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16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
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(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN
1	1	Design Authority D. M. Chenault *DM Chenault* 9-28-98 R3-86			
		S. A. Brisbin *SABrisbin* 9-28-98 R3-86			
		Design Agent			
1	1	Cog.Eng. A. L. Pajunen *[signature]* 9/28/98 R3-86			
1	1	Cog. Mgr. J. R. Frederickson *JR Frederickson* R3-86			
		QA			
		Safety			

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A. N. Praga *A.N. Praga* 9-28-98 Signature of EDT Originator / Date	J. R. Frederickson *JR Frederickson* 9/30/98 Authorized Representative for Receiving Organization / Date	J. R. Frederickson *JR Frederickson* 9/30/98 Design Authority/ Cognizant Manager / Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

MCO LOADING AND CASK LOADOUT TECHNICAL MANUAL

A. N. Praga
DE&S Hanford, Inc., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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Key Words: Spent Nuclear Fuel, Multi-Canister Overpack, Cask

Abstract: A compilation of the technical basis for loading a multi-canister overpack (MCO) with spent nuclear fuel and then placing the MCO into a cask for shipment to the Cold Vacuum Drying Facility. The technical basis includes a description of the process, process technology that forms the basis for loading alternatives, process control considerations, safety considerations, equipment description, and a brief facility structure description.

10/1/98

Release Approval Date

DATE: HANFORD RELEASE ID: 2
STA: 4
OCT 01 1998

Release Stamp

Approved for Public Release

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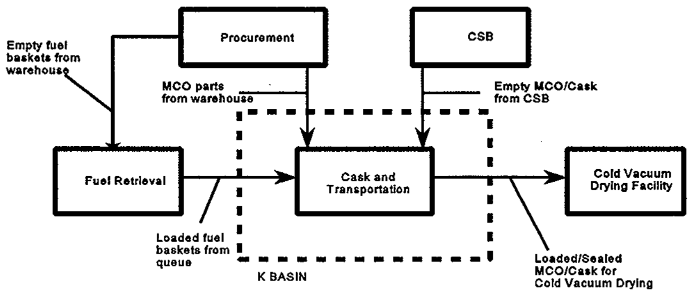
1.0 INTRODUCTION

The scope of the Spent Nuclear Fuel Project includes retrieval of all spent nuclear fuel at the K Basins for packaging and transportation to interim storage (Womack 1996). The configuration of systems selected for K Basin fuel retrieval and storage was based on evaluations of alternative strategies that resulted in defining a group of systems for placing the fuel in dry storage (Fulton 1994 and Gerber 1996). A two step drying process was selected from the alternative evaluated to expedite the schedule for removal of fuel from the K Basins. Further fuel characterization and analysis provided a basis for eliminating the high temperature drying step (Rasin 1997).

Cask Loadout represents the steps required, after fuel retrieval, to move spent nuclear fuel (SNF) from the K Basins to the Cold Vacuum Drying Facility (CVDF). As shown in Figure 1, fuel is cleaned and repacked into fuel baskets by the Fuel Retrieval System (FRS) at the K Basins. The Cask Loadout process places loaded fuel baskets from the FRS into a Multi-Canister Overpack (MCO) and places the loaded MCO on a conveyance in preparation for the move to the CVDF.

The scope of this document is to describe the technical bases for the Cask Loadout process, equipment and equipment performance used in the process. The document is intended for use as a reference for personnel responsible for startup and operation of the Cask Loadout processes.

Figure 1- Generalized Description of MCO Loading and Cask Loadout



2.0 PROCESS SUMMARY

The Cask Loadout process encompasses the steps required to prepare cleaned and packed spent nuclear fuel for transfer from the K Basins to the Cold Vacuum Drying Facility. The fuel, in baskets, is received from the fuel retrieval system following cleaning. The fuel baskets are loaded into an MCO/Cask while under water in the K Basins. The MCO/Cask is then removed from the basin, and placed on a conveyance for transfer to the Cold Vacuum Drying Facility for free water removal.

During basket loading, special attention is given to the number and position of baskets of scrap placed in each MCO/Cask. A maximum of two scrap baskets shall be loaded into each MCO. These baskets shall only be placed in the top or bottom tier loading positions. These configuration restrictions are required to keep thermal and gas generation within the approved SARP analyses.

The MCO/Cask is configured for shipping prior to placement on the conveyance for transfer. Configuring the MCO/Cask for transfer involves venting the MCO to the cask cavity, sealing the cask, and backfilling the MCO/Cask with helium. This configuration precludes the presence of flammable gas mixtures by lowering the oxygen content and allows for gas expansion.

The resulting MCO/Cask is then ready for transfer to the CVDF for free water removal. The MCO/Cask can be placed on the conveyance, and safely transported to the CVDF. In this configuration, the MCO/Cask shipping window is defined as 24 hours.

3.0 PROCESS DESCRIPTION

The Cask Loadout process takes spent nuclear fuel (SNF) repackaged during fuel retrieval through the steps required to prepare it for transfer to the Cold Vacuum Drying Facility (CVDF) for processing. These activities occur in the 100K Area at the KE and KW Basins. Figure 2 provides a summary level schematic of the Cask Loadout process. The process begins with K Basin receipt of an empty MCO/Cask from the Canister Storage Building (CSB). The MCO/Cask is removed from the conveyance and placed in an immersion pail, the pail is filled with water, the MCO is flooded, and the pail is lowered into the basin south loadout pit. Once in the pit, the MCO/Cask is loaded with fuel baskets staged in the fuel retrieval queue. When full, the shield plug assembly is installed and the MCO/Cask and immersion pail are raised to the top of the pit where the MCO/Cask is sealed and backfilled with helium. The MCO/Cask is then removed from the pail, and placed on the transfer conveyance. Once the MCO/Cask is placed on the conveyance and secured, it is ready for transfer to the CVDF for free water removal.

The Cask Loadout activities are supported by the CSB, the Fuel Retrieval System, the Integrated Water Treatment System (IWTS), the K Basin Utilities, the K Basin Crane Utilities, and the K Basin Warehouse. The CSB provides the empty MCO/Cask into which fuel baskets are loaded. The Fuel Retrieval System cleans and loads SNF into baskets, providing the main feed for cask loadout. The K Basin Utilities provide air, water, electrical, and hydraulics for MCO loading and tooling. The K Basin Crane Utilities provides the hydraulics, air, and electrical supply for the crane. The K Basin Warehouse provides an area for staging the shield plug assemblies, long process tubes, and associated components prior to assembly. The IWTS provides demineralized (fresh makeup) water to fill the immersion pail and to decontaminate the MCO/Cask following immersion, and deionized water to fill the MCO and "flush" the South Loadout Pit. Excess flush and decontamination water is also returned to the IWTS.

The following sections provide an expanded description of the process supporting completion of cask loadout.

3.1 Process Feed (Goldmann 1998a and Pajunen 1997b)

The Cask Loadout process receives several inputs or feeds from other SNF Project systems. These feeds include both the SNF and the equipment required to overpack and transfer the SNF to the CVDF for free water removal. Fuel inputs to the process include loaded fuel and scrap baskets from the fuel retrieval system. Equipment feeds arriving at the basin include the MCO/Cask (loaded on the transport trailer and containing the locking ring), long process tube, and shield plug assembly. Essential material feeds include compressed air, basin water, helium, and electricity.

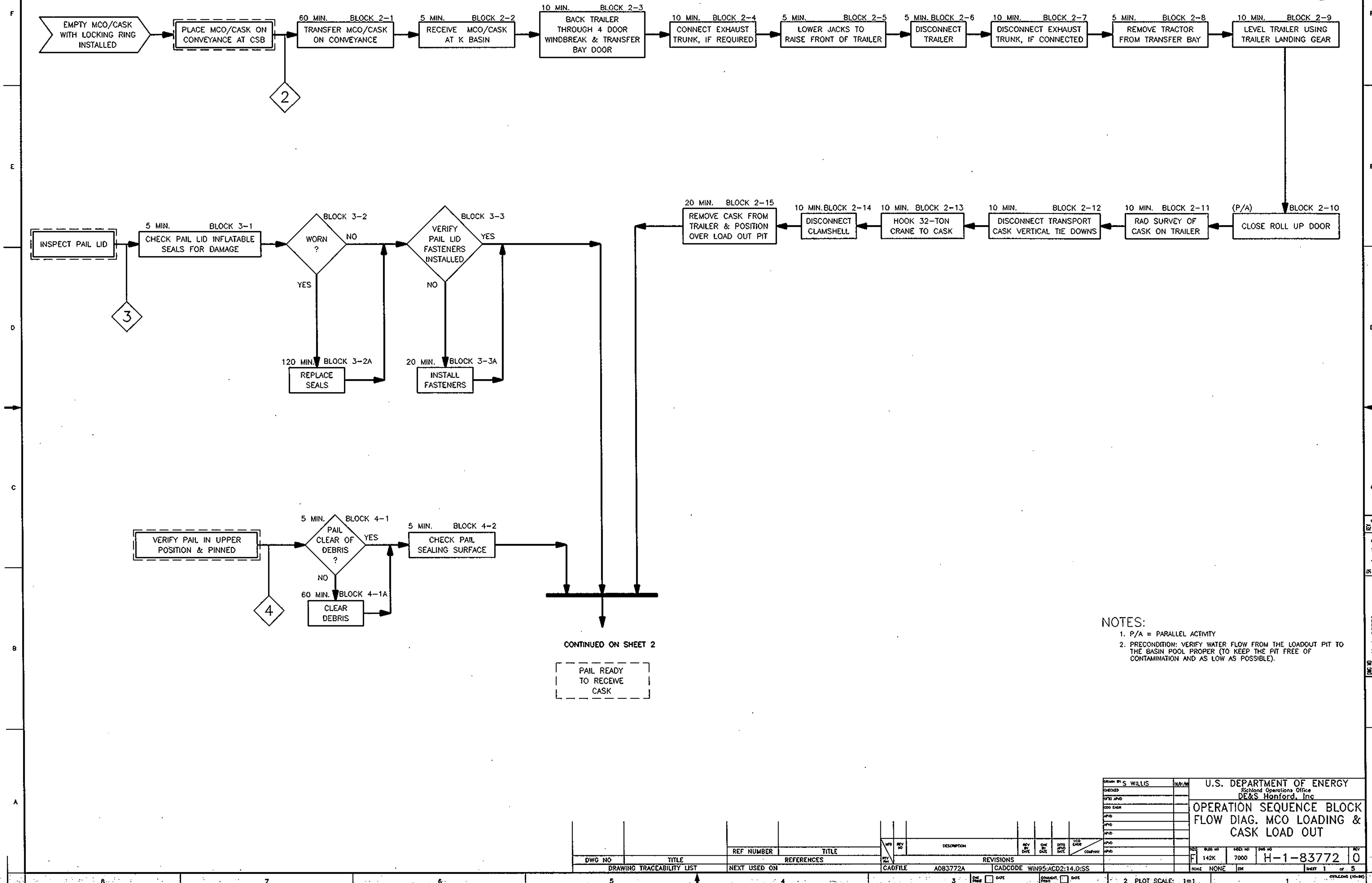
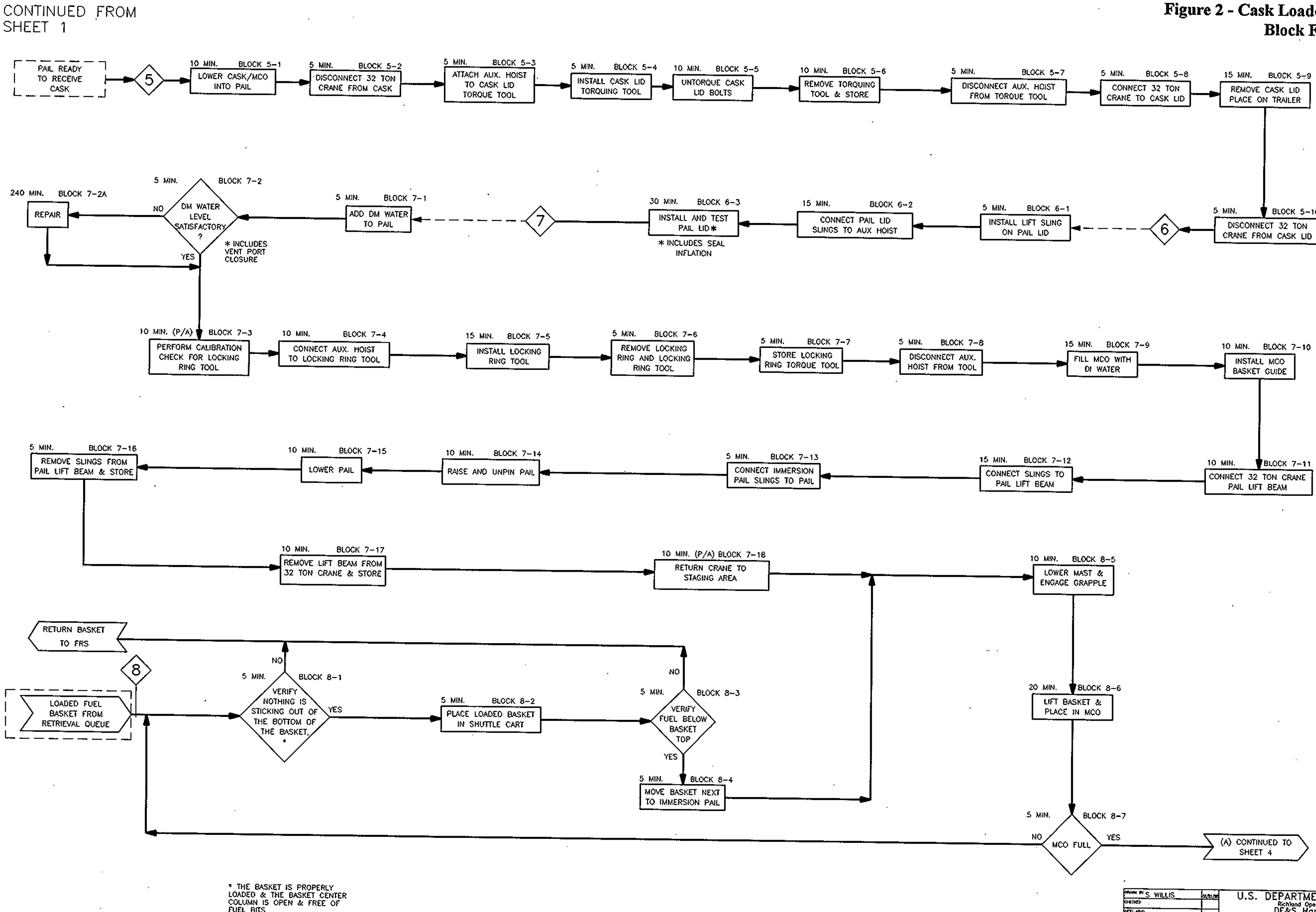


