Appendix A.6.5.5
NUHOMS®-24PTH DSC Criticality Evaluation

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Appendix A.6.5.5
NUHOMS®-24PTH DSC Criticality Evaluation

NOTE: References in this Appendix are shown as [1], [2], etc. and refer to the reference list in Section A.6.5.5.5.

This Appendix A.6.5.5 to Chapter A.6 demonstrates that the MP197HB package when transporting the NUHOMS®-24PTH DSC payload meets the criticality performance requirements specified in Sections 71.55 and 71.59 of 10 CFR Part 71 [2]. The criticality control design ensures that the effective multiplication factor (k_{eff}) of the contained fuel is no greater than an Upper Subcritical Limit (USL) for the most reactive configuration. The USL includes a confidence band with an administrative safety margin of 0.05. The design has a Criticality Safety Index (CSI, given in 10 CFR 71.59(b) as CSI = 50/"N") of 0 because "N" is infinity (∞). The number "N" is based on all of the following conditions being satisfied, assuming packages are stacked together in any arrangement and with close full reflection on all sides of the stack by water:

1. Five times "N" undamaged packages with nothing between the packages are subcritical;
2. Two times "N" damaged packages, if each package is subjected to the tests specified in 10 CFR Part 71.73 (HAC) is subcritical with optimum interspersed hydrogenous moderation; and
3. The value of "N" cannot be less than 0.5.

A.6.5.5.1 Discussion and Results

The NUHOMS® -24PTH DSC design is described in detail in Chapter A.1, Appendix A.1.4.3. Figure A.6.5.5-1 shows the radial cross section of the NUHOMS® -24PTH DSC. The NUHOMS® 24PTH DSC stainless steel basket consists of an "egg-crate" plate design. The fuel assemblies are housed in 24 stainless steel fuel compartment tubes. The basket structure, including the fuel compartment tubes, is held together with stainless steel insert plates and the poison and aluminum plates that form the "egg-crate" structure. The basket compartment structure is connected to perimeter transition rail assemblies, portions of it comprising of aluminum interface. The fuel compartment tube structure is connected to perimeter transition rail assemblies as shown on the drawings in Chapter A.1, Appendix A.1.4.10. The poison/aluminum plates are located between the fuel compartment tubes, as shown in Figure A.6.5.5-2.

The NUHOMS® -MP197HB Cask containing the NUHOMS® -24PTH DSC is shown to be subcritical for an infinite array of flooded undamaged casks and for an infinite array of damaged casks after being subjected to hypothetical accident conditions. "N" is equal to ∞. The cask is shown to be subcritical for five times "N" or an infinite number of undamaged packages with close full reflection between packages and no inleakage of water as required by 10 CFR Part 71.59(a)(1). In addition, as required by 10 CFR Part 71.59(a)(2), two times "N" or an infinite array of packages is shown to be subcritical with the fissile material in its most reactive configuration, optimum water moderation and close full water reflection consistent with its

damaged condition. A CSI of 0 (less than 50) ensures that, per 10 CFR Part 71.59 (c)(1), the package may be shipped by a carrier in a nonexclusive conveyance.

Table A.6.5.5-1 lists the fuel assemblies considered as authorized contents of the NUHOMS® 24PTH DSC. A detailed criticality analysis of the NUHOMS® 24PTH DSC that meets the applicable requirements of Part 72 for storage is documented in Appendix P, Chapter P.6 of the Standardized NUHOMS® System UFSAR (CoC 1004) [6]. The results of the sensitivity calculations to determine the most reactive configuration of the fuel assemblies / basket materials is directly utilized herein. The design basis models from the storage calculations are utilized as starting models for the criticality analysis documented herein.

The criticality analysis is performed using two bounding fuel assembly classes identified in Table A.6.5.5-1. These are the Westinghouse (WE) 17x17 and the WE 14x14 classes. The results of the WE 17X17 class bound those of the WE 15x15, the Babcock and Wilcox (B&W) 15x15, the Combustion Engineering (CE) 14x14, and CE 15x15 classes.

Criticality calculations are performed to determine the minimum assembly average burnup as a function of initial enrichment and cooling time for the two fuel assembly classes as a function of basket poison type which are listed in Table A.6.5.5-9. The calculations determine k_{eff} with the CSAS25 control module of SCALE-4.4 [1] for each assembly class and initial enrichment, including all uncertainties to assure criticality safety under all credible conditions. Note that burnup credit is employed in the criticality analysis of the NUHOMS® -24PTH DSC.

The Control Components (CCs) are also authorized for storage in the 24PTH DSCs. The authorized CCs are Burnable Poison Rod Assemblies (BPRAs), Control Rod Assemblies (CRAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping Rod Assemblies (APSRAs), Control Element Assemblies (CEAs), Vibration Suppressor Inserts (VSIs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources.

The results of the evaluation demonstrate that the maximum k_{eff}, including statistical uncertainty, is less than the USL determined from a statistical analysis of benchmark criticality experiments. The statistical analysis procedure includes a confidence band with an administrative safety margin of 0.05.

A.6.5.5.2 Package Fuel Loading

The NUHOMS® 24PTH DSC is capable of transporting and storing a maximum of 24 intact PWR fuel assemblies. In addition, a maximum of *12* damaged *(up to 8 failed)* and remaining intact (for a total of 24) PWR fuel assemblies can also be transported within the NUHOMS® 24PTH DSC. Reconstituted fuel assemblies, where the fuel pins are replaced by lower enriched fuel pins or non-fuel pins that displace the same amount of water, are considered intact fuel assemblies in the criticality evaluation. A detailed listing of the contents of the NUHOMS® 24PTH DSC is provided in Table A.6.5.5-1.

For all the fuel assembly classes CCs are also included as authorized contents. The only change to the package fuel loading to evaluate the addition of these CCs is replacing the water in the guide tubes/water holes with $^{11}B_4C$. Since these CCs displace moderator in the assembly guide and or instrument tubes, an evaluation is not needed to determine the potential impact of storage of CCs that extend into the active fuel region on the system reactivity. The presence of these CCs such as CRAs, CEAs and BPRAs will result in a reduction in the reactivity of the fuel assemblies. CCs that do not extend into the active fuel region of the assembly do not have any effect on the reactivity of the system as evaluated because only the active fuel region is modeled in this evaluation with periodic boundary conditions making the model infinite in the axial direction. Additionally, the presence of non-multiplying sources like the NSAs have no impact on criticality calculations.

Therefore, any CC that is inserted into the fuel assembly such that it does or does not extend into the active fuel region is considered as authorized for transportation without adjustment to the burnup or initial enrichment as required for control components. No credit is taken for the presence of any residual absorber remaining in the CC nor is any credit taken for the displacement of fresh water from within the guide tube of the fuel assemblies containing CCs.

Proprietary information on pages A.6.5.5-4 to A.6.5.5-16, withheld pursuant to 10 CFR 2.390

A.6.5.5.5 References

1. Oak Ridge National Laboratory, RSIC Computer Code Collection, "SCALE: A Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluations for Workstations and Personal Computers," NUREG/CR-0200, Revision 6, ORNL/NUREG/CSD-2/V2/R6.
2. 10 CFR 71, Packaging and Transportation of Radioactive Materials.
3. U.S. Nuclear Regulatory Commission, "Criticality Benchmark Guide for Light-Water-Reactor fuel in Transportation and Storage Packages," NUREG/CR-6361, Published March 1997, ORNL/TM-13211.
4. U.S. Nuclear Regulatory Commission, "Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packages," NUREG/CR-5661, Published April 1997, ORNL/TM-11936.
5. *NOT USED*
6. NUH-003, Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for the Irradiated Nuclear Fuel (UFSAR), Revision *11*.

**Proprietary information on pages A.6.5.5-18 to A.6.5.4-34
and pages A.6.5.5-34a to A.6.5.5-34ff withheld
pursuant to 10 CFR 2.390**

Table A.6.5.5-1
Authorized Contents for NUHOMS®-24PTH System

Assembly Type[1]	Array	Assembly Class
Westinghouse 17x17 LOPAR/Standard	17x17	WE 17x17
Westinghouse 17x17 OFA/Vantage 5[2]	17x17	WE 17x17
Framatome 17x17 MK BW	17x17	WE 17x17
Westinghouse 17x17 RFA	17x17	WE 17x17
B&W 15x15 Mark B (through B11)	15x15	BW 15x15
B&W 17x17 Mark C	17x17	BW 15x15
CE 15x15 Palisades	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 CE	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 WE	15x15	WE 15x15
Westinghouse 15x15 Standard/ZC	15x15	WE 15x15
Westinghouse 15x15 LOPAR/OFA/ DRFA/Vantage 5	15x15	WE 15x15
CE 14x14 Standard/Generic	14x14	CE 14x14
CE 14x14 Fort Calhoun	14x14	CE 14x14
Framatome-ANP 14x14 CE	14x14	CE 14x14
Exxon/ANF (ANP) 14x14 WE	14x14	WE 14x14
Exxon/ANF (ANP) 14x14 Toprod	14x14	WE 14x14
Westinghouse 14x14 Standard/LOPAR/ZCA/ZCB	14x14	WE 14x14
Westinghouse 14x14 OFA	14x14	WE 14x14

Notes:
(1) Reload fuel from other manufacturers with these parameters are also acceptable.
(2) Includes all Vantage versions (5, +, ++, 5H, etc.).

Table A.6.5.5-2
NUHOMS®-24PTH Basket Dimensions[1]

Basket Component Description	Actual Dimension, inches
Compartment Inside (Maximum) Compartment Inside (Nominal) Compartment Inside (Minimum)	8.900 8.950 8.775
Compartment wall (Minimum)	0.240
Stainless steel strip height	1.75
Stainless steel strip thickness	0.875
Poison plate thickness	0.125
Aluminum plate thickness	0.75
Horizontal gap	0.06
Vertical slot width / height	1.25/ 9.91
Basket outside diameter	65.94
DSC wall thickness	0.500
Section Height 24PTH-S 24PTH-L 24PTHS-LC	 21.48 22.15 21.96

Note:
[1] All dimensions shown are nominal unless otherwise specified.

Proprietary information on pages A.6.5.5-37 to A.6.5.5-39 withheld pursuant to 10 CFR 2.390

Table A.6.5.5-6
Material Property Data

Material	ID	Density g/cm^3	Element	Weight %	Atom Density (atoms/b-cm)
Zircaloy-4	2	6.56	Zr	98.23	4.2541E-02
			Sn	1.45	4.8254E-04
			Fe	0.21	1.4856E-04
			Cr	0.10	7.5978E-05
			Hf	0.01	2.2133E-06
Water (Pellet Clad Gap)	3	0.998	H	11.1	6.6769E-02
			O	88.9	3.3385E-02
Stainless Steel (SS304)	4	7.94	C	0.080	3.1877E-04
			Si	1.000	1.7025E-03
			P	0.045	6.9468E-05
			Cr	19.000	1.7473E-02
			Mn	2.000	1.7407E-03
			Fe	68.375	5.8545E-02
			Ni	9.500	7.7402E-03
$^{11}B_4C$ in CC	7	2.555	B11	78.56	1.0988E-01
			C	21.44	2.7470E-02
Aluminum	8	2.702	Al	100.0	6.0307E-02
Aluminum - Boron Poison Plate for Type A Basket (6.30 mg B-10/cm^2)	9	2.693	B10	0.01	1.33020E-05
			B11	0.14	2.01002E-04
			Al	99.85	5.83483E-02
Water	10	0.998	H	11.1	6.6769E-02
			O	88.9	3.3385E-02
Lead	11	11.344	Pb	100.0	3.2969E-02
Aluminum - Boron Poison Plate for Type B Basket (13.5 mg B-10/cm^2)	9	2.693	B10	2.63	4.26233E-03
			B11	0.29	4.30729E-04
			Al	97.08	5.83483E-02
Aluminum - Boron Poison Plate for Type C Basket (18.0 mg B-10/cm^2)	9	2.693	B10	3.47	5.68315E-03
			B11	0.39	5.74311E-04
			Al	96.15	5.83483E-02

Proprietary information on pages A.6.5.5-41 to A.6.5.5-52 withheld pursuant to 10 CFR 2.390

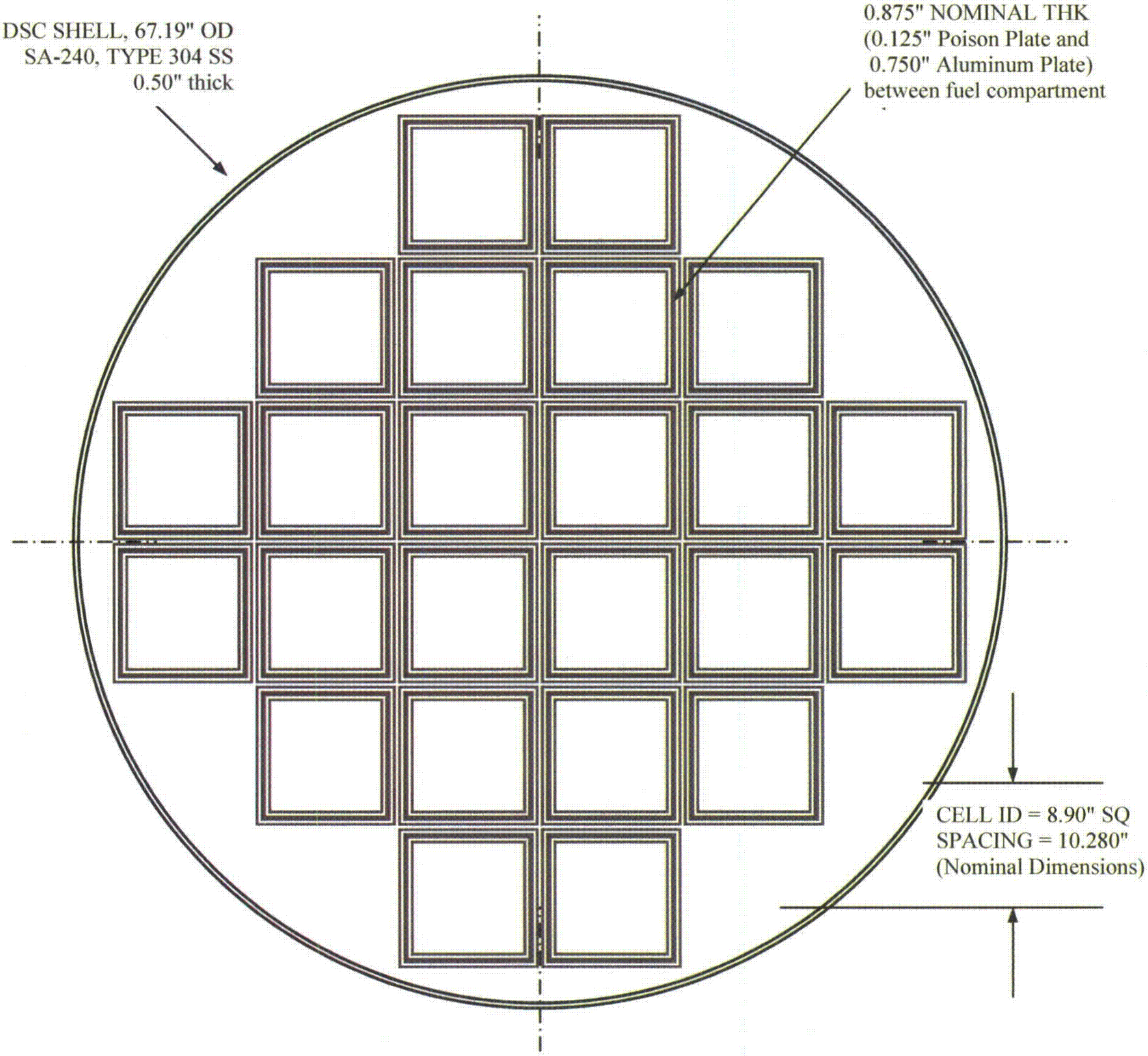

Figure A.6.5.5-1
NUHOMS® -24PTH Transportable DSC Basket Radial Cross Section

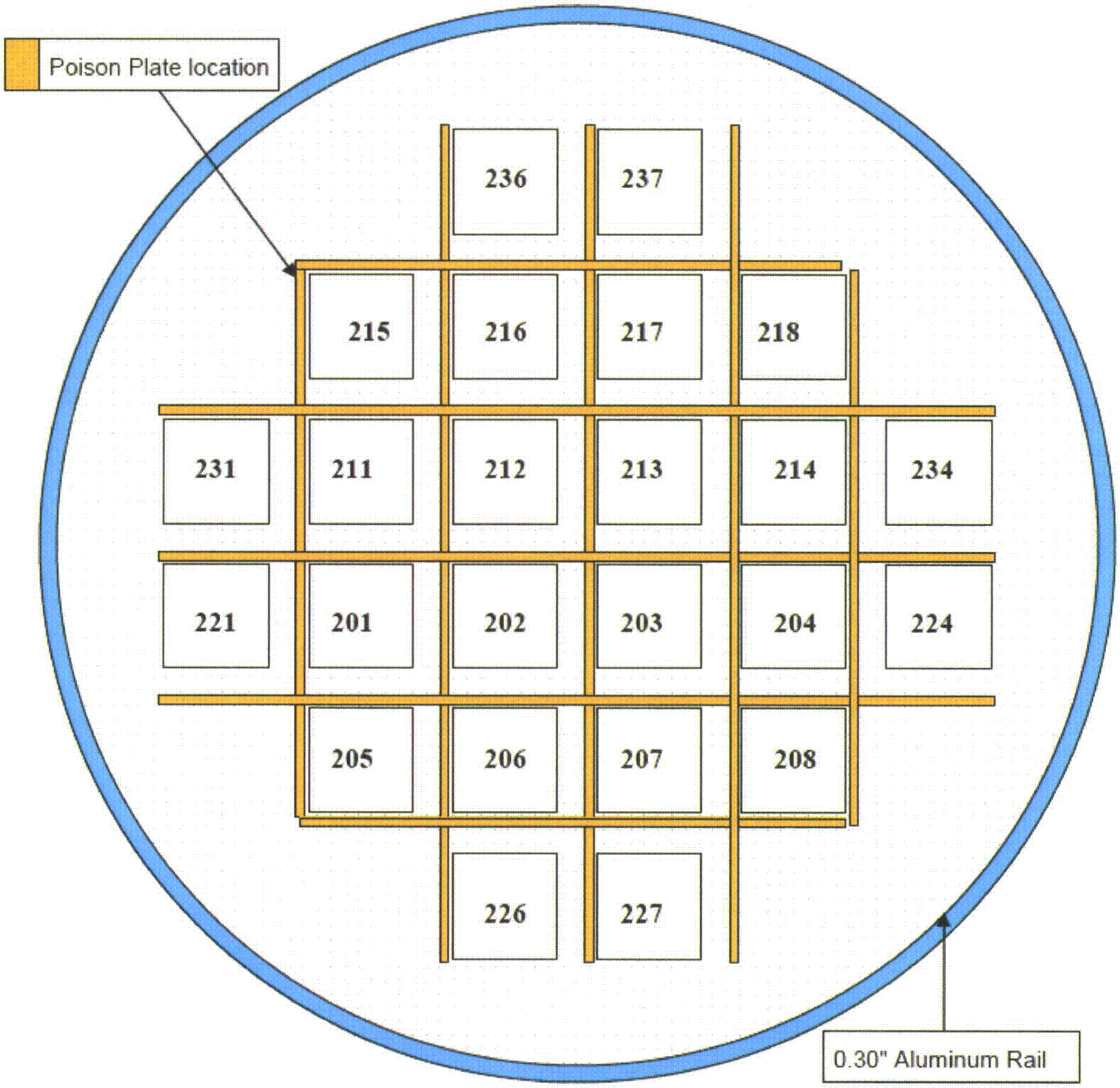

Figure A.6.5.5-2
Fuel Position and Poison Plate Location in the Design

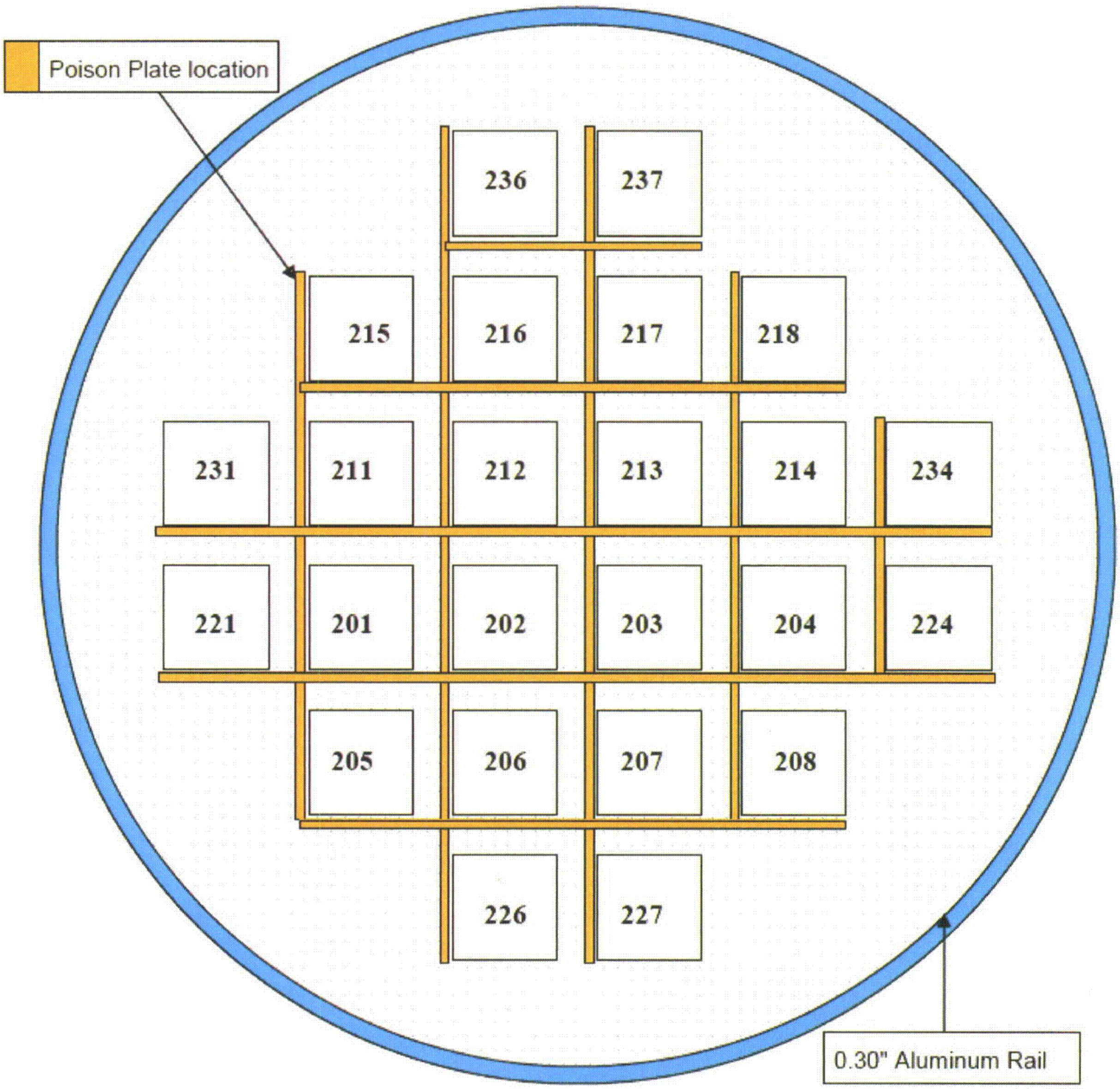

Figure A.6.5.5-3
Fuel Position and Poison Plate Location in Criticality Calculational KENO Model

Figure A.6.5.5-4
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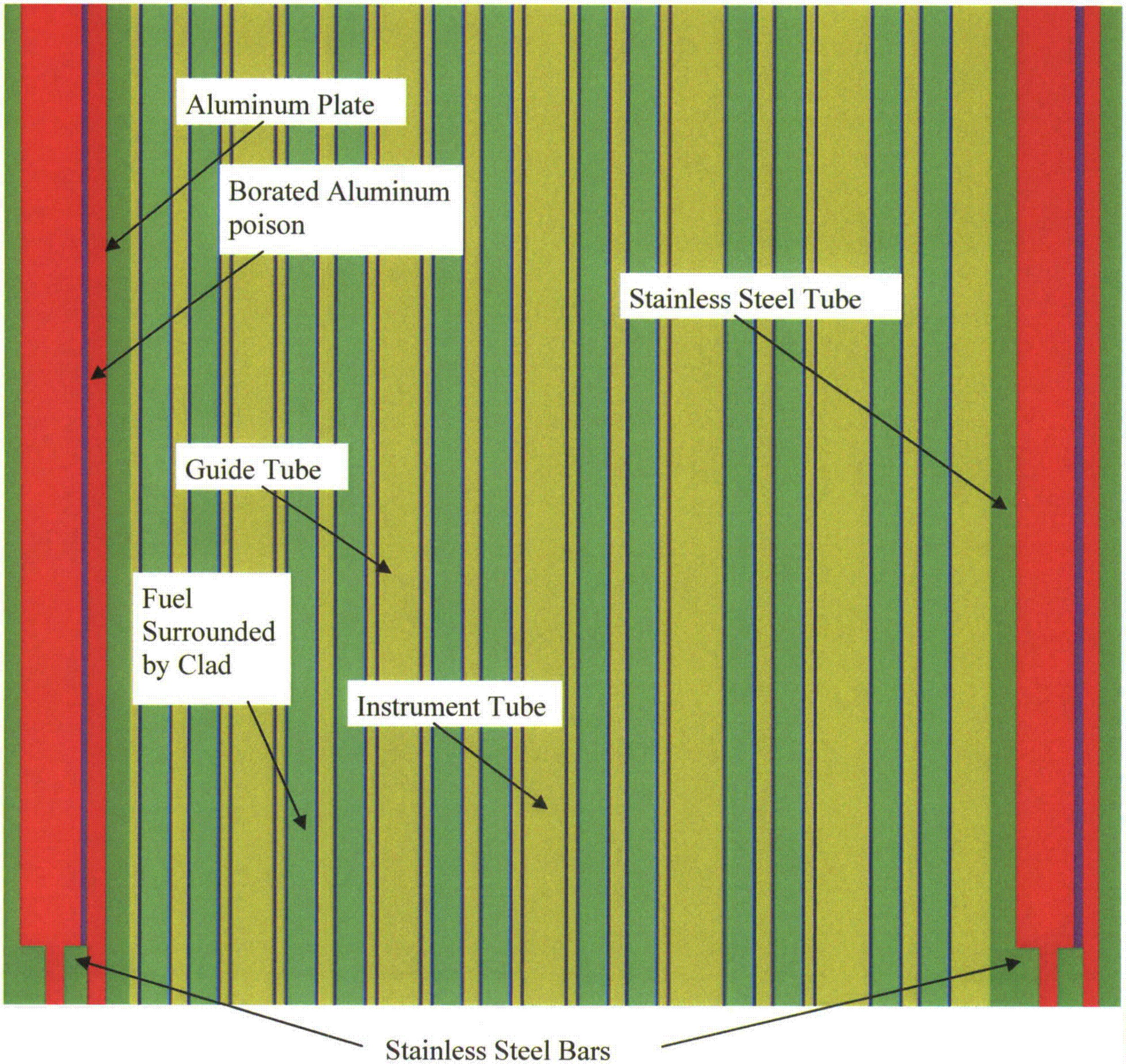

Figure A.6.5.5-5
Basket Model Compartment Wall with WE 17x17 Fuel Assembly - Criticality Calculational KENO Model

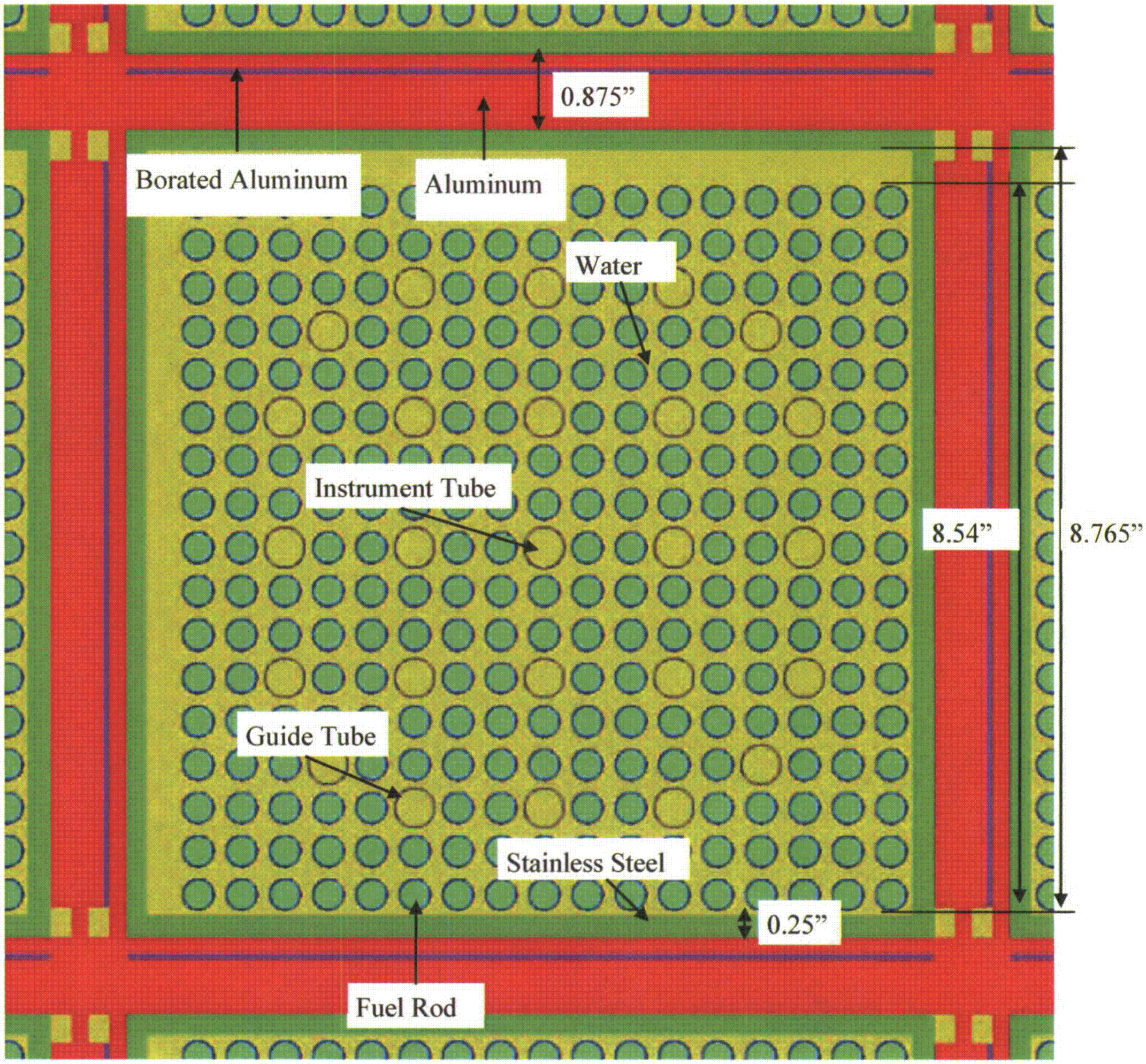

Figure A.6.5.5-6
Basket Compartment with WE17x17 Fuel Assembly - Criticality Calculational KENO Model

