NAC INTERNATIONAL

Atlanta Corporate Headquarters
3930 East Jones Bridge Road, Suite 200
Norcross, GA 30092
Phone 770-447-1144
www.nacintl.com

ADMINISTRATION

2014 OCT 20 AM 11: 20

October 17, 2014

CNSC CCSN
4542390

3.01.02
FILE DOSSIER 30-10-2-167
REFERRED TO REFERÉ À Garg, R
File

Mr. Rajesh Garg
Canadian Nuclear Safety Commis
280 Slater Street
Ottawa, ON K1P 5S9
Canada

Subject: NAC-LWT Cask, US NRC CoC 9225
Highly Enriched Uranyl Nitrate Liquid (HEUNL) Amendment

References: 1. ED20140105, Submission of NAC Responses to NRC's Third Request for Additional Information to NAC Amendment Request for Certificate of Compliance (CoC) No. 9225 for the NAC-LWT Cask to Incorporate Highly Enriched Uranyl Nitrate Liquid (HEUNL) as Authorized Content, October 17, 2014

Dear Mr. Garg,

NAC International (NAC) herewith provides an electronic copy of the proprietary and non-proprietary versions of NAC's response to the U.S. NRC Third Request for Additional Information (Reference 1) as Enclosure 1 on CD media. These documents are being provided to CNSC in support of the review of NAC's request for Canadian validation of the subject CoC for the shipment of HEUNL. Proprietary information is being withheld via 10CFR2.390. Please handle all proprietary information accordingly.

Should you require additional documents, please feel free to contact me.

Best Regards,

for T. Patko

Anthony L. Patko
Director, Licensing
Engineering

cc: Mr. Sylvain Faille – CNSC w/o Enclosure
Mr. Mark Chapman – AECL w/ Enclosure

Enclosures:

Enclosure 1 – ED20140105, Submission of NAC Responses to NRC's Third Request for Additional Information to NAC Amendment Request for Certificate of Compliance (CoC) No. 9225 for the NAC-LWT Cask to Incorporate Highly Enriched Uranyl Nitrate Liquid (HEUNL) as Authorized Content, October 17, 2014

ED20140110

September 2014

NAC-LWT

Legal Weight Truck Cask System

HEUNL RAI Response Package

NON-PROPRIETARY VERSION

Docket No. 71-9225

NAC INTERNATIONAL

Atlanta Corporate Headquarters: 3930 East Jones Bridge Road, Norcross, Georgia 30092 USA
Phone 770-447-1144, Fax 770-447-1797, www.nacintl.com

NAC INTERNATIONAL

Atlanta Corporate Headquarters
3930 East Jones Bridge Road, Suite 200
Norcross, GA 30092
Phone 770-447-1144
www.nacintl.com

October 17, 2014

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Attn: Document Control Desk

Subject: Submission of NAC Responses to NRC's Third Request for Additional Information to NAC Amendment Request for Certificate of Compliance (CoC) No. 9225 for the NAC-LWT Cask to Incorporate Highly Enriched Uranyl Nitrate Liquid (HEUNL) as Authorized Content

Docket No. 71-9225

References:

1. Model No. NAC-LWT Package, U.S. Nuclear Regulatory Commission (NRC) Certificate of Compliance (CoC) No. 9225, Revision 59, November 5, 2013
2. Safety Analysis Report (SAR) for the NAC Legal Weight Truck Cask, Revision 41, NAC International, April 2010
3. ED20120149, Submission of a Request for an Amendment of Certificate of Compliance (CoC) No. 9225 for the NAC-LWT Cask to Incorporate Highly Enriched Uranyl Nitrate Liquid (HEUNL) as Authorized Content, December 28, 2012
4. NRC Letter, Application for Amendment to the Model No. NAC-LWT – Supplemental Information Needed, U.S. NRC, January 31, 2013
5. ED20130029, Submission of NAC Responses to NRC's Request for Supplemental Information to NAC Amendment Request for Certificate of Compliance (CoC) No. 9225 for the NAC-LWT Cask to Incorporate Highly Enriched Uranyl Nitrate Liquid (HEUNL) as Authorized Content, NAC International, March 14, 2013
6. U.S. NRC Letter to NAC – Request for Additional Information for Review of the Certificate of Compliance No. 9225, for the Model No. NAC-LWT Package, U.S. NRC, July 2, 2013
7. ED20140007, Submission of NAC Responses to NRC's Request for Additional Information to NAC Amendment Request for Certificate of Compliance (CoC) No. 9225 for the NAC-LWT Cask to Incorporate Highly Enriched Uranyl Nitrate Liquid (HEUNL) as Authorized Content, NAC International, March 5, 2014
8. U.S. NRC Letter to NAC – Second Request for Additional Information for Review of the Certificate of Compliance No. 9225, for the Model No. NAC-LWT Package, U.S. NRC, June 3, 2013

9. ED20140070, Submission of NAC Responses to NRC's Second Request for Additional Information to NAC Amendment Request for Certificate of Compliance (CoC) No. 9225 for the NAC-LWT Cask to Incorporate Highly Enriched Uranyl Nitrate Liquid (HEUNL) as Authorized Content, July 16, 2014

10. U.S. NRC Letter to NAC – Third Request for Additional Information for Review of the Certificate of Compliance No. 9225, for the Model No. NAC-LWT Package, September 18, 2014

NAC International (NAC) hereby submits responses to Reference 10. This submittal includes a proprietary and a non-proprietary version of this submittal package, including this transmittal letter and Revision LWT-14E changed pages to the Reference 2 SAR and Reference 3, 5, 7 and 9 changed pages (Enclosure 6). All proprietary information is requested to be withheld from public disclosure, see Attachment 1 to this letter, via 10CFR2.390.

Enclosure 1 contains the Reference 10 RAI questions and respective NAC responses.

Enclosure 2 contains a brief summary of the changes to the SAR for the LWT-14E SAR changed pages. Consistent with NAC administrative practice, this proposed SAR revision is numbered to uniquely identify the applicable changed pages. Revision bars mark the SAR text changes on the Revision LWT-14E pages. This submittal includes 1 revised proprietary license drawings. Enclosure 3 to this transmittal letter lists all drawing changes in detail. The included List of Effective Pages identifies the current revision level of all pages in the application's SAR. In addition, Enclosure 4 contains a supporting proprietary NAC calculation.

In order to better facilitate the review process, NAC is providing the Revision LWT-14E change pages with appropriate backing pages. Consequently, a number of Revision 41, LWT-12E, LWT-13B, LWT-14B and LWT-14D changed pages are included. In accordance with NAC's administrative practices, upon final acceptance of this application, the LWT-12E, -13B, -14B, -14D and -14E changed pages will be reformatted and incorporated into the next revision of the NAC-LWT SAR.

In this amendment request, the proposed changes to the authorized contents are described in Chapter 1. The structural, thermal, containment, shielding and criticality evaluations documenting the suitability of the NAC-LWT packaging for the requested content are presented in SAR Chapters 2, 3, 4, 5 and 6, respectively. Chapters 7 and 8 have also been revised to address the operational & loading requirements and fabrication acceptance testing.

Enclosure 5 to this transmittal letter includes the requested changes to Reference 1. Approval of this HEUNL amendment is requested to support obtaining an updated US DOT Competent Authority Certificate and Foreign Validation in order to meet the associated shipping schedules.

If you have any comments or questions, please contact me on my direct line at 678-328-1274.

Sincerely,

Wren Fowler for T. Patko

Anthony L. Patko
Director, Licensing
Engineering

Attachment:

Attachment 1 – NAC International Affidavit Pursuant to 10 CFR 2.390

Enclosures:

Enclosure 1 – RAI Responses, No. 9225 for the NAC-LWT Cask, NAC-LWT SAR, Revision LWT-14E, HEUNL Amendment
Enclosure 2 – List of Changes, NAC-LWT SAR, Revision LWT-14E, HEUNL Amendment – RAI Responses
Enclosure 3 – List of Drawing Changes, NAC-LWT SAR, Revision LWT-14E, HEUNL Amendment
Enclosure 4 – Supporting Calculations, NAC-LWT SAR, Revision LWT-14E, HEUNL Amendment
Enclosure 5 – Proposed Changes for Revision 60 of Certificate of Compliance No. 9225 for the NAC-LWT Cask, NAC-LWT SAR, Revision LWT-14E, HEUNL Amendment
Enclosure 6 – SAR Page Changes and LOEP, No. 9225 for NAC-LWT SAR, Revision LWT-14E, HEUNL Amendment

NAC INTERNATIONAL
AFFIDAVIT PURSUANT TO 10 CFR 2.390

George Carver (Affiant), Vice President, Engineering and Licensing, of NAC International, hereinafter referred to as NAC, at 3930 East Jones Bridge Road, Norcross, Georgia 30092, being duly sworn, deposes and says that:

1. Affiant has reviewed the information described in Item 2 and is personally familiar with the trade secrets and privileged information contained therein, and is authorized to request its withholding.

2. The information to be withheld includes the following NAC Proprietary Information that is being provided to support the technical review of NAC's Request for a Certificate of Compliance (CoC) (No. 9225) for the NAC International Legal Weight Truck (LWT) Transport Cask.

   - NAC RAI Responses
     - Pages 3, 4, 5, 6 and 7
   - NAC International Proprietary Calculations
     - Calculation 65008500-2010, Revision 3
   - NAC-LWT SAR, Revision 14E, – Proprietary Version, including:
   - NAC International Proprietary License Drawings
     - List of Drawing Changes, and
     - 315-40-181, Revision 5P

   NAC is the owner of the information contained in the above documents. Thus, all of the above identified information is considered NAC Proprietary Information.

3. NAC makes this application for withholding of proprietary information based upon the exemption from disclosure set forth in: the Freedom of Information Act ("FOIA"); 5 USC Sec. 552(b)(4) and the Trade Secrets Act; 18 USC Sec. 1905; and NRC Regulations 10 CFR Part 9.17(a)(4), 2.390(a)(4), and 2.390(b)(1) for "trade secrets and commercial financial information obtained from a person, and privileged or confidential" (Exemption 4). The information for which exemption from disclosure is herein sought is all "confidential commercial information," and some portions may also qualify under the narrower definition of "trade secret," within the meanings assigned to those terms for purposes of FOIA Exemption 4.

4. Examples of categories of information that fit into the definition of proprietary information are:

   a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by competitors of NAC, without license from NAC, constitutes a competitive economic advantage over other companies.

   b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality or licensing of a similar product.

   c. Information that reveals cost or price information, production capacities, budget levels or commercial strategies of NAC, its customers, or its suppliers.

   d. Information that reveals aspects of past, present or future NAC customer-funded development plans and programs of potential commercial value to NAC.

e. Information that discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information that is sought to be withheld is considered to be proprietary for the reasons set forth in Items 4.a, 4.b, and 4.d.

5. The information to be withheld is being transmitted to the NRC in confidence.

6. The information sought to be withheld, including that compiled from many sources, is of a sort customarily held in confidence by NAC, and is, in fact, so held. This information has, to the best of my knowledge and belief, consistently been held in confidence by NAC. No public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements, which provide for maintenance of the information in confidence. Its initial designation as proprietary information and the subsequent steps taken to prevent its unauthorized disclosure are as set forth in Items 7 and 8 following.

