72-1015

NAC INTERNATIONAL

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October 11, 2005

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

Attn: Document Control Desk

Subject: Submittal of Replacement Pages to Update the NAC-UMS® FSAR from Revision 4 to Revision 5 (Docket No. 72-1015)

References:
1. Submittal of NAC-UMS® FSAR, Amendment 4 (Docket No. 72-1015), NAC International, November 19, 2004
2. Request for Amendment of Certificate of Compliance (CoC) No. 1015 for the NAC-UMS® Universal Storage System to Incorporate Changes to the Technical Specifications, NAC International, August 10, 2004
3. Submittal of NAC International Responses to the U.S. Nuclear Regulatory Commission Request for Additional Information for the Review of Proposed Amendment 4 to the NAC-UMS® Universal Storage System, NAC International, December 23, 2004
4. Submittal of Revised Technical Specifications in Support of the Review of Proposed Amendment No. 4 to the NAC-UMS® Universal Storage System, NAC International, February 17, 2005
5. Amendment No. 4 to Certificate of Compliance No. 1015 for the NAC International, Inc. Universal Storage System (NAC-UMS®), U.S. Nuclear Regulatory Commission (NRC), October 11, 2005

In accordance with the requirements of 10 CFR 72.248, NAC International (NAC) herewith provides five copies of the changed pages necessary to complete the update of the NAC-UMS® Universal Storage System Final Safety Analysis Report (FSAR) to Revision 5.

Revision 5 of the NAC-UMS® FSAR is based on Reference 1, on the Technical Specification changes proposed in References 2, 3, and 4 that have been reviewed and accepted by the NRC, and on the changes that have been reviewed and incorporated by NAC under the 10 CFR 72.48 regulation. A certification of the accuracy of the Revision 5 changes by a duly authorized officer of NAC is provided in Attachment 3.

The 10 CFR 72.48 Evaluation Summary Report for the NAC-UMS® Universal Storage System for the period of November 2004 – October 2005 is provided as Attachment 1.

A detailed description of all of the changes that are incorporated in the FSAR, Revision 5, is provided in the List of Changes for the NAC-UMS® FSAR, Revision 5, as Attachment 2.

NMSS01

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Consistent with NAC administrative practice, NAC-UMS® FSAR, Revision 5, changed pages are uniquely identified by the revision number located in the header of each page. Revision bars mark the FSAR text changes. The NAC-UMS® FSAR, Revision 5, reflects all of the requirements contained in the NAC-UMS® CoC, Revision 0, Amendment 1, Amendment 2, Amendment 3 and Amendment 4.

If you have any comments or questions, please contact me at my direct number, (678) 328-1274.

Sincerely,

Anthony L. Patko
Director, Licensing
Engineering

Attachment 1: 10 CFR 72.48 Evaluation Summary Report for the NAC-UMS® Universal Storage System (Period Covered: November 2004 – October 2005)

Attachment 2: List of Changes for the NAC-UMS® Universal Storage System FSAR, Revision 5

Attachment 3: Certification of the Accuracy of the Revision 5 Changes

Enclosures: Replacement pages to update the NAC-UMS® Universal Storage System Final Safety Analysis Report from Revision 4 to Revision 5 (5 copies)

cc: Glenn Michael - APS (w/o encl.)
John Niles - MY (w/o encl.)
Keith Waldrop - Duke (w/o encl.)

Attachment 1

10 CFR 72.48 Evaluation Summary Report

for the

NAC-UMS® Universal Storage System
(Docket No. 72-1015)

Period Covered: November 2004 – October 2005

NAC International

October 2005

72.48 Determination ID #NAC-04-UMS-053

Change Description

Revises Section 4.4.1.1, Off-Center Canister Evaluation, as follows: "The support ring may be used to aid in centering the canister during the lowering of the canister into the concrete cask. The final placement of the canister shall not be closer than 1 inch to the concrete cask liner."

Chapter 4, page 4.4.1-9

Source of Change: 72.48 Determination ID #NAC-04-UMS-053

Originating Document: DCR(L) 790-FSAR-4A

This 10 CFR 72.48 Determination concluded that an off-center canister in the VCC was bounded by the current thermal analysis, provided a 1-inch gap was maintained between the outer wall of the TSC and the inner wall of the VCC liner. A physical configuration was described to ensure maintenance of this gap (i.e., centering of the canister within the confines of the support ring assures a gap greater than 1 inch is maintained.). This was an extremely conservative approach, as the support ring width is 2-1/2 inches. The described change supports the analysis bases requiring a 1-inch gap, and it provides flexibility to the user as it removes the overly conservative requirement that the TSC resting location be within the boundary of the support ring.

72.48 Determination ID #NAC-04-UMS-055

Change Description

Revises Chapter 8, Operating Procedures, to add the following: "Caution shall be observed when lifting the concrete cask using the two pairs of lifting lugs to minimize possible uneven loading on the base of the concrete cask. For lifting devices provided with load measuring equipment, the load on each lug set should be evenly maintained, but in no case shall an uneven load exceed 25,000 pounds between lug sets."

Chapter 8, pages 8.1.3-1 & 8.2-1.

Source of Change: 72.48 Determination ID #NAC-04-UMS-055

Originating Document: DCR(L) 790-FSAR-4B

Excessive uneven loading of the lifting lug sets during vertical lifting can result in excessive loading to the base of the VCC concrete shell, which may cause cracking or shearing of the concrete surface at the base of the cask below the lifting lugs. NAC Calculation No. EA 790-2319, Revision 0, has shown that damage to the concrete can be prevented by limiting the uneven loading of the lifting lugs to less than 25,000 pounds. The addition of the "caution" to the UMS® operating procedures in Chapter 8, Sections 8.1.3 and 8.2, of the FSAR provides the required guidance to cask users for incorporation into the approved site cask loading and handling procedures.

72.48 Determination ID #NAC-04-UMS-056

Change Description

Revises Chapter 8, Operating Procedures, and Chapter 12 BASES, Section C3.1.1, CANISTER Maximum Time in Vacuum Drying, to clarify that the term "the introduction of helium backfill" in LCO 3.1.1 and SR 3.1.1.1 and SR 3.1.1.2, as intended and analyzed in the UMS® FSAR, includes completion of the entire helium backfill process up to and including completion of the final helium pressure for storage per LCO 3.1.3.

Chapter 8, page 8.1.1-5 & Chapter 12, pages 12C3-10 & 12C3-12.

Source of Change: 72.48 Determination ID #NAC-04-UMS-056

Originating Document: DCR(L) 790-FSAR-4C

This DCR(L) changes Chapters 8 & 12. The clarifying language in the BASES and the additional guidance in the Operating Procedures are intended to ensure that the users of the UMS® system appropriately implement the time duration limits and surveillances of LCO 3.1.1. This clarification does not change the required operating procedure currently specified in Chapter 8 or the supporting thermal analyses of the canister vacuum drying evolution during canister preparation and transfer operations.

72.48 Determination ID #NAC-05-UMS-001

Change Description

Revises Chapter 8, Operating Procedures, to allow flexibility to the user when placing the canister into the vertical concrete cask.

Chapter 8, page 8.1.1-2.

Source of Change: 72.48 Determination ID #s NAC-05-UMS-001

Originating Document: DCR(L) 790-FSAR-4D

This DCR(L) provides flexibility to the user by removing the conservative requirement that the final TSC position be located within the boundary of the support ring. The UMS® FSAR, Chapter 4, Section 4.4.1 was updated via DCR(L) 790-FSAR-4A. This DCR(L) provides this same flexibility in Chapter 8..

72.48 Determination ID #NAC-05-UMS-002

Change Description

Revises Chapter 4, Section 4.4.5.1, to change the PWR fuel canister calculated gas temperature for the normal storage condition from 418°F to 421°F in accordance with NAC Calculation EA790-3506, Revision 4.

Chapter 4, pages 4.4.5-2 & 4.4.5-3.

Source of Change: 72.48 Determination ID #NAC-05-UMS-002

Originating Document: DCR(L) 790-FSAR-4E

The 418°F calculated gas temperature for the PWR fuel canister for the normal storage condition currently shown in the UMS® FSAR is from an older version of the thermal analysis. The latest NAC Calculation EA790-3506, Revision 4, shows the PWR fuel canister average gas temperature for the normal storage condition as 421°F, so the wording in Section 4.4.5.1 of the UMS® FSAR was revised accordingly.

72.48 Determination ID #NAC-05-UMS-004

Change Description

Revises Section 1.8, License Drawings, to incorporate Rev. 15 of Drawing 790-562, Reinforcing Bar and Concrete Placement, VCC, NAC-UMS.

Chapter 1, page 1.8-1.

Source of Change: 72.48 Determination ID #NAC-05-UMS-004

Originating Document: DCR(L) 790-FSAR-4F

This DCR(L) was prepared to incorporate Revision 15 of Drawing 790-562 into the UMS® FSAR, Revision 5.

Revision 15 of Drawing 790-562 adds an "Optional Drain Hole (one per quadrant)" to the side of the inlet opening, in Section B-B.

This drain hole will provide a path for water drainage in the cavity formed by the vertical concrete cask bottom plate, inlet sides, shell liner, stand, and the shield ring. The addition of this feature (a drain hole in the side of the air inlet) is insignificant as related to the structural and shielding calculations and will not affect the form, fit or function of the Base Weldment and/or other vertical concrete cask components.

72.48 Determination ID #NAC-05-UMS-018

Change Description

Revises Section 1.8, License Drawings, to incorporate Rev. 12 of Drawing 790-582, Rev. 8 of Drawing 790-583, Rev. 19 of Drawing 790-584, Rev. 19 of Drawing 790-585, Rev. 10 of Drawing 790-595 and Rev. 6 of Drawing 412-502.

Chapter 1, pages 1.8-1 & 1.8-2.

Source of Change: 72.48 Determination ID #NAC-05-UMS-018

Originating Document: DCR(L) 790-FSAR-4G

This DCR(L) was prepared to incorporate the latest revisions of the above-listed drawings into the UMS® FSAR, Revision 5.

Revision 12 of Drawing 790-582 made the following change:

Changed Delta Note 7 to read, "...diameter are +.21"/-.24", or alternatively, the minimum inside diameter of the shell weldment, with the shell weldment vertical, shall be the as-built diameter of the shield lid assembly plus .01". Localized areas...."

Revision 8 of Drawing 790-583 includes the following changes:

1. Added a new Delta Note 3 to BOM and balloon callouts for Items 2-6, Tube: "Minor surface indentations and/or dimensional deviations are acceptable for Items 2-6, Tube."
2. Changed BOM Items 2-6, Specification: IS) COML; WAS) ASTM A249/A213.

Revision 19 of Drawing 790-584 includes the following changes:

1. Changed Delta Note 5 to read, "...for a particular project code, or other unique identifying number, and the YYY...."
2. Changed all dimension callouts in Detail J-J to be reference dimensions.
3. Added a Delta Note callout to Detail J-J that reads, "Surface finish requirements are optional for detail J-J."
4. Added a Delta Note callout to dimension leader callout (3X 1-8 UNC-2B) Sht 1 of 1, Zone 2E to read, "Alternatively, the location of these three shield cover attachment holes can be matched drilled with the shield cover."

72.48 Determination ID #NAC-05-UMS-018 (cont'd)

Revision 19 of Drawing 790-585 includes the following changes:

Changed Note 13 to read: "Inspection of the cold stack-up of the shield and structural lids should be performed prior to commencement of field welding. For reference purposes, the structural lid should not exceed the top edge of the canister shell by more than .180 inch. This inspection may either be performed at the fabricator's facility or in the field. Following completion of structural lid welding, the top surface of the structural lid shall be flush or above the edge of the TSC Shell."

The note change applies to the lid stack-up measurements, prior to installation of the two lids and their closure welding activities. This change has no impact on the performance of each component and/or the overall system functionality. The final structural lid height verification assures the TSC assembly complies with all analyzed condition(s). With this DCR(L), the drawing will bound all final as-built conditions noted in the site documentation packages for the Maine Yankee project.

Revision 10 of Drawing 790-595 includes the following changes:

Changed drawing Note 6 to read, "....Items 9, 19 and 20 (top nut)...."

This change is an editorial update to drawing note 6. The intent was not to limit this specific configuration to only being applicable to one basket assembly and one specific Top Nut, but rather to all assemblies and all Top Nut configurations. This DCR(L) brings the drawing current with all the final as-built deviations noted in the site documentation packages for the Maine Yankee project.

Revision 6 of Drawing 412-502 includes the following changes:

1. Added Delta Note 10 to Item 4, Wiper, "Minor edge surface and/or dimensional deviations are acceptable for Item 4, Wiper."
2. Deleted Detail B-B and callout on Sht 4 of 6, Zone A3 & D1.

The wiper is used to ensure that particles from damaged fuel assemblies stay inside the damaged fuel can. The surface finish and the exact profile/shape of the edge are not critical, so long as the wiper fills the gap between the damaged fuel can and the damaged fuel can lid to block that escape path. These changes have no impact on the performance of each component and/or the overall system functionality. With this DCR(L), the drawing will bound all the final as-built conditions noted in the site documentation packages for the Maine Yankee project.

72.48 Determination ID #NAC-05-UMS-019

Change Description

Revises Chapter 4 to clarify the allowable concrete temperatures in the FSAR, and removes specific concrete aggregate limitations specified in Chapter 1 for elevated temperature conditions.

Chapter 1, table 1.2-6, page 1.2-27; Chapter 4, table 4.1-3, page 4.1-6; table 4.1-4, page 4.1-7; table 4.1-5, page 4.1-8; table 4.4.3-1, page 4.4.3-14; table 4.4.3-2, page 4.4.3-15.

Source of Change: 72.48 Determination ID #NAC-05-UMS-019

Originating Document: DCR(L) 790-FSAR-4H

The current (Revision 4) aggregate limitations included in Table 1.2-6 and the long-term local concrete temperature allowable in the various tables identified above are based on the criteria defined in USNRC NUREG-1536 as an alternative to the temperature requirements of ACI 349. This NUREG was invoked and these changes were incorporated into the UMS® FSAR for the submittal containing the Advanced UMS® (A-UMS®) configuration, which required a higher local concrete temperature allowable (300°F) due to a higher design basis heat load.

When the A-UMS® submittal was pulled from NRC review, the NUREG-1536 reference was not concurrently removed. Since the reference was added specifically for A-UMS® and is not needed for UMS® concrete temperature conditions, the limitations of Table 1.2-6 for aggregates are being removed (reverting to the pre A-UMS® language of the table). Also, the normal local temperature limitations are being revised to 200°F (down from 300°F), as specified in ACI 349, A.4 (returning to the pre-A-UMS® allowable values).

72.48 Determination ID #NAC-05-UMS-023

Change Description

Revises Section 9.1.8, Cask Identification, to make reference to License Drawing No. 790-565, Nameplate, Vertical Concrete Cask (VCC), NAC-UMS®, for the information to be listed on the nameplate.

Chapter 9, page 9.1-10

Source of Change: 72.48 Determination ID #NAC-05-UMS-023

Originating Document: DCR(L) 790-FSAR-4I

The required nameplate information contained in the UMS® FSAR must be identical to that on License Drawing No. 790-565, Namplate, Vertical Concrete Cask (VCC), NAC-UMS®. Therefore, Section 9.1.8, Cask Identification, is revised to make reference to License Drawing No. 790-565.

72.48 Determination ID #NAC-05-UMS-024

(THIS 72.48 & DCR(L) WERE SUPERSEDED IN THEIR ENTIRETY BY 72.48 DETERMINATION ID #NAC-05-UMS-025 & DCR(L) 790-FSAR-4K.)

Change Description

Revises BASES C 3.1.1 & C 3.1.4 (Chapter 12) to clarify spent fuel pool water temperature and canister time in pool.

Chapter 12, pages 12C3-11 & 12C3-22

Source of Change: 72.48 Determination Checklist ID #NAC-05-UMS-024

Originating Document: DCR(L) 790-FSAR-4J

See 72.48 Determination ID #NAC-05-UMS-025 & DCR(L) 790-FSAR-4K on the following page.

72.48 Determination ID #NAC-05-UMS-025

Change Description

Revises BASES C 3.1.1 & C 3.1.4 (Chapter 12) to clarify spent fuel pool water temperature and canister time in pool.

Chapter 12, pages 12C3-11 & 12C3-22

Source of Change: 72.48 Determination ID #NAC-05-UMS-025

Originating Document: DCR(L) 790-FSAR-4K

The CANISTER must be cooled in the TRANSFER CASK for a minimum of 24 hours at a maximum temperature of 100°F. It is permissible to place the CANISTER/TRANSFER CASK in the pool at temperatures greater than 100°F, though the pool temperature must be reduced to temperatures ≤ 100°F prior to starting the required cooling cycle of 24 hours (minimum). The CANISTER will remain in a safe condition at temperatures greater than 100°F, as the condition of the CANISTER in water at temperatures less than boiling is enveloped by the CANISTER in its final storage condition.

72.48 Determination ID #NAC-05-UMS-026

Change Description

Revises Section 1.8, License Drawings, to incorporate Rev. 16 of Drawing 790-562, Reinforcing Bar and Concrete Placement, VCC, NAC-UMS.

Chapter 1, page 1.8-1.

Source of Change: 72.48 Determination ID #NAC-05-UMS-026

Originating Document: DCR(L) 790-FSAR-4L

This DCR(L) was prepared to incorporate Revision 16 of Drawing 790-562 into the UMS® FSAR, Revision 5.

Revision 16 of Drawing 790-562 changes Item 48, Retainer Plate, Alternate Fabrication-A (Sht 7 of 7, Zone D-6).

This change will allow the concrete anchor and anchor mounting hole to be moved away from the edge of the concrete (near the side of the inlet tunnel). If the mounting hole is too close the edge of the concrete, the thin wall section of concrete between the mounting hole and inlet weldment crumbles. This results in the need to glue the anchor in place with an adhesive product and repair the crumbled concrete.

This change will not have any adverse impact on the functionality of this component (the retainer plate), the mounting hardware nor the overall VCC assembly. Its only function is to protect the integrity of the concrete in the area of the inlet weldment during the installation of the inlet screens.

72.48 Determination Checklist ID #NAC-05-UMS-027

Change Description

Revises Table 2-1, Summary of Universal Storage System Design Criteria, to correct concrete temperature for normal conditions to ≤ 200°F (local) [was ≤ 300°F (local)] to agree with previous changes made by DCR(L) 790-FSAR-4H.

Chapter 2, table 2-1, page 2-2.

Source of Change: 72.48 Determination ID #NAC-05-UMS-027

Originating Document: DCR(L) 790-FSAR-4M

Table 2-1 was inadvertently overlooked when DCR(L) 790-FSAR-4H and 72.48 ID # NAC-04-UMS-019 were prepared to clarify the allowable concrete temperatures in the UMS® FSAR and remove specific concrete aggregate limitations specified in Chapter 1 for elevated temperature conditions. See page 10 of this document for technical justification for change.

72.48 Determination ID #NAC-04-UMS-029

Change Description

Revises Chapters 1, 2, 4, 8, 9, and 12, as applicable, to replace text and table notes as follows: **WAS** (Amendment 3); **IS** (CoC Number 1015).

Chapter 1, pages 1-2, 1.5-8 & 1.5-34; Chapter 2, pages 2.1.3-9 & 2.3-11; Chapter 4, page 4.5-1; Chapter 8, pages 8-1, 8-2, 8.1-1, 8.1.1-1, 8.1.2-1 & 8.1.3-1; Chapter 9, page 9.1-10; Chapter 12, pages 12-1, 12-3 & 12C3-36.

Source of Change: 72.48 Determination Checklist ID #NAC-05-UMS-029

Originating Document: DCR(L) 790-FSAR-4N

The specific references to Amendment 3 Technical Specifications were correct for FSAR Revision 3, but with the succeeding FSAR revisions, they are not appropriate. To preclude the need for changes for every revision, the generic reference to the CoC Number 1015 technical specifications will be inserted and will always be applicable.

Attachment 2

List of Changes

for

NAC-UMS® FSAR, Revision 5
(Docket No 72-1015)

NAC International

October 2005

List of Changes for the NAC-UMS® FSAR, Amendment 4

Incorporates UMS® Amendments UMSS-04A, UMSS-04B & UMSS-05A & 10 CFR 72.48 changes for the period November 2004 through October 2005

Chapter/Page/ Figure/Table	Source of Change: Amendment 72.48/DCR(L) Editorial	Description of Change
Note: The List of Effective Pages and the Chapter Table of Contents, List of Figures and List of Tables have been revised accordingly to reflect the list of changes detailed below.		
Chapter 1		
Page 1-2	72.48/DCR(L) 790-FSAR-4N	1st full paragraph, last sentence – changed "Amendment 3" to "CoC Number 1015"
Page 1-3, Table 1-1	Amendment UMSS-04A	Definition of Standard Fuel, 2nd sentence – added "(thimble plug)" & "a solid stainless steel rod insert"
Page 1.2-27, Table 1.2-6	72.48/DCR(L) 790-FSAR-4H	Under "Materials" – deleted 5th bullet and 2 sub-bullets
Page 1.3-2	Amendment UMSS-04A	Added item #11 to the list of UMS fuel limits
Page 1.5-8, Table 1.5-1	72.48/DCR(L) 790-FSAR-4N	Description of Compliance column, 2nd sentence – changed "Amendment 3" to "CoC Number 1015"
Page 1.5-34, Table 1.5-1	72.48/DCR(L) 790-FSAR-4N	1st full paragraph, last sentence – changed "Amendment 3" to "CoC Number 1015"
Pages 1.8-1 & 1.8-2	72.48/DCR(L) 790-FSAR-4F	Included Revision 15 of Drawing 790-562 (revised again by DCR(L) 790-FSAR-4L)
	72.48/DCR(L) 790-FSAR-4G	Included the following drawing revisions: 790-582, Rev. 12; 790-583, Rev. 8; 790-584, Rev. 19; 790-585, Rev. 19; 790-595, Rev. 10; & 412-502, Rev. 6
	72.48/DCR(L) 790-FSAR-4L	Included Revision 16 of Drawing 790-562
Section 1.8	Various	Incorporated revised drawings
Chapter 2		
Page 2-2, Table 2-1	72.48/DCR(L) 790-FSAR-4M	Changed concrete temperature for normal conditions (local) from "≤ 300°F" to "≤ 200°F"
Page 2.1-1	Amendment UMSS-04A	Section 2.1, 2nd paragraph – added new 3rd sentence to include solid stainless steel rods as part of the approved PWR fuel contents
Page 2.1.1-2, Table 2.1.1-1	Amendment UMSS-04A	General Notes: #3 – added "(thimble plug)" & "a solid stainless steel rod insert"; #4 – added "(thimble plug)"; #6 – added "including solid stainless steel rods inserted into guide tube positions"
	Editorial	General Notes: #6 – changed "non-fuel bearing components" to "nonfuel-bearing components"

Chapter/Page/ Figure/Table	Source of Change: Amendment 72.48/DCR(L) Editorial	Description of Change
Page 2.1.3-9, Table 2.1.3.1-1	72.48/DCR(L) 790-FSAR-4N	1st note under table – changed "Amendment 3" to "CoC Number 1015"
Page 2.2-4	Amendment UMSS-04B	Section 2.2.3, 3rd sentence – split into 2 sentences and added "or a collision of two casks" to the end of 3rd sentence. Added new 5th sentence to address cask sliding issue Section 2.2.3.1 – sentence revised throughout Section 2.2.3.2 – deleted former 2nd sentence & revised current 2nd sentence
	Editorial	Section 2.2.3.1 – removed initial caps from "transportable storage canister" & "vertical concrete cask"
Page 2.3-11	72.48/DCR(L) 790-FSAR-4N	2nd full paragraph – changed "Amendment 3" to "CoC Number 1015"
Chapter 4		
Page 4.1-6	72.48/DCR(L) 790-FSAR-4H	Changed concrete long-term local temperature limit (°F) from "150(B)/300(L)" to "150(B)/200(L)"
Page 4.1-7	72.48/DCR(L) 790-FSAR-4H	For PWR fuel, changed concrete long-term local temperature limit (°F), design condition, allowable, from "300" to "200"
Page 4.1-8	72.48/DCR(L) 790-FSAR-4H	For BWR fuel, changed concrete long-term local temperature limit (°F) design condition, allowable, from "300" to "200"
Page 4.4.1-9	72.48/DCR(L) 790-FSAR-4A	Off-Center Canister Evaluation – replaced former 3rd sentence with revised current 3rd & 4th sentences for clarity
Page 4.4.1-28	Amendment UMSS-04B	Added last paragraph & 3 canister thermal transient analysis conservatisms for the transfer operation
Page 4.4.3-14, Table 4.4.3-1	72.48/DCR(L) 790-FSAR-4H	For PWR fuel, changed concrete allowable temperature limit (°F) from "300 (local)" to "200 (local)"
Page 4.4.3-15, Table 4.4.3-2	72.48/DCR(L) 790-FSAR-4H	For BWR fuel, changed concrete allowable temperature limit (°F) from "300 (local)" to "200 (local)"
Page 4.4.5-2	72.48/DCR(L) 790-FSAR-4E	Last paragraph – replaced former 3rd & 4th sentences with revised current 3rd & 4th sentences
Page 4.4.5-3	72.48/DCR(L) 790-FSAR-4E	1st partial paragraph – added new 5th sentence
Page 4.5-1	72.48/DCR(L) 790-FSAR-4N	Section 4.5.1, 2nd paragraph, 2nd sentence – changed "Amendment 3" to "CoC Number 1015"
Chapter 6		
Page 6.1-1	Amendment UMSS-04A	Section 6.1, 1st paragraph – revised 4th sentence throughout; added new 5th sentence
Page 6.2-1	Amendment UMSS-04A	Section 6.2, 2nd paragraph, 2nd sentence – deleted "rod inserts" & added "rods or stainless steel rods"; 5th sentence – added "or a solid stainless steel rod"; 6th sentence – added "or a solid stainless steel rod"; 7th sentence – added "or a solid stainless steel rod insert"
Page 6.3-3	Amendment UMSS-04A	Section 6.3.2, 3rd bullet, 1st sentence – changed "burnable poisons" to "burnable poison rod inserts" & added "or solid stainless steel rod inserts"
Page 6.7-2	Editorial	Reference 20 – changed from MCBEND to MONK to reflect referenced text

Chapter/Page/ Figure/Table	Source of Change: Amendment 72.48/DCR(L) Editorial	Description of Change
Chapter 8		
Page 8-1	72.48/DCR(L) 790-FSAR-4N	3rd paragraph, last sentence – changed "Amendment 3" to "CoC Number 1015"
Page 8-2	72.48/DCR(L) 790-FSAR-4N	Last paragraph, 1st sentence – changed "Amendment 3" to "CoC Number 1015"
Page 8.1-1	72.48/DCR(L) 790-FSAR-4N	4th paragraph, 1st & last sentences – changed "Amendment 3" to "CoC Number 1015"
Page 8.1.1-1	72.48/DCR(L) 790-FSAR-4N	Item #4, Note – changed "Amendment 3" to "CoC Number 1015" Item #9, 1st Note – changed "Amendment 3" to "CoC Number 1015"; 2nd Note, 2nd sentence – changed "Amendment 3" to "CoC Number 1015"
Page 8.1.1-2	Amendment UMSS-04B	Step 12, 4th sentence – revised throughout; added new 6th sentence
Page 8.1.1-4	Amendment UMSS-05A	Step 28, 2nd sentence – added "(typically, the process ranges from 1 to 2 hours)"
Page 8.1.1-5	Amendment UMSS-04B	Added new 1st note following Step 28; revised 2nd note throughout (subsequently changed by DCR(L) 790-FSAR-4C); Step 30 – added "and isolate the vacuum pump"; Step 31, 3rd sentence – changed "LCO 3.1.2" to "LCO A 3.1.2"*; Step 31 – added Precaution; Step 34, 1st note – changed "LCO 3.1.3" to "LCO A 3.1.3"*; Step 34, 2nd note – changed "to the concrete cask" to "into and closure of the concrete cask" & changed "LCO 3.1.4" to "LCO A 3.1.4"* * The "A" in these LCOs was subsequently deleted via an editorial change (see below).
	Amendment UMSS-04A	Step 30 – changed "≤ 3 mm of mercury" to "≤ 10 mm of mercury"; Step 31, 1st sentence – changed "≤ 3 mm of mercury" to "≤ 10 mm of mercury" & "30 minutes" to "10 minutes"; Step 32 – added "Evacuate the cavity until a vacuum of ≤ 3 mm of mercury exists and"
	72.48/DCR(L) 790-FSAR-4C	Step 28, 2nd note – revised throughout for clarity
	Amendment UMSS-05A	Step 30 – added "and turn the pump off"
	Editorial	Step 31, 3rd sentence – changed "LCO A 3.1.2" to "LCO 3.1.2"; Precaution, last sentence – changed "LCO A 3.1.2" to "LCO 3.1.2" Step 34, 1st note – changed "LCO A 3.1.3" to "LCO 3.1.3"; 2nd note – changed "LCO A 3.1.4" to "LCO 3.1.4"
Page 8.1.2-1	72.48/DCR(L) 790-FSAR-4N	Item #7, Note – changed "Amendment 3" to "CoC Number 1015"
Page 8.1.2-2	72.48/DCR(L) 790-FSAR-4D	Step 14 – added 2nd sentence for clarity; Step 17, 1st note – revised throughout for clarity
Page 8.1.3-1	72.48/DCR(L) 790-FSAR-4B & DCR(L) 790-FSAR-4N	Section 8.1.3, 1st paragraph – added last 2 sentences to provide precautions to cask users regarding the vertical lifting and handling of the concrete cask; 2nd paragraph, 1st sentence – changed "Amendment 3" to "CoC Number 1015"

Chapter/Page/ Figure/Table	Source of Change: Amendment 72.48/DCR(L) Editorial	Description of Change
Page 8.2-1	72.48/DCR(L) 790-FSAR-4B	Section 8.2, 2nd paragraph – added last 2 sentences to provide precautions to cask users regarding the vertical lifting and handling of the concrete cask
Chapter 9		
Page 9.1-4	Amendment UMSS-04A	Section 9.1.2, 2nd paragraph – revised 1st sentence throughout and added reference [11]; deleted 2nd sentence
Page 9.1-10	72.48/DCR(L) 790-FSAR-4N 72.48/DCR(L) 790-FSAR-4I	Section 9.1.7, last sentence – changed "Amendment 3" to "CoC Number 1015" Section 9.1.8, 1st paragraph – added "at eye level"; 2nd paragraph – deleted; 3rd paragraph – added new text to replace previous Note
Page 9.3-2	Amendment UMSS-04A	Section 9.3 – added reference #12
Chapter 11		
Page 11.2.8-1	Amendment UMSS-04B	Section 11.2.8, 1st sentence – changed "acceleration of 0.26g and 0.30g" to "acceleration of 0.26g and 0.29g"
Page 11.2.8-6	Amendment UMSS-04B	Section 11.2.8.2.2, 1st sentence – revised throughout
Page 11.2.8-8	Amendment UMSS-04A	Added 2nd paragraph (last paragraph of Section 11.2.8.2.2) to address cask sliding issue
Page 11.2.8-9	Amendment UMSS-04B	Added new Section 11.2.8.2.4, Vertical Concrete Cask Sliding
Page 11.2.8-10	Amendment UMSS-04B	Continuation of new Section 11.2.8.2.4, Vertical Concrete Cask Sliding
Page 11.2.8-11	Amendment UMSS-04B	Continuation of new Section 11.2.8.2.4, Vertical Concrete Cask Sliding
	Amendment UMSS-04A	Section 11.2.8.3, 2nd sentence – revised throughout Section 11.2.8.4 – revised throughout
Chapter 12		
Page 12-1	72.48/DCR(L) 790-FSAR-4N	Section 12.1, 1st paragraph, 1st & 2nd sentences – changed "Amendment 3" to "CoC Number 1015"
Page 12-3	72.48/DCR(L) 790-FSAR-4N	2nd paragraph, 1st sentence – changed "Amendment 3" to "CoC Number 1015"
Page 12C3-9	Amendment UMSS-04A	Section C 3.1.1, Background, 2nd paragraph, last sentence – changed "Zircaloy" to "zirconium alloy"
Page 12C3-10	Amendment UMSS-04B	Section C 3.1.1, Applicable Safety Analysis, last sentence – changed "through the completion of the vacuum drying" to "through the completion of LCO A 3.1.3" Applicability, 1st sentence – changed "through the completion point of the CANISTER dryness verification testing" to "through the completion point of LCO A 3.1.3" **BOTH OF THESE CHANGES WERE SUPERSEDED BY DCR(L) 790-FSAR-4C.**
	72.48/DCR(L) 790-FSAR-4C	Section C 3.1.1, Applicable Safety Analysis – revised throughout to clarify Bases in accordance with LCO 3.1.1, CANISTER Maximum Time in Vacuum Drying LCO – added "through completion of the helium backfill operations" Applicability – revised throughout

Chapter/Page/ Figure/Table	Source of Change: Amendment 72.48/DCR(L) Editorial	Description of Change
Page 12C3-11	72.48/DCR(L) 790-FSAR-4K	Section C 3.1.1, Actions, A.2.1.1 – deleted "having a maximum water temperature of 100°F"
Page 12C3-12	Amendment UMSS-04B	Section C 3.1.1, Surveillance Requirements, SR 3.1.1.1, 1st sentence – changed "through completion of the CANISTER vacuum dryness verification testing" to "through completion of LCO A 3.1.3"; 2nd sentence – added "or forced air" SR 3.1.1.2, 1st sentence -- changed "through completion of the CANISTER vacuum dryness verification testing" to "through completion of LCO A 3.1.3"; 2nd sentence – added "or forced air" **BOTH OF THESE CHANGES WERE SUPERSEDED BY DCR(L) 790-FSAR-4C.**
	72.48/DCR(L) 790-FSAR-4C	Section C 3.1.1, Surveillance Requirements, SR 3.1.1.1 – revised throughout for clarity SR 3.1.1.2 – revised throughout for clarity References – Note added to clarify vacuum drying/helium backfill operations
Page 12C3-14	Amendment UMSS-04A	Section C 3.1.2, Applicable Safety Analysis – revised throughout LCO – changed "3 mm of mercury" to "≤ 10 mm of mercury"
	Amendment UMSS-04B	Section C 3.1.2, Applicable Safety Analysis, last sentence – revised throughout (changes to last sentence supersede Amendment 04A changes above)
	Amendment UMSS-05A	Section C 3.1.2, Applicable Safety Analysis, last sentence – added "and the pump turned off"
Page 12C3-15	Amendment UMSS-04A	Section C 3.1.2, Surveillance Requirements, SR 3.1.2.1 – revised throughout
Page 12C3-16	Amendment UMSS-04A	Section C 3.1.3, Background, 1st paragraph, 6th sentence – revised throughout; 2nd paragraph, 1st sentence – revised throughout
Page 12C3-17	Amendment UMSS-04A	Section C 3.1.3, Actions, A.1 – added last sentence for clarity
Page 12C3-19	Amendment UMSS-04A	Section C 3.1.4, Background, 2nd paragraph, 3rd sentence – changed "Zircaloy" to "zirconium alloy"
Page 12C3-21	Amendment UMSS-04A	Section C 3.1.4, Applicable Safety Analysis, 1st paragraph, 1st sentence – changed "Zircaloy" to "zirconium alloy" LCO, 3rd paragraph, last sentence – changed "Zircaloy" to "zirconium alloy"
Page 12C3-22	Amendment UMSS-04B	Section C 3.1.4, Applicability, 1st paragraph – added "and installing the CONCRETE CASK shield plug and cask lid"
	Amendment UMSS-04A	Section C 3.1.4, Actions – changes to A.1.1 were superseded by Revision 4. A.1.2 – changed "TRANSFER OPERATIONS and UNLOADING OPERATIONS" to "TRANSFER OPERATIONS or UNLOADING OPERATIONS"
	72.48/DCR(L) 790-FSAR-4K	Section C 3.1.4, Actions, A.1.1, 1st sentence – deleted "having a maximum water temperature of 100°F"; A.1.2 – revised throughout

Chapter/Page/ Figure/Table	Source of Change: Amendment 72.48/DCR(L) Editorial	Description of Change
Page 12C3-23	Amendment UMSS-04A	Section C 3.1.4, Actions, A.2.2 – changed "TRANSFER OPERATIONS and UNLOADING OPERATIONS" to "TRANSFER OPERATIONS or UNLOADING OPERATIONS" B.1 – deleted "operable" B.2 – deleted "operable" Surveillance Requirements, SR 3.1.4.1, 1st sentence – deleted "operable"
Page 12C3-27	Amendment UMSS-04A	Section C 3.1.6, Applicable Safety Analysis, 2nd paragraph, 5th sentence – changed "component is" to "components are"; added new last sentence
Page 12C3-28	Amendment UMSS-04A	Section C 3.1.6, Actions, 1st paragraph, 1st sentence – changed "which states that, for this LCO," to "that states for this LCO," A.1 – revised throughout
	Amendment UMSS-05A	Section C 3.1.6, Actions, A.1, 1st sentence – changed "has been determined to be inoperable" to "has been determined to not be OPERABLE"
Page 12C3-29	Amendment UMSS-04A	Section 3.1.6, Actions, A.1 – revised throughout (1st paragraph, 1st sentence subsequently changed by Amendment 05A) A.2 – added (superseded by Amendment 05A changes) B.1 – revised throughout (superseded by Amendment 05A changes) B.2 – deleted (new B.2 added by Amendment 05A)
	Amendment UMSS-05A	Section 3.1.6, Actions A.1, 1st sentence – revised throughout A.2 – revised throughout A.3 – added B.1 – revised throughout B.2 – added
Page 12C3-30	Amendment UMSS-04A	Section C 3.1.6, Surveillance Requirements, SR 3.1.6.1, 1st paragraph – revised throughout 2nd paragraph – added "and CANISTER" and changed "air inlets and outlets" to "air inlet and outlet screens" References – added Section 11.1.2
	Editorial	Section C 3.1.6, Surveillance Requirements, SR 3.1.6.1, 1st paragraph, 5th sentence – changed "air inlets and outlets" to "air inlet and outlet screens" for consistency
Page 12C3-36	72.48/DCR(L) 790-FSAR-4N	Section C 3.2.2, Surveillance Requirements, SR 3.2.2.1, last sentence – changed "Amendment 3" to "CoC Number 1015"
Page 12C3-39	Amendment UMSS-04A	Section C 3.3.1, Actions, A.2 – deleted "immediately" A.3, 1st sentence – revised throughout Surveillance Requirements, SR 3.3.1.1, 1st sentence – added "once"

<u>Attachment 3</u>

CERTIFICATION OF ACCURACY

OF THE

NAC-UMS® UNIVERSAL STORAGE SYSTEM FINAL SAFETY ANALYSIS REPORT,

REVISION 5

NAC International

October 2005

NAC INTERNATIONAL

CERTIFICATION OF ACCURACY PURSUANT TO 10 CFR 72. 248(c)(4)(i)

Thomas A. Danner (Affiant), Vice President, Engineering, of NAC International, hereinafter referred to as NAC, at 3930 East Jones Bridge Road, Norcross, Georgia 30092, being duly sworn, deposes and certifies that:

1. Affiant has reviewed the information described in Item 2, is personally familiar with the preparation, checking and verification of that information and is authorized to certify its accuracy.

2. The information being certified as accurate includes all of the changes incorporated into the NAC-UMS® Universal Storage System Final Safety Analysis Report, Revision 5.

STATE OF GEORGIA, COUNTY OF GWINNETT

Mr. Thomas A. Danner, being duly sworn, deposes and says:

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

Executed at Norcross, Georgia, this 11th day of October 2005.

Thomas A. Danner
Thomas A. Danner
Vice President, Engineering
NAC International

Subscribed and sworn before me this 11th day of October, 2005.

Jeannie Klinetob
Notary Public

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Chapter 1

1.0 GENERAL DESCRIPTION

NAC International Inc. (NAC) has designed a canister-based system for the storage and transportation of spent nuclear fuel. The system is designated the Universal MPC System® (UMS®). The storage component of the UMS® is designated the Universal Storage System. This Safety Analysis Report (SAR) demonstrates the ability of the Universal Storage System to satisfy the requirements of the U.S. Nuclear Regulatory Commission (NRC) for the storage of spent nuclear fuel as prescribed in Title 10 of the Code of Federal Regulations, Part 72 (10 CFR 72) [1], and NUREG-1536 [2]. The transportation component of the UMS® is designated the Universal Transportation System, which is addressed in the NAC Safety Analysis Report for the Universal Transport Cask, Docket No. 71-9270 [3].

The Universal Storage System primary components consist of the Transportable Storage Canister, Vertical Concrete Cask, and a transfer cask. The Transportable Storage Canister is designed and fabricated to meet the requirements for transport in the Universal Transport Cask (part of the Universal Transportation System) and to be compatible with the U.S. Department of Energy (DOE) MPC Design Procurement Specification [4], so as not to preclude the possibility of permanent disposal in a deep Mined Geological Disposal System.

In long-term storage, the Transportable Storage Canister is installed in a Vertical Concrete Cask, which provides passive radiation shielding and natural convection cooling. The Vertical Concrete Cask also provides protection during storage for the Transportable Storage Canister under adverse environmental conditions. The cask employs a double-welded closure design to preclude loss of contents and to preserve the general health and safety of the public during long-term storage of spent fuel.

The transfer cask is used to move the Transportable Storage Canister from the work stations where the canister is loaded and closed to the Vertical Concrete Cask. It is also used to transfer the canister from the Vertical Concrete Cask to the Universal Transport Cask for transport.

This Safety Analysis Report is formatted in accordance with U.S. NRC Regulatory Guide 3.61 [5]. This chapter provides a general description of the major components of the Universal Storage System and a description of system operation. Definition of terminology used throughout this report is summarized in Table 1-1. The term "concrete cask" or "cask" is routinely used to refer to the Vertical Concrete Cask. The term "Transportable Storage Canister" or "canister" is used to refer to both the PWR and BWR canisters where the discussion is common to both configurations. Discussion of features unique to each of the PWR and BWR configurations is handled in subsections, as appropriate, within each chapter.

Table 1.5-1 provides a compliance matrix to the regulatory requirements and acceptance criteria specified in NUREG-1536. This matrix describes how the Universal Storage System Safety Analysis Report addresses and demonstrates compliance with each requirement and criterion listed in NUREG-1536. Table B3-1 in Appendix B of the CoC Number 1015 Technical Specifications provides a list of the exceptions to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

Table 1-1 Terminology

Universal Storage System	The storage component of the Universal MPC System (UMS®) designed by NAC for the storage and transportation of spent nuclear fuel.
Universal Transport Cask	The packaging consisting of a Universal Transport Cask body with a closure lid and energy-absorbing impact limiters. The Universal Transport Cask is used to transport a Transportable Storage Canister containing spent fuel. The cask body provides the primary containment boundary during transport.
Confinement System	The components of the Transportable Storage Canister intended to retain the radioactive material during storage.
Contents	Twenty-four PWR fuel assemblies, or fifty-six BWR fuel assemblies. The fuel assemblies may be configured as Site Specific Fuel. The fuel assemblies are contained in a Transportable Storage Canister.
Standard Fuel	Irradiated fuel assemblies with a burnup less than, or equal to, 45,000 MWD/MTU and having the same configuration as when originally fabricated consisting generally of the end fittings, fuel rods, guide tubes, and integral hardware. For PWR fuel, a flow mixer (thimble plug), an in-core instrument thimble, a burnable poison rod insert, or a solid stainless steel rod insert is considered to be a component of standard fuel. For BWR fuel, the channel is considered to be integral hardware. The design basis fuel characteristics and analysis are based on the standard fuel configuration.
Consolidated Fuel	A nonstandard fuel configuration in which the individual intact fuel rods from one or more fuel assemblies are placed in a single container or a lattice structure that is dimensionally similar to a fuel assembly. Consolidated Fuel is stored in a Maine Yankee Fuel Can.
Intact Fuel (Assembly or Rod) (Undamaged Fuel)	A fuel assembly or fuel rod with no fuel rod cladding defects, or with known or suspected fuel rod cladding defects not greater than pinhole leaks or hairline cracks.

Table 1-1 Terminology (Continued)

Damaged Fuel (Failed Fuel)	A fuel assembly or fuel rod with known or suspected cladding defects greater than pinhole leaks or hairline cracks. Damaged Fuel must be placed in a Maine Yankee Fuel Can.
High Burnup Fuel	A fuel assembly having a burnup between 45,000 and 50,000 MWD/MTU, which must be preferentially loaded in peripheral positions of the basket.

Table 1.2-6 Vertical Concrete Cask Fabrication Specification Summary

Note: The American Society for Testing and Materials (ASTM) approved revisions of the ASTM standards referenced in this table that are in effect at the time of product/test procurement shall be invoked in meeting FSAR requirements.

Materials

- Concrete mix shall be in accordance with the requirements of ACI 318 and ASTM C94 [19].
- Type II Portland Cement, ASTM C150 [20].
- Fine aggregate ASTM C33 [21] or C637 [22].
- Coarse aggregate ASTM C33.
- Admixtures
  - Water Reducing and Superplasticizing ASTM C494 [23].
  - Pozzolanic Admixture (Loss on Ignition 6% or less) ASTM C618 [24].
- Compressive Strength 4000 psi at 28 days.
- Specified Air Entrainment per ACI 318.
- All steel components shall be of material as specified in the referenced drawings.

Welding

- Visual inspection of all welds shall be performed to the requirements of AWS D1.1, Section 8.6.1 [25].

Construction

- A minimum of two concrete samples for each concrete cask shall be taken in accordance with ASTM C172 [26] and ASTM C31 [27] for the purpose of obtaining concrete slump, density, air entrainment, and 28-day compressive strength values. The two samples shall not be taken from the same batch or truckload.
- Test specimens shall be tested in accordance with ASTM C39 [28].
- Formwork shall be in accordance with ACI 318.
- All sidewall formwork shall remain in place in accordance with ACI 318.
- Grade, type, and details of all reinforcing steel shall be in accordance with the referenced drawings.
- Embedded items shall conform to ACI 318 and the referenced drawings.
- The placement of concrete shall be in accordance with ACI 318.
- Surface finish shall be in accordance with ACI 318.

Quality Assurance

The concrete cask shall be constructed under a quality assurance program that meets 10 CFR 72 Subpart G. The quality assurance program must be accepted by NAC International and the licensee prior to initiation of the work.

Table 1.2-7 Major Physical Design Parameters of the Transfer Casks

	Transfer Cask Configuration	
Parameter	**Standard**	**Advanced**
Inside Diameter (in.)	67.8	67.8
Outside Diameter (in.)	85.3	85.3
Cavity Height (nominal) (in.)		
Class 1	177.3	177.3
Class 2	186.4	186.4
Class 3	194.0	194.0
Class 4	187.8	187.8
Class 5	192.6	192.6
Empty Weight (nominal) (lbs)		
Class 1	112,300	112,300
Class 2	117,300	117,300
Class 3	121,500	121,500
Class 4	118,100	118,100
Class 5	120,700	120,700
Allowable Canister Weight	≤ 88,000	≤ 98,000

1.3 Universal Storage System Contents

The Universal Storage System is designed to store up to 24 PWR fuel assemblies or up to 56 BWR fuel assemblies. The design basis fuel contents are subject to the limits presented in Section 1.3.1. Site specific contents are described in Section 1.3.2. The site specific contents are either shown to be bounded by the evaluation of the design basis fuel, or are separately evaluated to establish limits which are maintained by administrative controls.

1.3.1 Design Basis Spent Fuel

The Universal Storage System is evaluated based on a set of fuel assembly parameters that establish bounding conditions for the system. The bounding fuel parameters are provided in Table 2.1.1-1 for PWR fuel and in Table 2.1.2-1 for BWR fuel. Fuel assembly designs having parameters bounded by those in Tables 2.1.1-1 and 2.1.2-1 are acceptable for loading. Four different assembly array sizes: 14 × 14, 15 × 15, 16 × 16 and 17 × 17, produced by several different fuel vendors, were evaluated in the development of the PWR design basis spent fuel description. Three different arrays: 7 × 7, 8 × 8 and 9 × 9, produced by several different fuel vendors were evaluated in the development of the BWR design basis spent fuel description.

The Universal Storage System fuel limits are:

1. The characteristics of the PWR and BWR fuel to be stored shall be in accordance with Tables 2.1.1-1 and 2.1.2-1, respectively.

2. The total decay heat of the PWR fuel shall not exceed 23.0 kW.

3. The total decay heat of the BWR fuel shall not exceed 23.0 kW.

4. The maximum initial enrichment shall not exceed 5.0 wt % ^{235}U for PWR and 4.8 wt % ^{235}U for BWR fuel assemblies.

5. The maximum initial enrichment of the PWR fuel is based on a pool/canister water boron content of at least 1,000 parts per million for some fuel parameter combinations. The maximum initial enrichment of the BWR fuel is defined as the maximum initial peak planar-average enrichment. The initial peak planar-average enrichment is the maximum initial peak planar-average enrichment at any height along the axis of the fuel assembly. The initial peak planar-average may be higher than the bundle average enrichment value that appears in fuel design or plant documents. Unenriched fuel assemblies are not evaluated and are not included as a proposed content.

