, but many weaknesses were evident in several events and equipment problems. The events included two major leaks of decontamination fluid, the loss of control of demineralizer resins resulting in elevated radiation doses in plant piping, and the loss of control of a 5-ton floor block due to improper rigging. Plant staff failed to exhibit conservative decision-making in several instances, which contributed to some events. The licensee failed to adequately assess the material condition of the plant, particularly in the letdown and purification systems. Numerous demineralizer system failures hampered the smooth conduct of the decontamination. Several weaknesses were noted in the support for the decontamination, such as in the evaluations for the operation and attachments for the letdown booster pump; the operation of the C demineralizer and the replacement of the post-filter retention element; and, the review of floor block rigging. Apparent violations of Technical Specification 6.8.1 related to inadequate procedures included: 1) failure to perform adequate leak checks of the RCS decontamination boundary; 2) failure to adequately address potential transient conditions in the letdown system equipment; (3) failure to assure that activated resins would not pass through the lower retention element of the purification system under high flow conditions during the RCS decontamination; and (4) failure to provide procedural guidance and worker training on how to rig a pipe trench floor block that contributed to the loss of control of a five ton block.

The plant staff responded properly to events to mitigate adverse radiological conditions, and took appropriate actions to address degraded conditions. Following the identification of degraded piping, repairs were acceptable and the pressure tests provided assurance of the leak tightness. Engineered clamps used on temporary decontamination piping were acceptable. Repairs of permanent piping were completed per ANSI B31.1. Following the July 27 leak, engineering evaluations and thermal-hydraulic modeling performed for the static and expected operating conditions were adequate to ensure the systems were capable of supporting the anticipated operating parameters during the remainder of the decontamination process.
Plant Support and Radiological Controls:
Although challenged by events during the RCS decontamination, the licensee applied good radiological controls for normal activities, in response to events, and during subsequent maintenance activities. Several industrial safety issues were noted, along with deficiencies in the waste management of RCS decontamination water. The waste water was controlled within the plant without releases to the environment. The licensee was slow to recognize and respond to heat stress conditions in some plant areas.
The licensee measured and calculated the decontamination factors (DFs) for the RCS decontamination and reported successful results in lowering dose rates for future work. Radiological controls for RCS decontamination work were well planned and radiation protection personnel maintained close oversight of work. Radiation protection was effective in keeping workers’ radiological exposures ALARA. Radiation Protection response to the spill from LD-V-226 was adequate.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii
TABLE OF CONTENTS iv
REPORT DETAILS 1
Summary of Facility Activities 1
I. Decommissioning Operations 1
  O1 Conduct of RCS Decontamination Operations 1
    01.1 RCS Decontamination Overview 1
    01.2 Decontamination Events (VIO 98-04-01 through VIO 98-04-03) 3
  II. Decontamination Support Activities 12
    M1 Conduct of Maintenance 12
      1.1 Maintenance Support (URI 98-04-04, VIO 98-04-05) 12
      M1.2 Pressure Boundary Testing 15
      M1.3 Repairs of the Decontamination Pressure Boundary 16
    E1 Conduct of Engineering 17
      1.1 Engineering Evaluations for RCS Decontamination 17
      E1.2 Decontamination Procedure Safety Evaluation 17
  III. Plant Support and Radiological Controls 21
    R1 Radiological Surveys and Controls 21
    R2 Response to Events and Radiological Challenges 23
      2.1 Radiological Safety 23
      2.2 Industrial Safety Issues 24
      2.3 Waste Water Management 25
  IV. Management Meetings 25
    X1 Exit Meeting Summary 25
    X3 Management Meetings 26
PARTIAL LIST OF PERSONS CONTACTED 27
INSPECTION PROCEDURES USED 27
ITEMS OPEN, CLOSED, AND DISCUSSED 27
LIST OF ACRONYMS USED 28
TABLE 1 29

REPORT DETAILS

Summary of Facility Activities
Special NRC inspection of the chemical decontamination of the reactor coolant system (RCS). Specific areas reviewed included activities associated with ALARA planning, radiological controls, procedural controls, and process performance. The NRC reviewed the events and problems encountered during the decontamination, and performed a special inspection of the organizational and management issues contributing to licensee performance:
On August 3, 1998, A.R. Blough, the Director of the Division of Nuclear Materials Safety, toured the site and together with other NRC Region I and NRR staff met with licensee management on the status of decontamination activities. Attachment I provides the licensee’s presentation handout for the meeting.

On August 20, 1998, H. Miller, the NRC Region I Administrator, toured the site and met with licensee management to discuss NRC concerns highlighted by recent events.


Section X3 provides additional details of these efforts.

I. Decommissioning Operations

01 Conduct of RCS Decontamination Operations

01.1 RCS Decontamination Overview

a. Inspection Scope (71707, 71801, 42700, 40801, 62801, 93702, 92702)

The inspection scope was to provide overview of the chemical decontamination process using a combination of resident and region-based personnel. The inspections were conducted during routine day-shift operations, and during weekend and back-shift periods. Attachment II of this report provides a list of references and materials used during the inspection.

b. Observations and Findings

Chemical Decontamination Overview

The licensee continued with preparations for decontaminating the primary system in order to reduce radiation exposure during decommissioning activities. NRC review of the decontamination preparation was provided in Inspection 98-03. This licensee used the Siemen’s process called HP/ CORD D UV. The letters represent the following: HP = permanganic acid, CORD = chemical oxidation reduction decontamination, D = decommissioning, and UV = ultraviolet light. The process used the residual heat removal (RHR) pumps to provide about 2000 gallons per minute (gpm) flow to circulate the decontamination solution throughout the RCS and portions of the RCS attached piping (the high pressure safety injection system, the chemical and volume control system, the purification system, and the RCS fill and drain system). The licensee installed temporary pumps [letdown booster pump (LDBP) and letdown return pump (LDRP)] to allow the use of the in plant demineralizers with an optimum flow of 200 gpm. The decontamination flow path is shown in Figure 1.

After achieving system operating conditions for temperature and flow, the first step in the CORD process was to add permanganic acid to soften the chromium layer. The decontamination step begins with the addition of oxalic acid to remove the radioactive corrosion layer. The licensee used the plant demineralizers following the oxalic acid addition to remove the radioactivity from solution and transfer it to the spent resin storage tank. The A and B letdown demineralizers were used, along with the C demineralizer, which was isolated from the spent fuel pool (SFP) for the duration of the process. Cleanup from each phase was accomplished by the use of ultra violet light and the addition of hydrogen peroxide to remove the oxalic acid, and using the D demineralizer to clean the system. The licensee planned that the fourth and final cycle would be a more aggressive CORD-D process.

The licensee implemented the decontamination process with an initial plan to complete four CORD cycles. The major milestones for the RCS decontamination were as shown in Table 1. The inspector reviewed the licensee’s preparations for the RCS decontamination by independently observing the status of plant systems and equipment, and verifying that the plant configuration and process controls were as specified per procedures, and Sections 4.1, 4.2, 4.3 and 4.4 of SPL 10.11-1, in particular. The inspector verified, on a sampling basis, that workers followed the procedures during the decontamination process.
Although decontamination cycles 1 and 2 were successful relative to achieving the desired dose reductions on piping that would be removed during decommissioning, the plant experienced several problems and events that challenged plant personnel. Section O1.2 and E1.2 below summarizes NRC review of the combination of process, personnel and equipment performance problems encountered. Based on the results achieved after cycle 2, and after considering the benefits and risks of conducting a third cycle, the licensee determined on August 13 that a third cycle would not be performed. The RCS decontamination ended after CORD cycle 2. After removing the chemicals from cycle 2, the A RHR pump remained in service through the end of the inspection period to cool the RCS and reduce chromium levels in the RCS water.

**Decontamination Factors and Dose Reduction Factors**

The RCS decontamination was successful in reducing dose rates in the RCS and connected piping, and in the plant areas containing reactor related piping. The licensee planned to achieve a minimum decontamination factor of 15 from the CORD process. The licensee achieved this goal with an average DF of 15.65. The licensee reported that a total of 130 curies of radioactivity was removed from the system, which will result in an expected dose savings of about 900 person rem over the remainder of the decommissioning.

**c. Conclusions**

The RCS chemical decontamination accomplished substantial dose reduction in reactor piping; however, the process was hampered by several events that challenged plant personnel and the safe control of the radiological source term.

**01.2 Decontamination Events (VIO 98-04-01 through VIO 98-04-03)**

**a. Inspection Scope (71707, 71801, 42700, 40801 62801, 93702, 92702)**

The purpose of this inspection was to review licensee actions following operational events during the RCS decontamination. The inspection included observations of plant equipment, logs and records; interviews of plant personnel; a review of tests, troubleshooting, repairs, and procedure changes; and, a review of the licensee assessments and event investigations. The inspector completed an independent evaluation of each event and identified contributing causes. When licensee event summaries and investigation results were used, they were validated by the inspector to develop NRC conclusions and findings.

