Department of Energy
National Nuclear Security Administration
P.O. Box 5400
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April 27, 2017

Mr. Michael Layton, Director
Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Warehouse Mailroom
Attn: Document Control Desk
MS 3WFN-4-C68
4930 Boiling Brook Parkway
Rockville, MD 20852

Dear Sir:

This letter is in regard to Docket No. 71-9355. The purpose is to request a National Nuclear Security Administration (NNSA) revision of Model No. 435-B Package's Certificate of Compliance (CoC) Number 9355 for the 435-B Package, Package Identification Number USA/9355/B(U)-96. This request is supported by the enclosed 435-B Package Safety Analysis Report (SAR), Revision 4.2.

The changes in SAR Revision 4.2 include addition of a new case to the thermal analysis to evaluate the thermal effect of using metallic dunnage with a shielded device in the inner container (IC); a new section added to the thermal analysis documenting the evaluation of the thermal decomposition response of non-metallic materials within containment to hypothetical accident conditions; and removal of adhesive to attach neoprene to the lodgment, removal of thin neoprene, and breather vents added to the IC lid.

Once the CoC revision is issued, NNSA can continue its fabrication of the 435-B transport packagings that will be used to improve and continue to perform its Offsite Source Recovery Program mission.

If you have any questions in regards to this application please contact James Mumma at (505) 845-5715

Sincerely,

A.M. Al-Daouk

Ahmad M. Al-Daouk
NNSA Certifying Official

NMSS20

Enclosure:
435-B Transport Package Safety Analysis Report, Revision 4.2

cc w/o enclosure:
James Mumma, NA-531
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Roadmap of Detailed Changes Made to the 435-B SAR from Rev. 3.1 to Rev. 4.2

03/03/17

The following is a topical summary of the changes made to the 435-B SAR, Revision 3.1, to create Revision 4.2. Details of the changes are provided in the table which follows this list.

1. Adhesive is no longer used to attach neoprene to the lodgment, and the thin (1/8" thick) neoprene is eliminated. The thick (1/2") neoprene pad on the lower lodgment is retained by four stainless steel screws. This change was made to increase the assurance that the neoprene will remain in place under all conditions and for long periods. The thin neoprene was not considered to be necessary and could be eliminated. The option of using neoprene for bumpers on the inner container (IC) dunnage was added.
2. Breather vents have been added to the IC lid. The interior of the IC lid was a normally closed cavity, and during evacuation of the containment during helium leakage rate testing, the pressure differential between the interior and exterior of the IC lid could cause damage to the IC lid. Three breather vents have been added to prevent a pressure differential.
3. A new case has been added to the thermal analysis to evaluate the thermal effect of using metallic dunnage with a shielded device in the IC. The prior analysis had only considered foam dunnage. The analysis was expanded in order to ensure that bounding temperatures for the shielded device were used in the evaluation of non-metallic materials.
4. A new section (Section 3.4.3.5) has been added to the thermal analysis to document the evaluation of the thermal decomposition response under HAC of non-metallic materials that may be transported within containment. This evaluation was performed to verify that the maximum pressure and containment boundary stress calculated for HAC would not be affected by the decomposition of any non-metallic materials. The evaluation used published information and showed that none of the permitted materials will thermally decompose, with significant margins of safety. Consequently, the existing pressure and structural calculations remain valid.
5. The Operations chapter has been revised to allow the slings used to lift the shielded device during loading to be left in the IC for use in unloading. The non-metallic lifting sling materials are evaluated in Section 3.4.3.5.
6. During preparation of the packaging's operation and maintenance manual, several instances of potential improvement in operation have been identified. Accordingly, some changes to SAR Chapter 7 (*Package Operations*) and Section 8.2 (*Maintenance Program*) have been made.
7. During fabrication of the first packagings, several instances requiring correction or improvement have been identified. Accordingly, some changes to the drawings have been made.

The sections which follow include:

Roadmap of Detailed Changes Made to the 435-B SAR from Rev. 3.1 to Rev. 4.2
03/03/17

A. A table detailing each change to the SAR to create Revision 4.2. The table includes the change location sections from Rev. 3.1 to Rev. 4.2, a description of each change to the SAR text and to the SAR drawings, and a brief discussion and justification for the change. Of note, none of the changes that have been made reduce the level of safety of the 435-B packaging. Each change is identified and justified.