6. The maximum PWR fuel assembly burnup (MWD/MTU) and minimum cooling time (years) shall be as defined by Table 2.1.1-2.

7. The maximum BWR fuel assembly burnup (MWD/MTU) and minimum cooling time (years) shall be as defined by Table 2.1.2-2.

8. Radiation levels shall not exceed the requirements of 10 CFR 72.104 and 10 CFR 72.106.

9. An inert atmosphere shall be maintained within the canister where spent fuel is stored.

10. Stainless steel spacers may be used to axially position PWR fuel assemblies that are shorter than the canister cavity length to facilitate handling.

11. Flow mixers (thimble plugs), in-core instrument thimbles, burnable poison rods or solid stainless steel rods may be placed in PWR guide tubes as long as the maximum fuel assembly weights listed in Table 2.1.1-1 are not exceeded and no credit for soluble boron is taken.

1.3.2 Site Specific Spent Fuel

This section describes fuel assembly characteristics and configurations, which are unique to specific reactor sites. These site specific content configurations result from conditions that occurred during reactor operations, participation in research and development programs (testing programs intended to improve reactor operations), and from the placement of control components or other items within the fuel assembly.

Site specific fuel assembly configurations are either shown to be bounded by the analysis of the standard design basis fuel assembly configuration of the same type (PWR or BWR), or are shown to be acceptable contents by specific evaluation of the configuration.

Unless specifically excepted, site specific fuel must meet all of the conditions specified for the design basis fuel presented in Section 1.3.1 above. Site specific fuels are also described in Section 2.1.3.

Table 1.5-1 NUREG-1536 Compliance Matrix (continued)

Chapter 2 – Principal Design Criteria			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
3. Design Criteria for Safety Protection Systems **b. Structural**	SSC that are important to safety must be designed to accommodate the combined loads of normal operations, accidents, and natural phenomena events with an adequate margin of safety. [10 CFR 72.24(c)(3), 72.122(b), and 72.122(c)] The design-basis earthquake must be equivalent to or exceed the safe shutdown earthquake of a nuclear plant at sites evaluated under 10 CFR Part 100. [10 CFR 72.102(f)] The DCSS must maintain confinement of radioactive material within the limits of 10 CFR Part 72 and Part 20, under normal, off-normal, and credible accident conditions. [10 CFR 72.236(l)] The DCSS must be designed and fabricated so that the spent fuel is maintained in a subcritical condition all under all credible normal, off-normal, and accident conditions. [10 CFR 72.124(a) and 72.236(c)] The spent fuel cladding must be protected during storage against degradation that leads to gross ruptures, or the fuel must be otherwise confined such that degradation of the fuel during storage will not pose operational safety problems with respect to its removal from storage. [10 CFR 72.122(h)(1)] Storage systems must be designed to allow ready retrieval of spent fuel waste for further processing or disposal. [10 CFR 72.122(l)]	The SAR should define how the DCSS structural components are designed to accommodate combined normal, off-normal, and accident loads, while protecting the DCSS contents from significant structural degradation, criticality, and loss of confinement, while preserving retrievability. This discussion is generally a summary of the analytical techniques and calculational results from the detailed analysis discussed in SAR Section 3 and should be presented in a non-proprietary forum.	A discussion of the structural design criteria are presented in Section 2.2. Combined loadings are addressed specifically in Section 2.2.5, and in Tables 2.2-1 and 2.2-2. The design-basis earthquake is specified in Section 2.2.3 in accordance with 10 CFR 72.102 criteria. Analyses show that the system maintains adequate margins of safety during normal (Section 3.4.4.1), off-normal (Section 11.1) and accident condition (Section 11.2) events, therefore, confinement of the radioactive material is assured. As the system maintains adequate structural margins of safety during normal, off-normal and accident condition events, criticality control is assured based on the analyses presented in Chapter 6. The maximum allowable cladding temperatures are specified in Tables 2-1 and 4.1-3. The temperature results for the fuel cladding listed in Tables 4.1-4 and 4.1-5 show that the allowable cladding temperatures are not exceeded. Therefore, the fuel cladding is protected against degradation during storage. As described in Section 1.2, the system is designed to be readily retrievable and transported off site as necessary for further processing or disposal.

Table 1.5-1 NUREG-1536 Compliance Matrix (continued)

Chapter 2 – Principal Design Criteria			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
3. Design Criteria for Safety Protection Systems **c. Thermal**	Each spent fuel storage or handling system must be designed with a heat removal capability having testability and reliability consistent with its importance to safety. [10 CFR 72.128(a)(4)] The DCSS must be designed to provide adequate heat removal capacity without active cooling systems. [10 CFR 72.236(f)]	The applicant should provide a general discussion of the proposed heat removal mechanisms, including the reliability and verifiability of such mechanisms and any associated limitations. All heat removal mechanisms should be passive and independent of intervening actions under normal and off-normal conditions.	The testability of the heat removal capability of the storage system is described in Section 2.3.3.2. The reliability of the heat removal system is demonstrated in Chapter 4, and operating limits are established in Appendix A of the CoC Number 1015 Technical Specifications consistent with the temperature monitoring and routine surveillance described in Section 2.3.3.2 to ensure continued safe operation. As shown by the results of the thermal evaluation of the system reported in Tables 4.1-4 and 4.1-5, the storage system provides adequate heat removal through the passive cooling design features described in Section 1.2.1.3.

Table 1.5-1 NUREG-1536 Compliance Matrix (continued)

Chapter 8 – Operating Procedures		
Area	**Regulatory Requirement**	**Description of Compliance**
Health and Safety	1. The applicant must develop operating procedures that adequately protect health and minimize danger to life or property. [10 CFR 72.40(a)(5)]	Operating procedures are provided in Chapter 8. Notes and Cautions are listed among the steps to emphasize steps important to maintaining health and safety.
ALARA	2. The applicant must establish operational restrictions to meet the regulatory requirements of 10 CFR Part 20 and objective limits that are as low as is reasonably achievable (ALARA) for radioactive materials in effluents and direct radiation levels associated with ISFSI operations. [10 CFR 72.104(b) and 10 CFR 72.24(e)]	Section 8.0 specifies that the procedures are developed to maintain occupational dose ALARA. Automated welding systems and temporary shielding are utilized to minimize worker dose during canister loading operations. Appendix A, Section A 3.2.2 specifies maximum external dose rates to maintain reasonable dose level within a cask array for routine surveillance and inspection activities.
Control of Radioactive Effluents	3. The applicant must describe all equipment and processes used to maintain control of radioactive effluents. [10 CFR 72.24(l)(2)]	As described in Section 8.0, there are no radioactive effluents in routine operations other than pool water and helium gas that are removed from the canister. These effluents are routinely handled in Licensee operations.
Written Procedures	4. The general licensee shall conduct activities related to storage of spent fuel in accordance with written procedures. [10 CFR 72.212(b)(9)] 5. Vendors seeking approval of a cask design shall ensure that written procedures and appropriate tests are established before initial use of the casks. In addition, the vendor must provide a copy of these procedures and tests to each prospective cask user. [10 CFR 72.234(f)]	Written procedures for the system are provided in Chapter 8. These procedures are intended to provide general operational guidance for use of the system. These procedures will be used by an ISFSI operator to develop detailed, site specific procedures for use of the system.
Wet or Dry Loading and Unloading Facilities	6. The cask must be compatible with wet or dry spent fuel loading and unloading facilities. [10 CFR 72.236(h)]	The system design is compatible with both wet or dry loading and unloading facilities.
Decontamination Features	7. To the extent practicable, the design of the cask must facilitate decontamination. [10 CFR 72.236(i)]	The canister is designed to facilitate decontamination as described in Section 2.3.5.3. As described in Section 8.1.1, the annulus between the canister and transfer cask is filled with clean water prior to placement in the fuel pool to minimize the potential for contamination of the surface of the canister.
Ready Retrieval of Spent Fuel	8. The design of storage systems must allow ready retrieval of spent fuel for further processing or disposal. [10 CFR 72.122(l)]	The procedure provided in Section 8.2 and 8.3 specify the steps necessary for retrieval of the spent fuel from the system for further processing or disposal.

Table 1.5-1 NUREG-1536 Compliance Matrix (continued)

Chapter 8 – Operating Procedures		
Area	**Regulatory Requirement**	**Description of Compliance**
Radioactive Waste Generation	9. The design of the cask must minimize the quantity of radioactive waste generated. [10 CFR 72.128(a)(5) and 10 CFR 72.24(f)]	Operation of the system generates no radioactive waste, other than a limited amount of protective clothing and tools used during loading operations that could be easily disposed or decontaminated.
Inspection, Maintenance, and Testing	10. The design of structures, systems, and components (SSCs) that are important to safety must permit inspection, maintenance, and testing. [10 CFR 72.122(f)]	Appendix A of the CoC Number 1015 Technical Specifications specifies the inspection and maintenance activities required for the system.
Scope of Application	1. Major operating procedures apply to the principal activities expected to occur during dry cask storage. The expected scope of activities for the SAR operating procedure descriptions is described in Section II, "Areas of Review" (*of the SRP*), as well as Section 8 of Regulatory Guide 3.61. Operating procedure descriptions should be submitted to address the cask design features and planned operations.	The operating procedures provided in Chapter 8 cover all planned operations of the system, including loading of spent fuel, placement of the system at the site, and unloading of the system.
Process Control and Hazard Mitigation	2. Operating procedure descriptions should identify measures to control processes and mitigate potential hazards that may be present during planned normal operations. Section V, "Review Procedures" (*of the SRP*), discusses previously identified processes and potential hazards.	The operating procedures provided in Chapter 8 include Notes and Cautions to indicate steps important to mitigate potential hazards.
Operating Controls and Limits	3. Operating procedure descriptions should ensure conformance with the applicable operating controls and limits described in the technical specifications provided in SAR Chapter 12.	The operating controls and limits specified in Chapter 12 are included with the appropriate procedures in Chapter 8.

1.8 License Drawings

This section presents the list of License Drawings for the Universal Storage System.

1.8.1 License Drawings for the UMS® Universal Storage System

Drawing Number	Title	Revision No.	No. of Sheets
790-501	Canister/Basket Assembly Table, NAC-UMS®	3	1
790-559	Assembly, Transfer Adapter, NAC-UMS®	7	4
790-560	Assembly, Standard Transfer Cask (TFR), NAC-UMS®	17	7
790-561	Weldment, Structure, Vertical Concrete Cask (VCC), NAC-UMS®	12	4
790-562	Reinforcing Bar and Concrete Placement, Vertical Concrete Cask (VCC), NAC-UMS®	16	7
790-563	Lid, Vertical Concrete Cask (VCC), NAC-UMS®	4	1
790-564	Shield Plug, Vertical Concrete Cask (VCC), NAC-UMS®	7	3
790-565	Nameplate, Vertical Concrete Cask (VCC), NAC-UMS®	4	1
790-570	Fuel Basket Assembly, 56 Element BWR, NAC-UMS®	4	2
790-571	Bottom Weldment, Fuel Basket, 56 Element BWR, NAC-UMS®	3	1
790-572	Top Weldment, Fuel Basket, 56 Element BWR, NAC-UMS®	4	1
790-573	Support Disk and Misc. Basket Details, 56 Element BWR, NAC-UMS®	7	1
790-574	Heat Transfer Disk, Fuel Basket, 56 Element BWR, NAC-UMS®	3	1
790-575	BWR Fuel Tube, NAC-UMS®	10	2
790-581	PWR Fuel Tube, NAC-UMS®	9	2
790-582	Shell Weldment, Canister, NAC-UMS®	12	2
790-583	Assembly, Drain Tube, Canister, NAC-UMS®	8	1
790-584	Details, Canister, NAC-UMS®	19	3
790-585	Transportable Storage Canister (TSC), NAC-UMS®	19	3
790-587	Spacer Shim, Canister, NAC-UMS®	1	1
790-590	Loaded Vertical Concrete Cask (VCC), NAC-UMS®	5	2
790-591	Bottom Weldment, Fuel Basket, 24 Element PWR, NAC-UMS®	6	2

License Drawings
(Continued)

Drawing Number	Title	Revision No.	No. of Sheets
790-592	Top Weldment, Fuel Basket, 24 Element PWR, NAC-UMS®	8	1
790-593	Support Disk and Misc. Basket Details, 24 Element PWR, NAC-UMS®	7	2
790-594	Heat Transfer Disk, Fuel Basket, 24 Element PWR, NAC-UMS®	2	1
790-595	Fuel Basket Assembly, 24 Element PWR, NAC-UMS®	10	2
790-605	BWR Fuel Tube, Over-Sized Fuel, NAC-UMS®	11	2
790-613	Supplemental Shielding, VCC Inlets, NAC-UMS®	2	1
790-617	Door Stop, NAC-UMS®	3	2

1.8.2 Site Specific Spent Fuel License Drawings

Drawing Number	Title	Revision No.	No. of Sheets
412-501	Spent Fuel Can Assembly, Maine Yankee (MY), NAC-UMS®	4	2
412-502	Fuel Can Details, Maine Yankee (MY), NAC-UMS®	6	6

R-203475

REV	CHANGE
0	INITIAL ISSUE
1	INC DCR 0A
2	INC DCR 1A
3	INC DCR 2A
4	INC DCR 3A
5	INC DCR 4A
6	INC DCR 5A,5B,5C,5D,5E
7	INC DCR 6A,6B,6C
8	INC DCR 7A,7B,7C,7D
9	INC DCR 8A,8B,8C,8D,8E
10	INC DCR 9A
11	INC DCR 10A,10B,10C,10D
12	INC DCR 11A,11B,11C,11D,11E
13	INC DCR 12A,12B,12C,12D
14	INC DCR 13A,13B,13C
15	INC DCR 14A
16	INC DCR 15A

REBAR LENGTHS (TOLERANCE ±1)

ITEM 1	ITEM 2	ITEM 3	ITEM 4	ITEM 5	ITEM 6	CASK ASSEMBLY	CLASS
191.0	201.5	177.5	185.5	172.5	187.5	95	PWR 1
200.1	210.6	186.6	194.6	181.4	196.6	96	PWR 2
201.5	212	188	196	182.8	198	97	BWR 4
206.3	216.8	192.8	200.8	187.6	202.8	98	BWR 5
207.7	218.2	194.2	202.2	189	204.2	99	PWR 3

△22 APPLY SILICONE CAULK BETWEEN THE EDGE OF ITEM 34 AND THE TOP FLANGE OF THE LINER WELDMENT, IF THE GAP IS 3/8 OR LESS.

△21 ENGAGE THREAD OF ITEM 33 (REBAR) FLUSH TO THE TOP OF ITEM 32 (BASE PLATE).

△20 WELD EFFECTIVE THROAT MAY BE REDUCED BY 1/8 AT THE EDGE OF TAPPED HOLE.

△19 AFTER COMPLETION OF LOAD TESTING AND POST LOAD TESTING NDE, THE LIFT ANCHORS, FOR APPROXIMATELY 18" ON THE LIFT END, SHALL BE PREPARED IN ACCORDANCE WITH SSPC-SP1 AND COMMERCIAL BLASTED PER SSPC-SP6. APPLY KEELER & LONG KOLOR-POXY PRIMER #3200 AND KEELER & LONG ACRYTHANE ENAMEL Y-1 SERIES PER MANUFACTURES APPLICATION INSTRUCTIONS.

△18 ITEM 36 (CONCRETE ANCHOR) AND 37 (SCREEN SCREW) AND 38 (WASHER) TO BE USED WHEN ALTERNATE ASSEMBLIES -93 AND -94 ARE USED.

△17 ITEM 10 (REBAR) MAY REST ON THE TOP OF THE OUTLET WELDMENT LIFTING NUT OR MAY BE LOCATED TANGENT TO THE DIAMETER OF ITEM 9.

△16 SHIM PLATES MAY BE UTILIZED TO FACILITATE FIELD WELDING OPERATIONS ON ONE OR BOTH SIDES OF THE SUPPLEMENTAL SHIELDING WELDMENT. LOCATE WELDS APPROX. AS SHOWN.

△15 SECURE THE AIR OUTLETS TO PREVENT BOTH UPWARD DISPLACEMENT DURING CONCRETE PLACEMENT AND DOWNWARD DISPLACEMENT DUE TO FABRICATION PRIOR TO CONCRETE PLACEMENT.

△14 ITEM 5 MAY BE INSTALLED WITH HOOK AT TOP OF CASK. ALTERNATELY, THE 90° BEND MAY BE SUBSTITUTED WITH A 180° HOOK. LENGTH OF BAR MAY BE SAME AS ITEM 3 AS SHOWN ON THE REBAR LENGTH TABLE.

△13 ITEM 18, FLAT WASHER, MAY BE REPLACED AS NEEDED WITH A 5/8 DIA. STAINLESS STEEL BEVEL WASHER.

12. LOCATION OF HORIZONTAL REINFORCEMENT (HOOP BARS) CAN BE REVERSED WITH THE VERTICAL REINFORCEMENT, BOTH INSIDE AND OUTSIDE REINFORCEMENT CURTAIN.

△11 ITEM 17 MAY BE CONSTRUCTED FROM SINGLE PIECE PLATE. FIELD MODIFICATION OF HOLES IN ITEM 17 TO ALLOW FIT-UP IS PERMISSIBLE AS LONG AS SCREENS ARE NOT DAMAGED. ITEMS 16 AND 17 MAY BE TRIMMED IN THE FIELD TO ALLOW FIT-UP.

10. COAT ALL EXPOSED CONCRETE SURFACES WITH AN APPROVED SEALER.

△9 INSTALL PER MANUFACTURERS INSTRUCTIONS. OTHER STAINLESS STEEL DROP IN ANCHORS ARE ACCEPTABLE FOR USE IN PLACE OF ITEM 28. IF ALTERNATIVE ANCHORS ARE USED THEN THE SCREW/BOLT (ITEM 29) SHALL BE STAINLESS STEEL AND MATE WITH THE ANCHOR.

8. INSTALL PLUGS INTO SCREEN ATTACHMENT POINTS PRIOR TO FORMING

7. DURING FABRICATION SEGMENTED HOOPS MAY BE USED IN LIEU OF WHOLE HOOPS.

6. CONCRETE SHALL DEVELOP A COMPRESSIVE STRENGTH (F_C') OF 4000 PSI USING TYPE 2 PORTLAND CEMENT, 1 1/2 IN. MAXIMUM SIZE AGGREGATE. CONCRETE DENSITY SHALL BE 140 PCF MINIMUM.

5. ALL REBAR OVERLAPS TO BE 33 INCHES MINIMUM. REBAR OVERLAPS IN ADJACENT HOOPS SHALL NOT BE VERTICALLY ALIGNED.

4. A 3 INCH CONCRETE COVER SHALL BE MAINTAINED FOR REINFORCEMENT AT THE EXTERIOR CONCRETE SURFACES, 2 INCH CONCRETE COVER BETWEEN THE CASK LINER AND THE REINFORCEMENT, AND 3/4 INCH CONCRETE COVER BETWEEN THE OTHER NON-EXPOSED SURFACES AND THE REINFORCEMENT UNLESS OTHERWISE NOTED, IN ACCORDANCE WITH THE TOLERANCES AS ALLOWED BY ACI 117-90.

3. ALL BENDING OF REBARS SHALL BE PERFORMED COLD, ALL HOOKS ARE STANDARD UNLESS OTHERWISE DETAILED.

2. ALL REINFORCEMENT BARS MAY BE FIELD CUT, BENT AND PLACED OR TIED FOR CLEARANCE AS APPROVED BY NAC ENGINEERING.

1. REINFORCEMENT FABRICATION SHALL COMPLY WITH ACI 318/318R AND 349/349R STANDARDS. REINFORCEMENT PLACEMENT SHALL BE IN ACCORDANCE WITH ACI 117-90 TOLERANCES.

NOTES:

32. HILTI #00045788 OR #00336431, (HDI 3/8" SS303) MAY BE USED.

31. THE NAC-UMS VERTICAL CONCRETE CASK NUMBER MAY BE FORMED INTO THE CONCRETE SHELL. THE FORMED NUMBERS SHALL BE APPROXIMATELY 12" X 12" NOT TO EXCEED .4" DEEP.

△30 CONCRETE ANCHOR ADHESIVE SUCH AS HILTI ADHESIVE HIT HY 150 OR EQUIVALENT MAY BE USED TO PREVENT THE CONCRETE ANCHOR FROM BECOMING LOOSE OR PULLING OUT.

△29 SEAL WELD OPEN SEAMS.

△28 HOLES ARE TO BE LOCATED AND DRILLED IN THE FIELD AS NEEDED.

27. ITEM 32 AND NELSON STUDS ON THE BASE WELDMENT MAY COME IN CONTACT WITH REINFORCING STEEL, HOWEVER, A CLEAR COVER OF 3/4" SHALL BE MAINTAINED BETWEEN ITEM 31 AND REBAR.

△26 AT THE USE OF ASSY 92 (ALTERNATE CONFIGURATION-D) TWO OF ITEM 6 MAY BE CUT TO FIT.

△25 ITEM 44 TO BE HAND TIGHTENED AND TURNED ONE LAND. ITEM 45 TO BE MODIFIED AS REQUIRED FOR FIT-UP.

24. ITEM 43, 1 1/4 NOM. 120 KSI WILLIAMS ALL THREAD-BAR (R71) ITEM 44, WILLIAMS HEX NUT (R73-10) ITEM 45, WILLIAMS HARDENED WASHER (R9F-10)

△23 ITEMS 39, 40, AND 41 ARE APPLICABLE FOR ALTERNATE HOLE LOCATIONS ON ASSEMBLY 94 ALTERNATE FABRICATION-C AND THE 9/16" HOLES LOCATED ON EITHER SIDE. ITEMS 36, 37, AND 38 MAY BE USED FOR HOLES LOCATED AT THE TOP AND BOTTOM CENTER OF ASSEMBLY 94 ALTERNATE FABRICATION-C.

92 ASSY	93 ASSY	94 ASSY	95 ASSY	96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
			A/R	A/R	A/R	A/R	A/R	49	SCREEN	304 ST. STL.	COML		4X4 MILLING GR. .035" WIRE CLOTH
			8	8	8	8	8	48	RETAINER PLATE	304 ST. STL.	ASTM A240		14 GA. – 18 GA. SHEET
1								47	SPACER	CARBON STEEL	ASTM A537, CL 2		2 PLATE
8								46	REBAR	CARBON STEEL	ASTM A706		#11
12								45	WASHER	COML	SEE NOTE 24		SEE NOTE 24
12								44	NUT	COML	SEE NOTE 24		SEE NOTE 24
6								43	THREADED REBAR	COML	SEE NOTE 24		SEE NOTE 24
			4	4	4	4	4	42	SUPPLEMENTAL COVER	304 ST. STL.	ASTM A240		18 GA. SHEET
			28	28	28	28	28	41	WASHER	ST. STL.	COML		1/4 I.D.
			24	24	24	24	24	40	SCREEN BOLT	ST. STL.	COML		1/4-20 UNC X 1/2 LG. HEX HEAD BOLT
			24	24	24	24	24	39	CONCRETE ANCHOR	ST. STL.	COML		HILTI #00336430 (HDI 1/4" (SS303)
			32	32	32	32	32	38	WASHER	ST. STL.	COML		3/8 TYPE B, SERIES W
			32	32	32	32	32	37	SCREEN SCREW	ST. STL.	COML		HEX HEAD CAP SCREW
			32	32	32	32	32	36	CONCRETE ANCHOR	ST. STL.	COML		SEE NOTE 32
								35	SUPPLEMENTAL SHIELDING			790-613-99	
								34	LIFTING ANCHOR			790-562-92	
8								33	REBAR	CARBON STEEL	ASTM A615 GR 75		#11
1								32	BASE PLATE	CARBON STEEL	ASTM A537, CL 2		2 PLATE
2								31	LIFTING LUG	CARBON STEEL	ASTM A537, CL 2		2 PLATE
			1	1	1	1	1	30	NAME PLATE			790-565-1	
			4	4	4	4	4	29	SCREW	18-8 ST. STL.	COML.		DROP-IN ANCHOR FASTENER
			4	4	4	4	4	28	CONCRETE ANCHOR	ZINC-ALLOY	COML.		DROP-IN ANCHOR
								27	NOT USED				
								26	NOT USED				
			4	4	4	4	4	25	INLET SCREEN			790-562-93	
			4	4	4	4	4	24	OUTLET SCREEN			790-562-94	
			1					23	STRUCTURE WELDMENT			790-561-95	
				1				22	STRUCTURE WELDMENT			790-561-96	
					1			21	STRUCTURE WELDMENT			790-561-97	
						1		20	STRUCTURE WELDMENT			790-561-98	
			24	24	24	24	24	19	SCREEN SCREW	ST. STL.	COML.		5/8-11 UNC-2A X 1.0 LG. HEX BOLT
			24	24	24	24	24	18	FLAT WASHER	ST. STL.	COML.		5/8 DIA. TYPE B, SERIES W
	A/R	A/R						17	STRIP	304 ST. STL.	ASTM A240		18 GA. SHEET
	A/R	A/R						16	SCREEN	304 ST. STL.	COML.		4X4 MILLING GR. WIRE CLOTH
			A/R	A/R	A/R	A/R	A/R	15	CONCRETE SHELL	CONCRETE	COML.		TYPE 2 PORTLAND CEMENT
			4	4	4	4	4	14	OUTLET WELDMENT			790-561-93	
							1	13	STRUCTURE WELDMENT			790-561-99	
			1	1	1	1	1	12	BASE WELDMENT			790-561-94	
			4	4	4	4	4	11	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			4	4	4	4	4	10	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			1	1	1	1	1	9	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			45	47	48	49	49	8	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			23	24	24	25	25	7	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			12	12	12	12	12	6	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			8	8	8	8	8	5	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			28	28	28	28	28	4	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			20	20	20	20	20	3	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			16	16	16	16	16	2	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)
			8	8	8	8	8	1	REBAR	CARBON STEEL	ASTM A615/A615M		#6(19)

QUANTITY

NAC INTERNATIONAL

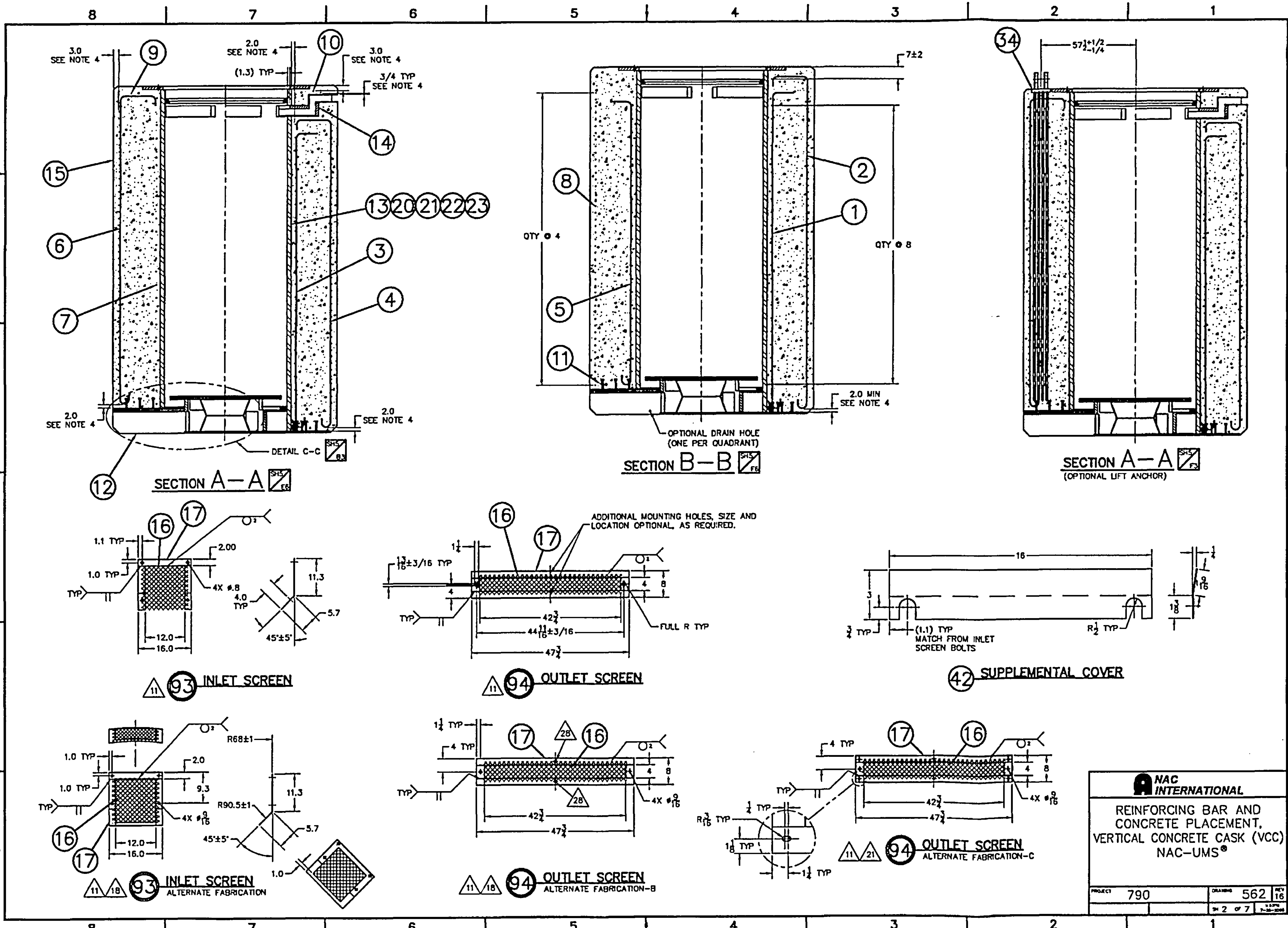
UNLESS OTHERWISE STATED
DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5M-94
ALL THREAD DEPTH CALLOUTS ARE TO BE CONSIDERED AS A MIN. DEPTH OF PERFECT THREADS.
ALL DIMENSIONS ARE IN INCHES
MACHINED SURFACES TO BE ▽ OR BETTER
NEXT ASSEMBLY: 790-590
DRAWING TYPE: LICENSE

GROUP	NAME	DATE
		7-26-05
		7-26-05
		7-26-05
		7/26/05
		7/27/05
		7/28/05

REINFORCING BAR AND CONCRETE PLACEMENT, VERTICAL CONCRETE CASK (VCC) NAC-UMS®

PROJECT 790 DRAWING 562 REV 16

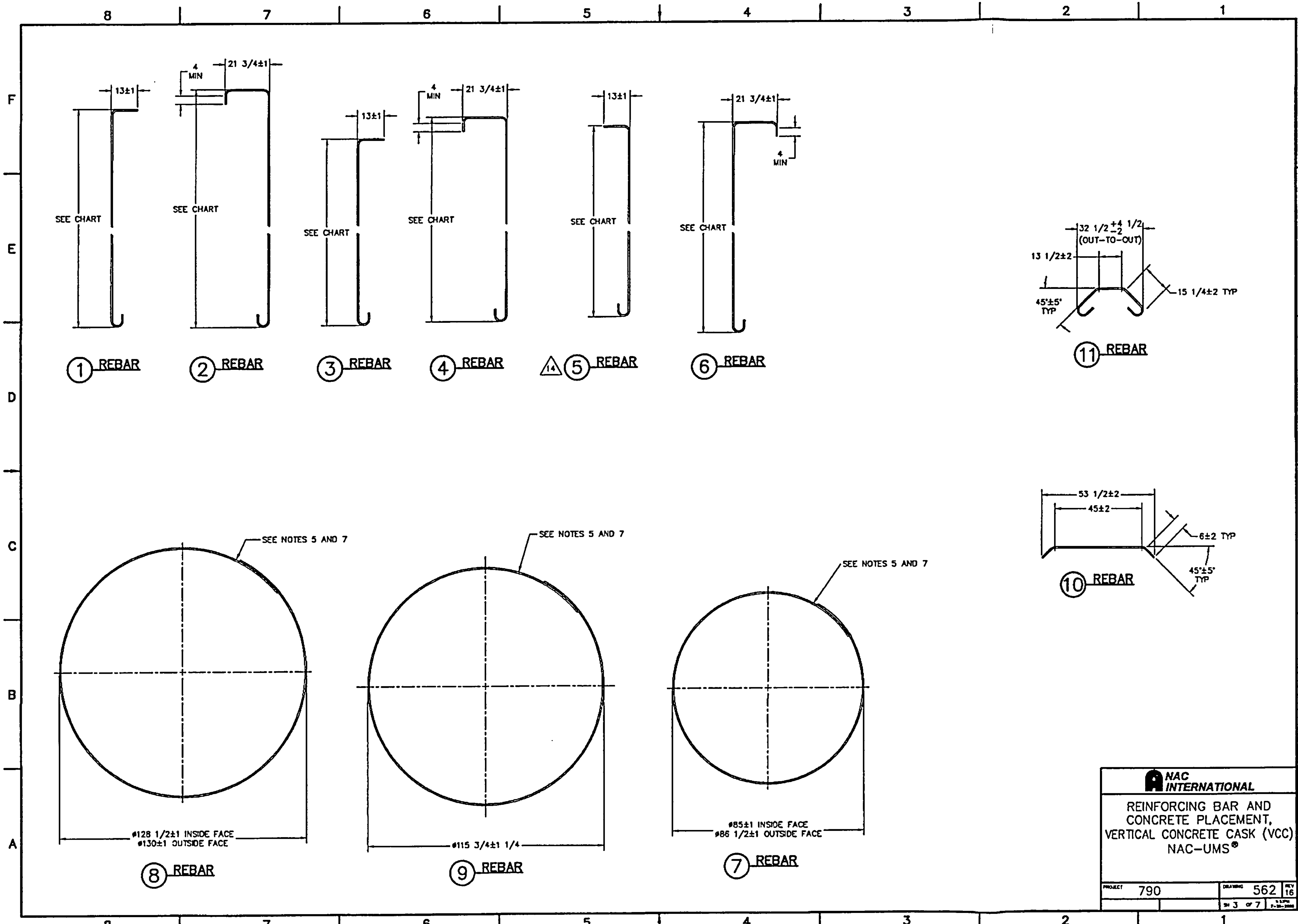
SH 1 OF 7

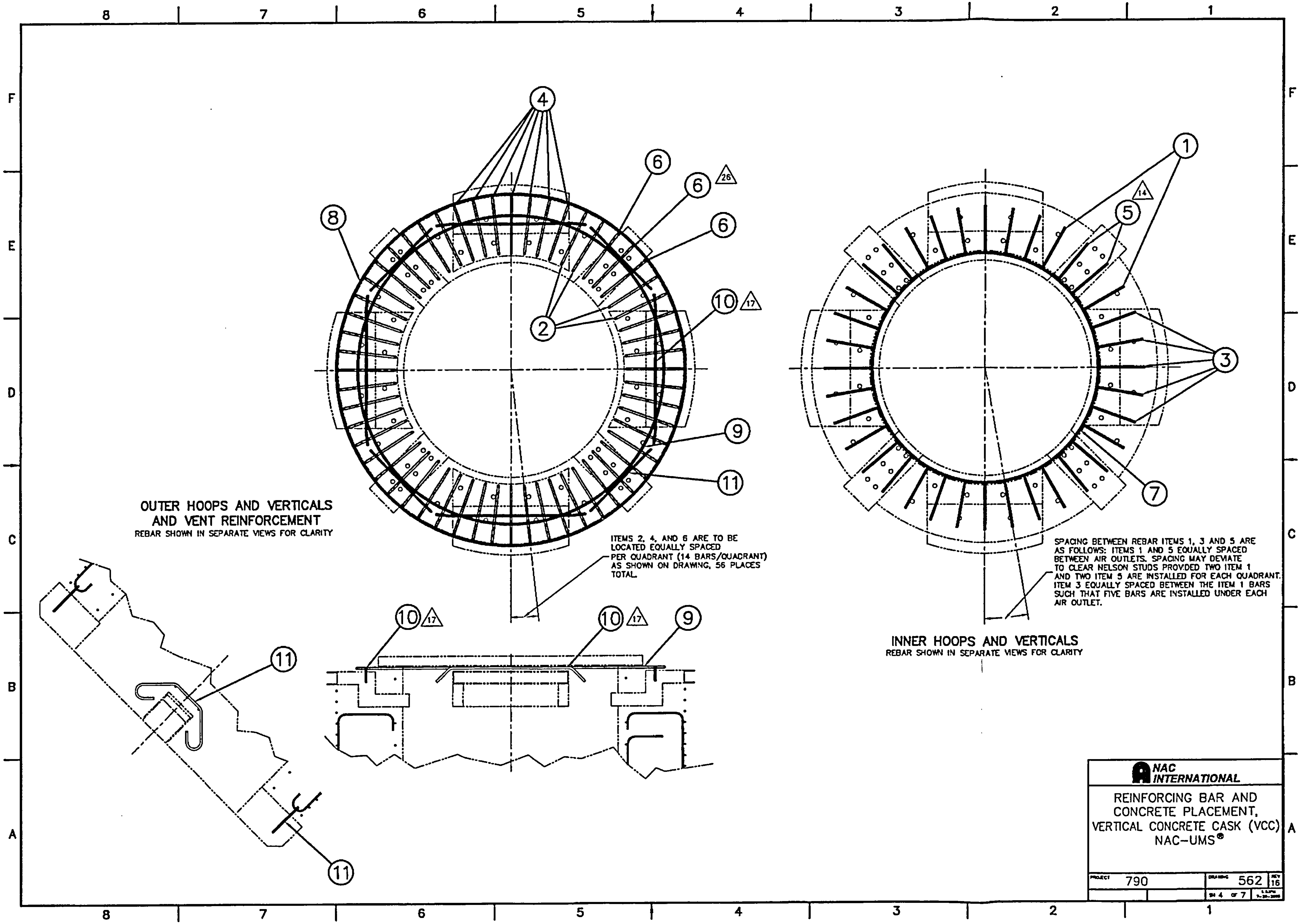


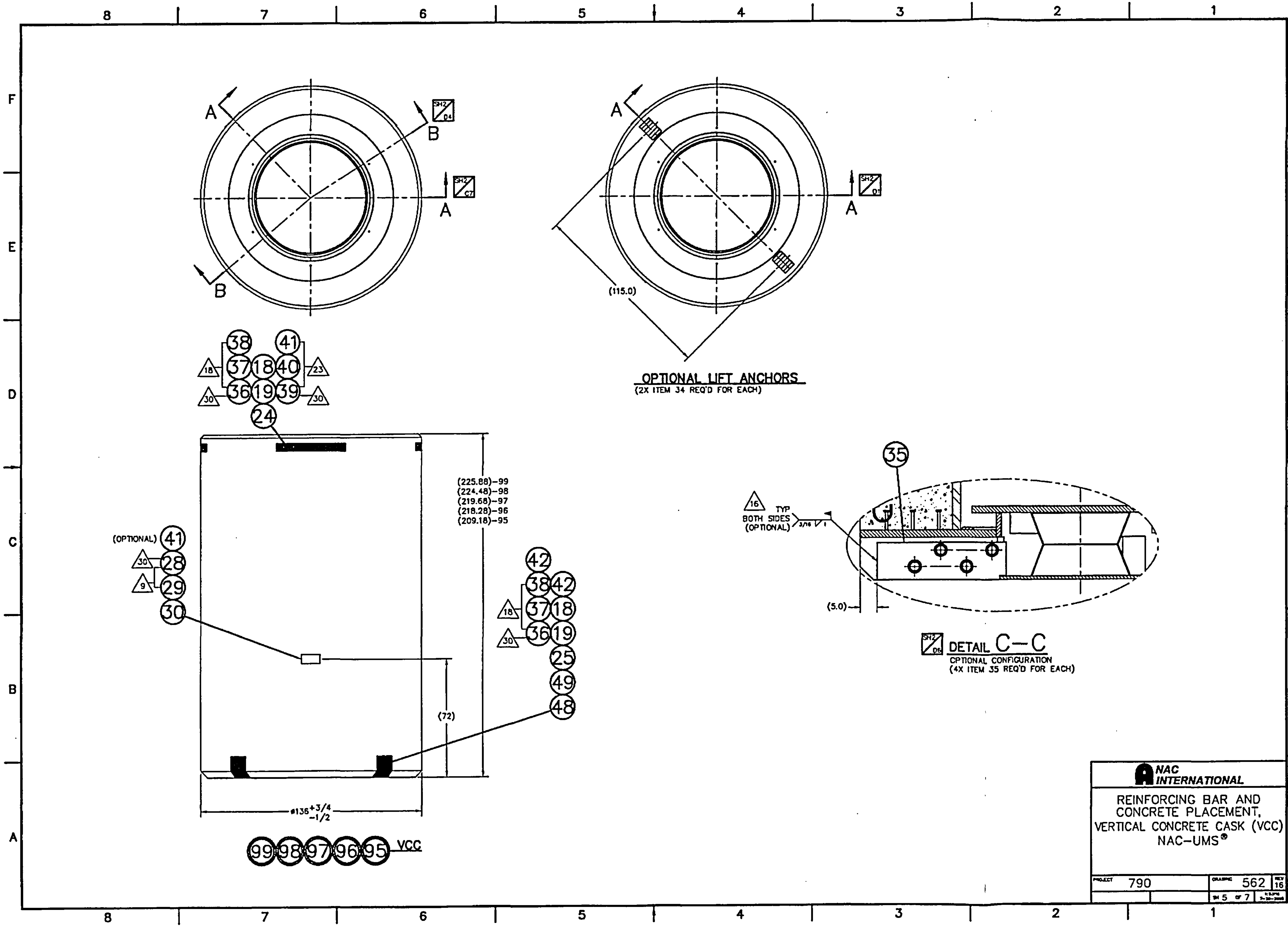
NAC INTERNATIONAL

REINFORCING BAR AND CONCRETE PLACEMENT, VERTICAL CONCRETE CASK (VCC) NAC-UMS®

PROJECT	DRAWING	REV
790	562	16
	SH 2 OF 7	


13±1
SEE CHART
1 REBAR
4 MIN
21 3/4±1
SEE CHART
2 REBAR
13±1
SEE CHART
3 REBAR
4 MIN
21 3/4±1
SEE CHART
4 REBAR
13±1
SEE CHART
14
5 REBAR
21 3/4±1
4 MIN
SEE CHART
6 REBAR
32 1/2 +4 1/2 −2
(OUT-TO-OUT)
13 1/2±2
15 1/4±2 TYP
45°±5° TYP
11 REBAR
53 1/2±2
45±2
6±2 TYP
45°±5° TYP
10 REBAR
SEE NOTES 5 AND 7
ø128 1/2±1 INSIDE FACE
ø130±1 OUTSIDE FACE
8 REBAR
SEE NOTES 5 AND 7
ø115 3/4±1 1/4
9 REBAR
SEE NOTES 5 AND 7
ø85±1 INSIDE FACE
ø86 1/2±1 OUTSIDE FACE
7 REBAR
NAC INTERNATIONAL
REINFORCING BAR AND CONCRETE PLACEMENT, VERTICAL CONCRETE CASK (VCC) NAC-UMS®
PROJECT 790
DRAWING 562
REV 16
SH 3 OF 7

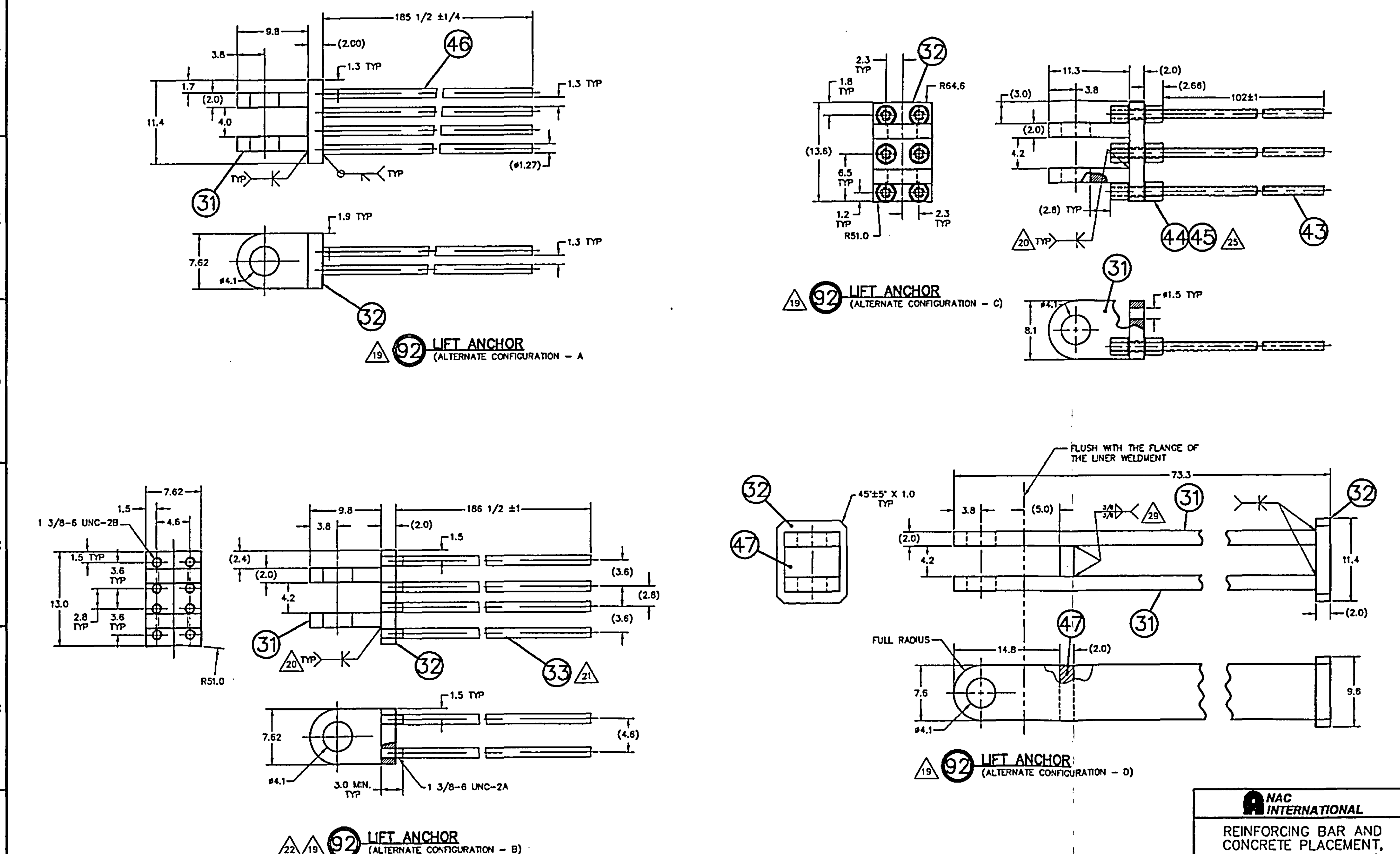

OUTER HOOPS AND VERTICALS AND VENT REINFORCEMENT
REBAR SHOWN IN SEPARATE VIEWS FOR CLARITY
ITEMS 2, 4, AND 6 ARE TO BE LOCATED EQUALLY SPACED PER QUADRANT (14 BARS/QUACRANT) AS SHOWN ON DRAWING, 56 PLACES TOTAL.
INNER HOOPS AND VERTICALS
REBAR SHOWN IN SEPARATE VIEWS FOR CLARITY
SPACING BETWEEN REBAR ITEMS 1, 3 AND 5 ARE AS FOLLOWS: ITEMS 1 AND 5 EQUALLY SPACED BETWEEN AIR OUTLETS. SPACING MAY DEVIATE TO CLEAR NELSON STUDS PROVIDED TWO ITEM 1 AND TWO ITEM 5 ARE INSTALLED FOR EACH QUADRANT. ITEM 3 EQUALLY SPACED BETWEEN THE ITEM 1 BARS SUCH THAT FIVE BARS ARE INSTALLED UNDER EACH AIR OUTLET.
NAC INTERNATIONAL
REINFORCING BAR AND CONCRETE PLACEMENT, VERTICAL CONCRETE CASK (VCC) NAC-UMS®
PROJECT 790
DRAWING 562
REV 16
SH 4 OF 7



