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Work Performed Under Contract DE-AC09-78ET-35900

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ALLIED-GENERAL NUCLEAR SERVICES
P.O. BOX 847
BARNWELL, SC 29812

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AGNS-35900-1.1-106

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STUDIES AND RESEARCH CONCERNING BNFP

CASK HANDLING EQUIPMENT STANDARDIZATION

Paul N. McCreery

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

PREPARED FOR THE
DEPARTMENT OF ENERGY
WASTE AND FUEL CYCLE TECHNOLOGY OFFICE
UNDER CONTRACT DE-AC09-78ET35900

FOREWORD

This report covers the activities of one of the sub-tasks within the "Spent LWR Fuel Transportation Receiving, Handling, and Storage" program. The sub-task is identified as "Cask Handling Equipment Standardization." The objective of the sub-task specifies:

> "Investigate and identify opportunities for standardization of cask interface equipment. This study will examine the potential benefits of standardized yokes, decontamination barriers and special tools, and, to the extent feasible, standardized methods and software for handling the variety of casks presently available in the U. S. fleet."

The result of the investigations is a compilation of reports that are related by their common goal of reducing cask turnaround time.

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REPORT NO. AGNS-35900-1.1-106

CASK HANDLING EQUIPMENT STANDARDIZATION

VOLUME I

SPECIFICATIONS FOR THE UNIVERSAL LWT LIFTING YOKE

Paul N. McCreery
Paul D. Steneck
Larry A. Kean

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

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1.0 THE UNIVERSAL LWT LIFTING YOKE

As of 6/1/80 there were six distinct models of spent nuclear fuel shipping casks certified by the USNRC, and each requires its unique lifting yoke. This does not normally present a problem to reactor sites when they are shipping spent fuel because one or more casks of the same model are usually assigned to a given shipping campaign. If, however, a limited number of AFR's or terminal storage facilities are brought into service, it is expected that numerous cask models may arrive in random sequence to be unloaded. This requires removing the previously used yoke and replacing it with the yoke needed to handle the next cask. Some yokes are relatively easy to attach to or to detach from the crane hook. Others, particularly some of those designed for use with redundant lift systems, can take up to an hour to change. It should be noted that the yokes in this latter category can be fitted with a simple adaptor to expedite changeover if their redundant capabilities are not needed. Since AFR's and terminal storage sites most likely will not need redundant lift capability, such adaptors are recommended for this type of yoke. If storage space were available at these installations, a complete inventory of six yokes and the necessary adaptors should be as time-efficient as any alternative. In the smaller receiving installations, however, one yoke for small casks and one for the larger ones may help alleviate a storage space problem.

The Barnwell Nuclear Fuel Plant probably has as much storage space available "under the crane" as any fuel handling facility in the U.S. Even so, reducing the number of yokes to be stored by a factor of three would be most welcome. The subject of this report is the development of this concept.

A survey of cask owners was made to establish the dimensions of components in the vicinity of the headend of their casks. With the fine cooperation of General Electric, Exxon, NAC, TN, and NL, in response to our requests for the dimensions shown in Figures 1 and 2, we were able to compile the data for Tables 1 through 4. From this information, we determined the maximum and minimum dimensions at each location, and these became the limiting values to which a handling device must conform.

This study was directed toward casks of the Legal Weight Truck (LWT) category rather than rail casks because the LWR's are considered to be the greater challenge. Note that the TN-8(9) OWT casks are of dimensions more in the range of those of the two rail casks rather than those of the LWT's. Note also that the General Atomic - Fort St. Vrain cask (FSV-1) is not now licensed to haul LWR fuel, but the paperwork is being readied for submittal to NRC for licensing. This cask is unique in that it has lifting sockets rather than trunnions. This adds another facet to the development of the universal yoke concept. Figure 3 shows the three LWT casks in approximate scale proportions.

Four criteria were considered in the design concept of this yoke. They were:

(1) Remote (underwater) operation

(2) Configuration changes to be made within approximately the same time interval as needed to change from one conventional yoke to another.

(3) The cost should not exceed the cost of the most costly of the conventional yokes.

(4) Operation and configuration changeover should be no more complicated than the handling of any of the existing yokes.

Underwater operation requires a guidance system to position the yoke in both axial rotation and elevation to assure the alignment necessary to engage and to release the lifting trunnions (sockets). For this purpose, a special adaptor for the head of each cask model is provided. See Drawings 535D-T-5004 and 535D-T-5005. They replace the turnbuckle slings otherwise required for remote head handling, so there is little net change in component handling by the operators. The head is suspended from the adaptor by two to four 8-inch studs screwed firmly into the threaded holes provided on most casks heads for lifting purposes. (The NL cask requires modified studs, pinned to lifting lugs.) Since the yoke and adaptor are bolted together, any rotational movement of the head will rotate the yoke. By using guide pins to orient the head as it is seated to the cask (if guide pins are not ordinarily used, they can be fabricated, then screwed into existing head bolt holes) the yoke arms will align diametrically with the trunnions. The yoke decends farther until the adaptor "bottoms out" on the head. At this point, because of the design of the adaptor, the elevation of the yoke is such that the arms will close over the trunnions (or into the sockets) as the yoke hydraulic system is activated. This head/adaptor system provides an additional benefit during disengagement. Some cranes, as they reverse direction, tend to rotate the block a few degrees. If the block is starting upward, this rotation might cause one of the lifting arms (now spread for disengagement) to reengage one trunnion and perhaps tip the cask over. With the adaptor guiding on the head studs while the head remains seated during the first few inches of travel, the rotation of the block is prevented until the lifting arms clear the trunnions.

The bending forces which would result on the lifting arm extensions if both strong-back sections of the yoke hung freely are eliminated by causing the horizontal force vectors to work against one another. These forces are transmitted through a spreader pin (Item 11, Drawing 5001) which is positioned according to the cask to be handled. As the actuating cylinder extends, the arms are caused to spread. When the cylinder is contracted, the arms close to the position determined by the position of the spreader pin.

It should be noted that, when using the yoke in the remote mode, the head of the cask always remains attached to the yoke. A follow through of the generic cask loading and unloading procedures (see Appendix A, Section 4.0) indicates that this will present no operational problems. Experience at GE's Morris Operations[1] has shown that operator dose levels are reduced if the head is in place any time the cask is out of the pool.

To the best of our knowledge, this is the first lifting yoke to be designed using as a guide ANSI N-14.6, "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kilograms) or More for Nuclear Materials." The entire N-14.6 paperwork package is included in this report as Appendix B to this section. Comments would be appreciated from readers of this report regarding the application of N-14.6, and these comments will be passed on to the chairman of that task group for consideration during future review of that standard.

A sketch of the yoke is shown in Figure 4. The yoke and adapter are drawn with heavy lines while the cask head and cask are represented by lighter lines. The cask head is represented as being suspended from the adapter and a few inches above the cask. The adapter would be removed prior to rotating the cask between the vertical and horizontal positions.

A complete set of drawings for this lifting yoke is included with this report. These are AGNS Drawings 535D-T-5001 through 535D-T-5005. Drawing 535D-T-5006 is for a storage stand for the yoke. The yoke support bar (tool support bar, Item 8) is inserted through the 3-inch holes of Item 22, Drawing 5003, and the yoke is lowered to rest on the support frame. The 1/2-inch hitch pins allow the support frame to be moved to a new location, either while suspended from the yoke or by engaging the crane hook onto the pinned support bar. The vertical section of 1-1/2-inch, Schedule 40, pipe welded to the base is for storage of the tool support bar when the latter is not in use.

The load testing fixture for this yoke is shown in Figure 7.

The status of the fabrication and testing of this yoke, as of September 30, 1980, is that if an FSV cask can be scheduled into AGNS for some remote-handling dry runs, then this yoke will be built to be used for these tests. The current FSV yoke cannot be used in the remote mode.

1.1 Alternate Proposal

The LWT yoke described in this report cannot be adapted to a system for redundant lifting. Another concept, with redundancy specifically in mind, is shown in Figures 5 and 6. The design details have not been completed (and will not be developed further unless some actual need arises). Matching pairs of holes are drilled into each side of the strongbacks to fix the lifting arms into the desired position for lifting a given cask. The pivot end of each lifting arm is shaped such that the arm cannot swing inboard beyond the verticle. Hydraulic cylinders move the palms outboard in a hand-clapping motion to allow for clearance of the trunnions. The lifting palms are identical to those of the yoke previously described; however, in this concept there is no provision for lifting a cask with sockets in place of trunnions, such as the FSV-1. One advantage of this system should be that, by swinging one arm out to the horizontal and providing means to hold it there, the assembled redundant system can be used while rotating casks between the horizontal and verticle positions. This could result in a time saving at sites which use current redundant systems of the four trunnion variety, wherein only one section of the dual system can be used during rotation of the cask. The overlaying of Figures 5 and 6 depict the two yoke sections in their redundant configuration.

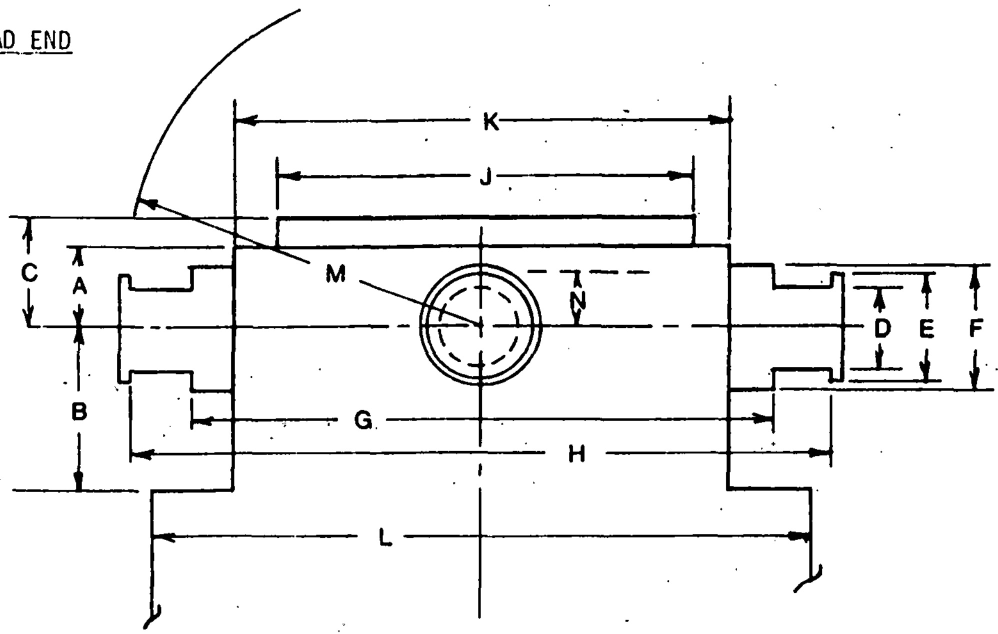
References

(1) Personal correspondence with Tom Tehan of General Electric, MFRP, Morris, Illinois.

TABLE 1

CASK HEADEND

CASK HEAD END



CASK MODEL IDENTIFICATION

Dimensions in Inches

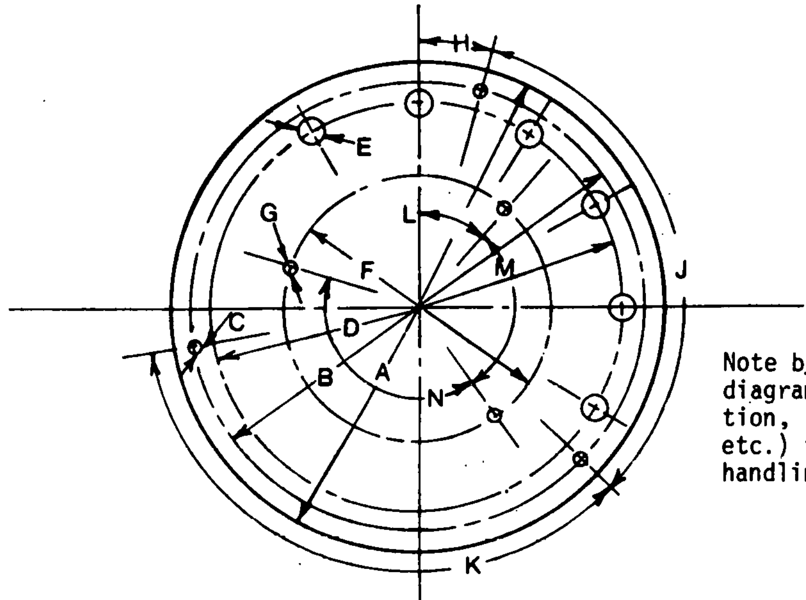
	NAC-1	NLI 1/2	FSV-1*	ENC 2/4	IF-300	NLI 10/24	ENC-Rail
A	6.5	4.5	6.13	13.6	10.06	7.25	26
B	None	5.0	None	*	None	22.75	*
C	8.5	8.875	10.75	13.6	P: 25.56 B: 35.81	7.75	27
D	8.625	4.13	4.18 soc	3	5.625	7.25	5.5
E	9.5	5.0	4.43 soc	4	7.5	8.0	6
F	12.75 sq	5.5	10.4	4.5	9 x 14	10.0	6
G	46.25	31.75	27.5	37.5 & 41.5	64	74.25	*
H	52.25	35.25	31	39.9 & 43.9	74	79.25	G + 15
J	25.50	24.00	31	None	61.75	64.5	68.86
K	50.00	30.00	31	36	63.75	71	68.86
L	39.20	47.125	28	41.5	63.75	88	74.74
M	26.9	18.125	7	*	48.2	39.5	*
N	N/A	2.875	5.875	N/A	N/A	5	*
P	-	-	-	-	-	-	-
Q	-	-	-	-	-	-	-

*LWR Mod. (Tentative) *Presently Unspecified *Presently Unspecified

TABLE 2

CASK LID

CASK LID



Note by marking on the head diagram any feature (penetration, location, irregularity, etc.) that could affect remote handling of the head.

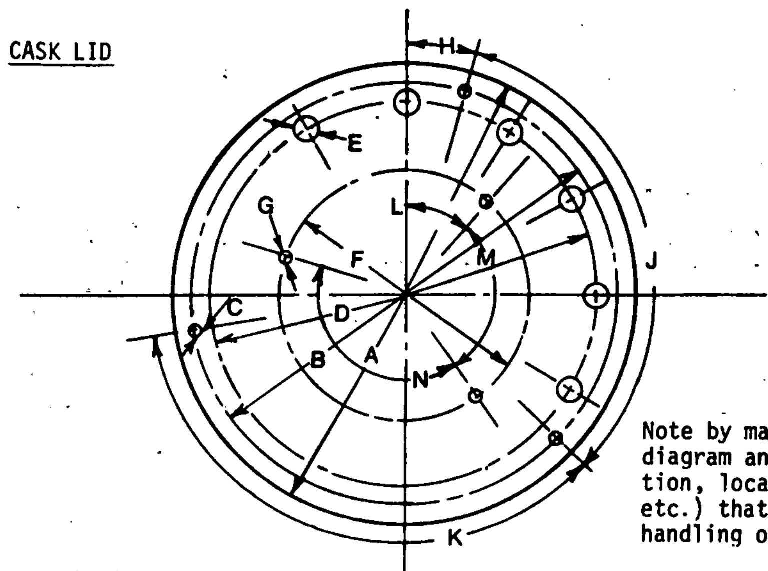
CASK MODEL IDENTIFICATION — Dimensions in Inches

	NAC-1	NLI 1/2	FSV-1	ENC 2/4	IF-300	NLI 10/24	ENC-Rail
A	25.5	18.0	27.13	30.5 x 23.5	61.75	58.75	63.4
B	22.62	16.25	25.25	*	52.25	53.75	*
C	1.312	1.312	1.25	*	1.760	1.875	*
D	22.62	8.125	25.25	28.5 x 21.5	45.75	53.75	59.6
F	1¼"-7UNC	1.13	0.5	1.75	1.5625	1.875	1.875
F	14	11.0	~ 14	*	51.75	52.5	*
G	1"-8	lug.	3/4"-10	*	lug,1.75hole	1"-8UNC	*
H	240°	150°	45°	*	180°	135°	*
J	-	150°	90°	*	168°45'	135°	*
K	-	-	165°	*	-	90°	*
L	90°	66½°	120°	*	45°*	90°	*
M	90°	180°	120°	*	90°*	135°	*
N	90°	-	120°	*	90°*	90°	*
P	90°	-	-	*	90°*	-	*
Q	6	12	24	20	32	16	32

*LWR Mod. (Tentative)   *Presently Unspecified   *est   *Presently Unspecified

TABLE 3

TN-HEAD



Note by marking on the head diagram any feature (penetration, location, irregularity, etc.) that could affect remote handling of the head.

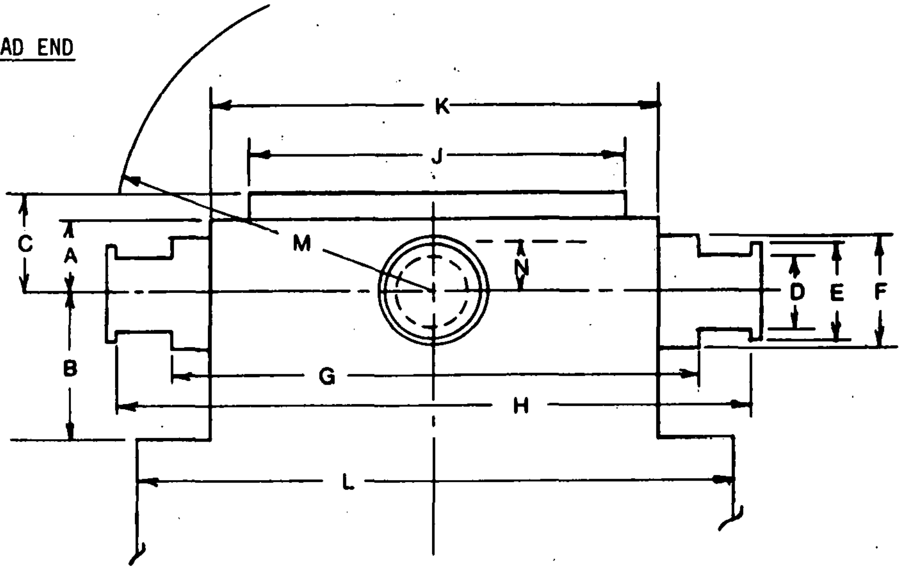
CASK MODEL IDENTIFICATION mm converted to inches

	TN-8		TN-9		TN-12		
A	880 mm	34.65 in	800 mm	31.50 in	1620 mm	63.78 in	
B	810	31.90	720	28.35	1560	61.42	
C	25	.98	25	.98	40	1.57	
D	810	31.90	720	28.35	1510	59.45	
E	M32 x 80	1.26	M32 x 80	1.26	M40	1.57	
F	260	10.24	260	10.24	1510	59.45	
G	lug,20ϕ	.79	lug,20ϕ	.79	lug,36ϕ	1.42	
H	22.5°		22.5°		27°		
J	157.5°		157.5°		208°		
K	-	-	-	-	-	-	
L	90°		90°		90°		
M	90°		90°		90°		
N	90°		90°		90°		
P	90°		90°		90°		
Q	16		16		40		

TABLE 4

TN-LID

CASK HEAD END

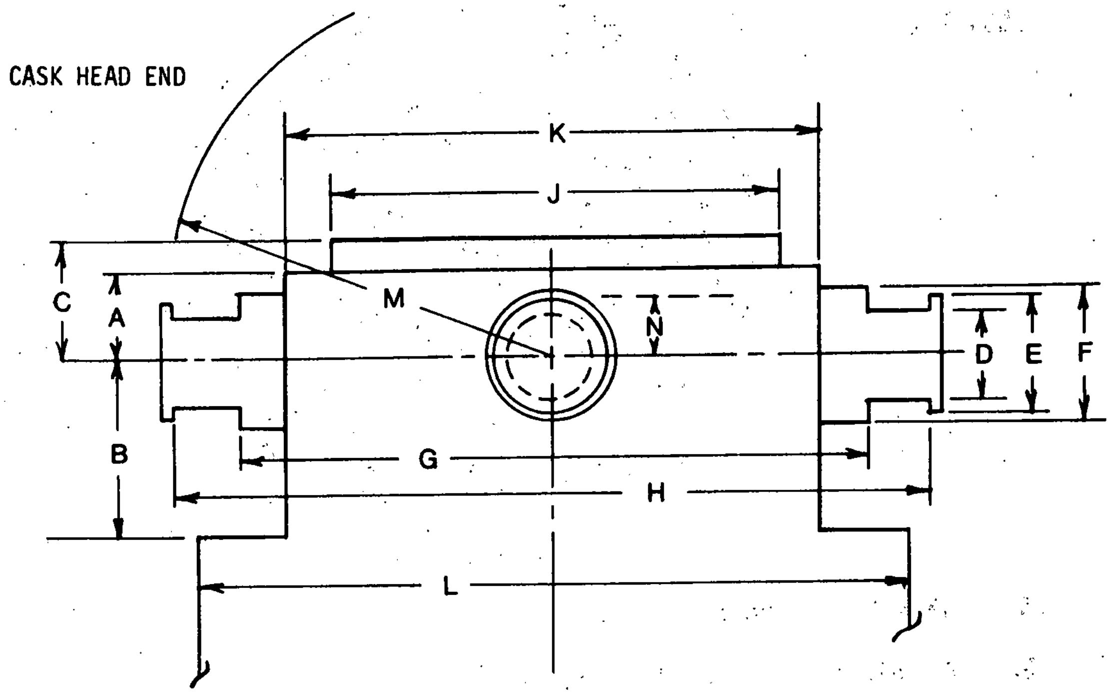


CASK MODEL IDENTIFICATION

mm converted to inches

	TN-8		TN-9		TN-12		
A	169 mm	6.65 in	289 mm	11.38 in	220 mm	8.66 in	
B	260	10.24	260	10.24	355	13.98	
C	192	* 7.56	314	* 12.36	390	15.35	
D	200	7.87	200	7.87	250	9.84	
E	220	8.66	220	8.66	280	11.02	
F	220	8.66	220	8.66	300	11.81	
G	1496	58.87	1496	58.87	2230	87.8	
H	1650	64.96	1650	64.96	2450	96.46	
J	880	34.65	800	31.50	1620	63.78	
K	1700	66.93	1700	66.93	2500	98.43	
L	1718	67.64	1718	67.64	2500	98.43	
M	850	33.46	850	33.46	1240	48.82	
N							
P							
Q							

* + 60 mm (2.36") lugs.



