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June 11, 1985

Docket No. 50-336
B11570

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

Reference: (1) W. G. Counsil letter to J. R. Miller, dated November 4, 1983.

(2) W. G. Counsil letter to J. R. Miller, dated November 20, 1984.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 2
Fuel Inspections

On June 13, 1984, Northeast Nuclear Energy Company (NNECO) presented to the NRC its ongoing fuel performance program. Summarized in that meeting were the three phases of post-irradiation examinations conducted during the End-of-Cycle 5 outage at Millstone Unit No. 2. It is the intent of this correspondence to update and highlight the recent major milestones which have been reached as part of NNECO's dedicated effort to improve core performance.

During the last half of Cycle 6 operation, three investigations were conducted. Foremost, the possibility of a weld defect problem was pursued. Two fuel rod end caps were removed, one from a Batch F rod and one from a Batch G rod. The detailed metallographic examinations demonstrated that the "white" patches and rings on the fuel rod end caps were actually a reddish-brown greater-than-normal local oxide corrosion area. Both welds were found intact and fabricated within specifications. It was concluded that the welds did not contribute to the failures of these fuel rods.

The second investigation was actually a continuation of a previous effort. Basically, the manufacturing records for interior rods and rods whose failures were not attributed to debris involvement were revisited in the areas of pellet hydrogen, cladding lots, rework codes, and pellet lots. As in the first review, the observations showed no process lot dependencies or trends. As a result, although no direct correlations with manufacturing variables were found, several process control improvements were implemented.

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The third investigation, which was a study of the statistical distribution of debris, revealed no definitive results.

Another milestone was reached at the End-of-Cycle 6 with the initiation of investigations into the Cycle 6 failures. The End-of-Cycle 6 fuel examinations conducted were sipping, ultrasonic testing, and visual inspections of the fuel.

Utilizing General Electric fuel sipping, the entire Cycle 6 core of 217 fuel assemblies was sipped. In addition, all nineteen recently reconstituted fuel assemblies were sipped as well as four other fuel assemblies utilized as "control" assemblies, bringing the total fuel sipped to 240 assemblies. All reconstituted fuel sipped clean.

In addition to the sipping, ultrasonic testing of thirty-three Cycle 6 fuel assemblies were performed to identify individual fuel pin failures. Based on the sipping and ultrasonic exams, sixteen Cycle 6 fuel assemblies containing nineteen failed fuel pins were identified. These leaking assemblies consisted of nine Batch "H" (once burned) and seven Batch "G" (twice burned) fuel. Figure 1 shows a Cycle 6 core map with the sixteen leakers highlighted. The distribution of leakers appeared to be random with no obvious cause. Fourteen of the sixteen leaking assemblies had only one failed fuel pin. One leaking assembly had two failed pins and another assembly had three failed pins. Assemblies with multiple pin failures did not have the failed pins near each other.

All sixteen leaking fuel assemblies were removed from the Cycle 7 loading plan.

All sixteen leaking fuel assemblies were examined visually by NNECO, specifically looking at the individual failed pins identified by ultrasonic testing. The visual exams showed that eight of the nineteen fuel pins identified as leakers had some obvious defect which indicated the pin was failed. Two pins had missing end plugs and others showed some form of hydriding, open blisters or fission product plumes. While some of these pin failures were obvious, the reasons for failure were not obvious with one exception. One fuel pin definitely was a debris failure as evidenced by debris markings below grid 1.

In addition to the fuel failure related work, visual examinations were also performed on the fuel top nozzle as a followup program to the mechanical problems identified at End-of-Cycle 5. The inspections were performed by NNECO. The results were:

a. Fifty-eight of eighty-eight Batch "H" Westinghouse fuel top nozzles were examined. They look excellent after one cycle. No unusual conditions were found. The problems previously identified with the old top nozzle design such as spring failures, top nozzle deformation or spring/post fretting were not found.

b. Fifty-two of fifty-two Batch "G" Westinghouse fuel top nozzles were examined. These inspections showed ten new broken springs, one cracked spring and one possibly cracked spring. These are in addition to those spring failures reported last outage. The Cycle 7 core will contain thirteen broken spring "G" assemblies each containing one broken holddown spring.

The conclusions presented in Reference (1) concerning broken holddown springs, that continued operation is acceptable, remain valid and applicable following these latest inspections.

c. Nine of fifty-six Batch "F" Westinghouse discharge fuel top nozzles were examined. Other than two new possibly cracked springs, no significant changes were identified from their End-of-Cycle 5 conditions.

In conclusion with regard to the top nozzle problems, the new top nozzle design (Batch H/J) has not had any deficiency identified with it and has resolved all known problems with the old top nozzle design (Batches F and G). Only sixty of 217 fuel assemblies in Cycle 7 will have the old top nozzle design and most of these will be in their last cycle of operation.

The final inspection campaign mounted during the End-of-Cycle 6 outage was directed at Control Element Assemblies (CEAs). Based on both the resident operating time and past measurements, all 73 CEAs from the Cycle 6 core were examined by a combination of Eddy Current (ECT), mechanical profilometry and TV visual examinations. These 73 CEAs are original CEAs and have never been moved out of their current core locations.

All 73 CEAs were examined for guide tube wear indications by ECT and were found to be acceptable.

Mechanical profilometry was performed on nine various CEA fingers to quantify wear and strain on the CEA fingers. Based on these measurements, the Group 7 CEAs (lead bank) were at or near the 1% strain limit. These nine Group 7 CEAs were scheduled for replacement and have been replaced. The remaining 65 CEAs were shown to have strains $\leq$ 0.84%. A follow on inspection program is planned for next outage. Based on these examinations, the remaining 63 CEAs are acceptable for reuse during Cycle 7.

In summary, the fuel failure investigation program has revealed no significant manufacturing related failure mechanisms, and has resulted in the determination that debris may be playing a role in the failures. The Cycle 6 failures are very similar to the Cycle 5 failures both in magnitude and distribution, thus it is judged that no new phenomenon have been introduced.

Regarding the possibility that debris is the cause of the failures, NNECO has performed examinations and cleanup of the Reactor Vessel and the Core Support Barrel as well as reemphasized the importance of housekeeping/cleanliness measures in and around open RCS boundaries. Stricter housekeeping controls also were implemented this outage. NNECO has therefore taken reasonable steps to preclude recurrence of fuel failures being possibly caused by debris.

The NRC will be informed, as you were during our last refuel startup, via the Startup Test Report, as to the existence of any appreciable amount of failed fuel from this next startup, should it occur. We trust you will find this information satisfactory.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

J. F. Opeka
Senior Vice President

By: C. F. Sears
Vice President