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July 24, 1984
NRC/TMI 84-051

Docket No. 50-320

Mr. B. K. Kanga
Director, TMI-2
GPU Nuclear Corporation
P.O. Box 480
Middletown, PA 17057

Dear Mr. Kanga:

Subject: IIF Processing System Safety Evaluation

References: (a) GPU letter 4410-84-L0082, B. K. Kanga to B. J. Snyder, dated May 31, 1984
(b) GPU letter 4410-84-L-0108, B. K. Kanga to B. J. Snyder, dated July 16, 1984

This letter is in response to the letters referenced above in which you forwarded both a safety evaluation and an addendum describing additional hardware improvements to support the proposed operation of the Internals Index Fixture Water Processing System (IIFPS). Your safety evaluation assessed both the use of the IIFPS to process reactor coolant through the SDS as well as its integration with other systems through special instrumentation and controls. Interfacing systems include the RCS makeup and purification system, RCS level monitoring system, RCS sampling system, liquid waste disposal system and the fuel canal fill and drain system. Your safety evaluation specifically addressed core decay heat removal, boron dilution controls and radiological considerations.

The staff had reviewed your initial safety evaluation (reference a) and determined that additional system modifications were needed to detect potential boron dilution events. Our recommendations for system modifications were discussed in meetings with members of your staff, and, based on these discussions, systems have been modified to improve water inventory measurement and core sampling capability. Based on your recent submittal (reference b), which proposed the use of a new RCS sampling system and improved water level indication in the reactor coolant bleed tanks, the staff concurs with your system modifications and proposed use of the IIF water processing system. The attached safety evaluation provides the basis for our approval of your IIFPS plan and includes an assessment of your Boron Dilution Controls, System Performance and Safety Controls, Radiological Controls and RCS Integrity Verification. Additionally, the staff has reviewed your functional testing of

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the IIFPS, including the associated safety interlocks, and determined there is reasonable assurance that the system will perform as designed.

Based on the attached safety evaluation, we additionally will require that RCS leak rates measurements be taken over a minimum four hour period to insure adequate measurement sensitivity. Final approval of the operation of the IIFPS will be provided upon your submittal and our review of your detailed operating procedure.

/s/

Philip J. Grant
Acting Deputy Program Director
TMI Program Office

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PROCESS DESCRIPTION

The IIF processing system will be installed on the reactor vessel after head removal. The primary purpose of the IIF processing system is to remove radioactive contamination from the primary water following the head lift to minimize worker exposure.

The IIF is a component supplied by the reactor manufacturer for use in aligning the plenum assembly during plenum movement into and out of the reactor vessel. The IIF is a six feet high cylinder designed to mate with the reactor vessel head flange. For reduction of radiation exposure levels, the IIF mating surface will be modified with a gasket to form a water seal which will allow reactor vessel water to be pumped into the IIF to serve as a shield for radiation emitting from the plenum surface. To function as an effective shield, the water in the IIF will need to be processed periodically to remove radioactive contamination which will gradually enter the water from the core debris.

The IIF processing system is designed to remove suspended and dissolved radioactive contaminants from the RCS. A submersible pump will be attached to the inside of the IIF. The pump will transfer RCS water from the IIF, through the submerged demineralizer system, to an empty reactor coolant bleed tank (RCBT). As water is pumped from the IIF, a normal plant waste water transfer pump will pump water from a full RCBT back to the reactor vessel through the normal makeup injection lines. Water level in the reactor vessel will remain constant throughout the process.

The processing system is designed to operate in essentially a continuous mode. The process will be halted periodically to sample and realign RCBT's and to measure reactor coolant system leak rates. The system is expected to operate at a flow rate of less than 15 gpm. The objective of the system is to maintain RCS water contamination at 0.1 uCi/cc or less.

SPECIFIC SYSTEM FEATURES

Boron Dilution Monitoring

Boron dilution of the RCS, if allowed to continue, could result in an inadvertent criticality. Safeguards have been established to prevent a dilution event from occurring. In the unlikely event that dilution does occur, the boron concentration in the RCS has been increased to 5050±100 ppm to provide a safety margin above any boron levels which may raise criticality concerns. Additionally, sampling techniques and water inventory accounting procedures have been established to provide early warning of a dilution event.

Dilution safeguards include procedural controls over all evolutions which involve the RCS and a physical, two boundary, isolation of the RCS from all systems which may be potential dilution sources. Conservative analyses indicate that criticality in the core will not occur if boron concentrations are maintained at 3500 ppm or higher. We conclude that a dilution event would be detected well before the boron concentration could decrease from the existing level, 5050±100 ppm, to 3500 ppm.

Boron sampling is one of two methods available to detect dilution. The initial GPU SER (reference a) proposed to periodically sample the IIF processing pump discharge to monitor for boron dilution. This concept was revised by the SER addendum (reference b) to be a more sensitive sampling technique which included a separate sampling pump for obtaining a sample from the area immediately above the core rubble bed. A conservative sampling frequency (once per six hours) was established to ensure early detection of a dilution event. The sampling frequency may be modified in the future after core mixing data is collected and analyzed during the IIF processing. An on-line boron monitoring system is also being developed, and if successful, the system may provide a basis to reduce the sampling requirements.