A Centerline of trunnions to top of cask body (no lid).

B Centerline of trunnions to nearest protrusion with a dimension greater than G (yoke arm interference).

C Centerline of trunnions to top of cask, with lid.

D Diameter of trunnion load bearing surface.

E Diameter of trunnion end flange.

F Diameter of trunnion boss (or base).

G Distance between trunnion boss faces.

H Distance between inboard faces of trunnion flanges.

J Diameter of any lid protruding above cask body.

K Diameter of cask body at top end.

L Diameter of cask body, maximum.

M Minimum clearance radius during cask rotation.

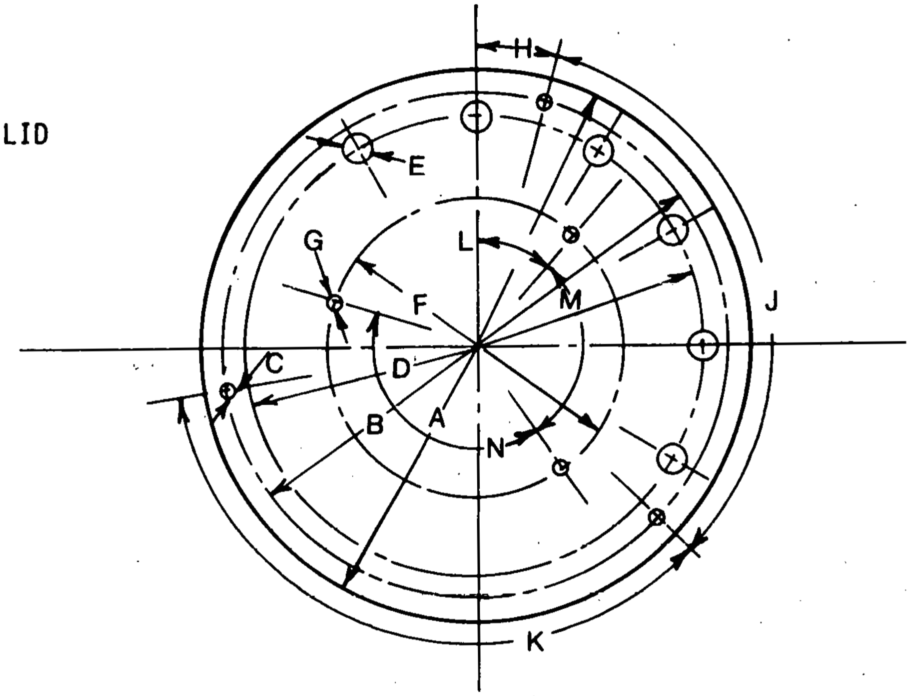
N Centerline of trunnions to upper surface of primary pressure boundary head (two-headed casks).

P Please note any other dimension which might affect yoke design.

<u>CASK HEADEND</u>

<u>FIGURE 1</u>

CASK LID



A Diameter of head

B Diameter of guide pin ring

C Guide pin hole (or slot) size

D Diameter of head bolt ring

E Head bolt hole size

F Diameter of lifting attachment bolt ring

G Bolt size for lifting attachment

H Included angle from top of cask (transport position, facing cask end) clockwise to first guide pin hole (or slot)

J Included angle from first guide pin clockwise to second

K Included angle from second guide pin clockwise to third

L Angle from top of cask to first lifting attachment fastener hole

M Angle from first lifting attachment fastener hole to second

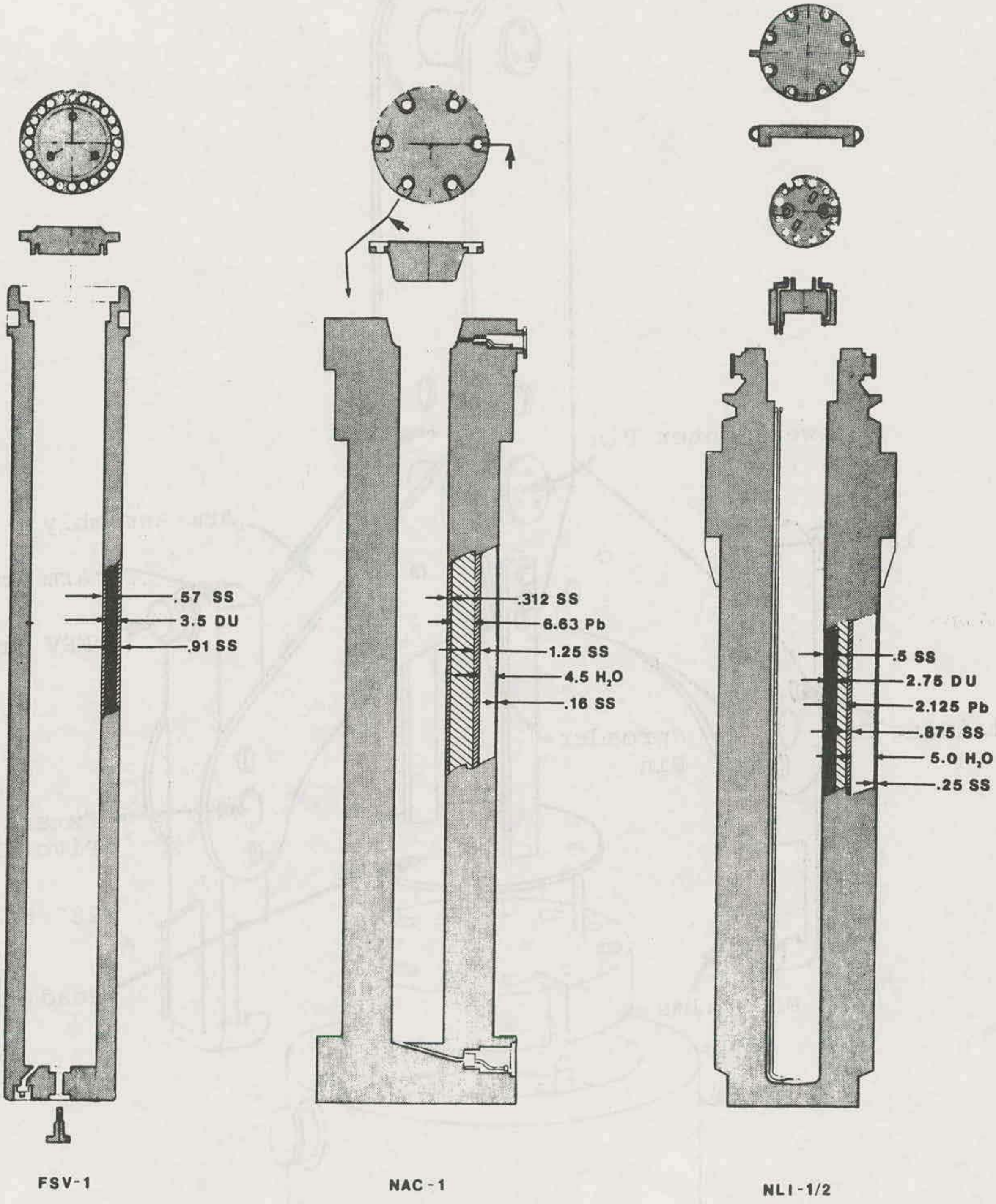
N Angle from second lifting attachment fastener hole to third

P Angle from third lifting attachment fastener hole to fourth

Q Number of head bolt holes

CASK LID

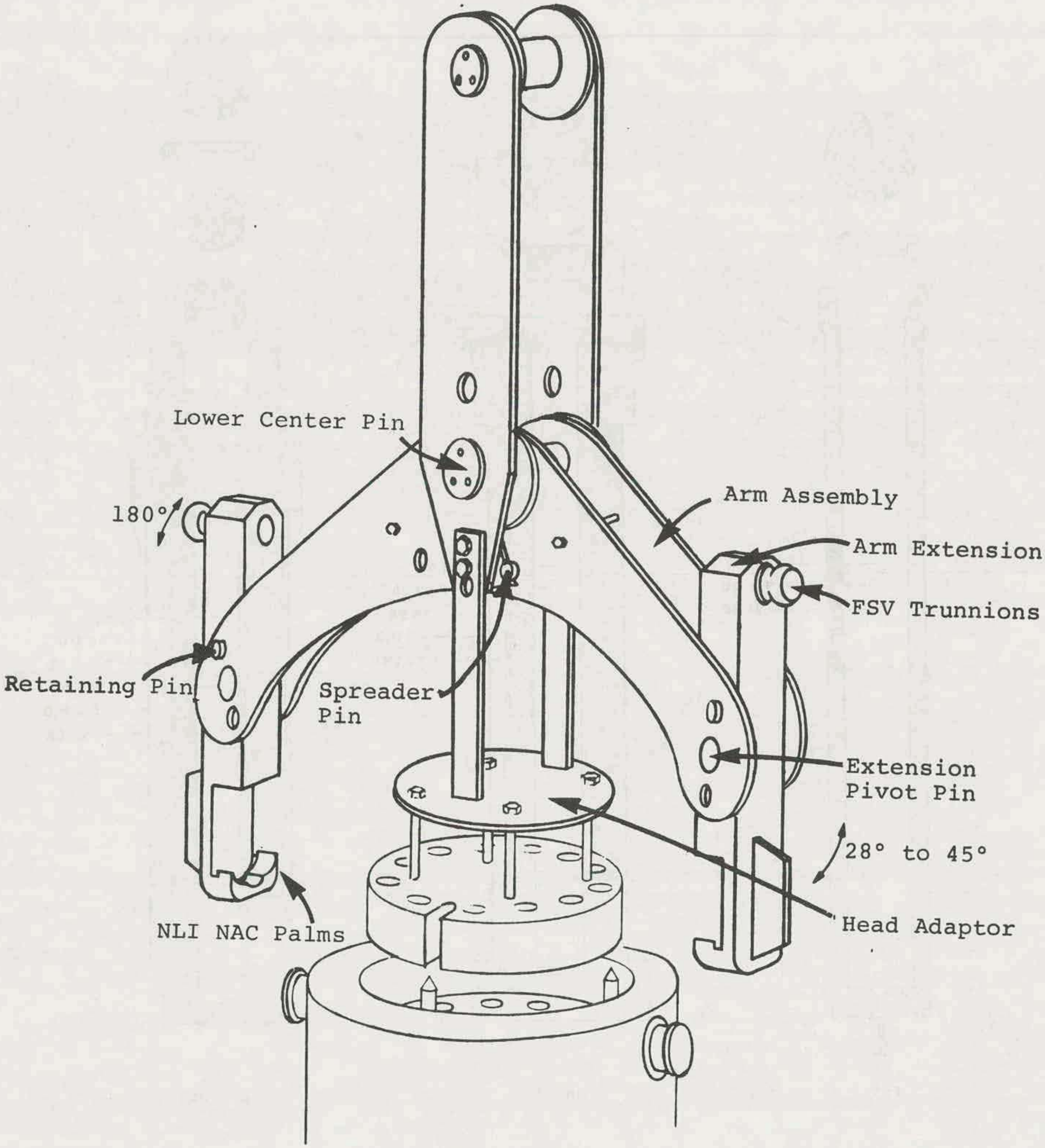
FIGURE 2



LWT CASKS

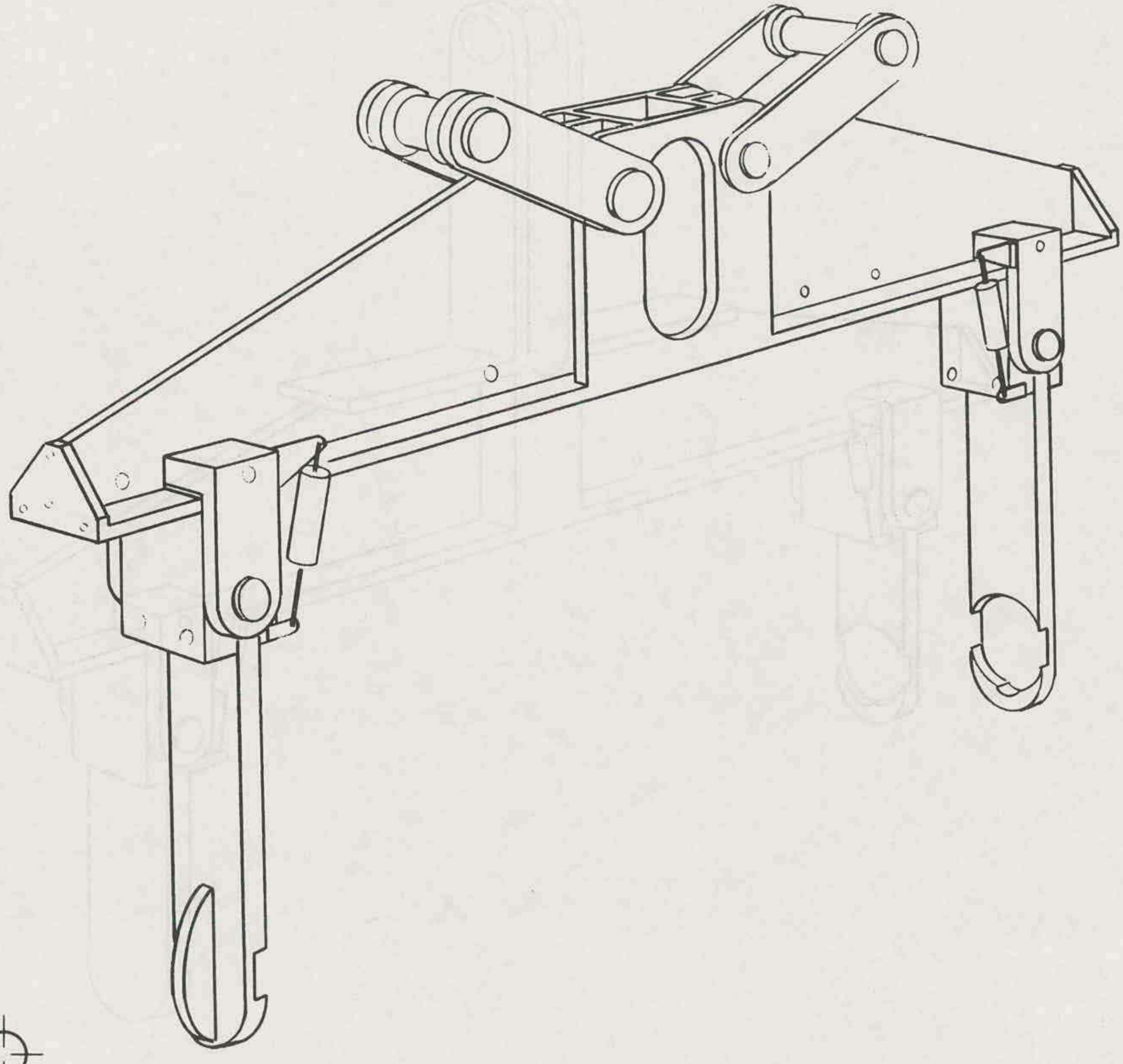
FIGURE 3

CASK LIFTING YOKE



CASK LIFTING YOKE

FIGURE 4



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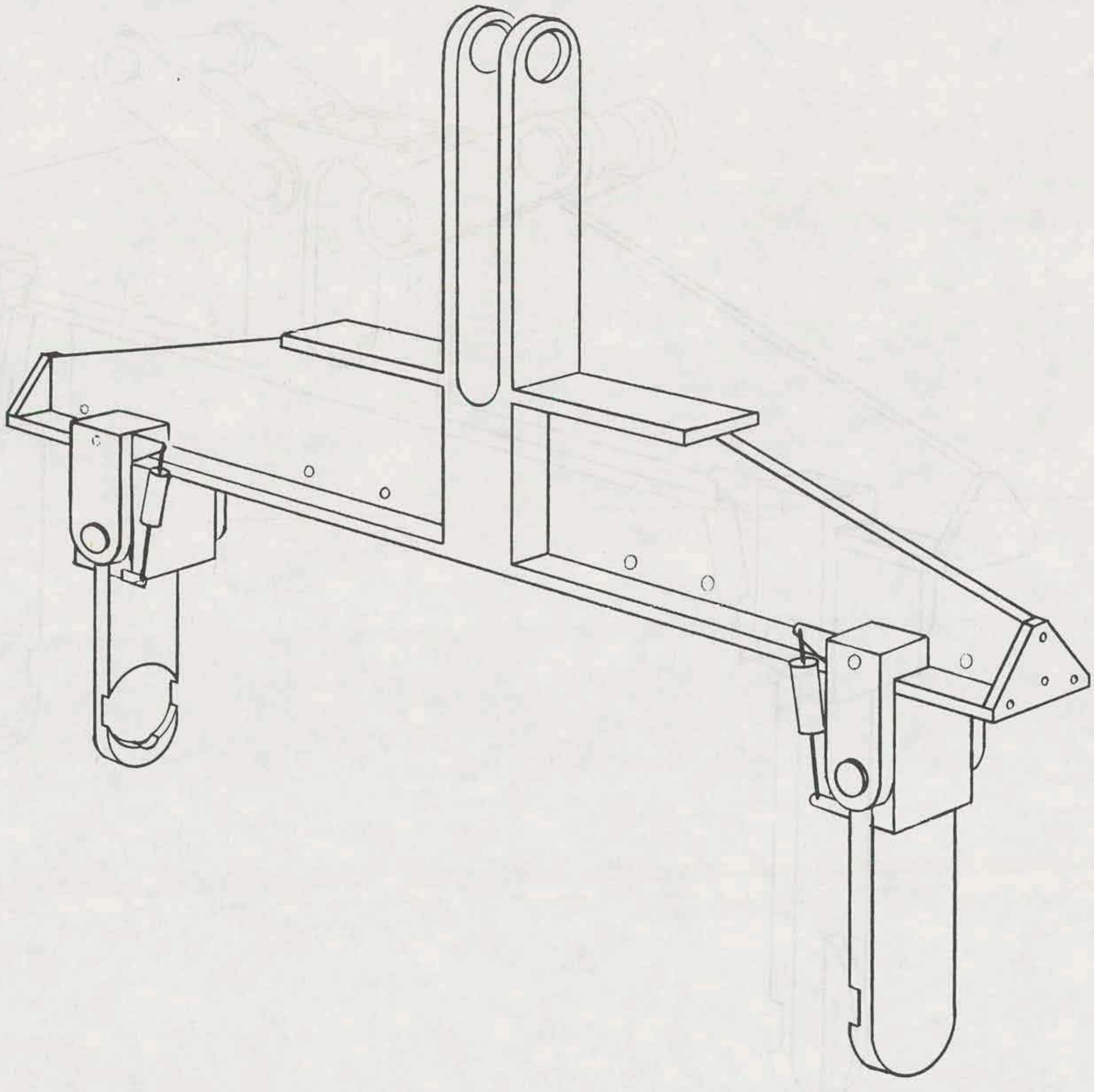
ALTERNATE CONCEPTUAL DESIGN "A" YOKE

FIGURE 5



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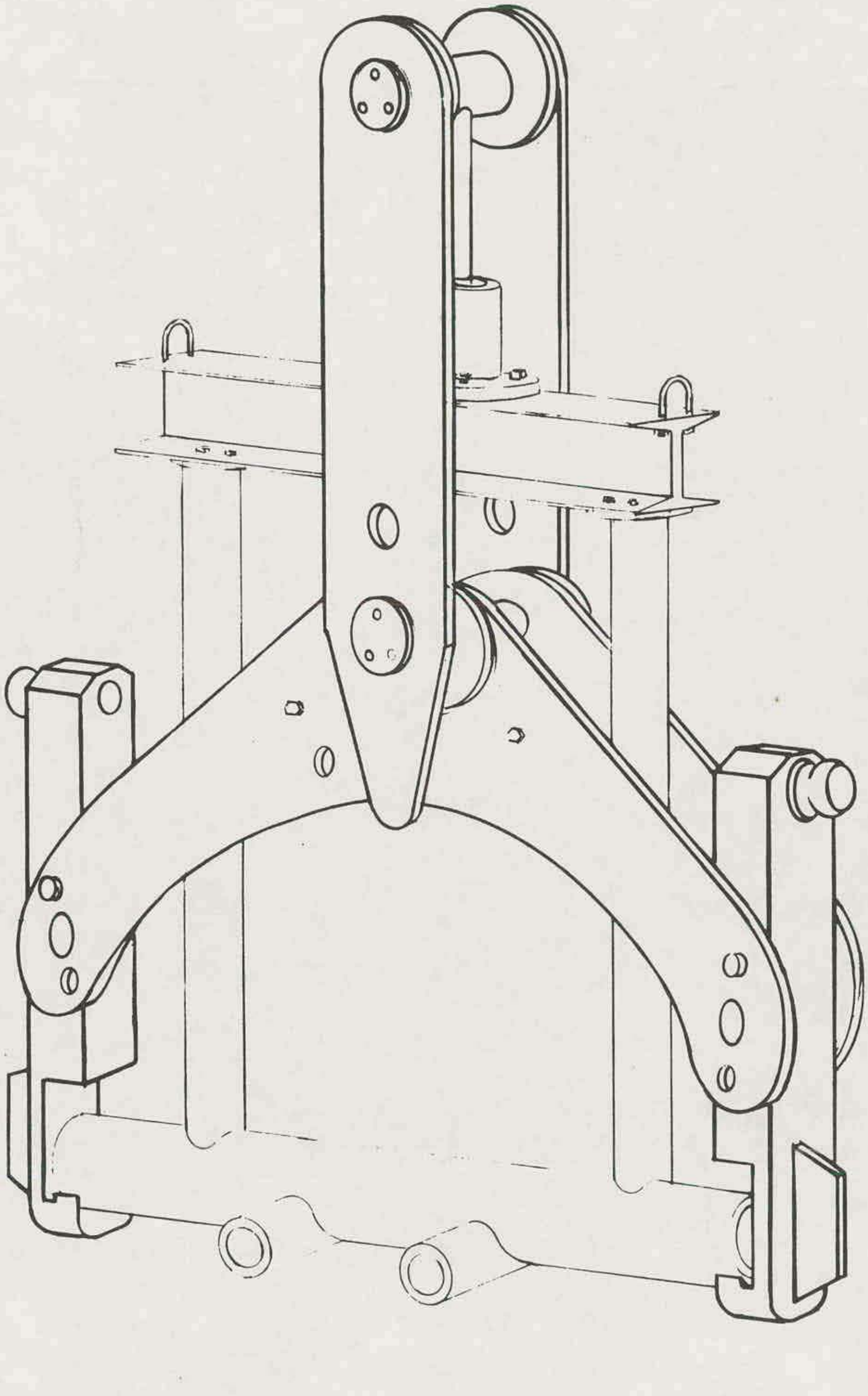
ALTERNATE CONCEPTUAL DESIGN "B" YOKE

FIGURE 6



LOAD TEST FIXTURE

FIGURE 7

REPORT NO. AGNS-35900-1.1-106

SPECIFICATIONS FOR THE UNIVERSAL LWT LIFTING YOKE

APPENDIX A TO VOLUME I

ANSI N-14.6 CRITERIA

Paul N. McCreery

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

1.0 GENERAL

1.1 The design, fabrication, testing, and use of this lifting yoke shall conform to ANSI N14.6 for noncritical loads (Section 6.0 is excepted).