B. A verbatim copy of the new Section 3.4.3.5, *Behavior of Non-metallic Contents Materials Under HAC*, including Table 3.4-4.

C. A listing of the references which are added to Section 3.5.1. Electronic copies of the added references in PDF will be supplied separately.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Page 1.2-5, second paragraph, Section 1.2.1.5	Page 1.2-5, second paragraph, Section 1.2.1.5	Revise sentences 4 and 5 to read: "The LTSS rests on a ½-inch thick plate covered with a ½-inch thick layer of neoprene rubber, which is attached to the plate using four, ¼-inch diameter screws. There is nominally no contact between lodgment ribs and the LTSS."	This change describes the attachment of the neoprene cushion to the base of the lodgment using fasteners. The rubber adhesive is no longer used.
Page 1.2-6, third paragraph, Section 1.2.1.7	Page 1.2-6, third paragraph, Section 1.2.1.7	Add a sentence to the end of the paragraph to read: "The outer rim of the lid features three breathers to equalize the pressure in the lid cavity."	Breathers have been added to the IC lid to prevent overpressure during evacuation of containment associated with leakage rate testing of the package containment boundary.
Section 1.3.3, Drawing No. 1916-01-01-SAR, Flag Note 34	Section 1.3.3, Drawing No. 1916-01-01-SAR, Flag Note 34	Require use of lock washer with fastener Item 9. Remove option for thread locking compound.	Increases assurance that fasteners will remain tight. Removes a potential source of gas generation under HAC.
Section 1.3.3, Drawing No. 1916-01-01-SAR, Flag Note 38	Section 1.3.3, Drawing No. 1916-01-01-SAR, Flag Note 38	Remove option for thread locking compound.	This option was not necessary. Removes a potential source of gas generation under HAC.
Section 1.3.3, Drawing No. 1916-01-01-SAR, Flag Note 43	Section 1.3.3, Drawing No. 1916-01-01-SAR, Flag Note 43	Delete Flag Note 43.	Remove optional rubber pads between upper internal impact limiter and support clips since they are not necessary. Removes a potential source of gas generation under HAC.
Section 1.3.3, Drawing No. 1916-01-01-SAR, List of Materials, Item 40	Section 1.3.3, Drawing No. 1916-01-01-SAR, List of Materials, Item 40	Add lock washer (Item 40) for use with Item 9 fasteners.	Increases assurance that fasteners will remain tight.
Section 1.3.3, Drawing No. 1916-01-01-SAR, Sheet 3, Section A-A, Zone B2	Section 1.3.3, Drawing No. 1916-01-01-SAR, Sheet 3, Section A-A, Zone B2	Add lock washer and quantities to callout, delete flag marker 43.	Increases assurance that fasteners will remain tight.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Section 1.3.3, Drawing No. 1916-01-01-SAR, Sheet 6, Detail D, Zone A2	Section 1.3.3, Drawing No. 1916-01-01-SAR, Sheet 6, Detail D, Zone A2	Add lock washer and quantities to callout.	Increases assurance that fasteners will remain tight.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 7	Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 7	Delete Flag Note 7.	Adhesive no longer used.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 8	Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 8	Add requirement for marking materials to have a minimum exposure rating of 500 °F.	Removes a potential source of gas generation under HAC.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Note 9	Section 1.3.3, Drawing No. 1916-01-02-SAR, Note 9	Delete General Note 9.	It is not necessary to seal unwelded sections. Contamination is not credible.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 14	Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 14	New Flag Note 14 requires removal of the plastic portion of the toggle clamp handles.	Removes a potential source of gas generation under HAC.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 15	Section 1.3.3, Drawing No. 1916-01-02-SAR, Flag Note 15	New Flag Note 15 states that holes in disc (Item 1) are optional in upper half of lodgment.	The holes are used in the disc with the fasteners that attach the lower neoprene cushion (Item 13). They are not needed on the upper half of the lodgment, but may be present for fabrication efficiency.
Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 5	Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 5	Update specification number for pipe.	Prior number became obsolete. Specification requirements did not change.
Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 6	Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 6	Delete Item 6.	The thin neoprene sheets were located on the ribs, to prevent potential marking the LTSS. However, contact between the ribs and the LTSS does not occur, and the strips are not necessary.
Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 7	Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 7	Add Flag Note 14 to Item 7 in list of materials.	Associates the note with the item.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 10	Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Item 10	Increase bolt length from 2.0 inches to 2.5 inches.	Provides a better fitup when installed with Item 11.
Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Items 14 – 16	Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Items 14 – 16	Add items 14, 15, and 16 to the list of materials.	These items are the four fasteners (screw, flat washer, locknut) that fasten the lower neoprene pad to the lodgment. They take the place of the adhesive, which is not used.
Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Items 17 & 18	Section 1.3.3, Drawing No. 1916-01-02-SAR, List of Materials, Items 17 & 18	Add items 17 & 18 to the list of materials.	These items are a bronze hex bolt and locknut for use with the toggle clamps. They take the place of the prior bolt and rubber tip.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2	Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2	Remove depiction and callouts of thin neoprene strips (formerly Item 6) and Flag Note 7 (adhesive) in multiple locations.	Item 6 and use of adhesive has been deleted.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2, Assembly A1, Zone C7	Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2, Assembly A1, Zone C7	Change depiction of toggle clamp bolts. Add callouts for Items 17 & 18.	Show new items 17 & 18 in place of prior bolts and rubber tips.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2, View C-C, Zone D3	Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2, View C-C, Zone D3	Add depiction of holes in plate, add Flag Note 15 marker.	The holes are used with the fasteners attaching the neoprene pad on the lower lodgment.
Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2, View B-B, Zone A1	Section 1.3.3, Drawing No. 1916-01-02-SAR, Sheet 2, View B-B, Zone A1	Add Section E-E.	This section shows the detail of the fasteners that attach the neoprene pad.
Section 1.3.3, Drawing No. 1916-01-03-SAR, General Note 9	Section 1.3.3, Drawing No. 1916-01-03-SAR, General Note 9	Add requirement for marking materials to have a minimum exposure rating of 500 °F.	Removes a potential source of gas generation under HAC.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Section 1.3.3, Drawing No. 1916-01-03-SAR, List of Materials, Items 7 & 8	Section 1.3.3, Drawing No. 1916-01-03-SAR, List of Materials, Items 7 & 8	Correct the description to signify the bolts are heavy hex. Update the specifications to the latest versions.	Update and clarification.
Section 1.3.3, Drawing No. 1916-01-03-SAR, List of Materials, Item 11	Section 1.3.3, Drawing No. 1916-01-03-SAR, List of Materials, Item 11	Add Item 11.	Include a breather vent in the inner container lid (3X).
Section 1.3.3, Drawing No. 1916-01-03-SAR, Sheet 2, Assembly A1	Section 1.3.3, Drawing No. 1916-01-03-SAR, Sheet 2, Assembly A1	Show depiction of breather vents in lid and add callout in Zone D7.	Add breather vents.
Section 1.3.3, Drawing No. 1916-01-03-SAR, Sheet 2, Sections B-B and D-D, Zones D1-D4	Section 1.3.3, Drawing No. 1916-01-03-SAR, Sheet 2, Sections B-B and D-D, Zones D1-D4	Show depiction of breather vents in sections.	Add breather vents.
Section 1.3.3, Drawing No. 1916-01-03-SAR, Sheet 2, Assembly A1, Zone C6	Section 1.3.3, Drawing No. 1916-01-03-SAR, Sheet 2, Assembly A1, Zone C6	Remove word 'optional' before 'breather hole'.	Require placement of breather holes in the inner container body.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Chapter 3, Sections 3.1, 3.2, 3.3, 3.4, and 3.5	Chapter 3, Sections 3.1, 3.2, 3.3, 3.4, and 3.5	A thermal analysis case has been added to the cases already analyzed. The new case considers the thermal effects of using metallic dunnage with a shielded device. Prior applications evaluated only the polyurethane foam dunnage case. No changes were made to any prior analyses (e.g., the LTSS case or the foam dunnage case). Note: other changes to specific sections of Chapter 3, not related to the added analysis case, are listed separately below.	The new case was added to support the evaluation of non-metallic materials which may be present in the containment, and to ensure that the maximum bounding temperatures were used for that evaluation. The new analysis utilized conservative bounding assumptions regarding the configuration of the metallic dunnage in NCT and HAC. The result of the new analysis showed that, under NCT and HAC, the foam dunnage case bounds all* packaging and payload maximum temperatures, except that the temperatures of the shielded device itself were moderately increased. All thermal margins of safety are positive. Results are summarized in Table 3.4-3 and Table 3.4-4. *The temperature of some packaging components increased by 1 °F in the metallic dunnage case, likely due to a software rounding difference.
Page 3.1-4, second paragraph, Section 3.1.1.1	Page 3.1-4, second paragraph, Section 3.1.1.1	Revise the last two sentences to read: "The LTSS rests on a ½-inch thick plate covered with a ½-inch thick layer of neoprene rubber, which is attached to the plate using four, ¼-inch diameter screws. There is nominally no contact between lodgment ribs and the LTSS."	This change describes the attachment of the neoprene cushion to the base of the lodgment using fasteners. The rubber adhesive is no longer used.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Page 3.2-4, second paragraph, Section 3.2.2	Page 3.2-4, second paragraph, Section 3.2.2	Revise the first sentence of the paragraph, and insert a new second sentence, to read: "A neoprene (chloroprene) pad is attached to the lodgment using stainless steel screws to provide a cushion for the LTSS. Neoprene bumpers may also be used on dunnage in the IC."	This change describes the attachment of the neoprene cushion to the base of the lodgment using fasteners. The rubber adhesive is no longer used. Add possible use of bumpers on IC dunnage.
Page 3.2-4, third paragraph, Section 3.2.2	Page 3.2-4, third paragraph, Section 3.2.2	Delete the third and fourth sentences from the paragraph.	These sentences discuss rubber adhesive, which is no longer used.
Page 3.2-4, third paragraph, Section 3.2.2	Page 3.2-4, third paragraph, Section 3.2.2	Add a sentence to the end of the paragraph to read: "The potential for thermal decomposition of payload materials under HAC is discussed in Section 3.4.3.5, *Behavior of Non-metallic Contents Materials Under HAC*."	Directs to a section associated with a thermal review of non-metallic materials inside containment.
Page 3.4-7, After Section 3.4.3.4	Page 3.4-7, New Section 3.4.3.5	Add new Section 3.4.3.5, *Behavior of Non-metallic Contents Materials Under HAC*. Full text given below.	A thermal review of non-metallic materials inside containment.
Page after Figure 3.4-13 (Page 3.4-23)	Page 3.4-26, New Table 3.4-4	New Table 3.4-4. Full text given below.	Summarizes the results in Section 3.4.3.5.
Page 3.5-3, Section 3.5.1	Page 3.5-3, Section 3.5.1	Add new references 30 through 42 to support Section 3.4.3.5. See below.	References in support of the review of non-metallic materials inside containment.
