TRANSNUCLEAR
AN AREVA COMPANY

April 30, 2009
E-28000

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

Subject: Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 1 to the NUHOMS® HD System, Response to Second Request for Additional Information (Docket No. 72-1030; TAC NO. L24153)

Reference: Letter from B. Jennifer Davis (NRC) to Donis Shaw (TN), "SECOND REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF AMENDMENT 1 TO THE NUHOMS® HD SYSTEM (TAC NO. L24153)," April 3, 2009

This submittal provides responses to the request for additional information (RAI) forwarded by the referenced letter. Enclosure 1 herein provides each of the NRC staff RAI followed by a TN response. Enclosure 2 provides a list of proposed NUHOMS® HD Technical Specifications (TS) and Updated Final Safety Analysis Report (UFSAR) pages that changed and are included herein.

Enclosure 3 provides TS and UFSAR Amendment 1 replacement pages. In both the TS and the UFSAR, Amendment 1 Revision 0 changes, Amendment 1 Revision 1 changes, Amendment 1 Revision 2 changes, and Amendment 1 Revision 3 changes are shown using italics for inserted text and revision bars for changed areas; however, Revision 3 changes are shaded to distinguish these new changes from Revision 0, Revision 1, and Revision 2 changes. For the UFSAR, page footers for replacement pages are annotated as "Amendment 1, Rev. 3, 4/09."

This submittal contains security-related information on the enclosed UFSAR drawing. Accordingly, Enclosure 4 provides a public version of that drawing.

Should the NRC staff require additional information to support review of this application, please do not hesitate to contact Mr. Don Shaw at 410-910-6878 or me at 410-910-6881.

Sincerely,

Jayant Bondre

Jayant Bondre, Ph.D.
Vice President - Engineering

cc: B. Jennifer Davis (NRC SFST) (six paper copies of this cover letter and Enclosures 1 through 3, provided separately)

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Enclosures:

1. RAI Responses
2. List of Changed Pages for CoC 1030 Amendment 1 Application Revision 3
3. NUHOMS® HD Amendment 1 Application Revision 3, Changed Proposed Technical Specifications and Proposed Updated Final Safety Analysis Report Pages
4. UFSAR Drawing 10494-72-1 (public version)

1.1 (Response to Round 1: RAI 8.1)
Quantify the "flammability limit" in terms of hydrogen concentration in Section 5.6 of the Technical Specifications.

The limiting concentration of hydrogen required for ignition (2.4%), which is specified in Section 8 of the application should be specified in the proposed Technical Specifications to prevent a hydrogen burn during welding.

This information is needed to determine compliance with 10 CFR 72.166.

Response to 1.1

The 2.4% limit in SAR Section 8 is a conservative limit. Section 5.6 of the Technical Specifications has been changed to specify a 4% limit.

1.2 (Response to Round 1: RAI 9-6)
Clarify in Section 9.1.7.2 of the application if the maximum total porosity (3%) and maximum open porosity (0.5%) refers to the volumetric porosity of the "core" of the neutron absorbing material, or the volumetric porosity of the total material, which includes the cladding.

The open porosity of the material can influence the material's resistance to blistering and corrosion.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.2

The third paragraph of Section 9.1.7.2 states, "...the final density ***of the core*** *shall be greater than 97% of theoretical density..." TN prefers to specify minimum density instead of maximum total porosity. TN believes this requirement is clear.*

Section 9.1.7.2 is revised as follows to clarify that the maximum interconnected porosity of 0.5 volume % refers only to the core of the final product:

"The final MMC product shall have density greater than 98% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity. For MMC with an integral cladding, the final density of the core shall be greater than 97% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity of the core and cladding as a unit of the final product."

1.3 (Response to Round 1: RAI 9-8)
Provide evidence or justification that rapid heating during vacuum drying of the clad neutron absorber after submersion will not damage the neutron absorbing material.

Rapid heating of low-porosity-type Boral plates under a vacuum have resulted in blistering of the Boral. Although these plates had a higher degree of open porosity (one to three-percent) than the proposed clad neutron absorber, the staff requests reasonable assurance that the proposed material will not blister during drying.

If sufficient justification that blistering will not occur is not available, the applicant should consider adding a qualifying testing program to the proposed Technical Specifications requiring some type of modified thermal shock test to ensure that blistering of the cladding is not an issue.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.3

The material properties of Boral are by no means representative of a Metal Matrix Composite. Boral is typically 92% (but no greater than 95%) dense. Isolated open porosity (defined as < 0.5 volume % connected porosity) will not lead to the suggested problems of water intrusion, cracking, and delamination.

The thermal durability test temperatures bound vacuum drying temperatures. TN has added the thermal durability qualification testing for MMC with an integral aluminum cladding in new Section 9.5.3.3.1, which is incorporated by reference into the Technical Specifications. TN has revised the SAR as follows:

Section 9.5.3.3 revised:

> *Thermal damage testing is not required for unclad MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842°F, well above the basket temperature under normal conditions of storage or transport[3].*

Technical Specifications Section 9.5.3.3.1 added:

> ***9.5.3.3.1 Delamination Testing of Clad MMC***
>
> ***Clad MMCs shall be subjected to thermal damage testing following water immersion to ensure that delamination does not occur under normal conditions of storage.***

Non-Technical Specifications Section 9.5.3.4(c) added:

> *For MMCs with an integral aluminum cladding, thermal durability testing demonstrating that after a 24 hour soak in either pure or borated water, followed by a 30 day heat treatment at a minimum temperature of 825°F in an inert environment, that the specimens are free of blisters and delamination and pass the mechanical testing requirements described in test 'a' of this section.*

1.4 (Response to Round 1: RAI 9.12)
Clarify or remove the, "alternate material" from the licensing drawing 10494-72-1 when referring to "SA240, Type 304 Steel."

Any material equivalent to SA240, Type 304 steel should have identical or superior properties, *and* should be certified to a widely recognized industry standard which ensures a level of quality identical or superior to materials meeting ASME Code requirements.