1.2 Any other standard referenced in this specification shall be considered a part of this specification.

1.3 Refer to Drawings AGNS-535D-T-5001 through 535D-T-5006.

2.0 DESIGN

2.1 Performance Criteria

2.1.1 The lifting yoke shall be designed to lift a load of 30 tons (including the weight of the yoke) with the arms each extended to 45°.

2.1.2 Each arm shall rotate freely (no binding) about the lower center pin. Motion of one arm shall not cause the other to move when neither the spreader pin nor the actuating cylinder are in place.

2.1.3 The fluid-operated cylinder shall function using either air or water.

2.2 Drawings

2.2.1 The quality of drawings shall comply with current AGNS Standards for engineering drawings.

2.2.2 Drawing size and scale is optional.

2.2.3 Provision shall be made to ensure that only the latest revision of any drawing is available for fabrication, testing, etc.

2.3 Material Specifications

2.3.1 All materials of construction shall be 304 stainless steel with the following exceptions:

(1) Load bearing pins, including the FSV lifting trunnions, shall be Nitronic 60®.

(2) Bolts shall be of a stainless series other than 304, to reduce gauling.

2.3.2 Material certifications to the extent noted shall be required at the time of acceptance of the above listed metals and elastomers.

2.4 In-Process Inspection

2.4.1 There are no hold points for witnessing or approval of any step by the designer.

2.4.2 The in-process inspector shall review the design and fabrication plan and shall specify a hold point for each step for which a subsequent step could negate his ability to verify the conformance of the step in question.

2.4.3 Refer to ANSI N14.6, Section 4.2, for inspector's responsibilities.

2.4.4 Refer to ANSI N14.6, Section 5.0, for NDE standards.

2.5 Fabrication Practices

2.5.1 Refer to ANSI N14.6, Section 4.0, for the fabricator's responsibilities.

2.5.2 The written procedures required by Step 4.1.10 of Section 4.0 (ibid) shall be approved by the designer prior to use.

2.6 Testing

2.6.1 The finished yoke shall be tested to demonstrate that it can support a 45-ton load (equally distributed through both arms) with the arms at 45 degrees from the vertical. The line from which the angle is determined is one that passes through the axial center of the lower center pin and the pin on which the arm extension rotates. The yoke in FSV configuration shall be tested to 45 tons with the arms at an angle compatible with the FSV socket spread. The testing fixture is shown in Figure 7 of the report to which this appendix is attached.

2.6.2 See ANSI N14.6, Section 5.2, for other testing requirements.

2.7 Quality Assurance Requirements

In addition to the specific quality assurance requirements given throughout this compilation of ANSI N-14.6 criteria, formally documented and administered programs shall exist to govern the following:

2.7.1 Objective evidence shall exist, through the use of design review with independent, alternate calculations or by the performance of suitable testing, that the design is adequate for its intended functions.

2.7.2 A material control system shall ensure that only the intended materials, appropriately certified, are used in the construction of the yoke.

2.7.3 Special processes, such as welding and nondestructive examination shall be controlled and accomplished by qualified personnel using qualified procedures in accordance with acceptable codes, standards, etc.

2.7.4 A system, traceable to recognized standards, shall be provided for the calibration of measuring and testing equipment used in fulfillment of the requirements of these criteria.

2.7.5 All nonconformances shall be referred to the designer for approval of or direction for corrective action.

2.8 Documentation and Record Retention

2.8.1 A written record shall be made of the values upon which acceptance is based for all items requiring certifications or acceptance testing.

2.8.2 A copy of the fabrication procedures, with each step initialed by the in-process inspector to indicate satisfactory completion, will be retained as a record.

2.8.3 Copies of all other records required by ANSI N14.6 shall be retained.

2.8.4 All records shall be retained for the life of the yoke, plus one year.

3.0 CRITICAL ITEMS LIST

3.1 Neither this yoke nor any component thereof is considered to be a critical item as defined by ANSI N14.6.

4.0 OPERATING PROCEDURE

4.1 Determine which cask model is to be lifted.

4.2 Pull the extension retaining pins.

4.3 Adapt the yoke as follows for the FSV-1 cask.

4.3.1 Position the extensions with the trunnion end down.

4.3.2 Replace the retaining pin in the lower holes of the arms.

4.3.3 Place the spreader pin through the strong-back holes marked "FSV."

4.4 Adapt the yoke as follows for the NLI 1/2 cask.

4.4.1 Position the extensions with the lifting palms down.

4.4.2 Replace the retaining pins in the upper holes of the arms.

4.4.3 Place the spreader pin through the strong-back holes marked "NL."

4.5 Adapt the yoke as follows for the NAC-1 cask.

4.5.1 Position the extensions with the lifting palms down.

4.5.2 Replace the retaining pins in the lower holes of the arms.

4.5.3 Place the spreader pin through the bottom holes of Item 22, Drawing 535D-T-5001.

4.6 Allow the yoke to hang freely from the crane with the hydraulic cylinder in the contracted position and visually confirm that both arm extensions are vertical.

4.7 Verify that the cylinder is filled with the fluid to be used to actuate it (air or water). See Section 4.31 for purging instructions.

4.8 If the yoke is not already on the crane, bring the hook (25-ton, if the load is equal to or less than 25 tons; otherwise, the 135-ton hook) under the top pin and raise to engage the pin.

4.9 If either side of the hook has more than 1/2 inch clearance with the inboard edge of the yoke, add spacers to either side of the hook and keep it centered. The yoke may have to be released from the hook to do this.

4.10 When an operator can work in the immediate vicinity of the yoke (e.g., cask on trailer), the arm extensions may be moved manually (rather than by hydraulic system) by removing the extension pin, pivoting the extension until it clears the trunnion, and once free of trunnion interference, returning the extensions to its lifting position and reinserting the pin.

4.11 When the cask is upright in the work area with the (inner) head accessible and the cask is ready to go into the pool, screw the required number of studs into the head (pin the studs to the NL cask).

4.12 Screw guide pins into the cask.

4.13 Attach the adapter, unique to the cask being processed, to the yoke. Open the yoke arms.

4.14 Bring the yoke and adaptor over the cask. Lower them carefully* and guide the head studs through the holes in the adaptor. Allow the adaptor to "bottom out" on the head.

4.15 In this position, the operator may want to close and open the arms to verify that trunnion engagement and disengagement is functioning without interference. Open the yoke arms.

4.16 Run a standard nut and a locknut onto each stud until the top of the stud is flush with the upper side of the upper nut.

<u>NOTE</u>: Use locknuts one time only.

4.17 Slowly raise the yoke until the adaptor is very near, but not touching, the lowest nut. Run all standard nuts down on the stud until it just makes contact with the adaptor.

4.18 Run all locknuts down on the stud until they seat against the standard nut.

<u>NOTE</u>: This step, once performed, should not have to be repeated for a given adaptor/head makeup.

4.19 Return the yoke and adaptor to the "bottom out" position and close the yoke arms.

4.20 Move the cask to the pool floor.

4.21 Open the yoke arms. Visually verify that they are in the full open position.

4.22 Slowly raise yoke until head clears the cask and guide pins.

4.23 Wash down yoke and head as they emerge from the pool.

---

*If the block has a tendency to cock due to the direction of rotation of the sheaves, try to manually turn its position before it engages the studs.

4.24 The head may be stored on a suitable stand with the adaptor left in place with the head. Detach the adaptor from the yoke by removing the four bolts which secure the adaptor to the yoke. The yoke is then available for other uses.

4.25 The cask is retrieved from the pool with the yoke/adaptor/head in the configuration of Step 4.23.

4.26 As the decending yoke nears the cask, maneuver the crane until the longer guide pin engages the guide hole (slot) on the head. Descend further and engage the second guide pin.

4.27 Descend further, visually guarding against head cocking, until the head seats properly on the cask and the yoke adaptor bottoms out on the head.

4.28 Close the lifting arms to engage the lifting trunnions or sockets. Confirm visually.

4.29 Lift the cask to the surface, washing as it emerges from the pool, and transport it to the work area.

<u>CAUTION</u>: Do not attempt to rotate the cask onto or from the trailer with the adaptor in place.

4.30 Remove adaptor, studs, and guide pins from the cask and store for the next use of a similar cask model.

4.31 To purge the actuating cylinder of one fluid by another.

4.31.1 Open the bypass valve.

4.31.2 Attach one line to the source of the desired fluid. Direct the open end of the other line to a suitable drain or off-gas venting system.

4.31.3 Rotate the cylinder assembly about the base pin until the piston is horizontal, with the inlet/outlet ports down when purging water from the system or with the ports in the highest position when purging air from the system.

4.31.4 Start the flow of the desired fluid.

4.31.5 Manually force the piston back and forth while observing the effluent. Continue this operation until the effluent is free of the fluid being purged. Stop the flow at its source.

4.31.6 Close the bypass valve.

4.31.7 Connect the two lines to the desired fluid source.

4.31.8 Rotate the cylinder assembly to its normal position and secure the piston end retaining pin.

5.0 MAINTENANCE AND REPAIR

5.1 Enough Neoluble® may be applied to the bearing surfaces of the lower center pin as needed to cover the bearing surface.

5.2 Any component of this system may be replaced with a similar component which has been manufactured and tested to the same specifications as the latest accepted revision of this design.

5.3 All repairs to components shall be subject to the following conditions.

5.3.1 The damage shall be described in writing, along with the recommended repair procedure.

5.3.2 Repair procedures must have the approval of the designer or the yoke custodian.

5.3.3 Repairs shall be subject to the same specifications as applicable to the latest revision of the yoke design, including stress analysis, fabrication, testing, etc.

5.4 A record of any component replacement or repair shall become a part of the permanent record of each yoke.

5.5 Adaptors will have separate, individual history files.

6.0 IDENTIFICATION

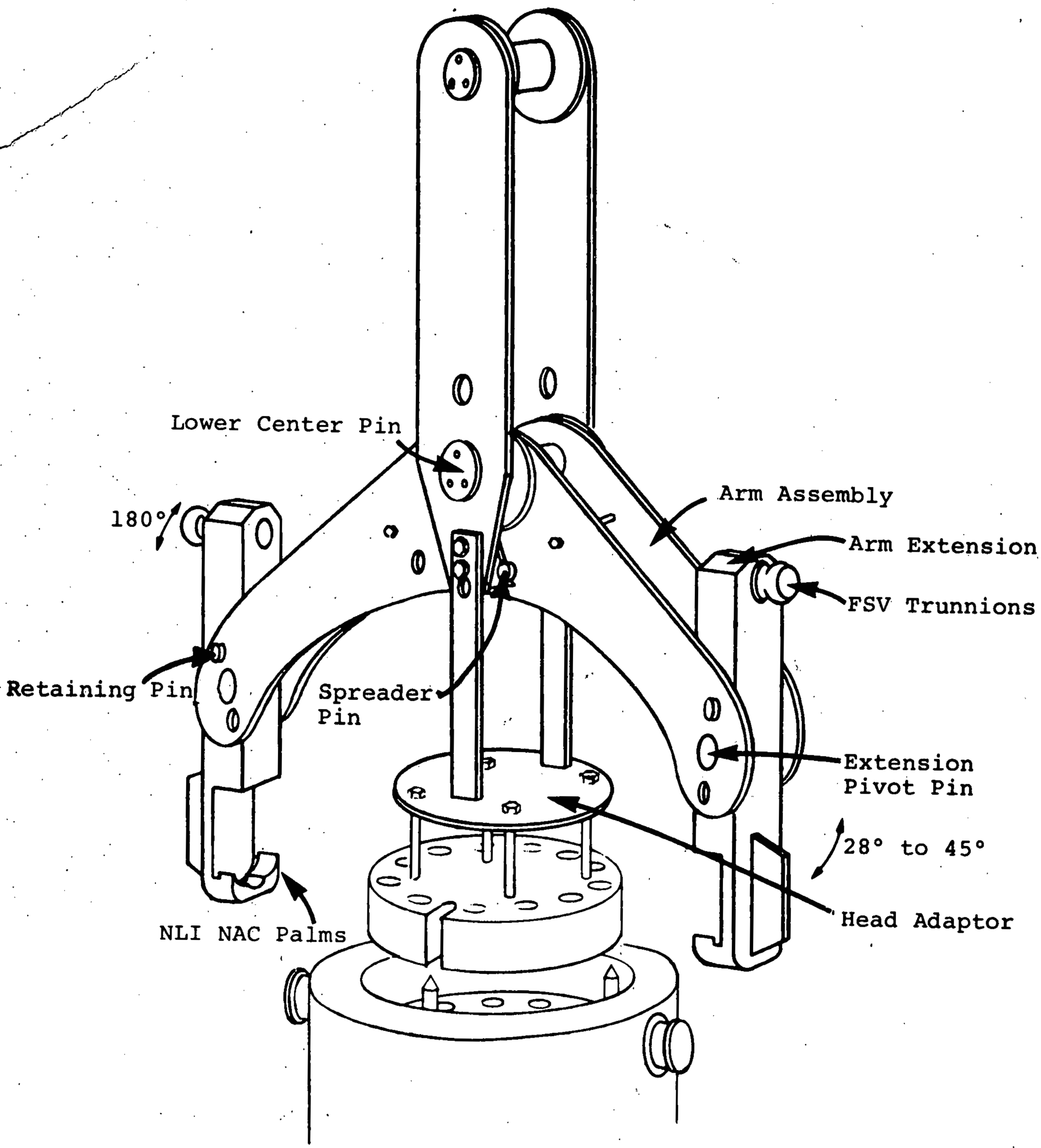
6.1 A name plate shall be seal-welded to one of the two vertical sections of the yoke, located beneath the lower four-inch pin and above the interface area of adaptor attachment.

6.2 The prototype yoke of this design will be identified as AGU-1 and the various components will be stamped 1-A through 1-O as shown in Figure A-1. Any subsequent yokes of this design will be serially numbered and similarly stamped with the serial prefix and the alphabetic suffix.

6.3 The name plate shall include the phrase "Load limit 30 tons."

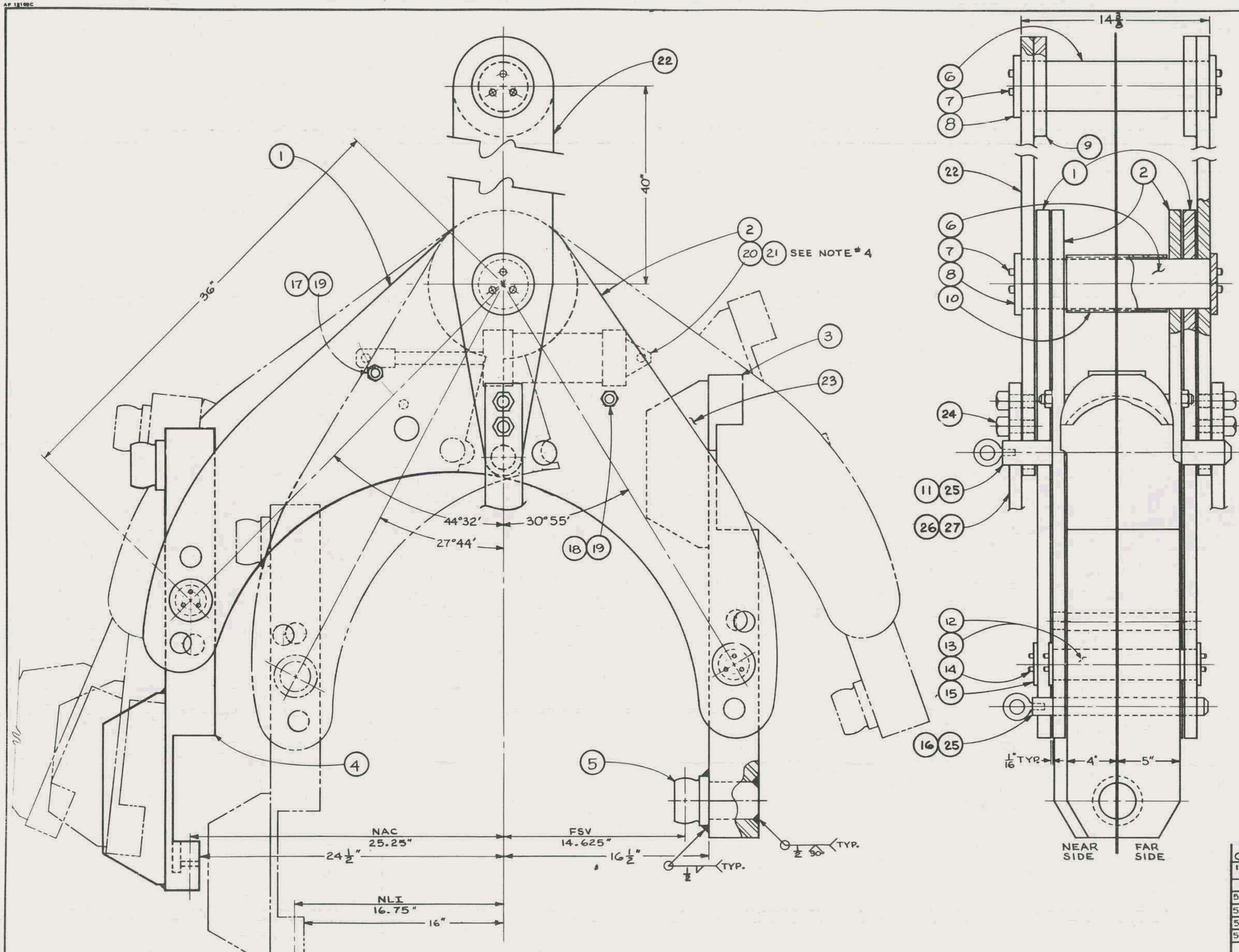
6.4 Adaptors will have nameplates seal-welded onto the upper surface of the circular plate. Adaptors for FSF casks will have an F prefix followed by a serially numbered suffix. Adaptors for NLI 1/2 will use the prefix L and those for the NAC cask will use the prefix C. All adaptors will be labeled "Load limit 1000 pounds."