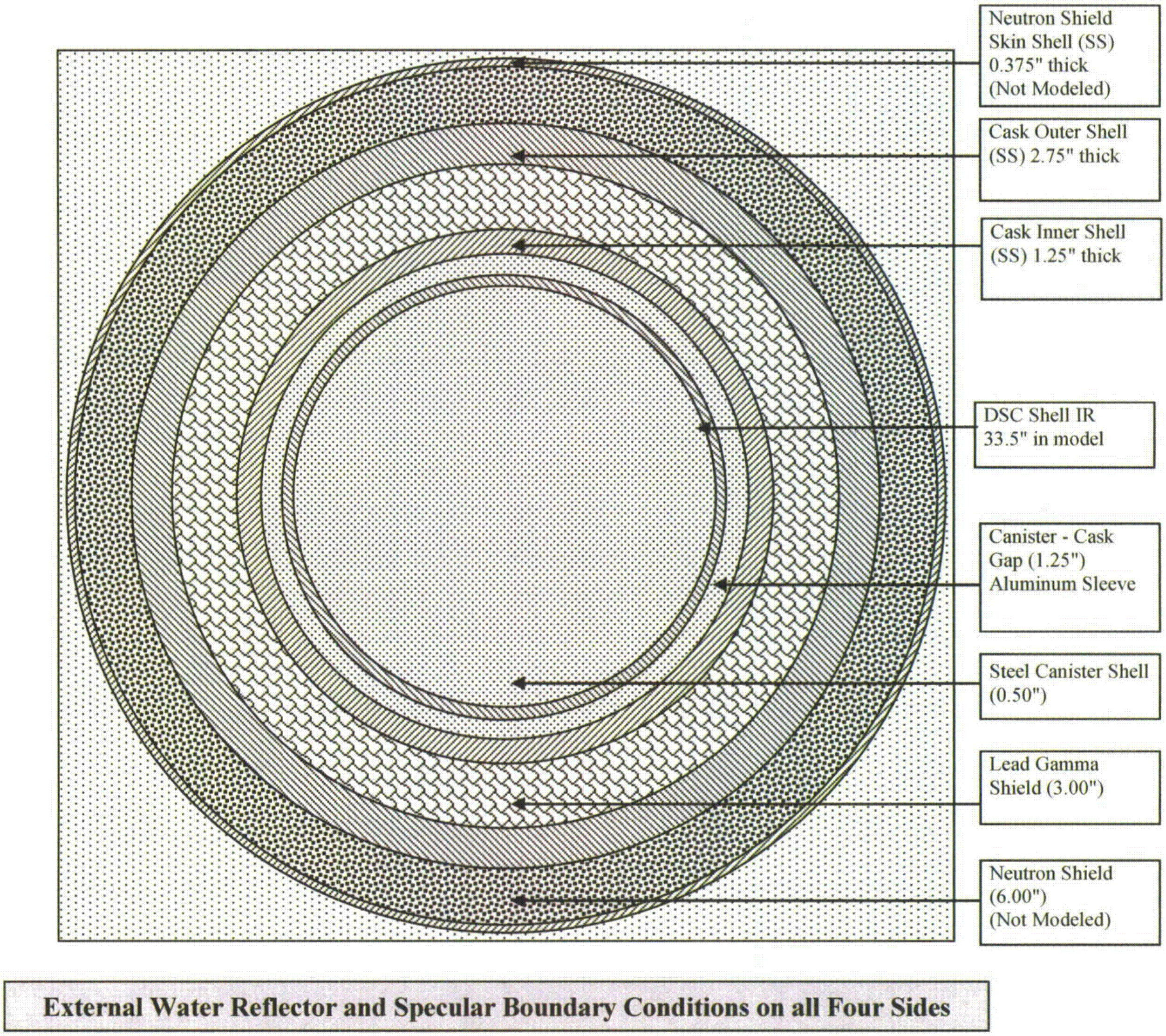

Figure A.6.5.5-7
Criticality Calculational KENO Model

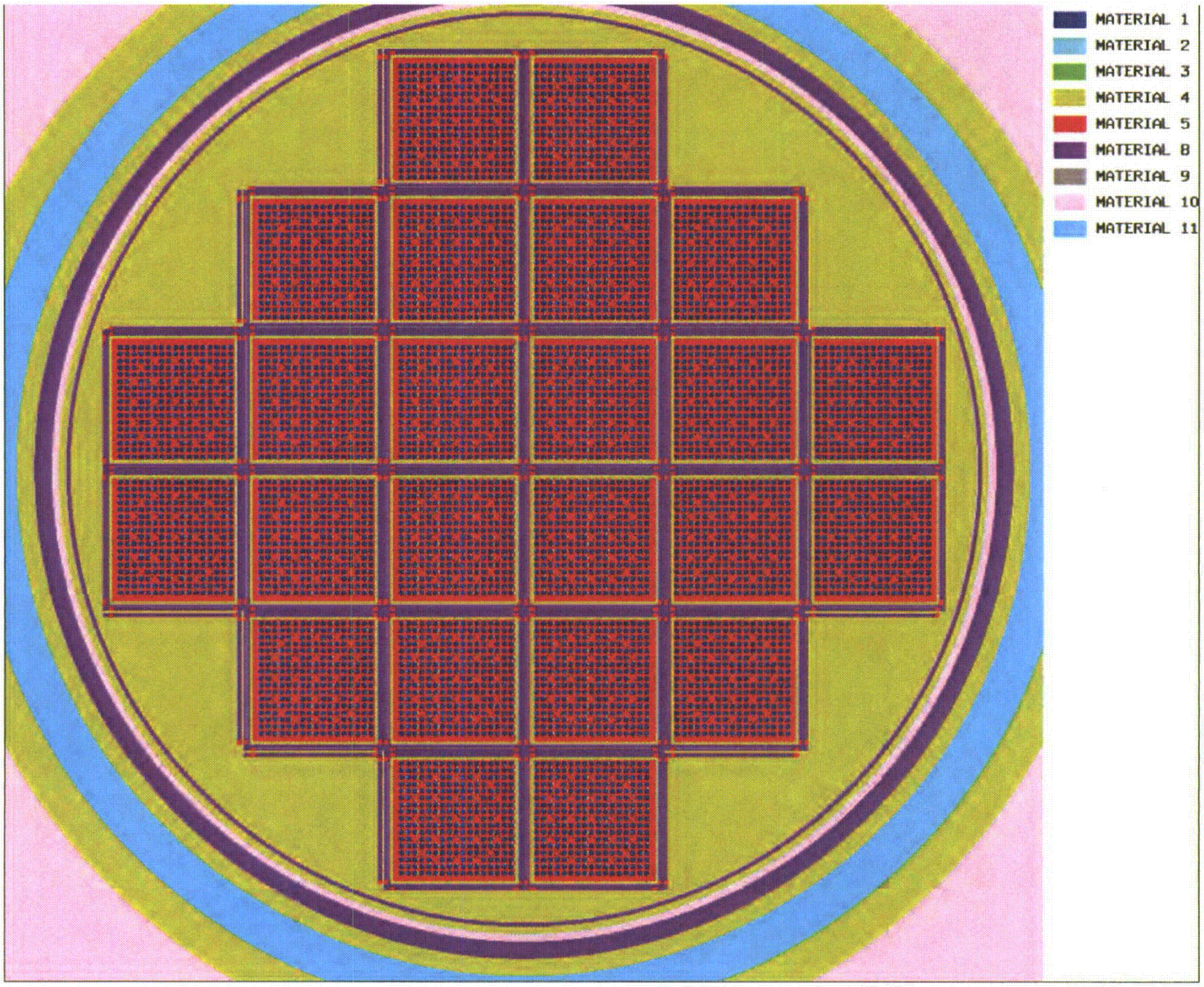

Figure A.6.5.5-8
WE 17x17 Class Assembly KENO Model

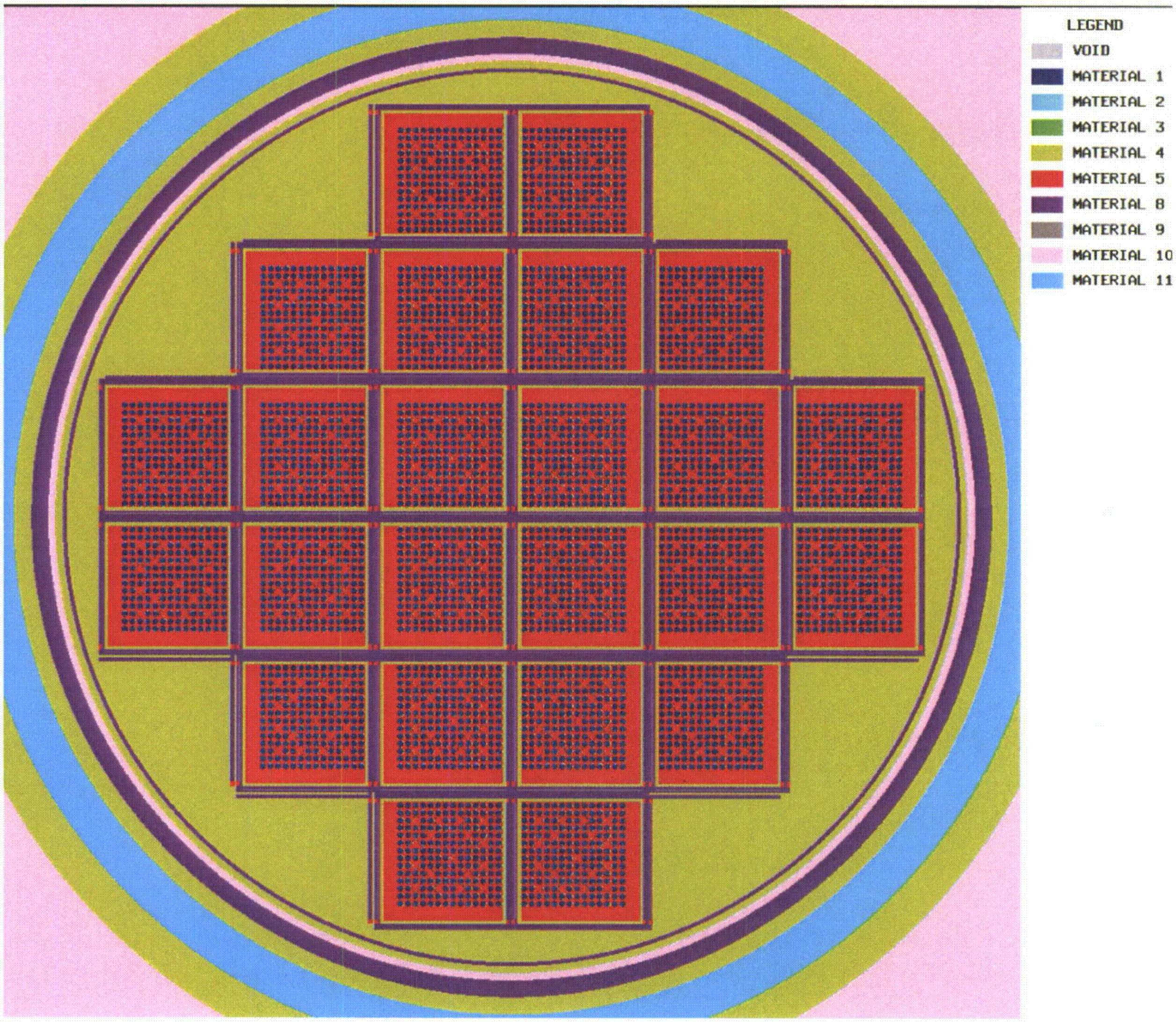

Figure A.6.5.5-9
WE 14x14 Class Assembly KENO Model

Figure A.6.5.5-10
DELETED

Appendix A.6.5.6
NUHOMS®-32PT DSC Criticality Evaluation

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Appendix A.6.5.6
NUHOMS®-32PT DSC Criticality Evaluation

NOTE: References in this Appendix are shown as [1], [2], etc. and refer to the reference list in Section A.6.5.6.5.

This Appendix A.6.5.6 to Chapter A.6 demonstrates that the MP197HB package when transporting the NUHOMS®-32PT DSC payload meets the criticality performance requirements specified in Sections 71.55 and 71.59 of 10 CFR Part 71 [2]. The criticality control design ensures that the effective multiplication factor (k_{eff}) of the contained fuel is no greater than an Upper Subcritical Limit (USL) for the most reactive configuration. The USL includes a confidence band with an administrative safety margin of 0.05. The design has a Criticality Safety Index (CSI, given in 10 CFR 71.59(b) as CSI = 50/"N") of 0 because "N" is infinity (∞). The number "N" is based on all of the following conditions being satisfied, assuming packages are stacked together in any arrangement and with close full reflection on all sides of the stack by water:

1. Five times "N" undamaged packages with nothing between the packages are subcritical;
2. Two times "N" damaged packages, if each package is subjected to the tests specified in 10 CFR Part 71.73 (HAC) is subcritical with optimum interspersed hydrogenous moderation; and
3. The value of "N" cannot be less than 0.5.

A.6.5.6.1 Discussion and Results

The NUHOMS® -32PT DSC design is described in detail in Chapter A.1, Appendix A.1.4.2. Figure A.6.5.6-1 show the radial cross section of the NUHOMS® -32PT DSC. The NUHOMS®-32PT DSC stainless steel basket consists of a welded plate design. The welded plates form 32 compartments with sufficient space to accommodate aluminum or poison/aluminum inserts and a PWR fuel assembly. The compartment structure is connected to perimeter rail structure comprising of a solid aluminum interface. The rail aluminum interface provides the circular perimeter geometry that fits the basket inside the canister shell and also increases the area of thermal conduction from the basket to the shell. Three different variations of the number and orientation of the poison/aluminum plates within the fuel compartment provides for the change in the fixed poison loading or basket "type."

The basket uses an aluminum/B_4C metal matrix composite as its neutron poison material. This material is ideal for long-term use in radiation and thermal environments of a dry cask storage system. The minimum required boron-10 loading is 0.070 g/cm^2 (90% credit is taken in the criticality analysis or 0.063 g/cm^2). In addition to the fixed neutron poison in the basket, "poison rod assemblies" (PRAs) are required for the center zero, four, eight or sixteen assemblies depending on fuel assembly design and initial enrichment. The minimum required B_4C content of the PRAs is 40% Theoretical Density (TD) (75% credit is taken in the criticality analysis or 30% TD). The minimum required B_4C content of the PRAs is only 30% (in the KENO input)

because assuming a higher B_4C content is not expected to reduce the reactivity of the system because PRA rods are already "black" to the neutrons in the system.

Three different basket types are applicable to the 32PT DSC depending on the number and orientation of the L-shaped poison/aluminum inserts. They are described as follows:

- 16-plate configuration (16PP) containing fixed poison in 16 compartments. Fuel assemblies containing PRAs are not authorized in this configuration
- 20-plate configuration (20PP) containing fixed poison in 20 compartments. Fuel assemblies containing 4, 8 or 16 PRAs are authorized in this configuration.
- 24-plate configuration (24PP) containing fixed poison in 24 compartments. Fuel assemblies containing 4, 8 or 16 PRAs are authorized in this configuration.

The arrangement of poison/aluminum plates in the fuel compartments of the basket for these three configurations is shown in Figure A.6.5.6-6 through Figure A.6.5.6-8. The mandatory location of the PRAs for the 4, 8 or 16 PRA configurations is shown in Figure A.6.5.6-2 through Figure A.6.5.6-4.

The NUHOMS® -MP197HB Cask containing the NUHOMS® -32PT DSC is shown to be subcritical for an infinite array of flooded undamaged casks and for an infinite array of damaged casks after being subjected to hypothetical accident conditions. "N" is equal to ∞. The cask is shown to be subcritical for five times "N" or an infinite number of undamaged packages with close full reflection between packages and no inleakage of water as required by 10 CFR Part 71.59(a)(1). In addition, as required by 10 CFR Part 71.59(a)(2), two times "N" or an infinite array of packages is shown to be subcritical with the fissile material in its most reactive configuration, optimum water moderation and close full water reflection consistent with its damaged condition. A CSI of 0 (less than 50) ensures that, per 10 CFR Part 71.59 (c)(1), the package may be shipped by a carrier in a nonexclusive conveyance.

Table A.6.5.6-1 lists the fuel assemblies considered as authorized contents of the NUHOMS® -32PT DSC. A detailed criticality analysis of the NUHOMS® -32PT DSC that meets the applicable requirements of Part 72 for storage is documented in Appendix M, Chapter M.6 of the Standardized NUHOMS® System (CoC-1004) [6]. The results of the sensitivity calculations to determine the most reactive configuration of the fuel assemblies / basket materials is directly utilized herein. The design basis models from the storage calculations are utilized as starting models for the criticality analysis documented herein.

The criticality analysis is performed using *two* bounding fuel assembly classes identified in Table A.6.5.6-1. These are the Westinghouse (WE) 17x17, and the WE 14x14 classes. The results of the WE 17X17 class bound those of the WE 15x15, the Babcock and Wilcox (B&W) 15x15, *the Combustion Engineering (CE) 14x14,* the CE 16x16 and CE 15x15 classes.

Criticality calculations are performed to determine the minimum assembly average burnup as a function of initial enrichment and cooling time for the *two* fuel assembly classes as a function of basket/poison type which are listed in Table A.6.5.6-8. The calculations determine k_{eff} with the CSAS25 control module of SCALE-4.4 [1] for each assembly type and initial enrichment,

including all uncertainties to assure criticality safety under all credible conditions. Note that burnup credit is employed in the criticality analysis of the NUHOMS® -32PT DSC.

The Control Components (CCs) are also authorized for storage in the 32PT DSCs. The authorized CCs are Burnable Poison Rod Assemblies (BPRAs), Control Rod Assemblies (CRAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping Rod Assemblies (APSRAs), Control Element Assemblies (CEAs), Vibration Suppressor Inserts (VSIs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources.

The results of the evaluation demonstrate that the maximum k_{eff}, including statistical uncertainty, is less than the USL determined from a statistical analysis of benchmark criticality experiments. The statistical analysis procedure includes a confidence band with an administrative safety margin of 0.05.

A.6.5.6.2 Package Fuel Loading

The NUHOMS® 32PT DSC is capable of transporting and storing a maximum of 32 intact PWR fuel assemblies. Reconstituted fuel assemblies, where the fuel pins are replaced by lower enriched fuel pins or non-fuel pins that displace the same amount of water, are considered intact fuel assemblies in the criticality evaluation. A detailed listing of the contents of the NUHOMS® 32PT DSC is provided in Table A.6.5.6-1. Damaged fuel assemblies are not authorized in the NUHOMS® 32PT DSC.

For all the fuel assembly classes CCs are also included as authorized contents. The only change to the package fuel loading to evaluate the addition of these CCs is replacing the water in the guide tubes/water holes with $^{11}B_4C$. Since these CCs displace moderator in the assembly guide and or instrument tubes, an evaluation is not needed to determine the potential impact of storage of CCs that extend into the active fuel region on the system reactivity. The presence of these CCs such as CRAs, CEAs and BPRAs will result in a reduction in the reactivity of the fuel assemblies. CCs that do not extend into the active fuel region of the assembly do not have any effect on the reactivity of the system as evaluated because only the active fuel region is modeled in this evaluation with periodic boundary conditions making the model infinite in the axial direction. Additionally, the presences of non-multiplying sources like the NSAs have no impact on criticality calculations.

Therefore, any CC that is inserted into the fuel assembly such that it does or does not extend into the active fuel region is considered as authorized for transportation without adjustment to the burnup or initial enrichment as required for control components. No credit is taken for the presence of any residual absorber remaining in the CC nor is any credit taken for the displacement of fresh water from within the guide tube of the fuel assemblies containing CCs.

Proprietary information on pages A.6.5.6-5 to A.6.5.6-13 withheld pursuant to 10 CFR 2.390

A.6.5.6.5 References

1. Oak Ridge National Laboratory, RSIC Computer Code Collection, "SCALE: A Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluations for Workstations and Personal Computers," NUREG/CR-0200, Revision 6, ORNL/NUREG/CSD-2/V2/R6.

2. 10 CFR 71, Packaging and Transportation of Radioactive Materials.

3. U.S. Nuclear Regulatory Commission, "Criticality Benchmark Guide for Light-Water-Reactor fuel in Transportation and Storage Packages," NUREG/CR-6361, Published March 1997, ORNL/TM-13211.

4. U.S. Nuclear Regulatory Commission, "Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packages," NUREG/CR-5661, Published April 1997, ORNL/TM-11936.

5. *NOT USED*

6. NUH-003, Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for the Irradiated Nuclear Fuel (UFSAR), Revision *11*.

Proprietary information on pages A.6.5.6-15 to A.6.5.6-24 and page A.6.5.6-24a withheld pursuant to 10 CFR 2.390

Table A.6.5.6-1
Authorized Contents for NUHOMS®-32PT System

Assembly Type[1]	Array	Assembly Class
Westinghouse 17x17 LOPAR/Standard	17x17	WE 17x17
Westinghouse 17x17 OFA/Vantage 5[2]	17x17	WE 17x17
Framatome 17x17 MK BW	17x17	WE 17x17
Westinghouse 17x17 RFA	17x17	WE 17x17
CE 16x16 System 80	16x16	CE 16x16
CE 16x16 Standard	16x16	CE 16x16
B&W 15x15 Mark B (through B11)	15x15	BW 15x15
B&W 17x17 Mark C	17x17	BW 15x15
CE 15x15 Palisades	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 CE	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 WE	15x15	WE 15x15
Westinghouse 15x15 Standard/ZC	15x15	WE 15x15
Westinghouse 15x15 LOPAR/OFA/ DRFA/Vantage 5	15x15	WE 15x15
CE 14x14 Standard/Generic	14x14	CE 14x14
CE 14x14 Fort Calhoun	14x14	CE 14x14
Framatome-ANP 14x14 CE	14x14	CE 14x14
Exxon/ANF (ANP) 14x14 WE	14x14	WE 14x14
Exxon/ANF (ANP) 14x14 Toprod	14x14	WE 14x14
Westinghouse 14x14 Standard/LOPAR/ZCA/ZCB	14x14	WE 14x14
Westinghouse 14x14 OFA	14x14	WE 14x14

Notes:

(1) Reload fuel from other manufacturers with these parameters are also acceptable.

(2) Includes all Vantage versions (5, +, ++, 5H, etc.)

Table A.6.5.6-2
NUHOMS®-32PT Basket Dimensions(1)

Basket Component Description	Actual Dimension, inches
Compartment Inside (Maximum) Compartment Inside (Nominal) Compartment Inside (Minimum)	8.925 8.825 8.715
Compartment wall (Maximum) Compartment wall (Nominal) Compartment wall (Minimum)	0.26 0.25 0.235
Aluminum Plate thickness if poison plate is present	0.050
Aluminum Plate thickness if poison plate is absent	0.125
Poison plate thickness (Maximum) Poison plate thickness (Nominal) Poison plate thickness (Minimum)	0.135 0.125 0.115
Chevron width (Minimum)	8.370
DSC inside radius	33.095
DSC wall thickness	0.500

Note 1: All dimensions shown are nominal unless specified otherwise

Proprietary information on pages A.6.5.6-27 and A.6.5.6-28 withheld pursuant to 10 CFR 2.390

Table A.6.5.6-5
Material Property Data

Material	ID	Density g/cm^3	Element	Weight %	Atom Density (atoms/b-cm)
Zircaloy-4	2	6.56	Zr	98.23	4.2541E-02
			Sn	1.45	4.8254E-04
			Fe	0.21	1.4856E-04
			Cr	0.10	7.5978E-05
			Hf	0.01	2.2133E-06
Water (Pellet Clad Gap)	3	0.998	H	11.1	6.6769E-02
			O	88.9	3.3385E-02
Stainless Steel (SS304)	5	7.94	C	0.080	3.1877E-04
			Si	1.000	1.7025E-03
			P	0.045	6.9468E-05
			Cr	19.000	1.7473E-02
			Mn	2.000	1.7407E-03
			Fe	68.375	5.8545E-02
			Ni	9.500	7.7402E-03
$^{11}B_4C$ in CC	8	2.555	B11	78.56	1.0988E-01
			C	21.44	2.7470E-02
Aluminum	6	2.702	Al	100.0	6.0307E-02
Aluminum - Boron Poison Plate (6.30 mg B-10/cm^2)	7	2.693	B10	0.01	1.33020E-05
			B11	0.14	2.01002E-04
			Al	99.85	5.83483E-02
Water	9	0.998	H	11.1	6.6769E-02
			O	88.9	3.3385E-02
Lead	10	11.344	Pb	100.0	3.2969E-02

Proprietary information on pages A.6.5.6-30 to A.6.5.6-45 withheld pursuant to 10 CFR 2.390

Tables A.6.5.6-20 through A.6.5.6-30 have been deleted along with corresponding pages A.6.5.6-47 through A.6.5.6-56.

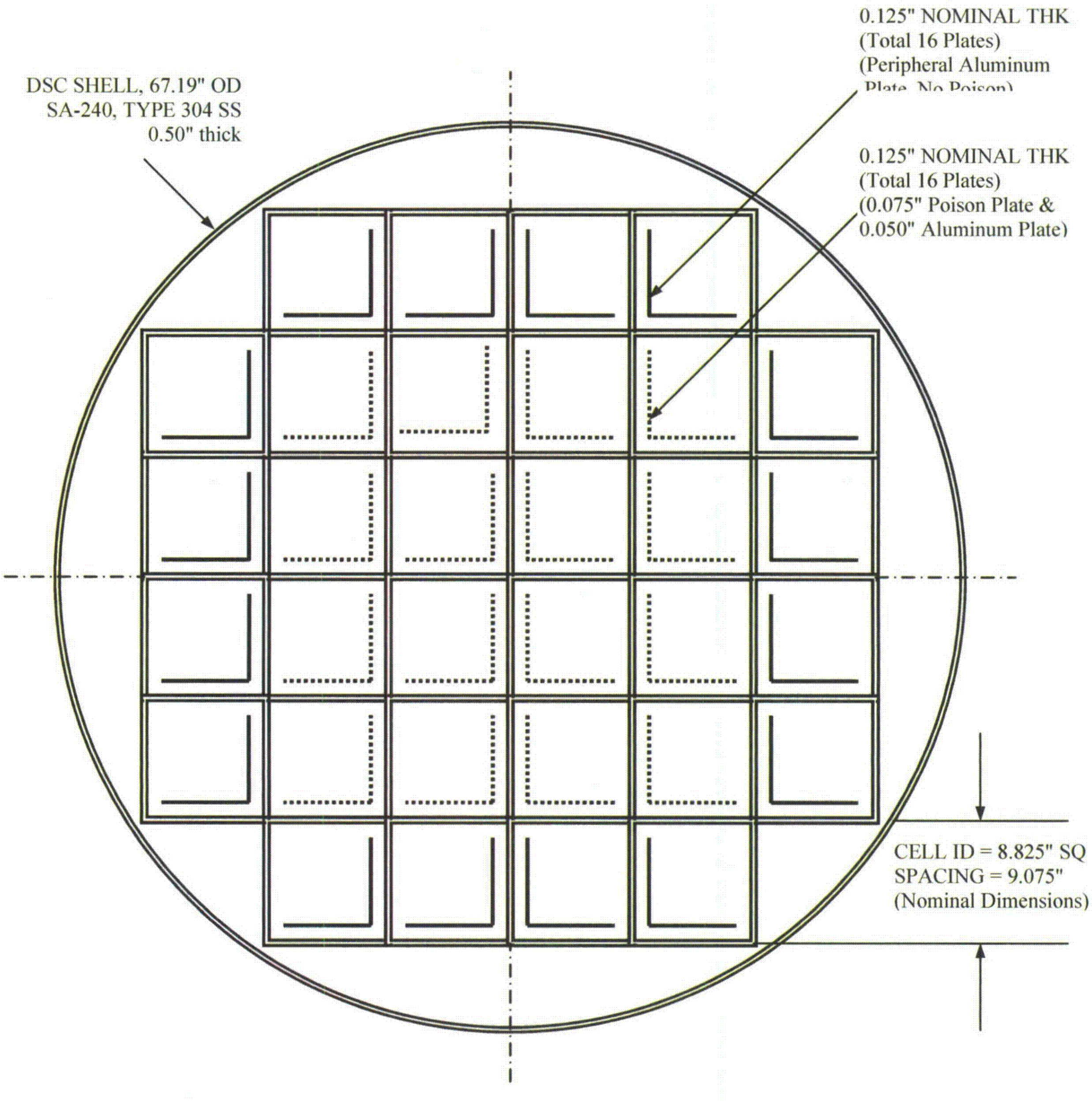

Figure A.6.5.6-1
NUHOMS® -32PT Transportable DSC Basket Radial Cross Section

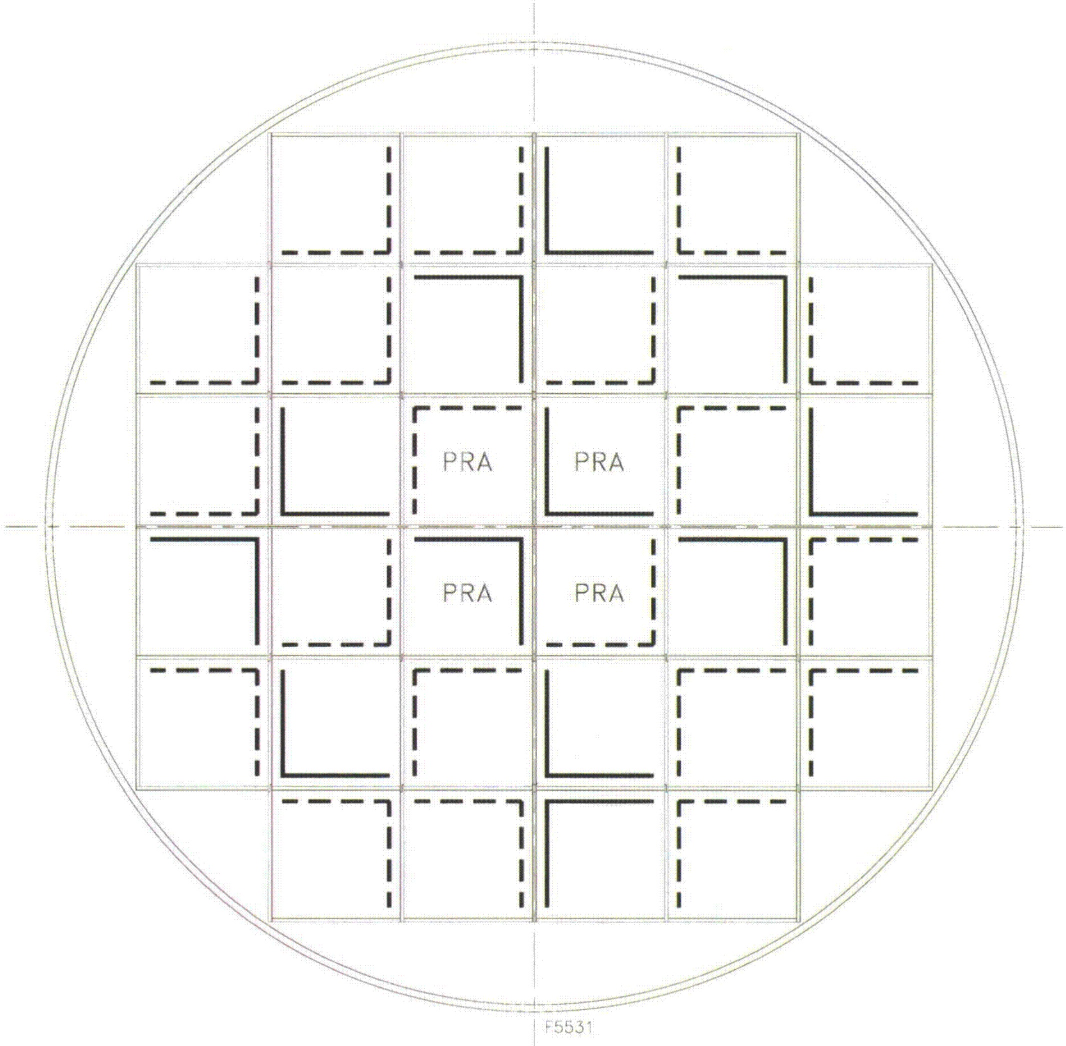

Figure A.6.5.6-2
Required PRA Locations for Configurations with Four PRAs

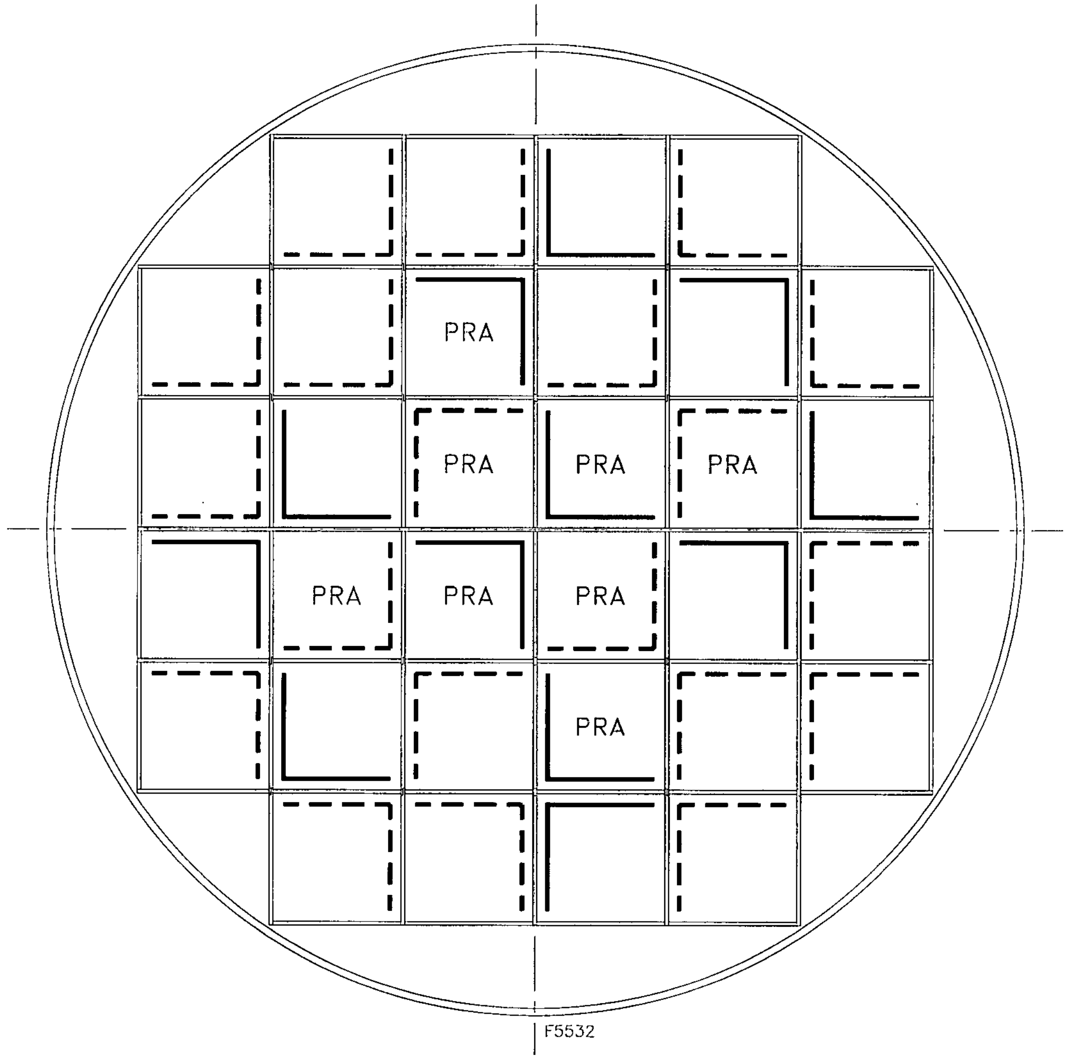

Figure A.6.5.6-3
Required PRA Locations for Configurations with Eight PRAs

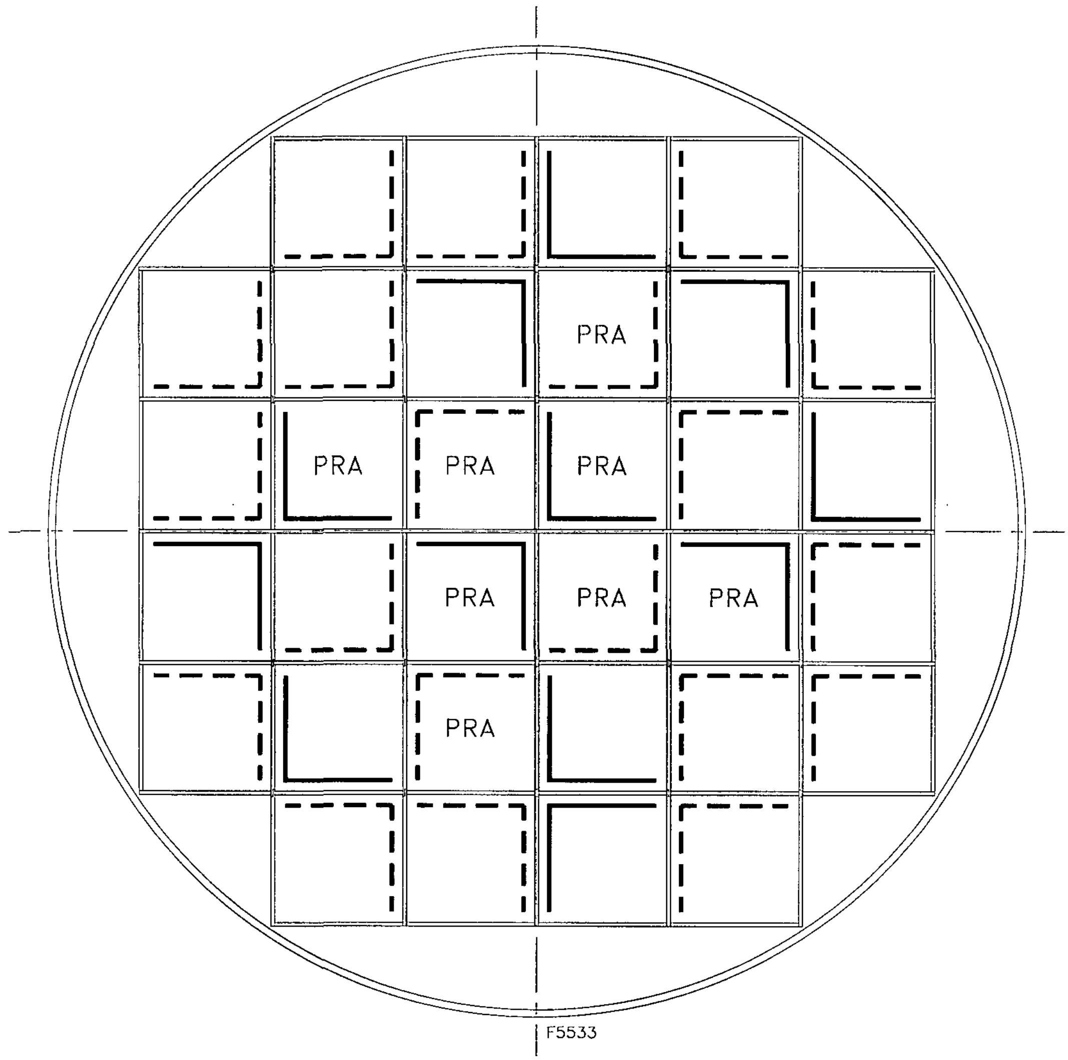

Figure A.6.5.6-3
Required PRA Locations for Configurations with Eight PRAs
(concluded)

