March 2018

Revision 18A

NAC-STC

NAC Storage Transport Cask

SAFETY ANALYSIS REPORT

Partial RAI Responses

Non-Proprietary Version

Docket No. 71-9235

NAC INTERNATIONAL

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Enclosure 1

RAI Responses for

NAC-STC SAR, Revision 18A

March 2018

NAC INTERNATIONAL

NON-PROPRIETARY RESPONSES TO THE

UNITED STATES
NUCLEAR REGULATORY COMMISSION

REQUEST FOR ADDITIONAL INFORMATION

February 2018

FOR REVIEW OF THE CERTIFICATE OF COMPLIANCE NO. 9235, STC TRANSPORATION PACKAGE

(CoC NO. 9235 DOCKET NO. 71-9235)

March 2018

TABLE OF CONTENTS

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

ACCEPTANCE AND MAINTENANCE TESTS EVALUATION

8.6 Provide additional clarification for the alternate lead pour procedures.

Section 8.4.2.2 states that during the lead pour the bottom end of the filler-tube is kept below the surface of the molten lead to preclude the formation of voids in the lead. Clarify whether the same practice is necessary for the alternate procedure.

Section 8.4.3.2 states that the body weldment will be heated in a steady, uniform, and controlled manner. Provide the allowable heating rates.

Section 8.4.3.2 states that the temperature of the entire body weldment is maintained between 640°F (338°C) and 740°F (393°C) throughout the lead pour operations, approximately. Provide clarification on what "approximately" is referring to in this context.

Section 8.4.3.3 states that the cooldown rate is held steady, uniform and controlled manner. Provide maximum cooldown rate and the maximum allowable temperature differential between the inner and outer shell.

This information is needed to determine compliance with 10 CFR 71.31(c) and 71.33(a)(5).

NAC International Response to Acceptance and Maintenance Tests Evaluation RAI 8-6:

When implementing the alternate lead pour procedure, the bottom end of the filler-tube is kept below the surface of the molten lead to preclude the formation of voids in the lead. SAR Section 8.4.3.2, Step 4, has been revised to include this practice.

SAR Section 8.4.3.2, Step 3, has been revised to include the same allowable heat up rate which is included in SAR Section 8.4.2.2 for the standard lead pour procedure.

SAR Section 8.4.3.2 has been revised to remove the word "approximately" from the end of Step 3.

SAR Section 8.4.3.3 has been revised to include cooldown requirements that prevent the development of a temperature differentials that exceed what is analyzed. Direct measurement of any temperature differential during the cooldown process is no longer required.

The alternate lead pour cooldown procedure differs significantly from the currently approved standard method. Specifically, the standard method utilizes water sprayers that cool the outside of the cask body only. The alternate method utilizes a bath system where both the inside and outside of the cask body are cooled simultaneously by the same water bath. Thereby, significantly reducing any thermal gradients.

However, to preclude the development of any thermal gradients which are greater than what is analyzed, the cooldown procedure for the alternate method is being revised to include a minimum inlet water temperature to the bath of 45°F (7°C) and a maximum rate of rise for the bath water level of 23.62 inches (600mm)/hr, in lieu of a directly measured cooldown rate. These two requirements together limit the development of any radial or axial thermal gradients and prevent the development of any thermal gradients greater than what is analyzed.

Enclosed in this submittal is the proprietary NAC calculation that demonstrates these two cooldown limits prevent the development of radial and axial thermal gradients greater than the analyzed limit of 160°F.

Enclosure 2

List of Drawing Changes

NAC-STC SAR, Revision 18A

March 2018

List of Drawing Changes, NAC-STC SAR, Revision 18A

Drawing 423-209, Rev 1

1. Updated title block to current standard
2. Revised next assembly to "423-900" was "423-100"
3. Added a note that reads "Localized dimensional variation beyond specified tolerances are permitted as a result of weld distortion provided that the net sections of the balsa wood and redwood are not affected."
4. Zone E6, revised dimension to "Ø87.1 +.1/-.2", was "Ø87.1".

