SAFETY EVALUATION REPORT

Docket No. 72-20
Department of Energy
Three Mile Island 2 Independent Spent Fuel Storage Installation
License No. SNM-2508
Amendment No. 4

SUMMARY

This Safety Evaluation Report (SER) documents the review and evaluation of an amendment to Special Nuclear Materials License No. 2508 for the Three Mile Island 2 (TMI-2) Independent Spent Fuel Storage Installation (ISFSI). By application dated January 31, 2005, as supplemented June 9, 2005, the Department of Energy (DOE) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 72.56, "Application for amendment of license," to amend the license to change the technical specification (TS) corrective actions if the 5 year leak test of the dry shielded canisters (DSCs) fails.

The NRC staff has reviewed the application, including the justifications for the proposed changes. As discussed in further detail below, based on the statements and representations in the application, as supplemented, the staff agrees that this change does not have an adverse effect on public health and safety, and the environment.

1.0 Introduction and General Description

The core debris from the TMI-2 reactor is stored in the ISFSI. The DSCs are vented through high efficiency particulate air (HEPA) filters to provide a diffusion path for hydrogen from the TMI-2 core debris. The interface between each vent housing and its DSC has dual metallic seals applied between polished surfaces of the DSC and the vent housings. The vent housing seals are subject to a limiting condition for operation (LCO), which specifies a maximum allowable leak rate. Verification of the LCO is performed by a surveillance performed on a 5 year period. If the leak test fails, the current TSs require reseating or replacing the seals and performing another leak check. If the seal integrity cannot be restored, then by current TSs the affected DSC must be removed from the horizontal storage module (HSM). The proposed TSs would allow replacement of the metallic seals with elastomeric seals that are less sensitive to surface imperfections without movement of the DSC. In addition, if the leak check fails after replacement of the seals, the proposed TS would no longer require removal of the DSC from its HSM. Instead, the proposed TSs would require a monthly contamination survey at the affected DSC-vent housing interface and the submission of a report to the NRC describing the condition, analysis, and corrective actions being taken.

The applicant requested the following changes to the TMI-2 ISFSI technical specifications:

- Revise TS 3.1.1 to remove the action to transport the DSC to an alternate facility for corrective actions.

- Add new TS 3.1.1 condition B and C.

  - Condition B requires that if the vent housing seal leak rate is not restored a monthly contamination survey must be performed and a report submitted to the NRC describing the condition, analysis, and corrective actions being taken.

  - Condition C requires that if the vent housing double metallic seals are replaced with double elastomeric seals, DOE must submit a report to the NRC describing the condition, analysis, and actions being taken and that the elastomeric seals be replaced after 5 years of service.

- Add new TS 3.1.2 to perform leak checks of the vent housing double elastomeric seals every year.

- Revise TS 4.2.1.3 and 4.2.1.4 to specify that these TSs are applicable prior to commencing transfers to the TMI-2 ISFSI.

- Make corresponding changes to safety analysis report Chapter 4, “Installation Design,” Chapter 7, “Radiation Protection,” and Chapter 8, “Analysis of Design Events,” and the TS Bases that support the proposed TS changes described above.

Regarding the proposed revision to TS 4.2.1.3, the current TS requires that a magnetic particle examination or a liquid penetrant examination be performed on the DSC top shield plug seal weld and top cover plate seals welds prior to commencing transfer operations. Similarly, TS 4.2.1.4 requires leak testing of the vent housing seals prior to commencing transfer operations. DOE requested in its January 31, 2005, submittal that TS 4.2.1.3 and 4.2.1.4 be changed to specify that these requirements are applicable “prior to commencing transfers to the TMI-2 ISFSI” rather than “prior to commencing transfer operations.” DOE requested these changes to clarify that TSs 4.2.1.3 and 4.2.1.4 are not applicable if the DSC is removed from the HSM after its initial placement in the HSM. The staff agrees with this clarification and finds the proposed changes to TSs 4.2.1.3 and 4.2.1.4 acceptable. Because the proposed changes to these TSs are administrative in nature they are not discussed further in this report.

In addition to the changes requested by DOE, three administrative changes to the license have been made. Specifically, 1) the mailing address was changed to reflect a new address, 2) reference to the Idaho National Engineering and Environmental Laboratory was changed to Idaho National Laboratory to reflect the name change of the DOE Laboratory, and 3) the term management and operation (M&O) contractor was changed to “DOE contractor,” to reflect how DOE now refers to this contractor. Because these changes to the license are administrative in nature they are not discussed further in this report.

2.0 Structural

The structural review is limited to the assessment of the ability of the double elastomeric O-rings to meet the requirements of 10 CFR 72.104 in fulfilling their sealing function, should they be used to replace the existing metallic O-rings at the interface between the Purge/Vent Port HEPA filter housing and the DSC mating surfaces.

