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TMI-2 Cleanup Project Directorate
Attn: Dr. W. D. Travers
Director
US Nuclear Regulatory Commission
c/o Three Mile Island Nuclear Station
Middletown, PA 17057

Dear Dr. Travers:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
TMI-2 Temporary Reactor Vessel Filtration System - Revision 2

Attached for your review and approval is Revision 2 to the subject Safety Evaluation Report (SER) which evaluates the operation of the TMI-2 Temporary Reactor Vessel Filtration System (TRVFS) with a new filter vessel. The modification enables the TRVFS to operate at higher flowrates with increased filter media capacity. The SER also addresses modification of the system operation to dispose of the filter residue to a knockout canister. The attached SER shows that the TRVFS can be operated safely and does not create undue risk to the health and safety of the public.

Per the requirements of 10 CFR 170, an application fee of $150.00 is enclosed.

Sincerely,

F. R. Standerfer
Vice President/Director, TMI-2

D009 w/check $150.00 #00022418
1/1

FRS/RBS/eml

Attachment

Enclosed: GPU Nuclear Corp. Check No. 00022418

GPU Nuclear

SAFETY ANALYSIS

SA # 4340-3220-86-0023

Rev. # 2

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TITLE

TMI-2 TEMPORARY REACTOR VESSEL FILTRATION SYSTEM

Originator Robert B. Sweitzwelder Date 4/14/86

CONCURRENCE

Lead Engineer/RTR [signature] Date 4/14/86 SRC [signature] Date 4/14/86

Cognizant Eng. J D Bobalick Date 4/14/86 RQ. [signature] Date 4-14-86

APPROVAL

Mgr. Eng. Section [signature] Date 4/14/86 Site Ops Director [signature] Date 4/14/86

Mgr. Recovery Pgms. [signature] Date 4/14/86

FORM 4000-ENG-7310.09.1 (5/83)

TMI-2 TEMPORARY REACTOR VESSEL FILTRATION SYSTEM

1. <u>Purpose and Scope</u>

The purpose of this Safety Analysis is to re-analyze the operation of the existing Temporary Reactor Vessel Filtration System for use with a new filter vessel and residue canister and show that it will not present an undue risk to the health and safety of the public.

The prime purpose of the Temporary Reactor Vessel Filtration System is to restore and maintain the visibility in the Reactor Vessel at acceptable levels to insure the continuation of the Early Defueling Program. Recent developments relative to the operation of the DWCS and the Filter Canisters have revealed that the Filter Canisters develop the maximum design pressure drop before the filter has processed significant quantities of water. Our investigation of this development has lead to the discovery of micro-organism growth in the reactor coolant. Theory and experience indicates that these micro-organisms are capable of plugging the filters in the filter canister prior to the collection of any significant quantity of core debris. These developments have created the need to design and operate a temporary filter system while GPU Nuclear develops a permanent program to control this phenomenon.

The principal safety questions relating to the system's operation are criticality control, waste disposal, and the potential consequences of spills.

2. <u>System Description</u>

The Temporary Reactor Vessel Filtration System (TRVFS) is provided to cleanup the Reactor Vessel water above the rubble bed to provide and maintain an adequate level of visibility to enable defueling to proceed.

The system consists of a pump, 1 1/2 inch diameter suction and discharge hoses, isolation valves, fittings, and the 30 inch high by 17 1/2 inch I.D. filter assembly as well as a knockout canister(s), return pump and associated hoses. The TRVFS will be operated only when operations personnel are on the defueling platform. The TRVFS will take suction from the IIF and/or the RV annulus and return the filtered water to the IIF. The flow rate through the filter is approximately 100 gpm. The filter is a standard Diatomaceous Earth (D.E.) pre-coat filter. The filter consists of 8 24-inch long by 1/2 inch wide leaves which provide approximately 48 ft^2 of filtration area. The leaves are housed in a stainless steel container. A six (6) pound load of D.E. is injected into the suction of the pump which coats the filter leaves. When the pressure drop across the filter reaches 10 psi, the filter is backwashed. The D.E., debris, and backwash water will be routed to a knock-out canister. The TRVFS is restored by establishing flow and injecting six (6) pounds of clean D.E. into the pump suction. Each backwash pumps six pounds of D.E. plus the captured debris and approximately 100 gallons of water to the knock-out canisters. The knock-out canisters will then be dewatered and the water returned to the reactor vessel.

3. <u>Criticality Prevention</u>

Any fluid system connected to the vessel which transports coolant system water from the IIF has the potential to move fuel bearing material. Consequently, the potential to accumulate fuel external to the reactor vessel has been addressed. Because of the temporary nature of the system and the unlikelihood of accumulating significant quantities of fuel based on the suction point for this system, GPU Nuclear believes that rigorous design controls are not required in this instance. However, the TRVFS design and operation does provide the following separate assurances to preclude significant fuel accumulation and criticality.

a. Only suspended material in the RCS will be moved.

b. Any material trapped by the filter will always be in contact with borated water.

