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4 October 2016

Mr. Bernard White, Senior Project Manager
U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Division of Spent Fuel Management
11555 Rockville Pike
One White Flint
Rockville, MD 20852

Docket: 71-9187
TAC No.: L25122

Dear Mr. White:

The following is submitted in response to your letter for additional information dated 9/6/16. In response to your RAI questions we provide the following additional information:

2.0 Structural Evaluation

1. *For those components requested to be made of "300 series" or "400 series" stainless steels, specify the standard organization (i.e., ASTM or ASME materials) and publication date to which these materials will be fabricated, and show that there will not be any significant galvanic or chemical reactions that may occur as a result of contact between dissimilar materials.*

   It is assumed that a "300 series" or "400 series" refers to the ASME standard, however the drawings do not indicate the standard. It is unclear how these materials will interact metallurgically (galvanic or chemical reactions) with other components made of dissimilar materials that they may come into contact with. Additionally, it is not clear how future materials added to the 300 or 400 series standard will behave in this fashion.

   This information is needed to determine compliance with Title 10 of the Code of Federal Regulations (10 CFR) 71.33(a)(5) and 71.43(d).

   Response:

   Although reference to "400 series" stainless steel does not specifically appear for any component on drawing R86000 Revision S, it is assumed that the use of "stainless steel" as material for components on this drawing may imply your concerns regarding the use of 300 or 400 series stainless steel for these components. Based on this our response will address references to "300 series" or "stainless steel" components on drawing R86000 Revision S.

NMSS01

The components identified on drawing R86000 Revision S as "stainless steel" are package components which have been determined as not important to safety (NITS) from a transport package integrity standpoint. Many of these items are springs, pins, or hardware that either serve no purpose when the package is prepared for transport (e.g., they are only important during operational use of the package as a radiography device), or whose failure in transport would have no adverse impact on the package integrity and compliance to the transport regulations

Components on drawing R86000 Revision S identified as "300 series" stainless steel, have been evaluated as having only a minor impact on safety during transport. Failure of these components, which include predominantly non-critical hardware, will not significantly reduce the package effectiveness or integrity during transport as additional component failures on the transport package would need to occur before a situation could potentially be created that could adversely affect public health and safety. Due to the low safety impact of the "300 series" and "stainless steel" components, compliance of these components to a material standard is not considered necessary to ensure the package integrity and compliance during transport.

Regarding the question of potential galvanic/chemical reactions between components of dissimilar materials, the MIL-STD-889 galvanic table for materials in seawater indicates that all stainless steel (e.g., 300 series, 400 series, 200 series, PH series) are closely grouped towards the cathodic end of the chart. Other materials of construction in contact with the stainless steel, like titanium (more cathodic) and brass (more anodic), are just below and just above stainless steel, respectively. The close proximity of these materials to the stainless steel indicates there will be a low galvanic interaction between them when in contact. The uranium shield is up towards the anodic end of the chart, but the large anode area of the shield, lowers the galvanic current density resulting in less attack on the shield.

Regarding the concern for any future materials added to the 300 or 400 series stainless steels, it is assumed that any material additions identified under a material standard will include materials that perform similarly in regards to galvanic/chemical interactions in order to be considered part of the "series" designation. This, in addition to the low safety significance of the components identified as 300 series or only stainless steel on drawing R86000 Revision S, any additions to these material classes will be expected to perform similarly to the materials currently included in these classifications. Any failure of one of these components will have no significant impact on the package integrity and therefore control to a specific material standard is not necessary to ensure package integrity or conformance.

Based on the assessment above, components identified as 300 series stainless steel or just as stainless steel will not significantly diminish the structural integrity of other package materials of construction in contact with them. Further, use of 300 series stainless steel or stainless steel for these components will not prevent the package from meeting the lifting/tie-down design requirements or the normal conditions of transport and hypothetical accident conditions of 10 CFR Part 71.