Page 7.1-1, Section 7.1.2	Page 7.1-1, Section 7.1.2	Add one sentence to end of Section 7.1.2: "NOTE: The visual inspections of packaging components delineated in the following steps may be performed at any time during the loading sequence."	This statement allows the user to perform the required inspections in a different order. This has the potential to reduce worker dose as well as wasted effort in case a component needs repair.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Page 7.1-2, Step 19, Section 7.1.2.1	Page 7.1-3, Step 19, Section 7.1.2.1	Add the following to the end of step 19: "NOTE: If the O-rings are removed, perform a visual surface finish inspection of the O-ring grooves for scratches or dents that could impair containment integrity. If necessary, repair the damaged surfaces per Section 8.2.3.2, *Sealing Area Routine Inspection and Repair*."	As currently written, Step 19 states that removal of the O-rings for inspection is optional. However, if the user chooses to remove the O-rings, an inspection of the O-ring grooves should be performed. This change is associated with the change to Section 8.2.3.2, below.
Page 7.1-4, Step 7, Section 7.1.2.2	Page 7.1-4, Step 7, Section 7.1.2.2	Revise the second sentence of Step 7(a) to read in part, "Dunnage shall be structural metal such as aluminum, stainless steel, or carbon steel in a welded or bolted configuration, which may include neoprene bumpers, or it may be made from…"	This change permits optional use of neoprene bumpers on the IC dunnage.
Page 7.1-4, Step 7, Section 7.1.2.2	Page 7.1-4, Step 7, Section 7.1.2.2	Add a sentence to the end of Step 7(a): "Any paint used on blocking/dunnage components shall be rated for 500 °F minimum."	This change requires any paint used on the IC dunnage to be rated for high-temperature.
Page 7.1-4, Step 7, Section 7.1.2.2	Page 7.1-4, Step 7, Section 7.1.2.2	Create new sub-step 7(d)(iv): "As an option, lifting slings made of steel, nylon, polyester, or Kevlar© may be left inside the IC during transport."	This change permits leaving the slings in the IC along with the devices. Section 3.4.3.5 includes a discussion of these materials under the HAC fire event.
Page 7.1-4, Step 7, Section 7.1.2.2	Page 7.1-5, Step 7, Section 7.1.2.2	Create new sub-step 7(f): "As an option, the device may be assembled together with the dunnage and lowered into the IC as a unit."	This change permits an optional method of loading the device and dunnage into the IC.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Page 7.1-6, Step 2, Section 7.1.2.2.1	Page 7.1-6, Step 2, Section 7.1.2.2.1	Replace Step 2 with: "Remove all components that are not necessary to the shielding function or to the source retention function, such as stands, cabinets, enclosures, electrical components including wires and insulation, turntable motors, beaker rotation sensors, or any other auxiliary or unnecessary equipment. Remove non-metallic labels, tape, and adhesive. Remove the auxiliary (external) shield components from the GC-3000. Lifting loops may be left intact."	This change clarifies the components to be removed from Group 1 devices prior to loading.
Page 7.1-6, Step 2, Section 7.1.2.2.2	Page 7.1-6, Step 2, Section 7.1.2.2.2	Replace Step 2 with: "Remove all components that are not necessary to the shielding function or to the source retention function, such as stands, cabinets, enclosures, electrical components including wires and insulation, or any other auxiliary or unnecessary equipment. Remove non-metallic labels, tape, and adhesive."	This change clarifies the components to be removed from Group 3 devices prior to loading.
Page 7.2-1, Steps 5 – 7, Section 7.2.1.1	Page 7.2-1, Steps 5 – 7, Section 7.2.1.1	Replace the requirement to collect and analyze a gas sample with a requirement to vent the package cavity to atmosphere.	Because the sources are sealed and are securely located during transport, contamination of the interior gas of the package is not credible, and sampling the gas is not necessary.
Page 7.2-2, Steps 5 – 7, Section 7.2.1.2	Page 7.2-2, Steps 5 – 7, Section 7.2.1.2		
Page 7.2-2, Step 19, Section 7.2.1.1	Page 7.2-2, Step 19, Section 7.2.1.1	Revise the third sentence to read, "Install the 24 closure bolts, and using a crossing pattern, tighten to at least 150 ft-lb torque, but not more than 330 ft-lb torque."	This change permits a lower closure bolt torque to be used during empty transport of the packaging. Empty transport presents a reduced radiological risk.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Page 7.2-3, Step 14, Section 7.2.1.2	Page 7.2-3, Step 14, Section 7.2.1.2	Revise the step to read, "Replace the lid on the IC and tighten the six, 1-8UNC bolts to a torque of at least 100 ft-lb torque, but not more than 210 ft-lb."	This change permits a lower IC lid attachment bolt torque to be used during empty transport of the packaging. Empty transport presents a reduced radiological risk.
Page 7.2-3, Step 17, Section 7.2.1.2	Page 7.2-3, Step 17, Section 7.2.1.2	Revise the third sentence to read, "Install the 24 closure bolts, and using a crossing pattern, tighten to at least 150 ft-lb torque, but not more than 330 ft-lb torque."	This change permits a lower closure bolt torque to be used during empty transport of the packaging. Empty transport presents a reduced radiological risk.
Page 8.2-2, last paragraph, Section 8.2.3.2	Page 8.2-2, last paragraph, Section 8.2.3.2	Revise the first sentence of the paragraph to read: "At the time of seal removal or replacement, containment sealing surfaces shall be visually inspected for damage that could impair the sealing capabilities of the packaging."	As currently written, the first sentence requires the O-ring seals to be removed before *each use*. This is not consistent with Step 19 of Section 7.1.2.1, which makes removal of the O-rings optional. The O-rings should not be removed for inspection before each shipment, because damage to the non-exposed surfaces (the O-ring groove or the inner side of the O-ring) is not credible. Further, removal of the O-ring introduces unnecessary risk of damage. Note that the change made to Step 19 of Section 7.1.2.1 above requires inspection of the O-ring groove and O-ring *if the choice is made to remove the O-ring*. Thus, Step 19 of Section 7.1.2.1 and Section 8.2.3.2 will now be consistent.

