NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

General Offices • Selden Street, Berlin, Connecticut

P.O. BOX 270
HARTFORD, CONNECTICUT 06141-0270
(203) 666-6911

February 15, 1985

Docket No. 50-336
B11450

Director of Nuclear Reactor Regulation
Attn: Mr. J. R. Miller, Chief
Operating Reactors Branch #3
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

References: (1) J. R. Miller letter to W. G. Counsil, dated May 8, 1984.

(2) W. G. Counsil letter to J. R. Miller, dated December 12, 1983.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 2
Core Barrel Inspection

In Reference (1) the Staff provided its review of the Millstone Unit No. 2 thermal shield recovery program. The Staff's principal recommendation was that the core barrel be inspected during the next refueling outage. The Staff also recommended the inspection methods be upgraded by using higher resolution television equipment and/or computer enhancement.

In Reference (2) Northeast Nuclear Energy Company (NNECO) provided a report in connection with the thermal shield removal and plant recovery program. In Section 9.5 of that report NNECO committed to evaluate performing inspections of the core barrel in order to verify that the through wall cracks at thermal shield support lugs 4 and 5 have not propagated.

Accordingly, Attachment 1 provides a summary of the core barrel inspection NNECO intends to perform at Millstone Unit No. 2 during the 1985 End of Cycle 6 refueling outage.

Based upon the current outage schedule, NNECO intends to provide the inspection results and conclusions to the NRC, on or about June 1, 1985.

A047
1/1

We trust you will find this information satisfactory.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil

W. G. Counsil
Senior Vice President

C. F. Sears

By: C. F. Sears
Vice President

Docket No. 50-336

Attachment 1

Millstone Nuclear Power Station, Unit No. 2

Core Barrel Inspection Plans

February, 1985

Attachment 1

Millstone Nuclear Power Station, Unit No. 2
Core Barrel Inspection Plans

1.0 INTRODUCTION

During a visual inspection of the reactor internals at Millstone Unit No. 2 in June 1983, extensive structural damage was found in the thermal shield and its support arrangement. A failure mechanism analysis showed that the damage was primarily caused by unstable motion of the thermal shield due to flow induced loads. Subsequent examinations also revealed damage to the core barrel which was induced by forces transmitted to the barrel through the thermal shield support lugs. It was decided to permanently remove the thermal shield to eliminate this problem. Detailed analyses were performed to justify continued operation without the thermal shield.

Following the removal of the thermal shield, a detailed nondestructive examination of the core support barrel was performed. Critical regions in the core support barrel were determined to be the areas around nine (9) thermal shield support lugs. These areas were examined using remote underwater television cameras which had sufficient resolution to detect outer surface cracking. Eddy current testing was performed to confirm the visual examination results and detect potential nonvisible cracks around the lugs. Ultrasound testing was used to measure the depths of the observed cracks and detect possible cracks under the lugs and cracks which could have originated from the inner surface of the core support barrel.

Visual examination revealed cracks at two of the nine lug locations (lugs 4 and 5). Subsequent eddy current and ultrasound testing confirmed the existence of these cracks. No other cracks were detected at any other lug location. These flaws, both through-wall and non-through-wall, appeared to propagate from the lug region on the core support barrel into the barrel itself.

Since flaws were found at lugs 4 and 5 only, these lugs were machined off to carry out the repairs to the core support barrel. Repair consisted of drilling crack arrestor holes at the ends of through-wall cracks and machining and blending of the non--through wall cracks. The repairs were justified based upon an analytical evaluation of the stress field in the damaged core barrel for various transient and steady state loading conditions. These stresses, in the absence of the loads due to the excessive vibrations of the thermal shield were found to be within acceptable fatigue analysis to assure that there would be no crack initiation from these holes.

A conservative flaw tolerance analysis was performed on the core barrel for normal operating and faulted condition loads. The analysis indicated that any flaw smaller than 3.6" through-wall would not grow under normal operating cyclic loads and remain stable under the faulted condition loads. Therefore, a flaw smaller than 3.6" through-wall could be left unrepaired without impairing the structural integrity of the core barrel. However, for added conservatism the sensitivity of the inspection equipment was set to detect flaws much smaller than 3.6" through-wall. All the flaws, within the sensitivity of the inspection equipment, were found and were either machined out or rendered acceptable by drilling appropriately sized crack arrestor holes. It was, therefore, concluded that growth of the existing cracks or initiation of any new ones was extremely unlikely. As a further verification, a nondestructive examination of the damaged regions of the core barrel has been planned for the end of Cycle 6 refueling outage.

2.0 INSPECTION STRATEGY

Flaws were found only at lugs 4 and 5. These flaws were caused by locally large loads due to the unstable motion of the thermal shield. This load has been eliminated with the removal of the thermal shield. The normal operating cyclic loads are very small. It has been shown that the stresses caused by these loads are not sufficient to initiate any new flaws elsewhere in the core barrel or cause the existing flaws at lugs 4 and 5 to grow. Therefore, it is concluded that an inspection of the regions around lugs 4 and 5 would suffice to confirm the analytical conclusions and demonstrate the adequacy of the repairs. The examinations will detect any propagation of existing flaws or initiation of any new flaws from the machined slots and the crack arrestor holes.

In order to minimize the risk of damage to alignment pins, etc., associated with the removal of the core barrel from the reactor vessel, and save time, it was decided to perform the inspections with the core barrel in place inside the reactor vessel. Access to the inspection region will be through 3" surveillance holes in the core barrel flange.

Inspection will consist of visual examination of the area around lugs 4 and 5. Specifically, the area along the length of the cracks and around the crack arrestor holes and machined slots will be examined. In accordance with the Staff's recommendations and in order to obtain improved resolution and to better characterize any indications which cannot be resolved by visual examination alone, computer enhancement techniques will also be utilized.

Should there be indications that cannot be resolved by visual examination including enhanced imaging, eddy current examination of these indications will be performed. The inspection equipment is capable of using an eddy current probe with the core barrel inside the reactor vessel.

The inspection equipment is designed to also work with the core barrel out of the reactor vessel. The sensitivity of the inspection equipment is given below.

> Video Camera: The camera will have at least a resolution capability of detecting a block line 5 mils wide on an 18% neutral gray card.
>
> Eddy Current Probe: The probe is set to have a detection threshold of one-fourth of an inch long by 0.03" deep cracks. This is the same sensitivity that was used in the original inspection.

3.0 CONCLUSIONS

With the removal of the thermal shield, the main cause of damage to the core barrel has been eliminated. The normal operating cyclic stresses are not sufficient to cause any growth or initiation of a flaw. The nondestructive examination of the damaged regions of the core barrel is intended to confirm these conclusions. The sensitivity of the inspection equipment is such that flaws much smaller than 3.6" (critical flaw size) through-wall can be detected.