TRANSNUCLEAR
AN AREVA COMPANY

January 7, 2013
E-34066

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Subject: Submittal of Biennial Report of 72.48 Evaluations Performed for the NUHOMS® HD System, CoC 1030, for the Period 01/08/11 to 01/07/13, Docket No. 72-1030

Pursuant to the requirements of 10 CFR 72.48(d)(2), Transnuclear, Inc. herewith submits the subject 72.48 summary report. Enclosure 1 provides a brief description of changes, tests, and experiments, including a summary of the 72.48 evaluation of each change implemented from 01/08/11 to 01/07/13, including indication as to whether the evaluations had associated Updated Final Safety Analysis Report (UFSAR) changes that were incorporated into the UFSAR for the NUHOMS® HD System, Revision 3, submitted on September 30, 2011.

Should you or your staff require additional information, please do not hesitate to contact me at 410-910-6878 or Clark Vanderniet at 410-910-6933.

Sincerely,

Donis Shaw
Licensing Manager

cc: B. Jennifer Davis (NRC SFST), provided in a separate mailing

Enclosures:

1. REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

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REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

Enclosure 1 Part 1 - DESIGN CHANGES

***Licensing Review (LR) 721030-255, Rev. 0* – (not yet incorporated into the UFSAR)**

Change Description

The change involved the use of thinner washer plates and nuts in the end wall-to-module bolted connection to allow for placement of additional horizontal storage modules (HSMs) without the need to remove existing end walls during HSM array expansion.

Evaluation

The change involved the following subcomponents of the end wall-to-module bolted connection:

- shield wall attachment washer plate – 1.5 inches thick
- shield wall attachment nut

The design functions of the HSM end wall are to provide physical protection for the dry shielded canister (DSC) and shielding from radiation emanating from the DSC. The wall spans vertically between the HSM's floor and roof. The wall is divided into two sections. One section overlaps the other section. Each section is secured to the module with four ties. Each tie connection consists of an embedment assembly embedded in the module, a threaded bolt, a washer plate, and a nut.

Per the licensing basis calculation, the end wall loads for tie rod connections to the module are developed from seismic and wind loads. The maximum tension load acting on each connection is 18.3 kips. Since there is no change to the embedment design and the threaded bolt, and the loads acting on the connection, the stresses in the bolt and the embedment, and ductility, remain unchanged. Thus, analysis documented in the licensing basis calculation for the embedment and the threaded bolt are unaffected by change. The bearing area of the proposed washer plate is the same as the original washer; therefore, the concrete bearing stresses documented in the calculation remain unchanged.

The proposed washer plate has a thickness of 0.75 inches and is made of ASTM A514. The bending stress is 48.55 ksi, which is less than the allowable bending of 67.5 ksi. The proposed nut (standard jam nut) has a nominal thickness of 0.84375 (27/32) inches, minimum thickness of 0.808 inches and is made of ASTM A194. The minimum length of engagement required to develop the full capacity of the bolt is 0.233 inches. Therefore, the proposed nut is adequate to carry the design load of the 1.5-inch bolt.

In conclusion, the proposed shield wall connection hardware is adequate to support and secure the wall to the module. Therefore, the change has no impact on the structural functions of the HSM.

The eight 72.48 evaluation criteria were met.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

LR 721030-308 Rev. 0 – (not yet incorporated into the UFSAR)

Change Description

The change involved reducing the thermal conductivity of the metal matrix composite (MMC) poison plates for the 32PTH Type 1 DSC. The change reduces the thermal conductivity from 200 W/m-K to 190 W/m-K.

Evaluation Summary

The reduction in thermal conductivity of the MMC poison plates results in a temperature increase of the basket and cavity gas. The shell temperature is not affected.

The basket assembly has three design functions: structural reinforcement to provide integrity in normal, off-normal, and accident events, thermal energy transfer from the fuel assemblies to the DSC shell, and criticality control by absorbing thermal neutrons when a moderator is present. The design function of the cavity gas is to provide an inert environment for the internal DSC components. The change does not affect the composition of the cavity gas (which could result in a malfunction of the confinement barrier) but the increased pressure inside the cavity would potentially result in higher stresses on the internal DSC components.

The structural, criticality, and confinement design functions are not affected by this change.

- Structural: A 700 °F uniform basket temperatures is used in design calculations. The calculation performed for this evaluation showed that this change results in a 700 °F peak temperature of the basket. Therefore, this activity does not deviate from the design calculations.

- Criticality: Criticality control for the MMC is assumed to be not affected by temperature in design calculations.

- Confinement: The increase in cavity pressure results in a pressure that is less than the design pressure. The structural normal, off-normal, and accident calculations use the design pressure rather than the calculated pressures. As such, this change does not deviate from the design calculation.

- The shielding design function is independent of the affected components and is not affected by this change.

The thermal design is affected by this change. The change results in a 7 °F increase in fuel cladding and basket component temperatures (from 719 °F to 726 °F) and a 2 °F increase in average cavity gas temperature (from 537 °F to 539 °F). The increase in temperature of the basket and fuel cladding would not have a negative impact on the design of the DSC, since all temperatures remain below the allowable limits for normal, off-normal, and accident conditions.

The eight 72.48 evaluation criteria were met.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

LR 721030-316 Rev. 0 – (no UFSAR changes)

Change Description

The change involved changing the concrete clear cover for the horizontal storage module (HSM) outlet vent cover (OVC) to 1.5 inches, applicable to the rebar ties around the OVC primary reinforcement.

Evaluation Summary

The design function of the OVC is to provide shielding at the outlet vents of the HSM. The OVC also provides protection to the outlet vents from debris and blockage.

Associated Transnuclear, Inc. (TN) calculations showed that there are no adverse effects to the design functions of the OVC for the HSM. Below is the revised evaluation with 1.5 inches clear concrete cover applied to the rebar ties. The OVC is analyzed as a simply supported beam. The increase in the clear concrete cover reduces the total beam section depth, as shown below. All stress ratios remain within design allowable limits.