2.1 General description

The dimensions of the proposed double elastomeric O-rings are 10.8 inches and 12.4 inches in diameter, respectively, with a circular cross-section (diameter = 0.103 inch). The O-rings are to be installed inside a groove located on the HEPA filter housing side. The dimensions of the rectangular groove are 0.113 inch wide and 0.074 inch deep.

2.2 Loading and environmental conditions

A design torque of 82±5 ft-lb is to be applied to the joint. This translates to a mechanical preload of 36,353 lb to the housing/DSC metallic joint and 2,551 lb, or 35 lb per inch in the O-rings. Thus, the O-rings are subjected to an imposed compressive strain of approximately 28% [=(0.103-0.074)/0.103] with an accompanying stationary compressive stress of approximately 350 psi, regardless of normal or accident conditions.

The most deleterious environmental condition besides the high compressive loads is temperature fluctuations at elevated temperatures. The service temperature can change from &60EF to +250EF. In order to facilitate installation, lubricant is applied to the O-rings. Thus, chemical compatibility between the applied vacuum grease and the elastomeric material poses another challenge. Other environmental conditions appear to be minor: not much exposure to air or oxygen and sunlight, insignificant pressure differentials (#30 psi) and low radiological readings (#100 mrem/h).

2.3 Material properties

The material selected for the dual elastomeric O-ring seals is Ethylene Polymer Diene Monomer (EPDM). The mechanical performance of EPDM under the conditions listed in Section 2.2 of this report has not been fully characterized. However, data supplied by the vendor under normal conditions (room temperature, moderate stress in air, etc.) showed promising results. EPDM has strong resistance in radioactivity. It shows little sign of permanent deformation if the cumulative dose is less than $1x10^6$ Rads. This means that it will take at least 1,140 years to see the radiation effects. The material also features excellent resistance to aging by air, ozone and sunlight. The hardness of EPDM ranges from 40 (softest) to 95 (hardest) with 70 being the most popularly used in industry. It is intended to use EPDM with 70 hardness for the time being. If necessary to improve working conditions, softer EPDM O-rings with hardness less than 70 may be used in the future.

The major concern is the long-term durability or service life of the EPDM O-rings under the conditions listed in Section 2.2 of this report (i.e.,of high stress, high temperature cycles and in an aggressive chemical corrosive environment of vacuum grease). Under the fixed displacement conditions in the amount of 28% compressive strain, creep will lead to stress relaxation and “compression set” in the O-rings gradually, which, over time, will eventually lose their sealing ability. Unfortunately, no data on lifetime under those conditions are available. From the experiences accumulated by the users, however, the material can last 15 to 20 years under normal usage. Assuming the service temperature at 239EF, and using the linear extrapolation method, the seal life is predicted to be 2 to 4 years [see page 8 of 28 of engineering design file (EDF) 5003, that was submitted as part of DOE’s January 31, 2005, request]. Since actual temperature exposed on the DSC is much less than 239EF, it is expected that the O-rings will last longer than 2-4 years, possibly in the 5-year time frame.

2.4 Acceptance criteria

As documented in EDF-5003, DOE installed two test samples of 0.103 inch O-rings in a dummy Purge Port filter housing. The dual O-rings of the first test sample were designated by Society of Automotive Engineer (SAE) standard AS 568B as Nos. -166 and -170, respectively. The -166 o-ring had dimensions of ID = 6.737±0.040 inches, cross-sectional diameter = 0.103±0.003 inch, whereas -170's ID= 7.737±0.045 inches. The second test sample was dual metric O-rings with IDs = 170 mm and 195 mm respectively and cross-sectional diameter = 2.5 mm. A small amount of vacuum grease was applied to the O-rings before installation in the housing grooves. The leak tests were performed on the two samples after they were tightened by the bolts with a torque of 82±5 ft-lb. The resulting leak rates were measured as 3.215×10^{-4} std-cc/sec and 5.531×10^{-4} std-cc/sec, respectively. Those levels were well below the acceptable leak rate listed in TS 3.1.1 as 1×10^{-2} std-cc/sec at one atmosphere differential. DOE concluded that, based on the leak test results, the proposed sized EPDM O-rings with the design loading conditions will fulfill the initial requirement of the sealing capability.