This information is needed to determine compliance with 10 CFR 72.236(b).

Response to 1.4

The note is revised to "ASTM material may be used in lieu of ASME material as provided in ASME Code Section II, Acceptable ASTM Editions."

1.5 Clarify in Section 9.5.2, the type of standard (e.g., zirconium diboride, metal matrix composite, etc.) that is being used to calibrate the neutron attenuation beam.

The staff is unclear whether the applicant is using a standard that may be heterogeneous and therefore not appropriate for neutron attenuation calibration standards.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.5

The paragraph as written is intended to not isolate acceptance testing to any single set of calibration standards. The key requirement is that the neutron attenuation is performed only by a boron compound. Non-homogeneous standards may be used, if testing shows them to provide neutron attenuation equivalent to a homogeneous standard.

TN has added the following statement to Section 9.5.2, which was already incorporated by reference into the Technical Specifications, to ensure that standards are properly calibrated:

"The calibration of the standards shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures."

1.6 Justify in Section 9.5.2 the use of a larger neutron attenuation beam and larger radioscopic image for acceptance testing of the neutron absorbing materials.

Internal studies by the staff suggest that neutron attenuation beam sizes up to 1-inch in diameter with a 10% tolerance, (or 1 square inch total) may be satisfactory for acceptance testing of the neutron absorbing materials.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.6

TN has changed the beam diameter from 1.5 to 1 inch in Section 9.5.2, which was already incorporated by reference into the Technical Specifications, and the area of digital analysis for radioscopic images is changed to from 1.75 to 0.75 inch^2 *accordingly.*

1.7 Clarify in Section 9.5.2 if the radioscopic images are taken using digital techniques, or using photographic film.

The staff is unclear as to the method used for determining quantitative values of the areal density of boron-10 in neutron absorbing materials. While the staff agrees that photographic film is capable of detecting defects in materials, it may not be appropriate for calculating areal densities.

ASTM C1671-07, "Standard Practice for Qualification and Acceptance of Boron Based Metallic Neutron Absorbers for Nuclear Criticality Control for Dry Cask Storage Systems and Transportation Packaging," describes the use of neutron attenuation for determining the areal density of boron-10 in neutron absorbers.

Since this document does not describe radioscopic imaging, the adequacy of this alternative method for quantifying attenuation to ensure its equivalency to standard neutron attenuation methods should be provided.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.7

By definition, a radioscopic image is not film; that is a radiograph. Evaluating shades of gray is just another means of counting neutrons. Digital image analysis would be subject to the same requirements for calibration and statistical analysis as with neutron attenuation testing. If an MMC supplier or a test laboratory could not quantify the areal density, then the test would not be accepted.

The acceptance criterion is absolute, but the means of demonstration is a function of TN's quality assurance program and should not be defined in Technical Specifications.

The area of image analysis is changed from 1.75 sq. inch to 0.75 sq. inch per the response to RAI # 1.6.

1.8 Specify the visual inspection criteria in Section 9.1.7.4 of the proposed Technical Specifications.

The visual inspection criterion is used to determine the general condition of the neutron absorbing materials. Plates with gross cracking, large pores, excessive open porosity, etc. should be rejected on the basis of structural unsoundness, poor corrosion resistance, and (for clad materials) susceptibility to blistering.

The Section was removed from the proposed Technical Specifications in the supplemental response to the Round 1 Request for Additional Information.

This information is needed to determine compliance with 10 CFR 72.236(b).

Response to 1.8

The inspection is important to safety and will be performed in accordance with TN's or the MMC Supplier's 10CFR72 quality assurance program. TN, in practice, does not specify rejection in the FSAR for inspections. It is possible and practical for a supplier to *rework or repair plates that fail visual inspection, thus salvaging the material. The statement of treating the material as non-conforming ensures that the material is taken out of production at the time of inspection and only brought back into production if acceptable per TN's nonconforming material control process.*

TN had removed the visual inspection criteria from the Technical Specifications in its previous response because the visual inspection does not represent a limiting condition of operation for the storage system. TN takes no structural credit for neutron absorbers in analysis. The ability of the material to perform design credited functions is verified through acceptance testing, not visual inspection.

However, in response to Staff's request, TN has added the following statement as a Technical Specifications requirement to SAR Section 9.1.7.4. The visual inspection acceptance criteria are separated as a non-TS section 9.1.7.5.

"Neutron absorbers shall be 100% visually inspected. Non-conforming materials shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures."

1.9 Specify an increase of open porosity or change in surface treatment as necessitating corrosion testing in the second paragraph of Section 9.5.3.3.

The staff considers that thermal damage and corrosion testing may be necessary if materials with the same chemical composition are used (even in the matrix is 1100 aluminum alloy), but the open porosity is increased.

The staff has previously discussed with the applicant the potential effects that open porosity can have on the neutron absorbing material. The application must indicate the need for thermal damage and corrosion testing if the open porosity is increased or if there is change in surface treatment.

The staff requested that Section 9.5.3.3 be put into the Technical Specifications in Request for Additional Information 9-1.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.9

TN understands that with the addition of the mandatory thermal damage test in response to RAI # 1.3 this question is resolved. The limit for open porosity is provided in Section 9.1.7.2 and Section 9.5.3.4.b. Test coupons are representative of the final product.

1.10 Include the second paragraph of Section 9.5.3.3 in the proposed Technical Specifications.

Thermal damage and corrosion testing may be necessary when the open porosity is increased or if there is change in surface treatment to the neutron absorbing material, even if materials with the same chemical composition are used (1100 aluminum alloy and boron carbide).

The staff requested that Section 9.5.3.3 be incorporated into the proposed Technical Specifications in the Round 1 Request for Additional Information 9-1.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.10

TN understands that with the addition of the mandatory thermal damage test in response to RAI # 1.3 this question is resolved.

1.11 (Response to Round 1: RAI 9-1)
Specify the qualification tests in Section 9.5.3.4 in the proposed Technical Specifications.