HSM-H – NUH24PTH-0220:

L = beam length = 166 inches
b = beam width = 24 inches
h = beam height = 12 inches
Moment Load = 129.3 kips-in
Shear Load = 3.1 kips
Provide #6 bars with #3 or #4 ties with 1.5 inches clear cover

d = 12 inches – 1.5 inches (cover) – 0.5 inches (#4 diameter) – 0.375 inches (.5 * #6 diameter) = 9.625 inches
Mu (moment capacity) = 865.6 kip-in, which is greater than 129.3 kip-in; therefore, this is acceptable
Vc (shear capacity) = 26.1 kips, which is > 3.1 kips; therefore, this is acceptable

The eight 72.48 evaluation criteria were met.

LR 721030-319 Rev. 0 – (not yet incorporated into the UFSAR)

Change Description

The change involved evaluating Westinghouse WE 15x15 and WE 17x17 class fuel assemblies containing instrument tube tie rods (ITTRs) for storage.

Some versions of WE 15x15 and WE 17x17 class fuel assemblies were fabricated with 304 stainless steel guide tube sleeves that have been found to be susceptible to intergranular stress corrosion cracking (IGSCC). This corrosion may potentially result in failure of the bulge joints that connect the top nozzle to the guide tubes when the fuel assembly is lifted. Therefore, the fuel assemblies fabricated with these sleeves risk top nozzle separation from the assembly when moved or lifted for loading/unloading into or out of the DSC using the standard fuel handling tools and procedures.

A resolution for this issue is to install a Westinghouse-designed component called the instrument tube tie rod (ITTR) in each of these fuel assemblies. The ITTR consists of a long stainless steel tube that is inserted in the instrument tube, through the top nozzle and extends through the bottom nozzle. The bottom portion of the ITTR is fitted with an expanding tip that secures it to the bottom nozzle. The top end of the ITTR extending above the top nozzle is threaded to accept a locknut that, when installed, ties the top and bottom nozzles together. The ITTR is designed to be capable of carrying the entire weight of the fuel assembly during handling.

Insertion of the ITTR into the instrument tube requires that a hole be machined through the top nozzle above the center instrument tube location. Once installed, the ITTR provides a load path that bypasses the potentially corroded sleeve bulge joints and allows the fuel assembly to be lifted normally using the top nozzle.

Evaluation Summary

The CoC 1030 Amendment 1 Technical Specifications provide a definition for intact and damaged fuel assemblies authorized for storage, as follows:

Intact Fuel Assembly is defined as "a spent nuclear fuel assembly without known or suspected cladding defects greater than pinhole leaks or hairline cracks and which can be handled by normal means."

Damaged Fuel Assembly is defined as "a spent nuclear fuel assembly with known or suspected cladding defects greater than pinhole leaks or hairline cracks and which can be handled by normal means. Fuel assemblies with damage greater than this cannot be stored as damaged fuel assemblies."

Evaluation for Intact Fuel Assemblies:

The installed ITTR in a fuel assembly does not contact or interact with the fuel rods. Thus, there is no impact on the ability of the fuel to meet its confinement function requirements due to ITTR installation.

The installation of the ITTR requires a hole to be machined into the top nozzle at the center instrument tube location. The top and bottom nozzles and the grid straps still provide support to the guide tubes and the fuel rods. Thus, there is no change in the configuration of the fuel rods due to ITTR installation. The ability of the guide tubes to react to all design loads is assured with the installation of an ITTR since the only documented failure mechanism is a tensile failure, which the ITTR is designed to preclude. Thus, there is no impact on the ability of the fuel to meet the configuration requirements.

The top nozzle remains secured to the bottom nozzle by the ITTR inserted through the instrument guide tube and through it to the balance of the fuel assembly. Thus, there is no impact on the ability of the fuel assembly to meet the required retrievability functions due to installation of the ITTR.

The fuel cladding of the intact fuel assemblies remains unchanged from its prior condition due to the installation of an ITTR. Thus, if a fuel assembly is initially classified as intact, it is deemed to be free from any kind of cladding defects that permit the release of gas from the interior of the fuel rod. There is no gross rupture of fuel cladding and no change in fuel pin pitch during normal or accident conditions. The intact fuel assemblies with installed ITTRs can fulfill all the required fuel-specific functions and system-related functions. Hence, the intact WE 15x15 and WE 17x17 fuel assemblies containing ITTRs can be classified as intact fuel.

Evaluation for Damaged Fuel Assemblies:

Damaged WE 15x15 and WE 17x17 fuel assemblies containing an ITTR are to be stored in the inner most sixteen basket compartments with top and bottom end caps. Similar to the justification provided above for intact fuel assemblies, confinement, configuration and retrievability functional requirements of damaged fuel assemblies are not altered by the installation of ITTRs in damaged WE 15x15 and WE 17x17 fuel assemblies.

Structural

The ITTR is designed by Westinghouse to carry the entire weight of WE 15x15 or WE 17x17 fuel assemblies (Fas) during lifting/handling. In the event of a potential failure of all of the Type 304 stainless steel sleeves, the ITTR provides a load path that bypasses the sleeve bulge joint and allows the FA to be handled by the top nozzle using standard fuel handling tools.

Westinghouse performed proprietary analyses to document the acceptability of the ITTR to support the dead load of the FA during lifting operations. The Westinghouse analyses were performed under three types of loading conditions: 1g lifting, 2g lifting and lateral translation in fuel pool water with up to a recommended velocity of 2.0 ft/sec. The Westinghouse analyses demonstrate that the ITTR concept meets the design goal of no elastic yield of the ITTR or the FA components under all three scenarios and allows for these FAs containing ITTRs to be handled using standard fuel handling tools and procedures. The weight of the WE 15x15 and WE 17x17 FAs containing ITTRs remains below the UFSAR design basis FA weight of 1585 lb.

The limiting FA weight of 1585 lb is used for all the structural evaluations performed for the UFSAR and bounds the fuel assembly classes allowed to be stored. Hence, the existing structural analysis documented in the UFSAR remains bounding for the WE 15x15 and WE 17x17 FAs containing ITTRs.

Thermal

The main effects of the ITTR on the thermal performance of the DSC are limited to:

(1) effective FA thermal properties, and
(2) DSC maximum internal pressure evaluation.