**b. Observations and Findings**

Several events occurred which interrupted the RCS decontamination process. The events included a leak of about 1200 gallons from the letdown system on July 27, 1998; a failure of the C ion exchanger and post filter, resulting in the transfer of resin into the process piping on August 11; and, the failure of the discharge piping in the LDBP and a leak of 125 gallons on August 13. Following each event, the licensee suspended the decontamination cycle, took immediate actions to mitigate the consequences, investigate the event causes with the assistance of independent review teams as needed, addressed affected equipment and material deficiencies, improved the decontamination process controls, and took actions to prevent recurrence. The response to the July 27 event was the subject of a special management meeting at the site on August 3, 1998, and a telephone briefing on August 7 with NRR and Region I management. A copy of the licensee presentation slides for the August 3 meeting is provided in Attachment I. Licensee investigations of the events and their causes were generally thorough and corrective actions were appropriate.

**b.1 July 27 Leak - Event Summary**

The injection of permanganic acid started at 10:00 p.m. on July 26 to begin CORD Cycle 1. After the chromium concentration reached equilibrium in the RCS, the licensee injected oxalic acid at 10:30 a.m. on July 27 to begin the next step in the decontamination process. While placing the B demineralizer in service per NOP 2.7-1 starting at 11:33 a.m., the plant operators noted unusual vibrations and noise from plant equipment at locations in the ion exchange alley and in the primary auxiliary building (PAB). The operators made two attempts to place the B demineralizer into service, but stopped when anomalies in header flow were
noted. The operators conferred with the decontamination project team regarding the possible causes and corrective measures. The operators verified the B demineralizer valve lineup, enhanced venting carbon dioxide from the RCS, and throttled the LDBP by using the discharge valve to reduce the flow rate.

During the third attempt to place the B demineralizer in service at 12:38 p.m., a pressure transient caused relief valve LD-RV-252 (200 psig setpoint) to lift and recede, which caused severe piping vibrations that resulted in leaks from the RCS at two locations in the letdown system (ACR 98-620). Plant operators followed AOP 3.2-70 and SPL 10.11-21 to respond to the leak and shutdown the operating pumps in the letdown line, and isolated the letdown line by closing valves LD-MOV-200 and LD-V-405. Based on initial reviews of the amount of water collected by the aerated drain tank, the licensee estimated that about 1000 gallons of decontamination water had leaked from the RCS. The estimate was revised to about 1200 gallons (Reference 21 - a range of 1200 to 1500 gallons) after considering uncertainties in the measurement.

After the letdown piping failed, the operator response to detect and isolate the leak was good. The leakage occurred at the time when the RCS water contained the highest concentration of corrosion products (about 0.69 microCi/ml). The leakage caused several areas within the plant to become contaminated, and the areas were required to be controlled as airborne radiation areas. However, all leakage was contained within plant buildings and was collected by plant sumps and tanks. The majority of the leakage was directed by the pipe trench to the sump in the spent resin tank area, which pumped the fluid to the aerated drains tank (Attachment II, References 31 - 35). There was no release of radioactive water to the environment. Radiological controls to clean up the leak and minimize airborne activity was good. Section R2.1 describes further NRC review of the response to the radiological conditions caused by the event.

Licensee Investigations and Follow up Actions

The July 27 leak occurred when the decontamination process piping failed at two locations. The sensing tubing for letdown pressure instrument PI 113 failed in the purification pump area (PAB 21' 6" elevation); and, a one-half inch diameter pipe failed on letdown line (3"-CH-151R-227) just upstream of valve LD-V-226 inside the pipe trench. Most of the July 27 leak was caused by the failure of the LD-V-226 drain line. Several other components were affected or damaged by piping vibrations during the July 27 event, or were discovered to be degraded during the follow up reviews and investigations.

Pressure instrument PI-113 was replaced along with the tubing up to the isolation valve. Pressure transmitter PT-113 was permanently damaged by the July 27 event and was not repaired. The licensee used a camera with local PI-113 to provide for operator monitoring of letdown pressure from the control room. Inspections and flow tests were completed to investigate possible sources of restriction in the demineralizer header, including an evaluation of LD-V-238, LD-CV-343A and LD-TCV-113A. Both relief valves in the letdown line were tested and found to lift at the correct setpoints, nominal 200 psig and 500 psig. LD-RV-252 was replaced. The letdown line was flow tested at 30 and 150 gpm to confirm no flow blockage existed. The RCS decontamination flow path was modeled using a thermal-hydraulics analysis; the results were used to improve demineralizer operations, and to study the system transient response.

The LD-V-226 drain line failed when a pre-existing, through-wall flaw was driven to failure as a result of the multiple system pressure transients and the piping vibrations, while placing the demineralizer in service (References 25, 26, 27). The licensee could not determine whether the pre-existing flaw produced visible leakage prior to the event. The failure to include this piping in the decontamination leak checks was a missed opportunity to have identified degraded conditions. The licensee removed the remnants of the failed half-inch line at the junction with the three-inch line, and applied an engineered clamp to restore leak
tightness of the header (Reference 16). The licensee completed walkdown of lines affected by event to assure no other structural deficiencies existed. Several minor pin holes leaks in the purification line 2"-AC-151R-101 near valve WD-V-10F were repaired by cutting out a section of affected piping and welding in a replacement pipe. This repair also addressed other pre-existing defects in the purification piping, evidenced by an old, non-engineered patch covering a degraded pipe section. The licensee established enhanced monitoring of purification piping inside the pipe trench using additional cameras. During the remainder of the RCS decontamination, the licensee continued to address minor leakage in the purification system piping, including: the replacement of an elbow with pin hole leaks, the identification of extensive pitting and flaking of the resin slurry line (ACR 98-718); and, the identification of additional pin hole leaks on 2"-PL-152-19 near valve WD-V-10A (ACR 98-725). Licensee actions to address the material deficiencies, and to provide continued demineralization for the RCS and the SFP continued at the end of the inspection period. Refer to Section M1.2 for further NRC review of purification and letdown piping repairs.

Event Causes
The July 27 transient occurred as a result of a severe flow restriction (blockage) in the letdown line while placing the B demineralizer in service. Following extensive testing and engineering evaluations, the licensee verified that the letdown flow path had no fixed blockage. Several evaluations (including radiographic) were performed of the letdown postfilter inlet isolation valve, LD-V-238. The 3-inch gate valve requires 19.5 turns of the handwheel to fully open. Immediately after the July 27 leak, the valve was opened an additional 12 turns, which indicated it had been only partially open when the B demineralizer was aligned per NOP 2.7-1. This operating procedure required that valve LD-V-238 be fully open. Based on the radiography and additional flow analyses, the licensee concluded that LD-V-238 had been almost completely closed on July 27. The mispositioned valve caused the flow restriction which, combined with the LDBP 450 psig discharge pressure, resulted in the pressure transient that lifted LD-RV-252 and the piping vibrations, line failures and leaks. Subsequent problems operating valve LD-V-238 were described in ACRs 98-709 and 98-723.

The licensee concluded a primary cause of the transient was the improper response by the operators and decontamination staff to the letdown flow anomalies, as was evident in the repeated attempts to operate the demineralizer without resolving the observed anomalies. The staff failed to exhibit a questioning attitude to resolve the anomalies. A second major cause was inadequate engineering evaluations and procedure guidance for the operating configuration created for the RCS decontamination (i.e., the failure to adequately address the potential for pressure transients and the over reliance on operator actions to control pressure). Following the event, the licensee added a pressure switch to the letdown line and modified the control circuit for the LDBP (Reference 19) to provide a high pressure trip that assured the demineralizer piping and valves operated below 150 psig.

Contributing factors included: the inadequate communication of plant conditions from the field to the control room; and, the focus by the decontamination team on the need to place a demineralizer into service once the chemical had been injected, which was not as time-critical as perceived by the plant staff. Despite consultation with the Siemens staff, licensee actions were ineffective to integrate information when making real-time decisions during the evolution. The above issues were examples of weaknesses in licensee control of the RCS decontamination process.

Licensee actions to assure readiness to proceed with Cycle 2 of the RCS decontamination were summarized in DPM 98-155 (Reference 37). The licensee revised procedures to ensure added cautions were taken when placing demineralizers in service, and to add guidance on how to operate the LDBP. To improve guidance for operating manual valves with handwheel
extensions like LD-V-238, the licensee developed a list that identified the number of turns needed to operate each manual valve used during the RCS decontamination. The licensee took measures to enhance monitoring of CO2 generation; enhanced communications and clarified expectations for the control of decontamination activities; and, performed flow testing and additional thermal hydraulic analyses to clarify decision criteria for decontamination operations. The inspector completed an independent review on August 9, 1998 to verify the licensee had completed the corrective actions necessary to proceed with Cycle 2 of the RCS decontamination.

