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May 5, 1986
NRC/TMI 86-041

Docket No. 50-320

Mr. F. R. Standerfer
Vice President/Director, TMI-2
GPU Nuclear Corporation
P. O. Box 480
Middletown, PA 17057

Dear Mr. Standerfer:

Subject: Safety Evaluation Report (SER) for Core Stratification Sample Acquisition, Revision 1

The Nuclear Regulatory Commission (NRC) staff has reviewed your August 30, 1985 Safety Evaluation Report (SER) for Core Stratification Sample Acquisition and the additional supporting information provided in your December 31, 1985 letter. As stated in the enclosed safety evaluation issued by the staff, we conclude that the proposed activities can be accomplished without significant risk to the health and safety of the public provided that they are in accordance with the limitations stated in both your SER and responses to the staff's request for additional information. This does not include the expanded scope of activities described in Revision 3 of your SER which is being reviewed separately. This activity falls within the scope of activities previously considered in the Programmatic Environmental Impact Statement.

We therefore approve the operation of the system as described in you SER contingent upon the submittal of the related procedures subject to Technical Specification 6.8.2.

Sincerely,

ORIGINAL SIGNED BY:
William D. Travers

William D. Travers
Director
TMI-2 Cleanup Project Directorate

Enclosure: As stated

cc: T. F. Demmitt
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FOR

CORE STRATIFICATION SAMPLE ACQUISITION

INTRODUCTION

By letter dated August 30, 1985, GPU Nuclear Corporation (GPUNC) submitted the Safety Evaluation Report (SER) for the Three Mile Island Nuclear Station, Unit 2 (TMI-2) Core Stratification Sample Acquisition, Revision 1. Additional information was requested by the NRC staff in a letter dated November 22, 1985. GPUNC provided the requested information and a revision to the SER in a letter dated December 31, 1985. The revised GPUNC SER addressed an expanded scope of work activity. This evaluation addresses the original scope of work activities. The staff will document its review of the expanded scope in a subsequent evaluation.

The core stratification sampling program will use a core drilling machine to obtain vertical core samples of the TMI-2 core. The core drilling machine is a modified version of a model commonly used in the petroleum exploration industry. The core drilling will provide information on the hardness, ductility, and composition of the resolidified portion of the TMI-2 core. The holes which are formed by the core drilling will be used to gain access to the lower portion of the reactor vessel for visual inspection. The core samples will be shipped to the Idaho National Engineering Laboratory (INEL) for examination.

EVALUATION

The staff considered the following aspects of the core stratification sampling program as having potential safety significance.

1. Possibility of leaking hydraulic fluids causing a boron dilution and a criticality.

2. Creation of pyrophoric materials followed by a burn.

3. Mechanical forces generated by the drilling rig adversely affecting reactor coolant system (RCS) integrity.

A. Criticality Concerns

The insertion of the drill bit, casing and core barrel into the reactor core will act as a diluent to the fuel. This will cause the core to have less reactivity and increase the margin to criticality. The water supply used for bit flushing and cooling will be borated in excess of 4350 ppm boron. Due to the high boron concentrations this water cannot function to dilute the soluble boron concentration in the core region.

There are two potential sources of non-borated fluids. The underwater clamp hydraulic system contains 1.4 gallons of demineralized water and the drill unit hydraulic system contains 27 gallons of Houghto-Safe-620 hydraulic fluid. The Houghto-Safe-620 is a mixture of glycols and water (95%) and additives (5%). It is slightly heavier than demineralized water but essentially neutrally buoyant with respect to the highly borated water in the RCS.

The demineralized water in the underwater clamp does not present a viable critical potential for several reasons. First, there is an insufficient quantity to cause a criticality. Greater than two gallons would be needed to cause criticality even if injected directly into the center of the reactor core under worst case conditions (References 1 and 2). Second, the demineralized water would be located in the reactor vessel but several feet from the nearest part of the core and would mix with several thousand gallons of highly borated RCS water before it could get to the core. The demineralized water is lighter than the RCS fluid and would rise to the surface of the IIF as it mixed rather than sink toward the core.