DSC finite element models simulate the FA with a homogenized material occupying the volume within the basket where the FAs are stored. Effective FA properties for density, specific heat and conductivity are determined for this homogenized material for use in the finite element models.

Effective FA Conductivity

The effective conductivity in the transverse direction of a FA is calculated based on the two-dimensional finite element model of the FA cross section to simulate heat transfer by radiation and conduction. The FA cross-section model considers hollow guide and instrument tubes to evaluate the effective transverse conductivity. The inserted ITTR in the instrument tube void will enhance heat transfer within the FA and has no adverse effect on the effective conductivity in the transverse direction.

Further, only the fuel cladding material in the FA is considered in the determination of the axial effective conductivity. The inserted ITTR in the FA has no effect on the evaluated axial effective conductivity.

Therefore, the effective conductivity values calculated based on design basis FA in the UFSAR remain bounding for ITTRs in the FAs.

Effective FA Density and Specific Heat

Effective FA density and specific heat are calculated in the UFSAR. Only fuel cladding and fuel pellets are considered in the determination of effective FA density and specific heat. Therefore, the effective fuel density and specific heat values based on design basis remain bounding for ITTRs in the FAs.

Effect of Inserted ITTR on DSC Maximum Internal Pressure

The insertion of the ITTR reduces the overall cavity volume of the DSC that might potentially lead to a DSC internal pressure increase based on the ideal gas law. The evaluation of the DSC internal pressure in the UFSAR considers a total volume of 148,488 in^3 for 32 FAs in the DSC cavity.

A TN calculation determined the ITTR volume per FA and the total FA volume with ITTR as shown below:

Volume per FA	WE 15x15	WE 17x17
ITTR volume per FA, in^3	34	34
Volume per FA with ITTR, in^3	4,237	4,386

Total FA volume in 32PTH DSC	WE 15x15	WE 17x17	Design Basis FA
Number of FAs per DSC	32	32	32
Total FA volume per DSC, in^3	135,584	140,352	148,488

As shown in the above table, the total FA volume per DSC for WE 15x15 and WE 17x17 FAs with ITTRs are smaller than the total design basis FA volume per DSC. Therefore, the total DSC cavity volumes for WE 15x15 and WE 17x17 FAs with ITTRs are larger than the design basis DSC cavity volume used in the UFSAR for the DSC maximum internal pressure calculation.

Since the insertion of the ITTRs does not reduce the DSC cavity volume considered in the UFSAR, the DSC maximum internal pressure in DSC cavity calculated in the UFSAR remains bounding for the FAs containing ITTRs.

Based on the discussion above, there is no adverse impact on the thermal performance of DSCs and DSC maximum internal pressure evaluations when WE 15x15 and WE 17x17 PWR FAs containing ITTRs are loaded. The maximum fuel cladding temperatures and DSC maximum internal pressures calculated in the UFSAR for normal, off-normal and accident conditions of storage and transfer remain bounding.

Criticality

The effect on criticality due to the addition of an ITTR to a FA is equivalent to the addition of a mild neutron absorber material (steel) which will cause a slight reduction in reactivity. The presence of the ITTR also displaces a small amount of moderator that could potentially adversely affect the reactivity of the system since borated water is credited in the criticality analysis. A TN calculation determined the effect on the system reactivity with ITTR inserted in the intact and damaged FA configurations shown in the UFSAR.

This evaluation uses identical methodology and assumptions as described in the UFSAR. Multiple representative cases were chosen for WE 15x15 and WE 17x17 FAs (damaged and intact) for performing the criticality analysis with ITTRs added to the model. The ITTR is modeled both as a solid stainless steel rod and as an annular stainless steel rod inserted in the instrument tube to determine the sensitivity of the system due to displacement of borated water.

The results show that the insertion of an ITTR modeled both as a solid stainless steel rod and as an annular stainless steel rod, in the instrument tube does not challenge the criticality analysis results for normal, off-normal and accident conditions. The effect on criticality due to ITTR is either statistically insignificant or results in a small reduction in reactivity.

Shielding

The design basis shielding calculations are performed using source terms from fuel assemblies and control components that are inserted in the guide tubes. The ITTR is unirradiated non-fuel hardware and, therefore, does not generate radioactive source terms. Therefore, there is no effect on the shielding analyses of the system.

Confinement

The confinement design function of the DSC is unaffected. When installed, the ITTR is an integral component of the FA that does not interact with the confinement boundaries of the system. As discussed in the thermal evaluation above, the maximum DSC pressure remains bounding for the FAs containing ITTRs. Hence, there is no impact on the confinement capabilities of the DSCs.

The eight 72.48 evaluation criteria were met.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

LR 721030-337 Rev. 0 – (no associated UFSAR change)

Change Description

The change involved the evaluation of the placement of stainless steel shims under HSM end walls. This resulted in changes to safety factors against sliding of the HSMs due to seismic, flood, and tornado generated loads.

Evaluation Summary

The HSM end wall provides structural protection and shielding to the HSMs and the DSCs stored inside the HSMs. The end wall also contributes to providing stability to the HSM array during accident conditions.

Effects on Design Functions:

The evaluation resulted in a change in the safety factors against sliding of the HSMs due to seismic, flood, and tornado generated loads, as follows:

HSM sliding due to seismic load

Safety factor against sliding in the original analysis = 1.44
Safety factor against sliding with shims = 1.24, which is greater than 1.1; therefore, this is acceptable

HSM sliding due to flood load

Safety factor against sliding in the original analysis = 2.55
Safety factor against sliding with shims = 2.2, which is greater than 1.1; therefore, this is acceptable

HSM sliding due to tornado generated wind load

Safety factor against sliding in the original analysis = 2.1
Safety factor against sliding with shims = 1.80, which is greater than 1.1; therefore, this is acceptable

HSM sliding due to tornado generated missile load

Total distance one module slides in the original analysis = 0.34 inches
Distance one module slides with shims = 0.68 inches

However, this sliding distance will be significantly reduced due to the presence of more than one module adjacent to one another. Therefore, the sliding displacement of the modules due to a massive missile impact is insignificant and will not cause any structural damage.