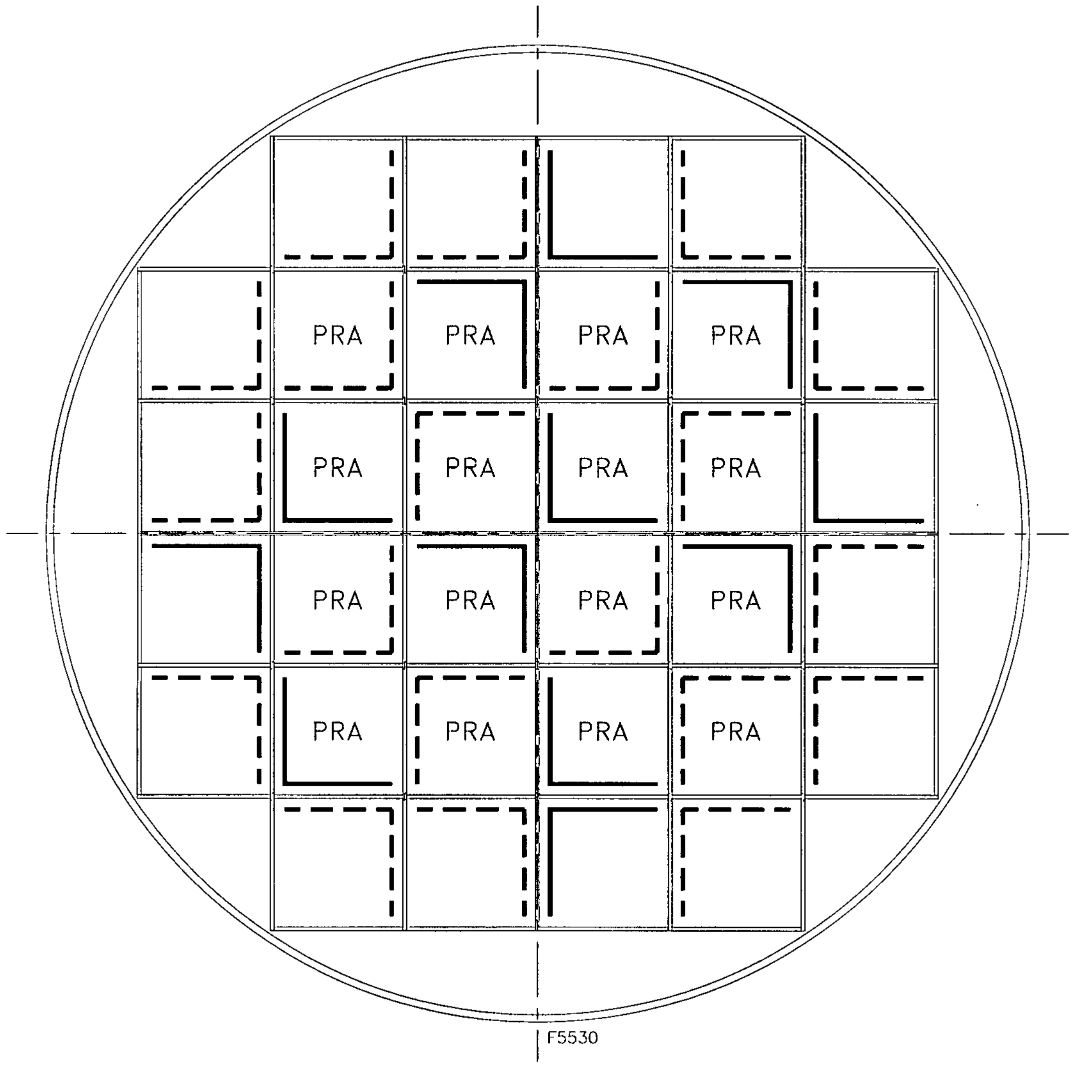

Figure A.6.5.6-4
Required PRA Locations for Configurations with Sixteen PRAs

Figure A.6.5.6-5
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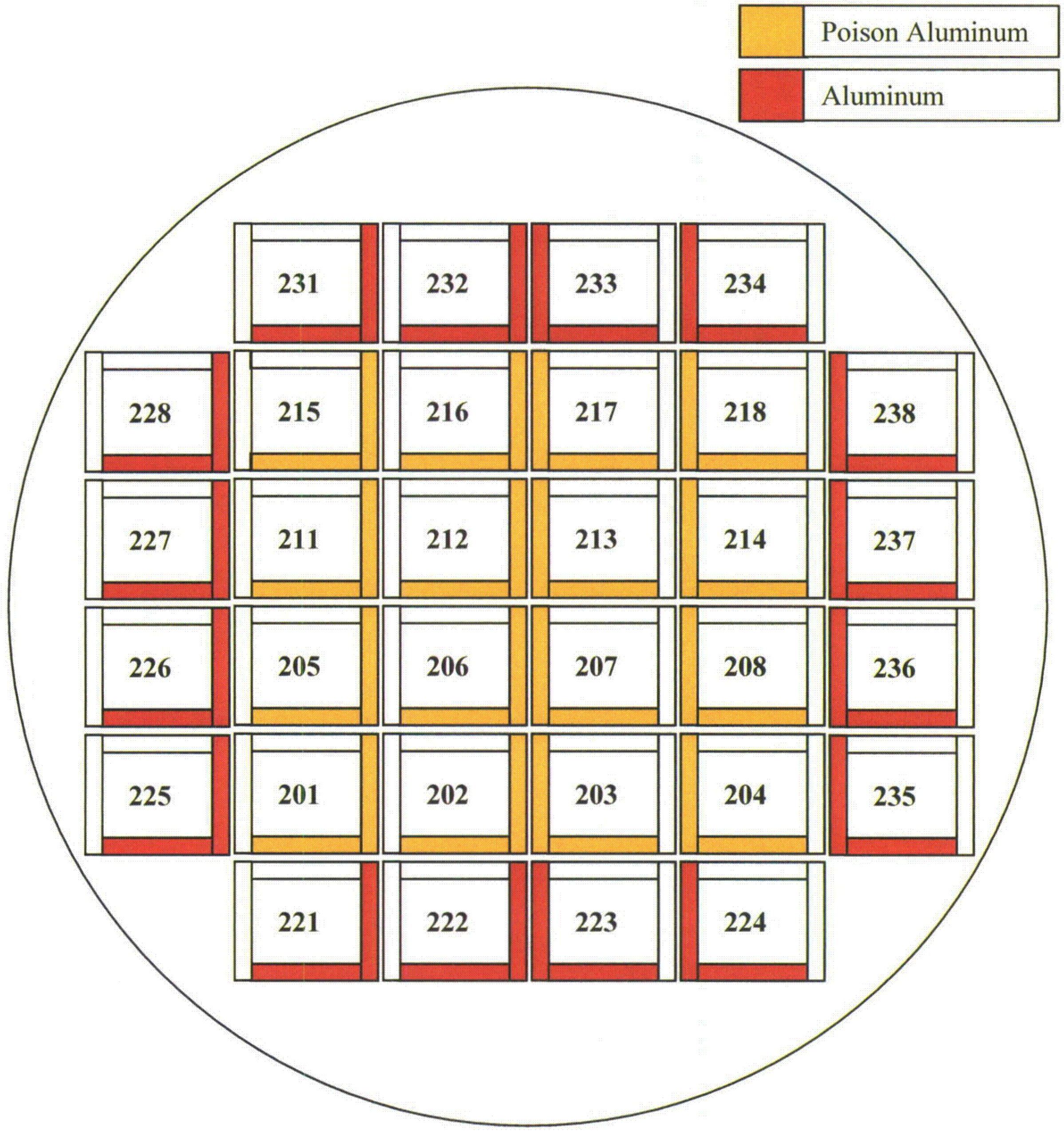

Figure A.6.5.6-6
Fuel Positions and Poison Locations-16PP Model

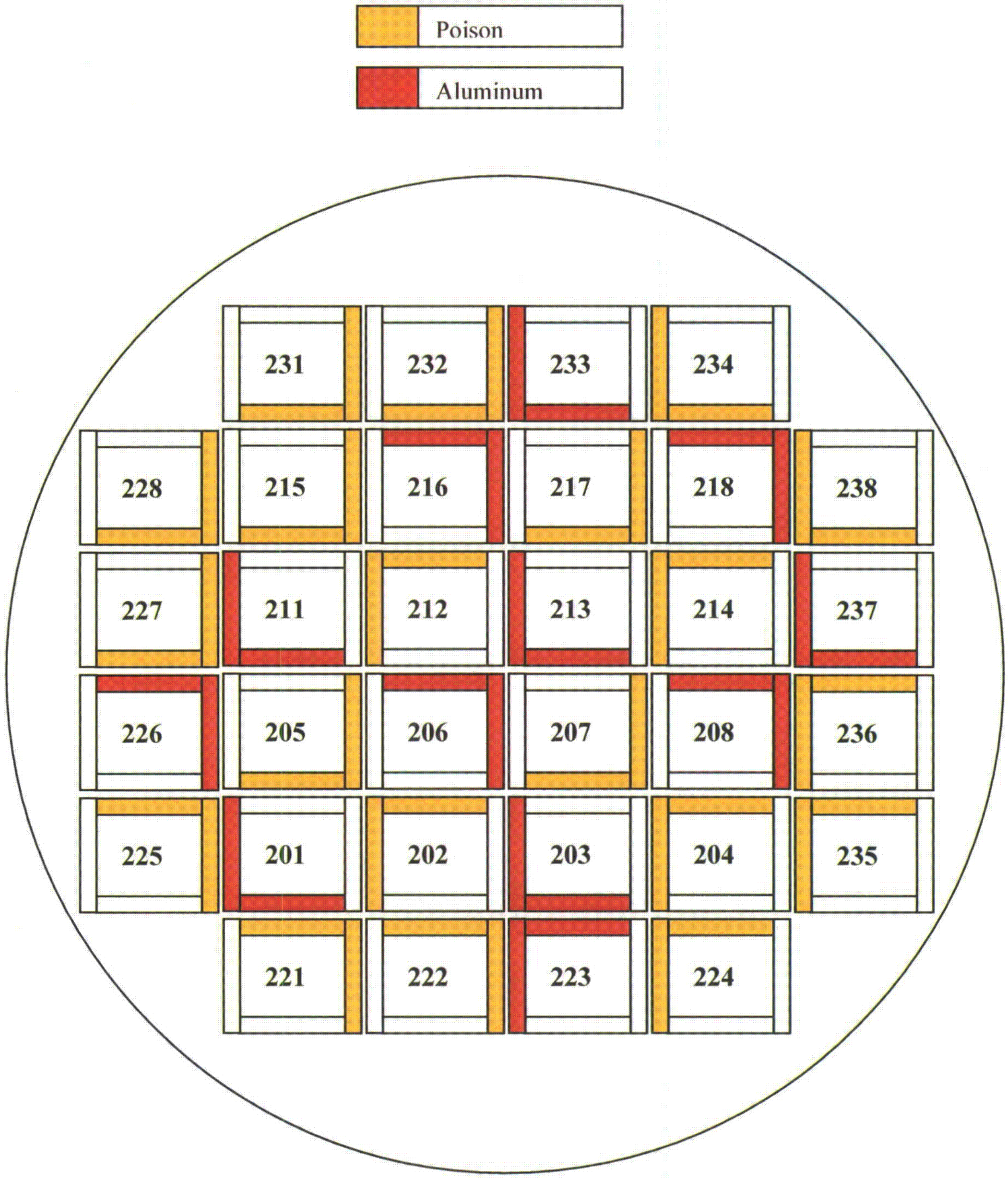

Figure A.6.5.6-7
Fuel Positons and Poison Locations-20 PP Model

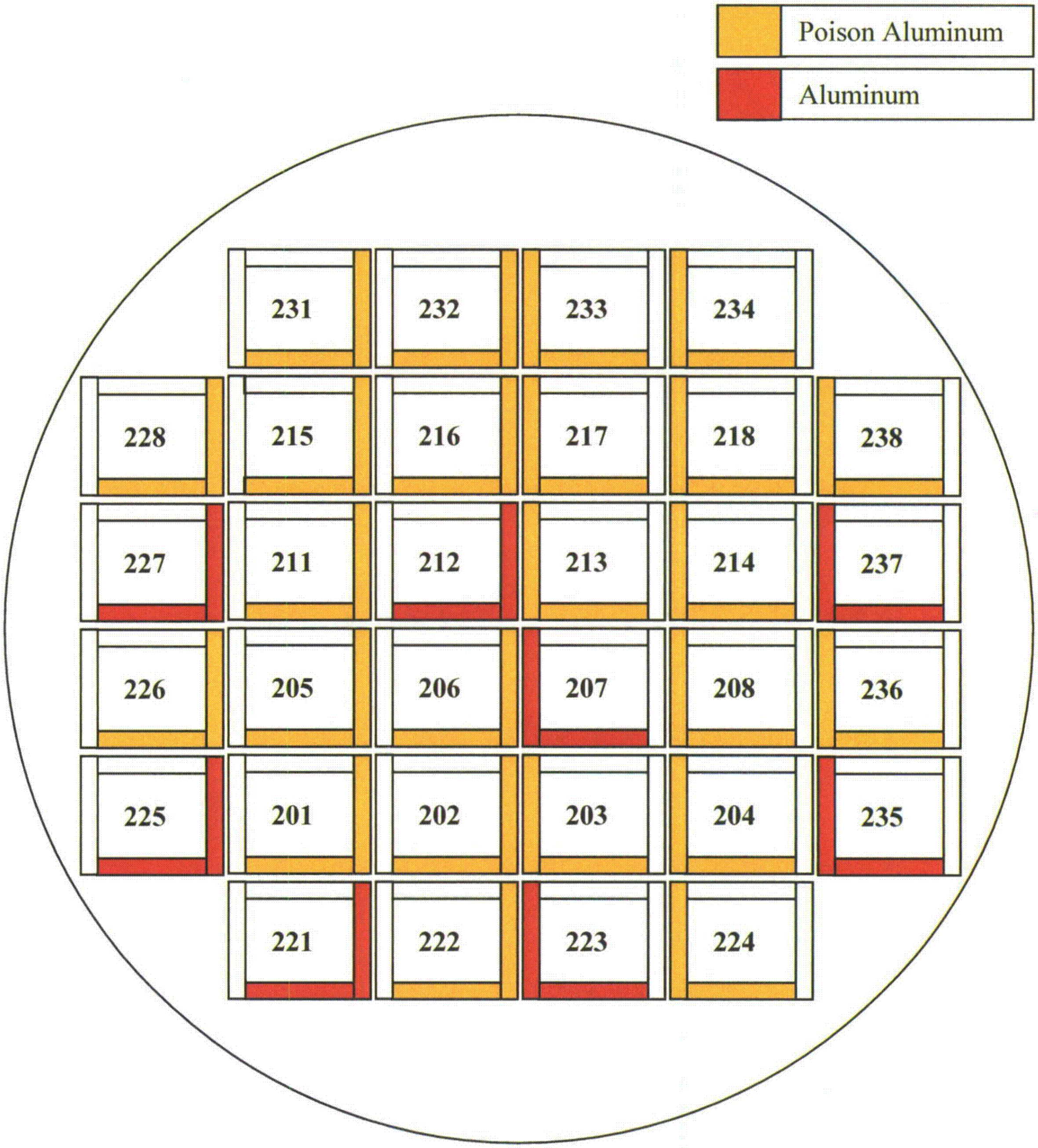

Figure A.6.5.6-8
Fuel Positions and Poison Locations-24 PP Model

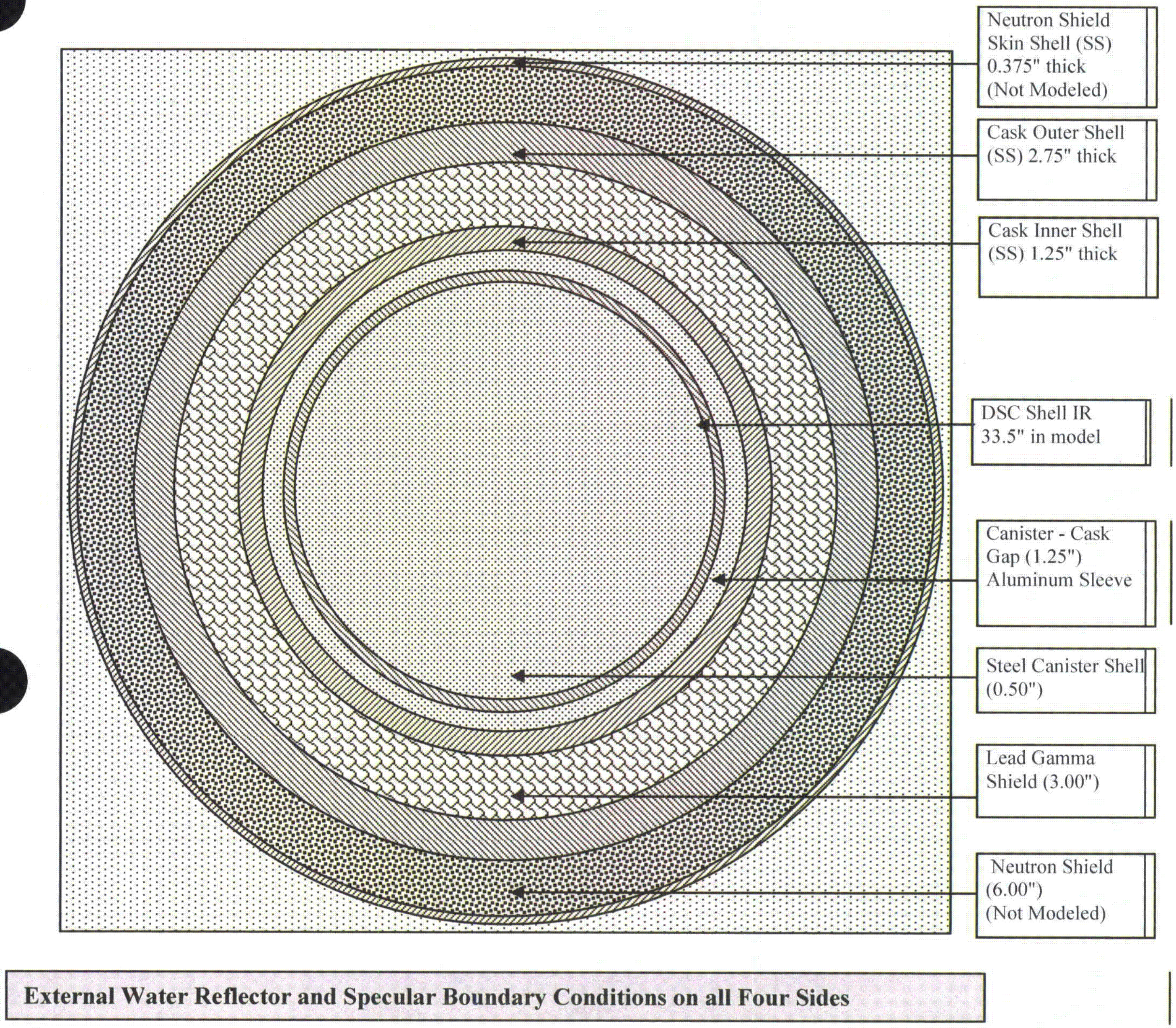

Figure A.6.5.6-9
Criticality Calculational KENO Model

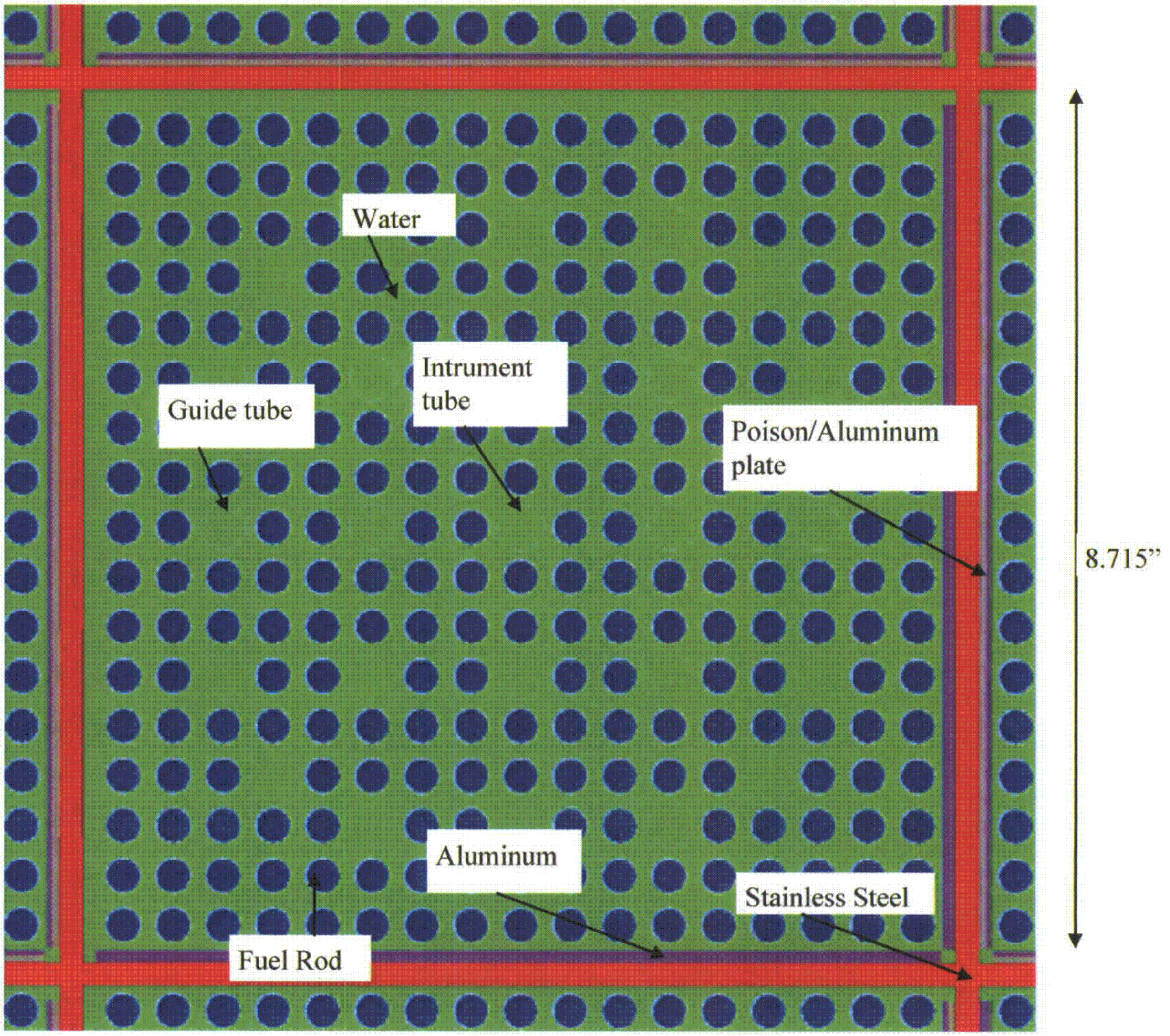

Figure A.6.5.6-10
32PT Fuel Compartment with WE17x17 Fuel Assembly–KENO Model

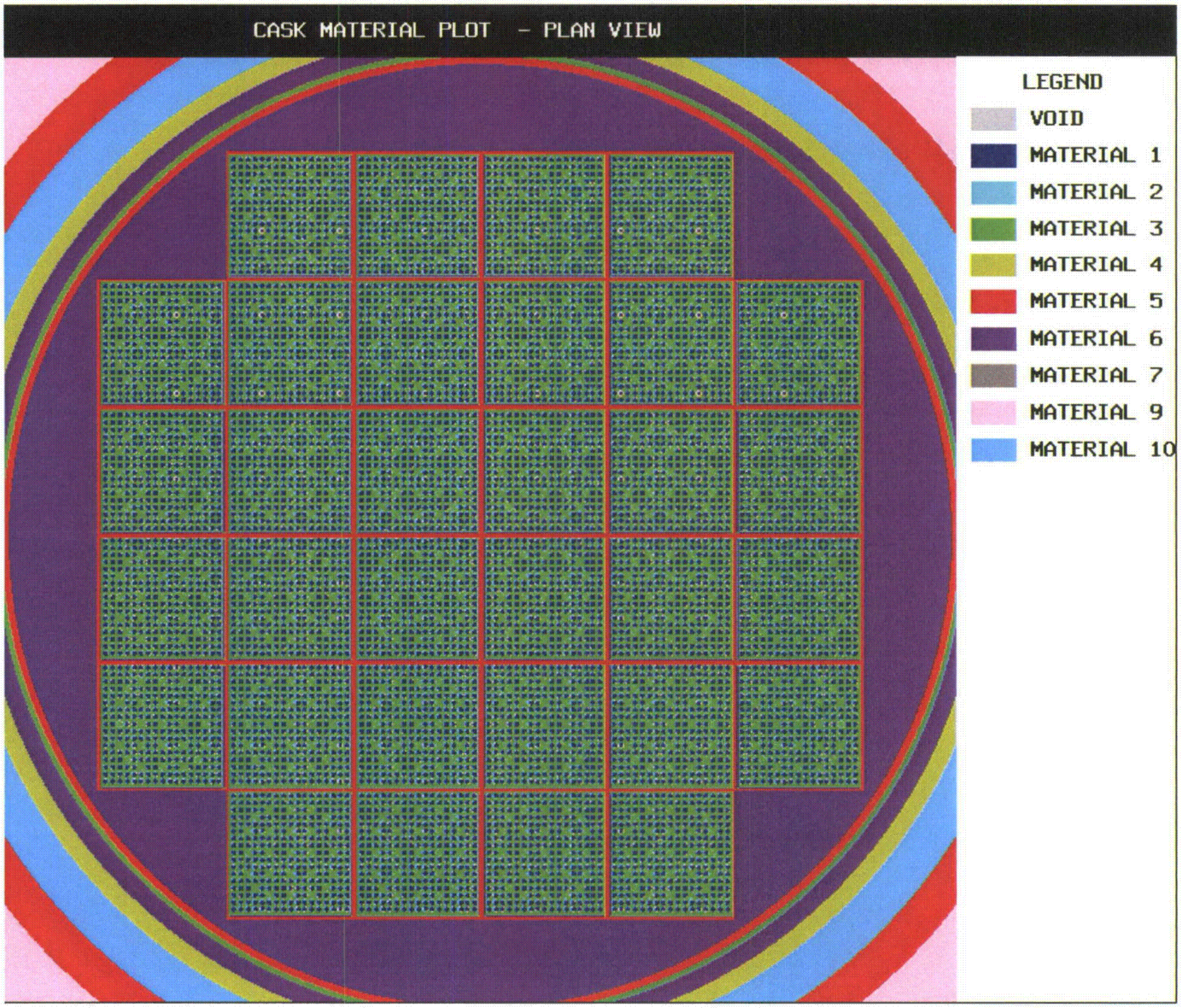

Figure A.6.5.6-11
Criticality Calculational KENO Model–24 Poison Plates–WE17x17

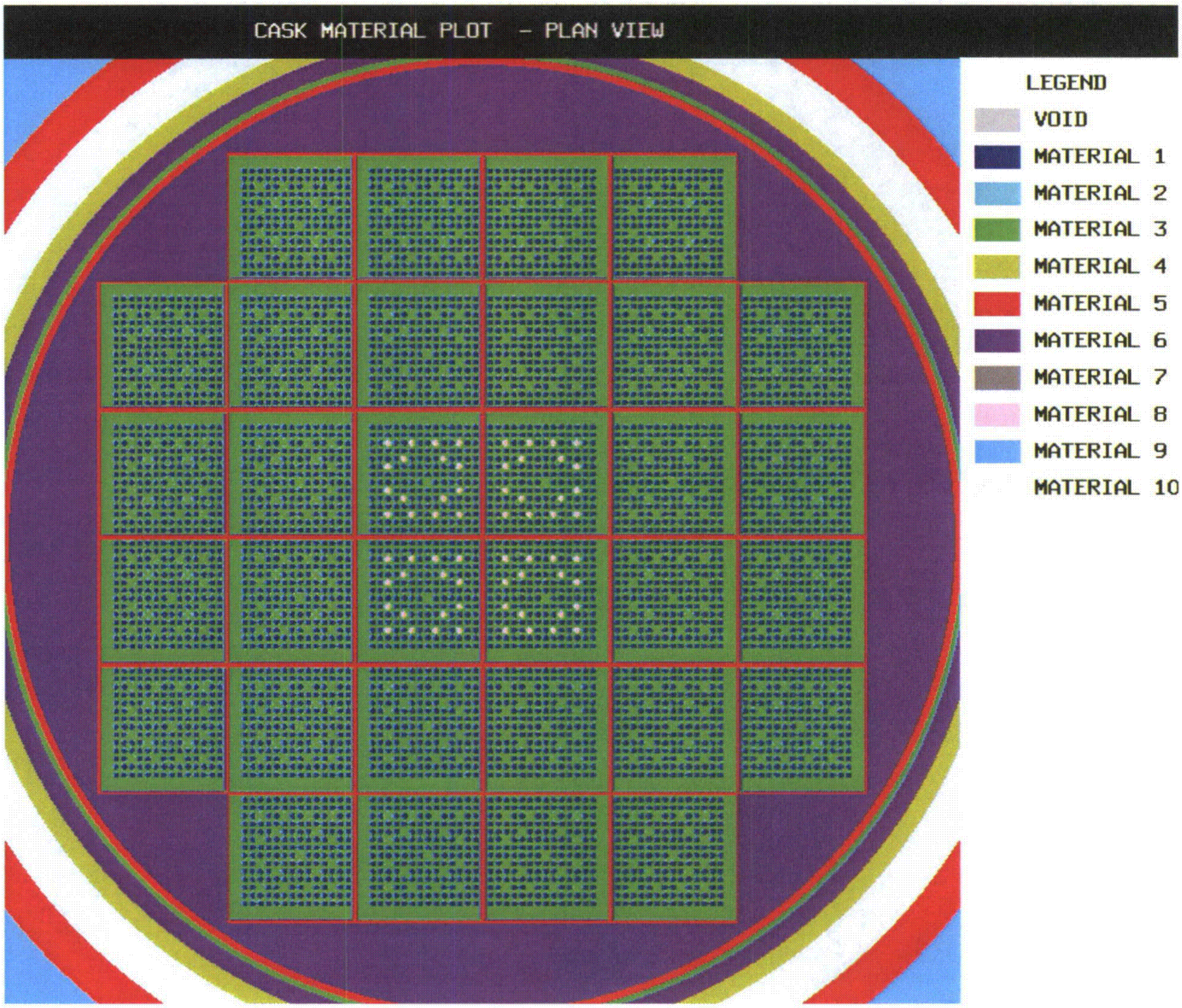

Figure A.6.5.6-12
Criticality Calculational KENO Model–24 Poison Plates 4 PRA–WE14x14

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Figure A.6.5.6-13

Appendix A.6.5.7
NUHOMS®-37PTH DSC Criticality Evaluation

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Appendix A.6.5.7
NUHOMS®-37PTH DSC Criticality Evaluation

NOTE: References in this Appendix are shown as [1], [2], etc. and refer to the reference list in Section A.6.5.7.5.