Figure 2 - Cask Loadout Operational Sequence Block Flow Diagram - Sheet 1

Figure 2 - Cask Loadout Operational Sequence Block Flow Diagram - Sheet 2



DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REVISIONS

CADFILE A083772B CADCODE WIN95:ACD2:14.0:SS

DRAWN BY S. WILLIS

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
DE&S Hanford, Inc

OPERATION SEQUIENCE BLOCK FLOW DIAG. MCO LOADING & CASK LOAD-OUT

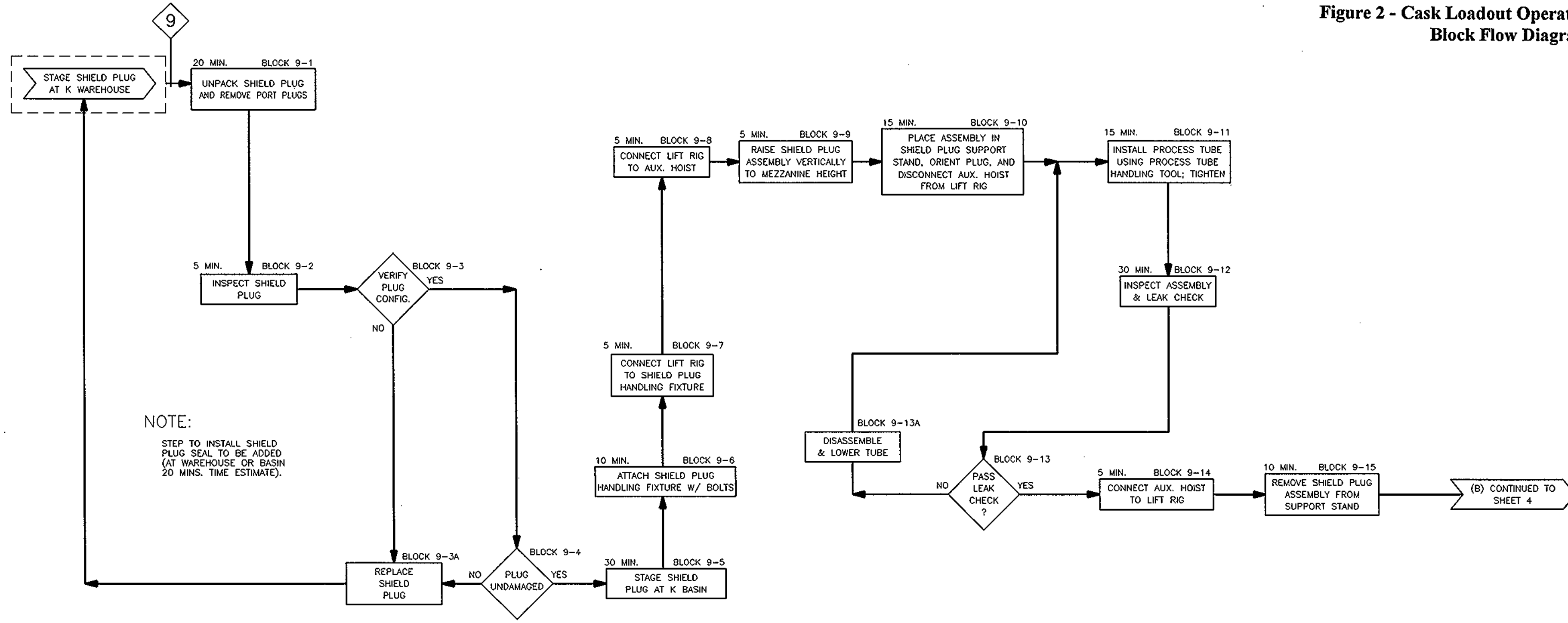
F 142K 7000 H-1-83772 0

SCALE NONE SHEET 2

PLOT SCALE: 1=1

DWG NO H-1-83772 SH 2 of REV 0

Figure 2 - Cask Loadout Operational Sequence Block Flow Diagram - Sheet 3



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		NEXT USED ON	

REVISIONS — CADFILE A083772C — CADCODE WIN95:ACD2:14.0:SS

DRAWN BY S WILLIS

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
DE&S Hanford, Inc

OPERATION SEQUENCE BLOCK FLOW DIAG. MCO LOADING & CASK LOAD-OUT

F 142K 7000 H-1-83772 0

SCALE SHOWN XX SHEET 3

PLOT SCALE: 1=1

DWG NO H-1-83772 SH 3 OF REV 0

Figure 2 - Cask Loadout Operational Sequence Block Flow Diagram - Sheet 4

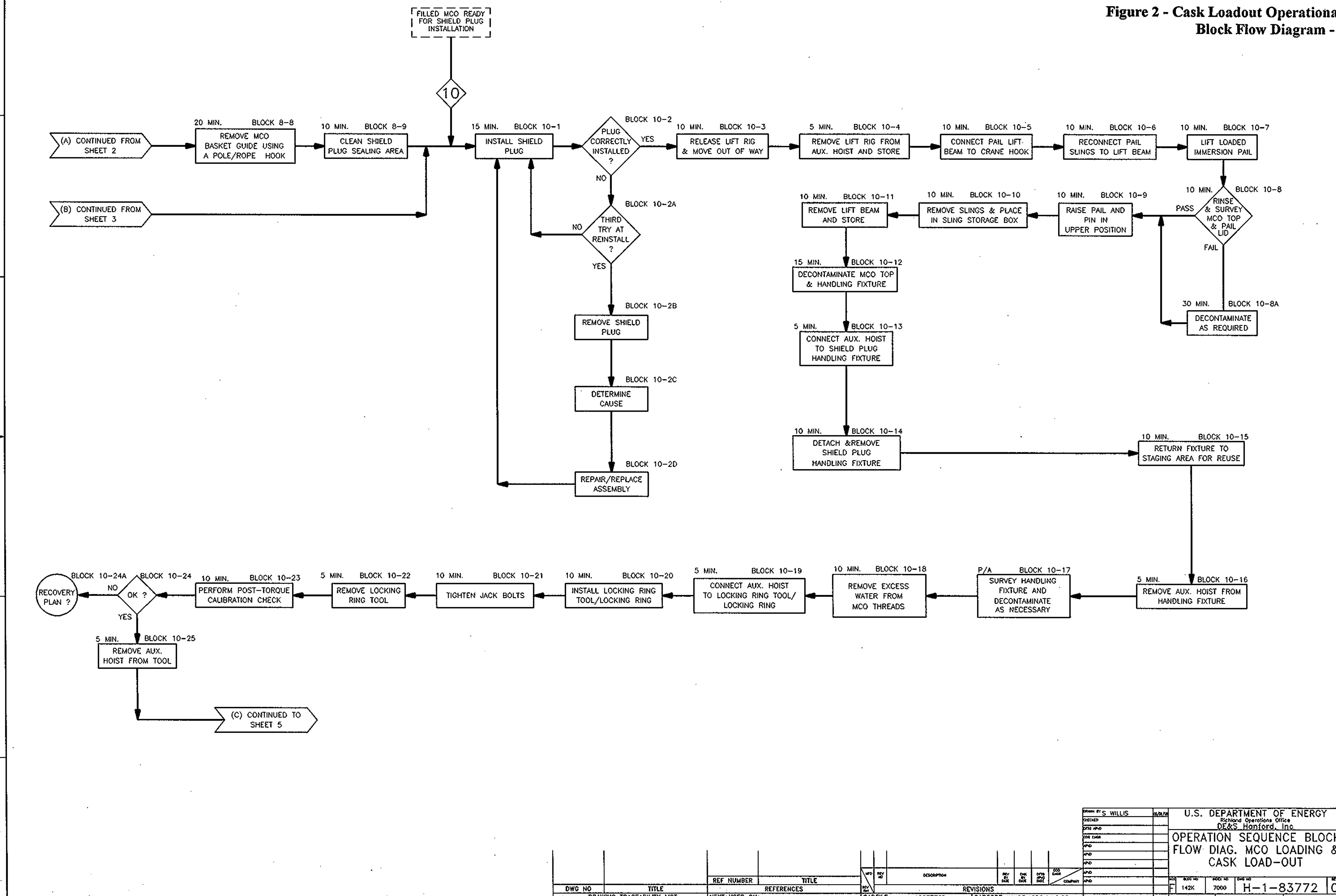


Figure 2 - Cask Loadout Operational Sequence Block Flow Diagram - Sheet 5

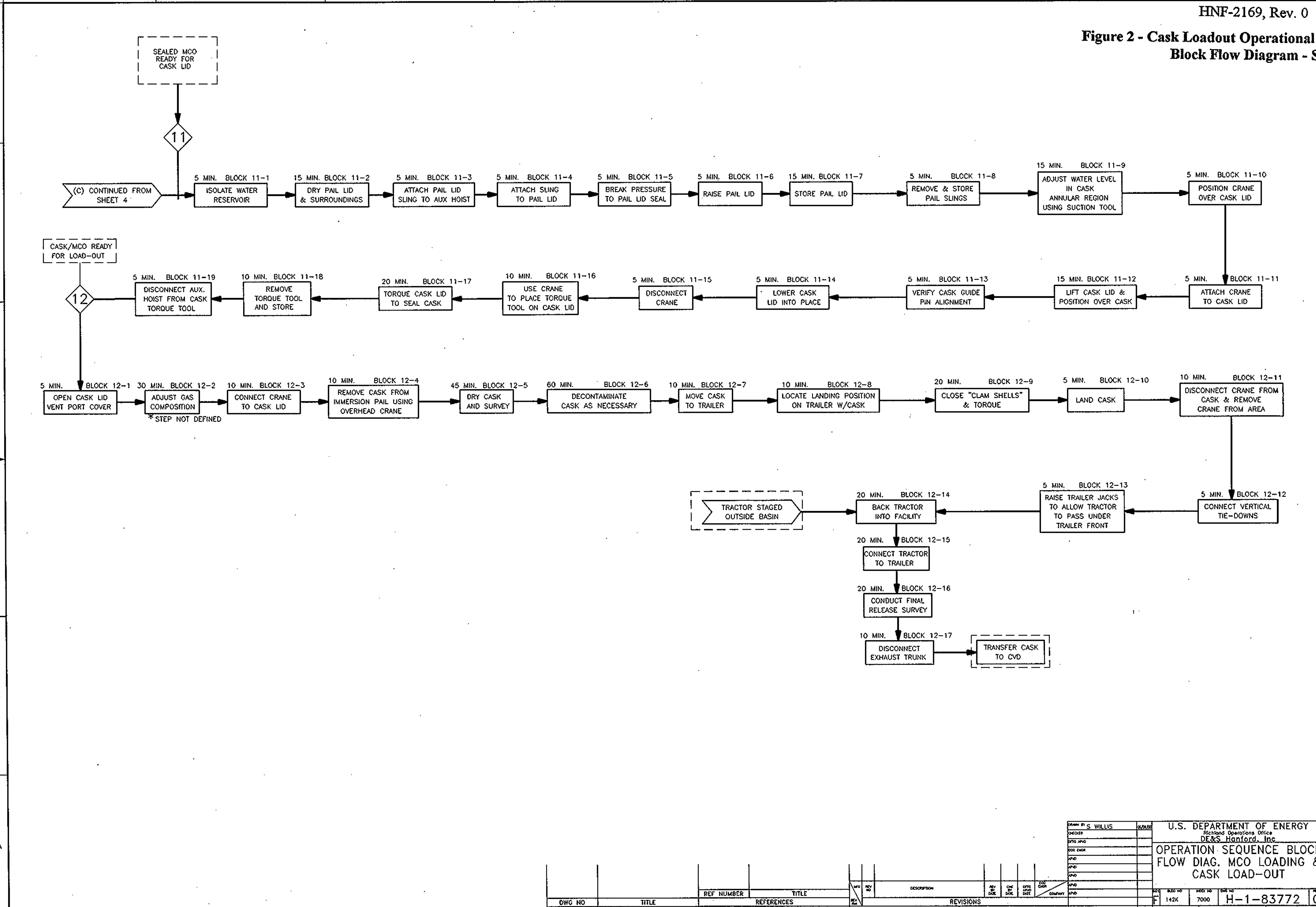


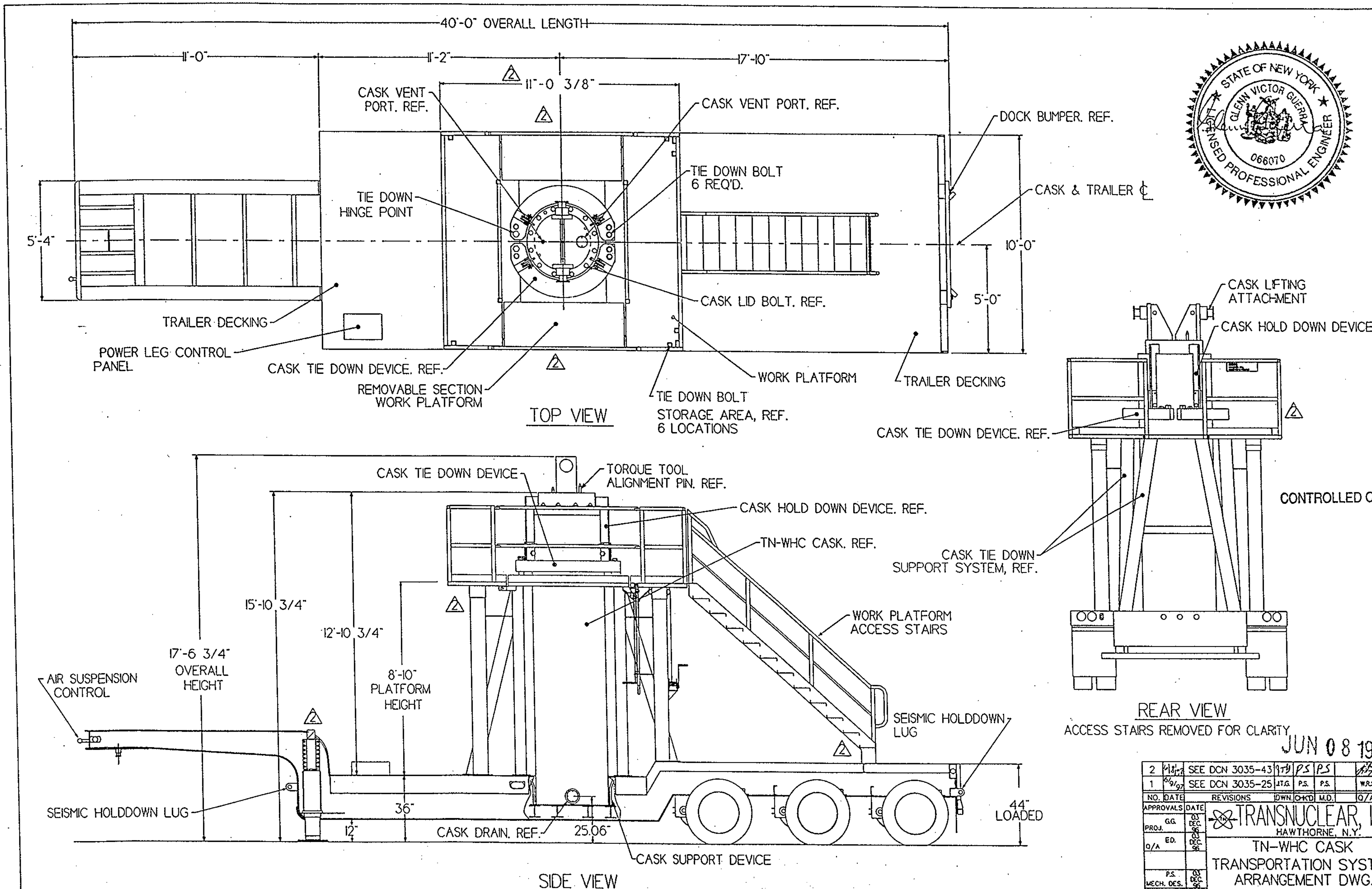
Figure 3 shows an assembly drawing of the transport trailer loaded with the MCO/Cask. The trailer has a design payload of 60,000 pounds, an overall length of 40 feet, and an overall width of 10 feet. The ground clearance is 12 inches, and the goose neck clearance is 96 inches to the tractor. The loaded deck height is 36 inches at the front end, and the loaded fifth wheel height (at the back) is 44 inches. The tri-axle semi trailer is equipped with air brakes and air ride suspension. Hydraulic-powered legs are provided to facilitate tractor coupling and uncoupling. Attachment points for seismic restraints have been included in the trailer design; however, seismic restraints will not be used in the K Basins.

The tie down system for the cask/MCO assembly is a fixed system that is an integral part of the conveyance system. Approximately 118 inches above the deck of the trailer, the cask is secured by a cask tie down device mounted onto a fixed frame of constructed of structural tube members and braced to the trailer deck with four structural tube members. The tie down system is constructed of rectangular structural steel tubing frame, which is welded to the transport trailer bed. The cask tie down device is designed as a hinged clamshell ring where each half section pivots about a fixed 1.5-inch hinge pin and secured with three 1.5-inch hex head bolts. The inside diameter of the clamping ring is constructed of 6061-T6 aluminum and equipped with a Neoprene gasket which forms a tight fit with the cask. Attached to the clamping ring are four cask hold-down brackets, equally spaced around the circumference, which restrain vertical movement of the cask. While within the cask tie down device, the cask rests in a vertical position with the bottom of the cask recessed in a section of the main deck.

The transport cask assembly drawing is shown in Figure 4. The cask is a vertical, cylindrical, stainless steel vessel with an outside diameter of approximately 40 inches, and a height of approximately 170 inches. The overall packaging assembly, including the lifting device, has an outside diameter of approximately 44 inches and an overall height of 190 inches. The cask cavity has an inside diameter of 25 inches and is 160 inches tall. The cask consists of a forged 7 inch (approximately) thick, 170 inch long stainless steel cylinder with an integrally welded stainless steel bottom head that is 6 inches thick (Edwards 1997).

The cask lid, also shown in Figure 4, is a stainless steel forging with a 3.5 inch thick top and 3 inch sides, an outer diameter of 35.5 inches, an inner diameter of 25.5. inches, and a height of 11 inches. The lid has a 4 inch tall, 4 inch wide flange at its base, making the lid diameter 40 inches at the flange. The base of the lid has a dovetail groove whose inner diameter is 4 inches from the base exterior. The interior of the lid base also has a 2 inch wide, 1 inch tall notch that mates with a similar-sized extension in the cask shell. The lid is bolted to the cask body with twelve 1.5-inch diameter bolts, which are arranged on a circle with a 36 inch diameter. A single Butyl rubber o-ring seal (trademark of Dewitt Products) forms the containment boundary between the cask body and lid. Lid installation is guided by two alignment pins that are integral to the cask body (Edwards 1997). Two lifting brackets are welded to the cask lid for lifting the cask and the lid. The brackets protrude 20 inches from the lid surface, and a 4 inch diameter trunnion is welded to each bracket.

Figure 3 - Transport System Arrangement



CONTROLLED COPY #: 3

JUN 08 1998

NO.	DATE	REVISIONS	DWN.	CHK'D	M.O.	Q/A	PROJ.
2	1/8/97	SEE DCN 3035-43	JTG	PS	PS		
1	6/9/97	SEE DCN 3035-25	JTG	PS	PS	WRS	GG

APPROVALS		DATE
PROJ.	GG	DEC. 96
Q/A	ED.	DEC. 96
MECH. DES.	PS	DEC. 96
CHK'D. BY	PS	DEC. 96
	JTG	DEC. 96

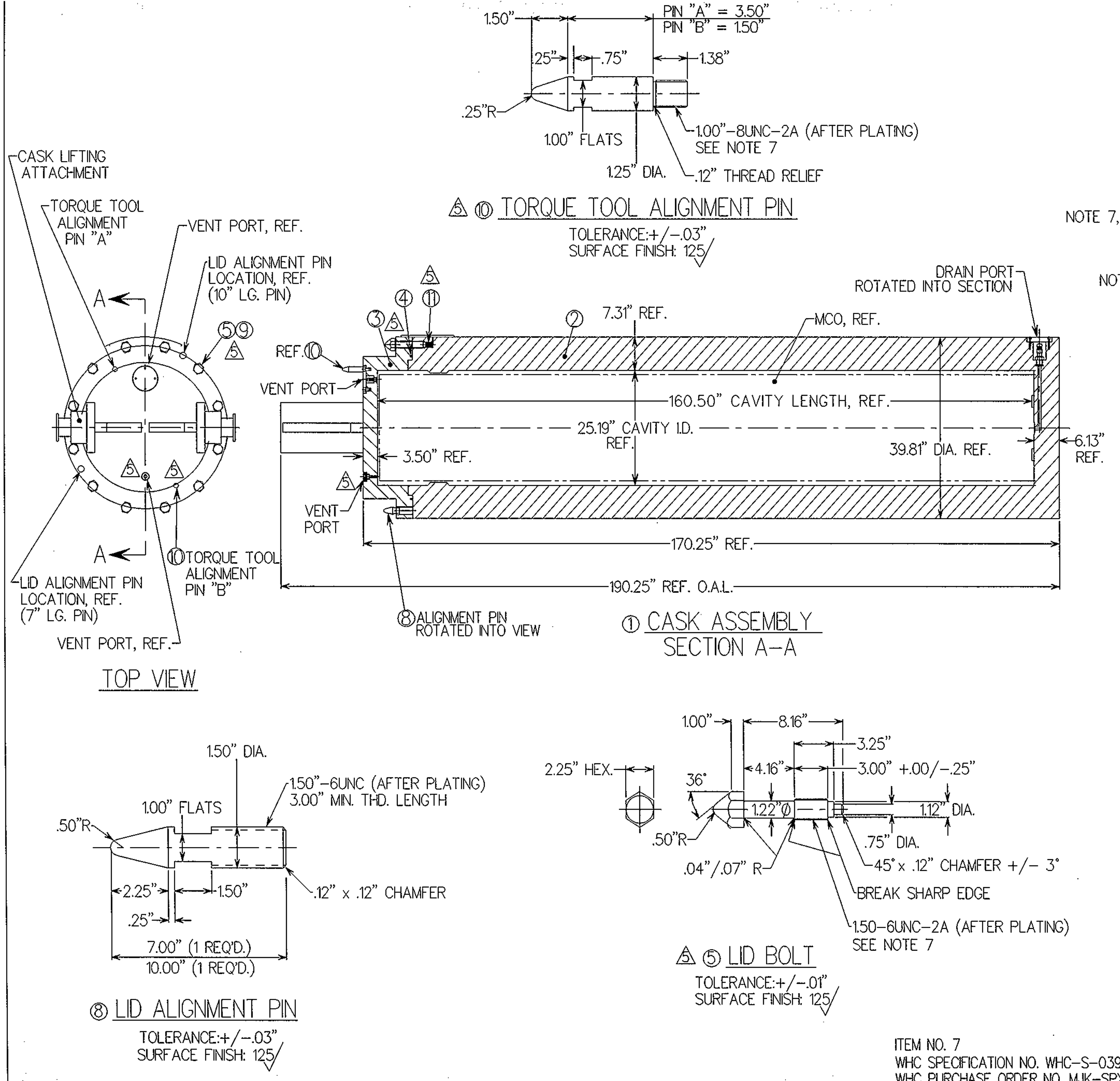
TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.

TN-WHC CASK TRANSPORTATION SYSTEM ARRANGEMENT DWG.
WHC DWG. NO. H-1-81533

NONE | B | 3035-1 | 2

ITEM NUMBER 7
WHC SPECIFICATION NUMBER WHC-S-0396

Figure 4 - Transport Cask Assembly



ITEM NO. 7
WHC SPECIFICATION NO. WHC-S-0396
WHC PURCHASE ORDER NO. MJK-SPX-452727

	4	1	O-RING SEAL	PARKER .275"DIA. XSECT. X 31.31"I.D. BUTYL # 8612 70 OR EQUIV.
NOTE 7	5	12	LID BOLT	SA-479-XM19 HOT ROLLED OR EQUIV.
	6		DELETED	
	7		DELETED	
NOTE 7, NOTE 4 *	8	2	LID ALIGNMENT PIN	SA-193-B8 OR EQUIV.
	9	12	WASHER	1.50" DIA. FLAT, SST
△5 *	10	2	TORQUE TOOL ALIGNMENT PIN	300 SERIES SST
NOTE 9 △5	11	12	BOLT SPRING	COMPRESSION, LEE P/N LC 105M 10 S MD NR OR EQUIV.

NOTES:

1. DELETED
2. DELETED
3. DELETED
4. * INDICATES NON SAFETY RELATED ITEM.
5. THIS PARTS LIST IS FOR SHEET 1 ONLY.
6. △5 TORQUE REQUIREMENTS:
   LID BOLTS: 300 FT. LBS. ± 10 FT. LBS.
   VENT & DRAIN PORT COVER SCREWS:
   15 FT. LBS. ± 3 FT. LBS.
   ALIGNMENT PINS: 40 FT. LBS. ± 5 FT. LBS.
   TORQUE TOOL ALIGNMENT PINS: 40 FT. LBS. ± 5 FT. LBS.
7. LID BOLTS & ALIGNMENT PINS TO BE CHROMIUM PLATED (THREADS ONLY) PER QQ-C-320-B, CLASS 2, TYPE 1 (.0002" MIN. THK.) BOLT TO BE INSPECTED TO NB-2580 OF ASME B & PV CODE, SECTION III, INCLUDING VT (VISUAL EXAMINATION) & LP (LIQUID PENETRANT EXAMINATION), BEFORE PLATING.
8. LUBRICATE BOLTS WITH NEOLUBE AS NEEDED.
9. △5 SUPPLIED BY OTHERS.

NO.	DATE	REVISIONS	DWN.	CHK'D.	M.D.		Q/A	PROJ.
5		SEE DCN 3035-27						
4	12/03/96	SEE DCN 3035-14	J.T.G.	P.S.	P.S.		E.D.	G.G.
3	10/18/96	SEE DCN 3035-11	J.T.G.	P.S.	P.S.		E.D.	G.G.
2	9/30/96	SEE DCN 3035-6	J.T.G.	P.S.	P.S.		E.D.	G.G.
1	8/6/96	SEE DCN 3035-1	J.T.G.	P.S.	P.S.		E.D.	G.G.

APPROVALS	DATE	
G.G. PROJ.	24 JUNE 96	TRANSNUCLEAR, INC. HAWTHORNE, N.Y.
E.D. Q/A	24 JUNE 96	TN-WHC CASK TRANSPORTATION SYSTEM ASSEMBLY & PARTS LIST WHC DWG. NO. H-1-81535
P.S. MECH. DES.	21 JUNE 96	
P.S. CHK'D. BY	21 JUNE 96	
J.T.G. DWN. BY.	21 JUNE 96	NONE SCALE / B SIZE / 3035-3 DWG. NO. / 5 REV.

SHEET 1 OF 6

The cask, with lid installed, has two vent ports and one drain port. The centers of the vent ports are located 5 inches from the exterior rim of the cask lid, while the drain port is positioned in the side of the cask body, 4 inches from the bottom. The drain port is closed with quick-disconnect couplings having an inside diameter of 0.63 inches. The drain port is covered by a 6 inch diameter, 0.75 inch thick cover that is bolted onto the cask with four 0.5 inch bolts. An alternate drain cover may also be used. The alternate drain port cover is also 0.75 inch thick and uses four 0.5 inch bolts, but has a 3 inch long, ¼ inch thick "snout" that projects into the drain port cavity to ease installation. One vent port is closed with a quick-disconnect coupling approximately 0.5 inch in diameter, which is covered by a 6 inch diameter, ¾ inch thick cover that is bolted to the lid with four ½ inch bolts. The other vent port is closed with a brass socket head cap screw, ½ inch in diameter, and is covered by a ¾ inch thick cover that is threaded into the lid with a 0.5 inch deep "snout". All ports or their cover plates utilize Butyl rubber o-ring seals as the containment boundary (Edwards 1997).

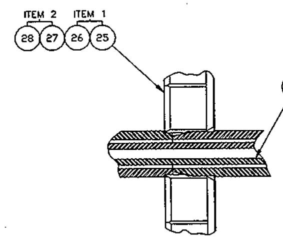
As shown in Figure 5, the MCO is a vertical, cylindrical stainless steel container used to retain spent fuel. The overall dimensions of the MCO are 24 inches in diameter by 160 inches tall. The wall thickness is 0.5 inch. The shell is welded to a stainless steel bottom forging 24 inches in diameter. The bottom plate is 2 inches thick with a center area approximately 0.88 inch thick, forming a deep pocket that minimizes residual water after draining. A 10.5 inch shielding thickness shield plug (overall height approximately 16 inches) is inserted into the top of the MCO. The shield plug has a 4 inch wide, 7 inch tall annular section cut out of the top, for MCO locking and lifting ring placement. The locking and lifting ring is threaded on the outside, mating with threads on the interior of the MCO shell collar. Eighteen 1-1/2 inch jack bolts penetrate the locking and lifting ring to further compress the MCO seal. The top of the shield plug has four penetrations which connect to appliances and plug valve actuators that are used for fuel drying inside the MCO and other purposes. The ports are described on Note 10 of H-2-828045, Sheet 1. For shielding purposes, all four penetrations have double bends as they penetrate the shield plug (Edwards 1997).

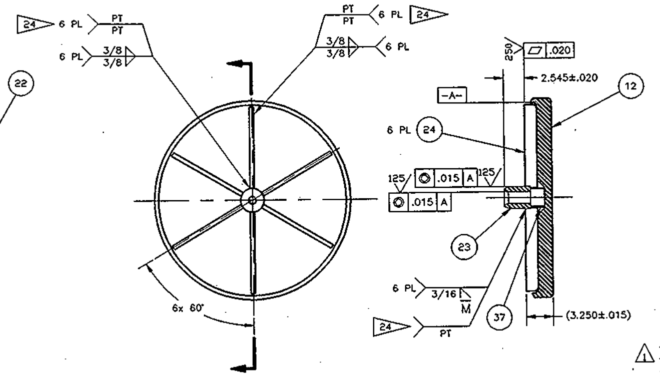
The MCO Shield Plug, seen in Figure 6, is a multi functional component of the MCO, providing confinement, containment, and axial shielding during various stages of the SNF conditioning process. The shield plug also retains the main MCO seal. The shield plug has a maximum diameter of 24 inches, and a shielding thickness of 12 inches of steel. The process ports are 5.5 inches in diameter. The ports, shown in Figure 5, function as follows (Goldmann 1998a):

1. Port One is a multifunction port which utilizes a threaded connection that will be plugged. It connects with a one inch penetration to the internal HEPA filter bank. The port cover plate has a four bolt pattern.

2. Port Two connects with a one inch penetration to the internal HEPA filter bank with a process plug valve. The shield port cover has a four bolt pattern. This port is primarily for vacuum process exhaust. The port cover plate has a four bolt pattern.

Figure 5 - Multi-Canister Overpack Assembly





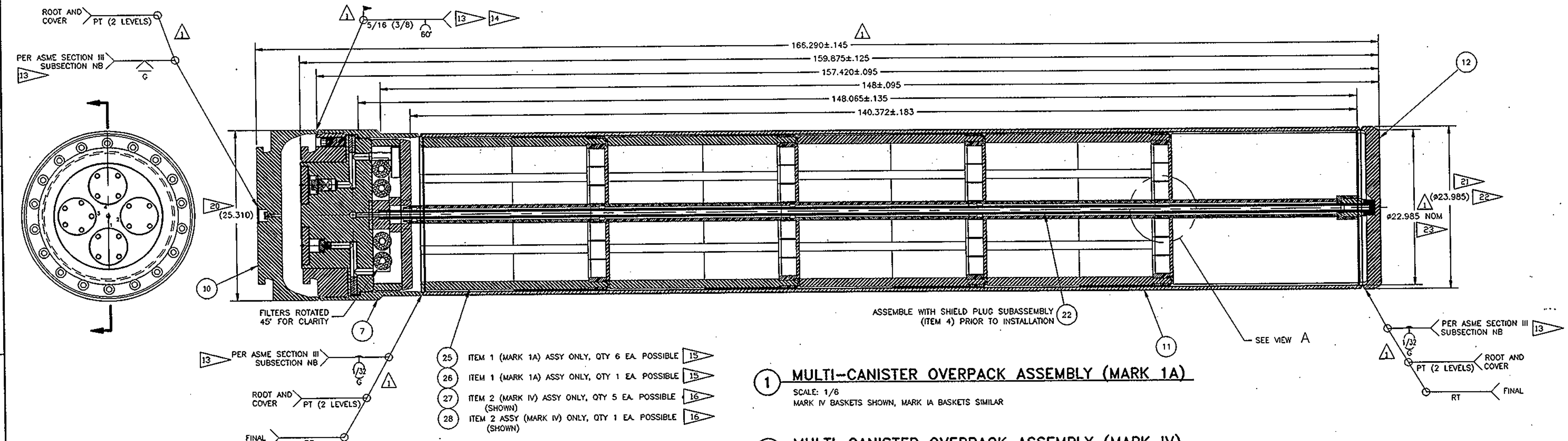
GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL DIMENSIONING AND TOLERANCING ARE IN ACCORDANCE WITH ANSI Y14.5M-82. DIMENSIONS ARE IN INCHES AND APPLY AT 72°F UNLESS OTHERWISE SPECIFIED.
2. UNSPECIFIED TOLERANCES SHALL BE:
   DECIMAL: .X= ±.060, .XX= ±.030, .XXX= ±.015
   FRACTIONAL: ±1/16
   ANGULAR: ±1/2°
   COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN ø.003.
3. UNSPECIFIED TOOL RADII SHALL BE .03 MAX.
4. SURFACE TEXTURES SYMBOLS ARE IN ACCORDANCE WITH ASME Y14.36-96. SURFACE TEXTURE VALUES ARE IN MICROINCHES PER ASME B46.1-95. ALL UNSPECIFIED MACHINED SURFACES SHALL BE 125 OR BETTER.
5. BREAK ALL SHARP EDGES & REMOVE ALL BURRS.
6. WELDING SYMBOLS ARE IN ACCORDANCE WITH ANSI/AWS A2.4-93.
7. WELDING AND NDE SHALL BE IN ACCORDANCE WITH ASME B & PV CODE 1995 EDITION, SECTION III, DIVISION 1, SUBSECTION NB (WITH THE EXCEPTION OF ITEM NOS. 37 AND 39). FULL PENETRATION WELDS AND WELD DETAILS MAY BE SUBMITTED FOR APPROVAL AND USED PENDING WRITTEN CONSENT OF THE BUYER.
8. MATERIALS, FABRICATION, WELDING AND INSPECTION SHALL BE IN ACCORDANCE WITH ASME SECTION III, DIVISION 1, SUBSECTION NB OR NG AS INDICATED BY SPECIFIC COMPONENT DRAWING.
9. ~~WHEN ASSEMBLED, THE TOP OF THE LOCKING & LIFTING RING (ITEM 8) SHALL BE A MINIMUM OF 1/8" BELOW THE TOP OF THE SHIELD PLUG (ITEM 13).~~ (1)

GENERAL NOTES CONTINUED ON SHEET 2, ZONE F4.