The eight 72.48 evaluation criteria were met.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

Enclosure 1 Part 2 - NONCONFORMANCES

LR 721030-293 Rev. 0* – *(no associated UFSAR change)

Change Description

The change involved the evaluation of stainless steel shims placed underneath the end wall of a specific HSM. This resulted in a change in the safety factors against sliding of the HSM due to seismic, flood and tornado generated loads.

Evaluation Summary

The HSM end wall provides structural protection and shielding to the HSMs and the DSCs stored inside the HSMs. The end wall also contributes to providing stability to the HSM array system during accident conditions.

EFFECTS ON DESIGN FUNCTION:

The evaluation resulted in a change in the safety factors against sliding of the HSM modules due to seismic, flood, and tornado generated loads, as follows:

HSM sliding due to seismic load

Safety factor against sliding in the original analysis = 1.44
Safety factor against sliding with shims = 1.24, which is greater than 1.1; therefore, this is acceptable

HSM sliding due to flood load

Safety factor against sliding in the original analysis = 2.55
Safety factor against sliding with shims = 2.2, which is greater than 1.1; therefore, this is acceptable

HSM sliding due to tornado generated wind load

Safety factor against sliding in the original analysis = 2.1
Safety factor against sliding with shims = 1.80, which is greater than 1.1; therefore, this is acceptable

HSM sliding due to tornado generated missile load

Total distance one module slides in the original analysis = 0.34 inches
Distance one module slides with End Wall and shims = 0.68 inches

However, this sliding distance will be significantly reduced due to the presence of more than one module adjacent to one another. Therefore, the sliding displacement of the modules due to a massive missile impact is insignificant and will not cause any structural damage.

The eight 72.48 evaluation criteria were met.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

LR 721030-295 Rev. 0 – (no associated UFSAR change)

Change Description

The changed involved evaluating storage of fuel assemblies containing debris found during visual inspections of certain general licensee fuel assemblies. This material was identified in the fuel assemblies and could not be removed prior to fuel loading into the DSC. This evaluation does not add these materials as a change to the generic design. There are two types of debris present within the FAs that require evaluation:

(1) Material debris - stainless steel or carbon steel metal debris shaped in different forms (wire, flat or ball) and

(2) Small size (1.32" x 0.44") paint chips.

The worst-case values for each type of foreign material are obtained by conservatively assuming that the values of the debris reported for all DSCs are loaded into a single DSC:

- Metal debris (stainless steel, carbon steel, or a combination): various sizes with a cumulative weight of all listed metal debris less than or equal to 0.10 lb per DSC.
- Paint chips (Ameron or Carboline type paint), maximum size of 1.32" x 0.44", maximum film thickness of .008" with a cumulative paint area of (0.49 + 0.58 + 0.58) in^2 or 1.65 in^2. In addition, based on data obtained, since Ameron Amerlock paint has the highest density (.000408 lb/sq. in), it results in a maximum mass of (.000408 lb/ in^2 x1.65 in^2) = .000673 lb. This is rounded up to .0007 lb of paint chips per DSC for this evaluation.

Evaluation

The DSC has structural/mechanical, containment, shielding, criticality, and thermal design functions. The primary function of the DSC is to provide confinement for the spent nuclear fuel. This is achieved by the stainless steel shell and inner and outer cover plates (top and bottom ends) which are integral to the shell assembly. The primary pressure boundary, which is 304 stainless steel, maintains an inert (helium) dry atmosphere inside the DSC to minimize pressure boundary and fuel degradation.

STRUCTURAL/MECHANICAL:

There are two concerns with regard to the introduction of a small amount of foreign material. The first is the impact of the material on the DSC pressure boundary. The second is the impact, if any, of the foreign material on the internal DSC environment, or atmosphere, including internal pressure.

Impact of Foreign Material on DSC Pressure Boundary and FA's

The foreign materials of concern could induce corrosion of the DSC components and/or fuel assemblies in an environment that is conducive to corrosion (an environment with water, air or other electrolyte present). However, the vacuum drying of the DSC reduces the quantity of water, air or other oxidizing agents to 0.25 volume percent or less. This level of concentration of oxidizing agent with the balance of the DSC free volume filled with inert helium gas will not support any significant corrosion in the DSC. Therefore, although the debris in the DSC (paint chips, carbon steel and stainless steel) could potentially cause some corrosion in an air/water environment, the lack of an oxidizing agent in the DSC and the inert helium gas fill of 99.75% of the free volume of the DSC, will preclude any corrosion of the pressure boundary, basket (or other DSC components) or fuel assemblies.

To quantify any impact of the foreign material on corrosion of the pressure boundary, corrosion rates for stainless steel were researched. Smithells Metals Reference Book, 6th Edition, Butterworths, 1983, gives uniform corrosion rates for 18 Cr, 8 Ni stainless steel in an industrial atmosphere (~21% O_2 and mildly corrosive) of 0.001 mm/year, or 0.0004 inch/year. The nominal DSC shell is 0.500" thick. A conservatively assumed rate of 0.0004 inch/year, which assumes a gaseous environment with O_2 and other corrosive gases, still would require over 125 years to reduce the nominal thickness 10%, a value that would still not significantly degrade the pressure boundary. Again it should be noted that the DSC internal atmosphere is not industrial air, but dry helium.

To quantify any impact of the foreign material on corrosion of the fuel cladding, corrosion rates for Zirconium were researched. Metals Handbook®, 9th Edition, Corrosion, ASM International, 1987, provides an extremely conservative case of liquid hydrochloric acid on zirconium, and gives a rate of < 0.001 inch/year. The nominal cladding thickness for FA's is 0.028" and full thickness corrosion would require more than 30 years. It again should be noted that the DSC internal atmosphere is not liquid hydrochloric acid, but dry helium.

The conclusion from both of these searches is that both the stainless steel pressure boundary and the zirconium cladding are resistant to corrosion and it would take many years, even assuming unrealistic environments, to reduce thickness to a level of concern. Therefore, corrosion from a very small amount of foreign material in a dry helium (inert gas) atmosphere is not a concern for the pressure boundary or the fuel cladding.

