Department of Energy
Idaho Operations Office
1955 Fremont Avenue
Idaho Falls, ID 83415

June 9, 2005

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Response to Request for Additional Information Regarding the Three Mile Island-2 (TMI-2) Independent Spent Fuel Storage Installation (ISFSI) (Docket 72-20) (TAC No. L23812) (EM-FMDP-05-031)

REFERENCE: Letter, Joseph M. Sebrosky to Elizabeth D. Sellers, Request for Additional Information Regarding the Three Mile Island-2 (TMI-2) Independent Spent Fuel Storage Installation (ISFSI) (TAC No. L23812), dated May 18, 2005

Dear Sir or Madam:

Please find enclosed (Enclosure 1) the Department of Energy, Idaho Operations Office response to your Request for Additional Information (RAI) dated May 18, 2005 referenced above. The enclosed response does not contain any information considered to be sensitive by DOE. Enclosure 2 provides revised Technical Specification 3.1.1. pursuant to the Enclosure 1 RAI response.

In the process of preparing our response to your subject RAI, DOE discovered an unrelated error in our license amendment submittal package that requires correction. As part of our license amendment request dated January 31, 2005, we provided a proposed markup of Technical Specification 4.0 entitled "DESIGN FEATURES" that is correct. Unfortunately, in providing the subsequent "clean copy" of Technical Specification 4.0, two sentences were inadvertently added at the end of the paragraph entitled "Section 4.1.1 Storage Capacity." These two superfluous sentences are not being proposed as a change and DOE requests that they be removed as follows:

> *4.1.1 Storage Capacity*
>
> *The total storage capacity of the TMI-2 ISFSI is limited to 30 HSMs, 29 which will be loaded, and one extra. Each of 29 HSMs holds a NUHOMS®-12T DSC containing up to 12 TMI-2 CANISTERs.* ~~*An extra HSM serves as a backup in case a challenged DSC needs additional confinement. This extra HSM will include a cylindrical overpack so that it can be used to provide an additional barrier for a challenged DSC.*~~

Accordingly, Enclosure 3 provides a revised first page of Technical Specification 4.0 consistent with the proposed markup submitted with our January 31, 2005 license amendment request

NMSS01

(deleting the superfluous sentences as shown above). DOE regrets any confusion that this error may have caused.

Please do not hesitate to contact Jan Hagers (208-526-0758) or Mark Gardner (208-526-5565) of my staff at your convenience should you require any clarification or have any questions regarding this submittal.

Your timely consideration of our January 31, 2005 license amendment request is appreciated.

Sincerely,

Elizabeth D. Sellers
Manager

Enclosures

cc w/enc:
J. Randall Hall, NRC SFPO
Joseph M. Sebrosky, NRC SFPO

Enclosure 1

Response to the May 18, 2005 Nuclear Regulatory Commission Request for Additional Information Regarding the DOE Request for License Amendment for the Three Mile Island Unit 2 Independent Spent Fuel Storage Installation TAC No. L23812, Docket 72-20

June 9, 2005

Request 4-1: Justify the apparent inconsistency in the safety analysis report (SAR) regarding the filter housing bolt properties or correct the inconsistency. The yield stress data for the filter housing bolts (SA193 Grade B8) under accident conditions in SAR Table 8.1-3 do not appear to be consistent with footnote (7) for Table 8.1-3. Footnote 7 states S_y is 75 ksi at all temperatures of interest.

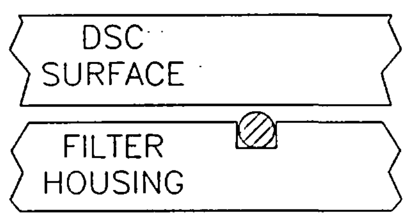
Response 4-1: The SAR Table 8.1-3 Footnote 7 contains a typographical error in that S_y should be S_u.

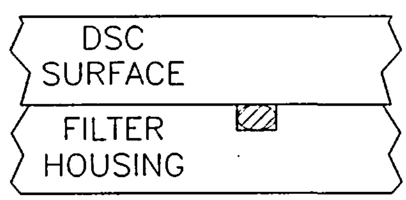
Commitment 1: DOE commits to correct this typographical error in the SAR under the provisions of 10 CFR 72.48 and 10 CFR 72.70.