NAC INTERNATIONAL

REINFORCING BAR AND CONCRETE PLACEMENT, VERTICAL CONCRETE CASK (VCC) NAC-UMS®

PROJECT	DRAWING	REV
790	562	16
	SH 5 OF 7	

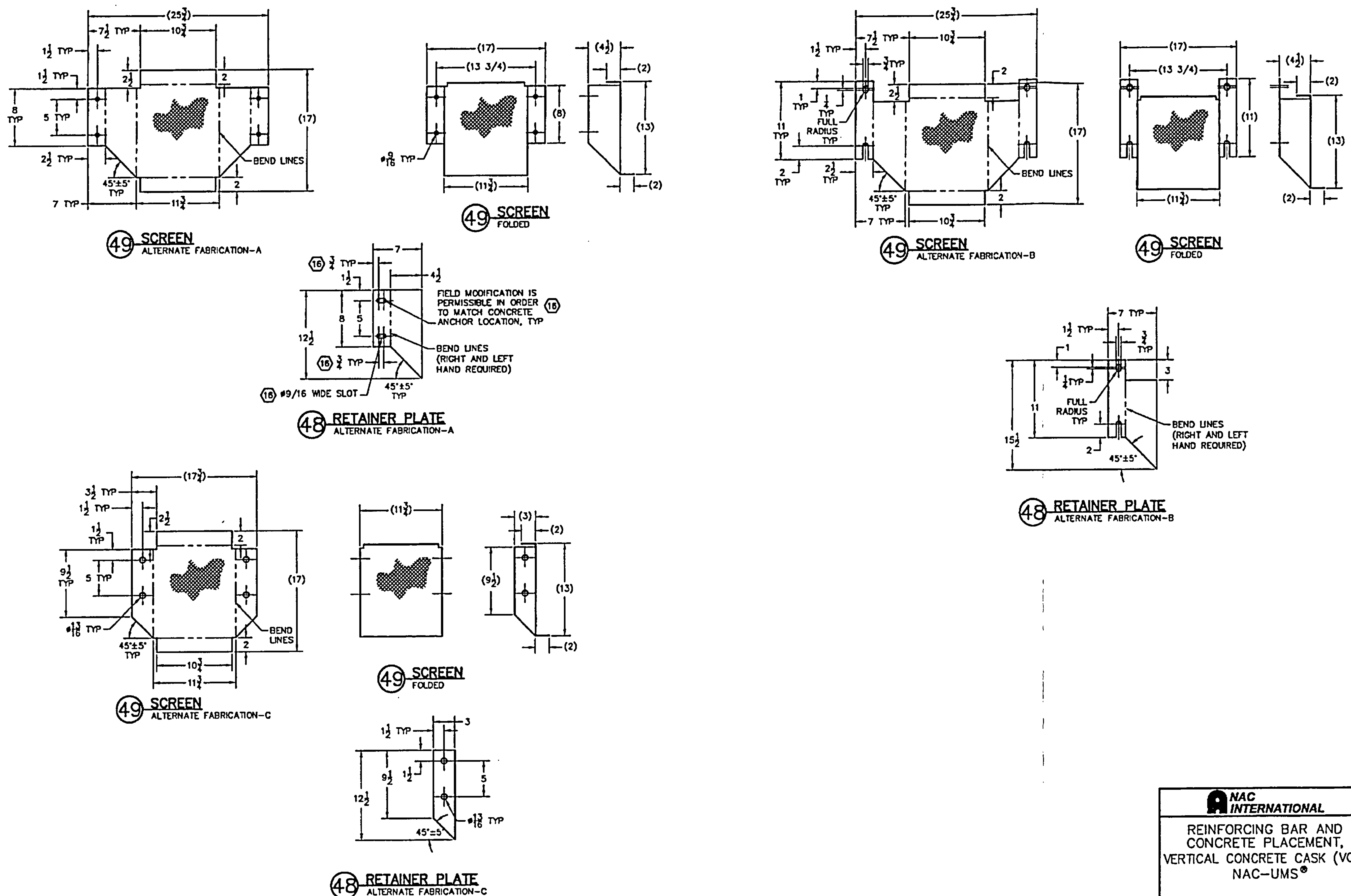


NAC INTERNATIONAL

REINFORCING BAR AND CONCRETE PLACEMENT, VERTICAL CONCRETE CASK (VCC) NAC-UMS®

PROJECT	DRAWING	REV
790	562	16

SH 6 OF 7



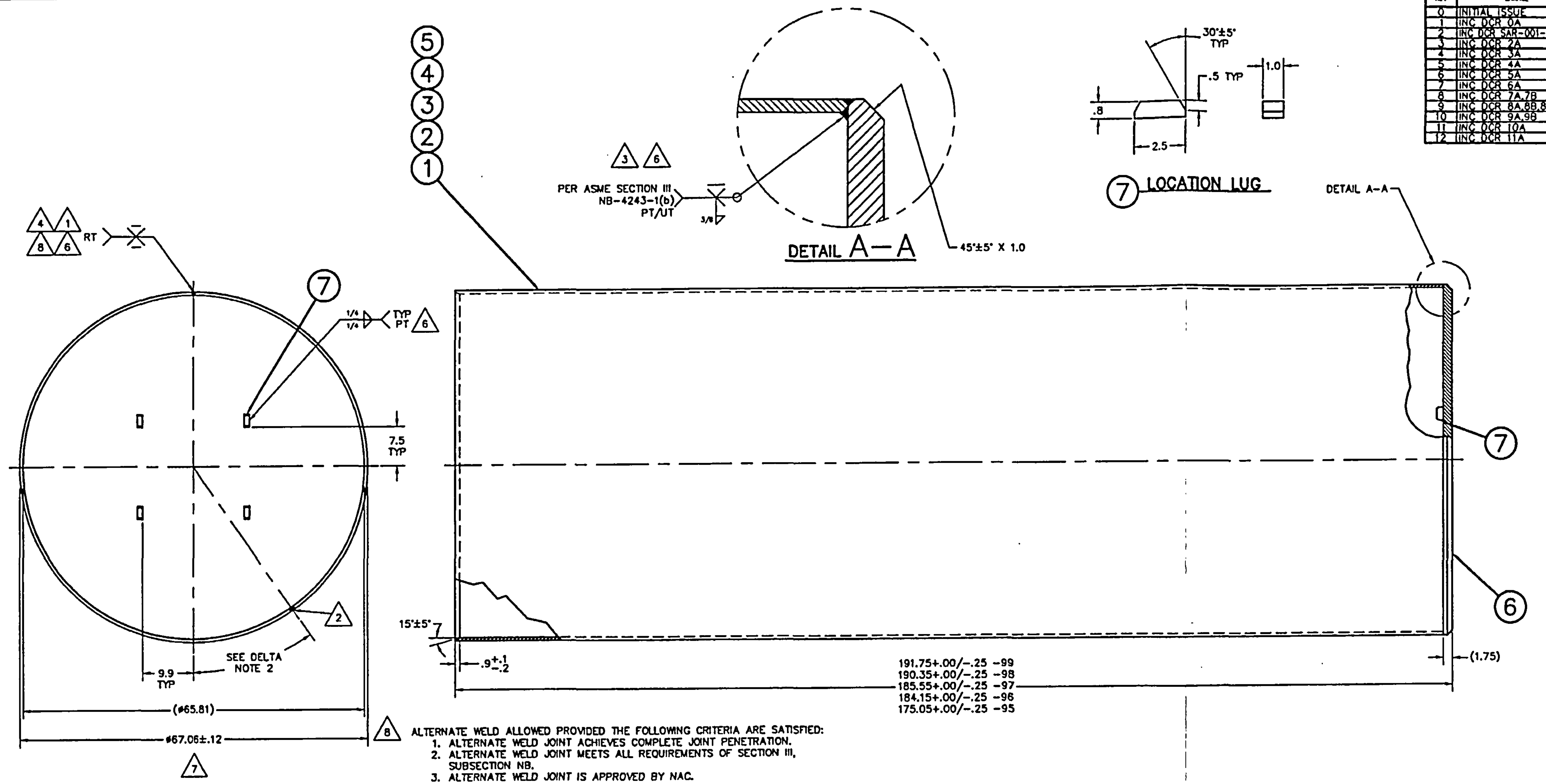
NAC INTERNATIONAL

REINFORCING BAR AND CONCRETE PLACEMENT, VERTICAL CONCRETE CASK (VCC) NAC-UMS®

PROJECT 790 | DRAWING 562 | REV 16 | SH 7 OF 7

R-203047

REV	CHANGE
0	INITIAL ISSUE
1	INC DCR 0A
2	INC DCR SAR-001-0A
3	INC DCR 2A
4	INC DCR 3A
5	INC DCR 4A
6	INC DCR 5A
7	INC DCR 6A
8	INC DCR 7A,7B
9	INC DCR 8A,8B,8C
10	INC DCR 9A,9B
11	INC DCR 10A
12	INC DCR 11A



99 SHELL WELDMENT

98 SHELL WELDMENT

97 SHELL WELDMENT

96 SHELL WELDMENT

95 SHELL WELDMENT

NOTES:

1. (Δ) TYPICAL FOR SEAM AND GIRTH WELDS, NUMBER AND LOCATION OPTIONAL. ADJACENT SECTIONS WITH SEAM WELDS SHALL BE OFFSET.
2. (Δ) OPTIONAL ENGRAVED STRIPE – FOR ASSY-99,96,95 ANGLE IS 35°±5° FOR ASSY-98,97 ANGLE IS 40°±5° ENGRAVE STRIPE 1.0 WIDE X .03 DEEP AND FILL WITH WEATHER RESISTANT YELLOW PAINT.
3. (Δ) ULTRASONIC EXAMINED PER ASME SECTION V, ARTICLE 5. ACCEPTANCE PER SECTION III, DIVISION 1, ARTICLE NB-5330.
4. (Δ) RADIOGRAPHIC EXAMINED PER ASME SECTION V, ARTICLE 2. ACCEPTANCE PER SECTION III, ARTICLE NB-5320.
5. ALL WELDING PROCEDURES AND QUALIFICATIONS TO BE IN ACCORDANCE WITH SECTION IX.
6. (Δ) LIQUID PENETRANT EXAMINED PER ASME SECTION V, ARTICLE 6. ACCEPTANCE PER SECTION III, ARTICLE NB-5350.
7. (12) (Δ) TOLERANCES APPLIED TO LOCALIZED AREAS OF SHELL DIAMETER ARE +.21"/-.24", OR ALTERNATIVELY, THE MINIMUM INSIDE DIAMETER OF THE SHELL WELDMENT, WITH THE SHELL WELDMENT VERTICAL, SHALL BE THE AS-BUILT DIAMETER OF THE SHIELD LID ASSEMBLY PLUS .01". LOCALIZED AREAS BEING FLATSPOTS, BULGES, ETC. AT NO POINT SHALL THERE BE ANY INTERFERENCE BETWEEN THE INTERFACING COMPONENTS AND THE SHELL.
8. (Δ) ALTERNATE WELD ALLOWED PROVIDED THE FOLLOWING CRITERIA ARE SATISFIED:
   1. ALTERNATE WELD JOINT ACHIEVES COMPLETE JOINT PENETRATION.
   2. ALTERNATE WELD JOINT MEETS ALL REQUIREMENTS OF SECTION III, SUBSECTION NB.
   3. ALTERNATE WELD JOINT IS APPROVED BY NAC.

95 ASSY	96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
4	4	4	4	4	7	LOCATION LUG	304 ST.STL.	ASTM A240/A276		PLATE/BAR
1	1	1	1	1	6	BOTTOM	304L ST.STL.	ASME SA240		1 3/4 PLATE
				1	5	SHELL	304L ST.STL.	ASME SA240		5/8 PLATE
			1		4	SHELL	304L ST.STL.	ASME SA240		5/8 PLATE
		1			3	SHELL	304L ST.STL.	ASME SA240		5/8 PLATE
	1				2	SHELL	304L ST.STL.	ASME SA240		5/8 PLATE
1					1	SHELL	304L ST.STL.	ASME SA240		5/8 PLATE

QUANTITY

UNLESS OTHERWISE STATED
DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5M-94, UNSPECIFIED DIMENSIONAL TOLERANCES ARE SHOWN BELOW.
ALL THREAD DEPTH CALLOUTS ARE TO BE CONSIDERED AS A MIN. DEPTH OF PERFECT THREADS. THE ACTUAL DEPTH OF THE THREADS IS NOT SUBJECT TO TOLERANCE CONTROLS.

.XXX	UNDER 3	±.003
	3-12	±.005
	OVER 12	±.010
.XX	UNDER 6	±.02
	6-18	±.03
	OVER 18	±.06
.X	ALL	±.1
FRACTIONAL ±1/8		
ANGLES ±0.5°		

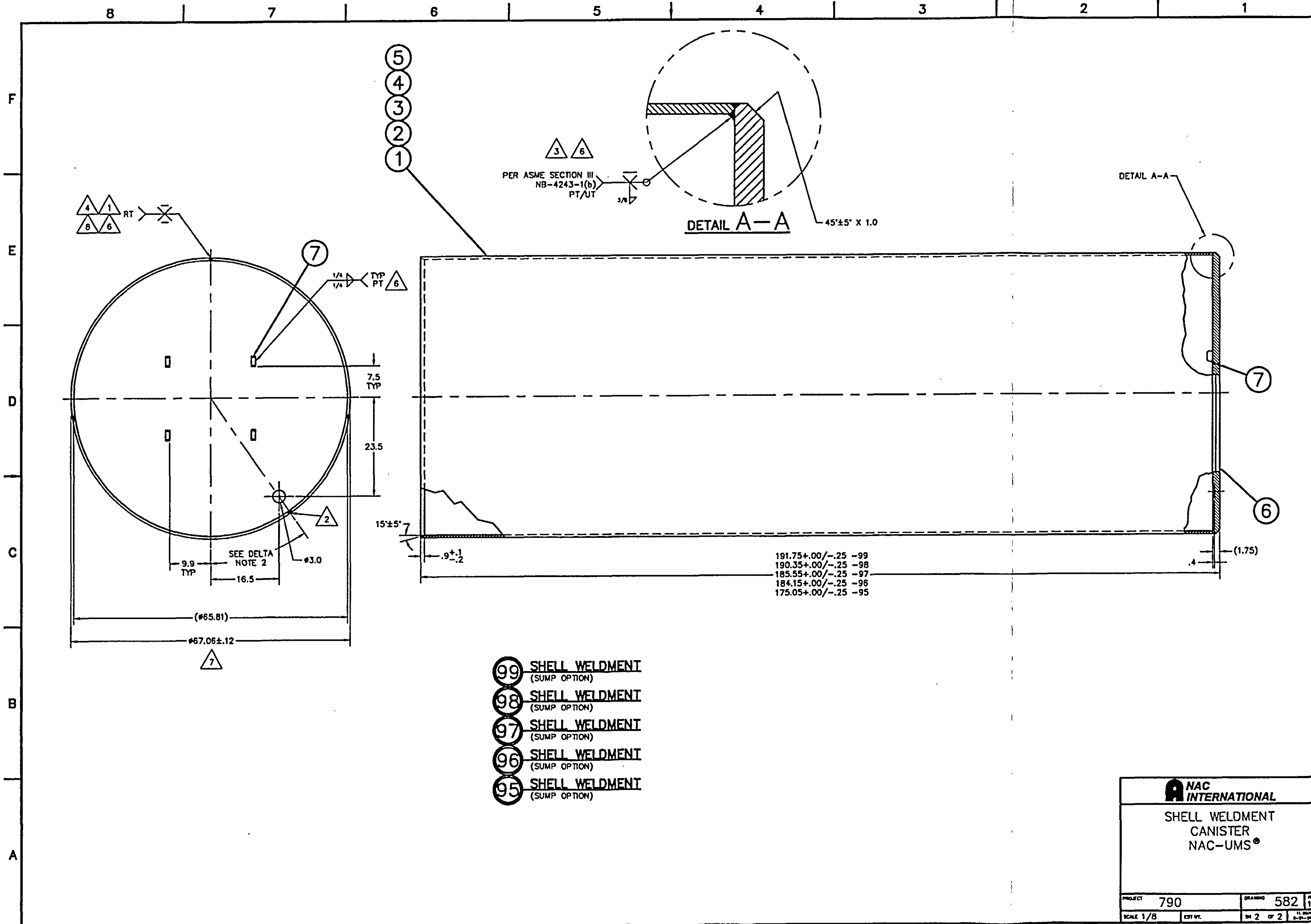
WEIGHTS ARE APPROXIMATE AND ARE TO BE USED FOR HANDLING PURPOSES ONLY
ALL DIMENSIONS ARE IN INCHES
BORDER SIZE: F (40 X 28)
ALL UNSPECIFIED TOOL RADII .015 – .030
BREAK ALL SHARP CORNERS .015 – .030
MACHINED SURFACES TO BE ∇ OR BETTER
NEXT ASSEMBLY: 790–585
DRAWING TYPE: LICENSE

GROUP	NAME	DATE
PREPARER	R. Walker	3-21-05
CHECKER	[signature]	3-21-05
PROJECT MANAGER	[signature]	3/22/05
ENGINEERING	[signature]	3/24/05
LICENSING	[signature]	3/24/05
QUALITY	[signature]	3/25/05

NAC INTERNATIONAL

SHELL WELDMENT
CANISTER
NAC–UMS®

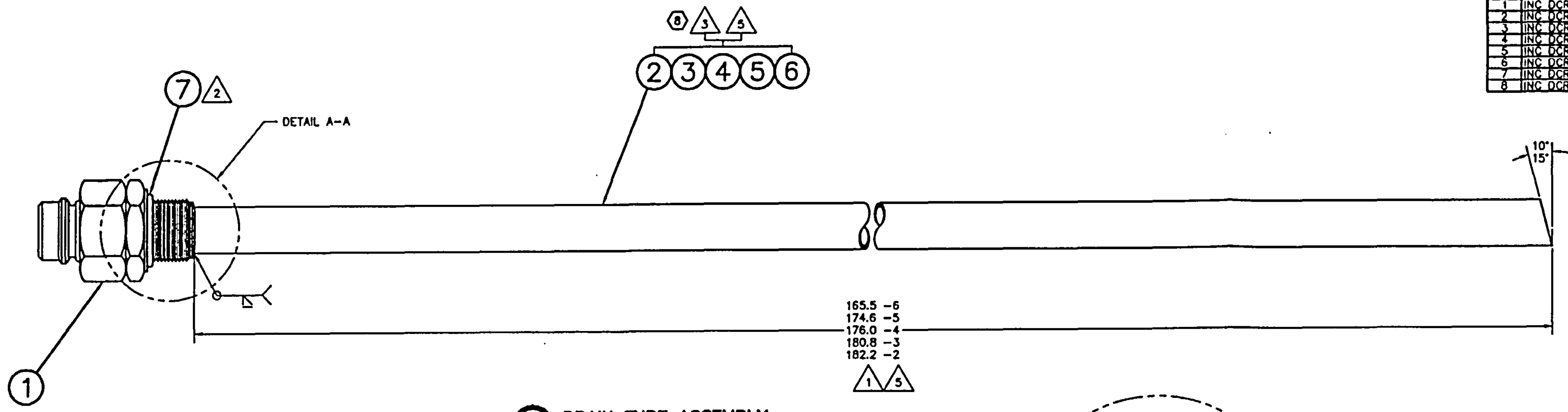
PROJECT 790 | DRAWING 582 | REV 12
SCALE 1/8 | WEIGHT | SH 1 OF 2



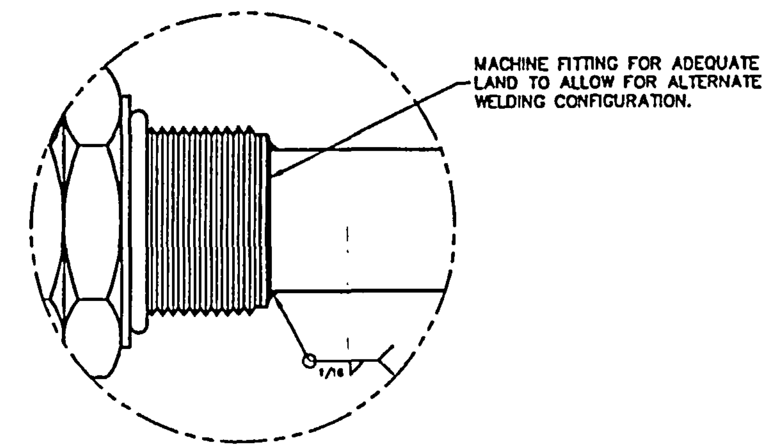
DETAIL A-A
PER ASME SECTION III
NB-4243-1(b)
PT/UT
3/8
45°±5° X 1.0
RT
1/4
1/4
TYP
PT
7.5
TYP
23.5
15°±5°
.9+.1/-.2
9.9
TYP
SEE DELTA NOTE 2
ø3.0
16.5
(ø65.81)
ø67.06±.12
(1.75)
.4
191.75+.00/-.25 -99
190.35+.00/-.25 -98
185.55+.00/-.25 -97
184.15+.00/-.25 -96
175.05+.00/-.25 -95
99 SHELL WELDMENT (SUMP OPTION)
98 SHELL WELDMENT (SUMP OPTION)
97 SHELL WELDMENT (SUMP OPTION)
96 SHELL WELDMENT (SUMP OPTION)
95 SHELL WELDMENT (SUMP OPTION)
NAC INTERNATIONAL
SHELL WELDMENT
CANISTER
NAC-UMS®
PROJECT 790
DRAWING 582
REV 12
SCALE 1/8
SH 2 OF 2

R-203048

REV	CHANGE
0	INITIAL ISSUE
1	INC DCR 0A
2	INC DCR 1A
3	INC DCR 2A
4	INC DCR 3A
5	INC DCR 4A
6	INC DCR 5A,5B,5C
7	INC DCR 6A,6B,6C
8	INC DCR 7A



99 DRAIN TUBE ASSEMBLY
98 DRAIN TUBE ASSEMBLY
97 DRAIN TUBE ASSEMBLY
96 DRAIN TUBE ASSEMBLY
95 DRAIN TUBE ASSEMBLY



DETAIL A-A
SCALE: 2:1
(ALTERNATE WELDING CONFIG.)

5. WHEN USED WITH OPTIONAL COUNTERBORE DETAIL ON DRAWING 790-582, TRIAL FIT AND ADJUST LENGTH IF NEEDED TO ENSURE A .12+/-.1 CLEARANCE BETWEEN END OF TUBE AND BOTTOM OF THE .38 DEEP COUNTERBORE IN THE BOTTOM PLATE.

4. (DELETED)

(8) 3. MINOR SURFACE INDENTATIONS AND/OR DIMENSIONAL DEVIATIONS ARE ACCEPTABLE FOR ITEMS 2-6, TUBE.

2. ITEM 7, SEAL TO BE SPECIFIED BY USER: ELASTOMER SEAL (VITON OR EPDM) OR A METAL SEAL.

1. WHEN THE OPTIONAL SUMP SHOWN ON DRAWING 790-582 IS USED THESE DIMENSIONS SHALL BE: (165.9) -6 (175.0) -5 (176.4) -4 (181.2) -3 (182.6) -2

NOTES:

(8)

95 ASSY	96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
1	1	1	1	1	7	SEAL	SEE NOTE 2	COML		SEE NOTE 2
1					6	TUBE	304 ST. STL.	COML		1 OD X .035 WALL TUBE
	1				5	TUBE	304 ST. STL.	COML		1 OD X .035 WALL TUBE
		1			4	TUBE	304 ST. STL.	COML		1 OD X .035 WALL TUBE
			1		3	TUBE	304 ST. STL.	COML		1 OD X .035 WALL TUBE
				1	2	TUBE	304 ST. STL.	COML		1 OD X .035 WALL TUBE
1	1	1	1	1	1	NIPPLE	ST. STL.	COML		QUICK DISCONNECT COUPLING

QUANTITY

(8)(3)(5)

UNLESS OTHERWISE STATED
DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5M-94, UNSPECIFIED DIMENSIONAL TOLERANCES ARE SHOWN BELOW.
ALL THREAD DEPTH CALLOUTS ARE TO BE CONSIDERED AS A MIN. DEPTH OF PERFECT THREADS. THE ACTUAL DEPTH OF THE THREADS IS NOT SUBJECT TO TOLERANCE CONTROLS.

.XXX	UNDER 3	±.003	WEIGHTS ARE APPROXIMATE AND ARE TO BE USED FOR HANDLING PURPOSES ONLY
	3-12	±.005	ALL DIMENSIONS ARE IN INCHES
	OVER 12	±.010	BORDER SIZE: F (40 X 28)
.XX	UNDER 6	±.02	ALL UNSPECIFIED TOOL RADII .015 - .030
	6-18	±.03	BREAK ALL SHARP CORNERS .015 - .030
	OVER 18	±.05	MACHINED SURFACES TO BE ▽ OR BETTER
.X	ALL	±.1	NEXT ASSEMBLY: 790-585
FRACTIONAL ±1/8			DRAWING TYPE: LICENSE
ANGLES ±0.5°			

GROUP	NAME	DATE
PREPARER	R. Walker	3-21-05
CHECKER	[signature]	3/22/05
PROJECT MANAGER	[signature]	5/22/05
ENGINEERING	[signature]	3/24/05
LICENSING	J.C. Thompson	3/24/05
QUALITY	[signature]	3/25/05

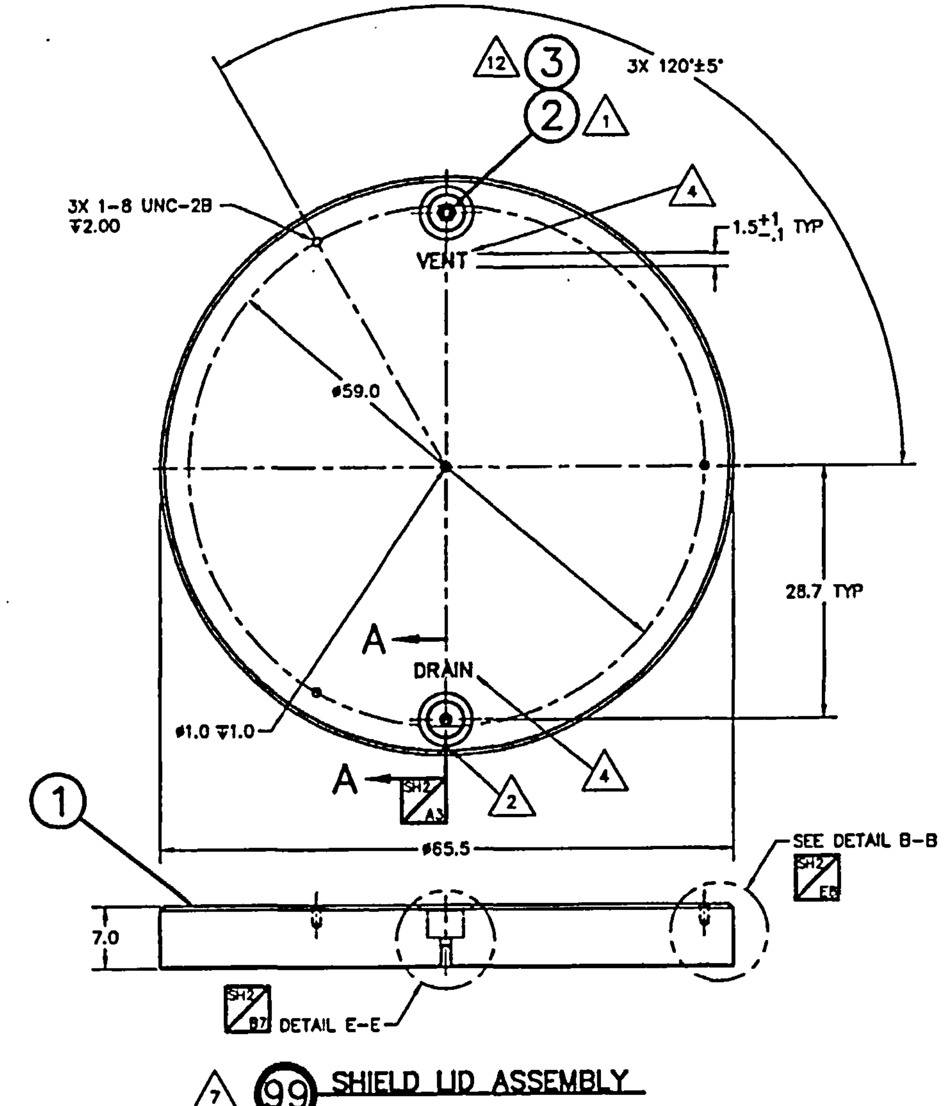
NAC INTERNATIONAL

ASSEMBLY,
DRAIN TUBE,
CANISTER
NAC-UMS®

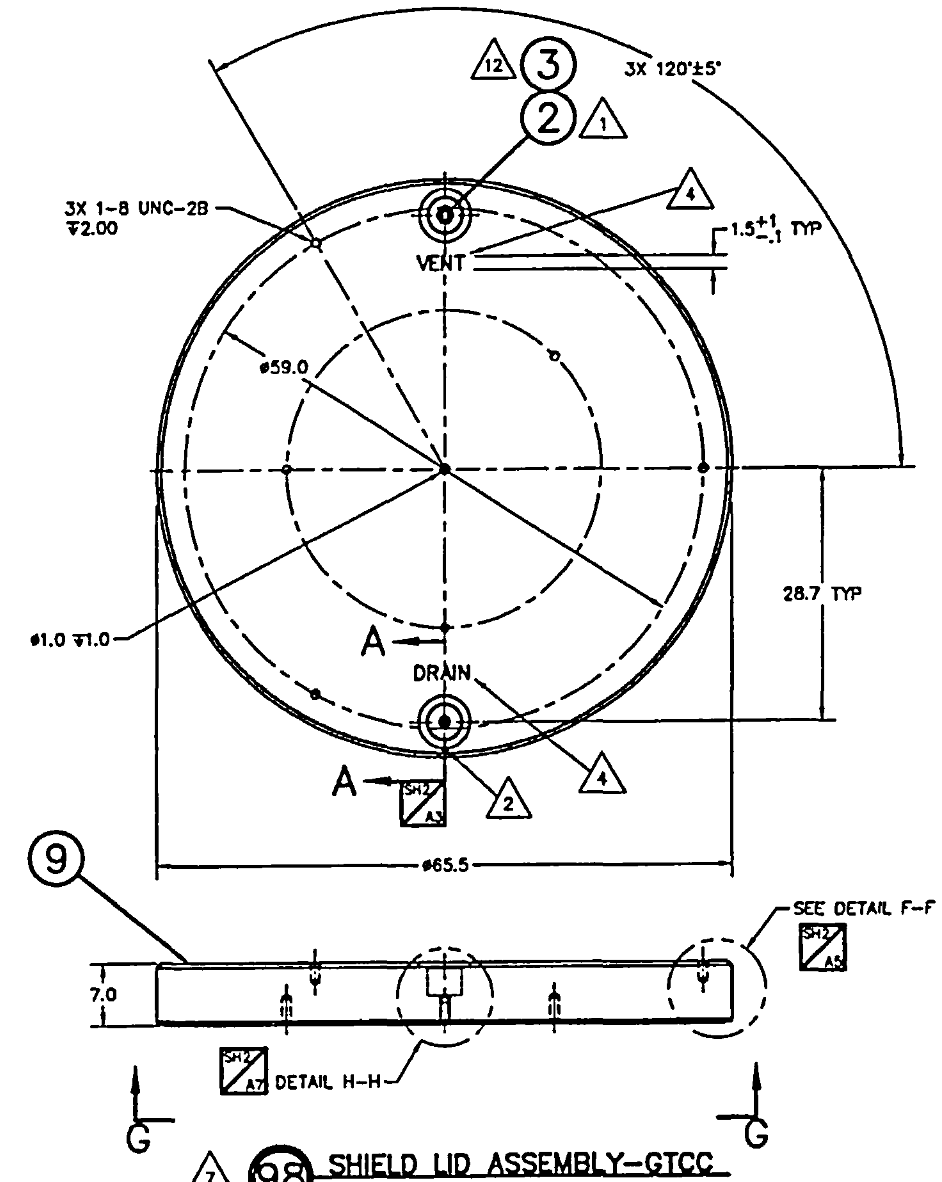
PROJECT 790 | DRAWING 583 | REV 8
SCALE 1/1 | WEIGHT | SH 1 OF 1

R-203049

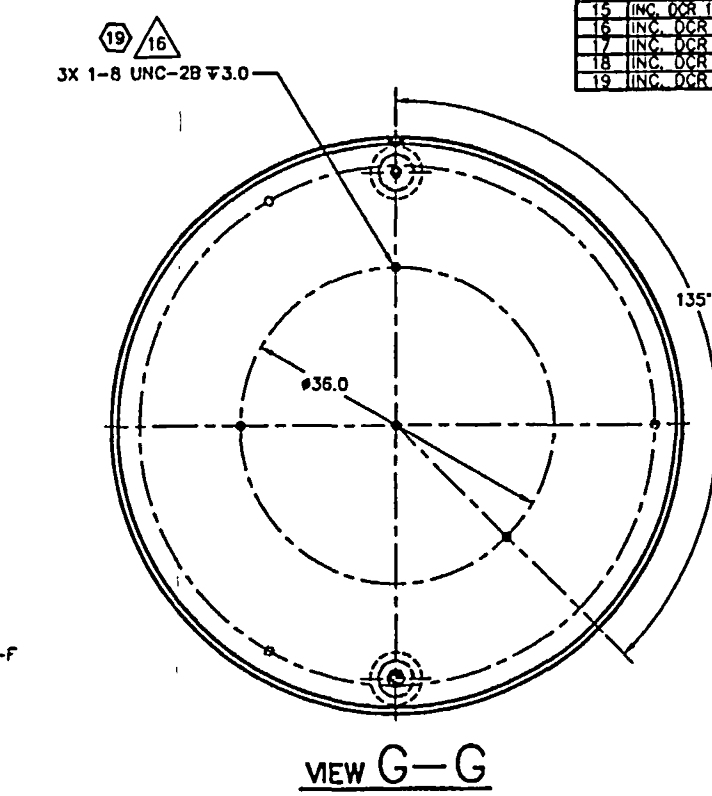
REV	CHANGE
0	INITIAL ISSUE
1	INC. DCR 0A
2	INC. DCR 1A
3	INC. DCR 2A
4	INC. DCR 3A
5	INC. DCR 4A
6	INC. DCR 5A
7	INC. DCR 6A
8	INC. DCR 7A
9	INC. DCR 8A
10	INC. DCR 9A,9B,9C
11	INC. DCR 10A,10B,10C,10D,10E
12	INC. DCR 11A,11B,11C
13	INC. DCR 12A,12B,12C
14	INC. DCR 13A,13B,13C,13D,13E,13F
15	INC. DCR 14A,14B,14C,14D
16	INC. DCR 15A
17	INC. DCR 16A
18	INC. DCR 17A
19	INC. DCR 18A



99 SHIELD LID ASSEMBLY



98 SHIELD LID ASSEMBLY-GTCC



VIEW G-G

8. WELD PREPARATION SHALL BE DETERMINED BY THE FABRICATOR BASED UPON THE WELD PROCESS USED. SEE DRAWING 790-585 AND 790-612 FOR EFFECTIVE THROAT SIZE OF WELD.

7. FOR ITEMS 1, 4 AND 9, THE SA182 FORGING MATERIAL MUST HAVE YIELD AND ULTIMATE STRENGTHS EQUAL TO OR GREATER THAN THE SA240 PLATE MATERIAL.

6. MAY BE FABRICATED USING MULTIPLE SECTIONS. ALL SEAMS BETWEEN SECTIONS MUST BE FULL PENETRATION WELDED UPON ASSEMBLY.

(19) 5. STEEL STAMP/ENGRAVE 1/2" HIGH THE FOLLOWING SEQUENCE LOCATED APPROX. AS SHOWN. "UMS-TSC-XXX-YYY" WHERE XXX IS INDICATED ON THE PURCHASE ORDER FOR A PARTICULAR PROJECT CODE, OR OTHER UNIQUE IDENTIFYING NUMBER, AND THE YYY IS A SEQUENTIAL SERIES OF NUMBERS STARTING WITH 001. "CALCULATED EMPTY CANISTER WEIGHT = ZZ,ZZZ LBS." WHERE ZZ,ZZZ IS INDICATED ON THE PURCHASE ORDER. DIRECTLY BELOW THIS NUMBER IS AN OPEN AREA FOR EACH CUSTOMER TO ADD ANY REQUIRED INFORMATION THEY CHOOSE.

4. METAL STAMP/ENGRAVE CHARACTERS APPROX. AS SHOWN X .03 DEEP, FILL WITH BLACK WEATHER RESISTANT PAINT.

3. LOCATION OF KEY SLOT IS TYPICAL ONE PLACE ONLY.

2. ENGRAVE DELTA .5" PER SIDE, OR CIRCLE .5" DIAMETER, X .03" DEEP, NOT TO INFRINGE ON THE WELD BEVEL, AND FILL WITH WEATHER RESISTANT BLACK PAINT.

1. LUBRICATE WITH A SPENT FUEL COMPATIBLE LUBRICANT SUCH AS NEOLUBE. INSTALL FITTING BY HAND UNTIL METAL TO METAL CONTACT IS ACHIEVED THEN TORQUE TO (115±5 FT-LBS FOR ELASTOMER SEALS) OR (135±15 FT-LBS FOR METAL SEALS).

NOTES:

(19) 16. ALTERNATIVELY, THE LOCATION OF THESE THREE SHIELD COVER ATTACHMENT HOLES CAN BE MATCHED DRILLED WITH THE SHIELD COVER.

15. SMALL INDENTATIONS AND IMPERFECTIONS ARE ALLOWED IN THE LAND OR GROOVE OF THE STRUCTURAL OR SHIELD LID WELD PREP, PROVIDING THAT THEY DO NOT ADVERSELY AFFECT THE WELDING PROCEDURES OR WELD PROCEDURE QUALIFICATIONS.

14. (DELETED)

(19) 13. SURFACE FINISH REQUIREMENTS ARE OPTIONAL FOR DETAIL J-J.

12. ITEM 3, SEAL TO BE SPECIFIED BY USER; ELASTOMER SEAL (VITON OR EPDM) OR A METAL SEAL.

11. TOOL MARKS AND OTHER MARKS ARE ACCEPTABLE ON ALL UNSPECIFIED MACHINED SURFACES AS LONG AS REQUIRED THICKNESS/DIAMETER OF ITEMS ARE MET.

10. ITEM 6, LID SUPPORT TO BE FIT-UP AND WELDED TO SHELL INSIDE DIAMETER IN A MANNER TO ASSURE MAINTENANCE OF THE 1" NOMINAL GAP.

9. MINIMUM OF .125 OF MATERIAL IS REQUIRED TO BE UNDERNEATH BOLT HOLE.

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
	1		9	SHIELD LID-GTCC	304 ST. STL.	ASME SA240/SA182		PLATE/FORGING
			8	KEY	304 ST. STL.	ASTM A240/A276		1/2 PLATE/BAR
			7	SPACER RING	304 ST. STL.	ASME SA479/SA240		1/2 X 1/2 SQ. BAR/PLATE
			6	LID SUPPORT RING	304 ST. STL.	ASME SA479/SA240		1/2 X 1/2 SQ. BAR/PLATE
			5	COVER	304 ST. STL.	ASME SA479		BAR
			4	STRUCTURAL LID	304L ST. STL.	ASME SA240/SA182		PLATE/FORGING
	1	1	3	SEAL	SEE NOTE 12	COML		SEE NOTE 12
	1	1	2	NIPPLE	ST. STL.	COML		QUICK DISCONNECT COUPLING
		1	1	SHIELD LID	304 ST. STL.	ASME SA240/SA182		PLATE/FORGING

QUANTITY

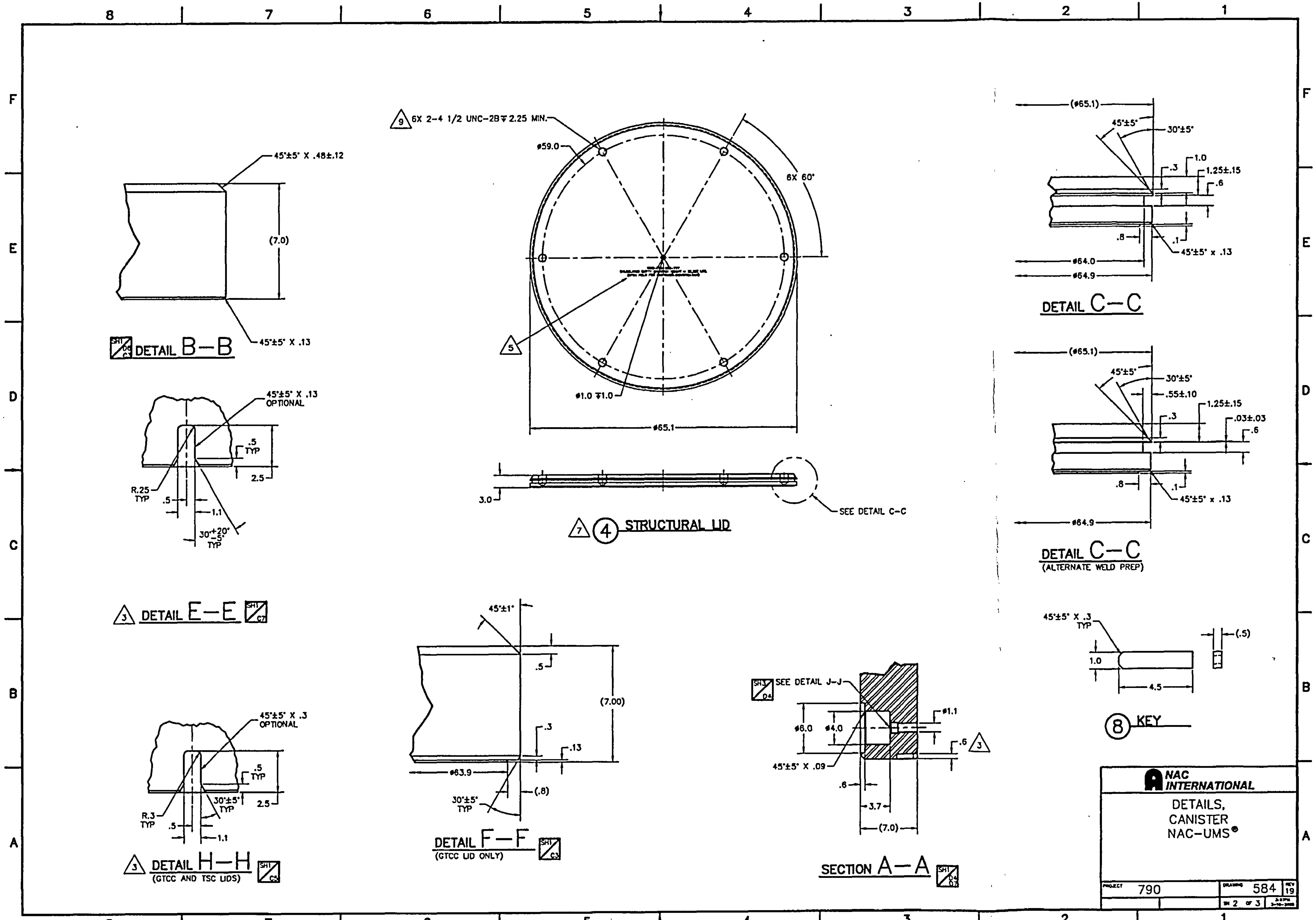
NAC INTERNATIONAL

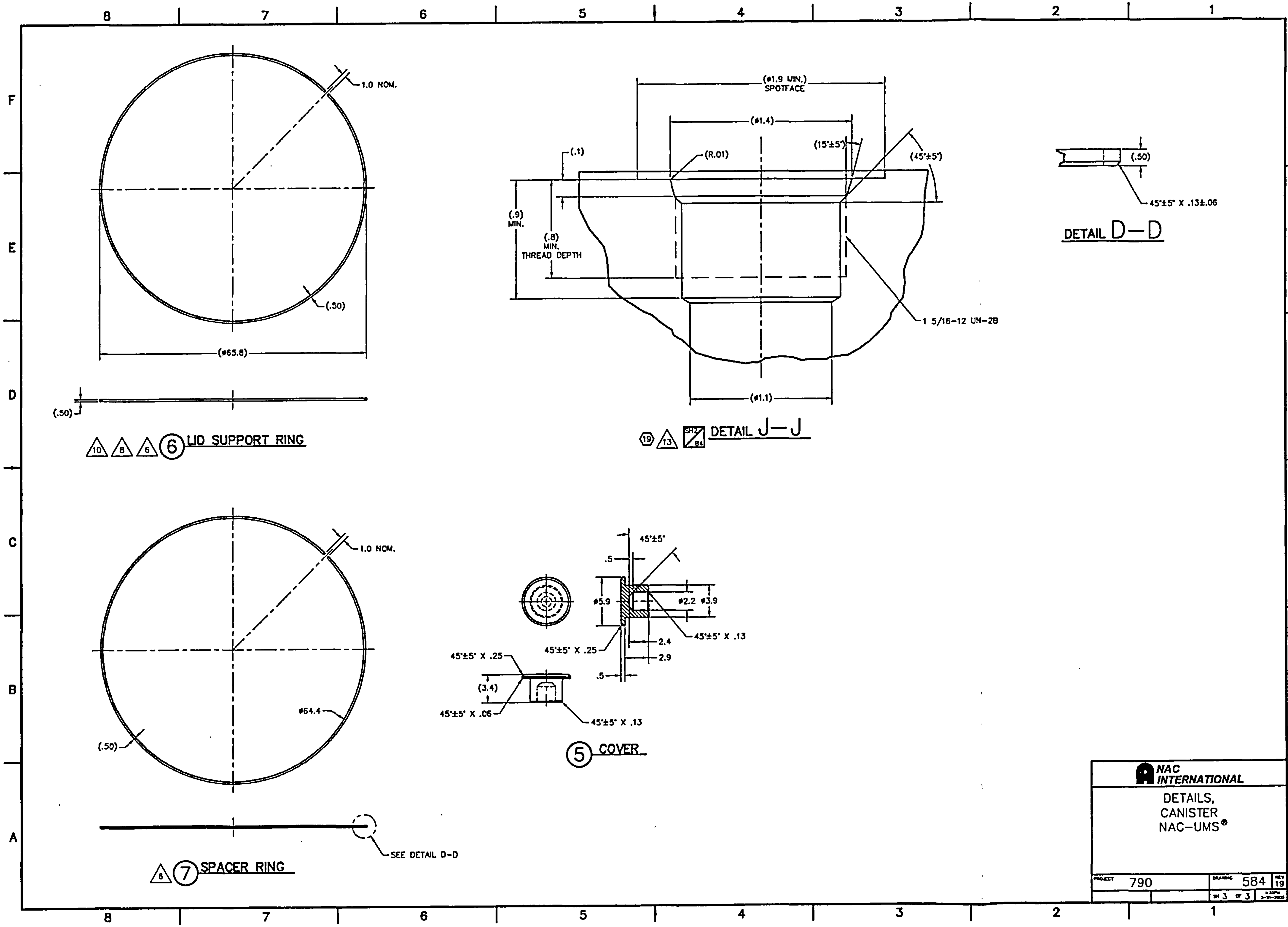
DETAILS,
CANISTER
NAC-UMS®

UNLESS OTHERWISE STATED
DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5M-94
ALL THREAD DEPTH CALLOUTS ARE TO BE CONSIDERED AS A MIN. DEPTH OF PERFECT THREADS.
ALL DIMENSIONS ARE IN INCHES
MACHINED SURFACES TO BE ∇ OR BETTER
NEXT ASSEMBLY: 790-585
DRAWING TYPE: LICENSE

GROUP	NAME	DATE
PREPARER	R. Walker	3-24-05
CHECKER	[signature]	3-24-05
PROJECT MANAGER	JR [signature]	3-24-05
ENGINEERING	[signature]	3/24/05
LICENSING	[signature]	3/24/05
QUALITY	B. [signature]	3/25/05

PROJECT 790 | DRAWING 584 | REV 19 | SH 1 OF 3


DETAIL B—B
45°±5° X .48±.12
(7.0)
45°±5° X .13
DETAIL E—E
45°±5° X .13 OPTIONAL
.5 TYP
2.5
R.25 TYP
.5
1.1
30°+20° -5° TYP
DETAIL H—H
(GTCC AND TSC LIDS)
45°±5° X .3 OPTIONAL
.5 TYP
30°±5° TYP
2.5
R.3 TYP
.5
1.1
6X 2-4 1/2 UNC-2B ∓ 2.25 MIN.
ø59.0
6X 60°
ø1.0 ∓1.0
ø65.1
3.0
SEE DETAIL C-C
4 STRUCTURAL LID
DETAIL F—F
(GTCC LID ONLY)
45°±1°
.5
(7.00)
.3
.13
ø63.9
(.8)
30°±5° TYP
SECTION A—A
SEE DETAIL J-J
ø6.0
ø4.0
ø1.1
.6
45°±5° X .09
.8
3.7
(7.0)
DETAIL C—C
(ø65.1)
45°±5°
30°±5°
1.0
.3
1.25±.15
.6
.8
.1
45°±5° x .13
ø64.0
ø64.9
DETAIL C—C
(ALTERNATE WELD PREP)
.55±.10
.03±.03
8 KEY
45°±5° X .3 TYP
1.0
4.5
(.5)
NAC INTERNATIONAL
DETAILS, CANISTER NAC-UMS®
PROJECT 790
DRAWING 584
REV 19
SH 2 OF 3


1.0 NOM.
(.50)
(ø65.8)
(.50)
6 LID SUPPORT RING
(ø1.9 MIN.) SPOTFACE
(ø1.4)
(15°±5°)
(45°±5°)
(.1)
(R.01)
(.9) MIN.
(.8) MIN. THREAD DEPTH
1 5/16-12 UN-2B
(ø1.1)
DETAIL J—J
(.50)
45°±5° X .13±.06
DETAIL D—D
1.0 NOM.
ø64.4
(.50)
SEE DETAIL D-D
7 SPACER RING
45°±5°
.5
ø5.9
ø2.2
ø3.9
45°±5° X .13
45°±5° X .25
2.4
2.9
.5
45°±5° X .25
(3.4)
45°±5° X .06
45°±5° X .13
5 COVER
NAC INTERNATIONAL
DETAILS, CANISTER NAC-UMS®
PROJECT 790
DRAWING 584
REV 19
SH 3 OF 3

ℓ-203050

REV	CHANGE
0	INITIAL ISSUE
1	INC DCR 0A
2	INC DCR SAR-001-0A
3	INC DCR 2A
4	INC DCR 3A
5	INC DCR 4A
6	INC DCR 5A
7	INC DCR 6A
8	INC DCR 7A,7B,7C
9	INC DCR 8A
10	INC DCR 9A,9B,9C
11	INC DCR 10A,10B,10C,10D,10E
12	INC DCR 11A
13	INC DCR 12A,12B,12C
14	INC DCR 13B,13C,13D,13E
15	INC DCR 14A,14B,14C
16	INC DCR 15A
17	INC DCR 16A
18	INC DCR 17A
19	INC DCR 18A

NOTES:

1. PACKAGE SHOWN FULLY ASSEMBLED. WELD SYMBOLS ARE FOR REFERENCE ONLY. REFERENCE PROCEDURE FOR OPERATIONAL ASSEMBLY SEQUENCE.