These tests are necessary to ensure the mechanical durability of the neutron absorbers and to limit the amount of interconnected porosity.

The staff requested that this Section be incorporated into the proposed Technical Specifications in Request for Additional Information 9-1.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.11

As previously stated, TN takes no structural credit for neutron absorbers and these tests do not represent a limiting condition of operation. TN has incorporated the thermal damage test as part of new Section 9.5.3.3.1, which is incorporated by reference into the Technical Specifications. This provides reasonable assurance that vacuum drying conditions will not blister or delaminate the clad MMC.

1.12 Clarify the criterion requiring re-qualification testing.

a) Specify the changes to key processes in Section 9.5.4.3 in the Technical Specifications.

The list in Section 9.5.4.3 provides significant examples of key process changes which should require requalification testing. This Section was removed from the proposed Technical Specifications during the supplemental response to the Request for Additional Information.

b) Revise the wording in Section 9.5.4.3 so that the listed changes will be regarded as key process changes.

Current wording in Section 9.5.4.3 states that certain key process changes (e.g., a change in billet production) "*may* be established as key process changes." Significant changes to the production of the neutron absorbing material as listed in Section 9.5.4.3 should be considered a change to a key process, and require the mechanical testing and porosity measurements listed under Section 9.5.3.4.

After further review of the application, the Staff considers that the word, "may" could lead to an unintended interpretation of key process changes.

c) Add a reference to Section 9.5.3.3 and Section 9.5.3.4 in Section 9.5.4.1, and ensure that there is language in the proposed Technical Specifications requiring the mechanical tests and porosity measurements in Section 9.5.3.4 if any key process (Sections 9.5.4.1, 9.5.4.2, or 9.5.4.3) is changed.

Section 9.5.4.1 references Section 9.5.4 for re-qualification, however Section 9.5.4 does delineate the tests that would be part of a re-qualification program.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.12

Sections 9.5.4.1 and 9.5.4.2 are now incorporated into Technical Specifications, which require the development of key process controls for every product and the evaluation for requalification if changes to the key process controls are made.

Because key process controls will be established for each product, TN cannot possibly develop an enveloping list of key process changes in the UFSAR that apply to future products. Section 9.5.4.3 should no longer be included in the Technical Specifications because of the incorporation of Sections 9.5.4.1 and 9.5.4.2.

Section 9.5.4.1 is revised to refer to Section 9.5.3 instead of Section 9.5.4.

1.13 Incorporate Section 9.5.2(b) into the proposed Technical Specifications.

Section 9.5.2(b) provides language for how the minimum design thickness is determined, and that plates with areal densities below 90% of the minimum design thickness will be rejected.

This Section was removed from the proposed Technical Specifications in the supplemental response to the Round 1 Request for Additional Information.

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.13

The acceptance criteria of finding the lower tolerance limit at 95% probability and 95% confidence level is specified in Section 9.5.2.a and is absolute. TN does not believe it is prudent to specify the detailed statistical means that may be used to accomplish this criteria in the Technical Specifications. The volume density method is one acceptable method that is commonly selected for unclad MMCs. Adding the method to the Technical Specifications would potentially prevent more advanced and acceptable methods from being used in the future.

TN has added the following Technical Specifications requirement to Section 9.5.2.a:

> ***"Demonstration of the one-sided tolerance limit shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures."***

The 0.5% surface area and 90% design thickness limits are only intended for dispositioning very localized surface defects, not for plates that are too thin. Even though it is provided in the section for areal density acceptance testing, it is only used for localized surface defects that are identified during visual inspection, and non-conforming conditions should be subject to evaluation in accordance with SAR/TS Section 9.1.7.4. For example, if a supplier demonstrated that the B10 areal density at the thin areas satisfied the material specification, exceeding the 0.5% / 90% limits could be justified.

1.14 Clarify the method used to establish the nonparametric lower tolerance limit to determine the lower tolerance limit for areal density of the neutron absorber.

The methodology used to determine the areal density of boron-10 is important to ensuring the efficacy of the neutron absorbing plates.

The staff considers ASTM C1671-07, "Standard Practice for Qualification and Acceptance of Boron Based Metallic Neutron Absorbers for Nuclear Criticality Control for Dry Cask Storage Systems and Transportation Packaging" as directly applicable to the acceptance testing of neutron absorbers, which states in Note 2 under Section 5.2.6.2(3) that "If the data set is not normally distributed, then a nonparametric lower tolerance limit may be used. In this case, the method must be documented."

This information is needed to determine compliance with 10 CFR 72.124(b).

Response to 1.14

The method is intentionally not specified because various acceptable methods exist for determining the one-sided tolerance limit of a distribution free sample. The most common method, Natrella Section 2-5.4.2, is applicable to a sample size of 60 or more; TN has not yet developed a method for smaller populations. Ensuring the acceptability of the method is a quality assurance activity and should not be incorporated into the Technical Specifications. TN believes this question is resolved with the proposed changes in response to RAI # 1.13.

1.15 (Editorial; Response to Round 1: RAI 1.4)
Clarify the definition of "Reconstituted Fuel Assembly" in the proposed Technical Specifications.

The definition provided by the applicant implies that rods (of unknown composition), containing other rods of specific material will be used to replace missing fuel rods in the fuel assembly. The staff believes this is a typographical error, and that the applicant meant that hollow rods of stainless steel or of a zirconium alloy containing rods of: stainless steel, low enriched uranium, natural uranium or zirconium based alloy will be used to replace the missing fuel rods.

Response to 1.15

The definition of "Reconstituted Fuel Assembly" in the proposed Technical Specifications has been clarified to address this item.

List of Changed Pages for CoC 1030 Amendment 1 Application Revision 3

Note: In both the TS and the UFSAR, Amendment 1 Revision 0 changes, Amendment 1 Revision 1 changes, Amendment 1 Revision 2 changes, and Amendment 1 Revision 3 changes are shown using italics for inserted text and revision bars for changed areas; however, Revision 3 changes are shaded to distinguish these new changes from Revision 0, Revision 1, and Revision 2 changes.