Findings

The licensee completed leak checks of the RCS decontamination boundary in accordance with Attachment 14 of SPL 10.11-1. While the checks focused on the temporary connections and accessible portions of the boundary, the licensee did not conduct walkdowns or leak checks of portions of the RCS boundary inside the pipe trenches. The failure to review this piping was a missed opportunity to identify possible leakage in the purification piping, and the degraded drain line connected to LD-V-226. Plant procedures were weak in this regard (see Section M1.2), and this is the first of two examples of a violation of Technical Specification 6.8.1 relative to SPL 10.11-1 (VIO 98-04-01). In response to NRC reviews during the August 3, 1998 management meeting, the licensee conducted a walkdown of the complete RCS decontamination boundary.

Section E1.2 of this report describes the licensee safety and technical reviews for the RCS decontamination. NRC review identified several engineering support weaknesses, which contributed to deficiencies in the decontamination process controls, as defined in the Master Decontamination Procedure, SPL 10.11-1, and associated procedures for operation of the letdown system. Specific inadequacies in the evaluations for the modifications that installed the LDBP included: the failure to adequately address the operational considerations related to the differences in pressures between the LDBP and the demineralizer components, particularly in regard to transient conditions; and, the deficiencies in the evaluations related to the pressure testing of components in the decontamination boundary. As a consequence, the decontamination procedures did not adequately address potential transient conditions in the letdown system. Although SPL 10.11-1, Sections 6.4 and 6.8, and SPL 10.11-24, Section 6.3, provided instructions for operation and static system pressure control using the letdown booster and return pumps, there was no guidance for transient pressure response, or termination criteria for abnormal pressure and flow conditions during demineralizer operation. As noted above, the licensee also concluded that the failure to address the potential for transients contributed to the July 27 leak. This inadequacy in SPL 10.11-1 and associated procedures was a second example of a violation of Technical Specifications 6.8.1 (VIO 98-04-02).

NRC concerns regarding valve lineups and plant configuration control were addressed in telephone conferences on July 8 and 15, 1998. Licensee corrective actions to address deficiencies in this area were described in a letter to the NRC dated July 16, 1998, and included basic valve operation training for personnel who manipulate valves or verify valve positions. Inspection 98-03 addressed the licensee's failure to follow procedures in the mispositioning of LD-V-238. The corrective actions implemented prior to the start of the RCS decontamination were not effective to preclude the events that contributed to the July 27 leak. The continuation of configuration control issues and the failure to take adequate corrective actions to address weaknesses in configuration control were examples of inadequate corrective actions.

b.2 August 11 Demineralizer and Filter Failure - Event Summary

Following repairs to the demineralizer system, the licensee completed the cleanup from CORD Cycle 1 using the C demineralizer (C IX). New resins were placed in the C IX on August 10 in preparation for CORD Cycle 2 of the RCS decontamination. The licensee initiated the injection of permanganic acid to begin Cycle 2 at 1:35 a.m., and injected oxalic
acid at 10:01 a.m. on August 10, 1998. At 3:55 a.m. on August 11, radiation monitor RMS-35 came into alarm, indicating an increase in PAB hallway area dose rates from 0.5 mRem/hr to 5 mRem/hr. Licensee reviews to identify the cause of the increased radiation continued on August 11. Initially, the licensee considered and then discounted whether the addition of peroxide had caused the increase. After identifying that demineralizer flow data had been incorrectly recorded, the licensee concluded that radiation levels increased following the actions to increase flow through the C demineralizer from 65 to 90 gpm per SPL 10.1-48. About 30 (of 45) cubic feet of resin passed through the lower retention element of the C IX at the elevated flow rate. The radiation levels were caused by the movement of activated resin from the C IX, which had migrated into the piping that was part of the RCS decontamination boundary. The C IX postfilter, FL-65-1A, failed to retain the resin. Radiation surveys confirmed elevated dose rates existed in portions of the high pressure safety injection (HPSI) piping from the PAB to the SI-861 valves (A through D) inside the containment. Contact dose rates on the lower end of the C IX were measured at 40 R/hr prior to the event, and had decreased. Dose rates were as high as 5 R/hr on contact with the piping inside the containment, with general area dose rates at 1 to 2 R/hr at 30 cm from the line. The event might have been worse had the filter failed prior to the last C IX change out when dose rates were about 250 R/hr. The affected portions of the HPSI piping inside the PAB were in the pipe trench, and were not readily accessible to workers. The affected HPSI piping inside the containment was already controlled as a high radiation area because of the RCS decontamination process. The licensee isolated portions of the decontamination flow path to keep the resin from entering the RCS piping.

Licensee Investigations and Follow up Actions

The failure of the C IX eliminated its use for the remainder of the RCS decontamination. The licensee used the letdown demineralizers to complete the RCS decontamination, and developed alternate methods for use of the RHR system in the purification mode (Reference 45). The licensee opened the top of the C IX and used boroscope examinations to investigate the internals. This examination identified a failed retention element. Since the C IX was the only source for SFP clean-up, licensee efforts continued at the end of the inspection period to provide a means to purify the SFP. The licensee was considering actions to accelerate the implementation of phase 2 of the nuclear island modifications, which would install new SFP demineralizers in the spent fuel building. The licensee flushed the decontamination chemicals out of the HPSI piping per procedure SPL 10.11-10 (Reference 9). The activated resins remained in the HPSI system pending the development of a procedure using a vendor-supplied process to flush the resins out of the piping. Postfilter FL-65-1A was opened and inspected (Reference 39). The screen material included in the retention element had disintegrated in the presence of the decontamination fluid, allowing the resin to pass through the filter. The element that failed had been installed by the licensee on July 25, 1998 as a temporary modification (References 41, 42). The normally installed, vendor-supplied 1 micron filter element was replaced with a 150 micron element fabricated onsite using the materials from the Haddam Neck and Millstone warehouses. Post-event chemical tests on the screen material used in the modified element showed that it had a high concentration of iron, even though the stock code indicated the material was type 304 stainless steel. Further licensee investigation determined that the material was stainless steel, but the screens had dissolved because of the fine mesh used in the fabric of the filter element. Licensee evaluations continued at the end of the inspection period. Even though the technical evaluation (Reference 42) addressed the structural integrity and hydraulic performance of the modified element, it was inadequate in that it did not consider whether the new element would be compatible with the decontamination fluid. This was an example of a weakness in engineering support for the RCS decontamination.

Findings
The technical evaluation in support of Jumper 98-36 (Reference 42) noted that the lower retention element passed resin with system flow rates at 140 gpm. The licensee concluded that flow testing had established proper C IX performance with flows at 100 gpm, which was established as a limit for demineralizer operation. Procedure SPL 10.1-48, Step 1.6.2, initially provided guidance to adjust purification system flow through the C IX at the discretion of the Decontamination Manager, but was revised on July 25 to limit flow to 100 gpm (TPC 98-117). Ultimately, the combination of technical evaluations for Jumper 98-36 and procedure controls was inadequate to assure the activated resins remained in the C IX during demineralizer operation. The failure to provide adequate procedures for purification system operation during the RCS decontamination was an example of a condition contrary to Technical Specifications 6.8.1 (VIO 98-04-03).

The licensee had identified that the lower retention element in the C IX was potentially failed and not functioning properly, since the postfilter had been inspected and cleaned of resins three times from July 14 to July 25, 1998 (Reference 40). The degraded condition of the retention elements was noted in the technical evaluation for Jumper 98-36, but the option of replacing the retention elements was rejected due to “ALARA considerations.” Although the degraded condition of the retention element was noted, the failure to adequately address this condition contributed to the migration of activated resins and the loss of control of a radiological source term. The failure to take timely action to address a degraded material condition was an example of inadequate corrective actions.

b.3 August 13 Letdown Booster Pump Leak - Event Summary
During the conduct of CORD cycle 2 on August 12, the LDBP tripped resulting in a level transient in the volume control tank. The operators responded per AOP 3.2-70 to control the transient and isolate the letdown line. The licensee identified and replaced a blown fuse in the LDBP control circuit of the (ACRs 98-679 and 98-684). The fuse blew because vibration of the skid mounted control panel caused wires to fray resulting in an electrical short circuit. The LDBP was started at 4:05 p.m. on August 13 to resume cleanup for Cycle 2. Operators noted excessive vibrations in the LDBP and requested engineering support to measure the vibrations levels and evaluate the pump status. A technical support engineer conducted measurements between 5:45 p.m. and 6:00 p.m., noting vibration levels 1.2 inches per second (ips) on the coupling, 1.7 ips on the baseplate, 2.5 ips and 4.0 ips on the motor, and 6.0 ips on the skid mounted control panel. The vibration levels were greatly increased from the baseline levels taken when the LDBP was initially installed (measured at much less the 1.0 ips). The technical support engineer also noted excessive movement of the LDBP skid. The technical support engineer immediately informed the duty shift manager and the lead representative in decontamination projects group of the excessive vibrations, and recommended that actions be taken as soon as possible to tighten the turnbuckles to lessen skid vibrations and allow further evaluation.