A periodic mass balance to determine primary system water inventory can also serve as a technique to detect a dilution inflow. GPU concluded that 12,480 gallons of unborated water would be required to dilute the 36,000 gallon reactor vessel/IIF volume from 4950 ppm boron to 3500 ppm boron. The NRC staff performed a more conservative analysis by assuming that the inflow of unborated water was restricted to the area outside the core barrel and to the lower hemisphere of the reactor vessel. This analysis was based on the concern that a critical fuel mass could have accumulated on the bottom hemisphere of the reactor vessel and a dilution inflow could interact with this critical mass after only limited mixing in the vessel. Structural baffles inside the reactor vessel and the core debris physically segregate the incoming makeup flow from the main body of water in the vessel. A 14,000 gallon water volume is formed outside the core region by this physical boundary. More than 4500 gallons of unborated water would be required to reduce the boron concentration in this region from 4950 ppm to 3500 ppm.

Based on the more conservative dilution scenario, we feel that the IIF processing system water inventory detection system should be designed with sufficient sensitivity to detect a 4500 gallon inflow of potentially unborated water. To achieve a total system sensitivity of 4500 gallons, each of the two RCBT's should include instrumentation capable of detecting water inventory to at least ±750 gallons. RCBT sensitivity to ±750 gallons would be required to include mass balance calculations as a viable technique for detecting dilution events. Inventory calculations would need to be performed hourly to provide effective dilution detection.

Based on the analysis described above, the RCBT inventory measuring capability was modified to increase the sensitivity to at least ±750 gallons. Hourly water inventory calculations are required by operating procedures.

The boron dilution controls described above have been incorporated into the IIF processing system and provide a defense in depth which minimizes any potential for inadvertent criticality. The onsite NRC staff will monitor IIF processing operations and will confirm the bases for this evaluation as operating data become available.

<u>System Performance and Safety Controls</u>

The staff has reviewed the functional testing of the IIFPS and the associated safety controls. The system, as designed, will transfer reactor coolant from the IIF, through the SDS, to a reactor coolant bleed holdup tank. The use of the existing SDS flowpath through reactor building penetration R-626 and the two train zeolite vessel system to the receiving bleed holdup tank had previously been approved by the staff via letter NRC/TMI 83-067 from L. H. Barrett to B. K. Kanga, dated November 8, 1983. Functional testing demonstrated the operation of the IIFPS including the safety interlocks associated with water level indicator (bubbler) high and low level alarm controls which automatically isolate makeup (WDL-V40) and letdown (FCC-V003) and trip the IIF processing pump. This control will insure RCS level is maintained in an acceptable range and the IIF will not be overfilled. The physical location of the IIF processing pump intake will preclude the IIF water level from decreasing below 2½ feet above the reactor vessel flange and this prevents the potential loss of shielding and insures personnel exposure protection.

During IIF processing, the return flowpath from the selected makeup bleed holdup tank to the RCS will be via the existing plant system design which has been used frequently for normal RCS bleed and feed operations. In addition, the functional testing demonstrated that the water level bubbler system adequately controlled the makeup throttle valve (MU-V9) under the full range of potential water levels in the IIF. It is our understanding however, that the makeup system will be operated in manual mode to reduce the cycling of MU-V9. We have determined that manual operation provides added safety assurance because of both operator awareness and better sensitivity to unusual makeup changes which may be associated with potential boron dilution events. We conclude that adequate system controls exist to insure isolation at system tie-in points with the fuel transfer canal and reactor building sump systems. Based on the IIFPS safety features in conjunction with both the Auxiliary and Fuel Handling Building ventilation and SDS off-gas and monitor system, we conclude that reasonable assurance exists to insure the IIFPS can be operated in a safe manner and adequate protection exists for both the health and safety of the workers and the public.

Radiological Controls

The IIF processing system is designed to maintain the radionuclide concentration in the RCS at a maximum of 0.1 uCi/ml. Additional radiation protection will be provided by the IIF cover which includes one inch of lead shielding. The combined effect of these two features is expected to reduce the dose rates above the IIF to near ambient levels.

Reactor Vessel Integrity Detection

The GPU safety evaluation addressed reactor vessel leak detection and specified that IIF processing would be stopped every 72 hours to measure leakage from the reactor vessel. The reactor vessel leakage would be measured over a two or four hour period. Due to the sensitivity of the existing reactor vessel level detectors, a leak check over a two hour period could fail to detect leaks as large as 1.3 gpm. Since station procedures initiate emergency actions when leak rates reach 1 gpm, we feel that the four hour leak detection period should be used to lower the leak detection threshold to below 1 gpm. The NRC site staff, by means of the normal procedure approval process, will ensure that the leak checks are performed over a four hour period.

Conclusion

On the basis of our safety review, we conclude that the proposed IIF processing system can be operated without posing a significant risk to the occupational work force or the offsite public. Additionally, the potential environmental impacts resulting from the system operation are minimal. The described activities fall well within the scope of those previously assessed in the staffs' Programmatic Environmental Impact Statement. Accordingly, we approve the operation of the IIF processing system subject to our approval of the associated operating procedures in accordance with Section 6.8.2 of the plant Technical Specifications.

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