Request 4-2: **Justify that the new polymeric o-rings can withstand the same torque as the metal seals without damaging the polymeric o-ring. The license amendment request states that the same amount of torque (82 ± 5 ft-lb) used for the old metal seals will be applied to the new replacement of elastomeric o-rings.**

Response 4-2: The sealing capability provided by the elastomeric o-ring results from compressing the o-ring seated in the filter housing o-ring groove against the mating DSC surface. Compression, as defined by the manufacturer, is the diameter reduction from the no load condition to the compressed condition. The amount of compression that would be applied to the elastomeric seals under the above joint configuration is within the range recommended by the o-ring manufacturer.

The bolt torque specified in the TMI-2 ISFSI SAR generates a metal-to-metal compressive preload between the filter housing and the DSC surface, creating a closed static (non-moving/non-flexible) joint. In other words, the metal face of the DSC surface is in contact with and compressed against the metal face of the filter housing under all service conditions. The following sketch, not drawn to scale, is provided to show the proposed placement and seating of the elastomeric o-rings in the filter housing groove and the mating DSC surface.





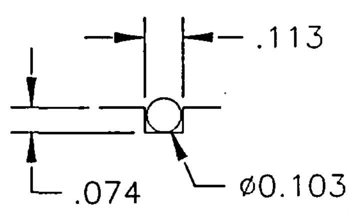
The torque applied to each bolt (82 ± 5 ft-lbs each) equates to a minimum bolt preload of 4,863 lbs. each for a total compressive load (with eight bolts per filter housing) of 38,904 lbs. Some of the load is needed to compress the seals located in grooves in the filter housing. Once a metal-to-metal joint is achieved, the seals (either metal or elastomeric) are appropriately compressed and no further seal compression occurs. The remaining compressive load is absorbed by the metal-to-metal interface between the filter housing and the DSC surface and is designed to ensure metal-to-metal contact during the normal and accident conditions addressed in the SAR.

The bolt torque specified in the SAR provides a compressive load of 21,865 lbs to seat the metal seals (300 lbs/in for two seals of 10.8" and 12.4" diameter) before metal-to-metal contact is achieved between the filter housing surface and the DSC surface. The remaining compressive load of (38,904 – 21,865 =) 17,039 lbs preloads the interface of the filter housing to the mating DSC surface. When elastomeric seals are used, the compressive load applied to the seals diminishes significantly due to the more elastic properties of the elastomeric seal material. The force required to seat the elastomeric o-rings is calculated from the manufacturer's design charts at (35 lbs/in for two seals of 10.8" and 12.4" diameter =) 2,551 lbs. This application results in (38,904 – 2,551 =) 36,353 lbs as the remaining compressive preload between the filter housing and the mating DSC surface. Therefore, use of the elastomeric o-ring increases the metal-to-metal joint preload by (36,353 – 17,039 =) 19,314 lbs over the use of the metallic seals. Though this excess joint preload is unnecessary from a joint design standpoint, it is preferred to keep all the bolt torques the same for consistency of operations rather than to reduce the bolt tightening torques for those joints which would utilize the elastomeric seals.

Commitment 2: DOE commits to address the information in Response 4-2 in a revision to EDF-5003, which is a reference in the proposed change to the TMI-2 ISFSI SAR Chapter 4, under the provisions of 10 CFR 72.48 and 10 CFR 72.70.

Request 4-3: Justify why a 0.090 inch diameter o-ring is considered as an alternative for replacement of a failed metal c-seal or remove this o-ring as an alternative. On page 12 of EDF-5003 (Attachment 7 to the license amendment request dated January 31, 2005), it is stated that the standard size o-ring with a 0.103 inch cross section diameter is recommended as a replacement for a failed metal c-seal. However, on page 9 of the EDF-5003, there is a discussion of an o-ring with a cross section diameter of 0.090 inches as an alternative. The staff does not understand why the 0.090 inch o-ring is considered as an alternative given that: 1) the groove size is 0.113 inch by 0.074 inch (area = 8.32E-3 sq. inches), and 2) the 0.090 inch o-ring cross-sectional area of 6.36E-3 sq. inches appears to be much less than the groove area.

