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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
Canister Dewatering

The purpose of this letter is to obtain NRC approval of an alternative dewatering acceptance criterion for defueling canisters and a reduction in the amount of catalysts required to be exposed following dewatering.

BACKGROUND

NRC Letter NRC/TMI-85-083 dated November 5, 1985, granted NRC approval of the Defueling Canisters Technical Evaluation Report (Canister TER) submitted via GPU Nuclear letter 4410-85-L-0067 dated April 9, 1985. NRC Letter NRC/TMI-86-060 dated June 20, 1986 granted NRC approval of the Canister Handling and Preparation for Shipment Safety Evaluation Report (CHAPS SER) submitted via GPU Nuclear letter 4410-86-L-0099 dated June 11, 1986. The Canister TER states:

> "A total of at least 200 grams of catalyst is installed in the canister in order to be assured that at least 100 grams is above the maximum water level for all canister orientations. At least 100 grams of catalyst is at either end of the canister and the bed arrangement at each end is symmetrical."

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The CHAPS SER states:

> "Dewatering is performed to ensure that the level of water inside the canister is such that a minimum of 50% of the recombiner catalyst is not submerged in any canister orientation."

The NRC approved method for demonstrating compliance with the dewatering acceptance criterion is stated in the CHAPS SER as follows:

> "Weights taken before and after the canister is dewatered will be used to determine the actual volume of water removed. If this amount exceeds 50% of the empty canister free volume, then the canister is considered to be sufficiently dewatered and can be shipped."

CATALYST EXPOSURE AT 50% VOID VOLUME

Review of the canister fabricator's drawings has indicated that the upper heads of the filter and knockout canisters contain two recombiner catalyst beds, each containing at least 50 grams of catalyst, which are asymmetrically placed 160° apart. The lower heads, which are identical with respect to catalyst bed arrangement for all canister types, contain four catalyst beds containing at least 25 grams of catalyst each. These beds are nominally placed 90° apart. However, there exists a $\pm 10°$ allowable tolerance for the lower head catalyst bed placements. Considering the allowable tolerance in the lower heads and the configuration of the beds in the upper heads, it is possible for a minimum of approximately 60 grams of catalyst to be exposed when a dewatered filter or knockout canister has been dewatered to the 50% void volume criterion and is in the horizontal position. Further, certain canister inclinations result in a minimum calculated quantity of exposed catalyst in dewatered filter and knockout canisters being reduced to 50 grams. Therefore, for filter and knockout canisters, dewatered to 50% void volume, the minimum quantity of recombiner catalyst exposed in any canister orientation could be as low as 50 grams.

The fuel canister upper head contains one catalyst bed of 7" diameter located at the center of the upper head. The capacity of this bed is at least 100 grams and may contain over 300 grams of catalyst. However, assuming only 100 grams of catalyst in the upper head and considering the allowable tolerance in the lower head catalyst bed placement, the minimum quantity of catalyst exposed for a fuel canister dewatered to the 50% void volume criterion, in the horizontal position, is approximately 82 grams. Considering canister inclinations, the minimum quantity of catalyst exposed for the dewatered fuel canister is approximately 65 grams. Therefore, for fuel canisters dewatered to 50% of void volume, the minimum quantity of recombiner catalyst exposed in any canister orientation could be as low as 65 grams.

Even though these quantities of exposed catalyst are less than previously stated, the resulting factor of safety to the available catalyst is still significant. Recent experiments performed by Rockwell Hanford Operations indicate that a factor of safety of 6.4 is achieved with 100 grams of catalyst exposed for a defueling canister containing 800 kg (1760 lbs) of fuel debris. This factor of safety considered the cumulative detrimental effects on the catalyst from activities encountered during canister fabrication, testing, hydraulic fluid contamination, and organism-kill operations. The factor of safety is proportional to the quantity of catalyst exposed and inversely proportional to the quantity of fuel debris. Thus, assuming 800 kg of fuel debris in the defueling canisters, the minimum factor of safety on the theoretical minimum quantity of exposed catalyst would be 3.2 for the filter and knockout canisters and approximately 4.2 for the fuel canisters for dewatered void volumes equal to 50% of the canister free volume.

REDUCED VOID VOLUMES

The above catalyst factors of safety assume that 50% of the canister free volume is void following dewatering. GPU Nuclear anticipates that the dewatering acceptance criterion stated in the CHAPS SER can be achieved for filter and knockout canisters due to the greater amount of free volume in these types of canisters when loaded. However, recent experience with dewatering of fuel canisters indicates that this criterion may not be achievable; in some cases 50% void volume is impossible to achieve. The inability to achieve sufficient fuel canister dewatering may be caused by the residual water being bound or trapped within the fuel debris or the fuel debris occupying more than 50% of the fuel canister free volume.