CASK LIFTING YOKE



YOKE COMPONENT IDENTIFICATION

FIGURE A-1



BILL OF MATERIAL		
ITEM	QTY	DESCRIPTION
1	2	PLATE - 1 X 17 X 48 LG. - S.S. T-304
2	2	PLATE - 1 X 17 X 48 LG. - S.S. T-304
3	1	PLATE - 4 X 9 1/4 X 38 LG. - S.S. T-304
4	1	PLATE - 4 X 10 1/4 X 38 LG. - S.S. T-304
5	2	ROUND BAR - 4" DIA. X 6 3/4 LG. - NITRONIC 60
6	2	ROUND BAR - 4" DIA. X 14 3/8 LG. - NITRONIC 60
7	12	SOCKET HEAD SCREW - 3/8-24 UNF X 1" LG. - S.S. 18-8
8	4	PLATE CIRCLE - 1/2 X 5" DIA. - S.S. T-304
9	2	PLATE CIRCLE - 1" X 9" DIA. - S.S. T-304
10	1	PIPE - 4" SCH. 40 X 8 1/8 LG. - S.S. T-304
11	1	ROUND BAR - 2" DIA. X 18 LG. - NITRONIC 60
12	1	ROUND BAR - 2 1/2" DIA. X 10 1/8 LG. - NITRONIC 60
13	1	ROUND BAR - 2 1/2" DIA. X 12 1/4 LG. - NITRONIC 60
14	12	SOCKET HEAD SCREW - 1/4-28 UNF X 3/4 LG. - S.S. 18-8
15	4	PLATE CIRCLE - 1/4 X 3 1/2 DIA. - S.S. T-304
16	2	ROUND BAR - 1 1/2 DIA. X 14 LG. - NITRONIC 60
17	1	ROUND BAR - 1" DIA. X 14 1/2 LG. - NITRONIC 60
18	1	ROUND BAR - 1" DIA. X 12 1/2 LG. - NITRONIC 60
19	4	LOCK NUT - HEX - 1"ϕ - 8 UNC - S.S.
20	1	CYLINDER - 4" BORE X 6" STROKE MEAD MODEL # 55 - STYLE # 1 - SEE NOTE # 4
21	1	CLEVIS - MEAD # R1-2 - SEE NOTE # 4
22	2	PLATE - 1 X 9 1/4 X 60 LG. - S.S. T-304
23	2	PLATE - 1 X 5 X 14 1/2 LG.
24	4	BOLT - 1"ϕ - 8 UNC X 2" LG. - S.S.
25	2	EYE BOLT - 1/2"ϕ - 13 THD. STUB - S.S.
26	1	SEE DWG. 535D-T-5004
27	1	SEE DWG. 535D-T-5005

NOTES:

1. LOAD TEST TO 90,000 POUNDS.
2. ALL WELDS PER PURCHASE ORDER SPECIFICATIONS.
3. EXAMINE ALL WELDS AND PRE & POST LOAD TEST PER PURCHASE ORDER SPECIFICATIONS.
4. PIN HOLE IN CLEVIS & CLEVIS END OF CYLINDER TO BE REAMED TO 1.02 DIA.
5. DRILL THRU 1/16" AND LOCKWIRE ITEM # 7 & # 14 AT ASSEMBLY.

ISSUE NO.	DATE	DESCRIPTION	BY	CHK	DESIGN ENG.	DESIGN MGR.	APP'L	APP'L	APP'L
0a	9/19/80	ISSUE FOR CONSTRUCTION	TCC LAK	RSD	POS				

REFERENCE DRAWINGS	
535D-T-5002	
535D-T-5003	
535D-T-5004	
535D-T-5005	

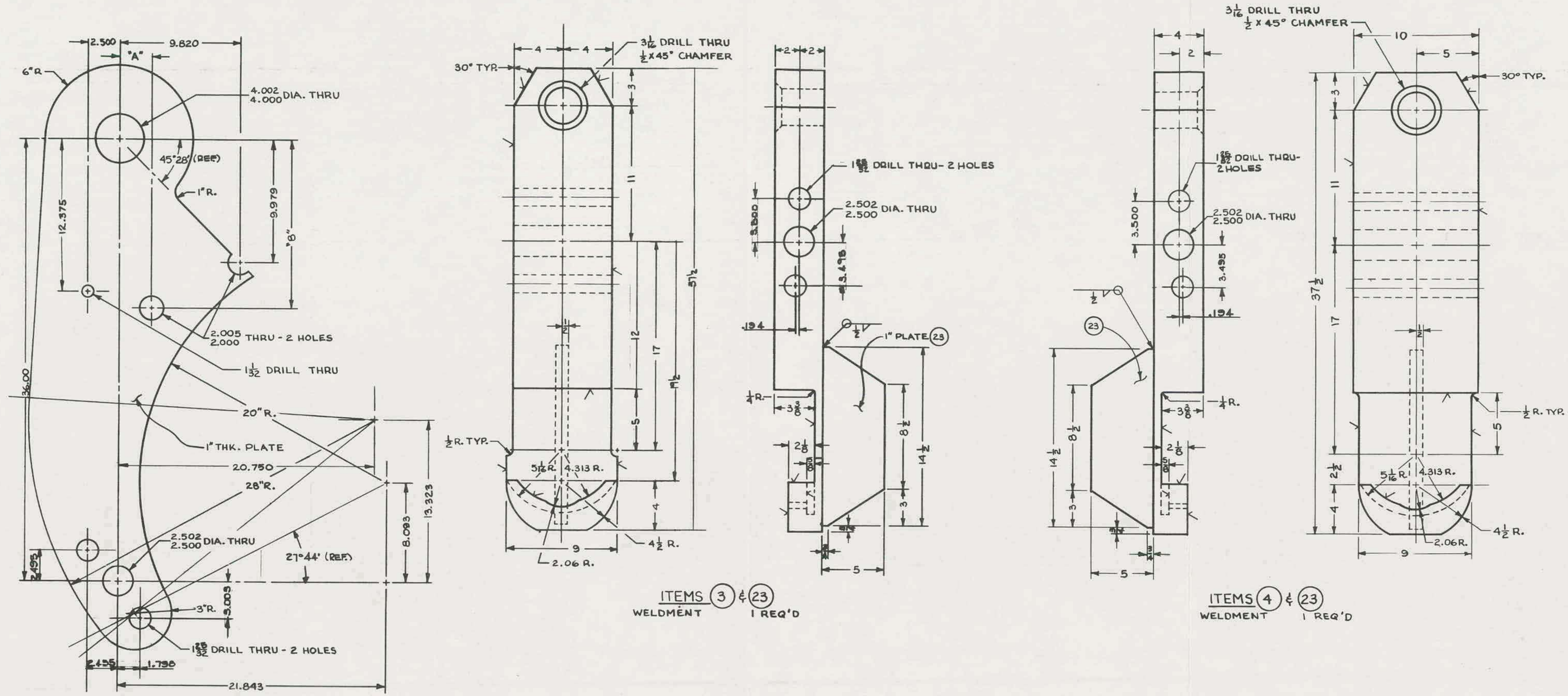
ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
BARNWELL SOUTH CAROLINA

AGNS DESIGN ENGINEERING DEPARTMENT
P. O. BOX 847
BARNWELL, S. C. 29812

UNIVERSAL LWT CASK LIFTING YOKE

SCALE	FACILITY	DRAWING NO.	ISSUE
3" = 1'-0"	DOE-1.2-80 3051001	535D-T-5001	0a

DWG. TYPE
PROCESS



ITEM (1)
2 REQ'D
A = 2.652 B = 13.746

ITEM (2)
2 REQ'D
A = 4.163 B = 13.367

NOTES:
1. FOR NOTES SEE DWG. NO. 535D-T-5001

DIMENSIONAL TOLERANCES						
FUNCTION		MACHINING	WELDMENT	CASTING	SHT METAL	
FRACTIONAL	0"-24"	± 1/64	± 1/16	± 1/16	± 1/32	
	OVER 24"	± 1/32	± 1/8	± 3/16	± 1/16	
DECIMAL	TWO PLACE	± .010			± .030	
	THREE PLACE	± .005			± .010	
ANGULAR		± 1/2°	± 1°	± 1°	± 1/2°	
DIMENSIONAL TOLERANCES APPLY UNLESS OTHERWISE NOTED						

ISSUE NO.	DATE	DESCRIPTION	BY	CHK	DESIGN ENG.	DESIGN MGR.	APP'L	APP'L	APP'L
Oa	7/17/80	ISSUE FOR CONSTRUCTION	[illegible]	RSD	PDS	[illegible]	[illegible]	[illegible]	

REFERENCE DRAWINGS
535D-T-5001

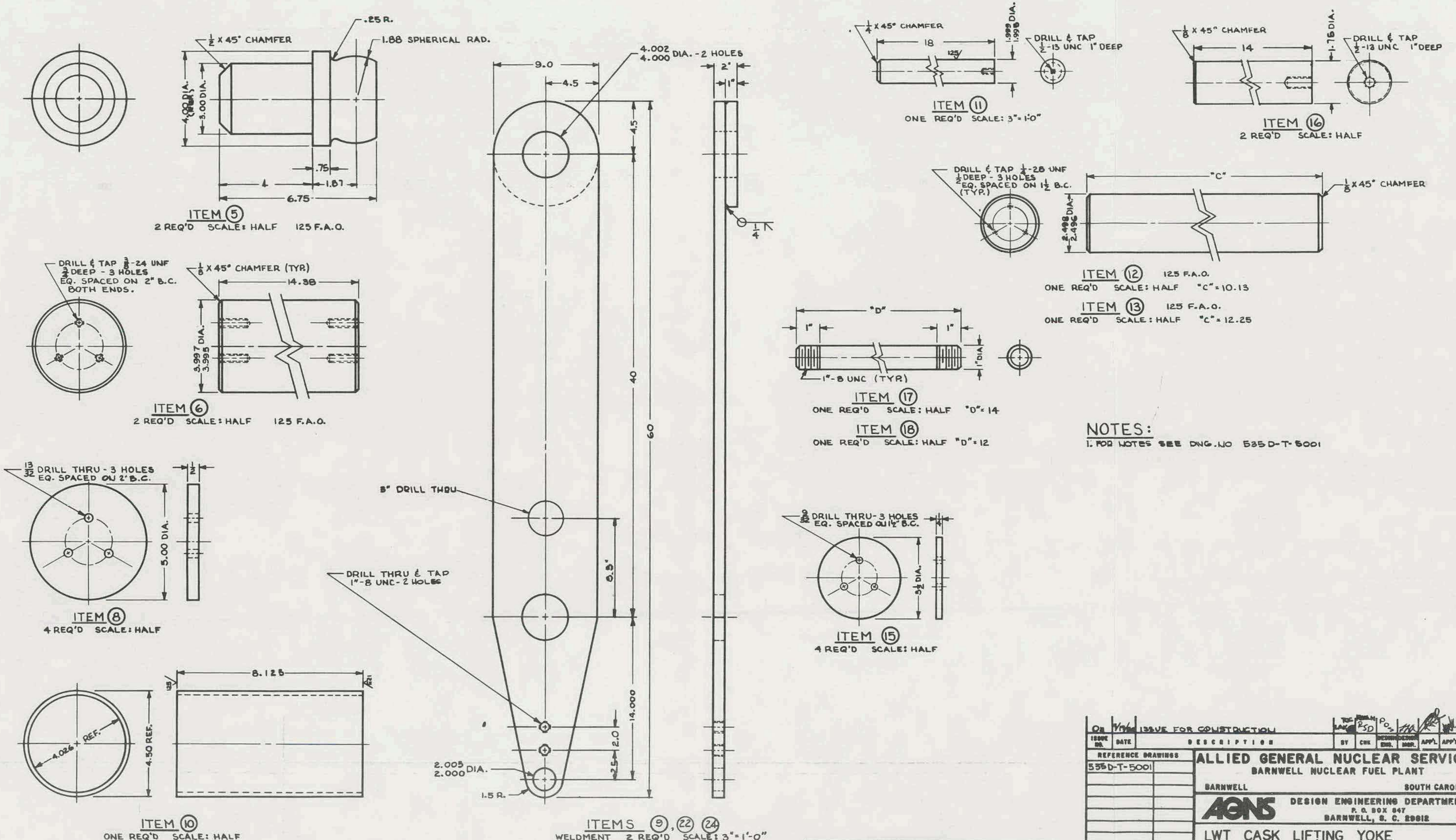
ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
BARNWELL SOUTH CAROLINA

AGNS DESIGN ENGINEERING DEPARTMENT
P. O. BOX 847
BARNWELL, S. C. 29812

LWT CASK LIFTING YOKE
DETAILS

SCALE 3" = 1'-0"
DWG. TYPE
PROCESS

FACILITY	DRAWING NO.	ISSUE
DOE-L2-80 3051001	535D-T-5002	Oa



NOTES:
1. FOR NOTES SEE DWG. NO 535D-T-5001

ISSUE NO.	DATE	DESCRIPTION	BY	CHK	DESIGN ENG.	DESIGN MGR.	APP'L	APP'L	APP'L
0a	[illegible]	ISSUE FOR CONSTRUCTION	[illegible]	RSD	POS	[illegible]	[illegible]	[illegible]	

REFERENCE DRAWINGS
535D-T-5001

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
BARNWELL SOUTH CAROLINA

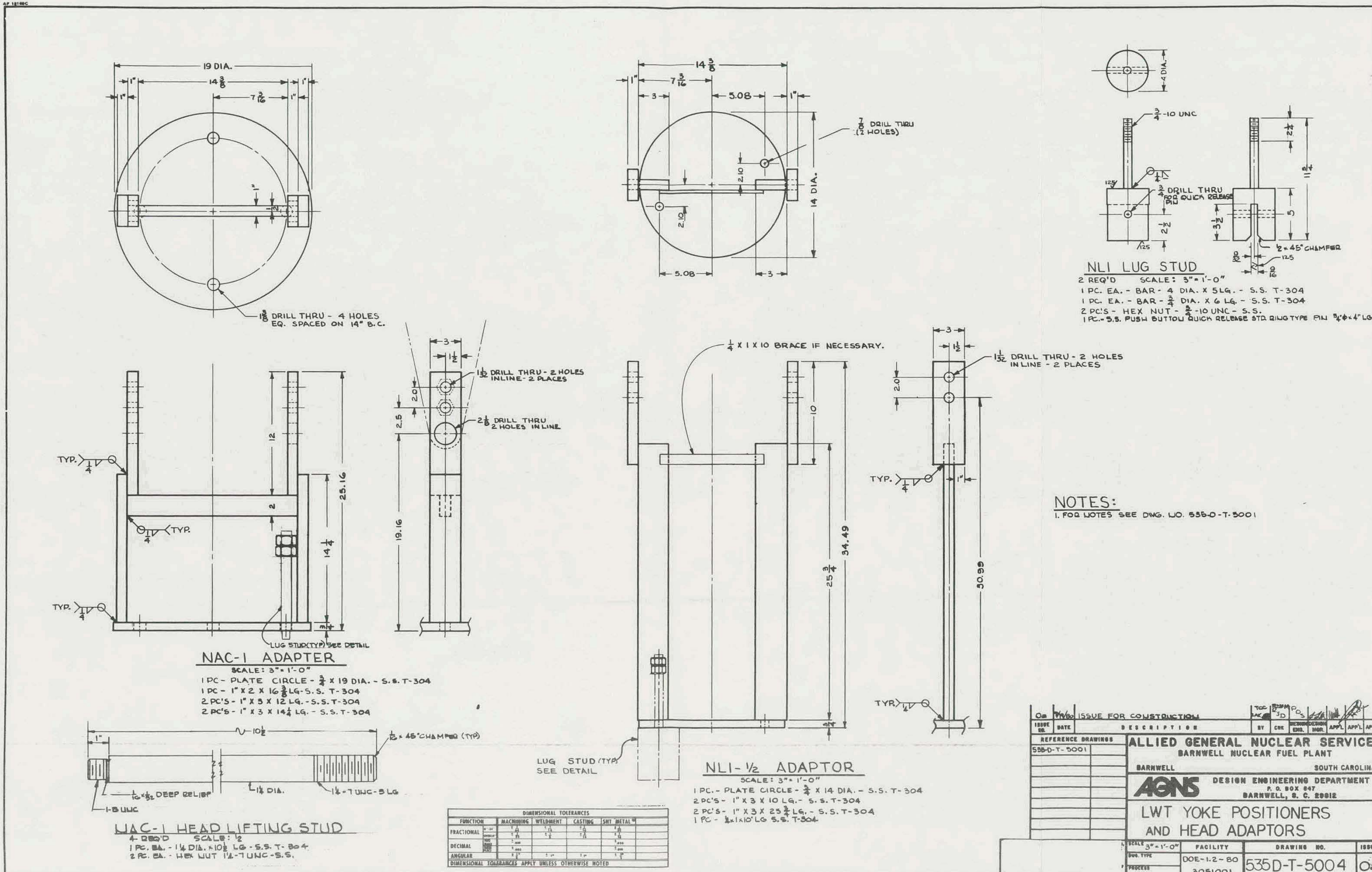
AGNS DESIGN ENGINEERING DEPARTMENT
P. O. BOX 847
BARNWELL, S. C. 29812

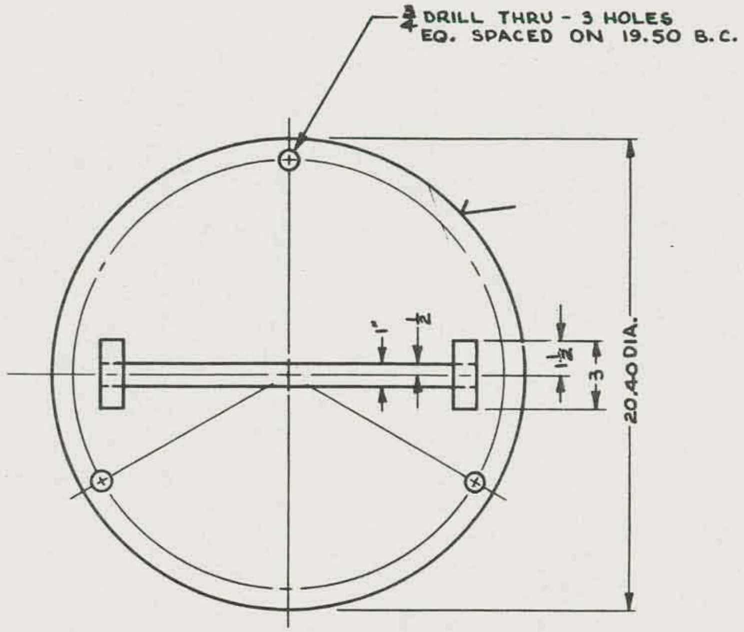
LWT CASK LIFTING YOKE
DETAILS

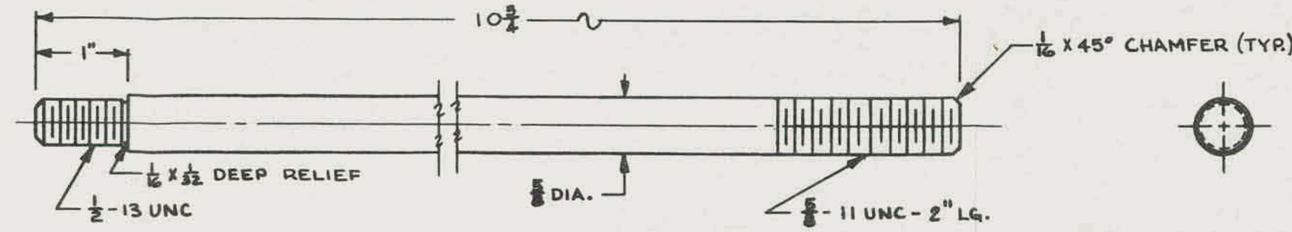
SCALE	FACILITY	DRAWING NO.	ISSUE
NOTED	DOE-1.2-80 3051001	535D-T-5003	0a

DWG. TYPE
PROCESS

DIMENSIONAL TOLERANCES						
FUNCTION		MACHINING	WELDMENT	CASTING	SHT METAL	
FRACTIONAL	0"-24"	± 1/64	± 1/16	± 1/16	± 1/32	
	OVER 24"	± 1/32	± 1/8	± 1/16	± 1/16	
DECIMAL	TWO PLACE	± .010			± .030	
	THREE PLACE	± .005			± .010	
ANGULAR		± 1/2°	± 1°	± 1°	± 1/2°	
DIMENSIONAL TOLERANCES APPLY UNLESS OTHERWISE NOTED						


19 DIA.
$14\frac{3}{8}$
$7\frac{3}{16}$
$1\frac{3}{8}$ DRILL THRU - 4 HOLES EQ. SPACED ON 14" B.C.
$\frac{7}{8}$ DRILL THRU (2 HOLES)
14 DIA.
5.08
2.10
$\frac{3}{4}$ DRILL THRU FOR QUICK RELEASE PIN
4 DIA.
$\frac{3}{4}$-10 UNC
$\frac{1}{2}$ x 45° CHAMFER
NLI LUG STUD
2 REQ'D SCALE: 3" = 1'-0"
1 PC. EA. - BAR - 4 DIA. X 5 LG. - S.S. T-304
1 PC. EA. - BAR - $\frac{3}{4}$ DIA. X 6 LG. - S.S. T-304
2 PC'S - HEX NUT - $\frac{3}{4}$-10 UNC - S.S.
1 PC. - S.S. PUSH BUTTON QUICK RELEASE STD. RING TYPE PIN $\frac{3}{4}$"φ x 4" LG.
$1\frac{1}{32}$ DRILL THRU - 2 HOLES INLINE - 2 PLACES
$2\frac{1}{8}$ DRILL THRU 2 HOLES IN LINE
$\frac{1}{4}$ X 1 X 10 BRACE IF NECESSARY.
$1\frac{1}{32}$ DRILL THRU - 2 HOLES IN LINE - 2 PLACES
TYP.
25.16
19.16
34.49
$25\frac{3}{4}$
50.99
LUG STUD (TYP) SEE DETAIL
NAC-1 ADAPTER
SCALE: 3" = 1'-0"
1 PC - PLATE CIRCLE - $\frac{3}{4}$ X 19 DIA. - S.S. T-304
1 PC - 1" X 2 X $16\frac{3}{8}$ LG - S.S. T-304
2 PC'S - 1" X 3 X 12 LG. - S.S. T-304
2 PC'S - 1" X 3 X $14\frac{1}{4}$ LG. - S.S. T-304
NOTES:
1. FOR NOTES SEE DWG. NO. 535-D-T-5001
LUG STUD (TYP) SEE DETAIL
NLI-½ ADAPTOR
SCALE: 3" = 1'-0"
1 PC. - PLATE CIRCLE - $\frac{3}{4}$ X 14 DIA. - S.S. T-304
2 PC'S - 1" X 3 X 10 LG. - S.S. T-304
2 PC'S - 1" X 3 X $25\frac{3}{4}$ LG. - S.S. T-304
1 PC - $\frac{1}{4}$ x 1 x 10" LG S.S. T-304
$10\frac{1}{2}$
$\frac{1}{8}$ x 45° CHAMFER (TYP)
$\frac{1}{16}$ x $\frac{1}{32}$ DEEP RELIEF
$1\frac{1}{4}$ DIA.
$1\frac{1}{4}$-7 UNC-5 LG
1-8 UNC
NAC-1 HEAD LIFTING STUD
4-REQ'D SCALE: ½
1 PC. EA. - $1\frac{1}{4}$ DIA. x $10\frac{1}{2}$ LG - S.S. T-304
2 PC. EA. - HEX NUT $1\frac{1}{4}$-7 UNC - S.S.
DIMENSIONAL TOLERANCES
FUNCTION | MACHINING | WELDMENT | CASTING | SHT METAL
FRACTIONAL
DECIMAL
ANGULAR
DIMENSIONAL TOLERANCES APPLY UNLESS OTHERWISE NOTED
0a ISSUE FOR CONSTRUCTION
ISSUE NO. | DATE | DESCRIPTION | BY | CHK | DESIGN ENG. | DESIGN MGR. | APP'L | APP'L | APP'L
REFERENCE DRAWINGS
535-D-T-5001
ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
BARNWELL SOUTH CAROLINA
AGNS DESIGN ENGINEERING DEPARTMENT
P. O. BOX 847
BARNWELL, S. C. 29812
LWT YOKE POSITIONERS AND HEAD ADAPTORS
SCALE 3" = 1'-0"
DWG. TYPE
PROCESS
FACILITY DOE-1.2-80 3051001
DRAWING NO. 535D-T-5004
ISSUE 0a