Response 4-3: The selection of the o-ring with the 0.103" cross-sectional diameter is based on commercial availability and compatible design parameters based on the existing joint configuration. The groove width is 0.113" and the groove depth is 0.074". The o-ring manufacturer recommends a minimum compression to ensure a sealing force between the o-ring and the metal surfaces and a maximum compression to avoid o-ring damage. The compression of the 0.103" o-ring described in EDF-5003 provides adequate sealing in this groove because the compression is (0.103 - 0.074 =) 0.029", which is within the manufacturer's recommended range (0.020 - 0.032"). Only the 0.103" o-ring is intended for use in the proposed application and is depicted in the filter housing o-ring groove in the sketch below.



All reference(s) to o-ring sizes other than the proposed 0.103 cross-sectional diameter o-ring proposed for this application will be deleted accordingly.

Commitment 3: DOE commits to delete all mention of o-ring sizes other than the proposed 0.103" o-ring and address the information in Response 4-3 in a revision to EDF-5003, which is a reference in the proposed change to the TMI-2 ISFSI SAR Chapter 4, under the provisions of 10 CFR 72.48 and 10 CFR 72.70.

Request 4-4: Justify the 5 year period for replacement of the elastomeric seals and the 1 year surveillance requirement for leak checking the elastomeric seals. The staff has a concern regarding the service life of the elastomeric o-ring. EDF-5003 provides a basis for a recommendation that the elastomeric o-rings substituted for metal seals should be leak-tested every 5 years to verify their performance. Proposed technical specification 3.1.1.C.2 would require that the elastomeric seals be replaced every 5 years. Proposed technical specification surveillance requirement 3.1.1.2 would require a leak check of the vent housing double elastomeric seals on each dry shielded canister every year during storage operation. The staff is concerned about the justification for replacement of the elastomeric seals every 5 years given that the elastomeric o-ring will be subjected to the following:

- **"Compression set" induced by the applied torques. The pressure differentials considered by the applicant are relatively minor (EDF-5003, Page 7 of 28)**
- **Thermal aging due to temperature changes (EDF-5003, Page 8 of 28)**
- **Chemical effects, if any, between EPDM material and vacuum grease (EDF-5003, Page 5 of 28).**

Response 4-4: Compression Set: The amount of compressive force applied to the elastomeric (and metallic) o-rings was addressed in Response 4-2. The compression applied to the o-rings in this application is within the range specified by the o-ring manufacturer.

Compression set is the loss of elastic properties in the o-ring material; essentially plastic deformation. Compression set is a measure of the permanent loss of original o-ring thickness (as compared to the original thickness) after the compressive load is removed.

$$Compression = D_{original} - D_{compressed}$$

$$Compression\ Set = D_{original} - D_{compressive\ load\ removed}$$

Compression set may be induced by factors in addition to compression itself; including exposure to air and chemicals, temperature, and time.

(1) Any compression set reduces the amount of sealing provided by the o-rings in their service by reducing the capability provided by the o-rings in the service configuration. In this service application, the o-rings provide essentially no differential pressure isolation due to the proximity of the HEPA filters exhausting the DSC to the environment. Rather, the o-rings provide a contamination

boundary upstream of the HEPA filters to ensure no unfiltered release of the DSC internal environment to the atmosphere. This contamination boundary is verified through the conduct of the leak test required by the LCO. Excessive compressive set may result in failure to meet leak test acceptance parameters. However, due to the lack of pressure differential (motive force) across the o-ring seals under service conditions (due to the proximity to the HEPA filter), any resultant loss of radioactive material confinement is still considered unlikely.

(2) In the service configuration described in the license amendment request, there is very little o-ring contact with air because the o-ring material is essentially isolated due to the closed static joint configuration (see the figure provided with Response 4-2). There is no credible scenario whereby the o-ring material will be exposed to active airflows in the service condition.

(3) The chemical compatibility of the o-ring material and any lubricant will be evaluated before a lubricant is used with the o-rings. No other chemicals are present in this service.

<u>Pressure Differential Across The Seals</u>: The force applied by the elastomeric o-ring material against the mating surfaces is needed to contain a pressure difference across the o-rings. In the proposed service, the o-rings would not see any measurable pressure differential except during the leak test required by the Technical Specification surveillance. Rather, as discussed above, the intended function of the o-rings is to provide a contamination control (rather than a pressure) boundary upstream of the HEPA filters.