The inlet and outlet hoses for the TRVFS are one and one-half (1 1/2) inch I.D. hoses. The hoses from the IIF to the pump will be secured in such a manner that the suction piping will normally be immersed in the IIF no more than two (2) feet below 327'-6". Consequently, the suction of the RCS water will occur within the confines of the IIF. At approximately 100 gpm, the velocity in the hose is approximately 17 feet per second; however, the fluid velocity ten feet from the hose would be four to five orders of magnitude less, if any velocity effect from the hose suction exists at all. At such velocities only particles smaller than 10 microns could be moved. It could be assumed that the suspended material in the reactor water is uranium oxide at a concentration of 1 ppm; representative of past sample concentrations. Twelve hours of continuous operation of the filter system at this concentration would deposit 0.2 Kg of UO_2 on the filter media, significantly less than that required to produce a criticality. The conservative nature of this hypothetical model is illustrated by comparison to the analysis of the pre and post-filter effluent in the DWCS operation; a similar but deeper suction and discharge arrangement with a higher flow rate. Analysis of DWCS fluid has shown no detectable fissile material in the flow stream. Therefore, it is concluded that a significant accumulation of uranium oxide will not occur in the TRVFS filter housing. Previous operations of the current TRVFS has resulted in the accumulation of less than 500 grams of fuel in each of two discharge drums used to date. Discharge from the TRVFS or canister will be routed to the IIF region (i.e., above 322 elevation).

During certain operations the suction may be taken from as low as elevation 310' in the RV annulus. This is approximately 15 feet above the fuel debris that has been observed in the lower head region. Given this distance and the flow rates involved, it is considered that fuel deposition in the TRVFS filter from this suction point will be not significantly different than discussed above. In any case, the presence of 4350 ppm of boron ensures any fuel deposit in the filter will remain subcritical. To preclude drain down of the RV to these lower levels, siphon breaks have been incorporated into the suction lines at approximately 325'6" (2 feet below normal water levels in the IIF).

The RCS Criticality Analysis (Reference 4) previously established that the core material could not go critical under any configuration postulated for defueling provided the surrounding water contained at least 4350 ppm boron. Since the TRVFS will be drawing water from the reactor vessel in a closed loop during normal operations, boron concentrations will be maintained at or above 4350 ppm. Thus, any fuel material deposited in the filter will be effectively poisoned by the boron content of the water. Backflushing operations will be performed using BWST water as the water supply. The water will be routed to the TRVFS via the flush wand connections. After dewatering of the knockout canister, large quantities of borated water will remain interstitially trapped. Even if all borated water is removed, the filter will remain subcritical since the low enriched uranium cannot generate a criticality without the presence of moderating material.

The potential for criticality due to a boron dilution event has been considered. Diatomaceous earth consists of approximately 88% silica and exhibits no propensity to remove or absorb boron. Operating experience with these filters in the fuel pool and RV has resulted in no detectable dilution of either body of water. Therefore, significant boron dilution caused by removal of boron by the diatomaceous earth filters is not considered credible. Boron dilution of the reactor vessel or the filter vessel during normal operation is judged not credible because of the closed loop nature of the system, the small number of system interconnections and the unavailability of unborated water sources in the vicinity of the suction connections. Administrative controls will be used to assure that there is not a significant probability of diluting the TRVFS or RV during backflush operations.

As an additional precaution to limit the potential for transporting significant quantities of fuel to the filter, aggressive defueling techniques (e.g. shredder operation, clamshell debris removal) will not be performed during TRVFS operation.

4. Waste Disposal

Calculations of the estimated radionuclide concentrations and the maximum expected concentrations of fissile material in the raw waste indicate levels slightly greater than that allowed for disposal (of the waste) as a Class C package. The Group 2, long-lived isotopes are controlling for Class C. Therefore, stabilization will be required for shallow land burial. Cement solidification of the waste will reduce the concentrations to those acceptable for shipment as Class C waste.

Consequently, it is concluded that shipment of these wastes will not represent an abnormal waste disposal concern for this program.

5. Dose Rate Evaluation and Spill Consequences

The filter housing will be monitored continuously for gamma radiation levels for personnel protection. The monitor will be situated inside the shield housing. At a preselected level the filter operation will be secured. Currently this level is calculated to reflect the target dose rate of 50 mR/hr at the outer surface of the shield housing. This level may be adjusted by Rad Con to account for changing conditions and personnel (ALARA) considerations. Additional shielding may be installed throughout the system so that the target dose rate can be met. Radiation levels from the knock-out canister are not considered since the canister will be stored underwater in the FTC racks and handled in the same manner as other canisters.

It may be possible during the transfer of D.E. from filter to canister to experience a spill. In this case, the transfer water, approximately six (6) pounds of D.E. and the filtered material are spilled onto the surface of the North End Defueling Platform. Should such a spill occur, a portion of the platform would be contaminated with up to 2.1 curies of Strontium/Yttrium-90 and 0.1 curies of Cesium-137 based on sample results from previous operations. If the spill spreads to cover a depth of 1/8" (3 mm), an area of about 500 ft^2 will be contaminated. Dose rates attributable to this contamination will be in the range of 1.2 rad per hour at 10 cm above the floor. Using a resuspension factor of 0.0001, the airborne radioactivity levels would be in the range of 3.1×10^{-7} uCi/cc. At these levels, the local area airborne radioactivity monitors would alarm within 2 seconds of the spill. A five (5) minute stay in this environment would result in 33 MPC hours for the involved isotope assume no protection factor and the airborne activity was equally distributed in the canal.