Given that this material was placed within the DSC, three scenarios are possible for the paint chip debris materials:

1. The paint chip material did not melt/vaporize during vacuum drying operations and remains present at the start of storage. This material is then present in an inert dry atmosphere (helium).

2. The paint chip material decomposed/melted during vacuum drying operations, but did not vaporize. It thus remains as a solid reconfigured piece of material.

3. The paint chip material melted and vaporized during vacuum drying operations and all that remains is residue.

In all three cases, if this material is in contact with the pressure boundary (304 stainless steel) there is no concern of boundary degradation, given the dry inert atmosphere. If this material were in contact with the FA, specifically the cladding, the worst case result would be localized cladding corrosion. Given the extremely small amount of foreign material (< 0.2 lb) and the inert dry helium atmosphere, cladding breach would not occur. Even if a non-mechanistic conservative assumption is made that the pin gas inventory is released, the release of fill gas is already an analyzed event and this foreign material does not increase the severity of the event.

The 32PTH DSC free cavity volume is 308,146 in^3 (178.3 ft^3). This results in a DSC water inventory weight of approximately 178.3 ft^3 x 62.4 lb/ft^3 or 11,100 lb. As discussed above, the weight of paint chips per DSC is less than 0.0007 lb, which yields a paint chip concentration of 0.0007/11,100 = 63 ppb (parts per billion). This extremely small concentration will have no impact on reflooding operation. This is a conservative assessment for a reflood condition. This quantity of foreign material (paint chips) in an inert DSC will have no impact on the performance of the DSC or fuel cladding.

Impact of Foreign Material on DSC Internal Pressure

Regarding added volume due to vaporization, both the stainless steel and carbon steel are stable and will not volatize, so no contribution from this debris is calculated.

To calculate the added volume due to vaporization of the paint chips, it is conservatively assumed that the helium atmosphere inside the DSC is @ 14.7 psia (0 psig), in order to maximize the impact of any contribution from the plastic material.

Assuming that the paint chips fully convert into hydrogen (the gas with the lowest density, and thus the greatest volume increase), results in an added hydrogen gaseous volume of (0.0007 lb)/0.0056 lb/ft^3 = 0.125 ft^3 of hydrogen.

This is a very conservative assumption since much of the paint chip material is of heavier elements that will result in lower volumes of gas.

The impact of the foreign material on DSC pressurization is assessed. The DSC free cavity volume is 178.3 ft^3. Conservatively assume that the helium atmosphere is @ 14.7 psia (0 psig), in order to maximize the impact of any contribution from off-gassing of the debris. As determined above, the conservative estimate for additional gas volume is 0.125 ft^3. This then results in a pressure increase of (0.125)/178.3 = .07%.

The design pressure is 15 psig for normal, 20 psig for off-normal and 70 psig for accident cases. The actual pressure values calculated are 4.8 psig for normal, 8.6 psig for off-normal and 11.3 psig for accident conditions, respectively. In all cases, the pressure increase due to the foreign material (conservatively calculated) of 0.07% is much less than the margin between the calculated and design pressure.

The hydrogen combustible limit of 4% is addressed by standard procedural requirements, in place on all DSC closure and opening operations that require monitoring for hydrogen. If hydrogen levels are above the set limits, the canister will be purged with helium to reduce the hydrogen concentration to acceptable limits prior to any welding/cutting. This ensures that the debris in the DSC will not adversely impact DSC pressure or combustibility limits.

MECHANICAL:

There is no adverse impact. The material is of a small enough volume (less than 0.2 lb. per DSC), that no problems are anticipated in successfully vacuum drying. Prior to leaving the fuel building for storage, the vacuum drying and sealing operations will have been performed successfully. It can be inferred that any reflooding operations would be similarly unaffected. Assuming that the debris is still intact, it would either be retained as it was before or it would have become dislodged during horizontal transfer and is now "loose" in the DSC. In either case, this debris is not large enough to block reflooding through the siphon tube, nor would it interfere with subsequent gas venting.

THERMAL:

There is no adverse impact. The limiting source term is unchanged. The volume of the foreign material is not sufficient to alter the DSC internal atmosphere and thus alter gaseous heat transfer.

SHIELDING:

There is no adverse impact. The introduction of foreign material into the DSC does not change the source term limits of the fuel qualification table. The shielding analysis does not explicitly rely on the DSC internal gas environment. The volume of the foreign material is very small, contains no significant material susceptible to activation (no cobalt), and thus will not significantly alter the long-term source term.

CRITICALITY:

There is no adverse impact. The DSC will be drained, successfully vacuum dried, and sealed. The very small amount of foreign material will not create a concern during future reflooding. As shown previously, the concentration of dissolved materials (conservatively assuming that it all goes into solution following reflood) is very low and thus will not adversely change k_{eff}. The fuel cladding will not be breached by this small amount of material, within a dry helium atmosphere. Thus the cladding will not be breached and there will be no dispersal or reconfiguration of pellet material. The fuel assembly will not become "damaged".

WEIGHT:

There is no adverse impact. The weight of the foreign material is less than 0.2 lb. This will not change the DSC center of gravity location or exceed any weight limits.

CONFINEMENT:

There is no impact on the confinement capabilities of the DSCs as there are no new leak paths introduced. As stated previously, the foreign material will not adversely impact the stainless steel DSC pressure boundary.

The eight 72.48 evaluation criteria were met.

<u>LR 721030-313 Rev. 0</u> – (no associated UFSAR change)

<u>Change Description</u>

The change involved allowing use of a reduced-thickness dry shielded canister (DSC) inner bottom cover plate (IBCP) at a general licensee ISFSI. The design thickness is 2.25 inches. The reduced-thickness IBCP is 2.17 inches.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

Evaluation

The IBCP is a part of confinement boundary, which provides an inert environment, structural support for 32 PWR fuel assemblies. The IBCP is a part of the DSC bottom assembly, which also provides shielding.