Section Rev. 3.1	Section Rev. 4.2	Change	Discussion and Justification
Page 8.2-3, Section 8.2.3.3	Page 8.2-3, Section 8.2.3.3	1. Revise the second sentence to read in part: "The lower internal impact limiter shall be inspected…" 2. Add a second paragraph to the section: "Once per year, the upper internal impact limiter shall be inspected for proper installation and to ensure that the ⅜-16 UNC SHCS are intact and tightened to the value specified in drawing 1916-01-01-SAR, Flag Note 34. Any damage shall be repaired prior to further use."	The first change removes the requirement to inspect the upper internal impact limiter before each use. This component is not manipulated or placed under load during use or transport. In addition, a change to the SAR drawing requires that the two ⅜-16 UNC SHCS (drawing 1916-01-01-SAR, item 9) be installed using lock washers (new item 40). Thus there is no credible reason to require frequent inspections. The second change instates a requirement to inspect the upper internal impact limiter once per year. This inspection frequency is adequate to ensure the function of the upper internal impact limiter. Of note, this revision does not change the requirement to inspect the lower internal impact limiter before each use.
Page 9.2-8, Table 9.2-2	Page 9.2-8, Table 9.2-2	Add IC lid breather vents to table as quality category C.	Breather vents are category C because they are unlikely to have any affect on package safety.

