VERMONT YANKEE
NUCLEAR POWER CORPORATION

Ferry Road, Brattleboro, VT 05301-7002

REPLY TO:
ENGINEERING OFFICE
580 MAIN STREET
BOLTON, MA 01740
(508) 779-6711

January 28, 1997
BVY 97-17

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

References:
(a) License No. DPR-28 (Docket No. 50-271)
(b) USNRC Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," NVY 96-151, dated September 30, 1996
(c) Letter, VYNPC to USNRC, BVY 96-136, dated October 30,1996
(d) Letter, VYNPC to USNRC, "Amendment No. 22 to License Application dated December 22, 1996" dated February 25, 19[illegible]
(e) GOTHIC Analysis of a Containment Fan Cooler Unit Under LOCA & LOOP Conditions, EPRI, May 1996
(f) Waterhammer Prevention, Mitigation and Accommodations, EPRI NP-6766, Volume 5, Part 1, July 1992

Subject: Vermont Yankee 120-Day Response to Generic Letter 96-06

In Reference (b) NRC notified licensees about safety-significant issues that could affect containment integrity and equipment operability during accident conditions. The NRC requested licensees to evaluate the susceptibility of their plant systems to the identified conditions and report within 120 days the results of their evaluation. The purpose of this letter is to provide the requested information.

Attachment 1 provides a summary of our evaluation of the information in Reference (b). In performing this evaluation, we considered Vermont Yankee's postulated accident conditions and the scenarios referenced in the Generic Letter. Where appropriate, we have also addressed the operability of related systems.

We trust that the information provided is acceptable. However, should you have any questions or require additional information, please contact this office.

Sincerely,

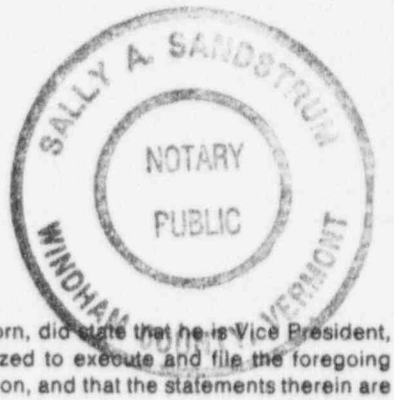
VERMONT YANKEE NUCLEAR POWER CORPORATION

Donald A. Reid
Vice President, Operations

A072

Attachment

cc: USNRC Region 1 Administrator
USNRC Project Manager - VYNPS
USNRC Resident Inspector - VYNPS



STATE OF VERMONT)
)ss
WINDHAM COUNTY)

Then personally appeared before me, Donald A. Reid, who, being duly sworn, did state that he is Vice President, Operations, of Vermont Yankee Nuclear Power Corporation, that he is duly authorized to execute and file the foregoing document in the name and on the behalf of Vermont Yankee Nuclear Power Corporation, and that the statements therein are true to the best of his knowledge and belief.

Sally A. Sandstrum

Sally A. Sandstrum, Notary Public
My Commission expires February 10, 1999

**Vermont Yankee's 120-Day Response to NRC Generic Letter 96-06:
Assurance of Equipment Operability and Containment Integrity During
Design-Basis Accident Conditions**

Requested Information

Within 120 days of the date of this generic letter, addressees are requested to submit a written summary report stating actions taken in response to the requested actions noted above, conclusions that were reached relative to susceptibility for waterhammer and two-phase flow in the containment air cooler cooling water system and overpressurization of piping that penetrates containment, the basis for continued operability of affected systems and components as applicable, and corrective actions that were implemented or are planned to be implemented. If systems were found to be susceptible to the conditions that are discussed in this generic letter, identify the systems affected and describe the specific circumstances involved.