Page	Associated RAI(s)
Tech Specs Page 1-2	RAI 1.15
Tech Specs Page 4-2	RAIs 1.3 and 1.8
Tech Specs Page 5-11	RAI 1.1
SAR Drawing 10494-72-1	RAI 1.4
SAR Page 9-3	RAI 1.8
SAR Page 9-4	RAIs 1.2 and 1.9
SAR Page 9-5	RAI 1.8
SAR Page 9-6	Information shifted; no actual changes
SAR Page 9-7	Information shifted; no actual changes
SAR Page 9-8	RAI 1.6
SAR Page 9-9	RAIs 1.5, 1.6, 1.7 and 1.13
SAR Page 9-10	RAIs 1.3 and 1.11
SAR Page 9-11	RAI 1.9
SAR Page 9-12	RAI 1.12

<u>Enclosure 3 to TN E-28000</u>

NUHOMS® HD Amendment 1 Application Revision 3, Changed Proposed Technical Specifications and Proposed Updated Final Safety Analysis Report Pages

1.1 Definitions (continued)

RECONSTITUTED FUEL ASSEMBLY	*A RECONSTITUTED FUEL ASSEMBLY is an INTACT FUEL ASSEMBLY where one or more fueled rods are replaced by hollow rods of stainless steel or zirconium alloy containing low enriched uranium or natural uranium or Zirconium alloy pellets. In addition, the replacement rods can be solid stainless steel or zirconium alloy rods. The nominal volume of the replacement rods is equivalent to the replaced fueled rods in the active fuel region of the fuel assembly.*
STORAGE OPERATIONS	STORAGE OPERATIONS include all licensed activities that are performed at the ISFSI while a 32PTH DSC containing INTACT or DAMAGED FUEL ASSEMBLIES is located in an HSM-H on the storage pad within the ISFSI perimeter.
TRANSFER CASK (TC)	The TRANSFER CASK consists of a licensed NUHOMS® OS187H onsite transfer cask. The TRANSFER CASK will be placed on a transfer trailer for movement of a 32PTH DSC to the HSM-H.
TRANSFER OPERATIONS	TRANSFER OPERATIONS include all licensed activities involving the movement of a TRANSFER CASK loaded with a 32PTH DSC containing INTACT or DAMAGED FUEL ASSEMBLIES. TRANSFER OPERATIONS begin when the TRANSFER CASK is placed *horizontal* on the transfer trailer *ready for TRANSFER* OPERATIONS and end when the 32PTH DSC is located in an HSM-H on the storage pad within the ISFSI perimeter.
UNLOADING OPERATIONS	UNLOADING OPERATIONS include all licensed activities on a 32PTH DSC to unload INTACT or DAMAGED FUEL ASSEMBLIES. UNLOADING OPERATIONS begin when the 32PTH DSC is removed from the HSM-H and end when the last INTACT or DAMAGED FUEL ASSEMBLY has been removed from the 32PTH DSC.

4.0 Design Features (continued)

4.3 Canister Criticality Control

The NUHOMS®-32PTH is designed for unirradiated fuel with an assembly average initial enrichment of less than or equal to 5.0 wt. % U-235 taking credit for soluble boron in the DSC cavity water during loading operations and the boron content in the poison plates of the DSC basket. The 32PTH DSC has multiple basket configurations, based on the material type and boron content in the poison plates, as listed in Table 6. Table 7 defines the requirements for boron concentration in the DSC cavity water as a function of the DSC basket type for the various intact and damaged fuel classes (most reactive) authorized for storage in the 32PTH DSC.

A Type I basket contains poison plates that are either borated aluminum or MMC while a Type II basket contains Boral® poison plates. The basket types are further defined by the B-10 areal density in the plates, ranging from the lowest, Type A to the highest, Type E.

4.3.1 Neutron Absorber Tests

Borated Aluminum, MMCs, or Boral® shall be supplied in accordance with FSAR Sections 9.1.7.1, 9.1.7.2, 9.1.7.3, *9.1.7.4*, 9.5.2.*a*, *9.5.3.3.1*, 9.5.3.5, *9.5.4.1* and *9.5.4.2*, with the minimum B10 areal density specified in Table 6. These sections of the FSAR are hereby incorporated into the NUHOMS® HD CoC.

4.4 Codes and Standards

4.4.1 <u>Horizontal Storage Module (HSM-H)</u>

The reinforced concrete HSM-H is designed to meet the requirements of ACI 349-97. Load combinations specified in ANSI 57.9-1984, Section 6.17.3.1 are used for combining normal operating, off-normal, and accident loads for the HSM-H.

If an independent spent fuel storage installation site is located in a coastal salt water marine atmosphere, then any load-bearing carbon steel DSC support structure rail components of any associated HSM-H shall be procured with a minimum 0.20 percent copper content for corrosion resistance.

4.4.2 Dry Shielded Canister (32PTH DSC)

The 32PTH DSC is designed, fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Division 1, 1998 Edition with Addenda through 2000, Subsections NB, NF, and NG for Class 1 components and supports. Code alternatives are discussed in 4.4.4.

4.4.3 Transfer Cask (OS187H)

The OS187H Transfer Cask is designed, fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, 1998 Edition with Addenda through 2000, Subsection NC for Class 2 vessels.

5.6 Hydrogen Gas Monitoring

For DSCs, while welding the inner top cover/shield plug during loading operations, and while cutting the outer or inner top cover/shield plug during unloading operations, hydrogen monitoring of the space under the inner top cover/shield plug in the DSC cavity is required, to ensure that the combustible mixture concentration remains below the flammability limit of 4%. If this limit is exceeded, all welding operations shall be stopped and the DSC cavity purged with helium to reduce hydrogen concentration safely below the limit before welding or cutting operations can be resumed.