Before the licensee took additional action, the piping in the discharge of the LDBP failed at about 7:09 p.m. on August 13, resulting in a spill of about 125 gallons of decontamination fluid in the lower level of the containment. Plant operators recognized the indications of a RCS system leakage based on inputs to the containment sump, and promptly responded to isolate the leak per AOP 3.2-70 and SPL 10.11-21. The health physics group responded to control the spread of contamination and minimize the potential for airborne radioactivity by flushing the spilled water back to the containment sump.

Licensee Investigations and Follow up Actions
Subsequent investigation of the LDBP identified the following damage: the socket weld at the transition from the 3 inch discharge line to the 1 inch recirculation line had failed, with indications of a 180 degree crack; the pump to motor coupling was damaged; one of four motor mounting bolts on the cart was failed; and, one of four turnbuckles was bent. The failed weld was the source of the leakage. The licensee determined that the weld failed due to high cycle fatigue caused by the excessive vibrations. Licensee actions were appropriate
to repair the damaged equipment, and investigate the structural integrity of the pump skid and associated piping (References 5, 6) prior to the resumption of decontamination operations on August 18, 1998. The piping inspections and non-destructive examinations were thorough to verify system integrity and that there were no other vibration induced defects.

The licensee also concluded that the high vibrations on the LDBP skid had contributed to various problems experienced with the LDBP control circuit during the RCS decontamination, including the start circuit problems, frayed wires and blown fuse. The licensee operated the pump discharge valve almost fully throttled closed in order to control the pressure and flow in the down stream letdown piping. This mode of operation contributed to the vibrations and “rough” operating conditions on the skid, as evidenced by the tendency of the LDBP discharge valve to vibrate open. The licensee response was to install a restraining device on the discharge valve.

Findings

The LDBP failed in service, resulting in a 125 gallon leak to the containment sump. There was no leakage to the environment. The operator response to detect and isolate the leak was good. HP follow up to clean up the leak and minimize the spread of airborne activity was good.

The LDBP was installed per MMOD CY-98509, DCY-00-0054-98 and DCY-01-0054-98. The original plan was to use anchor bolts to mount the pump skid directly to the containment floor. The plan was changed by leaving the skid mounted on wheels to facilitate installation and removal. Turnbuckles were used to restrain the skid at the four corners of the cart. No lock nuts were used, and the turnbuckles loosened from the vibrations that occurred when operating the LDBP. Engineering support was inadequate regarding the review to change the mounting details, in setting the design and operating limits for the LDBP, and in how the LDBP operation was integrated with the RCS decontamination. Section E1.2 below also addresses this area.

Engineering support was inadequate on August 13 by not recommending immediate shutdown of the LDBP on the basis of vibration data that was recognized by the support staff as excessive and unacceptable. Although vibration measurements taken at several locations on the pump skid were found excessively high, there was no official procedure or acceptance criteria used by engineering to evaluate the LDBP for continued operability. Prior to the pump failure, the operator evaluations of the vibration did not exhibit a good questioning attitude; operator actions were not adequate to preclude the LDBP failure. The failure to take prompt actions to shutdown the LDBP when excessive vibrations were observed was an example of inadequate corrective actions. Continued pump operation resulted in the piping failure and the loss of control of the radiological source term. Licensee communications and actions to integrate information from the decontamination and support staff were ineffective when making real-time decisions during this event. This was a second example (see Section b.1) of a weakness in the control of the RCS decontamination.

c. Conclusions

Licensee preparations for and conduct of the RCS decontamination was generally adequate, but many equipment and personnel performance issues and process deficiencies were evident in several events that challenged the plant staff. The operators and support staff responded properly to major events (a 1200 gallon leak, and the loss of control of resins and radioactive material, and a 125 gallon leak) to mitigate adverse radiological conditions, and take appropriate actions to address degraded conditions. However, weaknesses were noted in the incomplete leak checks for the RCS decontamination boundary, several deficiencies in engineering evaluations and procedures, and in the failure to take effective corrective actions for adverse conditions, such as excessive pump vibrations, failed demineralizer retention elements, and inadequate control of the plant configuration (valve lineups). Corrective actions were not comprehensive to preclude additional events.
NRC staff concerns regarding inadequate procedures and corrective actions, and in the control of shutdown operations, were previously noted in NRC Inspections 96-10, 96-11, 96-80 and 96-201, and in the May 12, 1997 Escalated Enforcement Action. In addition to root cause and event investigations for the individual events, licensee actions continued at the end of the inspection to address organizational issues, and to complete a common cause evaluation for the RCS decontamination events.

II. Decontamination Support Activities

M1 Conduct of Maintenance

M1.1 Maintenance Support (URI 98-04-04, VIO 98-04-05)

a. Inspection Scope

Using Inspection Procedure 71707, 61726 and 62707, the inspector reviewed plant maintenance and surveillance in support of the RCS decontamination.

b. Observations and Findings

Several equipment problems hampered the decontamination process and challenged plant personnel. Some problems involved valves and filters that support the plant purification process, which exhibited poor material conditions that were pre-existing and became apparent as the decontamination process proceeded. Some problems occurred as a result of rough equipment operation or system transient conditions. Plant workers responded to each problem to complete repairs. While work was conducted with good regard for equipment and personnel safety, exceptions to good performance were noted, as discussed below.

- repair of several valves that failed on demand (diaphragm type)
- repair of pressure instrument and drain line from July 27 leak
- repair of LDBP discharge line following August 13 leak
- purification line 2"-AC-151R-101 pin hole leaks
- waste disposal line 2"-PL-152-19 (WD-V-10A) pin hole leaks
- VCT manway cover leak (ACR 98-668)
- C ion exchanger and RCS letdown postfilter replacement
- resin slurry line corrosion (pitted, crusted, flaking)
- LDBP control circuit problems - frayed wires, start problems, blown fuse
- testing and replacement of letdown relief valve LD-RV-205, 252

Purification (Demineralizer) System Leaks and Valve Performance

The licensee encountered several problems with the demineralizers and associated piping and valves during the RCS decontamination, which challenged personnel and hampered the smooth conduct of the process. Although the licensee had identified the potential vulnerabilities on the use of diaphragm valves, the plant experienced multiple valve failures during demineralizer operations. There was no preventive maintenance on the demineralizer system valves; valve maintenance was conducted as failures occurred. The demineralizer valves are located in the pipe trench, but are operated by long reach rods. Most valves with reach rods have no design provision for providing visual feedback on valve position. The valves are often hard to operate, and provide ambiguous tactile indication that the valve has reached the end of its travel.

The plant design included the use of thin-walled stainless steel piping ("speedline pipe") associated with the demineralizers. The nominal wall thickness for the Schedule 10 piping was 0.10 inches. The licensee identified several leaks in the piping during the RCS decontamination, and continued to discover leaks after the decontamination (ACRs 98-636, 98-639, 98-687, 98-725, and 98-767). The resin slurry header near the D demineralizer had external corrosion and was bulged in spots (ACR 98-718). Licensee evaluations determined the piping had pin hole defects resulting from stress corrosion cracking type indications. Since the licensee had not inspected the piping during the preoperational leak checks, it was indeterminate whether the leaks had existed prior to the addition of the decontamination fluids. However, the RCS decontamination fluids likely removed wall material in the flaw areas and initiated the leaks.
There is some evidence that degraded conditions existed in the purification system piping prior to the RCS decontamination. A temporary patch (non-engineered clamp consisting of rubber wrapping and two common hose clamps) was identified on July 30, 1998 during reviews inside the pipe trench following the initial identification of leaks. Maintenance personnel had no record on when the patch was installed, but estimated it had been in place for many years.

Failed Rigging - PAB Floor Block

The licensee used the overhead crane in the PAB to lift floor block RS-5 to gain access to the pipe trench to repair valve LD-RV-252 (Reference 18). The block weighs about five tons, and was handled per procedure WCM 2.2-7, PAB/Pipe Trench Floor Block Lifting Procedure. While WCM 2.2-7 provides general guidance to safely handle the load, the procedure provided no details on how to rig the block. Plant workers, after consultation with plant engineering and the safety personnel, rigged the block using two turnbuckles and two metal slings. When the block was lifted and moved east on August 2, 1998, the northwest attachment failed, causing the corner of the block to fall two inches and strike block RS-4 (ACR 98-646). The attachment failed when a one inch diameter swivel eye bolt pulled out of the Richmond Rocket insert in the concrete. No personnel injuries occurred and licensee engineering verified that the structural integrity of block RS-4 was not compromised.