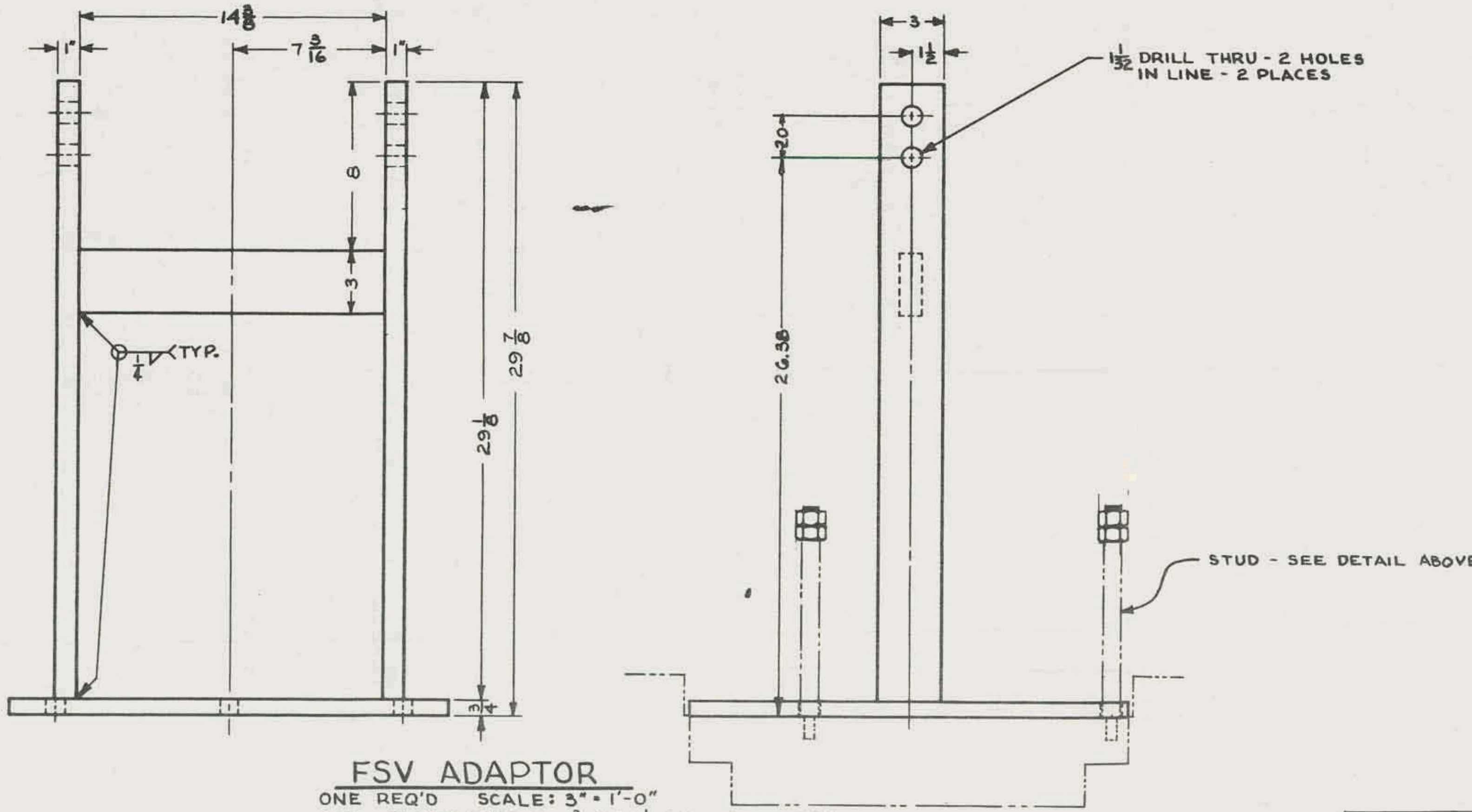




FSV HEAD LIFTING STUD

3 REQ'D SCALE: FULL
1 PC. EA. - $\frac{5}{8}$ DIA. X $10\frac{3}{4}$ LG. - S.S. T-304
2 PC. EA. - HEX NUT - $\frac{5}{8}$-11 UNC - S.S.

NOTES:
1. FOR NOTES SEE DWG. NO 535D-T-5001



FSV ADAPTOR

ONE REQ'D SCALE: 3" = 1'-0"
1 PC. - PLATE CIRCLE - $\frac{3}{4}$ X $20\frac{1}{2}$ DIA - S.S. T-304
1 PC. - 1" X 3 X $14\frac{3}{8}$ LG. - S.S. T-304
2 PC'S - 1" X 3 X $29\frac{1}{8}$ LG. - S.S. T-304

DIMENSIONAL TOLERANCES						
FUNCTION		MACHINING	WELDMENT	CASTING	SHT METAL	
FRACTIONAL	0"-24"	± $\frac{1}{64}$	± $\frac{1}{16}$	± $\frac{1}{16}$	± $\frac{1}{32}$	
	OVER 24"	± $\frac{1}{32}$	± $\frac{1}{8}$	± $\frac{3}{32}$	± $\frac{1}{16}$	
DECIMAL	TWO PLACE	± [illegible]			± .030	
	THREE PLACE	± .005			± .010	
ANGULAR		± $\frac{1}{2}$°	± 1°	± [illegible]	± $\frac{1}{2}$°	
DIMENSIONAL TOLERANCES APPLY UNLESS OTHERWISE NOTED						

ISSUE NO.	DATE	DESCRIPTION	BY	CHK	DESIGN ENG.	DESIGN MGR.	APP'L	APP'L	APP'L
0a	7/11/80	ISSUE FOR CONSTRUCTION	[illegible]	RSD	POS	[illegible]	[illegible]	[illegible]	

REFERENCE DRAWINGS
535D-T-5001

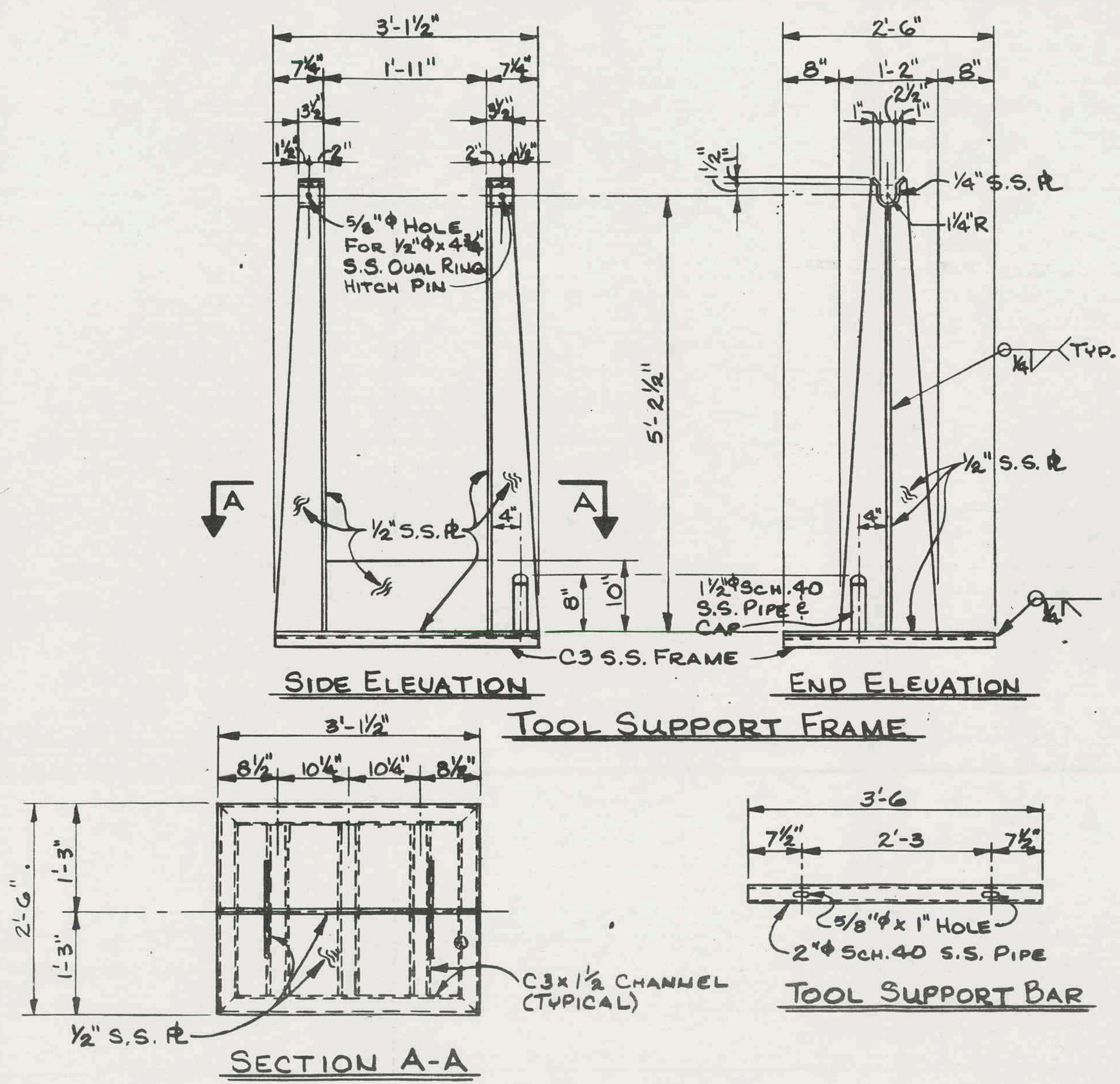
ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
BARNWELL SOUTH CAROLINA

AGNS DESIGN ENGINEERING DEPARTMENT
P. O. BOX 847
BARNWELL, S. C. 29812

LWT YOKE POSITIONER & HEAD ADAPTOR

SCALE	FACILITY	DRAWING NO.	ISSUE
NOTED	DOE-1.2-80 3051001	535D-T-5005	0a

DWG. TYPE
PROCESS



BILL OF MATERIALS

ITEM NO	DESCRIPTION	QTY.
1	PL ¼" x 0'-3½ 304-L S.S.	2 L.F.
2	PL ½" x 0'-7 304-L S.S.	11 L.F.
3	PL ½" x 1'-2 304-L S.S.	11 L.F.
4	PL ½" x 2'-6 304-L S.S.	4 L.F.
5	C3 x 1½ 304-L S.S.	18 L.F.
6	1½"ϕ SCH. 40 304-L S.S. PIPE	1 L.F.
7	1½"ϕ SCH. 40 304-L S.S. PIPE CAP	1 REQ'D.
8	2"ϕ SCH. 40 304-L S.S. PIPE	4 L.F.
9	½"ϕ x 4¾" OVAL RING HITCH PIN 303 S.S.	2 REQ'D.

NOTES

1. ALL STAINLESS STEEL SHALL BE ASTM A240 & A312 CONFORMING TO AGNS PEDIGREE NO'S. 1, 4, & 6.
2. ALL SHOP WELDS SHALL CONFORM TO AGNS WELDING PROCEDURE WP-4.
3. VISUALLY INSPECT WELDS PER AGNS PROCEDURE QCP-6.
4. DEBURR & RADIUS ALL EXPOSED EDGES.
5. ALL FRACTIONAL DIMENSIONS SHALL HAVE A TOLERANCE OF ± 1/8".

ISSUE NO.	DESCRIPTION	DRN.	CHK	APPROVED	DATE
0a	ISSUED FOR CONSTR.	[illegible]	TCC	[illegible]	1/3/[illegible]

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT

TOOL SUPPORT BAR & FRAME

SCALE: 3/4" = 1'-0"

AGNS DESIGN ENGINEERING DEPARTMENT
P.O. BOX 847
BARNWELL, S.C. 29812

PROJECT NUMBER 3051001 | DRAWING NUMBER 535 B-T-5006 | ISSUE 0a

REPORT NO. AGNS-35900-1.1-106

CASK HANDLING EQUIPMENT STANDARDIZATION

VOLUME II

FLEET SERVICING FACILITY SOFTWARE SUPPORT SYSTEM

Paul N. McCreery

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

ABSTRACT

The hardware and operating techniques envisioned for a Spent Fuel Cask Fleet Servicing Facility (FSF) have been discussed in considerable detail in previous reports. This report complements the earlier ones in that it describes, in general terms, a system for the control of the many activities associated with the FSF. Using as a base the generation and retention of records to track the continuing recertification requirements, the system becomes integrated with scheduling, spare parts, operating procedures, etc.

To emphasize the simplicity of the system, it is designed to operate using a micro, or "personal" computer, with a cost of less than $3500.

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1.0 INTRODUCTION

This report is a spin-off of the concept of the Fleet Servicing Facility.(1, 2) That is the term used to describe an installation, the main purpose of which is to supply all of the maintenance, services, and requalification requirements for a fleet of spent fuel casks and their associated vehicles. A fleet of several cask models, several casks of each model, and many interchangeable components making up each cask presents a formidable control problem in assuring that all of the required testing and maintenance can mesh with regular cask usage.

Ideally, a Fleet Servicing Facility (FSF) should be located and operated as a part of a cask unloading site. This will give the greatest number of casks exposure to the maintenance facility without deviating from their in-service travel patterns. Whether built as an add-on to an existing AFR or constructed as an integral part of some new facility such as a terminal storage site, studies(2) have shown that the more nearly integrated the FSF with the companion facility, the more efficient the combined operations. This integration can be even more complete in the software systems that supply management with the information needed to run these facilities, day by day and year by year.

It might do well at this point to state some things that this report is not.

It is not an exercise in computer programming.

It is not an academic analysis of data base management.

It is not an advocacy for a "black box" to relieve management personnel of their appropriate responsibilities.

To nullify the notion that an elaborate computer system is needed to perform the tasks described in this report, this system is described as using one of the new, low-priced (<$3500) micro-computers; the so-called "personal" computer. The system, shown in Figure 1, consists of a terminal with 32K RAM, and CRT display; a 150 character-per-second, program-controlled matrix printer; and dual "floppy" data storage disks with 340K bytes of memory. Data are processed by the PET BASIC program language and texts are processed using the "Wordpro III" text editing package.

Our purpose is to demonstrate that a comparatively simple system can provide a great deal of information as a management tool in working with a complex fleet of Type B packages. Although we have limited our scope to spent fuel casks, packages for HLW, TRU, etc., could be included with little additional effort.

The premise is that a central facility has been established to provide the necessary maintenance for a fleet of casks. If the cask fleet with which it would be concerned were an extrapolation of the equipment currently available, we may assume:

- The fleet may consist of as many as eight different models of casks
- Some parts may be interchangeable between cask models while others may not be interchangeable within models of the same cask
- As many as a dozen or so cask owners may be involved; requiring differentiation among records, tests, purchases, etc.
- The transporting vehicles (power units excluded) will be subject to maintenance procedures, schedules, and some form of certification.

All of the tests and repairs necessary for compliance with USNRC requirements for each component of each cask system will be performed in the FSF. The two salient objectives of FSF management should be:

- To assure that no cask ever is in active service with an expired certification or on an unroadworthy vehicle
- To keep the out-of-service time for each unit to a minimum.

This report relates specifically to the software support for management of the facility. It has two specific goals in that it must provide accurate and timely information for a quality-assurance intensive program and it must function as a part of an overall data base system, as opposed to a separate, satellite system. A complete computer code is not presented because each code would have to be developed to fit a specific need. A sufficient number of subroutines is included to show in some detail just how the various components of the system interact to achieve the desired end. Since the computer language used is BASIC, the logic statements can be followed relatively easily.

The advantage to be gained by using a more sophisticated computer is that of reduced processing time.

2.0 DESCRIPTION

The data base consists of about 15 files, for purposes of illustration. More may evolve as the system is adapted to a given facility. The files are identified and described in Table 1. In Table 2, the identity of each field is shown for the individual records that make up each file. Each file consists of "i" records (n = 1 to i) and "j" fields (n = 1 to j), so a variable $X_{(i, j)}$ will pertain to one, and only one, item of data in the entire data base. Thus, any item of data is available for operations that may affect it as a result of processing that file or any other file in the system. Since the 32K RAM obviously will not accommodate all the data needed in such a system, file access must be controlled via block address systems with the various blocks being associated with known increments of the file. This can be alleviated or avoided with larger memory banks that are available with other computers.

The first field in each record (except #10) is the "key," in that the order of the records in that file is determined by the numeric or alphabetic sequence of this key field. File #10 is a continuous 10-year calendar which is used to convert dates of the form MO/DA/YR to a form more amenable to calculating elapsed time, and then converting the newly calculated date back to the more common form. Subroutines are listed to illustrate how this is done, as well as to give an indication of the simplicity of the BASIC program language. File #8 is unique in that Field 2 is sorted numerically within repetitive numbers of Field 1.

Table II provides an overview of the complete data base. From this, one can see how entering a shipper's code number as a destination in Field 7 of File 5 can provide the means by which the shipper's data can be identified and accessed from File 13. To the departure time, entered in Fields 4 and 5 of File 5, can be added the scheduled travel and turn-around time from Fields 7, 8, and 9 of File 13 to determine the estimated date of return to be inserted automatically into Field 8 of the proper record of File 5. Similarly, File 8 which contains each critical component, will be referenced as a cask is scheduled for departure (File 5) and all the components of that cask system are identified (File 7) and the certification status of each component is checked (File 8). If "estimated date of return" is less than the "date due" for any component in File 8 (plus a safety margin) then the "out of service" flag is raised in Field 9 of File 5 and a message is printed stating that the cask is out of service and for what reason, by part number, and test requirement.

The keyboard inquiry system is an important management feature. It is discussed in more detail in a following section.

3.0 SYSTEM OPERATION

Eight unique input forms are required to operate this system. These are described in Sections A-1 through A-8. All but the first make use of a routinely used reporting document (part requisition, receiving report, etc.) for the desired data and these forms should be designed with this use in mind. Item 1 is simply a complete record for whichever file is to be expanded.

Input data is manipulated by directing it to routines which perform assigned functions; and these routines, in turn, may call subroutines for such jobs as file updating or information printout.

As an example of how the system would be accessed, once the program is loaded and ready to run:

Operator: RUN (Typed on keyboard)

Computer: SELECT THE DESIRED ACTIVITY BY ENTERING THE INITIAL LETTER. (Visual display on CRT)

New data
Arrival
Departure
Service status change
Component reassignment
Part requisition
Receiving report
Test
Keyboard inquiry

Suppose, for example, that the operator wishes to add a new record into a file. The operator would respond:

Operator: N

Computer: WHICH FILE?

M	Master	C	Cask I.D.	S	Supplier
N	Inventory	K	Cert Cont.	O	Owner
L	Cask Act'ty	T	Test	Q	Certs
P	Cask Control			R	Shipper

If the file to be expanded is the inventory file, the operator would respond with:

Operator: N

The computer would then request data to fill exactly one record of that file, to which the operator would respond as each question is asked.

Computer: PART NUMBER?________
QUAN. ON HAND?________
REORDER LEVEL?________
REORDER QUAN.?________
STORES LOC.?________
LEAD TIME?________
UNIT PRICE?________
CERT. NO.?________
CERT. NO.?________
CERT. NO.?________

A "carriage return" without inputting a certification identification number will terminate the input sequence. At that time the computer code "INSERT" (see II A-8) will place the new record in part-number numerical order in the inventory file. Note that program "INSERT" will insert the record in its proper sequence in a file of 2000 records with about 15 to 20 comparisons.

A. System Input

1. New items or changes

Input: The complete new record for each affected file.

System Response: (1) Insert the new record, in sequence, into the appropriate file.

(2) Check other files and update them accordingly, or, if the necessary companion record is missing from another file, print out a message regarding the omission.

(It is through this type of entry that the original files would be set up.)

2. Cask Arrival

Input: File number, cask (body) part number, date and time of arrival.

System Response: (1) Replace the previous "arrival" data, but do not change the existing departure data. (Later, comparisons of arrival and departure dates will indicate whether the cask is in-house or on the road.)

(2) Compare elapsed travel time with corresponding data in SHIPPER* (travel time plus turnaround time for that specific shipper) and flag

---

*References to files are in upper case characters.

differences of > ±x for rail shipments and > ±y for truck.