7. Initial approval of proprietary treatment of a document/information is made by the Vice President, Engineering, the Project Manager, the Licensing Specialist, or the Director, Licensing – the persons most likely to know the value and sensitivity of the information in relation to industry knowledge. Access to proprietary documents within NAC is limited via "controlled distribution" to individuals on a "need to know" basis. The procedure for external release of NAC proprietary documents typically requires the approval of the Project Manager based on a review of the documents for technical content, competitive effect and accuracy of the proprietary designation. Disclosures of proprietary documents outside of NAC are limited to regulatory agencies, customers and potential customers and their agents, suppliers, licensees and contractors with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

8. NAC has invested a significant amount of time and money in the research, development, engineering and analytical costs to develop the information that is sought to be withheld as proprietary. This information is considered to be proprietary because it contains detailed descriptions of analytical approaches, methodologies, technical data and/or evaluation results not available elsewhere. The precise value of the expertise required to develop the proprietary information is difficult to quantify, but it is clearly substantial.

9. Public disclosure of the information to be withheld is likely to cause substantial harm to the competitive position of NAC, as the owner of the information, and reduce or eliminate the availability of profit-making opportunities. The proprietary information is part of NAC's comprehensive spent fuel storage and transport technology base, and its commercial value extends beyond the original development cost to include the development of the expertise to determine and apply the appropriate evaluation process. The value of this proprietary information and the competitive advantage that it provides to NAC would be lost if the information were disclosed to the public. Making such information available to other parties, including competitors, without their having to make similar investments of time, labor and money would provide competitors with an unfair advantage and deprive NAC of the opportunity to seek an adequate return on its large investment.

STATE OF GEORGIA, COUNTY OF GWINNETT

Mr. George Carver, being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated herein are true and correct to the best of his knowledge, information and belief.

Executed at Norcross, Georgia, this 17TH day of October, 2014.

George Carver
Vice President, Engineering and Licensing
NAC International

Subscribed and sworn before me this 17TH day of October, 2014.

Notary Public

AZUREE OWENS NOTARY EXPIRES GEORGIA DEC. 15, 2017 PUBLIC GWINNETT COUNTY

Enclosure 1

RAI Responses

No. 9225 for NAC-LWT Cask

NAC-LWT SAR, Revision LWT-14E

HEUNL Amendment

NAC INTERNATIONAL

RESPONSE TO THE

UNITED STATES
NUCLEAR REGULATORY COMMISSION

REQUEST FOR ADDITIONAL INFORMATION

FOR REVIEW OF THE CERTIFICATE OF COMPLIANCE NO. 9225, REVISION FOR THE MODEL NO. NAC-LWT PACKAGE TO INCORPORATE HEUNL

(TAC NO. L24708 DOCKET NO. 71-9225)

September 2014

TABLE OF CONTENTS

Page

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

GENERAL INFORMATION EVALUATION

1.1 Revise the application to provide the classification and category of the HEUNL canister and lid assembly components or confirm that the components listed in Drawing No. 315-40-181, Rev. 3P have a Category A quality classification for importance to safety.

NAC's response dated July 16, 2014, (see Agencywide Documents Access and Management System (ADAMS) Accession No. ML14203A315) to NRC's question No. 4.3 in letter dated June 3, 2014 (see ADAMS Accession No. ML14155A016) indicated that the port plug/seal positioned inside the inner HEUNL lid O-ring seal and the HEUNL lid O-ring are Category A components. It also mentioned that the port plug/seal positioned outside the inner HEUNL lid O-ring seal and outer lid O-ring are Category C components. In addition, provide in the application the classification and category of the remaining items in Drawing No. 315-40-181, Rev. 3P or confirm that the remaining items in Drawing No. 315-40-181, Rev 3P are Category A components.

This information is needed to determine compliance with Title 10, *Code of Federal Regulations* (10 CFR) 71.33.

<u>NAC International Response to General Information Evaluation RAI 1.1:</u>

All components listed on drawing 315-40-181 are important to safety. The end of the first paragraph in SAR Section 1.2.3.12 has been revised by adding following statement:

"All hardware indicated on drawing 315-40-181 has been determined to be "Important to Safety" and has been evaluated, characterized and will be controlled in accordance with NAC's QA Program as described in section 1.3."

[redacted]

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

GENERAL INFORMATION EVALUATION

1.2 Revise the SAR to address the following regarding the Type I and Type II HEUNL containers:

a. Clarify whether the Type I HEUNL container design will be used for vertical draining only, and whether the Type II HEUNL container design will be used for vertical or horizontal draining. In addition, describe any other reasons for using a Type I or Type II HEUNL container.

b. Address the potential confusion regarding note 4 in association with item 25, both of which appear on Drawing No. 315-40-181, Rev. 3P considering the need for complete removal of contents and accountability of the fissile contents.

If the Type II HEUNL container is drained in the horizontal orientation, it appears the vent tube (item 25 from Drawing No. 315-40-181, Rev. 3P) is used for draining instead of the drain tube (item 15 from Drawing No. 315-40-181, Rev. 3P) (i.e. the HEUNL liquid will come out of the vent tube when the HEUNL container and vent tube are in the proper orientation.) Note that means for the Type II HEUNL container, the vent tube (item 25 from Drawing No. 315-40-181, Rev. 3P) should have the stamp/engraving “Drain/fill” as described in note 4 from Drawing No. 315-40-181, Rev. 3P, or more accurately the stamp/engraving “Drain.” This could result in incorrect stamping/engraving and potentially incomplete removal of contents, or incorrect accountability of contents. It may not be the intention to “Fill” through the vent tube because the tube doesn’t reach the bottom of the HEUNL container during the required vertical filling operations. For example, Section 7.1.14.2 step 3 of the application may not be accurate for the Type II HEUNL container. If this is not correct, provide further explanation how the Type II HEUNL container will be completely drained in the horizontal orientation.

This information is needed to determine compliance with Title 10, Code of Federal Regulations (10 CFR) 10 CFR 71.33.

<u>NAC International Response to General Information Evaluation RAI 1.2:</u>

a. NAC has revised SAR Section 1.2.3.12 by adding an additional paragraph as follows to provide clarity for the Type I and Type II container designs:

[redacted]

b. NAC has revised drawing 315-40-181 by adding delta notes 3 and 4 as follows:

[redacted]

In addition, the terminology for the ports in Operating Procedures, Sections 7.1.14.1 and 7.1.14.2 have been revised accordingly.

NAC INTERNATIONAL RESPONSE

TO
REQUEST FOR ADDITIONAL INFORMATION

CONTAINMENT EVALUATION

4.1 [redacted]

NAC International Response to Containment Evaluation RAI 4.1:

[redacted]

[redacted]

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

OPERATING PROCEDURES EVALUATION

7.1 Clarify the acceptance criteria when leak testing the HEUNL lid plug and HEUNL closure lid O-ring seals to ensure HEUNL containment after filling.

SAR Section 7.1.14.2 steps 7.i and 9.d (page 7.1-66), indicate a leakage rate sensitivity of $1X10^{-3}$ ref-cm^3/s, per American National Standards Institute (ANSI) in ANSI N14.5-1997, "Radioactive Materials - Leakage Tests on Packages for Shipment." According to ANSI N14.5-1997, the acceptance criteria for a preshipment leakage rate test is either "a leakage rate of not more than the reference air leakage rate" or "no detected leakage when tested to a sensitivity of at least $1X10^{-3}$ ref-cm^3/sec." As currently written in Section 7.1.14.2 of the SAR, it appears that the HEUNL lid plug and O-ring seal leakage test procedures accept a certain amount of leakage.

This information is needed to determine compliance with 10 CFR 71.33, and 10 CFR 71.87.

NAC International Response to Operating Procedures Evaluation RAI 7.1:

SAR Section 7.1.14.2, Steps 7 and 9 have been extensively revised to clarify that the specified preshipment leakage test acceptance criteria for both the closure lid plug & seal and the closure lid inner O-ring seal is no detected leakage when tested to a sensitivity of $\leq 1 \times 10^{-3}$ ref-cm^3/sec per ANSI N14.5-1997.

A note has been added to SAR Section 7.1.14.2, Step 4, requiring that all pre-shipment testing procedures of the HEUNL container pressure boundary shall be performed in accordance with written procedures prepared and approved by personnel certified by ANST as a Level III examiner for leakage testing.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

OPERATING PROCEDURES EVALUATION

7.2 Clarify whether Section 7.1.14.2 of the SAR addresses that the functional leakage rate test ensures there is no leakage of air from the valved nipple(s) and container interface, and the vent tube or siphon tube to the HEUNL container's top end cap interface.

The focus of the NAC response dated July 16, 2014, (see ADAMS Accession No. ML14203A315) to NRC's question No. 7.4 (in letter dated June 3, 2014 (see ADAMS Accession No. ML14155A016) was on the quick disconnect valve, and it is not clear whether the functional leakage rate test of this component also tests the integrity of the vent tube or siphon tube interface with the HEUNL container's top end cap. In order to ensure that an under fill void volume of at least 1 gallon based on the length of the siphon assembly and vent tube, there cannot be leakage of air from the HEUNL container during filling operations. That also means there cannot be leakage from the valved nipple(s) and container interface, or the vent tube or siphon tube to the HEUNL container's top end cap interface. It is not clear whether the test described in Section 7.1.14.2.5 of the application captures those multiple interfaces.

This information is needed to determine compliance with 10 CFR 71.87.

<u>NAC International Response to Operating Procedures Evaluation RAI 7.2:</u>

SAR Sections 7.1.14.1, Step 6 and 7.1.14.2, Step 5 have been revised to show that the specified pre-fill and post-fill functional verification tests will ensure that there is no leakage of air past the valved nipples and the valved nipple O-ring sealed connections to the HEUNL container's top end cap interface.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

ACCEPTANCE AND MAINTENANCE TESTS EVALUATION

8.1 Justify the use of personnel certified by American Society of Nondestructive Testing (ASNT) as a Level II examiner to develop and approve helium and pressure change leakage rate testing procedures considering that industry standards indicate that this should be performed by a Level III examiner.

Both the NAC's response dated July 16, 2014, (see ADAMS Accession No. ML14203A315) to NRC's question No. RAI 4.1 in letter dated June 3, 2014 (see ADAMS Accession No. ML14155A016) and SAR Section 8.1.4.4 indicate that leak test procedures would be prepared and approved by an ASNT Level II examiner. However, the ANSI/ASNT CP-189-2006, "Standard for Qualification and Certification of Nondestructive Testing Personnel", which provides the minimum training, education, and experience requirements for nondestructive testing personnel, states that a nondestructive testing personnel Level III examiner has the qualifications to develop and approve written instruction for conducting the leak testing.

This information is needed to determine compliance with 10 CFR 71.37, 10 CFR 71.87, and 10 CFR 71.119.

NAC International Response to Acceptance and Maintenance Test Evaluation RAI 8.1:

SAR Section 8.1.4.4 has been revised to specify that the leak test procedures specified in the section are prepared and approved by an ASNT Level III examiner in accordance with the requirements of ANSI/ASNT CP-189-2006, "Standard for Qualification and Certification of Nondestructive Testing Personnel".