(2) PT ROOT, EACH SUCCESSIVE 3/8 INCH WELD THICKNESS, AND FINAL SURFACE. EXAMINE PER ASME SECTION V, ARTICLE 6. ACCEPTANCE PER ASME SECTION III, ARTICLE NB-5350; OR, UT PER ASME SECTION V, ARTICLE 5. ACCEPT PER ASME SECTION III, ARTICLE NB-5330 IN CONJUNCTION WITH PT EXAMINATION PER NOTE 5.

(3) LUBRICATE WITH A SPENT FUEL COMPATIBLE LUBRICANT SUCH AS NEOLUBE. INSTALL FITTING BY HAND UNTIL METAL TO METAL CONTACT IS ACHIEVED THEN TORQUE TO (115±5 FT-LBS FOR ELASTOMER SEALS) OR (135±15 FT-LBS FOR METAL SEALS). LENGTH MAY BE ADJUSTED IN THE FIELD TO ALLOW FOR STACK UP CONDITIONS.

(4) AFTER INSTALLING BASKET (ITEMS 6-10), POSITION KEY (ITEM 21) IN SLOT AT TOP OF BASKET, AS SHOWN, AND TACK WELD KEY TO SIDE OF SHELL (ITEMS 1-5). INSTALL LID SUPPORT RING (ITEM 16), AS SHOWN, AND WELD TO SHELL AND KEY. INSTALL SHIELD ASSEMBLY (ITEM 17), LOCATING ON KEY.

(5) PT ROOT AND FINAL SURFACE. SHOULD ROOT AND FINAL SURFACE BE ONE AND THE SAME (i.e. SINGLE PASS WELD) THEN ONLY ONE PT EXAMINATION IS REQUIRED. EXAMINED PER ASME SECTION V, ARTICLE 6, ACCEPTANCE PER ASME SECTION III, ARTICLE NB-5350.

(6) AT THE OPTION OF THE USER, STAINLESS STEEL SHIMS (ASME SA240/479, TYP 304L) OF APPROPRIATE THICKNESS MAY BE USED IN THE WELDING OF THE STRUCTURAL LID (ITEM 19) TO THE SHELL WELDMENT (ITEM 1-5).

(7) PT FINAL SURFACE. EXAMINED PER ASME SECTION V, ARTICLE 6. ACCEPTANCE PER ASME SECTION III, ARTICLE NB-5350.

(8) ITEMS 22 AND 24 SHALL BE FIELD MODIFIED IF REQUIRED TO FIT FLUSH OR BELOW THE TOP SURFACE OF THE RESPECTIVE LID DURING INSTALLATION. ITEM 24 MAY BE GROUND TO FACILITATE A PRESS FIT DURING INSTALLATION. ITEM 23 IS TO BE INSTALLED FOR THE STORAGE CONFIGURATION (790-590) AND IS TO BE REMOVED FOR THE TRANSPORT CONFIGURATION (790-516).

(9) AT THE OPTION OF THE USER, STAINLESS STEEL (ASTM/ASME A/SA240, TYPE 304/304L) SHIMS OF APPROPRIATE THICKNESS MAY BE USED IN THE WELDING OF THE SHIELD LID (ITEM 17) TO THE SHELL WELDMENT (ITEMS 1-5).

(10) AT THE OPTION OF THE USER, SPACER SHIMS (DRAWING 790-587) MAY BE USED TO ADJUST THE STACK HEIGHT OF THE STRUCTURAL LID AND ENSURE THAT THE TOP OF THE LID IS AT EITHER LEVEL WITH THE TOP OF THE CANISTER OR EXTENDS PAST THE TOP EDGE OF THE CANISTER, SO LONG AS THE THE MIN. EFFECTIVE WELD THROAT IS MAINTAINED FOR THE CLOSURE WELD.

11. FIELD INSTALLED CODE NAMEPLATES SHALL BE LOCATED ON THE STRUCTURAL LID AS DIRECTED BY THE CLIENT. CODE NAMEPLATES TO BE WELDED TO THE STRUCTURAL LID WITH FOUR FILLET TACK WELDS 1/4 INCH LONG (MINIMUM), ONE ADJACENT TO EACH CORNER OF THE PLATE. FILLET WELD SIZE TO BE EQUAL TO THE THICKNESS OF THE NAMEPLATE.

12. DELETED

(19) 13. INSPECTION OF THE COLD STACK-UP OF THE SHIELD AND STRUCTURAL LIDS SHOULD BE PERFORMED PRIOR TO COMMENCEMENT OF FIELD WELDING. FOR REFERENCE PURPOSES, THE STRUCTURAL LID SHOULD NOT EXCEED THE TOP EDGE OF THE CANISTER SHELL BY MORE THAN .180". THIS INSPECTION MAY EITHER BE PERFORMED AT THE FABRICATOR'S FACILITY OR IN THE FIELD. FOLLOWING COMPLETION OF THE STRUCTURAL LID WELDING, THE TOP SURFACE OF THE STRUCTURAL LID SHALL BE FLUSH OR ABOVE THE EDGE OF THE TSC SHELL.

14. FOR ASME CODE STAMPED TSC's, THE GROOVE WELD FROM THE TOP OF THE STRUCTURAL LID ROOT PASS WELD TO THE SHORTEST DISTANCE OF THE FINISHED WELD PROFILE SHALL BE AT LEAST 0.72", FOR MAINE YANKEE CANISTER ONLY.

15. THE STRUCTURAL LID AND INSTALLED SPACER RING CAN BE FIELD DRESSED IN LOCALIZED AREAS TO ELIMINATE INTERFERENCE WITH THE CANISTER SHELL DURING INSTALLATION OF THE LID.

16. AT THE OPTION OF THE USER, STAINLESS STEEL (ASTM/ASME A/SA240 TYPE 304/304L) SHIMS OF APPROPRIATE SIZE AND THICKNESS MAY BE USED IN THE SPACER RING GROOVE IN THE STRUCTURAL LID TO ENSURE THE BAR FITS TIGHTLY AGAINST THE TOP OF THE GROOVE AT THE BOTTOM OF THE WELD JOINT.

17. AFTER SHIELD LID WELDING, TSC SHELLS MAY BE RE-ROUNDED BY MECHANICAL METHODS OR TOOLING. IF RE-ROUNDING IS PERFORMED, THE EXAMINATION OF THE SHIELD LID FINAL WELD SURFACE, PRESSURE TEST AND LEAK TEST SHALL BE PERFORMED, AFTER ALL RE-ROUNDING ACTIVITIES ARE COMPLETED.

(18) WELD NOT TO EXCEED TOP SURFACE OF ITEM 17 (SHIELD LID ASSY)

19. DELETED

(20) FOR ASSEMBLIES 98 AND 97 (BWR) WELD SIZE IS (7/8), FOR ASSY 99, 96, AND 95 (PWR) WELD SIZE IS (3/4).

(21) FOR ASSEMBLIES 98 AND 97 (BWR) WELD SIZE IS (1/2), FOR ASSY 99, 96, AND 95 (PWR) WELD SIZE IS (3/8).

95 ASSY	96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
2	2	2	2	2	24	DOWEL PIN	ST. STL.	COML.		1.0 DIA X 1.0 LONG
6	6	6	6	6	23	STRUCTURAL LID PLUG	304 ST. STL.	ASTM A276		2 DIA BAR
3	3	3	3	3	22	SHIELD LID PLUG	304 ST. STL.	ASTM A276		1 DIA BAR
1	1	1	1	1	21	KEY			790-584-8	
1	1	1	1	1	20	SPACER RING			790-584-7	
1	1	1	1	1	19	STRUCTURAL LID			790-584-4	
2	2	2	2	2	18	COVER			790-584-5	
1	1	1	1	1	17	SHIELD LID ASSY			790-584-99	
1	1	1	1	1	16	LID SUPPORT RING			790-584-6	
				1	15	DRAIN TUBE ASSY			790-583-99	
			1		14	DRAIN TUBE ASSY			790-583-98	
		1			13	DRAIN TUBE ASSY			790-583-97	
	1				12	DRAIN TUBE ASSY			790-583-96	
1					11	DRAIN TUBE ASSY			790-583-95	
1					10	FUEL BASKET ASSY			790-595-99	PWR – CANISTER CLASS 1
	1				9	FUEL BASKET ASSY			790-595-98	PWR – CANISTER CLASS 2
		1			8	FUEL BASKET ASSY			790-570-99	BWR – CANISTER CLASS 4
			1		7	FUEL BASKET ASSY			790-570-98	BWR – CANISTER CLASS 5
				1	6	FUEL BASKET ASSY			790-595-97	PWR – CANISTER CLASS 3
				1	5	SHELL WELDMENT			790-582-99	
			1		4	SHELL WELDMENT			790-582-98	
		1			3	SHELL WELDMENT			790-582-97	
	1				2	SHELL WELDMENT			790-582-96	
1					1	SHELL WELDMENT			790-582-95	
QUANTITY										

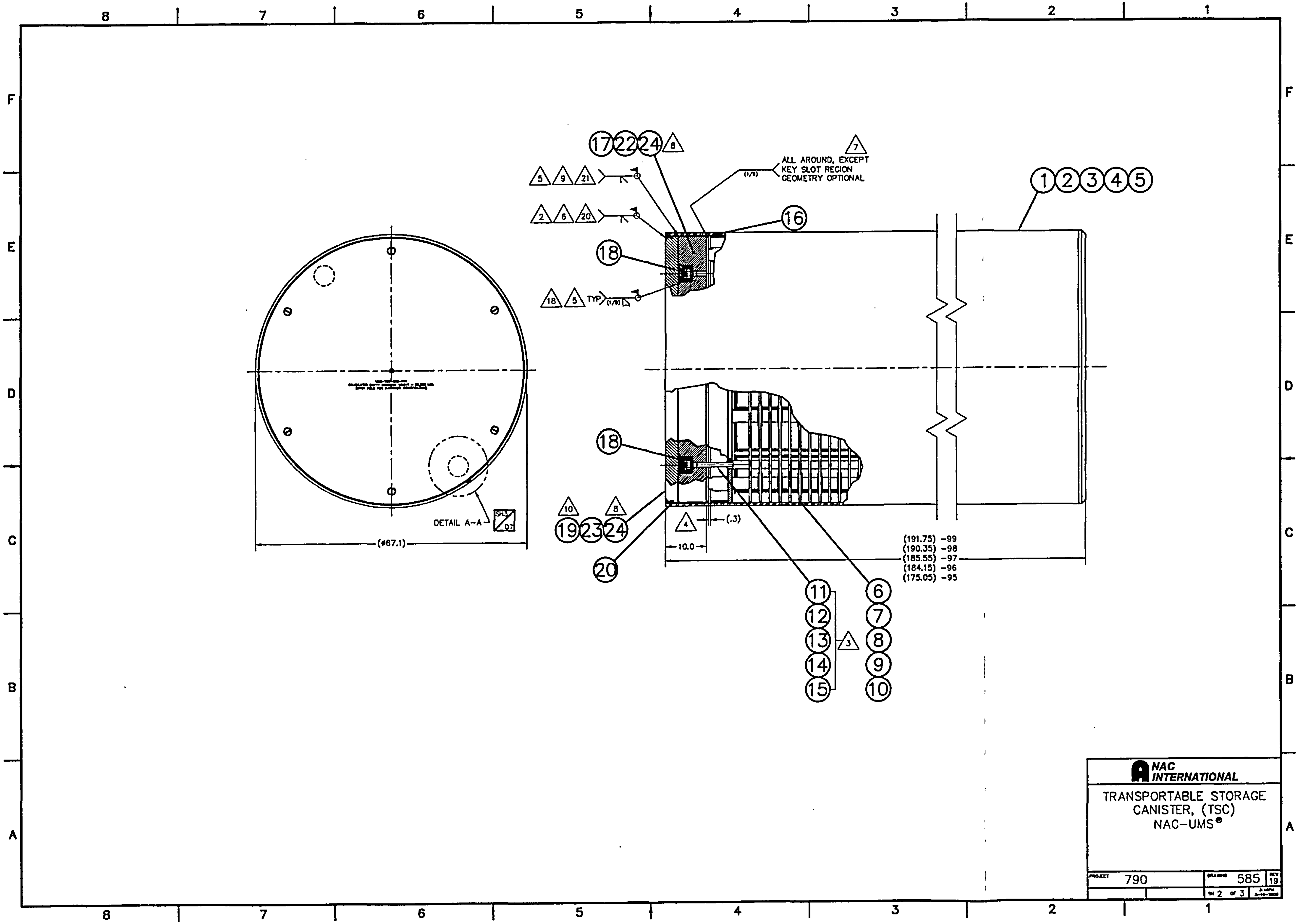
NAC INTERNATIONAL

UNLESS OTHERWISE STATED
DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5M-94
ALL THREAD DEPTH CALLOUTS ARE TO BE CONSIDERED AS A MIN. DEPTH OF PERFECT THREADS.
ALL DIMENSIONS ARE IN INCHES
MACHINED SURFACES TO BE ▽ OR BETTER
NEXT ASSEMBLY: 790-590/516
DRAWING TYPE: LICENSE

GROUP	NAME	DATE
PREPARER	[signature]	3-24-05
CHECKER	[signature]	3/24/05
PROJECT MANAGER	[signature]	3/24/05
ENGINEERING	[signature]	3/24/05
LICENSING	[signature]	3/24/05
QUALITY	[signature]	3/25/05

TRANSPORTABLE STORAGE CANISTER, (TSC) NAC-UMS®

PROJECT 790 | DRAWING 585 | REV 19 | SH 1 OF 3

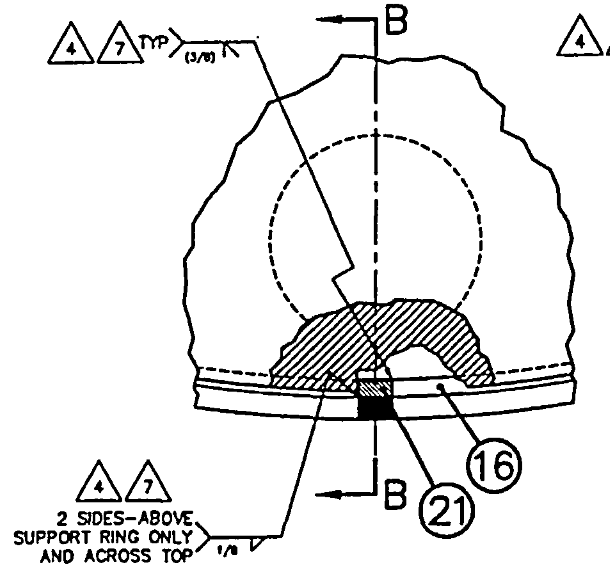


NAC INTERNATIONAL

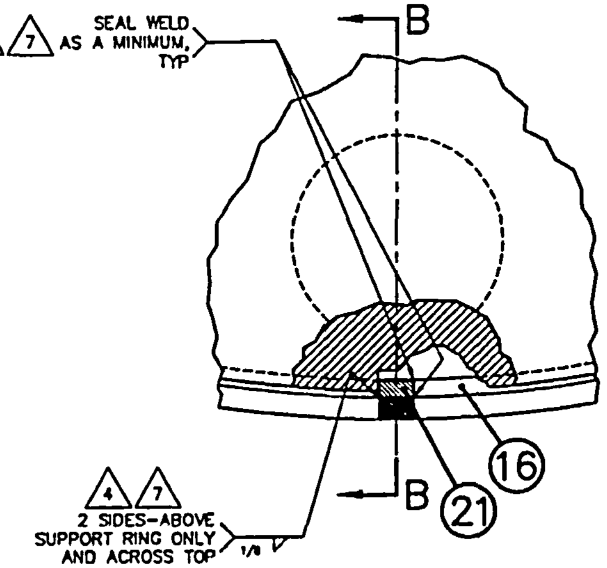
TRANSPORTABLE STORAGE CANISTER, (TSC) NAC-UMS®

PROJECT 790 DRAWING 585 REV 19

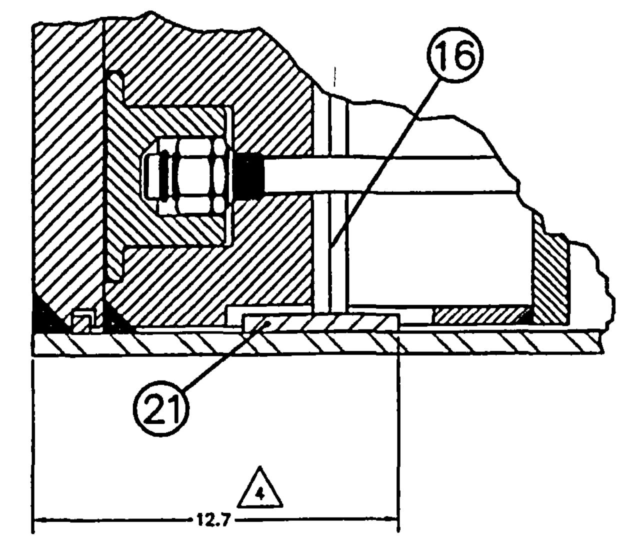
SH 2 OF 3



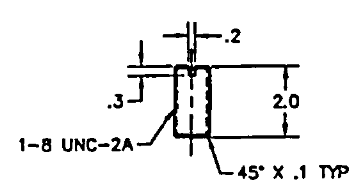
SH2 C6 DETAIL A—A
VIEW ROTATED
OPTIONAL ENGRAVED STRIPE SHOWN



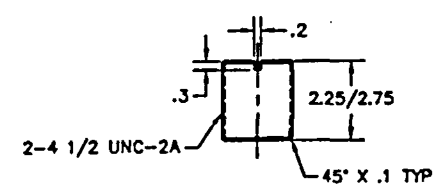
SH2 C6 DETAIL A—A
VIEW ROTATED
ALTERNATE CONFIGURATION
OPTIONAL ENGRAVED STRIPE SHOWN



SECTION B—B



8 22 SHIELD LID PLUG



8 23 STRUCTURAL LID PLUG

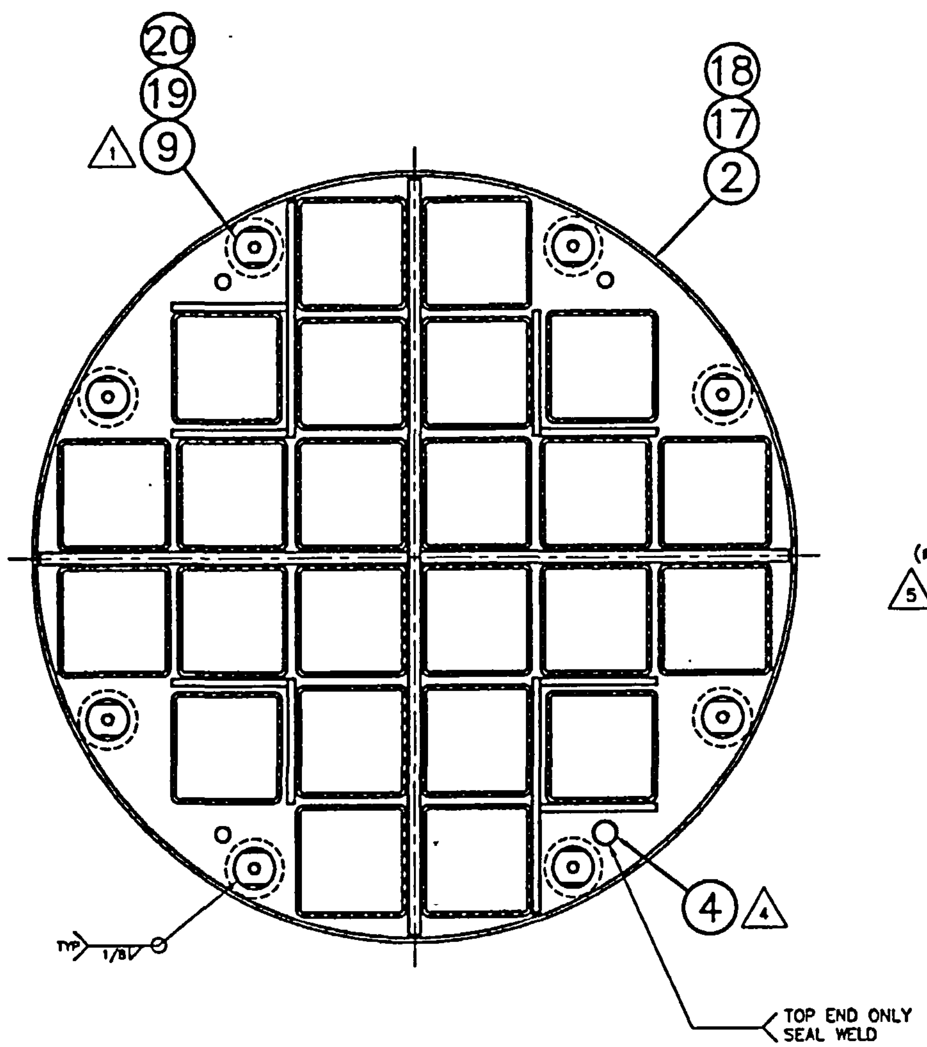
NAC INTERNATIONAL

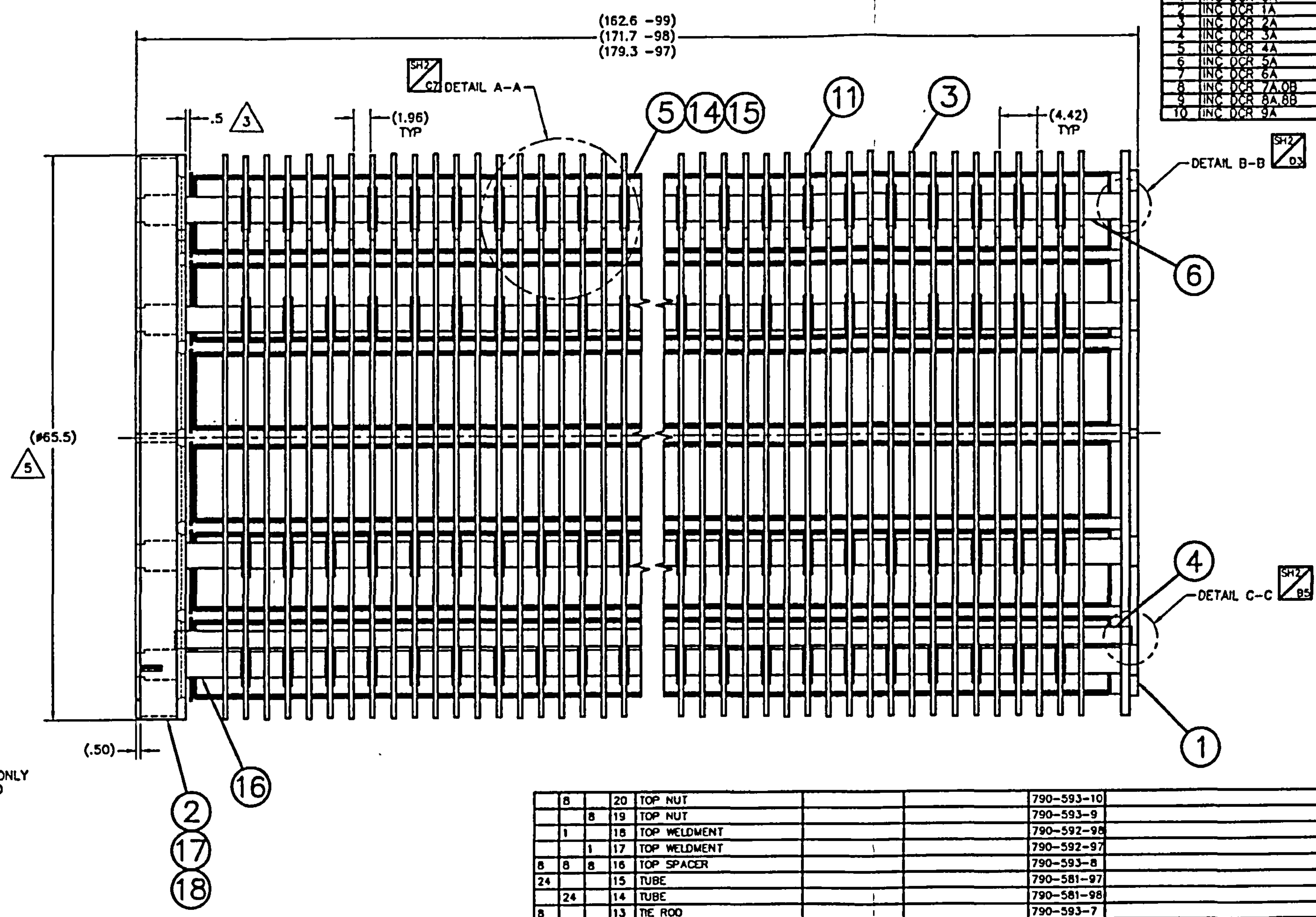
TRANSPORTABLE STORAGE CANISTER, (TSC) NAC-UMS®

PROJECT	DRAWING	REV
790	585	19
	SH 3 OF 3	

R-20305,1

REV	CHANGE
0	INITIAL ISSUE
1	INC DCR 0A
2	INC DCR 1A
3	INC DCR 2A
4	INC DCR 3A
5	INC DCR 4A
6	INC DCR 5A
7	INC DCR 6A
8	INC DCR 7A,0B
9	INC DCR 8A,8B
10	INC DCR 9A





99 FUEL BASKET ASSEMBLY

98 FUEL BASKET ASSEMBLY

97 FUEL BASKET ASSEMBLY

97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
	8		20	TOP NUT			790-593-10	
		8	19	TOP NUT			790-593-9	
	1		18	TOP WELDMENT			790-592-98	
		1	17	TOP WELDMENT			790-592-97	
8	8	8	16	TOP SPACER			790-593-8	
24			15	TUBE			790-581-97	
	24		14	TUBE			790-581-98	
8			13	TIE ROD			790-593-7	
	8		12	TIE ROD			790-593-6	
33	31	29	11	HEAT TRANSFER DISK			790-594-1	
		8	10	TIE ROD			790-593-5	
8			9	TOP NUT			790-593-4	
528	496	464	8	FLAT WASHER	ST. STL.	COML ANSI B18.22.1		2 1/2 TYPE A PLAIN WASHER
528	496	464	7	SPLIT SPACER			790-593-2	
8	8	8	6	SPACER			790-593-3	
		24	5	TUBE			790-581-99	
1	1	1	4	DRAIN TUBE SLEEVE	304 ST. STL.	COML		2 DIA TUBE WITH .035 OR .065 WALL
34	32	30	3	SUPPORT DISK			790-593-1	
1			2	TOP WELDMENT			790-592-99	
1	1	1	1	BOTTOM WELDMENT			790-591-99	

QUANTITY

NOTES:

1. (△1) LUBRICATE WITH A SPENT FUEL POOL COMPATIBLE LUBRICANT SUCH AS NEOLUBE AND TORQUE NUTS TO 50±10 FT-LBS PRIOR TO WELDING.
2. (△2) (DELETED)
3. (△3) THIS DIMENSION IS TO BE HELD BY ADJUSTMENT OF THE TOP SPACERS (ITEM 16). LONGER OR SHORTER PARTS MAY BE USED. THIS DIMENSION APPLIES TO THE GAP BETWEEN THE TALLEST FUEL TUBE AND THE TOP WELDMENT ONLY.
4. (△4) ITEM 4 LENGTH TO EXTEND BEYOND ITEM 2, 17, OR 18 SURFACE BY .25 +.02/-.25.
5. (△5) ASSEMBLY -99, -98, -97 TO BE FREELY INSERTED INTO CANISTER, DURING FINAL ASSEMBLY. ALTERNATE ASSEMBLY IN CANISTER OPTIONAL.
6. (10) IF AFTER FINAL ASSEMBLY, THE 1-8 UNC-2B THREADS OF ITEMS 9, 19 AND 20 (TOP NUT) ARE DAMAGED, THEY WILL NOT REQUIRE REPLACEMENT IF A MINIMUM OF 4 UNDAMAGED EQUALLY SPACED TOP NUTS REMAIN.

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5-94. UNSPECIFIED DIMENSIONS AND TOLERANCES SHOWN BELOW. DIMENSIONS ARE IN INCHES. FRACTIONAL TOLERANCE: ±1/8

SYM.	GEOMETRY	.XXX	TOL.	.XX	TOL.
▱	FLATNESS	UNDER 3	±.003	UNDER 6	±.03
	STRAIGHTNESS	3-12	±.005	6-18	±.03
∠	ANGULARITY	OVER 12	±.010	OVER 18	±.09
⊥	PERPENDICULARITY	.X	±.1	ANGLES ±0.5°	
//	PARALLELISM	ALL UNSPECIFIED TOOL RADII: .015 - .030			
○	CONCENTRICITY	BREAK ALL SHARP CORNERS .015 - .030			
⊕	TRUE POSITION	ALL UNSPECIFIED MACHINED SURFACES SHALL BE ∇ OR BETTER			

NEXT ASSEMBLY: 790-585

DRAWING TYPE: LICENSE

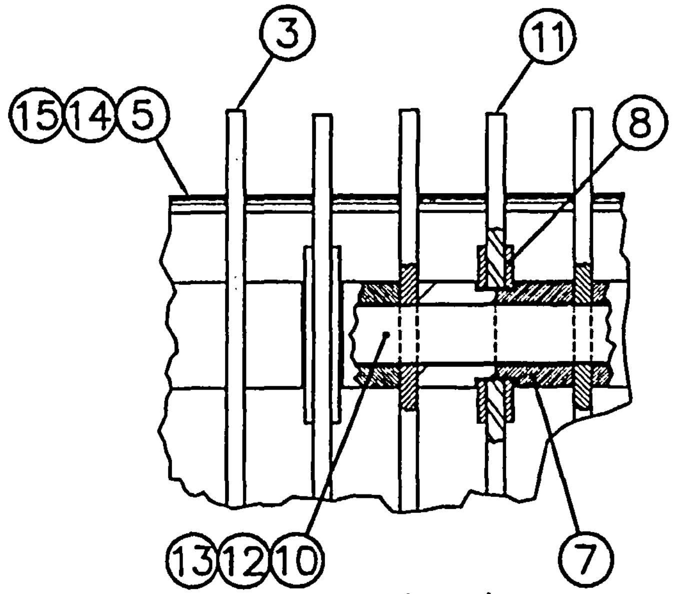
GROUP	NAME	DATE
PREPARER	R. Walden	3-21-05
CHECKER	[signature]	3-21-05
PROJECT MANAGER	[signature]	3/21/05
DIRECTOR DESIGN AND ANALYSIS	[signature]	3/24/05
DIRECTOR LICENSING	[signature]	3/24/05
VICE PRESIDENT, QUALITY	[signature]	3/25/05

NAC INTERNATIONAL

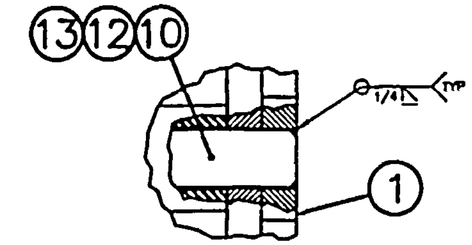
FUEL BASKET ASSEMBLY, 24 ELEMENT PWR NAC-UMS®

PROJECT 790 | DRAWING 595 | REV 10

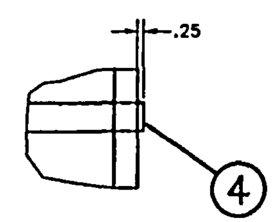
SCALE 1/8 | EST.WT. | SH 1 OF 2 | 3-21-2005



SH1 F4 DETAIL A—A
SCALE: 1/2



SH1 F1 DETAIL B—B
SCALE: 1/2



SH1 D1 DETAIL C—C
SCALE: 1/2

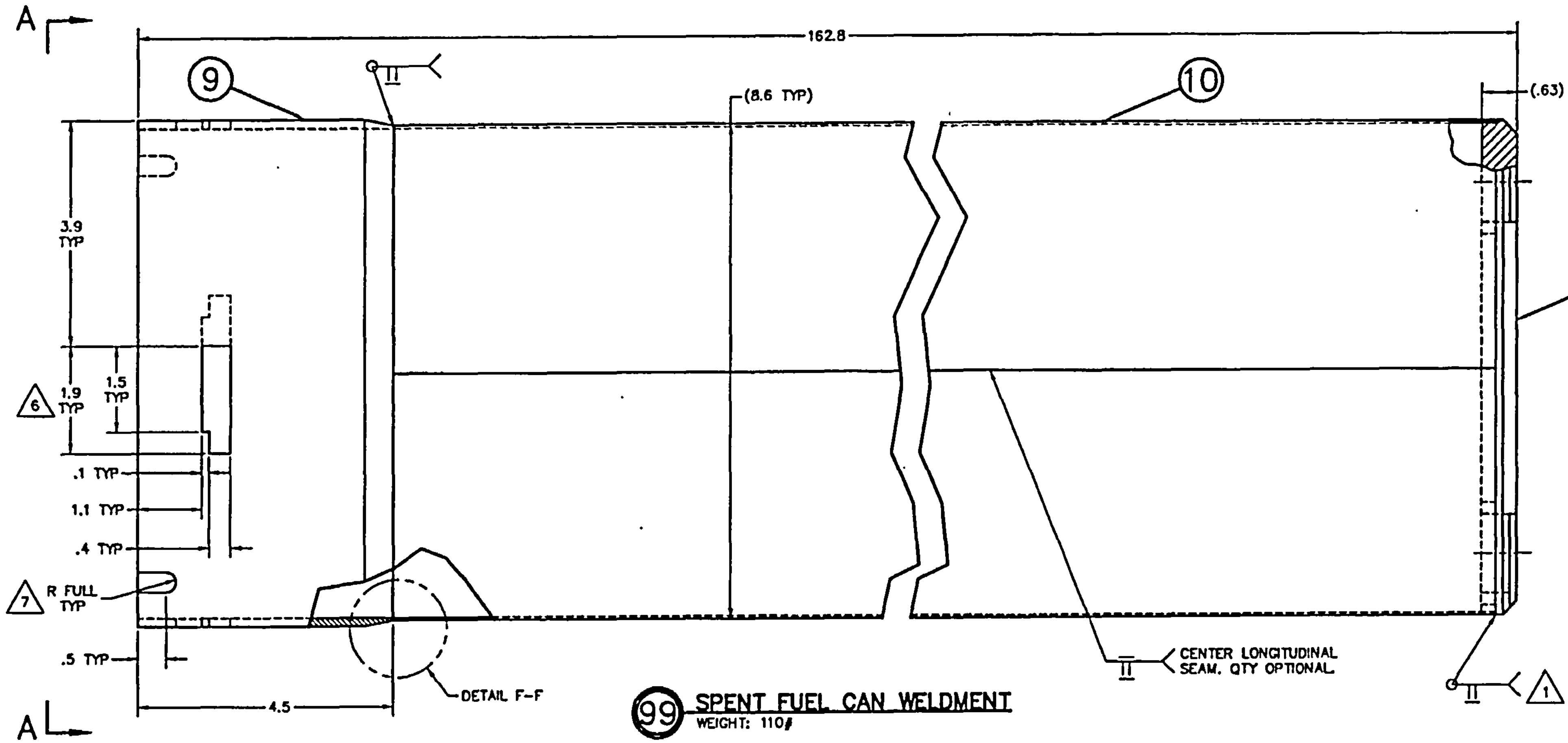
NAC INTERNATIONAL

FUEL BASKET ASSEMBLY,
24 ELEMENT PWR
NAC–UMS®

PROJECT 790		DRAWING 595	REV 10
SCALE 1/6	EST WT.	SH 2 OF 2	

R-203040

REV	CHANGE
0	INITIAL ISSUE
1	INC DCR 0A
2	INC DCR 1A
3	INC DCR 2A,2B
4	INC DCR 3A,3B,3C
5	INC DCR 4A
6	INC DCR 5A



99 SPENT FUEL CAN WELDMENT

WEIGHT: 110#

6/10 MINOR EDGE SURFACE AND/OR DIMENSIONAL DEVIATIONS ARE ACCEPTABLE FOR ITEM 4, WIPER.

9. VISUALLY INSPECT (VT) ALL WELDS IN ACCORDANCE WITH ASME SECTION V, ARTICLE 9. ACCEPTANCE PER ASME SECTION III, NG-5360.

8. ALL WELDING PROCEDURES AND QUALIFICATIONS TO BE IN ACCORDANCE WITH ASME SECTION IX.

7. CORNERS MAY BE ROUNDED PROVIDED THE SLOT OPENING DOES NOT EXCEED 0.5

6. BREAK ALL INTERIOR EDGES OF SLOT.

5. FOR ITEM 4 WIPER MATERIAL IS 6061-T6 ALUMINUM ASTM B209, .032 SHEET OR ITEM 4 ALTERNATE WIPER IS ST. STL. COMMERCIAL, .005-.008 (.127-.203MM) SHEET/STRIP, MATERIAL FOR ST. STL. WIPER TO HAVE A MINIMUM YIELD STRENGTH OF 100KSI.

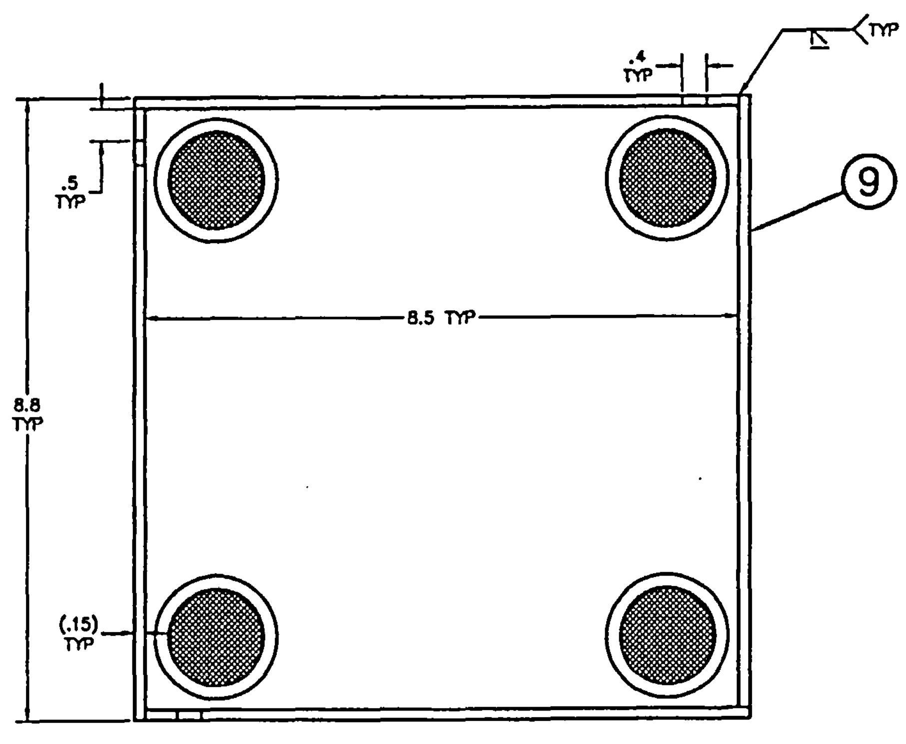
4. THE CORRESPONDING DESIGN DRAWING FOR THE ALTERNATE CONFIGURATION IS 412-109.

3. MACHINE ITEM 20, BOTTOM ASSEMBLY, FOR SLIP FIT OF ITEM 19, TUBE BODY.

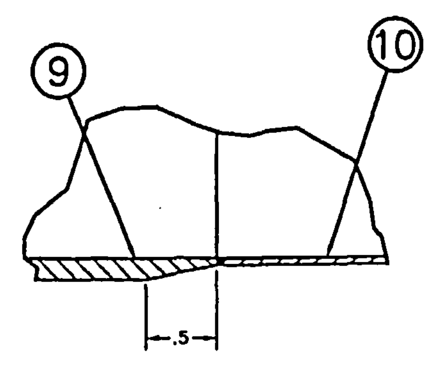
2. MACHINE ITEM 1, FOR LIGHT PRESS FIT WITH ITEM 8 OR 17, BOTTOM PLATE. THE THICKNESS OF ITEM 1 IS MAINTAINED SO THAT IT IS FLUSH WITH ITEM 8 OR 17 WHEN THE SCREENS ARE IN PLACE AND THE TWO ITEMS ARE WELDED TOGETHER.

1. MACHINE ITEM 11, BOTTOM ASSEMBLY, FOR SLIP FIT OF ITEM 10, TUBE BODY.

NOTES:



VIEW A—A



DETAIL F—F

SCALE: 2/1

95 ASSY	96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
	1				20	BOTTOM ASSEMBLY			412-502-95	
	1				19	TUBE BODY	304 ST. STL.	ASME SA240		18 GAGE SHEET
	4				18	SIDE PLATE	304 ST. STL.	ASME SA240/SA479		PLATE/BAR
1					17		304 ST. STL.	ASME SA240		5/8 PLATE
			4		16	DOWEL PIN	ST. STL.	COML		1/4 DIA X 3/4 LONG
			A/R		15	BACKING SCREEN	ST. STL.	COML		NEWARK ZQ1 16 X 16 .023
			A/R		14	FILTER SCREEN	ST. STL.	COML		NEWARK PAC 250 X 250 X .0016
			1		13	SUPPORT RING	304 ST. STL.	ASME SA312		6" SCH 40 PIPE
			1		12	LIFT TEE	304 ST. STL.	ASME SA240/SA479		PLATE/BAR
				1	11	BOTTOM ASSEMBLY			412-502-97	
				1	10	TUBE BODY	304 ST. STL.	ASME SA240		18 GAGE SHEET
				4	9	SIDE PLATE	304 ST. STL.	ASME SA240/SA479		PLATE/BAR
		1			8	BOTTOM PLATE	304 ST. STL.	ASME SA240		5/8 PLATE
A/R		A/R			7	BACKING SCREEN	ST. STL.	COML		NEWARK ZQ1 16 X 16 .023
A/R		A/R			6	FILTER SCREEN	ST. STL.	COML		NEWARK PAC 250 X 250 X .0016
			1		5	LID BOTTOM	304 ST. STL.	ASME SA240		5/16 PLATE
			1		4	WIPER	SEE NOTE 5	SEE NOTE 5		SEE NOTE 5
			4		3	LID GUIDE	304 ST. STL.	ASME SA240/SA479		1/4 PLATE/BAR
			1		2	LID PLATE	304 ST. STL.	ASME SA240		3/8 PLATE
4		4			1	COLLAR	304 ST. STL.	ASME SA240/SA479		PLATE/BAR

QUANTITY

UNLESS OTHERWISE STATED

NEXT ASSEMBLY: 412-501

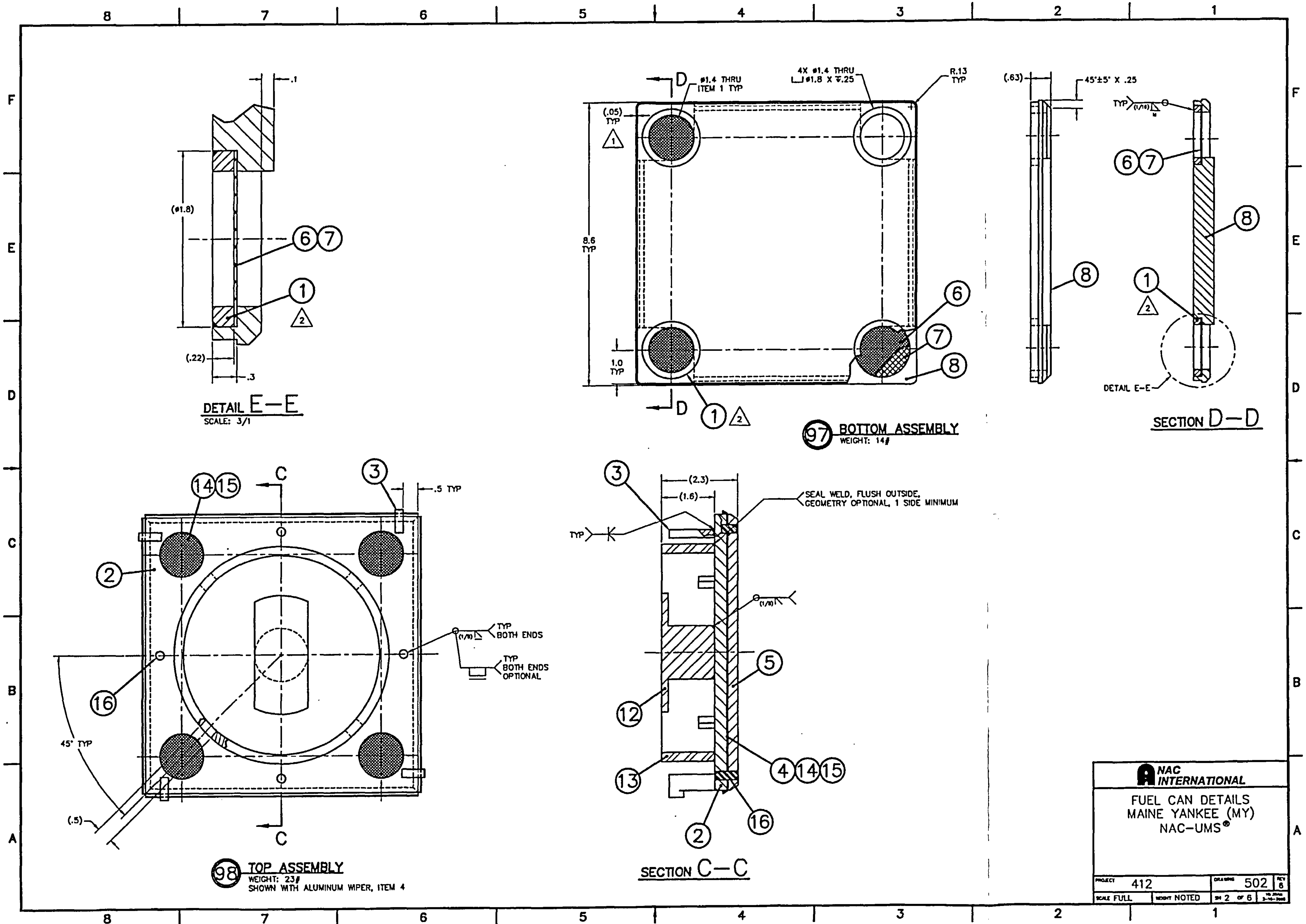
DRAWING TYPE: LICENSE

NAC INTERNATIONAL

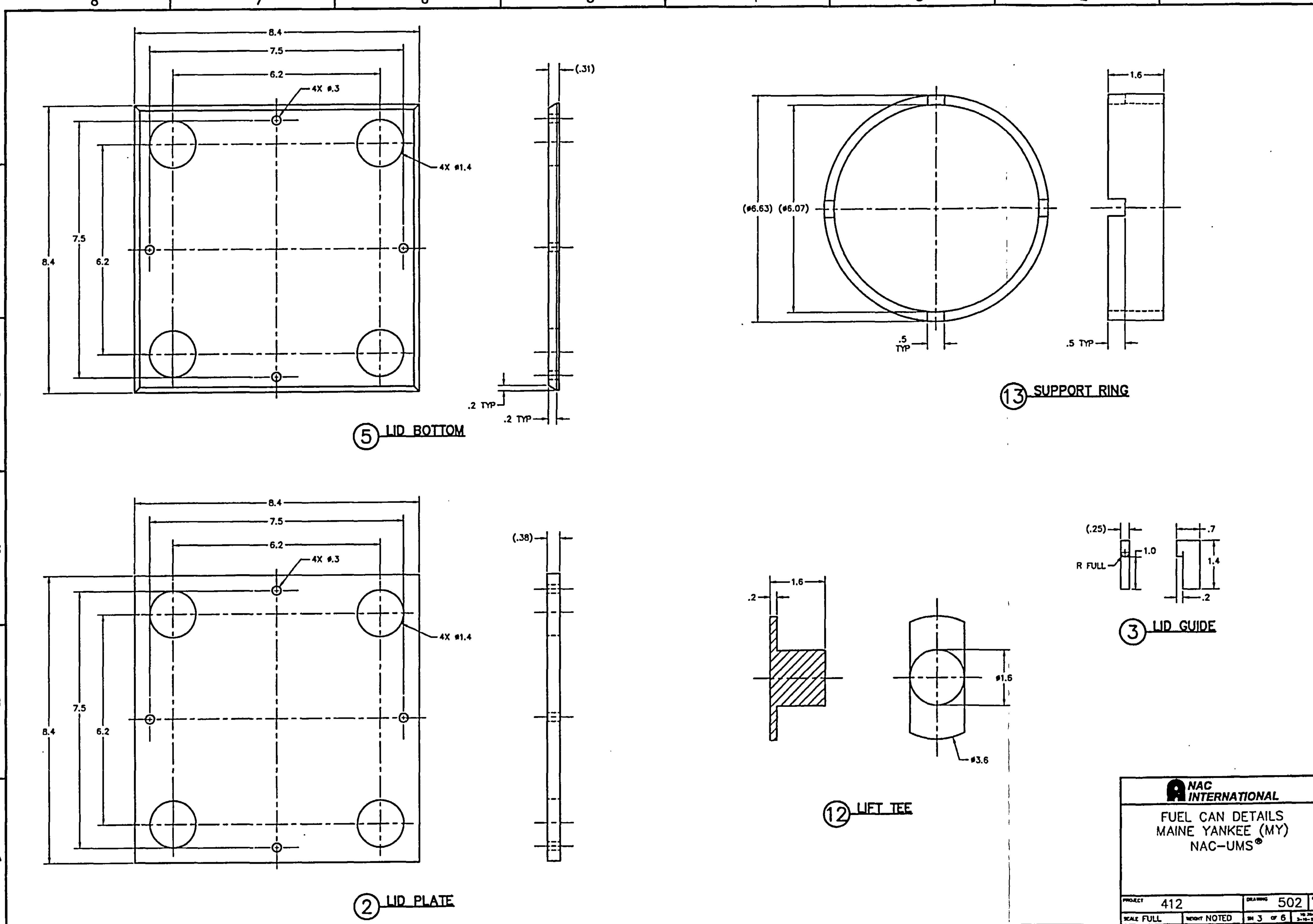
FUEL CAN DETAILS
MAINE YANKEE (MY)
NAC-UMS®