(3) Print out a listing of SOP's and checklists to be available at each work station as the cask system is processed through the facility. Ditto for special tool kits.

(4) Print out the next certification testing due date for each component in the system. If any due date is within x days for rail or y days for truck, set the out-of-service flag automatically.

(5) Update HISTORY for all cask components.

3. Cask Departure

Input: (At the time the departure is first scheduled.) File number (CASK ACT), cask (body) part number, trip pack number and destination code.

System Response:

(1) Replace previous departure data with current trip information.

(2) Check all components within the system for next certification testing due-date and flag out-of-service if that date falls due in less than, for example, twice the scheduled travel time.

(3) Compare cask makeup with SHIPPER to verify that the cask model and its associated internals are compatible with the requirements of that reactor.

(4) Compare cask capacity with the number of fuel assemblies remaining in the current commitment and if less than a full load, print out a message flag.

Input: (At the time of actual departure.) File number, cask (body) part number, date, and time of departure.

System Response:

(1) Update HISTORY for each component.

(2) Compare date and time-out versus date and time-in and determine in-house turnaround time.

(3) Update estimated date of return.

4. In-service Change

Input: The out-of-service code in CASK ACT will be changed automatically when tests are needed or when they are satisfactorily completed. This code may be changed via manual input to take casks out of service (e.g., for repairs) and as a system override to return them to service.

System Response: Either method of input will update HISTORY.

5. Component Reassignment (to or from a cask). Note: "Storage" is assigned a "cask number."

Input: Component file number (INVENTORY), component number, new "Location."

System Response:
(1) update CASK ID (2 P/N's)
(2) update HISTORY

6. Test Performed

Input: File number (CERT CON), part number, date, and test results.

System Response:
(1) Determine next due date and update that field in the record.

(2) Scan CASK ACT and remove the OOS flag if no other component of that system is deliquent.

7. Part Requisition

Input: File number (USAGE), part number, quantity, date, job

System Response:
(1) Decreases quantity on-hand (QOH) in INVENTORY

(2) Compares new QOH to reorder level (ROL). If QOH < ROL, the system will:

a. generate a new record in ACT ORD indicating an active order.

b. print out a serially numbered Purchase Order to the coded vendor for the reorder quantity (ROQ) with certification requirements listed on the order.

c. generate memo on the printer giving part number, QOH, due date, owner, description.

d. ACT ORD date due will be determined by order date plus lead time (from INVENTORY).

(3) Assign cost of part to the job number assigned to the work being done as a part of the costing system.

(4) Updates the usage rate for that part for the previous 6 months (or 1 year, etc.) as a monitor of reordering parameters.

8. Receiving Report/Invoice

Input: File name (ACC ORD), part number, P.O. #, RR #, date received, quantity received, certs received, unit cost.

System Response:

(1) Compares certs requested to certs received; places flag beside quantity received until all certs are in compliance.

(2) Calculates delivery time and updates lead time (INVENTORY) by a weighted factor

(3) Updates price (assuming LIFO accounting)

(4) Compares usage rate to ROL, ROQ, and lead time. Print out results for management info.

(5) Updates QOH in INVENTORY when parts are OK'd for use.

In all of the foregoing, the system response can, and should, be varied in accordance with the specific needs of the user.

B. System Output

1. Automatic Output

Previous mention has been made of the automatic responses to certain modes of input to the data base. In addition, a periodic output (daily, weekly) of the following information is appropriate.

(1) Cask numbers and date due to return to the site during the next x days.

(2) Tests due to be performed within the next x days.

(3) Quantity of fuel remaining at each reactor applicable to the current shipping commitment.

(4) Parts received but lacking all certs.

(5) Inventory listing and value, by owner.

(6) Casks or components out of service and reason.

(7) Cask utilization factors.

(8) Anticipated testing schedules by week, month.

2. Keyboard Inquiry

A useful attribute of any data base system is the provision for the user to ask for specific information by typing inquiries into the system. By activating a certain program and then supplying answers to questions printed on the console screen, the system will display (on the CRT) or print out the response. For example:

Computer: INFORMATION REQUESTED?
Operator: COMPONENT LOCATION
Computer: PART NUMBER?
Operator: 84-4378
Computer: PART NUMBER 84-4378 IS A RELIEF VALVE ASSIGNED TO CASK 81-1002 (CP&L OWNED IF-300) DISPATCHED ON 10/24/83 TO MEGAJOLT REACTOR. EDR IS 11/17/83.

Similar inquiries could include:

- Number of helium leak tests to be done between November 1 and December 1
- Part numbers with the 10 highest usage rates.
- Historical data on part number xxx between two dates
- Why is cask # yyy out of service? etc.

Some General Comments

The part number should be given careful consideration as to its structure. The first digit might define the part as being:

1. a cask component (body, head, basket, etc.)
2. a stores item
3. a special part, expendable (cask sit-down disk)

4. a special part, nonexpendable (lifting yoke)
5. etc.

Thus, only part numbers beginning with the digit "1," for example, need be screened for certification status. Similar expediencies would apply to the other digits. The second digit might identify the part number with a specific cask model (i.e., 1 to 9) or as a general part not associated with any specific cask (Ø). A similarly coded third digit might be used, or the remaining digits could be unique to each given part. Coding of certification requirements, test identification, standard operating procedures, etc., should be considered in a similar manner.

The controls which monitor cask compliance can be applied equally well to the Q.C. instrument calibration control needs, without setting up a separate system for this vital function.

Data available in the parts control portion can be set up to provide input to the costing system. It can adapt to either LIFO or FIFO costing, with current inventory value always available within minutes.

Job shop costing fits in easily if time cards are designed with the system in mind. This affords the option of billing parts and services on the basis of time and materials. Or, if a fixed price for each job is invoiced, actual performance can be compared to the "standard" charge, subdivided to the extent desired.

As a separate entity on the same hardware system, a $200 investment enables one to include word processing (or text editing) capabilities. As procedures are prepared, they are stored in the magnetic memory of the floppy disks. In the word processing mode, words, sentences, or paragraphs can be added or deleted very quickly. Through "search and change" commands, a given string of characters can be changed throughout the document to any other specified string. For example, "SOP 12345, Rev. 6," can be changed, anywhere it appears, to read "SOP 12345, Rev. 7," and new copies of the updated procedure can be typed automatically with a very low probability of errors (unless they already were in the stored version) at a rate of one page per minute. Merging this capability with the document control requirements of a given facility would require administrative procedures unique to each facility.

If more than one FSF were to exist and casks were routed to them on a more or less random basis, a periodic data exchange could keep all systems current. In this situation, however, it would be better to set up one central station with terminals at the other facilities accessing the system on a time-share basis.

Conclusions and Recommendations

This report provides one approach to overseeing the QA requirements of a continuing recertification program for a variety of casks at any given servicing facility. The likelihood of more than one servicing facility warrants the need to examine the ramifications of this contingency in more detail.

It is recommended that some computerized system be formulated for recertification control before an FSF is put into operation. An adequate system would appear to exceed the capabilities of manual record-keeping.

References

1. McCreery, P. N., et al, The Conceptual Design of a Spent Fuel Cask Fleet Servicing Facility, AGNS-1040-1.5-48, Work performed under DOE Contract E7-78-C-09-1040 (September 1978).

2. Watson, C. D., and McCreery, P. N., et al, Fleet Servicing Facilities for Servicing, Maintaining, and Testing Rail and Truck Radioactive Waste Transport Systems, ORNL/Sub-79/13866/1, AGNS-SFP-5. Work performed under DOE Contract W-7405-eng-26 (May 1980).

TABLE 1

FILE DESCRIPTIONS

File No.	Name	Tag*	Description
1	MASTER	M	Part description
2	INVENTORY	N	Primary inventory control file
3	ACT ORD	A	Active order file for parts ordered; receiving incomplete
4	USAGE	U	Running usage rate "Requisition" file
5	CASK ACT	L	Cask status and location
6	CASK CONT	P	Record of SOP's (operational and test) for each cask component
7	CASK ID	C	Record of components in each cask system
8	CERT CONT	K	Record of each test required for each component; date last performed and next date due
9	HISTORY	H	A compilation of every activity affecting each cask component
10	DATES	D	A calendar of the number of days from an arbitrary starting date of the last day of each month for x years
11	TESTS	T	A record describing each test in use
12	SHIPPER	R	Information pertaining to each shipper
13	SUPPLIER	S	Name and address of each supplier
14	OWNER	O	Name and address of each owner
15	CERTS	Q	Certification requirements description

*This is the variable unique to each file.

TABLE 2

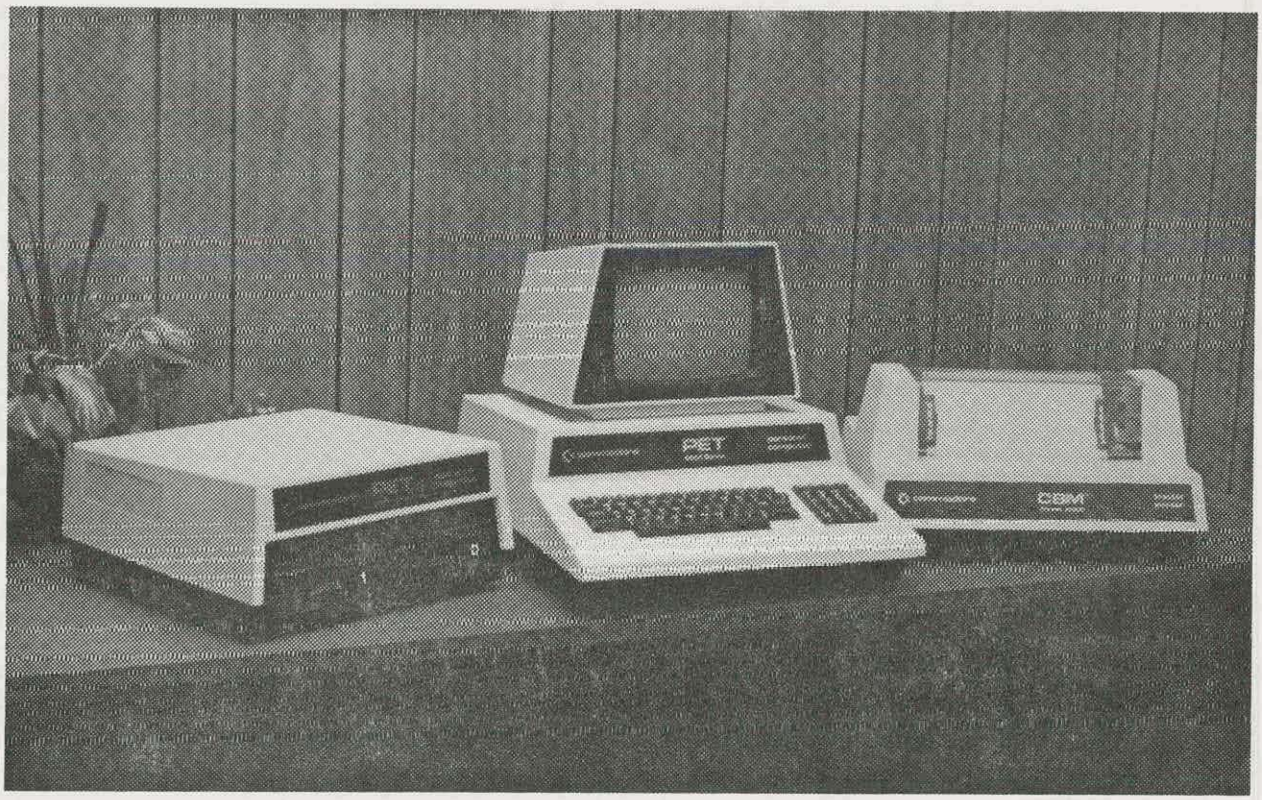
FILE RECORD DESCRIPTION

File No.	Name	Varia.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	MASTER	M	P/N	Owner's #	Category	Description	Drawing Number	Revision Number									
2	INVENTORY	N	P/N	QOH	ROL	ROO	Loc	Lead Time	Price	Cert.	Cert.	Cert.					
3	ACT ORD	A	P/N	Quantity	P. O. No.	V Code	Dt. ord.	Dt. due	Dt. rec'd.	R. R. No.	Cert.	Cert.	Cert.				
4	USEAGE	U	P/N	Quantity	Date	Job	6-mo. rate										
5	CASK ACT	L	P/N	Dt. in	Time in	Dt. out	Time out	T.P. out	Dest.	EDR	OOS Code	Dead Time	E Dead Tm.				
6	CASK CONT	P	P/N	SOP	SOP	SOP	SOP	SOP	Test	Test	Test	Test	Test				
7	CASK ID	C	P/N	Head #1	Head #2	Basket PWR/BWR	Spacer	Impact 1	Impact 2	Relief Valve 1	Relief Valve 2	Vehicle					
8	CERT CON	K	P/N	T/N	Dt. due	Dt. OK	Owner	Test Result									
9	HISTORY	H	P/N	Event Code	Date	Add to	Trip Pack										
10	DATES	D	1	2	3	4	5	6	7	8	9	10					
11	TESTS	T	T/N	Description	SOP	Tool Kit	Accpt Or.	$	Duration								
12	SHIPPER	R	R/N	Name	Location	License #	Mode	Opt	TTT	TTF	TAT	UTS	Cask N.G.	Type	Spcr.	Quantity	Rem
13	SUPPLIER	S	S/N	Name	Address	City	St.	Zip	Attn.	Phone	Prod. Line						
14	OWNER	O	O/N	Name	Address	City	St.	Zip	Attn.	Phone							
15	CERTS	Q	C/N	Desc.													

Legend:

P/N = Part number
T/N = Test number
S/N = Supplier number
O/N = Owner number
C/N = Cert. number
UTS = Unit train size
QOH = Quantity on hand
ROL = Reorder level
R/N = Shipping number
RR = Receiving report

ROQ = Reorder quantity
LOC = Location
OOS = Out of service
EDR = Estimated time of return
TTT = Travel time to
TTF = Travel time from
TAT = Turn around time
NG = Not acceptable
SOP = Standard operating procedure



COMMODORE PET PERSONAL COMPUTER SYSTEM

FIGURE 1

REPORT NO. AGNS-35900-1.1-106

FLEET SERVICING FACILITY SOFTWARE SUPPORT SYSTEM

APPENDIX A TO VOLUME II

<u>EXAMPLES OF BASIC LANGUAGE SUBROUTINES</u>

Paul N. McCreery

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

The preparation of the complete computer program to handle the transactions of the FSF would be more voluminous than complicated. For the most part, it consists simply of "... if X(i,j) is changed, then locate Y(i,j) and make a corresponding change." Some of the subroutines involve more logic so a few examples are presented.

A routine entitled "DATES", Page A-2, will generate a continuous calendar for any number of future years, listing the last day of each month. All dates recorded throughout the system would be stored in this continuous form. A printout of this routine is shown on Page A-3. A similar routine "CALEN," on Page A-4, generates a file consisting of the same data. This file then is used in such applications as "DATE DIF," on Page A-5, which will calculate the number of days between any two dates given in the form M/D/Y. The routine "DATEREAD" will change any of the continuous dates (the type in memory) to the form M/D/Y for reporting purposes (see Page A-6). The last example given, on Page A-7, is a program, "INSERT," which will insert a new record into an existing file in its proper sequence by eliminating from further testing half of the records remaining after each test.

These are working programs but they cannot be said to be absolutely debugged. Anyone attempting to make use of the last example is cautioned that it was written as though rows and columns are reversed between file reading and file use.

Some explanation of the variables used in "INSERT."

I1	The number of items in each record (see Table II).
R1	The number of records in the file. It is shown as manual input in this program; in practice it would be the first bit of data in each file.
F(J,I)	The "key" to each record. This is more easily handled if it is numeric. The remainder may be numeric or alphabetic, represented by F$(J,K).
Z(I)	The "key" (numeric) to the record to be inserted. The other items, Z$(I) may be numeric or alphabetic.
U and L	Upper and lower limits of the possible range of records into which the new record may fall.

Note that the output is to the printer. In practice it would "write over" the original data file.

DATES

This program generates a continuous calendar, such as listed on the following pages.

```
0:DATES

READY.

 90 DIM D(12),M$(12),T(12,15)
 100 DATA31,28,31,30,31,30,31,31,30,31,30,31
 110 FOR I=1 TO 12:READ D(I):NEXT
 120 DATA"JAN","FEB","MAR","APR","MAY","JUN","JUL","AUG","SEP","OCT","NOV","DEC
 130 FOR I=1 TO 12:READ M$(I):NEXT
 140 PRINT "START WITH THE YEAR 19__■■■";
 150 INPUT S
 160 PRINT "AND END WITH THE YEAR 19__■■■";
 170 INPUT E
 180 OPEN1,4:CMD1
 190 OPEN 2,4,2
 200 OPEN3,4,1
 210 F$=" 9999 ■i"
 220 PRINT#2,F$
 230 PRINT#1,CHR$(1),"    Y E A R"
 240 PRINT#1," ";
 250 FOR I=S TO (E-1)
 255 PRINT#1,"      ";
 260 PRINT#3,I+1900;:NEXT
 270 PRINT#3,E+1900
 280 PRINT#1,"===============================================================";
 281 PRINT#1,"============"
 290 FOR J=(S-80) TO (E-80)
 300 FOR I=1 TO 12
 310 N=N+D(I)
 320 IF I=2 AND J/4=INT(J/4) THEN N=N+1
 330 T(I,J)=N
 340 NEXT:NEXT
 350 FOR I=1 TO 12
 360 PRINT#1," ";M$(I);" |";
 370 FOR J=(S-80) TO (E-81)
 380 PRINT#3,T(I,J);
 390 NEXT
 400 PRINT#3,T(I,(E-80))
 410 NEXT
 500 PRINT#1:CLOSE1
 510 PRINT#2:CLOSE2
 520 PRINT#3:CLOSE3
 999 END
READY.
```

YEAR

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
JAN	31	396	761	1127	1492	1857	2222	2588	2953	3318
FEB	59	424	790	1155	1520	1885	2251	2616	2981	3346
MAR	90	455	821	1186	1551	1916	2282	2647	3012	3377
APR	120	485	851	1216	1581	1946	2312	2677	3042	3407
MAY	151	516	882	1247	1612	1977	2343	2708	3073	3438
JUN	181	546	912	1277	1642	2007	2373	2738	3103	3468
JUL	212	577	943	1308	1673	2038	2404	2769	3134	3499
AUG	243	608	974	1339	1704	2069	2435	2800	3165	3530
SEP	273	638	1004	1369	1734	2099	2465	2830	3195	3560
OCT	304	669	1035	1400	1765	2130	2496	2861	3226	3591
NOV	334	699	1065	1430	1795	2160	2526	2891	3256	3621
DEC	365	730	1096	1461	1826	2191	2557	2922	3287	3652

CALEN

This program generates a continuous calendar and writes it to a floppy-disk file for future reference.

```
 0 PRINT "AND END WITH THE YEAR 19__"
 80 OPEN 15,8,15
 90 DIM D(12),M$(12),T$(12,12)
 100 DATA31,28,31,30,31,30,31,31,30,31,30,31
 110 FOR I=1 TO 12:READ D(I):NEXT
 140 PRINT "START WITH THE YEAR 19__"
 150 INPUT S
 160 PRINT "AND END WITH THE YEAR 19__"
 170 INPUT E
 290 FOR J=(S-80) TO (E-80)
 300 FOR I=1 TO 12
 310 N=N+D(I)
 320 IF I=2 AND J/4=INT(J/4) THEN N=N+1
 330 T$(I,J)=STR$(N)
 340 NEXT:NEXT
 345 CR$=CHR$(13)
 350 OPEN 2,8,14,"@0:CALREAD,SEQ,WRITE"
 355 GOSUB 1000
 360 FOR J=(S-80) TO (E-80)
 370 FOR I=1 TO 12
 380 PRINT#2,T$(I,J);CR$;
 385 PRINT T$(I,J);
 387 NEXT:NEXT
 390 CLOSE2
 999 END
 1000 INPUT#15,EN$,EM$,ET$,ES$
 1010 IF EN$="00" THEN RETURN
 1020 PRINT "ERROR ON DISK"
 1030 PRINT EN$,EM$,ET$,ES$
 1040 CLOSE2
 1050 GO TO 999
READY.
```

DATEDIF

```
100 REM  THIS PROGRAM WILL DETERMINE
110 REM  THE NUMBER OF DAYS BETWEEN
120 REM  TWO DATES FORMATTED AS M/D/Y
130 REM     PNM 1/30/80  'DATEDIF'.
190 G=0:S=0:N=0:I=0:Z=0:J=0:X=0:A=0
200 DIM T(13,13)
210 OPEN 15,8,15
220 PRINT#15,"I0"
230 GOSUB 800
240 OPEN 32,8,14,"0:CALREAD,S,R"
250 FOR J=1 TO 12
260 FOR I=1 TO 12
270 INPUT#32,T(I,J)
280 RS=ST
290 IF RS=64 THEN 310
300 NEXT:NEXT
310 PRINT "TYPE TWO DATES EACH IN THE
320 PRINT "FORMAT M/D/Y , SEPARATED
330 PRINT "BY A 'COMMA'
340 INPUT C$(1),C$(2)
350 A=A+1
360 FOR S=1 TO 8
370 IF MID$(C$(A),S,1)="/" THEN 400
380 NEXT S
390 GO TO 310
400 N=N+1
410 X(N)=VAL(MID$(C$(A),G+1,S-1-G))
420 G=S: IF N=2 THEN 430:GO TO 380
425 GO TO 380
430 I=X(1):D=X(2)
435 J=(VAL(RIGHT$(C$(A),2)))-79
437 IF (I-1)>.5 THEN 440
438 I=13:J=J-1
440 Z(A)=T((I-1),J)+D
450 IF A>1.5 THEN 470
460 N=0:G=0:GO TO 350
465 PRINT Z(1),Z(2)
470 PRINT "ELAPSED DAYS = ",Z(2)-Z(1)
480 CLOSE 32:END
800 INPUT#15,EN$,EM$,ET$,ES$
810 IF EN$="00" THEN RETURN
820 PRINT "ERROR ON DISK"
830 PRINT "EN$,EM$,ET$,ES$
840 CLOSE 15
850 END
READY.
```