This Appendix A.6.5.7 to Chapter A.6 demonstrates that the MP197HB package when transporting the NUHOMS®-37PTH DSC payload meets the criticality performance requirements specified in Sections 71.55 and 71.59 of 10 CFR Part 71 [2]. The criticality control design ensures that the effective multiplication factor (k_{eff}) of the contained fuel is no greater than an Upper Subcritical Limit (USL) for the most reactive configuration. The USL includes a confidence band with an administrative safety margin of 0.05. The design has a Criticality Safety Index (CSI, given in 10 CFR 71.59(b) as CSI = 50/"N") of 0 because "N" is infinity (∞). The number "N" is based on all of the following conditions being satisfied, assuming packages are stacked together in any arrangement and with close full reflection on all sides of the stack by water:

1. Five times "N" undamaged packages with nothing between the packages are subcritical;
2. Two times "N" damaged packages, if each package is subjected to the tests specified in 10 CFR Part 71.73 (HAC) is subcritical with optimum interspersed hydrogenous moderation; and
3. The value of "N" cannot be less than 0.5.

A.6.5.7.1 Discussion and Results

The NUHOMS®-37PTH DSC design is described in detail in Chapter A.1, Appendix A.1.4.6. Figure A.6.5.7-1 shows the radial cross section of the NUHOMS®-37PTH DSC. The NUHOMS®-37PTH DSC stainless steel basket consists of a welded plate design. The welded plates form 37 compartments with sufficient space to accommodate aluminum or poison/aluminum inserts and a PWR fuel assembly. The compartment structure is connected to perimeter rail structure comprising of a solid aluminum interface. The rail aluminum interface provides the circular perimeter geometry that fits the basket inside the canister shell and also increases the area of thermal conduction from the basket to the shell.

The basket uses Borated Aluminum or Aluminum/B_4C metal matrix composite (MMC) or Boral® as its neutron poison material. These materials are ideal for long-term use in radiation and thermal environments of a dry cask storage system. The minimum required boron-10 loading is 0.020 g/cm^2 (90% credit is taken in the criticality analysis or 0.018 g/cm^2) for Borated Aluminum or MMC and the minimum required boron-10 loading is 0.025 g/cm^2 (75% credit is taken in the criticality analysis or 0.018 g/cm^2) for Boral®.

The arrangement of poison/aluminum plates in the fuel compartments of the basket for the 37PTH DSC is shown in Figure A.6.5.7-1.

The NUHOMS®-MP197HB Cask containing the NUHOMS®-37PTH DSC is shown to be subcritical for an infinite array of flooded undamaged casks and for an infinite array of damaged casks after being subjected to hypothetical accident conditions. "N" is equal to ∞. The cask is shown to be subcritical for five times "N" or an infinite number of undamaged packages with close full reflection between packages and no inleakage of water as required by 10 CFR Part 71.59(a)(1). In addition, as required by 10 CFR Part 71.59(a)(2), two times "N" or an infinite array of packages is shown to be subcritical with the fissile material in its most reactive configuration, optimum water moderation and close full water reflection consistent with its damaged condition. A CSI of 0 (less than 50) ensures that, per 10 CFR Part 71.59 (c)(1), the package may be shipped by a carrier in a nonexclusive conveyance.

Table A.6.5.7-1 lists the fuel assemblies considered as authorized contents of the NUHOMS®-37PTH DSC. The criticality analysis is performed using *two* bounding fuel assembly classes identified in Table A.6.5.7-1. These are the Westinghouse (WE) 17x17 and the WE 14x14 classes. The results of the WE 17x17 class bound those of the WE 15x15, *Combustion Engineering (*CE*)* 14x14, CE 16x16 and CE 15x15 classes.

Criticality calculations are performed to determine the minimum assembly average burnup as a function of initial enrichment and cooling time for the *two* fuel assembly classes which are listed in Table A.6.5.7-9. The calculations determine k_{eff} with the CSAS25 control module of SCALE-4.4 [1] for each assembly *class* and initial enrichment, including all uncertainties to assure criticality safety under all credible conditions. Note that burnup credit is employed in the criticality analysis of the NUHOMS®-37PTH DSC.

The Control Components (CCs) are also authorized for storage in the 37PTH DSCs. The authorized CCs are Burnable Poison Rod Assemblies (BPRAs), Control Rod Assemblies (CRAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping Rod Assemblies (APSRAs), Control Element Assemblies (CEAs), Vibration Suppressor Inserts (VSIs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources.

The results of the evaluation demonstrate that the maximum k_{eff}, including statistical uncertainty, is less than the USL determined from a statistical analysis of benchmark criticality experiments. The statistical analysis procedure includes a confidence band with an administrative safety margin of 0.05.

A.6.5.7.2 Package Fuel Loading

The NUHOMS®-37PTH DSC is capable of storing and transporting a maximum of 37 intact PWR fuel assemblies. In addition, a maximum of 4 damaged and remaining intact (for a total of 37) PWR fuel assemblies can also be transported within the NUHOMS®-37PTH DSC. Reconstituted fuel assemblies, where the fuel pins are replaced by lower enriched fuel pins or non-fuel pins that displace the same amount of water in the active fuel region of the fuel assemblies, are considered intact fuel assemblies in the criticality evaluation. A detailed listing of the contents of the NUHOMS®-37PTH DSC is provided in Table A.6.5.7-1.

For all the fuel assembly classes CCs are also included as authorized contents. The only change to the package fuel loading to evaluate the addition of these CCs is replacing the water in the guide tubes/water holes with $^{11}B_4C$. Since these CCs displace moderator in the assembly guide and or instrument tubes, an evaluation is not needed to determine the potential impact of storage of CCs that extend into the active fuel region on the system reactivity. The presence of these CCs such as CRAs, CEAs and BPRAs will result in a reduction in the reactivity of the fuel assemblies. CCs that do not extend into the active fuel region of the assembly do not have any effect on the reactivity of the system as evaluated because only the active fuel region is modeled in this evaluation with periodic boundary conditions making the model infinite in the axial direction. Additionally, the presences of non-multiplying sources like the NSAs have no impact on criticality calculations.

Therefore, any CC that is inserted into the fuel assembly such that it does or does not extend into the active fuel region is considered as authorized for transportation without adjustment to the burnup or initial enrichment as required for control components. No credit is taken for the presence of any residual absorber remaining in the CC nor is any credit taken for the displacement of fresh water from within the guide tube of the fuel assemblies containing CCs.

Proprietary information on pages A.6.5.7-4 to A.6.5.7-15 withheld pursuant to 10 CFR 2.390

A.6.5.7.5 References

1. Oak Ridge National Laboratory, RSIC Computer Code Collection, "SCALE: A Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluations for Workstations and Personal Computers," NUREG/CR-0200, Revision 6, ORNL/NUREG/CSD-2/V2/R6.
2. 10 CFR 71, Packaging and Transportation of Radioactive Materials.
3. U.S. Nuclear Regulatory Commission, "Criticality Benchmark Guide for Light-Water-Reactor fuel in Transportation and Storage Packages," NUREG/CR-6361, Published March 1997, ORNL/TM-13211.
4. U.S. Nuclear Regulatory Commission, "Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packages," NUREG/CR-5661, Published April 1997, ORNL/TM-11936.
5. *NUH-003, Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for the Irradiated Nuclear Fuel (UFSAR), Revision 11.* The Certificate of Compliance (CoC) for Amendment 10 to Part 72 CoC 1004 *was* issued on *August 24th*, 2009.

Proprietary information on pages A.6.5.7-17 to A.6.5.7-28 and A.6.5.7-28a to A.6.5.7-28w withheld pursuant to 10 CFR 2.390

Table A.6.5.7-1
Authorized Contents for NUHOMS®-37PTH System

Assembly Type[1]	Array	Assembly Class
Westinghouse 17x17 LOPAR/Standard	17x17	WE 17x17
Westinghouse 17x17 OFA/Vantage 5[2]	17x17	WE 17x17
Framatome 17x17 MK BW	17x17	WE 17x17
Westinghouse 17x17 RFA	17x17	WE 17x17
CE 16x16 System 80	16x16	CE 16x16
CE 16x16 Standard	16x16	CE 16x16
B&W 17x17 Mark C	17x17	BW 15x15
CE 15x15 Palisades	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 CE	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 WE	15x15	WE 15x15
Westinghouse 15x15 Standard/ZC	15x15	WE 15x15
Westinghouse 15x15 LOPAR/OFA/ DRFA/Vantage 5	15x15	WE 15x15
CE 14x14 Standard/Generic	14x14	CE 14x14
CE 14x14 Fort Calhoun	14x14	CE 14x14
Framatome-ANP 14x14 CE	14x14	CE 14x14
Exxon/ANF (ANP) 14x14 WE	14x14	WE 14x14
Exxon/ANF (ANP) 14x14 Toprod	14x14	WE 14x14
Westinghouse 14x14 Standard/LOPAR/ZCA/ZCB	14x14	WE 14x14
Westinghouse 14x14 OFA	14x14	WE 14x14

Notes:

(1) Reload fuel from other manufacturers with these parameters are also acceptable.
(2) Includes all Vantage versions (5, +, ++, 5H, etc.)

Table A.6.5.7-2
NUHOMS®-37PTH Basket Dimensions

Basket Component Description	***Actual Dimension, inches***
Compartment Inside width (4 corner compartments)	*9.000 (Nominal)*
Compartment Inside width (Remaining 33 compartments)	*8.675 (Nominal)* *8.625 (Minimum)*
Compartment wall thickness [(1)]	*0.25 or 0.31*
Aluminum Plate thickness if poison plate is present	*0.040 (minimum)*
Aluminum Plate thickness if poison plate is absent	*0.115 (minimum)*
Poison plate thickness when paired with Aluminum	*0.075 (nominal)*
Width of the Absorber Plate (L-insert)	*8.125* *(minimum)*
DSC inside radius	*34.40 (nominal)*
DSC wall thickness	*0.500 (nominal)*

Note: [(1)] *Several fuel compartments are based on a wall thickness of 0.25" in one direction and 0.31" in the other direction. The center fuel compartment has a uniform wall thickness of 0.31" on all four sides.*

Proprietary information on pages A.6.5.7-31 and A.6.5.7-32 withheld pursuant to 10 CFR 2.390

Table A.6.5.7-5
Material Property Data

Material	ID	Density g/cm^3	Element	Weight %	Atom Density (atoms/b-cm)
Zircaloy-4	2	6.56	Zr	98.23	4.2541E-02
			Sn	1.45	4.8254E-04
			Fe	0.21	1.4856E-04
			Cr	0.10	7.5978E-05
			Hf	0.01	2.2133E-06
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			O	88.9	3.3385E-02
Stainless Steel (SS304)	5	7.94	C	0.080	3.1877E-04
			Si	1.000	1.7025E-03
			P	0.045	6.9468E-05
			Cr	19.000	1.7473E-02
			Mn	2.000	1.7407E-03
			Fe	68.375	5.8545E-02
			Ni	9.500	7.7402E-03
$^{11}B_4C$ in CC	8	2.555	B11	78.56	1.0988E-01
			C	21.44	2.7470E-02
Aluminum	6	2.702	Al	100.0	6.0307E-02
Aluminum–Boron poison Plate Basket (18.00 mg B-10/cm^2)	7	2.693	B10	3.47	5.68315E-03
			B11	0.39	5.74311E-04
			Al	96.15	5.83483E-02
Water	9	0.998	H	11.1	6.6769E-02
			O	88.9	3.3385E-02
Lead	10	11.344	Pb	100.0	3.2969E-02

Proprietary information on pages A.6.5.7-34 to A.6.5.7-38 withheld pursuant to 10 CFR 2.390

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Proprietary information on pages A.6.5.7-40 to A.6.5.7-44 withheld pursuant to 10 CFR 2.390

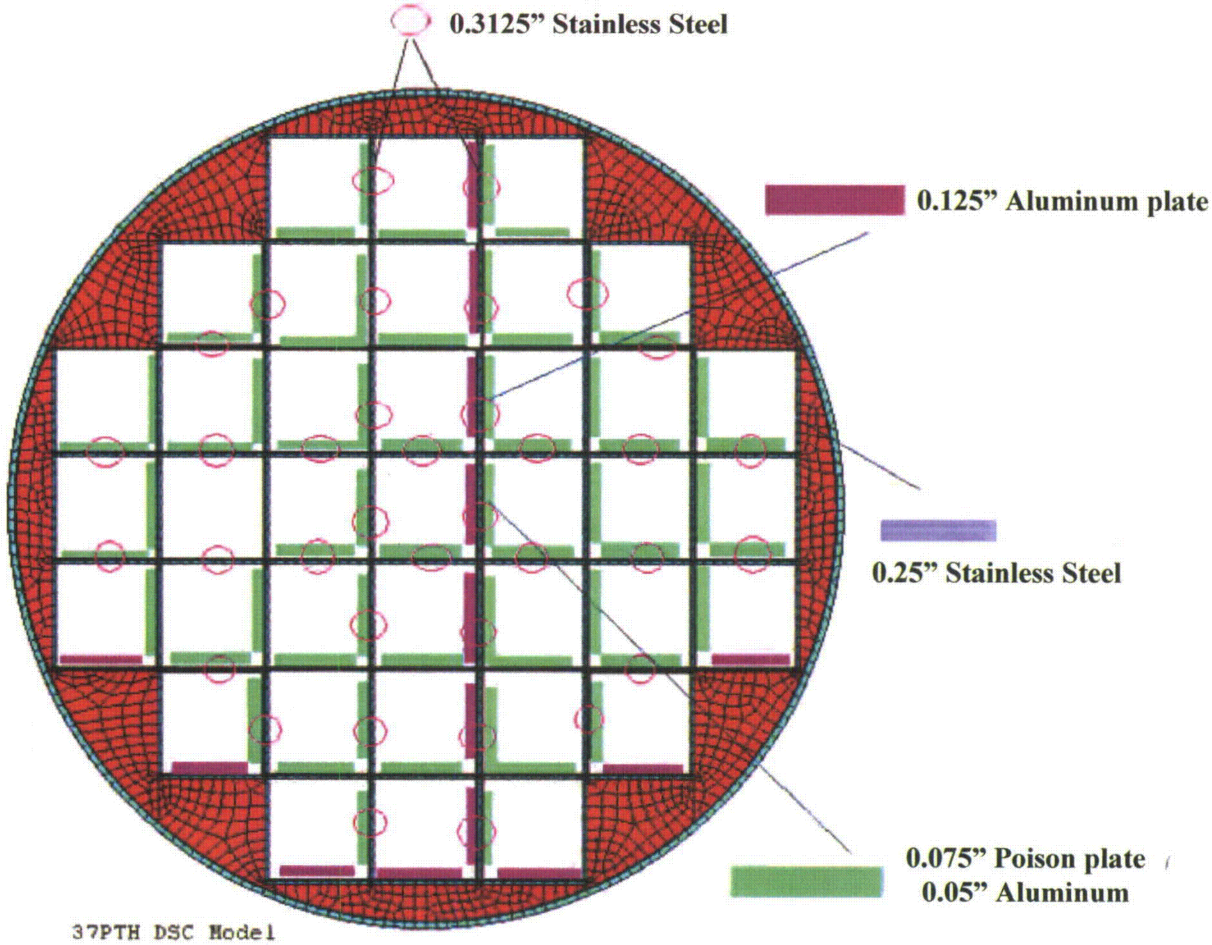

Figure A.6.5.7-1
NUHOMS®-37PTH Transportable DSC Basket Radial Cross Section

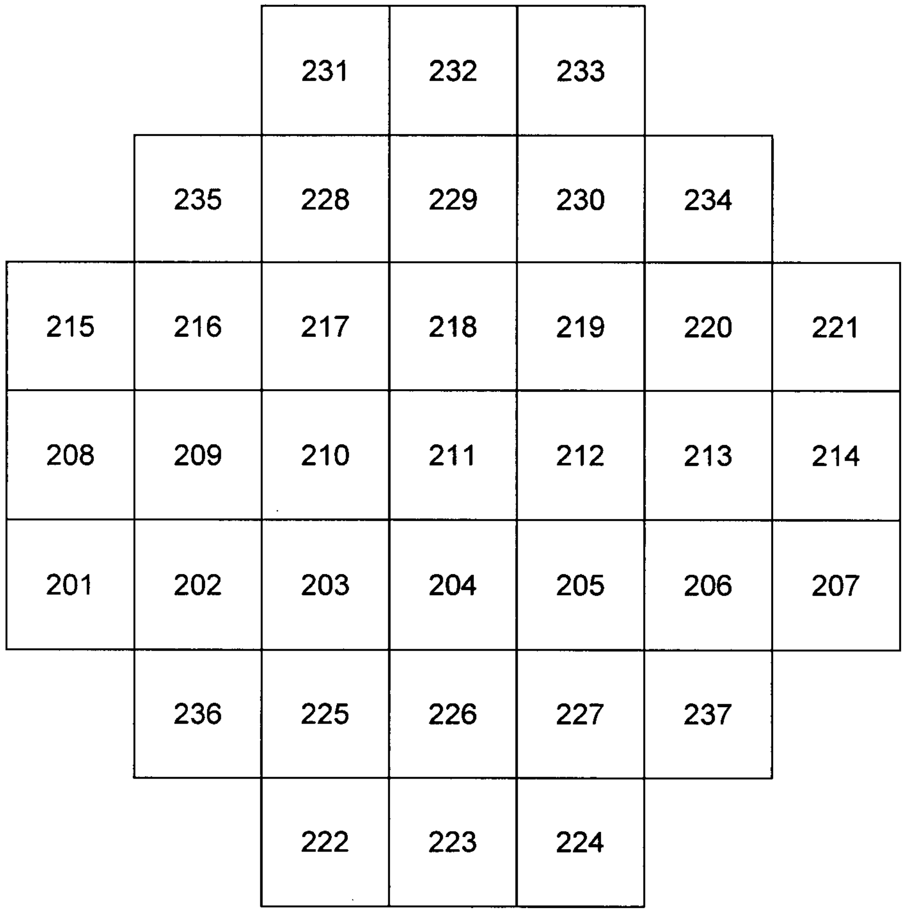

Figure A.6.5.7-2
Fuel Position in the 37PTH DSC Design–Criticality Calculational KENO Model

Figure A.6.5.7-3
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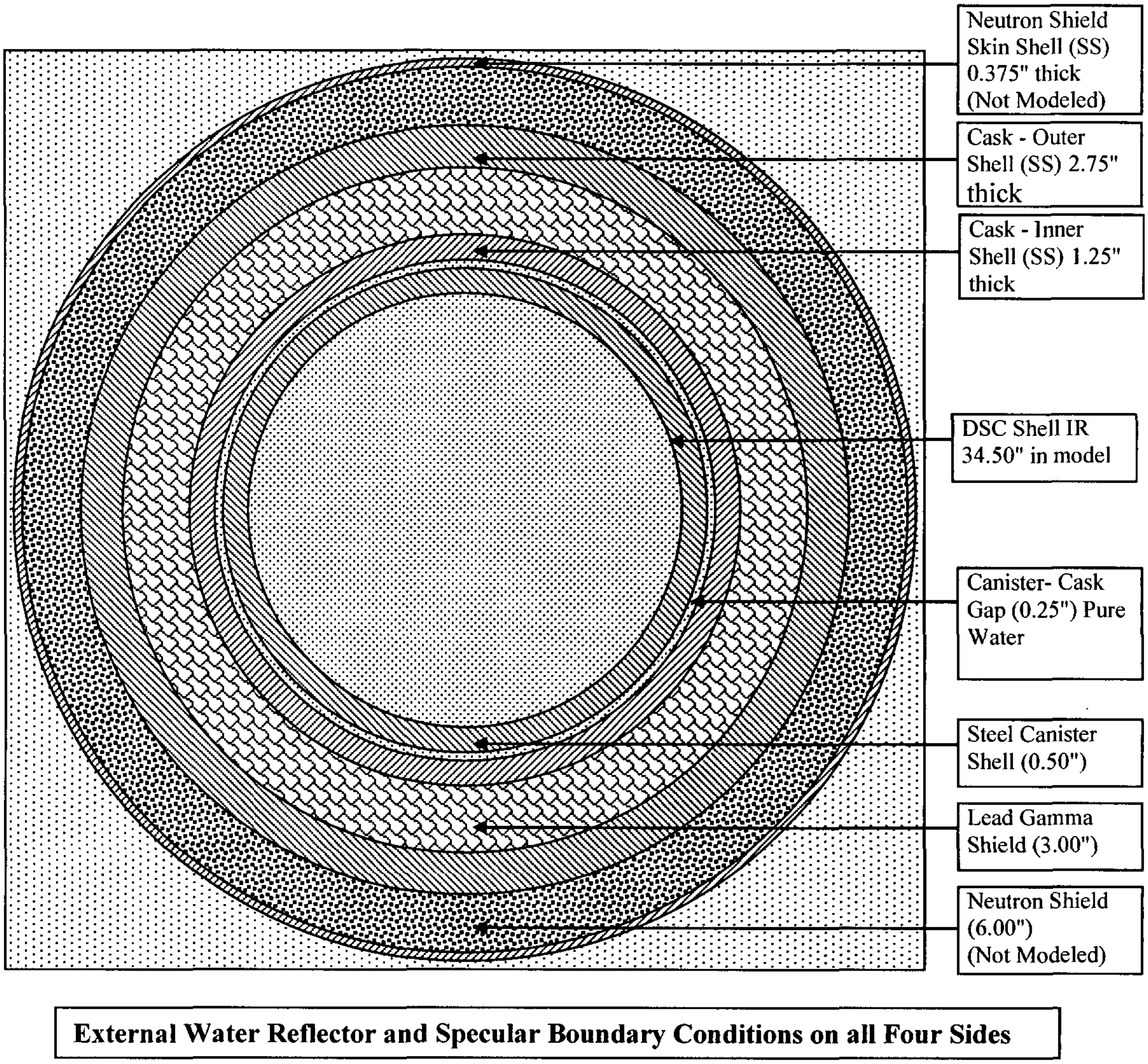

Figure A.6.5.7-4
Criticality Calculational KENO Model

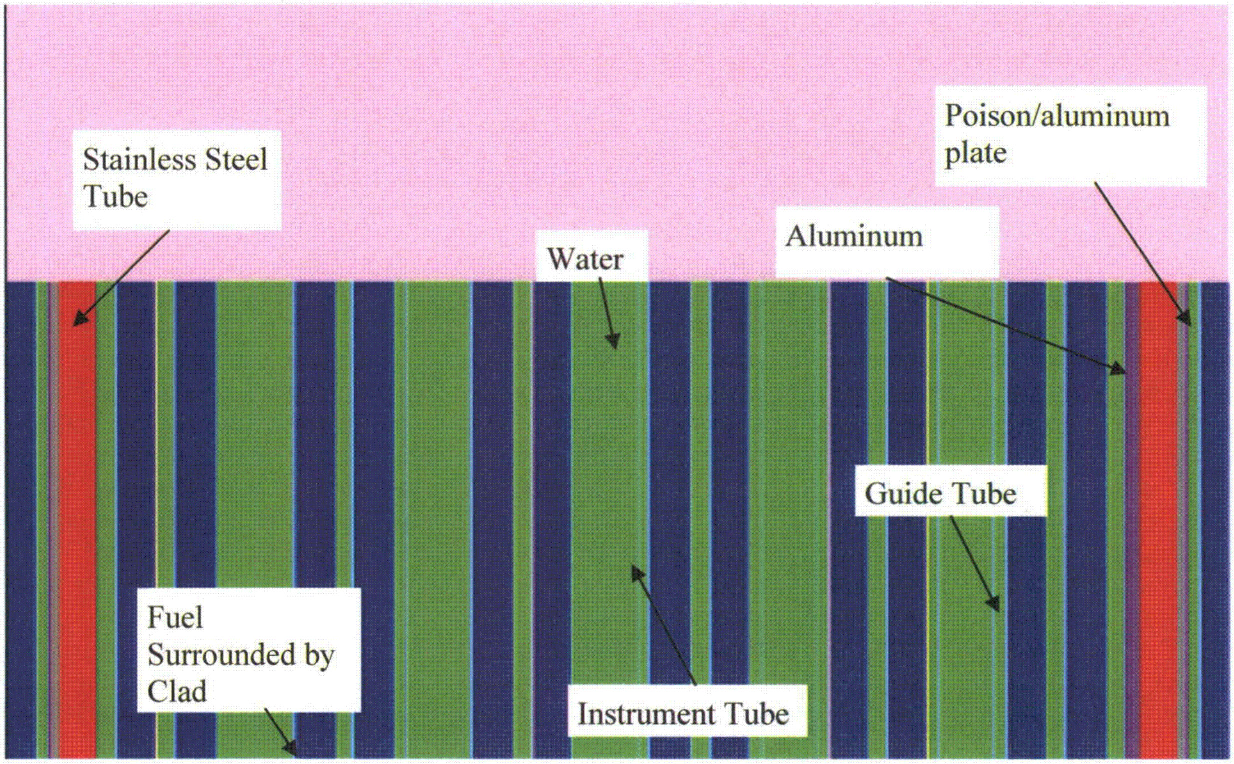

Figure A.6.5.7-5
Basket Model Compartment Wall with WE17x17 Fuel Assembly–Criticality Calculational KENO Model

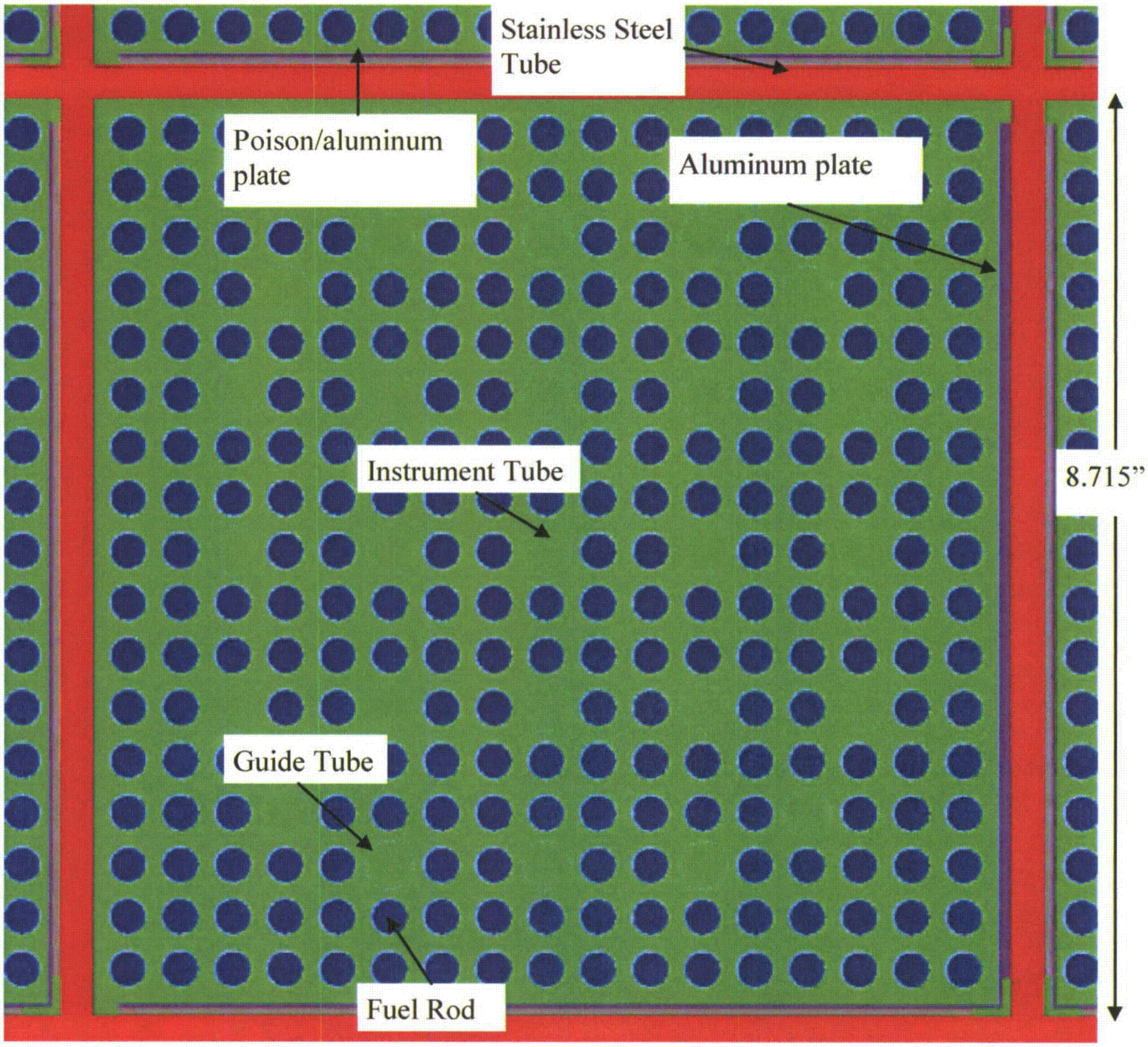

Figure A.6.5.7-6
Basket Compartment with WE 17x17 Fuel Assembly–Criticality Calculational KENO Model