9.1.7 Neutron Absorber Tests

CAUTION

Sections 9.1.7.1 through 9.1.7.4 below are incorporated by reference into the NUHOMS® CoC 1030 Technical Specifications (paragraph 4.3.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of these sections is shown in bold type to distinguish them from other sections.

The neutron absorber used for criticality control in the DSC basket may consist any of the following types of material:

(a) Boron-aluminum alloy (borated aluminum)

(b) Boron carbide / *A*luminum metal matrix composite *(MMC)*

(c) Boral®

The 32PTH DSC safety analyses do not rely upon the tensile strength of these materials. The radiation and temperature environment in the cask is not sufficiently severe to damage these metallic/ceramic materials. To assure performance of the neutron absorber's design function only the presence of B10 and the uniformity of its distribution need to be verified, with testing requirements specific to each material. The boron content of these materials is given in Table 9-1.

References to metal matrix composites throughout this chapter are not intended to refer to Boral®.

9.1.7.1 Boron Aluminum Alloy (Borated Aluminum)

See the Caution in Section 9.1.7 before deletion or modification to this section.

The material is produced by direct chill (DC) or permanent mold casting with boron precipitating as a uniform fine dispersion of discrete AlB_2 or TiB_2 particles in the matrix of aluminum or aluminum alloy. For extruded products, the TiB_2 form of the alloy shall be used. For rolled products, either the AlB_2, the TiB_2, or a hybrid may be used.

Boron is added to the aluminum in the quantity necessary to provide the specified minimum B10 areal density in the final product, with sufficient margin to minimize rejection, typically 10 % excess. The amount required to achieve the specified minimum B10 areal density will depend on whether boron with the natural isotopic distribution of the isotopes B10 and B11, or boron enriched in B10 is used. In no case shall the boron content in the aluminum or aluminum alloy exceed 5% by weight.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of borated aluminum. The basis for this credit is the B10 areal density acceptance testing, which shall be as specified in Section 9.5.2. The specified acceptance testing assures that at any location in the material, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

9.1.7.2 Boron Carbide / Aluminum Metal Matrix Composites (MMC)

See the Caution in Section 9.1.7 before deletion or modification to this section.

The material is a composite of fine boron carbide particles in an aluminum or aluminum alloy matrix. The material shall be produced by either direct chill casting, permanent mold casting, powder metallurgy, or thermal spray techniques. It is a low-porosity product, with a metallurgically bonded matrix. The boron carbide content shall not exceed 40% by volume. ***The boron carbide content for MMCs with an integral aluminum cladding shall not exceed 50% by volume.***

The final MMC product shall have density greater than 98% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity. For MMC with an integral cladding, the final density of the core shall be greater than 97% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity of the core and cladding as a unit of the final product.

Boron carbide particles for the products considered here typically have an average size in the range 10-40 microns, although the actual specification may be by mesh size, rather than by average particle size. No more than 10% of the particles shall be over 60 microns.

Prior to use in the 32PTH DSC, MMCs shall pass the qualification testing specified in Section 9.5.3, and shall subsequently be subject to the process controls specified in Section 9.5.4.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of MMCs. The basis for this credit is the B10 areal density acceptance testing, which is specified in Section 9.5.2. The specified acceptance testing assures that at any location in the final product, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

9.1.7.3 Boral®

See the Caution in Section 9.1.7 before deletion or modification to this section.

This material consists of a core of aluminum and boron carbide powders between two outer layers of aluminum, mechanically bonded by hot-rolling an "ingot" consisting of an aluminum box filled with blended boron carbide and aluminum powders. The core, which is exposed at the edges of the sheet, is slightly porous. The average size of the boron carbide particles in the finished product is approximately 50 microns after rolling. The nominal boron carbide content shall be limited to 65% (+ 2% tolerance limit) of the core by weight.

The criticality calculations take credit for 75% of the minimum specified B10 areal density of Boral®. B10 areal density will be verified by chemical analysis and by certification of the B10 isotopic fraction for the boron carbide powder, or by neutron transmission testing. Areal density testing is performed on a coupon taken ***from*** **the sheet produced from each ingot. If the measured areal density is below that specified, all the material produced from that ingot will be either rejected, or accepted only on the basis of alternate verification of B10 areal density for each of the final pieces produced from that ingot.**

9.1.7.4 Visual Inspections of Neutron Absorbers

Neutron absorbers shall be 100% visually inspected. Non-conforming material shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

9.1.7.5 Visual Inspections Acceptance Criteria

For borated aluminum and MMCs, visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4 "Quality Control, Visual Inspection of Aluminum Mill Products and Castings"[5]. Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable. Widespread blisters, rough surface, or cracking shall be treated as non-conforming. Inspection of MMCs with an integral aluminum cladding shall also include verification that the matrix is not exposed through the faces of the aluminum cladding and that solid aluminum is not present at the edges.

For Boral, visual inspection shall verify that there are no cracks through the cladding, exposed core on the face of the sheet, or solid aluminum at the edge of the sheet.

9.2 Maintenance Program

The NUHOMS® HD System is designed to be totally passive with minimal maintenance requirements. The 32PTH DSC does not require any maintenance once it is loaded into the HSM-H. The HSM-H does not require any maintenance other than that indicated in off-normal operations, Chapter 11, such as clearing of blocked air inlets. Periodic inspection is therefore limited to the Transfer Cask.

9.2.1 Inspection

The following inspections of the transfer cask should be performed prior to each fuel loading or unloading campaign:

A. Visual inspection of the transfer cask trunnions for damaged bearing surfaces

B. Visual or functional inspection of all taps, threaded inserts, and bolts

C. Functional inspection of all quick-connect fittings

D. Visual inspection of the interior surface of the cask for any indications of excessive wear.

E. Visual inspection of the neutron shield jacket for indications of damage

F. Visual inspection of all Transfer Cask o-rings for indications of damage

Within the year prior to any loading or unloading campaign, the top trunnion bearing surfaces and accessible welds shall be examined by dye penetrant. No linear indications shall be acceptable other than surface scratches and wear.