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

ACCEPTANCE AND MAINTENANCE TESTS EVALUATION

8.2 Revise the verification test in Section 8.1.4.4.B "Pressure Testing" which ensures the under filled void volume is at least 1 gallon by:

a. describing the siphon assembly item 26 in drawing 315-40-181, Rev. 3P, and providing Drawing No. 315-40-181-94.

b. addressing that this verification test is applicable to the Type II container vent tube (item 25 from Drawing No. 315-40-181, Rev. 3P), as well as the Type I container siphon assembly (item 26 from Drawing No. 315-40-181, Rev. 3P),

c. addressing that this verification test must be performed with the HEUNL container in the vertical orientation,

d. clarifying the procedure regarding, "the drain tube and siphon assembly are installed,"

e. including steps to verify the drain tube was not tested in place of the vent tube or siphon tube.

Drawing No. 315-40-181-94 was not provided. This verification test description only addresses the siphon assembly for the Type I container, it does not address that the verification test is also applicable to the vent tube for the Type II container. For verification of the under filled void volume of at least 1 gallon based on the length of the siphon assembly and vent tube, the HEUNL container must be in the vertical orientation, as it must be during filling operations. It is not clear whether the drain tube, siphon assembly (and vent tube that was not addressed), are installed prior to the hydrostatic test or after the hydrostatic test. If the tubes are installed after the hydrostatic test, details should be provided to clarify how this is performed considering the geometry (straight, or with bends) of the tubes. Although the drain tube is described to be closed in the Section 8.1.4.4.B procedures, a separate RAI (see item 2 in Chapter 1 – General Information Evaluation, above) noted how mislabeling of the drain or vent could occur. Because the container will have to be completely drained, it may be beneficial to include steps in the procedure that describes completely draining the HEUNL container. This could also verify the wrong tube (drain instead of vent or siphon) was not initially tested.

This information is needed to determine compliance with 10 CFR 71.33(b)(2), and 71.87(d).

<u>NAC International Response to Acceptance and Maintenance Test Evaluation RAI 8.2:</u>

a. The syphon assembly, Item 26 is a section of tube welded to a quick-disconnect for insertion into the Type I container. This assembly functions the same as the statically mounted vent tube, Item 25, for establishing the 1-gallon air pocket. There is not a separate drawing 315-40-181-94, it is a sub-weldment detail to the 315-40-181 drawing. NAC has added the detail to the subject drawing.

b. NAC has clarified in SAR Section 8.1.4.4.B that the verification test of "1-gallon void" is to be performed for both the Type I and the Type II containers.

c. NAC has added clarification to SAR Section 8.1.4.4.B that the hydrostatic test is to be performed vertically, disconnect side up.

d. NAC has provided additional clarification in SAR Section 8.1.1.4.B for the Type I and Type II variations. Only the Type I has a syphon assembly installed. The Type II container has an internally mounted vent tube.

e. NAC has revised the testing description in SAR Section 8.1.4.4.B to provide additional clarity for the verification testing.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

ACCEPTANCE AND MAINTENANCE TESTS EVALUATION

8.3 Revise Section 8.1.4.4.B, "Pressure Testing" of the SAR to:

a. Address whether the siphon assembly for the Type I HEUNL container and vent tube for the Type II HEUNL container is installed prior to the hydrostatic test. If these parts are installed prior to the hydrostatic test, revise the section to:

i. address how it is possible to perform a hydrostatic test which necessitates completely filling the container, including how air is let out of the HEUNL container, and

ii. describe steps in Section 7.1.14.2 of the operating procedures to prevent the complete filling of the HEUNL container.

b. Describe hydrostatic pressure testing of the lid plug and the associated O-ring seal.

If the vent tube or siphon assembly is installed prior to the hydrostatic test, it should not be possible to completely fill the HEUNL container to perform the hydrostatic test, because that is the purpose of the minimum dimensioned length in Note 11 of Drawing No. 315-40-181, Rev. 3P. It is also not clear how air is let out of the HEUNL container to allow complete filling of the HEUNL container, if the vent tube or siphon assembly is installed prior to the hydrostatic test. If the vent tube or siphon assembly is installed prior to the hydrostatic test, it should be completely described in Section 7.1.14.2 of the operating procedures how any steps that are taken to completely fill the HEUNL container during the hydrostatic test are prevented during the filling operations.

The lid plug and associated O-ring seal are part of the pressure boundary as described in Section 8.1.4.4.B of the SAR. Section 8.1.4.4.B states, "The pressure test system will be installed in the container lid plug hole to allow container filling, venting and application of the hydrostatic pressure." It is not clear how the lid plug and associated O-ring seal are being pressure tested in this section of the SAR.

This information is needed to determine compliance with 10 CFR 71.33, 10 CFR 71.43(f), and 10 CFR 71.51.

<u>NAC International Response to Acceptance and Maintenance Tests Evaluation RAI 8.3:</u>

a. Hydrostatic testing in SAR Section 8.1.4.4.B has been revised for clarity. The following represents a method in which the containers can be filled to support hydrostatic testing in accordance with the ASME requirements:

The syphon assembly, Item 26, is a section of tube welded to the quick-disconnect for insertion into the Type I container for maintaining the 1-gallon air pocket. This is used exclusively for the Type I container. For the Type I container, NB-6211 can be complied with by removing the vent syphon tube assembly and pumping water into the container through the drain fitting. Once the water is flowing out of the vent opening, the drain fitting is removed and the lid installed. Final filling of the container is performed through the lid port. The hydrostatic test rig is then installed and bled of air.

For the Type II container, the syphon tube is mounted inside the container. NB-6211 can be complied with by rotating the container upside down for filling, using the fill line as the vent and the vent/drain line as the fill port. After the Type II container is filled, it is returned to the upside up, vertical orientation for final filling following that described for the Type I container above. In both the Type I and Type II configurations, the quick-disconnects are removed from the container prior to hydrostatic testing.

b. NAC has determined the lid plug and seal are exempted from hydrostatic testing due to their small size.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

ACCEPTANCE AND MAINTENANCE TESTS EVALUATION

8.4 Clarify how a straight section drain line (e.g. lance) of a diameter which can be inserted through the vent port could be used with the item 25 vent tube from Drawing No. 315-40-181, Rev. 3P.

It is not clear how a straight section drain line (e.g. lance) could be used to drain the Type II HEUNL container for the Type II container considering the bends in the item 25 vent tube from Drawing No. 315-40-181, Rev. 3P.

This information is needed to determine compliance with 10 CFR 71.43(f).

<u>NAC International Response to Thermal Evaluation RAI 8.4:</u>

In the case where Item 25 is used in the Type II container, the contingency drain line will need to be flexible in order to navigate the vent tube bends.

Enclosure 2

List of Changes

NAC-LWT SAR, Revision LWT-14E

HEUNL Amendment – RAI Responses

List of Changes, NAC-LWT SAR, Revision LWT-14E

Note: The List of Effective Pages and the Chapter Tables of Contents, including the List of Figures, the List of Tables, and the List of Drawings, were revised as needed to incorporate the following changes.

Chapter 1

- Page 1.2-18, modified Section 1.2.3.12 by adding text to the end of the first paragraph and inserting a new second paragraph below it.

Chapter 2

- Page 2.6.12-101, modified the second paragraph under the heading "Design Pressure Case."
- Page 2.6.12-102, modified the second paragraph under the heading "1 Foot Top End Drop."
- Page 2.6.12-103, deleted heading "Pressure Case" and the two paragraphs that followed; this deletion caused text flow changes thru page 2.6.12-107.
- Page 2.6.12-105, modified the second paragraph under the heading, "Cold Conditions."
- Page 2.6.12-107, modified the paragraph that follows Figure 2.6.12-19.
- Page 2.7.7-75 thru 2.7.7-77, modified subsection 2.7.7.15.2 throughout, and modified the second paragraph of subsection 2.7.7.15.3.
- Page 2.7.7-78, modified the paragraph under the heading, "Bolt Stresses."

Chapter 3

- No changes.

Chapter 4

- No changes.

Chapter 5

- No changes.

Chapter 6

- No changes.

Chapter 6 Appendices

- No changes.

List of Changes, NAC-LWT SAR, Revision LWT-14D (cont'd)

Chapter 7

- Page 7.1-63, modified the first sentence of the first paragraph of Section 7.1.14.1.
- Page 7.1-64 thru 7.1-67, modified step 6 of Section 7.1.14.1 and Section 7.1.14.2, throughout.
- Page 7.2-18, modified the third paragraph of Section 7.2.8.
- Page 7.2-19, text flow changes.

Chapter 8

- Pages 8.1-9 thru 8.1-10, modified subsection 8.1.4.4.B, "Pressure Testing," throughout.
- Pages 8.1-11 thru 8.1-13, modified the last paragraphs of subsections 8.1.4.4.C.1, C.2 and C.3, to show a Level III ANST examiner.
- Pages 8.1-14 thru 8.1-15, text flow changes.
- Page 8.2-5, modified the first line of the third paragraph in the section, "HEUNL Container," of Table 8.2-1.

Chapter 9

- No changes.

Enclosure 3

List of Drawing Changes

NAC-LWT SAR, Revision LWT-14E

HEUNL Amendment

List of Drawing Changes, NAC-LWT SAR, Revision LWT-14E

Drawing 315-40-181, Revision 4P

Updated graphics per DCR(L) 315-40-181-3PA associated with following container design changes:

Sheet 1:

[redacted]

Sheet 2: (added)

[redacted]

Drawing 315-40-181, Revision 5P

Updated graphics per DCR(L) 315-40-181-4PA associated with following container design changes:

Sheet 1:

[redacted]

Enclosure 4

Supporting Calculations

No. 9225 for NAC-LWT Cask

NAC-LWT SAR, Revision LWT-14E

HEUNL Amendment

Enclosure 4 Contents

1. Calculation “65008500-2010, Revision 3

NAC CALCULATION 65008500-2010, REVISION 3
WITHHELD IN ITS ENTIRETY PER 10CFR2.390

Enclosure 5

Proposed Changes for Revision 60 of Certificate of Compliance

No. 9225 for NAC-LWT Cask

NAC-LWT SAR, Revision LWT-14E

HEUNL Amendment

Drawings (new)

CoC Page 4 of 31:

LWT 315-40-180, Rev. 3P & 0NP	LWT Transport Cask Assembly, HEUNL Contents
LWT 315-40-181, Rev. 5P, sheets 1 and 2, & 0NP	Container Assembly, HEUNL
LWT 315-40-182, Rev. 2P & 0NP	Container Spacer, HEUNL
LWT 315-40-183, Rev. 1P & 0NP	Container Guide, HEUNL

CoC Sections (new)

CoC Page 19 of 31:

5.(b)(1) Type and form of material (continued)

(xx) HEUNL as specified below:

Parameter	Liquid HEU
Maximum HEUNL payload per Container	58.1 L (15.35 gal)
Maximum Cask Heat Load	4.65 W
Maximum Per Container Heat Load	1.16 W
Maximum HEUNL Heat Load	0.02 W/L
Maximum Curie Content (gamma emitters)	9.0 Ci/L
Maximum ^{235}U content	7.4 g ^{235}U/L
Maximum ^{235}U enrichment	93.4 wt%

CoC Page 27 of 31:

5.(b)(2) Maximum quantity of material per package (continued)

(xxi) For the HEUNL described in Item 5.(b)(1)(xx):

Up to 58.1 L (15.35 gallons) of HEUNL may be loaded per container. Plus, a minimum of 1 gallon void volume within each container. A total of 4 containers per cask shall be loaded. Full, partially filled and empty containers shall be in accordance with NAC Drawing Nos. 315-40-181, 315-40-182 and 315-40-183. Cask configuration to be in accordance with NAC Drawing No. 315-40-180.