The Houghto-Safe-620 is contained in a reservoir and system hoses, etc. on the drill rig. The licensee has installed a drip pan to collect leakage and a leak detection system with automatic unit shutdown. However, in the worst case the entire 27 gallons could leak. The Houghto-Safe 620 would leak onto the top of the RCS water at the 327'6" elevation. There is 12 feet of vertical elevation and over 20,000 gallons of borated RCS water to the vessel nozzles. Being neutrally buoyant and miscible the Houghto-Safe 620 would mix with the over 20,000 gallons of RCS water which is above the reactor vessel nozzles. The core region is located several feet below the nozzles. Mixing with only 225 gallons of 4950 ppm B water would produce a criticality safe concentration. Thus the Houghto-Safe-620 does not pose a credible source of inadvertent criticality.

Based on the above evaluations, we have determined that none of the potential criticality concerns represent a credible or significant safety risk. We therefore conclude that the proposed activity is acceptable with respect to criticality issues.

B. Pyrophoricity Concerns

Bulk zirconium or Zircaloy is normally protected from reaction with air or water by a tight impervious surface film of zirconium oxide. The operation of core drilling through metallic Zircaloy structures will necessarily produce sizable quantities of finely divided metallic Zircaloy particles. Even as a powder, the metal can normally be handled in air at ordinary temperatures without burning. However, when ignited finely divided zirconium or Zircaloy metal burns violently in air. At high temperatures the metal can "burn" in steam, generating hydrogen gas and zirconium dioxide.

The key to preventing pyrophoric reactions is to provide conditions where the heat of the metal oxidation reaction is rapidly conducted away from the reacting surface. At low surface temperature, the rate of oxidation is slow and a protective oxide film is formed, preventing the runaway pyrophoric reactions. Finely divided zirconium or Zircaloy particles can be prevented from igniting by submerging them in water. Zirconium powders and machining chips are therefore commonly stored under water. No cases of spontaneous ignition under these conditions have been reported. Some studies indicate that 25% water by volume is enough to provide safe storage for finely divided zirconium.

Machining operations on zirconium alloys or zirconium hydride compositions are sometimes performed with a cooling gas stream directed at the cutting edge of the machine tool to carry away the heat generated by the cutting operation. The rapidly cooled machined chips do not burn. The flush water surrounding the cutting bits of the core drilling tool provides a very efficient heat sink to dissipate the heat generated by the drilling operation. The drill unit is designed to shut down automatically upon loss of flush water. Therefore, there is reasonable assurance that no pyrophoric reactions will be caused by the heat generated by drill bit friction.

The remaining core sampling operations include replacing the water in the core barrel with inert gas and transferring the core sample into a fuel canister. There is low potential for pyrophoric reactions during these operations since no friction heat is generated and the core sample contains little finely divided metallic material.

Fines and cutting chips filtered out of the coolant after the core drilling operation are also kept submerged in water and are not subjected to friction heat. Further, the metallic components of this material would be mixed with the inert nonflammable components, diluting the pyrophoric potential. There is therefore no significant risk from this source.

The provision of an inert gas atmosphere in the fuel canisters containing the core samples and the filtered samples will further protect against the possibility of pyrophoric reactions.

The risk of pyrophoric reactions during the removal of loose core debris before the core drilling operations is low for the reasons given in our August 12, 1983 SER on Underhead Characterization and Core Sampling. Tests on samples of loose core debris show that it contains very little unoxidized material and is not ignitable. The pyrophoric risk is therefore not significant even though large quantities of materials are involved. The risk is further reduced by collecting and storing the loose debris under water or in an inert gas atmosphere.

On the basis of the above evaluation, we have reasonable assurance that there is no significant risk of pyrophoric reactions during the proposed Core Stratification Sample Acquisition activities. We therefore conclude that the proposed activities are acceptable with respect to pyrophoric issues.

C. Mechanical Forces/RCS Integrity

The core stratification sampling equipment assembly consists mainly of a core drilling machine, work platforms and a support structure. The drilling machine is supported by the drill indexing platform which accommodates positioning of components at the proper locations for drilling. The platform mounts to a interface platform which is attached to the defueling work platform above the reactor vessel.