2. *Provide the minimum yield strength, ultimate strength, and rupture strain for the following materials to be used for the washers, lock washers, rib nut, rib bolt, lock pin, shaft roll pin, shaft spring, retainer disc, knob, plunger lock screw, lock cover set screw, plunger lock screw, lock extension and lock cover roll pin and cotter pin. Show that, for these components, the proposed material properties meet or exceed the material properties for the materials used in free drop for normal conditions of transport and hypothetical accident conditions and for lifting and tie-down.*

Both "300 series" and "400 series" materials have a wide range of mechanical properties. These components will undergo loading during lifting, hypothetical accident conditions (free drop and puncture), and normal conditions of transport (vibration/fatigue and free drop). It is unclear how materials with potentially lesser mechanical properties in the "300" or "400" series will behave during lifting/tie down operations, hypothetical accident conditions, and normal conditions of transport.

This information is needed to determine compliance with 10 CFR 71.45, 10 CFR 71.71, and 10 CFR 71.73.

Response:

The range of product forms, hardness conditions, and minimum mechanical properties as well as the ASTM specifications for wrought type "300 series" material are shown on Table 10 on page 26 through 28 in Reference #1 from Table 2.2a of SAR Revision 4 (page 2-2).

The range of product forms, hardness conditions, and minimum mechanical properties as well as the ASTM specifications for wrought type "400 series" material are shown on Table 3 on page 16 through 17 in Reference #1 from Table 2.2a of SAR Revision 4 (page 2-2).

Each item is evaluated in order in which they appear on drawing R86000 Revision S. The basis of the evaluation focuses on the items function and its importance to safety during transport.

The **cotter pin** of sheet 3 is important to safety for this transport package because it helps to retain the shield pin in the shield mount of the welded port assembly. It is not usually subjected to any significant loads during transport since the shield pin is also supported by the polyurethane foam surrounding the shield. In a worst case load condition, where assembly friction and the foam are both absent and the package is dropped from 9-meters (30-feet) in the HAC free drop test, the cotter pin is loaded in direct double shear by the momentum of the shield pin upon impact when the package lands onto the flat surface of the package end plate.

If we conservatively estimate the load on the cotter pin at 54 pounds (200 g-load times the 0.27-pound shield pin weight), then the maximum direct shear stress on the 0.06-inch diameter cotter pin assuming double shear is 9,550 psi.

In the range of type 300-series stainless steels, type 304L and 316L in the annealed condition both have the lowest minimum tensile stress at 65,000 psi. If we assume the allowable direct shear stress to be 82% of the minimum tensile strength or 53,000 psi, then the minimum factor of safety is over 5 for using a cotter pin made from any type 300-series material in the worst case loading condition.

Cotter pins made from any type 300-series stainless steel material in any condition will not adversely diminish the radiological safety or prevent continued compliance of the package to 10 CFR Part 71.

The **washers** of sheet 4 are not important to safety for this transport package. These only provide a bearing surface for the screws attaching the optional plastic rib inserts to the rib assemblies. The plastic inserts act as a protective cover for the hex bolts and give the package color for identification and aesthetics. Washers made from any type 300-series or 17-4 stainless steel material in any condition will not adversely diminish the radiological safety or prevent continued compliance of the package to 10 CFR Part 71.

The **lock washers, rib bolts, & rib nuts** of sheet 4 are of minor importance to safety for this transport package. The primary function of these items is to attach the radiography projector to a hand cart for use in radiography applications.

Although these items do contribute to the lifting and tie-down strength of the package, they do so in a redundant manner. The lifting and tie-down analysis of Technical Reports 171 & 172 (reference SAR Revision 4 Sections 2.12.9 and 2.12.10) respectively show the load pins and other items are sufficient without the need for the rib nuts, bolts, and lock washer for the lifting and tie-down requirements of 10 CFR Part 71. These items made from any type 300-series or 17-4 stainless steel material in any condition will not adversely diminish the radiological safety or prevent continued compliance of the package to 10 CFR Part 71.