CoC Sections (revised)

CoC Page 29 of 31:

5(c) Criticality Safety Index (CSI)

For HEUNL described in 5.(b)(1)(xx) and limited in 5.(b)(2)(xxi)	0.0

CoC Page 30 and 31 of 31

16. For shipment of HEUNL contents:

    (a) The maximum cumulative time an HEUNL container shall contain HEUNL solution is 15 months

    (b) The maximum one-way trip time the NAC-LWT shall be in transport with an HEUNL payload is 3 months

    (c) No HEUNL container shall be filled and used in transport when its cumulative time containing HEUNL solution is greater than 12 months

17. For shipment of non-fissile contents, with fissile content in the package not exceeding Type A quantity, and qualifying as a fissile exempt quantity under 10 CFR 71.15, the Model No. NAC-LWT shall be designated as Type B(U)F-96, with package identification number USA/9225/B(U)-96.

18. Transport by air is not authorized.

19. The packaged authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

20. Revision 59 and 60 of this certificate may be used until February 28, 2015, respectively.

21. Expiration Date: February 28, 2015.

REFERENCES

NAC International, Inc., application dated June 18, 2010.

NAC International, Inc., supplements dated February 3, March 2, and May 24, October 26, and December 5, 2012; January 14, February 14, July 19 (two supplements), and October 18, 2013; December 28, 2012, March 14, 2013, March 5, 2014, July 16, 2014 and TBD.

Enclosure 6

SAR Page Changes and LOEP

No. 9225 for NAC-LWT Cask

NAC-LWT SAR, Revision LWT-14E

HEUNL Amendment

September 2014

Revision LWT-14E

NAC-LWT

Legal Weight Truck Cask System

SAFETY ANALYSIS REPORT

NON-PROPRIETARY VERSION

Docket No. 71-9225

NAC INTERNATIONAL

Atlanta Corporate Headquarters: 3930 East Jones Bridge Road, Norcross, Georgia 30092 USA
Phone 770-447-1144, Fax 770-447-1797, www.nacintl.com

LIST OF EFFECTIVE PAGES

LIST OF EFFECTIVE PAGES (Continued)

Chapter 3

Chapter 4

Chapter 5

LIST OF EFFECTIVE PAGES (Continued)

Chapter 6

LIST OF EFFECTIVE PAGES (Continued)

Appendix 6.6

Chapter 7

Chapter 8

LIST OF EFFECTIVE PAGES (Continued)

List of Drawings

* Packaging Unit Nos. 1, 2, 3, 4 and 5 are constructed in accordance with this revision of drawing.

List of Drawings (continued)

plates. Two thick (0.635 cm) aluminum nonfuel side plates support the fuel plate stack from two sides, making a possible total of 16 plates per bundle. At each axial end, the plates in the stack are connected by a pin. Spacing between plates is maintained by disk spacers placed onto the top and bottom pins between each fuel plate and the aluminum side plates. A sketch of a typical MOATA plate bundle is provided in Figure 1.2.3-15.

1.2.3.10 Solid, Irradiated and Contaminated Hardware

The design basis characteristics of the solid, irradiated and contaminated hardware are provided in Table 1.2.3-1. As described in the content definition, the solid, irradiated and contaminated hardware may contain small quantities of fissile materials. Fissile materials in the irradiated hardware contents are acceptable if the quantity of fissile material does not exceed a Type A quantity and does not exceed the exemptions of 10 CFR 71.15, paragraphs (a), (b) and (c).

The irradiated hardware may be directly loaded into the NAC-LWT cask cavity, or may be contained in a secondary container or basket. As needed, appropriate component spacers, dunnage and shoring may be used to limit the movement of the contents during normal and accident conditions of transport.

To ensure that the movement of the irradiated hardware contents above the lead shielded length of the NAC-LWT cask body (i.e., the approximately upper 6.25 inches of the cavity length) is precluded, an Irradiated Hardware Lid Spacer as shown on Drawing No. 315-40-145 shall be installed for all irradiated hardware content configurations. The total installed height of the spacer is 6.5 inches. Therefore, the available cavity length for the irradiated hardware is approximately 171 inches. The NAC-LWT cask shall be assembled for transport as shown on NAC Drawing No. 315-40-01 with the irradiated hardware spacer installed on the lid.

A comparative shielding evaluation for a conservatively selected irradiated hardware transport configuration (i.e., a single line source with no self-shielding) or consideration of the additional shielding provided by additional spacers, dunnage, inserts or secondary containers is presented in Chapter 5. The evaluations show that the regulatory dose rate requirements per 10 CFR 71.47 for normal conditions of transport, or 10 CFR 71.51(b) under hypothetical accident conditions, are not exceeded.

1.2.3.11 PWR MOX Fuel Rods

The NAC-LWT cask is analyzed and evaluated for the transport of up to 16 PWR MOX fuel rods (or a combination of up to 16 PWR MOX and UO_2 fuel rods) loaded into a 5 × 5 insert placed in a screened or free flow PWR/BWR Rod Transport Canister. The authorized characteristics of the evaluated PWR MOX fuel rods are provided in Table 1.2-4. For mixed PWR MOX and UO_2 PWR fuel rod combinations, the UO_2 PWR fuel rods may have the identical heat load, burnup and cool time characteristics as the PWR MOX fuel rods.

In addition to the 16 PWR MOX fuel rods (or a combination of PWR MOX and UO_2 PWR fuel rods), up to 9 burnable poison rods (BPRs) may be loaded in the remaining openings in the 5 × 5 insert in the PWR/BWR Rod Transport Canister.

1.2.3.12 HEUNL Containers

HEUNL material packaged in HEUNL containers may be directly loaded into the NAC-LWT cavity. Four containers must be packaged in the NAC-LWT for transport. The containers may be partially filled. [redacted] A sketch of the HEUNL container is provided in Figure 1.2.3-19. The container design is presented in NAC drawing 315-40-181. All hardware indicated on drawing 315-40-181 has been determined to be "Important to Safety" and has been evaluated, characterized and will be controlled in accordance with NAC's QA Program as described in Section 1.3.

[redacted]

HEUNL material consists of a solution of uranyl nitrate, various other nitrates (primarily aluminum nitrate), and water. The solution may contain uranyl nitrates with up to 7.40 g/L ^{235}U. Key physical, radiation protection, and thermal characteristics of the HEUNL material are provided in Table 1.2.3-14.

Table of Contents (continued)

Table of Contents (continued)

List of Figures

List of Figures (continued)

Sections P6, P7 and P13 are not shown in the figures but are located at the center of the container shell half way between the bottom end cap and the top end cap.

The allowable stress S_m for SA-240, Type 304 at 200 °F is 20 ksi.

Design Pressure Case

As identified in Section 8.1.4.4 the canister is to be hydrostatically tested to 140 +10/-0 psig. This condition is treated as a normal condition, which bounds the maximum pressure expected during normal operational conditions identified in Section 4.5.6. A pressure case of 150 psig was evaluated. For this case a 30° sector of the 180° model was used and the liquid region of material was eliminated.

The maximum membrane stress intensity from the 14 section cuts was 3.24 ksi and the maximum membrane plus bending stress intensity was 4.83 ksi. For the Normal Conditions of Transport, the margin of safety is 4.67 for the membrane stress and 5.21 for the membrane plus bending stress.

1 Foot Side Drop

For the side drop each container rests against the inner shell of the LWT cask. The gap elements on the outside surface of the guide bars have two nodes. The outermost nodes are constrained in the radial, tangential and axial direction. This boundary condition represents the inner surface of the LWT cask as rigid, which is a conservative approach since this produces higher loads on the container guide rails.

For the side drop case an acceleration of 25 g is applied in the lateral (X) direction.

The maximum membrane stress intensity from the 14 section cuts was 2.32 ksi and the maximum membrane plus bending stress intensity was 4.30 ksi. For the Normal Conditions of Transport, the margin of safety is 7.62 for the membrane stress and 5.98 for the membrane plus bending stress. For additional details refer to item 1 in Section 2.6.12.13.5.

The bearing stress between the guide rail and the inner surface of the LWT cask was also computed. Assuming that the entire weight of the filled container is supported by one guide rail, the bearing stress is 0.330 ksi. This gives a margin of safety greater than 10. For additional details refer to item 1 in Section 2.6.12.13.5.

1 Foot Bottom End Drop

For the bottom end drop case an acceleration of 25 g is applied in the vertical (Z) direction. The lowest container rests on the spacer ring, which rests on the bottom forging of the LWT cask. The vertical acceleration accounts for the weight of the lowest container; however, the remaining 3 containers are stacked on the top of the lowest container. To account for the weight of the other three containers an equivalent pressure load is applied to the top of the FEA model for the bottom container.

The maximum membrane stress intensity from the 14 section cuts was 4.23 ksi and the maximum membrane plus bending stress intensity was 6.21 ksi. Comparing this to the allowable stress gives a margin of safety of 3.73 for the membrane stress and 3.83 for the membrane plus bending stress. For additional details refer to item 1 in Section 2.6.12.13.5.

The bearing stress between the lowest container and the top surface of the support spacer was computed. The bearing stress is 5.42 ksi. This gives a margin of safety against the yield strength of 3.61. The bearing stress between the bottom of the support ring and the bottom of the LWT cask was also checked. This bearing stress is 6.15 ksi, which gives a margin of safety of 3.07. For additional details refer to item 1 in Section 2.6.12.13.5.

The container wall was also evaluated for potential buckling with a standard closed form solution. The calculated critical buckling stress calculated was 131 ksi. Compared to the calculated compressive stress in the container wall of 5.42 ksi, the margin of safety is greater than 10. For additional details refer to item 1 in Section 2.6.12.13.5.

The support ring FEA model was utilized to evaluate this case. The maximum membrane stress intensity calculated was 16.77 ksi and the maximum membrane plus bending stress intensity was 20.19 ksi. Comparing this to the allowable stress gives a margin of safety of 0.19 for the membrane stress and 0.49 for the membrane plus bending stress. For additional details refer to item 1 in Section 2.6.12.13.5.

<u>1 Foot Top End Drop</u>

For the top end drop case an acceleration of 25 g is applied in the vertical (-Z) direction. The topmost container rests on the closure lid of the LWT cask. The vertical acceleration accounts for the weight of the lowest container; however, the remaining 3 containers are stacked on the top of the lowest container. To account for the weight of the other three containers, an equivalent pressure load is applied to the bottom of the FEA model of the top container.

The maximum membrane stress intensity from the 14 section cuts is 4.77 ksi and the maximum membrane plus bending stress intensity is 5.56 ksi. Comparing this to the allowable stress gives a margin of safety of 3.19 for the membrane stress and 4.4 for the membrane plus bending stress. For additional details refer to item 1 in Section 2.6.12.13.5.

The bearing stress between the topmost container and the bottom surface of the LWT cask closure lid was also checked. The bearing stress is 1.44 ksi, which gives a margin of safety greater than 10. For additional details refer to item 1 in Section 2.6.12.13.5.

