

U. S. NUCLEAR REGULATORY COMMISSION

REGION I

Report No. 84-20
Docket No. 50-271
License No. DPR-28 Priority -- Category C

Licensee: Vermont Yankee Nuclear Power Corporation
RD 5 Box 169, Ferry Road
Brattleboro, Vermont 05301

Facility Name: Vermont Yankee Nuclear Power Station

Inspection at: Vernon, Vermont

Inspection Conducted: July 17-31, 1984

Inspectors: William J. Raymond 8/24/84
W. J. Raymond, Senior Resident Inspector

Glen W. Meyer 8/30/84
for Lowell E. Tripp, Chief, Reactor Projects
Section 3A, Projects Branch 3

Inspection Summary:
Inspection on July 17-31, 1984 (Inspection Report No. 50-271/84-20)

Areas Inspected: Special announced inspection by the resident inspector of the July 17, 1984 loss of secondary containment event, including the event sequence and consequences, personnel actions, and reportable occurrence evaluations. The inspection involved 34 hours on site by the resident inspector.

Results: Three apparent violations were identified regarding: the failure to maintain secondary containment integrity on July 17, 1984 as required by technical specification 3.7.C.1 - paragraph 5.0; failure to prepare a safety evaluation in accordance with AP 0020 for a change to the facility effected by mechanical bypass 84-14 - paragraph 7.0; and, failure of plant workers to process a system tagging request or otherwise obtain shift supervisor permission to perform work without tags - paragraph 7.0.

DETAILS

1. Persons Contacted

Vermont Yankee Nuclear Power Corporation

Mr. D. Allen, Reactor Engineering Assistant
Mr. R. Branch, Assistant Operations Supervisor
Mr. B. Metcalf, Shift Supervisor
Mr. R. Pagodin, Engineering Support Supervisor
Mr. J. Pelletier, Plant Manager
Mr. D. Porter, Shift Supervisor
Mr. D. Reid, Operations Superintendent

Mercury Company

Mr. A. Douda, Construction Superintendent
Mr. J. Leh, Construction Superintendent

2. Inspection Summary

A special inspection was conducted on July 17-31, 1984, to review the events related to a loss of secondary containment on July 17, 1984, while fuel movement was in progress in the spent fuel storage pool. The inspection was initiated following a 10 CFR 50.72 report made by the shift supervisor to the NRC Duty Officer at 5:40 A.M. on July 17, 1984. The chronology and event details that follow were developed from a review of plant records and are based on interviews with licensee and contractor employees.

The loss of secondary containment occurred from about 12 midnight until about 3:30 A.M. on July 17, 1984, while fuel was moved in the spent fuel pool to support fuel and channel inspection activities. Secondary containment integrity was lost when workers opened a two inch diameter service water line at a connection point to a refueling floor ventilation unit during the implementation of a mechanical bypass request. The partially operating service water system made the return piping more negative than the reactor building atmosphere, which caused air from the refueling floor to be drawn into the service water system. A leakage path was thus established from the refueling zone air space through the service water return piping to the main condenser discharge block and thereafter to the circulating water outfall at the station discharge structure. Secondary containment was re-established by operations personnel at about 3:30 A.M. when a mechanical cover was affixed to the open service water line.

The failure to maintain secondary containment during the movement of irradiated fuel constituted a violation of Technical Specification 3.7.C.1. The loss of secondary containment was caused principally by a failure of the workers to follow the administrative controls established in AP 0025 by opening the service water system without obtaining tags for the job or otherwise informing operations personnel that work was going to proceed without tags. The event was also caused, in part, by the failure of engineering personnel to complete a proper review and evaluation of the implementation of the mechanical bypass.

3. Plant Conditions Prior to the Event

The plant was in a shutdown condition for a refueling and maintenance outage which began on June 15, 1984. Fuel and channel inspection activities were in progress during the swing and mid shifts on July 16-17, 1984. The reactor mode switch was in the Refuel position. Secondary containment was established to support the spent fuel pool work. A performance check of the standby gas treatment system was satisfactorily completed on July 13, 1984.