The **lock pin springs** of sheet 6 are of minor importance to safety for this transport package. The function of the spring is to only retract the lock pin to unlock and release the source. The cam action of the selector ring mechanically pushes the lock pins in which engages the source cable and locks the source for transport. The springs do not need to be present to lock the source in its fully shielded, safe position for transport. Lock pin springs made from any stainless steel material in any condition will not adversely diminish the radiological safety or prevent continued compliance of the package to 10 CFR Part 71.

The **shaft roll pin, shaft spring, retainer disc, and knob** of sheet 7 are of various degrees of importance to the package safety during transport. The retainer discs only function is to locate the knob during use – not during transport, and it is not structurally significant in transport. The new material changes for these items appear in Table 1 below. The minimum mechanical properties for these materials in any condition are equivalent or exceed the material specified in the original transport test specimens for compliance to 10 CFR Part 71. For the retainer disc as well as the shaft roll pin, shaft spring and knob, material acceptability is based on the properties specified for these components which were used during the transport testing for these packages.

Table 1: Selected Test Specimen Material Properties at Room Temperature

Item	Form	Material	Alloy	Minimum		
				Tensile Strength (ksi)	Yield Strength (ksi)	Elongation (%)
Shaft roll pin	Strip	Tested	SAE 30302 or 30304	75	30	10
		Change	SAE 30302 or 30304, Type 302 or 304	75	30	10
Shaft spring	Wire	Tested	Stainless Steel	70	25	30
		Change	Type 301, 302, 304, 316, or 17-7PH	70	25	30
Retainer disc	Bar, plate or sheet	Tested	TYPE 303	75	30	7
		Change	Type 302, 303, 304, or 316	75	30	7
Knob	Bar, plate, sheet, or casting	Tested	Type 304 or ACI CF8	75	30	7
		Change	Type 302, 304, 316, or ACI CF8	75	30	7

As these components are not relied upon to retain the source in the transport package we believe that identification of these components based on the properties shown for these materials in Table 1 is sufficient to ensure the component's satisfactory performance under all required package transport conditions.

The **plunger lock screw** of sheet 10 is of minor importance to safety for this transport package. The screw does not aid in locking the source in the safe position and can be absent without affecting the safety of the package. Its only function is to limit the movement of the plunger lock when it is unlocked. Plunger lock screws made from any stainless steel material in any condition will not adversely diminish the radiological safety or prevent continued compliance of the package to 10 CFR Part 71.

The **lock cover set screw** and **lock cover roll pins** of sheet 10 are of minor importance to safety for this transport package. The set screw functions as a security feature preventing access to the plunger lock screw and can be absent without affecting the safety of the transport package.

The lock cover roll pins are only needed to align the cover pins in the assembly. Once the lock and dust covers are attached to the package, the covers pins are captured between the lock cover and the dust cover assemblies and the roll pins are no longer needed to secure the cover pins.

Both of these items could be absent without reducing the safety or integrity of the transport package or prevent the package from meeting the NCT and HAC test requirements and condition of 10 CFR Part 71. These items made from any stainless steel material in any condition will not adversely diminish the radiological safety or prevent continued compliance of the package to 10 CFR Part 71.

The **lock extension** of sheet 10 is of minor importance to safety for this transport package. The lock extension, along with the plunger lock, prevents unauthorized access to the source, but they do not directly secure the source in the package. As shown in the HAC test results of Test Plan 180, the lock extension can be either removed or completely destroyed without affecting the safety of the transport package. Without the extension, the redundant safety mechanisms of the rear plate assembly would require the cover pins to be completely removed from engaging the rear plate and also require the selector ring to rotate to a specific index before the source could be unlocked in the package. A lock extension made from any stainless steel material in any condition will not adversely diminish the radiological safety or prevent continued compliance of the transport package to 10 CFR Part 71.