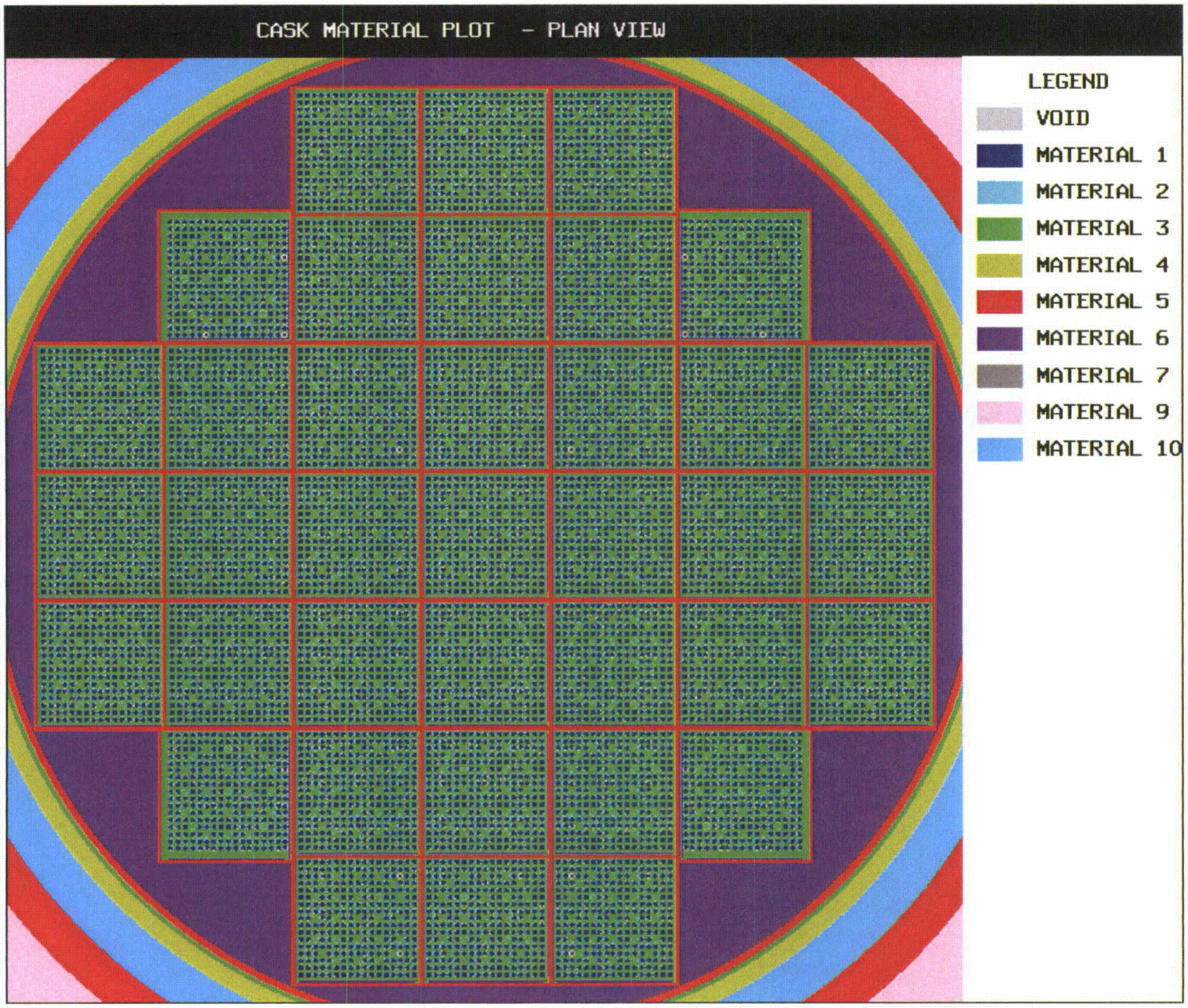

Figure A.6.5.7-7
Criticality Calculational KENO Model–WE17x17

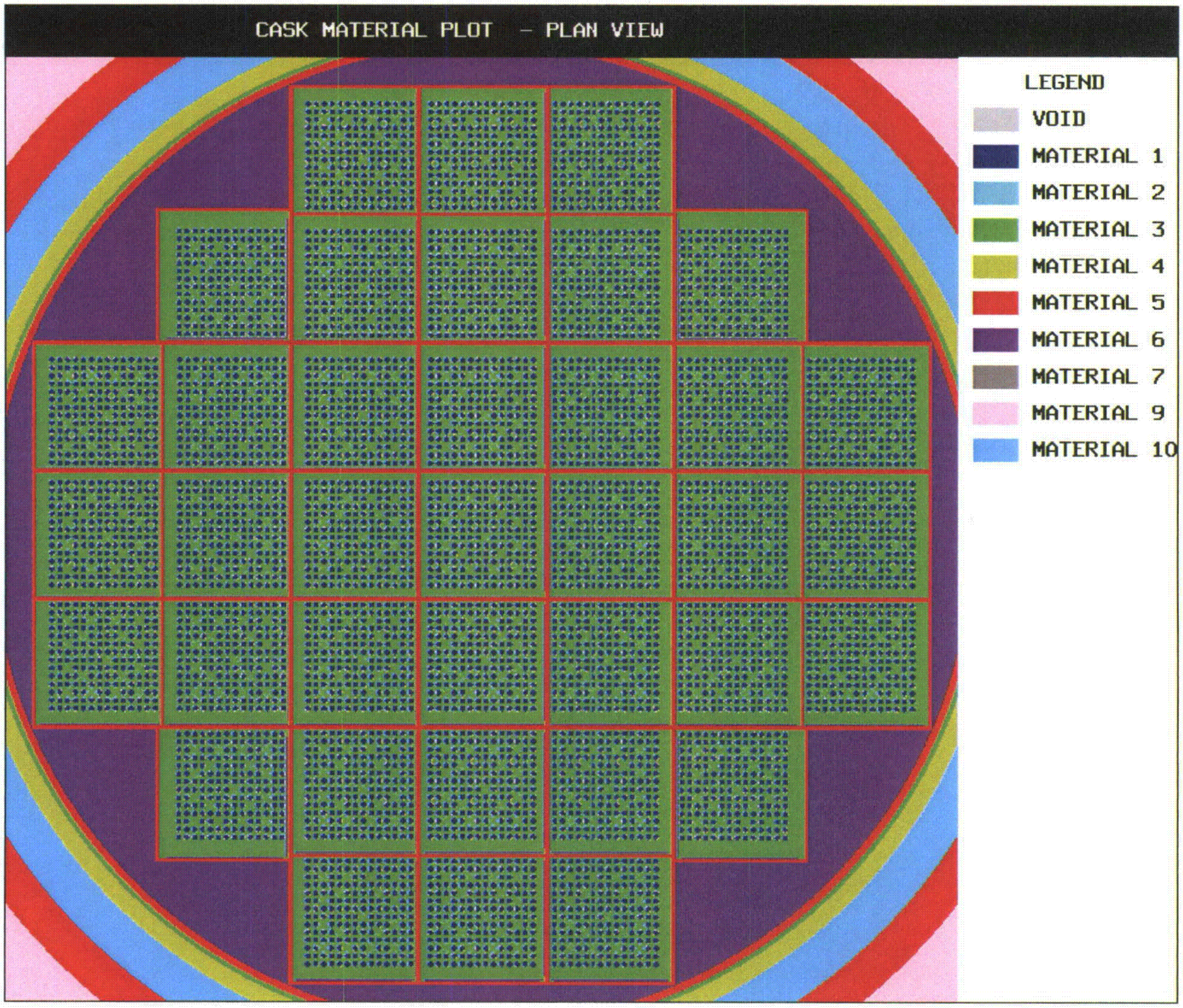

Figure A.6.5.7-8
Criticality Calculational KENO Model–*WE*14x14

Figure A.6.5.7-9
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Chapter A.7
Package Operations

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A.7 PACKAGE OPERATIONS

NOTE: References in this chapter are shown as [1], [2], etc., and refer to the reference list in Section A.7.5. A glossary of terms used in this chapter is provided in Section A.7.6.

This chapter contains NUHOMS®-MP197HB cask loading and unloading procedures that are intended to show the general approach to cask operational activities. The procedures in this chapter are intended to show the types of operations that will be performed and are not intended to be limiting. Site specific conditions and requirements may require the use of different equipment and ordering of steps to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package.

A separate operations manual (OM) will be prepared for the NUHOMS®-MP197HB cask to describe the operational steps in greater detail. The OM, along with the information in this chapter, will be used to prepare the site-specific procedures that will address the particular operational considerations related to the cask.

A.7.1 NUHOMS®-MP197HB Package Loading

The use of the NUHOMS®-MP197HB cask to transport fuel offsite involves (1) preparation of the cask for use, (2) verification that the fuel assemblies loaded in the dry shielded canister (DSC) meet the criteria set forth in this document, and (3) installation of a DSC into the cask. Also included herein are procedures to prepare and load fuel in an empty DSC contained in a NUHOMS®-MP197HB cask and to close the DSC.

The use of the NUHOMS®-MP197HB cask to transport dry irradiated and/or contaminated non-fuel bearing solid materials in radioactive waste canisters (RWCs) involves (1) preparation of the cask for use, (2) verification that the waste to be loaded meet the criteria set forth in this document, and (3) loading of the RWC and waste into the cask.

Offsite transport involves (1) preparation of the cask for transport, (2) assembly verification leakage-rate testing of the packaging containment boundary, (3) placement of the cask onto a transportation vehicle, and (4) installation of the impact limiters.

During shipment, the packaging contains any one of the DSCs with its authorized contents as described in Chapter A.1, Appendices A.1.4.1 through A.1.4.9 or an RWC with dry irradiated and/or contaminated non-fuel bearing solid material as described in Appendix A.1.4.9A. Procedures are provided in this section for (1) transport of the cask/DSC/RWC directly from the plant spent fuel pool and (2) transport of a DSC/RWC which was previously stored in a NUHOMS® horizontal storage module (HSM). Section A.7.7 contains an appendix for each DSC model detailing its loading procedures. Table A.7-3 lists these appendices.

A.7.1.1 NUHOMS®-MP197HB Cask Preparation for Loading

Procedures for preparing the cask for use after receipt at the loading site are provided in this section and are applicable for shipment of DSCs loaded with fuel or of RWCs loaded with dry irradiated and/or contaminated non-fuel bearing solid materials.

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1. *R*emove the impact limiters from the cask.
2. *P*rior to removing the lid, sample the cask cavity atmosphere.
3. Remove the transportation skid personnel barrier and tie down assembly.
4. Take contamination smears on the outside surfaces of the cask. If necessary, decontaminate the cask.
5. O-ring seals shall be discarded after each use.
6. Install the front and rear trunnions, if required. *I*nstall the trunnion bolts and torque them *to 1000-1100 ft-lbs* following the torquing sequence shown in Figure A.7-1.
7. *L*ift the cask and place it on the onsite transfer trailer or upending frame, or lift the cask/transport skid and place them in the appropriate location.
8. *NOT USED.*
9. *NOT USED.*
10. If transporting any of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or an RWC, verify that the MP197HB cask has been fitted with an internal aluminum sleeve (Refer to Drawing MP197HB-71-1014 provided in Chapter A.1, Appendix A.1.4.10.1). This step, if required, can be performed at any time prior to placing the DSC or RWC in the cask.
11. If transporting a NUHOMS®-69BTH DSC with heat load greater than 26 kW, verify that the removable external aluminum fins are available to be fitted to the cask after the cask is closed (Refer to Drawing MP197HB-71-1011 provided in Appendix A.1.4.10.1). Note that fins are not required to meet the 10 CFR 71 requirements and are optional.
12. For a specific DSC model to be loaded inside the MP197HB cask, verify the canister/basket type (A, B, C, D or E as applicable) is appropriate for the fuel to be transported.
13. The candidate intact, damaged and failed fuel assemblies to be transported in a specific DSC model must be evaluated *(by plant records or other means)* to verify that they meet the criteria of the applicable fuel specification as listed in Table A.7-2.
14. For the transportation of fuel within the NUHOMS®-32PT, 24PTH, 32PTH, 32PTH1, or 37PTH DSCs where burnup credit is employed for criticality safety, additional administrative controls to prevent misloading are also outlined in the applicable appendices of this chapter.

A.7.1.2 NUHOMS®-MP197HB Cask Wet Loading

NOTE: The wet loading procedure described in this section is applicable only when using the MP197HB cask for loading fuel from a spent fuel pool into any one of the DSCs listed in Chapter A.1 or for loading irradiated waste into a RWC. This section also provides steps for closure of the DSC/RWC.

Site specific conditions and requirements may require the use of different equipment and ordering of steps than those described below to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package.

1. Prior to being placed in service, the cask is to be cleaned or decontaminated as necessary.
2. *NOT USED.*
3. Remove the ram access closure plate, inspect the sealing surfaces, replace the old seals with new seals, lubricate and re-install the ram access closure plate.
4. *NOT USED.*
5. Engage the cask front trunnions with the lifting yoke using the plant crane, rotate the cask to a vertical orientation, lift the cask from the onsite transfer skid, and place the cask in the plant designated preparation area.
6. Install the shear key plug assembly.
7. If the cask lid has not already been removed, remove the bolts from the cask lid and lift the lid from the cask.
8. *Discard the used lid O-rings.*
9. *NOT USED.*
10. If loading any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or RWCs from the MP197HB cask, install an unloading flange. Depending on the DSC model being loaded, verify that a DSC bottom spacer of appropriate height is placed at the bottom of the cask. The height of the DSC bottom spacer required for each type of DSC is listed in Table A.7-1.
11. Place an empty DSC in the cask.
12. If damaged fuel is to be loaded in the DSC, place the required number of bottom end caps into the cell locations that are to receive damaged fuel. For the NUHOMS®-24PT4 DSC only, verify that the failed fuel cans, required for loading damaged fuel assemblies if used, have replaced the guide sleeves at the locations specified for the specific configurations of the 24PT4 DSC basket.
13. If failed fuel is to be loaded in the DSC *(24PTH or 61BTH DSCs only)*, put the appropriate empty failed fuel cans in the appropriate locations.

13a. *If fuel and basket spacers are required, the height of the fuel and basket spacers required for each type of DSC is listed in Table A.7-1.*

14. Fill the cask/DSC annulus with water. *Install* the annulus seal.
15. Fill the DSC cavity with water. For the NUHOMS®-32PT, 24PTH, 32PTH, 32PTH1, and 37PTH DSCs, a minimum soluble boron concentration is required during loading and unloading operations.
16. *NOT USED.*
17. *NOT USED.*
18. *NOT USED.*
19. *NOT USED.*
20. *NOT USED.*
21. *NOT USED.*

A.7.1.2.1 DSC/RWC Wet Loading

The procedures for loading, vacuum drying, and sealing the DSC/RWC are described in detail in Appendices A.7.7.1 through A.7.7.10 as listed in Table A.7-3.
Following the completion of the wet loading activities described in a specific appendix listed in Table A.7-3, the MP197HB cask is prepared for downending as described in the next section.

A.7.1.2.2 Preparing the NUHOMS®-MP197HB Cask for Downending

1. Discard and install new drain port seals.
2. If transporting any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or RWC, place a cask spacer ring at the top of the aluminum sleeve as shown in Drawing MP197HB-71-1014, Chapter A.1, Appendix A.1.4.10.1.
3. Verify that the lid O-ring seals are new.
4. *NOT USED.*
5. Install shims, if required.

5a. Install the DSC top spacer if required. The appropriate height of the DSC top spacer required for each type of DSC is listed in Table A.7-1.

6. Install the cask lid. Follow the torquing sequence shown in Figure A.7-1. *Torque to between 950 and 1040 ft-lbs.*
7. Install new cask vent port seals.
8. *I*nstall new cask test port seals.
9. Evacuate the cavity between the cask and the DSC and backfill with helium.
10. Perform the assembly verification leakage test following the procedure given in Section A.7.4.1.

A.7.1.2.3 NUHOMS®-MP197HB Cask Downending

NOTE: *A*lternate procedures may be developed *for plants with unique requirements.*

1. Remove the shear key plug assembly from the cask.
2. *L*ift the cask over the onsite transfer skid on the transfer trailer.
3. *NOT USED.*
4. Position the cask rear trunnions onto the onsite transfer skid pillow blocks.
5. *Downend the cask and secure it to the skid.*
6. *NOT USED.*
7. *NOT USED.*
8. *NOT USED.*
9. Prepare the cask for transportation in accordance with the procedure described in Section A.7.1.4.

A.7.1.3 NUHOMS®-MP197HB Cask Dry Loading (Transferring a Loaded DSC or RWC from an Overpack into an MP197HB Cask)

A number of NUHOMS® DSCs are currently being used for onsite storage of spent fuel inside the NUHOMS® horizontal storage modules (HSMs) or the advanced horizontal storage modules (AHSMs) under the provisions of 10 CFR 72.

This section summarizes the steps for transferring a previously loaded DSC under a 10 CFR 72 license from the HSM or AHSM (generally referred here as HSM) to the MP197HB cask for transportation. Depending on the most recent use of the cask, several of the initial steps listed below may not be necessary.

An RWC may be stored in an HSM, AHSM or other allowed overpack on the plant site. When the MP197HB cask is dry loaded with an RWC, operational steps similar to dry loading a DSC from an HSM into the MP197HB cask should be used depending on the storage overpack.

CAUTION:

Before initiating any steps described in this section:

- For the DSCs that are already in dry storage under the requirements of 10 CFR 72, the licensee shall review the loading records to ensure that the DSC was not damaged during the insertion or extraction process and that if necessary, appropriate evaluations were performed to verify the integrity of the DSC shell.
- If the storage license of a DSC has been extended beyond the initial licensed term of 20 years, the licensee shall verify that an appropriate time-limited aging analysis (TLAA) has been performed and an aging management program has been implemented to assure that the DSC, basket, and its contents are within the analyzed conditions. The TLAA should consider the effect of fatigue, radiation, depletion of neutron absorbing material, and environmental conditions including internal temperature and pressures. The aging management program should consider use of periodic in-service inspections of accessible canister surfaces to monitor for adverse indications along with radiation and contamination monitoring.
- The licensee shall perform an audit of spent fuel pool records from the time of canister loading for the identification of the loaded fuel assemblies, and
- The licensee shall compare the irradiation parameters of the loaded contents against those shown in Table A.6-17 to ensure compliance with the isotopic depletion analysis.

1. *V*erify that the contents are in compliance with the fuel specification requirements or waste requirements in the Certificate of Compliance (CoC). An independent check of this verification is also required.
2. *V*erify that the prerequisites for the preparation of the NUHOMS®-MP197HB cask for transport in Section A.7.1.1 have been met.
3. If loading any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) in the NUHOMS®-MP197HB cask, install an unloading flange. *V*erify that a DSC bottom spacer of appropriate height is placed at the bottom of the cask. The height of the DSC bottom spacer required for each type of DSC is listed in Table A.7-1.

4. Remove the ram access closure plate and the lid.
5. *NOT USED.*
6. *B*ring the onsite transfer trailer and the NUHOMS®- MP197HB cask to the ISFSI site.
7. Remove the HSM door and the DSC seismic restraint assembly from the HSM.
8. *NOT USED.*
9. *A*lign and dock the cask with the HSM.
10. Install the cask/HSM restraints.
11. Align the hydraulic ram cylinder in the ram trunnion support assembly.
12. Extend the ram hydraulic cylinder *and engage the grapple ring.*
13. *NOT USED.*
14. Retract the ram hydraulic cylinder until the DSC is fully retracted into the cask.
15. *NOT USED.*
16. Remove the hydraulic ram and ram trunnion support assembly.
17. Install the cask ram closure plate following the torquing sequence shown in Figure A.7-1.
18. Remove the cask/HSM restraints.
19. *M*ove the cask to the transfer position.
20. *NOT USED.*
21. *NOT USED.*
22. If transporting any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH), place a cask spacer ring at the top of the aluminum sleeve as shown in Drawing MP197HB-71-1014, Chapter A.1, Appendix A.1.4.10.1.
23. Install shims, if required.

23a. Install the DSC top spacer *as specified* in Table A.7-1.

24. Install the cask lid following the torquing sequence shown in Figure A.7-1. *Torque to between 950 and 1040 ft-lbs.*
25. *NOT USED.*
26. *Install* new cask test port seals.
27. Evacuate the cavity between the cask and the DSC and backfill with helium.
28. Remove the shear key plug assembly from the cask.
29. Perform the assembly verification leakage test following the procedure given in Section A.7.4.1.
30. Prepare the cask for transportation in accordance with the procedure described in Section A.7.1.4.

A.7.1.4 NUHOMS®-MP197HB Cask Preparation for Transport

Once the NUHOMS®-MP197HB cask has been loaded using either the wet loading procedure described in Section A.7.1.2 or the dry loading procedure described in Section A.7.1.3 above, the following tasks are performed to prepare the cask for transportation. The cask is assumed to be seated horizontally in the onsite transfer skid. *Alternate procedures may be developed for plants with unique requirements.*

1. Verify that the cask surface removable contamination levels meet the requirements of 49 CFR 173.443 [2] and 10 CFR 71.87 [3].
2. Verify that the assembly verification leakage rate testing specified in Section A.7.4.1 has been performed. This test must be performed within 12 months prior to the shipment.

A.7.1.4.1 Placing the NUHOMS®-MP197HB Cask onto the Conveyance

The procedure for placement of the cask on the conveyance is given in this section. If cask is already on the transportation skid, rig the cask/skid, lift and place them on to the conveyance, then skip to Step 8.

1. *B*ring the cask and onsite transfer trailer to the conveyance.
2. *NOT USED.*
3. *NOT USED.*
4. *NOT USED.*
5. Place the cask onto the transportation skid.
6. Remove the cask upper and lower trunnions and install the trunnion plugs.
7. *NOT USED.*
8. If necessary, install the optional external aluminum fins.
9. Install the transportation skid tie-down straps.
10. Install the impact limiters on the cask *and torque the attachment bolts in accordance with the drawings in Chapter A.1, Appendix A.1.4.10.1.*
11. Remove the impact limiter hoist rings and replace them with hex bolts.
12. Install the cask tamperproof seals.
13. Install the transportation skid personnel barrier.
14. Perform a final radiation survey to assure the cask radiation levels do not exceed 49 CFR 173.441 [2] and 10 CFR 71.47 [3] requirements.
15. Verify that the temperature on all accessible surfaces is < 185°F.
16. Prepare the final shipping documentation and release the loaded cask for shipment.

A.7.2 NUHOMS®-MP197HB Package Unloading

Unloading the NUHOMS®-MP197HB cask after transport involves removing the cask from the conveyance and removing the DSC/RWC from the cask. The cask is designed to allow the DSC/RWC to be unloaded from the cask into a NUHOMS® staging module, hot cell or other

suitable overpack, and provisions exist to allow wet unloading into a fuel pool. The necessary procedures for these tasks are essentially the reverse of those described in Section A.7.1.

A.7.2.1 Receipt of Loaded NUHOMS®-MP197HB Package from Carrier

Procedures for receiving the loaded cask after shipment are described in this section. Procedures for receiving an empty cask are provided in Section A.7.1.1.

1. Verify that the tamperproof seals are intact.
2. Remove the tamperproof seals.
3. Remove the hex bolts from the impact limiters and replace them with the impact limiter hoist rings provided.
4. *R*emove the impact limiters from the cask.
5. Remove the transportation skid personnel barrier and tie-down straps.
6. Remove the external aluminum fins, if present.
7. Take contamination smears on the outside surfaces of the cask. If necessary, decontaminate the cask.
8. Install the front and rear trunnions *and torque them to 1000-1100 ft-lbs* following the torquing sequence shown in Figure A.7-1.
9. *NOT USED.*
10. *L*ift the cask from the conveyance. Place cask onto the onsite transfer trailer or other location.
11. *NOT USED.*
12. Transfer the cask to a staging module, fuel pool, dry cell or storage overpack and unload using the procedures described in the following sections.

A.7.2.2 Removal of Contents from NUHOMS®-MP197HB Cask

A.7.2.2.1 Unloading the NUHOMS®-MP197HB Cask to a Suitable Overpack

The procedure for unloading a DSC/RWC from the cask into an HSM or other authorized overpack is summarized in this section. This procedure is typical of NUHOMS® ISFSIs. *Alternate procedures may be developed for plants with unique requirements.*

1. *V*erify that the prerequisites for the preparation of the MP197HB cask in Section A.7.1.1 have been met.
2. If the shear key plug assembly is not in place, install the shear key plug assembly.
3. Position the onsite transfer trailer in front of the module face.
4. Sample the cask cavity atmosphere through the vent port. Flush the cask interior gases if necessary.
5. Remove the cask ram closure plate.

6. *NOT USED.*
7. Remove the HSM/overpack door.
8. *A*lign the cask with the HSM/overpack.
9. Remove the cask lid.
10. If unloading any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or smaller RWCs from the MP197HB cask, install an unloading flange.
11. Dock the cask with the HSM/overpack and install the cask/HSM restraints.
12. *NOT USED.*
13. Extend the ram hydraulic cylinder *and engage the grapple ring.*
14. *NOT USED.*
15. Using the ram hydraulic cylinder move the DSC/RWC into the HSM/overpack.
16. *NOT USED.*
17. *NOT USED.*
18. Remove the cask/HSM restraints and move the cask *away* from the HSM/overpack.
19. Install the cask lid and cask ram closure plate, if required.
20. Install the HSM/overpack door and seismic restraint, as applicable.
21. *NOT USED.*
22. *NOT USED.*

A.7.2.2.2 Unloading the NUHOMS®-MP197HB Cask to a Fuel Pool

The procedure for unloading the cask and DSC/RWC to a fuel pool is summarized in this section. Site specific conditions and requirements may require the use of different equipment and ordering of steps than those descried below to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package. Note that the NUHOMS®-MP197HB cask or an alternate suitable cask may be used for onsite movements of the DSC/RWC.

1. *V*erify that the prerequisites for the preparation of the NUHOMS®-MP197HB cask in Section A.7.1.1 have been met.
2. Place the cask in the fuel receiving area.
3. *NOT USED.*
4. *R*otate the cask to a vertical orientation and place the cask in the decon pit.
5. If the shear key plug assembly is not already in place, install the shear key plug assembly.
6. Sample the cask cavity atmosphere. Flush the cask interior gases if necessary.
7. Remove the lid from the cask.
8. *NOT USED.*

9. If the cask contains any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or RWC, remove the cask spacer ring at the top of the aluminum sleeve as shown in Drawing MP197HB-71-1014, Appendix A.1.4.10.1.
10. Fill the cask/DSC or cask/RWC annulus with water and install the cask/DSC or cask/RWC annulus seal.

After completion of the preparatory steps described above, follow the specific DSC unloading procedure as described in one of Appendices A.7.7.1 through A.7.7.9 as listed in Table A.7-4.

Section A.7.2.2.4 describes the procedures used for unloading of a NUHOMS®-MP197HB cask with an RWC.

A.7.2.2.3 Unloading the NUHOMS®-MP197HB Cask to a Dry Cell

The procedure for handling a DSC in a dry cell is highly dependent on the design of the dry cell and on the intended future use of the DSC. The procedure described below is intended to show the type of operations that will be performed and is not intended to be limiting.

1. Tow the onsite transfer trailer to the hot cell area.
2. *NOT USED.*
3. Using the cask lifting yoke, place the cask in the appropriate handling area.
4. Sample the cask cavity atmosphere. Flush the cask interior gases if necessary.
5. Install the shear key plug assembly, if required.
6. Remove the lid from the cask.
7. *NOT USED.*
8. Transfer the cask to the unloading area.
9. Remove the contents from the cask.
10. Decontaminate the cask as necessary.
11. *NOT USED.*

A.7.2.2.4 Horizontal Unloading of an RWC from the NUHOMS®-MP197HB Cask

This procedure is for handling a NUHOMS®-MP197HB cask with an RWC at a disposal site. The procedure described below is intended to show the type of operations that will be performed and is not intended to be limiting.

1. *NOT USED.*
2. Lift the cask and transfer it onto an unloading cradle.
3. *NOT USED.*
4. *NOT USED.*
5. *NOT USED.*
6. *R*emove the lid from the cask.

7. Install sealing surface protection, as appropriate.
8. Attach liner or waste removal tools.
9. Unload the cask contents into the disposal area.

A.7.3 Preparation of Empty Package for Transport

Previously used and empty NUHOMS®-MP197HB casks shall be prepared for transport per the requirements of 49 CFR 173.427 [2].

A.7.4 Other Operations

A.7.4.1 Leakage Testing of the Containment Boundary

The procedure for leakage testing of the cask containment boundary prior to shipment is given in this section. Assembly verification leakage testing shall conform to the requirements of ANSI N14.5 [1] or ISO -12807 [11]. A flow chart of the assembly verification leakage test is provided in Figure A.7-2. The order in which the leakage tests of the various seals are performed may vary. If more than one leakage detector is available then more than one seal may be tested at a time. Personnel performing the leakage test shall be specifically trained in leakage testing in accordance with SNT-TC-1A [7].

1. Remove the cask vent port plug.
2. Install the cask port tool in the cask vent port.
3. *O*pen the cask vent port.
4. Attach a suitable vacuum pump to the cask port tool.
5. Reduce the cask cavity pressure to below 1.0 psia.
6. *NOT USED.*
7. Fill the cask cavity with helium to atmospheric pressure.
8. Close the vent port bolt.
9. Remove the helium-saturated cask port tool and install a clean (helium free) cask port tool.
10. Connect a mass spectrometer leak detector to the cask port tool.
11. Evacuate the vent port until the vacuum is sufficient to operate the leakage detection equipment.
12. Perform the leakage test. If the leakage rate is greater than 1×10^{-7} ref·cm^3/s repair or replace the vent port bolt and/or seal as required and retest.

    NOTE: Upon removing the vent port bolt, it will be necessary to reduce the cask cavity pressure below 1.0 psia and refill with helium through the vent port.
13. Remove the leakage detection equipment.
14. Remove the cask port tool and replace the vent port plug.
15. Remove the lid test port plug.

16. Install the cask port tool in the lid test port.
17. *O*pen the lid test port.
18. Connect the vacuum pump to the cask port tool.
19. Connect the leakage detector to the cask port tool.
20. Evacuate the lid test port until the vacuum is sufficient to operate the leakage detection equipment per the manufacturer's recommendations. Perform a pressure rise leakage test to confirm leakage rate past the outer seal is less than 7×10^{-3} ref·cm^3/s of air.
21. Perform the helium leakage test. If the leakage rate is greater than 1×10^{-7} ref·cm^3/s repair or replace the cask lid or the cask lid O-ring seals as required and retest.

    NOTE: Upon removing and reinstalling the cask lid, it will be necessary to reduce the cask cavity pressure below 1.0 psia and refill with helium through the vent port. The vent port assembly verification leakage test must also be retested as described above.
22. Remove the leakage detection equipment.
23. Tighten the lid test port screw *in accordance with Drawing MP197HB-71-1002 in Chapter A.1, Appendix A.1.4.10.1*. Remove the cask port tool from the lid test port and replace the lid test port plug.
24. Remove the cask drain port plug.
25. Install the cask port tool in the cask drain port.
26. *V*erify that the cask drain port is closed.
27. Connect the vacuum pump to the cask port tool.
28. Connect the leakage detector to the cask port tool.
29. Evacuate the drain port until the vacuum is sufficient to operate the leakage detection equipment.
30. Perform the leakage test. If the leakage rate is greater than 1×10^{-7} ref·cm^3/s repair or replace the drain port bolt and/or seal as required and retest.

    NOTE: Upon removing the drain port bolt, it will be necessary to reduce the cask cavity pressure below 1.0 psia and refill with helium through the vent port. The vent port assembly verification test must also be retested as described above.
31. Remove the leakage detection equipment.
32. Tighten the drain port bolt *in accordance with Drawing MP197HB-71-1002 in Chapter A.1, Appendix A.1.4.10.1*. Remove the cask port tool from the cask drain port and replace the drain port plug.
33. Remove the bottom test port plug.
34. Install the cask port tool in the bottom test port.
35. *O*pen the bottom test port.
36. Connect the vacuum pump to the cask port tool.
37. Connect the leakage detector to the cask port tool.

38. Evacuate the bottom test port until the vacuum is sufficient to operate the leakage detection equipment. Perform a pressure rise leakage test to confirm leakage rate past the outer seal is less than $7x10^{-3}$ ref·cm^3/s of air.

39. Perform the helium leakage test. If the leakage rate is greater than $1x10^{-7}$ ref·cm^3/s repair or replace the cask ram access closure plate or the cask ram access closure plate O-ring seals as required and retest.

    NOTE: Upon removing the cask ram access closure plate, it will be necessary to reduce the cask cavity pressure below 1.0 psia and refill with helium through the vent port. The vent port assembly verification test must also be retested as described above.

40. Remove the leakage detection equipment.

41. Tighten the bottom test port bolt *in accordance with Drawing MP197HB-71-1002 in Chapter A.1, Appendix A.1.4.10.1.* Remove the cask port tool from the bottom test port and replace the bottom test port plug.

This concludes the assembly verification leakage test procedure.

Pages A.7-14 through A.7-16 are intentionally left blank.

A.7.5 References

1. ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.
2. Title 49, Code of Federal Regulations, Part 173 (49 CFR 173), "Shippers - General Requirements for Shipments and Packaging."
3. Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), "Packaging and Transportation of Radioactive Material."
4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."
5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.
6. *Not Used.*
7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."
8. Updated Final Safety Analysis Report *for* The Standardized Advanced NUHOMS® Horizontal Modular Storage System For Irradiated Nuclear Fuel (CoC 1029) Revision 3.
9. Not used.
10. Not used.
11. ISO-12807, "Safety Transport of Radioactive Materials – Leakage Testing on Packages," First Edition, 1996.

A.7.6 Glossary

The terms used in the above procedures are defined below.

annulus seal: Seal placed between the cask and DSC/RWC during operations in the fuel pool.

cask lifting yoke: Passive, open hook lifting yoke used for vertical lifts of the cask.

cask/HSM restraints: Provides the load path between the cask and HSM during DSC transfer operation.

conveyance: Any suitable conveyance such as a railcar, heavy haul trailer, barge, ship, etc.

horizontal storage module (HSM): Concrete shielded structure used for onsite storage of DSCs. HSM references herein refer to all models of HSM (e.g., HSM Model 80, Model 102, Model 152, Model 202, HSM-H, HSM-HS, AHSM, etc.) HSM also includes any other overpack authorized to accept a DSC or RWC via a horizontal transfer.

hydraulic ram: Hydraulic cylinder used to insert/withdraw DSCs to/from HSMs.

onsite transfer skid: Skid present on the onsite transfer trailer used to support the cask during onsite movements. Note in some cases the transportation skid may function as the onsite transfer skid.

onsite transfer trailer: A trailer used for onsite movements of the cask.

ram trunnion support assembly: Frame attached to the skid which provides an anchor for the hydraulic ram during DSC insertion and retrieval.

skid positioning system: Hydraulically operated alignment system that provides the interface between the onsite transfer trailer and the onsite transfer skid. It is used to align the skid (and cask) with the HSM prior to transfer.

A.7.7 APPENDICES

Table A.7-1
DSC, Fuel, and Basket Spacer Nominal Heights for Each Type of DSC (in.)