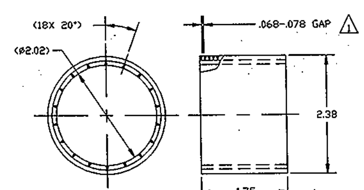
QTY REQD -040	-030	-020	-010	PART NO.	DESCRIPTION		ITEM
			X	-010	MULTI-CANISTER OVERPACK ASSY (MARK IA)	1	1
		X		-020	MULTI-CANISTER OVERPACK ASSY (MARK IV)	1	2
	X	1	1	-030	SUBASSEMBLY, BOTTOM PLATE	1	3
X		1	1	-040	SUBASSEMBLY, SHIELD PLUG	2	4
							5
							6
1				H-2-828042-001	CANISTER COLLAR		7
1				H-2-828042-002	LOCKING & LIFTING RING		8
18				H-2-828042-003	SET SCREW		9
		1	1	H-2-828042-010	CANISTER COVER ASSEMBLY		10
		1	1	H-2-828043-001	SHELL		11
	1			H-2-828044-001	SHELL BOTTOM		12
1				H-2-828045-010	SHIELD PLUG ASSEMBLY		13
1				H-2-828046-001	GUARD PLATE		14
1				H-2-828046-002	GUARD PLATE RING		15
2				H-2-828047-001	PROCESS VALVE		16
1				H-2-828047-010	PROCESS VALVE/RUPTURE DISK ASSEMBLY		17
3				H-2-828048-010	4 HOLE COVER PLATE ASSEMBLY		18
1				H-2-828048-020	5 HOLE COVER PLATE ASSEMBLY		19
1				H-2-828049-001	INTERNAL HEPA FILTER ASSEMBLY		20

FOR CONTINUATION SEE SHEET 2 ZONE F2



1 MULTI-CANISTER OVERPACK ASSEMBLY (MARK 1A)
SCALE: 1/6
MARK IV BASKETS SHOWN, MARK IA BASKETS SIMILAR

2 MULTI-CANISTER OVERPACK ASSEMBLY (MARK IV)
SCALE: 1/6
MARK IV BASKETS SHOWN



37 FILTER SCREEN
SCALE: FULL

DWG NO	TITLE		
		H-2-828040	DRAWING INDEX
		REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	END ITEM

REFERENCES

REV	DESCRIPTION	DATE
1	General Revision per ECN 648626	7/9/98

REVISIONS

CADFILE B828041A CADCODE WIN95:ACD2:14.0:SS

BT BECKER; JD OSTERLOH; N/A R BASTAR; G PARKER (QA); C TEMUS (CM); R BASTAR (PM)

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
Duke Engineering & Services Hanford, Inc.

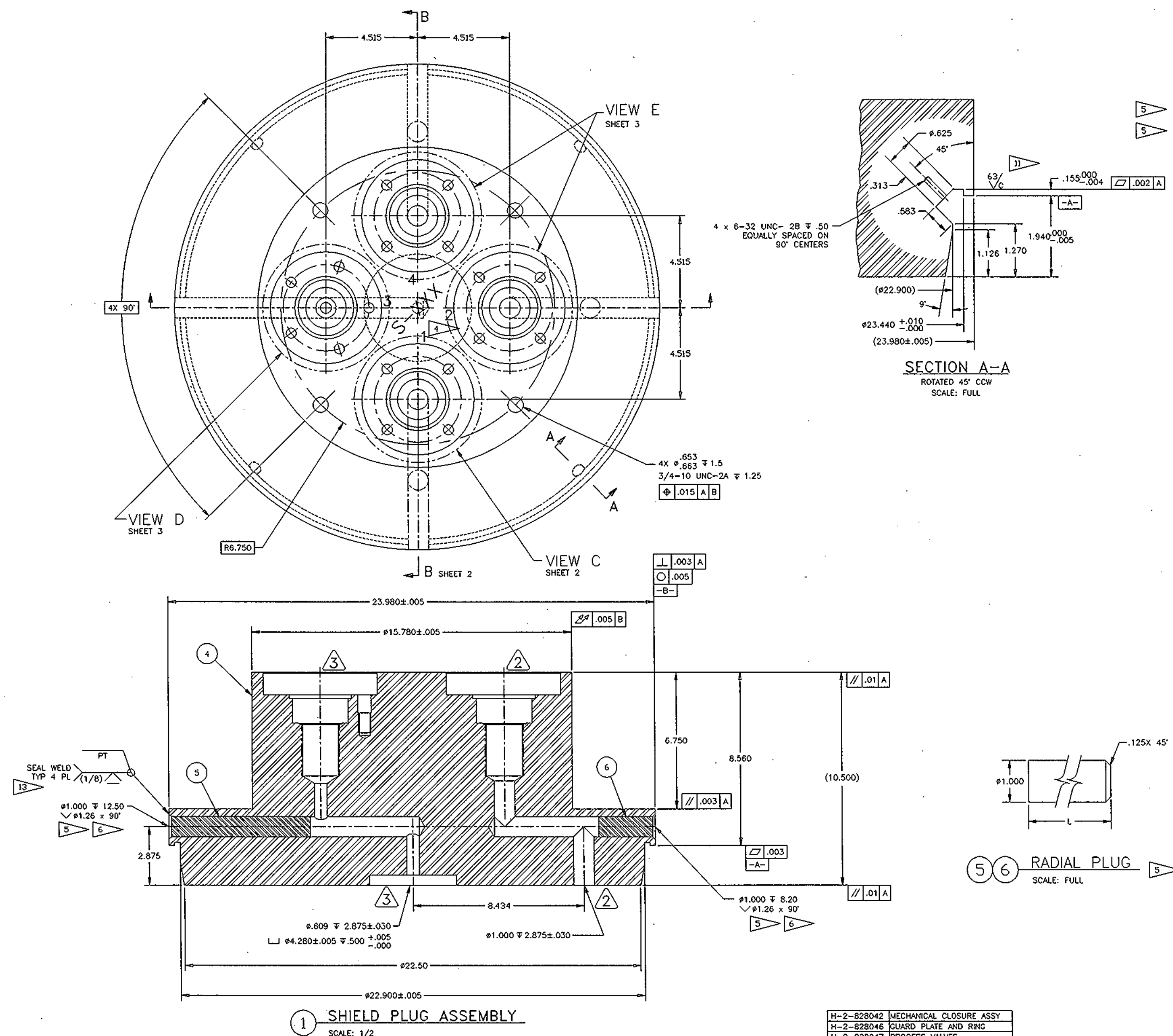
MULTI-CANISTER OVERPACK ASSEMBLY

F 212-H 3902 H-2-828041 1

PARSONS I. & T. INC. SHOWN SHEET 1 OF 3

2 PLOT SCALE: 1=1 1 GTITLE.DWG (10/96)

Figure 6 - MCO Shield Plug



QTY REQD -020	-010					
						2
						3
	1	-001	SHIELD PLUG	SA 182 F304L SST	1	4
	1	-002	RADIAL PLUG, ⌀1.00X 6.9 L		1	5
	3	-003	RADIAL PLUG, ⌀1.00X 2.7 L		1	6
						7

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL DIMENSIONS ARE IN INCHES. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-94. TOLERANCES: DECIMAL: .X= ±.060 .XX= ±.030 .XXX= ±.015 ANGLES: ±1/2° ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN ⌀.003.
2. REMOVE ALL BURRS. BREAK SHARP EDGES.
3. ALL MACHINED SURFACES SHALL BE 125 OR BETTER PER ASME B46.1-95.
4. IDENTIFY PER FABRICATION SPECIFICATION HNF-S-0453 IN APPROXIMATE LOCATION SHOWN.
5. FABRICATOR MAY USE DOWEL OR THREADED PLUG PER SA-240 OR SA-479 304L STAINLESS STEEL TO FACILITATE WELD. IF DOWEL IS USED, MATE PARTS IN ACCORDANCE WITH A LC4 CLEARANCE LOCATIONAL FIT, ANSI B4.1-67 (R94).
6. COUNTERSINK AS REQUIRED FOR .125 MIN WELD PREP.
7. MATERIALS, FABRICATION, WELDING AND INSPECTION SHALL BE IN ACCORDANCE WITH ASME SECTION III, DIVISION 1, SUBSECTION NB.
8. ADDITIONAL FABRICATION REQUIREMENTS ARE IN HNF-S-0453, FABRICATION SPECIFICATION FOR MULTI-CANISTER OVERPACK.
9. PIECE/PART TOLERANCES ON THESE DRAWINGS SHOULD LEND TO ACCEPTABLE ASSEMBLY GEOMETRIES. ALTERNATE PIECE/PART TOLERANCES MAY BE UTILIZED WITH THE BUYER'S APPROVAL. ACCEPTABLE FINAL ASSEMBLY GEOMETRIES ARE SHOWN IN THE FABRICATION SPECIFICATION'S CRITICAL DIMENSION TABLES/SKETCHES. IN THE EVENT THAT THERE IS A CONFLICT BETWEEN THE CRITICAL DIMENSION TABLES/SKETCHES AND THE DESIGN DRAWINGS, THE BUYER SHALL BE NOTIFIED FOR RESOLUTION.
10. PROCESS PORTS ARE AS FOLLOWS:
    1. PLUG/INTERNAL FILTER ASSEMBLY.
    2. FILTERED PROCESS.
    3. LONG PROCESS TUBE.
    4. PROCESS VALVE/RUPTURE DISK.
11. THE SEALING FACE MUST BE LATHE TURNED. THE USE OF EMERY CLOTH IS LIMITED TO TOUCHING UP MINOR ACCIDENTAL DEFECTS AND MUST BE PERFORMED BY RUBBING IN LINE WITH THE LAY OF THE TOOL MARKS.
12. DRILL, TAP AND COUNTER BORE DEPTHS AS WELL AS PROJECTED TOLERENCING ARE REFERENCED FROM DATUM PLANES "C", "E", AND "G".
13. SHIELD PLUG CIRCUMFERENCE AFFECTED BY RADIAL PLUG WELDS MAY BE RECESSED UP TO .060.

REF NUMBER	TITLE
H-2-828042	MECHANICAL CLOSURE ASSY
H-2-828046	GUARD PLATE AND RING
H-2-828047	PROCESS VALVES
H-2-828048	PROCESS PORT FLANGES
H-2-828049	INTERNAL FILTER ASSY
H-2-828050	BASKET STABILIZER EXTENSION
NEXT USED ON	H-2-828041

REFERENCES — DRAWING TRACEABILITY LIST — REVISIONS — CADFILE B828045A — CADCODE WIN95:ACD2:13.0:SS

DRAWN BT BECKER; CHECKED JD OSTERLOH; N/A R BASTAR; G PARKER (QA); C TEMUS (CM); R BASTAR (PM); PARSONS I & T, INC.

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
Duke Engineering & Services Hanford, Inc.

MCO MECHANICAL CLOSURE SHIELD PLUG

F 212-H 3902 H-2-828045 REV 1 — SCALE: SHOWN — SHEET 1 OF 3 — PLOT SCALE: 1=1 — GTITLE.DWG (10/96)

3. Port Three connects with a 0.54 inch diameter axial process tube, and has a process plug valve. The flange cover has a five bolt cover flange and sealing surface that mates with the operator tool. This port is primarily for bulk water removal and is 2 mm screened.

4. Port Four connects to a 2 mm screened short process tube through a one inch diameter connection. The process plug for this port has a one inch rupture disk built into the upper portion. The rupture disk is replaceable by changing the process plug. The rupture disk is sandwiched between the top and bottom of the plug. This assembly is welded together such that the rupture disk is also welded to the bottom of the plug. The cover flange has a four hole pattern that can contain either a blind flange for sealing or a flange with a 1 inch or 1/4 inch orifice. This port also serves as a backup to Port #2 as an unfiltered process exit port.

Ports 2 - 4 have a hollow, cross-drilled, threaded plug that seals when fully engaged, but allows flow when the plug is turned out until the cross-drilled holes are exposed and the seal disengaged; the metal seal can reseal over 10 times (verified through testing, guaranteed for 5 times) when the plug is torqued into place. All the cover plates have capture bolts which allow for remote removal and installation of the covers. The cover plates use a metal C-seal that requires a relatively low sealing pressure and has a slightly eccentric shape which snaps to the cover plate, facilitating remote handling.

The primary seal for the MCO seals the MCO shell to the shield plug. The primary seal is a Helicoflex seal comprised of a high strength alloy spring covered with a 300 series stainless steel jacket encompassed by a silver outer jacket. The seal is held in place with four stainless steel clips that are secured to the shield plug. This seal, when properly preloaded (recommended minimum value of 1700 pounds per inch of seal), will maintain a leak tight condition. The seal is similar to the standard mechanical seals approved by the NRC for dry fuel storage.

The preload on the seal is maintained using a locking ring and jacking bolt arrangement. The locking ring is a stainless steel forging that is threaded into the buttress threads on the MCO collar after the MCO is removed from the pool. This ring provides a grapple interface for MCO handling and support for the jacking bolts that preload the shield plug and the seal. Eighteen SA-193 B8S 1-1/2 inch set screws are threaded into the locking ring. The screws serve as jacking bolts to preload the seal and were sized to maintain the appropriate preload throughout the operating temperature range while not allowing the joint components to yield. An integral compression limiter in the shield plug sets the strain on the seal.

The baskets of fuel and scrap received from the fuel retrieval system have slightly different designs based on enrichment of the fuel which they contain. Two series of storage baskets exist: the Mark 1A higher enrichment storage baskets, and the Mark IV storage baskets. Each series is comprised of a fuel basket and a scrap basket. The Mark 1A storage baskets are designed to accommodate fuel assemblies that are 20.91 inches long and 2.40 inches in diameter; Mark IV storage baskets accommodate fuel assemblies 26.1 inches long and 2.42 inches in diameter.

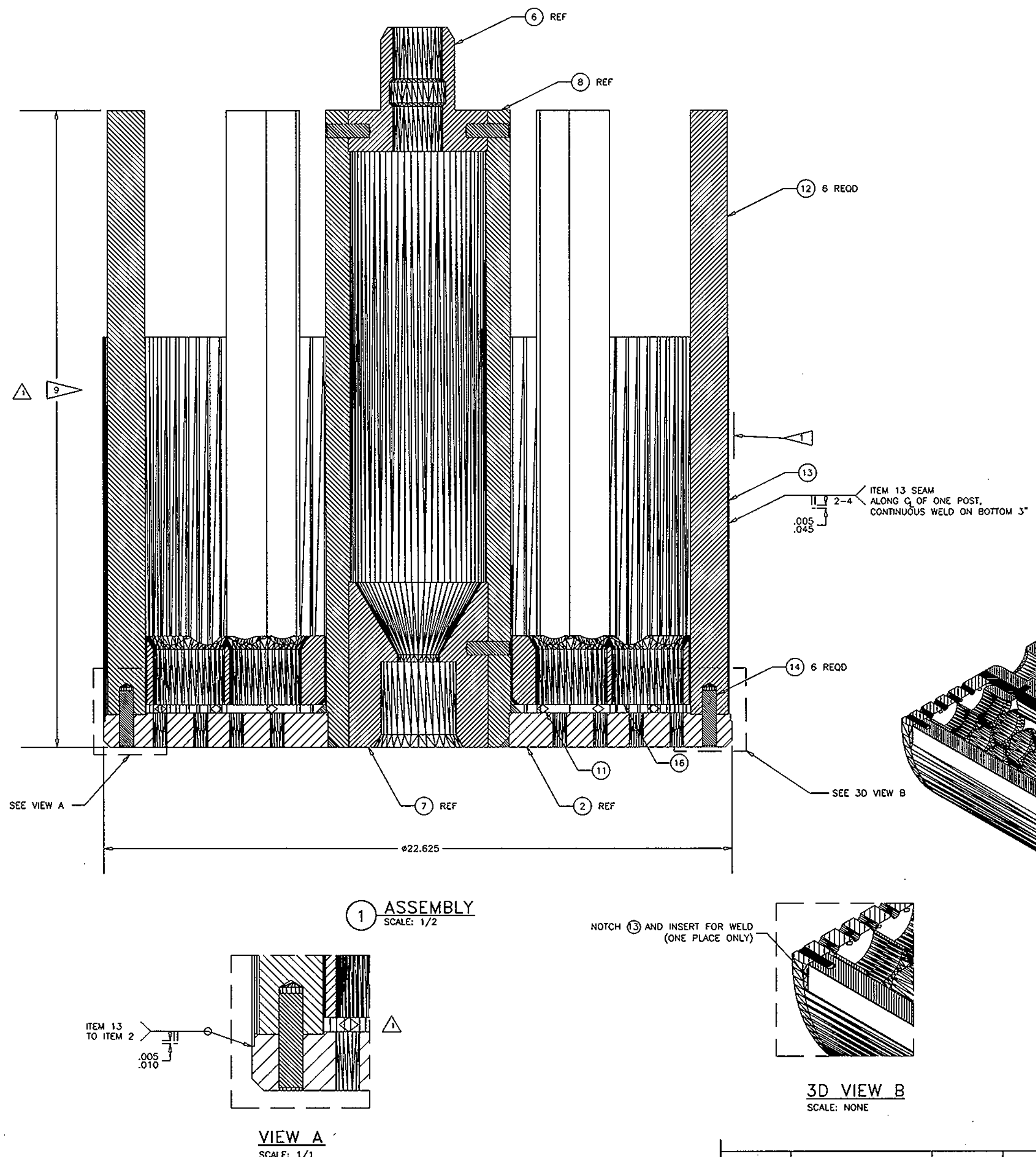
The Mark 1A storage baskets, Figure 7, consist of a center six inch pipe welded to a bottom support plate with six support rods at the periphery of the plate. The center pipe and six support rods (parallel to the center pipe) make up the main basket structural members. The basket also has a sheet metal shroud enveloping the six support rods and an aluminum fuel rack plate in the bottom to help position the fuel during handling; the rack plate has 48 holes to receive the fuel. Between the bottom plate and the rack plate is a layer of expanded metal to keep the fuel from resting directly on the plate effecting draining and circulation. The expanded metal layer prevents gas flow blockage through the ½ inch diameter holes in the bottom support plate. Neither the expanded metal nor the spacer plate are connected to the support plate, minimizing the bending moment couple loading to the bottom plate during a side drop accident. The six support rods on the periphery of the plate are trapezoidal in shape and the length is toleranced so that they share the load with the center tube during axial loading. This is done to ensure that the bottom plate is not deformed significantly and can still support the center pipe during a horizontal drop following a vertical drop. All of the structural members of the Mark 1A basket are designed to meet ASME Section II Subsection NG requirements, supplemented by criticality control deformation limits from the Performance Specification (Goldmann 1998b).

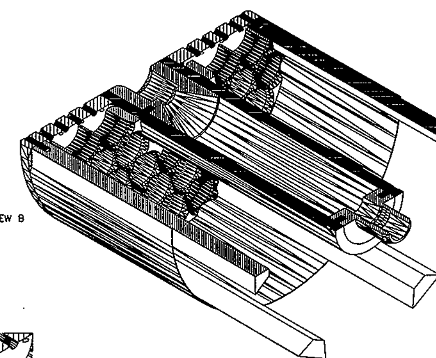
The Mark 1A scrap basket, shown in Figure 8, is similar to the Mark 1A storage basket in design, criticality control, and ASME code requirements. The major difference is that the copper shroud extends the full length of the support rods, and there is no aluminum positioning plate or expanded metal on the support plate. In addition, the shroud is copper for heat transfer purposes, rather than stainless steel. There are also six dividers that create compartments in the basket cavity. Flow restrictors are provided to direct adequate gas flow.

The Mark IV storage basket is designed to hold up to 54 intact Mark IV fuel assemblies and are made of 304L stainless steel. The Mark IV, however, has no deformation limits for criticality control, and no resultant requirements except self support and lifting requirements of ANSI N14.6. The basket has a 2.75 inch diameter center tube that is connected to a spacer plate; the spacer plate consists of a plate with 54 holes for the fuel, and 3/8 x 1/4 inch bars to support the fuel at the bottom of the plate. The basket is supported by the center tube and six 1-1/4 inch diameter round bars, and has an 11 inch high non-structural shroud to help in handling fuel. The basket is lifted by a groove on the interior of the center tube; the center tube extends above the support rods and up into the basket above. This coupling aids in the basket stability and the insertion of the process tube through the center of the basket.

The Mark IV scrap basket is designed to handle damaged Mark IV fuel. The scrap basket design includes a 2.75 inch diameter center tube that connects to a 1 1/4 inch thick plate perforated with ½ inch diameter holes. The basket has a full height copper shroud connected to six divider plates. The shroud and divider plate provide some support to the baskets above as well as to the bottom

Figure 7 - Mark 1A Storage Basket





PART/MATERIAL LIST

	QUANTITY REQUIRED -040	-030	-020	-010	PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO.
				X	-010	ASSEMBLY		1	1
			X	1	-020	SUBASSEMBLY, CENTER POST & BASEPLATE		2	2
		X	1		-030	SUBASSEMBLY, CENTER POST		2	3
									4
									5
△1		1			-006	CENTER COUPLING, BAR ROUND, CENTERLESS GROUND TO ⌀5.0012 – 5.0019 X 4.5 L	SA-479 304L SST	3	6
△1		1			-007	CENTER BUSHING, BAR ROUND, CENTERLESS GROUND TO ⌀5.0012 – 5.0019 X 6 L	SA-479 304L SST	3	7
		1			-008	CENTER POST, PIPE 6" SCHD XXS, SMLS (.800 MIN WALL)	SA-312 DUAL CERT TP 304/304L SST	3	8
			1		-009	BOTTOM PLATE, APPROX. ⌀24 X 1.25 THK	SA-240 304L SST	4	9
									10
				1	-011	SPACER, AL 5005H-34 EXPANDED METAL APPROX. .300 THK	RYERSON STYLE 3/4 NO. .081 HVY	5	11
△1				6	-012	OUTSIDE POST, CUSTOM TRAPEZOID	SA-479 OR SA-240 304N SST	5	12
				AR	-013	SHROUD, SHEET METAL 18 GA, APPROX. 14 X 71 L X .048 THK	ASTM A-240 304L SST	1	13
				6	-014	.500 COILED SPRING PIN, 2.0 LONG, STANDARD OR HEAVY DUTY	SAE J405 (30302) OR (30304) ANSI/ASME B18.8.2-94	–	14
		5			-015	.500 COILED SPRING PIN, 1.5 LONG, STANDARD OR HEAVY DUTY	SAE J405 (30302) OR (30304) ANSI/ASME B18.8.2-94	–	15
△1				1	-016	FUEL RACK, WROUGHT OR CAST ALUMINUM PLATE, APPROX. ⌀24 X 2.5 THK	ASTM B-209 6061-T651 OR B-26 A03560-T6 AL	4	16

GENERAL NOTES:

1. ALL PARTS AND MATERIAL AS SPECIFIED OR ENGINEERING APPROVED EQUAL.
2. △1 ABBREVIATIONS ARE IN ACCORDANCE WITH ANSI/ASME Y1.1-89.
3. △1 WELDING SYMBOLS ARE IN ACCORDANCE WITH ANSI/AWS A2.4-93.
4. △1 SURFACE TEXTURE SYMBOLS ARE IN ACCORDANCE WITH ANSI/ASME Y14.36-96. SURFACE TEXTURE VALUES ARE IN MICROINCHES AND ARE IN ACCORDANCE WITH ANSI/ASME B46.1-95.
5. △1 ALL UNSPECIFIED MACHINED SURFACES SHALL BE 250√ OR BETTER.
6. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
7. ALL UNSPECIFIED MACHINE TOOL RADII SHALL BE .03 MAXIMUM.
8. WELDED SURFACES SHALL BE SMOOTH AND UNIFORM IN APPEARANCE WITHOUT ABRUPT CHANGES IN CONTOUR.
9. △1 DIMENSIONING AND TOLERANCING SHALL BE PER ANSI/ASME Y14.5M-82. DIMENSIONS ARE IN INCHES AND APPLY AT 72°F UNLESS OTHERWISE SPECIFIED. UNSPECIFIED TOLERANCES SHALL BE:
   - –DECIMAL: .X ± .1, .XX ± .03, .XXX ± .010
   - –ANGULAR: ± 1°
   - –ALL IMPLIED 90° ANGLES SHALL BE PERPENDICULAR WITHIN THE GREATEST TOLERANCE OF THE LINEAR DIMENSION.
   - ~~–ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN ⌀.003 UNLESS OTHERWISE SPECIFIED.~~
10. APPROXIMATE WEIGHT = 397 LB.
11. FABRICATION, WELDING AND INSPECTION SHALL BE IN ACCORDANCE WITH ASME SECTION III DIVISION 1, SUBSECTION NG AND SECTION IX.
12. △1 MATE PARTS IN ACCORDANCE WITH, INTERFERENCE LOCATIONAL FITS PER ANSI/ASME B4.1-1967, R1994.
13. ADDITIONAL FABRICATION REQUIREMENTS ARE IN HNF-S-0453, FABRICATION SPECIFICATION FOR MULTI-CANISTER OVERPACK.
14. PIECE / PART TOLERANCES ON THESE DRAWINGS SHOULD LEND TO ACCEPTABLE ASSEMBLY GEOMETRIES. ALTERNATE PIECE / PART TOLERANCES MAY BE UTILIZED WITH THE BUYER'S APPROVAL. ACCEPTABLE FINAL ASSEMBLY GEOMETRIES ARE SHOWN IN THE FABRICATION SPECIFICATION'S CRITICAL DIMENSION TABLES / SKETCHES. IN THE EVENT THAT THERE IS A CONFLICT BETWEEN THE CRITICAL DIMENSION TABLES / SKETCHES AND THE DESIGN DRAWINGS, THE BUYER SHALL BE NOTIFIED FOR RESOLUTION.

SEE SHEET 2 FOR ADDITIONAL NOTES

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

REVISIONS

REV	DESCRIPTION		
1	REVISED PER ECN 654047, 645078, 645982, 645985, 645998 AND 648626	BTB	7/9/98

CADFILE: B828060A CADCODE: WIN95:ACD3:14.0:SS

DRAWN: J D OSTERLOH
CHECKED: Z SARGENT
DSGN: R BASTAR (PM)
C TEMUS
R BASTAR

U.S. DEPARTMENT OF ENERGY
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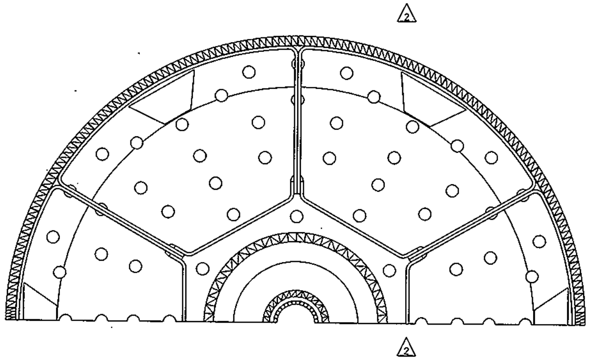
Duke Engineering & Services Hanford, Inc.

