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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 3

GPU Nuclear letter 4410-86-L-0185 dated November 17, 1986, transmitted Revision 3 to the TMI-2 Temporary Reactor Vessel Filtration System Safety Evaluation Report (SER). However, Page 4 of 8 of the SER was inadvertently omitted. To correct this omission, a complete copy of the subject revised SER is submitted herein.

Sincerely,



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

FRS/RDW/em1

Attachment

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SAFETY ANALYSIS

SA # 4340-3220-86-0023

Rev. # 3

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TITLE

TMI-2 TEMPORARY REACTOR VESSEL FILTRATION SYSTEM

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TMI-2 TEMPORARY REACTOR VESSEL FILTRATION SYSTEM1. Purpose and Scope

The purpose of this Safety Analysis is to re-analyze the operation of the existing Temporary Reactor Vessel Filtration System (TRVFS) at lower depths within the reactor vessel and the use of filter canisters as receptacles for the TRVFS filter backwash to show that these changes 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 ensure the continuation of the 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 and metallic oxides in colloidal suspension in the reactor coolant. Theory and experience indicates that these micro-organisms and the colloids are capable of plugging the filter media 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. System Description

The designed function of Temporary Reactor Vessel Filtration System (TRVFS) is to cleanup the Reactor Vessel water above the rubble bed in order 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 knockout or filter canisters, return pump and associated hoses. The suction depths are controlled by fixed lengths of solid piping. The TRVFS will be operated only when operations personnel are on the defueling platform, or both the command center and the SDS control panel are manned to observe, via CCTV cameras, the radiation monitor alarm and pressure gauge on the TRVFS filter and the alarming air samples in the area of the TRVFS. A remote shutdown switch at the SDS control station is provided in addition to the local control switch.

The TRVFS will take suction from the IIF and/or the RV 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 eight (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 or filter 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 canisters. The knockout canister will then be dewatered and the water returned to the reactor vessel. The filter canister allows water to be returned to the deep end of the FTC via the outlet connection.

3. Criticality Prevention

Any fluid system connected to the vessel which transports reactor coolant system (RCS) water 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 boric water.

Various suction depths within the IIF and the reactor vessel may be used with TRVFS. A shallow suction depth at elevation 325'-6" (two (2) feet below the IIF water level) and deeper suction depths no lower than elevation 313'-6" (one (1) foot above the normal core region) are planned. At these suction elevations only suspended material in the RCS will be picked up by TRVFS which will minimize the quantity of fuel trapped on the filter. As a bounding elevation, the quantity of UO_2 that could be trapped on the filter was determined based on the following assumptions:

- o Flow rate - 100 gpm
- o Gross alpha concentration of 10^{-2} uCi/cc (based on occurred concentrations during core drilling)
- o 150 uCi of gross alpha per gram of UO_2
- o Twelve (12) hours of continuous TRVFS operation
- o All fuel picked up by TRVFS is trapped on the filter

Using these assumptions approximately 18 kg of UO_2 could be deposited in the filter. This quantity is much less than the minimum critical mass for TMI-2 fuel (i.e., 93 kg).

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 (also borated to at least 4350 ppm) as the water supply. This water supply will be routed to the TRVFS via the existing flush wand connections.

In addition, GPU Nuclear has determined that, at a distance of one foot below the suction elevation, the flow velocity toward the suction is less than the settling velocity of fuel particles with sizes greater than 300 microns. Since the deepest suction elevation for TRVFS is greater than eight (8) feet above the core debris bed and at least one (1) foot above any known area within the RV which may contain fuel debris, fuel particles greater than 300 microns in size are not expected to be picked up by the TRVFS. As a further precaution, GPU Nuclear will not perform aggressive defueling techniques (e.g., shredder operation, clamshell debris removal) during TRVFS operation to limit the size of fuel particles that could be suspended. Therefore, filter canisters can be used with TRVFS operation without impacting the criticality evaluations, given in the Safety Analysis Report (SAR) for the NuPac 125B Shipping Cask, which limit fuel particle sizes to less than or equal to 850 microns in the filter canisters.

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.

4. Waste Disposal

The knockout and filter canisters being used as receptacles for the filter backwash will be handled like other defueling canisters and will be shipped off-site with the other defueling canisters using the licensed NuPac 125B Shipping Cask. The TRVFS filter and hoses will be cleaned and flushed so that their disposal would not represent an abnormal waste disposal concern.

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 or filter canister are not considered since the canisters 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 ft² 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. Similar consequences would be obtained at higher RCS contamination levels since the majority of the dose consequences is from the spent diatomaceous earth. The spill is postulated during filter backwash which is assumed to occur when the radiation level on the surface of the shield housing is 50 mrem/hr. 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 assuming no protection factor and the airborne activity equally distributed in the canal volume.

A "liquid only" spill has also been 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 the use of siphon breaks when lower suction is employed, potential leakage is limited to 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 off-site 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, test, 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 or filter 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 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 canisters due to the engineered safeguards. Additionally, because of the relative positions of TRVFS suction with respect to fuel debris locations and the restriction on aggressive defueling techniques during TRVFS operation, the expected particle sizes of trapped fuel debris that may be routed to filter canisters are within the particle size considerations used in the accident evaluations given in the SAR for the NuPac 125B Shipping Cask.

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.

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 4410-86-L-0039, dated March 19, 1986, from F. R. Standerfer to W. D. Travers.
4. Criticality Report for the Reactor Coolant System, Revision 0, 15737-2-N09-001 dated October, 1984.