3. *Specify how shell Rivnuts, small Rivnuts, and large Rivnuts indicated on sheets 2 and 3 of the engineering drawings made of A493 material will meet or exceed currently approved material properties currently shown on the engineering drawings for these Rivnuts.*

   The applicant has requested the optional use of ASTM A493 steel for use with Rivnuts which potentially undergo loading during lifting and tie-down operations (shell Rivnuts), normal conditions of transportation (fatigue, vibration, drop tests) and hypothetical accident conditions (drop testing) for the large and small Rivnuts. This material specification includes a wide variety of mechanical material properties and variety of alloys. It is unclear how the mechanical properties of this material will continue to meet or exceed the mechanical properties of the NAS1330NBE-426 material used for Rivnuts currently called out on the plans and those used in the prototypes for drop testing the package. Specify the mechanical properties of the grade(s) to be used as there are many grades available within the ASTM A493 (Austenitic, Ferritic, and Martensitic are available) family with various yield strengths, ultimate strengths, and rupture strains. Also state how this material will preclude brittle fracture.

   This information is needed to determine compliance with 10 CFR 71.45, 10 CFR 71.71, and 10 CFR 71.73.

Response:

Our request appears to be unclear and can be rewritten. The Rivnut material is controlled by the NAS1330 specification which requires Type 316 stainless steel per ASTM A276. Our intent is not to allow a different type of stainless steel, but just the option to allow for use of Type 316 stainless steel per either the ASTM A276 or ASTM A493 standards. To clarify our intent, we have revised the specification descriptions for these Rivnuts on drawing R86000 Revision T sheets 2 and 3 to read as follows:

On sheet 2,
Shell Rivnut: "NAS1330N8E-426 per ASTM A276 or A493"

On sheet 3,
Small Rivnut: "NAS1330N5E-256 per ASTM A276 or A493"
Large Rivnut: "NAS1330N8E-326 per ASTM A276 or A493"

4. *Clarify the apparent discrepancy between Note 3 and Note 6 on Drawing No. R86000 Rev. No. S.*

   Note 3 requires "threadlocker applied to all screws and rib bolts," yet Note 6 on the same sheet indicates "lockwashers and threadlubricant used in place of threadlocker." Combining both notes would clarify the use of lockwashers in lieu of threadlocker.

   This information is needed to determine compliance with 10 CFR 71.33(a)(5).

   Response:

   Drawing R86000 Revision T enclosed has been revised as requested for clarity. We have deleted Note 6 and Note 3 has been rewritten to state: "Thread locker applied to all screws and bolts. Optionally, lockwashers and thread lubricant may be applied instead of thread locker as needed."

5.0 Shielding Evaluation

Justify the use of reference dimensions for the depleted uranium shielding and show that the package can be expected to meet the regulatory dose rate limits in 10 CFR 71.47 accounting for expected manufacturing tolerances and defects.

NUREG-1609 "Standard Review Plan for Transportation Packages for Radioactive Materials" instructs the reviewer to evaluate design features important to shielding, specifically dimensions and tolerances. In addition, the standard review plan instructs the reviewer on two separate occasions to check for changes in dimensions and/or effectiveness of shielding resulting under normal conditions of transport or hypothetical accident conditions (Section 5.5.3.1 and 5.5.3.2). Section 5.5.4.4 again mentions changes to shielding efficacy but instructs the reviewer to consider that, since pre-shipment measurements are required, other factors may be considered. However, the applicant has neither expected changes to dose rates nor provide justifications for bounding shielding assumptions in lieu of minimum dimensions.

This information is required to determine compliance with 10 CFR 71.47.

Response:

As required in the Safety Analysis Report (SAR) section 8.1.6 Shielding Tests, the radiation levels at the surface and 1 meter from the surface of every Model Sentry 110, Sentry 330 and 867 transport package is measured and evaluated prior to first use as a Type B package. This radiation profile, intended to demonstrate compliance of the transport package to regulatory dose rate limits of 10 CFR 71.47, is performed at the time of manufacture to identify any significant void volumes or shield porosity which could prevent the finished package from complying with the dose limits in 10 CFR 71.47.