DATEREAD

```
100 REM  THIS PROGRAM CHANGES CON-
110 REM  TINUOUS CALANDER DATES TO
120 REM  THE FORMAT 'MM/DD/YY.
130 REM       PNMC  1/30/80  DATEREAD
200 D=0:I=0:J=0
210 DIM T(12,12)
220 OPEN 15,8,15
230 PRINT#15,"I0"
240 GOSUB 800
250 OPEN 16,8,13,"0:CALREAD,S,R"
260 FOR J=1 TO 12
270 FOR I=1 TO 12
280 INPUT#16,T(I,J)
290 RS=ST
300 IF RS=64 THEN 320
310 NEXT:NEXT
320 PRINT "CONVERT THE DATE
330 INPUT D
335 IF D=0 THEN 450
340 IF D<365*(J) THEN 348
345 PRINT "DATE OUT OF RANGE.
346 GO TO 320
348 K=J
350 FOR J=1 TO K
355 PRINTJ,
360 IF J=K+1 THEN 400
370 IF D<(T(1,J)-31) THEN 390
380 NEXT J
390 J=J-1
400 FOR I=1 TO 12
405 PRINTT(I,J)
410 IF D=<T(I,J) THEN 421
420 NEXT
421 W=I:L=J
422 IF I-1=0 THEN W=13
423 IF W=13 THEN J=J-1
435 D=D-T(W-1,J)
440 PRINT I;"/";D"/";L+79
445 J=K:GO TO 320
450 CLOSE16:END
800 INPUT#15,EN$,EM$,ET$,ES$
810 IF EN$="00" THEN RETURN
820 PRINT "ERROR ON DISK
830 PRINT EN$;EM$;ET$;ES$
840 CLOSE15
850 END
READY.
```

INSERT

```
10 REM  THIS PROGRAM IS USED TO INSERT A NEW RECORD INTO AN
20 REM  EXISTING SEQUENTIAL FILE.  PNMC -- 9/80.
100 PRINT "FILE NAME TO BE EXPANDED, AND THE NUMBER OF ITEMS IN THAT FILE"
110 INPUT Q$,I1
120 FL$="1:"+Q$+",S,R"
130 OPEN17,8,2,FL$
140 PRINT "WHAT IS R1"
150 INPUT R1
160 DIM F(R1+1,1)
170 DIM F$(R1+1,I1)
180 DIM Z(R1+1)
190 DIM Z$(I1)
200 FOR J=1 TO R1
210 INPUT#17,F(J,1)
220 NEXT
230 FOR I=2 TO I1
240 FOR J=1 TO R1
250 INPUT#17,F$(J,I)
260 NEXT:NEXT
270 PRINT#17:CLOSE17
280 PRINT "ENTER NEW RECORD"
290 INPUT Z(1)
300 FOR I3=2 TO I1
310 INPUT Z$(I3)
320 NEXT
330 I=INT(R1/2)
340 U=R1:L=0
350 IF Z(1)>F(R1,1) THEN 400
360 IF Z(1)<F(I,1) THEN U=I:I=INT((I+L)/2)
370 IF Z(1)>F(I,1) THEN L=I:I=INT(I+(U-I)/2)
380 IF ABS(U-L)<=1 THEN 450
390 GO TO 360
400 F(R1+1,1)=Z(1)
410 FOR K=2 TO I1
420 F$(R1+1,K)=Z$(K)
430 NEXT
440 GO TO 540
450 FOR J=R1+1 TO I+2 STEP-1
460 F(J,1)=F(J-1,1)
470 FOR K=2 TO I1
480 F$(J,K)=F$(J-1,K)
490 NEXT:NEXT
500 F(I+1,1)=Z(1)
510 FOR I3=2 TO I1
520 F$(I+1,I3)=Z$(I3)
530 NEXT
540 OPEN4,4
550 CMD4
560 FOR J=1 TO R1+1
570 PRINT#4,F(J,1);
580 FOR I=2 TO I1
590 PRINT#4,F$(J,I);
600 NEXT:NEXT
610 PRINT#4:CLOSE4
620 END
READY.
```

REPORT NO. AGNS-35900-1.1-106

CASK HANDLING EQUIPMENT STANDARDIZATION

VOLUME III

FLEET SERVICING FACILITY FOR A 600-MTU/YEAR AFR

Paul N. McCreery
Eugene M. Easterling
with GPSS analysis
by Barry Hudson, ORNL

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

ABSTRACT

This study is a continuation of work done at Allied-General Nuclear Services during 1978 and a joint UCC-AGNS effort in 1979-80. The former describes an independently operated cask Fleet Servicing Facility (FSF) and later compares the independent FSF with both an integrated concept, one built and operated as an integral part of a fuel receiving complex, and one colocated -- sharing a wall -- with an existing complex. The referenced studies assumed a fuel receiving rate of 2000 MTU. However, the present size of the United States cask fleet limits the receiving rate to approximately 600 MTU/year. The subject study examines design and cost comparisons between the 600 MTU/year and the 2000 MTU/year FSF's, both of which are cask fleet servicing facilities colocated with the existing BNFP fuel receiving and storage station.

Two cases are examined in this study. They are:

(1) Receipt of 600 MTU/year of LWR spent fuel assemblies.

(2) Receipts, per Case I, and the shipment of 600 MTU/year of disassembled and canistered fuel.

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1.0 INTRODUCTION

In studies recently performed,[1, 2] which compared three conceptual designs of cask fleet servicing facilities, a fuel receiving rate of 2000 MTU/year was assumed in each case. While this delivery rate is appropriate for a reprocessing plant, it is about three times larger than might be anticipated for an early regional AFR. Allied-General Nuclear Services currently is under contract to DOE (DE-AC-97-ET47921) to furnish design and licensing information preparatory to conversion of a nuclear fuel reprocessing plant's fuel receiving and storage facility to an Away-From-Reactor (AFR) spent fuel storage facility, using BNFP as a model. A fuel receiving rate of 2 MTU/day or 600 MTU/year is assumed for BNFP as an AFR.

In this study we first examine the FSF requirements for an AFR receiving spent fuel at a rate of 600 MTU/year, and then as a second case, we add the requirements of shipping 600 MTU/year as disassembled fuel in canisters. The second case represents the startup, at some later date, of a terminal storage facility.

When evaluating a hypothetical facility, it is, of course, necessary to make many assumptions regarding input parameters. An effort is made, using sensitivity analyses, to identify those assumptions for which variations will significantly affect the results. Assumptions used in this study should be compared with the then-current situation at any time this report is referenced for design basis.

ASSUMPTIONS

1. The facility will service the transportation systems required to deliver 600 MTU/year with 75%, by weight, of the spent fuel being moved by rail and 25% by legal weight truck.

2. The facility will be incorporated within the BNFP SNM license.

3. Any required test for any USNRC certified cask can be performed in this facility.

4. The facility will maintain an inventory of spare parts, as delineated by each cask owner, to be used as required to minimize cask idle time.

5. All repairs except those of a major nature (e.g., distorted head due to high impact) will be performed at this facility.

6. Provision for decontamination of casks and parts is provided in addition to that already installed in the Fuel Receiving and Storage Station (FRSS).

7. Cask/vehicle inspection will be performed prior to each departure of a cask system. Inspections may include nondestructive examination.

8. Maintenance will be performed on any equipment that is a part of any cask system.

9. No provision is made for servicing the commercial road tractors which haul the highway casks.

10. In the second phase of the study, canistered fuel is removed from the BNFP at a rate of 600 MTU/year, all by rail, to a location 2400 miles distant.

11. Canistered fuel is disassembled and shipped at twice the weight per unit volume as incoming fuel.

12. The capacity of incoming rail casks is a weighted average of the capacity of the six existing rail casks. The capacity of the outgoing rail casks (canistered fuel) is that of the largest existing rail casks.

13. The BNFP is assumed to be a "regional AFR," so the average distance between the shippers and Barnwell will be considerably less than those of previous studies.

14. Assume for rail shipments:
    (a) Average distance, 600 miles for incoming, 2400 miles for outgoing
    (b) Average speed, incoming fuel, 5 miles per hour
    (c) Average speed, outgoing fuel (Case II), 10 miles per hour
    (d) Cask loading and unloading time, 2 days each
    (e) Effective utilization of casks; 75% for incoming, 90% for outgoing
    (f) Available 335 days/year.

15. Assume for LWT shipments:
    (a) Average distance, 500 miles
    (b) Average speed, 36 miles per hour
    (c) Cask loading and unloading time, 1 day each
    (d) Cask utilization is 75%
    (e) Cask capacity is 1 PWR, 2 BWR's
    (f) Available 350 days/year.

16. Load ratios are 62% PWR, 38% BWR, by weight, all moves.

17. Only one cask unloading pool (CUP) is to be used for unloading casks. (The other is to be used for storage.)

Based on the above assumptions, cask needs and frequencies of arrival are calculated as follows:

Rail-Incoming

- One way travel time; 600 miles/5 mph = 120 hours = 5 days
- Time for one complete trip; (5 x 2) + (2 x 2) = 14 days
- .62 x .45 MTU/unit x 8 units + .38 x .19 MTU/unit x 20 units = 3.7 MTU/load, average
- 600 MTU/year x .75 (rail) ÷ 3.7 MTU/load = 122 loads/year
- 335 days/year ÷ 14 days/trip x .75 (util.) = 18 loads/yr/car
- 122 loads/year ÷ 18 loads/year/car = 7 cars
- Average arrival frequency, 365 days/year ÷ 122/loads/year = 3 days/load or 1 every 3 days.

Rail-Outgoing

- One way travel time; 2400 miles/10 mph = 240 hours = 10 days
- Time for one complete trip; (10 x 2) + (2 x 2) = 24 days
- .62 x .9 MTU/unit x 10 units + .38 MTU/unit x 24 units = 9.1 MTU/load
- 600 MTU/year ÷ 9.1 MTU/load = 67 loads/year
- 335 days/year ÷ 24 days/trip x .9 (util.) = 12.5 load/yr/car
- 67 loads/year ÷ 12.5 loads/year/car = 5.3 = 6 cars
- Average departure frequency, 365 days/year ÷ 67 loads/year = 5.4 days/load or alternate 5th and 6th day departures.

LWT Casks

- One way travel time; 500 miles ÷ 36 mph = 14 hours
- Total time for one trip (14 x 2 ÷ 24) + (1 x 2) = 3.25 days
- .62 x .45 MTU/unit + .38 x .19 MTU/unit x 2 units = .42 MTU/load, avg
- 600 MTU/year x .25 (LWT) ÷ .42 MTU/load = 357 loads/year
- 350 days/year ÷ 3.25 days/trip x .75 (util.) = 81 loads/year/cask
- 357 loads/year ÷ 81 loads/year/cask = 4.4 = 5 casks
- Average arrival frequency, 365 days/year ÷ 357 loads/year = 1 load/day.

2.0 FACILITY CONCEPT

2.1 Site

This facility would be located immediately adjacent to the Fuel Receiving and Storage Station (FRSS) of the Barnwell Nuclear Fuel Plant. Figure 2-1 shows the proposed service facility as it would appear next to the existing (shaded) FRSS. This arrangement has been demonstrated(3) as providing faster overall turnaround time for casks than separated structures can provide.

The facility would occupy space now allocated to the berm (between the bays) and to a portion of the parking lot. The reduction in parking lot area is negligible. The location of the maintenance bay ③ has been verified as not interfering with any planned or potential expansion of the storage pool and access thereto.

2.2 Functional Description

2.2.1 Facility Description

The 600 MTU/year facility is for the most part, simply a scaled-down version of the 2000 MTU/year concept described in the second reference. The cost is less but the economics of scale are apparent. The Summary Facility Description, Section 3.2.1 of Reference 2, is used as a guide for the following description of the 600 MTU/year facility, and a direct comparison of the two will serve to highlight the differences.

- The existing crane can handle all cask lifting.
- Existing bays for off-loading and reloading casks will continue to be used as such except that highway vehicles can be accommodated in either bay while rail cars can use only one of them.
- Areas of potentially high radiation levels are arranged in a compact array with those in need of the greatest shielding at the center.
- Additional storage area is made available to the FRSS as well as the FSF.

The colocated FSF is envisioned as a southward extension of the FRSS. The core structure which houses the high radiation areas is about 45 feet by 85 feet and this is the only added area requiring substantial foundations. The remainder of the 100-foot by 200-foot structure, except for the 15-ton crane-way supports, will require no more than conventional loadings for light industrial operations. The center of the 45-foot by 85-foot core structure will be about 23 feet greater in overhead elevation than the ends, so the roof of the lower sides will provide room for inactive storage which was not available in the previous concepts. The 15-ton crane serves both incoming and outgoing bays as well as the storage and shop area between the bays. The Health

Physics counting room is close to the receiving and departure areas, but well away from the high radiation areas of the complex.

It is expected that the FSF will be capable of repairing damaged casks. However, casks damaged so severely that they cannot be opened in a normal way will be considered on a case-by-case basis. The contents of the casks; spent fuel, high-level wastes, etc., will be a major consideration as to how it is opened and the kind of area needed to perform the opening or repair operations. The E-MAD Facility in Jackass Flats, Nevada, might serve as a central repair station for severely damaged casks.

The overall facility makeup is nearly identical to that of the 2000 MTU/year colocated FSF. The arrangement of the various components is changed to the extent necessary to be as compatible as practical with existing facilities, with a minimum cost.

Highway vehicles may enter either available bay for off-loading or on-loading. Rail cars use the east bay only. Vehicle maintenance may be performed outside either bay or in a separate maintenance location identified as ③ on Figure 2-1.

Removable impactors or personnel barriers are taken from the cask at positions ② or ④ and are stored in area ⑨ until ready to be replaced after the cask has been processed and is ready to leave.

Once off-loaded, a cask follows essentially the same flow pattern as in conventional FRSS operations except that contingencies for receiving only 600 MTU/year include the availability of only one Cask Unloading Pool (CUP).

A cask moving to the cask maintenance area (⑥ or ⑦ on Figure 2-1) must be lowered onto a set of air pallets in the west bay, position ⑪. While on the pallets, the cask is then moved along the flat, level surface ⑤ to the T&R stalls of position ⑥ or the basket change station, ⑦. The latter also serves as a decontamination station for cask received with excessive contamination.

Two test and repair stalls are provided based on an extrapolation of needs determined by computer simulations of the earlier concepts.

The roof over the areas for test and repair, cleaning equipment service, decontamination and contaminated storage will provide excellent sheltered storage for infrequently used equipment from both the FSF and the FRSS. It is accessible from the FRSS at the same floor level as at pool-side and is accessible from the FSF work area by a jib crane. A section could be extended to allow service by the 15-ton crane.

An office area, Health Physics office, wash rooms, records vault, data processing room, etc., are provided for the FSF operators and for representatives of the cask owners.

2.2.2 Summary Operating Procedure

(1) Cask systems are stopped at the security access portal* where they are surveyed for both security and preliminary Health Physics requirements.

(2) Vehicles will be parked inside the security access portal by the commercial carriers. All subsequent movement within the secured area will be by plant motive power.

(3) Vehicles without excessive contamination will be routed to the outside washdown area and cleaned of road dirt. Those with excessive contamination will be taken inside where the vehicle will be decontaminated until acceptable for outside washing, and the cask will be decontaminated in the cask and insert cleaning area.

(4) Rail cars will be brought into the east, or receiving and washdown,** bay. Highway vehicles may enter either available bay. Vehicles will receive spot cleaning as required and be given an inspection for travel damage.

(5) Removable personnel barriers and impact limiters will be taken off and moved to a location in the shop and storage bay.

(6) The loaded cask will be moved into the unloading bay. The cask will be available for immediate lift-off as soon as the vehicle is positioned.

(7) Cask handling from the vehicle, into the Test and Decontamination (T&D) Pit of the FRSS, into and out of the Cask Unloading Pools (CUP), through decontamination and back onto the car in the cask loading bay will be identical to existing BNFP handling procedures, except that only one Cask Unloading Pool will be used.

(8) While the cask is in the T&D/CUP complex, the vehicle will be moved to a vehicle maintenance bay for inspection, servicing, and repair.

(9) If periodic checking is due for cask qualification, if cask repair is needed, if cask cleaning or internals changeout is needed, the 135-ton crane (existing in the FRSS) will place the cask onto an air pallet in the west bay, on which it will be transported to a work station.

---

*Not shown on drawings in this report.

**This term is retained for easier reference to the other FSF concepts. In this concept, it might be better described as a "spot cleaning" bay.

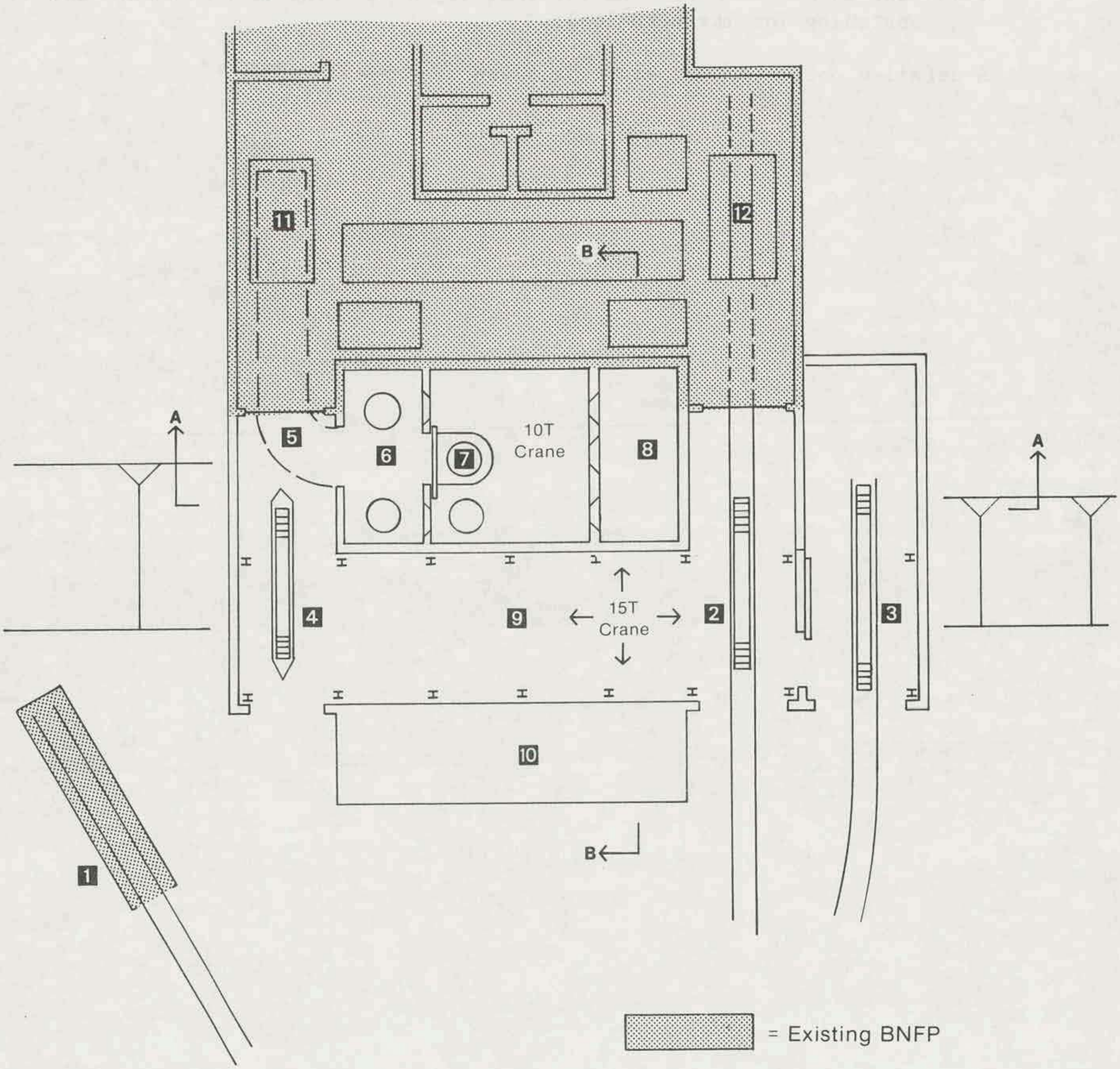
(10) When both cask and vehicle have been processed, the vehicle will move into any available loading bay to receive the cask.

(11) The cask and vehicle will return to the Maintenance and Inspection Bay to have impact limiters reattached, personnel barriers set into place, and Health Physics checks completed.

(12) The cask system will be returned to the parking area to await dispatching for its next load.