Drawing 423-210, Rev 1

1. Updated title block to current standard
2. Revised next assembly to "423-900" was "423-100"
3. Revised est. weight to "8865 lbs", was "140 lbs"
4. Added a note that reads "Localized dimensional variation beyond specified tolerances are permitted as a result of weld distortion provided that the net sections of the balsa wood and redwood are not affected."
5. Zone E6, revised dimension to "Ø87.1 +.1/-.2", was "Ø87.1".

Drawing 423-257, Rev 3

1. Updated title block to current standard
2. Added a note that reads "Localized dimensional variation beyond specified tolerances are permitted as a result of weld distortion provided that the net sections of the balsa wood and redwood are not affected."
3. Zone D3, revised dimension to "Ø87.1 +.1/-.2", was "Ø87.1".

Drawing 423-258, Rev 3

1. Updated title block to current standard
2. Added a note that reads "Localized dimensional variation beyond specified tolerances are permitted as a result of weld distortion provided that the net sections of the balsa wood and redwood are not affected."
3. Zone D3, revised dimension to "Ø87.1 +.1/-.2", was "Ø87.1".

Drawing 423-802, Sheet 1 of 7, Revision 25

Sheet 3:

1. Zone F2, revised dimension to "12.15 +.15/-.06", was "12.15".

Sheet 5:

1. Zone E1, revised dimension to "(12.15)", was "12.15".

Drawing 423-802, Sheet 1 of 7, Revision 24

Revision 24 is currently under NRC Review (i.e., Submittal 17D).

Enclosure 3

Supporting Calculations for

NAC-STC SAR, Revision 18A

March 2018

List of Calculations and Supporting Documents

1. Calculation 30045-3000, Revision 0

Calculation withheld in its entirety per 10 CFR 2.390.

Enclosure 4

Proposed Changes for Certificate of Compliance Revision 19

NAC-STC SAR, Revision 18A

March 2018

CoC Sections (revised)

Page 5 of 19
5.(a)(3) Drawings

(i) The cask is constructed and assembled in accordance with the following Nuclear Assurance Corporation (now NAC International) Drawing Nos.:

423-800, sheets 1-3, Rev. 19P & 19NP
423-802, sheets 1-7, Rev. 25
423-803, sheets 1-2, Rev. 14
423-804, sheets 1-3, Rev. 12
423-805, sheets 1-2, Rev. 8
423-806, sheets 1-2, Rev. 13
423-807, sheets 1-3, Rev. 5
423-811, sheets 1-2, Rev. 13
423-812, Rev. 7
423-900, Rev. 8
423-209, Rev. 1
423-210, Rev. 1
423-901, Rev. 3

Page 6 of 19
5.(a)(3) Drawings

(ii) For the directly loaded configuration, the basket is constructed and assembled in accordance with the following Nuclear Assurance Corporation (now NAC International) Drawing Nos.:

423-870, Rev. 7
423-871, Rev. 5
423-872, Rev. 6
423-873, Rev. 2
423-874, Rev. 3
423-875, sheets 1-2, Rev. 11
423-878, sheets 1-2, Rev. 5
423-880, Rev. 2P & 1NP

Page 7 of 19
5.(a)(3) Drawings (Continued)

(v) The Balsa Impact Limiters are constructed and assembled in accordance with the following NAC International Drawing Nos.:

423-257, Rev. 3
423-258, Rev. 3
423-843, Rev. 6
423-859, Rev. 1

Enclosure 5

List of Changes

NAC-STC SAR, Revision 18A

March 2018

List of Changes, NAC-STC SAR, Revision 18A

Chapter 1

- Page 1-iii, modified List of Drawings as needed to reflect drawing revisions.

Chapter 2

- No changes.

Chapter 3

- No changes.

Chapter 4

- No changes.

Chapter 5

- No changes.

Chapter 6

- No changes.

Chapter 7

- No changes.