As the intent of canister dewatering is to provide a sufficient quantity of exposed recombiner catalyst to recombine hydrogen and oxygen that may be formed by the radiolysis of retained water, GPU Nuclear proposes an alternative dewatering acceptance criterion based on a factor of safety for the required quantity of catalyst. The catalyst factor of safety is currently 4.2 for 50% void volume of dewatered fuel canisters containing 1760 pounds of fuel debris and 65 grams of exposed catalyst. Since the catalyst factor of safety is proportional to the quantity of catalyst exposed and inversely proportional to the quantity of fuel debris, GPU Nuclear has determined the required void volume (see attached table) in a dewatered fuel canister, for a given canister payload to expose sufficient catalyst, in any canister orientation, to obtain a factor of safety of three.

To implement this alternative dewatering acceptance criterion, the following expression has been developed to specify the quantity of water to be removed during fuel canister dewatering.

$$W \geq 0.05P + 80$$

where W = weight of water removed, lbs
and P = fuel canister payload, lbs

This expression will ensure that sufficient water is removed from each canister to expose sufficient recombiner catalyst to meet the criteria specified above.

Since the quantity of fuel debris in a fuel canister cannot be accurately assessed because of residual water and the presence of non-core debris material (e.g., debris buckets), the total fuel canister payload weight will be conservatively obtained by substracting the empty fuel canister weight from the weight of the dewatered fuel canister. Thus, because of the conservative method used to determine fuel debris weight, the actual factor of safety achieved is greater than three.

GPU Nuclear has evaluated the consequences of reduced void volumes for dewatered fuel canisters on the Certificate of Compliance (C of C) for the NuPac 125B shipping cask. The cask C of C (No. 9200, Rev. 1) specifies that the canisters must be dewatered in accordance with Section 7.1.1 of the application. The application is the Safety Analysis Report for the NuPac 125B Shipping Cask (Cask SAR). Section 7.1.1 of the Cask SAR addresses canister handling, dewatering, storage, and weighing. Section 7.1.1 does not specify a dewatering criterion. Instead, it states that the weights of the canister, taken before and after dewatering, will be compared to determine the volume of water removed to provide assurance that a sufficient quantity of catalyst would not be submerged in the residual water in the canister, and to determine the void volume. Since the proposed dewatering acceptance criterion will ensure sufficient quantity of catalyst is available, reducing the void volume in a dewatered fuel canister would not deviate from the cask C of C requirement on canister dewatering. The cask C of C also specifies that the molar quantity of hydrogen or oxygen in each canister must be limited to no more than 5% by volume, over a period of time that is twice the expected shipment time (with the shipment period beginning when the canister is closed). GPU Nuclear will continue to perform analyses of gas samples obtained from each dewatered canister to show compliance to this C of C requirement. Therefore, reducing the void volume in a dewatered fuel canister would not impact GPU Nuclear's compliance to the cask C of C limits on combustible gas concentrations.

GPU Nuclear also has evaluated the consequences of the reduced void volumes on the NRC Safety Evaluation Report accompanying the cask C of C (Cask SER). The Cask SER does not specify a void volume in dewatered canisters; however, the maximum allowable pressure in the canisters, which would be dependent on canister void volume, is defined. The pressures in the canisters presented in the Cask SER are identical to the pressures calculated in Table 3.4.4-4 of the Cask SAR. Review of the Cask SAR analysis has found that the canister pressures are based on the following:

o Canister internal temperature of 200°F.

o Volumetric expansion of the argon cover gas in the canisters.

o Vapor pressure of water within the canister debris.

o One year buildup of hydrogen generated from the radiolytic decomposition of water within the canisters due to the assumption of complete oxygen scavenging (thereby rendering the catalyst recombiner ineffective).

o Canister void volume equal to 50% of canister free volume.

Reducing the void volume in a dewatered fuel canister would not impact the canister internal temperature assumed in the SAR analysis. The canister internal temperature calculated in the Cask SAR is based on heat transfer from the canister internals to the exterior wall of the canister, to maximize the canister internal temperature. The reduction of void volume in the canisters would not, therefore, increase the calculated canister internal temperature. GPU Nuclear does recognize that reducing the void volume in dewatered canisters would increase the calculated canister internal pressures, if the hydrogen gas buildup assumed in the Cask SAR analysis is used. Therefore, GPU Nuclear proposes that actual hydrogen appearance rates be used rather than an assumed generation rate. From the analysis of the gas sample obtained from each dewatered canister, GPU Nuclear currently projects the hydrogen concentration over twice the shipment time for compliance with the cask C of C. GPU Nuclear proposes to project the quantity of hydrogen generated in each canister not dewatered to 50% void volume, over a one year period, based on the hydrogen appearance rate determined from the gas sample analysis. Using this projected quantity of hydrogen and the void volume determined by the quantity of water removed during dewatering, the maximum internal pressure for a one year buildup time will be determined for each canister. This maximum internal pressure will be based on 200°F and will also include the contributions from the volumetric expansion of argon and from the water vapor in the canister. If this projected pressure is less than or equal to 150 psig, GPU Nuclear proposes that a canister dewatered to the reduced void volume is bounded by the evaluations given in the Cask SAR, as presented in the Cask SER, and the canister can be shipped. It should be noted that this projection of hydrogen buildup will be conservative in many cases. The buildup of hydrogen is based on the hydrogen appearance rate determined from a gas sample which could be taken shortly after canister dewatering and, thus, prior to the catalyst being fully activated (i.e., 100% efficient). Catalyst testing has shown that wet catalyst does not perform as effectively as dry catalyst; therefore, as the catalyst dries the recombination rate would increase and reduce the hydrogen appearance rate. Additionally, this hydrogen buildup is independent of canister orientation since the quantity of catalyst available, in any canister orientation, is greater than the quantity of catalyst required for the maximum probable gas generation rate as determined in GEND-051 (i.e., a factor of safety $>$ 1).