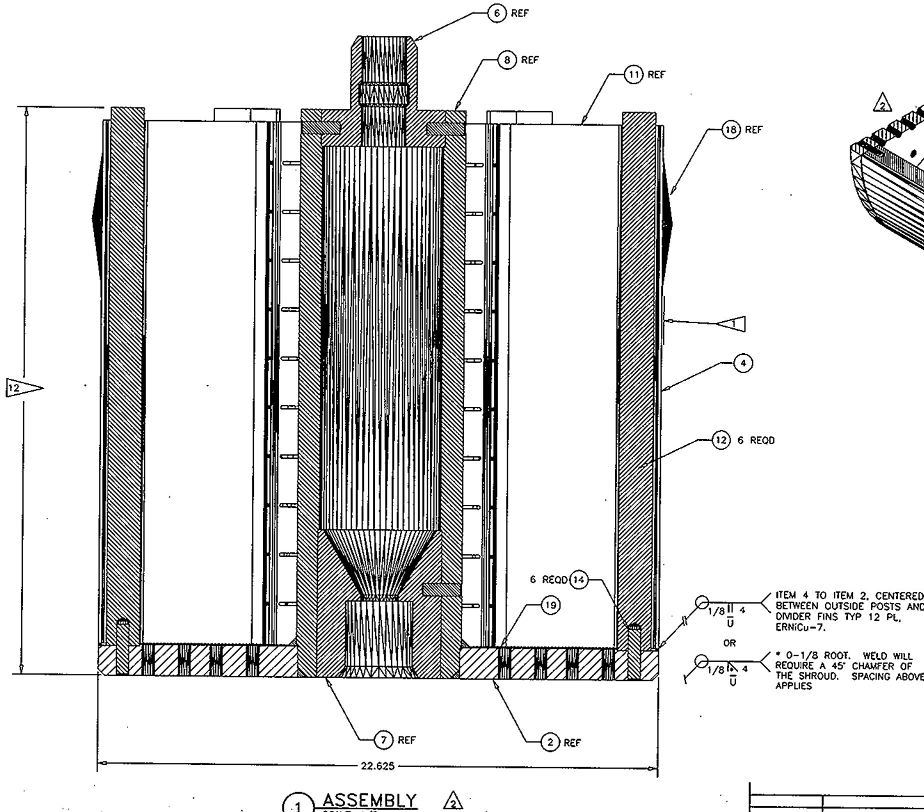
K-BASIN SNF STORAGE BASKET MARK 1A

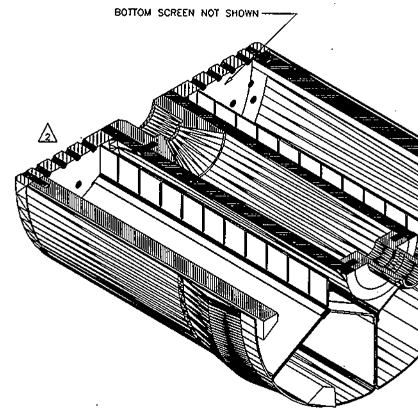
PARSONS I & T, INC.
SIZE F 212-H 3902 DWG NO H-2-828060 REV 1
SCALE: SHOWN SHEET 1 OF 5

DWG NO H-2-828060 SH 1 OF 5 REV 0A

Figure 8 - Mark 1A Scrap Basket







PART/MATERIAL LIST

QTY -040	QTY -030	QTY -020	QTY -010	PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO.
			X	-010	ASSEMBLY		1	1
		X	1	-020	SUBASSEMBLY, CENTER POST & BASEPLATE		2	2
	X	1		-030	SUBASSEMBLY, CENTER POST		2	3
X			1	-040	SUBASSEMBLY, SHROUD		4	4
								5
	1			-006	CENTER COUPLING, BAR ROUND, CENTERLESS GROUND TO ø5.0012 – 5.0019 X 4.5 L	SA-479 304L SST	3	6
	1			-007	CENTER BUSHING, BAR ROUND, CENTERLESS GROUND TO ø5.0012 – 5.0019 X 6 L	SA-479 304L SST	3	7
	1			-008	CENTER POST, PIPE 6" SCHD XXS, SMLS (.800 MIN. WALL)	SA-312 DUAL CERT TP 304/304L SST	3	8
		1		-009	BOTTOM PLATE, APPROX. ø24 X 1.25 THK	SA-240 304L SST	4	9
								10
6				-011	SHROUD, 60° SEGMENT, APPROX. 23.34 X 21.35 X .125 THK	ASTM B152, UNS C12200-060	5	11
			6	-012	OUTSIDE POST, CUSTOM TRAPEZOID	SA-240 OR SA-479 304N SST	5	12
6				-013	SHROUD CHANNEL, APPROX. 5.82 X 21.35 X .125 THK	ASTM B152, UNS C12200-060	5	13
			6	-014	.500 COILED SPRING PIN, 2.0 LONG, HEAVY OR STANDARD DUTY	SAE J405 (30302) OR (30304) ANSI/ASME B18.8.2-94	–	14
	5			-015	.500 COILED SPRING PIN, 1.5 LONG, HEAVY OR STANDARD DUTY	SAE J405 (30302) OR (30304) ANSI/ASME B18.8.2-94	–	15
								16
13				-017	FLUSH HEAD BLIND RMT, SERIES NO. 4, STYLE 3 OR 4, RMT NO. 43	GRADE 51, IFI-114	4	17
1				-018	FLOW RESTRICTER, APPROX. 6 X 71 X .013 THK	ASTM B-103, UNS C51000-H08	5	18
			1	-019	BOTTOM SCREEN	SEE FLAG NOTE 8	5	19
								20

GENERAL NOTES:

1. ALL PARTS AND MATERIAL AS SPECIFIED OR ENGINEERING APPROVED EQUAL.
2. ABBREVIATIONS ARE IN ACCORDANCE WITH ANSI/ASME Y1.1-89.
3. WELDING SYMBOLS ARE IN ACCORDANCE WITH ANSI/AWS A2.4-93.
4. SURFACE TEXTURE SYMBOLS ARE IN ACCORDANCE WITH ANSI/ASME Y14.36-96. SURFACE TEXTURE VALUES ARE IN MICROINCHES AND ARE IN ACCORDANCE WITH ANSI/ASME B46.1-95.
5. ALL UNSPECIFIED MACHINED SURFACES SHALL BE 250√ OR BETTER.
6. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
7. ALL UNSPECIFIED MACHINE TOOL RADII SHALL BE .03 MAXIMUM.
8. WELDED SURFACES SHALL BE SMOOTH AND UNIFORM IN APPEARANCE WITHOUT ABRUPT CHANGES IN CONTOUR.
9. DIMENSIONING AND TOLERANCING SHALL BE PER ANSI/ASME Y14.5M-82. DIMENSIONS ARE IN INCHES AND APPLY AT 72°F UNLESS OTHERWISE SPECIFIED. UNSPECIFIED TOLERANCES SHALL BE:
   - –DECIMAL: .X ± .1, .XX ± .03, .XXX ± .010
   - –ANGULAR: ± 1°
   - –ALL IMPLIED 90° ANGLES SHALL BE PERPENDICULAR WITHIN THE GREATEST TOLERANCE OF THE LINEAR DIMENSION.
   - ~~–ALL COAXIAL FEATURES SHALL BE CONCENTRIC WITHIN ø.003 –UNLESS OTHERWISE SPECIFIED.~~
10. APPROXIMATE WEIGHT = 520 LB.
11. FABRICATION, WELDING AND INSPECTION SHALL BE IN ACCORDANCE WITH ASME SECTION III DIVISION 1, SUBSECTION NG AND SECTION IX. THE COPPER SHROUD SUBASSEMBLY IS A NON-CODE ITEM AND IS EXEMPT FROM CODE REQUIREMENTS.
12. MATE PARTS IN ACCORDANCE WITH INTERFERENCE LOCATIONAL FITS PER ANSI/ASME B4.1-1967, R1994.
13. ADDITIONAL FABRICATION REQUIREMENTS ARE IN HNF-S-0453, FABRICATION SPECIFICATION FOR MULTI-CANISTER OVERPACK.
14. PIECE / PART TOLERANCES ON THESE DRAWINGS SHOULD LEND TO ACCEPTABLE ASSEMBLY GEOMETRIES. ALTERNATE PIECE / PART TOLERANCES MAY BE UTILIZED WITH THE BUYER'S APPROVAL. ACCEPTABLE FINAL ASSEMBLY GEOMETRIES ARE SHOWN IN THE FABRICATION SPECIFICATION'S CRITICAL DIMENSION TABLES / SKETCHES. IN THE EVENT THAT THERE IS A CONFLICT BETWEEN THE CRITICAL DIMENSION TABLES / SKETCHES AND THE DESIGN DRAWINGS, THE BUYER SHALL BE NOTIFIED FOR RESOLUTION.
15. ~~DIVIDER ASSEMBLY IS TO BE SILVER-BRAZED TOGETHER PRIOR TO INSTALLATION INTO THE STRUCTURE.~~

NOTES:

ADDITIONAL NOTES PAGE 2.

⚠1 GENERAL REVISION: OPTIMIZE HEAT TRANSFER TO THE SHROUD BY INCORPORATING COPPER COMPONENTS.

REV	DESCRIPTION	DATE
2	REVISED PER ECN 645048, 645982, 645985, 645990, 645997, 645998 AND 648626	BTB 7/9/98
1A		3/16/98

J D OSTERLOH 4-18-97
Z SARGEANT 4-18-97
R BASTAR (PM) 4-18-97
C TEMUS (CE) 4-18-97
R BASTAR (PM) 4-18-97

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
Duke Engineering & Services Hanford, Inc.

K-BASIN SNF
SCRAP BASKET
MARK 1A

212-H | 3902 | H-2-828065 | 2

DWG NO | TITLE | REF NUMBER | TITLE
REFERENCES | REVISIONS
DRAWING TRACEABILITY LIST

SH 1 OF 5 | REV 1A | DWG NO H-2-828065

plate, although it is not needed. All structural components are welded together and are fabricated from 304L material. The scrap basket also has flow restrictors on the exterior of the shroud to direct processing gas flow through the bottom plate.

The storage and scrap baskets are supported by a spider on the bottom of the MCO that keeps the baskets approximately 1 inch away from the bottom plate. This plenum aids in removal of water using the long process tube and the distribution of process gasses. The baskets are centered by a process tube guide cone in the center of the spider. The one inch NPS process tube is inserted down the center of the baskets to remove the water and circulate process gases. The process tube provides some centering support for the baskets during non-axial load conditions.

As part of the shield plug/guard plate assembly, a MCO basket Stabilizer Extension mates with the center tube extensions for both storage basket designs, providing a locking mechanism to stabilize the baskets during non-axial loadings. The stabilizer is made of 304L stainless steel, and can accommodate six Mark 1A or five Mark IV series baskets, maintaining a minimum of 1 inch spacing, and maintaining basket and MCO coupling in the worst tolerance undersize condition.

3.2 Product Criteria

Edwards (1997) defines MCO conditions that were evaluated to analyze the transportation envelope. The following process related safety items are required for safe transport of the MCO and MCO Cask (Edwards 1997).

1. The MCO, with shield plug installed and vented to the Cask interior, will be backfilled with 3 psig of helium to ensure that flammable gas mixtures are not present during shipment.

2. The loaded MCO will contain either five or six fuel baskets (depending on fuel type), of which a maximum of two can contain fuel scrap, and may only be placed in the top or bottom tier loading positions to ensure that the approved thermal and gas generation analyses in the SARP are not exceeded.

The shipment between K Basins and the CVDF is a wet transfer. The MCO and MCO Cask annulus are filled with water to a height approximately 4 inches below the bottom of the MCO shield plug main body. At the time of loading, the void space remaining within the cask and MCO is filled with helium gas to an internal pressure of 3 psig; the MCO is vented to the cask cavity, and the cask is sealed for transfer. This configuration allows gases in the MCO to expand into the cask interior void space. Under these [normal] conditions the shipping window is defined as 24 hours for a worst-case loading at 15 °C (Edwards 1997).

3.3 MCO/Cask Preparation for MCO Loading

MCO/Cask preparation activities, as shown in Figure 2, begin when a conveyance from the CSB, carrying an empty MCO loaded in a transport cask, arrives outside the roll-up door wind break structure to the KE or KW Basin Transfer Bay Area. The transfer bay door is opened and the tractor positions the trailer carrying the MCO/Cask in the transfer bay. Exhaust trunks are connected to the tractor as required by Industrial Safety.

Once the trailer is positioned in the transfer bay, the trailer jacks are lowered, and the trailer is disconnected from the tractor. The exhaust trunks are removed and the tractor is moved outside the transfer bay to an area clear of the wind break. The trailer is connected to the building compressed air system using a glad hand connection, and the trailer is leveled using the landing gear. The transfer bay door is then lowered. A radiation survey of the MCO/Cask is completed to ensure contamination levels are within acceptable limits.

The four quick release locking bolts from the cask hold down device are removed, freeing the cask for vertical movement (See Figure 3 for Cask Transportation System). The hooks for the 32 ton crane are aligned and engaged with the cask lifting trunnions; the crane hoist is raised to apply a slight load on the crane. The cask clamps are swung open, freeing the cask for lateral movement. The clamp bolts are placed in the storage positions provided on the work platform. The work platform is then removed from the working side of the trailer. The working side of the platform floor is then swung open, removing any barriers to cask movement. Using the crane, the cask is lifted to clear the trailer/tie down device and moved out over the safe load path to a position over the South Loadout Pit.

As shown in Figure 2, two other processes occur in parallel with cask receipt at the K Basins. The first set of activities involves inspection of the immersion pail lid, immersion pail, and pail set down area in preparation for moving the MCO/Cask from the trailer into the immersion pail. First, the seal surface of the pail lid is inspected for damage, scars, or other gouges that might affect the inflatable seal. The inflatable seal is also inspected for wear (including cracking and feathering) and, if necessary, the seal is replaced. Next, installation of the pail lid fasteners in their captive position is visually verified. The lift sling may be installed at this time on the three pail lid lift lugs, one sling leg per lug. When these steps are completed, the pail lid is ready for installation on the pail.

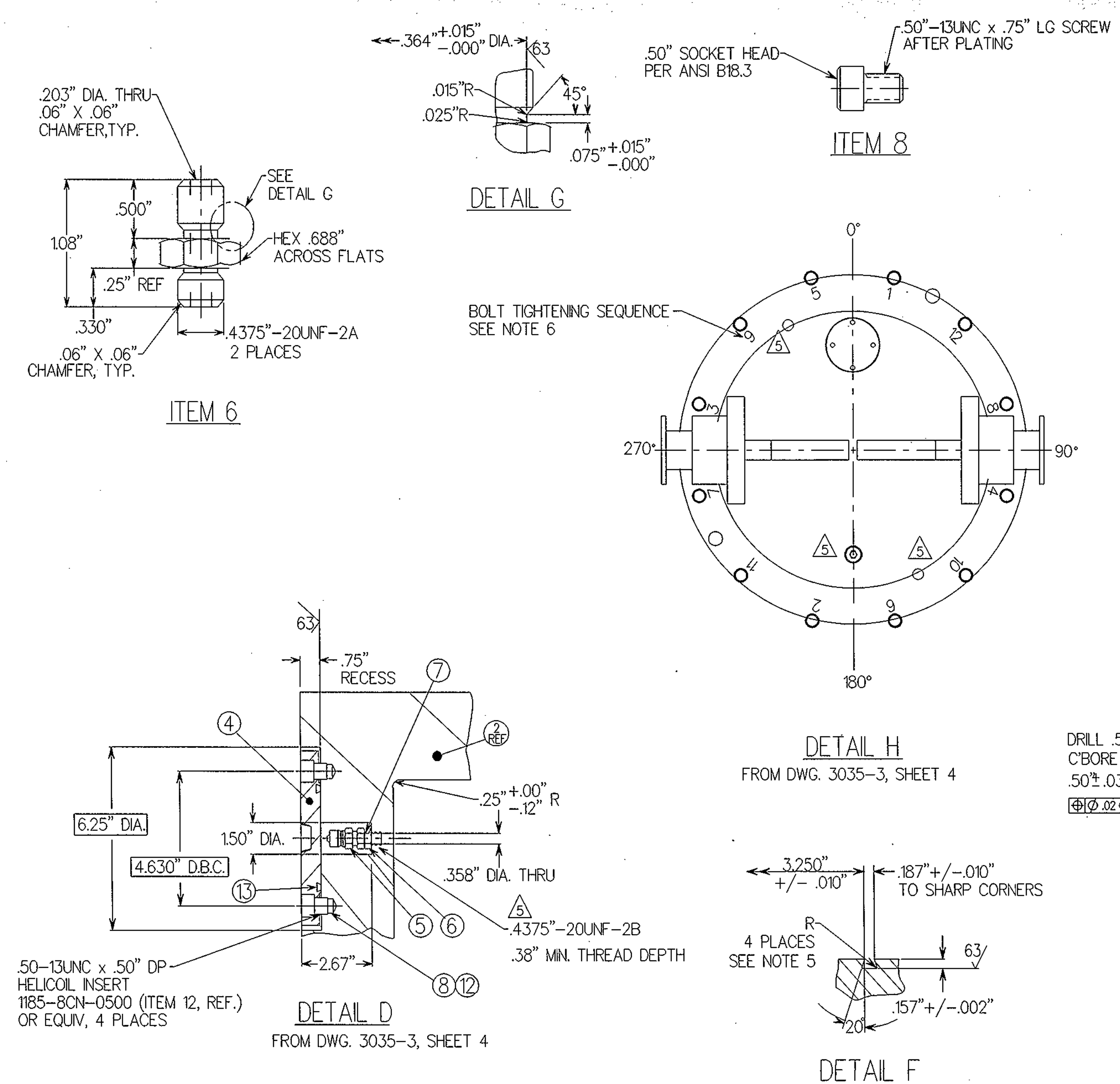
The second process begins with inspection of the immersion pail for proper position in the support structure, and correct pail lock position. The pail should be in the upper position, locked in place. Additionally, the inside of the immersion pail is visually inspected to ensure that it is free of foreign material or debris. The pail is cleared as necessary. The pail sealing surface is also inspected for nicks, scars or gouges that might affect the inflatable seal. The immersion pail water level is then checked to verify that water in the pail has reached the correct level. If the water level is too low, demineralized (i.e. fresh makeup) water is added until the appropriate level is reached. At this point, the pail is ready to receive the MCO/Cask.

Prior to lowering the MCO/Cask into the immersion pail, the cask position over the loadout pit is verified relative to the immersion pail, and the steadiness of the load is checked; swinging or oscillation is not allowable as it could damage the cask, the pail, or other equipment. The cask is lowered toward the pail opening and slowly lowered into the immersion pail, using the 32 ton crane. Lowering continues until the cask is resting on the bottom of the immersion pail and the weight of the cask is removed from the crane hooks. The 32 ton crane hooks are disconnected and removed from the cask. The cask torquing tool is installed using the auxiliary hoist and the cask lid bolts are loosened using the sequence shown in Figure 9 (as specified in the SARP). The cask torquing tool loosens two bolts at the same time, e.g. 1 and 2, then 3 and 4, etc. When it is certain that the bolts captive on the lid have disengaged from the cask, the torquing tool is removed and stored. The 32 ton crane hooks are then reconnected to the cask lid and slowly hoisted to remove the cask lid. The cask lid is positioned on the cask lid storage tool where the o-ring is visually inspected for wear. The 32 ton crane hooks are disconnected from the cask lid.

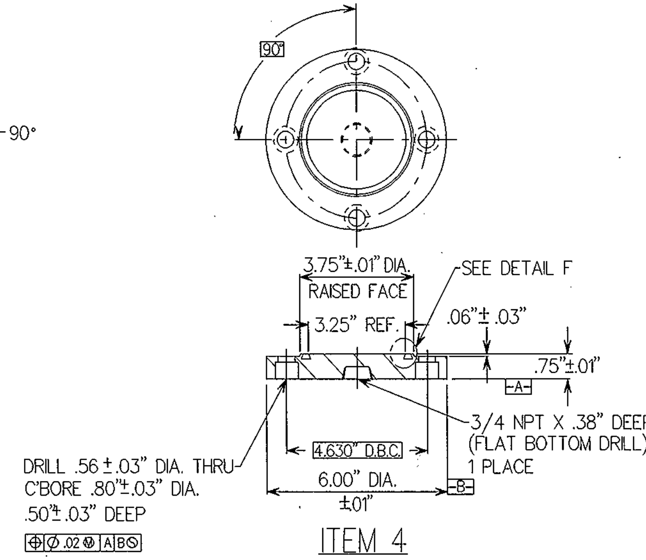
The lift sling is now connected to the immersion pail lid, if not already done. The sling is then connected to the 32 ton crane hooks. The immersion pail lid is retrieved from storage and carefully lowered into place using guide pins to ensure correct positioning. The four pail lid retention fasteners are engaged, and the immersion pail lid seals are inflated to 45 psi maximum using the building compressed air. The pail lid fasteners are tightened hand tight. The vent hose is attached to the Pail Lid Vent connector. The Immersion Pail /Cask Annular region is filled with demineralized water (i.e., fresh makeup) and, when water is seen exiting the Pail Lid vent line, the water is turned off and the vent line is disconnected. Once the vent line is disconnected, the demineralized water supply is reestablished. It is crucial to maintain the Pail/Cask Annular space water at a slightly higher pressure than what the casks is exposed to in the Load Out Pit (for contamination purposes). The pit is continuously flushed with clean water to move contamination into the Basin pools proper.

Before preparations for basket loading can continue, the locking ring must be removed; this is done using the locking ring tool. The locking ring tool is calibration tested and then installed using the auxiliary hoist. When the locking ring tool is positioned, the grapple attaches to the rim of the locking ring. The hydraulic jacks are actuated by manually rotating the 40 inch wheel on the locking ring tool. The locking ring is captured in the locking ring tool when it is removed. The locking ring tool and the locking ring are removed using the auxiliary hoist. The locking ring and tool are then surveyed for contamination, and placed in a non-contaminated storage area. Approximately 40 gallons of deionized water discharged from the IWTS are then added to the MCO cavity to offset the buoyant effect of water in the cask annular region, without mixing with the cask annular region demineralized water and prior to being submerged in the load out pit.

Figure 9 - Transportation Lid System



NOTES:
1. FOR CASK ASSEMBLY SEE DWG. 3035-3, SHEET 1.
2. TOLERANCE, UNLESS OTHERWISE SPECIFIED:
   - 2 PLACE DECIMALS: +/- .12"
   - 3 PLACE DECIMALS: +/- .010"
   - ANGLES: +/- .5°
3. REMOVE ALL BURRS & WELD SPLATTER AND BREAK ALL SHARP EDGES.
4. SURFACE FINISH, UNLESS OTHERWISE SPECIFIED: 125
5. RADIUS TO BE SPECIFIED BY FABRICATOR.
6. TEXT SIZE .50" HIGH, METHOD TO BE PERMANENT IDENTIFICATION MARKING.
7. LUBRICATE BOLTS WITH NEOLUBE AS NEEDED.



ITEM NO. 7
WHC SPECIFICATION NO. WHC-S-0396
WHC PURCHASE ORDER NO. MJK-SPX-452727

NO.	DATE	REVISIONS	DWN.	CHK'D.	M.D.		Q/A	PROJ.
5		SEE DCN 3035-31						
4	2/21/97	SEE DCN 3035-21	J.T.G.	P.S.	P.S.		W.R.S.	G.G.
3	12/3/96	SEE DCN 3035-18	J.T.G.	P.S.	P.S.		E.D.	G.G.
2	9/30/96	SEE DCN 3035-10	J.T.G.	P.S.	P.S.		E.D.	G.G.
1	8/6/96	SEE DCN 3035-5	J.T.G.	P.S.	P.S.		E.D.	G.G.

APPROVALS		DATE
PROJ.	G.G.	24 JUNE 96
Q/A	E.D.	24 JUNE 96
MECH. DES.	P.S.	21 JUNE 96
CHK'D. BY	P.S.	21 JUNE 96
DWN. BY.	J.T.G.	21 JUNE 96

TRANSNUCLEAR, INC.
HAWTHORNE, N.Y.

TN-WHC CASK
TRANSPORTATION SYSTEM
LID
WHC DWG. NO. H-1-81535

SCALE	SIZE	DWG. NO.	REV.
NONE	B	3035-3	5

SHEET 5 OF 6

Prior to lowering the pail, the MCO Basket Guide is installed in the mouth of the MCO/Cask. Fashioned as a large stainless steel funnel, the basket guide protects the internal shield plug retainer threads and sealing surface as baskets are inserted. The basket guide also serves to align the baskets during the loading process. The MCO basket guide is about 10 inches long, with outer diameters of 27 inches at the top and 24 inches at the bottom, and protrudes approximately 3 inches above the MCO/Cask when installed. The MCO basket guide weighs approximately 32 pounds, and is equipped with a lifting bale. A hand-held pole or rope hook is attached to lifting bale and the MCO basket guide is manually moved over the loadout pit. The basket guide is then lowered into the MCO opening.