Chapter 8

- Pages 8.4-10 thru 8.4-12, modified items 3 and 4 of Section 8.4.3.2; modified items 1 and 2 of Section 8.4.3.3; deleted item 3 of Section 8.4.3.3 and renumbered the remaining two items; and, deleted item 3 from Section 8.4.3.4.

Chapter 9

- No changes.

Enclosure 6

SAR Changed Pages and LOEP

NAC-STC SAR, Revision 18A

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List of Effective Pages

Chapter 1

Chapter 2

List of Effective Pages (continued)

List of Effective Pages (continued)

List of Effective Pages (continued)

List of Effective Pages (continued)

Chapter 3

Chapter 4

List of Effective Pages (continued)

Chapter 5

Chapter 6

Chapter 7

Chapter 8

List of Effective Pages (continued)

Chapter 9

List of Drawings

Drawing Number	Revision No.	Title
423-800, sheets 1-3	Rev 19P(1)	Cask Assembly – NAC-STC Cask
423-800, sheets 1-3	Rev 19NP(1)	Cask Assembly – NAC-STC Cask
423-802, sheets 1-7	Rev 25	Cask Body – NAC-STC Cask
423-803, sheets 1-2	Rev14	Lid Assembly – Inner, NAC-STC Cask
423-804, sheets 1-3	Rev 12	Details - Inner Lid, NAC-STC Cask
423-805, sheets 1-2	Rev 8	Lid Assembly – Outer, NAC-STC Cask
423-806, sheets 1-2	Rev 13	Port Coverplate Assy – Inner Lid, NAC-STC Cask
423-807, sheets 1-3	Rev 5	Assembly, Port Cover, NAC-STC Cask
423-209	Rev 1	Impact Limiter Assy – Upper, NAC-STC Cask
423-210	Rev 1	Impact Limiter Assy – Lower, NAC-STC Cask
423-257	Rev 3	Balsa Impact Limiter, Upper, NAC-STC Cask
423-258	Rev 3	Balsa Impact Limiter, Lower, NAC-STC Cask
423-811, sheets 1-2	Rev 13	Details – NAC-STC Cask
423-812	Rev 7	Nameplates – NAC-STC Cask
423-843	Rev 6	Transport Assembly, Balsa Impact Limiters, NAC-STC
423-859	Rev 1	Attachment Hardware, Balsa Limiters, NAC-STC
423-870	Rev 7	Fuel Basket Assembly, PWR, 26 Element, NAC-STC Cask
423-871	Rev 5	Bottom Weldment, Fuel Basket, PWR, 26 Element, NAC-STC Cask
423-872	Rev 6	Top Weldment, Fuel Basket, PWR, 26 Element, NAC-STC Cask
423-873	Rev 2	Support Disk and Misc. Basket Details, PWR, 26 Element, NAC-STC Cask
423-874	Rev 3	Heat Transfer Disk, Fuel Basket, PWR, 26 Element, NAC-STC Cask
423-875, sheets 1-2	Rev 11	Tube, NAC-STC Cask
423-878, sheets 1-2	Rev 5	Alternate Tube Assembly, NAC-STC Cask
423-880	Rev 2P(1)	Shielded Thermal Shunt Assembly, NAC-STC Cask
423-880	Rev 1NP(1)	Shielded Thermal Shunt Assembly, NAC-STC Cask
423-900	Rev 8	Package Assembly Transportation, NAC-STC Cask
423-901	Rev 3	Transportation Package Concept, NAC-STC Cask
455-800, sheets 1-2	Rev 2	Assembly, Transport Cask, MPC-Yankee

(1) Proprietary and Non-proprietary drawing versions are only included in their respective SAR versions.

