Docket File

50-289

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 8, 1995

LICENSEE: GPU Nuclear Corporation

FACILITY: Three Mile Island Nuclear Station, Unit 1 (TMI-1)

SUBJECT: SUMMARY OF OCTOBER 12, 1995, MEETING WITH GPU NUCLEAR CORPORATION REGARDING FUEL CLADDING DISTINCTIVE CRUD PATTERNS AT THREE MILE ISLAND NUCLEAR STATION, UNIT 1 (TMI-1)

[CORRECTED SUMMARY - SUPERSEDES SUMMARY ISSUED ON OCTOBER 20, 1995]

On Thursday, October 12, 1995, a public meeting was held between the U.S. Nuclear Regulatory Commission (NRC) and GPU Nuclear Corporation (GPUN) at the NRC Headquarters Office in Rockville, Maryland. The purpose of the meeting was to discuss the cause and safety implications of a distinctive crud pattern (DCP) observed on several fuel rods during the 11R refueling outage. Attachment 1 is the list of participants at the meeting. Attachment 2 is a copy of the handouts used during the meeting.

BACKGROUND

During examination of fuel pins during the 11R refueling outage, GPUN and Babcock & Wilcox Fuel Company (BWFC) observed a corrosion pattern in 40 of the 177 fuel assemblies that is significantly different than the "normal" corrosion pattern. Ten fuel rods were found to be defective (through-wall pinhole leaks) through a combination of ultrasonic and eddy current testing. Nine of the defective rods were in the most recently loaded batch ("first-burn" rods), which was installed in October 1993. Although the number of failed rods is not unusual, the unusual crud deposition pattern on the 9 first-burn failed rods, described as a marbled (or variegated) pattern, was unanticipated. This pattern was also observed on approximately 220 other first-burn rods adjacent to the defective rods and in symmetrically equivalent rods in other quadrants of the core. The core quadrant where the most prevalent damage (8 defective rods) and unusual crud pattern occurred had an initial flux tilt of approximately + 2%. The area of the rods exhibiting the failures and abnormal patterns is consistently in the range of 100 to 130 inches above the bottom of the core. Furthermore, the abnormal corrosion patterns and failures were only found on the outside surface of peripheral fuel rods.

On the basis of the initial failures detected by UT, GPUN initiated additional visual and ECT examinations of 266 fuel rods. No failed rods or rods that indicate any amount of clad thinning (by ECT) were reinstalled in the core. GPUN made a decision that it is acceptable to reinstall rods with the DCP as long as no clad thinning can be measured. Fuel assemblies with nonreusable rods were reconstituted using either stainless steel rods or "donor" rods containing fuel. The examination of 266 rods and reconstitution of 21 fuel assemblies were completed on October 2. A total of 87 rods were replaced with stainless steel rods, as allowed by License Amendment No. 183 (implementing the provisions of Generic Letter 90-02).

DF01

GPUN assembled a panel of experts (including B&W, EPRI, Duke Power, and GE) on 9/28/95 to review all available information, agree on a most probable root cause of the DCP, make corrective/preventive action recommendations, and arrive at a consensus opinion on reuse of rods that exhibit DCP but have no clad thinning.

DISCUSSION

An introductory discussion by GPUN reviewed the charter, root cause assessment, and recommendations of the special Degraded Fuel Advisory Panel assembled to review the DCP anomaly (see Attachment 2). The panel concluded that the root cause was that low pH due to high boron and low lithium concentrations caused unusual crud deposits in high temperature regions of the core where localized boiling in adjacent hot channels occurred. The panel's recommendations included operating in the future with reactor coolant system (RCS) pH level no less than 6.9 and other RCS parameters consistent with the new EPRI primary water chemistry guidelines.

GPUN reviewed the core history for operating cycle 10 and compared various core parameters to previous cycles. Cycle 10 had fuel enrichment as high as 4.75 w/o U-235 and had maximum local power peaking factors of 1.51. The staff expressed concern that the combination of high peaking factors and enrichment may have caused abnormally high local linear heat generation rates that contributed to localized boiling and accelerated corrosion. GPUN stated that other B&W cores have had higher linear heat rates without the DCP and that the major contributing factor was the decision to operate at pH levels between 6.6 and 6.8 during the first five months or so of the operating cycle. Reduced pH enhances generation and deposition of corrosion products and the deposition will occur preferentially in areas of higher temperatures and lower flow.

BWFC reviewed the results of their investigation of the DCP. They concluded that there was no correlation to manufacturing or materials. The only new fuel design feature (other than higher than previous enrichment) in the fuel installed in 1993 was four rods containing gadolinia (burnable poison) near the corners of 28 fuel assemblies. All core analyses were performed in accordance with the NRC-approved topical report (BAW-10179P-A). The expected power in fresh assemblies was expected to be slightly higher than in other cycles. BWFC also stated that the quadrant flux/power tilt was not excessive but that the upper level detectors in the outer ring showed unusual behavior with burnup. The conclusion was that the DCP-affected areas of the core correlate to high temperature and relatively lower flow velocities but these conditions would not in themselves lead to fuel degradation.

The special advisory panel, GPUN, and BWFC concluded that it is acceptable to reinstall rods with the DCP for Cycle 11 as long as no clad thinning can be measured because 1) the RCS boron concentration will be considerably lower during this cycle, 2) the maximum fuel enrichment will be lower (4.55 w/o vs 4.75 w/o), 3) pH will be held above 6.9 for the entire cycle, 4) other RCS chemistry parameters (including suspended solid or crud concentrations) will be optimized, and 5) peak fuel temperatures should be slightly lower.

Crud samples were taken near the degraded fuel and in other locations (spent fuel pool) and were analyzed. Chemical analysis of the crud indicated that the crud taken from fuel rods showed the presence of zeolites, which are hydrated silicates of aluminum with alkali metals (calcium, magnesium). These samples also showed lower levels of nickel and iron as compared to crud samples taken elsewhere. Part of GPUN's chemistry plan for Cycle 11 is to develop onsite capability to monitor calcium, magnesium, and aluminum.

GPUN plans to perform clad oxide and crud measurements in the spent fuel pool in the near future. The staff questioned the planned actions, if any, to conduct hot cell examinations on specimens of the damaged or degraded fuel to confirm the stated root cause. GPUN did not commit to any additional testing at this time but may propose that such examinations may be sponsored by the B&W Owners Group.

The staff suggested that GPUN closely monitor radiochemistry during Cycle 11 to detect any fuel pin leaks and recommended that a fuel action plan to respond to leaks be developed in advance rather than waiting for leaks to be detected.

The staff plans to look at the procedures used by the NRC to review core designs to determine if changes need to be made to those procedures on a generic basis.

Original signed by:
Ronald W. Hernan, Senior Project Manager
Project Directorate I-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

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Attachments: 1. List of Attendees
2. GPUN meeting handout

cc w/atts: See next page

Distribution w/atts. 1 & 2	Distribution w/att. 1	
Docket File	WRussell/FMiraglia	
PUBLIC	RZimmerman	SWu
PD I-3 Memo	SVarga	EKendrick
JFRogge, RI	JZwolinski	DBrewer
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Ronald W. Hernan

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Attachment: List of Attendees

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OCTOBER 12, 1995 MEETING WITH GPU NUCLEAR CORPORATION

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Michelle Evans	NRC/Region I	Senior Resident Inspector
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Bill Connor	GPUN	Engineering, HQ
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Bill Dean	NRC/EDO	EDO Liaison, Region I

ATTACHMENT 1