The licensee conducted an apparent cause for the event, in recognition that the failure to control the heavy load was a significant precursor event with the potential to adversely affect systems and components below the 21-foot elevation of the PAB. Although engineering and maintenance personnel verified that the lift angle was acceptable (31.4 degrees versus a minimum acceptable of 30 degrees), neither the workers nor the engineering or safety personnel verified that the turnbuckles were used properly with the slings; i.e., configuring the turnbuckles on the same side of the load, rather than being diametrically opposed. Rather than spreading the load evenly over four eye bolts as intended, the swivel insert became over stressed and failed when the weight of the block was spread over two bolts.

There were several contributing causes to this event. The workers made a new rigging method for the RS-5 lift because the old lift rig, which had been used successfully for years, had been removed from service in 1996 due to no formal tests to assure operability (ACR 96-399). The lift rig remained stored in the east end of the PAB within 50 feet of RS-5. Alternate rigging was available at Millstone, but was not obtained; instead, the plant workers created a new rigging method using available materials at the CY site while trying to proceed with the repairs. Although the workers and support personnel resolved questions that were raised regarding the lift angle, not all questions were resolved regarding the use of turnbuckles. Both engineering and plant safety personnel approved the intended lift method without seeing the rigging installed. Communications between maintenance and engineering was poor regarding the configuration used for the turnbuckles: engineering assumed the workers knew how to install the rigging properly; and the workers believed the support personnel had approved the configuration. The activity was completed under schedule pressures, which was a factor on how well the licensee prepared for the lift and reviewed the lift method.

Licensee actions continued at the conclusion of the inspection to address the apparent cause recommendations, and to recover block RS-5. The apparent cause investigation for the event (Reference 38) was thorough and identified several actions to improve rigging practices at Haddam Neck, including the evaluation of training and obtaining a proper lift rig for PAB floor blocks. This item is unresolved pending the completion of licensee actions to address weaknesses in this area (URI 98-04-04).

Although WCM 2.2-7 provided general guidance to safely handle PAB floor blocks, the procedure provided no details on how to rig the block. The combination of procedure guidance and worker training was inadequate to properly rig the block. This failure to
provide adequate procedures is an example of a violation of Technical Specifications 6.8.1 (VIO 98-04-05).

c. Conclusions
The material conditions of purification and demineralizer system valves and piping were poor, which hampered the decontamination efforts and challenged plant personnel. Past NRC inspections noted previous weaknesses in this area (reference NRC Inspections 96-10, 96-11, and 97-01). The licensee did not adequately assess or compensate for the material conditions in the purification and demineralizer system until failures occurred that challenged workers and the safe control of the radiological source term. This was a weakness in the preparation for the RCS decontamination. Weaknesses were also noted in the conduct of rigging for a heavy load (PAB floor block); communications and the integration of support by engineering and the plant safety group were poor.

M1.2 Pressure Boundary Testing
a. Inspection Scope
The inspector reviewed pressure test requirements specified by CYAPCo to assure leak integrity of the chemical decontamination pressure boundary. Test requirements for selected minor modifications, system repairs, and the “Master Decontamination Procedure,” SPL 10.11-1, were reviewed.

b. Observations and Findings
Minor Modifications
The inspector reviewed selected minor modification packages listed in Attachment II of this report and interviewed engineering personnel. The inspector found the pressure test required met the requirements of the RWQA program and ANSI B31.1 and provided ample assurance of the pressure boundary integrity. Adequate technical justification was noted for the selected hydrostatic test pressures, the majority of which were 150% of system design pressure. If a hydrostatic test was not performed, pressure testing to a lower value had been adequately justified and complied with ANSI B31.1.

System Repairs
The required pressure tests for repairs to the instrument piping, temporary patch on the letdown line, and the piping replacement in the SFP purification line were noted to provide adequate assurance of the repair’s leak integrity and met the requirements of ANSI B31.1. The additional piping inspections and pressure tests, performed to identify additional locations of system degradation and/or leakage, were found to be adequate in the areas performed. When the extent of the effort was questioned by the inspector, CYAPCo identified their intent to expand the effort to encompass the entire decontamination pressure boundary.

Master Decontamination Procedure Leak Checks
The Master Decontamination Procedure, SPL 10.11-1, required visual checks per attachment 14 be performed to identify external or intersystem leakage prior to heating up, at 200°F, and at a minimum of four-hour intervals once the chemical decontamination had begun. The visual inspections were performed by walkdowns and remote CCTV monitoring systems. Based on review of attachment 14 and discussion with plant personnel, inspection of the permanently installed piping was not a significant attribute of the visual inspection. The lack of a thorough inspection of the permanently installed piping was a missed opportunity to identify potentially pre-existing piping degradation and leakage. Although it is not known if active leakage from the SFP purification line, relief valve LD-RV-252, or the drain line containing valve LD-V-226 (which later failed) existed prior to the spill event on July 27, 1998, the presence of an old temporary piping repair, made using sheet rubber and hose clamps, could have been identified.

c. Conclusions
The required pressure tests provided adequate assurance for the leak integrity of the systems and temporary equipment installed for the chemical decontamination of the reactor
coolant and associated systems and met the requirements of the radioactive waste quality assurance program and ANSI B31.1. Testing specified for the repairs to the permanent piping was found to be adequate, meeting the requirements of ANSI B31.1. Though not technically required, the inspector noted an opportunity to identify potentially pre-existing system degradation and leakage that was missed due to the lack of a thorough visual inspection of the permanently installed piping during the operational leak checks of the Master Decontamination Procedure.

M1.3 Repairs of the Decontamination Pressure Boundary

a. Inspection Scope
The inspector reviewed the intended repairs for the piping failures identified during cycle 1 of the decontamination process.

b. Observations and Findings
CYAPCo stated in part, permanent repairs would be made to the pressure boundary of systems defined as “operable” or “available” in accordance with the applicable code requirements. Temporary repairs, determined to be acceptable based on an engineering evaluation, would be made for systems categorized as “lay-up” but returned to service for the decontamination process prior to being declared “abandoned.” An acceptable temporary repair may be considered for systems defined as “operable” or “available” based on the safety significance and expected remaining service life of the system.

The repairs to correct the system leaks and piping failures from cycle 1 were found technically adequate. The repair specified for the degraded piping in the SFP purification line (categorized as “operable”) required the piping to be permanently replaced to meet code standards. The temporary repair applied to the letdown line (categorized as “lay-up”) where the LD-V-226 drain line broke off, was accomplished using a pipe clamp with a pressure and temperature rating exceeding the system requirements and a gasket material compatible with the environmental conditions produced by the decontamination process.

c. Conclusions
The repairs specified to correct the pressure boundary piping failures noted during cycle 1 were technically adequate. The graded approach employed by CYAPCo, in regard to the extent of repair to be performed, adequately balanced the safety significance of the system and remaining expected service life prior to abandonment with the concern for unnecessary personnel exposure, while also ensuring that the repair was technically acceptable.

E1 Conduct of Engineering

E1.1 Engineering Evaluations for RCS Decontamination

a. Inspection Scope (37801, 42700, 37700, 40801)
The inspector reviewed the conduct of engineering activities this period that supported decommissioning planning and implementation.

b. Observations and Findings
Proto-Power Thermal-Hydraulic Model
The inspector reviewed selected portions of the thermal-hydraulic model developed by Proto-Power for the decontamination evolution for indications of potential system over pressure conditions. Review of data from the thermal-hydraulic model identified the expected pressures for the areas in which the piping failures occurred were all within the allowable pressure rating for the system. Additional modeling performed subsequent to the spill on July 27, 1998, verified the installed system relief valves (200 psig and 500 psig) each were capable of relieving the flow capacity developed by the LDBP. The model also identified the maximum obtainable pressure from the LDBP was 511 psia.

c. Conclusions
Adequate engineering evaluations and thermal-hydraulic modeling were performed for the static and expected operating conditions to ensure the systems were capable of supporting the anticipated operating parameters (e.g. pressure, temperature, and flow) during the decontamination process.
E1.2 Decontamination Procedure Safety Evaluation

a. Inspection Scope (37801)
An inspection was performed on Safety Evaluation No. SY-EV-98-0021, "Master Decontamination Procedure", prepared by the licensee to evaluate the activities and modifications associated with the RCS chemical decontamination. The evaluation was dated June 30, 1998. Two of the supporting plant modifications, MMOD CY-98509 and MMOD CY-98512, were also inspected.

b. Observations and Findings
The purpose of the decontamination was to reduce the occupational doses to personnel performing decommissioning activities by about 1000 rem. Major portions of the RCS, chemical and volume control system (CVCS), and RHR systems were included in the decontamination flow circuit. The reactor vessel and internals were bypassed and not included in the flow circuit.