The Cask SER also presents the maximum quantities of water in dewatered canisters which were estimated in the Cask SAR; however, for conservatism in the criticality evaluations, the optimum fuel-to-moderator ratio is employed. Therefore, even if reduced void volumes in dewatered canisters should increase the quantity of water in dewatered canisters, the criticality evaluations given in the Cask SER and in the Cask SAR would be bounding.

MINIMUM FACTOR OF SAFETY ON CATALYST

It has been shown that a factor of safety of at least three can be obtained on the required quantity of catalyst for 50% void volumes in dewatered filter and knockout canisters, and for reduced void volumes in dewatered fuel canisters (with reduced fuel canister payloads). However, future activities, which may include addition of chemicals to the RCS to improve filter canister performance, leakage of different types of hydraulic fluids into the RCS, and possible unforeseen additional difficulties in canister dewatering could further reduce the effectiveness or quantity of available catalyst. Therefore, GPU Nuclear proposes that an acceptable factor of safety for the required quantity of catalyst be established as 1.5 (i.e., 50% more catalyst than required). It should be noted that the determination of this factor of safety considers: accumulative catalyst contaminations which may not necessarily be experienced by the catalyst; minimum quantity of catalyst available based on the worst canister orientation; and gas generation rates based upon the maximum probable rate given in GEND-051. Therefore, considering the conservatisms employed in the determination of the catalyst factor of safety, a factor of safety of 1.5 is more than adequate to ensure that the available catalyst will control the gases generated from the radiolysis of water retained in the defueling canisters.

CONCLUSION

GPU Nuclear has demonstrated that a sufficient quantity of catalyst is exposed in 50% dewatered canisters to achieve a safety factor of at least three even though the minimum quantity of catalyst exposed in any canister orientation is less than previously reported. GPU Nuclear has also demonstrated that the proposed dewatering acceptance criterion, presented herein for fuel canisters, will ensure a sufficient quantity of catalyst is exposed in any fuel canister orientation to achieve at least a safety factor of three. Further, GPU Nuclear considers the proposed method of determining maximum internal pressure in canisters not dewatered to 50% void volume to be bounded by the pressure evaluations given in the Cask SAR and that these dewatered canisters satisfy the canister shipping requirements given in the cask C of C. Additionally, GPU Nuclear proposes that a factor of safety of 1.5 to the required quantity of catalyst is an adequate margin of safety when the conservatisms employed to determine the factor of safety are considered.

GPU Nuclear, therefore, requests NRC approval of the revised dewatering acceptance criterion for fuel canisters which, under current conditions, will achieve a minimum factor of safety of 3.0 on a catalyst and the proposed method of determining maximum internal pressure in canisters not dewatered to 50% void volume. Further, GPU Nuclear requests NRC concurrence that a minimum factor of safety of 1.5 on catalyst is an acceptable criterion. It is GPU Nuclear's intent to make reasonable effort (i.e., up to two canister dewatering evolutions) to achieve a minimum factor of safety of 3.0 on catalyst for all dewatered canisters. In those instances when this factor of safety is not achievable. GPU Nuclear will ensure that a factor of safety of at least 1.5 is achieved prior to shipping the canisters. The Canister TER and the CHAPS SER will be revised to reflect the quantity of catalyst exposed for 50% dewatered canisters and, subsequent to NRC approval, to address the proposed dewatering acceptance criterion for fuel canisters.

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

Sincerely,

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

FRS/RDW/eml

Attachment

Enclosed: GPU Nuclear Corp. Check No. 00027231

ATTACHMENT
4410-86-L-0193

FUEL CANISTER PAYLOADS AND DEWATERED CANISTER VOID VOLUMES TO ACHIEVE A FACTOR OF SAFETY OF THREE ON CATALYST

Canister Payload (lbs)	Required Void Volume
1760	40%
1690	39%
1588	38%
1494	37%
1397	36%
1310	35%
1232	34%