The container wall was evaluated for potential buckling with a standard closed form solution. The calculated critical buckling stress calculated was 131 ksi. The calculated compressive stress in the container wall is 5.42 ksi; therefore, the margin of safety is greater than 10. For additional details refer to item 1 in Section 2.6.12.13.5.

Pressure Case Combined with Drop Cases

The maximum stress intensities for the pressure case are added absolutely to the maximum stress intensities for the drop cases to get the combined stress intensity. The maximum combined membrane stress intensity is 6.94 ksi and the maximum combined membrane plus bending stress intensity is 9.51 ksi. Comparing this to the allowable stress gives a margin of safety of 1.88 for the membrane stress and 2.15 for the membrane plus bending stress. For additional details refer to item 1 in Section 2.6.12.13.5.

Liquid Sloshing

[redacted]

Thermal Stresses

Since the heat load for each HEUNL container is less than 5 Watts, there will not be any significant thermally induced stresses for the Normal Condition of Transport.

Extreme Cold Ambient Conditions (-40 °F)

[redacted]

2.6.12.13.3 Closure Assembly Model

The closure assembly model is evaluated for the conditions of bolt preload, normal pressure loading and cold conditions. The bolt preload requirement was determined by the maximum load required to resist the blow-off load for maximum pressure or the maximum load required to compress the O-rings to the point of metal-to-metal contact between the closure lid and the top of the container. The compression load required to compress the seals was larger than that required to resist the blow-off load. The bolt preload requirement was determined to be 18,000 lbs or 3,000 lbs per bolt.

The bolt preload for the FEA model was achieved by specifying as an initial strain for the beam elements representing the bolts.

Normal Condition Pressure Case

The stresses are linearized through the closure lid at two locations; 1) the center of the lid and 2) at the location of the maximum stress which is from the bottom of the counter-bore to the bottom of the lid. These paths are shown in Figure 2.6.12-18.

Figure 2.6.12-18 Stress Linearization Paths in Closure Lid

[redacted]

The normal condition pressure of 100 psi was applied to the lower surface of the closure lid from the center out to the inner diameter of the inner O-ring. The maximum stress occurs at the counter-bore for the cap screws in the lid. The linearized stresses at the two locations were checked. The maximum membrane stress was 12.2 ksi and the maximum membrane plus bending stress was 18.46 ksi. Comparing these stresses to the allowable stress gives a margin of safety of 0.64 for membrane stress and 0.63 for membrane plus bending.

The contact pressure on the inner seal is checked to ensure that full contact between the closure lid and the inner seal is maintained. This validates the assumption that the pressure load only extends to the inner radius of the inner seal.

The maximum axial bolt load calculated for the 100 psi case was 3,162 lbs. Using the thread tensile area, the bolt tensile stress calculated was 22.98 ksi. The maximum bolt moment calculated was 133.6 in-lbs. This produces a bending stress of 18.52 ksi. The combined axial plus bending stress is 41.5 ksi.

Bolt Stresses

Using an allowable stress of $(S_m)_{BM}$ = 45.0 ksi for SA 705, Type 630 (17-4 PH) at 200 °F gives a margin of safety of 2.92 for the axial stress and 2.25 for axial plus bending stress.

Thread shear stress

The shear stress for the internal threads in the container is limiting since the bolt is SA 705, Type 630 and the container is SA 240, Type 304. The internal thread shear stress for a bolt load of 3,162 lbs is 2.81 ksi. Using the allowable for shear stress gives a margin of safety of 3.27.

For additional details refer to item 1 in Section 2.6.12.13.5.

Cold Conditions

[redacted]

Since the pressure in the container for cold conditions is 38.2 psig (52.9 psia), it is assumed that this pressure exists underneath the closure lid also. The 100 psig normal condition pressure load is applied from the center of the lid out to the inner radius of the inner seal.

The maximum stress occurs at the counter-bore for the cap screws in the lid. The linearized stresses at the two locations were checked. The maximum membrane plus bending stress was 28.86 ksi. Since this is a displacement controlled load, the allowable stress for membrane plus bending is $3S_m$. For SA 240, Type 304 at -40 °F, S_m is 20 ksi. Therefore the margin of safety is 1.08 based on the linearized membrane plus bending stress.

The contact pressure on the inner seal is checked to ensure that full contact between the closure lid and the inner seal is maintained. This validates the assumption that the pressure load only extends to the inner radius of the inner seal.

The maximum axial bolt load calculated for the cold condition case was 5,921 lbs. Using the thread tensile area, the bolt tensile stress calculated was 43.03 ksi. The maximum bolt moment calculated was 470.9 in-lbs. This produces a bending stress of 65.27 ksi. The combined axial plus bending stress is 108.3 ksi.

Bolt Stresses

Using an allowable stress of $(S_m)_{BM}$ = 45.0 ksi for SA 705, Type 630 (17-4 PH) at 200 °F gives a margin of safety of 1.09 for the axial stress and 0.25 for axial plus bending stress.

Thread shear stress

The shear stress for the internal threads in the container is limiting since the bolt is SA 705, Type 630 and the container is SA 240, Type 304. The internal thread shear stress for the bolt load of 5,921 lbs is 5.27 ksi. Using the allowable for shear stress gives a margin of safety of 1.28.

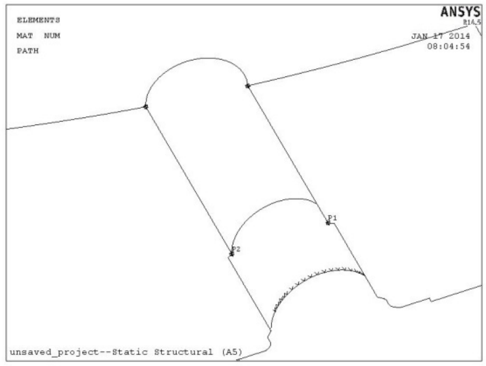
For additional details refer to item 1 in Section 2.6.12.13.5.

2.6.12.13.4 Fill/Drain Port Model

[redacted]

To evaluate the stresses due to cold conditions, two paths are defined along the inner radius of the port passage. These paths are shown in Figure 2.6.12-19.

Figure 2.6.12-19 Stress Linearization Paths in Fill/Drain Ports



The maximum linearized stresses at these two locations are 16.78 ksi for membrane stress and 20.16 ksi for membrane plus bending stress. Since this is a displacement controlled load, the allowable stress for membrane plus bending is $3S_m$. For SA 240, Type 304 at -40 °F, S_m is 20 ksi. Therefore the margin of safety for the membrane plus bending stress is 1.98.

For additional details refer to item 1 in Section 2.6.12.13.5.

2.6.12.13.5 HEUNL Structural Calculations

1. 65008500-2010 “Canister Structural Evaluations for HEUNL in the NAC-LWT”

2.6.12.14 Conclusion

Loads generated during normal operations conditions for each basket assembly design result in total equivalent stresses, which each basket body can adequately sustain. Analyses show that all basket-bearing stresses during a side drop are much less than the material yield strength. Column analyses demonstrate that each basket assembly is self-supporting during an end drop. The minimum Margin of Safety, for all basket designs, is +0.10 as reported in Section 2.6.12.7.4 for the TRIGA basket; +0.003 as shown in Table 2.6.12-2 for the DIDO basket; +0.10 as reported in Section 2.6.12.9.2 for the GA fuel basket; and +0.26 as reported in Section 2.6.12.11.1 for the ANSTO basket. The HEUNL container has a minimum margin of safety of +0.19 as reported in Section 2.6.12.13.2. Therefore, it can be concluded that all basket/container designs have sufficient structural integrity for adequate service during normal conditions of transport.

Figure 2.7.7-2 Internal Pressure Case – 30° Sector Model

[redacted]

2.7.7.15.2 <u>HEUNL Container 30 Foot Drop Case</u>

The HEUNL container is evaluated for both end drops (top and bottom drops) and a side drop. An equivalent acceleration of 61 g is used to evaluate the 30 foot drops.

For each drop case, the container and the support ring FEA models are utilized. The linearized stresses are checked at 14 section locations for the container model. The sections used were shown in Figures 2.6.12-13 and 2.6.12-14, previously.

The allowable stresses are based on either S_m, which is 20.0 ksi, or S_u, which is 66.2 ksi for SA 240, Type 304 at 300 °F. The allowable stress for membrane is either 2.4 S_m or 0.7 S_u, whichever is smaller, and the allowable stress for membrane + bending is either 3.6 S_m or 1.0 S_u, whichever is smaller. For SA-240, Type 304, the lower allowable stresses are 2.4 S_m and 3.6 S_m. The pressure inside the canister is the 100 psig normal condition pressure during the accident drop.

<u>30 Foot Side Drop</u>

For the side drop each container rests against the inner shell of the of the LWT cask. The gap elements on the outside surface of the guide bars have two nodes. The outermost nodes are constrained in the radial, tangential and axial direction. This boundary condition represents the inner surface of the LWT cask as rigid, which is a conservative approach since this produces higher loads on the container guide rails.

For the side drop case an acceleration of 61 g is applied in the lateral (X) direction.

For the 30-foot side drop loading, the maximum membrane stress intensity from the 14 section cuts was 4.26 ksi and the maximum membrane plus bending stress intensity was 7.82 ksi. To determine the stress intensity combined with the 100 psig pressure, the maximum membrane stress intensity of 3.24 ksi and the maximum membrane plus bending stress intensity of 4.83 ksi of the 150 psig pressure case are conservatively added to internal loading stress intensities to generate a combined value of 7.50 ksi for membrane and 12.65 ksi for membrane plus bending. This gives a margin of safety of 5.18 for the membrane stress intensity and 4.23 for the membrane plus bending stress intensity. For additional details, refer to item 1 in Section 2.7.7.15.4.

30 Foot Bottom End Drop

For the bottom end drop case, an acceleration of 61 g is applied in the vertical (Z) direction. The lowest container rests on the bottom forging of the LWT cask. The vertical acceleration accounts for the weight of the lowest container; however, the remaining 3 containers are stacked on the top of the lowest container. To account for the weight of the other three containers an equivalent pressure load is applied to the top of the FEA model of the bottom container.

The maximum membrane stress intensity from the 14 section cuts was 10.29 ksi and the maximum membrane plus bending stress intensity was 14.00 ksi. To determine the stress intensity combined with the 100 psig pressure, the maximum membrane stress intensity of 3.24 ksi and the maximum membrane plus bending stress intensity of 4.83 ksi of the 150 psig pressure case are conservatively added to inertial loading stress intensities to generate a combined value of 13.53 ksi for membrane and 18.83 ksi for membrane plus bending. This gives a margin of safety of 2.42 for the membrane stress and 2.52 for the membrane plus bending stress intensity. For additional details, refer to item 1 in Section 2.7.7.15.4.

The container wall was also evaluated for potential buckling with a standard closed form solution. The calculated critical buckling stress calculated was 119 ksi. Compared to the calculated compressive stress in the container wall of 13.22 ksi, the margin of safety is 8.00. For additional details, refer to item 1 in Section 2.7.7.15.4.