List of Drawings (continued)

Drawing Number	Revision No.	Title
455-801, sheets 1-2	Rev 4	Assembly, Transport Cask, NAC-MPC
455-820, sheets 1-2	Rev 3	Spacers, Transport Cask, MPC-Yankee
455-870	Rev 5	Canister Shell, MPC-Yankee
455-871, sheets 1-2	Rev 8	Details, Canister, MPC-Yankee
455-871, sheets 1-3	Rev 7P2	Details, Canister, MPC-Yankee
455-872, sheets 1-2	Rev 12	Assembly, Transportable Storage Canister (TSC), MPC-Yankee
455-872, sheets 1-2	Rev 11P1	Assembly, Transportable Storage Canister (TSC), MPC-Yankee
455-873	Rev 4	Assembly, Drain Tube, Canister, MPC-Yankee
455-881, sheets 1-3	Rev 8	PWR Fuel Tube, MPC-Yankee
455-887, sheets 1-3	Rev 4	Basket Assembly, 24 GTCC Container, MPC-Yankee
455-888, sheets 1-2	Rev 8	Assembly, Transportable Storage Canister (TSC), 24 GTCC Container, MPC-Yankee
455-891, sheets 1-2	Rev 1	Bottom Weldment, Fuel Basket, MPC-Yankee
455-891, sheets 1-3	Rev 2P0	Bottom Weldment, Fuel Basket, MPC-Yankee
455-892, sheets 1-2	Rev 3	Top Weldment, Fuel Basket, MPC-Yankee
455-892, sheets 1-3	Rev 3P0	Top Weldment, Fuel Basket, MPC-Yankee
455-893	Rev 3	Support Disk and Misc. Basket Details, MPC-Yankee
455-894	Rev 2	Heat Transfer Disk, Fuel Basket, MPC-Yankee
455-895, sheets 1-2	Rev 5	Fuel Basket Assembly, MPC-Yankee
455-895, sheets 1-2	Rev 5P0	Fuel Basket Assembly, MPC-Yankee
455-919	Rev 2	Retainer, United Nuclear Test Assy, MPC-Yankee
414-801, sheets 1-2	Rev 2	Cask Assembly, NAC-STC, CY-MPC
414-820	Rev 0	Canister Spacer CY-MPC
414-870	Rev 3	Canister Shell, CY-MPC
414-871, sheets 1-2	Rev 6	Details, Canister CY-MPC
414-872, sheets 1-3	Rev 6	Assembly, Transportable Storage Canister (TSC), CY-MPC
414-873	Rev 2	Drain Tube Assembly, CY-MPC
414-874	Rev 0	Shim, Canister, CY-MPC
414-875	Rev 0	Spacer Shim, Canister, CY-MPC
414-881, sheets 1-2	Rev 4	Fuel Tube, Transportable Storage Canister (TSC), CY-MPC
414-882, sheets 1-2	Rev 4	Oversize Fuel Tube, Transportable Storage Canister (TSC), CY-MPC

The following drawings have been withheld as Sensitive Unclassified Non-Safeguards Information-Security-Related Information:

Drawing Nos 423-802, Sheets 1 through 7, Revision 25

Drawing 423-209, Revision 1

Drawing 423-210, Revision 1

Drawing 423-257, Revision 3

Drawing 423-258, Revision 3

8.4.3.1 Preparation for Lead Pour

The following activities must be completed in preparation for pouring of the lead in the NAC-STC cask body:

1. Temporary stiffener bars/rings are installed inside the body weldment at intermittent locations along the cask length. Optional stiffener bars/rings may be installed on the outside of the body weldment at intermittent locations along the cask length. The stiffeners support the shells during the lead pour and cooldown in order to maintain the specified dimensions of the lead annulus. The stiffeners are removed after the cooldown operation is completed.

2. Pairs of thermocouples are used to monitor the heating and cooling cycle of the inner and outer shells. Each pair of thermocouples is positioned at approximately the same radial and axial location, one on the inside diameter of the inner shell and one on the outside diameter of the outer shell. The exact number of pairs shall be determined prior to the lead pour.

3. Heaters are installed in the cask cavity for use in heating the inner shell. Typical heaters include but are not limited to electric, gas, etc.