Another outage activity in progress on July 17, 1984, involved the modification of the service water (SW) lines at the discharge of the recirculation motor generator set lube oil coolers in accordance with Plant Design Change Request (PDCR) 84-01. The SW system valve lineup was modified by Switching and Tagging Order (S+TO) 84-650 in accordance with AP 0140 on July 4, 1984 to support the PDCR activities by isolating the service water header supplying the lube oil coolers.

The valve tagging boundary established by S+TO 84-650 was proper to complete the PDCR 84-01 modifications. However, the tagging boundary also isolated the service water supply to 7 reactor recirculation units (RRUs 10-16) inside the reactor building, along with the supply to four air conditioning units (RBACs 1A-1D) on the refuel floor. RBAC cooling water return valve, 23C, was closed by S+TO 84-650, but cooling water supply valve, 23D, was left open in accordance with the SW system operating procedure. The partial SW system isolation effected by the tagging order remained in effect for several weeks during the implementation of PDCR 84-01.

The licensee recognized the adverse impact that the loss of air conditioning would have on refuel floor working conditions. On July 3, 1984, the Engineering Support Department (ESD) initiated mechanical bypass request (MBR) 84-14 in accordance with AP 0020 to provide a temporary source of cooling water to RBAC-1B during the installation of PDCR 84-01. Temporary cooling would be provided from the fire water system by constructing temporary piping from fire system valve 321 to RBAC-1B. The alternate cooling supply would be connected to RBAC-1B by opening a 2 inch diameter threaded joint just downstream of the normal supply isolation valve, V70-505B, located at the cooler. Cooling water from RBAC-1B would return to the service water discharge through the normal return lines.

MBR 84-14 was initiated by an ESD engineer and was reviewed for technical accuracy by a second engineer (this second review was not documented on the MBR). On July 3, 1984, the Engineering Support Supervisor (ESS) approved the request (step e of VYAPF 0020.02) as the supervisor of the 'originating department' responsible for the proposed change, on the basis of the technical acceptability of the materials used to construct the temporary piping. A fire permit was required while the mechanical bypass was in effect and system retest requirements were specified.

The Engineering Support Supervisor further approved the request (Step f of VYAPF 0020.02) after performing an evaluation which concluded that a safety evaluation in accordance with 10 CFR 50.59 was not necessary prior to making the facility modifications.

No further actions were taken under MBR 84-14 on July 3, 1984. Further action on the request was deferred pending receipt of the materials necessary to construct the temporary piping.

4. Event Details

The materials required for MBR 84-14 were available on July 16, 1984, and the request was assigned to a contractor work party for installation. The shift supervisor on the swing shift on July 16, 1984 completed the reviews required by the Operations Supervisor (Step g of VYAPF 0020.02) and determined that installation of the bypass would not impact plant operations nor affect compliance with the technical specifications. The shift supervisor approved the request (Step h of VYAPF 0020.02), indicating that implementation of the request was allowed by existing plant conditions. Upon granting his approval, the duty shift supervisor instructed the workers to return to the control room, after obtaining materials from the Stores Department, to determine the tagging boundary that would be needed to do the job.

After obtaining materials from stores, the workers went to the work site on the refueling floor to scope out the effort required to implement the bypass. It was determined that all materials were available to proceed with the job. The work party leader concluded that no tagging order would be required to complete the bypass, since (i) the service water system was "shutdown"; and, (ii) valve 505B was going to be removed from the system.

The first action taken by the workers was to open a one-quarter inch vent valve (507B) to determine whether or not the system was under pressure. The workers noted that the service water line sucked air into it when the valve was opened at about 12 midnight on July 17, 1984. The workers proceeded to construct the temporary piping to span the 6 foot distance from fire system valve 321 to the RBAC-1B connection point. After noting that air was still being drawn through the open vent valve, the workers concluded that water in the lines was draining to lower elevations within the service water system. Valve 505B was disconnected from the cooler to assist the draining process, which created a two inch diameter opening in the supply line. Air continued to be drawn into the piping.