Response

Executive Summary

Vermont Yankee has completed a review of the information provided in Generic Letter 96-06 and performed an assessment of the susceptibility of Vermont Yankee Nuclear Power Station (VYNPS) to the conditions described therein. This assessment considered not only Vermont Yankee's postulated accident conditions but also the scenarios referenced in the Generic Letter. As a result of our assessment, we have determined that: (1) VYNPS is not susceptible to over-pressurization of isolated piping since over-pressure protection was installed during the Fall 1996 refueling outage to address this concern, and (2) the section of our Reactor Building Closed Cooling Water (RBCCW) system that provides cooling water to our containment coolers is potentially susceptible to waterhammer conditions. Vermont Yankee has determined that the RBCCW system is operable, but will evaluate any necessary long-term actions in accordance with our Corrective Action program.

Background

The containment air coolers at Vermont Yankee are supplied by cooling water from the RBCCW system. The cooling water enters the drywell through a single penetration and is then distributed to the four containment cooling units, the cooling coils for each recirculation pump, and the drywell equipment drain sump cooling coil. The water exits the drywell through another single penetration. The RBCCW system also supplies cooling water to other components and systems within the Reactor Building. The cooling water is circulated by one pump, with a redundant pump in a standby mode which starts automatically on low system pressure. None of the equipment served by the RBCCW system is required to function following a Design-Basis Accident (DBA). A more detailed description of the RBCCW system can be found in the Vermont Yankee Updated Final Safety Analysis Report, Section 10.9.

The four containment air coolers have been upgraded from the original design and are designated as RRUs 1,2,3 and 4. Each RRU has two fans located in common ducting, so that either or both fans will draw air across the common cooling coil. The RRUs at Vermont Yankee do not perform a design-basis post-accident containment cooling function. In fact, an accident signal (high drywell pressure or low reactor water level with low reactor pressure) will trip the fan motors.

Cooling water circulates continuously through each RRU during normal operation. Power for the RBCCW pumps is from 480 Volt buses that receive emergency electrical power from the standby diesel generators. In the event normal electrical power is lost, the RBCCW pumps are automatically restarted 60 seconds after emergency power is restored to the bus. Under DBA conditions, the RBCCW pump would restart approximately 73 seconds after the initiation of the accident. However, as previously stated, the RBCCW System is not required to mitigate the consequences of a DBA. The pumps are automatically restarted upon restoration of emergency power as an operator convenience and to minimize the potential negative impact of the loss of cooling water flow to non-essential systems.

Discussion

Thermal Overpressurization

Generic Letter 96-06 reported the potential for an overpressurization of isolated piping segments due to the heat up and subsequent thermal expansion of entrapped fluid. This issue was resolved by Vermont Yankee during the Fall 1996 refueling outage with the installation of pressure relief devices in piping determined to be susceptible to thermal overpressurization. Vermont Yankee installed relief valves in the RBCCW and Radwaste systems and check valves in the Main Steam Drain, RHR Shutdown Cooling, and Nuclear Boiler (Sample) systems.

The relief valves were installed in, and relieve into, the primary containment. The check valves relieve overpressure to the upstream side of each respective inboard isolation valve to the reactor pressure vessel. The rate of thermal expansion of isolated fluid, relief requirements as well as the effects of stuck-open relief valves and associated environmental flooding and radiation hazards were considered. The new valves were, and will continue to be, tested in accordance with 10CFR50, Appendix J.

Two Phase Flow and Waterhammer

Generic Letter 96-06 provides a description of circumstances at other nuclear plants where the generation of two phase flow conditions in containment air coolers had the potential to impact the design-basis heat removal capability of the containment coolers. The primary concern identified was the degradation of cooling water flow and design-basis heat removal capability. Since Vermont Yankee does not rely on its containment coolers or other RBCCW-cooled components for design-basis heat removal, the generation of two phase flow in the containment cooling piping is not a concern at Vermont Yankee in the context of heat removal degradation.

Generic Letter 96-06 also provides a description of circumstances at other nuclear plants which concluded that during a design-basis LOCA with concurrent loss of offsite power, cooling water in the containment fan coolers could flash to steam. Subsequent restart of the cooling water pumps could result in rapid collapse of the steam voids, resulting in a waterhammer induced loading condition that could challenge the integrity and function of the fan coolers and the component cooling water system. Both of the nuclear units discussed in Generic Letter 96-06 depend on the fan coolers for post-accident containment heat removal.