Section 3.4.3.5, Behavior of Non-metallic Contents Materials Under HAC

Several non-metallic materials are present in association with the contents of the 435-B and are exposed to elevated temperatures during or after the HAC fire event. The discussion below (summarized in Table 3.4-4) lists each non-metallic material, its location within the package, its maximum temperature based on the calculated results taken from Table 3.4-1, Table 3.4-2, or Table 3.4-3, and the material's minimum thermal decomposition temperature based on published reference information. As shown, each non-metallic material has a significant margin of safety on its temperature limit, and gas generation from the thermal decomposition of these materials in association with the HAC fire event will not occur. Of note, none of these materials are important to safety, consequently their function under NCT or HAC is not required.

In the paragraphs below:

- *Lodgment maximum temperature* is equal to 464 °F from Table 3.4-1.
- *IC cylindrical shell maximum temperature* is equal to 445 °F from Table 3.4-3.
- *Shielded device shell maximum temperature* is equal to 260 °F, from Table 3.4-3.

Marking paint may be used on the lodgment or IC for alignment marks or identification. Paint may also be used on the dunnage. The temperature of paint on the lodgment is bounded by the lodgment maximum temperature, and the temperature of paint on the dunnage within the IC is bounded by the IC shell maximum temperature. Per drawings 1916-01-02-SAR and 1916-01-03-SAR and Section 7.1.2.2, *Loading the Inner Container (IC) into the 435-B*, this paint must be rated for a temperature of at least 500 °F. Commercial high-temperature paints easily meet this standard. The minimum margin of safety is at least 36 °F.

Nitrile rubber is used for the O-ring dust seals on the LTSS end doors. The temperature of the dust seals is bounded by the maximum temperature of the LTSS shell of 270 °F given in Table 3.4-1. Figure 19 of [14] shows weight loss is negligible below approximately 300 °C (572 °F). The minimum margin of safety is 302 °F.

Nylon is present in the self-locking nuts used to attach the two halves of the lodgment together and on the fasteners attaching the neoprene pad (drawing 1916-01-02-SAR, items 11 and 16, respectively). Nylon may also be used on any fasteners used with dunnage in the IC. The temperature is bounded by the lodgment maximum temperature. Page 204 of [34] gives a thermal decomposition temperature for nylon of 578 K (581 °F). The minimum margin of safety is 117 °F.