4. The body weldment (Section 8.4.1) of the NAC-STC is inverted and supported in a stable, vertical position within a structure that provides a basically draft-free operational area.

5. An auxiliary dam extension and supports are welded to the open end of the outer shell. The extension and supports permit the full length of the lead shell to be poured in one operation while maintaining the annulus spacing at the open end of the outer shell.

6. Heating/water cooling systems are installed around the outside of the body weldment for use in heating, and later in cooling, the outer shell. A heating system is also used on the outside surface of the bottom inner forging. Heating methods include but are not limited to electric, gas, etc. Cooling methods include but are not limited to cooling rings, cooling shells, etc. encompassing the inner and outer shells.

7. The body weldment surfaces, especially the lead annulus, are checked for dimensional accuracy to ensure that the required spacing has been maintained and for cleanliness to ensure that no foreign materials are present.

8. The typical general arrangement of the equipment for the alternate method lead pour operation is shown in Figure 8.4-2.

8.4.3.2 Lead Pour Operations

The requirements and activities that must be completed during the pouring of the lead in the NAC-STC cask body are:

1. The lead material certification is checked to ensure that it conforms to the requirements of the American Society of Testing Materials (ASTM) B29, Chemical Copper Grade - 99.90 percent pure.

2. Approximately 60,000 pounds of lead is placed in appropriate size kettles and melted. During the lead pouring operations the temperature of the molten lead is maintained above a sufficient temperature to conduct the pour but below 790°F (421°C).

3. At the same time that the lead is being melted, the NAC-STC body weldment is simultaneously heated on both the interior and exterior. The body weldment will be heated in a steady, uniform, and controlled manner at a rate not exceeding 125°F/hour (69.4°C/hour). A heating system is also used to heat the exterior of the bottom inner forging. The surface temperature of the body weldment is never permitted to exceed 800°F (427°C). The temperature of the entire body weldment is maintained between 640°F (338°C) and 740°F (393°C) throughout the lead pour operations.

4. The lead pour is initiated after the temperatures of the lead and the body weldment are stabilized, as previously described. The actual pouring of the lead is completed without interruption and in as short a period of time as possible. During the lead pour the bottom end of the filler-tube is kept below the surface of the molten lead to preclude the formation of voids in the lead.

5. The lead is poured to a level that is sufficient to ensure that dross removal and contraction during solidification do not reduce the finished surface below the required level. A long steel rod inserted into the molten lead annulus is used to ensure that no solidification has begun anywhere in the volume of molten lead.

8.4.3.3 Cooldown Following Lead Pour

The procedures and requirements that must be completed during cooldown of the NAC-STC body weldment following completion of the lead pour are as follows:

1. Cooldown is initiated by turning off the interior and exterior heaters at the lowest end of the cask (in the as-poured position). A water tank cooling system is then used to facilitate and control cooling. As cask cooling proceeds, effected by raising the cooling system water level, the heaters upward along the cask are successively turned off, ensuring the head of lead during cooling remains in the molten state.

2. The cooldown process is temperature controlled to maintain approximately uniform solidification conditions across the thickness and around the circumference of the annulus. This is maintained by controlling both the minimum inlet water temperature and the rate in which the water level is increased. The maximum water level rate of increase shall be no greater than 23.62 inches (600mm)/hr and the minimum inlet water temperature shall be greater than 45°F (7°C). Overall cooling rate(s) should be controlled by lead solidification measurements described below in Step 3 below.

3. The solidification level in the lead annulus is checked with the aid of a long steel rod in order to verify there is no significant difference in solid surface between the inside and outside of the annulus.

4. Dross is skimmed off the top of the lead while maintaining the molten head throughout the cooldown process.

8.4.3.4 Lead Pour Documentation

The following data is included in the Data Package for the Lead Pour Operation:

8.4.3.4 Lead Pour Documentation

The following data is included in the Data Package for the Lead Pour Operation:

1. Certificate of Chemical Analysis of the lead.

2. Heating and cooling charts showing elapsed time and temperatures.