The support ring FEA model was utilized to evaluate this case. The maximum membrane stress intensity calculated was 40.92 ksi and the maximum membrane plus bending stress intensity was 49.26 ksi. Comparing this to the allowable stress gives a margin of safety of 0.13 for the membrane stress and 0.34 for the membrane plus bending stress. For additional details, refer to item 1 in Section 2.7.7.15.4.

30 Foot Top End Drop

For the top end drop case an acceleration of 61 g is applied in the vertical (-Z) direction. The topmost container rests on the closure lid of the LWT cask. The vertical acceleration accounts for the weight of the lowest container; however, the remaining 3 containers are stacked on the top of the lowest container. To account for the weight of the other three containers, an equivalent pressure load is applied to the bottom of the FEA model of the top container. Again the total reaction load was checked to ensure that the weight of all 4 containers was accounted for.

The maximum membrane stress intensity from the 14 section cuts was 11.65 ksi and the maximum membrane plus bending stress intensity was 13.88 ksi. To determine the stress intensity combined with the 100 psig pressure, the maximum membrane stress intensity of 3.24 ksi and the maximum membrane plus bending stress intensity of 4.83 ksi of the 150 psig pressure case are conservatively added to inertial loading stress intensities to generate a combined value of 14.89 ksi for membrane and 18.71 ksi for membrane plus bending. This gives a margin of safety of 2.11 for the membrane stress and 2.54 for the membrane plus bending stress. For additional details, refer to item 1 in Section 2.7.7.15.4.

The container wall was evaluated for potential buckling with a standard closed form solution. The calculated critical buckling stress calculated was 119 ksi. The calculated compressive stress in the container wall is 13.22 ksi; therefore, the margin of safety is 8.00. For additional details, refer to item 1 in Section 2.7.7.15.4.

<u>Internal Pressure Case</u>

[redacted]

<u>Thermal Expansion</u>

[redacted]

2.7.7.15.3 Closure Assembly Model

<u>Accident Condition Pressure Case</u>

The stresses are linearized through the closure lid at two locations; 1) the center of the lid and 2) at the location of the maximum stress which is from the bottom of the counter-bore to the bottom of the lid. These paths are shown in Figure 2.6.12-18.

The accident condition pressure of 200 psi was applied to the lower surface of the closure lid from the center out to the inner diameter of the inner O-ring. The maximum stress occurs at the counter-bore for the cap screws in the lid. The linearized stresses at the two locations were checked. The maximum membrane stress was 13.67 ksi and the maximum membrane plus bending stress was 20.87 ksi. Comparing these stresses to the allowable stress gives a margin of safety of 2.39 for membrane stress and 2.17 for membrane plus bending.

The contact pressure on the inner seal is checked to ensure that full contact between the closure lid and the inner seal is maintained. This validates the assumption that the pressure load only extends to the inner radius of the inner seal.

The maximum axial bolt load calculated for the 200 psi case was 3,573 lbs. Using the thread tensile area, the bolt tensile stress calculated was 25.97 ksi. The maximum bolt moment calculated was 167.9 in-lbs. This produces a bending stress of 23.27 ksi. The combined axial plus bending stress is 49.24 ksi.

Bolt Stresses

Using an allowable stress of S_y = 93.0 ksi and S_u = 135.0 ksi for SA 705, Type 630 (17-4 PH) at 200 °F gives a margin of safety of 2.58 for the axial stress and 1.74 for axial plus bending stress.

Thread shear stress

The shear stress for the internal threads in the container is limiting since the bolt is SA 705, Type 630 and the container is SA 240, Type 304. The internal thread shear stress for a bolt load of 3,573 lbs is 3.18 ksi. Using the allowable for shear stress gives a margin of safety of 7.74.

For additional details refer to item 1 in Section 2.7.7.15.4.

2.7.7.15.4 HEUNL Structural Calculations

1. 65008500-2010, “Canister Structural Evaluation for HEUNL in the NAC-LWT”

27. Determine the appropriate Criticality Safety Index (CSI) assigned to the package contents in accordance with the CoC, and indicate the correct CSI on the Fissile Material label applied to the package per 49 CFR 172, Subpart E.
28. Complete the shipping documents, carrier instructions (as required), and apply appropriate placards and labels.

7.1.14 Procedures for the Vertical Filling of HEUNL Contents into HEUNL Containers

This section describes the procedural steps required to load and prepare a HEUNL Container for transport in a NAC-LWT cask. Four HEUNL containers, as shown on Drawing 315-40-181 are to be loaded into a NAC-LWT, using empty HEUNL containers as spacers if four (4) filled HEUNL containers are not loaded into the cask. The total fill time and lifetime for utilization of a HEUNL container is limited by the CoC to 15 months. The total fill time is determined by recording the date of filling of the HEUNL container with material, recording the date that the HEUNL material is emptied/flushed from the container and tracking the cumulative time the HEUNL container is filled. This allowable fill duration is identified as "HEUNL Container Content Fill Time" and is controlled utilizing a HEUNL Container Fill Log for each individual HEUNL container maintained for its identification number. Each HEUNL Container Fill Log shall record the actual "HEUNL Container Content Fill Time" for each loaded transport based on date and time of filling and emptying of HEUNL material from the HEUNL container, replacement of any removable components, and the results of all loading and unloading inspections and tests. In addition, each NAC-LWT transport is controlled to limit the total transport duration from time of cask loading to ≤ 3 months. Verification will be performed prior to filling to ensure that the filled HEUNL container does not violate the HEUNL container total fill time if the maximum transport duration is applied (e.g., no HEUNL container shall be filled if the total "HEUNL Container Content Fill Time" is > 12 months).

7.1.14.1 Preparation of HEUNL Container Prior to Filling

The HEUNL container must be filled with HEUNL material with the container positioned in a vertical orientation, disconnect valves up. The following steps and procedures shall be performed on each empty HEUNL container prior to filling:

1. Record the HEUNL container identification number in the HEUNL Container Fill Log.
2. Confirm that a minimum of 3 months of HEUNL Container Content Fill Time remains for the container.
3. Remove the HEUNL container lid bolts and remove the lid.
4. Visually inspect the installed Viton inner and outer O-rings and lid bolts for damage. If damage to the inner O-ring is identified the container shall be taken out of service

until the inner O-ring seal can be replaced and the helium pressure boundary verification test of the replaced seal is performed in accordance with Section 8.1.4.4.C.3. (Note that the non-pressure boundary outer O-ring seal and lid screws can be replaced without the need to re-perform the containment maintenance leakage test.) The component replacement and testing shall be recorded in the HEUNL Container Fill Log.

5. Store the HEUNL container lid and bolts for later installation following HEUNL material filling.
6. Verify the fill/drain & vent (Type I container) or vent/drain & fill (Type II container) quick disconnect valves are operational and undamaged, including verification of sealing at container interface to quick disconnect nipple and nipple poppet. The verification of the quick disconnect sealing will be performed by a vacuum pressure rise test utilizing the fill system interface device and will confirm no detected leakage past the nipple to container interface or nipple poppet valve when tested to a sensitivity of at least 1×10^{-3} ref-cm^3/sec. If damage to the drain/fill & vent or vent/drain & fill quick disconnect valves is identified, the valves and seals will be replaced. The quick disconnect valve visual leakage testing inspection results, and component replacements, shall be recorded in the HEUNL Container Fill Log.
7. Visually inspect the externals of the empty HEUNL container for transport and corrosion damage, and record any identified issues for further evaluation prior to filling (for previously filled HEUNL containers only).
8. Empty HEUNL containers that are confirmed as acceptable may be released for filling.
9. Lift and place the empty HEUNL container into the appropriate vertical filling system.

7.1.14.2 Filling of HEUNL Container

1. Ensure accepted HEUNL container is properly positioned in the vertical HEUNL material filling station.
2. Allow the HEUNL container to reach an acceptable temperature for material filling of between 60°F and 90°F as verified with a surface pyrometer or equivalent instrument. Record the container surface temperature in the HEUNL Container Fill Log.
3. Connect HEUNL material fill line to the fill/drain (Type I) or fill (Type II) quick disconnect valve and the HEUNL material vent line to the vent (Type I) or vent/drain (Type II) quick disconnect valve.
4. Verify that the minimum liquid temperature of HEUNL material is ≥ 68° F (20° C) and, if acceptable, initiate the HEUNL material filling process until discharge of liquid material from the vent line. Follow liquid filling process with air/inert gas purge to clear fill and vent lines. Vent container to atmospheric pressure. Close/disconnect the fill and vent lines. Note the height of the vent/siphon line

ensures that a minimum void volume of 1 gallon is achieved when following this procedure.

Note: For the last HEUNL filling operation, sufficient HEUNL material may not be available to completely fill the container such that material discharges from the vent line (Type I) or vent/drain (Type II). The loading and transport of a partially filled HEUNL container is authorized.

Note: All pre-shipment leakage testing procedures of the HEUNL container pressure boundary shall be performed in accordance with written procedures prepared and approved by personnel certified by the American Society of Nondestructive Testing (ASNT) as a Level III examiner for leakage testing. All leakage test results shall be documented.

5. [redacted]

6. Remotely install the HEUNL container closure lid. Apply Never-Seez to the closure lid screws and torque them to 20, +/-0.5 ft-lbs.

7. If the container closure lid plug was removed to test the quick disconnect valves, reinstall the plug and torque to 60, ± 6 in-lbs and perform a vacuum pressure rise preshipment leakage test of the lid plug and seal as follows:

Note: It is not necessary to perform this preshipment leakage test if the lid port plug has not been removed since the last completed assembly leak test or was tested prior to filling the canister. The requirement for performance of the preshipment leakage test is to be confirmed using the HEUNL Container Fill Log.

a. Verify lid plug and seal has been torqued to 60, ± 6 in-lbs.

b. Install a vacuum test bell and leak test system over the plug.

c. Leak test system to include a vacuum pump, isolation and vent valves, and calibrated vacuum gauge with minimum readability of 5 torr. The test equipment volume and the readability of the vacuum gauge shall be selected to ensure a preshipment leakage test sensitivity of $\leq 1 \times 10^{-3}$ ref-cm^3/sec per ANSI N14.5-1997 is achieved.

d. Start vacuum test system by starting the vacuum pump.

e. Close vent valve.

f. Open vacuum pump isolation valve and evacuate the leak test bell volume until vacuum pressure as read on the vacuum gauge is ≤ 10 torr.

g. Isolate and turn off vacuum pump. Record test starting time and vacuum pressure.

h. Observe vacuum pressure gauge for pressure rise for a minimum of 10 minutes.

i. At the end of the minimum 10 minute test period, record the final vacuum pressure and test time completion. If the change in vacuum pressure is less than the readability of the vacuum gauge, the preshipment leakage test confirms that there is no detected leakage when tested to a sensitivity of $\leq 1 \times 10^{-3}$ ref-cm^3/sec.

j. Record the time and results of the satisfactory completion of the lid port leakage test in the HEUNL Container Fill Log.

k. If test is not acceptable, remove the port plug and seal, inspect, clean and reinstall plug, and repeat step 7.a. through 7.j. If satisfactory leakage results are not achieved after retesting, the container shall be emptied and taken out of service until the port plug can be replaced and helium pressure boundary verification testing of a new seal and/or plug can be performed.

l. Record the time and results of the satisfactory completion of the closure lid plug assembly verification test in the HEUNL Container Fill Log.