A small decrease in plate thickness will generally result in a small increase in stress for primary and a small decrease in secondary loads. The primary stresses in a flat plate subjected to internal pressure are inversely proportional to the thickness of the lid and the bending stresses are inversely proportional to the square of the thickness of the lid. Thus the stresses are scaled by a factor of (2.25/2.17) = 1.04 for membrane (P_m) stress and $(2.25"/2.17")^2$ = 1.08 for membrane and bending (P_m+ P_b) stress. Therefore, stress results are scaled by 4% for P_m and 8% for P_m+ P_b. Although the stress increased as a result of reduced IBCP thickness, the maximum stress ratio is 0.93, which is less than 1 and therefore acceptable. The combined thickness of the bottom shield plug and cover plates is greater than the minimum design thickness of 8.75 inches. Therefore, there is no effect on the shielding design function.

The eight 72.48 evaluation criteria were met.

***LR 721030-327 Rev. 0* – (no associated UFSAR change)**

Change Description

The change is to evaluate the effect of 1 inch of water accumulation on the HSM floor. During inspections of the HSMs at a general licensee ISFSI, approximately 1 inch of water was found to have accumulated on the HSM floor.

Evaluation

The DSC has structural, containment, shielding, criticality, and thermal design functions. The primary function of the DSC is to provide confinement for the spent nuclear fuel. This is achieved by the stainless steel shell and inner and outer cover plates (top and bottom ends) that are integral parts of the shell assembly. The DSC provides gamma shielding at its ends by the use of thick end plugs. Criticality control is provided by the DSC's internal basket assembly. The DSC also provides heat rejection from the fuel assemblies to the HSM cavity and maintains the maximum fuel cladding limit below regulatory limits.

The HSM provides shielding, heat transfer and structural protection for the DSC during normal, off-normal operations, postulated accidents or natural phenomena. Shielding and structural design functions are provided by the reinforced concrete walls and the roof. The heat transferred from the DSC shell is dissipated via natural convection airflow within the HSM module and also via radiation and conduction between the concrete components, support structure and heat shields.

Thermal Function

The presence of 1 inch of water accumulated on the HSM floor reduces the total area available for natural convection and has the potential to increase the maximum airflow, HSM and DSC component temperatures, along with the fuel cladding temperature. A TN calculation addresses the effect of 1 inch of water accumulation on the HSM floor and also considers that 1 inch of water accumulation exists within the inlet vents. Based on the evaluation, the effect on the thermal performance due to 1 inch of water accumulation on the HSM floor is insignificant.

Structural, Criticality, Shielding, and Confinement Functions

The presence of 1 inch of water accumulation on the HSM floor does not impact these remaining design functions.

The eight 72.48 evaluation criteria were met.

***LR 721030-329 Rev. 0* – (no associated UFSAR change)**

Change Description

The change involved evaluation of two ISFSI non-conforming conditions, following a 5.8 magnitude seismic event at a general licensee site. Inspections noted that certain HSMs appeared to have shifted during the seismic event. The two non-conforming conditions resulting from this seismic event are as follows:

Non-Conforming Condition #1:

Measurements of the gaps between adjacent HSMs. The design specification requires that the gap between the adjacent roofs shall not exceed 0.75 inches. For double rows, the gap between back-to-back roofs shall not exceed 0.75 inches. In addition, the design specification requires maximum side-to-side contact and back-to-back contact (for double arrays) at the bases. Three roof-to-roof gaps measured between certain HSMs exceed the maximum 0.75 inches roof-to-roof gap requirement (a maximum roof-to-roof gap of 1.25 inches exists between two of these HSMs). None of the gaps between the back-to-back roofs exceeded the 0.75-inch criteria. In addition, the base-to-base gap between two of these HSMs is 1.0 inch with no contact while other base-to-base gaps are 0.75 inches or less and appear to be in contact.

Non-Conforming Condition #2:

The general licensee's soil structure interaction (SSI) analysis for the ISFSI pad for revised ground motion following the seismic event determined that the peak seismic accelerations at the center-of-gravity (CG) of the HSM resulting from the seismic event are Vertical = 0.39g, Longitudinal (North-South) = 0.56g, Transverse (East-West) = 0.29g. Two of these three values exceed the maximum acceleration values of 0.37g horizontally (longitudinal and transverse) and 0.2g vertical at the CG of the HSM as specified in the UFSAR.

Evaluation

Calculations were completed to address the above two non-conforming conditions.

Design Criteria

The seismic design criteria for the HSM are based on NRC Regulatory Guide 1.60 (R.G.). As stated in the UFSAR, the response spectra are anchored to a maximum ground acceleration of 0.30g for the horizontal components and 0.20g for the vertical component. The results of the frequency analysis of the HSM structure (which includes a simplified model of the DSC) yield a lowest frequency of 23.2 Hz in the transverse direction and 28.4 Hz in the longitudinal direction. The lowest vertical frequency exceeds 33 Hz. Thus, based on the R.G. 1.60 response spectra amplifications, the corresponding seismic accelerations used for the design of the HSM are 0.37g and 0.33g in the transverse and longitudinal directions, respectively, and 0.20g in the vertical direction. The corresponding accelerations applicable to the 32PTH DSC are 0.41g and 0.36g in the transverse and longitudinal directions, respectively, and 0.2g in the vertical direction.

The general licensee SSI analysis determined that the peak seismic accelerations at the CG of the HSM resulting from the seismic event are Vertical = 0.39g, Longitudinal (North-South) = 0.56g, Transverse (East-West) = 0.29g. Two of these three values exceed the maximum acceleration values of 0.37g horizontally (longitudinal and transverse) and 0.2g vertical at the CG of the HSM as specified in the UFSAR.

Structural Evaluation

HSM Structural Evaluation

The increased seismic accelerations determined in the general licensee SSI analysis are rounded up conservatively as listed below:

- Vertical = 0.4g
- Side-to-Side = 0.6g
- Front-to-Back = 0.3g

In the UFSAR, load combinations COMB4C and COMB4S have been used for the seismic evaluation of the concrete components and support steel, respectively.