The containment cooling units at Vermont Yankee do not perform a design-basis post-accident containment cooling function. However, the portion of the RBCCW system that is within the drywell is considered a closed system in accordance with 10CFR50, Appendix A, General Design Criterion 57. This part of the system is considered an extension of the containment and as such is maintained as a seismic Category 1, Safety Class 2 system. The RBCCW piping inside the drywell is credited as one of the two required barriers; the isolation valves on the supply and return lines constitute the second barrier. Therefore, a waterhammer induced load has been evaluated at Vermont Yankee because of its potential to affect the integrity of one of the two containment barriers.

Vermont Yankee determined that for boiling to occur in the coils the temperature of the cooling water must reach 272°F. The driving force for heat transfer to the cooling water is the ambient condition in the drywell following a LOCA. The Design-Basis LOCA, a guillotine break of a recirculation line (UFSAR Section 14.6.3.3) with a coincident loss-of-offsite-power (LOOP), causes drywell temperature to exceed 272°F for approximately 15 seconds (UFSAR Figure 14.6-6). Drywell temperature drops below 272°F 16 seconds into the event and remains below 272°F thereafter. A heat transfer study has shown that the cooling water temperature will lag the increase in containment temperature. Since the containment temperature will be decreasing below 272°F when the cooling water temperature reaches saturation, boiling of the containment cooling water will not occur. Therefore, for the DBA LOCA there is reasonable assurance that waterhammer will not occur when RBCCW flow through the containment coolers is restored 73 seconds into the event.

Vermont Yankee also considered a main steam line break (MSLB) with a coincident LOOP. Reference (d) reported the analysis results of a number of steam line breaks ranging in size from 0.02 ft^2 to 0.5 ft^2. The analysis demonstrated that drywell temperature would remain below the saturation temperature of the containment cooling water for the first 73 seconds of the accident. Therefore, for this spectrum of breaks, containment cooling water flow would be restored prior to the onset of void formation within the containment coolers, providing reasonable assurance that waterhammer would not occur for these scenarios.

Vermont Yankee does not have a plant-specific analysis for MSLB >0.5 ft^2 and therefore has conservatively assumed that waterhammer could occur for such an event. In its analysis of waterhammer, EPRI postulates that the loads associated with the reintroduction of cooling water flow would be mitigated by the presence of hot water on either side of the void region [Reference (e)]. That is, the hot water would slow down the condensation rate of the steam voids and thus reduce the pressure differential for accelerating flow. Additionally, the pressure in the steam region would not drop below the saturation pressure of the heated water. Thus, a steam void would remain to mitigate waterhammer impact loads.

In attempting to quantify the anticipated waterhammer loads, Vermont Yankee has used EPRI guidelines, Reference (f), for estimating loads for water filling a voided line or water column rejoining. The estimated load relative to the water column velocity is between 25 psi per 1 ft/sec and 50 psi per 1 ft/sec. The water velocity in the cooling coil tubes during normal operation is about 4 ft/sec. The estimated loads would thus be between 100 and 200 psi. If the water slug is assumed to be accelerated by the steam bubble collapse, the impact velocity would increase relative to the initial velocity. Again from Reference (f), if the initial column length in the cooling coil tube is at least 1% of the total length, the velocity could be increased to 1.5 times the initial velocity. In this case, the loads would be between 150 and 300 psi. The containment cooling coils at the VYNPS were pneumatically tested at 200 psig and hydro tested at 300 psig. Therefore, the expected waterhammer induced loads on containment cooling piping are within piping design limits and operability is maintained.

Conclusion

Vermont Yankee has installed modifications that will preclude overpressurization of isolated piping at VYNPS and has concluded that there is reasonable assurance that waterhammer will not occur upon restoration of containment cooling following a DBA LOCA with a coincident LOOP. Additionally, in the event of a steam line break inside containment (MSLB) Vermont Yankee has determined that containment operability would also be maintained. Vermont Yankee will continue to follow industry activities in this area and to refine its analyses to better quantify the likelihood of waterhammer and the severity of its effects on the containment cooler piping.