In light of the initial applied compression and the benign service conditions, a significant loss of sealing force from the elastomeric material against the mating surfaces is not anticipated. Any loss of sealing force from the elastomeric material against the mating surfaces is expected to be gradual and would be detected during the annual leak test performed during the Technical Specification surveillance long before any loss of contamination control would be reasonably expected. In addition to the leak test, periodic radiological surveillances provide added assurance that the o-rings are performing their confinement function as designed.

<u>Thermal Aging (effects of temperature and time)</u>: The seal manufacturer's design information identifies a recommended temperature range of -40 F to +300 F for the EPDM material. The maximum temperature for this proposed application of the DSC vent housing seal of 200 F is thus well within the seal manufacturer's recommended range. Actual service temperature conditions in service will be well below this postulated 200 F maximum. The vendor's curve (see Parker O-Ring Handbook, Catalog ORD5700A/US, Figure 2-24*) plotting expected service

life as a function of service temperature for EPDM flattens at 1,000 hours and 315 F, thus indicating that at service temperatures below 300 F, EPDM material remains stable over time. Therefore, it can be reasonably assumed that the thermal environment (not exceeding 200 F) for this application is not a significant parameter that would invalidate the proposed 5-year period of replacement. This interpretation is consistent with vendor discussions.

The second bullet in Request 4-4 refers to thermal aging due to temperature changes. Thermal aging is a chemical reaction in the EPDM material that occurs at higher rates at higher temperatures. The EDF-5003 page referenced with this part of Request 4-4 describes a service life when the seals are held to a constant temperature. This EDF-5003 discussion of a service life calculation referred to a worst-case assumption that the seals would be held at the highest temperature, which would cause the chemical reaction leading to compression set being maximized. Such worst-case assumptions are appropriate if it is desired to simplify the service life calculations, however such calculations are conservative with respect to actual storage conditions.

Chemical Effects: As stated above, the chemical compatibility of the o-ring material and any lubricant will be evaluated before such lubricant is used with the o-rings. No other chemicals are present in this service.

Justification for Proposed Service Life and Surveillance Frequency: DOE considers the proposed 5-year service life for elastomeric o-ring seals in this application, coupled with an annual leak test requirement, to be both technically and operationally appropriate and conservative. As previously discussed, vendor data supports the 5-year service life of the EPDM o-ring material at the benign service conditions (including temperature) in this proposed application.

The current Technical Specification 3.1.1 requirement (upon failure of a successive leak test after replacing/reseating the seals) to withdraw the Dry Shielded Canister from the Horizontal Storage Module and transport it to TAN (Test Area North Facility) or other appropriate facility for corrective actions presents significantly greater radiological exposure and safety risk than the option of substituting elastomeric seals as proposed in this license amendment request.

A 5-year service life (with annual leak testing and periodic radiological surveillances) is justified for this proposed application by considerations including the following:

(1) ALARA considerations for facility operators during seal replacement operations;

(2) the low radiological consequences (below offsite dose limits) to the public of o-ring failure, even without mitigation;

(3) the relatively benign service conditions (including temperature and relative isolation from exposure to the environment due to the tight joint configuration);

(4) the o-ring serves as a radiological material confinement boundary rather than pressure boundary (with the exception of the leak test performance);

(5) essentially no pressure differential across the seals while in service;

(6) any loss of seal elasticity would be gradual over time under these service conditions; and

(7) the availability of trending data from the annual leak rate tests to predict failure timeframes.

Therefore, DOE considers the 5-year service life, coupled with annual leak test requirements and routine radiological surveys, appropriately conservative for this proposed application.

* Available at www.parker.com/o-ring/Literature/ORD5700.pdf

Commitment 4: DOE commits to address the information in Response 4-4 in a revision to EDF-5003, which is a reference in the proposed change to the TMI-2 ISFSI SAR Chapter 4, under the provisions of 10 CFR 72.48 and 10 CFR 72.70.

Request 7-1: Revise Technical Specification 3.1.1B to report to the NRC the corrective actions that have been taken to ensure that offsite limits are met. Corresponding changes should also be made to the Technical Specification bases.

The cover letter states "If the leak test fails, the seal must be replaced and/or reseated and then retested." It is not clear that the technical specification requires that corrective actions be taken to restore the required leak rate, but only requires that the NRC is informed of the actions taken within 90 days.