The Immersion Pail/Cask/MCO is lowered into the pit using the 32 ton crane. The Immersion Pail Lift Beam is attached to the hooks on the 32 ton crane, and the lift beam is positioned over the Immersion Pail; the lift beam is set at an elevation that facilitates attachment of the Immersion Pail Lift Slings. The hook end of each sling is attached to the Lift Beam master links. The Lift Beam is raised and the lift slings are carefully fed out. The Lift Beam is slowly raised until there is tension in the slings; all connections are verified and checked for uneven loading. The Pail is slowly raised until the red alignment lines on the lifting lugs are exposed at the lock pin housings. The lock pin gates are lifted and the lock pins are pulled out until the pin gates can be closed in the pin disengaged position; this ensures full retraction.

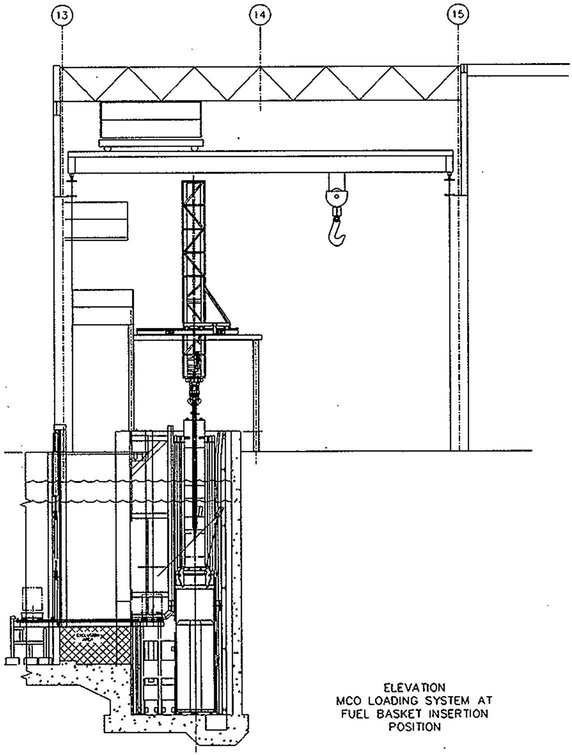
The Immersion Pail is lowered approximately 2 feet and held in that position while the Immersion Pail Lid Seal Area is checked for leaks. To confirm the Immersion Pail Lid Seal integrity, the reservoir water level and loadout pit water are observed for level changes or air bubbles that would indicate leaks in the seal. Lowering of the Pail is resumed until the pail is resting on the support structure bottom plate. The lift beam is then lowered for removal of sling hooks from the master links and the hooks are secured to the sling storage boxes; this ensures that the slings are pulled toward the sides of the pit, leaving the pail lid clear. The Immersion Pail Lift Beam is removed from the pit area and disconnected from the crane hooks.

3.4 MCO Loading

MCO loading encompasses those activities required to receive a full basket from the fuel retrieval storage queue (FRS has the tool that places the basket on the shuttle), place it within the submerged MCO/Cask, and prepare the MCO/Cask for sealing. Repositioning of the baskets for loading from the FRS queue is described in Fuel Basket Repositioning, Section 3.7.1 of this document. MCO loading is accomplished in the K-Basin while the MCO/Cask is submerged. Existing and specially developed equipment are used to complete the process. The MCO Loading System and Immersion Pail are shown in Figure 10.

Prior to loading fuel or scrap baskets into the MCO, the payload is visually gauged to ensure that no elements or scrap protrude above the basket rim. The axial void of the baskets are also

Figure 10 - MCO Loading System



ELEVATION
MCO LOADING SYSTEM AT
FUEL BASKET INSERTION
POSITION

verified as clean and free of fuel bits and debris. This ensures that fuel and scrap baskets will "nest" when placed in the MCO.

The gantry mast and grapple assembly (Figure 11) is used to lift the fuel basket from the MCO Loading System (MLS) shuttle, support the basket as the gantry traverses to a position located over the center of the MCO/Cask, and to lower the basket to a predefined position within the MCO/Cask. The single axis bridge gantry is a linear motion device mounted on facility structural steel; the structural steel extends from the mezzanine support columns parallel to the loadout pit transfer channel. The gantry travel is approximately four feet axially along the canal centerline.

The drive motion is provided by a rack and pinion gear, linear-bearing arrangement. The gantry motion control is provided by a ¼ HP motor with a 8:1 gear reducer and redundant limit switch control stops.

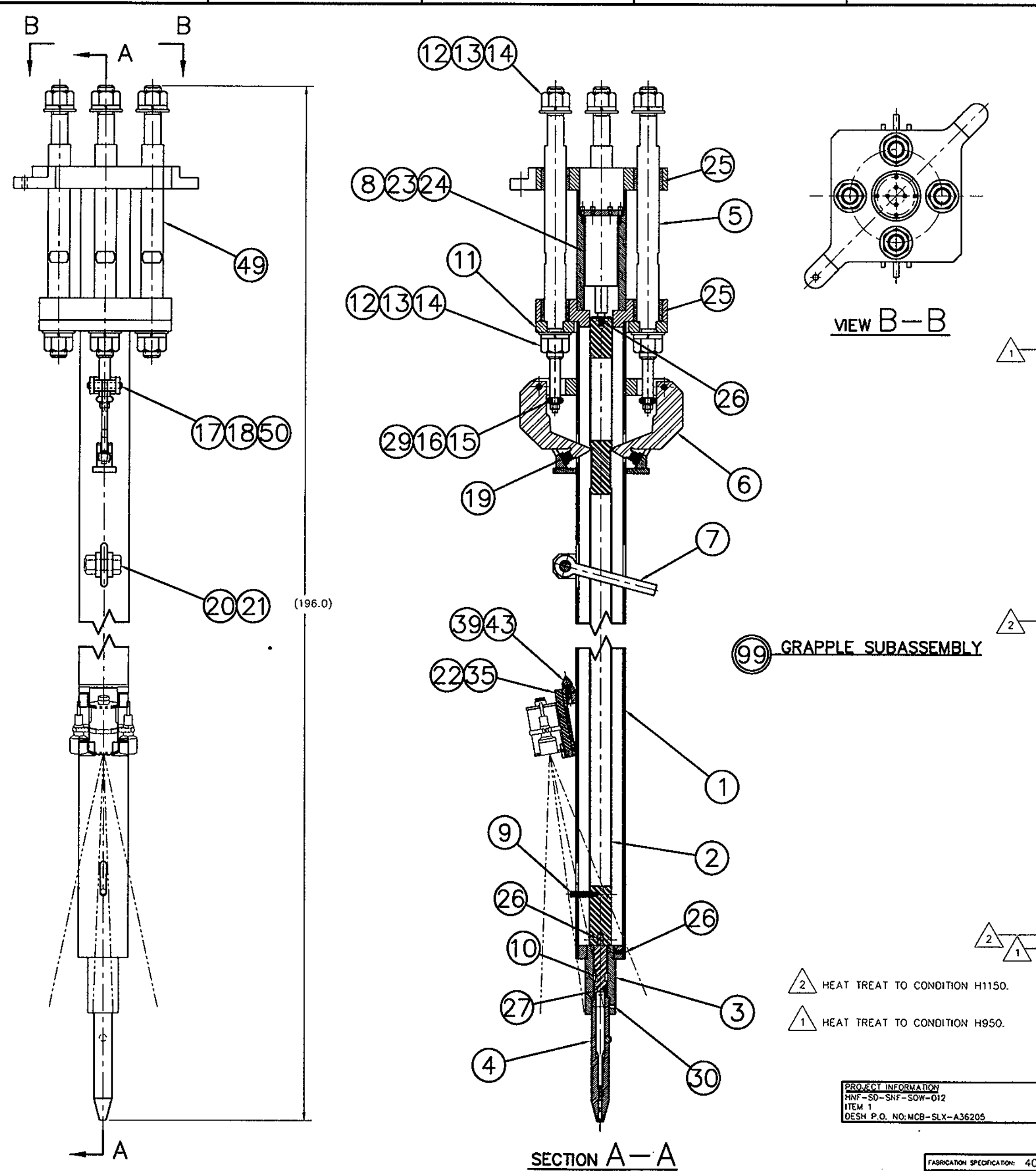
The mast is a linear guided ball screw drive device which picks the loaded basket from the shuttle unload position and places it into the MCO/Cask. The ball screw is driven by a 2.5 HP servo motor, controller, and a 40:1 gear reducer. Position feedback monitoring of the mast load is provided by a Linear Variable Differential Transducer (LVDT). Receiving a signal which indicates a system loading outside the normal limits will stop all mast motion. The mast incorporates a Grapple Extension Compliance Mechanism (GECM) device connected to a LVDT. The GECM provides compensation to the extending mast by allowing the column to retract up to two inches before the assembly will be exposed to compressive loading.

The grapple is pneumatically operated by a cylinder mounted in the GECM. A video camera mounted at the base of the mast focuses on the grapple. The video camera provides monitoring of all grapple operations and a full view of the basket. In addition to the grapple locked load design, a Grapple Anti-Release Mechanism (GARM) limits grapple operations to operator directed action. The mast descends 1½ inches beyond the initial no load signal to release the GARM.

The fuel basket is lifted by extending the mast to the basket on the shuttle, and energizing the grapple cylinder. The grapple anti-release mechanism locks automatically. The loaded basket is then retracted approximately 1 inch, and the load cell readout is used to verify that the load is within the appropriate predetermined weight range for the specific fuel basket type. The basket is lifted to the minus 8 foot 6 inch level (reference grating is at the 0 foot 0 inch level). The shuttle, now empty, is actuated and the cart returns to the "load" position next to the fuel queue. The basket is then moved laterally to a position over the MCO/Cask, and lowered to a preset position determined for specific basket type and loading positions.

The mast descends an additional 1¼ inches after the no load signal is received and the grapple anti-release mechanism begins to disengage. The mast descends an additional ¼ inch to completely disengage the mechanism. The operator reviews the console display to verify no load

Figure 11 - Grapple Subassembly



No.	REVISION	BY	APPROVED BY	DATE
0	INITIAL ISSUE			

⚠2 HEAT TREAT TO CONDITION H1150.

⚠1 HEAT TREAT TO CONDITION H950.

PROJECT INFORMATION
HNF-SD-SNF-SOW-012
ITEM 1
DESH P.O. NO.MCB-SLX-A36205

95 ASSY	96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
	2				59	LOWER GUIDE	304 ST. STL.	ASTM A240		1 PLATE
	2				58	UPPER GUIDE	304 ST. STL.	ASTM A240		1 PLATE
	1				57	BACK PLATE	304 ST. STL.	ASTM A240		1/4 PLATE
	1				56	LOWER PLATE	304 ST. STL.	ASTM A240		1/2 PLATE
	1				55	UPPER PLATE	304 ST. STL.	ASTM A240		1 PLATE
2					54	DOWEL PIN	ST. STL.	COML.		3/8 DIA X 1 1/2 LG
1					53	MOUNTING PLATE	304 ST. STL.	ASTM A276/A240		3/4 BAR/PLATE
1					52	PIN PLATE	304 ST. STL.	ASTM A276/A240		1/2 BAR/PLATE
				1	51	MOUNT BASE			401-201-96	
				4	50	BUSHING	304 ST. STL.	ASTM A276		1 DIA BAR
				2	49	GUIDE ROD ⚠1	455 ST. STL.	ASTM A564		2 DIA BAR
		1			48	END	304 ST. STL.	ASTM A276		2 DIA BAR
		1			47	TUBE	304 ST. STL.	ASTM A511		2 OD X .063 WALL TUBE
		1			46	LOCKING SLEEVE	304 ST.STL.	ASTM A276		2 DIA BAR
		1			45	HEAD	304 ST. STL.	ASTM A276		2 DIA BAR
		1			44	TUBE	304 ST. STL.	ASTM A511		2 OD X .063 WALL TUBE
				1	43	BOLT SPRING	ST. STL.	COML.		CENTURY #PP-89
			2		42	SPRING HOUSING	304 ST. STL.	ASTM A276		1 1/8 DIA BAR
			2		41	SPRING MOUNT	304 ST. STL.	ASTM A276/A240		BAR/PLATE
			2		40	BRACE	304 ST. STL.	ASTM A276/A240		1/2 BAR/PLATE
				1	39	LOCKING BOLT	304 ST. STL.	ASTM A276/A240		3/4 BAR/PLATE
			2		38	LEVER PIVOT	304 ST. STL.	ASTM A276/A240		1/2 BAR/PLATE
			2		37	PAWL PIVOT	304 ST. STL.	ASTM A276/A240		1 1/2 BAR/PLATE
			1		36	END GUIDE PLATE	304 ST. STL.	ASTM A240		2 PLATE
				1	35	CAMERA MOUNT			401-201-95	
			1		34	CYLINDER HOUSING	304 ST. STL.	ASTM A511		4 1/2 OD X 3/4 WALL TUBE
			1		33	GUIDE PLATE	304 ST. STL.	ASTM A240		2 1/2 PLATE
			1		32	HEAD	304 ST. STL.	ASTM A240/A276		PLATE/BAR
			1		31	MAIN TUBE	304 ST. STL.	ASTM A511		4 1/2 OD X 1/4 WALL TUBE
				1	30	SET SCREW	ST. STL.	COML.		1/4-20 UNC-2A X 1/2 LG, NYLON TIP
				2	29	CAM RING ⚠2	17-4PH ST. STL.	ASTM A564		BAR
					28					
				1	27	ACTUATOR COUPLING				DESH #H-1-82857-020
				3	26	NYLON TIP SET SCREW	ST. STL.	COML.		#10-24 UNC X 1/2 LG
				8	25	BUSHING	GRAPHITE	COML.		GRAPHALLOY #117-32
				8	24	HEX HEAD BOLT	ST. STL.	COML.		#10-24 UNC X 3/4 LG
				1	23	BASE MOUNT	304 ST. STL.	ASTM A240		1/2 PLATE
				4	22	SPRING PLUNGER	ST. STL.	COML.		McMASTER CARR #84985A65
				1	21	NYLOK HEX NUT	ST. STL.	COML.		1-8 UNC-3B
				1	20	HEX HD BOLT	ST. STL.	COML.		1-8 UNC-3A X 2 1/2 LG
				2	19	SPRING	ST. STL.	COML.		CENTURY #72371S
				4	18	SNAP RING	ST. STL.	COML.		WALDES TRUARC #5160-50-H
				2	17	PIN	304 ST. STL.	ASTM A276		ROUND BAR
				2	16	LOCKWASHER	ST. STL.	COML.		1/2 DIA
				2	15	HEX NUT	ST. STL.	COML.		1/2-13 UNC-2B
				8	14	FLATWASHER	ST. STL.	COML.		1 1/2 DIA
				8	13	LOCKWASHER	ST. STL.	COML.		1 1/2 DIA
				8	12	HEX NUT	ST. STL.	COML.		1 1/2-12 UNF-2B
				1	11	RETAINER PLATE	304 ST. STL.	ASTM A240		1 PLATE
				1	10	CONNECTOR	304 ST. STL.	ASTM A276		1/2 DIA BAR
				1	9	STROKE INDICATOR	304 ST. STL.	ASTM A276		1/2 DIA BAR
				1	8	AIR CYLINDER	ST. STL.	COML.		BIMBA #DWC-502.5-2
				1	7	MANUAL LEVER	304 ST. STL.	ASTM A240/A276		1/2 PLATE/BAR
				2	6	LOCKING PAWL ⚠2	17-4PH ST. STL.	ASTM A693/A564		1/2 PLATE/BAR
				2	5	GUIDE ROD ⚠1	455 ST. STL.	ASTM A564		2 DIA BAR
				1	4	GRAPPLE BODY				DESH #H-1-82857-6
				1	3	GRAPPLE BOSS	304 ST. STL.	ASTM A276		2 3/4 DIA BAR
				1	2	ACTUATOR WELDMT			401-201-97	
				1	1	MAST EXT WELDMT			401-201-98	

QUANTITY

NAC INTERNATIONAL

GRAPPLE SUBASSEMBLY
MCO LOADING SYSTEM

SYM	GEOMETRY
	FLATNESS
	STRAIGHTNESS
	ANGULARITY
	PERPENDICULARITY
	PARALLELISM
	CONCENTRICITY
	TRUE POSITION

TOLERANCES UNLESS OTHERWISE SPECIFIED

3 PLACE DEC.	TOL.	2 PLACE DEC.	TOL.
UNDER 3	±.003	UNDER 6	±.02
3-12	±.005	6-18	±.03
OVER 12	±.010	OVER 18	±.06
1 PLACE DEC.	±.1	FILLETS .015 TO .030	
FINISH (✓)-AA-125 MICRO IN		ANGLES ±.5°	
THREADS-UNIFIED CL2A-2B		CORNERS R.01-.03	

NEXT ASSEMBLY: 401-211
DRAWING TYPE:

FABRICATION SPECIFICATION: 401-S-03
DESIGN SPECIFICATION: 444-S-01

GROUP	NAME	DATE
PREPARER		
CHECKER		
PROJECT MANAGER		
VP/CHIEF ENGINEER	NA	—
DIRECTOR of PROJECTS	NA	—
LICENSING MANAGER	NA	—
QUALITY		
SRU VP	NA	—

PROJECT 401 | DESIGN PACKAGE | DRAWING 201 | REV 0
SCALE 1/4 | EST.WT. 450# | SH 1 OF 5

on the load cell, correct height position on the controls, and correct grapple motion pin position for release. Following successful verification, the grapple is opened and the basket is released. The mast is retracted 2 inches and the load cell readout is monitored to verify a "dead load" consisting of mast weight only. Following successful verification, the mast and the gantry are returned to the shuttle unload position. The MCO loading process described above is repeated until the MCO is full. When the MCO is full, the MLS shuttle cart is returned to the unload position next to the immersion pail. The basket guide is removed from the MCO/Cask using a pole or rope hook and stored in the Transfer Bay.

3.5 Shield Plug Installation

The shield plug and o-ring are assembled near the load out pit, as described in Section 3.7.2, and then transferred to the basin. Following MCO loading, the shield plug sealing area is prepared for shield plug installation. The shield plug sealing area is cleaned underwater using a tool to clean the sealing surface to remove debris or foreign material. The shield plug assembly with the shield plug handling fixture attached, is then positioned over the MCO and lowered into the MCO using the auxiliary hoist. Shield plug rotational positioning is done using visual markers on the shield plug handling fixture; observational techniques are in development.

The shield plug is checked to ensure proper seating. Correct shield plug installation depth and alignment of the shield plug ports are verified; the techniques used to verify correct installation are in development, and will be included in the next revision of this document. If the shield plug installation is correct, the lift rig is released and the auxiliary hoist is moved out of the way; the lift rig is then removed from the auxiliary hook. While still over the loadout pit, the auxiliary hoist is decontaminated as necessary.

The Immersion Pail Lift Beam is reattached to the hooks of the 32 ton crane, and the lift beam is positioned over the Immersion Pail; the lift beam is set at an elevation that facilitates attachment of the Immersion Pail Lift Slings. The hook end of each sling is attached to the Lift Beam master links. The Lift Beam is slowly raised until there is tension in the slings; all connections are verified and checked for uneven loading.

The pail is then slowly raised to water level, where the Pail Lid and Shield Plug Handling Fixture surface are rinsed thoroughly with demineralized (fresh makeup) water; the Shield Plug Handling Fixture top is surveyed for contamination. Following the survey, the pail continues to be raised and rinsed until the red Immersion Pail Lift Lug alignment lines are visible over the Lock Pin housings. The Lock Pin gates are then lifted, and the lock pins are extended until the gates can close, the pail is lowered until its weight rests on the pins. This ensures full extension and secures the Immersion Pail in the upper position. The slings are disconnected and the ends are fed into the sling storage box. The sling hooks are disconnected and attached to the side of the loadout pit grating structure. The Immersion Pail Lift Beam is removed and stored.

The shield plug handling fixture is released from the shield plug. It is then raised from the MCO, cleaned and surveyed, and removed from the loadout pit area, and placed in a staging rack for reuse with later shield plugs using the auxiliary hoist.

After the shield plug handling fixture is removed, the locking ring is installed; this ring functions to secure the shield plug for transportation. The locking ring tool is installed using the auxiliary hoist. When the locking ring tool is positioned, the locking ring is then rotated until seated. When the locking ring is seated, the hydraulic wrenches on the locking ring tool are actuated; simultaneously, each of the 18 wrenches applies the appropriate torque to each of the corresponding 18 jacking bolts. The locking ring tool is ungrappled from the locking ring, and removed using the auxiliary hoist. The locking ring tool is then calibration tested, surveyed for contamination, and placed in a storage area. The MCO can then be prepared for transfer to the CVDF.

3.6 MCO/Cask Loadout and Preparation for Transfer

With the water reservoir permanently attached to the Immersion Pail clean water volume, the pressure to the MCO seal is broken, allowing clean water to flush the seal annulus; flushing occurs at about 3 psi. The water reservoir is isolated. The Pail Lid and surrounding area are rinsed thoroughly with demineralized water.

The Immersion Pail Lift Sling is attached to the crane hook, the crane is positioned so that the sling can be attached to the Aux Hoist, and the sling legs are attached to the Pail Lid. The four pail lid bolts are loosened and captively engaged in the lid. The pressure to the Pail/Lid Seals is then broken. The lid is then slowly raised from the pail and placed in storage. The pail lid sling is removed from the crane and placed in storage. The cask water level is then adjusted using a specially designed suction tool. The crane hooks are positioned over the cask lid, and then attached to the cask lid using the trunnions. The Cask Lid is lifted and positioned over the cask; the alignment with the Cask Guide Pins is verified. The lid is slowly lowered onto the cask, the load removed from the crane hoist, and the crane hooks are disconnected from the lid.

The lid is fastened to the cask using the cask lid torquing tool. The torquing tool is placed on the cask lid using the auxiliary hoist, and the bolts are tightened to 40 ft-lb using the torquing pattern in Figure 9. The cask torquing tool tightens two bolts at the same time, e.g. 1 and 2, then 3 and 4, etc. The torquing pattern is repeated, tightening the bolts to 300 ft-lb. A second pass of final torque at 300 ft-lb is applied. The torquing tool is removed and stored for later use.

The cask secondary vent port cover is removed in preparation for gas addition. Inert gas is added using a specially designed gas addition apparatus. When the appropriate gas composition is reached the MCO/Cask meets safety requirements for shipping. The process and equipment used for gas addition/composition adjustment are in development. The gas adjustment equipment is removed and the dust cover is replaced. The 24-hour shipping window begins when the vent port is sealed.

Using the 32 ton crane, the cask is raised from the immersion pail until it is high enough to clear the pit wall. Excess water is wiped from the cask as it is removed from the pail. A contamination survey is also completed, and the cask is decontaminated if necessary. The cask is then moved from the loadout pit to the trailer area. The cask is carefully aligned and lowered into the trailer support device. Just prior to contacting the trailer deck, cask lowering is halted, and the cask tie-down devices are closed. One clamp bolt is installed hand tight on each side. Lowering the cask is then completed, and any safety chains, handrails or platforms removed during operations are reinstalled at this time.

The crane hooks are disconnected and the crane is removed from the trailer area. The vertical tie-downs are connected to the cask. The trailer jacks are raised to allow the tractor to pass under the front of the trailer. The truck bay roll-up door is opened, disconnected from the building compressed air, exhaust trunks are connected, and the tractor is positioned in front of the trailer. The trailer is connected to the tractor and then a final release survey is conducted, and the cask is transferred to the CVDF.

3.7 Support Activities

3.7.1 Fuel Basket Repositioning

The Fuel Basket Repositioning activities move fuel baskets from a location above the fuel retrieval queue to a position where the baskets can be loaded into the MCO/Cask. The MLS is used to complete these activities. The MLS shuttle is an underwater linear motion device which provides approximately 11.5 feet of horizontal travel. The shuttle "loading"position is directly over the FRS basket queue; the shuttle "unloading" position is located next to the immersion pail structure. The shuttle is comprised of a cart with corrosion resistant linear motion rollers riding on parallel rails. The rails are suspended from a structural steel framework anchored to the K Basin operations floor. Shock absorbers and "hard stops" (fixed after installation) control the shuttle unloading position. The shuttle is operated from a control station located in Corridor 7.

The MLS shuttle drive system consists of a fixed length cable connected to a pneumatic cylinder on each end of the shuttle carriage. The shuttle cart is attached to the cable at the center of system travel. The pneumatic cylinders are located external to the pool with only cylinder rods exposed to the basin water. The cable, pulleys, and shuttle frame and cart system equipment are permanently located beneath the water surface. Upon activation, one cylinder retracts, the opposite cylinder extends, and the carriage is pulled by the cable to the end of the shuttle rail against a "hard stop." To minimize the potential for airborne contamination, the cylinder rods are immediately sleeved by the cylinders as they are raised from the pool surface.

Loaded fuel/scrap baskets from the fuel retrieval queue are placed on the MLS shuttle cart using the perimeter monorail (Flexible Transfer Crane) and the FRS grappling tool; the tool is used to move loaded baskets to and from the queue. When the basket has been loaded into the shuttle cart, an underwater camera is used to verify that fuel does not extend above the top of the basket. This ensures that the next basket loaded will seat properly. Following successful verification, the shuttle system is actuated at the MLS control station, and the basket is moved to the unloading position next to the immersion pail structure. In this position, the fuel basket is correctly located to facilitate MCO loading.

3.7.2 Shield Plug Staging and Assembly

MCO Shield Plug Staging and Assembly activities begin when the MCO shield plug is shipped to the 190 KE warehouse, independent of other MCO loading and cask loadout activities. Shipping, staging, inspection and assembly occur in parallel with the MCO/Cask preparation and MCO loading activities. The shield plug and associated components are provided by the MCO subproject.