A TN calculation evaluates the HSM concrete and steel components by recalculating the seismic loads for COMB4C and COMB4S load combinations using the increased seismic accelerations listed above. Table 1 below presents the results for the COMB4C load combination for the HSM concrete components.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

Table 1
Evaluation of Load Combination COMB4C for the HSM Concrete Components

Concrete Component	Quantity	V_i kips/ft	V_{01} kips/ft	V_{02} kips/ft	M_1 kip-in/ft	M_2 kip-in/ft	T_1 Tension kips/ft	T_1 Comp. kips/ft	T_2 Tension kips/ft	T_2 Comp. kips/ft
Rear Wall (upper)	Computed	8.26	4.16	2.39	25.66	81.32	12.72	25.33	9.59	33.31
	Capacity	76.80	14.50	14.50	305.90	305.90	63.00	379.00	63.00	379.00
	Ratio	0.11	0.29	0.16	0.08	0.27	0.20	0.07	0.15	0.09
Rear Wall (lower)	Computed	17.00	8.58	4.99	67.14	87.22	3.61	61.54	27.51	69.33
	Capacity	98.40	36.20	36.20	778.10	778.10	63.00	807.40	63.00	807.40
	Ratio	0.17	0.24	0.14	0.09	0.11	0.06	0.08	0.44	0.09
Side Walls (upper)	Computed	9.34	4.53	4.68	96.02	64.77	23.38	120.44	16.39	31.77
	Capacity	55.40	14.80	14.80	202.10	202.10	40.30	365.90	40.30	365.90
	Ratio	0.17	0.31	0.32	0.48	0.32	0.58	0.33	0.41	0.09
Side Walls (lower)	Computed	25.74	12.10	9.79	111.24	160.31	31.88	104.72	28.55	32.73
	Capacity	64.00	23.40	23.40	322.90	322.90	40.30	537.30	40.30	537.30
	Ratio	0.40	0.52	0.42	0.34	0.50	**0.79**	0.19	0.71	0.06
Roof	Computed	5.51	6.39	12.95	136.66	489.57	4.49	9.34	14.25	18.55
	Capacity	177.6	59.10	59.10	2438.10	2438.10	120.90	1326.2	120.90	1326.2
	Ratio	0.03	0.11	0.22	0.06	0.20	0.04	0.01	0.12	0.01
Front Wall (upper)	Computed	26.34	25.74	20.64	929.55	1824.02	41.44	29.45	18.58	73.65
	Capacity	174.7	56.30	56.30	2317.20	2317.20	120.90	1269.1	120.90	1269.1
	Ratio	0.15	0.46	0.37	0.40	**0.79**	0.34	0.02	0.15	0.06
Front Wall (lower)	Computed	33.80	38.30	27.53	1555.04	765.87	65.65	94.26	79.80	166.71
	Capacity	192.1	73.60	73.60	3042.50	3042.50	120.90	1611.8	120.90	1611.8
	Ratio	0.18	0.52	0.37	0.51	0.25	0.54	0.06	0.66	0.10

As seen from Table 1 above, the maximum ratio is 0.79 (for the HSM Upper Front Wall and the Lower Side Wall) which is less than 1.0. All the HSM concrete components remain qualified after the seismic event. The limiting load case for the HSM concrete components is the blocked vent accident condition, as reported in the UFSAR, with a maximum ratio of 0.97.

The interaction ratios/stress ratios for the COMB4S load combination determined for the HSM rail, extension plates, and the cross members are as listed below in Table 2 below.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

Table 2
Evaluation of Load Combination COMB4S for the HSM Steel Components

Component	Maximum Interaction Ratio	UFSAR Maximum Interaction Ratio	Maximum Stress Ratio	UFSAR Maximum Stress Ratio
HSM Rails	0.56	0.51	0.90	0.96
HSM Extension Plates	0.76	0.60	0.05	0.60
HSM Cross Members	--	--	0.23	0.25

As seen from Table 2 above, the maximum stress ratio for HSM rails, extension plates, and cross-members are each less than 1.0 and thus remain acceptable following the seismic event.

The top heat shields, side heat shields, and various embedments of the HSM components have all been re-evaluated with the increased seismic accelerations. Each of these components remains qualified.

DSC Structural Evaluation

The seismic loads used for the DSC and the basket analysis in the UFSAR are as follows:

- Transverse = 0.65g
- Longitudinal = 0.65g
- Vertical = 0.3g

The above listed seismic loads envelope the DSC seismic loads determined in the UFSAR. Further, the UFSAR analysis conservatively compares the calculated loads against the lower ASME Level A stress limits instead of Level C stress limits.

A TN calculation uses the increased spectral response determined in the general licensee SSI analysis and applies a damping value of 4% in accordance with Regulatory Guide 1.61 to determine the new acceleration levels. These values are listed in Table 3 below. Also shown are the values used in the UFSAR DSC analysis.

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

Table 3
Maximum Acceleration G Load Based on Response Spectra

Direction	Frequency (Hz)	DSC Maximum Acceleration	UFSAR DSC Maximum Acceleration
Axial	60.4	0.24g	0.65g
Transverse	54.4	0.57g	0.65g
Vertical	54.4	1.38g(1)	1.30g(1)

Note 1: Includes 1g down for dead weight.

As shown in Table 3 above, only the vertical acceleration load is increased relative to the UFSAR values. However, the TN calculation conservatively scales up the UFSAR loads in all three directions by the same ratio of 1.38/1.30 or 1.06 for determining the DSC stresses. Also, consistent with the UFSAR analysis, the calculated stress loads are conservatively compared to ASME Level A allowable limits. The limiting results for the DSC, basket and rail are summarized in Table 4 below.

Table 4
DSC and Basket Stress Results under Normal and Accident Conditions

Component	Loads	New Stress Intensity	Allowable Stress	Stress Ratio
DSC	30 psig Internal Pressure + Seismic Load + Thermal (-20° F)	30.37	54.3	0.56
Basket	Seismic	9.33	16.0	0.58
Rails	Seismic + Normal Thermal	27.16	49.2	0.55

Based on the results shown in Table 4 above, all the stress ratios are less than 1.0. Hence, the DSC and basket remain structurally adequate for the increased seismic loads resulting from the seismic event.

Time History Evaluation of the HSM and DSC

The UFSAR performs a seismic equivalent static analysis for a HSM module loaded with a DSC.