The defueling work platform rotates about the reactor centerline and will be used to position the drill indexing platform in the approximate circumferential location for drilling. It consists of a circular beam approximately 17 feet in diameter with cross beams and is supported from the refueling canal floor by the shielded support structure. The circular and cross beams of the platform are welded girders made of 304 stainless steel.

The shielded support structure consists of framework made of ASTM A36 carbon steel resting on four columns which transfer all loads above to the concrete floor.

The purpose of this review was to ascertain that:

a. Existing structure can take the platform loads and operating forces;

b. Reactor vessel can take the operating forces; and

c. Accidents in operation will not damage the structural integrity of the system.

In order to assure structural integrity of the system, all applied loads, static and dynamic, must be accounted for; load paths and load distributions be well understood; critical load combinations be studied; and structural assemblies be adequately designed.

The drill indexing platform structural assembly is comprised of three major subassemblies identified as the wing assembly, the upper level assembly and the lower level assembly. The total load is 22,400 lbs. and twelve load combinations are considered. The structure is designed to meet AISC Specifications.

The defueling work platform consists of circular and cross beams made of 304 stainless steel. They are built to within the design limits specified in the ASME Boiler and Pressure Vessel Code Section III, Division 1 - Appendix XVII.

Structural analyses have been performed to evaluate the structural integrity of the defueling work platform and the shielded support structure. Five loading cases including two cases for core drilling have been considered. The total weight including 100 psf live load and platform shielding is 81,101 lbs. Maximum stresses of all components of the work platform are well within allowable limits.

The core drilling equipment is supported by the defueling work platform which is in turn supported from the floor of the fuel transfer canal. The equipment loads associated with the drilling operation are therefore not imparted to the reactor vessel. The only significant operating force imparted to the vessel is the downward force exerted by the drill bit face and the drilling equipment is designed such that the maximum force will not exceed 10,000 lbs. The force on bit acting at an inclined angle to the vessel is anticipated to be 1118 lbs. and insignificant. These forces transmitted to the vessel will not cause damage to the vessel.

Damage that could be caused by accidents resulting from the core drilling operation has been addressed in the report. No damage to the structural integrity of the system is expected.

Based on the above described analyses, discussions and finding, the staff concludes that there is reasonable assurance that the TMI-2 core stratification sampling operation will not cause impairment of structural integrity of the work platform, support structure and the reactor vessel. We therefore find that the proposed activities are acceptable with respect to mechanical forces and reactor coolant system integrity.

CONCLUSIONS

The staff has examined and evaluated the potential risks associated with the Core Stratification Sample Acquisition Program (Revision 1). The staff has concluded that there is no significant risk from pyrophoricity, criticality or RCS integrity issues. We therefore conclude that the Core Stratification Sample Acquisition Activities (Revision 1) can be implemented without significant risk to the health and safety of the public.

REFERENCES

1. NRC Memorandum Carl H. Berlinger, Core Performance Branch, to R. Weller, TMIPO, "Review of TMI-2 Foreign Materials Criticality Report" dated December 2, 1985

2. GPUN "Report on Limits of Foreign Materials Allowed in the TMI-2 Reactor Coolant System During Defueling Activities, Rev. 1, 15737-2-N09-002, September 1985

3. NRC Memorandum Victor Benaroya, Chemical Engineering Branch, to Philip Grant, TMIPO "Review of Zirconium Pyrophoricity Issues Related to the TMI-2 Core Stratification Sample Acquisition, dated November 20, 1985

4. NRC Memorandum Charles E. Rossi, Assistant Director PWR-A, to P. J. Grant "TMI-2 SER for Core Stratification Sample Acquisition," dated May 1, 1986

5. GPUN Letter with attached SER from F. R. Standerfer, 4410-85-L-0147, to B. J. Snyder dated August 30, 1985

6. GPUN Letter with attached SER from F. R. Standerfer, 4410-85-L-0248, to W. D. Travers dated December 31, 1985