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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 134

TO FACILITY OPERATING LICENSE NO. DPR-61

CONNECTICUT YANKEE ATOMIC POWER COMPANY

HADDAM NECK PLANT

DOCKET NO. 50-213

1.0 INTRODUCTION

By letter dated June 25, 1990, as supplemented July 19, 1990, Connecticut Yankee Atomic Power Company (CYAPCO), the licensee for Haddam Neck Plant, proposed Technical Specification (TS) changes to Appendix A of Operating License DPR-61 for Haddam Neck Plant. Connecticut Yankee Atomic Power Company proposed TS changes to add a new Limiting Condition for Operation (LCO), its corresponding Surveillance Requirements (SR) and Bases for the reactor coolant specific activity.

The NRC staff's safety evaluation of the failed fuel rods Technical Specification (TS) request was evaluated in the following two areas:

Section 1.1 - Radiation Protection

Section 1.2 - Reactor Systems

1.1 RADIATION PROTECTION

1.1.1 Introduction

The proposed TS changes consist of (1) a new LCO Section 3.4.12, "Failed Fuel Rods," on a new page 3/4 4-51, (2) its corresponding new surveillance requirements, Section 4.4.12.1, on the same page, and (3) a new Bases Section 3/4 4.12, "Failed Fuel Rods," added to existing page B 3/4 4-13.

The proposed new LCO limits the number of allowable fuel rod failures for Cycle 16 and 17 to a maximum of 160 fuel rods. The licensee submitted, with its June 25, 1990 letter, an augmented radiochemistry monitoring program to support the new LCO and SR.

1.1.2 Evaluation

The proposed LCO states that the total estimated number of failed fuel rods shall not exceed 160 for more than 7 consecutive days of steady state power operation. If this LCO cannot be met, the reactor is required by the action statement to be in hot standby within 6 hours. A 7-day sampling period is provided to preclude a spurious analysis result from causing a plant shutdown. The proposed SR describes the testing to demonstrate compliance with the LCO. The licensee proposed that their augmented radiochemistry monitoring program submitted for the staff's review will be used for the means for implementing the SR. The program supplements the primary coolant radioiodine analyses with Xenon-133 measurements and calculates that potential number of failed fuel rods using an empirical equation developed by the licensee. The equation is based on data from radioiodine and xenon analyses performed by the licensee on primary coolant samples and on the number of failed fuel rods observed in previous fuel cycles.

The existing LCOs for the reactor coolant specific activity in the Haddam Neck TS, a dose equivalent Iodine-131 specific activity of 1.0 microcurie/gram and a gross specific activity of 68/E-bar, will remain the same. Therefore, the proposed TS changes neither remove nor relax the existing requirements.

On September 2, 1989, the licensee shutdown the Haddam Neck Plant for the 15th refueling and maintenance outages. Iodine-131 levels during Cycle 15 operation ranged 0.02 to 0.03 microcurie/cc which were within the normal operating ranges for PWRs (NRC GALE Code value for I-131 is 0.045 microcurie/cc). The licensee stated that the first indication that the coolant activity was not representative of the actual fuel clad conditions occurred during the RCS depressurization at the end of cycle when the coolant I-131 activity spiked at 11 microcurie/cc (a factor of 440).

The licensee stated that ultrasonic, visual, and eddy current inspections of the fuel revealed 456 failed fuel rods in 133 fuel assemblies of the Cycle 15 core. The licensee characterized the fuel defects that occurred during Cycle 15 as a result of debris induced fretting at the bottom of the fuel defects that occurred during Cycle 15 as a result of debris induced fretting at the bottom of the fuel rod. When similar defects occur in zircaloy clad fuel rods, secondary failures usually follow at a higher elevation on the rod. As with other defects at this higher elevation, the gas in the rod normally escapes, allowing water to enter the rod, and in turn, facilitate iodine and other soluble fission product transport into the bulk coolant. The licensee stated in the case of Cycle 15, these secondary defects did not occur, primarily because the stainless steel cladding is relatively impervious to hydriding. As a result, RCS iodine concentrations were not indicative of the number of fuel failures.

