UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY OFFICE OF NUCLEAR REACTOR REGULATION

WATER HAMMER EVENTS

MILLSTONE STATION, UNIT NO. 1

DOCKET NO. 50-245

1.0 INTRODUCTION

By letter dated April 27, 1982, Northeast Nuclear Energy Company (the licensee)(NNECO) provided:

- o updated responses to NRC questions related to water hammer events in the Millstone Unit No. 1 isolation condenser steam inlet piping;
- o the basis for their belief that circumferential cracks, detected during the last inservice inspection outage (October 1980), occurred as the result of chloride contamination. The cracks were detected in a pipe-to-isolation condenser safe-end weld, isolation condenser steam supply line welds, and a weld in the shutdown cooling "A" line;
- o a commitment and implementation schedule for design changes to prevent reactor vessel overfill that has in the past caused iso-condenser steam supply line water hammer and unintentional automatic isolation of the iso-condenser (an emergency safety feature (ESF) required when at reactor power levels in excess of 40%).

With regard to the last item above, the licensee states that: (1) a high reactor vessel level feedwater pump trip system will be designed and installed during the refueling outage currently scheduled to begin about October 1982. At the same time the automatic reactor water cleanup system isolation setpoint will be lowered; and (2) automatic reactor level setdown following reactor trip and low-flow feedwater controller improvements will be implemented by midyear 1984.

2.0 EVALUATION

2.1 Water Hammer and Pipe Supports

On December 19, 1979, a water hammer incident in the steam inlet line to the isolation condenser resulted in minor concrete damage at containment penetration X-10A. Also, some expansion anchor bolts at other supports of the isolation condenser piping system were pulled slightly out of the concrete. Our letter dated

November 6, 1981 forwarded our Safety Evaluation and concluded that by strengthening the supports on the isolation condenser steam supply line the piping could withstand the effects of water-hammer loads. However, one design area did not, at that time, comply with NRC I&E Bulletin 79-02 which required a safety factor of at least four for expansion anchor bolts under all design conditions. A factor of two instead of four had been calculated for "Normal Operating Loads + High Energy Pipe Break." The licensee anticipated that a new more rigorous mechanistic evaluation of discrete pipe break locations consistent with current technology would result in a safety factor of at least four. The NRC staff understood that the reevaluation was to be completed by NNECO as soon as practical. The staff has not as yet received the results of this analysis. The results should be submitted soon as they are available.

Another isolation condenser water hammer event occurred on August 10, 1981. This event was also caused by high reactor vessel water level after a reactor scram and showed no evidence of the abnormal pipe movement observed after the December 19, 1979 water hammer incident. This occurrence confirmed that the abnormal pipe movement previously observed had been eliminated and to this extend it demonstrated the effectiveness of the post-1979 water hammer incident pipe-support modifications. On the basis of its documented evaluation and a post modification water hammer event (that revealed no abnormal pipe movement), the staff has concluded that the design modifications to the isolation condenser pipe supports provide acceptable margins of safety.

2.2 Pipe Cracks

At meetings on March 6, 1981 in Bethesda, Maryland and November 3, 1981 at the Millstone site involving representatives of the licensee and the NRC staff, the extent and nature of the pipe cracking detected during the scheduled October 1980 refueling outage inservice inspection was reviewed in detail (see NRC's 3/16/81 and 11/13/81 meeting summaries).

The licensee reported that all of the cracks were in 304 stainless steel piping and specifically in weld material or the heat affected zone. At that time it was postulated by the licensee that the cracks in the isolation condenser piping could have initiated during the sea-water intrusion that occurred in 1972. Attachment 5 to the licensee's April 27, 1982 letter (NEDE-25400 - May 1981) provided the results of destructive analyses.

The presence of circumferential intergranular and shallow transgranular stress corrosion cracks was confirmed. The report indicates that the cracks could have been initiated by the chloride intrusion incident that occurred in 1972.

All of the cracked material was replaced or repaired in accordance with NUREG-0313 and where necessary the 304 stainless steel piping (e.g. iso-condenser steam supply line inside containment) was replaced by 316K stainless steel piping prior to the return to power operation in April 1981 i.e., prior to completion of the seventh refueling outage (reload 7). Replacement or repair of the cracked material resolved the staff safety concerns. The staff also concluded that the primary coolant system boundary integrity had been restored in accordance with the staff requirements described in NUREG-0313.

2.3 Reactor Vessel High Water Level Feedwater Pump Trip

Millstone Unit No. 1 depends on a main feedwater train to provide emergency high pressure coolant injection for small reactor coolant system breaks. Operation of the feedwater following a small break could result in a high water level in the reactor vessel that could lead to water hammer and subsequent isolation of the emergency condenser. The emergency (iso) condenser is a required engineered safety feature (ESF) and must be available to remove decay heat if the normal heat sink is unavailable following reactor scram from power levels greater than 40% of full power. The February 1, 1978 letter from the staff to the licensee recommended installation of an automatic feedwater pump trip to prevent excessive increases in the reactor vessel water level. The licensee has completed an evaluation of alternatives for preventing excessive water level. Based on that evaluation, they have proposed to install the high water level feedwater pump trip. This concept is consistent with the staff recommendation and therefore acceptable.

The licensee has already implemented additional non-safety related improvements in the feedwater control system to make it more responsive following reactor scram to avoid excessive addition of water with resultant water level increase. The licensee also plans to automatically lower the normal water level set point and the isolation set point for the reactor water clean up system. Since the purpose of these additional changes is to reduce dependence on the reactor vessel high water level feedwater pump trip that the licensee plans to install the staff agrees with their conceptual plans. However, the staff requests that the licensee technical review and safety evaluation for all of the modifications that have been proposed be submitted to the NRC as soon as they are completed so that the staff may complete their review.

The staff has considered the licensees schedule for pump trips and clean up system modifications during the late 1982 refueling outage and automatic water level set down and flow controller modifications by mid 1984. They have concluded that the proposed schedule reflects acceptable priorities and reasonable time to design, purchase, and modify the plant.

3.0 SUMMARY

Based on the considerations discussed above, the staff concludes that NNECO's short-term and long-term corrective action for water hammer events assures that Millstone Station Unit No. 1 can continue to operate without endangering the health and safety of the public.

4.0 ACKNOWLEDGEMENT

This evaluation has been prepared by J. Shea.

Date: August 30, 1982