The opening at valve 505B created the following flow path from the refueling floor to the outside atmosphere: 2 inch diameter opening in RBAC-1B service water supply line; to the 4 inch diameter refuel floor RBAC supply header; to the open RBAC supply isolation valve 23D; to the branch header for service water supply to RRUs 10-16; to the RRU service water return header; to the 18 inch diameter SW-12 service water branch return line; to the 20 inch diameter SW-12 return header; to the 24 inch diameter SW-24 return header;

to the main condenser circulating water discharge block in the turbine building; and, to the station discharge structure at the Southeast end of the site.

The workers finished constructing the temporary piping up to the cooler connection point, but did not make the final tie-in. The final connection was deferred until the day shift to allow time for the glue used on the PVC piping to dry. The workers finished the job at about 1:15 A.M. and left the job site. Prior to leaving, the work party leader contacted the control room to report the status of the job. The fact that air was still being drawn into the service water line was communicated to the control room. The full significance of that condition was not appreciated at the time but the condition was noted for further investigation and followup.

The duty shift supervisor went to the refueling floor sometime after 3:00 A.M. to investigate the open service water line. After inspecting the work location, he suspected that a leak path could exist, but the flow path was not readily apparent. The shift supervisor affixed some duct tape to the 2 inch opening at about 3:30 A.M. and returned to the control room to review piping diagrams. The duct tape was subsequently sucked into the opening and a more rigid make-shift cover was affixed to the opening while the review continued.

During the period from 12 midnight until 3:30 A.M., the following moves occurred within the spent fuel pool (as recorded on SNM Transfer Form 0400.02, Sheet #1130):

- 1:52 A.M. - assembly LJU 720 moved from SFP PM-2 to SFP U-34
- 2:01 A.M. - assembly LJU 719 moved from SFP T-31 to SFP PM-2
- 2:10 A.M. - assembly LJP 268 moved from SFP PM-1 to SFP BB-32

The shift supervisor recinded his approval to move fuel pending completion of his review of the suspected leakage path. Planned fuel moves within the spent fuel pool were suspended as of about 3:30 A.M. on July 17, 1984.

After a review of the system flow diagrams, the shift supervisor concluded that (i) a vent path from the refuel floor to the outside environment had existed; and, (ii) service water RBAC supply isolation valve 23D should have been closed to isolate the supply header. These observations were entered in the shift supervisor's log at 3:52 A.M. A shift supervisor hold tag was placed on valve 23D at about 5:00 A.M. (S+T0 84-812) and the valve was closed. Plant operators removed the temporary cover from the service water line opening and verified that no leakage occurred with valve 23D closed.

The shift supervisor reviewed AP 0156 for applicable reporting requirements. A call was made to the NRC Duty Officer at 5:40 A.M. on July 17, 1984 in accordance with AP 0156, Appendix B, Item 3.c - Four hour notification for

any event that alone could have prevented the fulfillment of a safety function of a system needed to control the release of radioactive material. A Potential Report Form was submitted per AP 0010. The shift supervisor allowed fuel moves to resume later on July 17, 1984, after establishing control over the opening in the service water line.

5. Performance of Affected Systems

The safety design basis and safety evaluation for the secondary containment system are described in Section 5.3 of the FSAR. The secondary containment is designed to minimize any ground level release of radioactivity which might result from an accident. It is the only barrier to a release to the environment for an accident involving a dropped irradiated fuel assembly. The secondary containment system consists of the reactor building, the standby gas treatment system (SGTS), the reactor building normal HVAC system and the reactor building penetrations. The plant technical specifications define secondary containment integrity to mean that the reactor building is intact and, the following conditions are met: at least one door in each access opening is closed; the SGTS is operable; and, all automatic building isolation valves are operable or closed.