Plant modifications installed to accomplish the work were identified in the safety evaluation. The modifications included connections to the decontamination vendor’s equipment, two additional pumps, a jumper from the SFP demineralizer to the high pressure safety injection (HPSI) header, removal of the letdown orifices, electric power connections to temporary equipment, and a nozzle dam and jumper arrangement to bypass flow around the reactor vessel internal surfaces.

Two of the supporting modification design packages were inspected. MMOD CY-98509 installed a booster pump to provide flow to the letdown system. The LDBP was located to provide 200 gpm to the A, B, or D ion exchangers in the CVCS system. Shutoff head of the pump was 465 psig. Operational considerations were not provided in the booster pump design package, instead, those considerations were stated as being addressed in the Master Decontamination Procedure (MDP) safety evaluation. The MDP safety evaluation stated that the booster pump was designed to provide 200 gpm at 400 psig discharge pressure. No safety evaluation was performed for the booster pump modification. The applicability review done to determine whether a safety evaluation was necessary stated that, because the systems involved had been classified as "layup" or "abandoned", changes to the system are not considered a change to the facility as described in the SAR.

MMOD CY-98512 removed the letdown orifices and associate air operated block valves and replaced them with a pipe jumper. Removal of the orifices was necessary to allow sufficient flow through the letdown system to accommodate the decontamination process. The design package stated that the RCS and supporting systems would operate at less than 100 psig and 200 °F, and that the expected maximum operating pressure and temperature for the decontamination were 165 psig and 200 °F. The design flow rate of demineralizers A, B, and D was stated as 150 gpm. In a fashion similar to the booster pump modification, operational considerations were not addressed, and no safety evaluation was performed. The MDP safety evolution was referenced for operational considerations. Invocation of the system categorization as "layup" or "abandoned" justified the decision not to perform a safety evaluation.

The letdown orifice removal modification design package stated operating pressure and flow parameters that were less than the expected pressure and flow delivered from the booster pump modification. The MDP safety evaluation did not address the apparent contradiction between the two modifications. However, the MDP safety evaluation stated that the booster pump design pressure was well within the piping classification assigned to the letdown line in the area. The MDP safety evaluation noted that the letdown line had considerable pressure drop, and that there was pressure relief to the volume control tank (VCT) to maintain design conditions. The MDP safety evaluation did not address the apparent mismatch of using a pump with a 400 psig discharge pressure to feed a system with a pressure relief valve set at 200 psig.
Both modifications involved welds subject to the requirements of Haddam Neck specification SP-ME-925, which required dye penetrant and radiographic examination of the welds. However, ANSI B31.1 required only visual inspection of welds made on pipes used for service at conditions below 350°F and 1025 psig. The provisions of ANSI B31.1 were applied to the welds. The licensee justified that decision on the basis that the systems involved were classified as “layup”, the piping was for temporary use during the decontamination, less inspection reduced occupational exposure, and that a hydrostatic test would be performed after installation.

The MDP safety evaluation incorporated operations procedures by reference. Several potential malfunctions were also considered:

- A break in the return line from the SFP demineralizer
- Internal system leakage
- Loss of power (1000 hours allowed before corrosion becomes a concern)
- Pump malfunction (loss of fluid circulation capability by a pump)
- Heater malfunction
- Operator error
- Nozzle dam failure
- Resin spill
- Containment vent malfunction
- Leak detection and response to leaks

The break in the return line from the SFP demineralizer, if it occurred, was assumed to release 1600 gallons of demineralized decontamination fluid onto the ground in the vicinity of the refueling water storage tank (RWST). The basis of the assumption was that operators would secure flow from the purification pump within 10 minutes. Yard drains in the area were plugged as a precaution against releasing the water to the environment. Although not mentioned in the safety evaluation, the licensee placed a dike around the area to contain a leak, if it occurred. The licensee conservatively assumed no reduction in activity as the solution went through the demineralizer, and determined that an airborne release from the postulated spill was bounded by the resin fire accident scenario.

Pressure testing and leak testing were addressed by the MDP safety evaluation. The mechanical modifications made to enable full system decontamination were hydrostatically tested as part of the installation sequence. The decontamination vendor supplied pressure test certifications for their equipment. Pressure testing of existing plant equipment, other than components coincidentally included in the test boundary of the modifications, was not addressed in the MDP safety evaluation.

A leak test was specified for the entire system as part of the startup sequence for the decontamination. System flow, temperature, and pressure were held as constant as possible. The test monitored water level in the VCT and pressurizer to determine if leakage was present.

The wastes generated were evaluated for compliance with 10 CFR Part 61 waste disposal criteria. In addition, the MDP safety evaluation stated that resin wastes would be sampled and analyzed prior to preparing the resin for shipment to a waste disposal site to verify compliance with Part 61.

System material compatibility with the decontamination chemicals was reviewed by the decontamination vendor. Based on the corrosion rate of SS-304, the expected maximum penetration after 5 decontamination cycles was 1.24 micro meters (µm), considered to be a negligibly small fraction of the available wall thickness of stainless steel piping. The corrosion rate of the inconel steam generator tubes was higher, and up to 10 µm penetration was expected. The penetration was considered acceptable based on the 62 µm thickness of the tubes. No material incompatibilities were identified in the safety evaluation. No unreviewed safety questions were found by the licensee. A Technical Specification change was required to eliminate RCS chemistry limits that would prohibit introduction of
decontamination chemicals. The required change was part of License Amendment No. 193, Defueled Technical Specifications, issued on June 30, 1998.

Assessment
Passing greater than design flow through the demineralizers increased the pressure drop across the resin beds. When combined with an unexpected flow blockage, the letdown system pressure could increase to the discharge pressure of the LDBP. Because the lower setting of the system relief valves was 200 psig and the pump shutoff head was 465 psig, a potential existed to lift the relief valve if a flow upset occurred. This potential was not recognized in the safety evaluation for the decontamination procedure, and may have contributed to the leakage event experienced on July 27, 1998.

The MDP did not address effects of potential corrosion of plant systems placed in layup condition after the plant permanently shut down. The material condition of the plant may have degraded in the last two years. The system leak testing performed during the startup sequence for the decontamination did not include walkdowns of plant systems to determine if leakage too small to detect from tank level changes might have been present. Such leakage could be a precursor to a large leak. The evaluation did not adequately consider the use of the decontamination chemicals with the thin-walled (schedule 10) piping in the purification system, and failed to assure that the purification system would remain leak tight for the duration of the RCS decontamination.

The 10 CFR 50.59 applicability review performed for MMOD CY-98509, Letdown Booster Pump, states that the activity does not make a change to the facility as described in the UFSAR because the system has been depicted in the UFSAR in the “Layup” category. The applicability review further states that UFSAR Chapter 1 states that changes “Layup” systems are not considered changes to the facility since any recategorization or modification of these components will not result in an unreviewed safety question. UFSAR Chapter 1 provides definitions of the various categories of plant systems, including the “Layup” category. However, the UFSAR does not state that changes to systems categorized as “Layup” are not considered changes to the facility.

c. Conclusions
Several inadequacies were noted in the engineering support for the RCS decontamination, and the associated safety evaluations.

III. Plant Support and Radiological Controls

R1 Radiological Surveys and Controls
R1.1 Radiological Surveys
a. Inspection Scope (83750)
The inspectors reviewed the licensee’s methods for determining the effectiveness of the RCS decontamination through the calculation of DFs.
b. Observations and Findings
The licensee developed a procedure to determine the DF and monitor the effectiveness of the RCS decontamination. The DF was determined by measuring the exposure rates at various fixed locations before and after the decommissioning activity. The DF was calculated by dividing the initial measurement by the final measurement.
The licensee monitored over 40 locations (pipes and components) with teledosimetry units that provided remote read-out capability. This enabled the licensee’s staff to monitor the exposure rates without actually entering the areas and avoided potential radiation exposure to workers. However, for the initial (baseline) and final calculation of the DF, radiation protection technicians went to each location and performed a radiological-dose rate measurement with a hand-held instrument.
The licensee expected to obtain an average DF in excess of 15 for the RCS decontamination. The decontamination would remove a significant amount of radioactivity from the system and lower dose rates. The net benefit of lower dose rates would amount to approximately 1000 person-rem saved during the decommissioning of the facility. The actual
DFs averaged approximately 15 and an estimated 130 curies were removed from the system. The licensee estimates that this will result in an overall dose savings of 900 person-rem during the decommissioning.

c. Conclusions
The licensee measured and calculated the DFs for the RCS decontamination and reported successful results in lowering dose rates for future work.