The MCO shield plug is shipped from the manufacturer to the 190 KE warehouse with the rupture disk, process valves and port covers installed. The 24" diameter Helicoflex metallic o-ring and the axial dip tube (process tube) are shipped separately to the warehouse. The plug, seal, dip tube and associated components are staged in the warehouse until needed. Inspections will occur at the 190 KE warehouse.

The shield plug port plugs and any storage material are removed as required to allow inspection of shield plug condition and cleanliness. The plug is then reassembled using appropriate torquing of valves, port covers and other components as required. The o-ring is also unpacked and inspected. The o-ring seating surfaces are inspected to ensure a good sealing surface, and that the seal is installed. When needed, the shield plug, along with the process tube and o-ring, are transferred from the warehouse to a staging area in the K Basins. The shield plug with o-ring installed, and a long process tube are transferred separately to the basin.

At the basin, the shield plug handling fixture seal is inspected and attached to the shield plug using four 3/4 inch bolts and seal washers. This handling fixture allows the shield plug to be lifted with a crane, keeps the shield plug top contamination free during underwater insertion into the MCO, and provides a means to decontaminate and dry the area between the fixture and the MCO threads. The lift rig is attached to the shield plug handling fixture, and the lift rig is connected to the auxiliary hook on the overhead crane. The shield plug assembly is lifted vertically to mezzanine height, placed in the shield plug support stand, and oriented for process tube assembly; the shield plug support stand is a fixture that is attached to the mezzanine and functions to reduce shield plug movement during process tube installation. The process tube is then moved to the same location.

The process tube is installed in the shield plug using the mezzanine for access. A mezzanine deck height of 12'-6" allows the required access to lift the 12'-3" long process tube. The process tube handling tool is used to lift, position and tighten the 45 lb. axial process tube into position during installation.

Following process tube installation, the connection is leak tested to ensure a good seal between the process tube and shield plug. A pressure decay test is used to satisfy this requirement. A final inspection of the shield plug is completed to ensure cleanliness and condition. When needed, the shield plug is removed from the shield plug support stand and transferred to the loadout pit for insertion into the MCO, as described in Section 3.5 of this document.

4.0 PROCESS TECHNOLOGY

Cask Loading involves primarily mechanical operations with loading of the fuel and scrap baskets into the MCO. These activities allow definition of water in an MCO with installation of the Shield Plug. They also define the void volume at the top of the MCO for gas accumulation. The key parameters in the cask loading process, then, are MCO loading, water volume in the MCO, and the void volume at the top of the MCO for gas accumulation. These parameters are discussed in the following sections.

4.1 Fuel and Scrap Basket Characteristics

A MK IV fuel basket contains up to 54 assemblies while a MK 1A fuel basket contains up to 48 assemblies (Goldmann 1998b). The average mass of a single MK IV fuel assembly is 24.34 kg with a maximum mass of 25.12 kg. The average mass of a single MK 1A fuel assembly is 17.74 kg with a maximum mass of 18.01 kg (Willis 1998). The criticality limits established in the *Fuel Removal System Criticality Safety Evaluation Report* (Kessler and Peck 1998), for a MK IV and MK 1A scrap baskets are 980 kg and 575 kg, respectively. Table 4.1-1 shows the various weights of fuel baskets to be loaded into the MCO.

Table 4.1-1: Fuel and Scrap Basket Masses

Fuel Type	Type	Empty	Loaded Basket
MK IV	Fuel Basket	90 kg	1,404 - 1,446 kg[1]
	Scrap Basket	202 kg	1,133 kg[2]
MK 1A	Fuel Basket	180 kg	1,032 - 1,044 kg[1]
	Scrap Basket	249 kg	795 kg[2]

Notes:

(1) Basket mass ranges due to difference in calculation using average mass fuel assembly to maximum mass fuel assembly.

(2) Scrap baskets are assumed to be loaded to 95% of the criticality mass limit for each fuel type.

4.2 Loaded MCO Characteristics

The mass of materials contained by a MCO is dependent on the N Reactor fuel type loaded (Mk IV or Mk 1A) due to the different basket design required for criticality control. Each fuel type includes assemblies fabricated to a variety of lengths (see Table 3.1 of Willis 1998). The condition of some fuel assemblies is projected to be degraded to the extent that the fuel will not fit in a fuel basket array and fuel cleaning at the basin will result in some breakage. Degraded fuel and broken prices are placed in a scrap basket. All SPR fuel will be placed in MK 1A scrap baskets. The quantity of scrap generated during retrieval cannot be predicted with certainty prior to operation. Each of these factors contribute to variability in estimates for the mass of material loaded in a MCO.

4.2.1 Loading Alternatives

Table 4.2.1-1 summarizes estimates for the mass of materials contained in an MCO upon loading based on alternative loading assumptions. A MCO primarily contains structural materials, fuel assemblies, fuel scrap, residual fuel particulate corrosion products, and water. Water volumes are based on a 4 inch gas void at the top of a MCO and the mass of water is based on displacement by the various fuel loadings. A maximum fuel mass, characterized by the mass of uranium fuel and Zircaloy cladding in fuel assemblies, is achieved in an MCO loaded only with fuel baskets containing the maximum length fuel assembly. Scrap basket masses are limited by criticality constraints for basket loading in the basin or the packing density of variable sized pieces achieved during loading. The scrap basket weight is also limited to be no greater than the maximum weight of a fuel basket. This is due to limits of the lifting crane.

Table 4.2.1-1: Alternative Loaded Masses per MCO

Fuel Type	Mk IV				Mk 1A			
Loading Description	Maximum Fuel Load with 0/1/2 Scrap Baskets			Nominal Fuel Load	Maximum Fuel Load with 0/1/2 Scrap Baskets			Nominal Fuel Load
Basis	270 E Length Assemblies	216 E Length Assemblies	162 E Length Assemblies	Average of Mk IV Assembly Lengths	288 M Length Assemblies	240 M Length Assemblies	192 M Length Assemblies	Average of Mk 1A Assembly Lengths
No. Of Fuel Baskets[1]	5	4	3	4	6	5	4	5
No. Of Scrap Baskets	0	1	2	1	0	1	2	1
MCO Parts[2] (kg)								
-Shell	880	880	880	880	880	880	880	880
-Shield Plug	699	699	699	699	699	699	699	699
-Fuel Basket	450	360	270	360	1,080	900	720	900
-Scrap Basket	0	202	404	202	0	249	498	249
Total Mass of Parts	*2,029*	*2,141*	*2,253*	*2,141*	*2,659*	*2,728*	*2,797*	*2,728*
Fuel Materials[3]								
Assemblies[4]								
-Fuel (kg U)	6,340	5,072	3,804	4,912	4,778	3,982	3,185	3,922
-Cladding (kg Zr)	443	354	266	345	409	341	273	336
Scrap[5]								
-Fuel (kg U)	0	870	1,740	870	0	503	1,006	503
-Cladding (kg Zr)	0	61	122	61	0	43	86	43
Total Masses								
-Fuel (kg U)	6,340	5,942	5,544	5,782	4,778	4,485	4,191	4,425
-Cladding (kg Zr)	443	415	388	406	409	384	359	379
Particulate[6] (kg)								
- Sludge deposit	3.5	2.8	2.1	0.48	3.74	3.11	2.49	0.53
- Cladding film	10.65	10.05	9.46	2.52	9.09	8.58	6.86	2.14
- Oxide film	0.4	0.77	1.14	0.39	0.3	0.54	0.75	0.30
- Particulate	5.40	12.14	18.88	2.42	5.76	11.18	16.60	2.46
Total Particulate	19.95	25.76	31.58	5.81	18.89	23.41	26.70	5.43
Free Water [7](kg)	*478*	*498*	*517*	*506*	*503*	*522*	*542*	*527*
Total Mass of MCO Contents (kg)	7,281	6,881	6,481	6,700	5,709	5,414	5,119	5,336
Total MCO Mass (kg)	9,310	9,022	8,734	8,841	8,368	8,142	7,916	8,064

Notes:

1. Design basis for MCO taken from Goldmann (1998b).
2. Mass data taken from Smith (1998).
3. Nominal loading case based on average length fuel assembly in fuel baskets. Scrap baskets assumed loaded to 95% of the criticality mass limit for each fuel type.
4. Assembly data taken from *Willis (1998).*
5. Combined mass of scrap and fuel cladding limited by criticality administrative limits taken from Kessler and Peck (1998) for the maximum loading case.
6. For maximum cases, bounding (high) particulate values were used from Table 6.1 of Sloughter (1998). For nominal cases, nominal (best estimate) particulate values were used from Table 6.1 of Sloughter (1998). The bounding and nominal particulate values for Mk 1A MCOs are based on the methods in Sloughter (1998) modified for Mk 1A MCO loading cases.
7. Free water mass estimate based on difference between the total void volume and the nominal gas void volume for the listed configuration.

4.2.2 MCO Void Space Volume

The void volume of a MCO, based on alternative loadings and equipment dimensions, is calculated and summarized in Table 4.2.2-1 following. The MCO void volume is based on the MCO cavity volume minus the displacement from the fuel and cladding and the displacement from the fuel baskets.

Table 4.2.2-1: Summary of Void Volume Estimates for Alternative MCO Loadings

Fuel Type	Mk IV				Mk 1A			
Loading Description	Maximum Fuel Loading	Maximum Particulate Loading		Nominal Loading	Maximum Fuel Loading	Maximum Particulate Loading		Nominal Loading
No. Fuel Baskets	5	4	3	4	6	5	4	5
No. Scrap Baskets	0	1	2	1	0	1	2	1
Basis	270 E Length Assemblies	216 E Length Assemblies	162 E Length Assemblies	Average of Assembly Lengths	288 M Length Assemblies	240 M Length Assemblies	192 M Length Assemblies	Average of Assembly Lengths
Void Volume (L)	499	519	538	527	524	543	563	548

4.2.2.1 Calculations

The MCO Void Volume = MCO Cavity Volume - Fuel Displacement - Fuel Basket Displacement - Scrap Fuel Displacement - Scrap Basket Displacement

<u>MCO Cavity Volume</u> The cavity volume is $V_{MCO} = (\pi/4)D^2L$

where : D = MCO internal diameter (23 in., H-2-828041, Rev. 0, Sh. 1), and
L = MCO internal length (140 in., H-2-828041, Rev. 0, Sh. 1)

$$V_{MCO} = (\pi/4)\ (23 \text{ in} \times 2.54 \text{ cm/in})^2\ (140 \text{ in} \times 2.54 \text{ cm/in})$$
$$V_{MCO} = 953{,}000 \text{ cm}^3 \times (1\text{L} / 1000 \text{ cm}^3) = 953 \text{ L}$$

<u>Fuel Displacement Volume</u> The fuel displacement volume (per assembly) is:

$$V_{fuel,Assy} = (\pi/4)\ (D^2_{o,o} - D^2_{i,o} + D^2_{o,i} - D^2_{i,i})\ L$$

<u>Scrap Displacement Volume</u> The scrap fuel displacement volume is:

$$V_{scrap\ fuel} = W_{uranium} \times V_{disp\ vol}$$

Where $W_{uranium}$ = Weight of uranium in scrap (see following equation)
$V_{disp\ vol}$ = Fuel displacement volume per MTU (67 L/MTU, Willis 1998)

The weight of uranium in a scrap basket is derived from the fuel weight limit as follows:

Fuel weight = Cladding weight + Uranium weight

OR $F = C + U$

Divide equation by U: $F/U = C/U + 1$

Then $U/F = (C/U + 1)^{-1}$

and $U = F\,(C/U + 1)^{-1}$

The ratio C/U is provided in Willis (1998) as a weighted average ratio of Zircaloy-2 to uranium for N Fuel (e.g. Mk IV is 70.3 kg/MTU, or 0.0703 kg/kgU). This number is then multiplied by the scrap fuel weight (F) to obtain the kg U.

4.2.2.2 Maximum Mk IV Fuel Loading Case

This calculation considers the case where an MCO is loaded with 270 E length Mk IV assemblies, with 0 scrap baskets, and 5 Mk IV fuel baskets. An alternate maximum fuel load case considers an MCO loaded with 216 E length Mk IV assemblies with 1 scrap basket (filled with 931 kg scrap) and 4 Mk IV fuel baskets, or 162 E length Mk IV assemblies with 2 scrap baskets and 3 Mk IV fuel baskets. The MCO void volume, then, is calculated as follows:

MCO Void Volume = MCO Cavity Volume - Fuel Displacement - Fuel Basket Displacement - Scrap Fuel Displacement - Scrap Basket Displacement

Where the fuel characteristics are (Willis and Praga 1998):

For a maximum length Mk IV fuel assembly

$D_{o,o} = 6.15$ cm, $D_{i,o} = 4.32$ cm, $D_{o,i} = 3.25$ cm, $D_{i,i} = 1.22$ cm, $L = 66.3$ cm

$$V_{fuel,Assy} = (\pi/4)[(6.15\text{cm})^2 - (4.32\text{cm})^2 + (3.25\text{cm})^2 - (1.22\text{cm})^2](66.3\text{ cm})$$
$$= 1{,}470\text{ cm}^3 \times (1\text{ L}/1000\text{ cm}^3) = 1.47\text{ L / assembly}$$

The MCO cavity volume (previously calculated) is 953 L
The fuel basket displacement is 11.43 L (from Smith 1998)
The scrap basket displacement is 12.90 L (from Smith 1998)

The scrap fuel displacement is $V_{scrap\ fuel} = W_{uranium} \times V_{disp\ vol}$

where $W_{uranium}$ = weight of uranium in scrap,

$U = F\,(C/U + 1)^{-1}$

and $U = 931\ kg\ (0.0703+1)^{-1} = 870\ kg\ U$

$V_{disp\ vol}$ = 67 L/MTU (Willis 1998)

$$V_{scrap\ fuel} = \frac{(870\ kg\ U) \times 67\ L/MTU}{1000\ kgU/1MTU} = 58.29\ L$$

For 5 Mk IV fuel baskets loaded with 270 E length assemblies:
MCO VOID VOLUME = 953 L - 270(1.47 L/assembly) - 5(11.43 L) = 499 L

For 4 Mk IV fuel baskets loaded with 216 E length assemblies & 1 scrap basket:
MCO VOID VOLUME = 953 L - 216(1.47 L/assembly) - 4(11.43 L) - 58.29 L - 12.90 L = 519 L

For 3 Mk IV fuel baskets loaded with 162 E length assemblies & 2 scrap baskets:
MCO VOID VOLUME = 953 L - 162(1.47 L/assembly) - 3(11.43 L) - 2(58.29 L) - 2(12.90 L) = 538 L

4.2.2.3 Nominal Mk IV Fuel Loading Case

This calculation considers the case where an MCO is loaded with 216 average length Mk IV fuel assemblies in 4 fuel baskets and one scrap basket filled with 931 kg of scrap. The MCO void volume is thus calculated as follows:

Where the fuel characteristics are (Willis and Praga 1998):

For an average length Mk IV fuel assembly

$D_{o,o}$ = 6.15 cm, $D_{i,o}$ = 4.32 cm, $D_{o,i}$ = 3.25 cm, $D_{i,i}$ = 1.22 cm, L = 64.3 cm

$$V_{fuel,Assy} = (\pi/4)[(6.15cm)^2 - (4.32cm)^2 + (3.25cm)^2 - (1.22cm)^2](64.3\ cm)$$
$$= 1{,}426\ cm^3 \times (1\ L/1000\ cm^3) = 1.43\ L\ /\ assembly$$

The MCO cavity volume (previously calculated) is 953 L
The fuel basket displacement is 11.43 L (from Smith 1998)
The scrap basket displacement is 12.90 L (from Smith 1998)
The scrap fuel displacement (previously calculated in Section 4.2.2.2) is 58.29 L

MCO VOID VOLUME = 953 L - 216(1.43 L/assembly) - 4(11.43 L) - 58.29 L - 12.90 L = 527 L

4.2.2.4 Maximum Mk 1A Fuel Loading Case

This calculation considers the case where an MCO is loaded with 288 M length Mk 1A assemblies, with 0 scrap baskets, and 6 Mk 1A fuel baskets. An alternate maximum fuel load case considers an MCO loaded with 240 M length Mk 1A assemblies with 1 scrap basket (filled with 546 kg scrap) and 5 Mk 1A fuel baskets, or 192 M length Mk 1A assemblies with 2 scrap baskets and 4 Mk 1A fuel baskets. The MCO void volume, then, is calculated as follows:

MCO Void Volume = MCO Cavity Volume - Fuel Displacement - Fuel Basket Displacement - Scrap Fuel Displacement - Scrap Basket Displacement

Where the fuel characteristics are (Willis and Praga 1998):

For a maximum length Mk 1A fuel assembly

$D_{o,o} = 6.10$ cm, $D_{i,o} = 4.50$ cm, $D_{o,i} = 3.18$ cm, $D_{i,i} = 1.11$ cm, L = 53.1 cm

$$V_{fuel,Assy} = (\pi/4)[(6.10cm)^2 - (4.50cm)^2 + (3.18cm)^2 - (1.11cm)^2](53.1\ cm)$$
$$= 1{,}078\ cm^3 \times (1\ L/1000\ cm^3) = 1.08\ L\ /\ assembly$$

The MCO cavity volume (previously calculated) is 953 L

The fuel basket displacement is 19.67 L (from Smith 1998)

The scrap basket displacement is 18.28 L (from Smith 1998)

The scrap fuel displacement is $V_{scrap\ fuel} = W_{uranium} \times V_{disp\cdot vol}$

where $W_{uranium}$= weight of uranium in scrap,

$$U = F\ (C/U + 1)^{-1}$$

and $U = 546\ kg\ (0.0857+1)^{-1} = 503\ kg\ U$

$V_{disp\ vol} = 67$ L/MTU (Willis 1998)

$$V_{scrap\ fuel} = \frac{(503\ kg\ U) \times 67\ L/MTU)}{1000\ kgU/1MTU} = 33.70\ L$$

For 6 Mk 1A fuel baskets loaded with 288 M length assemblies:

MCO VOID VOLUME = 953 L - 288(1.08 L/assembly) - 6(19.67 L) = 524 L

For 5 Mk 1A fuel baskets loaded with 240 M length assemblies & 1 scrap basket:

MCO VOID VOLUME = 953 L - 240(1.08 L/assembly) - 5(19.67 L) - 33.70 L - 18.28 L = 543 L

For 4 Mk 1A fuel baskets loaded with 192 M length assemblies & 2 scrap baskets:

MCO VOID VOLUME = 953 L - 192(1.08 L/assembly) - 4(19.67 L) - 2(33.70 L) - 2(18.28 L) = 563 L

4.2.2.5 Nominal Mk 1A Fuel Loading Case

This calculation considers the case where an MCO is loaded with 240 average length Mk 1A fuel assemblies in 5 fuel baskets and one scrap basket filled with 546 kg of scrap. The MCO void volume is thus calculated as follows:

Where the fuel characteristics are (Willis and Praga 1998):

For an average length Mk 1A fuel assembly

$D_{o,o}$ = 6.10 cm, $D_{i,o}$ = 4.50 cm, $D_{o,i}$ = 3.18 cm, $D_{i,i}$ = 1.11 cm, L = 52.3 cm

$$V_{fuel,Assy} = (\pi/4)[(6.10\text{cm})^2 - (4.50\text{cm})^2 + (3.18\text{cm})^2 - (1.11\text{cm})^2](52.3\text{ cm})$$
$$= 1{,}061\text{ cm}^3 \times (1\text{ L}/1000\text{ cm}^3) = 1.06\text{ L / assembly}$$

The MCO cavity volume (previously calculated) is 953 L
The fuel basket displacement is 19.67 L (from Smith 1998)
The scrap basket displacement is 18.28 L (from Smith 1998)
The scrap fuel displacement (previously calculated in Section 4.2.2.4) is 33.70 L

MCO VOID VOLUME = 953 L - 240(1.06 L/assembly) - 5(19.67 L) - 33.70 L - 18.28 L = 548 L

4.2.3 Water Volume

The nominal water volume in the MCO is estimated from the total void volume minus the nominal gas void space at the top of the MCO (see Section 4.2.4, following). The nominal water volume is then estimated to be (527 - 21) 506 L in a Mk IV MCO and (548 - 21) 527 L in a Mk 1A MCO. The minimum volume of water in a MCO is estimated at 478 L, while the maximum depends on the fuel loading of the baskets contained by a MCO.

4.2.4 Gas Void Space

The mass of gas contained in the void space is relatively small, based on a nominal void volume of the top 4 inches of the MCO. Edwards (1997) estimates a gas void volume of 15 L in the cask cavity. The dimensions shown in Figure 5 results in the following nominal void volume estimate.

$$V_{void} = \text{MCO void} + \text{cask void}$$
$$= \pi/4\,(20.5^2 - 4^2\text{ in}^2)\,(4\text{ in}) + 15\text{ L}$$
$$= 1{,}270\text{ in}^3 + 15\text{ L} = 20.8\text{ L} + 15\text{ L} = 35.8\text{ L}$$

4.2.3.1 Hydrogen Generation

Uranium metal fuel will react with water and other oxidants. Uranium metal is exposed to reactants when cladding defects exist, which allows the uranium to corrode. The corrosion of uranium metal by water vapor produces hydrogen according to the following stoichiometry.

$$U + 2H_2O \rightarrow UO_2 + 2H_2$$

From this stoichiometry, the hydrogen generation can be converted to mg wt gain:

$$\left(32\frac{\text{g wt gain}}{\text{gmol U}}\right)\left(10^{3}\frac{\text{mg}}{\text{g}}\right)\left(\frac{\text{1 gmol U}}{\text{2 gmol H2}}\right) = 16{,}000\frac{\text{mg wt gain}}{\text{gmol H2}}$$

The reaction rate constant is based on Reilly (1998), which indicates:

For liquid water with T < 373 K (O_2 free)

$$\text{Log } K = 7.634 - (3016 / T)$$

$$K = 10^{(7.634 - 3016/T)}$$

where K is mg wt gain / hr -cm^2 and T is temperature, in Kelvin

Since the reaction rate relationships were developed for unirradiated uranium samples, an adjustment factor is required to account for the increased surface area and reactivity of the N Reactor fuel due to corrosion and irradiation (Edwards 1997). An Enhancement Factor of 3 (design basis) is shown in Reilly (1998) to account for these effects.

The hydrogen generation rate can be found from combining the above equations to:

Hydrogen Generation Rate =

$$\frac{[\text{Reaction Rate (mg wt gain/hr-cm}^2)] \times [\text{Fuel Surface Area (cm}^2)] \times [\text{Enhancement Factor}]}{16{,}000 \text{ (mg wt gain / gmol H}_2)}$$

As part of the Spent Nuclear Fuel Evaluations Phase II Characterization, spent nuclear fuel and fuel canister sludge was sampled from sealed canisters in the 105-K West Basin. These samples were stored in KW for short periods of time before transport to the 327 Building facility. While stored, the total volume of gas (assumed to be hydrogen) released from a particular sample container was collected over a known period of time (Briggs and Roe 1997). The gas captured in the monitors was not sampled and thus no definitive characterizations were possible as to what gas was collected. It was noted that some fuel samples exhibited a measurable "dead time" prior to gas generation. These results seemed to indicate a dormant period before gas generation occurred. Table 4.2.3.1-1 presents the generation rates recorded as the entire gas volume (ml) for the entire monitoring evolution (hr). In comparison, Figure 12 presents hydrogen generation rates for various loading alternatives based on the modeling equations previously presented.

Conclusions made as a result of the comparison between observed gas generation and the modeling equations are as follows:

1) The rates varied from 2.6 x 10^{-6} to 3.1 x 10^{-5} gmol H_2/hr; which for 270 outer elements, corresponds to 7 x 10^{-4} to 8 x 10^{-3} gmol H_2/hr, and is about the same as the modeling equations. This shows that the measured reaction rates of the samples in the basin prior to shipping match predicted values from modeling equations.

2) The enhancement factor calculated from the sample shipping experience varies from 0.45 to 5.9 and therefore corresponds well to the design basis number provided in Reilly (1998).

3) An induction period can be expected before hydrogen generation begins if the water is oxygenated. This is a likely explanation for the sample shipping experience. The calculations do not take credit for this as it would be difficult to predict. This effect has been observed in studies of the effect of oxygen and other gases on the uranium-water reaction. Baker, et. al. (1966) found that, in this reaction, some hydrogen was formed in the early stages, but the concentration showed a barely perceptible upward trend in this period. The water vapor pressure remained constant and the oxygen pressure fell linearly. When the oxygen pressure became zero there was an immediate rise in hydrogen concentration and a fall of water vapor pressure. The resulting plot is shown in Figure 13, taken from Baker et. al. (1966).