Radiation monitors installed on the refueling floor would detect the release of radiation that may result from a dropped fuel assembly and would initiate automatic actions to isolate the secondary containment and start the SGTS to provide for an elevated, filtered release point for radioactive material. These automatic actions would mitigate the consequences of the accident, as described in FSAR Sections 5.3 and 14.6.4.

The fact that air flowed from the refueling floor into the service water system (and thence to the environs) demonstrated that a leakage path existed that could have bypassed the intended release point. The reactor building was therefore not intact, and thus, secondary integrity was not maintained during the period from 12 midnight to 3:30 A.M. on July 17, 1984. The open service water line would have allowed radioactive material to bypass the engineered safeguard systems designed to mitigate the consequences of an accident had one occurred.

There was no release of radioactive material during that time, and thus there was no actual adverse safety impact created while the opening existed. However, there was a potential for an adverse safety impact.

Technical Specification 3.7.C.1.d requires that secondary containment integrity be maintained when irradiated fuel is being moved in the reactor building. The failure to meet the limiting condition for operation for Technical Specification 3.7.C.1.d from about 12 midnight to about 3:30 A.M. on July 17, 1984 is considered a violation (VIO 84-20-01).

6. Licensee Immediate Corrective Actions

The licensee reviewed the events of July 17, 1984, to determine what items contributed to the event and what additional actions should be taken. The

following is a summary of the licensee's conclusions and immediate corrective actions. The actions taken by the shift personnel on July 17, 1984, are included for completeness.

- a. Upon discovery of a suspected leakage path, shift personnel halted movement of irradiated fuel in the reactor building. Shift personnel subsequently issued a tagging order to close service water valve 23D to isolate the unintended flow path and establish a proper tagging boundary for implementation of MBR 84-14.
- b. Shift personnel reported the event in accordance with administrative procedures to the NRC Duty Officer and licensee management.
- c. Licensee management reviewed the event with the personnel involved with the work on July 17, 1984. This review concluded that the event resulted from the error by the workers of not obtaining a tagging order to do the work in accordance with the requirements of OP 0140, VY Local Switching and Tagging Rules.
- d. The licensee determined that the instructions of AP 0020 should be reviewed to determine whether further clarifications were warranted regarding the control of tagging operations in conjunction with mechanical bypasses.
- e. The licensee determined that the presence of radiation monitor RAM 17-332 in the service water effluent stream to the condenser discharge block would have provided for a monitored release through the service water system. Any increases in radiation levels in the service water discharge stream would have been alarmed in the control room.
- f. The licensee concluded initially that the opening in the service water line did not represent a breach in containment based on a correlation provided in procedure OP 5216, Secondary Containment Penetration. The determination by shift personnel on July 17, 1984, that resulted in the NRC notification was considered to have been appropriate, but conservative.

OP 5216 provides a correlation between the performance of the SGTS and the maximum allowable sized penetration ("hole") that SGTS could pull against and still maintain the building at a negative pressure. Based on a July 13, 1984 SGTS performance test conducted in accordance with OP 4116, operation of either SGTS train could have maintained the reactor building at an average building vacuum of 0.197 inches of water. The maximum allowable penetration size corresponding to this vacuum would be an equivalent sized hole of about 5 inches in diameter. Thus, the 2 inch diameter opening in the service water system on July 17, 1984 was considered to be well within the capability of SGTS, had it been required to start in response to an accident signal.

Based on the above actions and the reviews completed as of July 19, 1984, the licensee concluded that no LCO violation had occurred.

The above assessment was discussed with the Operations Superintendent on July 19, 1984. Further review of the July 17, 1984 containment conditions showed that the reactor building was being maintained at -0.90 inches of vacuum due to the operation of the normal building ventilation system. Since the service water system was pulling air through the opening against that negative pressure, it was apparent that operation of the SGTS would not have terminated leakage out of the opening in the service water line.