R1.2 Radiological Controls
a. Inspection Scope (83750)
The inspector toured the radiologically controlled area (RCA) and discussed specific radiological controls with radiation protection (RP) supervision and RP technicians. The inspectors also reviewed radiological controls implemented for the RCS decontamination effort including the radiation work permit (RWP), the Radiological Safety Review 98-040, and associated radiological surveys.

b. Observations and Findings
The inspectors toured various areas within the RCA, including the PAB, the containment building, and outside areas near the pipe trench openings. Appropriate controls were observed for Radiation Areas and High Radiation Areas. Postings and barriers were effectively placed to notify workers regarding changes in radiation levels. Appropriate controls were noted to prevent the spread of radioactive contamination. The inspectors noted that workers were taking the proper precautions for radiation protection as required by the licensee’s staff. During tours, good radiological housekeeping and good worker awareness of radiological hazards was noted.

No inadequacies were noted regarding the RWP or the Radiological Safety Review 98-040 for the RCS decontamination activities. The licensee had estimated that RCS decontamination activities could be completed with an estimated 39 person-rem of exposure to workers. The actual total dose for the decontamination of the RCS was approximately 28 person-rem. Extensive use was made of teledosimetry and cameras whose output were routed to several control points in low-dose areas. This helped maintain exposures as low as is reasonably achievable (ALARA) by minimizing the need for routine operator staff rounds, routine RP coverage, and RP surveys after each decontamination step. One good practice noted was that RP staff incorporated expected ranges of dose rates and contamination levels into the Radiological Safety Review.

All workers in the containment building were assigned teledosimetry, in addition to the electronic dosimeters and the thermoluminescent dosimeters used for routine personnel monitoring, to allow real-time monitoring of their radiological exposure. The units displayed the exposure results in the containment building control point, the Health Physics desk on the operating floor, and at the control station in the PAB. The system also allowed trending of exposures and exposure totals.

Additional controls were implemented for work in the pipe trench due to the higher radiological contamination in some areas of the trench. For example, tents were erected and portable high efficiency particulate air (HEPA) filtration units were required with the exhaust directed to the plant ventilation system. All material from the pipe trench was expected to be bagged and surveyed. Respirators and personal breathing zone analyzers (BZAs) were required for all workers making a PAB pipe trench entry.

Up to the time of the inspection, whole body counting results of individuals indicated that no workers had received any significant internal exposure during chemical decontamination efforts. This was largely due to workers wearing respirators. Additionally, there were no dose assignments made to workers from skin or clothing contaminations.

c. Conclusions
Radiological controls for RCS decontamination work were well-planned and radiation protection personnel maintained close oversight of work. Radiation protection was effective in keeping workers’ radiological exposures ALARA.
R2 Response to Events and Radiological Challenges
R2.1 Radiological Safety
a. Inspection Scope (83750)
The inspectors reviewed the licensee’s identification and corrective actions associated with recent events or incidents, including actions taken in regard to the spill of contaminated liquid to the PAB floor add pipe trench on July 27, 1998, due to the failure of valve LD-V-226.
b. Observations and Findings
The spilled material/fluid released due to the failure of valve LD-V-226 contained both radioactive and hazardous materials/fluids. Therefore, response to the spill was initially limited to specially trained staff. Contamination surveys (smears) indicated approximately 200,000 disintegrations per minute in a 100-centimeter squared area (dpm/100cm²) for beta and gamma emitting isotopes and 600 dpm/100cm² for alpha emitting isotopes. Significant potential airborne radioactivity was expected if the liquid dried. The licensee attempted to keep the area wet until the clean-up could be performed.

Major clean-up efforts were conducted in chemical protective suits and respirators, although the respirators were mainly used due to the potentially hazardous chemicals. Potential effects of heat stress on workers were also monitored by licensee staff and stay times were provided to workers. Heat stress was of particular concern during pipe trench work activities because heat was transferred from the elevated temperatures of the decontamination liquid in piping and there was restricted air flow through the pipe trench. The inspectors noted that very good training was provided to first-line supervisors regarding heat stress prevention. However, some heat stress issues were still encountered during the work in the pipe trench. Licensee management responded to worker concerns by making ice jacket vests more readily available to those workers who desired to use them.

The clean-up of the PAB was successfully completed within a few days.
c. Conclusions
Radiation Protection response to the spill from LD-V-226 was adequate.

R2.2 Industrial Safety Issues
a. Inspection Scope (71801)
The purpose of this inspection was to review licensee actions in response to industrial safety issues.
b. Observations and Findings
Several issues occurred during the RCS decontamination that presented challenges to personnel safety. NRC findings discussed in Sections O1 and M1 described events involving the leakage of thermally hot and radioactivity contaminated water (leaks on July 27 and August 13), the loss of control of activated resin (August 11), and the failure of the rigging on a 5 ton floor block (August 2).

Several issues also occurred involving heat stress inside the containment and the RHR pit. Conditions within these plant areas usually exhibit adverse temperature and humidity conditions during the summer conditions. The containment temperature also rose due to the gradual heat up of the reactor cavity to 140° F, which added heat and humidity to the containment. Containment area temperatures rose to above 95° F. Similarly, in the RHR pit, the operating A RHR pump with 200° F fluid temperatures and no cooling to the RHR heat exchangers, caused the area temperature to increase above 100° F, with local area temperatures greater than 120° F.

Measures to help workers to deal with heat in the containment included the location of a water cooler close to the containment access, the use of “cool tents” on the charging floor, and the supply of ice vests. The licensee was slow to recognize the deterioration in working conditions in the RHR pit, and bolstered heat stress controls for the RHR pit only after two instances in which workers were almost overcome by heat while working in the pit (reference ACRs 98-629, 656 and 661).
c. Conclusions
The licensee was slow to respond to heat stress conditions in some plant areas. Once
focused on the issue, licensee controls of heat stress conditions improved.
R2.3 Waste Water Management
a. Inspection Scope (84750)
The purpose of this inspection was to review licensee actions to control RCS
decontamination waste water.
b. Observations and Findings
During the RCS decontamination, plant events resulted in the leakage of approximately 1200
gallons of decontamination process water on July 27, 1998, and approximately 125 gallons
on August 13, 1998. The water was contained within the existing plant drain systems. The
July 27, 1998 event water was collected in sump(s) and was pumped into the Aerated
Drain Tank (ADT) via sumps in the RHR pit and the spent resin tank pit. The water that was
released in the August 13, 1998 event was collected in the containment building sump and
was pumped to the ADT. The water from drains was collected in holding tanks until it can
be processed (reference drawings 16103 sheets 26018, 26030, 27049 and 50078). None
of the waste water has been processed or discharged.
The CORD process was designed to destroy the chemicals used during the decontamination.
However, the leaks occurred prior to the elimination of all the chemicals. Although the
licensee had planned to segregate the decontamination process water from normal plant
process water, this segregation did not occur because of the leaks. The waste water was
controlled within the plant without releases to the environment. The licensee and the State
of Connecticut Department of Environmental Protection (DEP) took samples of the affected
tanks for analysis and to characterize the waste. The characterization results are expected to
be completed by mid-September, 1998. The results of the evaluation will be used to
determine whether the waste water from decontamination activities can be processed under
the current NPDES permit, or will require separate authorization from the CT DEP.
The consequence of this matter was that the licensee waste water tanks were near full
capacity, such that the generation of additional waste water, such as from the rain water
collected within the radiologically controlled areas of the plant, further challenged the control
of tank inventories and building drains. The licensee planned to develop a method to direct
rain water from the outside diked area to the A waste test tank for processing and release in
accordance with the NPDES permit. This matter remained under review at the conclusion of
the inspection.

IV. Management Meetings
X1 Exit Meeting Summary
The inspectors presented the inspection results to members of licensee management periodically
during the inspection, and during a meeting with Mr. R. Mellor and Mr. J. Haseltine at the
conclusion of the inspection on September 11, 1998. The licensee acknowledged the findings
presented. The inspector reviewed with the licensee whether any materials examined during the
inspection should be considered proprietary. No proprietary information was identified.
X3 Management Meetings
On August 3, 1998, A.R. Blough, the Director of the Division of Nuclear Materials Safety, toured
the site and together with other NRC Region I and NRR staff met with licensee management on the
status of decontamination activities. The NRC requested information on root cause determinations,
corrective actions, and readiness to proceed safely with the next phase of the RCS
decontamination. This meeting was open for public observation. Following the conclusion of the
meeting, NRC staff remained to answer questions from members of the public.
On August 20, 1998, H. Miller, the NRC Region I Administrator, toured the site and met with
licensee management to discuss NRC concerns regarding licensee performance highlighted by recent
events. The NRC discussed the need to preclude operational events, along with the improvements
necessary in the areas of process controls, communications, planning and preparation for future decommissioning activities and evolutions.

On September 3-4, 1998, Mr. W. Axelson, Mr. T. Johnson, Mr. G. Pangburn, Mr. T. Fredrichs and Mr. W. Raymond toured the site and conducted interviews with 30 Haddam Neck workers, supervisors and managers. The purpose of the reviews was to obtain information on the organizational and management issues associated with the events during the RCS decontamination.