Graphite is used in bushings in the GC-40 shielded device. Its temperature is bounded by the temperature of the shielded device drawer of 293 °F from Table 3.4-3. Table II of [14] gives a temperature limit of 800 °C (1,472 °F). The minimum margin of safety is 1,179 °F.

Lifting slings are used to place the shielded device into the IC. As a convenience to the user, or if the device is resting on the slings, it may be necessary to leave the slings in place in the IC. Slings may be made from steel, nylon, polyester, or Kevlar©. The temperature of the slings is bounded by the IC shell maximum temperature. The temperature limit for nylon is given above as 581 °F. Figure 1(a) of [35] shows negligible decomposition for polyester below approximately 350 °C (662 °F). Page 155 of [34] gives a temperature limit for Kevlar© of 700 K (800 °F). The minimum margin of safety is 136 °F.

Silicone sealant may be used to seal crevices between the intermittent welds of the IC. The temperature of the sealant is bounded by the IC shell maximum temperature (except as noted below for sealant used in locations not adjacent to the IC shell). The chemical name for silicone materials is polydimethylsiloxane (PDMS). Table 3 of [36] lists the temperature of onset of thermal degradation (equivalent to a 1% mass loss) for several PDMS compounds in air. All of the temperatures exceed 300 °C (572 °F). Similarly, Figure 5 of [37] shows no significant mass loss for PDMS below 300 °C. Of note, this thermal decomposition temperature will be higher than the recommended maximum use temperature. The minimum margin of safety is 127 °F.

A small amount of silicone sealant may reach a temperature in excess of its decomposition temperature. However, this is shown to be negligible relative to pressure rise within the package. As shown on drawing 1916-01-03-SAR, Sheet 2, Assembly A1, the external ribs of the IC consist of circumferentially continuous rings separated by vertical rib segments that are attached using intermittent welds (1" long on 2" centers). Each joint between a vertical rib and a circumferential ring has a radial dimension of 3 inches. (The vertical joints are adjacent to the shell as discussed above.) Thus the weld consists of two, one-inch long welds on either side of a one-inch long unwelded length, which may be sealed with a small bead of silicone sealant. Since the same weld exists on both sides of the vertical rib, there may be up to four, one-inch long segments of silicone sealant bead at each intersection of a vertical rib with a circumferential ring. The bead has the same nominal profile as the specified 1/8" fillet weld, and thus has a cross sectional area of $(0.125)^2/2 = 0.0078$ in^2, or a volume of 0.0312 in^3 of sealant per rib intersection (four, one-inch long beads). As shown in Figure 3.4-12, the maximum temperature of the IC is limited to a small region adjacent to the HAC puncture bar impact. The right side of the figure represents the temperature distribution at 43 minutes after the start of the HAC fire, and is the point at which the shell temperature reaches its maximum. As can be seen, the maximum size of the hot region of the ribs (i.e., where the temperature exceeds that of the IC shell) includes approximately two rib intersections. It is only at these intersections that any silicone sealant could exceed the temperature of the IC shell. Silicone sealant has a specific gravity essentially equal to unity, and the maximum credible gas which could result from the decomposition of the sealant would be the equivalent mass of water vapor. To calculate the maximum amount of sealant that could possibly decompose, it will be conservatively assumed that a total of six intersections (i.e., three times the number indicated by Figure 3.4-12) exceed the silicone sealant decomposition temperature of at least 572 °F. This volume is $6 \times 0.0312 = 0.1872$ in^3, or an equivalent of 0.0068 lb of water (about 3 ml). The pressure that could result from the addition of 0.0068 lb of water vapor to the void volume of the 435-B (46,310 in^3 per Section 3.4.3.4, *Maximum HAC Pressures*), is negligible.

Paint is used on the outer surfaces of most shielded devices. The temperature of the paint is bounded by the shielded device shell temperature. Thermogravimetric analysis (TGA) for various paint types show that significant degradation, measured as weight loss, does not occur below 200 °C to 300 °C (392 °F to 572 °F). See Figures 1 and 2 of [30], Figure 1a of [31], and Figure 1 of [32]. The minimum margin of safety is 132 °F.