PROJECT 412 | DRAWING 502 | REV 6

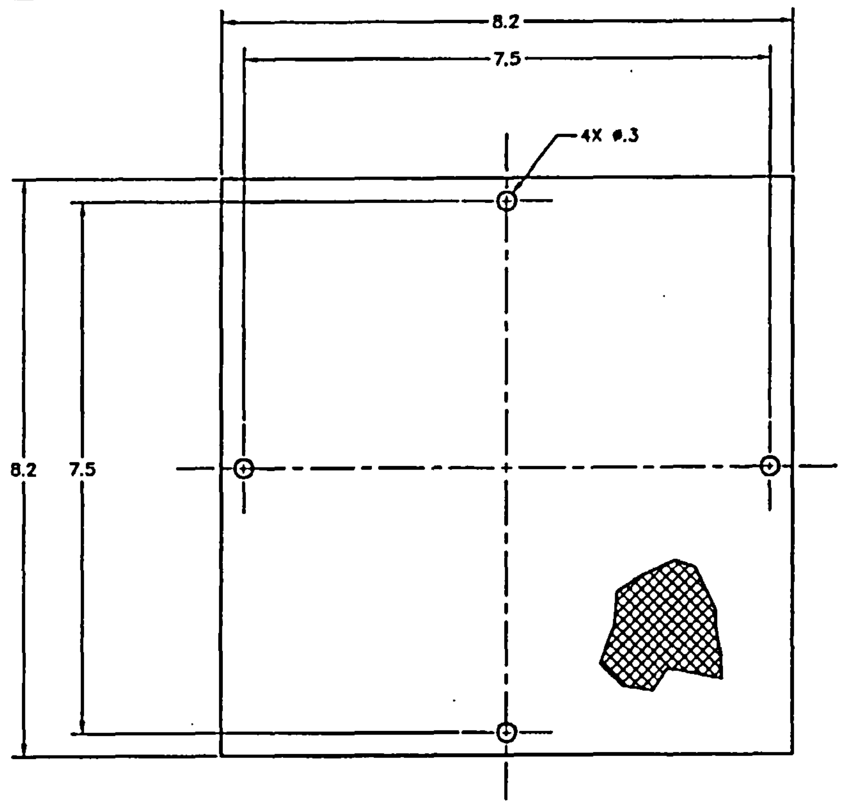
SCALE FULL | WEIGHT NOTED | SH 1 of 6



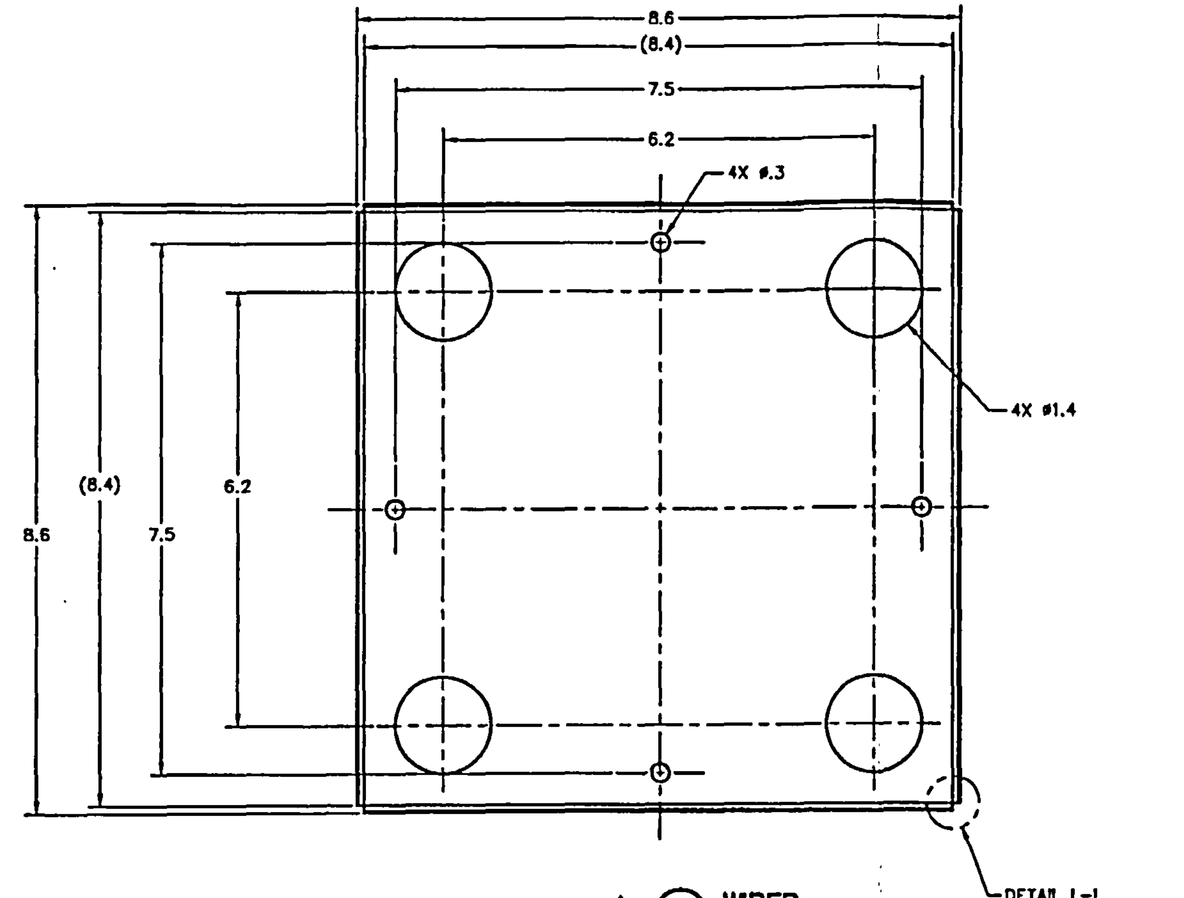
DETAIL E—E
SCALE: 3/1
(ø1.8)
(.22)
.3
.1
BOTTOM ASSEMBLY
WEIGHT: 14#
ø1.4 THRU ITEM 1 TYP
4X ø1.4 THRU ⌴ ø1.8 X ↧.25
R.13 TYP
(.05) TYP
8.6 TYP
1.0 TYP
SECTION D—D
(.63)
45°±5° X .25
DETAIL E-E
TOP ASSEMBLY
WEIGHT: 23#
SHOWN WITH ALUMINUM WIPER, ITEM 4
.5 TYP
TYP BOTH ENDS
TYP BOTH ENDS OPTIONAL
45° TYP
(.5)
SECTION C—C
(2.3)
(1.6)
SEAL WELD, FLUSH OUTSIDE, GEOMETRY OPTIONAL, 1 SIDE MINIMUM
NAC INTERNATIONAL
FUEL CAN DETAILS
MAINE YANKEE (MY)
NAC-UMS®
PROJECT 412
DRAWING 502
SCALE FULL
WEIGHT NOTED
SH 2 OF 6



8.4
7.5
6.2
4X ø.3
4X ø1.4
(.31)
.2 TYP
5 LID BOTTOM
(ø6.63) (ø6.07)
.5 TYP
1.6
13 SUPPORT RING
(.38)
2 LID PLATE
1.6
.2
ø1.6
ø3.6
12 LIFT TEE
(.25)
1.0
R FULL
.7
1.4
.2
3 LID GUIDE
NAC INTERNATIONAL
FUEL CAN DETAILS
MAINE YANKEE (MY)
NAC-UMS®
PROJECT 412
DRAWING 502
REV 6
SCALE FULL
WEIGHT NOTED
SH 3 OF 6

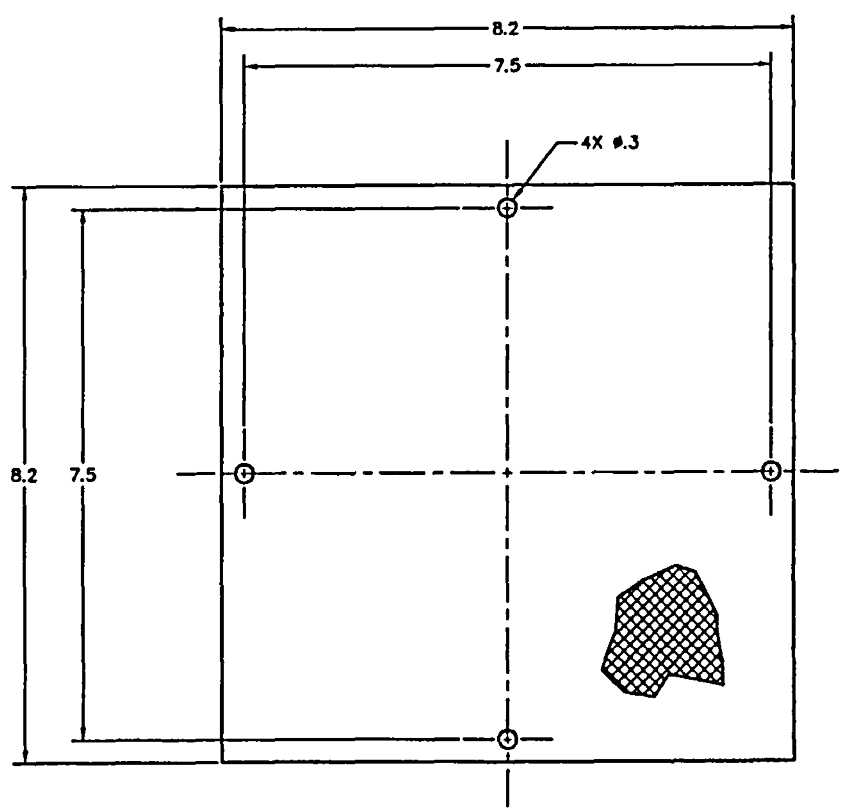


(14) FILTER SCREEN



(6) 10 (4) WIPER

(6)



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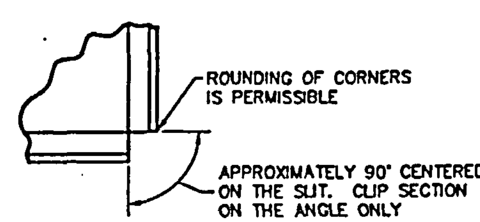

DETAIL L—L
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NAC INTERNATIONAL

FUEL CAN DETAILS
MAINE YANKEE (MY)
NAC-UMS®

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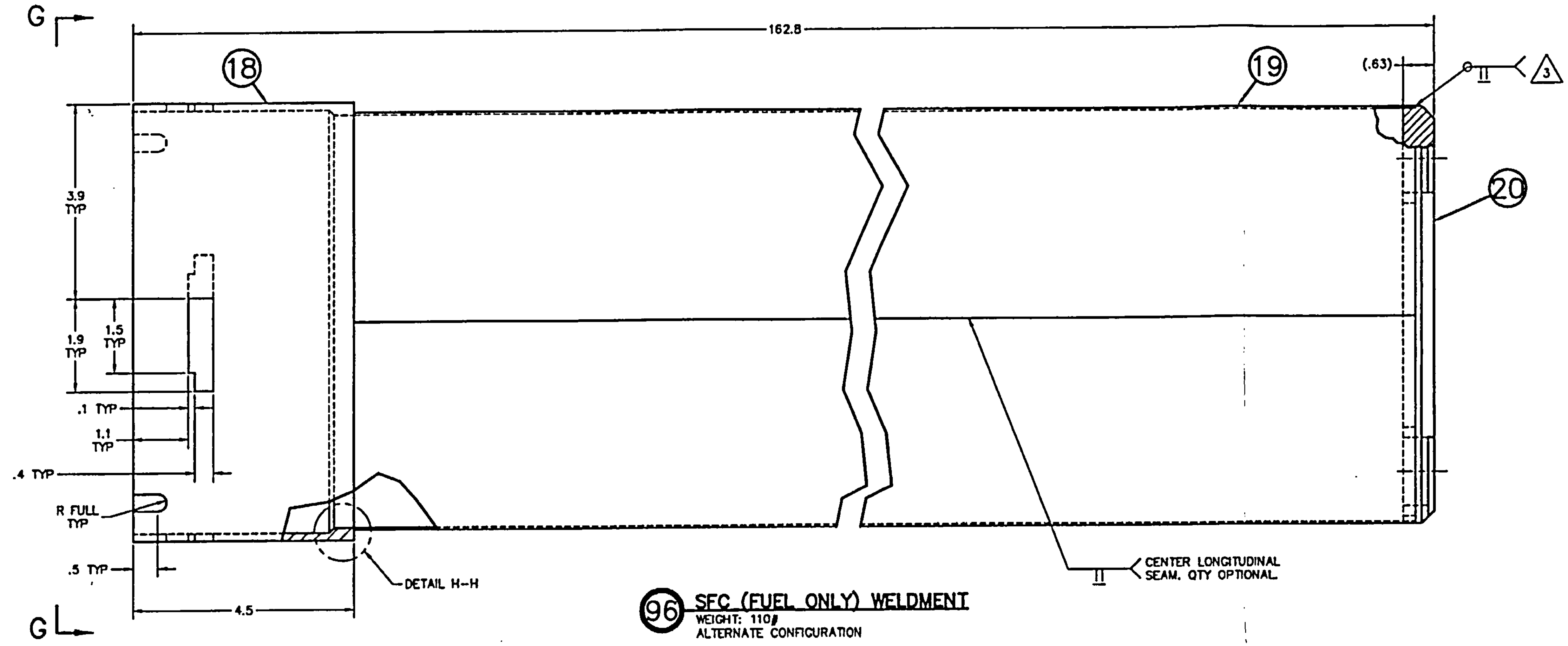

96 SFC (FUEL ONLY) WELDMENT
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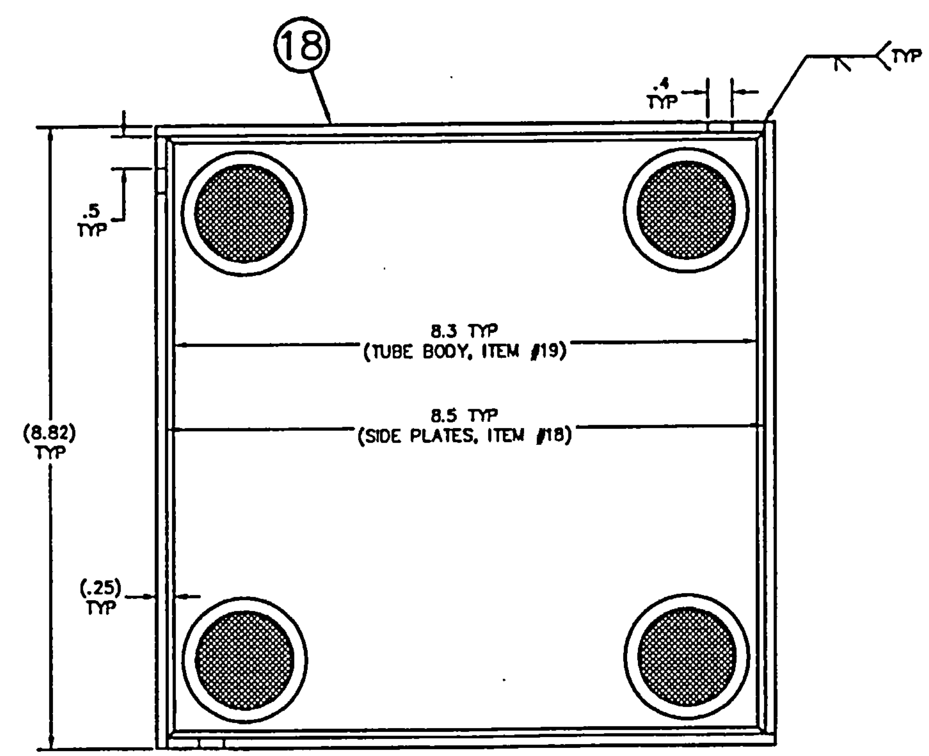
ALTERNATE CONFIGURATION



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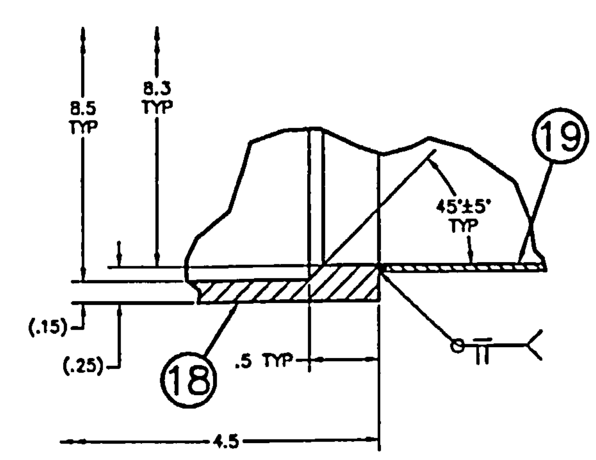

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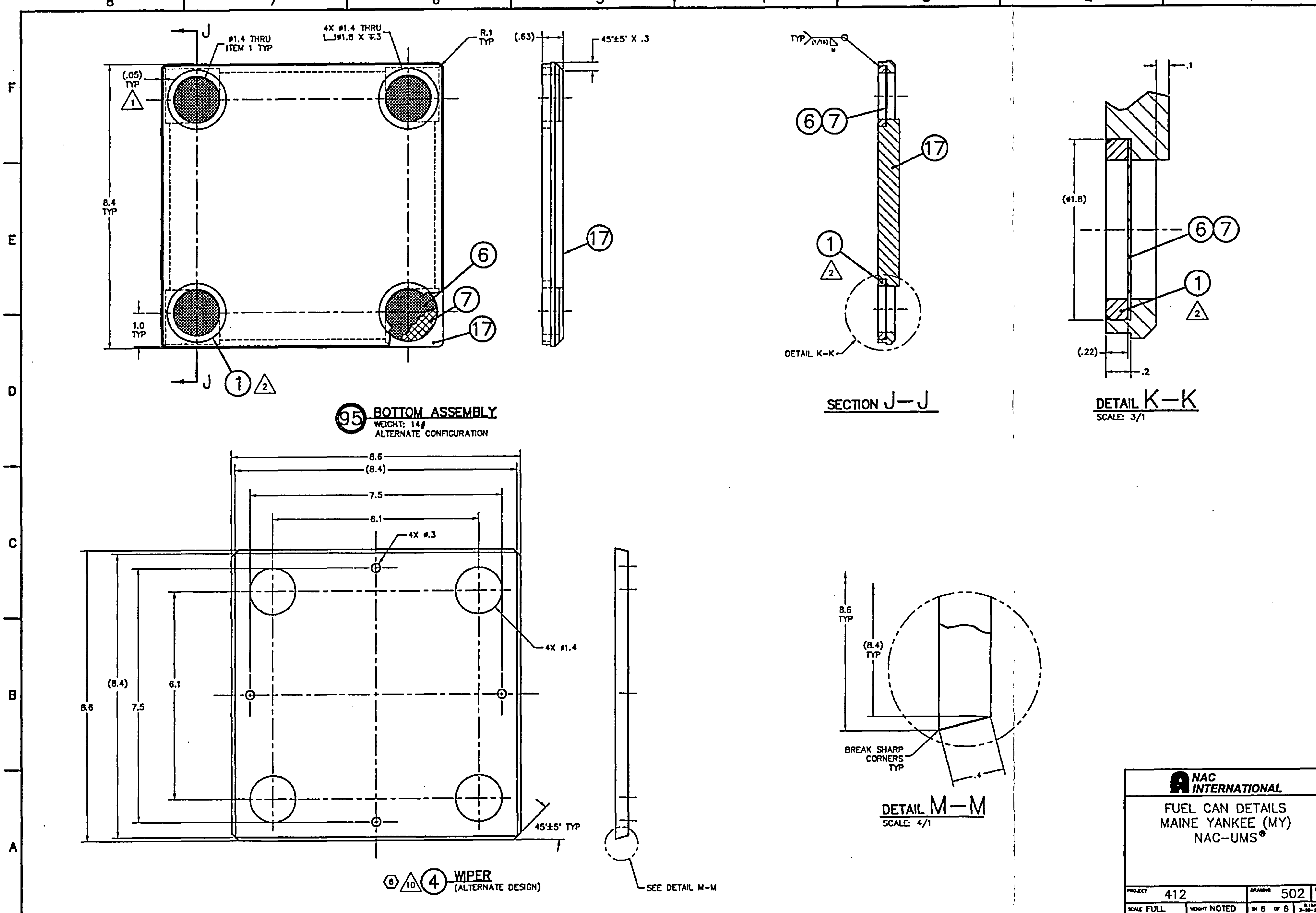
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NAC INTERNATIONAL
FUEL CAN DETAILS
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PROJECT 412
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SCALE FULL
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SH 6 OF 6

Chapter 2

2.0 PRINCIPAL DESIGN CRITERIA

The Universal Storage System is a canister-based spent fuel dry storage cask system that is designed to be compatible with the Universal Transportation System. It is designed to store a variety of intact PWR and BWR fuel assemblies. This chapter presents the design bases, including the principal design criteria, limiting load conditions, and operational parameters of the Universal Storage System. The principal design criteria are summarized in Table 2-1.

Table 2-1 Summary of Universal Storage System Design Criteria

Parameter	Criteria
Design Life	50 years
Design Code - Confinement	ASME Code, Section III, Subsection NB [1] for confinement boundary
Design Code - Nonconfinement	
Basket	ASME Code, Section III, Subsection NG [2] and NUREG/CR-6322 [3]
Vertical Concrete Cask	ACI-349 [4], ACI-318 [5]
Transfer Cask	ANSI N14.6 [6] and NUREG-0612 [7]
Maximum Weight:	
Canister with Design Basis PWR Fuel Assembly (dry, including inserts) (Class 2)	72,900 lbs.
Canister with Design Basis BWR Fuel (dry) (Class 5)	75,600 lbs.
Vertical Concrete Cask (loaded) (Class 5)	323,900 lbs.
Transfer Cask (Class 3)	121,500 lbs.
Thermal:	
Maximum Fuel Cladding Temperature:	
PWR Fuel	752°F (400°C) for Normal and Transfer [25] 1058°F (570°C) Off-Normal and Accident [21]
BWR Fuel	752°F (400°C) for Normal and Transfer [25] 1058°F (570°C) Off-Normal and Accident [21]
Ambient Temperature:	
Normal (average annual ambient)	76°F
Off-Normal (extreme cold; extreme hot)	-40°F; 106°F
Accident	133°F
Concrete Temperature:	
Normal Conditions	≤ 150°F (bulk); ≤ 200°F (local) [24]
Off-Normal/Accident Conditions	≤ 350°F local/ surface [4]
Cavity Atmosphere	Helium

2.1 Spent Fuel To Be Stored

The Universal Storage System is designed to safely store up to 24 PWR spent fuel assemblies, or up to 56 BWR spent fuel assemblies, contained within a Transportable Storage Canister. On the basis of fuel assembly length and cross-section, the fuel assemblies are grouped into three classes of PWR fuel assemblies and two classes of BWR fuel assemblies. The class of the fuel assemblies is shown in Tables 6.2-1 and 6.2-2 for PWR and BWR fuel, respectively, and is based primarily on overall length.

The PWR and BWR fuel having the parameters shown in Tables 2.1.1-1 and 2.1.2-1, respectively, may be stored in the Universal Storage System. As shown in Table 2.1.1-1, the evaluation of PWR fuel includes fuel having thimble plugs and burnable poison rods in guide tube positions. In addition, solid stainless steel rods may be inserted into guide tube positions as long as the fuel assembly weight limits in Table 2.1.1-1 are not exceeded and no soluble boron credit is taken. As shown in Table 2.1.2-1, the BWR fuel evaluation includes fuel with a zirconium alloy channel. Any empty fuel rod position must be filled with a solid filler rod fabricated from either zirconium alloy or Type 304 stainless steel, or may be solid neutron absorber rods inserted for in-core reactivity control prior to reactor operation.

In addition to the design basis fuel, fuel that is unique to a reactor site, referred to as site specific fuel, is also evaluated. Site specific fuel consists of fuel assemblies that are configured differently, or have different parameters (such as enrichment or burnup), than the design basis fuel assemblies.

Site specific fuel is described in Section 2.1.3.

Site specific fuel is shown to be bounded by the fuel parameters shown in Tables 2.1.1-1 or 2.1.2-1, or it is separately evaluated.

The minimum initial enrichment limits are shown in Tables 2.1.1-2 and 2.1.2-2 for PWR and BWR fuel, respectively. The minimum enrichment limits exclude the loading of fuel assemblies enriched to less than 1.9 wt.% ^{235}U, including unenriched fuel assemblies, into the Transportable Storage Canister. However, fuel assemblies with unenriched axial end-blankets may be loaded into the canister.

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2.1.1 PWR Fuel Evaluation

The parameters of the PWR fuel assemblies that may be loaded in the transportable storage canister (canister) are shown in Table 2.1.1-1. The maximum initial enrichment limit represents the maximum fuel rod enrichment limit for variably enriched PWR assemblies. Each canister may contain up to 24 intact PWR fuel assemblies.

The design of the Universal Storage System is based on certain reference fuel assemblies that maximize the source terms used for the shielding and criticality evaluation, and that maximize the weight used in the structural evaluation. These reference fuel assemblies are described in the chapters appropriate to the condition being evaluated. The principal characteristics and parameters of a reference fuel, such as fuel volume, initial enrichment, cool time and burnup, do not represent limiting or bounding values. Bounding values for a fuel class are established based primarily on how principal parameters are combined and on the loading conditions or restrictions established for a class of fuel based on its parameters.

The maximum decay heat load for the storage of all types of PWR fuel assemblies is 23.0 kW (0.958 kW/assembly), except in cases where preferential loading is employed.

The minimum cool time is based on the maximum decay heat load (23.0 kW) and the dose rate limits for the concrete and transfer casks and is presented in Section 5.5. PWR fuel must be loaded in accordance with Table 2.1.1-2.

Site specific fuel that does not meet the enrichment and burnup limits of this section and Table 2.1.1-1 is separately evaluated in Section 2.1.3 to establish loading limits.

Table 2.1.1-1 PWR Fuel Assembly Characteristics

Fuel Class[1,2]	14 x 14	14 x 14	15 x 15	15 x 15	15 x 15	16 x 16	17 x 17
Fissile Isotopes	UO_2	UO_2	UO_2	UO_2	UO_2	UO_2	UO_2
Max Initial Enrichment (wt % ^{235}U)[3]	5.0	5.0	4.6	4.4	4.2	4.8	4.3
Max Initial Enrichment (wt % ^{235}U)[4]	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Number of Fuel Rods	176	179	204	208	216	236	264
Number of Water Holes	5	17	21	17	9	5	25
Max Assembly Average Burnup (MWD/MTU)	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Min Cool Time (years)	5	5	5	5	5	5	5
Min Average Enrichment (wt % ^{235}U)	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Cladding Material	Zirconium Alloy	Zirconium Alloy	Zirconium Alloy	Zirconium Alloy	Zirconium Alloy	Zirconium Alloy	Zirconium Alloy
Non-Fuel Hardware[5]	FM, T, BPR	FM, T, BPR	FM, T, BPR	FM, T, BPR	FM, T, BPR	FM, T, BPR	FM, T, BPR
Max Weight (lb) per Storage Location[6]	1,602	1,602	1,602	1,602	1,602	1,602	1,602
Max Decay Heat (Watts) per Storage Location[7]	958.3	958.3	958.3	958.3	958.3	958.3	958.3
Fuel Condition	Intact	Intact	Intact	Intact	Intact	Intact	Intact

General Notes:

1. Fuel, except Maine Yankee fuel, must be loaded in accordance with Table 2.1.1-2.
2. Maine Yankee fuel must be loaded in accordance with Tables 2.1.3.1-4 and 2.1.3.1-5, as appropriate.
3. Maximum initial enrichment without boron credit. Represents the maximum fuel rod enrichment for variably enriched assemblies. Assemblies meeting this limit may contain a flow mixer (FM) (thimble plug), an ICI thimble (T), a burnable poison rod insert (BPR), or a solid stainless steel rod insert.
4. Maximum initial enrichment with taking credit for a minimum soluble boron concentration of 1000 ppm in the spent fuel pool water. Represents the maximum fuel rod enrichment for variably enriched assemblies. Assemblies meeting this limit may contain a flow mixer (thimble plug).
5. Assemblies may not contain control element assemblies, except as permitted for site specific fuel.
6. Weight includes the weight of nonfuel-bearing components, including solid stainless steel rods inserted into guide tube positions.
7. Maximum decay heat may be higher for site-specific fuel configurations, which control fuel loading position.

Table 2.1.3.1-1 Maine Yankee Site Specific Fuel Population

Site Specific Spent Fuel Configurations[1]	Est. Number of Assemblies[2]
Standard Fuel	1,434
Inserted Control Element Assembly (CEA)	168
Inserted In-Core Instrument (ICI) Thimble	138
Consolidated Fuel	2
Fuel Rod Replaced by Rod Enriched to 1.95 wt %	3
Fuel Rod Replaced by Stainless Steel Rod or Zirconium Alloy Rod	18
Fuel Rods Removed	10
Variable Enrichment	72
Variable Enrichment and Axial Blanket	68
Burnable Poison Rod Replaced by Hollow Zirconium Alloy Rod	80
Damaged Fuel in Maine Yankee Fuel Can	12
Burnup between 45,000 and 50,000 MWD/MTU	90
Maine Yankee Fuel Can	As Required
Inserted Startup Source	5
Inserted CEA Fingertips or ICI String Segment	1

1. The loading of the site- specific fuel is controlled by the requirement of Appendix B, Section B 2.0, of the CoC Number 1015 Technical Specifications.
2. The number of fuel assemblies in some categories may vary depending on future fuel inspections.

Table 2.1.3.1-2 Maine Yankee Fuel Can Design and Fabrication Specification Summary

<u>Design</u>

- The Maine Yankee Fuel Can shall be designed in accordance with ASME Code, Section III, Subsection NG except for: 1) the noted exceptions of Table B3-1 for fuel basket structures; and 2) the Maine Yankee Fuel Can may deform under accident conditions of storage.
- The Maine Yankee Fuel Can will have screened vents in the lid and base plate. Stainless steel meshed screens (250×250) shall cover all openings.
- The Maine Yankee Fuel Can shall limit the release of material from damaged fuel assemblies and fuel debris to the canister cavity.
- The Maine Yankee Fuel Can lifting structure and lifting tool shall be designed with a minimum factor of safety of 3.0 on material yield strength.

<u>Materials</u>

- All material shall be in accordance with the referenced drawings and meet the applicable ASME Code sections.
- All structural materials are ASME SA 240, Type 304 stainless steel.

<u>Welding</u>

- All welds shall be in accordance with the referenced drawings.
- The final surface of all welds (first unit) shall be liquid penetrant examined in accordance with ASME Code Section V, Article 6, with acceptance in accordance with ASME Code Section III, NG-5350. Subsequent units shall be visually examined in accordance with ASME Code Section V, Article 9, with acceptance in accordance with ASME Code Section III, NG-5360.

<u>Fabrication</u>

- All cutting, welding, and forming shall be in accordance with ASME Code Section III, NG-4000.

<u>Acceptance Testing</u>

- The Maine Yankee Fuel Can (first unit) and handling tool shall be load tested and visually inspected at the completion of fabrication.

<u>Quality Assurance</u>

- The Maine Yankee Fuel Can shall be constructed under a quality assurance program that meets 10 CFR 72 Subpart G. The quality assurance program must be accepted by NAC International and the licensee prior to initiation of the work.
- A Certificate of Conformance (or Compliance) shall be issued by the fabricator stating that the component meets the specifications and drawings.

2.2.2 Water Level (Flood) Design

The Vertical Concrete Cask may be exposed to a flood during storage on an unsheltered concrete storage pad at an ISFSI site. The source and magnitude of the probable maximum flood depend on specific site characteristics.

2.2.2.1 Flood Elevations

The Vertical Concrete Cask is evaluated in Section 11.2.9 for a maximum flood water depth of 50 feet above the base of the cask. The flood water velocity is assumed to be 15 feet per second. Results of the evaluation show that under design basis flood conditions, the cask does not float, tip, or slide on the storage pad, and that the confinement function is maintained.

2.2.2.2 Phenomena Considered in Design Load Calculations

The occurrence of flooding at an ISFSI site is dependent upon the specific site location and the surrounding geographical features, natural and man-made. Some possible sources of a flood at an ISFSI site are: (1) overflow from a river or stream due to unusually heavy rain, snow-melt runoff, a dam or major water supply line break caused by a seismic event (earthquake); (2) high tides produced by a hurricane; and (3) a tsunami (tidal wave) caused by an underwater earthquake or volcanic eruption.

Flooding at an ISFSI site is highly improbable because of the extensive environmental impact studies that are performed during the selection of a site for a nuclear facility.

2.2.2.3 Flood Force Application

The evaluation of the Universal Storage System for a flood condition determines a maximum allowable flood water current velocity and a maximum allowable flood water depth. The criteria employed in the determination of the maximum allowable values are that a cask sliding or tip-over will not occur, and that the canister material yield strength is not exceeded. The evaluation of the effects of flood conditions on the system is presented in Section 11.2.9.

The force of the flood water current on the cask is calculated as a function of the current velocity by multiplying the dynamic water pressure by the frontal area of the cask that is normal to the current direction. The dynamic water pressure is calculated using Bernoulli's equation relating fluid velocity and pressure. The force of the flood water current is limited such that the overturning moment on the cask will be less than that required to tip the cask over.

2.2.2.4 Flood Protection

The inherent strength of the reinforced concrete cask provides a substantial margin of safety against any permanent deformation of the cask for a credible flood event at an ISFSI site. Therefore, no special flood protection measures for the cask are necessary. The evaluation presented in Section 11.2.9 shows that for the design basis flood, the allowable stresses in the canister are not exceeded.

2.2.3 Seismic Design

An ISFSI site may be subject to seismic events (earthquakes) during its lifetime. The seismic response spectra experienced by the cask depends upon the geographical location of the specific site and the distance from the epicenter of the earthquake. The only significant effect of a seismic event on the vertical concrete cask is a possible tip-over or a collision of two casks. However, tip-over does not occur during the design basis earthquake. For sites not implementing a friction limitation, it is possible for two casks to collide due to sliding. Seismic response of the cask is presented in Section 11.2.8.

2.2.3.1 Input Criteria

The transportable storage canister and vertical concrete cask are designed and analyzed by applying a seismic acceleration or a maximum resultant horizontal planar velocity of the ISFSI pad.

2.2.3.2 Seismic - System Analyses

The analysis for the earthquake condition applied to nuclear facilities is provided in Section 11.2.8.2. Evaluations of the consequences of a hypothetical tip-over event or a collision of two vertical concrete casks are provided in Section 11.2.12.

handling and transfer. Transfer operations could include temporary holding of a loaded canister in the transfer cask to allow repair of a concrete cask, transfer of a canister from one concrete cask to another, or transfer from a concrete cask to a transport cask.

The design of the Canister Handling Facility would meet the requirements of the Universal Storage System described in Approved Contents and Design Features presented in Appendix B of the CoC Number 1015 Technical Specifications, in addition to those requirements established by the site.

The design, analysis, fabrication, operation and maintenance of the Canister Handling Facility would be performed in accordance with the quality assurance program requirements of the site general licensee, or the site-specific licensee of the ISFSI. The Canister Handling Facility would be classified as Important to Safety or Not Important to Safety in accordance with the guidelines of NUREG-6407.

Table 2.3-1 Safety Classification of Universal Storage System Components

Drawing No.	Description	Item No.	Component	Function	Safety Class
790-559	Assembly, Transfer Adapter	17	Cylinder Bolt	Operations	C
		15	Connector Body Bolt	Operations	C
		14	Wear Pad Bolt	Operations	NQ
		13	Wear Pad	Operations	NQ
		12	Connector Body	Operations	C
		10	Cylinder Nut	Operations	C
		8	Door Cylinder	Operations	C
		7	Lift Lug	Operations	C
		6	Support	Operations	C
		5	Side Shield	Operations	C
		3, 4	Door Rail	Operations	C
		2	Locating Ring	Operations	C
		1	Base Plate	Operations	C
790-560	Assembly, Transfer Cask	46	Dowel Pin	Operations	NQ
		45	Fill/Drain Line Pipe	Operations	C
		44	Fill/Drain Line Plate	Operations	C
		43	Shielding Ring	Shielding	B
		42	Transfer Adapter SHCS	Shielding	B
		41	Transfer Cask Extension	Shielding	B
		39	Connector	Operations	C
		38	Retaining Ring Bolt	Operations	B
		37	Scuff Plate	Operations	NQ
		36	Gamma Shield Brick	Shielding	B
		33-34	Neutron Shield Cover Plate	Operations	C
		28-32	Neutron Shield Boundary	Structural	C
		26-27	Bottom Plate	Structural	B
		25	Stainless Steel Sheet	Operations	NQ
		24	Paint	Operations	NQ

Chapter 4

Table 4.1-2 Summary of Thermal Design Conditions for Transfer

Condition[1,2]	Maximum Duration (Hours)[3]	
	PWR	BWR
Canister Filled with Water[4]	20	17
Vacuum Drying	27	25
Canister Filled with Helium	20	16

(1) The canister is inside the transfer cask, with an ambient temperature of 76°F.

(2) See Section 8.1 for description of limiting conditions.

(3) Maximum durations based on 23 kW heat load.

(4) The initial water temperature is considered to be 100°F.

Table 4.1-3 Maximum Allowable Material Temperatures

Material	Temperature Limits (°F)		Reference
	Long Term	Short Term	
Concrete	150(B)/200(L)(1)	350	ACI-349 [4]
Fuel Clad PWR Fuel (5-year cooled) BWR Fuel (5-year cooled)	 752 752	 752/1,058(2) 752/1,058(2)	 ISG-11 [38] and PNL-4835 [2]
Aluminum 6061-T651	650	750	MIL-HDBK-5G [7]
NS-4-FR	300	300	GESC [8]
Chemical Copper Lead	600	600	Baumeister [9]
SA693 17-4PH Type 630 Stainless Steel	650	800	ASME Code [13] ARMCO [11]
SA240 Type 304 Stainless Steel	800	800	ASME Code [13]
SA240 Type 304L Stainless Steel	800	800	ASME Code [13]
ASTM A533 Type B Carbon Steel	700	700	ASME Code [13]
ASME SA588 Carbon Steel	700	700	ASME Code Case N-71-17 [12]
ASTM A36 Carbon Steel	700	700	ASME Code Case N-71-17 [12]

(1) B and L refer to bulk temperatures and local temperatures, respectively. The local temperature allowable applies to a restricted region where the bulk temperature allowable may be exceeded.

(2) The temperature limit of the fuel cladding is 400°C (752°F) for storage (long-term) and transfer (short-term) conditions. The temperature limit of the fuel cladding is 570°C (1,058°F) for off-normal and accident (short-term) conditions.

Table 4.1-4 Summary of Thermal Evaluation Results for the Universal Storage System: PWR Fuel

Long-Term Condition:						
	Maximum Temperatures (°F)					
Design Condition	Concrete Bulk	Concrete Local	Heat Transfer Disks	Support Disks(1)	Canister(2)	Fuel Clad
Normal (76°F Ambient)	135	186	599	601	351	648
Allowable	150	200	650	650	800	752

Short-Term Condition:					
	Maximum Temperatures (°F)				
Design Condition	Concrete	Heat Transfer Disks	Support Disks (1)	Canister(2)	Fuel Clad
Off-Normal - Half Inlets Blocked (76°F Ambient)	191	600	603	350	649
Off-Normal - Severe Heat (106°F Ambient)	228	626	628	381	672
Off-Normal - Severe Cold (-40°F Ambient	17	502	505	226	561
Accident - Extreme Heat (133°F Ambient)	262	648	650	408	693
Accident - Fire	244	639	641	391	688
Allowable	350	750	800	800	1058
	Maximum Temperatures (°F)				
Transfer - Vacuum Drying	N/A	641	644	304	732
Transfer - Backfilled with Helium	N/A	680	683	455	732
Allowable	350	750	800	800	752

1. SA 693, 17-4PH Type 630 SS.
2. SA240, Type 304L SS (including canister shell, lid and bottom plate).

Table 4.1-5 Summary of Thermal Evaluation Results for the Universal Storage System: BWR Fuel

Long-Term Condition:						
	Maximum Temperatures (°F)					
	Concrete		Heat Transfer	Support		
Design Condition	Bulk	Local	Disks	Disks[1]	Canister[2]	Fuel Clad
Normal (76°F Ambient)	136	192	612	614	376	642
Allowable	150	200	650	700	800	752

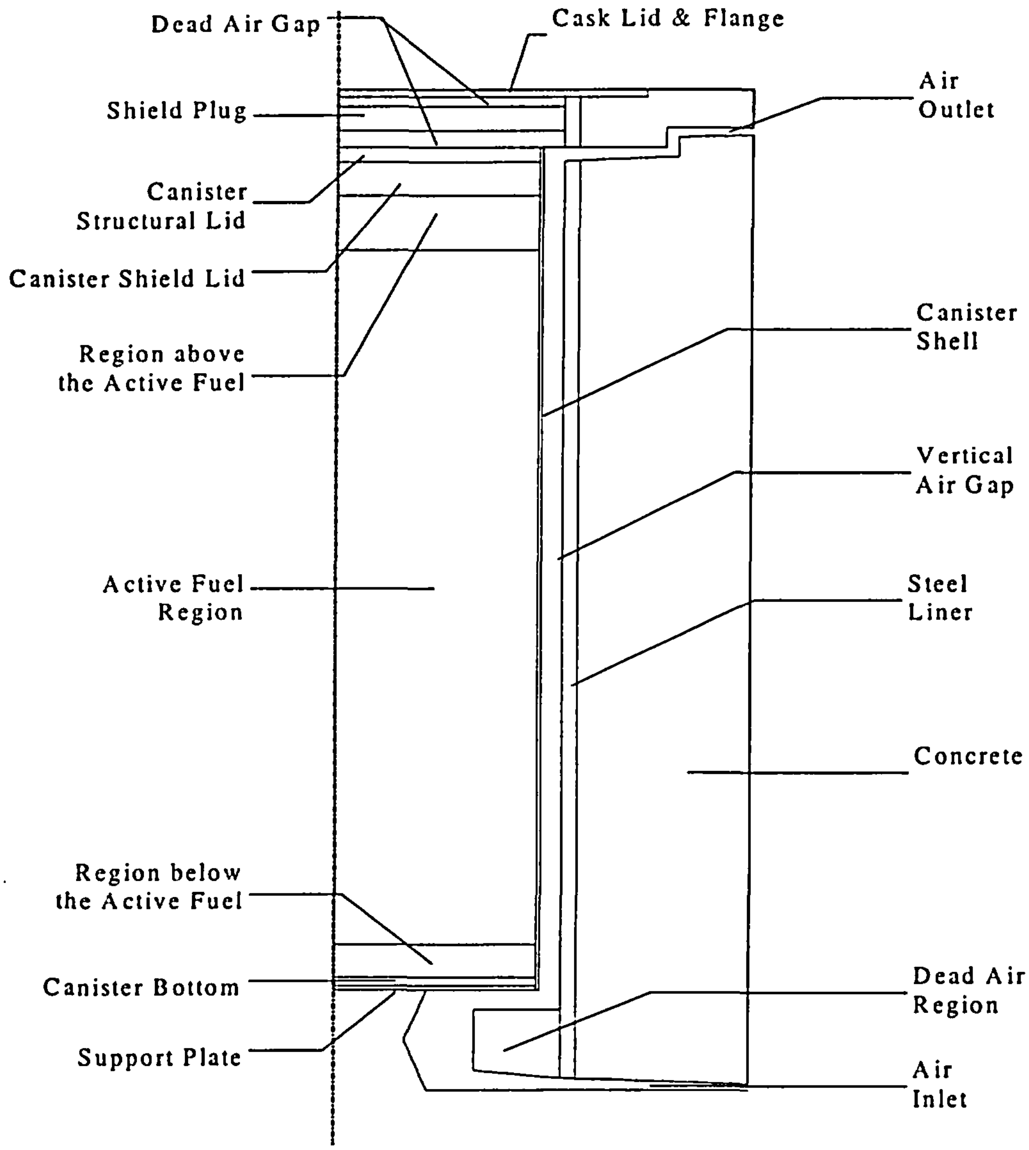
Short-Term Condition:					
	Maximum Temperatures (°F)				
Design Condition	Concrete	Heat Transfer Disks	Support Disks[1]	Canister[2]	Fuel Clad
Off-Normal - Half Inlets Blocked (76°F Ambient)	195	612	614	373	642
Off-Normal - Severe Heat (106°F Ambient)	231	638	640	405	667
Off-Normal - Severe Cold (-40°F Ambient)	20	504	505	252	540
Accident - Extreme Heat (133°F Ambient)	266	662	664	432	690
Accident - Fire	244	652	654	416	682
Allowable	350	750	700	800	1058
	Maximum Temperatures (°F)				
Transfer - Vacuum Drying	N/A	653	659	267	733
Transfer - Backfilled with Helium	N/A	683	686	462	733
Allowable	350	750	700	800	752

1. SA 533, Type B, CS.
2. SA240, Type 304L SS (including canister shell, lid and bottom plate).

Off-Center Canister Evaluation

The analysis assumes that the canister is centered in the concrete cask. However, the potential exists for the canister to be placed off-center when it is installed in the storage cask. The support ring may be used to aid in centering the canister during the lowering of the canister into the concrete cask. The final placement of the canister shall not be closer than one inch to the concrete cask liner. This placement reduces the area of the air flow path in an arc established by the canister shell and concrete cask liner. An air flow analysis is performed to evaluate the effects of the off-center positioning of the canister. The analysis results show an increase in air mass flow rate occurs in the annulus, which results in a temperature reduction in the canister shell and concrete cask liner. Consequently, the off-center canister placement condition is bounded by the condition that the canister is at the center of the concrete cask, as considered in the two-dimensional axisymmetric finite element model described in this section.

Figure 4.4.1.1-1 Two-Dimensional Axisymmetric Air Flow and Concrete Cask Model: PWR



4.4.1.3 Three-Dimensional Transfer Cask and Canister Models

The three-dimensional quarter-symmetry transfer cask model is a representation of the PWR canister and transfer cask assembly. A half-symmetry model is used for the BWR canister and transfer cask. The model is used to perform a transient thermal analysis to determine the maximum water temperature in the canister for the period beginning immediately after removing the transfer cask and canister from the spent fuel pool. The model is also used to calculate the maximum temperature of the fuel cladding, the transfer cask and canister components during the vacuum drying condition and after the canister is backfilled with helium. The transfer cask is evaluated separately for PWR or BWR fuel using two models. For each fuel type, the class of fuel with the shortest associated canister and transfer cask is modeled in order to maximize the contents heat generation rate per unit volume and minimize the heat rejection from the external surfaces. The models for PWR and BWR fuel are shown in Figures 4.4.1.3-1 and 4.4.1.3-2, respectively. ANSYS SOLID70 three-dimensional conduction elements, LINK31 (PWR model) and MATRIX50 (BWR model) radiation elements are used. The model includes the transfer cask and the canister and its internals. The details of the canister and contents are modeled using the same methodology as that presented in Section 4.4.1.2 (Three-Dimensional Canister Models). Effective thermal properties for the fuel regions and the fuel tube regions are established using the fuel models and fuel tube models presented in Sections 4.4.1.5 and 4.4.1.6, respectively. The effective specific heat and density are calculated on the basis of material mass and volume ratio, respectively.

Radiation across the gaps was represented by the LINK31 elements or the MATRIX50 elements, which used the gray body emissivities for stainless and carbon steels. Convection is considered at the top of the canister lid, the exterior surfaces of the transfer cask, as well as at the annulus between the canister and the inner surface of the transfer cask. The combination of radiation and convection at the transfer cask exterior vertical surfaces and canister lid top surface is taken into account in the model using the same method described in Section 4.4.1.2 for the three-dimensional canister models. The bottom of the transfer cask is modeled as being in contact with the concrete floor. In the PWR configuration analysis, for the condition when the canister is filled with water at the start of the transfer operation, natural circulation of the water is taken into account by adjusting the effective conductivities in the fuel and water regions based on a classical energy balance calculation of the canister contents. Water circulation is not considered in the BWR configuration analysis. Volumetric heat generation (Btu/hr-in^3) is applied to the active fuel region based on a total heat load of 23 kW for both PWR and BWR fuel. The model considers the active fuel length of 144 inches and an axial power distribution, as shown in Figures 4.4.1.1-3 and 4.4.1.1-4 for PWR and BWR fuel, respectively.