Canister Type	61BT	61BTH		69BTH	24PTH			24PT4	32PT				32PTH	32PTH	32PTH1			37PTH		RWC
		Type 1	Type 2		S	L	S-LC		S-100	S-125	L-100	L-125		Type1	S	M	L	S	M	
DSC bottom spacer height(1)	2.20	2.20	2.20	1.24	11.7	5.7	11.7	2.2	11.7	11.7	5.7	5.7	12.5	5.25	12.5	5.25	N/A	16.25	9.0	11.75
DSC top spacer height	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Fuel spacer height	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	(2)(3)	N/A
Basket spacer height(3)(4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5	N/A	N/A	N/A	N/A	1.75	1.75	1.75	1.75	1.75	1.5	1.75	N/A

(1) DSC top and bottom spacers can be combined to one spacer. If one spacer is used, it can be installed either on top or bottom of the DSC. *The height of the spacer is to be determined at the time of transport using the methodology specified in Appendix A.2.13.14, Table A.2.13.14-1 at the time of transport such that the maximum gap between the cask and DSC is below 0.5".*

(2) Fuel spacer can be installed either on top or bottom of the fuel assembly. The height of the spacer to be determined using the formula specified in Appendix A.2.13.14, Table A.2.13.14-2 at *the* time of transport such that the maximum *combined gap (cask and DSC + fuel and DSC)* is below 0.9".

(3) Fuel and basket spacers can be combined *in* one spacer.

(4) Basket spacer can be installed either on top or bottom of the basket.

Table A.7-2
Applicable Fuel Specification for Various DSCs

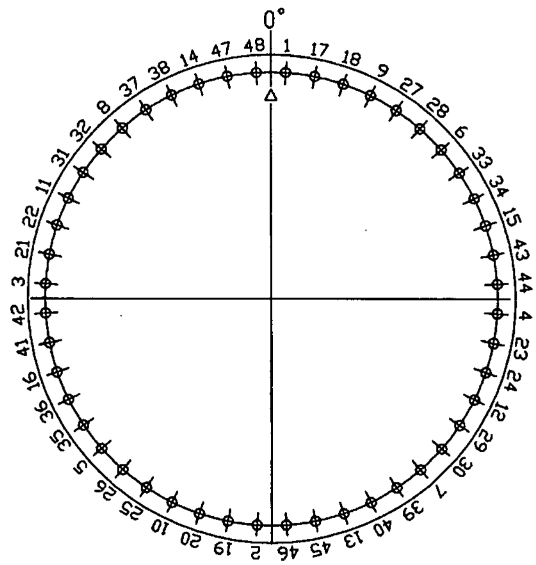
DSC MODEL	Applicable Fuel Specification from Chapter A.1
NUHOMS®-24PT4	Tables A.1.4.1-1 and A.1.4.1-2
NUHOMS®-32PT	Table A.1.4.2-2
NUHOMS®-24PTH	Table A.1.4.3-2
NUHOMS®-32PTH	Table A.1.4.4-2
NUHOMS®-32PTH1	Table A.1.4.5-2
NUHOMS®-37PTH	Table A.1.4.6-2
NUHOMS®-61BT	Table A.1.4.7-2
NUHOMS®-61BTH	Table A.1.4.8-2
NUHOMS®-69BTH	Table A.1.4.9-1

Table A.7-3
Appendices Containing Loading Procedures for Various DSCs

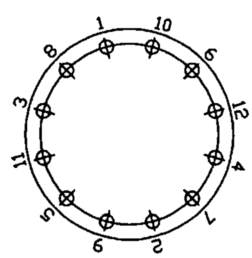
DSC Model	Appendix
NUHOMS®-24PT4	A.7.7.1
NUHOMS®-32PT	A.7.7.2
NUHOMS®-24PTH	A.7.7.3
NUHOMS®-32PTH	A.7.7.4
NUHOMS®-32PTH1	A.7.7.5
NUHOMS®-37PTH	A.7.7.6
NUHOMS®-61BT	A.7.7.7
NUHOMS®-61BTH	A.7.7.8
NUHOMS®-69BTH	A.7.7.9
RWC	A.7.7.10

Table A.7-4
Appendices Containing Unloading Procedures for Various DSCs

DSC Model	Appendix
NUHOMS®-24PT4	A.7.7.1, Section A.7.7.1.4
NUHOMS®-32PT	A.7.7.2, Section A.7.7.2.4
NUHOMS®-24PTH	A.7.7.3, Section A.7.7.3.4
NUHOMS®-32PTH	A.7.7.4, Section A.7.7.4.4
NUHOMS®-32PTH1	A.7.7.5, Section A.7.7.5.4
NUHOMS®-37PTH	A.7.7.6, Section A.7.7.6.4
NUHOMS®-61BT	A.7.7.7, Section A.7.7.7.4
NUHOMS®-61BTH	A.7.7.8, Section A.7.7.8.4
NUHOMS®-69BTH	A.7.7.9, Section A.7.7.9.4



MP197HB Cask Lid



Trunnion and Ram Closure Plate

Figure A.7-1
Torquing Patterns

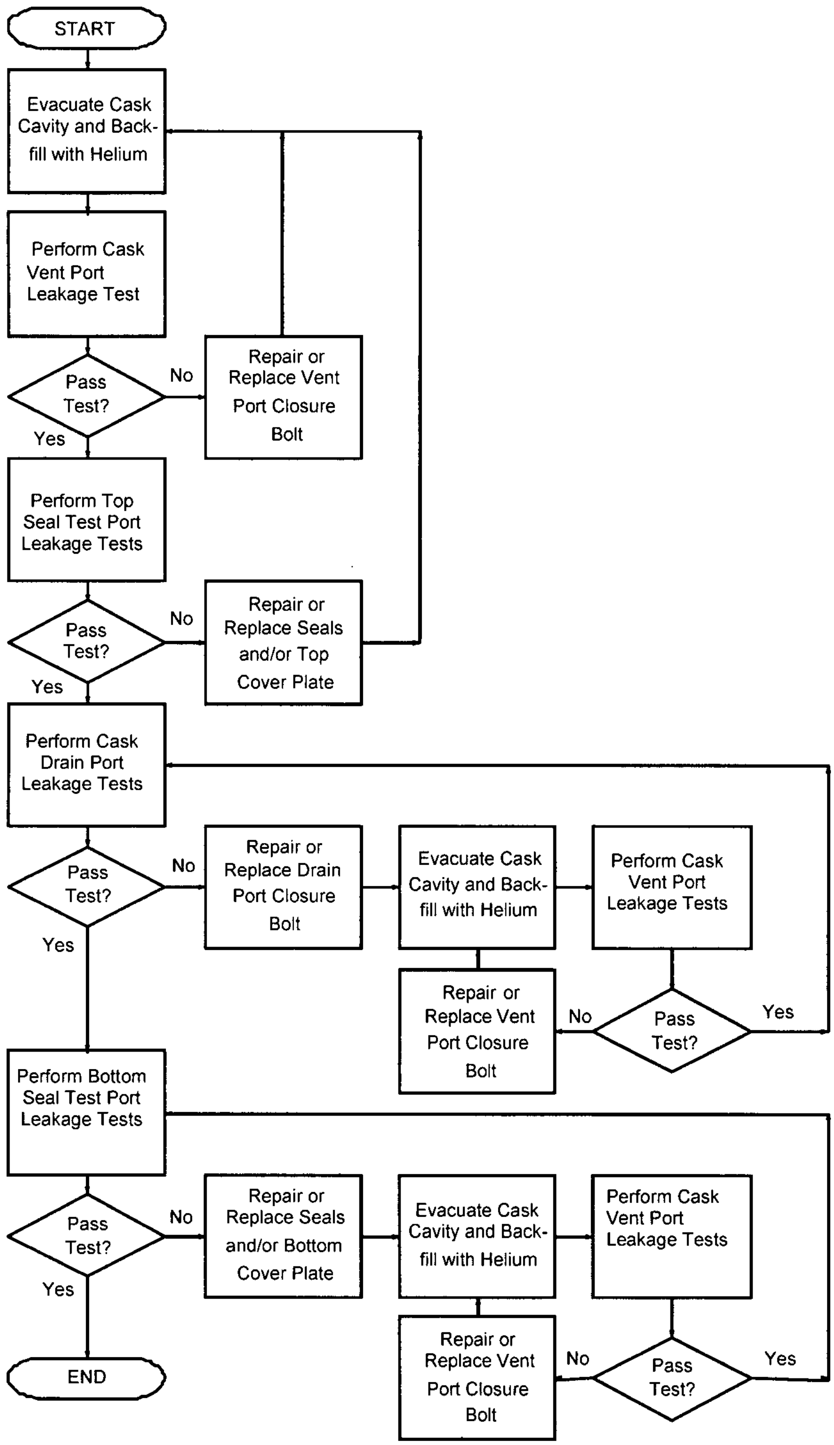


Figure A.7.2
Assembly Verification *Leakage* Test

APPENDIX A.7.7.1
NUHOMS®-24PT4 DSC Wet Loading and Unloading

Appendix A.7.7.1
NUHOMS®-24PT4 DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.7.7.1.5. The term DSC as used in this appendix refers to the NUHOMS®-24PT4 DSC.

A.7.7.1.1 NUHOMS®-24PT4 DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that damaged and/or intact fuel assemblies are placed into a known cell location within a DSC will typically consist of the following:
   - A cask/DSC loading plan is developed to verify that the intact and damaged fuel assemblies meet the burnup, enrichment, and cooling time parameters of the applicable sections as listed in step 13 of Section A.7.1.1.
   - The loading plan is independently verified and approved before the fuel load.
   - A fuel movement schedule is then written, verified, and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
   - If loading damaged fuel assemblies, verify that the required number of failed fuel cans for the 24PT4 DSC have replaced the guide sleeves at the authorized locations within the 24PT4 DSC basket.

been fully loaded, check and record the identity and location of each fuel assembly in the DSC.

8. After all the SFAs have been placed into the DSC and their identities verified, position the lifting yoke and the top shield plug (shield plug assembly) and lower the shield plug into the DSC. Optionally the shield plug may be installed using alternate rigging in lieu of the yoke.
9. Visually verify that the top shield plug is properly seated in the DSC.
10. *NOT USED.*
11. Raise the cask to the pool surface *using the cask trunnions and lifting yoke.*
12. *V*erify that *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.
13. Continue to raise the cask from the pool until the top region of the cask is accessible.
14. Drain any excess water from the top of the DSC shield plug.
15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.
16. As required for crane load limitations, drain water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC cavity.
17. Lift the cask from the fuel pool. As the cask is raised from the pool.
18. Move the cask with loaded DSC to the plant designated preparation area.
19. *If* water *is* removed at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.1.2 NUHOMS®-24PT4 DSC Drying and Backfilling

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. *NOT USED.*
3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.
4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.
5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer *exposed* surface of the DSC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary

shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of the welding operations, drain approximately 60 gallons of water from the DSC. *Use 1 to 3 psig of helium* to backfill the DSC with an inert gas as water is being removed.

7. *NOT USED.*

8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.

9. Check radiation levels along the surface of the inner top cover plate. Temporary shielding may be installed as necessary.

10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. *Take precautions* to prevent debris and weld splatter from entering the annulus.

12. *W*eld the inner top cover plate to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.

14. *NOT USED.*

15. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, pressurized helium may be introduced through the vent port to *assist removal of* water from the DSC cavity through the siphon port.

16. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.

17. Connect the VDS to *the cask.*

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

18. *S*tart the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize moisture removal and avoid freezing. During/between vacuum during steps,* the pump is valved off and the cavity pressure monitored. The

cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 torr or less.

NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 torr for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. Open the valve to the vent port and allow the helium to flow into the DSC cavity.
20. Pressurize the DSC cavity with helium to 6.0 +1.0/-0.0 psig.
21. Perform a helium leakage test on the top shield plug assembly and vent/siphon block and verify that a criterion of $\leq 1 \times 10^{-4}$ ref.cm^3/sec is met.
22. If a leak is found, repair the weld in accordance with the Code of Construction. Re-pressurize the 24PT4-DSC and repeat the helium leakage test.
23. Once no leaks are detected, depressurize the DSC cavity by releasing the helium through the VDS to the plant's spent fuel pool or radioactive waste system, or other appropriate system.
24. Re-evacuate the 24PT4 DSC cavity. The cavity pressure should be reduced in steps. *During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 torr.
25. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the 24PT4 DSC to 6.0 +1.0/-0.0 psig (stable for 30 minutes after filling).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

26. *NOT USED.*

A.7.7.1.3 NUHOMS®-24PT4 DSC Sealing Operations

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *required* dye penetrant weld examination*(s).*

NOTE: At licensee discretion, a strongback may be installed on the outer top cover plate to flatten the plate. This will require that the outer top cover plate to the 24PT4 DSC shell tack welds be made manually, as the AWS will not fit over the strongback. Remove the strongback after tack welding and install AWS prior to placing the outer top cover plate-weld root pass.

2. Install the outer top cover plate *with* the automated welding system onto the 24PT4 DSC.
3. Tack weld the outer top cover plate to the 24PT4 DSC shell. Weld outer top cover plate root pass. Perform dye penetrant examination of the root pass weld.
4. Weld out the outer top cover plate to the shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
5. *NOT USED.*
6. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.1.4 Unloading the NUHOMS®-24PT4 DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air, or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

CAUTION: (a) The water fill rate must be regulated during this reflooding operation to ensure that the 24PT4 DSC vent pressure does not exceed 20 psig.

(b) Provide for continuous hydrogen monitoring of the 24PT4 DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% hydrogen concentration is not exceeded [4] and [5]. Purge *with 2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water (or other plant-designated water source) through the siphon port with the vent port open and routed to the plant's off-gas system.

6. *Take precautions to prevent debris from entering* the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].

8. Remove the DSC outer top cover plate.
9. *R*emove the closure weld from the DSC inner top cover plate.
10. Remove the DSC inner top cover plate.
11. NOT USED
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.
13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. Lower the cask into the fuel pool *using the upper trunnions and lifting yoke*.
17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug.
18. Remove the fuel assemblies (or fuel cans as applicable for damaged fuel assemblies) from the DSC.
19. *R*emove the cask from the pool, and place it in the decon area.
20. Remove the water from the DSC cavity and cask/DSC annulus.
21. Remove the DSC from the cask.
22. Decontaminate the cask inner and outer surfaces as necessary.
23. *NOT USED.*

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A.7.7.1.5 References

1. Not Used.

2. Not Used.

3. Not Used.

4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."

5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.

6. *Not Used.*

APPENDIX A.7.7.2
NUHOMS®-32PT DSC Wet Loading and Unloading

Appendix A.7.7.2
NUHOMS®-32PT DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.7.7.2.5. The term DSC as used in this appendix refers to the NUHOMS®-32PT DSC.

A.7.7.2.1 NUHOMS®-32PT DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that intact spent fuel assemblies (SFAs) and control components (CCs), if applicable, are placed into a known cell location within a DSC will typically consist of the following:
    - A cask/DSC loading plan is developed to verify that the fuel assemblies, and CCs, if applicable, meet the burnup, enrichment and cooling time parameters of the applicable section as listed in step 13 of Section A.7.1.1. If poison rod assemblies (PRAs) are determined to be needed, record the number required and the DSC cell location for each of the PRAs on the loading plan.
    - The loading plan is independently verified and approved before the fuel load.
    - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.

5.A Since burnup credit is employed for demonstration of criticality safety, additional administrative controls are required for verification of fuel assembly burnup and to prevent misloading. Fuel loading plans developed in step 5 above shall also include the additional requirements shown in Section A.6.3.4.

6. Prior to loading of an SFA (and CC, if applicable) into the DSC, the identity of the assembly (and CC, if applicable) is to be verified by two individuals using an underwater video camera or other means. Verification of CC identification is optional if the CC has not been moved from the host fuel assembly since its last verification. Read and record the identification number from the fuel assembly (and CC, if applicable) and check this identification number against the DSC loading plan which indicates which fuel assemblies (and CCs, if applicable) are acceptable for transport.
7. Position the fuel assembly for insertion into the selected DSC compartment and load the fuel assembly. Repeat steps 6-7 for each SFA loaded into the DSC. If applicable, insert the required number of PRAs at specific locations called out in the loading plan. After the

DSC has been fully loaded, check and record the identity and location of each fuel assembly and CC, if applicable, in the DSC. Also record the location of each PRA inserted in the DSC (if applicable).

8. After all the SFAs, CCs, and PRAs, if applicable, have been placed into the DSC and their identities verified, lower the shield plug onto the DSC.
9. Visually verify that the top shield plug is properly seated in the DSC.
10. *NOT USED.*
11. Raise the cask to the pool surface *using the cask trunnions and lifting yoke.*
12. *V*erify that *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.
13. Continue to raise the cask from the pool until the top region of the cask is accessible.
14. Drain any excess water from the top of the DSC shield plug.
15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.
16. Water may be drained from the DSC back into the fuel pool or other suitable location to meet the weight limit on the crane. *Use 2 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC.
17. Lift the cask from the fuel pool.
18. Move the cask with loaded DSC to the plant designated preparation area.
19. *If water is removed* at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.2.2 NUHOMS®-32PT DSC Drying and Backfilling

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. *NOT USED.*
3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.
4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.
5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer *exposed* surface of the DSC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of the welding operations, drain a minimum of 750 gallons of water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed.
7. *NOT USED.*
8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.
9. Check radiation levels along the surface of the inner top cover plate. Temporary shielding may be installed as necessary.
10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.
11. *Take precautions* to prevent debris and weld splatter from entering the annulus.
12. *W*eld the inner top cover plate to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.
14. *NOT USED.*
15. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, pressurized helium may also be introduced through the vent port to *assist removal of* water from the DSC cavity through the siphon port.
16. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.
17. Connect the VDS to *the cask.*

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

18. *S*tart the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize moisture removal and avoid freezing. During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure

increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. Open the valve to the vent port and allow the helium to flow into the DSC cavity.
20. *NOT USED.*
21. *NOT USED.*
22. *NOT USED.*
23. *NOT USED.*
24. Re-evacuate the DSC cavity. The cavity pressure should be reduced in steps. *During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg *or less.*
25. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC to 2.5 ± 1.0 psig backfill pressure (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.
26. *NOT USED.*

A.7.7.2.3 NUHOMS®-32PT DSC Sealing Operations

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *the required* dye penetrant weld examination*(s).*
2. Install the outer top cover plate and the automated welding system onto the DSC.
3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
4. Perform a helium leakage test of the inner top cover plate and vent/siphon port plate welds using the test port in the outer top cover plate and verify that the "leak-tight"

criterion is met. Verify that the personnel performing the leakage test are qualified in accordance with SNT-TC-1A [7]. Alternatively, this leakage test can be done with a test head following step 1.

5. If a leak is found, remove the outer cover plate root pass (if not using the test head), the vent and siphon port plugs and repair the inner cover plate welds. Then repeat applicable procedure steps from Section A.7.7.2.2, step 17.
6. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
7. Seal weld the prefabricated plug (when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.2.4 Unloading a NUHOMS®-32PT DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

CAUTION:
(a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

(b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge with *2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water (or other plant designated water source) through the siphon port with the vent port open and routed to the plant's off-gas system. Soluble boron requirements per step 5.A of Section A.7.7.2.1 are applicable for the pool and DSC cavity water.
6. *Take precautions to prevent debris from entering* the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

    CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].

8. Remove the DSC outer top cover plate.
9. *R*emove the closure weld from the DSC inner top cover plate.
10. Remove the DSC inner top cover plate.
11. NOT USED
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.
13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. Lower the cask into the fuel pool *using the upper trunnions and lifting yoke.*
17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug.
18. Remove the fuel assemblies from the DSC.
19. *R*emove the cask from the pool, and place it in the decon area.
20. Remove the water from the DSC cavity and cask/DSC annulus.
21. Remove the DSC from the cask.
22. Decontaminate the cask inner and outer surfaces as necessary.
23. *NOT USED.*

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A.7.7.2.5 References

1. ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.
2. Not Used.
3. Not Used.
4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."
5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.
6. *Not Used.*
7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."

APPENDIX A.7.7.3
NUHOMS®-24PTH DSC Wet Loading and Unloading

Appendix A.7.7.3
NUHOMS®-24PTH DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc. and refer to the reference list in Section A.7.7.3.5. The term DSC as used in this appendix refers to the NUHOMS®-24PTH DSC.

The steps listed below are incorporated by reference into the CoC 9302 Conditions (paragraph 7.(c)) and shall not be deleted or altered in any way without a CoC revision approval from the NRC.

A.7.7.3.1 NUHOMS®-24PTH DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that failed, damaged and/or intact spent fuel assemblies (SFAs) and control components (CCs), if applicable, are placed into a known cell location within a DSC will typically consist of the following:
   - A cask/DSC loading plan is developed to verify that the intact, damaged and failed SFAs, and CCs, if applicable, meet the burnup, enrichment and cooling time parameters of the applicable sections as listed in step 13 of Section A.7.1.1.
   - The loading plan is independently verified and approved before the fuel load.
   - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
   - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate locations in the basket.
   - If loading failed fuel, verify that the required number of failed fuel cans are installed in the appropriate locations, or, once loaded with fuel, are installed in the appropriate locations in the basket.

5.A Since burnup credit is employed for demonstration of criticality safety, additional administrative controls are required for verification of fuel assembly burnup and to prevent misloading. Fuel loading plans developed in step 5 above shall also include the additional requirements shown in Section A.6.3.4.

6. Prior to loading of an SFA (and CC, if applicable) into the DSC, the identity of the SFA (and CC, if applicable) is to be verified by two individuals using an underwater video camera or other means. Verification of CC identification is optional if the CC has not

been moved from the host fuel assembly since its last verification. Read and record the identification number from the SFA (and CC, if applicable) and check this identification number against the DSC loading plan which indicates which SFAs (and CCs, if applicable) are acceptable for transport.

7. Position the fuel assembly for insertion into the selected DSC storage cell and load the fuel assembly. Repeat steps 6–7 for each SFA loaded into the DSC. If loading damaged fuel assemblies, place top end caps over each damaged fuel assembly placed into the basket. If loading failed fuel, ensure that the failed fuel can lids are installed. After the DSC has been fully loaded, check and record the identity and location of each fuel assembly and CC, if applicable, in the DSC.

8. After all the SFAs and CCs, if applicable, have been placed into the DSC and their identities verified, position the lifting yoke and the top shield plug (shield plug assembly) and lower the shield plug into the DSC. Optionally the shield plug may be installed using alternate rigging in lieu of the yoke.

9. Visually verify that the top shield plug is properly seated in the DSC.

10. *NOT USED.*

11. Raise the cask to the pool surface *using the cask trunnions and lifting yoke.*

12. *V*erify that *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.

13. Continue to raise the cask from the pool until the top region of the cask is accessible.

14. Drain any excess water from the top of the DSC shield plug.

15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.

16. As required for crane load limitations, drain water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC cavity.

17. Lift the cask from the fuel pool.

18. Move the cask with loaded DSC to the plant designated preparation area.

19. *If* water *is* removed at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.3.2 NUHOMS®-24PTH DSC Drying and Backfilling

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.

2. *NOT USED.*

3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.

4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.

5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer *exposed* surface of the DSC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of the welding operations, drain a minimum of 750 gallons of water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC gas as water is being removed from the DSC.

7. *NOT USED.*

8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.

9. Check radiation levels along the surface of the inner top cover plate. Temporary shielding may be installed as necessary.

10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. *Take precautions* to prevent debris and weld splatter from entering the annulus.

12. *W*eld the inner top cover plate to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.

14. *NOT USED.*

15. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, pressurized helium may be introduced through the vent port to *assist removal* water from the DSC cavity through the siphon port.

16. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.

17. Connect the VDS to *the cask.*

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

18. Start the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize moisture removal and avoid freezing. During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

    NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. Open the valve to the vent port and allow the helium to flow into the DSC cavity.
20. *NOT USED.*
21. *NOT USED.*
22. *NOT USED.*
23. *NOT USED.*
24. Re-evacuate the DSC cavity. The cavity pressure should be reduced in steps. *During/between vacuum during steps,* the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.
25. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC cavity to 2.5 ± 1.0 psig (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

26. *NOT USED.*

A.7.7.3.3 NUHOMS®-24PTH DSC Sealing Operations

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *the required* dye penetrant weld examination*(s)*.
2. Install the outer top cover plate and the automated welding system onto the DSC.
3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
4. Perform a helium leakage test of the inner top cover plate and vent/siphon port plate welds using the test port in the outer top cover plate and verify that the "leak-tight" criterion is met. Verify that the personnel performing the leakage test are qualified in accordance with SNT-TC-1A [7]. Alternatively, this leakage test can be done with a test head following step 1 above.
5. If a leak is found, remove the outer cover plate root pass (if not using a test head), the vent and siphon port plugs and repair the inner cover plate welds. Then repeat the applicable procedure steps from Section A.7.7.3.2, step 17.
6. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
7. Seal weld the prefabricated plug (when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.3.4 Unloading the NUHOMS®- 24PTH DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

CAUTION: (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

(b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge *with 2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water (or other plant-designated water source) through the siphon port with the vent port open and routed to the plant's off-gas system. Soluble boron requirements per step 5.A of Section A.7.7.3.1 are applicable for the pool and DSC cavity water.
6. *Take precautions to prevent debris from entering* the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

   CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].
8. Remove the DSC outer top cover plate.
9. *R*emove the closure weld from the DSC inner top cover plate.
10. Remove the DSC inner top cover plate.
11. NOT USED
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.
13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. Lower the cask into the fuel pool *using the upper trunnions and lifting yoke.*
17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug.
18. Remove the fuel assemblies (or fuel cans/end caps as applicable for failed/damaged fuel assemblies) from the DSC.
19. *R*emove the cask from the pool.
20. Remove the water from the DSC cavity and cask/DSC annulus.
21. Remove the DSC from the cask.
22. Decontaminate the cask as necessary.
23. *NOT USED.*

Pages A.7.7.3-7 and A.7.7.3-8 left intentionally blank.

A.7.7.3.5 References

1. ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.

2. Not Used.

3. Not Used.

4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."

5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.

6. *Not Used.*

7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."

APPENDIX A.7.7.4
NUHOMS®-32PTH DSC Wet Loading and Unloading

Appendix A.7.7.4
NUHOMS®-32PTH DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.7.7.4.5. The term DSC as used in this appendix refers to the NUHOMS®-32PTH DSC.

A.7.7.4.1 NUHOMS®-32PTH DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that damaged and/or intact spent fuel assemblies (SFAs) and control components (CCs), if applicable, are placed into a known cell location within a DSC will typically consist of the following:
    - A cask/DSC loading plan is developed to verify that the intact, damaged SFAs and CCs, if applicable, meet the burnup, enrichment and cooling time parameters of the applicable sections as listed in step 13 of Section A.7.1.1.
    - The loading plan is independently verified and approved before the fuel load.
    - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
    - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate locations in the basket.

5.A Since burnup credit is employed for demonstration of criticality safety, additional administrative controls are required for verification of fuel assembly burnup and to prevent misloading. Fuel loading plans developed in step 5 above shall also include the additional requirements shown in Section A.6.3.4.

6. Prior to loading of an SFA (and CCs, if applicable) into the DSC, the identity of the assembly (and CCs, if applicable) is to be verified by two individuals using an underwater video camera or other means. Verification of CC identification is optional if the CC has not been moved from the host SFA since its last verification. Read and record the identification number from the SFA (and CCs, if applicable) and check this identification number against the DSC loading plan which indicates which SFA (and CC, if applicable) are acceptable for transport.

7. Position the fuel assembly for insertion into the selected DSC compartment and load the fuel assembly. Repeat steps 6–7 for each SFA loaded into the DSC. After the DSC has been fully loaded, check and record the identity and location of each fuel assembly and CCs, if applicable, in the DSC. If loading damaged fuel assemblies, place top end caps over each damaged fuel assembly placed into the basket.
8. After all the SFAs and CCs, if applicable, have been placed into the DSC and their identities verified, lower the shield plug into the DSC.
9. Visually verify that the top shield plug is properly seated in the DSC.
10. *NOT USED.*
11. Raise the cask to the pool surface *using the cask trunnions and lifting yoke.*
12. *V*erify that *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.
13. Continue to raise the cask from the pool until the top region of the cask is accessible.
14. Drain any excess water from the top of the DSC shield plug.
15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.
16. As required for crane load limitations, drain water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC cavity.
17. Lift the cask from the fuel pool.
18. Move the cask with loaded DSC to the plant designated preparation area.
19. *If water is removed* at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.4.2 NUHOMS®-32PTH DSC Drying and Backfilling

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Check the radiation levels *around* perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. *NOT USED.*
3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.
4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.

5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer *exposed* surface of the DSC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. If water was not drained from the DSC earlier, remove up to 1300 gallons of water. Up to *1 to 3 psig* of helium gas may be applied at the vent port to assist the water pump down.

7. *NOT USED.*

8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.

9. Check radiation levels along the surface of the inner top cover plate.

10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. *Take precautions* to prevent debris and weld splatter from entering the annulus.

12. *W*eld the inner top cover plate to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.

14. *NOT USED.*

15. *Remove* remaining water from the DSC.

16. Engage the helium supply and open the valve on the vent port and allow *up to 15 psig* helium to *assist removal of* water from the DSC cavity through the siphon port.

17. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

18. Connect a vacuum pump/helium backfill manifold to the vent port or to both the vent and drain ports.

    Optionally, leak test the manifold and the connections to the DSC. The DSC may be pressurized to no more than 15 psig for leakage testing.

    When the cavity pressure stabilizes, the pump is valved in to complete the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

    NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. If the DSC cavity pressure remains below the specified limit for the required duration with the pump isolated, continue to the next step. If not, repeat steps 18 and 19.

20. Purge air from the backfill manifold, open the isolation valve, and backfill the DSC cavity with helium to 16.5 to 18 psig and hold for 10 minutes.

21. Reduce the DSC cavity pressure to atmospheric pressure, or slightly over.

22. If the quick connect fittings were removed for vacuum drying, remove the vacuum line adapters from the ports, and re-install the quick connect fittings using suitable pipe thread sealant.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

23. Evacuate the DSC through the vent port quick connect fitting to a pressure 100 mbar or less.

24. Purge air from the backfill manifold, open the isolation valve, and backfill the DSC cavity with helium to 2.5 ± 1 psig (stable for 30 minutes).

25. *NOT USED.*

A.7.7.4.3 NUHOMS®-32PTH DSC Sealing Operations

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Disconnect the VDS from the DSC. Weld the covers over the vent and drain ports, performing *the required* non-destructive examination of the weld surface*(s)*.
2. Install a temporary test head fixture (or any other alternative means). Perform a helium leakage test of the inner top cover/shield plug to the DSC shell welds and siphon/vent cover welds to demonstrate that these welds meet the "leak-light" criterion. If the leakage rate *is not met,* check and repair these welds. Verify that the personnel performing the leakage test are qualified in accordance with SNT-TC-1A [7].
3. Place the outer top cover plate onto the DSC. Install the automated welding machine onto the outer top cover plate.
4. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
5. If not previously performed, perform helium leakage test of the inner top cover plate and vent/siphon port plate welds using the test port in the outer top cover plate and verify that the "leak-tight" criterion is met. Verify that the personnel performing the leakage test are qualified in accordance with SNT-TC-1A [7]. Alternatively, this leakage test can be done with a test head in step 2.
    a. If a leak is found, remove the outer cover plate root pass (if not using a test head), the vent and siphon port plugs and repair the inner cover plate welds. Then repeat applicable procedure steps from Section A.7.7.4.2, step 18.
6. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
7. Seal weld the prefabricated plug (when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.4.4 Unloading a NUHOMS®-32PTH DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

   CAUTION:

   (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 15.0 psig.

   (b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge *with 2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water (or other plant-designated water source) through the siphon port with the vent port open and routed to the plant's off-gas system. Soluble boron requirements per step 5.A of Section A.7.7.4.1 are applicable for the pool and DSC cavity water. The vented cavity gas may include steam, water, and radioactive material, and should be routed accordingly. Monitor the vent pressure and regulate the water fill rate to ensure that the pressure does not exceed 15 psig.
6. Install the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

   CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].

8. Remove the DSC outer top cover plate.
9. *R*emove the closure weld from the DSC inner top cover plate.
10. *NOT USED.*
11. NOT USED.
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.

13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. *NOT USED.*
17. Lower the cask into the fuel pool *using the upper trunnions and lifting yoke.*
18. Disengage the lifting yoke from the cask trunnions and remove the top shield plug.
19. Remove the fuel assemblies (end caps as applicable for damaged assemblies) from the DSC.
20. *R*emove the cask from the pool, and place it in the decon area.
21. Remove the water from the DSC cavity and cask/DSC annulus.
22. Remove the DSC from the cask.
23. Decontaminate the cask as necessary.
24. *NOT USED.*

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A.7.7.4.5 References

1. ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.
2. Not Used.
3. Not Used.
4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."
5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.
6. *Not Used.*
7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."

APPENDIX A.7.7.5
NUHOMS®-32PTH1 DSC Wet Loading and Unloading

Appendix A.7.7.5
NUHOMS®-32PTH1 DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc. and refer to the reference list in Section A.7.7.5.5. The term DSC as used in this appendix refers to the NUHOMS®-32PTH1 DSC.

A.7.7.5.1 NUHOMS®-32PTH1 DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that damaged and/or intact spent fuel assemblies (SFAs) and control components (CCs), if applicable, are placed into a known cell location within a DSC will typically consist of the following:
   - A cask/DSC loading plan is developed to verify that the SFAs, and CCs, if applicable, meet the burnup, enrichment and cooling time parameters of the applicable sections listed in step 13 of Section A.7.1.1.
   - The loading plan is independently verified and approved before the fuel load.
   - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
   - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate basket locations.

5.A Since burnup credit is employed for demonstration of criticality safety, additional administrative controls are required for verification of fuel assembly burnup and to prevent misloading. Fuel loading plans developed in step 5 above shall also include the additional requirements shown in Section A.6.3.4.