The shielding verification by radiation survey inspection is further described on Drawing R86000 Revisions S and T (see Note 7 on sheet 9 and Note 3 sheet 11). Since the depleted uranium shields are free-form cast components where the minimum primary shielding features are difficult if not impossible to verify by direct measurement methods, controlled radiation inspection confirms that only packages meeting the dose limit requirements of 10 CFR 71.47 are accepted for use as an approved Type B transport package.

Since each shield assembly is evaluated for conformance to the dose limit requirements of 10 CFR 71.47 as part of the package radiation survey inspection, the use of reference dimensions, as requested on drawing R86000 Revision S will have no adverse impact on the package compliance since the shield assembly is evaluated by direct radiation measurement as part of the package radiation survey inspection. Failure of any manufactured Sentry 110, Sentry 330 or 867 package to meet the dose limits in 10 CFR 71.47 will result in rejection of the package. Packages where the dose rate measurements based on radiation profile do not comply with the requirements of 10 CFR 71.47 are not accepted for shipment or distribution under the USNRC Type B Certificate of Compliance.

In addition to the changes to drawing R86000 Revision T described in response to your RAI questions we have also modified Note 1 on page 2 of drawing R86000 Revision T to clarify that a weld may not be present if ASTM A182 material is used for the shell. This change is for clarification only based on the material specification of ASTM A182 and does not change how this material's use was specified on Revision S of drawing R86000. If is for added clarity only.

Should you have any additional questions, or wish to discuss this issue or our amendment request, please contact me.

Sincerely,

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Manager,
Regulatory Affairs/Quality Assurance
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RA/QA Approval — 4 OCT 2016 Date

Engineering Approval — 4 OCT 2016 Date

Enclosure: Drawing R86000 Revision T

cc: ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
One White Flint
Rockville, MD 20852

Security-Related Information Figure
Withheld Under 10 CFR 2.390.

ERF #	APPROVALS	DATE
3524		30oct16
		30 Oct 16
		30oct16

QSA GLOBAL
40 NORTH AVE, BURLINGTON, MA 01803

DESCRIPTIVE DRAWING

TITLE: SENTRY TRANSPORT PACKAGE

SIZE	DWG. NO.	REV
A	R86000	T
	SCALE: NONE	SHEET 1 OF 11

Security-Related Information Figure
Withheld Under 10 CFR 2.390.

QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE		
SIZE A	DWG. NO. R86000	SCALE: NONE	SHEET 2 OF 11	REV T

Security-Related Information Figure
Withheld Under 10 CFR 2.390.

QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE		
SIZE A	DWG. NO. R86000		REV T
	SCALE: NONE	SHEET 3 OF 11	

Security-Related Information Figure
Withheld Under 10 CFR 2.390.

QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803		DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE	
SIZE A	DWG. NO. R86000	REV T
	SCALE: NONE	SHEET 4 OF 11

Security-Related Information Figure
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QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803		DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE	
SIZE A	DWG. NO. R86000	REV T
	SCALE: NONE	SHEET 5 OF 11

Security-Related Information Figure
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OSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE		
SIZE A	DWG. NO. R86000	SHEET 6 OF 11	REV T
	SCALE: NONE		

Security-Related Information Figure
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QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE		
SIZE A	DWG. NO. R86000		REV T
	SCALE: NONE	SHEET 7 OF 11	

Security-Related Information Figure
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QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE		
SIZE A	DWG. NO. R86000		REV T
	SCALE: NONE	SHEET 8 OF 11	

Security-Related Information Figure
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QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE		
SIZE A	DWG. NO. R86000		REV T
	SCALE: NONE	SHEET 9 OF 11	

Security-Related Information Figure
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QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803			DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE		
SIZE A	DWG. NO. R86000		REV T
	SCALE: NONE	SHEET 10 OF 11	

Security-Related Information Figure
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QSA GLOBAL 40 NORTH AVE, BURLINGTON, MA 01803		DESCRIPTIVE DRAWING
TITLE	SENTRY TRANSPORT PACKAGE	
SIZE A	DWG. NO. R86000	REV T
	SCALE: NONE	SHEET 11 OF 11