The applicant modified the TSs in the following way. In view of the fact that the EPDM O-rings will last around 5 years, but it is not certain, it is proposed that they be replaced at the end of the 5 year service time, irrespective of their conditions. Furthermore, within the 5-year duration, annual leak tests will be performed to make sure the O-rings still maintain their sealing capabilities. If the leak test fails to pass, corrective actions must be made, and a report documenting the events must be filed with the NRC. In addition, to provide added assurance, periodic radiological surveillances within the 1-year term will be performed in order to detect any property degradation for the O-rings in the 1-year intervals. As spelled out by the Surveillance Requirement 3.2.2.1 of TS 3.2.2, the radiological survey periodicity for all but one DSC is quarterly for the first year, and annually thereafter.

To assure chemical compatibility between the EPDM material and the vacuum grease, an evaluation will be performed before the lubricant is used with the O-rings. The evaluation involves a review of chemical composition and compatibility literature for lubricants. A lubricant will be selected based on commercial availability, chemical compatibility with EPDM, and chemical compatibility with the hydrogen analyzer. Silicone-based lubricants will be excluded, because they may poison the catalytic sensor used to determine hydrogen concentrations within the DSC.

Based on the statements and presentations made in the safety analysis report (SAR), as supplemented, the staff concludes that the amended TSs are acceptable and the proposed EPDM O-rings, in case the existing metallic O-rings need to be replaced, do not compromise the sealing ability for the DSCs to meet the requirements of 10 CFR 72.104.

3.0 CONFINEMENT

The applicant requested changes to TS 3.1.1 to allow corrective actions, in-place rather than moving the DSC to another building, if the seal leak rate does not meet 1×10^{-2} standard-cm^3/sec. Corrective actions potentially include replacing the metallic seals with new metallic seals, elastomeric seals or keeping the canister in its storage location until another suitable option can be evaluated. The revised TS 3.1.1 would also require seal leak rate testing yearly and seal replacement every 5 years, if the metallic seals are replaced by elastomeric seals.

In support of the requested changes, the applicant revised the basis for TS 3.1.1 and submitted revised dose calculations to show that if a seal were leaking for a one year period, the dose received would not exceed any limits in either 10 CFR Parts 20 or 72. The applicant's revised dose calculation determines the potential increase of the offsite dose resulting from the unshielded contamination deposited on the filter vent housing and the contamination that is not deposited locally and is carried by the wind offsite. Based on the known radionuclide loading of each TMI-2 canister, the applicant determined the maximum release rate from the canister with the bounding source term. The bounding source term was used to determine the maximum release from the canister in a one year period, assuming an unfiltered release. The filtered direct and scattered dose rates at the Idaho National Engineering and Environmental Laboratory (INEEL) site boundary were increased by the ratio of the unfiltered release to the filtered release. The applicant also determined the maximum committed effective dose equivalent (CEDE) from inhalation and ingestion to an individual who might be located at the INEEL site boundary. In Engineering Design File (EDF) No. 4728 submitted as part of the amendment request, the applicant determined the maximum CEDE to be 1.7×10^{-4} rem/year at the INEEL site boundary, which meets the whole body offsite dose limit of 25 mrem/year from 10 CFR 72.104. Although the one year unfiltered release meets the requirements of 10 CFR Part 72, the applicant has committed to ensuring that the release rates from the canisters will meet the maximum release rate of 1×10^{-2} standard-cm^3/sec.

Based on the statements and presentations made in the SAR, as supplemented, the staff concluded that the amended TSs are acceptable and that in the event that the maximum leak rate can not be met, the dose rates offsite will be within the limits of 10 CFR Part 72, while the applicant determines the appropriate corrective actions.

4.0 REQUIREMENTS FOR NOTICING PROPOSED ACTION

The staff considered the amendment's potential impact on the health and safety of the public. The staff finds that this license amendment involves changes in the scope or type of operations presently authorized by the license. Specifically, the licensee would be allowed to attempt repairs of the double metallic seals if they fail their leak tests in-situ instead of removing the DSC to an alternate facility. The staff has determined that the amendment does not present a genuine issue as to whether public health and safety will be significantly affected.

Accordingly, pursuant to 10 CFR 72.46(b)(2), immediate action on this amendment may be taken without notice of the proposed action or a notice of opportunity for hearing.

5.0 ENVIRONMENTAL REVIEW

Pursuant to Part 51 of the Code of Federal Regulations, an Environmental Assessment (EA) has been prepared for this action and a Finding of No Significant Impact (FONSI) was issued. The EA and FONSI were published in the Federal Register on June 28, 2005 (70 FR 37124).

6.0 CONCLUSION

The NRC staff concludes that the proposed revision to the TMI-2 ISFSI TSs and corresponding changes to the SAR and TS Bases do not affect prior staff conclusions and findings made in granting approval of Amendment 3. Based on the information provided in the application, as

supplemented, the staff concludes that Materials License SNM-2508, meets the requirements of 10 CFR Part 72.

Issued with Materials License No. 2508, Amendment No. 4, on June 30, 2005.