6. Prior to loading of an SFA (and CC, if applicable) into the DSC, the identity of the assembly (and CC, if applicable) is to be verified by two individuals using an underwater video camera or other means. Verification of CC identification is optional if the CC has not been moved from the host fuel assembly since its last verification. Read and record the identification number from the SFA (and CC, if applicable) and check this identification number against the DSC loading plan which indicates which SFAs(and CCs, if applicable) are acceptable for transport.

7. Position the fuel assembly for insertion into the selected DSC compartment and load the fuel assembly. Repeat steps 6 through 7 for each SFA loaded into the DSC. If loading damaged fuel assemblies, place top end caps over each damaged fuel assembly placed into the basket. After the DSC has been fully loaded, check and record the identity and location of each SFA and CC, if applicable, in the DSC.

8. After all the SFAs, and CCs, if applicable, have been placed into the DSC and their identities verified, lower the shield plug onto the DSC.

9. Visually verify that the top shield plug is properly seated in the DSC.

10. *NOT USED.*

11. Raise the cask to the pool surface *using the cask trunnions and lifting yoke.*

12. *V*erify that *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.

13. Continue to raise the cask from the pool until the top region of the cask is accessible.

14. Drain any excess water from the top of the DSC shield plug.

15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.

16. Drain a minimum of 50 gallons of water. Optionally water may be drained from the DSC back into the fuel pool or other suitable location to meet the weight limit on the crane. *Use 1 to 3 psig of* helium to backfill the DSC with helium gas as water is being removed from the DSC.

17. Lift the cask from the fuel pool. Provisions shall be made to assure that air will not enter the DSC cavity.

18. Move the cask with loaded DSC to the plant designated preparation area.

19. *If water is removed* at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.5.2 NUHOMS®-32PTH1 DSC Drying and Backfilling

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.

2. *NOT USED.*

3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.

4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.

5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer surface of the DSC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of the welding operations, drain approximately 900 gallons of water from the DSC. *Use 1 to 3 psig* helium to backfill the DSC with an inert gas as water is being removed from the DSC.

7. *NOT USED.*

8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.

9. Check radiation levels the surface of the inner top cover plate. Temporary shielding may be installed as necessary.

10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. *Take precautions* to prevent debris and weld splatter from entering the annulus.

12. *W*eld the inner top cover plate to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.

14. *NOT USED.*

15. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, helium at up to 15.0 psig may be introduced through the vent port to *assist removal of* water from the DSC cavity through the siphon port.

16. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.

17. Connect the VDS to *the cask.*

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

18. Start the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize the moisture removal and avoid freezing. During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

    NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. Open the valve to the vent port and allow the helium to flow into the DSC cavity.
20. *NOT USED.*
21. *NOT USED.*
22. *NOT USED.*
23. *NOT USED.*
24. Re-evacuate the DSC cavity. The cavity pressure should be reduced in steps. *During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg *or less.*
25. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC to between 16.5 psig to 18.0 psig and hold for about 10 minutes. Depressurize the DSC cavity by releasing the helium through the VDS to plant fuel pool or radioactive waste system to a backfill pressure of 2.5 ± 1.0 psig (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

26. *NOT USED.*

A.7.7.5.3 NUHOMS®-32PTH1 DSC Sealing Operations

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *the required* dye penetrant weld examination*(s)*.
2. Install outer top cover plate and the automated welding system onto the DSC.
3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
4. Perform a helium leakage test of the inner top cover plate and vent/siphon port plate welds using the leak test port in the outer top cover plate and verify that the "leak-tight" criterion is met. Verify that the personnel performing the leakage test are qualified in accordance with SNT-TC-1A [7]. Alternatively, this leak test can be done with a test head following step 1.
5. If a leak is found, remove the outer cover plate root pass (if not using a test head), the vent and siphon port plugs and repair the inner cover plate welds. Then repeat applicable procedure steps from Section A.7.7.5.2, step 17.
6. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
7. Seal weld the prefabricated plug(when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.5.4 Unloading a NUHOMS®-32PTH1 DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.

4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

   CAUTION: (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

   (b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge with *2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water (or other plant-designated water source) through the siphon port with the vent port open and routed to the plant's off-gas system. Soluble boron requirements per step 5.A of Section A.7.7.5.1 are applicable for the pool and DSC cavity water.
6. *Take precautions to prevent debris from entering* the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

   CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].

8. Remove the DSC outer top cover plate.
9. *R*emove the closure weld from the DSC inner top cover plate.
10. Remove the DSC inner top cover plate.
11. NOT USED.
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.
13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. Lower the cask into the fuel pool *using the upper trunnions and lifting yoke.*
17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug.
18. Remove the fuel assemblies (end caps as applicable for damaged fuel assemblies) from the DSC.
19. *R*emove the cask from the pool.
20. Remove the water from the DSC cavity and cask/DSC annulus.
21. Remove the DSC from the cask.
22. Decontaminate the cask as necessary.
23. *NOT USED.*

Pages A.7.7.5-7 and A.7.7.5-8 left intentionally blank.

A.7.7.5.5 References

1. ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.
2. Not Used.
3. Not Used.
4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."
5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.
6. *Not Used.*
7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."

APPENDIX A.7.7.6
NUHOMS®-37PTH DSC Wet Loading and Unloading

Appendix A.7.7.6
NUHOMS®-37PTH DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.7.7.6.5. The term DSC as used in this appendix refers to the NUHOMS®-37PTH DSC.

A.7.7.6.1 NUHOMS®-37PTH DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that damaged and/or intact spent fuel assemblies (SFAs) and control components (CCs), if applicable, are placed into a known cell location within a DSC will typically consist of the following:
   - A cask/DSC loading plan is developed to verify that the intact, damaged fuel assemblies, and CCs, if applicable, meet the burnup, enrichment and cooling time parameters of the applicable sections as listed in step 13 of Section A.7.1.1.
   - The loading plan is independently verified and approved before the fuel load.
   - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
   - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate basket locations.

5.A Since burnup credit is employed for demonstration of criticality safety, additional administrative controls are required for verification of fuel assembly burnup and to prevent misloading. Fuel loading plans developed in step 5 above shall also include the additional requirements shown in Section A.6.3.4.

6. Prior to loading of an SFA (and CC, if applicable) into the DSC, the identity of the SFA (and CC, if applicable) is to be verified by two individuals using an underwater video camera or other means. Verification of CC identification is optional if the CC has not been moved from the host fuel assembly since its last verification. Read and record the identification number from the SFAs (and CCs, if applicable) and check this identification number against the DSC loading plan which indicates which SFAs (and CCs, if applicable) are acceptable for transport.
7. Position the fuel assembly for insertion into the selected DSC compartment and load the fuel assembly. Repeat steps 6–7 for each SFA loaded into the DSC. After the DSC has

been fully loaded, check and record the identity and location of each fuel assembly and CC, if applicable, in the DSC. If loading damaged fuel assemblies, place top end caps over each damaged fuel assembly placed into the basket.

8. After all the SFAs and CCs, if applicable, have been placed into the DSC and their identities verified, lower the shield plug into the DSC.
9. Visually verify that the top shield plug is properly seated in the DSC.
10. *NOT USED.*
11. Raise the cask to the pool surface *using the cask trunnions and lifting yoke.*
12. *V*erify *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.
13. Continue to raise the cask from the pool until the top region of the cask is accessible.
14. Drain any excess water from the top of the DSC shield plug.
15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.
16. As required for crane load limitations, drain water from the DSC back into the fuel pool or other suitable location. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed.
17. Lift the cask from the fuel pool.
18. Move the cask with loaded DSC to the plant designated preparation area.
19. *If water is removed* at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.6.2 NUHOMS®-37PTH DSC Drying and Backfilling

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. *NOT USED.*
3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.
4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.
5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer *exposed* surface of the DSC shell and check for smearable contamination as required.

CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of the welding operations, drain a minimum of 100 gallons of water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC.
7. *NOT USED.*
8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.
9. Check radiation levels along the surface of the inner top cover plate. Temporary shielding may be installed as necessary.
10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.
11. *Take precautions* to prevent debris and weld splatter from entering the annulus.
12. *W*eld the inner top cover plate to the DSC shell.

CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.
14. *NOT USED.*
15. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, helium at up to 15.0 psig may be introduced through the vent port to *assist removal of* the water from the DSC cavity through the siphon port.
16. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.
17. Connect the VDS to *the cask.*

NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

18. Start the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize moisture removal and avoid freezing. During/between vacuum drying steps*, the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

    NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. Open the valve to the vent port and allow the helium to flow into the DSC cavity.
20. *NOT USED.*
21. *NOT USED.*
22. *NOT USED.*
23. *NOT USED.*
24. Re-evacuate the DSC cavity using the VDS. The cavity pressure should be reduced in steps. *During/between vacuum drying steps*, the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg *or less*.
25. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC between 16.5 and 18.0 psig and hold for 10 minutes. Depressurize the DSC cavity to 2.5 ± 1.0 psig (stable for 30.0 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

26. *NOT USED.*

A.7.7.6.3 NUHOMS®-37PTH DSC Sealing Operations

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *the required* dye penetrant weld examination*(s)*.
2. Install the outer top cover plate the automated welding system onto the DSC.
3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
4. Perform a helium leakage test of the inner top cover plate and vent/siphon port plate welds using the test port in the outer top cover plate and verify that the "leak-tight" criterion is met. Verify that the personnel performing the leakage test are qualified in accordance with SNT-TC-1A [7]. Alternatively, this leakage test can be done with a test head following step 1 above.
5. If a leak is found, remove the outer cover plate root pass (if not using a test head), the vent and siphon port plugs and repair the inner cover plate welds. Then repeat applicable procedure steps from Section A.7.7.6.2, step 17.
6. Perform *the required* dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform dye penetrant examination on the weld surface*(s)*.
7. Seal weld the prefabricated plug (when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.6.4 Unloading a NUHOMS®-37PTH DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

CAUTION: (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

(b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge *with 2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water through the siphon port with the vent port open and routed to the plant's off-gas system. Soluble boron requirements per step 5.A of Section A.7.7.6.1 are applicable for the pool and DSC cavity water.
6. *Take precautions to prevent debris from entering* the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

   CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].
8. Remove the DSC outer top cover plate.
9. Remove the closure weld from the DSC inner top cover plate.
10. Remove the DSC inner top cover plate.
11. NOT USED
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.
13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. Lower the cask slowly into the fuel pool *using the upper trunnions and lifting yoke.*
17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug.
18. Remove the fuel assemblies (or end caps as applicable for damaged assemblies) from the DSC.
19. *R*emove the cask from the pool, and place it in the decon area.
20. Remove the water from the DSC cavity and cask/DSC annulus.
21. Remove the DSC from the cask.
22. Decontaminate the cask as necessary.
23. *NOT USED.*

Pages A.7.7.6-7 and A.7.7.6-8 left intentionally blank.

A.7.7.6.5 References

1. ANSI N14.5-1997,"American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.
2. Not Used.
3. Not Used.
4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."
5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.
6. *Not Used.*
7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."

APPENDIX A.7.7.7
NUHOMS®-61BT DSC Wet Loading and Unloading

Appendix A.7.7.7
NUHOMS®-61BT DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.7.7.7.5. The term DSC as used in this appendix refers to the NUHOMS®-61BT DSC.

A.7.7.7.1 NUHOMS®-61BT DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that damaged and/or intact spent fuel assemblies (SFAs) are placed into a known cell location within a DSC will typically consist of the following:
    - A cask/DSC loading plan is developed to verify that the SFAs meet the burnup, enrichment and cooling time parameters of the applicable sections as listed in step 13 of Section A.7.1.1.
    - The loading plan is independently verified and approved before the fuel load.
    - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
    - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate fuel compartment tube locations before fuel load.

8. After all the SFAs have been placed into the DSC and their identities verified, place the hold down ring *if it is not integral to the basket*. Alternately, the hold down ring may be placed on the basket before loading the SFAs. *L*ower the shield plug onto the DSC.
9. Visually verify that the top shield plug is properly seated in the DSC.
10. *NOT USED.*
11. Raise the cask to the pool surface *using the cask trunnions and lifting yoke*.
12. *V*erify that *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.
13. Continue to raise the cask from the pool until the top region of the cask is accessible.
14. Drain any excess water from the top of the DSC shield plug.
15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.
16. As required for crane load limitations, drain water from the DSC back into the fuel pool or other suitable location to meet the weight limit on the crane. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC.
17. Lift the cask from the fuel pool.
18. Move the cask with loaded DSC to the plant designated preparation area.
19. *If water is removed* at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.7.2 NUHOMS®-61BT DSC Drying and Backfilling

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. *NOT USED.*
3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.
4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.
5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the *exposed* surface of the DSC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Drain a minimum of 1100 gallons of water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC.

7. *NOT USED.*

8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.

9. Check radiation levels along the surface of the inner top cover plate. Temporary shielding may be installed as necessary.

10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. *Take precautions* to prevent debris and weld splatter from entering the annulus.

12. *T*ack weld the inner top cover plate to the DSC shell. Complete the inner top cover plate weld to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.

14. Place the strongback on the inner top cover plate and is oriented such that:

15. *NOT USED.*

16. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, helium (up to 10 psig) may also be used on the vent port and allow helium to *assist removal of* the water from the DSC cavity through the siphon port.

17. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.

18. Connect the VDS to *the cask.*

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

19. *S*tart the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize moisture removal and avoid freezing. During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

20. Open the valve to the vent port and allow the helium to flow into the DSC cavity.
21. *NOT USED.*
22. *NOT USED.*
23. *NOT USED.*
24. *NOT USED.*
25. Re-evacuate the DSC cavity. The cavity pressure should be reduced in steps. *During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg *or less.*
26. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC to 2.5 ± 1.0 psig backfill pressure (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

27. *NOT USED.*
28. Remove the strongback.

A.7.7.7.3 NUHOMS®-61BT DSC Sealing Operations

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *the required* dye penetrant weld examination*(s)*.
2. Install the outer top cover plate and the automated welding system onto the DSC. .
3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
4. Perform helium leakage test of the inner top cover plate and vent/siphon port plate welds using the test port in the outer top cover plate and verify that the "leak-tight" criterion is met. Verify that the personnel performing the leak test are qualified in accordance with SNT-TC-1A [7]. Alternatively, this leak test can be done with a test head following step 1.

5. If a leak is found, remove the outer cover plate root pass, the vent and siphon port plugs and repair the inner cover plate welds. Then repeat applicable procedure steps from Section A.7.7.7.2, step 18.
6. Perform *the required* dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform dye penetrant examination on the weld surface*(s)*.
7. Seal weld the prefabricated plug (when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.7.4 Unloading the NUHOMS®-61BT DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring or airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain and minimize the spread of and impact on the health and safety of workers due to contamination.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

CAUTION: (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

(b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge *with 2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water (or other plant designated water source) through the siphon port with the vent port open.
6. *Take precautions to prevent debris from entering* the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].

8. Remove the DSC outer top cover plate.
9. *R*emove the DSC inner top cover plate.
10. Remove the DSC inner top cover plate.
11. NOT USED.
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.
13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. Lower the cask slowly into the fuel pool *using the upper trunnions and lifting yoke.*
17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug and hold down ring.
18. Remove the fuel assemblies (end caps as applicable for damaged fuel assemblies) from the DSC.
19. *R*emove the cask from the pool.
20. Remove the water from the DSC cavity and cask/DSC annulus.
21. Remove the DSC from the cask.
22. Decontaminate the cask as necessary.
23. *NOT USED.*

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A.7.7.7.5 References

1. ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.
2. Not Used.
3. Not Used.
4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."
5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.
6. *Not Used.*
7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."

APPENDIX A.7.7.8
NUHOMS®-61BTH DSC Wet Loading and Unloading

Appendix A.7.7.8
NUHOMS®-61BTH DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc. and refer to the reference list in Section A.7.7.8.5. The term DSC as used in this appendix refers to the NUHOMS®-61BTH DSC.

A.7.7.8.1 NUHOMS®-61BTH DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that failed, damaged and/or intact spent fuel assemblies (SFAs) are placed into a known cell location within a DSC, will typically consist of the following:
   - A cask/DSC loading plan is developed to verify that the failed, damaged and/or intact SFAs meet the burnup, enrichment and cooling time parameters of the applicable sections as listed in step 13 of Section A.7.1.1.
   - The loading plan is independently verified and approved before the fuel load.
   - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
   - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate fuel compartment tube locations before fuel load.

damaged fuel assemblies, place top end caps over each damaged fuel assembly placed into the basket. If loading failed fuel, ensure that the FFC lids are installed. After the DSC has been fully loaded, check and record the identity and location of each fuel assembly in the DSC.

8. a. After all the SFAs have been placed into the DSC and their identities verified, place the hold-down ring or optional top grid assembly as applicable. If using the hold down ring, it may be placed on the basket before loading the SFAs.

   b. *L*ower the shield plug into the DSC.

9. Visually verify that the top shield plug is properly seated in the DSC.
10. *NOT USED.*
11. Raise the cask to the pool surface.
12. *V*erify that *the top shield plug* properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.
13. Continue to raise the cask from the pool.
14. Drain any excess water from the top of the DSC shield plug back to the fuel pool. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.
15. Drain water as needed from the DSC back into the fuel pool or other suitable location to meet the crane load limits. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC.
16. Lift the cask from the fuel pool.
17. Move the cask with loaded DSC to the plant designated preparation area.
18. *If* water *is* removed at step 15, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.8.2 NUHOMS®-61BTH DSC Drying and Backfilling

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. *NOT USED.*
3. Disengage the top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.
4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.

5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer *exposed* surface of the DSC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of the welding operations, drain approximately 1100 gallons of water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed from the DSC.

7. *NOT USED.*

8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.

9. Check radiation levels along the surface of the inner top cover plate. Temporary shielding may be installed as necessary.

10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. *Take precautions* to prevent debris and weld splatter from entering the annulus.

12. *T*ack weld the inner top cover plate to the DSC shell. Complete the inner top cover plate weld to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform dye penetrant examination of the weld surface.

14. If loading a Type 2 61BTH DSC skip to step *16*; otherwise, *install* the strongback on the inner top cover plate.

15. *NOT USED.*

16. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, helium (at up to 10.0 psig for Type 1 DSC or 15.0 psig for Type 2 DSC) may be introduced through the vent port to *assist removal of* the water from the DSC.

17. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.

18. Connect the VDS to *the cask.*

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

19. *S*tart the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize moisture removal and avoid freezing. During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

    NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes. Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

20. Open the valve to the vent port and allow the helium to flow into the DSC cavity.

21. *NOT USED.*

22. *NOT USED.*

23. *NOT USED.*

24. *NOT USED.*

25. Re-evacuate the DSC cavity. The cavity pressure should be reduced in steps. *During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

26. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC between 14.5 to 16.0 psig for 61BTH Type 1 and 18.5 to 20.0 psig for 61BTH Type 2 DSC and hold for 10 minutes. Depressurize the DSC cavity to 2.5 psig ± 1.0 psig backfill pressure (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

27. *NOT USED.*

28. If installed, remove the strongback.

A.7.7.8.3 NUHOMS®-61BTH DSC Sealing Operations

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *the required* dye penetrant weld examination*(s)*.
2. Install the outer top cover plate and the automated welding system onto the DSC.
3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
4. Perform helium leakage test of the inner top cover plate and vent/siphon port plate welds using the test port in the outer top cover plate and verify that the "leak-tight" criterion is met. Verify that the personnel performing the leakage test are qualified in accordance with SNT-TC-1A [7]. Alternatively, this leakage test can be done with a test head following step 1 above.
5. If a leak is found, remove the outer cover plate root pass (if not using a test head), the vent and siphon port plugs and repair the inner cover plate welds. Then install the strongback (if used) and repeat procedure steps from A.7.7.8.2, step 18.
6. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
7. Install and seal weld the prefabricated plug (when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.8.4 Unloading a NUHOMS®-61BTH DSC to a Fuel Pool Using the NUHOMS®-MP197HB Cask

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

   CAUTION: (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

   (b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge *with 2-3 psig* helium as necessary to maintain the hydrogen concentration safely below this limit.
5. Fill the DSC with spent fuel pool water (or other plant-designated water source) through the siphon port with the vent port open.
6. *Take precautions to prevent debris from entering* the cask/DSC annulus.
7. *R*emove the closure weld from the outer top cover plate.

   CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].
8. Remove the DSC outer top cover plate.
9. *R*emove the closure weld from the DSC inner top cover plate.
10. Remove the DSC inner top cover plate.
11. NOT USED
12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.
13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.
14. *NOT USED.*
15. *NOT USED.*
16. Lower the cask into the fuel pool *using the upper trunnions and lifting yoke.*
17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug.
18. Remove the holddown ring (if not integral to the basket).
19. Remove the fuel assemblies (or fuel cans/end caps as applicable for failed/damaged fuel assemblies) from the DSC.
20. *R*emove the cask from the pool.
21. Remove the water from the DSC cavity and cask/DSC annulus.
22. Remove the DSC from the cask.

23. Decontaminate the cask as necessary.
24. *NOT USED.*

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A.7.7.8.5 References

1. *ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.*
2. *Not Used.*
3. *Not Used.*
4. *U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."*
5. *U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.*
6. *Not Used.*
7. *SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."*

APPENDIX A.7.7.9
NUHOMS®-69BTH DSC Wet Loading and Unloading

Appendix A.7.7.9
NUHOMS®-69BTH DSC Wet Loading and Unloading Procedures

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.7.7.9.5. The term DSC as used in this appendix refers to the NUHOMS®-69BTH DSC.

A.7.7.9.1 NUHOMS®-69BTH DSC Fuel Loading

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that damaged and/or intact spent fuel assemblies (SFAs) are placed into a known cell location within a DSC will typically consist of the following:
    - A cask/DSC loading plan is developed to verify that the intact and damaged fuel assemblies meet the burnup, enrichment and cooling time parameters of the applicable sections as listed in step 13 of Section A.7.1.1.
    - The loading plan is independently verified and approved before the fuel load.
    - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance with the fuel movement schedule.
    - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate locations in the basket.
6. Prior to loading of an SFA into the DSC, the identity of the assembly is to be verified by two individuals using an underwater video camera or other means. Read and record the identification number from the SFA and check this identification number against the DSC loading plan which indicates which SFAs are acceptable for transport.
7. Position the fuel assembly for insertion into the selected DSC fuel compartment and load the fuel assembly. Repeat steps 6 through 7 for each SFA loaded into the DSC. If loading damaged fuel assemblies, place top end caps over each damaged fuel assembly placed into the basket. After the DSC has been fully loaded, check and record the identity and location of each fuel assembly in the DSC.
8. After all the SFAs have been placed into the DSC and their identities verified, install the hold down ring *if it is not integral to the basket.* Alternately, the hold down ring may be placed before loading the SFAs.

    *L*ower the shield plug into the DSC.

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9. Visually verify that the top shield plug is properly seated in the DSC.

10. *NOT USED.*

11. Raise the cask to the pool surface.

12. *V*erify that *the top shield plug* is properly seated within the DSC. If not, lower the cask and reposition the top shield plug. Repeat steps 9 through 12 as necessary.

13. Continue to raise the cask from the pool until the top region of the cask is accessible.

14. Drain any excess water from the top of the DSC shield plug.

15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.

16. As required for crane load limitations, drain water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed.

17. Lift the cask from the fuel pool.

18. Move the cask with loaded DSC to the plant designated preparation area.

19. *If* water *is* removed at step 16, *it* may be replaced with spent fuel pool water or equivalent.

A.7.7.9.2 NUHOMS®-69BTH DSC Drying and Backfilling

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Check the radiation levels *around* the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.

2. *NOT USED.*

3. Disengage top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.

4. Decontaminate the exposed surfaces of the DSC *cylindrical* shell perimeter and remove the annulus seal.

5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer *exposed* surface of the DSC shell and check for smearable contamination as required.

CAUTION: Radiation dose rates are expected to be high at the DSC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of the welding operations, drain a minimum of 100 gallons of water from the DSC. *Use 1 to 3 psig of* helium to backfill the DSC as water is being removed.

7. *NOT USED.*

8. Install the automated welding machine onto the inner top cover and place the inner top cover with the automated welding machine onto the DSC. Alternately, the inner top cover may be placed on the DSC separately or the inner top cover may be part of the shield plug; in these cases the automated welding machine is installed on the inner top cover already installed in the DSC.

9. Check radiation levels along the surface of the inner top cover plate. Temporary shielding may be installed as necessary.

10. Insert suitable tubing through the vent port such that it terminates just below the DSC top shield plug. Connect the tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. *Take precautions* to prevent debris and weld splatter from entering the annulus.

12. *W*eld the inner top cover plate to the DSC shell.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the tube arrangement described in step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [4] and [5]. If this limit is exceeded, stop all welding operations and purge the DSC cavity *with 2-3 psig* helium to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform *required* dye penetrant examination of the weld surface*(s)*.

14. *NOT USED.*

15. *R*emove remaining bulk water from the DSC cavity. *U*se helium to backfill the DSC as water is being removed from the DSC. Alternately, helium at up to 15.0 psig may be introduced through the vent port to *assist removal of* the water from the DSC cavity through the siphon port.

16. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the gas source.

17. Connect the VDS to *the cask.*

    NOTE: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

18. *S*tart the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps *to optimize moisture removal and avoid freezing. During/between vacuum drying steps,* the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less.

    NOTE: The user shall ensure that the vacuum pump is isolated from the canister cavity when demonstrating compliance with <3 mm Hg for 30 minutes.

Simply closing the valve between the canister and the vacuum pump is not sufficient, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the canister. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the canister.

CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. Open the valve to the vent port and allow the helium to flow into the DSC cavity.
20. *NOT USED.*
21. *NOT USED.*
22. *NOT USED.*
23. *NOT USED.*
24. Re-evacuate the DSC cavity. The cavity pressure should be reduced in steps *During/between vacuum drying steps*, the pump is valved off and the cavity pressure monitored. When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg *or less*.
25. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC between 16.5 and 18.0 psig and hold for 10 minutes. Depressurize the DSC cavity to 2.5 ± 1.0 psig (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

26. *NOT USED.*

A.7.7.9.3 NUHOMS®-69BTH DSC Sealing Operations

CAUTION: During performance of steps listed in this section, monitor the cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Disconnect the VDS from the DSC. Seal weld the prefabricated covers over the vent and siphon ports, inject helium into the blind space just prior to completing welding, and perform *the required* dye penetrant weld examination*(s)*.
2. Install the outer top cover plate and the automated welding system onto the DSC.
3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.
4. Perform a helium leakage test of the inner top cover plate and vent/siphon port plate welds using the test port in the outer top cover plate and verify that the "leak-tight" criterion is met. Verify that the personnel performing the leakage test are qualified in

accordance with SNT-TC-1A [7]. Alternatively, this leakage test can be done with a test head following Step 1 above.

5. If a leak is found, remove the outer cover plate root pass (if not using a test head), the vent and siphon port plugs and repair the inner cover plate welds. Then repeat applicable procedure steps from Section A.7.7.9.2, step 17.
6. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
7. Seal weld the prefabricated plug (when applicable) over the outer cover plate test port and perform dye penetrant weld examinations.
8. *NOT USED.*
9. *D*rain the water from the cask/DSC annulus.

The cask/DSC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.9.4 Unloading a NUHOMS®-69BTH DSC to a Fuel Pool

CAUTION: The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with site procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the use of prudent housekeeping measures and monitoring of airborne particles. Procedures may require tenting, respirators, supplied air or other measures to contain contamination and minimize the impact on the health and safety of workers.

1. *NOT USED.*
2. *R*emove the siphon cover plate.
3. *R*emove the vent cover plate.
4. Sample the DSC cavity atmosphere. If necessary, flush the DSC cavity gases to the site radwaste systems.

CAUTION: (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

(b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [4] and [5]. Purge *with 2-3 psig* helium (or any other inert medium) as necessary to maintain the hydrogen concentration safely below this limit.

5. Fill the DSC with spent fuel pool water (or other plant-designated water source) through the siphon port with the vent port open and routed to the plant's off-gas system.

6. *Take precautions to prevent debris from entering* the cask/DSC annulus.

7. *R*emove the closure weld from the outer top cover plate.

   CAUTION: Monitor the hydrogen concentration in the DSC cavity during this step to ensure that it does not exceed 2.4% by volume [4] and [5].

8. Remove the DSC outer top cover plate.

9. *R*emove the closure weld from the DSC inner top cover plate.

10. Remove the DSC inner top cover plate.

11. NOT USED

12. Remove excess material on the DSC inside shell surface which may interfere with top shield plug removal.

13. Clean the cask surface of dirt and debris that may have accumulated during transportation or weld removal.

14. *NOT USED.*

15. *NOT USED.*

16. Lower the cask slowly into the fuel pool *using the upper trunnions and lifting yoke.*

17. Disengage the lifting yoke from the cask trunnions and remove the top shield plug and hold-down ring, as applicable.

18. Remove the fuel assemblies (or end caps as applicable for damaged assemblies) from the DSC.

19. *R*emove the cask from the pool.

20. Remove the water from the DSC cavity and cask/DSC annulus.

21. Remove the DSC from the cask.

22. Decontaminate the cask as necessary.

23. *NOT USED.*

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A.7.7.9.5 References

1. *ANSI N14.5-1997, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, 1997.*
2. *Not Used.*
3. *Not Used.*
4. *U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."*
5. *U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.*
6. *Not used.*
7. *SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."*

APPENDIX A.7.7.10
Radioactive Waste Canister (RWC) Wet Loading Procedures

Appendix A.7.7.10
Radioactive Waste Canister (RWC) Wet Loading Procedures

Note: The procedure outlined below applies to the final loading of either the RWC-W or the RWC-B prior to release for shipment. Both versions of the RWC have a top shield plug and an outer top cover plate. Both the plug and the plate are welded in place prior to transport.

A.7.7.10.1 Wet Loading of the RWC

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool *used for* the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. *L*oad the RWC cavity. Record contents and location on the cask loading report to the extent practical.
6. Install the liner shield plug (RWC-W), as applicable, and then install the RWC top shield plug.
7. *NOT USED.*
8. *NOT USED.*
9. Inspect the shield plug/lid to verify that it is properly seated within the RWC. Repeat steps 6 through 8 as necessary.
10. *NOT USED.*
11. Drain any excess water from the top of the RWC back to the fuel pool.
12. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask.
13. *NOT USED.*
14. Lift the cask from the fuel pool.
15. Move the cask to the plant designated preparation area.

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A.7.7.10.2 RWC Drying and Backfilling

1. Check the radiation levels along the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. *NOT USED.*
3. Disengage top shield plug *from* the lifting yoke and position *the yoke* clear of the cask.
4. Decontaminate the exposed surfaces of the RWC *cylindrical* shell perimeter and remove the annulus seal.
5. *A*llow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the RWC shell. Take swipes around the outer *exposed* surface of the RWC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the RWC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.
6. Prior to the start of welding operations drain approximately 100 gallons of water from the RWC.
7. *NOT USED.*
8. Install the automated welding machine onto the top shield plug.
9. Check radiation levels along the surface of the top shield plug. Temporary shielding may be installed as necessary.
10. *Take precautions* to prevent debris and weld splatter from entering the annulus.
11. *W*eld the top shield to the RWC shell.
12. Perform *required* dye penetrant examination of the weld surface*(s)*.
13. *NOT USED.*
14. *R*emove remaining bulk water from the RWC cavity.
15. Once the water stops flowing from the RWC, close the RWC siphon port and disengage the gas source.
16. Connect the VDS to *the cask.*
17. *S*tart the VDS and draw a vacuum on the RWC cavity until dry. That is, until a vacuum of approximately 10 mbar can be maintained for 10 minutes.
18. *Use* air or helium to pressurize the RWC to 2.5 ± 1.0 psig backfill pressure (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.
19. Close the line connected to the vent port.

A.7.7.10.3 RWC Sealing Operations

1. Disconnect the VDS from the RWC. Seal weld the prefabricated covers over the vent and siphon ports and perform *the required* dye penetrant weld examination*(s)*.
2. Install the outer top cover plate and the automated welding system onto the RWC.
3. Tack weld the outer top cover plate to the RWC shell. Place the outer top cover plate weld root pass.
4. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the RWC shell and perform *the required* dye penetrant examination on the weld surface*(s)*.
5. Remove the automated welding machine from the RWC.
6. *D*rain the water from the cask/RWC annulus.

The cask/RWC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

Chapter A.8
Acceptance Tests and Maintenance Program

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Chapter A.8
Acceptance Tests and Maintenance Program

NOTE: References in this Chapter are shown as [1], [2], etc. and refer to the reference list in Section A.8.3.

A.8.1 Acceptance Tests

The following reviews, inspections, and tests shall be performed on the NUHOMS®-MP197HB packaging prior to initial transport. Many of these tests will be performed at the fabricator's facility prior to delivery of the cask or dry shielded canister (DSC) to the utility for use. Tests will be performed in accordance with written procedures.

A.8.1.1 Visual Inspection and Measurements

Visual inspections are performed at the fabricator's facility to ensure that the packaging conforms to the drawings and specifications. The visual inspections include:

- cleanliness inspections,
- visual weld inspections as required by ASME Code [1],
- inspection of sealing surface finish, and
- dimensional inspections for conformance with the drawings included in Chapter A.1, Appendix A.1.4.10.

A.8.1.2 Weld Examinations

The structural materials are chemically and physically tested to confirm that the required properties are met.