8. Upon satisfactory completion of the closure lid plug vacuum pressure rise test, if required, remove the vacuum test bell and system.

9. Perform preshipment gas pressure drop leakage test of the closure lid O-ring seals to confirm the integrity of the container closure lid inner O-ring seal as follows:

a. Remove the container closure lid interseal test plug and install a pressure test fixture to the lid test port, including a calibrated pressure gauge with a minimum sensitivity of 0.25 psi. The test equipment volume and the readability of the pressure gauge shall be selected to ensure a preshipment leakage test sensitivity of $\leq 1 \times 10^{-3}$ ref-cm^3/sec per ANSI N14.5-1997 is achieved.

b. Pressurize the closure lid seal annulus to 15 psig, +1, -0 psi with air, helium or nitrogen gas.

c. Isolate the gas supply and observe the pressure gauge for a pressure drop for a minimum of ten (10) minutes.

d. At the end of the minimum 10 minute test period, record the final pressure and test time completion. If the change in pressure is less than the test gauge sensitivity, the preshipment leakage test confirms that there is no detectable leakage past the inner seal when tested to a sensitivity of $\leq 1 \times 10^{-3}$ ref-cm^3/sec.

e. If test is not acceptable, remove the container closure lid screws and container closure lid, inspect and clean the container closure lid O-ring seals and container seating surfaces, and repeat steps 9.a. through 9.d. If satisfactory leakage results are not achieved after retesting, the container shall be emptied and taken out of service until the lid O-ring seals can be replaced and helium pressure boundary verification testing of a new lid O-ring seals or seal surface repairs can be performed.

f. Upon satisfactory completion of the container closure lid O-ring seal pressure drop preshipment test, remove the pressure test system and reinstall the container closure lid interseal test plug and torque the specified value.

g. Record the time and results of the satisfactory completion of the closure lid O-ring seal preshipment verification test in the HEUNL Container Fill Log.

10. The HEUNL container is now satisfactorily loaded with HEUNL material, properly closed and tested, and ready for placement into a vertical or horizontal Dry Transfer and Loading System for loading into the NAC-LWT cask in accordance with the procedures of Section 7.1.13.

11. Record the date and time of HEUNL container filling and closure in the HEUNL Container Fill Log.

4. Remove the top impact limiter and tamper indicating device (TID). Verify no tampering with seal has occurred during transport.
5. Visually inspect the neutron shield tank fill, drain and level inspection plugs for signs of neutron shield fluid leakage. If leakage is detected, verify shield tank fluid level and correct, as required.
6. Remove the Alternate vent and drain valve port covers. Visually inspect the valved quick-disconnect nipples and replace them, if necessary.

   Note: It is not necessary to inspect or replace the Alternate port cover seals. Seal inspection replacement and leak testing will be performed prior to the next loaded transport.
7. Connect cask cavity pressure monitoring system to the cask's vent port quick disconnect. System will include a pressure gauge, isolation valve and connections to radioactive off-gas system.
8. If cask cavity pressure exceeds 15.0 psia, record the pressure and vent the cavity to the radioactive off-gas system prior to closure lid removal.
9. Attach the horizontal lid removal tool to the closure lid.
10. Remove closure lid bolts.
11. Remove the closure lid and set it on a support that is suitable for radiological control and for maintaining the cleanliness of the closure lid.

    Note: It is not necessary to inspect or replace the closure lid metallic seal. A new metallic seal will be installed and tested prior to the next loaded shipment.
12. Unload the first filled HEUNL container from the cask cavity using a horizontal Dry Transfer and Unloading System.
13. Record and verify the identification number of the filled HEUNL container.
14. Place filled HEUNL containers into site specified shielded interim storage positions for subsequent draining.
15. Repeat the unloading and independent verification of the HEUNL containers from the cask cavity until four (4) HEUNL containers are unloaded from the cask. If required, empty HEUNL container(s) may have been loaded to bring the total number of HEUNL containers in the cask cavity to four.
16. Verify that a HEUNL container spacer is secured to the bottom HEUNL container. If not, install the HEUNL container spacer.
17. Load four empty HEUNL containers properly closed in accordance with the procedures provided in Section 7.2.8.
18. Position the closure lid in the cask using the lid match marks as guides to align the lid. Visually confirm that the closure lid is flush with the top of the cask and properly seated. Install lid bolts hand tight and remove the horizontal tool.
19. Tighten the 12 closure lid bolts to 260 ± 20 ft-lb in three passes, using the torque sequence stamped on the closure lid.
20. Install the Alternate vent and drain port covers and torque the bolts to 100 ± 10 inch-pounds.

21. Decontaminate the cask. Survey the cask for surface contamination and radiation dose rates and decontaminate the cask as required.

    Note: Removable contamination levels and radiation levels shall comply with 49 CFR 173.443 and 173.441, respectively.

22. Verify the correct installation of the cask tie-down strap. Install the top impact limiter and verify the correct installation of the bottom impact limiter.
23. Replace roof cross-members, close ISO container doors and install ISO container roof.
24. Complete a Health Physics survey on the external surface of the packaging and record the results.

    Note: Removable contamination levels and radiation levels shall comply with 49 CFR 173.443 and 173.441, respectively.

25. Complete the shipping documents and apply appropriate placards and labels.

7.2.8 Procedures for Preparing Empty HEUNL Containers for Return Shipment

Following the unloading of the HEUNL containers, after transport in a NAC-LWT cask, subsequent operations to remove the HEUNL material from the containers shall be performed. Prior to emptying an HEUNL container, the container temperature will be confirmed to be at an acceptable temperature (between 40°F and 100°F) for HEUNL material removal, as verified with a surface pyrometer or equivalent instrument.

As noted previously, the total fill time and lifetime for utilization of a HEUNL container is limited by the CoC to a total of ≤ 15 months. Total fill time is determined by recording the date of filling of the HEUNL container with material, recording the date that the HEUNL material is emptied/flushed from the container and tracking the cumulative time the HEUNL container is filled. This allowable fill duration is identified as "HEUNL Container Content Fill Time" and is controlled utilizing a HEUNL Container Fill Log for each individual HEUNL container maintained for its identification number. Each HEUNL Container Fill Log shall record the actual "HEUNL Container Content Fill Time" for each loaded transport based on date and time of filling and draining of HEUNL material and the results of all filling and draining inspections and tests.

The HEUNL container shall be emptied of HEUNL material in accordance with site developed procedures. The operating procedures prepared for the emptying of the HEUNL material from the containers shall include appropriate verification that the approved operating procedures are appropriate for the HEUNL container type (either Type I for vertical unloading or Type II for horizontal unloading).

Continued processing of the HEUNL containers for return shipment and for re-filling shall include a flushing sequence with demineralized water or ≤ 0.5 M nitric acid in which any residual contents can be declared as having insignificant radioactive and corrosive properties. Prior to return shipment of empty HEUNL containers to the facility for filling, the empty container shall be verified as having an HEUNL Container Content Fill Time of ≤ 12 months.

8.1.4.4 HEUNL Container

A. Visual and NDE Inspections

Following completion of fabrication, the structural welds of the HEUNL container will be visually and non-destructively examined as indicated on the License Drawings. The structural welds shall be examined by dye-penetrant examination (PT) and ultrasonic examination (UT) in accordance with ASME Code, Section V, Articles 1, 5 and 6, respectively with acceptance criteria in accordance with ASME Code, Section III, Subsection NB, Articles NB-5350 NB-5330, respectively.

B. Pressure Testing

The pressure retaining boundary of the HEUNL container shall be qualified by hydrostatic test prior to first use following fabrication. The pressure boundary of the HEUNL container is defined as the container shell, top end cap, bottom end cap, container lid, lid plug and O-ring seal, and container lid inner O-ring seal. As described in Chapter 2, the HEUNL container pressure boundary is designed, fabricated, examined, and tested in accordance with the requirements of the ASME Code, Section III, Subsection NB, to the maximum practical extent.

A hydrostatic test will be performed in accordance with the ASME Code Section III, Subsection NB, Article NB-6200, to 140 +10/-0 psig (1.25 × 100 psi = 125 psi ≈ 140 psig). The test requirements and acceptance criteria for the tests are described below.

The HEUNL container is hydrostatically tested using demineralized water in the vertical (disconnect side up) orientation. The test is performed with the quick disconnect valves removed, and the container lid installed with the inner circumferential O-ring installed and the test port plug between the inner and outer O-rings removed. The pressure test system will be installed in the container lid plug hole to allow container filling, venting and application of the hydrostatic pressure. The HEUNL container shall be pressurized and the hydrostatic pressure shall be maintained for a minimum of 10 minutes. Following the 10 minute minimum hold period a visual inspection of the container to detect any evidence of leakage or structural deformation shall be performed while the pressure is maintained. Any evidence of leakage of the HEUNL container is cause for rejection. Following completion of the visual inspection, the container pressure is vented. Rejected HEUNL containers that are repaired shall be retested to the original test criteria prior to acceptance.

[redacted]

[redacted]

C. Leakage Testing

C.1 Fabrication Acceptance Leakage Testing

At the completion of the pressure boundary hydrostatic testing and post-test inspections, each HEUNL container shall be leakage tested in accordance with the requirements and approved methods of ANSI N14.5-1997 to confirm the total leakage rate is less than, or equal to, 1×10^{-7} ref. cm^3/s (i.e., leaktight). The sensitivity of the test shall be one-half of the acceptance test criteria as specified in ANSI N14.5-1997.

The HEUNL container will be assembled with the container lid and inner O-ring seal installed and the fill/drain and vent quick disconnect valved nipples removed. A test envelope will be installed around the assembled HEUNL container enclosing all of the pressure boundary welds, base metal plates, and the container lid. The vacuum system shall be connected to the lid plug opening for evacuation of the container volume to a pressure of $\leq$ 10 torr. After the container is evacuated, the test envelope will be filled with 99.95% (minimum) pure helium to an acceptable test concentration. The percentage of helium gas in the test envelope shall be accounted for in the determination of the test sensitivity. A mass spectrometer leak detector (MSLD) will be used to sample the evacuated volume for helium.

If helium leakage is detected, the area of leakage shall be identified, repaired and re-examined in accordance with the ASME Code, Section III, Subsection NB, NB-4450 or NB-4130, as appropriate. Following repair, the complete helium leakage test shall be re-performed to the original test acceptance criteria.

In order to ensure the integrity of the HEUNL container lid port plug and O-ring seal (port opening used for evacuation of container for helium leakage test of the pressure boundary), a helium leakage test of the lid port plug and seal is performed. The evacuated HEUNL container is filled with 99.95% (minimum) pure helium, and the port plug and seal are installed and torqued. A test cover is installed over the top of the port plug and the test cover volume is evacuated to a low pressure by a helium MSLD system. The leakage test of the port plug is in accordance with the evacuated envelope method as described in ANSI N14.5. The leakage test is to confirm that the leakage rate for the port plug is $\leq 1\times10^{-7}$ ref. cm^3/s (i.e., leaktight). The sensitivity of the test shall be one-half of the acceptance test criteria as specified in ANSI N14.5-1997. The concentration of helium gas in the HEUNL container shall be accounted for in the determination of the test sensitivity.

If leakage is detected, the area of leakage shall be identified, repaired and re-examined, and the plug O-ring seal replaced. Following repair and seal replacement, the helium leak test shall be re-performed to the original test acceptance criteria.