The NRC observations were discussed in a meeting with Mr. Don Davis on September 4, 1998. While the RCS decontamination leaks and events were contained inside the plant and did not endanger the public, the NRC remained concerned regarding the licensee’s performance. The NRC assessment to understand the reasons for the performance problems continued at the end of this inspection period. The NRC findings to date indicate employees are not reluctant to raise concerns and that performance problems do not appear to be linked to the licensee’s process for maintaining a safety conscious work environment.

PARTIAL LIST OF PERSONS CONTACTED

Russell Mellor, Vice President Operations and Decommissioning
Gary Bouchard, Unit Director
Kerry Harner, Chemistry Manager
Doug Heffernan, Maintenance Manager
Gerry Waig, Operations Manager
James Pandolfo, Security Manager
Richard Sexton, Radiation Protection Manager
Gerry van Noordennen, Nuclear Licensing
Pete Hollenbeck, Site Characterization Supervisor
Keith Sicles, Design Engineer
Edward Bingham, Engineering
John Haseltine, Engineering Director
Jay Tarzia, HP/Chemistry Technical Support
William Symczack, RCS Decontamination Program Manager
Robert Sojka, CYAPCO Decontamination Manager
Bert Mayer, Decontamination Project System Engineer
Frank Gilbert, Decontamination Project System Engineer
Patrick Holmes, Decontamination Project System Engineer
Robert Pritchard, Engineering Supervisor, Mechanical Systems

INSPECTION PROCEDURES USED

IP 37700: Design Changes and Modifications
IP 37801: Safety Reviews, Design Changes, and Modifications at PSRs
IP 40801: Self-Assessment, Auditing, and Corrective Action
IP 42700: Plant Procedures
IP 61726: Surveillance Observations
IP 62707: Maintenance Observations
IP 62801: Maintenance and Surveillance at Permanently Shutdown Reactors
IP 71707: Operational Safety Verification
IP 71801: Decommissioning Performance and Status Review at PSRs
IP 83750: Occupational Radiation Exposure
IP 84750: RadWaste Treatment, and Effluent & Environmental Monitoring
IP 92702: Follow-up on Corrective Actions for Violations and Deviations
IP 93702: Prompt Onsite Response to Events at Operating Power Reactors

ITEMS OPEN, CLOSED, AND DISCUSSED

Open
98-04-01 VIO Inadequate Procedure for RCS Decontamination (Leak Check)
98-04-02 VIO Inadequate Procedure for RCS Decontamination (Pressure Control)
98-04-03 VIO Inadequate Procedure for Purification Operation (Flows)
LIST OF ACRONYMS USED

ACP Administrative Control Procedure
ACR Adverse Condition Report
ADT Aerated Drain Tank
AEOD Office for Analysis and Evaluation of Operational Data
ALARA As Low As Is Reasonably Achievable
AOP Abnormal Operating Procedure
BZA Breathing Zone Analyzers
CCTV Closed Circuit Television
CFR Code of Federal Regulations
CVCS Chemical and Volume Control System
CYAPCo Connecticut Yankee Atomic Power Company
DEP Department of Environmental Protection
DF Decontamination Factor
F Fahrenheit
gpm gallons per minute
HEPA high efficiency particulate air
HP Health Physics
HPSI High Pressure Safety Injection
ips inches per second
IR Inspection Report
LDBP Letdown Booster Pump
LDRP Letdown Return Pump
MDP Master Decontamination Procedure
NOP Normal Operating Procedure
NOV Notice of Violation
NRC Nuclear Regulatory Commission
PAB Primary Auxiliary Building
PDR Public Document Room
RCA Radiological Controlled Area
RCS Reactor Coolant System
RHRR Residual Heat Removal
RP Radiation Protection
RWP Radiation Work Permits
RWST Refueling Water Storage Tank
SAR Safety Analysis Report
SFP Spent Fuel Pool
UFSAR Updated Final Safety Analysis Report
VCT Volume Control Tank
WCM Work Control Manual

TABLE 1
RCS DECONTAMINATION
MAJOR MILESTONES

DATE(s) EVENT
July 17-18 Additional verification of decontamination valve boundary
July 21 Begin RCS decontamination; A RHR and letdown pumps in service
July 22 Start system heat up to 200 F
July 23-26 Hold for purification system alignments and repairs
July 26 10:00 p.m. - start Cycle 1 permanganate acid injection
July 27 10:30 a.m. - Cycle 1 oxalic acid injection
July 27 12:38 p.m. - 1200 gallon leak of RCS decontamination fluid
July 27 - Leak recovery, repairs, event investigation and corrective actions

August 10
August 10 10:01 a.m. - Start Cycle 2 injection of oxalic acid
August 11 3:35 a.m. - C Demineralizer/Postfilter failure - loss of resin
August 13 Licensee decision to end decontamination after Cycle 2
August 13 7:07 p.m. - LDBP discharge pipe failure - 125 gallon leak
August 13-18 Leak recovery and repairs
August 18 Recommence final cleanup for Cycle 2
August 22 Alternate RCS cleanup using RHR purification
August 22 Start RCS cooldown via RHR cooling
August 24 Cycle 2 cleanup complete

August 24 -
September 11 A RHR remains in service for cooling and further RCS cleanup

Attachment II
References and Documents Reviewed
1. CYDE 98-644, Lessons Learned ACR 98-620, 8/8/98
2. Root Cause Report, ACR 98-620: Mechanical Failure in Purification
3. Root Cause Report, Mispositioned SI Valves for Tag Out 98020
4. Root Cause Report, Mechanical Failure in Purification System Revision 2
5. NCR 98-0073, Liquid Penetrant Exam of 1” dia. LDBP Recirc. Line Welds
6. NCR 98-0072, LDBP Recirc Line Visual and LPE of Sock-O-Let and Welds
7. SPL 10.11-1, Master Decontamination Procedure
8. SPL 10.11-9, Leak Check Of Purification Demineralizer and Piping
9. SPL 10.11-10, Flush of SFP Ion Exchanger and HPSI Header Discharge Piping
10. SPL 10.11-30, Leak Check Of Purification Demineralizer I-1-1B
11. SPL 10.11-24, Preoperational Flow Test and Leak Check
12. MMOD CY 98507, Jumper Reactor Pressure Vessel Head Deluge to Pressurizer
13. MMOD CY 98508 and 98509, Letdown Return Pump
14. MMOD CY 98511, Spent Fuel Pool Ion Exchanger Return Jumper
15. MMOD CY 98512, Letdown Orifice Removal and Piping Replacement
16. AWO CY 98-02226, Letdown Header Drain Isolation Temporary Repair Jumper
17. AWO CY 98-02289, 2”-AC-151R-101 Temporary Repair/Jumper
18. AWO CY 98-02278, Removal of Shield Blocks to Access LD-RV-252
19. AWO CY 98-02230, Letdown Booster Pump High Pressure Cutout Switch
22. CYDE 98-0222, RCS Decon Piping Structural Integrity Assessment
23. CY-J DH-98-025, Proto Power Model Testing for LD-V-238
24. ERT Report, Mispositioned Primary Water Isolation Valve
25. Preliminary Analysis of LDV266 Stub Tube Failure, dated August 7, 1998
27. Metallurgy Sample #2391 - Preliminary Assessment of Pipe at Valve LD-V-226
28. P&ID 16103-26018 Sh. 1 - Chemical & Volume Control Letdown to VCT
29. P&ID 16103-26018 Sh. 2 - Chemical & Volume Control Purification
30. P&ID 16103-26028 - Residual Heat Removal System
31. P&ID 16103-26030 Sh. 5 - Liquid Waste System Spent Resin Building
32. P&ID 16103-26030 Sh. 4 - Liquid Waste System Primary Drain Header
33. P&ID 16103 - 26030 Sh. 2 - Liquid Waste System Aerated Drains Tanks
34. P&ID 16103-27049 Arrangement Ion Exchangers and Resin Storage
35. P&ID 10899-FC-33A&B Dets. Sh.1 & 2 Ion Exchangers and Resin Storage Building
36. P&ID 16103-26018 Sh. 2&6 - Chemical&Volume Control (C&VC) Purification
37. DPM 98-155, Readiness to Proceed with Decontamination Cycle 2 & 3
38. CY-GHB-98-134, Apparent Cause Report, ACR 98646 - Dropped PAB Floor Block
39. AWO 98-2444, SFP Filter Inspection
40. AWOs 97-4324 and 98-2119, 2134, Postfilter FL-65-1A Inspection and Cleaning
41. Jumper Device 98-36, Postfilter FL-65-1A Element Replacement
42. Technical and Safety Evaluation DP 98-145, IS-1-1C Postfilter Retention Element
43. SPL 10.1-48, RHR Purification System Operation
44. NOP 2.7-1, Reactor Coolant Letdown Post Filter and Purification Demineralizers
45. SPL 10.1-54, Alternate RHR Purification