An initial temperature of 100°F is considered in the entire model on the basis of the typical average water temperature in a spent fuel pool. For the design basis heat loads, the thermal transient analysis is performed for 20 hours (PWR) and 17 hours (BWR) with the water inside the canister, 27 hours (PWR) and 25 hours (BWR) for the vacuum condition, and 20 hours (PWR) and 16 hours (BWR) for the helium condition, followed by a steady-state analysis (in helium condition). Different time durations are used for the transient analyses for the reduced heat load cases, as specified in Section 4.4.3.1. The temperature history of the fuel cladding and the basket components, as well as the transfer cask components, is determined and compared with the short-term temperature limits presented in Tables 4.4.3-3 and 4.4.3-4.

Note that the first phase of the thermal transient analysis considers that the canister is filled with water, including the period of canister draining as described in Step 12 of Section 8.1.1. A typical transportable storage canister drain-down process (performed by suction or by a blow-down gas pressure) ranges from 1 to 2 hours. The thermal analysis basis of assuming a water condition during drain-down is acceptable due to the following conservatisms in the thermal transient analysis for the transfer operation:

(1) The system as analyzed does not include the rejection of heat from the system due to the removal of water, which has significant thermal capacitance;

(2) The energy absorbed by the change in the state of residual water to steam, as the pressure is reduced during the vacuum drying phase of the transient, is ignored in the analysis; and

(3) No contact is considered between components in the transportable storage canister in the thermal model.

Figure 4.4.3-8 BWR Fuel Basket Location Numbers

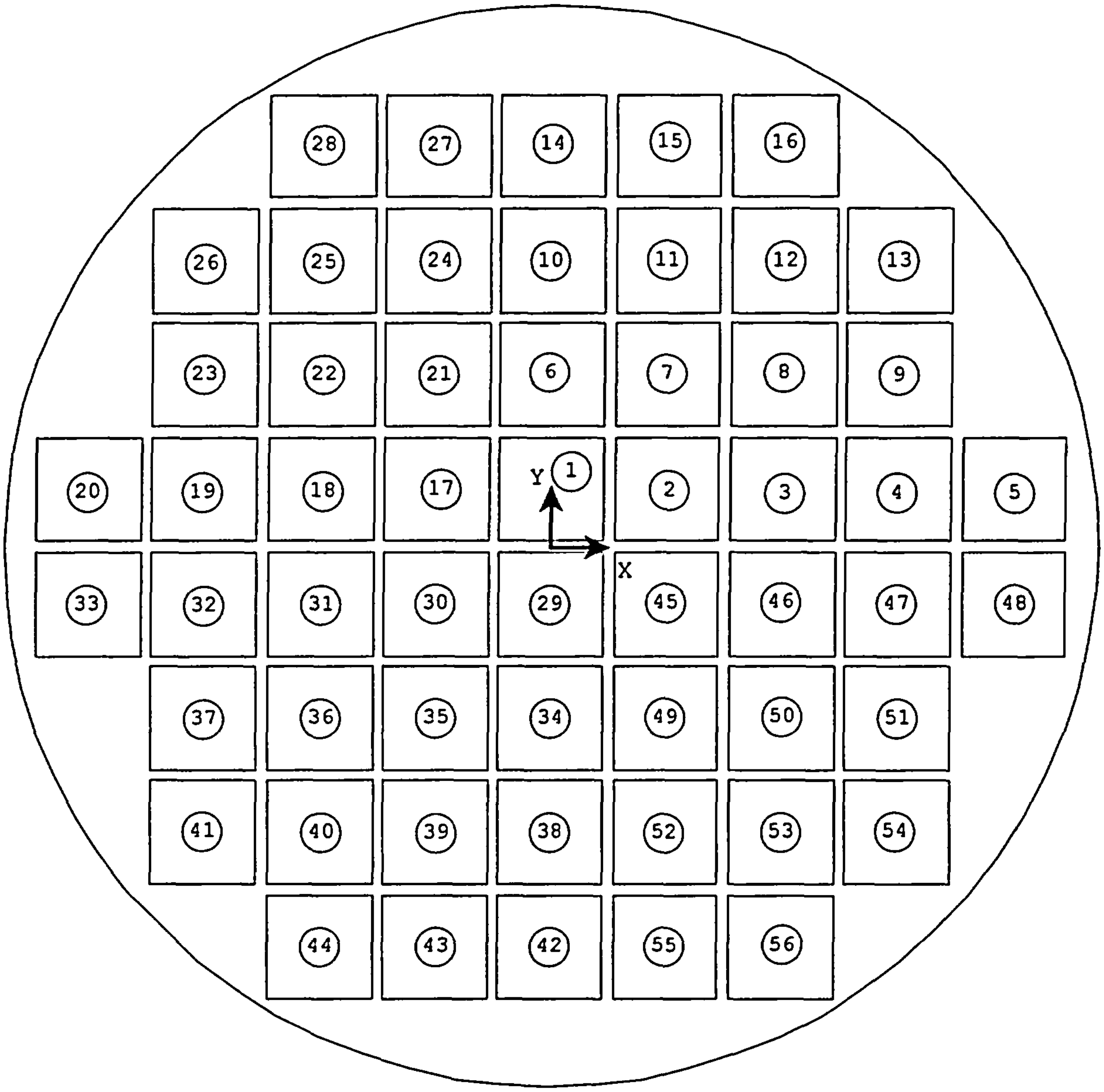


Table 4.4.3-1 Maximum Component Temperatures for the Normal Storage Condition - PWR

Component	Maximum Temperature (°F)	Allowable Temperatures (°F)
Fuel Cladding	648	752
Heat Transfer Disk	599	650
Support Disk	601	650
Top Weldment	399	800
Bottom Weldment	159	800
Canister Shell	351	800
Canister Structural Lid	204	800
Canister Shield Lid	212	800
Concrete	186 (local) 135 (bulk*)	200 (local) 150 (bulk)

* The volume average temperature of the concrete region is used as the bulk concrete temperature.

Table 4.4.3-2 Maximum Component Temperatures for the Normal Storage Condition - BWR

Component	Maximum Temperature (°F)	Allowable Temperatures (°F)
Fuel Cladding	642	752
Heat Transfer Disk	612	650
Support Disk	614	700
Top Weldment	361	800
Bottom Weldment	276	800
Canister Shell	376	800
Canister Structural Lid	180	800
Canister Shield Lid	185	800
Concrete	192 (local) 136 (bulk*)	200 (local) 150 (bulk)

*The volume average temperature of the concrete region is used as the bulk concrete temperature.

Table 4.4.3-3 Maximum Component Temperatures for the Transfer Condition – PWR Fuel with Design Basis 23 kW Uniformly Distributed Heat Load

Component	Maximum Temperature (°F)		Allowable Temperature (°F)
	Vacuum[1]	Helium[1]	
Fuel	724	724	752
Lead	151	271	600
Neutron Shield	149	267	300
Heat Transfer Disk	641	680	750
Support Disk	644	683	800
Canister	304	455	800
Transfer Cask Shells	168	300	700

1. See Figure 4.4.3-5 for history of maximum component temperatures.

Table 4.4.3-4 Maximum Component Temperatures for the Transfer Condition – BWR Fuel with Design Basis 23 kW Uniformly Distributed Heat Load

Component	Maximum Temperature (°F)		Allowable Temperature (°F)
	Vacuum[1]	Helium[1]	
Fuel	703	708	752
Lead	137	252	600
Neutron Shield	135	249	300
Heat Transfer Disk	645	683	750
Support Disk	646	686	700
Canister	267	462	800
Transfer Cask Shells	153	286	700

1. See Figure 4.4.3-6 for history of maximum component temperatures.

4.4.5 Maximum Internal Pressures

The maximum internal operating pressures for normal conditions of storage are calculated in the following sections for the PWR and BWR Transportable Storage Canisters.

4.4.5.1 Maximum Internal Pressure for PWR Fuel Canister

The internal pressures within the PWR fuel canister are a function of fuel type, fuel condition (failure fraction), burnup, UMS® canister type, and the backfill gases in the canister cavity. Gases included in the canister pressure evaluation include rod-fill, rod fission and rod backfill gases, canister backfill gases and burnable poison generated gases. Each of the fuel types expected to be loaded into the UMS® canister system is separately evaluated to arrive at a bounding canister pressure.

Fission gases include all fuel material generated gases including long-term actinide decay generated helium. Based on detailed SAS2H calculations of the maximum fissile material mass assemblies in each canister class, the quantity of gas generated by the fuel rods rises as burnup and cool time is increased and enrichment is decreased. To assure the maximum gas is available for release, the PWR inventories are extracted from 60,000 MWD/MTU burnup cases at an enrichment of 1.9 wt. % ^{235}U and a cool time of 40 years. Gas inventories at 60,000 MWD/MTU bound those calculated at 45,000 MWD/MTU, the maximum allowable burnup. Gases included are all krypton, iodine, and xenon isotopes in addition to helium and tritium (^{3}H). Molar quantities for each of the maximum fissile mass assemblies are summarized in Table 4.4.5-1. Fuel generated gases are scaled by fissile mass to arrive at molar contents of other UMS® fuel types.

Fuel rod backfill pressure varies significantly between the PWR fuel types. The maximum reported backfill pressure is listed for the Westinghouse 17×17 fuel assembly at 500 psig. With the exception of the B&W fuel assemblies, which are limited to 435 psig, all fuel assemblies evaluated are set to the maximum 500 psig backfill reported for the Westinghouse assembly. Backfill quantities are based on the free volume between the pellet and the clad and the plenum volume. The fuel rod backfill gas temperature is conservatively assumed to have an initial temperature of 68°F.

Burnable poison rod assemblies (BPRAs) placed within the UMS® storage canister may contribute additional molar gas quantities due to (n,alpha) reactions of fission generated neutrons with ^{10}B during in-core operation. ^{10}B forms the basis of a portion of the neutron poison population. Other neutron poisons, such as gadolinium and erbium, do not produce a significant amount of helium nuclides (alpha particles) as part of their activation chain. Primary BPRAs in existence include Westinghouse Pyrex (borosilicate glass) and WABA (wet annular burnable absorber) configurations, as well as B&W BPRAs and shim rods employed in CE cores. The CE shim rods replace standard fuel rods to form a complete assembly array. The quantity of helium available for release from the BPRAs is directly related to the initial boron content of the rods and the release fraction of gas from the matrix material in question. Release from either of the low temperature, solid matrix materials is likely to be limited, but no release fractions were available in open literature. As such, a 100% release fraction is assumed based on a boron content of 0.0063 g/cm ^{10}B per rod, with the maximum number of rods per assembly. The maximum number of rods is 16 for Westinghouse core 14×14 assemblies, 20 rods for Westinghouse and B&W 15×15 assemblies, and 24 rods for Westinghouse and B&W 17×17 assemblies. The length of the absorber is conservatively taken as the active fuel length. CE core shim rods are modeled at 0.0126 g/cm ^{10}B for 16, 12, and 12 rods applied to CE manufactured 14×14, 15×15 and 16×16 cores, respectively.

The canister backfill gases are conservatively assumed to be at 250°F, which is significantly below the canister shell maximum initial temperature of 304°F at the end of vacuum drying. The initial pressure of the canister backfill gas is 1 atm (0.0 psig). Free volume inside each PWR canister class is listed in Table 4.4.5-2. The listed free volumes do not include fuel assembly components since these components vary for each assembly type and fuel insert. Subtracting out the rod and guide tube volumes and all hardware components arrives at free volume of the canisters including fuel assemblies and a load of 24 BPRAs. For the Westinghouse BPRAs, the Pyrex volume is employed since it displaces more volume than the WABA rods.

The total pressure for each of the UMS® payloads is found by calculating the releasable molar quantity of each gas (30% of the fission gas and 100% of the rod backfill adjusted for the 1% fuel failure fraction), and summing the quantities directly. The quantity of gas is then employed in the ideal gas equation in conjunction with the average gas temperature at normal operating conditions to arrive at system pressures. The normal system pressure calculation for maximum system pressure limits assumes the average PWR gas temperature to be 420°F. The actual calculated gas temperature determined by the three-dimensional canister model is 421°F for the normal storage condition. The 1°F temperature difference has an insignificant effect on the system pressure calculation. Each of the UMS® PWR fuel types is individually evaluated for normal condition pressure, and sets the maximum normal condition pressure at 4.21 psig. A summary of the maximum pressure in each PWR canister class is shown in Table 4.4.5-3. The table also includes the fuel type producing the listed maximum pressures.

4.4.5.2 Maximum Internal Pressure for BWR Fuel Canister

BWR canister maximum pressures are determined in the same manner as those documented for the PWR canister cases. Primary differences between PWR and BWR analysis include a maximum normal condition average gas temperature of 410°F, rod backfill gas pressures of 132 psig, and limits pressurizing gases to fission gases (including helium actinide decay gas), rod backfill gases, and canister backfill gas. The 132 psig employed in this analysis is significantly higher than the 6 atmosphere maximum pressure reported in open literature. BWR assemblies do not contain an equivalent to the PWR BPRAs and, therefore, do not require ^{10}B helium generated gases to be added. Fissile gas inventories for the maximum fissile material assemblies in each of the three BWR lattices configurations (7×7, 8×8, and 9×9) are shown in Table 4.4.5-4. Free volumes, without fuel components, in UMS® canister classes 4 and 5 are shown in Table 4.4.5-5. Maximum pressures for each canister class are listed in Table 4.4.5-6. The maximum normal condition pressure of 3.97 psig is based on a GE 7×7 assembly, designed for a BWR/2-3 reactor, with gas inventories conservatively taken from a 60,000 MWD/MTU source term. The normal condition pressure for a UMS® storage canister containing the GE 9×9 fuel assembly with 79 fuel rods is 3.96 psig. Similar fuel masses and displaced volume account for similar canister pressures.

Table 4.4.5-1 PWR Per Assembly Fuel Generated Gas Inventory

Array	Assy Type	MTU	Moles
14×14	WE Standard	0.4144	35.52
15×15	B&W	0.4807	41.32
16×16	CE (System 80)	0.4417	38.10
17×17	WE Standard	0.4671	40.18

Table 4.4.5-2 PWR Canister Free Volume (No Fuel or Inserts)

Canister Class	1	2	3
Basket Volume (in^3)	69800	74490	77460
Canister Height (inch)	175.05	184.15	191.75
Canister Free Volume w/o Fuel (liter)	7970	8400	8770

Table 4.4.5-3 PWR Maximum Normal Condition Pressure Summary

Canister Class	Fuel Type	Pressure (psig)
Class 1	WE 17×17 Standard	4.20
Class 2	B&W 17×17 Mark C	4.21
Class 3	CE 16×16 System 80	4.11

4.5 Thermal Evaluation for Site Specific Spent Fuel

This section presents the thermal evaluation of fuel assemblies or configurations, which are unique to specific reactor sites or which differ from the UMS® Storage System design basis fuel. These site specific configurations result from conditions that occurred during reactor operations, participation in research and development programs, and from testing programs intended to improve reactor operations. Site specific fuel includes fuel assemblies that are uniquely designed to accommodate reactor physics, such as axial fuel blanket and variable enrichment assemblies, and fuel that is classified as damaged. Damaged fuel includes fuel rods with cladding that exhibit defects greater than pinhole leaks or hairline cracks.

Site specific fuel assembly configurations are either shown to be bounded by the analysis of the standard design basis fuel assembly configuration of the same type (PWR or BWR), or are shown to be acceptable contents by specific evaluation.

4.5.1 Maine Yankee Site Specific Spent Fuel

The standard spent fuel assembly for the Maine Yankee site is the Combustion Engineering (CE) 14×14 fuel assembly. Fuel of the same design has also been supplied by Westinghouse and by Exxon. The standard 14×14 fuel assembly is included in the population of the design basis PWR fuel assemblies for the UMS® Storage System (See Table 2.1.1-1). The maximum decay heat for the standard Maine Yankee fuel is the design basis heat load for the PWR fuels (23 kW total, or 0.958 kW per assembly). This heat load is bounded by the thermal evaluations in Section 4.4 for the normal conditions of storage, Section 4.4.3.1 for less than design basis heat loads and Chapter 11 for off-normal and accident conditions.

Some Maine Yankee site specific fuel has a burnup greater than 45,000 MWD/MTU, but less than 50,000 MWD/MTU. As shown in Table B2-6 in Appendix B of the CoC Number 1015 Technical Specifications, loading of fuel assemblies in this burnup range is subject to preferential loading in designated basket positions in the Transportable Storage Canister. Certain fuel assemblies in this burnup range must be loaded in one of the two configurations of the Maine Yankee Fuel Can.

The site specific fuels included in this evaluation are:

1. Consolidated fuel rod lattices consisting of a 17 × 17 lattice fabricated with 17 × 17 grids, 4 stainless steel support rods and stainless steel end fittings. One of these

lattices contains 283 fuel rods and 2 rod position vacancies. The other contains 172 fuel rods, with the remaining rod position locations either empty or containing stainless steel dummy rods.

2. Standard fuel assemblies with a Control Element Assembly (CEA) inserted in each one.
3. Standard fuel assemblies that have been modified by removing damaged fuel rods and replacing them with stainless steel dummy rods, solid zirconium rods, or 1.95 wt % enriched fuel rods.
4. Standard fuel assemblies that have had the burnable poison rods removed and replaced with hollow zirconium alloy tubes.
5. Standard fuel assemblies with in-core instrument thimbles stored in the center guide tube.
6. Standard fuel assemblies that are designed with variable enrichment (radial) and axial blankets.
7. Standard fuel assemblies that have some fuel rods removed.
8. Standard fuel assemblies that have damaged fuel rods.
9. Standard fuel assemblies that have some type of damage or physical alteration to the cage (fuel rods are not damaged).
10. Two (2) rod holders, designated CF1 and CA3. CF1 is a lattice having approximately the same dimensions as a standard fuel assembly. It is a 9x9 array of tubes, some of which contain damaged fuel rods. CA3 is a previously used fuel assembly lattice that has had all of the rods removed, and in which damaged fuel rods have been inserted.
11. Standard fuel assemblies that have damaged fuel rods stored in their guide tubes.
12. Standard fuel assemblies with inserted startup sources and other non-fuel items.

The Maine Yankee site specific fuels are also described in Section 1.3.2.1.

The thermal evaluations of these site specific fuels are provided in Section 4.5.1.1. Section 4.5.1.2 presents the evaluation of the Maine Yankee preferential loading of fuel exceeding the design basis heat load (0.958 kW) per assembly on the basket periphery.

Chapter 6

6.0 CRITICALITY EVALUATION

This chapter documents the criticality evaluation of the Universal Storage System with either PWR or BWR contents. The results demonstrate that the effective neutron multiplication factor, k_{eff}, of the Universal Storage System under normal, off-normal, and accident conditions, is less than 0.95 including biases and uncertainties. The system design therefore meets the criticality requirements of 10 CFR 72.124(a) [1], 10 CFR 72.236(c), and Chapter 6 of NUREG-1536 [2].

6.1 Discussion and Results

The Universal Storage System consists of a Transportable Storage Canister, a transfer cask and a Vertical Concrete Cask. The system is designed to safely store up to 24 intact PWR fuel assemblies or 56 intact BWR fuel assemblies. Maximum initial enrichment for each PWR and BWR fuel assembly grouping, as a function of the assemblies' key parameters, is shown in Tables 6.1-1 and 6.1-2. For PWR fuel assemblies, the maximum allowable enrichment ranges from 4.2 wt. % to 5.0 wt. % without any soluble boron. With at least 1000 ppm of soluble boron, the maximum allowable enrichment is 5.0 wt. % for all PWR assemblies. Maximum initial enrichment is defined as peak rod enrichment for PWR assemblies and the maximum initial peak planar-average enrichment for BWR assemblies. The maximum initial peak planar-average enrichment is the maximum planar-average enrichment at any height along the axis of the fuel assembly. For BWR fuel assemblies, the maximum enrichment allowed ranges from 4.4 wt. % to 4.8 wt. %.

Primarily on the basis of their lengths and cross-sections, the fuel assemblies are categorized into classes. Three classes of PWR fuel assemblies and two classes of BWR fuel assemblies are evaluated for storage. Five Transportable Storage Canister assemblies of different lengths and configuration are designed to store the three classes of PWR fuel assemblies and the two classes of BWR fuel assemblies. The canister is comprised of a stainless steel canister and a fuel basket within which fuel is loaded. The canister is loaded into the Vertical Concrete Cask for storage. The length of the Vertical Concrete Cask also varies depending upon the type of the canister it is designed to store.

A transfer cask is used for handling the canister during loading of spent fuel. Fuel is loaded into the canister contained within the transfer cask underwater in the spent fuel pool. Once loaded with fuel, the canister is drained, dried, inerted, and welded shut. The transfer cask is then used to transfer the canister into and out of the concrete cask or shipping cask. The transfer cask provides shielding during the canister loading and transfer operations.

The PWR transfer cask is designed in two configurations, standard and advanced. The advanced design is identical to the standard design with the exception of a trunnion support plate. This plate has no impact on system reactivity. Therefore, all analysis of the standard transfer cask applies to the advanced transfer cask.

Under normal conditions, such as loading in a spent fuel pool, moderator (water) is present in the canister while it is in the transfer cask. Also, during draining and drying operations, moderator with varying density is present. Thus, the criticality evaluation of the transfer cask includes a variation in moderator density and a determination of optimum moderator density. Off-normal and accident conditions are bounded by assuming the most reactive mechanical basket configuration as well as moderator intrusion into the fuel cladding (i.e., 100% fuel failure).

Under normal and accident conditions, moderator is not present in the canister while it is in the concrete cask. However, access to the environment is possible via the air inlets in the concrete cask and the convective heat transfer annulus between the canister and the cask steel liner. This access provides paths for moderator intrusion during a flood. Under off-normal conditions, moderator intrusion into the convective heat transfer annulus is evaluated. For the initial evaluation without soluble boron credit, under hypothetical accident conditions, it is assumed that the canister confinement fails, and moderator intrusion into the canister and into the fuel cladding (100% fuel failure) is evaluated. This is a conservative assumption, since normal, off-normal and design basis accident analysis shows that the confinement boundary remains intact. Therefore, there are no circumstances under which there would be water in the canister. In the PWR soluble boron evaluation, credit is taken for the dry canister. For this configuration, a wet transfer cask containing a canister filled with a water/soluble boron mixture and a dry canister in a concrete cask are assumed.

Criticality control in the PWR basket is achieved by using a flux trap, or a combination flux trap and soluble neutron absorber (boron). Individual fuel assemblies are held in place by fuel tubes surrounded by four neutron absorber sheets. The neutron absorber modeled is a borated aluminum neutron absorber. Any similar material meeting the ^{10}B areal density and physical dimension requirement will produce similar reactivity results. A stainless steel cover holds the neutron absorber sheets in place. The fuel tubes are separated by a gap that is filled with water when the canister is flooded. Fast neutrons escaping one fuel assembly are moderated in the water gap and are absorbed by the neutron absorber between the assemblies before they can cause a fission in the adjacent assembly. The flux trap gap spacing is maintained by the basket's stainless steel support disks, which separate individual fuel assembly tubes. Alternating stainless steel disks and aluminum heat transfer disks are placed axially at intervals determined by thermal and structural constraints. The PWR basket design includes 30, 32, or 34 support disks and 29, 31, or 33 heat transfer disks, respectively. The minimum loading of the neutron absorber sheets

6.2 Spent Fuel Loading

The Universal Storage System is designed to store Transportable Storage Canisters containing spent nuclear fuel. Canisters of five different lengths are designed, each to accommodate one of three classes of PWR fuel assemblies or one of two classes of BWR fuel assemblies. The classification of the fuel assemblies is based primarily on fuel assembly length and cross-section. The classes of major fuel assemblies to be stored in the Universal Storage System and their characteristics are shown in Tables 6.2-1 (PWR) and 6.2-2 (BWR). Sections 6.4.5 and 6.4.6 extend the evaluation of the single PWR (4.2 wt. % ^{235}U) and BWR (4.0 wt. % ^{235}U) maximum initial enrichments to an assembly-specific maximum initial enrichment. The enrichments represent maximum planar average enrichment for BWR assemblies and peak fuel rod enrichments for PWR assemblies. Tables 6.2-1 and 6.2-2 include a column containing an identifier linking each of the listed assembly types to the allowable maximum initial enrichment searches in Sections 6.4.5 and 6.4.6.

Class 1 Westinghouse fuel assemblies and Class 2 B&W fuel assemblies include inserts. Fuel assembly inserts are nonfuel-bearing components, such as flow mixers, in-core instrument thimbles, burnable poison rods or solid stainless steel rods. These components are inserted into the fuel assembly guide tubes. The criticality analyses do not take credit for displacement of moderator by the inserts. For the unborated moderator analyses, insertion of an in-core instrument thimble, a burnable poison rod assembly or a solid stainless steel rod reduces reactivity by further decreasing the (unborated) moderator to fuel ratio in the fuel assembly lattice. For the analyses that take credit for soluble boron in the moderator, insertion of an in-core instrument thimble, a burnable poison rod assembly or a solid stainless steel rod would displace boron for which credit is taken. Therefore, a burnable poison rod assembly, an in-core instrument thimble or a solid stainless steel rod insert shall only be loaded into an assembly that does not require credit to be taken for soluble boron in the moderator in order to meet the assembly enrichment limit. Insertion of a flow mixer is not restricted, as this component does not displace moderator in the active fuel region.

To preclude a potential increase in reactivity as a result of empty fuel rod positions in the assembly, any empty fuel rod position is to be filled with a solid filler rod. Filler rods may be fabricated from either solid zirconium alloy or solid Type 304 stainless steel, or may be solid neutron absorber rods inserted for in-core reactivity control prior to reactor operations.

Table 6.2-1 PWR Fuel Assembly Characteristics (Zirc-4 Clad)

Fuel Class	Vendor	Array	Version	Max MTU	No of Fuel Rods	Pitch (in)	Rod Dia. (in)	Clad Thick (in)	Pellet Dia (in)	Active Length (in)	ID
1	CE	14 x 14	Std.	0.4037	176	0.5800	0.440	0.0280	0.3765	137.0	ce14a
1	CE	14 x 14	Ft Cal.	0.3772	176	0.5800	0.440	0.0280	0.3765	128.0	ce14a
1	CE	15 x 15	Palis.	0.4317	216	0.5500	0.418	0.0260	0.3580	132.0	—[1]
1	CE	16 x 16	Lucie 2	0.4025	236	0.5060	0.382	0.0250	0.3250	136.7	ce16d
1	Ex/ANF	14 x 14	WE	0.3689	179	0.5560	0.424	0.0300	0.3505	142.0	ex14a
1	Ex/ANF	14 x 14	CE	0.3814	176	0.5800	0.440	0.0310	0.3700	134.0	ce14a
1	Ex/ANF	14 x 14	Praire Isl.	0.3741	179	0.5560	0.417	0.0300	0.3505	144.0	—[1]
1	Ex/ANF	15 x 15	WE	0.4410	204	0.5630	0.424	0.0300	0.3565	144.0	ex15a
1	Ex/ANF	15 x 15	Palis	0.4310	216	0.5500	0.417	0.0300	0.3580	131.8	—[1]
1	Ex/ANF	17 x 17	WE	0.4123	264	0.4960	0.360	0.0250	0.3030	144.0	ex17a
1	WE	14 x 14	Std/ZCA	0.4144	179	0.5560	0.422	0.0225	0.3674	145.2	we14a
1	WE	14 x 14	OFA	0.3612	179	0.5560	0.400	0.0243	0.3444	144.0	we14b
1	WE	14 x 14	Std/ZCB	0.4144	179	0.5560	0.422	0.0225	0.3674	145.2	we14a
1	WE	14 x 14	CE Model	0.4115	176	0.5800	0.440	0.0260	0.3805	136.7	we14d
1	WE	15 x 15	Std	0.4646	204	0.5630	0.422	0.0242	0.3659	144.0	we15a
1	WE	15 x 15	Std/ZC	0.4646	204	0.5630	0.422	0.0242	0.3659	144.0	we15a
1	WE	15 x 15	OFA	0.4646	204	0.5630	0.422	0.0242	0.3659	144.0	we15a
1	WE	17 x 17	Std	0.4671	264	0.4960	0.374	0.0225	0.3225	144.0	we17a
1	WE	17 x 17	OFA	0.4282	264	0.4960	0.360	0.0225	0.3088	144.0	we17b
1	WE	17 x 17	Vant 5	0.4282	264	0.4960	0.360	0.0225	0.3088	144.0	we17b
2	B&W	15 x 15	Mark B	0.4807	208	0.5680	0.430	0.0265	0.3686	144.0	bw15a
2	B&W	15 x 15	Mark BZ	0.4807	208	0.5680	0.430	0.0265	0.3686	144.0	bw15a
2	B&W	17 x 17	Mark C	0.4658	264	0.5020	0.379	0.0240	0.3232	143.0	bw17a
3	CE	16 x 16	Sono 2&3	0.4417	236	0.5060	0.382	0.0230	0.3255	150.0	ce16e
3	CE	16 x 16	ANO2	0.4417	236	0.5060	0.382	0.0230	0.3255	150.0	ce16e
3	CE	16 x 16	SYS80	0.4417	236	0.5060	0.382	0.0230	0.3255	150.0	ce16e

1. These site specific fuels were not re-evaluated and remain at a maximum initial enrichment of 4.2 wt% ^{235}U.

6.3.2 Model Assumptions

Assumptions for the basket model are as follows.

- The fuel assembly is modeled at a fuel density of 95% theoretical (0.95×10.96 gm/cm^2 = 10.412 g/cm^2).

- Baseline enrichment for the PWR fuel assembly is 4.2 wt % ^{235}U. The PWR fuel assembly included in this model is the Westinghouse 17×17 OFA fuel assembly which is determined to be the most reactive assembly in the PWR basket (see Section 6.4.1.2.1). The most reactive BWR fuel assembly included in this model is the Ex/ANF 9×9 fuel assembly with an enrichment of 4.00 wt % ^{235}U (see Section 6.4.1.2.2). BWR analysis of heterogeneous versus homogeneous pin enrichment shows that assuming a homogeneous enrichment produces conservative k_{eff} values in the BWR canister (see section 6.4.1.3.2). Homogeneous enrichment is defined to be a planar-average enrichment.

- With the exception of the fuel assembly channels in the BWR case, no fuel assembly structural materials (e.g., spacer grids, thimble plugs, burnable poison rod inserts or solid stainless steel rod inserts as applicable to PWR/BWR fuel types) are included in the active fuel region. Eliminating the structural materials simplifies model construction significantly. Removing parasitic absorbers and increasing the effective H/U ratio in the normally under-moderated assembly increases reactivity. Evaluation of the reactivity impact for a variety of channel dimensions in the BWR most reactive assembly analysis demonstrates that the impact of the channel material on cask criticality is not statistically significant. Removal of the channel on the most reactive assembly (Ex/ANF 9×9) results in k_{eff} decrease of 0.001 from 0.872 to 0.871 with a Monte Carlo uncertainty of 0.001.

- Fuel assembly neutron poisons, e.g., gadolinium rods (BWR), are excluded from the analysis, thereby substantially increasing assembly reactivity of the unburned assembly.

- Fuel assembly cladding is intact. For normal operating conditions, no water is present in the gap between fuel pellet and clad. For hypothetical accident conditions, water is assumed to be present in the pellet-to-clad gap. Because the canister is shown not to fail structurally under normal or accident conditions and the presence of water in the pellet-to-clad gap requires failure of the sealed canister and the fuel, the assumption of water in the pellet-to-clad gap for accident analysis is extremely conservative.

- The moderator is assumed to be pure water (no soluble boron) at standard temperature and pressure (293K and 0.9982 gm/cm^3) or water containing soluble boron at 1000 ppm. The density of 0.9982 gm/cm^3 corresponds to a relative density in SCALE's Material Information Processor of 1.0. The fuel, cladding and other structural materials are assumed to be at 293K.

- The models for all analyses are axially infinite, i.e., no axial leakage. The BWR basket design contains fuel elevations with and without heat transfer disks. The axially infinite length basket model relies on the basket elevation containing the aluminum heat transfer disk. Criticality control in both PWR and BWR baskets is by neutron absorber plate. The neutron absorber plates contain ^{10}B as a neutron absorber, which requires thermalization of the neutrons prior to capture. Modeling the basket elevation containing the heat transfer disk displaces water required for neutrons to be thermalized prior to reaching the neutron absorber plate and, therefore, increases the reactivity of the system.

- ^{10}B density is reduced to 75% in accordance with 10 CFR 71 [10] licensing guidance and requirements provided in the "Standard Review Plan for Dry Cask Storage Systems" (NUREG-1536) [2].

- Geometric tolerances and mechanical perturbations (fuel movement in tube, tube movement in the disk opening, and combined fuel and tube movement) are analyzed to arrive at the highest reactivity basket configuration. PWR system geometric tolerances and mechanical perturbations are initially evaluated by using an "infinite array" of tubes in the basket model. An "infinite array" of tubes is produced by modeling mirrored boundary conditions in the x-y plane and a single fuel tube surrounded by the basket structure out to one half the web width. A basket-in-canister model taking into account any positive biases determined from the single-tube-in-basket model is the "worst case," highest reactivity, concrete cask configuration. BWR geometric tolerances and mechanical perturbations are directly evaluated by a basket-in-cask model.

- Fuel assembly and basket will retain their structure and will not show any significant permanent deformation during normal or accident conditions.

6.7 References

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Chapter 8

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8.0 OPERATING PROCEDURES

This chapter provides general guidance for operating the Universal Storage System. Three operating conditions are addressed. The first is loading the transportable storage canister, installing it in the vertical concrete cask, and transferring it to the storage (Independent Spent Fuel Storage Installation (ISFSI)) pad. The second is the removal of the loaded canister from the concrete storage cask. The third is opening the canister to remove spent fuel in the unlikely event that this should be necessary.

The operating procedure for transferring a loaded canister from a storage cask to the Universal Transport Cask, is described in Section 7.2.2 of the UMS® Universal Transport Cask Safety Analysis Report. [1]

Users shall develop written and approved site-specific procedures that implement the operational sequences presented in the procedures in this chapter. These procedures present the general guidance for operations and the establishment of the process in which Technical Specification limits and requirements presented in Appendix A of Certificate of Compliance No. 72-1015 are met. The procedures provide the guidance and basis for the development and implementation of more detailed site-specific operating and test procedures required of the NAC-UMS® Storage System user. A departure from the specific way in which a given operational activity is performed may result from variations in specific site equipment or operational philosophy. Site-specific procedures shall also incorporate site-specific Technical Specifications, surveillance requirements, administrative controls, and other limits appropriate to the use of the NAC-UMS® Storage System to ensure that system/component design function is maintained. The user's site-specific procedures shall incorporate spent fuel assembly selection and verification requirements to ensure that the spent fuel assemblies loaded into the UMS® Storage System are as authorized by the Approved Contents and Design Features presented in Appendix B of the CoC Number 1015 Technical Specifications and the Certificate of Compliance.

Operation of the Universal Storage System requires the use of ancillary equipment items. An example listing of ancillary equipment normally required for system operation is shown in Table 8.1.1-1. Alternative ancillary equipment such as heavy-haul trailer and canister lifting devices may be utilized based on a site-specific evaluation. When a specific ancillary equipment item is referred to in the procedure, alternative ancillary equipment is allowable (i.e., vertical cask transporter, canister lifting systems, etc.). The system does not rely on the use of bolted closures, but bolts are used to secure retaining rings and lids. The hoist rings used for lifting the shield lid and canister have threaded fittings. Table 8.1.1-2 provides the torque values for installed bolts and hoist rings. Supplemental shielding may be employed to reduce radiation exposure for certain of the tasks specified by these procedures. Use of supplemental shielding is at the discretion of the User.

The design of the Universal Storage System is such that the potential for spread of contamination during handling and future transport of the canister is minimized. The transportable storage canister is loaded in the spent fuel pool but is protected from gross contact with pool water by a jacket of clean or filtered pool water while it is in the transfer cask. Clean water is processed or filtered pool water, or any water external to the spent fuel pool that has a water chemistry that is compatible with use in the pool. Only the top of the open canister is exposed to contaminated pool water. The top of the canister is closed by the structural lid, which is not contaminated when it is installed. Consequently, the canister external surface is expected to be essentially free of contamination. There are no radioactive effluents from the canister or the concrete cask in routine operations or in the design basis accident events.

The guidance procedures described in this chapter allow the cask user to develop site-specific procedures that minimize the dose to the operators in accordance with As Low As Reasonably Achievable (ALARA) principles.

A training program is described in Section A 5.0 of Appendix A of the CoC Number 1015 Technical Specifications, that is intended to assist the User in complying with the training and dry run requirements of 10 CFR 72. This program addresses the controls and limits applicable to the UMS® Storage System. It also addresses the system operational features and requirements.

8.1 Procedures For Loading the Universal Storage System

The Universal Storage System consists of three principal components: the transportable storage canister (canister), the transfer cask, and the vertical concrete cask. The transfer cask is used to hold the canister during loading and while the canister is being closed and sealed. The transfer cask is also used to transfer the canister to the concrete cask and to load the canister into the transport cask. The principal handling operations involve closing and sealing the canister by welding, and placing the loaded canister in the vertical concrete cask. The typical vent and drain port locations are shown in Figure 8.1.1-1.

The transfer cask is provided in either the Standard or Advanced configuration that weigh approximately 121,500 pounds each, depending on Class. Canister handling, fuel loading and canister closing are operationally identical for either transfer cask configuration. Either transfer cask can accommodate an extension fixture to allow the use of the next longer length canister. The user shall verify that the appropriate extension is installed and torqued prior to initiating the canister-loading process.

This procedure assumes that the canister with an empty basket is installed in the transfer cask, that the transfer cask is positioned in the decontamination area or other suitable work station, and that the vertical concrete cask is positioned in the plant cask receiving area or other suitable staging area. The transfer cask extension must be installed on the transfer cask if its use is required. To facilitate movement of the transfer cask to the concrete cask, the staging area should be within the operational "footprint" of the cask handling crane. The concrete cask may be positioned on a heavy-haul transporter, or on the floor of the work area.

The User must ensure that the fuel assemblies selected for loading conform to the Approved Contents provisions of Section B2.0 of Appendix B of the CoC Number 1015 Technical Specifications. Fuel assembly loading may also be administratively controlled to ensure that fuel assemblies with specific characteristics are preferentially loaded in specified positions in the canister. Preferential loading requirements are described in Section B2.1.2 of Appendix B of the CoC Number 1015 Technical Specifications.

Certain steps of the procedures in this section may be completed out of sequence to allow for operational efficiency. Changing the order of these steps, within the intent of the procedures, has no effect on the safety of the canister loading process and does not violate any requirements stated in the Technical Specifications. These steps include the placement and installation of air pads and the sequence and use of an annulus fill system, including optional seals and/or foreign material exclusion devices.

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8.1.1 Loading and Closing the Transportable Storage Canister

1. Visually inspect the basket fuel tubes to ensure that they are unobstructed and free of debris. Ensure that the welding zones on the canister, shield, and structural lids, and the port covers are prepared for welding. Ensure transfer cask door lock bolts/lock pins are installed and secure.
2. Fill the canister with clean water until the water is about 4 inches from the top of the canister.

   Note: Do not fill the canister completely in order to avoid spilling water during the transfer to the spent fuel pool.

   Note: If fuel loading requires boron credit, the minimum boron concentration of the water in the canister must be at least 1,000 ppm (boron), in accordance with LCO 3.3.1.
3. Install the annulus fill system to transfer cask, including the clean water lines.
4. If it is not already attached, attach the transfer cask lifting yoke to the cask handling crane, and engage the transfer cask lifting trunnions.

   Note: The minimum temperature of the transfer cask (i.e., surrounding air temperature) must be verified to be higher than 0°F prior to lifting, in accordance with Section B3.4.1 (8) of Appendix B of the CoC Number 1015 Technical Specifications.
5. Raise the transfer cask and move it over the pool, following the prescribed travel path.
6. Lower the transfer cask to the pool surface and turn on the clean water line to fill the canister and the annulus between the transfer cask and canister.
7. Lower the transfer cask as the annulus fills with clean water until the trunnions are at the surface, and hold that position until the clean water overflows through the upper fill lines or annulus of the transfer cask. Then lower the transfer cask to the bottom of the pool cask loading area.

   Note: If an intermediate shelf is used to avoid wetting the cask handling crane hook, follow the plant procedure for use of the crane lift extension piece.
8. Disengage the transfer cask lifting yoke to provide clear access to the canister.
9. Load the previously designated fuel assemblies into the canister.

   Note: Contents must be in accordance with the Approved Contents provisions of Section B2.0 of Appendix B of the CoC Number 1015 Technical Specifications.

   Note: Contents shall be administratively controlled to ensure that fuel assemblies with certain characteristics are preferentially loaded in specified positions in the basket. Preferential loading requirements are presented in Section B2.1.2 of Appendix B of the CoC Number 1015 Technical Specifications.

10. Attach a three-legged sling to the shield lid using the swivel hoist rings. Torque hoist rings in accordance with Table 8.1-2. Attach the suction pump fitting to the vent port.

    Caution: Verify that the hoist rings are fully seated against the shield lid.

    Note: Ensure that the shield lid key slot aligns with the key welded to the canister shell.
11. Using the cask handling crane, or auxiliary hook, lower the shield lid until it rests in the top of the canister.
12. Raise the transfer cask until its top just clears the pool surface. Hold at that position, and using a suction pump, drain the pool water from above the shield lid. After the water is removed, continue to raise the cask. Note the time that the bottom of the transfer cask clears the spent fuel pool water. Operations through Step 28 must be completed in accordance with the time limits presented in Table 8.1.1-3. The "time in water" clock is to be initiated if the lifting of the transfer cask from the pool is interrupted with the cask partially removed from the pool.

    Note: For the PWR configuration, in the event that the drain time limit is not met, either forced air or in-pool cooling, or monitoring the water temperature (see following note) is required. Forced air cooling is implemented by supplying 375 CFM air with a maximum temperature of 76°F to the 8 transfer cask lower inlets. Forced air or in-pool cooling of the canister shall be maintained for a minimum of 24 hours. After 24 hours, the cooling may be discontinued based on heat load as follows:

<u>Time Periods for Discontinued Cooling after 24 Hours</u>

Heat Load (kW)	For Forced Air Cooling (hrs)	For In-Pool Cooling (hrs)
$20 < L \leq 23$	4	15
$17.6 < L \leq 20$	7	18
$14 < L \leq 17.6$	11	22
$11 < L \leq 14$	14	24
$8 < L \leq 11$	20	29
$L \leq 8$	28	34

Note: Alternately, the temperature of the water in the canister may be used to establish the time for completion through Step 28 for the PWR configuration. Those operations must be completed within 2 hours of the time that the canister water reaches the temperatures shown in the following table. For this alternative, the water temperature must be determined every 2 hours beginning at the time shown in the following table after the time the transfer cask is removed from the pool.

Heat Load (kW)	Canister Water Temperature (°F)	Time to Start Temperature Measurement (hrs)
$20 < L \leq 23$	180	18
$17.6 < L \leq 20$	180	21
$14 < L \leq 17.6$	180	25
$11 < L \leq 14$	170	28
$8 < L \leq 11$	160	33
$L \leq 8$	150	38

Note: As an alternative, some sites may choose to perform welding operations for closure of the canister in a cask loading pit with water around the canister (below the trunnions) and in the annulus. This alternative provides additional shielding during the closure operation. If this alternative is implemented, the start time for compliance with Table 8.1.1-3 limits, as defined in Step 12, begins when the top of the canister is above the pool water surface (i.e., no longer fully submerged).

13. As the cask is raised, spray the transfer cask outer surface with clean water to wash off any gross contamination.
14. When the transfer cask is clear of the pool surface, but still over the pool, turn off the clean water flow to the annulus, remove hoses and allow the annulus water to drain to the pool. Move the transfer cask to the decontamination area or other suitable work station.
    Note: Access to the top of the transfer cask is required. A suitable work platform may need to be erected.
15. Verify that the shield lid is level and centered.
16. Attach the suction pump to the suction pump fitting on the vent port. Operate the suction pump to remove free water from the shield lid surface. Disconnect the suction pump and suction pump fitting. Remove any free standing water from the shield lid surface and from the vent and drain ports.
17. Decontaminate the top of the transfer cask and shield lid as required to allow welding and inspection activities.
    Note: Supplemental shielding may be used for activities around the shield lid.
18. Insert the drain tube assembly with a female quick-disconnect attached through the drain port of the shield lid into the basket drain tube sleeve. Remove the female quick-disconnect. Torque the drain tube assembly by hand until metal-to-metal contact is achieved; then torque to 135 ± 15 ft-lbs for Furon metal seals or 115 ± 5 ft-lbs for elastomer seals (EPDM or Viton). Install a quick-disconnect in the vent port.

19. Connect the suction pump to the drain port. Verify that the vent port is open. Remove approximately 70 gallons of water from the canister. Disconnect and remove the pump.
    Caution: Radiation level may increase as water is removed from the canister.
20. Install the automatic welding equipment, including the supplemental shield plate.
21. Attach the hydrogen gas detector to the vent port. Verify that the concentration of any detectable hydrogen gas in the free volume beneath the shield lid is less than 2.4%. Continue monitoring for hydrogen gas during completion of the shield lid root pass weld.
    Note: If, at any time, the hydrogen gas concentration exceeds 2.4%, stop welding operations and connect and operate the vacuum system, or use a gas purge through the vent port to remove the gases from beneath the shield lid. Reverify that the hydrogen gas concentration beneath the shield lid is less than 2.4%. Disconnect and remove the vacuum or purging system.
22. Operate the welding equipment to complete the root weld joining the shield lid to the canister shell following approved procedures. Remove the hydrogen detector from the vent tube. Leave the connector and vent tube installed to vent the canister.
23. Examine the root weld using liquid penetrant and record the results.
24. Complete welding of the shield lid to the canister shell.
25. Liquid penetrant examine the final weld surface and record the results.
26. Attach a regulated air, nitrogen or helium supply line to the vent port. Install a fitting on the drain port. Pressurize the canister to 35 psia and hold the pressure. There must be no loss of pressure for a minimum of 10 minutes.
27. Release the pressure.
    Note: As an option, an informational helium leak test may be conducted at this point using the following steps (the record leak test is performed at Step 49).
    27a. Evacuate and backfill the canister with helium having a minimum purity of 99.9% to a pressure of 18.0 psia.
    27b. Using a helium leak detector ("sniffer" detector) with a test sensitivity of 5×10^{-5} cm^3/sec (helium), survey the weld joining the shield lid and canister shell.
    27c. At the completion of the survey, vent the canister helium pressure to one atmosphere (0 psig).
28. Drain the canister.

    Drain the remaining water from the canister cavity (typically, the process ranges from 1 to 2 hours). Draining of the canister may be performed by suction, by a blow-down gas pressure of 15-18 psig, or by a combination of suction and a blow-down gas pressure of 15-18 psig. After removal of the water from the canister, disconnect the equipment from the canister. Note the time that the last free water is removed from the canister cavity. If not already installed, install a quick-disconnect to the open vent port.

    Caution: Radiation levels at the top and sides of the transfer cask will rise as water is removed.

Note: If the canister draining operation is interrupted or only partially completed, the canister shall be refilled with water prior to start of the auxiliary cooling operations (i.e., forced air or in-pool cooling), per the Note following Step 12.

Note: The total time duration from the completion of draining the water from the canister (Step 28), or from completion of either in-pool or forced air cooling, through completion of dryness verification testing per LCO 3.1.2 (Step 31) and the completion of the helium backfill process per LCO 3.1.3 (Step 34) shall be controlled and monitored in accordance with the surveillance requirements and actions of LCO 3.1.1.

29. Attach the vacuum equipment to the vent and drain ports. Dry any free standing water in the vent and drain port recesses.
30. Operate the vacuum equipment until a vacuum of ≤10 mm of mercury exists in the canister and isolate the vacuum pump and turn the pump off.
31. Verify that no water remains in the canister by holding the vacuum of ≤10 mm of mercury for a minimum of 10 minutes. If water is present in the cavity, the pressure will rise as the water vaporizes. Continue the vacuum/hold cycle until the conditions of LCO 3.1.2 are met.

    Precaution: If the spent fuel pool water temperature for canisters vacuum dried in the pool, or the cask preparation area ambient temperature for canisters vacuum dried outside the pool is below 65°F, the vacuum drying of the canister shall be extended below the standard pressure value of ≤ 10 mm Hg until a cavity pressure of ≤ 5 mm Hg is achieved. The dryness verification shall be performed and meet the acceptance criteria as specified in LCO 3.1.2, but limiting any pressure rise during the 10-minute hold period to ≤ 5 mm Hg.
32. Evacuate the cavity until a vacuum of ≤3 mm of mercury exists and backfill the canister cavity with helium having a minimum purity of 99.9% to a pressure of one atmosphere (0 psig).
33. Restart the vacuum equipment and operate until a vacuum of 3 mm of mercury exists in the canister.
34. Backfill the canister with helium having a minimum purity of 99.9% to a pressure of one atmosphere (0 psig).

    Note: Canister helium backfill pressure must conform to the requirements of LCO 3.1.3.

    Note: Monitor the time from this step (completion of helium backfill) until completion of canister transfer into and closure of the concrete cask in accordance with LCO 3.1.4.
35. Disconnect the vacuum and helium supply lines from the vent and drain ports. Dry any residual water that may be present in the vent and drain port cavities.