9.2.2 Tests

The Transfer Cask lid and ram access cover o-rings, vent and drain quick connect fittings, and neutron shield fittings shall be leak tested within the year before the start of any fuel loading or unloading campaign. If bubble leak testing is used, no leak indication is allowed. If pressure drop or helium leak testing is used, the maximum allowable leak for each of the components listed is 10^{-3} ref cm^3/s. If any of the listed components is replaced, that component shall be leak tested before use in fuel loading or unloading operations.

No periodic testing of the 32PTH DSC, HSM-H or routine support equipment is required.

Temperature and radiation monitoring is provided in accordance with the Technical Specifications. Periodic calibration of the monitoring equipment shall be as required by the licensee's quality program.

9.2.3 Repair, Replacement, and Maintenance

Any parts which fail inspections listed in 9.1.2 shall be repaired or replaced. Such parts may also be accepted as-is if determined appropriate by engineering and licensing review.

9.3 Marking

The HSM-H and 32PTH DSC are marked with the model number, unique identification number, and empty weight in accordance with 10 CFR 72.236(k). The 32PTH DSC nameplate is shown in drawing 10494-72-7.

9.4 Pre-Operational Testing and Training Exercise

A dry run training exercise of the loading, closure, handling, unloading, and transfer of the NUHOMS® HD System shall be performed by each licensee prior to their first use of the system to load spent fuel assemblies. The dry run shall be conducted with simulated fuel to match the weight of the actual fuel. The dry run need not be performed in the sequence of operations in Chapter 8. The dry run shall include:

(a) Loading of mock-up fuel
(b) DSC draining, vacuum drying, welding, and backfilling
(c) Loading of the Transfer Cask onto the Transfer Trailer, and transfer to the ISFSI
(d) DSC transfer to the HSM-H
(e) DSC retrieval from the HSM-H
(f) Re-flooding of a sealed 32PTH DSC
(g) Removal of the covers from a sealed 32PTH DSC

The dry run will simulate, as nearly as possible, the detailed written procedures developed by the licensee for NUHOMS® HD System operations. Guidelines for the dry run follow.

A. An actual or a mock-up 32PTH DSC loaded with mock-up fuel is typically utilized. The 32PTH DSC is loaded into the transfer cask; the transfer cask/DSC annulus seal is installed.

B. Functional testing is performed with the transfer cask and lifting equipment. These tests are to ensure that the transfer cask can be safely lifted from the plant's cask receiving area to the cask washdown area. The cask is partially lowered into the spent fuel pool and positioned in the cask loading area to verify clearances and travel path. The inner top cover is installed to verify handling and alignment operations.

C. The transfer cask is placed on the transfer trailer, which is moved to the ISFSI aligned with an HSM-H. Compatibility of the transfer trailer with the transfer cask, verification of the transfer route to the ISFSI, and maneuverability within the confines of the ISFSI are verified.

D. The transfer trailer is aligned and docked with the HSM-H. The hydraulic ram is used to insert the 32PTH DSC loaded with mock-up fuel assemblies into the HSM-H and then to retrieve it. Transfer of the 32PTH DSC to the HSM-H will verify that the support skid positioning system and the hydraulic ram system operate safely for both insertion and retrieval.

E. A weld mockup, typically a shortened 32PTH DSC mockup modeling the top end, covers, and drain tube, is used to demonstrate closure welding, draining, drying, backfill, re-flooding, and canister opening operations.

F. The dry run is deemed successful if the expected results are achieved safely and without damage to any of the components or associated equipment.

G. Should any equipment or components require modification in order to achieve the expected results, it will be retested, as necessary, to confirm that the modification is adequate. Should the dry run indicate that procedures require change in order to achieve the expected results, the changes will be incorporated into the appropriate operating procedures prior to use for fuel transfer.

9.5 Specification for Neutron Absorbers

9.5.1 Specification for Thermal Conductivity Testing of Neutron Absorbers

Testing shall conform to ASTM E1225[1], ASTM E1461[2], or equivalent method, performed at room temperature on coupons taken from the rolled or extruded production material. Previous testing of borated aluminum and metal matrix composite, Table 9-2, shows that thermal conductivity increases slightly with temperature. Initial sampling shall be one test per lot, defined by the heat or ingot, and may be reduced if the first five tests meet the specified minimum thermal conductivity.

If a thermal conductivity test result is below the specified minimum, additional tests may be performed on the material from that lot. If the mean value of those tests falls below the specified minimum, the associated lot shall be rejected.

After twenty five tests of a single type of material, with the same aluminum alloy matrix, the same boron content, and the boron appearing in the same phase, e.g., B_4C, TiB_2, or AlB_2, if the mean value of all the test results less two standard deviations meets the specified thermal conductivity, no further testing of that material is required. This exemption may also be applied to the same type of material if the matrix of the material changes to a more thermally conductive

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1 ASTM E1225, "Thermal Conductivity of Solids by Means of the Guarded-Comparative-Longitudinal Heat Flow Technique"

2 ASTM E1461, "Thermal Diffusivity of Solids by the Flash Method"

alloy (e.g., from 6000 to 1000 series aluminum), or if the boron content is reduced without changing the boron phase.

The thermal analysis in Chapter 4 assumes a 3/16 inch thick neutron absorber paired with a 5/16 inch aluminum 1100 plate. The specified thickness of the neutron absorber may vary, and the thermal conductivity acceptance criterion for the neutron absorber will be based on the nominal thickness specified. The minimum thermal conductivity shall be such that the total thermal conductance (sum of conductivity * thickness) of the neutron absorber and the aluminum 1100 plate shall equal the conductance assumed in the analysis, as shown in Table 9-3, where the acceptance criterion is highlighted.

The aluminum 1100 plate does not need to be tested for thermal conductivity; the material may be credited with the values published in the ASME Code Section II part D. The neutron absorber material need not be tested for thermal conductivity if the nominal thickness of the aluminum 1100 plate is 0.425 inch or greater. This case is examined explicitly in chapter 4, where no credit is taken for the thermal conductivity of Boral®.