Leakage testing of the HEUNL container pressure boundary shall be performed in accordance with written procedures prepared and approved by personnel certified by the American Society of Nondestructive Testing (ASNT) as a Level III examiner for leakage testing. All leakage test results shall be documented.

C.2 Periodic Leakage Testing

In accordance with ANSI N14.5-1997, if an HEUNL container has been in service longer than 12 calendar months from time of initial loading, the container lid inner O-ring and port plug O-ring seals shall be replaced and periodic helium leakage rate tests of the replaced container lid O-ring seals shall be performed prior to returning the HEUNL container to service. The HEUNL container shall be emptied, flushed, dried, and the O-ring seals replaced. Following O-ring seal replacement, a helium leakage test of the replaced O-ring seal is performed prior to returning the container to service.

Following seal replacement, the HEUNL container shall be reassembled with the lid port plug removed. A helium supply shall be connected to the lid through the lid port opening and the volume under the installed container lid is filled with 99.95% (minimum) pure helium, and the port plug with a new O-ring seal is re-installed. The leakage test of the container lid inner O-ring seal is in accordance with the evacuated envelope method as described in ANSI N14.5. The volume between the container lid inner and outer O-ring seals is evacuated through the O-ring test port opening to a low pressure (approximately ≤ 1 torr) by a helium MSLD system. The acceptance criteria for the periodic leakage test is to confirm that the leakage rate for the container lid inner O-ring seal is $\leq 1\times10^{-7}$ ref. cm^3/s (i.e., leaktight). The sensitivity of the test shall be one-half of the acceptance test criteria as specified in ANSI N14.5-1997. The concentration of helium gas in the HEUNL container shall be accounted for in the determination of the test sensitivity.

Following completion of the container lid inner O-ring test, a test cover is installed over the top of the port plug and the test cover volume is evacuated to a low pressure by a helium MSLD system. The leakage test of the port plug is in accordance with the evacuated envelope method as described in ANSI N14.5. The leakage test is to confirm that the leakage rate for the port plug is $\leq 1\times10^{-7}$ ref. cm^3/s (i.e., leaktight). The sensitivity of the test shall be one-half of the acceptance test criteria as specified in ANSI N14.5-1997. The concentration of helium gas in the HEUNL container shall be accounted for in the determination of the test sensitivity.

If leakage is detected, the area of leakage shall be identified, and the plug O-ring seal replaced. Following seal replacement, the helium leak test shall be re-performed to the original test acceptance criteria.

Periodic leakage testing of the HEUNL container pressure boundary O-ring seals shall be performed in accordance with written procedures prepared and approved by personnel certified by the American Society of Nondestructive Testing (ASNT) as a Level III examiner for leakage testing. All leakage test results shall be documented.

C.3 Maintenance Leakage Testing

Field replacement of the lid pressure boundary O-ring seals and/or repair of the HEUNL container pressure boundary components shall require the performance of maintenance leakage rate testing of the replaced seal(s) or of the entire HEUNL container pressure boundary depending on the extent of the replacements and/or repairs completed.

HEUNL container lid inner O-ring and port plug O-ring seals identified as leaking or damaged during operational use shall require the HEUNL container to be emptied, flushed and dried, and the applicable seal replaced. Following O-ring seal replacement, helium leakage testing of the replaced O-ring seal(s) is performed prior to returning the container to service. O-ring helium leakage testing shall be performed in accordance with the procedures specified in Section 8.1.4.4, C.2.

In addition, if in-service inspection identifies damage or leakage of an HEUNL container boundary pressure due to container lid and/or shell assembly damage, the HEUNL container shall be emptied, flushed and dried, and the appropriate repairs completed in accordance with approved written procedures. Following HEUNL container repairs, the helium leakage test of the HEUNL container pressure boundary shall be re-performed in accordance with the leakage test procedures specified in Section 8.1.4.4, C.1.

Leakage testing of the HEUNL container pressure boundary shall be performed in accordance with written procedures prepared and approved by personnel certified by the American Society of Nondestructive Testing (ASNT) as a Level III examiner for leakage testing. All leakage test results shall be documented.

8.1.4.5 Miscellaneous

The cask impact limiter structures contain a two-part, aluminum honeycomb that is fabricated to have dynamic crush strengths of 3,500 psi (plus 5 percent, minus 10 percent) and 250 psi (plus 10 percent, minus 10 percent), respectively. Sample lots of honeycomb material are subjected to dynamic crush testing to verify the crush strength of the impact limiter material. A dynamic crush strength of a sample outside of the allowable variation is cause for rejection of the batch lot of honeycomb material.

8.1.5 Tests for Shielding Integrity

A gamma scan inspection of all steel and lead shielding is conducted in order to verify shielding integrity. This inspection is performed on the cask body, including the cask bottom.

The test is conducted by continuous scanning or probing over 100 percent of all accessible surfaces, using a 3-inch detector and a ^{60}Co source of sufficient strength to produce a count rate that equals or exceeds three times the background count rate.

Scan path spacing is 2.5 inches. Scan speed is 4.5 feet-per-minute or less. All probing is on a 2-inch grid pattern (when using a 3-inch detector) and the count time is a minimum of one minute.

Acceptance is based on a lead and steel mock-up, where the material thicknesses are equivalent to the minimum thicknesses specified by the drawings. The lead and steel mock-up is produced using the same pouring technique as that approved for the cask.

Any area that produces a count rate over that established by the mock-up is considered rejected and must be corrected and retested prior to use.

Test equipment is checked before and after each use to ensure that shield test results are accurate.

8.1.6 Thermal Acceptance Tests

8.1.6.1 Thermal Test

A heat transfer acceptance test is conducted to test the integrity of the lead/stainless steel interface and to establish the heat rejection capability of the cask. The test is conducted with the neutron shield tank full[1] and the pressurized water reactor (PWR) basket located in the dry cask cavity.

The cask is internally heated at a rate of 8,500 BTU per hour (± 1,000 BTU per hour). A minimum of 12 internal and 12 external temperatures on the cask are measured with thermocouples. A test closure lid is used to allow penetrations for electric heaters and thermocouples. The steady state heat rate, transient cask temperatures, and ambient temperature are recorded. The test is conducted with the cask 3 feet (approximately) above the ground, horizontal and in still air.

8.1.6.2 Retest

If any equipment should fail during the test, such that the test must be aborted, the test is repeated.

8.1.6.3 Heat Source

The heat source for the thermal test is an electrical heater (cal-rod type) with an active length of 144 to 150 inches and is capable of generating at least 2.5 kilowatts.

8.1.7 Neutron Absorber Tests

8.1.7.1 General

Neutron absorber material in the form of borated stainless steel sheets is used in the TRIGA poison basket modules. After manufacturing, test samples from each batch of neutron absorber (poison) sheets shall be tested using neutron absorption techniques to verify the presence, proper distribution, and minimum weight percent of enriched boron. The tests shall be performed in accordance with approved written procedures.

---

1 The neutron shield tank is filled with a liquid consisting of 58 weight percent ethylene glycol, 39 weight percent demineralized water and 3 weight percent potassium tetraborate ($K_2B_4O_7$).

8.1.7.2 Preparation of Samples for Spectroscopic Examination

Detailed written procedures to perform neutron absorption tests of each batch of neutron absorber sheets shall be established by the manufacturer and approved by NAC. For each batch of neutron absorber sheets, a sample shall be taken from each sheet. The samples shall be indelibly marked and recorded for identification.

At least 2 percent of the sheets in a batch shall be tested using a grid pattern of locations covering the entire surface of the sheet. Each of the remaining sheets in a batch shall be tested at one random location to ensure the presence of boron.

8.1.7.3 Neutron Absorption Test Performance

An approved facility with a neutron source and neutron detection capability shall be selected to perform the described tests. The tests will assure that the neutron absorption capacity of the material tested is equal to, or higher than, the given reference value and will verify the uniformity of boron distribution of a batch of neutron absorber sheets. The principle of measurement of neutron absorption is that the presence of boron results in a slowing down of neutron flux between the neutron sources, the reflector, and the neutron detector – depending on the material thickness and boron content.

Typical test equipment will consist of a neutron source/neutron detector, a reflector, and a counting instrument. The test equipment is calibrated using approved reference sheet(s), whose ^{10}B content has been checked and verified by an independent method such as chemical analysis. The highest permissible counting rate is determined from the neutron counting rates of the reference sheet(s), which should be ground to the minimum allowable plate thickness. This calibration process shall be repeated daily (at least once every 24 hours) while tests are being performed.

8.1.7.4 Acceptance Criteria

The neutron absorption test shall be considered acceptable if the neutron count determined for each test specimen is less than or equal to the highest permissible neutron count rate determined from the reference sheet(s). The poison sheets shall have a minimum of 1.04 weight-percent enriched boron content, with ^{10}B being a minimum of 93.88 atom percent. Any specimen not meeting the acceptance criteria for maximum neutron count shall be rejected and all of the sheets from that lot shall be similarly rejected.

Table 8.2-1 Maintenance Program Schedule (continued)

Water Jacket Relief Valve	
Annually	Replace With New Pre-set Valve, or Verify Opening and Reseating Pressure (Allowable variation is ± 10 psig of Nominal Valve Opening Pressure, 165 psig)
Fasteners, Valved Nipples, Washers, Reusable O-rings, and Helicoils	
Each Shipment	Inspect and Replace as necessary
Lid and Alternate B Port Cover Metallic O-rings	
Each Loaded Shipment	Replace and perform helium leakage rate testing to the criteria specified in Section 8.1.3.
HEUNL Container	
Each Loaded Shipment	Test fill/drain and vent quick disconnect valves. Flush with demineralized water or ≤ 0.5 M nitric acid and visually inspect HEUNL container for damage following discharge of contents and prior to return to service. Perform preshipment leakage test on closure lid inner O-ring seal and lid plug O-ring seal to verify pressure boundary assembly integrity.
After Inner Lid O-ring Seal Replacement or Port Plug and/or O-ring Seal Replacement, or Pressure Boundary Component Replacement or Repair	The container to be emptied and a maintenance helium leakage test to leak tight criteria shall be performed on the replaced seal, or replaced or repaired component.
Annually Every 12 Months or Prior to Returning the Container to Service	The container to be emptied, the inner lid and lid port plug O-ring seals replaced and a periodic helium leakage test to leak tight criteria shall be performed on the closure lid inner O-ring and lid port plug O-ring seals. Replace the container lid outer O-ring seal. Replace fill/drain and vent quick disconnect valved nipples and associated seals

Table 8.2-1 Maintenance Program Schedule (continued)

HEUNL Container (continued)	
After 15 Months of "HEUNL Container Content Fill Time" Usage	Each HEUNL shall be replaced and appropriately disposed of following achieving a total "HEUNL Container Content Fill Time" approaching 15 months. No HEUNL container shall be loaded for transport if ≤ 3 months are remaining from the 15 month "HEUNL Container Content Fill Time" life limit. [redacted] Independent of the remaining service life of an HEUNL container, any HEUNL container exposed to accident conditions shall be recovered, unloaded and replaced/disposed.
Following Accident Conditions of Transport	Independent of the remaining service life of an HEUNL container, any HEUNL container exposed to accident conditions of transport shall be recovered, unloaded and replaced/disposed.