A "liquid only" spill must also be considered. A pipe break at the pump discharge would exhibit the potential for spilling liquid from the IIF onto the 322'-6" elevation of the FTC floor. This event can be detected using the IIF level monitoring system. The liquid would drain to the sump in the canal floor on the south-east corner of the upper canal where it would collect and be pumped to a staging or processing location. With the TRVFS suction limited to two (2) feet below the surface of the water in the IIF via the hose suction point or suction breaks, this presents approximately 4000 gallons of RCS water. It is not expected that such an event would significantly increase the radiation exposure to workers on the Defueling Platform.

Another potential concern relates to the consequences of a filter breakthrough causing six (6) pounds of diatomaceous earth to be pumped into the reactor vessel. As previously stated, diatomaceous earth is chiefly silica, in a fine powder form, with little, if any, hydrogeneous material. It would, therefore, significantly increase the turbidity of the RCS fluid but would not effect the present shutdown margin of the bulk core. Eventually, it would be expected to settle to the top of the rubble bed and be removed with the rubble during defueling.

Canister handling will be performed using the Reactor Building canister handling bridge as described in Reference 1. As stated, drop of a canister during transfer operation is considered unlikely. However, the effects of a dropped canister on offsite releases is bounded by Reference 1. The effects of a dropped canister on worker doses is addressed in Reference 1 via response to an NRC question (GPU Nuclear letter 4410-85-L-0181, dated October 3, 1985).

6. Summary

It is concluded, based on the evaluations presented in this Safety Analysis, that the operation of the Temporary Reactor Vessel Filtration System may be conducted without undue risk and exposure to the operating personnel nor will it present undue risk to the health and safety of the public.

10 CFR 50, Paragraph 50.59, permits the holder of an operating license to make changes to the facility or perform a test or experiment, provided the change, text, or experiment is determined not to be an unreviewed safety question and does not involve a modification to the plant Technical Specifications.

A proposed change involves an unreviewed safety question if:

a. The probability of occurrence or the consequences of an accident or malfunction of equipment important to safety analysis may be increased; or

b. The possibility for an accident or malfunction of a different type than any evaluated previously in a safety analysis report may be created; or

c. The margin of safety, as defined in the basis for any Technical Specifications, is reduced.

A variety of events have been analyzed in this SER. It has been determined that the events due to operation of the TRVFS are similar to events described in several previous submittals (References 1, 2 and 3). Of primary concern are a handling accident, deboration of the RV, draindown of the RV and criticality concerns in the filter. The drop of the knock-out canister and subsequent release of radioactivity to the environment is bounded by the canister drop accident described in Reference 1. Deboration of the RV is possible by one of the two methods: absorption of boron by the D.E. or by dilution caused by improper hookup and operation of the filter system. The filter media has shown no propensity to remove boron during test operations in the fuel pool and previous RV operation. Operation of similar types of systems have been addressed in the Boron Hazards Analysis (Reference 2) and it has been demonstrated that the RCS can be processed without incurring a significant dilution hazard.

Due to the setup of hose suction and discharges, draindown of the reactor vessel is not considered credible. Previous evaluations have shown that ambient cooling is adequate with water level above the vessel flange. Since draindown will be limited to the upper two (2) feet of the IIF, this event is bounded.

Technical Specification safety margins at TMI-2 are concerned with criticality controls and prevention of further core damage due to overheating. As demonstrated by this Safety Evaluation Report, Technical Specification safety margins will be maintained throughout the filtering process. Subcriticality is ensured by establishing the boron concentration at greater than 4350 ppm during the early defueling process and ensuring that this concentration is maintained by monitoring the boron concentration and inventory levels and by isolating potential deboration pathways. Subcriticality in the filter system is maintained primarily by ensuring contact with borated water. Criticality is not a concern in the canister due to the engineered safeguards.

Thus, it is concluded that the operation of the Temporary Reactor Vessel Filtration System does not constitute an unreviewed safety question as defined by 10 CFR Part 50, Paragraph 50.59.

ATTACHMENT
4410-86-L-0063

REFERENCES

1. Safety Evaluation Report for Early Defueling of the TMI-2 Reactor Vessel, Revision 4, GPU Nuclear letter 4410-86-L-0200, dated October 10, 1985, from F. R. Standerfer to B. J. Snyder.

2. Boron Hazards Analysis, Revision 2, GPU Nuclear letter 4410-85-L-0195, dated September 27, 1985, from F. R. Standerfer to B. J. Snyder.

3. Technical Evaluation Report for Defueling Canisters, Revision 1, GPU Nuclear letter 4410-85-L-0183, dated September 10, 1985, from F. R. Standerfer to B. J. Snyder.

4. Criticality Report for the Reactor Coolant System, Revision 0, 15737-2-N09-001 dated October, 1984.