To the maximum extent practical, all welding is performed using qualified processes and qualified personnel, according to the ASME Boiler and the Pressure Vessel Code [1]. Base materials and welds are examined in accordance with the ASME Boiler and Pressure Vessel Code requirements. NDE requirements for welds are specified on the drawings provided in Appendix A.1.4.10. All NDE is performed in accordance with written procedures. The inspection personnel are qualified in accordance with SNT-TC-1A [2].

The containment welds of the NUHOMS®-MP197HB cask, and the NUHOMS®-DSCs are designed, fabricated, tested and inspected in accordance with ASME B&PV Code Subsection NB. Welds of the noncontainment structure are inspected as per the NDE acceptance criteria of ASME B&PV Code, Subsection NF.

The NUHOMS®-DSC fuel baskets are designed, fabricated, and inspected in accordance with the ASME B&PV Code Subsection NG. Fusion weld tests as required are shown on drawings provided in Appendix A.1.4.10.

Alternatives to the code are described in Chapter A.2, Section A.2.1.4 and Appendix A.2.13.13.

A.8.1.3 Structural and Pressure Tests

A.8.1.3.1 Load Tests

Two sets of trunnions are provided for the NUHOMS®-MP197HB transport package lifting. One set of trunnions has double shoulders (non-single failure proof). The other set of trunnions has a single shoulder (single failure proof). Only one set of trunnions is used depending on site and transfer operation requirements. The trunnions are fabricated and tested in accordance with ANSI N14.6 [3]. A load test of 3.0 times the design lift load (for single failure proof trunnions) or 1.5 times the design lift load (for non-single failure proof trunnions) is applied to the trunnions for a period of ten minutes, to ensure that the trunnions can perform satisfactorily.

A force equal to 1.5 times the impact limiter weight will be applied to the hoist rings of each impact limiter for a period of ten (10) minutes. At the conclusion of the test, the impact limiter hoist rings will be visually examined for defects and permanent deformation.

A.8.1.3.2 Pressure Tests

A pressure test is performed on the NUHOMS®-MP197HB packaging assembly at a pressure between 40.0 and 45.0 psig. This is well above 1.5 times the maximum normal operating pressure of 12.7 psig (Chapter A.3, Table A.3-20). The test pressure is held for a minimum of 10 minutes. The test is performed in accordance with ASME B&PV Code, Section III, Subsection NB, Paragraph NB-6200 or NB-6300. All visible joints/surfaces are visually examined for possible leakage after application of the pressure.

In addition, a bubble leakage test is performed on the resin enclosure. The purpose of this test is to identify any potential leakage passages in the enclosure welds.

A.8.1.4 Containment Boundary Leakage Tests

A.8.1.4.1 MP197HB Cask Leakage Tests

Leakage tests are performed on the MP197HB cask containment boundary prior to first use, typically at the fabricator's facility. The fabrication verification leakage test can be separated into the following five tests: 1) cask leakage integrity, 2) cask vent port closure bolt seal integrity, 3) cask drain port closure bolt seal integrity, 4) cask lid seal integrity, and 5) ram access closure plate seal integrity. These tests are usually performed using the helium mass spectrometer method. Alternative methods are acceptable, provided that the required sensitivity is achieved. The leakage test is performed in accordance with ANSI N14.5 [4] or ISO-12807 [11]. The personnel performing the leakage test are qualified in accordance with SNT-TC-1A [2].

Cask Leakage Integrity Test

Prior to lead pour and final machining of the inner shell, the cylindrical portion of the containment boundary, including the bottom end closure, will be leakage tested in accordance with the requirements of ANSI N14.5 [4] or ISO-12807 [11], using temporary closures and seals for the ram access cover plate and lid. Because the inner shell will not be accessible for leakage testing after lead is poured, leakage testing will be performed during the fabrication process, as permitted by ANSI N14.5 Table 1 [4].

If a leakage is discovered, the source will be determined, repaired, and the shells retested to ensure that the measured leakage rate is less than 1×10^{-7} ref cm^3/s.

The test will be performed in conjunction with the non-destructive examination of the inner shell welds in accordance with ASME B&PVC Code, Section III, Subsection NB. An MT or PT examination of every weld layer in the shell-to-top-forging closure weld and an MT or PT examination of all final machined weld surfaces of the inner shell will be performed per the Code.

Fabrication Verification Leakage Tests

The fabrication verification leakage tests include the following:

- Cask vent port closure bolt seal integrity
- Cask drain port closure bolt seal integrity
- Cask lid seal integrity
- Cask ram access closure plate seal integrity

The tests will be performed as described in Chapter A.7, Section A.7.4.1, in accordance with the ANSI N 14.5 [4] or ISO-12807 [11]. The acceptance criterion requires each component to be individually leaktight, that is, the leakage rate must be less than 1×10^{-7} ref cm^3/s.

A.8.1.4.2 NUHOMS® DSCs Leakage Test

The containment boundary of a NUHOMS® DSC is leakage tested to verify it is leaktight in accordance with ANSI N14.5 [4] or ISO-12807 [11]. The leakage tests are typically performed using the helium mass spectrometer method. Alternative methods are acceptable, provided that the required sensitivity is achieved. Following completion of the welding of the DSC inner top cover plate and siphon and vent cover plates, these welds are leakage tested to $\leq 1.0 \times 10^{-7}$ ref cm^3/s.

If the leakage rate exceeds this criteria, the inner top cover plate seal weld and siphon and vent cover plate welds will be inspected and repaired where necessary.

For the 24PT4 DSC, the leakage test requirements outlined in CoC 1029 are used to demonstrate leaktightness in lieu of the above criteria.

A.8.1.5 MP197HB Cask Component and Material Tests

A.8.1.5.1 Valves, Rupture Discs, and Fluid Transport Devices

There are no valves, rupture discs, or couplings in the containment of the NUHOMS®-MP197HB packaging.

A.8.1.5.2 Gaskets

The lid and all the other containment penetrations are sealed using O-ring seals. Leak*age* testing of the seals is described in *Section* A.8.1.4.1.

A.8.1.5.3 Impact Limiter Leakage Test

Prior to initial use, the following test will be performed, after all the seal welds have been completed on the impact limiter to verify that the impact limiter wood is completely enclosed, thereby preventing any moisture exchange with the ambient environment.

Each impact limiter container is pressurized to a pressure between 2.0 and 3.0 psig. Test all the weld seams and penetrations for leakage using a soap bubble test.

A.8.1.5.4 Functional Tests

The following functional tests will be performed prior to *the* first use of the cask. Generally these tests will be performed at the fabrication facility.

a. Installation and removal of the lid, ram access cover plates, port plugs, and other fittings will be observed. Each component will be checked for difficulties in installation and removal. After removal, each component will be visually examined for damage. Any defects will be corrected prior to *the* acceptance of the cask.
b. After installation of the fuel basket into the DSC, each basket compartment will be checked by gauge to demonstrate that the fuel assemblies will fit in the basket.

A.8.1.6 Shielding Tests

Chapter A.5 presents the analyses performed to ensure that the NUHOM*S*®-MP197HB package shielding integrity is adequate.

A.8.1.6.1 Gamma Shield Test

The integrity of the NUHOMS®-MP197HB cask poured lead shielding will be confirmed via gamma scanning prior to installation of the neutron shield.

The outer cask surface is gridded and a *gamma scan* chart is made to reflect the gridded surface. The gamma scan *is* performed using a detector with a detection area enveloping the grid minimum area (e.g., for a 6" × 6" grid, the detector will encompass a 6" × 6" square).

The acceptance criterion for the gamma scan is based on the results of dose rate measurements of mockup test block constructed to replicate the MP197HB cask through-wall configuration. The test block consists of the inner wall, layer of lead, and the outer wall. The test uses nominal thicknesses of steel walls (provided in SAR drawings given in Chapter A.1, Appendix A.1.4.10) and nominal less 5% thickness of lead layer. The dose rate measured *using the* test block *configuration* is used as the maximum acceptable reading for the inspected *cask*.

The source/detector distance used in the cask inspection shall be the same as that used in establishing the maximum dose rate limit.

A.8.1.6.2 Neutron Shield

The radial neutron shield is protected from damage or loss by the aluminum and steel enclosure. The neutron shield material, VYAL B, is a proprietary vinyl ester resin mixed with alumina hydrate and zinc borate which are added for their fire retardant properties.

The primary function of the resin is to shield against neutrons, which is performed primarily by the hydrogen content in the resin. The sole function of the boron is to suppress n-γ reactions with hydrogen. The resin also provides some gamma shielding, which is a function of the overall resin density, and is not sensitive to composition.

The proprietary process for the VYAL-B mixing and installation is described in SAR Section A.5.8.

The following are acceptance values for density and chemical composition for the resin. The values used in the shielding calculations of Chapter A.5 are included for comparison.

Chapter A.5 values		Acceptance Testing Values		
Element	Nominal wt %	Element	Wt %	Acceptance range (wt %)
H	4.54	H	5.0	± 8
B	0.82	B	0.9	± 10

The minimum resin density in acceptance testing is 1.75 g/cm^3. Resin composition or density test results which fall outside of this range will be evaluated to ensure that the shielding regulatory dose limits are not exceeded.

Tests are performed at loading to ensure that the radiation dose limits are not exceeded for each cask.

A.8.1.7 Neutron Absorber Tests

The neutron absorber used for criticality control in the DSC baskets may consist of any of the following types of material. Depending on the DSC model, these neutron absorber materials may be used alone or be paired with aluminum:

(a) Boron-aluminum alloy (borated aluminum)

(b) Boron carbide/Aluminum metal matrix composite (MMC)

(c) Boral®

These materials only serve as neutron absorber for criticality control and as heat conduction paths. The MP197HB packaging safety analyses do not rely upon their mechanical strength. The radiation and temperature environment in the cask is not sufficiently severe to damage these metallic/ceramic materials. To assure performance of the neutron absorber's design function only the presence of B10 and the uniformity of its distribution need to be verified, with testing requirements specific to each material. The boron content of these materials is given in the Appendices A.1.4 for each DSC type.

References to metal matrix composites throughout this chapter are not intended to refer to Boral®, which is described later in this section.

A.8.1.7.1 Boron Aluminum Alloy (Borated Aluminum)

The material is produced by direct chill (DC) or permanent mold casting with boron precipitating *primarily* as a uniform fine dispersion of discrete AlB_2 or TiB_2 particles in the matrix of aluminum or aluminum alloy *(other boron compounds, such as* AlB_{12}*, can also occur)*. For extruded products, the TiB_2 form of the alloy shall be used. For rolled products, either the AlB_2, the TiB_2, or a hybrid may be used.

Boron is added to the aluminum in the quantity necessary to provide the specified minimum B10 areal density in the final product. The amount required to achieve the specified minimum B10 areal density will depend on whether boron with the natural isotopic distribution of the isotopes B10 and B11, or boron enriched in B10 is used. In no case shall the boron content in the aluminum or aluminum alloy exceed 5% by weight.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of borated aluminum. The basis for this credit is the B10 areal density acceptance testing, which shall be as specified in Section A.8.1.7.6. The specified acceptance testing assures that at any location in the material, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

A.8.1.7.2 Boron Carbide/Aluminum Metal Matrix Composites (MMC)

The material is a composite of fine boron carbide particles in an aluminum or aluminum alloy matrix. The material shall be produced by either direct chill casting, permanent mold casting, powder metallurgy, or thermal spray techniques. The boron carbide content shall not exceed 40% by volume. The boron carbide content for MMCs with an integral aluminum cladding shall not exceed 50% by volume.

The final MMC product shall have density greater than 98% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity. For MMC with an integral cladding, the final density of the core shall be greater than 97% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity of the core and cladding as a unit of the final product.

Boron carbide particles for the products considered here *shall be smaller than* 40 microns or less. No more than 10% of the particles shall be over 60 microns.

Prior to use in the DSC, MMCs shall pass the qualification testing specified in Section A.8.1.7.7, and shall subsequently be subject to the process controls specified in Section A.8.1.7.8.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of MMCs. The basis for this credit is the B10 areal density acceptance testing, which is specified in Section A.8.1.7.6. The specified acceptance testing assures that at any location in the final product, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

A.8.1.7.3 Boral®

This material consists of a core of aluminum and boron carbide powders between two outer layers of aluminum, mechanically bonded by hot-rolling an "ingot" consisting of an aluminum box filled with blended boron carbide and aluminum powders. The core, which is exposed at the edges of the sheet, is slightly porous. *Before rolling, at least 80% by weight of the B_4C particals in BORAL® shall be smaller than 200 microns.* The nominal boron carbide content shall be limited to 65% (+ 2% tolerance limit) of the core by weight.

The criticality calculations take credit for 75% of the minimum specified B10 areal density of Boral®. B10 areal density will be verified by chemical analysis and by certification of the B10 isotopic fraction for the boron carbide powder, or by neutron transmission testing. Areal density testing is performed on a coupon taken from the sheet produced from each ingot. If the measured areal density is below that specified, all the material produced from that ingot will be either rejected, or accepted only on the basis of alternate verification of B10 areal density for each of the final pieces produced from that ingot.

A.8.1.7.4 Visual Inspections of Neutron Absorbers

Neutron absorbers shall be 100% visually inspected in accordance with the Certificate Holder's QA procedures. Material that does not meet the following acceptance criteria shall be reworked, repaired, or scrapped. Blisters shall be treated as non-conforming. Inspection of MMCs with an integral aluminum cladding shall also include verification that the matrix is not exposed through the faces of the aluminum cladding and that solid aluminum is not present at the edges. For Boral, visual inspection shall verify that there are no cracks through the cladding, exposed core on the face of the sheet, or solid aluminum at the edge of the sheet.

A.8.1.7.5 Other Visual Inspections Criteria (non-CoC Conditions)

For borated aluminum and MMCs, visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4 “Quality Control, Visual Inspection of Aluminum Mill Products and Castings”[12]. Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable.

A.8.1.7.6 Specification for Acceptance Testing of Neutron Absorbers by Neutron Transmission

A.8.1.7.6a Neutron Transmission acceptance testing procedures shall be subject to approval by the Certificate Holder. Test coupons shall be removed from the rolled or extruded production material at locations that are systematically or probabilistically distributed throughout the lot. Test coupons shall not exhibit physical defects that would not be acceptable in the finished product, or that would preclude an accurate measurement of the coupon’s physical thickness.

A lot is defined as all the pieces produced from a single ingot or heat or from a group of billets from the same heat. If this definition results in lot size too small to provide a meaningful statistical analysis of results, an alternate larger lot definition may be used, so long as it results in accumulating material that is uniform for sampling purposes.

The sampling rate for neutron transmission measurements shall be such that there is at least one neutron transmission measurement for each 2000 square inches of final product in each lot.

The B10 areal density is measured using a collimated thermal neutron beam of no more than 1 inch diameter.

The neutron transmission through the test coupons is converted to B10 areal density by comparison with transmission through calibrated standards. These standards are composed of a homogeneous boron compound without other significant neutron absorbers. For example, boron carbide, zirconium diboride or titanium diboride sheets are acceptable standards. These standards are paired with aluminum shims sized to match the effect of neutron scattering by aluminum in the test coupons. Uniform but non-homogeneous materials such as metal matrix composites may be used for standards, provided that testing shows them to provide neutron attenuation equivalent to a homogeneous standard. Standards will be calibrated, traceable to nationally recognized standards, or by attenuation of a monoenergetic neutron beam correlated to the known cross section of boron 10 at that energy.

Alternatively, digital image analysis may be used to compare neutron radioscopic images of the test coupon to images of the standards. The area of image analysis shall be no more than 0.75 sq. inch.

The minimum areal density specified shall be verified for each lot at the 95% probability, 95% confidence level or better. If a goodness-of-fit test demonstrates that the sample comes from a normal population, the one-sided tolerance limit for a normal distribution may be used for this purpose. Otherwise, a non-parametric (distribution-free) method of determining the one-sided tolerance limit may be used. Demonstration of the one-sided tolerance limit shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

A.8.1.7.6b The following illustrates one acceptable method and is intended to be utilized as an example. Therefore, the following text is not part of the CoC 9302 Conditions.

The acceptance criterion for individual plates is determined from a statistical analysis of the test results for their lot. The B10 areal densities determined by neutron transmission are converted to volume density, i.e., the B10 areal density is divided by the thickness at the location of the neutron transmission measurement or the maximum thickness of the coupon. The lower tolerance limit of B10 volume density is then determined, defined as the mean value of B10 volume density for the sample, less K times the standard deviation, where K is the one-sided tolerance limit factor with 95% probability and 95% confidence [13].

Finally, the minimum specified value of B10 areal density is divided by the lower tolerance limit of B10 volume density to arrive at the minimum plate thickness which provides the specified B10 areal density.

Any plate which is thinner than the statistically derived minimum thickness from Section A.8.1.7.6a or the minimum design thickness, whichever is greater, shall be treated as non-conforming, with the following exception. Local depressions are acceptable, so long as they total no more than 0.5% of the area on any given plate, and the thickness at their location is not less than 90% of the minimum design thickness. *Edge effects due to manufacturing operations such as shearing, deburring, and chamfering need not be included in this determination.*

Non-conforming material shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

A.8.1.7.7 Specification for Qualification Testing of Metal Matrix Composites

A.8.1.7.7.1 Applicability and Scope

Metal matrix composites (MMCs) acceptable for use in the DSCs are described in Section A.8.1.7.2.

Prior to initial use in a spent fuel transport system, such MMCs shall be subjected to qualification testing that will verify that the product satisfies the design function. Key process controls shall be identified per Section A.8.1.7.8 so that the production material is equivalent to or better than the qualification test material. Changes to key processes shall be subject to qualification before use of such material in a spent fuel dry storage or transport system.

ASTM test methods and practices are referenced below for guidance. Alternative methods may be used with the approval of the certificate holder.

A.8.1.7.7.2 Design Requirements

In order to perform its design functions the product must have at a minimum sufficient strength and ductility for manufacturing and for the normal and accident conditions of the transport system. This is demonstrated by the tests in Section A.8.1.7.7.4. It must have a uniform distribution of boron carbide. This is demonstrated by the tests in Section A.8.1.7.7.5.

A.8.1.7.7.3 Durability

There is no need to include accelerated radiation damage testing in the qualification. Such testing has already been performed on MMCs, and the results confirm what would be expected of materials that fall within the limits of applicability cited above. Metals and ceramics do not experience measurable changes in mechanical properties due to fast neutron fluences typical over the lifetime of spent fuel transport, about 10^{15} neutrons/cm^2.

The need for thermal damage and corrosion (hydrogen generation) testing shall be evaluated case-by-case based on comparison of the material composition and environmental conditions with previous thermal or corrosion testing of MMCs.

Thermal damage testing is not required for unclad MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842°F, well above the basket temperature under normal conditions of transport[1].

Corrosion testing is not required for MMCs (clad or unclad) consisting only of boron carbide in an aluminum 1100 matrix, because testing on one such material has already been performed by Transnuclear[2].

A.8.1.7.7.3.1 Delamination Testing of Clad MMC

Clad MMCs shall be subjected to thermal damage testing following water immersion to ensure that delamination does not occur under normal conditions of storage. *This testing shall include conditions to simulate water conditions of the pool and heating temperatures for storage. An example of such a test would be: (1) immerse a specimen at least 6 x 6 inches in water under pressure ≥30 psig for at least 24 hours, (2) place the specimen in a vacuum furnace preheated to at least 300°F and evacuate the furnace. Acceptance criterion for the test shall be no blistering or delamination of the cladding.*

A.8.1.7.7.4 Required Qualification Tests and Examinations to Demonstrate Mechanical Integrity

At least three samples, one each from approximately the two ends and middle of the qualification material run shall be subject to:

a) room temperature tensile testing (ASTM- B557[3]) demonstrating that the material has the following tensile properties:

- Minimum yield strength, 0.2% offset: 1.5 ksi
- Minimum ultimate strength: 5 ksi
- Minimum elongation in 2 inches: 0.5%

As an alternative to the elongation requirement, ductility may be demonstrated by bend testing per ASTM E290[4]. The radius of the pin or mandrel shall be no greater than three times the material thickness, and the material shall be bent at least 90 degrees without complete fracture,

b) Testing to verify more than 98% of theoretical density for non-clad MMCs and 97% for the matrix of clad MMCs. Testing or examination for interconnected porosity on the faces and edges of unclad MMC, and on the edges of clad MMC shall be performed by a means to be approved by the Certificate Holder. The maximum interconnected porosity is 0.5 volume %, and for at least one sample,

1 Sung, C., "Microstructural Observation of Thermally Aged and Irradiated Aluminum/Boron Carbide (B_4C) Metal Matrix Composite by Transmission and Scanning Electron Microscope," 1998.

2 Boralyn testing submitted to the NRC under docket 71-1027, 1998.

3 ASTM B557 Standard Test Methods of Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products

4 ASTM E290, Standard Methods for Bend Testing of Materials for Ductility.

c) For MMCs with an integral aluminum cladding, thermal durability testing demonstrating that after a minimum 24 hour soak in either pure or borated water, then insertion into a preheated oven at approximately 825°F for a minimum of 24 hours, the specimens are free of blisters and delamination and pass the mechanical testing requirements described in test 'a' of this section.

A.8.1.7.7.5 Required Tests and Examinations to Demonstrate B10 Uniformity

Uniformity of the boron distribution shall be verified either by:

a) Neutron radioscopy of material from the ends and middle of the test material production run, verifying no more than 10% difference between the minimum and maximum B10 areal density, or
b) Quantitative testing for the B10 areal density, B10 density, or the boron carbide weight fraction, on locations distributed over the test material production run, verifying that one standard deviation in the sample is less than 10% of the sample mean. Testing may be performed by a neutron transmission method similar to that specified in Section A.8.1.7.6, or by chemical analysis for boron carbide content in the composite.

A.8.1.7.7.6 Approval of Procedures

Qualification procedures shall be subject to approval by the Certificate Holder.

A.8.1.7.8 Specification for Process Controls for Metal Matrix Composites

This section provides process controls to ensure that the material delivered for use is equivalent to the qualificaion test material.

A.8.1.7.8.1 Applicability and Scope

Key processing changes shall be subject to qualification prior to use of the material produced by the revised process. The Certificate Holder shall determine whether a complete or partial re-qualification program per Section A.8.1.7.7 is required, depending on the characteristics of the material that could be affected by the process change.

A.8.1.7.8.2 Definition of Key Process Changes

Key process changes are those which could adversely affect the uniform distribution of the boron carbide in the aluminum, reduce density, reduce corrosion resistance, or reduce the mechanical strength or ductility of the MMC.

A.8.1.7.8.3 Identification and Control of Key Process Changes

The manufacturer shall provide the Certificate Holder with a description of materials and process controls used in producing the MMC. The Certificate Holder and manufacturer shall identify key process changes as defined in Section A.8.1.7.8.2.

An increase in nominal boron carbide content over that previously qualified shall always be regarded as a key process change. The following are examples of other changes that are established as key process changes, as determined by the Certificate Holder's review of the specific applications and production processes:

a) *Changes in the boron carbide particle size specification that increase the average particle size by more than 5 microns or that increase the amount of particles larger than 60 microns from the previously qualified material by more than 5% of the total distribution but less than the 10% limit,*

b) *Change of the billet production process, e.g., from vacuum hot pressing to cold isostatic pressing followed by vacuum sintering,*

c) *Change in the nominal matrix alloy,*

d) *Changes in mechanical processing that could result in reduced density of the final product, e.g., for PM or thermal spray MMCs that were qualified with extruded material, a change to direct rolling from the billet,*

e) *For MMCs using a magnesium-alloyed aluminum matrix, changes in the billet formation process that could increase the likelihood of magnesium reaction with the boron carbide, such as an increase in the maximum temperature or time at maximum temperature,*

f) *Changes in powder blending or melt stirring processes that could result in less uniform distribution of boron carbide, e.g., change in duration of powder blending, and*

g) *For MMCs with an integral aluminum cladding, a change greater than 25% in the ratio of the nominal aluminum cladding thickness (sum of two sides of cladding) and the nominal matrix thickness could result in changes in the mechanical properties of the final product.*

In no case shall process changes be accepted if they result in a product outside the limits in Sections A.8.1.7.7.1 and A.8.1.7.7.4.

A.8.1.7.9 Neutron Absorber for DSCs Already Loaded and DSCs Under Fabrication

The neutron absorber tests and acceptance criteria as described in Section A.8.1.7.1 through Section A.8.1.7.8 are only applicable to all the canister types that will be loaded in the spent fuel pool using the MP197HB cask. However, for canister types which are already in service under 10CFR Part72, the neutron absorber material acceptance requirements for each specific canister type as described in the applicable 10CFR Part72 approved certificate of compliance are applicable.

A.8.1.8 *Cask* Thermal Tests

The thermal evaluation of the MP197HB cask described in Chapter A.3 is performed using very conservative and bounding assumptions. Gaps between the components are modeled in the thermal analysis to account for possible gaps expected during fabrication. Gaps are assumed to be present during NCT and HAC post fire cases when calculating heat flow out of the cask and gaps are assumed closed when calculating heat flow into the cask (i.e., during the HAC fire). The calculated cladding temperatures are much lower than the cladding temperature limit, assuring large margins to the limits. The cladding temperatures reported for the DSCs are very conservative because the allowed heat loads for a given DSC are reduced until the calculated DSC shell temperature in the MP197HB cask is below that calculated for storage conditions in the applicable 10 CFR Part 72 license. The reported cladding temperature is that of the higher heat load allowed under storage conditions with the same or higher DSC shell temperature.

However, to provide additional assurance that the thermal performance of the fabricated cask is equal to or exceeds the theoretical performance reported in the SAR, a thermal test is performed after fabrication of MP197HB cask.

Heat dissipation for the MP197HB cask to the ambient occurs three-dimensionally with a significant portion of the design heat load being radially dissipated through the neutron shield region of the cask body. The cask top and bottom ends beyond the neutron shield region are covered by the impact limiters. Due to limited contact between the thermal shields and the cask end plates (cask bottom plate and cask lid) and the insulating properties of wood within the impact limiters, the heat dissipation in the axial direction is largely restricted and is insignificant in comparison to the radial heat dissipation.

The thermal test measures the effective thermal conductivity of a cask in the radial direction over an approximately 10-ft exposed length within the neutron shield region. These measured thermal conductivities will be used as thermal input into the ANSYS model described in the SAR, Chapter A.3, Section A.3.3.1.1 for the NCT thermal analysis. The temperature distribution computed with the measured conductivity of the cask is then compared against the corresponding values in the SAR, Chapter A.3, Table A.3-8, and A.3-10 to demonstrate the thermal performance of the fabricated cask is equal to or exceeds the theoretical performance reported in the SAR.

A.8.1.9 Neutron Absorber Thermal Conductivity Testing

Acceptance testing shall conform to ASTM E1225, ASTM E1461, or equivalent method, performed at room temperature on coupons taken from the rolled or extruded production material. Initial sampling shall be one test per lot, and may be reduced if the first five tests meet

the specified minimum thermal conductivity. For cast products, the lot shall be defined by the heat or ingot. For other products, the lot shall be defined as material produced in a single production campaign using the same heat or lots of aluminum and boron carbide feed materials.

If a thermal conductivity test result is below the specified minimum, at least four additional tests shall be performed on the material from that lot. If the mean value of those tests, including the original test, falls below the specified minimum, the associated lot shall be rejected.

After twenty five tests of a single type of material, with the same aluminum alloy matrix, the same boron content, and the same primary boron phase, e.g., B_4C, TiB_2, or AlB_2, if the mean value of all the test results less two standard deviations meets the specified thermal conductivity, no further testing of that material is required. This exemption may also be applied to the same type of material if the matrix of the material changes to a more thermally conductive alloy (e.g., from 6000 to 1000 series aluminum), or if the boron content is reduced without changing the boron phase.

The measured thermal conductivity values shall satisfy the minimum required conductivities as shown in Section A.3.2.1, Table 17 for HLZC #1, #2 and #3, and in Section A.3.2.1, Table 19 for HLZC #4.

In cases where the specified thickness of the neutron absorber may vary, the equations introduced in Section A.3.3.1.5 shall be used to determine the minimum required effective thermal conductivity.

The thermal conductivity test requirement does not apply to aluminum that is paired with the neutron absorber.

A.8.2 Maintenance Program

A.8.2.1 Structural and Pressure Tests

Within 14 months prior to any lift of a NUHOMS®-MP197HB transport package, the front trunnions shall be subject to either of the following:

- A test load equal to 300% of the maximum service load per ANSI N14.6 [3], paragraph 7.3.1(a) for single failure proof trunnions or a test load equal to 150% of the maximum service load per ANSI N14.6 [3], paragraph 7.3.1(b) for non-single failure proof trunnions. After sustaining the test load for a period of not less than 10 minutes, accessible critical areas shall be subjected to visual inspection for defects, and all components shall be inspected for permanent deformation.
- Dimensional testing, visual inspection and nondestructive examination of accessible critical areas of the trunnions including the bearing surfaces in accordance with Paragraph 6.3.1 of ANSI N14.6 [3].

A.8.2.2 Leakage Tests

The following containment boundary components shall be subject to periodic maintenance, and preshipment leakage testing in accordance with ANSI N14.5 [4] or ISO-12807 [11]:

- Lid
- Ram Access Closure Plate
- Vent Port
- Drain Port

Test	Frequency	Acceptance Criteria	Typical Method (ANSI N14.5 TABLE A-1, [4])
Periodic	Within 12 months prior to shipment	Each component individually ≤ 1×10^{-7} ref cm^3/s	(He) A.5.3 A.5.4
Pre-shipment	Before each shipment, after the contents are loaded and the package is closed	No detected leakage, sensitivity of 10^{-3} ref cm^3/s or better, unless seal is replaced.	A.5.1 A.5.2 A.5.8 A.5.9
Maintenance	After maintenance, repair, or replacement of containment components, including inner seals	Each component individually ≤ 1×10^{-7} ref cm^3/s	(He) A.5.3 A.5.4

No leakage tests are required prior to shipment of an empty NUHOMS®-MP197HB packaging.

A.8.2.3 Component and Material Tests

A.8.2.3.1 Fasteners

All threaded fasteners and port plugs shall be inspected whenever removed, and annually, for deformed or stripped threads. Damaged parts shall be evaluated for continued use and replaced as required.

At a minimum, the MP197HB cask lid bolts shall be replaced at least every 250 shipments (round trip) to ensure adequate fatigue strength is maintained.

A.8.2.3.2 Impact Limiters

A visual examination of the impact limiters before each shipment will be performed to ensure that the impact limiters have not been degraded between leak*age* test intervals. If there is no evidence of weld cracking or other damage which could result in water in-leakage, the wood will not be degraded. If there is visual damage, the impact limiter will be removed from service, repaired, if possible, and inspected for degradation of the wood. Impact limiters will be leak*age* tested once every five years to ensure that water has not entered the impact limiters. If the leak*age* test indicates that the impact limiters have a leak, a humidity test will be performed to verify that there is no free water in the impact limiters.

A.8.2.3.3 Valves, Rupture Discs, and Gaskets on Containment Vessel

If the ram access cover plate or the lid is removed, the seals are replaced prior to transport of a loaded DSC or *RWC*. The seals will be leak tested after retorquing the bolts in accordance with Chapter A.7, Section A.7.4.

O-ring seals may be reused for transport of an empty NUHOMS®-MP197HB packaging.

There are no valves, rupture discs, *or couplings* on the *containment of the* NUHOMS®-MP197HB packaging.

A.8.2.3.4 Shielding

There are no periodic tests or inspections required for the NUHOMS®-MP197HB shielding. As described in Chapter A.7, radiation surveys will be performed on the package exterior to ensure that the limits specified in 10 CFR 71.47 are met prior to each shipment.

The material composition of the VYAL-B neutron shielding resin employed in the shielding calculations are based on minimum guaranteed values that are determined as a result of extensive tests under various (including extreme) environmental conditions. These tests indicate that the neutron shielding resin does not degrade under normal conditions and is durable over extended periods of time. The shielding calculations employed are based on conservative models and design basis source terms and demonstrate that the dose rate criteria are satisfied with sufficient margin. The comparisons of calculated and measured dose rate have indicated that the calculated dose rates are highly conservative. The 10CFR 71 dose rate compliance measurements serve to

indicate the shielding effectiveness of the package. Therefore, periodic tests for the neutron shielding resin are not necessary.

A.8.2.4 *Periodic* Thermal Tests

There are no periodic tests or inspections required for the NUHOMS®-MP197HB package heat transfer components for the reasons explained in Section A.8.1.8.

A.8.2.5 Miscellaneous Tests

There are no additional maintenance tests required for the MP197HB package.

A.8.3 References

1. ASME Boiler and Pressure Vessel Code, Section III, 2004 Edition including 2006 addenda. (For the MP197HB; various editions apply to specific DSCs. See Chapter A.2 for specific applications).
2. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."
3. ANSI N14.6-1993, "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds or More for Nuclear Materials," New York.
4. ANSI N14.5-1997, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials."
5. Not Used.
6. Not Used.
7. Not Used.
8. Not Used.
9. Not Used.
10. Not Used.
11. ISO-12807, "Safe transport of radioactive material - Leakage testing on packages," First Edition, 1996.
12. "Aluminum Standards and Data, 2003," The Aluminum Association.
13. Natrella, "Experimental Statistics," Dover, 2005.
14. *ASTM E1225, "Thermal Conductivity of Solids by Means of the Guarded-Comparative-Longitudinal Heat Flow Technique."*
15. *ASTM E1461, "Thermal Diffusivity of Solids by the Flash Method."*