9.5.2 Specification for Acceptance Testing of Neutron Absorbers by Neutron Transmission

CAUTION
Sections 9.5.2.a and 9.5.3.3.1 are incorporated by reference into the NUHOMS® CoC 1030 Technical Specifications (paragraph 4.3.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of these sections is shown in bold type to distinguish them from other sections.

a. **Neutron Transmission acceptance testing procedures shall be subject to approval by the Certificate Holder. Test coupons shall be removed from the rolled or extruded production material at locations that are systematically or probabilistically distributed throughout the lot. Test coupons shall not exhibit physical defects that would not be acceptable in the finished product, or that would preclude an accurate measurement of the coupon's physical thickness.**

A lot is defined as all the pieces produced from a single ingot or heat *or from a group of billets from the same heat.* If this definition results in lot size too small to provide a meaningful statistical analysis of results, an alternate larger lot definition may be used, so long as it results in accumulating material that is uniform for sampling purposes.

The sampling rate for neutron transmission measurements shall be such that there is at least one neutron transmission measurement for each 2000 square inches of final product in each lot.

The B10 areal density is measured using a collimated thermal neutron beam of *no more than 1 inch* diameter.

The neutron transmission through the test coupons is converted to B10 areal density by comparison with transmission through calibrated standards. These standards are composed of a homogeneous boron compound without other significant neutron

absorbers. For example, boron carbide, zirconium diboride or titanium diboride sheets are acceptable standards. These standards are paired with aluminum shims sized to match the effect of neutron scattering by aluminum in the test coupons. Uniform but non-homogeneous materials such as metal matrix composites may be used for standards, provided that testing shows them to provide neutron attenuation equivalent to a homogeneous standard. *The calibration of the standards shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.*

Alternatively, digital image analysis may be used to compare neutron radioscopic images of the test coupon to images of the standards. The area of image analysis shall be ***no more than 0.75 sq. inch.***

The minimum areal density specified shall be verified for each lot at the 95% probability, 95% confidence level or better. ***If a goodness-of-fit test demonstrates that the sample comes from a normal population, the one-sided tolerance limit for a normal distribution may be used for this purpose. Otherwise, a non-parametric (distribution-free) method of determining the one-sided tolerance limit may be used.*** *Demonstration of the one-sided tolerance limit shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.*

b. The following illustrates one acceptable method *and is intended to be utilized as an example. Therefore, the following text is not part of the Technical Specifications.* The acceptance criterion for individual plates is determined from a statistical analysis of the test results for their lot. The B10 areal densities determined by neutron transmission are converted to volume density, i.e., the B10 areal density is divided by the thickness at the location of the neutron transmission measurement or the maximum thickness of the coupon. The lower tolerance limit of B10 volume density is then determined, defined as the mean value of B10 volume density for the sample, less K times the standard deviation, where K is the one-sided tolerance limit factor with 95% probability and 95% confidence [7].

Finally, the minimum specified value of B10 areal density is divided by the lower tolerance limit of B10 volume density to arrive at the minimum plate thickness which provides the specified B10 areal density.

Any plate which is thinner than this minimum or the minimum design thickness, whichever is greater, shall be treated as non-conforming, with the following exception. Local depressions are acceptable, so long as they total no more than 0.5% of the area on any given plate, and the thickness at their location is not less than 90% of the minimum design thickness.

Non-conforming material shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

9.5.3 Specification for Qualification Testing of Metal Matrix Composites

9.5.3.1 Applicability and Scope

Metal matrix composites (MMCs) *acceptable for use in the 32PTH DSC are described in Section 9.1.7.2.*

Prior to initial use in a spent fuel dry storage or transport system, such MMCs shall be subjected to qualification testing that will verify that the product satisfies the design function. Key process controls shall be identified per Section 9.5.4 so that the production material is equivalent to or better than the qualification test material. Changes to key processes shall be subject to qualification before use of such material in a spent fuel dry storage or transport system.

ASTM test methods and practices are referenced below for guidance. Alternative methods may be used with the approval of the certificate holder.

9.5.3.2 Design Requirements

In order to perform its design functions the product must have at a minimum sufficient strength and ductility for manufacturing and for the normal and accident conditions of the storage/ transport system. This is demonstrated by the tests in Section 9.5.3.4. It must have a uniform distribution of boron carbide. This is demonstrated by the tests in Section 9.5.3.5.

9.5.3.3 Durability

There is no need to include accelerated radiation damage testing in the qualification. Such testing has already been performed on MMCs, and the results confirm what would be expected of materials that fall within the limits of applicability cited above. Metals and ceramics do not experience measurable changes in mechanical properties due to fast neutron fluences typical over the lifetime of spent fuel storage, about 10^{15} neutrons/cm^2.

Thermal damage and corrosion (hydrogen generation) testing shall be performed unless such tests on materials of the same chemical composition have already been performed and found acceptable. The following paragraphs illustrate two cases where such testing is not required.

Thermal damage testing is not required for *unclad* MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842°F, well above the basket temperature under normal conditions of storage or transport[3].

Corrosion testing is not required for MMCs *(clad or unclad)* consisting only of boron carbide in an aluminum 1100 matrix, because testing on one such material has already been performed by Transnuclear[4].

9.5.3.3.1 Delamination Testing of Clad MMC

Clad MMCs shall be subjected to thermal damage testing following water immersion to ensure that delamination does not occur under normal conditions of storage.

9.5.3.4 Required Qualification Tests and Examinations to Demonstrate Mechanical Integrity

At least three samples, one each from the two ends and middle of the *qualification* material run shall be subject to:

a) room temperature tensile testing (ASTM- B557[5]) demonstrating that the material has the following tensile properties:

[3] Sung, C., "Microstructural Observation of Thermally Aged and Irradiated Aluminum/Boron Carbide (B4C) Metal Matrix Composite by Transmission and Scanning Electron Microscope," 1998

[4] Boralyn testing submitted to the NRC under docket 71-1027, 1998

[5] ASTM B557 Standard Test Methods of Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products.