36. Install the vent and drain port covers.
37. Complete the root pass weld of the drain port cover to the shield lid.
    Note: If the drain port cover weld is completed in a single pass, the weld final surface is liquid penetrant inspected in accordance with Step 40.
38. Prepare the weld and perform a liquid penetrant examination of the root pass. Record the results.
39. Complete welding of the drain port cover to the shield lid.
40. Prepare the weld and perform a liquid penetrant examination of the drain port cover weld final pass. Record the results.
41. Complete the root pass weld of the vent port cover to the shield lid.
    Note: If the drain port cover weld is completed in a single pass, the weld final surface is liquid penetrant inspected in accordance with Step 44.
42. Prepare the weld and perform a liquid penetrant examination of the root pass. Record the results.
43. Complete welding of the vent port cover to the shield lid.
44. Prepare the weld and perform a liquid penetrant examination of the weld final surface. Record the results.
45. Remove the welding machine and any supplemental shielding used during shield lid closure activities.
46. Install the helium leak test fixture.
47. Attach the vacuum line and leak detector to the leak test fixture fitting.
48. Operate the vacuum system to establish a vacuum in the leak test fixture.
49. Operate the helium leak detector to verify that there is no indication of a helium leak exceeding 2×10^{-7} cm^3/second, at a minimum test sensitivity of 1×10^{-7} cm^3/second helium, in accordance with the requirements of LCO 3.1.5.
50. Release the vacuum and disconnect the vacuum and leak detector lines from the fixture.
51. Remove the leak test fixture.
52. Attach a three-legged sling to the structural lid using the swivel hoist rings.
    Caution: Ensure that the hoist rings are fully seated against the structural lid. Torque the hoist rings in accordance with Table 8.1.1-2. Verify that the spacer ring is in place on the structural lid.
    Note: Verify that the structural lid is stamped or otherwise marked to provide traceability of the canister contents.
53. Using the cask handling crane or the auxiliary hook, install the structural lid in the top of the canister. Verify that the structural lid is flush with, or protrudes slightly above, the canister shell. Verify that the gap in the spacer ring is not aligned with the shield lid alignment key. Remove the hoist rings.

54. Install the automatic welding equipment on the structural lid including the supplemental shield plate.
55. Operate the welding equipment to complete the root weld joining the structural lid to the canister shell.
56. Prepare the weld and perform a liquid penetrant examination of the weld root pass. Record the results.
57. Continue with the welding procedure, examining the weld at 3/8-inch intervals using liquid penetrant. Record the results of each intermediate and the final examination.
    Note: If ultrasonic testing of the weld is used, testing is performed after the weld is completed.
58. Remove the weld equipment and supplemental shielding.
59. Install the transfer cask retaining ring. Torque bolts to 155 ± 10 ft-lbs. (Table 8.1.1-2).
60. Decontaminate the external surface of the transfer cask to the limits established for the site.

Figure 8.1.1-1 Typical Vent and Drain Port Locations

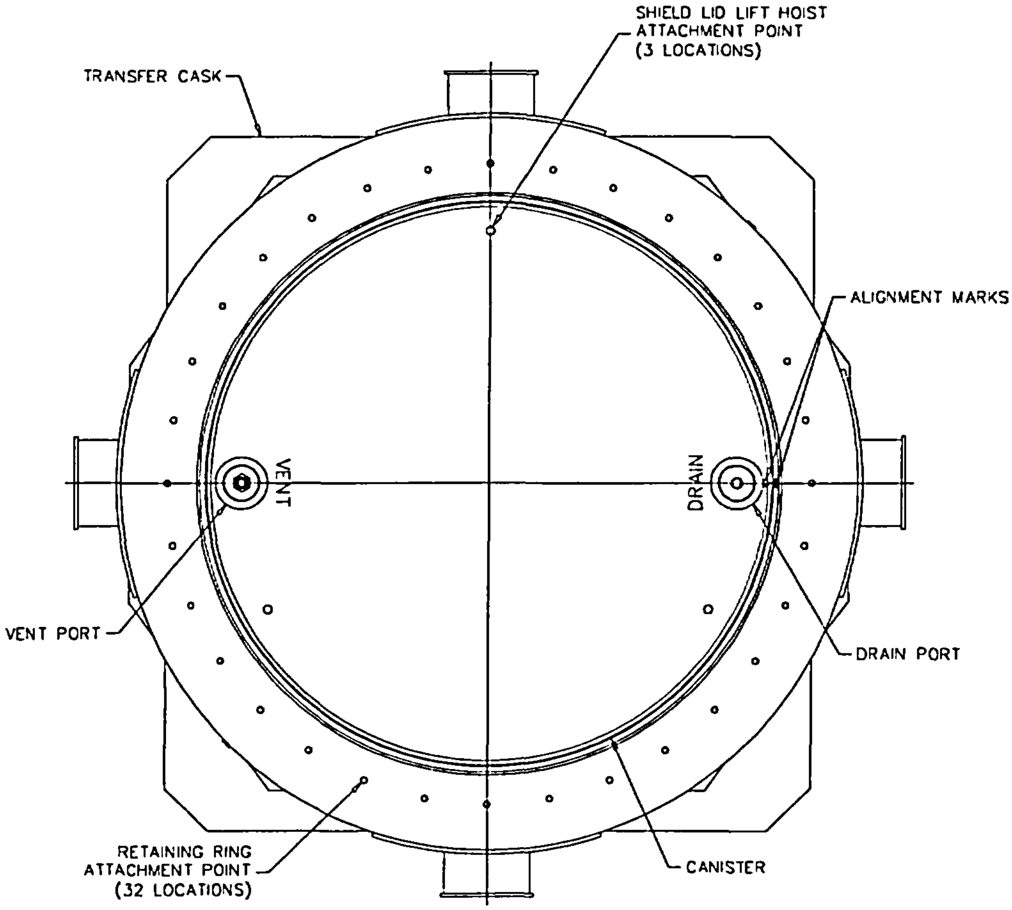

Table 8.1.1-1 List of Principal Ancillary Equipment

Item	Description
Transfer Cask Lifting Yoke	Required for lifting and moving the transfer cask.
Heavy-Haul Transporter (Optional)	Heavy-haul (double drop frame) trailer required for moving the loaded and empty vertical concrete cask to and from the ISFSI pad.
Mobile Lifting Frame (Optional)	A self-propelled or towed A-frame lifting device for the concrete cask. Mobile Lifting Frame is used to lift the cask and move it using two lifting lugs in the top of the concrete cask.
Helium Supply System	Supplies helium to the canister for helium backfill and purging operations.
Vacuum Drying System	Used for evacuating the canister. Used to remove residual water, air and initial helium backfill.
Automated Welding System	Used for welding the shield lid and structural lid to the canister shell.
Self-Priming Pump	Used to remove water from the canister.
Shield Lid Sling	A three-legged sling used for lifting the shield lid. It is also used to lift the concrete cask shield plug and lid.
Redundant Canister Lifting Sling System (1)	A set of 2 three-legged slings used for lifting the structural lid by itself, or for lifting the canister when the structural lid is welded to it. The slings are configured to provide for simultaneous loading during the canister lift.
Transfer Adapter	Used to align the transfer cask to the vertical concrete cask or the Universal Transport Cask. Provides the platform for the operation of the transfer cask shield doors.
Transfer Cask Extension	A carbon steel ring used to extend the height of the transfer cask when using the next longer size canister.
Hydraulic Unit	Operates the shield doors of the transfer cask.
Lift Pump Unit	Jacking system for raising and lowering the concrete cask.
Air Pad Rig Set	Air cushion system used for moving the concrete cask.
Supplemental Shielding Fixture	An optional carbon steel fixture inserted in the Vertical Concrete Cask air inlets to reduce radiation dose rates at the inlets.

(1) Note: Alternative canister lifting systems may be utilized based on a site-specific analysis and evaluation.

Table 8.1.1-2 Torque Values

Fastener	Torque Value (ft-lbs)	Torque Pattern
Transfer Adapter Bolts (Optional)	40 ± 5	None
Transfer Cask Retaining Ring	155 ±10	0°, 180°, 270° and 90° in two passes
Transfer Cask Extension	155 ±10	None
Vertical Concrete Cask Lid	40 ± 5	None
Lifting Hoist Rings – Canister Structural Lid Lid Only Loaded Canister	 Hand Tight 800 +80, -0	None
Canister Lid Plug Bolts Shield Lid Plug Bolts	Hand Tight Hand Tight	None None
Transfer Cask Door Lock Bolts	Hand Tight	None
Canister Drain Tube	135 ± 15 (Furon metal seals) or 115 ± 5 (elastomer seals, EPDM or Viton)	None

Table 8.1.1-3 Handling Time Limits Based on Decay Heat Load with Canister Full of Water

Total Heat Load (L) (kW)	PWR Time Limit (Hours)	BWR Time Limit (Hours)
20.0 < L ≤ 23.0	20	17
17.6 < L ≤ 20.0	23	17
14.0 < L ≤ 7.6	27	17
11.0 < L ≤ 14.0	30	17
8.0 < L ≤ 11.0	35	17
L ≤ 8.0	40	17

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8.1.2 Loading the Vertical Concrete Cask

This section of the loading procedure assumes that the vertical concrete cask is located on the bed of a heavy-haul transporter, or on the floor of the work area, under a crane suitable for lifting the loaded transfer cask. The vertical concrete cask shield plug and lid are not in place, and the bottom pedestal plate cover is installed.

1. Using a suitable crane, place the transfer adapter on the top of the concrete cask.
2. If using the transfer adapter bolt hole pattern for alignment, align the adapter to the concrete cask. Bolt the adapter to the cask using four (4) socket head cap screws. (Note: Bolting of the transfer adapter to the cask is optional.)
3. Verify that the shield door connectors on the adapter plate are in the fully extended position.
   Note: Steps 4 through 6 may be performed in any order, as long as all items are completed.
4. If not already done, attach the transfer cask lifting yoke to the cask handling crane. Verify that the transfer cask retaining ring is installed.
5. Install six (6) swivel hoist rings in the structural lid of the canister and torque to the value specified in Table 8.1.1-2. Attach two (2) three-legged slings to the hoist rings.
   Caution: Ensure that the hoist rings are fully seated against the structural lid.
6. Stack the slings on the top of the canister so they are available for use in lowering the canister into the storage cask.
7. Engage the transfer cask trunnions with the transfer cask lifting yoke. Ensure that all lines are disconnected from the transfer cask.
   Note: The minimum temperature of the transfer cask (i.e., temperature of the surrounding air) must be verified to be higher than 0°F prior to lifting, in accordance with Section B 3.4.1(8) of Appendix B of the CoC Number 1015 Technical Specifications.
8. Raise the transfer cask and move it over the concrete cask. Lower the transfer cask, ensuring that the transfer cask shield door rails and connector tees align with the adapter plate rails and door connectors. Prior to final set down, remove transfer cask shield door lock bolts/lock pins (there is a minimum of one per door), or the door stop, as appropriate.
9. Ensure that the shield door connector tees are engaged with the adapter plate door connectors.
10. Disengage the transfer cask yoke from the transfer cask and from the cask handling crane hook.

11. Return the cask handling crane hook to the top of the transfer cask and engage the two (2) three-legged slings attached to the canister.

    Caution: The top connection of the three-legged slings must be at least 75 inches above the top of the canister.

12. Lift the canister slightly (about ½ inch) to take the canister weight off of the transfer cask shield doors.

    Note: A load cell may be used to determine when the canister is supported by the crane.

    Caution: Avoid raising the canister to the point that the canister top engages the transfer cask retaining ring, as this could result in lifting the transfer cask.

13. Using the hydraulic system, open the shield doors to access the concrete cask cavity.
14. Lower the canister into the concrete cask, using a slow crane speed as the canister nears the pedestal at the base of the concrete cask. The support ring may be used to aid in centering the canister during the lowering of the canister into the concrete cask.
15. When the canister is properly seated, disconnect the slings from the canister at the crane hook, and close the transfer cask shield doors.
16. Retrieve the transfer cask lifting yoke and attach the yoke to the transfer cask.
17. Lift the transfer cask off of the vertical concrete cask and return it to the decontamination area or designated work station.

    Note: The canister is intended to be centered in the concrete cask, but the final position of the canister may result in the canister shell being as close as one inch from the concrete cask liner due to system component alignment.

    Note: Perform removable contamination surveys on the canister exterior and/or transfer cask interior surfaces as required to confirm canister surface contamination is less than the limits specified in Technical Specification LCO 3.2.1.

18. Using the auxiliary crane, remove the adapter plate from the top of the concrete cask.
19. Remove the swivel hoist rings from the structural lid and replace them with threaded plugs.
20. Install three swivel hoist rings in the shield plug and torque in accordance with Table 8.1.1-2.
21. Using the auxiliary crane, retrieve the shield plug and install the shield plug in the top of the concrete cask. Remove swivel hoist rings.
22. Install seal tape around the diameter of the lid bolting pattern on the concrete cask flange.
23. Using the auxiliary crane, retrieve the concrete cask lid and install the lid in the top of the concrete cask. Secure the lid using six stainless steel bolts. Torque bolts in accordance with Table 8.1.1-2.
24. Ensure that there is no foreign material left at the top of the concrete cask. Install the tamper-indicating seal.
25. If used, install a supplemental shielding fixture in each of the four inlets. Note: The supplemental shielding fixtures may also be shop installed.

8.1.3 Transport and Placement of the Vertical Concrete Cask

This procedure assumes that the loaded vertical concrete cask is positioned on a heavy-haul transporter and is to be positioned on the ISFSI pad using the air pad set. Alternately, the concrete cask may be lifted and moved using a mobile lifting frame. The mobile lifting frame lifts the cask using four lifting lugs at the top of the concrete cask. The lifting frame may be self-propelled or towed, and does not use the air pad set. Caution shall be observed when lifting the concrete cask using the two pairs of lifting lugs to minimize possible uneven loading on the base of the concrete cask. For lifting devices provided with load measuring equipment, the load on each lug set should be evenly maintained, but in no case shall an uneven load exceed 25,000 pounds between lug sets.

The vertical concrete cask lift height limit is 24 inches when the cask is moved using the air pad set or the mobile lifting frame in accordance with the requirements of Section A5.6(c) and Table A5-1 of Appendix A of the CoC Number 1015 Technical Specifications. Because of lift fixture configuration, the maximum lift height of the concrete cask using the jacking arrangement is approximately 4 inches.

The concrete cask surface dose rates must be verified in accordance with the requirements of LCO 3.2.2. These measurements may be made prior to movement of the cask, at a location along the transport path, or at the ISFSI. An optional supplemental shielding fixture, shown in Drawing 790-613, may be installed in the concrete cask air inlets to reduce the radiation dose rate at the inlets.

1. Using a suitable towing vehicle, tow the heavy-haul transporter to the dry storage pad (ISFSI). Verify that the bed of the transporter is approximately at the same height as the pad surface. Install four (4) hydraulic jacks at the four (4) designated jacking points at the air inlets in the bottom of the vertical concrete cask.
2. Raise the concrete cask approximately 4 inches using the hydraulic jacks.
   Caution: Do not exceed a maximum lift height of 24 inches, in accordance with the requirements of Administrative Control A5.6(c).
3. Move the air-bearing rig set under the cask.
4. Inflate the air-bearing rig set. Remove the four (4) hydraulic jacks.
5. Using a suitable towing vehicle, move the concrete cask from the bed of the transporter to the designated location on the storage pad.
   Note: Spacing between concrete casks must not be less than 15 feet (center-to-center).
6. Turn off the air-bearing rig set, allowing it to deflate.

7. Reinstall the four (4) hydraulic jacks and raise the concrete cask approximately 4 inches. Caution: Do not exceed a maximum lift height of 24 inches, in accordance with the requirements of Administrative Control A5.6(c).
8. Remove the air-bearing rig set pads. Ensure that the surface of the dry storage pad under the concrete cask is free of foreign objects.
9. Lower the concrete cask to the surface and remove the four (4) hydraulic jacks.
10. Install the screens in the inlets and outlets.
11. Install/connect temperature monitoring equipment and verify operation in accordance with LCO 3.1.6.
12. Scribe/stamp concrete cask name plate to indicate loading information.

8.2 Removal of the Loaded Transportable Storage Canister from the Vertical Concrete Cask

Removal of the loaded canister from the vertical concrete cask is expected to occur at the time of shipment of the canistered fuel off site. Alternately, removal could be required in the unlikely event of an accident condition that rendered the concrete cask or canister unsuitable for continued long-term storage or for transport. This procedure assumes that the concrete cask is being returned to the reactor cask receiving area. However, the cask may be moved to another facility or area using the same operations. It identifies the general steps to return the loaded canister to the transfer cask and return the transfer cask to the decontamination station, or other designated work. area or facility. Since these steps are the reverse of those undertaken to place the canister in the concrete cask, as described in Section 8.1.2, they are only summarized here.

The concrete cask may be moved using the air pad set or a mobile lifting frame. This procedure assumes the use of the air pad set. If a lifting frame is used, the concrete cask is lifted using four lifting lugs in the top of the cask, and the air pad set and heavy haul transporter are not required. The mobile lifting frame may be self-powered or towed. Caution shall be observed when lifting the concrete cask using the two pairs of lifting lugs to minimize possible uneven loading on the base of the concrete cask. For lifting devices provided with load measuring equipment, the load on each lug set should be evenly maintained, but in no case shall an uneven load exceed 25,000 pounds between lug sets.

At the option of the user, the canister may be removed from the concrete cask and transferred to another concrete cask or to the Universal Transport Cask at the ISFSI site. This transfer is done using the transfer cask, which provides shielding for the canister contents during the transfer.

Certain steps of the procedures in this section may be completed out of sequence to allow for operational efficiency. Changing the order of these steps, within the intent of the procedures, has no effect on the safety of the canister loading process and does not violate any requirements stated in the Technical Specifications or the NAC-UMS® FSAR. This includes the placement and installation of the air pads.

1. Remove the screens and instrumentation.
2. Using the hydraulic jacking system and the air pad set, move the concrete cask from the ISFSI pad to the heavy-haul transporter. The bed of the transporter must be approximately level with the surface of the pad and sheet metal plates are placed across the gap between the pad and the transporter bed.
   Caution: Do not exceed a maximum lift height of 24 inches when raising the concrete cask.

3. Tow the transporter to the cask receiving area or other designated work area or facility.
4. Remove the concrete cask lid and shield plug. Install the hoist rings in the canister structural lid and torque to the value specified in Table 8.1.1-2. Verify that the hoist rings are fully seated against the structural lid and attach the lift slings. Install the transfer adapter on the top of the concrete cask.
5. Retrieve the transfer cask with the retaining ring installed, and position it on the transfer adapter. Attach the shield door hydraulic cylinders.

   Note: The surrounding air temperature for cask unloading operations shall be ≥ 0°F.
6. Open the shield doors. Attach the canister lift slings to the cask handling crane hook.

   Caution: The attachment point of the two three-legged slings must be at least 75 inches above the top of the canister.
7. Raise the canister into the transfer cask.

   Caution: Avoid raising the canister to the point that the canister top engages the transfer cask retaining ring, as this could result in lifting the transfer cask.
8. Close the shield doors. Lower the canister to rest on the shield doors. Disconnect the canister slings from the crane hook. Install and secure door lock bolts/lock pins.

   Note: Monitor the time from this step (closing of shield doors) until initiation of canister cooldown operations, or completion of transfer to a concrete cask or Universal Transport Cask in accordance with LCO 3.1.4.
9. Retrieve the transfer cask lifting yoke. Engage the transfer cask trunnions and move the transfer cask to the decontamination area or designated work station.

After the transfer cask containing the canister is in the decontamination area or other suitable work station, additional operations may be performed on the canister. It may be opened, transferred to another storage cask, or placed in the Universal Transport Cask.

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ASME Code, Section V, Article 2, with acceptance criteria per Section III, Subsection NB-5320. The canister shell to base plate weld shall be examined by ultrasonic examination in accordance with ASME Code, Section V, Article 5, with acceptance per Section III, Subsection NB-5330. The field installed shield lid and structural lid welds shall be inspected by ultrasonic or dye penetrant examination methods. The shield lid to shell and port cover to shield lid welds shall be dye penetrant examined at the root and final pass in accordance with ASME Code, Section V, Article 6, with acceptance per Section III, Subsection NB-5350. Should the root and final pass be one and the same (i.e., single pass weld), then only one dye penetrant examination is required. The structural lid to shell weld shall be examined by either ultrasonic or dye penetrant examination in accordance with ASME Code, Section V, Articles 5 or 6, respectively.

Ultrasonic examinations acceptance criteria shall be in accordance with ASME Code, Section III, Subsection NB-5330. The acceptance criteria for the dye penetrant examination of the structural lid root, every 3/8-inch layer and final surface shall be in accordance with ASME Code, Section III, Subsection NB-5350. The results of the structural lid dye penetrant examination final interpretation, as described in ASME Code, Section V, Article 6, T-676, including all relevant indications, shall be recorded by video, photographic or other means to provide retrievable records of weld integrity.

The basket shall be fabricated in accordance with the ASME Code, Section III, Subsection NG requirements, except for approved Code exceptions as listed in Table B3-1 of Appendix B of the CoC. The final surface of identified basket welds shall be examined by the dye penetrant examination in accordance with ASME Code, Section V, Article 6, with acceptance per Section III, Subsection NG-5350.

Personnel performing nondestructive examinations shall be qualified in accordance with SNT-TC-1A [11]. A written report shall be prepared for each weld examined and shall include, at a minimum, the identification of the part, material, name and level of examiner, NDE procedure used, and the findings or dispositions, if any.

9.1.1.2 Construction Inspections

Concrete mixing slump, air entrainment, strength and density are field verified using either the American Concrete Institute (ACI) or the American Society for Testing and Materials (ASTM) standard testing methods and acceptance criteria, as appropriate, to ensure adequacy. Reinforcing steel is installed per specification requirements based on ACI-318 [7].

9.1.2 Structural and Pressure Test

The transportable storage canister is pressure tested at the time of use. After loading of the canister basket with spent fuel, the shield lid is welded in place after approximately 70 gallons of water are removed from the canister. Removal of the water ensures that the water level in the canister is below the bottom of the shield lid during welding of the shield lid to the canister shell. Prior to removing the remaining spent fuel pool water from the canister, the canister is pressure tested at 35 psia. This pressure is held for a minimum 10 minutes. Any loss of pressure during the test period is unacceptable. The leak must be located and repaired. The pressure test procedure is described in Section 8.1.1.

If the canister is to be ASME Code N-stamped, the canister shall be hydrostatically tested in accordance with the requirements of ASME Code Subsection NB-6220 and Code Case N-595-4 [12].

9.1.2.1 Transfer Casks

The transfer cask is provided in the Standard or Advanced configuration. The Standard transfer cask is restricted to handling the Standard weight canister. The Advanced transfer cask incorporates a reinforced trunnion design that allows it to handle either the standard weight, or a heavier weight, canister.

For any configuration, the transfer cask lifting trunnions and the bottom shield doors shall be tested in accordance with the requirements of ANSI N14.6, "Special Lifting Devices for Shipping Containers Weighing 10,000 pounds (4,500 kg) or More for Nuclear Materials" [8].

Standard Transfer Cask

The Standard transfer cask lifting trunnion load test shall consist of applying a vertical load of 630,000 pounds, which is greater than 300% of the maximum service load for the transfer cask and loaded canister with the shield lid and full of water (208,400 lbs). The bottom shield door and rail load test shall consist of applying a vertical load of 265,200 pounds, which is over 300% of the maximum service load (88,400 lbs). These maximum service loads are selected based on the heaviest configuration and, thus, bound all of the other configurations.

at least 6 measurements on each sheet. No rejected neutron absorber sheet is used. The sampling plan is supported by written and approved procedures.

The sampling plan requires that a coupon sample be taken from each of the first 100 sheets of absorber material. Thereafter, coupon samples are taken from 20 randomly selected sheets from each set of 100 sheets. This 1 in 5 sampling plan continues until there is a change in lot or batch of constituent materials of the sheet (i.e., boron carbide powder, aluminum powder, or aluminum extrusion) or a process change. The sheet samples are indelibly marked and recorded for identification. This identification is used to document neutron absorber test results, which become part of the quality record documentation package.

9.1.6.2 Neutron Absorber Wet Chemistry Testing

Wet chemistry testing of the test coupons obtained from the sampling plan is used to verify the ^{10}B content of the neutron absorber material. Wet chemistry testing is applied because it is considered to be the most accurate and practical direct measurement method for determining ^{10}B, boron and B_4C content of metal materials and is considered by the Electric Power Research Institute (EPRI) to be the method of choice for this determination.

An approved facility with chemical analysis capability, which could include the neutron absorber vendor's facility, shall be selected to perform the wet chemistry tests. Personnel performing the testing shall be trained and qualified in the process and in the test procedure.

Wet chemistry testing is performed by dissolving the aluminum in the matrix, including the powder and cladding, in a strong acid, leaving the B_4C material. A comparison of the amount of B_4C material remaining to the amount required to meet the ^{10}B content specification is made using a mass-balance calculation based on sample size.

A statistical conclusion about the neutron absorber sheet from which the sample was taken and that batch of neutron absorber sheets may then be drawn based on the test results and the controlled manufacturing processes.

The adequacy of the wet chemistry method is based on its use to qualify the standards employed in neutron blackness testing. The neutron absorption performance of a test material is validated based on its performance compared to a standard. The material properties of the standard are demonstrated by wet chemistry testing. Consequently, the specified test regimen provides adequate assurance that the neutron absorber sheet thus qualified is acceptable.

9.1.6.3 Acceptance Criteria

The wet chemistry test results shall be considered acceptable if the ^{10}B areal density is determined to be equal to, or greater than, that specified on the fuel tube License Drawings. Failure of any coupon wet chemistry test shall result in 100% sampling, as described in the sampling plan, until compliance with the acceptance criteria is demonstrated.

9.1.7 Thermal Tests

No thermal acceptance testing of the Universal Storage System is required during construction. Thermal performance of the system is confirmed in accordance with the procedure specified in Section 9.2.3. In addition, temperature measurements are taken at the air outlets of the concrete cask(s) placed in service, in accordance with Appendix A of the CoC Number 1015 Technical Specifications, as verification of the thermal performance of the storage system.

9.1.8 Cask Identification

A stainless steel nameplate is permanently attached at eye level on the outer surface of the concrete cask as shown on Drawing No. 790-562.

Drawing No. 790-565 shows the information included on the nameplate.

9.3 References

1. ASME Boiler and Pressure Vessel Code, Section III, Division I, Subsection NB, "Class 1 Components," 1995 Edition with 1995 Addenda.

2. ASME Boiler and Pressure Vessel Code, Section V, "Nondestructive Examination," 1995 Edition with 1995 Addenda.

3. ASME Boiler and Pressure Vessel Code, Section VIII, Subsection B, Part UW, "Requirements for Pressure Vessels Fabricated by Welding," 1995 Edition with 1995 Addenda.

4. American Welding Society, Inc., "Structural Welding Code - Steel," AWS D1.1, 1996.

5. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications," 1995 Edition with 1995 Addenda.

6. ASME Boiler and Pressure Vessel Code, Section III, Division I, Subsection NG, "Core Support Structures," 1995 Edition with 1995 Addenda.

7. American Concrete Institute, "Building Code Requirements for Structural Concrete," ACI-318-95, October 1995.

8. American National Standards Institute, "Radioactive Materials - Special Lifting Devices for Shipping Containers Weighting 10,000 Pounds (4,500 kg) or More," ANSI N14.6-1993, 1993.

9. American National Standards Institute, "Leakage Tests on Packages for Shipment," ANSI N14.5-1997.

10. "Report on the Thermal Performance of the NAC-UMS® System at the Palo Verde Nuclear Generating Station (PVNGS) Independent Spent Fuel Storage Installation," NAC International, May 2003.

11. Recommended Practice No. SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing," The American Society for Nondestructive Testing, Inc., edition as invoked by the applicable ASME Code.

12. ASME Boiler and Pressure Vessel Code, Section III, Division 1, Code Case N-595-4, "Requirements for Spent Fuel Storage Canisters," May 2004.

Chapter 11

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11.2.8 Earthquake Event

This section provides an evaluation of the response of the vertical concrete cask to an earthquake imparting a horizontal acceleration of 0.26g and 0.29g at the top surface of the concrete pad. This evaluation shows that the loaded or empty vertical concrete cask does not tip over or slide in the earthquake event. The vertical acceleration is defined as 2/3 of the horizontal acceleration in accordance with ASCE 4-86 [36].

11.2.8.1 Cause of the Earthquake Event

Earthquakes are natural phenomena to which the storage system might be subjected at any U.S. site. Earthquakes are detected by the ground motion and by seismic instrumentation on and off site.

11.2.8.2 Earthquake Event Analysis

In the event of earthquake, there exists a base shear force or overturning force due to the horizontal acceleration ground motion and a restoring force due to the vertical acceleration ground motion. This ground motion tends to rotate the concrete cask about the bottom corner at the point of rotation (at the chamfer). The horizontal moment arm extends from the center of gravity (C.G.) toward the outer radius of the concrete cask. The vertical moment arm reaches from the C.G. to the bottom of the cask. When the overturning moment is greater than or equal to the restoring moment, the cask will tip over. To maximize this overturning moment, the dimensions for the Class 3 PWR configuration, which has the highest C.G., are used in this evaluation. Based on the requirements presented in NUREG-0800 [22], the static analysis method is considered applicable if the natural frequency of the structure is greater than 33 cycles per second (Hz).

The combined effect of shear and flexure is computed as:

$$\frac{1}{f^2} = \frac{1}{f_f^2} + \frac{1}{f_s^2} = \frac{1}{348.6} + \frac{1}{150.7} \quad [19]$$

or

$$f = 105.2 \text{ Hz} > 33 \text{ Hz}$$

where:

f_f = frequency for the first free-free mode based on flexure deformation only (Hz),
f_s = frequency for the first free-free mode based on shear deformation only (Hz).

The frequency f_f is computed as:

$$F_f = \frac{\lambda^2}{2\pi L^2}\sqrt{\frac{EI}{M}} = \frac{4.730^2}{2\pi(226)^2}\sqrt{\frac{(3.38\times10^6)\times(1.4832\times10^7)}{2.005}} \quad [19]$$

$f_f = 348.6$ Hz

where:

$\lambda = 4.730$,

$L = 226$ in, length of concrete cask,

$E = 3.38 \times 10^6$ psi, modulus of elasticity for concrete at 200°F,

$$I = \text{moment of inertia} = \frac{\pi\left(D_o^4 - D_i^4\right)}{64} = \frac{\pi\left[(136\ \text{in})^4 - (79.5\ \text{in})^4\right]}{64} = 1.4832\times10^7\ \text{in}^4,$$

$$\rho = \frac{140}{1728\times386.4} = 2.096\times10^{-4}\ \text{lbm/in}^3\text{, mass density,}$$

$$M = \pi(68^2 - 39.75^2)\times(2.096\times10^{-4}) = 2.005\ \text{lbm/in}$$

The frequency accounting for the shear deformation is:

$$f_s = \frac{\lambda_s}{2\pi L}\sqrt{\frac{KG}{\mu}} = \frac{3.141593}{2(3.141595)(226)}\sqrt{\left(\frac{(0.6947)(1.40\times10^6)}{2.096\times10^{-4}}\right)} \quad [19]$$

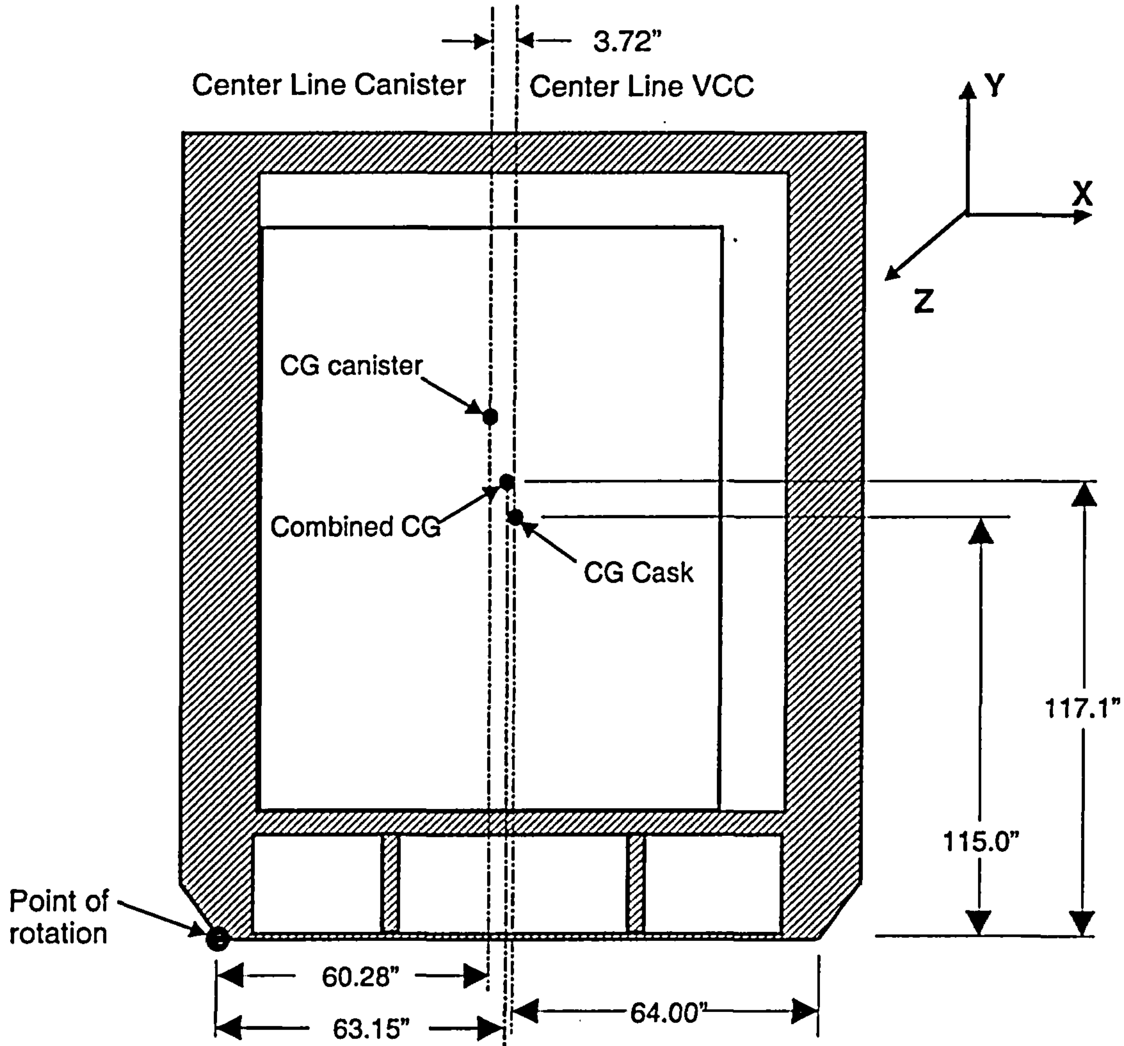
$f_s =$ 150.7 Hz

where:

$\lambda_s = \pi$,

$L = 226$ in, length of concrete cask,

$$K = \frac{6(1+\nu)(1+m^2)^2}{(7+6\nu)(1+m^2)+(20+12\nu)m^2}\text{, shear coefficient,}$$



substituting for G_h and G_v gives:

Case 1

$$(1-a)\frac{b}{d} \geq 0.566 \times a$$

$$a \leq \frac{b/d}{0.566 + 1.0\left(b/d\right)}$$

Case 2

$$\left(1-0.4a\right)\frac{b}{d} \geq 1.077a$$

$$a \leq \frac{b/d}{1.077 + 0.4\left(b/d\right)}$$

Because the canister is not attached to the concrete cask, the combined center of gravity for the concrete cask, with the canister in its maximum off-center position, must be calculated. The point of rotation is established at the outside lower edge of the concrete cask.

The inside diameter of the concrete cask is 74.5 inches and the outside diameter of the canister is 67.06 inches; therefore, the maximum eccentricity between the two is:

$$e = \frac{74.50\,\text{in} - 67.06\,\text{in}}{2} = 3.72\ \text{in.}$$

The horizontal displacement, x, of the combined C.G. due to eccentric placement of the canister is:

$$x = \frac{70{,}701(3.72)}{310{,}345} = 0.85\,\text{in.}$$

Therefore,

$$b = 64 - 0.85 = 63.15\ \text{in.}$$

$$d = 117.1\ \text{in.}$$

1) $$a \le \frac{63.15/117.1}{0.566 + 1.0 \times 63.15/117.1}$$

$a \le 0.49\text{g}$

2) $$a \le \frac{63.15/117.1}{1.077 + 0.4 \times 63.15/117.1}$$

$a \le 0.42\text{g}$

Therefore, the minimum ground acceleration that may cause a tip-over of a loaded concrete cask is 0.42g. Since the 0.26g design basis earthquake ground acceleration for the UMS® system is less than 0.42g, the storage cask will not tip over.

The factor of safety is 0.42 / 0.26 = 1.61, which is greater than the required factor of safety of 1.1 in accordance with ANSI/ANS-57.9.

Since an empty vertical concrete cask has a lower C.G. as compared to a loaded concrete cask, the tip-over evaluation for the empty concrete cask is bounded by that for the loaded concrete cask.

11.2.8.2.2 Sliding Evaluation of the Vertical Concrete Cask

For sites imposing the restriction that the Vertical Concrete Cask does not slide during a seismic event, the force holding the cask (F_s) has to be greater than or equal to the force trying to move the cask.

Based on the equation for static friction:

$$F_s = \mu N \geq G_h W$$
$$\mu\left(1 - G_v\right) W \geq G_h W$$

where:

μ = coefficient of friction
N = the normal force
W = the weight of the concrete cask
G_v = vertical acceleration component
G_h = resultant of horizontal acceleration component

Substituting G_h and G_v for the two cases:

Case 1	Case 2
μ (1 – 1.0a) ≥ 0.556a	μ (1 – 0.4a) ≥ 1.077a

For the coefficient of friction of 0.35 [21] between the steel bottom plate of the concrete cask and the concrete surface of the storage pad:

Case 1: $0.35\times(1\text{-}a) \geq 0.566a$
$a \leq 0.38g$

Case 2: $0.35\times(1\text{-}0.4a) \geq 1.077a$
$a \leq 0.29g$

For a design acceleration of 0.26g, the minimum factor of safety (FS) for acceleration is:

$$FS = \frac{0.29g}{0.26g} = 1.12$$

For a coefficient of friction of 0.4 between the steel bottom plate of the concrete cask and the concrete surface of the storage pad:

Case 1: $0.4\times(1\text{-}a) \geq 0.566a$
$a \leq 0.41$

Case 2: $0.4\times(1\text{-}0.4a) \geq 1.077a$
$a \leq 0.32$

For a design acceleration of 0.29g, the minimum factor of safety (FS) for acceleration is:

$$FS = \frac{0.32g}{0.29g} = 1.10$$

The analysis shows that the minimum safety factor against cask sliding for the design earthquake accelerations is 1.1 and meets the requirements of ANSI/ANS-57.9.

While the analyses presented in this section demonstrate that the minimum safety factors for sliding meet the requirements of ANSI/ANS 57.9, it should be noted that there is no safety concern with the sliding of a loaded concrete cask on the storage pad. The two possible outcomes of cask sliding are cask tip-over (see 11.2.12) and cask impact with another loaded cask. The stresses induced from the analyzed cask tip-over event far exceed those from the impact of two casks sliding into each other. Consequently, there is no safety concern with the impact of sliding casks. As a result, there is no safety concern if the designed pad coefficient of friction is reduced for any reason.

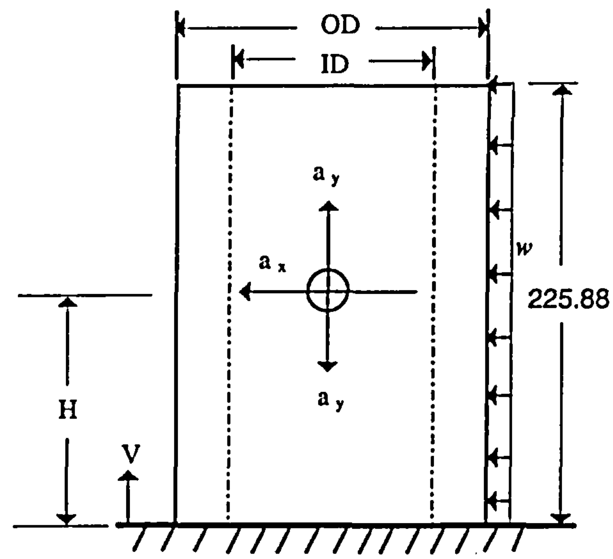
11.2.8.2.3 Stress Generated in the Vertical Concrete Cask During an Earthquake Event

To demonstrate the ability of the concrete cask to withstand earthquake loading conditions, the fully loaded cask is conservatively evaluated for seismic loads of 0.5g in the horizontal direction and 0.5g in the vertical direction. These accelerations reflect a more rigorous seismic loading, and, therefore, bound the design basis earthquake event. No credit is taken for the steel inner liner of the concrete cask. The maximum compressive stress at the outer and inner surfaces of the concrete shell are conservatively calculated by assuming the vertical concrete cask to be a cantilever beam with its bottom end fixed. The maximum compressive stresses are:

$$\sigma_{v\ outer} = (M / S_{outer}) + ((1+a_y)(W_{vcc}) / A) = -84 - 51 = -135 \text{ psi},$$
$$\sigma_{v\ inner} = (M / S_{inner}) + ((1+a_y)(W_{vcc}) / A) = -49 - 51 = -100 \text{ psi},$$

where:

$a =$ 0.50 g, horizontal direction,
$a_y =$ 0.50 g, vertical direction,
$H =$ 117.1 in., fully loaded C.G.,
$W_{vcc} =$ 325,000 lbf, bounding cask weight
$OD =$ 136 in., concrete exterior diameter,
$ID =$ 79.50 in., concrete interior diameter,
$A = \pi (OD^2 - ID^{2)} / 4 = 9{,}562.8$ in.^{2},
$I = \pi (OD^4 - ID^{4)} / 64 = 14.83 \times 10^6$ in.^{4},
$S_{outer} = 2I / OD = 218{,}088.2$ in.^{3},
$S_{inner} = 2I / ID = 373{,}035.0$ in.^{3},
$w = a_x W_{vcc} / 225.88 \approx 720$ lbf / in.
$M = w (225.88)^2 / 2 = 1.84 \times 10^7$ in.-lbf,
the maximum bending moment at the support.



The calculated compressive stresses are used in the load combinations for the vertical concrete cask as shown in Table 3.4.4.2-1.

11.2.8.2.4 Vertical Concrete Cask Sliding

For sites permitting the movement of the vertical concrete cask during the seismic event, it is possible that two vertical concrete casks may impact each other during the seismic event.

The bounding condition for the impact of the vertical concrete cask is for one cask to directly impact an adjacent cask with the direction of motion through the centerline of the casks. In this fashion, all the kinetic energy is absorbed in the crushing of the concrete or in the elastic deformation of the concrete. For an incremental thickness of crush (dy), the increment in the crush energy (dE_c) is:

$$dE_c = L \times \sigma \times L_c \times dy$$

where:

$L =$ axial length of contact between the two vertical concrete casks (inch)
$L_c =$ the width of the contact, (inch)
$\sigma =$ crush strength (psi)

The width of the crush for a specific crush depth (y) varies as the crush increases and is expressed as:

$$L_c(y) = 2\left(R_o^2 - (R_o - y)^2\right)^{1/2}$$

where:

R_o = outer radius of the vertical concrete cask, (inch)

The crushing will continue until the energy absorbed by crush is equal to the initial kinetic energy, which is associated with the initial velocity V_o. The total sum of all the increments from the initiation of crush to the final value of D_f (depth of crush) is the integral of the above expression, and it is equated to the kinetic energy.

$$0.5 \times W\left(\frac{V_o^2}{g}\right) = \sigma \times L \int_0^{D_f} L_c dy$$

where:

W = weight of the vertical concrete cask (lb)
g = 386.3 in/sec^2

Evaluating this integral leads to:

$$0.5 \times W\left(\frac{V_o^2}{g}\right) = \sigma \times L \times R_o^2 \times F(\beta)$$

where:

$$F(\beta) = \left[\frac{\pi}{2} - (1-\beta)\left(1-(1-\beta)^2\right)^{1/2} - \sin^{-1}(1-\beta)\right]$$

and

$\beta = D_f/R_o$

The D_f is computed by incrementing β from zero until the kinetic energy equals the crush energy. For the PWR and the BWR, velocities of 68 in/sec and 50 in/sec are computed, respectively. These result in the following accelerations and crush depths using the weights and heights of the five classes of the vertical concrete cask.

Vertical Concrete Cask Acceleration/Crush Summary

	Class 1	Class 2	Class 3	Class 4	Class 5
VCC Side Impact Acceleration (g)	32.5	32.6	32.7	26.3	26.3
Design Basis Tip-over Acceleration (A_d) in (g)	40	40	40	30	30
Dynamic Load Factor (DLF) for the Tip-over Evaluation	1.19	1.11	1.2	1.05	1.04
A_d/DLF	33.6	36.0	33.3	28.6	28.8
Crush (in)	.3	.3	.3	.2	.2

As indicated in the preceding table, the accelerations resulting from the impact are less than the factored accelerations (A_d/DLF) of the basket used in the PWR and BWR basket and canister evaluations. Therefore, the stresses and displacements of the basket and canister resulting from the tip-over evaluation bound the stresses and displacements resulting from a side impact of two vertical concrete casks.

11.2.8.3 Corrective Actions

Inspection of the vertical concrete casks is required following an earthquake event. As sliding may occur, the positions of the concrete casks should be verified or the casks shall be repositioned to ensure they maintain the 15-foot center-to-center spacing on the ISFSI pad established in Section 8.1.3. The temperature monitoring system should be checked for operation.

11.2.8.4 Radiological Impact

Minor radiological consequences may result if the concrete casks are required to be repositioned on the ISFSI pad.

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Chapter 12

12.0 OPERATING CONTROLS AND LIMITS

This chapter identifies operating controls and limits, technical parameters and surveillance requirements imposed to ensure the safe operation of the NAC-UMS® System.

Controls used by NAC International (NAC) as part of the NAC-UMS® design and fabrication are provided in the NAC Quality Assurance Manual and Quality Procedure. The NAC Quality Assurance Program is discussed in Chapter 13.0. If procurement and fabrication of the NAC-UMS® System is performed by others, a Quality Assurance Program prepared in accordance with 10 CFR 72 Subpart G shall be implemented. Site specific controls for the organization, administrative system, procedures, record keeping, review, audit and reporting necessary to ensure that the NAC-UMS® storage system installation is operated in a safe manner, are the responsibility of the user of the system.

12.1 Administrative and Operating Controls and Limits for the NAC-UMS® System

The NAC-UMS® Storage System operating controls and limits are summarized in Table 12-1. Appendix A of the CoC Number 1015 Technical Specifications provides the proposed Limiting Conditions for Operations (LCO). The Approved Contents and Design Features for the NAC-UMS® System are presented in Appendix B of the CoC Number 1015 Technical Specifications. The Bases for the specified controls and limits are presented in Appendix 12C.

Section 3.0 of Appendix B presents Design Features that are important to the safe operation of the NAC-UMS® System, but that are not included as Technical Specifications. These include items which are singular events, those that cannot be readily determined or re-verified at the time of use of the system, or that are easily implemented, verified and corrected, if necessary, at the time the action is undertaken.

12.2 Administrative and Operating Controls and Limits for SITE-SPECIFIC FUEL

This section describes the administrative and operating controls and limits placed on the loading of fuel assemblies that are unique to specific reactor sites. SITE-SPECIFIC FUEL configurations result from conditions that occurred during reactor operations, participation in research and development programs, testing programs intended to improve reactor operations, from the placement of control components or other items within the fuel assembly and from the disposition of damaged fuel assemblies or fuel rods.

SITE-SPECIFIC FUEL assembly configurations are either shown to be bounded by the analysis of the standard design basis fuel assembly configuration of the same type (PWR or BWR), or are shown to be acceptable contents by specific evaluation of the configuration. Separate evaluation may establish different limits, which are maintained by administrative controls for preferential loading. The preferential loading controls take advantage of design features of the UMS® Storage System to allow the loading of fuel configurations that may have higher burnup or additional hardware material that is not specifically considered in the design basis fuel evaluation.

Unless specifically excepted, SITE SPECIFIC FUEL must meet all of the conditions specified for the design basis fuel presented in Table 12-1.

12.2.1 Operating Controls and Limits for Maine Yankee SITE-SPECIFIC FUEL

The fuel design used at Maine Yankee is the Combustion Engineering (CE) 14 × 14 fuel assembly. The CE 14 × 14 fuel assembly is one of those included in the design basis evaluation of the UMS® Storage System as shown in Table B2-2 of Appendix B of Certificate of Compliance No. 72-1015. The estimated Maine Yankee SITE-SPECIFIC FUEL inventory is shown in Table B2-6. Except as noted in this section, the spent fuel in this inventory meets the Fuel Assembly Limits provided in Table B2-1.