Response 7-1: The proposed Required Action B describes the actions to be performed after entering condition B of Technical Specification 3.1.1. Required Action B.2, the object of Request 7-1, is revised to state:

```
B.2    Submit report to NRC describing condition, analysis,
       and corrective actions being taken.
```

The change (highlighted in bold print) to proposed Required Action B.2 is from "actions being taken" to "corrective actions being taken". Note that the same change is made to Required Action C.1.

Attached is a revised Technical Specification 3.1.1 pursuant to the above changes. DOE requests that NRC substitute the revised Technical Specification 3.1.1 with this RAI response for that provided in the original license amendment request dated January 31, 2005.

The proposed Technical Specification Bases will be changed to refer to corrective actions "to restore the LCO". The following is an excerpt from Attachment 6 of the license amendment request with the change (highlighted in bold print) to the second sentence.

```
B.2    If the seal cannot be repaired or replaced and tested
       to satisfy the LCO, then concerns related to the
       adequacy of the seal design and maintenance must be
       addressed in a written report. This written report is
       expected to address the characterization and extent
       of condition, cause or engineering analysis, and
       corrective actions to restore the LCO. The note that
       LCO 3.0.2 does not apply indicates that, upon entry
       into Condition B, the report to NRC is required even
       if the condition is exited before the 90 day
       completion time of this ACTION.
```

Commitment 5: DOE commits to revising the B 3.1.1 Technical Specification Bases as described above.

Request 7-2: **It is not clear that the resuspension factor (RF) used to calculate the loose surface contamination on page 13 of EDF-4728 is appropriate. Clearly justify the RF of 10^{-4} cm^{-1} is appropriate considering a lower RF will lead to more contamination on the surface of interest.**

The applicant states that a conservative RF has been chosen and uses NUREG-1720, "Re-evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule," as a base document for specifying the RF. In NUREG-1720, the NRC staff reevaluated the RF in order to determine the appropriate value for use in the DandD code to determine the default concentration or surface activity screening limits after decontamination has occurred. In NUREG-1720, the NRC staff recommended using an RF of 10^{-6} m^{-1} (10^{-8} cm^{-1}), which would be clearly conservative for back-calculating the surface concentration limits, but the applicant used an RF of 10^{-4} cm^{-1}. The RF varies depending on how tightly the contamination is bounded to the surface and the behavior conditions leading to resuspension. Note that while 10^{-4} cm^{-1} might be the appropriate value to use in this calculation, the applicant has not shown that the value is appropriate based on the surface contamination and the driving force for resuspension.

Response 7-2: The radioactive airborne particulate activity concentration potentially released through an unmitigated filter housing seal leak is calculated to be 2E-08 Ci/cc (EDF-4728, page 13). A resuspension factor (RF) can be used to calculate the loose surface radioactive contamination deposited on the DSC cover plate that might be attributed to such a release using the following equation.

$$Surface\ \ Contamination, \frac{Ci}{cm^2} = \frac{Airborne\ Contamination, \dfrac{Ci}{cm^3}}{RF, \dfrac{1}{cm}}$$

Loose surface radioactive contamination deposited on the DSC cover plate is a sensitive indicator of the unmitigated potential release. Loose surface contamination levels ranging from 4E+10 to 4E+14 dpm/100 cm^2 would be expected from an unmitigated release, depending on the RF value selected. An RF value of 1E-04/cm would be appropriate for an environment where the likelihood of disturbance of the loose surface contamination is relatively high (low likelihood of deposition). An RF value of 1E-08/cm (as recommended for applications using draft NUREG-1720) would be appropriate for an environment where the likelihood of disturbance of the loose surface contamination is relatively low (high likelihood of deposition). Health physics literature reports that an RF value of 1E-06/cm is reasonable for the purpose of estimating the hazard from loose surface contamination when conditions leading to resuspension (deposition) are unknown.

Since the TMI-2 ISFSI is an outdoor facility, the DSC cover plate surface and filter housing joint housing the o-rings (although inset 2.5 feet from the HSM external surface and behind a vented steel door) is exposed to climatic conditions including wind, precipitation, and temperature fluctuation that increase the likelihood of resuspension. An RF value of 1E-04/cm is therefore considered appropriate because conditions leading to resuspension and deposition are known and justified for describing the quantitative relationship between radioactive airborne particulate activity concentration and loose surface radioactive contamination. An RF value of 1E-04/cm will also provide the highest Ci/cc/dpm value for use in estimating offsite exposure attributed to an unmitigated vent housing seal leak.