Based on the above, the inspector requested the licensee to reconsider his initial assessment, to address whether an LCO violation had occurred and to document the bases for his conclusions in an engineering evaluation. The licensee subsequently completed a review of the issue and concluded in the Potential Report Form and attached evaluation dated July 23, 1984, that a violation of secondary containment integrity had occurred on July 17, 1984.

During a discussion of this matter with the Plant Manager on July 31, 1984, the inspector inquired whether an evaluation had been completed to address the potential safety significance of a refueling accident had one occurred under the conditions of July 17, 1984. The licensee stated that a preliminary informal assessment had been completed to show that a refueling accident on July 17, 1984 would have resulted in no significant safety impact. The licensee stated that an additional analysis would be completed and the results would be made available for review. These results are described further in paragraph 9.0 below.

7. Administrative Procedures and Requirements

Licensee procedures AP 0020, Temporary Electrical Jumpers, Lifted Leads and Mechanical Bypasses, Revision 7 and AP 0025, Plant Equipment Control, Revision 4, provide controls over the activities of July 16 and 17, 1984.

Steps 1, 2 and 4 of AP 0025 specifies that the leader of a work party assigned to perform work on plant equipment must first contact the duty shift supervisor to:

- (i) explain what work he intends to do;
- (ii) describe how he intends to do it; and,
- (iii) obtain the permission of the shift supervisor to proceed with the activity.

The workers can then proceed with the job after mutual agreement has been reached between the shift supervisor and the work party leader that plant

conditions are satisfactory to support the intended activity. Inherent in this review process is the determination whether tagging in accordance with AP 0140 is required to complete the work activity.

The primary cause for this event was the failure to initiate a tagging order in accordance with AP 0140 when MBR 84-14 was implemented to establish an isolation boundary prior to opening the service water system. The failure to process a tagging request and obtain final permission from the shift supervisor to proceed with the job was contrary to the requirements of AP 0025 and Technical Specification 6.5.1 (VIO 84-20-02).

Step E of AP 0020 states that a safety evaluation is required to perform a mechanical bypass if the bypass request renders the plant unlike the written or pictorial description in the FSAR, unless the following conditions are met for the proposed modifications.

- (1) the technical specifications allow removal of the equipment from service per AP 0025;
- (2) the request is for a maintenance activity with no interim operational configuration intended to be installed; or,
- (3) the request has no significance to plant safety.

A contributing cause for the event was the failure to perform an adequate review of the proposed facility modification when MBR 84-14 request was initiated on July 3, 1984. The review was incomplete because a safety evaluation was not performed to assess the potential impact on plant safety during the interim configurations created while the bypass was being installed. The correct conclusion in response to the question of Step f on form VYAPF 0020.02 was that a safety evaluation in accordance with 10 CFR 50.59 was required, as indicated by General Requirements - Step E of AP 0020, and Item (3) above.

The review conducted on July 3, 1984 failed to consider what impact the opening in the cooling water supply line would have on reactor building integrity and service water system performance. The review failed to establish what the service water system isolation boundary should be during installation and removal of the mechanical bypass request. While it is recognized that actual tagging operations must be performed at the time a request is implemented, it appears that the proper system tagging boundary should have been identified during the engineering review process that occurred when the MBR was initiated. Once the appropriate tagging boundary is identified, then workers need only determine whether the job is covered by existing tags at the time the request is implemented.

The failure to complete a safety evaluation in accordance with 10 CFR 50.59 for MBR 84-14 was contrary to the requirements of AP 0020 and Technical Specification 6.5.1 (VIO 84-20-03).

8. Reports to NRC

As noted above, the shift supervisor notified the NRC Duty Officer at 5:40 A.M. on July 17, 1984, of a condition that could have resulted in the loss of a function required to control the release of radioactive material. The telephone notification satisfied the requirements of 10 CFR 50.72, Section 50.72(b)(2)(iii). The licensee subsequently issued a Potential Report Form on July 23, 1984 and concluded that the event was also reportable to the NRC in accordance with sections 50.73(a)(2)(i) and 50.73(a)(2)(v). A licensee event report in accordance with the above requirements is due by August 17, 1984. This item is unresolved pending submittal of the licensee event report and subsequent review by the NRC (UNR 84-20-04).