As shown in Table B2-6, certain of the Maine Yankee fuel has characteristics, such as fuel assembly lattice configurations, different from STANDARD FUEL, from PWR INTACT FUEL ASSEMBLIES - including CONSOLIDATED FUEL, DAMAGED FUEL and fuel with higher burnup or enrichment, that differs from the characteristics of the fuel considered in the design basis. As shown in Table B2-6, certain fuel configurations must be preferentially loaded in corner or peripheral fuel tube positions in the fuel basket based on the shielding, criticality or thermal evaluation of the fuel configuration.

The corner positions are used for the loading of fuel configurations with missing fuel rods, and for DAMAGED FUEL and CONSOLIDATED FUEL in the MAINE YANKEE FUEL CAN. Specification for placement in the corner fuel tube positions results primarily from shielding or criticality evaluations of the designated fuel configurations.

Spent fuel having a burnup from 45,000 to 50,000 MWD/MTU is assigned to peripheral locations, and may require loading in a Maine Yankee fuel can. The interior locations must be loaded with fuel that has lower burnup and/or longer cool times in order to maintain the design basis heat load and component temperature limits for the basket and canister.

The Fuel Assembly Limits for the Maine Yankee SITE SPECIFIC FUEL are shown in Table B2-7 of Appendix B of the CoC Number 1015 Technical Specifications. Part A of the table lists the STANDARD, INTACT FUEL ASSEMBLY and SITE SPECIFIC FUEL that does not require preferential loading.

Part B of the table lists the SITE SPECIFIC FUEL configurations that require preferential loading due to the criticality, shielding or thermal evaluation. The loading pattern for Maine Yankee SITE SPECIFIC FUEL that must be preferentially loaded is presented in Section B 2.1.2. The preferential loading controls take advantage of design features of the UMS® Storage System to allow the loading of fuel configurations that may have higher burnup or additional hardware or fuel source material that is not specifically considered in the design basis fuel evaluation.

Fuel assemblies with a Control Element Assembly (CEA) or a CEA plug inserted are loaded in a Class 2 canister and basket due to the increased length of the assembly with either of these components installed. However, these assemblies are not restricted as to loading position within the basket.

The Transportable Storage Canister loading procedures for Maine Yankee SITE SPECIFIC FUEL are administratively controlled in accordance with the requirements of Section B 2.1.2 for the loading of: (1) a fuel configuration with removed fuel or poison rods, (2) a MAINE YANKEE FUEL CAN, or (3) fuel with burnup between 45,000 MWD/MTU and 50,000 MWD/MTU.

Table 12-1 NAC-UMS® System Controls and Limits

Control or Limit	Applicable Technical Specification	Condition or Item Controlled
1. Fuel Characteristics	Table B2-1	Type and Condition
	Table B2-2	Class, Dimensions and Weight for PWR
	Table B2-3	Class, Dimensions and Weight for BWR
	Table B2-4	Minimum Cooling Time for PWR Fuel
	Table B2-5	Minimum Cooling Time for BWR Fuel
	Table B2-7	Maine Yankee Site Specific Fuel Limits
	Table B2-8	Minimum Cooling Time for Maine Yankee Fuel – No CEA
	Table B2-9	Minimum Cooling Time for Maine Yankee Fuel – With CEA
2. Canister	LCO 3.1.4	Time in Transfer Cask (fuel loading)
Fuel Loading	Table B2-1	Weight and Number of Assemblies
	Table B2-7	Maine Yankee Site Specific Fuel Limits
	Table B2-4	Minimum Cooling Time for PWR Fuel
	Table B2-5	Minimum Cooling Time for BWR Fuel
Drying	LCO 3.1.2	Vacuum Drying Pressure
Backfilling	LCO 3.1.3	Helium Backfill Pressure
Sealing	LCO 3.1.5	Helium Leak Rate
Vacuum	LCO 3.1.1	Time in Vacuum Drying
External Surface	LCO 3.2.1	Level of Contamination
Unloading	Note 1	Fuel Cooldown Requirement
3. Concrete Cask	LCO 3.2.2	Surface Dose Rates
	Note 1	Cask Spacing
	Note 2	Cask Handling Height
4. Surveillance	LCO 3.1.6	Heat Removal System
5. Transfer Cask	B 3.4(8)	Minimum Temperature
6. ISFSI Concrete Pad	B3.4.1(6) B3.4.2(7)	Seismic Event Performance

1. Procedure and/or limits are presented in the Operating Procedures of Chapter 8.
2. Lifting height and handling restrictions are provided in Section A5.6 of Appendix A.

APPENDIX 12C

TECHNICAL SPECIFICATION BASES
FOR THE NAC-UMS® SYSTEM

Appendix 12C
Table of Contents

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.1 CANISTER Maximum Time in Vacuum Drying

BASES

BACKGROUND	A TRANSFER CASK with an empty CANISTER is placed into the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents limits. A shield lid is then placed on the CANISTER. The TRANSFER CASK and CANISTER are raised out of the spent fuel pool. The TRANSFER CASK and CANISTER are then moved to a preparation area, where dose rates are measured and the CANISTER shield lid is welded to the CANISTER shell and the lid weld is examined, pressure tested, and leak tested. The water is drained from the CANISTER, and CANISTER cavity vacuum drying is performed. The CANISTER cavity is then backfilled with helium. Additional dose rates are measured, and the CANISTER vent port and drain port covers and structural lid are installed and welded. Non-destructive examinations are performed on the welds. Contamination measurements are completed prior to moving the TRANSFER CASK and CANISTER in position to transfer the CANISTER to the CONCRETE CASK. After the CANISTER is transferred, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad. Limiting the elapsed time from the end of CANISTER draining operations through dryness verification testing and subsequent backfilling of the CANISTER with helium ensures that the short-term temperature limits established in the Safety Analyses Report for the spent fuel cladding and CANISTER materials are not exceeded and that the test duration of 30 days (720 hours) considered in PNL-4835 for zirconium alloy clad fuel for storage in air is not exceeded.
APPLICABLE SAFETY ANALYSIS	Limiting the total time for loaded CANISTER vacuum drying operations ensures that the short-term temperature limits for the fuel cladding and CANISTER materials are not exceeded. If vacuum drying operations are not completed in the required time period, the CANISTER is backfilled with helium and cooled for a minimum of 24 hours of in-pool cooling or forced air cooling.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)	Analyses reported in the Safety Analysis Report conclude that spent fuel cladding and CANISTER material short-term temperature limits will not be exceeded for total elapsed time in the vacuum drying operation and in the TRANSFER CASK with the CANISTER filled with helium. Since the rate of heat up is slower for lower total heat loads, the time required to reach component limits is longer than for the design basis heat load. Consequently, longer time limits are specified for heat loads below the design basis for the PWR and BWR fuel configurations as shown in LCO 3.1.1. As shown in the LCO, for total heat loads not specified, the time limit for the next higher specified heat load is conservatively applied. Analyses show that the fuel cladding and CANISTER component temperatures are below the allowable temperatures for the time durations specified from the completion of CANISTER draining, or from the end of in-pool cooling or forced air cooling, through the completion of vacuum drying, dryness verification testing per LCO 3.1.2, and the helium backfill process per LCO 3.1.3[(1)]. Following completion of helium backfill, the fuel cladding and CANISTER temperatures are also maintained within allowable limits for the time(s) specified in LCO 3.1.4 for the helium-filled CANISTER in the TRANSFER CASK through completion of the transfer of the CANISTER to the CONCRETE CASK.
LCO	Limiting the length of time for vacuum drying operations through completion of the helium backfill operations for the CANISTER ensures that the spent fuel cladding and CANISTER material temperatures remain below the short-term temperature limits for the NAC-UMS® SYSTEM.
APPLICABILITY	The elapsed time restrictions for vacuum drying operations on a loaded CANISTER apply during LOADING OPERATIONS from the completion of CANISTER draining operations through completion of dryness verification testing per LCO 3.1.2 and the completion of the helium backfill process per LCO 3.1.3[(1)]. LCO 3.1.1 is not applicable to TRANSPORT OPERATIONS or STORAGE OPERATIONS.

(continued)

ACTIONS

A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each NAC-UMS® SYSTEM. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each NAC-UMS® SYSTEM not meeting the LCO. Subsequent NAC-UMS® SYSTEMS that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1
If the LCO time limit is exceeded, the CANISTER will be backfilled with helium to a pressure of 0 psig (+1,-0).

AND

A.2.1.1
The TRANSFER CASK containing the loaded CANISTER shall be placed in the spent fuel pool. For in-pool cooling operations with the TRANSFER CASK and loaded CANISTER submerged, the annulus fill system is not required to be operating. If only the loaded CANISTER is submerged for in-pool cooling, the annulus fill system is required to be operating.

AND

A.2.1.2
The TRANSFER CASK and loaded CANISTER shall be maintained in the spent fuel pool with the water level above the top of the CANISTER, and a maximum water temperature of 100°F for a minimum of 24 hours prior to the restart of LOADING OPERATIONS.

OR

A.2.2.1
A cooling air flow of 375 CFM at a maximum temperature of 76°F shall be initiated. The airflow will be routed to the annulus fill/drain lines of the TRANSFER CASK and will flow through the annulus and cool the CANISTER.

AND

A.2.2.2
The cooling air flow shall be maintained for a minimum of 24 hours prior to restart of LOADING OPERATIONS.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.1.1.1

The elapsed time shall be monitored from completion of CANISTER draining through completion of the vacuum dryness verification testing per LCO 3.1.2 and completion of the helium backfill process per LCO 3.1.3[1]. Monitoring the elapsed time ensures that if the drying process is not completed in the prescribed time, the CANISTER can be backfilled with helium and in-pool or forced air cooling operations initiated in a timely manner during LOADING OPERATIONS to prevent fuel cladding and CANISTER materials from exceeding short-term temperature limits.

SR 3.1.1.2

The elapsed time shall be monitored from the end of in-pool cooling or forced air cooling of the CANISTER through completion of vacuum dryness verification testing per LCO 3.1.2 and the completion of the helium backfill process per LCO 3.1.3[1]. Monitoring the elapsed time ensures that if the drying process is not completed in the prescribed time, the CANISTER can be backfilled with helium and in-pool or forced air cooling initiated in a timely manner during LOADING OPERATIONS to prevent the fuel cladding and CANISTER materials from exceeding short-term temperature limits.

REFERENCES

1. FSAR Sections 4.4 and 8.1.

Note:
[1] LCO 3.1.1, SR 3.1.1.1 and SR 3.1.1.2 specify time limitations and monitoring requirements for the allowable duration(s) from completion of draining of the CANISTER, or from the completion of in-pool or forced air cooling of the CANISTER, through completion of vacuum drying testing and the "introduction" of helium. Clarifications have been added to the Bases of LCO 3.1.1 to highlight that the introduction and start of helium backfill defines the system configuration that is established following completion of final helium pressure adjustment of the CANISTER as specified in LCO 3.1.3.

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.2 CANISTER Vacuum Drying Pressure

BASES

BACKGROUND	A TRANSFER CASK with an empty CANISTER is placed into the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents Limits. A shield lid is then placed on the CANISTER. The TRANSFER CASK and CANISTER are raised out of the spent fuel pool. The TRANSFER CASK and CANISTER are then moved to a preparation area, where dose rates are measured and the CANISTER shield lid is welded to the CANISTER shell and the lid weld is examined, pressure tested, and leak tested. The water is drained from the CANISTER, and CANISTER cavity vacuum drying is performed. The CANISTER cavity is then backfilled with helium. Additional dose rates are measured, and the CANISTER vent port and drain port covers and structural lid are installed and welded. Non-destructive examinations are performed on the welds. Contamination measurements are completed prior to moving the TRANSFER CASK and CANISTER in position to transfer the CANISTER to the CONCRETE CASK. After the CANISTER is transferred, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad. CANISTER cavity vacuum drying is utilized to remove residual moisture from the CANISTER cavity after the water is drained from the CANISTER. Any water not drained from the CANISTER cavity evaporates due to the vacuum. This is aided by the temperature increase, due to the heat generation of the fuel.
APPLICABLE SAFETY ANALYSIS	The confinement of radioactivity (including fission product gases, fuel fines, volatiles, and crud) during the storage of design basis spent fuel in the CANISTER is ensured by the multiple confinement boundaries and systems. The barriers relied on are: the fuel pellet matrix, the metallic fuel cladding tubes where the fuel pellets are contained, and the CANISTER where the fuel assemblies are stored. Long-term integrity of the fuel and cladding depends on storage in an inert atmosphere. This is accomplished by removing water from the CANISTER and backfilling the cavity with helium. The thermal analysis assumes that the CANISTER cavity is dried and filled with helium.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)	The heat-up of the CANISTER and contents will occur during CANISTER vacuum drying, but is controlled by LCO 3.1.1. Dryness of the CANISTER (e.g., no free water) is verified by holding a vacuum of ≤10 mm Hg for a period of not less than 10 minutes. The vapor pressure of water at 70°F is approximately 20 mm Hg. Selecting a pressure that is 1/2 of the vapor pressure at 70°F ensures that all of the free water in the CANISTER is removed without excursion to a low vacuum condition that could lead to icing. The actual temperature in the loaded CANISTER is expected to be above 70°F, which would result in a higher vapor pressure. Consequently, the vacuum pressure of 10 mm Hg is conservatively selected. Holding the vacuum pressure of ≤10 mm of mercury for 10 minutes, with the CANISTER isolated from the vacuum pump and the pump turned off, demonstrates that there is no free water in the CANISTER, since the presence of any significant free water would result in the vacuum pressure increasing in a short period of time to the vapor pressure corresponding to the average temperature of the CANISTER and contents.
LCO	A vacuum pressure of ≤10 mm of mercury, as specified in this LCO, indicates that liquid water has evaporated and been removed from the CANISTER cavity. Removing water from the CANISTER cavity helps to ensure the long-term maintenance of fuel cladding integrity.
APPLICABILITY	Cavity vacuum drying is performed during LOADING OPERATIONS before the TRANSFER CASK holding the CANISTER is moved to transfer the CANISTER into the CONCRETE CASK. Therefore, the vacuum requirements do not apply after the CANISTER is backfilled with helium and leak tested prior to TRANSPORT OPERATIONS and STORAGE OPERATIONS.
ACTIONS	A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each CANISTER. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER not meeting the LCO. Subsequent CANISTERs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

(continued)

ACTIONS (continued)

A.1

If the CANISTER cavity vacuum drying pressure limit cannot be met, actions must be taken to meet the LCO. Failure to successfully complete cavity vacuum drying could have many causes, such as failure of the vacuum drying system, inadequate draining, ice clogging of the drain lines, or leaking CANISTER welds. The Completion Time is sufficient to determine and correct most failure mechanisms. Excessive heat-up of the CANISTER and contents is precluded by LCO 3.1.1.

B.1

If the CANISTER fuel cavity cannot be successfully vacuum dried, the fuel must be placed in a safe condition. Corrective actions may be taken after the fuel is placed in a safe condition to perform the A.1 action provided that the initial conditions for performing A.1 are met.

A.1 may be repeated as necessary prior to performing B.1. The time frame for completing B.1 can not be extended by re-performing A.1. The Completion Time is reasonable, based on the time required to reflood the CANISTER, perform fuel cooldown operations, cut the shield lid weld, move the TRANSFER CASK into the spent fuel pool, and remove the CANISTER shield lid in an orderly manner and without challenging personnel.

SURVEILLANCE REQUIREMENTS

SR 3.1.2.1

The long-term integrity of the stored fuel is dependent on storage in a dry, inert environment. Cavity dryness is demonstrated by evacuating the cavity to a very low absolute pressure and verifying that the pressure remains below a specified vapor pressure for a specific period of time. A low vacuum pressure is an indication that the cavity is dry. The surveillance must be performed prior to TRANSPORT OPERATIONS, as the vacuum drying pressure must be achieved before the CANISTER is sealed. This allows sufficient time to backfill the CANISTER cavity with helium, while minimizing the time the fuel is in the CANISTER without water or the assumed inert atmosphere in the cavity.

REFERENCES

1. FSAR Sections 4.4, 7.1 and 8.1.

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.3 CANISTER Helium Backfill Pressure

BASES

BACKGROUND	A TRANSFER CASK with an empty CANISTER is placed into the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents limits. A shield lid is then placed on the CANISTER. The TRANSFER CASK and CANISTER are raised out of the spent fuel pool. The TRANSFER CASK and CANISTER are then moved to a preparation area, where dose rates are measured and the CANISTER shield lid is welded to the CANISTER shell and the lid weld is examined, pressure tested, and leak tested. The water is drained from the CANISTER, and CANISTER cavity vacuum drying is performed. The CANISTER cavity is then evacuated to ≤3 mm of mercury to remove any residual oxidizing gases and the cavity is backfilled with helium. Additional dose rates are measured, and the CANISTER vent port and drain port covers and structural lid are installed and welded. Non-destructive examinations are performed on the welds. Contamination measurements are completed prior to moving TRANSFER CASK and CANISTER in position to transfer the CANISTER to the CONCRETE CASK. After the CANISTER is transferred, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad. Evacuating and backfilling of the CANISTER cavity with helium removes residual oxidizing gases to ≤1 mole, promotes heat transfer from the spent fuel to the CANISTER structure and protects the fuel cladding. Providing a helium pressure equal to atmospheric pressure ensures that there will be no in-leakage of air over the life of the CANISTER, which might be harmful to the heat transfer features of the NAC-UMS® SYSTEM and harmful to the fuel.
APPLICABLE SAFETY ANALYSIS	The confinement of radioactivity (including fission product gases, fuel fines, volatiles, and crud) during the storage of spent fuel in the CANISTER is ensured by the multiple confinement boundaries and systems. The barriers relied on are: the fuel pellet matrix, the metallic fuel cladding tubes where the fuel pellets are contained, and the CANISTER where the fuel assemblies are stored. Long-term integrity of the fuel and cladding depends on the ability of the NAC-UMS® SYSTEM to remove heat from the CANISTER and reject it to the

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

environment. This is accomplished by removing water from the CANISTER cavity and backfilling the cavity with an inert gas. The heat-up of the CANISTER and contents will continue following backfilling with helium, but is controlled by LCO 3.1.4.

The thermal analyses of the CANISTER assume that the CANISTER cavity is dried and filled with dry helium.

LCO

Backfilling the CANISTER cavity with helium at a pressure equal to atmospheric pressure ensures that there is no air in-leakage into the CANISTER, which could decrease the heat transfer properties and result in increased cladding temperatures and damage to the fuel cladding over the storage period. The helium backfill pressure of 0 psig specified in this LCO was selected based on a minimum helium purity of 99.9% to ensure that the CANISTER internal pressure and heat transfer from the CANISTER to the environment are maintained consistent with the design and analysis basis of the CANISTER.

APPLICABILITY

Helium backfill is performed during LOADING OPERATIONS, before the TRANSFER CASK and CANISTER are moved to the CONCRETE CASK for transfer of the CANISTER. Therefore, the backfill pressure requirements do not apply after the CANISTER is backfilled with helium and leak tested prior to TRANSPORT OPERATIONS and STORAGE OPERATIONS.

ACTIONS

A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each CANISTER. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER not meeting the LCO. Subsequent CANISTERs that do not meet the LCO are governed by subsequent condition entry and application of associated Required Actions.

A.1

If the backfill pressure cannot be established within limits, actions must be taken to meet the LCO. The Completion Time is sufficient to determine and correct most failures, which would prevent backfilling of the CANISTER cavity with helium. These actions include identification and repair of helium leak paths or replacement of the helium backfill equipment. In addition, the CANISTER can be maintained in a safe condition based on the use of forced air cooling or water cooling.

(continued)

ACTIONS (continued)

B.1

If the CANISTER cavity cannot be backfilled with helium to the specified pressure, the fuel must be placed in a safe condition. Corrective actions may be taken after the fuel is placed in a safe condition to perform the A.1 action provided that the initial conditions for performing A.1 are met. A.1 may be repeated as necessary prior to performing B.1. The time frame for completing B.1 cannot be extended by reperforming A.1. The Completion Time is reasonable based on the time required to re-flood the CANISTER, perform cooldown operations, cut the CANISTER shield lid weld, move the TRANSFER CASK and CANISTER into the spent fuel pool, remove the CANISTER shield lid, and remove the spent fuel assemblies in an orderly manner and without challenging personnel.

SURVEILLANCE REQUIREMENTS

SR 3.1.3.1

The long-term integrity of the stored fuel is dependent on storage in a dry, inert atmosphere and maintenance of adequate heat transfer mechanisms. Filling the CANISTER cavity with helium at a pressure within the range specified in this LCO will ensure that there will be no air in-leakage, which could potentially damage the fuel. This pressure of helium gas is sufficient to maintain fuel cladding temperatures within acceptable levels.

Backfilling of the CANISTER cavity must be performed successfully on each CANISTER before placing it in storage. The surveillance must verify that the CANISTER helium backfill pressure is within the limit specified prior to installation of the structural lid.

REFERENCES

1. FSAR Sections 4.4, 7.1 and 8.1.

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.4 CANISTER Maximum Time in the TRANSFER CASK

BASES

BACKGROUND

A TRANSFER CASK with an empty CANISTER is placed into the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents limits. A shield lid is then placed on the CANISTER. The TRANSFER CASK and CANISTER are raised out of the spent fuel pool. The TRANSFER CASK and CANISTER are then moved to a preparation area, where dose rates are measured and the CANISTER shield lid is welded to the CANISTER shell and the lid weld is examined, pressure tested, and leak tested. The water is drained from the CANISTER, and CANISTER cavity vacuum drying is performed. The CANISTER cavity is then backfilled with helium. Additional dose rates are measured, and the CANISTER vent port and drain port covers and structural lid are installed and welded. Non-destructive examinations are performed on the welds. Contamination measurements are completed prior to moving TRANSFER CASK and CANISTER in position to transfer the CANISTER to the CONCRETE CASK. After the CANISTER is transferred, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad.

Backfilling the CANISTER cavity with helium promotes heat transfer from the fuel and the inert atmosphere protects the fuel cladding. The cumulative time a loaded, helium backfilled CANISTER may remain in the TRANSFER CASK is limited to 600 hours. This limit ensures that the test duration of 30 days (720 hours) considered in PNL-4835 for zirconium alloy clad fuel for storage in air is not exceeded and ensures that the TRANSFER CASK is used as intended. The time limit is established to preclude long-term storage of a loaded CANISTER in the TRANSFER CASK.

Intermediate time limits are established for CANISTERS with heat loads above 20 kW (PWR) or 17 kW (BWR) if they are not in either forced air cooling or in-pool cooling. These intermediate limits assure that the short-term temperature limits established in the Safety Analysis Report for the spent fuel cladding and CANISTER materials are not exceeded. Placing the CANISTER in either forced air cooling or in-pool cooling for a minimum of 24 hours maintains temperatures within the short-term limits. For heat loads less than or equal to 20kW (PWR) or 17kW (BWR), neither forced air cooling nor in-pool cooling is required.

(continued)

APPLICABLE SAFETY ANALYSIS

Analyses reported in the Safety Analysis Report conclude that for heat loads greater than 20 kW (PWR) or greater than 17 kW (BWR), spent fuel cladding and CANISTER material short-term temperature limits will not be exceeded for the total elapsed times specified in LCO 3.1.4. As shown in the LCO, for total heat loads not specified, the time limit for the next higher specified heat load is conservatively applied. The thermal analysis shows that the fuel cladding and CANISTER component temperatures are below their allowable temperatures for the time durations specified, with the CANISTER in the TRANSFER CASK and backfilled with helium, after completion of 24 hours of in-pool cooling or forced air cooling. For lower heat loads, the steady state fuel cladding and component temperatures are below the allowable temperatures.

The basis for forced air cooling is an inlet maximum air temperature of 76°F which is the maximum normal ambient air temperature in the thermal analysis. The specified 375 CFM air flow rate exceeds the CONCRETE CASK natural convective cooling flow rate by a minimum of 10 percent. This comparative analysis conservatively excludes the higher flow velocity resulting from the smaller annulus between the TRANSFER CASK and CANISTER, which would result in improved heat transfer from the CANISTER.

From calculated temperatures reported in the Safety Analysis Report, it can be concluded that spent fuel cladding and CANISTER material short-term temperature limits will not be exceeded for a total elapsed time of greater than 20 hours for PWR fuel or 30 hours for BWR fuel for high heat loads, if the loaded CANISTER backfilled with helium is in the TRANSFER CASK. A 2 hour completion time is provided to establish in-pool or forced airflow cooling to ensure cooling of the CANISTER.

For heat loads of 20 kW or less (PWR), or 17 kW or less (BWR), and with the CANISTER backfilled with helium, the analysis shows that the fuel cladding and CANISTER components reach a steady-state temperature below the short-term allowable temperatures. Therefore, the time in the TRANSFER CASK is limited to 600 hours. For heat loads greater than 20 kW (PWR) or greater than 17 kW (BWR), and if the intermediate time is exceeded, the analysis shows that if in-pool cooling or forced air cooling at 375 CFM with air at 76°F is used, the temperatures of the fuel cladding and CANISTER components will not exceed short-term temperature limits.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

This limit ensures that the test duration of 30 days (720 hours) considered in PNL-4835 for zirconium alloy clad fuel for storage in air is not exceeded and ensures that the TRANSFER CASK is used as intended. Since the 600 hours is significantly less than the 720 hours considered in PNL-4835, operation in the TRANSFER CASK to this period is acceptable.

Since the cooling provided by the forced air is equivalent to the passive cooling provided by the CONCRETE CASK and TRANSPORT CASK, relocation of a loaded and helium-filled CANISTER to a CONCRETE CASK or TRANSPORT CASK ensures that the fuel cladding and CANISTER component short-term temperature limits are not exceeded.

LCO

For PWR heat loads less than or equal to 20 kW, and BWR heat loads less than or equal to 17 kW, the thermal analysis shows that the presence of helium in the CANISTER is sufficient to maintain the fuel cladding and CANISTER component temperatures below the short-term temperature limits. Therefore, forced air cooling or in-pool cooling is not required for these heat load conditions.

For higher heat loads of these fuels, as shown in the LCO, once forced air cooling or in-pool cooling is established, the amount of time the CANISTER resides in the TRANSFER CASK is not limited by the intermediate time limits; since the cooling provided by the forced air or water is equivalent to the passive cooling that is provided by the CONCRETE CASK or TRANSPORT CASK. If forced air flow or in-pool cooling is continuously maintained for a period of 24 hours, or longer, then the temperatures of the spent fuel cladding and CANISTER components are at, or below, the values calculated for the CONCRETE CASK normal conditions. Therefore, forced air cooling or in-pool cooling may be ended, allowing a new entry into Condition A of this LCO. This provides a new period in which continuation of LOADING OPERATIONS, TRANSFER OPERATIONS or UNLOADING OPERATIONS for high heat load PWR and BWR fuel may occur.

Similarly, in LOADING OPERATIONS, TRANSFER OPERATIONS or UNLOADING OPERATIONS for heat loads up to the design basis, continuous forced air cooling or in-pool cooling maintains the fuel cladding and CANISTER component temperatures below the short-term temperature limits. Therefore, the CANISTER may remain in the TRANSFER CASK for up to 600 hours, where the time limit is based on the test duration of 30 days (720 hours) considered in PNL-4835 for zirconium alloy clad fuel for storage in air rather than on temperature limits.

(continued)

APPLICABILITY	For LOADING OPERATIONS, the elapsed time restrictions on the loaded CANISTER apply from the completion point of the CANISTER helium backfilling through completion of the transfer from the TRANSFER CASK to the CONCRETE CASK and installing the CONCRETE CASK shield plug and cask lid. For TRANSFER OPERATIONS, the elapsed time restrictions on the loaded CANISTER apply from the completion point of the closing of the TRANSFER CASK shield doors through completion of the unloading of the CANISTER from the TRANSFER CASK. For UNLOADING OPERATIONS, the elapsed time restrictions on the loaded CANISTER apply from the completion point of the closing of the TRANSFER CASK shield doors through initiation of CANISTER cooldown.
ACTIONS	A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each NAC-UMS® SYSTEM. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each NAC-UMS® SYSTEM not meeting the LCO. Subsequent NAC-UMS® SYSTEMS that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions. A note has been added to Condition A that reminds users that all time spent in Condition A is included in the 600-hour cumulative limit. If LCO 3.1.4 intermediate time is exceeded: <u>A.1.1</u> The TRANSFER CASK containing the loaded CANISTER shall be placed in the spent fuel pool. For in-pool cooling operations with the TRANSFER CASK and loaded CANISTER submerged, the annulus fill system is not required to be operating. If only the loaded CANISTER is submerged for in-pool cooling, the annulus fill system is required to be operating. <u>AND</u> <u>A.1.2</u> The TRANSFER CASK and a loaded CANISTER shall be maintained in the spent fuel pool having a maximum water temperature of 100°F for a minimum of 24 hours prior to restart of LOADING OPERATIONS, TRANSFER OPERATIONS or UNLOADING OPERATIONS.

(continued)

ACTIONS (continued)	OR A.2.1 A cooling air flow of 375 CFM at a maximum temperature of 76° F shall be initiated. The airflow will be routed to the annulus fill/drain lines in the TRANSFER CASK and will flow through the annulus and cool the CANISTER. AND A.2.2 The cooling air flow shall be maintained for a minimum of 24 hours prior to restart of LOADING OPERATIONS, TRANSFER OPERATIONS or UNLOADING OPERATIONS. If the LCO 3.1.4. 600-hour cumulative time limit is exceeded: B.1 The CANISTER shall be placed in a CONCRETE CASK. OR B.2 The CANISTER shall be placed in a TRANSPORT CASK. OR B.3 The CANISTER shall be unloaded. The 5-day Completion Time for Required Actions B.1, B.2, and B.3 assures that the PNL-4835 30-day test duration used to establish the LCO limit will not be exceeded, taking into account the 600 hours allowed by the LCO.
SURVEILLANCE REQUIREMENTS	SR 3.1.4.1 The elapsed time from entry into the LCO conditions of Applicability until placement of the CANISTER in a CONCRETE CASK or TRANSPORT CASK, or until CANISTER cooldown is initiated for UNLOADING OPERATIONS shall be monitored. This SR ensures that the fuel cladding and CANISTER component temperature limits are not exceeded.
REFERENCES	1. FSAR Sections 4.4, 8.1 and 8.2.

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.5 CANISTER Helium Leak Rate

BASES

BACKGROUND	A TRANSFER CASK with an empty CANISTER is placed into the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents limits. A shield lid is then placed on the CANISTER. The TRANSFER CASK and CANISTER are raised out of the spent fuel pool. The TRANSFER CASK and CANISTER are then moved to a preparation area, where dose rates are measured and the CANISTER shield lid is welded to the CANISTER shell and the lid weld is examined, pressure tested, and leak tested. The water is drained from the CANISTER, and CANISTER cavity vacuum drying is performed. The CANISTER cavity is then backfilled with helium. Additional dose rates are measured, and the CANISTER vent port and drain port covers and structural lid are installed and welded. Non-destructive examinations are performed on the welds. Contamination measurements are completed prior to moving TRANSFER CASK and CANISTER in position to transfer the CANISTER to the CONCRETE CASK. After the CANISTER is transferred, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad. Backfilling the CANISTER cavity with helium promotes heat transfer from the fuel to the CANISTER shell. The inert atmosphere protects the fuel cladding. Prior to transferring the CANISTER to the CONCRETE CASK, the CANISTER helium leak rate is verified to meet leaktight requirements to ensure that the fuel and helium backfill gas is confined.
APPLICABLE SAFETY ANALYSIS	The confinement of radioactivity (including fission product gases, fuel fines, volatiles, and crud) during the storage of spent fuel in the CANISTER is ensured by the multiple confinement boundaries and systems. The barriers relied on are: the fuel pellet matrix, the metallic fuel cladding tubes where the fuel pellets are contained, and the CANISTER where the fuel assemblies are stored. Long-term integrity of the fuel and cladding depends on maintaining an inert atmosphere, and maintaining the cladding temperatures below established long-term limits. This is accomplished by removing water from the CANISTER and backfilling the cavity with helium. The heat-up of the CANISTER and contents will continue following backfilling the cavity and leak testing the shield lid-to-shell weld, but is controlled by LCO 3.1.4.

(continued)

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.6 CONCRETE CASK Heat Removal System

BASES

BACKGROUND	The CONCRETE CASK Heat Removal System is a passive, air-cooled convective heat transfer system, which ensures that heat from the CANISTER is transferred to the environment by the upward flow of air through the CONCRETE CASK. Relatively cool air is drawn into the annulus between the CONCRETE CASK and the CANISTER through the four air inlets at the bottom of the CONCRETE CASK. The CANISTER transfers its heat from the CANISTER surface to the air via natural convection. The buoyancy created by the heating of the air creates a chimney effect and the air flows back into the environment through the four air outlets at the top of the CONCRETE CASK.
APPLICABLE SAFETY ANALYSIS	The thermal analyses of the CONCRETE CASK take credit for the decay heat from the spent fuel assemblies being ultimately transferred to the ambient environment surrounding the CONCRETE CASK. Transfer of heat away from the fuel assemblies ensures that the fuel cladding and CANISTER component temperatures do not exceed applicable limits. Under normal storage conditions, the four air inlets and four air outlets are unobstructed and full air flow (i.e., maximum heat transfer for the given ambient temperature) occurs. Analyses have been performed for the complete obstruction of all of the air inlets and outlets. The complete blockage of all air inlets and outlets stops air cooling of the CANISTER. The CANISTER will continue to radiate heat to the relatively cooler inner shell of the CONCRETE CASK. With the loss of air cooling, the CANISTER component temperatures will increase toward their respective short-term temperature limits. The limiting components are the CANISTER basket support and heat transfer disks, which, by analysis, approach their temperature limits in 24 hours, if no action is taken to restore air flow to the heat removal system. The maximum fuel clad temperatures remain below allowable accident limits for approximately six days (150 hours) with complete air flow blockage.
LCO	The CONCRETE CASK Heat Removal System must be verified to be OPERABLE to preserve the assumptions of the thermal analyses.

(continued)

LCO (continued)	Operability of the heat removal system ensures that the decay heat generated by the stored fuel assemblies is transferred to the environment at a sufficient rate to maintain fuel cladding and CANISTER component temperatures within design limits.
APPLICABILITY	The LCO is applicable during STORAGE OPERATIONS. Once a CONCRETE CASK containing a CANISTER loaded with spent fuel has been placed in storage, the heat removal system must be OPERABLE to ensure adequate heat transfer of the decay heat away from the fuel assemblies.
ACTIONS	A note has been added to ACTIONS that states for this LCO, separate Condition entry is allowed for each CONCRETE CASK. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each CONCRETE CASK not meeting the LCO. Subsequent CONCRETE CASKs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the CONCRETE CASK heat removal system has been determined to not be OPERABLE, it must be restored to an analyzed safe status immediately, with adequate heat removal capability. Immediately, defined as the required action to be pursued without delay and in a controlled manner, provides a reasonable period of time (typically, one operating shift) to take action to remove the obstructions in the air flow path.

In order to meet A.1, adequate heat removal capability must be verified to exist, either by visual observation of at least two unobstructed air inlet and outlet screens or by physically clearing any blockage from two air inlet and outlet screens, to prevent exceeding the short-term temperature limits.

Thermal analysis of a fully blocked CONCRETE CASK shows that without adequate heat removal, the fuel cladding accident temperature limit could be exceeded over time. As a result, requiring immediate verification of adequate heat removal capability will ensure that the CONCRETE CASK and CANISTER components and the fuel cladding do not exceed their short-term temperature limits.

The thermal analysis also shows that complete blockage of two air inlet and outlet screens results in no potential for exceeding accident fuel cladding, CONCRETE CASK or CANISTER component temperature limits. As a result, verifying that there are at least two unobstructed

(continued)

ACTIONS (continued)

air inlet and outlet screens will ensure that the accident temperature limits are not exceeded during the time that the remainder of the air linlet and outlet screens are returned to OPERABLE status.

AND

A.2

In addition to Required Action A.1, the fuel loading per the Approved Contents condition of the CoC is verified.

The Completion Time for this Required Action of 7 days will ensure that the CANISTER remains in a safe, analyzed condition.

AND

A.3

In addition to Required Actions A.1 and A.2 that ensure the adequate heat removal capability and verify the fuel loading, restoring the CONCRETE CASK Heat Removal System to OPERABLE is not an immediate concern. Therefore, restoring it within 25 days is considered a reasonable period of time.

B.1

If the Required Actions A.1, A.2 or A.3 cannot be met, an engineering evaluation is performed to verify that the CONCRETE CASK heat removal system is OPERABLE.

The Completion Time for this Required Action of 5 days will ensure that the CANISTER remains in a safe, analyzed condition.

OR

B.2

Place the affected NAC-UMS SYSTEM in a safe condition.

The Completion Time for this Required Action is 5 days. Requiring B.2 action completion within 5 days will ensure that the NAC-UMS SYSTEM is maintained in a safe condition.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.1.6.1

The long-term integrity of the stored fuel is dependent on the ability of the CONCRETE CASK to reject heat from the CANISTER to the environment. Visual observation that all four air inlet and outlet screens are unobstructed and intact ensures that air flow past the CANISTER is occurring and heat transfer is taking place. Complete blockage of one or more air inlet or outlet screens renders the heat removal system inoperable and this LCO is not met. Partial blockage of one or more air inlet or outlet screens does not constitute inoperability of the heat removal system. However, corrective actions should be taken promptly to remove the obstruction and restore full flow through the affected air inlet and outlet screens. Alternatively, based on the analyses, if the air temperature rise is less than the limits stated in the SR, adequate air flow and, therefore, adequate heat transfer is occurring to provide assurance of long-term fuel cladding integrity. The reference ambient temperature used to perform this Surveillance shall be measured at the ISFSI facility.

The Frequency of 24 hours is reasonable based on the time necessary for CONCRETE CASK and CANISTER components to heat up to unacceptable temperatures assuming design basis heat loads, and allowing for corrective actions to take place upon discovery of the blockage of the air inlet and outlet screens.

REFERENCES

1. FSAR Chapter 4 and Chapter 11, Section 11.1.2 and Section 11.2.13.

C 3.2 NAC-UMS® SYSTEM Radiation Protection

C 3.2.1 CANISTER Surface Contamination

BASES

BACKGROUND	A TRANSFER CASK containing an empty CANISTER is immersed in the spent fuel pool in order to load the spent fuel assemblies. The external surfaces of the CANISTER are maintained clean by the application of clean water to the annulus of the TRANSFER CASK. However, there is potential for the surface of the CANISTER to become contaminated with the radioactive material in the spent fuel pool water. Contamination exceeding LCO limits is removed prior to moving the CONCRETE CASK containing the CANISTER to the ISFSI in order to minimize the radioactive contamination to personnel or the environment. This allows the ISFSI to be entered without additional radiological controls to prevent the spread of contamination and reduces personnel dose due to the spread of loose contamination or airborne contamination. This is consistent with ALARA practices.
APPLICABLE SAFETY ANALYSIS	The radiation protection measures implemented at the ISFSI are based on the assumption that the exterior surfaces of the CANISTER are not significantly contaminated. Failure to decontaminate the surfaces of the CANISTER to below the LCO limits could lead to higher-than-projected occupational dose and potential site contamination.
LCO	Removable surface contamination on the exterior surfaces of the CANISTER is limited to 10,000 dpm/100 cm^2 from beta and gamma sources and 100 dpm/100 cm^2 from alpha sources. Only loose contamination is controlled, as fixed contamination will not result from the CANISTER loading process. Experience has shown that these limits are low enough to prevent the spread of contamination to clean areas and are significantly less than the levels that could cause significant personnel skin dose.

(continued)

LCO (continued)

LCO 3.2.1 requires removable contamination to be within the specified limits for the exterior surfaces of the CANISTER. Compliance with this LCO may be verified by direct and/or indirect methods. The location and number of CANISTER and TRANSFER CASK surface swipes used to determine compliance with this LCO are determined based on standard industry practice and the user's plant-specific contamination measurement program for objects of this size. The objective is to determine a removable contamination value representative of the entire CANISTER surface area, while implementing sound ALARA practices.

Swipes and measurements of removable surface contamination levels on the interior surfaces of the TRANSFER CASK may be performed to verify the CANISTER LCO limits following transfer of the CANISTER to the CONCRETE CASK. These measurements will provide indirect indications regarding the removable contamination on the exterior surfaces of the CANISTER.

APPLICABILITY

Verification that the exterior surface contamination of the CANISTER is less than the LCO limits is performed during LOADING OPERATIONS. This occurs before TRANSPORT OPERATIONS and STORAGE OPERATIONS. Measurement of the CANISTER surface contamination is unnecessary during UNLOADING OPERATIONS, as surface contamination would have been measured prior to moving the subject CANISTER to the ISFSI.

(continued)

ACTIONS

A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each CANISTER LOADING OPERATION. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER not meeting the LCO. Subsequent CANISTERs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the removable surface contamination of the CANISTER that has been loaded with spent fuel is not within the LCO limits, action must be initiated to decontaminate the CANISTER and bring the removable surface contamination to within limits. The Completion Time of prior TRANSPORT OPERATIONS is appropriate, given that the time needed to complete the decontamination is indeterminate and surface contamination does not affect the safe storage of the spent fuel assemblies.

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1

This SR verifies (either directly or indirectly) that the removable surface contamination on the exterior surfaces of the CANISTER is less than the limits in the LCO. The Surveillance is performed using smear surveys to detect removable surface contamination. The Frequency requires performing the verification prior to initiating TRANSPORT OPERATIONS in order to confirm that the CANISTER can be moved to the ISFSI without spreading loose contamination.

REFERENCES

1. FSAR Section 8.1.
2. NRC IE Circular 81-07.

C 3.2 NAC-UMS® SYSTEM Radiation Protection

C 3.2.2 CONCRETE CASK Average Surface Dose Rates

BASES

BACKGROUND	The regulations governing the operation of an ISFSI set limits on the control of occupational radiation exposure and radiation doses to the general public (Ref. 1). Occupational radiation exposure should be kept as low as reasonably achievable (ALARA) and within the limits of 10 CFR Part 20. Radiation doses to the public are limited for both normal and accident conditions in accordance with 10 CFR 72.
APPLICABLE SAFETY ANALYSIS	The CONCRETE CASK average surface dose rates are not an assumption in any accident analysis, but are used to ensure compliance with regulatory limits on occupational dose and dose to the public.
LCO	The limits on CONCRETE CASK average surface dose rates are based on the Safety Analysis Report shielding analysis of the NAC-UMS® SYSTEM (Ref. 2). The limits are selected to minimize radiation exposure to the public and to maintain occupational dose ALARA to personnel working in the vicinity of the NAC-UMS® SYSTEM. The LCO specifies sufficient locations for taking dose rate measurements to ensure the dose rates measured are indicative of the effectiveness of the shielding materials.
APPLICABILITY	The CONCRETE CASK average surface dose rates apply during STORAGE OPERATIONS. These limits ensure that the CONCRETE CASK average surface dose rates during STORAGE OPERATIONS are bounded by the shielding safety analyses. Radiation doses during STORAGE OPERATIONS are monitored by the NAC-UMS® SYSTEM user in accordance with the plant-specific radiation protection program as required by 10 CFR 72.212(b)(6) and 10 CFR 20 (Reference 1).
ACTIONS	A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each loaded CONCRETE CASK. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CONCRETE CASK not meeting the LCO. Subsequent NAC-UMS®

(continued)

ACTIONS (continued)

SYSTEMs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the CONCRETE CASK average surface dose rates are not within limits, it could be an indication that a fuel assembly that did not meet the Approved Contents Limits in Section B2.0 of Appendix B was inadvertently loaded into the CANISTER. Administrative verification of the CANISTER fuel loading, by means such as review of video recordings and records of the loaded fuel assembly serial numbers, can establish whether a misloaded fuel assembly is the cause of the out-of-limit condition. The Completion time is based on the time required to perform such a verification.

A.2

If the CONCRETE CASK average surface dose rates are not within limits and it is determined that the CONCRETE CASK was loaded with the correct fuel assemblies, an analysis may be performed. This analysis will determine if the CONCRETE CASK would result in the ISFSI offsite or occupational calculated doses exceeding regulatory limits in 10 CFR Part 72 or 10 CFR Part 20, respectively. If it is determined that the measured average surface dose rates do not result in the regulatory limits being exceeded, STORAGE OPERATIONS may continue.

B.1

If it is verified that the fuel was misloaded, or that the ISFSI offsite radiation protection requirements of 10 CFR Part 20 or 10 CFR Part 72 will not be met with the CONCRETE CASK average surface dose rates above the LCO limit, the fuel assemblies must be placed in a safe condition in the spent fuel pool. The Completion Time is reasonable, based on the time required to transport the CONCRETE CASK, transfer the CANISTER to the TRANSFER CASK, remove the structural lid and vent and drain port cover welds, perform fuel cooldown operations, cut the shield lid weld, move the TRANSFER CASK and CANISTER into the spent fuel pool, remove the shield lid, and remove the spent fuel assemblies in an orderly manner and without challenging personnel.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.2.2.1

This SR ensures that the CONCRETE CASK average surface dose rates are within the LCO limits after transfer of the CANISTER into the CONCRETE CASK and prior to the beginning of STORAGE OPERATIONS. This Frequency is acceptable as corrective actions can be taken before off-site dose limits are compromised. The surface dose rates are measured approximately at the locations indicated on Figure A3-1 of Appendix A of the CoC Number 1015 Technical Specifications, following standard industry practices for determining average surface dose rates for large containers.

REFERENCES

1. 10 CFR Parts 20 and 72.

2. FSAR Sections 5.1 and 8.2.

C 3.3 NAC-UMS® SYSTEM Criticality Control

C 3.3.1 Dissolved Boron Concentration

BASES

BACKGROUND	A TRANSFER CASK with an empty CANISTER is placed into a PWR spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents Limits shown in Table B2-2. A shield lid is then placed on the CANISTER. The TRANSFER CASK and CANISTER are raised out of the spent fuel pool. The TRANSFER CASK and CANISTER are then moved into the cask decontamination area, where dose rates are measured and the CANISTER shield lid is welded to the CANISTER shell and the lid weld is examined, pressure tested, and leak tested. The water is drained from the CANISTER, and CANISTER cavity vacuum drying is performed. The CANISTER cavity is then backfilled with helium. Additional dose rates are measured, and the CANISTER vent port and drain port covers and structural lid are installed and welded. Non-destructive examinations are performed on the welds. Contamination measurements are completed prior to moving the TRANSFER CASK and CANISTER in position to transfer the CANISTER to the CONCRETE CASK. After the CANISTER is transferred, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad.
APPLICABLE SAFETY ANALYSIS	During loading into, or unloading from, the CANISTER, criticality control of certain PWR fuel requires that the water in the CANISTER contains dissolved boron in a concentration of 1,000 parts per million, or greater. As shown in Table B2-2, spent fuel with the enrichments shown in the "without (w/o) boron" column may be loaded with no assured level of boron in the water in the CANISTER. However, spent fuel with the enrichments shown in the "with boron" column must be loaded or unloaded from the CANISTER when the water in the CANISTER has a boron concentration of 1,000 parts per million or greater. Since boron concentration varies with water temperature, water temperature must be considered in measuring the boron concentration.

(continued)

LCO	The criticality analysis shows that PWR fuel with certain combinations of initial enrichment and fuel content requires credit for the presence of at least 1,000 parts per million of boron in solution in the water in the CANISTER (see Section B3.2.1 for the requirements for assuring soluble boron concentration during loading or unloading). This water must be used to flood the canister cavity during underwater PWR fuel loading or unloading. The boron in the pool water ensures sufficient thermal neutron absorption to preserve criticality control during fuel loading in the basket. Consequently, if boron credit is required for the fuel being loaded or unloaded, the canister must be flooded with water that contains boron in the proper concentration in accordance with the requirements of LCO 3.3.1. Concentration of boron must also be measured and maintained in accordance with LCO 3.3.1. The dissolved boron concentration requirement, and measurement requirement, applies to both the spent fuel pool water and to water in the CANISTER, when pool water is used to fill the CANISTER.
APPLICABILITY	Control of Boron concentration is required during LOADING or UNLOADING OPERATIONS when the CANISTER holds at least one spent fuel assembly that requires dissolved boron for criticality control as described in Table B2-2. This LCO does not apply to spent fuel having an enrichment within the limits specified in the table in the "without (w/o) boron" column.
ACTIONS	A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each CANISTER. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER not meeting the LCO. Subsequent CANISTERs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions. <u>A.1</u> If the required dissolved Boron concentration of the water in the CANISTER is not met, immediate actions must be taken to restore the required dissolved boron concentration. No actions, including continued loading, may be taken that increases system reactivity. <u>AND</u>

(continued)

A.2

The required concentration of dissolved Boron must be restored.

AND

A.3

If the required boron concentration in the water in the CANISTER cannot be established within 24 hours, remove all fuel assemblies that exceed the enrichment limits of Table B2-2 for fuel assemblies taking no boron credit from the CANISTER to bring the system to a safe configuration. The 24 hour period provides adequate time to restore the required boron concentration.

SURVEILLANCE REQUIREMENTS

SR 3.3.1.1

The assurance of an adequate concentration of dissolved boron in the water in the CANISTER must be established once within 4 hours of beginning any LOADING or UNLOADING OPERATION, using two independent measurements of determining boron concentration. During LOADING or UNLOADING OPERATIONS, verification of continued adequate dissolved boron concentration must be performed every 48 hours after the beginning of operations. The 48-hour boron concentration verification is not required when no water is being introduced into the CANISTER cavity. In this situation, no potential exists for the boron in the CANISTER to be diluted, so verification of the boron concentration is not necessary.

REFERENCES

Section B3.2.1 and Table B2-2.

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