Using the licensee's proposed 160 failed fuel rods as a LCO limit (instead of the 456 failed rods experienced during Cycle 15), the staff calculated the following radiological consequences of a steam generator tube rupture (SGTR) accident. The calculated values indicate that the new LCO will provide reasonable assurance that the radiological consequences of an SGTR accident will be within the guidelines provided in SRP Section 15.6.3 and the dose reference values specified in 10 CFR 100.11.

	Cycle 15 [1]	Cycle 16 [2]	
		DIF	TF
I-131 (Microcurie/cc)	0.025[3]	0.01[4]	0.5[5]
I-131 Dose Equivalent (Microcurie/cc)	0.05[3]	0.02[4]	1.0[5]
Iodine Spike (Microcurie/cc)	11[3]	4[4]	8.4[6]
Offsite Doses (REM)[7]	18.5	2	14

DIF = Debris Induced Failure
RF = Traditional Failure

(1) With 456 failed fuel rods
(2) With 160 failed fuel rods
(3) Actual observed/measured values
(4) Based on Cycle 15 data
(5) Based on the licensee's iodine analysis and fuel failure data in previous cycles
(6) Calculated SGTR accident initiated iodine spike (SRP Section 15.6.3)
(7) Calculated thyroid dose at EAB (SRP limits is 30 rem)

1.1.3 Conclusion

Based on the foregoing evaluation, we find that the licensee's proposed TS changes are acceptable. The bases for our acceptance are that (1) the proposed TS changes neither remove nor relax the existing requirements, (2) the offsite radiological consequences due to the controlling design basis accident (steam generator tube rupture) with the proposed new LCO will be within the guidelines provided in SRP Section 15.6.3 and the dose reference values specified in 10 CFR 100.11, and (3) the augmented radiochemistry program proposed by the licensee provides reasonable assurance that it will quantify the potential number of failed fuel rods in the LCO by iodine and xenon measurements in the primary coolant.

1.2 Reactor Systems

1.2.1 Introduction

On September 2, 1989, CYAPCO shutdown the Haddam Neck Plant for the 15th refueling and maintenance outage. During the shutdown, primary system radiochemistry indicated a significant number of potential fuel rod failures in the core. Ultrasonic testing (UT), based upon two diverse inspections using different UT vendors, led to an estimate that 456 failed rods existed at the end of Cycle 15. Observations of the failed rods led the licensee to conclude that the majority of the failures were due to debris fretting. The majority of the defects in the failed rods were found between the first support grid and the lower end cap of the fuel rods. The potential for rods with partial throughwall damage led the licensee to perform eddy current (EC) testing on a sampling of rods (approximately 2,000).

In preparation for the startup of Cycle 16, the licensee initiated a repair program which has four objectives:

(1) Replace all failed fuel rods
(2) Remove all visible debris
(3) Replace all inspected rods with defects greater than 20% throughwall
(4) Estimate the number of uninspected rods with defects greater than 20% throughwall.

In order to meet these objectives the licensee did the following:

(1) All failed fuel rods as identified by the two diverse 100% UT inspections were replaced.
(2) A best effort cleanup effort was performed to free the core of all visible debris. The licensee believes that the core is now virtually debris free with the exception of a few pieces which could not be dislodged without risking damage to the grids. The licensee believes that the small amount of debris remaining is not a significant threat to the cladding.
(3) The licensee performed an EC inspection of 1,740 rods adjacent to failed rods and in known debris locations. Of the 1,740 inspected, 156 rods were determined to have greater than 20% throughwall and were replaced.
(4) The licensee estimated the number of damaged fuel rods that remain in Cycle 16 by doing a statistical analysis of 910 fuel rods which were EC inspected in regions other than debris sites and adjacent to failed rods. The estimated number of fuel rods with damage greater than 20% throughwall is 375 rods. The estimated number of rods with damage greater than 90% throughwall is less than 50 rods. These results are based on best estimates, and assume a uniform damage distribution.