To demonstrate that no significant load is applied on the DSC due to its uplifting during the seismic event, a seismic non-linear time history analysis of a loaded and unloaded HSM was performed using a methodology consistent with that described in Appendix U, Chapter U.3.7 of the CoC 1004 Standardized NUHOMS® UFSAR. This methodology has been approved by the NRC for a NUHOMS® HSM-HS module loaded with a 32PTH1 DSC. The NUHOMS® HSM-HS is nearly identical to the HSM evaluated here.

This dynamic seismic analysis uses the LS-DYNA 3-D element model of the HSM. The maximum acceleration time histories in all three directions obtained from the general licensee SSI analysis are applied simultaneously to the HSM model. Two configurations are analyzed:

- A loaded HSM with one rear shield wall and a concrete pad (Model I)
- A loaded HSM with one rear shield wall, one end shield wall, one corner wall and a concrete pad (Model II).

A minimum coefficient of friction value of 0.2 is used in runs to maximize the sliding displacement, while a maximum coefficient of friction of 0.8 is used to maximize the vertical uplifting movement.

The results of the TN calculation are as follows:

- The tipping/uplift vertical response is negligibly small for model II, but relatively large for model I.
- Sliding is the primary mode of response of the HSM when the friction coefficient is 0.2, while the uplifting/rocking is relatively large with friction coefficient of 0.8.
- For friction coefficient of 0.2, the maximum sliding displacements are on the order of 1.221" in the horizontal X-direction and 0.110" in the horizontal Y-direction. For friction coefficient of 0.8, the maximum sliding displacements are on the order of 0.009" in the horizontal X-direction and 0.013" in the horizontal Y-direction. The maximum uplift is 0.687" for the worst case with friction coefficient of 0.8. The maximum rocking is 0.170" and 0.705", about x and y for the worst case.
- It is clear from DSC displacement time histories that because of the vertical seismic load, the uplift of DSC from the support rails is instantaneous which is insufficient for the DSC to disengage from the support rails. This demonstrates that the DSC maintains its position and remains constrained within the HSM DSC steel support structure.

Shielding Evaluation

A TN calculation is performed to determine the effect of gaps between the HSMs using design basis source terms. This shielding calculation models a maximum uniform gap of 1.5 inches between the HSMs and between the HSMs and the rear shield wall. This is defined as the "new normal" condition for the general licensee's ISFSI following the seismic event and envelopes non-conforming condition #1.

Dose rates are also determined with a maximum uniform gap of 4.0 inches between the HSMs and between the HSMs and the rear shield wall. This condition assumes an additional seismic event that is equivalent to the initial event and is considered an accident condition. A TN calculation had determined that the seismic event produces a maximum HSM displacement of 1.22 inches in either direction. This displacement, when added to an initial maximum gap of 1.5 inches yields a maximum gap of 4.0 inches for this accident condition.

A summary of the HSM maximum and average dose rates calculated with 1.5-inch gap and 4.0-inch gap are presented in Table 5 and Table 6 below, respectively.

Table 5

REPORT OF 72.48 EVALUATIONS PERFORMED FOR THE NUHOMS® HD SYSTEM FOR THE PERIOD 01/08/11 to 01/07/13

Dose Rate Location	Maximum Total (mrem/hr) UFSAR – No gap	Maximum Total (mrem/hr) 1.5"Gap – Normal Condition	Maximum Total (mrem/hr) 4.0"Gap – Accident Condition
HSM Roof Birdscreen	170.0	228.2	314.5
HSM Front Birdscreen	752.0	752.0	1000.2
HSM End (Side) Shield Wall Surface	1.4	1.42	NA
HSM	1.6	1.68	NA

Table 6

Dose Rate Location	Average Total (mrem/hr) UFSAR – No gap	Average Total (mrem/hr) 1.5"Gap – Normal Condition	Average Total (mrem/hr) 4.0"Gap – Accident Condition
HSM Roof	15.85	20.85	41.0
HSM Front	20.77	22.73	33.44

Table 7 shows the estimates of the annual dose for a 2x10 array ISFSI for the new normal and accident conditions.

Table 7
ISFSI Annual Dose at 200m for the 2x10 Array – 100% Occupancy

Dose Location at 200m from ISFSI	Annual Dose (mrem) UFSAR – No gap	Annual Dose (mrem) 1.5"Gap – Normal Condition	Annual Dose (mrem) 4.0"Gap – Accident Condition
Front of Array	89	120	240
Side of Array	57	80	160

The increase in dose at the site boundary is proportional to the number of loaded HSMs in the array with gaps. As shown in Table 7, for a 1.5-inch gap in a 20-module array, the increase in the annual dose at the site boundary at 200m is approximately 30 mrem and is an insignificant increase compared to the applicable limit per 10 CFR 72.106(b) discussed below. For a 4.0-inch gap in a 20-module array, the increase in the annual dose at the site boundary at 200m is approximately 150 mrem and again is an insignificant increase compared to the applicable limit per 10 CFR 72.106(b) discussed below.

The applicable limit per 10 CFR 72.106(b) is that the dose at the site boundary is limited to 5000 mrem per accident. At an assumed site boundary distance of 200m, the maximum calculated dose rate with a uniform 4.0-inch gap between each module for a 40-module array is less than 500 mrem. For the general licensee ISFSI with a site boundary of approximately 800m and a 26-module array with a non-uniform gap between HSMs, the annual dose at the site boundary due to the ISFSI is expected to be insignificant (less than 0.5 mrem).

Thermal Evaluation

The thermal design function of the HSMs is not adversely affected as a result of non-conforming conditions #1 and #2. Side-to side gaps exceeding the TN design specification do not create an unanalyzed thermal condition nor change the HSM thermal design parameters as described in the UFSAR. All inlet and outlet vent have been visually inspected after the seismic event and no blockage has been reported.

Criticality and Confinement Evaluations

The HSM does not perform any criticality or confinement design function. However, the DSC does have criticality and confinement design functions. As discussed earlier in this evaluation, the structural evaluation of the DSC due to the increased seismic loads notes that the stress ratios still remain well below 1.0. As a result of this, it can be concluded that the DSC remains structurally unaffected by the increased seismic loads and, therefore, the criticality and confinement functions of the DSC are maintained and not affected.

The eight 72.48 evaluation criteria were met.