Grease may be present in bearings or other mating parts of the shielded devices or as vacuum grease on the containment O-ring and vent port seal. The temperature of grease is bounded by the vent port sealing washer temperature of 274 °F from Table 3.4-1. Section 2.3 (with Figure 4) of [33] indicates that grease thickener begins to decompose at around 250 °C (482 °F). Of note, this thermal decomposition temperature will be higher than the recommended maximum use temperature. The minimum margin of safety is 208 °F.

Epoxy adhesive may be present on some devices. The temperature of epoxy is bounded by the shielded device shell temperature. The brand of epoxy adhesive used is 3M™ Scotch-Weld DP 100. The manufacturer's data sheet [38] shows a 5% weight loss at 318 °C (604 °F) in air. The minimum margin of safety is 344 °F. In these applications, a very small amount of thread locking compound may be used. Any gas that could be generated by the decomposition of this material will be negligible.

Acrylic plastic (PMMA or Lucite) or ***Acetal plastic*** (POM or Delrin) may be present on some devices. The temperature of these materials is bounded by the shielded device shell temperature. Figure 5(a) of [39] shows that thermal decomposition of PMMA (solid line) does not occur below at least 250 °C (482 °F). The MSDS for Delrin [40] states that thermal decomposition will not occur at the processing temperature of 210 – 220 °C (410 – 428 °F). The minimum margin of safety (based on Delrin at 410 °F) is 150 °F.

Thus, as discussed above and summarized in Table 3.4-4, gas generation due to the thermal decomposition of non-metallic materials which may be present within the containment of the 435-B, during or after the HAC fire event, is not of concern.

Table 3.4-4 – Non-metallic Contents Materials①

Material	Location	Calculated Temperature, °F	Temperature Limit and Data Source
Marking paint & IC dunnage paint	Lodgment	Lodgment maximum②	High temperature paint (500 °F minimum use temperature) specified on SAR drawings and in Section 7.1.2.2.
	IC	IC shell maximum②	
Nitrile rubber	LTSS dust seals	270 °F (for LTSS shell, Table 3.4-1)	Figure 19 of [14] shows weight loss is negligible below approximately 300 °C (572 °F).
Nylon	Lodgment self-locking nuts	Bounded by Lodgment maximum②	578 K (581 °F) from pg. 204 of [34]
Graphite	GC-40 device bushings	293 °F (for shielded device drawer, Table 3.4-3)	800 °C (1,472 °F) from Table II of [14].
Lifting slings (Nylon)	IC	IC shell maximum②	578 K (581 °F) from pg. 204 of [34]
Lifting slings (polyester)	IC	IC shell maximum②	Figure 1(a) of [35] shows negligible decomposition below approximately 350 °C (662 °F).
Lifting slings (Kevlar©)	IC	IC shell maximum②	700 K (800 °F) from pg. 155 of [34]
Silicone sealant	IC	IC shell maximum②	Degradation does not occur below 300 °C (572 °F), from Table 3 of [36] and Figure 5 of [37].
Paint	On shielded device payload	Shielded device shell②	Significant degradation does not occur below 200 °C to 300 °C (392 °F to 572 °F), from Figure 1 and Figure 2 of [30], Figure 1a from [31], and Figure 1 of [32].
Grease	On shielded device payload	Shielded device shell②	Decomposition of the grease thickener begins at about 250 °C (482 °F), from Section 2.3 of [33].
Vacuum Grease	Vent port sealing washer	274 °F (Table 3.4-1)	
Epoxy adhesive	On shielded device payload	Shielded device shell②	Weight loss is less than 5% up to 318 °C (604 °F), per [38].
Acrylic or Acetal plastic	On shielded device payload	Shielded device shell②	Lower bound degradation (Acetal) does not occur below 210 °C (410 °F) [40].

Notes:

1. Neoprene rubber and polyurethane foam may also be present on the contents. These materials are discussed in Section 3.2.2. The butyl containment O-ring is discussed in Section 3.4.3.1.
2. Lodgment maximum temperature is 464 °F from Table 3.4-1. IC cylindrical shell maximum temperature (not including the external ribs) is 445 °F from Table 3.4-3. The shielded device maximum shell temperature is 260 °F from Table 3.4-3.

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