Table 4.2.3.1-1: Reaction Rate Comparison Based on Shipping Gas Generation

SFEC	Gas Rate	Basin Water Temp		H_2 Generation (gmol/hr)[1]	Picture / Estimated Reaction Area		Apparent Wt Gain (mg wt gain/hr-cm^2)[3]	Enhancement Factor [4]
		°F	°C		Fig. #	Area [2]		
9-94-18	10 ml / 96 hr	69	20.6	6.2×10^{-6}	4	½ of ½" $\Rightarrow$ 12.3 cm^2	8.0×10^{-3}	3.6
12-96-1	30 ml / 96 hr	69	20.6	1.9×10^{-5}	6	5" $\Rightarrow$ 245 cm^2	1.2×10^{-3}	0.54
12-96-2	5 ml / 116 hr	71	21.7	2.6×10^{-6}	12	No Estimate	--	--
12-96-9	60 ml / 116 hr	71	21.7	3.1×10^{-5}	14	10" $\Rightarrow$ 490 cm^2	1.0×10^{-3}	0.45
12-96-3	40 ml / 96 hr	69	20.6	2.5×10^{-5}	5	No Estimate	--	--
12-96-5	20 ml / 116 hr	71	21.7	1.0×10^{-5}	11	½ of ½" $\Rightarrow$ 12.3 cm^2	1.3×10^{-2}	5.9
12-96-7	5 ml / 116 hr	71	21.7	2.6×10^{-6}	13	No Estimate	--	--

Notes:

(1) H_2 generation measured based on pressure of 15 ft H_2O, gage and Basin temp, $\dot{n} = \dfrac{(\text{ml}/\text{hr})(1.44\ \text{atm})}{(82.06)\,T}$

(2) Areas based on an outer element outside surface area Area / L = π D = π (6.15 cm) = 19.3 cm^2/cm

(3) H_2 generation converted to mg wt gain / hr by stoichiometry $U + 2H_2O \rightarrow UO_2 + 2H_2$

(4) Compared to expected rate at 20°C, Predicted Rate = $10^{[7.634 - (3016/T)]} = 2.2 \times 10^{-3}$ mg wt gain / hr-cm^2

Figure 12 - Hydrogen Generation Rates

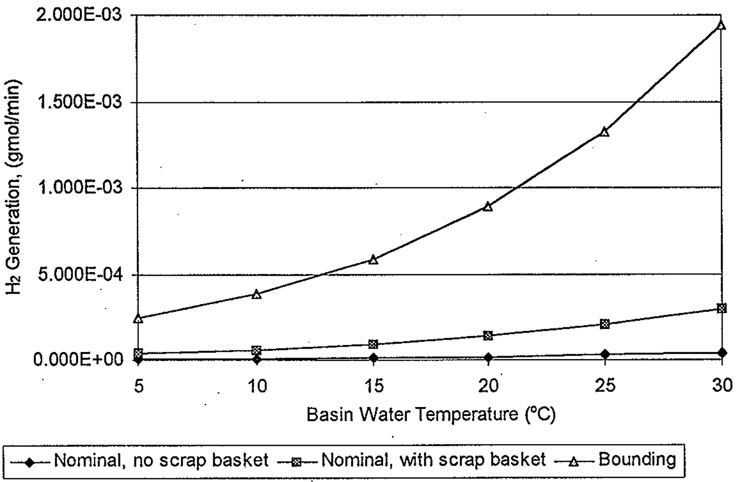
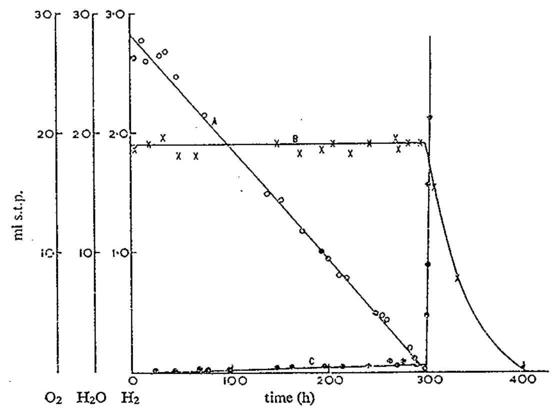


Figure 13 - Variation of Gas Composition with Time (Baker, et. al. 1966)
(Legend: A, O_2; B, H_2O; C, H_2)



4.2.3.2 Gas Space Inerting

There is a 4-inch void head space at the top of the MCO. An inert gas is required to fill the head space in order to preclude flammable mixtures from developing. If the head space is not filled with inert gas, it has been shown that the MCO could exceed its 4 vol% H_2 limit in as little as one hour (using the bounding surface area).

There are two alternatives to establish an inert atmosphere in the Cask/MCO:

1) Pressurize with helium and bleed off.

2) Evacuate and backfill.

The helium pressurize and bleed alternative was selected to minimize equipment installation in the basins.

Each alternative has a wide range available for selecting operating pressures and the number of cycles. Figure 14 shows how repeating cycles of pressurizing and bleeding can reduce the oxygen concentration in the MCO/Cask to below acceptable concentrations. This figure also shows that the MCO will be the limiting factor when determining the optimum number of cycles as its oxygen concentration consistently remains higher than that of the Cask for all pressure-bleed cycles.

Assuming that it is desirable to have a final oxygen concentration of less than 2.0 volume percent (mole fraction .02), a conservative conclusion can be drawn that 5 pressurize and bleed cycles with a minimum charge pressure of 24 psig or 4 cycles with a minimum charge pressure of 30 psig could be needed to provide an appropriately oxygen deficient atmosphere. Figure 15, then shows the variation of charge pressure with number of pressurize and bleed cycles required to obtain a final oxygen concentration in the MCO of 2.0 volume percent.

Figure 14 - Variation of Oxygen Concentration in Cask and MCO Void Volumes During Pressure-Bleed Cycles with an Inert Gas

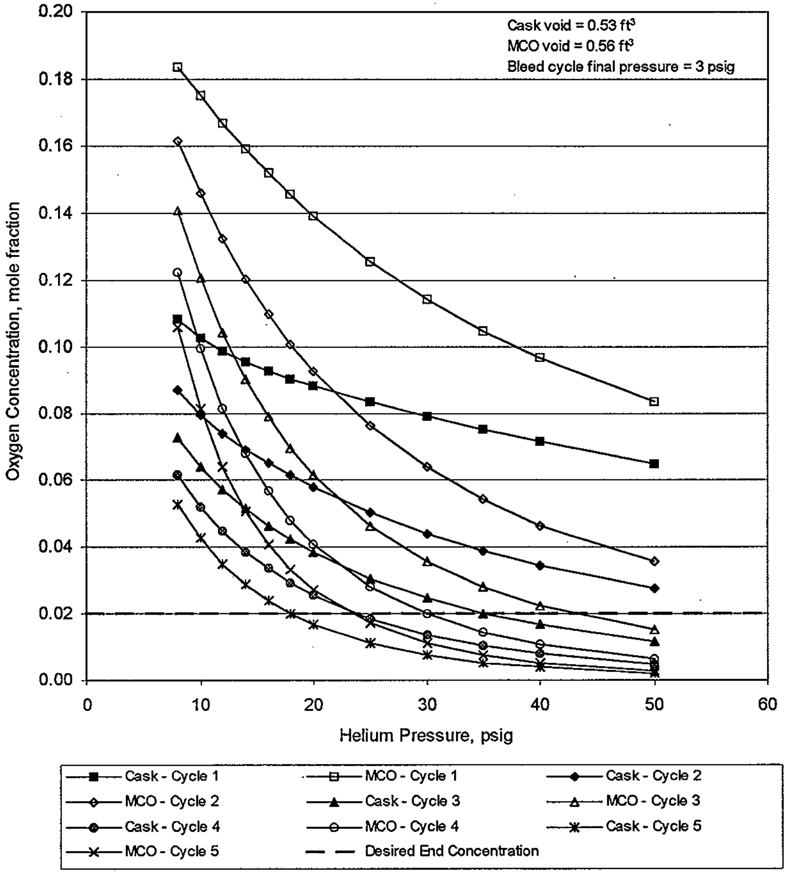
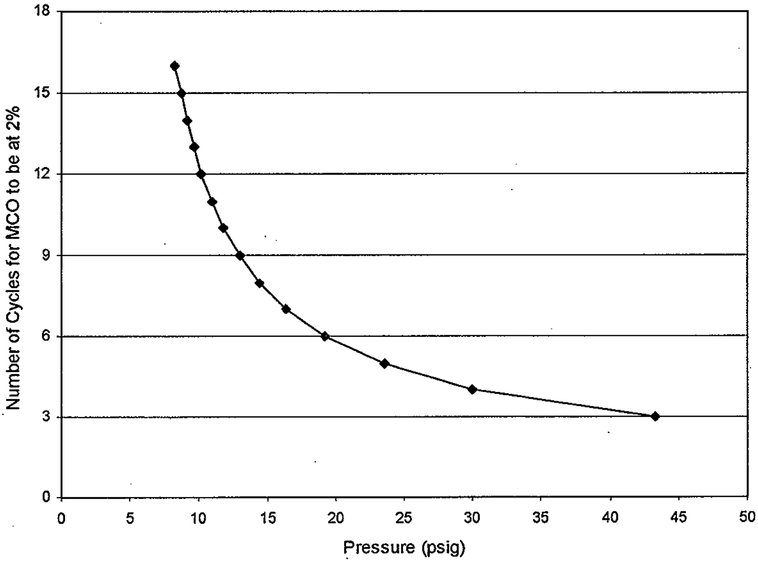


Figure 15 - Variation in Charge Pressure with Number of Pressure-Bleed Cycles to Secure MCO Oxygen Concentration at 2.0 Volume Percent



5.0 PROCESS CONTROL

The following process control features come from Pajunen and Sederburg (1998). Please see that document for explanation of the basis for each specification.

MCO Sealing

MCO seal ring cleanliness is controlled by design of a basket loading guide. Cleanliness is administratively controlled by specifying that the basket guide must be in place during basket loading activities and cleaning the seal area prior to shield plug installation. After the basket guides are removed, the seal ledge surface is cleaned to remove any particles using a qualified tool and procedure.

MCO Cask Package Backfill Gas

Helium inerting will be performed through the shield plug filter trap prior to loadout to CVD. Inerting will thereby be performed through the cask lid by over pressurizing and then bleeding off the MCO and Cask (i.e., MCO communicates directly with the cask cavity through an internal MCO High Efficiency Particulate Air [HEPA] filter). The objective of inerting the MCO and cask void spaces with helium is to establish an atmosphere that remains a non-flammable gas mixture as hydrogen is generated within the MCO.

MCO Cask Package Pressure

This will be administratively controlled to less than 3 psig as measured after backfill.

Cask Water Fill Level

The MCO port number 3 is not used at the load out pits; therefore, the water in the MCO will never drain to a level below the top of the fuel for shipping operations. The cask water level is dictated by the MCO/Cask seal location. Any drainage needed to accommodate thermal expansion is also accounted for.

6.0 OFF-STANDARD CONDITIONS

Off-standard or off-normal conditions can occur at various stages of the MCO loading and cask loadout process. Recovery actions are then required to remedy the situation. Following are some off-normal conditions and recovery actions. References to Figure 2 (Operational Sequence Block Flow Diagram) are made for purposes of finding where the off-normal situations may occur in the process. This list is not all-inclusive and additional items may be added in the future.

- Replacement of the Pail Lid Seal

  In Block 3-1 (Figure 2), the pail lid is inspected for damage prior to use in the Loadout Pit. If the inflatable seals are found to be worn, then the seals will require replacement before use. An estimate of two hours is required to replace the seals, and this would impact the MCO loading time (if no other pail lids were available to use).

- Debris Present in Pail

  In Block 4-1 (Figure 2), the pail is inspected in order to determine that it is clear of debris prior to placement in the Loadout Pit. If there is debris present in the pail, then an additional 60 minutes (estimate) is required to rid the pail of the debris.

- Water Level in Pail and Vent Port Closure Unsatisfactory

  In Block 7-1 (Figure 2), the pail is filled with demineralized water. In Block 7-2, the water level is checked to verify the correct level/volume is present in the pail. In addition, the pail lid has been installed (previously) and the vent port closure is also verified closed in this step. If repair is needed, up to an additional four hours (estimate) could be required for this task.

- Replace Shield Plug

  The shield plug is received and staged at the K Warehouse (Block 9-1 through 9-3, Figure 2). There it is unpacked, the port plugs are removed, and then it is inspected to determine that the plug configuration is correct. If it is not, then the shield plug requires replacement or reconfiguration.

- Shield Plug Assembly Leak Check

  In Block 9-12 (Figure 2), the shield plug assembly is leak checked prior to installation on the MCO. If the assembly does not pass the leak check test, then the process tube must be removed from the assembly and the assembly disassembled in order to determine the cause of the failure.

- Shield Plug Installation

  In Block 10-1 (Figure 2), the shield plug is installed on the MCO. Three attempts are allowed to install the shield plug correctly. If the third try is unsuccessful, then recovery actions are required. The shield plug is removed in order to determine the cause of the failure, and repair and/or replacement of the assembly is completed, as necessary (Blocks 10-2A through 10-2D). If replacement of the shield plug is required, then additional actions to obtain a new shield plug will require additional time and effort.

- Decontaminate MCO Top and Pail Lid

  As the immersion pail is lifted from the Loadout Pit, the top of the MCO and the pail lid is surveyed to determine the level of contamination, if any (Block 10-8, Figure 2). If contamination is detected, then up to an additional 30 minutes may be required for decontamination.

- Decontaminate Shield Plug Handling Fixture

  As the lift beam is removed from the top of the MCO, any excess water that is trapped between the Shield Plug Handling Fixture and the MCO is removed, and the top of the MCO and the handling fixture is decontaminated (Block 10-12, Figure 2). In addition, after the auxiliary hoist is removed from the handling fixture, then the underside of the handling fixture can be surveyed and decontaminated as necessary (Block 10-16, Figure 2).

- Post-Torque Calibration Test

  In Block 10-22 (Figure 2), a post-torque calibration test is conducted to verify that the shield plug locking ring has been correctly tightened to lock the Shield Plug onto the MCO. If the post-torque calibration test fails, then a recovery plan is needed to determine the cause of the failure and the necessary steps required to correct the situation. These steps are yet to be determined.

- Decontaminate Cask

  As the cask is removed from the immersion pail, it must be dried and then surveyed (Block 12-5, Figure 2). Any contamination found will be removed prior to moving the cask to the trailer (Block 12-6). Decontamination is expected to take up to 60 minutes, if necessary.

7.0 SUMMARY FACILITY DESCRIPTION / INTERFACES

7.1 105 K Basin Description

The 105 K East (KE) and 105 K West (KW) Basins are located in the 100 K Area of the Hanford Site. The KE Basin is adjacent to and north of the 105 KE Reactor building; the KW Basin is adjacent to and north of the 105 KW Reactor building. The basic structural features of the 105 KE and 105 KW fuel storage basins are illustrated in Figure 16.

The below-grade reinforced concrete fuel storage basins are basically rectangular, approximately 125 feet long and 67 feet wide. The floor elevation is at a ground elevation of 465 feet above sea level. The water retention walls are 20 feet 9 inches high with a normal operating water depth of 16 feet. The basin floor is a 2 foot thick reinforced concrete mat. The normal operating depth is 16 feet 10 inches in KE (due to dose reduction activities) and 16 feet in KW. A discharge pickup chute is connected to the south side of the basins, directly behind the reactor; the chute was originally used to discharge fuel elements from the reactor, but is no longer in operation. The discharge chute is isolated from the main basin by barrier doors that were installed for that purpose. The building exterior walls are steel with corrugated asbestos cement panels.

The KE and KW fuel storage basins are identical except for retaining wall thickness and the metal roof over the KW fuel storage basin roof. The KE fuel storage basin has a constant wall thickness of 27 inches. With the exception of the west wall, the KW fuel storage basin walls are tapered from a 27-inch base to an 18 inch top. The 20 feet-9 inch high basin walls are cantilevered from the floor mat. The reinforcing steel sizes are identical, which means the KE fuel storage basin section strengths are consistently as high or higher than the KW fuel storage basin walls.

The system descriptions and design criteria for the facilities are discussed in *Technical Manual-Systems Descriptions* (Frier 1996). The resulting design bases require that safety class systems be designed to survive the natural phenomena detailed in Table 7.1-1 below. Design requirements for non-safety class structures are provided in Table 7.1-2; non-safety class structures are identified in the *Safety Equipment List for K Basins* (Frier 1998).

Figure 16 - North-South Cross Section of 105-K Reactor Building and Basin

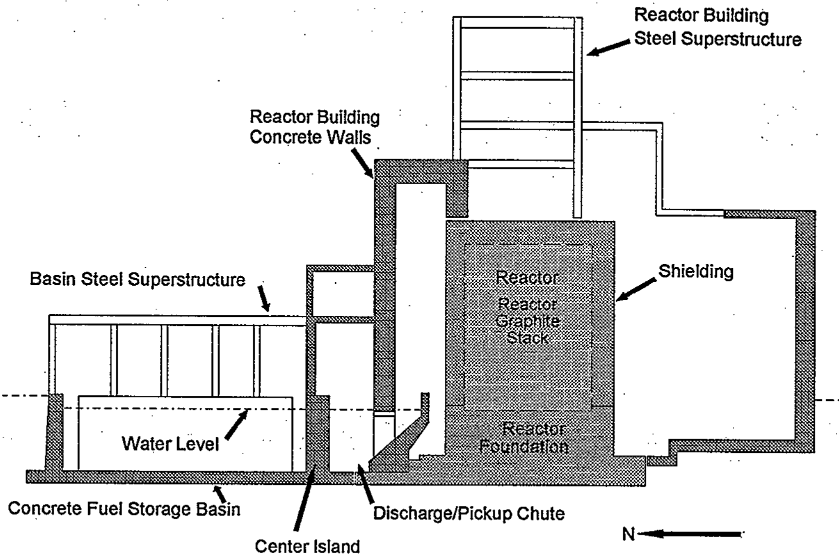


Table 7.1-1 - K Basin Safety Class Structures Natural Phenomena Hazard Design Criteria

Safety Class Structures	
Phenomena	Design Requirement
Seismic event	- 0.2g horizontal - 0.13g vertical
Straight wind	- 90 mph
Snow*	- 20 lb/ft^2 ground load

*Note: Criteria for additional live, dead and seismic loads are detailed in WHC-SD-SNF-SDD-002.

Table 7.1-2 - K Basin Non-Safety Class Structures Natural Phenomena Hazard Design Criteria

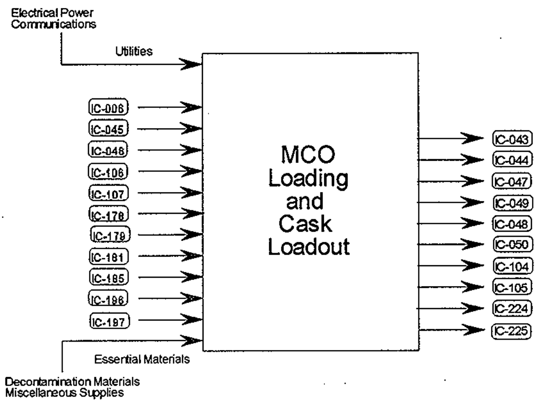
Non- Safety Class Structures	
Phenomena	Design Requirement
Seismic event	- 0.09g to 0.12g horizontal - vertical not used
Straight wind	- 70 mph
Snow*	- 20 lb/ft^2 ground load

*Note: Criteria for additional live, dead and seismic loads are detailed in WHC-SD-SNF-SDD-002.

7.2 Facility/Process System Interfaces

Figure 17 provides a summary of the facility and process system interfaces. Supply interfaces consist of the empty MCO/Cask delivered to the K Basins from the CSB, fresh water to support cask loading, and treated water to support cask loading, compressed air, helium, and electrical supplies. The MCO/Cask loadout process produces loaded MCO/Casks for transport to the CVDF for vacuum drying. The process also produces decontamination waste which is sent to KE or KW Basin Solid Waste Handling, and flush water which is sent to the KE or KW Basin Water Systems for processing. Additional detail, quantifying the process interfaces, can be found on the mass balance tables in Section 11.

Figure 17 - Summary of Interfaces



IC-006 - Empty MCO/Cask on Conveyance from CSB
IC-043 - Loaded KE MCO/Cask Delivered to K Basin SNF Vacuum Drying
IC-044 - Loaded KW MCO/Cask Delivered to K Basin SNF Vacuum Drying
IC-045 - Treated Water Cask Flush from KE Basin Water System
IC-046 - Treated Water Cask Flush from KW Basin Water System
IC-047 - Flush Water to KE Basin Water System
IC-048 - Flush Water to KW Basin Water System
IC-049 - Decon Waste to KE Basin Solid Waste Handling
IC-050 - Decon Waste to KW Basin Solid Waste Handling
IC-104 - Loaded MCO to MCO Closure
IC-105 - Loaded MCO to MCO Closure
IC-106 - Loaded KE MCO/Cask with Shield Plug from MCO
IC-107 - Loaded KW MCO/Cask with Shield Plug from MCO
IC-178 - Fresh Water to KE Cask Loadout
IC-179 - Fresh Water to KW Cask Loadout
IC-181 - Water in KE MCO After Loading
IC-185 - Water in KW MCO After Loading
IC-196 - KE MCO Basket from Fuel Retrieval
IC-197 - KW MCO Basket from Fuel Retrieval
IC-224 - Exhaust from Venting KE MCO/Cask Void Spaces
IC-225 - Exhaust from Venting KW MCO/Cask Void Spaces

8.0 EQUIPMENT DESCRIPTION

Several tools specific to the SNF project are in development. Of those in development, the tools required to complete MCO loading and cask loadout are identified in Table 8.0-1, following. The tool description and associated process block number (shown in Figure 2) is also provided below.

Table 8.0-1 - Required Tool Equipment List

Process Block No.	Tool or Tool Purpose
2-1, 12-14	Tractor for Trailers
2-4, 2-7, 12-17	Exhaust Trunk for Tractor
2-9, 12-13	Air Supply Gladhand for Inflation of Trailer Suspension
5-3, 5-4, 5-5, 5-6, 11-16, 11-17, 11-18, 11-19	Cask Lid Automatic Torque Tool
5-6	Cart or Stand for Automatic Cask Torque Tool
5-9	Fixture for Cask Lid
6-2, 11-3, 11-4	Lifting Sling for Immersion Pail Lid
7-3, 7-4, 7-5, 7-6, 10-18, 10-19, 10-20, 10-21, 10-24	MCO Locking Ring Installation and Torque Tool
7-3, 10-22	Torque Standard for MCO Jack Bolts
7-7	Rack / Cart to Store Torque Tool / Standards
7-10, 8-8	Fuel Basket Guide & Tool to Install / Remove (Baskets)
7-11, 7-12, 7-13, 7-16, 7-17, 10-5, 10-6, 10-10, 10-11	Immersion Pail Lift Beam
7-14, 10-9, 11-5	Tools to Operate Immersion Pail System
7-17	Rack for Immersion Pail Lift Beam Assembly
8-2	FRS Stiff Back Grapple - Baskets
8-2, 8-5	Fuel Basket Grapple (connects to baskets)
8-8, 11-7	Table for Immersion Pail Lid, and Basket Guide
8-9	Sealing Face Cleaning Tool
9-6, 9-7, 10-13, 10-14, 10-16	MCO Shield Plug Handling Tool
9-7, 9-8, 10-3, 10-4	Shield Plug Pad Eye Capturing Lift Rig
9-10	Shield Plug Support Stand
9-11	Long Process Tube Lifting Tool
9-11	Process Tube Installation Wrench
9-12	Process Tube / Shield Plug Seal Verification Equipment
10-1	Shield Plug Orientation Tool
10-2	Process Tube "after installation" Measuring Device
10-3	Tool to Actuate Shield Plug Quick Release
10-12	Cask / MCO Decon / Water Removal Tools
10-15	Table for Shield Plug Handling Fixture

Process Block No.	Tool or Tool Purpose
11-9	Tools to Remove ~3 in. of Water from Cask Annulus
12-1	Cask Secondary Vent Port Dust Cap Removal Tool
12-2	Cask Secondary Vent Port Access Tool
12-2	Cask / MCO Inerting Tools
12-4	Tool to Wipe Cask as it is Removed from the Pail

9.0 SAFETY (TBD)

10.0 ESSENTIAL MATERIALS

A summary of the materials which must be purchased for basket loading and cask loadout are provided in Table 10.0-1 below. This information has been taken from the SNF Project Cask/Transportation Level 1 material balance (Figure 18), and was compiled by performing a material take-off.

Note: If per MCO quantities are desired, each of the quantities below should be divided by 398, as there are 398 MCOs.

Table 10.0-1 - Summary of MCO Loading and Cask Loadout Purchased Essential Materials

Essential Materials		
Interface Number	Material	System Quantity
TE-2	Decontamination Materials	3.90E+02 kg
TW-2	Decontamination Materials	4.06E+02 kg

A summary of the materials supplied by other subprojects to complete basket loading and cask loadout is provided in Table 10.0-2 below. This information has been taken from the SNF Project Cask/Transportation Level 1 material balance (Figure 18), and was compiled by performing a material take-off.

Table 10.0-2 - Essential Materials Supplied by Other Subprojects.

Essential Materials			
Responsible Subproject	Interface Number	Material	System Quantity
IWTS	IC-045	Treated Water Cask Flush	2.21E+08 L
IWTS	IC-046	Treated Water Cask Flush	2.31E+08 L
IWTS	IC-178	Fresh Water to KE Cask Loadout	1.11E+08 L
IWTS	IC-179	Fresh Water to KW Cask Loadout	1.15E+08 L

11.0 FLOW DIAGRAMS AND MATERIAL BALANCE TABLES

Drawing H-1-81168 (Sheets 1 through 4) presents the process flow diagram and material balance tables for the SNF Cask/Transportation Subproject. The activities for MCO Loading and Cask Loadout are represented on this figure (Figure 18 in this document). The material balances are presented on a subproject basis, representing the quantity of material projected in the system interface.