1.2.2 <u>Evaluation</u>

1.2.2.1 <u>Overpressurization Transients</u>

CYAPCO testing performed by the fuel vendor of simulated fuel rod segments with debris damage have demonstrated that damaged fuel rods subjected to limiting mechanical loading will not fail with defects up to 90% throughwall. Testing of defects greater than 90% throughwall was limited by the ability to accurately machine the defect on the fuel rod surface. The combination of tests performed with and without the backing of a simulated pellet stack demonstrates that the presence of the pellet stack inhibits the failure of the cladding during overpressure conditions. There is no reason to believe that this phenomenon would not be effective in rods with defects greater than tested defect depths. If there were a failure threshold in the 90% throughwall range, it is highly probable that the rod would fail during normal operation. The elimination of incipient failures indicates that the radiological consequences during an abnormal anticipated operational occurrence (AOO) should not be significantly affected by the presence of damaged fuel rods. Therefore, CYAPCO has concluded that there is no unreviewed safety question (USQ) associated with Cycle 16 operation. The expected number of failed rods is representative of failure rates experienced by other observed failure modes during normal operation. Therefore, CYAPCO has concluded that overpressurization transients are essentially unaffected by the proposed 160 failed rod limit.

1.2.2.2 Depresurrization Accidents

The limiting depressurization accident is the steam generator tube rupture (SGTR) which is a design basis accident for which no fuel failures are assumed to occur as a result of the event but which have radiological consequences as a result of releases of normal coolant activity, or coolant activity with post-transient spikes. The SGTR accident assumes an initial RCS specific activity consistent with the 1.0 microcurie/gram Dose Equivalent Iodine (DEI) limit in the technical specifications. The proposed limit of 160 failed fuel rods was chosen to be consistent with the DEI limit, based on the experience that the Haddam Neck DEI is a factor of two higher than the I-131 concentration, and that all of the rod failures conservatively release iodine in the traditional manner. The Cycle 15 experience with debris induced failures indicates that this failure mode releases very little iodine during normal operation. The algorithm developed for the augmented monitoring program has the capability to identify a debris-type failed fuel rod.

Therefore, if all failed rods were debris-type failures, the resulting initial condition DEI and expected spiking factor yield radiological consequences would be bounded by the current design basis. Similarly, if all 160 failed rods were traditional type failures, the initial condition assumptions remain valid.

1.2.2.3 Proposed Changes to Technical Specification

CYAPCO is proposing technical specification changes, including limiting conditions for operation (LCO) and surveillance requirements (SR), that limit the number of allowable fuel failures for Cycle 16 to a maximum of 160 fuel rods. This limit would apply to debris induced failures, traditional type failures or any combination thereof. The augmented radiochemistry monitoring program described in Reference 1 provides the means for implementing the surveillance requirement.

The proposed changes (1) consist of a new LCO, 3.4.12 (new page 3/4 4-51). The LCO specifies that the total estimated number of failed fuel rods shall not exceed 160 for more than 7 consecutive days of steady state power operation. If this LCO cannot be met, the reactor is required by the action statement to be in hot standby within 6 hours. A 7-day sampling period is provided to preclude a spurious analysis result from causing a plant shutdown. The initial test of Specification 4.4.12.1.a is performed after 20 days of steady state power operation to ensure that the radioiodines and noble gas concentrations in the primary system have reached equilibrium. In addition, the surveillance requirements provide an increased testing frequency if there is an increase in the calculated number of failed fuel rods. Also a new Bases section, 3/4.4.12 Failed Fuel Rods, is being added to page B 3/4 4-13.

1.2.3 Conclusions

The staff has reviewed CYAPCO's submittals (Refs. 1 and 2) and has found that the proposed Technical Specification limit of 160 rods is acceptable. In addition, the staff believes that the licensee has taken reasonable and prudent actions to assure that the core is as free from debris and damaged fuel as is practical.

2.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.21, 51.32, and 51.35, an environmental assessment and finding of no significant impact have been prepared and published in the Federal Register on December 2., 1990 (55 FR 53214). Accordingly, based upon the environmental assessment, we have determined that the issuance of the amendment will not have a significant effect on the quality of the human environment.

3.0 CONCLUSION

We have concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

References

1. Letter, E. J. Mroczka (CYAPCO) to USNRC, dated June 25, 1990.

2. Letter, E. J. Mroczka (CYAPCO) to USNRC, dated July 19, 1990.

Dated: January 4, 1991

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