9. Licensee Followup Actions

The licensee summarized additional reviews and actions that were taken during a meeting with the Plant Manager on August 5, 1984. The licensee removed the responsible work party leader from the list of authorized personnel who could request tags in accordance with AP 0140. This action was taken based on the licensee's conclusion that the event resulted from personnel error by not following the established instructions for the control of plant equipment. The controls in AP 0140 and 0020 were reviewed and determined not to have been a contributing factor to the event.

The licensee's analysis for a refueling accident as a design basis event is described in FSAR Section 14.6.4. The results of the accident analysis shows the offsite dose to be well below the guidelines provided in 10 CFR Part 100, as listed in FSAR Tables 14.6.10A and 14.6.10B. The major differences between the conditions that existed on July 17, 1984 and those assumed in the FSAR safety analysis were as follows:

- + The FSAR assumed that all radioactive material would be released from the stack, an elevated release point, after filtration through the standby gas treatment system. The release path through the open service water system would traverse about a 1000 feet of piping from the refuel floor to the condenser discharge block and then as much as an additional 1000 feet from the condenser to the discharge structure. Much of the discharge path would be through water in the service and circulating water piping. Thus, a release on July 17, 1984 through the service water system would have been a partially filtered, ground level release.
- + The FSAR assumed a fission product inventory that exists soon after shutdown from power operation. The source term available on July 17, 1984 was substantially less due to the 30 days of plant shutdown since the start of the refueling outage.
- + The FSAR assumed the fuel handling accident occurs over the reactor vessel where the distance a fuel assembly can fall from is the greatest.

All fuel movement on July 17, 1984 occurred in the spent fuel pool, which would have resulted in less fuel damage than that analyzed for.

The licensee completed a bounding analysis for the results of a fuel handling accident under the conditions that prevailed on July 17, 1984. The analysis considered that the entire release goes through the vented path. A factor of 10 reduction was incorporated in the analysis for the retention of iodine by water in the discharge pathway. The analysis took no credit for the following in determining the projected dose:

- (i) Partial iodine removal by the standby gas treatment system - all activity was assumed to go out the service water system.
- (ii) FSAR assumes fuel falls through air over the core and all pins break. The kinetic energy of a dropped fuel assembly would be reduced by a factor of 3.5 due to the fact that fuel was moved only over the spent fuel pool on July 17, 1984. Any reductions due to water resistance were also not considered.
- (iii) FSAR assumed a 7X7 fuel type whereas P8X8R is the present fuel used. A 4% to 10% reduction in activity was not taken.
- (iv) Credit for neither meteorological conditions nor large reductions for dispersion were considered.
- (v) The FSAR assumed power levels of 1665 MWt and the plant operates at a maximum power of 1593 MWt. Thus, an additional 5% reduction in activity was not taken.

The licensee's analysis determined that an individual at the discharge structure (site boundary) would have received no more than 20% of the 10 CFR Part 100 thyroid dose, or 60 Rem. The actual estimated dose would be significantly less than that value if the above considerations were incorporated in the analysis. The whole body dose would have been negligible. Based on the above, the licensee concluded that the dose generated by the hypothetical accident would be well below the 10 CFR 100 limits, and therefore, no consequences to the health and safety of the public due to the event could have occurred. The licensee's analysis and conclusions will be subject to further review by the NRC staff. This item is open pending completion of that review (IFI 84-20-05).

10. Management Meetings

The inspector met with licensee management at various times during the inspection period to present inspection findings and to obtain the status of the licensee's review findings and corrective actions. These items are as summarized above. A final oral summary of the inspection findings was presented prior to issuance of the inspection report. The inspector informed the licensee that the inspection findings were under consideration for escalated enforcement actions in accordance with 10 CFR 2. The licensee acknowledged the inspector's comments.