Figure 18 - Process Flow Diagram - Sheet 1

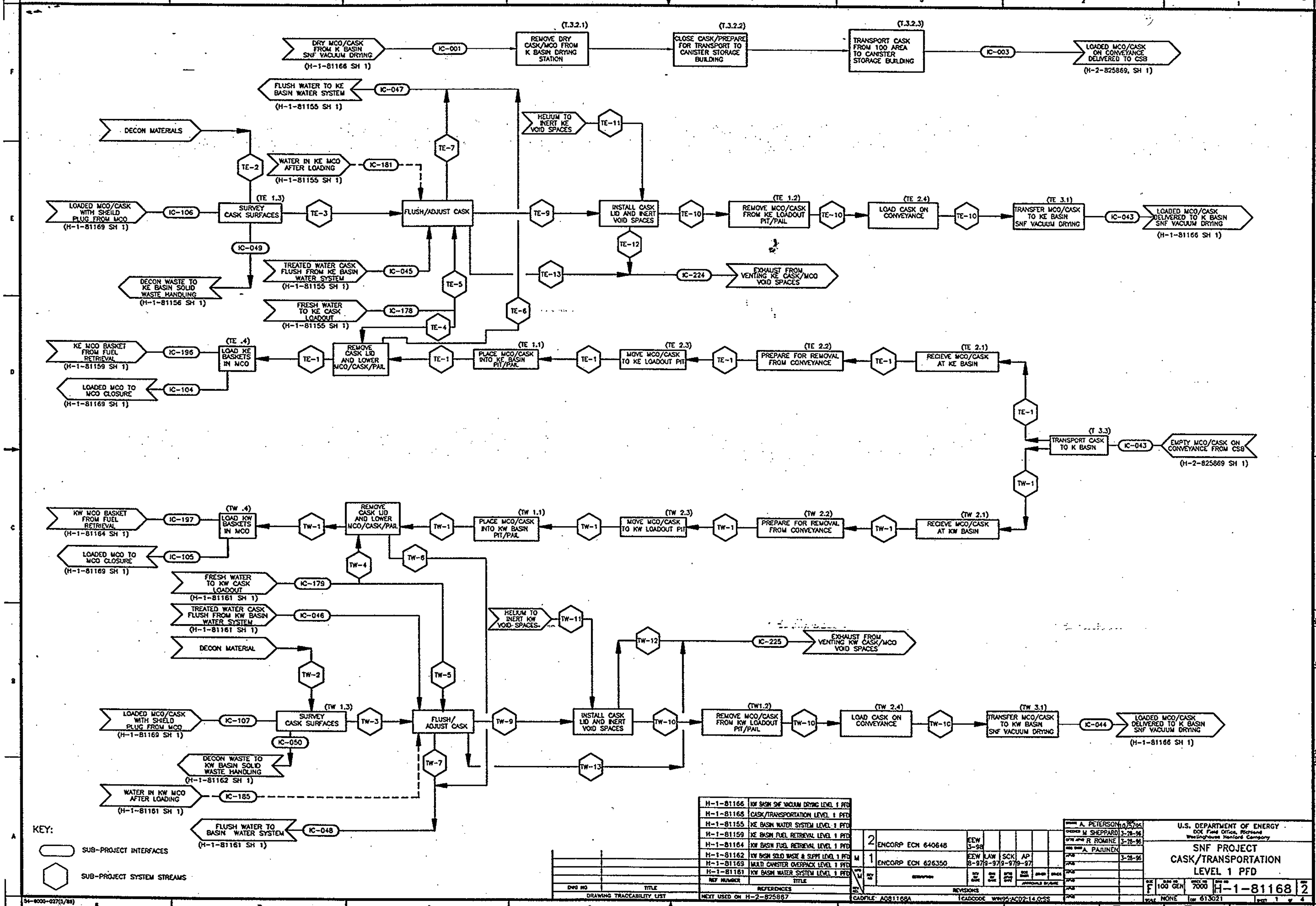


Figure 18 - Mass Balance - Sheet 2

STREAM NUMBER	IC-001	IC-003	IC-006	IC-043	IC-044	IC-045	IC-046
DESCRIPTION	VACUUM DRIED K BASIN FUEL IN MCO/CASK	VACUUM DRIED FUEL IN MCO/CASK DELIVERED TO CSB	EMPTY MCO LOADED IN CASK FOR TRANSPORT TO BASINS	MCO/CASK LOADED WITH WET KE BASIN FUEL	MCO/CASK LOADED WITH WET KW BASIN FUEL	TREATED WATER CASK FLUSH FROM KE WATER SYSTEM	TREATED WATER CASK FLUSH FROM KW WATER SYSTEM
TRANSFER TYPE	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH
PHASE (NOTE 1)	S	S	S	S/L/G	S/L/G	L	L
NUMBER OF ITEMS	398	398	398	195	203	–	–
ITEM COUNT BASIS	MCO	MCO	MCO	MCO	MCO	–	–
VOLUME, CUBIC METERS	–	–	–	–	–	2.21E+02	2.31E+02
DENSITY, g/cc	–	–	–	–	–	1.00	1.00
PRESSURE, torr	900	900	–	915	915	–	–
TEMPERATURE, Deg C	50	50	AMBIENT	10	10	20	20
COMPONENTS, kg (NOTE 2)							
FUEL	2.27E+06	2.27E+06	0.00E+00	1.23E+06	1.04E+06	0.00E+00	0.00E+00
URANIUM	2.10E+06	2.10E+06	0.00E+00	1.14E+06	9.52E+05	0.00E+00	0.00E+00
PLUTONIUM	4.03E+03	4.03E+03	0.00E+00	2.15E+03	1.88E+03	0.00E+00	0.00E+00
OTHER	1.71E+05	1.71E+05	0.00E+00	8.72E+04	8.42E+04	0.00E+00	0.00E+00
SLUDGE	1.38E+02	1.38E+02	0.00E+00	2.34E+03	2.44E+03	0.00E+00	0.00E+00
WATER IN SLUDGE	6.73E+01	6.73E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER	7.09E+01	7.09E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER SOLIDS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
STAINLESS STEEL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ALUMINUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
WATER	6.91E-01	6.91E-01	0.00E+00	9.78E+04	1.04E+05	2.21E+05	2.31E+05
AIR	0.00E+00	0.00E+00	0.00E+00	4.29E-01	4.47E-01	0.00E+00	0.00E+00
OTHER GASES	5.08E+01	5.08E+01	0.00E+00	1.17E+00	1.22E+00	0.00E+00	0.00E+00
ARGON	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HYDROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HELIUM	5.08E+01	5.08E+01	0.00E+00	1.17E+00	1.22E+00	0.00E+00	0.00E+00
NITROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL MASS, kg	2.27E+06	2.27E+06	0.00E+00	1.33E+06	1.14E+06	2.21E+05	2.31 ~~1.36E+06~~ E+05
STATUS (NOTE 3)	B	B	B	B	B	B	B

STREAM NUMBER	IC-047	IC-048	IC-049	IC-050	IC-104	IC-105
DESCRIPTION	KE BASIN CASK FLUSH WATER	KW BASIN CASK FLUSH WATER	KE BASIN CASK DECON SOLID WASTE	KW BASIN CASK DECON SOLID WASTE	LOADED MCO TO MCO CLOSURE	LOADED MCO TO MCO CLOSURE
TRANSFER TYPE	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH
PHASE (NOTE 1)	L	L	S	S	S/L	S/L
NUMBER OF ITEMS	–	–	–	–	195	203
ITEM COUNT BASIS	–	–	–	–	MCO	MCO
VOLUME, CUBIC METERS	3.32E+02	3.46E+02	6.50E-01	6.77E-01	–	–
DENSITY, g/cc	1.00	1.00	0.60	0.60	–	–
PRESSURE, torr	–	–	–	–	–	–
TEMPERATURE, Deg C	20	20	AMBIENT	AMBIENT	AMBIENT	AMBIENT
COMPONENTS, kg (NOTE 2)						
FUEL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+06	1.04E+06
URANIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+06	9.63E+05
PLUTONIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E+03	1.81E+03
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.72E+04	7.34E+04
SLUDGE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E+03	2.44E+03
WATER IN SLUDGE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER SOLIDS	0.00E+00	0.00E+00	3.90E+02	4.06E+02	0.00E+00	0.00E+00
STAINLESS STEEL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ALUMINUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER	0.00E+00	0.00E+00	3.90E+02	4.06E+02	4.06E+02	0.00E+00
WATER	3.32E+05	3.46E+05	0.00E+00	0.00E+00	SEE NOTE 5	SEE NOTE 5
AIR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER GASES	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ARGON	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HYDROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HELIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NITROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL MASS, kg	3.32E+05	3.46 ~~2.21~~E+05	3.90E+02	4.06E+02	1.23E+06	1.04E+06
STATUS (NOTE 3)	B	B	B	B	B	B

ASSUMPTIONS:

1. ASSUMED WATER LOSS FROM CASK IMMERSION PAIL DURING EACH CASK LOADOUT CYCLE = 50 GAL/MCO
2. ASSUMED TREATED WATER VOLUME FOR PRELIMINARY CASK FLUSH = 300 GAL/MCO
3. ASSUMED FRESH WATER VOLUME FOR CASK FLUSHING = 100 GAL PER MCO/CASK
4. ASSUME DECON MATERIALS = 2 Kg OF SOLIDS (RAGS)/MCO
5. ASSUME DECON MATERIAL DENSITY = 0.6 KG/L, BEFORE AND AFTER USE
6. ASSUME NO MATERIAL ADDED OR REMOVED DURING RECEIPT OF MCO/CASK AT BASIN
7. ASSUME NO MATERIAL ADDED OR REMOVED DURING STAGING OF CASK FOR HANDLING AT BASIN
8. ASSUME NO MATERIAL ADDED OR REMOVED DURING CASK LID REMOVAL AND PREPARATION FOR REMOVAL OF CASK FROM CONVEYANCE
9. ASSUME NO MATERIAL ADDED OR REMOVED DURING MCO/CASK TRANSFER FROM CONVEYANCE TO LOADOUT PIT
10. ASSUME NO ADDITION OR REMOVAL OF MATERIALS DURING LOADING OF CASK ON CONVEYANCE
11. ASSUME NO ADDITION OR REMOVAL OF MATERIALS DURING REMOVAL OF CASK STAGING
12. ASSUME NO ADDITION OR REMOVAL OF MATERIALS DURING TRANSFER OF MCO/CASK TO K BASIN VACUUM DRYING
13. ASSUME NO MATERIAL ADDED OR REMOVED DURING REMOVAL OF MCO/CASK FROM K BASIN DRYING STATION
14. ASSUME NO MATERIAL ADDED OR REMOVED DURING CASK CLOSURE AND PREPARATION FOR TRANSPORT FROM K BASIN VACUUM DRYING
15. ASSUME NO MATERIAL ADDED OR REMOVED DURING TRANSPORT OF MCO/CASK FROM 100 AREA TO CBS
16. ASSUME NO MATERIAL ADDED OR REMOVED DURING TRANSPORT OF EMPTY MCO/CASK FROM CSB TO 100 AREA
17. ASSUME 5 HELIUM OVERPRESSURE AND BLEED-OFF CYCLES ARE USED TO INERT CASK/MCO VOID SPACES, WHERE VOID SPACES ARE PRESSURIZED TO 25 PSIG, AND THEN BLED OFF DOWN TO 3 PSIG.

NOTE:

1. S = SOLID, L = LIQUID, G = GAS, AND MIXTURES INDICATED AS S/L = SOLID/LIQUID MIXTURE
2. FUEL CONSISTS OF TOTAL MASS OF FUEL COMPONENTS, INCLUDING FUEL AND CLADDING. SLUDGE MASS IS REPORTED ON A WET BASIS. OTHER SOLIDS CONSIST OF A VARIETY OF MATERIALS, PRIMARILY METALS, EXCLUDING CONTAINER MATERIALS LIKE THE MCO, CASK, AND SOLID WASTE PACKAGING DRUMS.
3. STATUS INDICATES CURRENT ESTIMATE BASIS: A = BASED ON APPROVED LOWER LEVEL PFD OR PROJECT DATA, B = BASED ON PRELIMINARY LOWER LEVEL PFD OR DATA CONTAINING UNVALIDATED ASSUMPTIONS, C = PRELIMINARY ESTIMATE.
4. THE CASK/TRANPORTATION AND IWTS RELATIONSHIP AND MASS BALANCES FOR INTERFACES IC-188 AND IC-189 ARE CAPTURED IN THE IWTS DRAWING (IC-188 IN H-1-81155 AND IC-189 IN H-1-81161).
5. MCO FLOODED IN BASIN WITHOUT SHIELD PLUG.
6. THESE INTERFACES SUMMARIZE THE TOTAL WATER REMOVED FROM BASINS LOADOUT THAT MUST BE CONSIDERED BY THE WATER TREATMENT SYSTEM. THE MASS OF WATER WAS ASSUMED TO BE DEFINED UPON INSTALLATION OF THE SHEILD PLUG ON H-1-81161 AND IS ALSO INCLUDED IN STREAMS IC-106 AND IC-107.

2	ENCORP ECN 640648	EEW 3-98	
1	ENCORP ECN 626350	EEW 8-97 / LAW 9-97 / SCK 9-97 / AP 9-97	
	REVISIONS		

DRAWN A. PETERSON 2/10/96; CHECKED M. SHEPHERD 3-28-96; R. ROMINE 3-28-96; A. PAJUNEN 3-28-96

U.S. DEPARTMENT OF ENERGY
DOE Field Office, Richland
Westinghouse Hanford Company

SNF PROJECT
CASK/TRANSPORTATION
LEVEL 1 PFD

F 100K 0 7000 H-1-81168 2
SCALE NONE 613021 SHEET 2
CADFILE A0811688 CADCODE WIN95:AC02:14:SS

DRAWING TRACEABILITY LIST — DWG NO / TITLE; REFERENCES — REF NUMBER / TITLE; NEXT USED ON SH 1

54-6000-027(5/89)

Figure 18 - Mass Balance - Sheet 3

STREAM NUMBER	IC-106	IC-107	IC-178	IC-179	IC-181	IC-185	IC-196	IC-197	IC-224	IC-225	TE-1	TE-2	TE-3
DESCRIPTION	LOADED KE MCO/CASK WITH SHIELD PLUG INSTALLED	LOADED KW MCO/CASK WITH SHIELD PLUG INSTALLED	FRESH WATER FROM KE BASIN WATER SYSTEM	FRESH WATER FROM KW CASK WATER SYSTEM	WATER IN KE MCO AFTER LOADING	WATER IN KW MCO AFTER LOADING	KE MCO BASKET FROM FUEL RETRIEVAL	KW MCO BASKET FROM FUEL RETRIEVAL	EXHAUST FROM VENTING KE CASK/MCO VOID SPACES	EXHAUST FROM VENTING KW CASK/MCO VOID SPACES	EMPTY MCO/CASK DELIVERED TO KE BASIN	KE BASIN CASK DECON MATERIALS	LOADED MCO/CASK WITHIN KE BASIN
TRANSFER TYPE	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH
PHASE (NOTE 1)	S/L	S/L	L	L	S	S	S	S	G	G	S	S	S/L
NUMBER OF ITEMS	195	203	–	–	–	–	195	203	–	–	195	–	195
ITEM COUNT BASIS	MCO	MCO	–	–	–	–	MCO	MCO	–	–	MCO	–	MCO
VOLUME, CUBIC METERS	–	–	1.11E+02	1.15E+02	2.12E+02	2.21E+02	–	–	4.56E+01	4.75E+01	–	6.50E-01	–
DENSITY, g/cc	–	–	1.00	1.00	1.00	1.00	–	–	3.16E-04	3.16E-04	–	0.60	–
PRESSURE, torr	961	961	–	–	–	–	–	–	760	760	–	–	961
TEMPERATURE, Deg C	10	10	20	20	AMBIENT	AMBIENT	AMBIENT	AMBIENT	10	10	AMBIENT	AMBIENT	10
COMPONENTS, kg (NOTE 2)													
FUEL	1.23E+06	1.04E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+06	1.04E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+06
URANIUM	1.14E+06	9.52E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+06	9.63E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+06
PLUTONIUM	2.15E+03	1.88E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E+03	1.81E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E+03
OTHER	8.72E+04	8.42E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.72E+04	7.34E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.72E+04
SLUDGE	2.34E+03	2.44E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E+03	2.44E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E+03
WATER IN SLUDGE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER SOLIDS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E+02	0.00E+00
STAINLESS STEEL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ALUMINUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.90E+02	0.00E+00
WATER	9.78E+04	1.04E+05	1.11E+05	1.15E+05	2.12E+05	2.21E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.78E+04
AIR	4.73E+00	4.93E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.61E+00	7.92E+00	0.00E+00	0.00E+00	4.73E+00
OTHER GASES	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.79E+00	7.07E+00	0.00E+00	0.00E+00	0.00E+00
ARGON	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HYDROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HELIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.79E+00	7.07E+00	0.00E+00	0.00E+00	0.00E+00
NITROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL MASS, kg	1.33E+06	1.14E+06	1.11E+05	1.15E+05	2.12E+05	2.21 ~~2.12E+05~~	1.23E+06	1.04E+06	1.44E+01	1.50E+01	0.00E+00	3.90E+02	1.33E+06
STATUS (NOTE 3)	B	B	B	B	B	B	B	B	B	B	B	B	B
					(SEE NOTE 6)	(SEE NOTE 6)							

STREAM NUMBER	TE-4	TE-5	TE-6	TE-7	TE-9	TE-10	TE-11	TE-12	TE-13				
DESCRIPTION	FRESH WATER TO KE CASK IMMERSION PAIL	KE BASIN FINAL CASK FLUSH	WATER LOSS FROM KE CASK IMMERSION PAIL	USED KE CASK FLUSH WATER	LOADED AND VENTED MCO/CASK WITHIN KE BASIN	INERT AND SEALED MCO/CASK WITHIN KE BASIN	HELIUM TO INERT KE VOID SPACES	EXHAUST FROM KE INERTING	VENT AIR FROM KE MCO'S				
TRANSFER TYPE	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH				
PHASE (NOTE 1)	L	L	L	L	S/L	S/L/G	G	G	G				
NUMBER OF ITEMS	–	–	–	–	195	195	–	–	–				
ITEM COUNT BASIS	–	–	–	–	MCO	MCO	–	–	–				
VOLUME, CUBIC METERS	3.69E+01	7.38E+01	3.69E+01	2.95E+02	–	–	–	4.48E+01	8.50E-01				
DENSITY, g/cc	1.00	1.00	1.00	1.00	–	–	–	3.01E-04	1.22E-03				
PRESSURE, torr	–	–	–	–	AMBIENT	915	–	760	760				
TEMPERATURE, Deg C	20	20	20	20	10	10	10	10	10				
COMPONENTS, kg (NOTE 2)													
FUEL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E+06	1.23E+06	0.00E+00	0.00E+00	0.00E+00				
URANIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+06	1.14E+06	0.00E+00	0.00E+00	0.00E+00				
PLUTONIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E+03	2.15E+03	0.00E+00	0.00E+00	0.00E+00				
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.72E+04	8.72E+04	0.00E+00	0.00E+00	0.00E+00				
SLUDGE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E+03	2.34E+03	0.00E+00	0.00E+00	0.00E+00				
WATER IN SLUDGE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
OTHER SOLIDS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
STAINLESS STEEL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
ALUMINUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
WATER	3.69E+04	7.38E+04	3.69E+04	2.95E+05	9.78E+04	9.78E+04	0.00E+00	0.00E+00	0.00E+00				
AIR	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.69E+00	4.29E-01	0.00E+00	6.57E+00	1.04E+00				
OTHER GASES	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E+00	7.93E+00	6.79E+00	0.00E+00				
ARGON	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
HYDROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
HELIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E+00	7.93E+00	6.79E+00	0.00E+00				
NITROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
Kr-85 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
TOTAL MASS, kg	3.69E+04	7.38E+04	3.69E+04	2.95E+05	1.33E+06	1.33E+06	7.93E+00	1.35E+01	1.04E+00				
STATUS (NOTE 3)	B	B	B	B	B	B	B	B	B				

REV	DESCRIPTION				
2	ENCORP ECN 640648	EEW 3-98			
1	ENCORP ECN 626350	EEW 8-96	LAW 9-97	SCK 9-97	AP 9-97

DRAWING TRACEABILITY LIST — DWG NO / TITLE
REFERENCES — REF NUMBER / TITLE
NEXT USED ON SH 1
CADFILE A081168C — CADCODE WIN95.0/ACD2.14:SS

A. PETERSON 2/10/96
W SHEPHERD 3-28-96
R ROMINE 3-28-96
A. PAJUNEN 3-28-96

U.S. DEPARTMENT OF ENERGY
DOE Field Office, Richland
Westinghouse Hanford Company

SNF PROJECT
CASK/TRANSPORTATION
LEVEL 1 PFD

F 100K G 7000 H-1-81168 2
SCALE NONE 613021 SHEET 3
3/28/96

Figure 18 - Mass Balance - Sheet 4

STREAM NUMBER	TW-1	TW-2	TW-3	TW-4	TW-5	TW-6	TW-7	TW-9	TW-10	TW-11	TW-12	TW-13	
DESCRIPTION	EMPTY MCO/CASK DELIVERED TO KW BASIN	KW BASIN CASK DECON MATERIALS	LOADED MCO/CASK WITHIN KW BASIN	FRESH WATER TO KW CASK IMMERSION PAIL	KW BASIN FINAL CASK FLUSH	WATERLOSS FROM KW CASK IMMERSION PAIL	USED KW CASK FLUSH WATER	LOADED AND VENTED MCO/CASK WITHIN KW BASIN	INERT AND SEALED MCO/CASK WITHIN KW BASIN	HELIUM TO INERT KW VOID SPACES	EXHAUST FROM KW INERTING	VENT AIR FROM KW MCO'S	
TRANSFER TYPE	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	
PHASE (NOTE 1)	S	S	S/L	L	L	L	L	S/L	S/L/G	G	G	G	
NUMBER OF ITEMS	203	–	203	–	–	–	–	203	203	–	–	–	
ITEM COUNT BASIS	MCO	–	MCO	–	–	–	–	MCO	MCO	–	–	–	
VOLUME, CUBIC METERS	–	6.77E-01	–	3.84E+01	7.68E+01	3.84E+01	3.07E+02	–	–	–	4.66E+01	8.83E-01	
DENSITY, g/cc	–	0.60	–	1.00	1.00	1.00	1.00	–	–	–	3.01E-04	1.22E-03	
PRESSURE, torr	–	–	961	–	–	–	–	AMBIENT	915	–	760	760	
TEMPERATURE, Deg C	AMBIENT	AMBIENT	10	20	20	20	20	10	10	10	10	10	
COMPONENTS, kg (NOTE 2)													
FUEL	0.00E+00	0.00E+00	1.04E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E+06	1.04E+06	0.00E+00	0.00E+00	0.00E+00	
URANIUM	0.00E+00	0.00E+00	9.52E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.52E+05	9.52E+05	0.00E+00	0.00E+00	0.00E+00	
PLUTONIUM	0.00E+00	0.00E+00	1.88E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E+03	1.88E+03	0.00E+00	0.00E+00	0.00E+00	
OTHER	0.00E+00	0.00E+00	8.42E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.42E+04	8.42E+04	0.00E+00	0.00E+00	0.00E+00	
SLUDGE	0.00E+00	0.00E+00	2.44E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E+03	2.44E+03	0.00E+00	0.00E+00	0.00E+00	
WATER IN SLUDGE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
OTHER	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
OTHER SOLIDS	0.00E+00	4.06E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
STAINLESS STEEL	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
ALUMINUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
OTHER	0.00E+00	4.06E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
WATER	0.00E+00	0.00E+00	1.04E+05	3.84E+04	7.68E+04	3.84E+04	3.07E+05	1.04E+05	1.04E+05	0.00E+00	0.00E+00	0.00E+00	
AIR	0.00E+00	0.00E+00	4.93E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.84E+00	4.47E-01	0.00E+00	6.84E+00	1.08E+00	
OTHER GASES	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E+00	8.25E+00	7.07E+00	0.00E+00	
ARGON	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
HYDROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
HELIUM	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E+00	8.25E+00	7.07E+00	0.00E+00	
NITROGEN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Kr-85 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
TOTAL MASS, kg	0.00E+00	4.06E+02	1.14E+06	3.84E+04	7.68E+04	3.84E+04	3.07E+05	1.14E+06	1.14E+06	8.25E+00	1.39E+01	1.08E+00	
STATUS (NOTE 3)	B	B	B	B	B	B	B	BB	BB	B	B	B	

STREAM NUMBER													
DESCRIPTION													
TRANSFER TYPE													
PHASE (NOTE 1)													
NUMBER OF ITEMS													
ITEM COUNT BASIS													
VOLUME, CUBIC METERS													
DENSITY, g/cc													
PRESSURE, torr													
TEMPERATURE, Deg C													
COMPONENTS, kg (NOTE 2)													
FUEL													
URANIUM													
PLUTONIUM													
OTHER													
SLUDGE													
WATER IN SLUDGE													
OTHER													
OTHER SOLIDS													
STAINLESS STEEL													
ALUMINUM													
OTHER													
WATER													
AIR													
OTHER GASES													
ARGON													
HYDROGEN													
HELIUM													
NITROGEN													
Kr-85 (Ci)													
TOTAL MASS, kg													
STATUS (NOTE 3)													

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U.S. DEPARTMENT OF ENERGY
Richland Operations Office
DE&S Hanford, Inc.
SNF PROJECT
CASK/TRANSPORTATION
LEVEL 1 PFD

DWG NO H-1-81168 REV 0

DWG NO | TITLE | REF NUMBER | TITLE
DRAWING TRACEABILITY LIST | NEXT USED ON | REFERENCES | REVISIONS

12.0 REFERENCES

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