Radiation protection and ALARA program controls demonstrating compliance with 10 CFR 20 would be implemented upon detection of loose surface radioactive contamination at levels (nominally between 100 and 1,000 dpm/100 cm^2) several orders of magnitude below the level anticipated for an unmitigated release.

Commitment 6: DOE commits to address the information in Response 7-2 in a revision to EDF-4728, which is a reference in the proposed change to the TMI-2 ISFSI SAR Chapter 4, under the provisions of 10 CFR 72.48 and 10 CFR 72.70.

Enclosure 2

Revised Technical Specification 3.1.1
License No. SNM-2508

3.1 DSC INTEGRITY

3.1.1 Leak Testing DSC Vent Housing Seals

LCO 3.1.1 — The leak rate of the vent housing seals shall not exceed 1×10^{-2} standard cc/sec.

APPLICABILITY: During STORAGE OPERATIONS.

ACTION

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The vent housing seal leak rate is exceeded during STORAGE OPERATIONS	A.1 Perform contamination survey at affected DSC-vent housing interfaces.	24 Hours
	AND	
	A.2.1 Reseat or replace seals.	7 Days
	AND	
	A.2.2 Perform leak check on seals.	7 Days
B. The vent housing seal leak rate is not restored within 7 days during STORAGE OPERATIONS	B.1 Perform contamination survey at affected DSC-vent housing interfaces.	Monthly
	AND	
	B.2 Submit report to NRC describing condition, analysis, and corrective actions being taken.	90 Days. Note: LCO 3.0.2 does not apply. This report is required upon entry into Condition B.
C. The vent housing double metallic seals are replaced with double elastomeric seals during STORAGE OPERATIONS	C.1 Submit report to NRC describing condition, analysis, and corrective actions being taken.	90 Days
	AND	
	C.2 Replace the elastomeric seals.	After 5 years in service.

3.1.1 Leak Testing DSC Vent Housing Seals (continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.1.1	Perform leak check of the vent housing double metallic seals on each DSC containing TMI-2 CANISTERs.	7 days after insertion of DSC into HSM. AND Every 5 years during STORAGE OPERATIONS. NOTE: SR 3.0.2 is not applicable.
SR 3.1.1.2	Perform leak check of the vent housing double elastomeric seals on each DSC containing TMI-2 CANISTERs.	Every year during STORAGE OPERATIONS.

Enclosure 3

Revised Technical Specification 4.0
(First Page Only)
License No. SNM-2508

4.0 DESIGN FEATURES

4.1 Storage Features

4.1.1 Storage Capacity

The total storage capacity of the TMI-2 ISFSI is limited to 30 HSMs, 29 which will be loaded, and one extra. Each of 29 HSMs holds a NUHOMS®-12T DSC containing up to 12 TMI-2 CANISTERs.

4.2 Codes and Standards

4.2.1 Dry Shielded Canister

4.2.1.1 Design Exceptions to Codes, Standards, and Criteria

Table 4-1 lists approved exceptions for the design and fabrication of the TMI-2 ISFSI Dry Shielded Canister.

4.2.1.2 Construction/Fabrication Exceptions to Codes, Standards, and Criteria

Proposed alternatives to ASME Code, Section III, 1992 Edition with Addenda through 1993, including exceptions allowed by Section 4.3.1, may be used when authorized by the Director of the Office of Nuclear Material Safety and Safeguards or designee. The licensee should demonstrate that:

1. The proposed alternatives would provide an acceptable level of quality and safety, or
2. Compliance with the specified requirements of ASME Code Section III, 1992 Edition with Addenda through 1993, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Requests for relief in accordance with this section shall be submitted in accordance with 10 CFR 72.4.

4.2.1.3 DSC top shield plug seal weld (inner cover plate) and top cover plate (outer cover plate) seal welds shall meet the applicable requirements of ASME Boiler and Pressure Vessel Code (B&PVC) Section III, NB-5340 for magnetic particle examination (MT) or NB-5350 for liquid penetrant (PT) examination, prior to commencing transfers to the TMI-2 ISFSI.

4.2.1.4 The leak rate of the vent housing seals shall be conducted in accordance with ANSI N14.5 and shall not exceed 1×10^{-2} standard cc/sec prior to commencing transfers to the TMI-2 ISFSI.

(continued)