- Minimum yield strength, 0.2% offset: 1.5 ksi
- Minimum ultimate strength: 5 ksi
- Minimum elongation in 2 inches: 0.5%

As an alternative to the elongation requirement, ductility may be demonstrated by bend testing per ASTM E290[10]. The radius of the pin or mandrel shall be no greater than three times the material thickness, and the material shall be bent at least 90 degrees without complete fracture.

b) *Testing* (ASTM-B311[6]) to verify more than 98% of theoretical density *for non-clad MMCs and 97% for the matrix of clad MMCs*. Testing or examination for interconnected porosity *on the faces and edges of unclad MMC, and on the edges of clad MMC* shall be performed by a means to be approved by the Certificate Holder. *The maximum interconnected porosity is 0.5 volume %,*

and

c) *For MMCs with an integral aluminum cladding, thermal durability testing demonstrating that after a 24 hour soak in either pure or borated water, followed by a 30 day heat treatment at a minimum temperature of 825°F in an inert environment, that the specimens are free of blisters and delamination and pass the mechanical testing requirements described in test 'a' of this section.*

9.5.3.5 Required Tests and Examinations to Demonstrate B10 Uniformity

CAUTION
Section 9.5.3.5 is incorporated by reference into the NUHOMS® CoC 1030 Technical Specifications (paragraph 4.3.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of this section is shown in bold type to distinguish it from other sections.

Uniformity of the boron distribution shall be verified either by:

(a) Neutron radioscopy or radiography (ASTM E94[7], E142[8], and E545[9]) of material from the ends and middle of the test material production run, verifying no more than 10% difference between the minimum and maximum B10 areal density, or

(b) Quantitative testing for the B10 areal density, B10 density, or the boron carbide weight fraction, on locations distributed over the test material production run, verifying that one standard deviation in the sample is less than 10% of the sample mean. Testing may be performed by a neutron transmission method similar to that specified in Section 9.5.2, or by chemical analysis for boron carbide content in the composite.

9.5.3.6 Approval of Procedures

Qualification procedures shall be subject to approval by the Certificate Holder.

[6] ASTM B311, Test Method for Density Determination for Powder Metallurgy (P/M) Materials Containing Less Than Two Percent Porosity
[7] ASTM E94, Recommended Practice for Radiographic Testing
[8] ASTM E142, Controlling Quality of Radiographic Testing
[9] ASTM E545, Standard Method for Determining Image Quality in Thermal Neutron Radiographic Testing
[10] *ASTM E290, Standard Methods for Bend Testing of Materials for Ductility*

9.5.4 Specification for Process Controls for Metal Matrix Composites

This section provides process controls to ensure that the material delivered for use is equivalent to the qualification test material.

CAUTION
Sections 9.5.4.1 and 9.5.4.2 are incorporated by reference into the NUHOMS® CoC 1030 Technical Specifications (paragraph 4.3.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of these sections is shown in bold type to distinguish them from other sections.

9.5.4.1 Applicability and Scope

Key processing changes shall be subject to qualification prior to use of the material produced by the revised process. The Certificate Holder shall determine whether a complete or partial re-qualification program per Section 9.5.3 is required, depending on the characteristics of the material that could be affected by the process change.

9.5.4.2 Definition of Key Process Changes

Key process changes are those which could adversely affect the uniform distribution of the boron carbide in the aluminum, reduce density, or reduce the mechanical strength or ductility of the MMC.

9.5.4.3 Identification and Control of Key Process Changes

The manufacturer shall provide the Certificate Holder with a description of materials and process controls used in producing the MMC. The Certificate Holder and manufacturer shall identify key process changes as defined in Section 9.5.4.2.

An increase in nominal boron carbide content over that previously qualified shall always be regarded as a key process change. The following are examples of other changes that may be established as key process changes, as determined by the Certificate Holder's review of the specific applications and production processes:

(a) Changes in the boron carbide particle size specification that increase the average particle size by more than 5 microns or that increase the amount of particles larger than 60 microns from the previously qualified material by more than 5% of the total distribution but less than the 10% limit,

(b) Change of the billet production process, e.g., from vacuum hot pressing to cold isostatic pressing followed by vacuum sintering,

(c) Change in the nominal matrix alloy,

Enclosure 4 to TN E-28000

UFSAR Drawing 10494-72-1 (public version)

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SECURITY RELATED INFORMATION WITHHELD UNDER 10 CFR 2.390

REVISION	DESCRIPTION	DATE
3B	C.O.C. 1030 AMENDMENT 1 APPLICATION, REV 3	4/30/09
3A	C.O.C. 1030 AMENDMENT 1 APPLICATION	12/11/08
2	REVISED PER FCN 721030-058, 081; UPDATED TITLE BLOCK	09/27/07
1	SEE DCN 10494-39	02/09/05

	NAME / INITIALS	DATE
P.E.	PETER SHIH PS	4/30/09
NUCLEAR	PRAKASH NARAYANAN PAN	04/30/2009
MECHANICAL THERMAL	PRAKASH NARAYANAN PAN	04/30/2009
STRUCTURAL	PETER SHIH PS	4/30/09
CHECKED	O. GANDOU/ OG	04/30/09
DRAWN	Joanna/ian/JT	04/30/09

UNLESS OTHERWISE SPECIFIED

ALL DIMENSIONS ARE IN INCHES & DEGREES.

TOLERANCES

ALL DIMENSIONS ARE NOMINAL UNLESS A SPECIFIC TOLERANCE IS INDICATED WITH THE DRAWING DIMENSION

TRANSNUCLEAR
AN AREVA COMPANY

SAFETY ANALYSIS REPORT
NUHOMS® 32PTH
TRANSPORTABLE CANISTER FOR PWR FUEL
PARTS LIST

DRAWING NO.	SCALE	SHEET	REVISION
10494-72-1	NONE	1 OF 1	3B