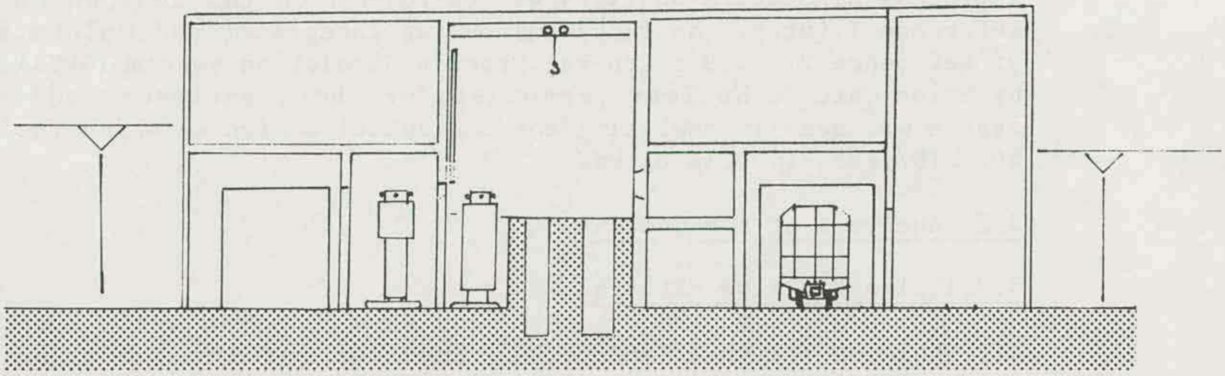
A detailed operating procedure is given in Appendix A.

1 Washdown
2 Rail car inspection
3 Vehicle Maintenance
4 Trailer inspection
5 Air-pallet path
6 Test & repair stalls
7 Cask & insert cleaning area
8 Cask & insert service area
9 Shop & storage area
10 Offices, personnel services
11 Truck Bay
12 Truck or rail bay

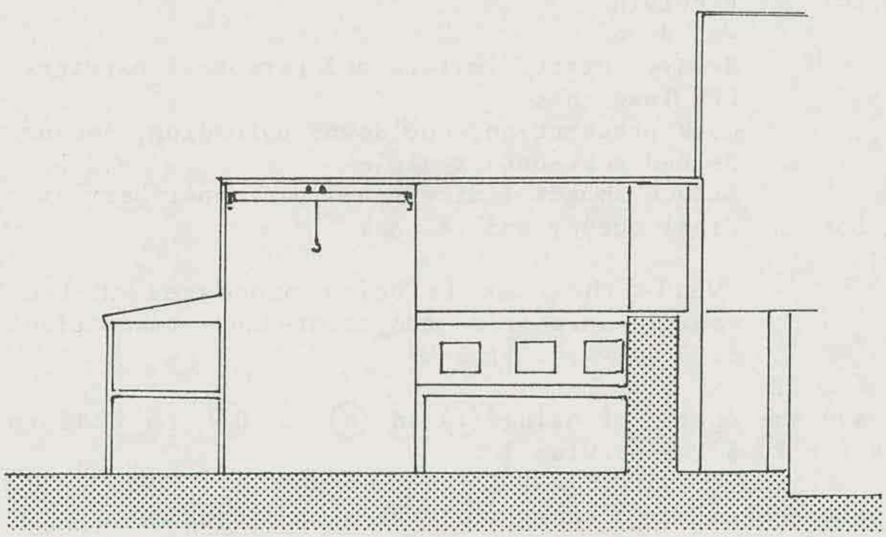


BNFP COLOCATED FSF - 600 MTU/YEAR (PLAN VIEW)

FIGURE 2-1



Section A-A



Section B-B

BNFP COLOCATED FSF - 600 MTU/YEAR (ELEVATIONS)

FIGURE 2-2

3.0 COMPUTER SIMULATION ANALYSIS

3.1 Background

A process simulation analysis was performed on the Independent FSF of Reference 1 (after the fact) and on the Integrated and Colocated FSF's of Reference 2. IBM's General Process Simulation System (GPSS) was used by Union Carbide Nuclear personnel for those analyses, and the same system was used in analyzing the conceptual design on which the current, 600 MTU/year study is based.

3.2 Analysis of the Concept

3.2.1 Traffic Flow Patterns

All vehicles arrive at and depart from the parking lot. The initial queue may form at this location as vehicles await their turn to enter the system.

A routine unloading of either rail or truck vehicles would proceed as follows. Refer to Figure 2-1 for location identifying numbers.

Location	Event
Parking Lot	Receiving
1	Washdown
2	Remove impact limiters and personnel barriers
12	Off-load cask
FRSS*	Cask preparation, cooldown, unloading, decontamination
12	Reload cask onto vehicle
2	Attach impact limiters and personnel barrier
Parking Lot	Final survey and release

*2 While the cask is being processed in the FRSS, the vehicle inspection and maintenance takes place in Bay 2 or 3 (or 4, if truck).

Trucks have the option of using ① to ④ to ⑪ to FRSS to ⑪ (or 12) to 4 (or 2, 3) to parking lot.

Excessively contaminated casks would be sent directly to ⑫, then to ⑪ (or directly to ⑪, if truck) to ⑤ to ⑦ where the cask would be cleaned. It then returns to ⑤ to ⑪ to FRSS and is processed further as in the routine mode. About 5% of the receipts are assumed to go this route.

Casks requiring recertification, maintenance, or basket change are first unloaded as in the routine mode; but instead of reloading onto the vehicle, they are sent to ⑪ to ⑤ to ⑥, where the work is performed. After recertification, etc., the routine is to ⑤ to ⑪ to ⑫ to ② to parking lot. Note that for trucks, the cask must vacate (11) before a vehicle can be brought into bay (11) for cask loading.

3.2.2 Events

The events used in the analysis of the system are presented in Table 3-1.

3.2.3 Assumptions

In addition to the assumptions discussed earlier in this report, the following assumptions/restraints govern simulation decisions. Refer to Table 3-1.

(1) Use the same time estimates for shipping canistered fuel (rail casks only) except Step 7, Cooldown/Flush will be 0 minutes.

(2) If a truck cask requires extraordinary decontamination, the preferred routing is 4-11-5-7 for off-loading. If Position 4 is occupied, then 2-12-11-5-7 may be used. Rail casks can only go 2-12-11-5-7. Vehicles may be assumed to be removed from the bay as soon as the cask is gone. Positions 5, 11, and a space in the T&D pit must be open to remove a cask from decontamination Postion 7.

(3) The bay should correspond to the line used for the preceding event.

(4) The on-loading bay need not be the same as the off-loading bay, for trucks.

(5) If vehicle T&I is not performed in-line with the off-loading bay, add 30 minutes to the T&I time.

(6) Assume no basket changes for outgoing shipments (canistered fuel to repository). Basket changes for casks with incoming fuel will be initiated after fuel is unloaded. Positions 5 and 11 must be open to remove a cask from basket change. The cask can occupy Position 11 without being on a vehicle while the crane is used elsewhere. Idle time for the cask in this position does not change the 240-minute working time.

(7) Cask testing and recertification times are applicable to each cask at six-month intervals.

(8) The time intervals, as stated, include appropriate changes of lifting yokes and crane positioning time.

3.2.4 Cases

Two specific cases are examined, namely:

(1) The receipt of 600 MTU/year in the quantity and mix of spent fuel casks as postulated earlier in this report.

(2) The receipt of 600 MTU/year, as in Case I, plus the shipment by rail of 600 MTU/year of disassembled, canisterized fuel to a western repository.

3.2.5 Discussion

The time intervals of Table 3-1 are average, or mean, values. The deviation from this mean time was established based on either a "tight" or "wide" distribution of ±50%. With the wide distribution, 33% of the time will fall outside the range of ±20%, but with the tight distribution, only 18% of its points fall outside this range. Crane movements follow the tight distribution, and all others use the wide distribution. Cask arrival times are distributed uniformly over a range of ±50% from the midpoint of the average interval between cask arrivals.

Summaries of Cases I and II follow, as Table 3-2, along with histograms showing cask turnaround times and pit occupancy. All statistics are the average of four independent two-year runs after an initial two-year warmup period. Any differences of more than 5% between comparable numbers in the two cases are considered statistically significant.

3.2.6 Conclusions

The system ran smoothly in both cases. No facility has utilization of over 20%, the highest being the 135-ton crane, the CUP, and the Pit in Case II. Throughput times were not affected by the additional casks in the system for shipments out. The areas affected were as expected; namely, the rail bay, pit, cranes, and vehicle maintenance areas. The only queue of significance in any run was for the CUP, although only 7% of the casks waited in Case I and 10% in Case II. These waits added an average of less than 15 minutes to turnaround times. Even though truck casks were allowed to enter via the rail route, less than 2% of these casks found it advantageous to do so.

One might conclude that this conceptual design could handle considerably more fuel than the combined 600 MTU/year coming in plus the 600 MTU/year going out. How much more would be rather academic at this time. Another alternative might be to reduce the capacity of the FSF (the FRSS already exists and reducing its capacity -- other than by the elimination of one CUP as already postulated -- would be meaningless as a cost-saving endeavor). From an operations point of view, this FSF is about as small as it can be, while still accomplishing all its necessary functions.

TABLE 3-1

OPERATING EVENTS, 600 MTU/YEAR COLOCATED CONCEPT

Event (1)	Location* Rail/LWT	Time (8) Rail/LWT
Receiving	Parking Lot	125/100
Washdown	1/1	35/25
Extraordinary Decontamination	7/7 (2)	180/150
Remove Impact Limiters and Personnel Barrier	2/2 or 4	60/40
Cask Off-Loading	12/11 or 12 (3)	45/30
Cask Preparation for Cooldown	FRSS	90/40
Cooldown/Flush	FRSS	240/120
Attach Decontamination Barrier, Yoke, Slings; then Transport to CUP	FRSS	180/75
Unload Fuel	FRSS	150/40
Transport to T&D Pit	FRSS	45/25
Decontamination, Ready to Ship	FRSS	420/170
Cask On-Loading	12/11 or 12 (4)	45/30
Attach Impact Limiters and Personnel Barrier	2/2 or 4 (3)	75/45
Final Survey	Parking Lot	75/65
Vehicle T&I	2 or 3/2, 3 or 4 (5)	300/130
Basket Change	7 (6)	240/240
Cask T&R	6 (7)	2050/1300

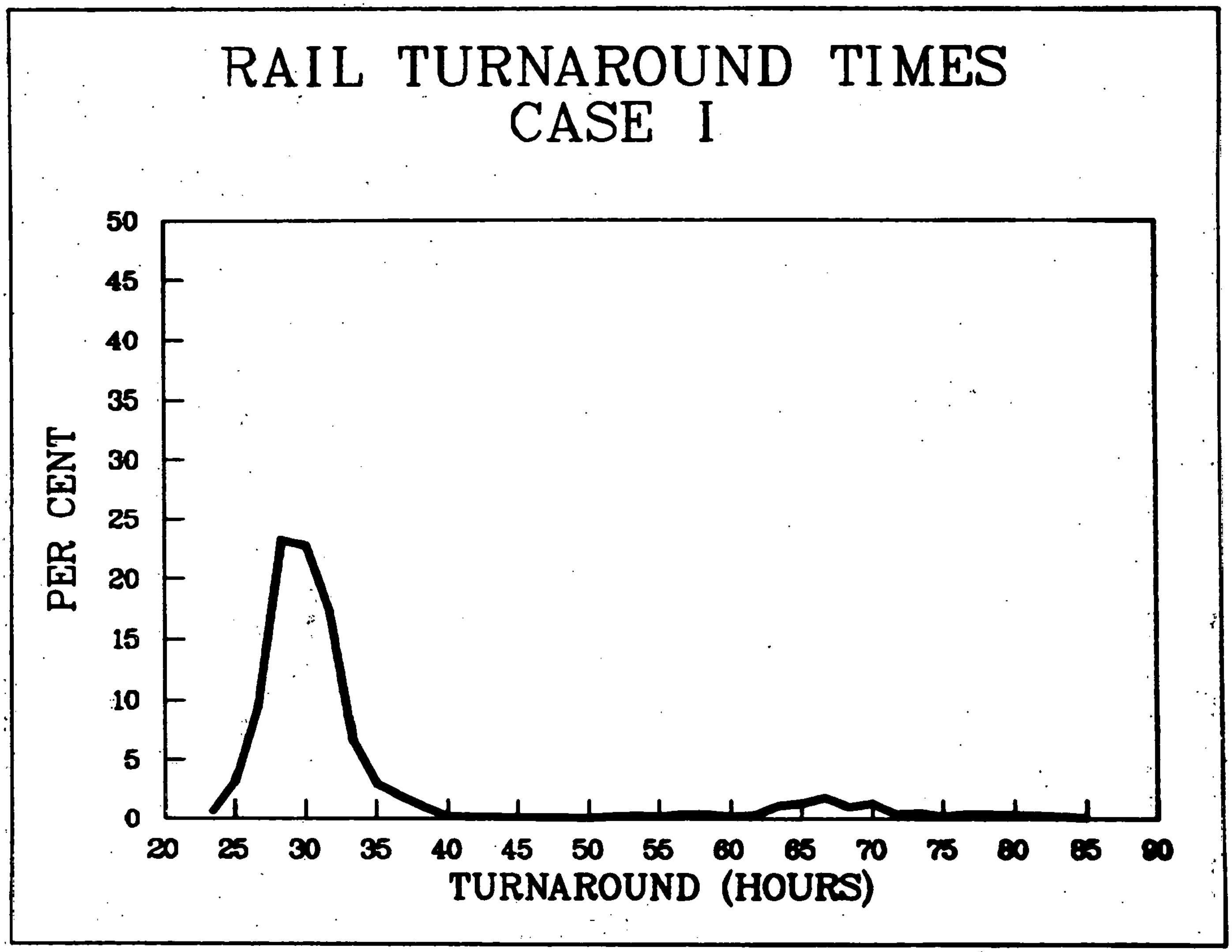
*See Figure 2.1.

TABLE 3-2

SUMMARIES

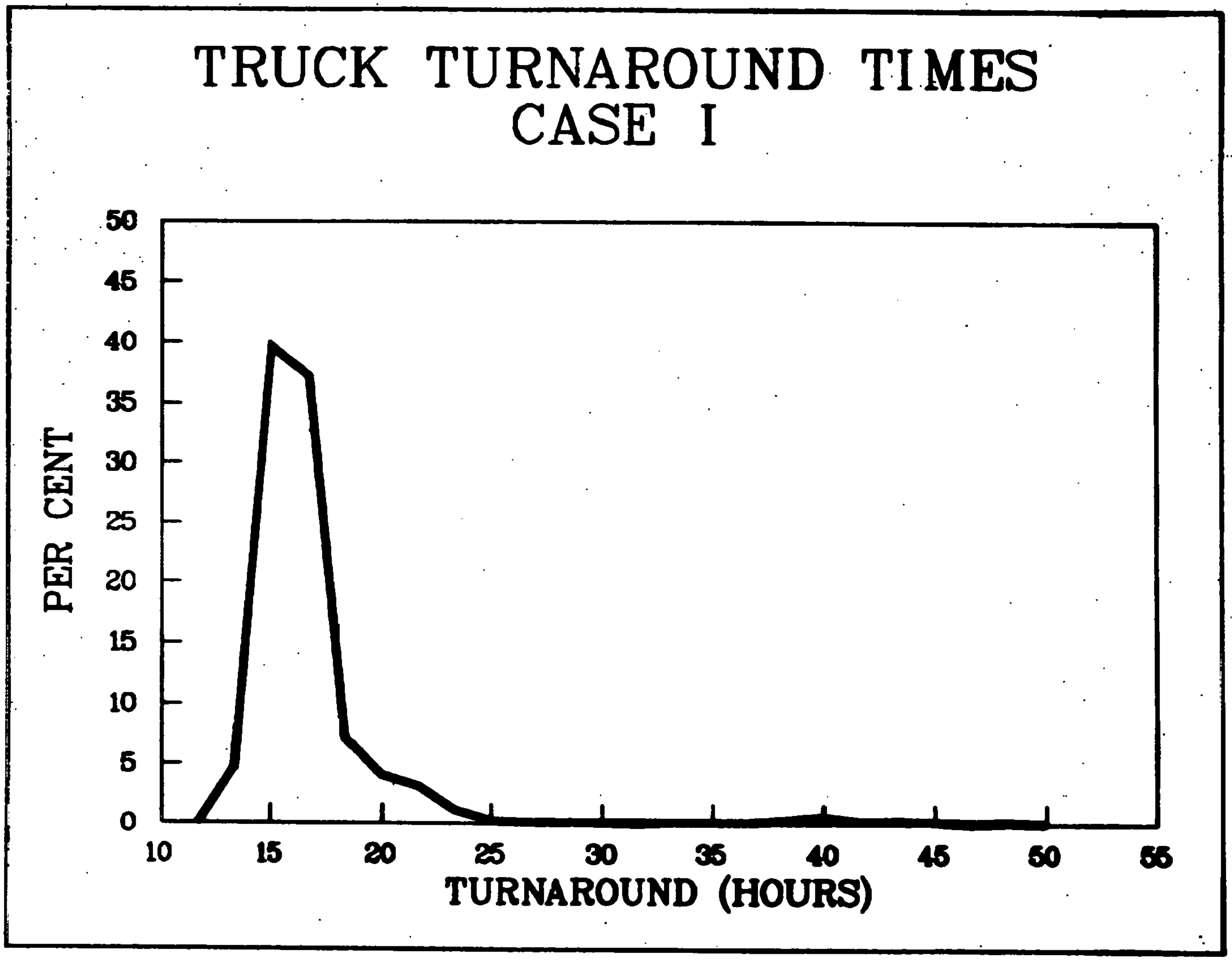
Receiving Time	Case I	Case II
Rail	1982 min	1985 min
Truck	968 min	983 min
Shipping Time		
Rail	--	1903 min
	Average Contents	Average Contents
15-Ton Crane*	0.085	0.099
135-Ton Crane*	0.133	0.157
Pallet*	0.010	0.012
Rail Off*	0.046	0.072
Truck Off*	0.090	0.088
Rail Bay*	0.024	0.037
Truck Bay*	0.057	0.060
Clean & Basket	0.029	0.030
T&R*	0.081	0.134
CUP*	0.128	0.159
Vehicle Maintenance*	0.164	0.201 (divide by 2 for utilization)
Pit*	0.640	0.760 (divide by 4 for utilization)

*Denotes differences of statistical significance that exist between the two cases.



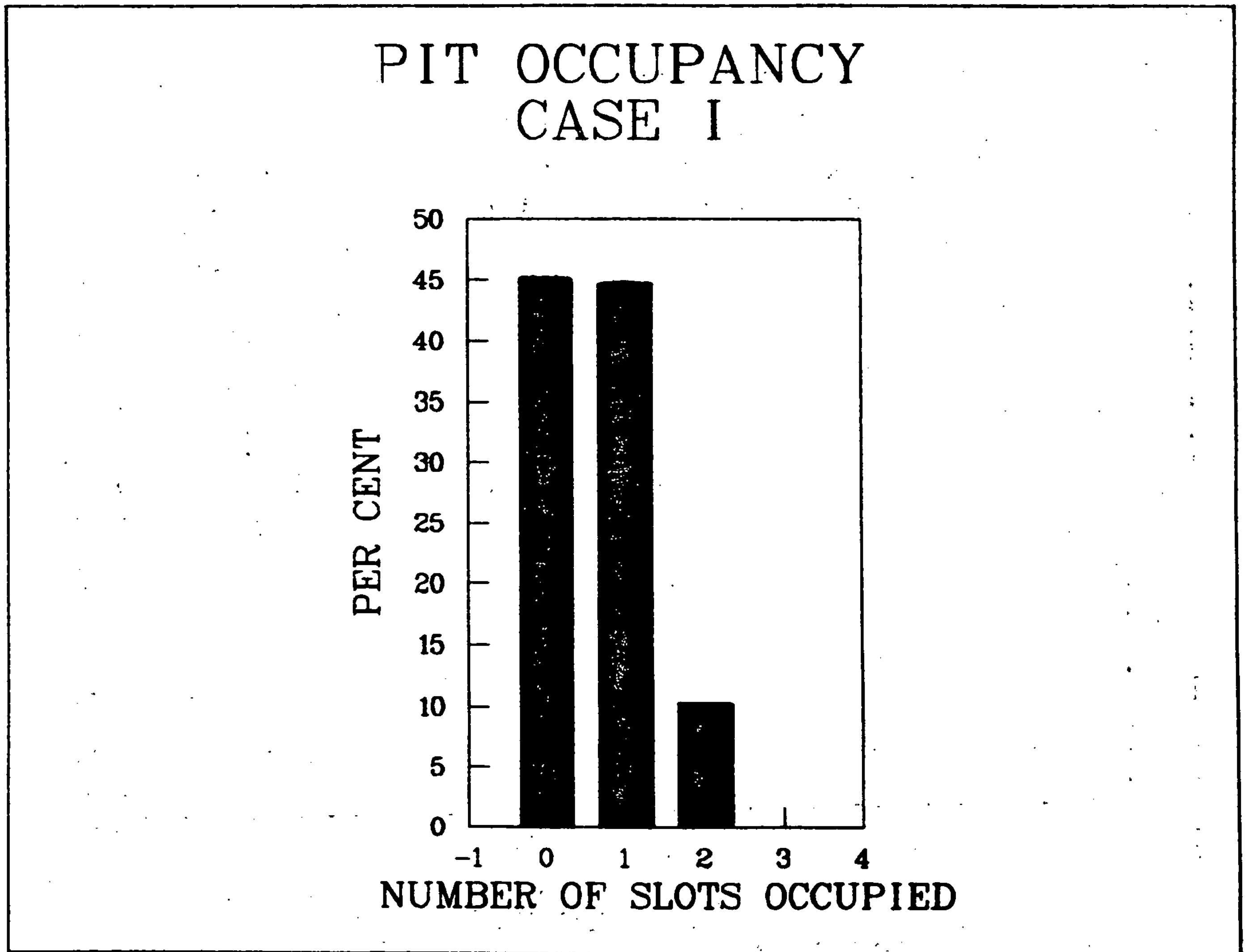
RAIL TURNAROUND TIMES - CASE I

FIGURE 3-1



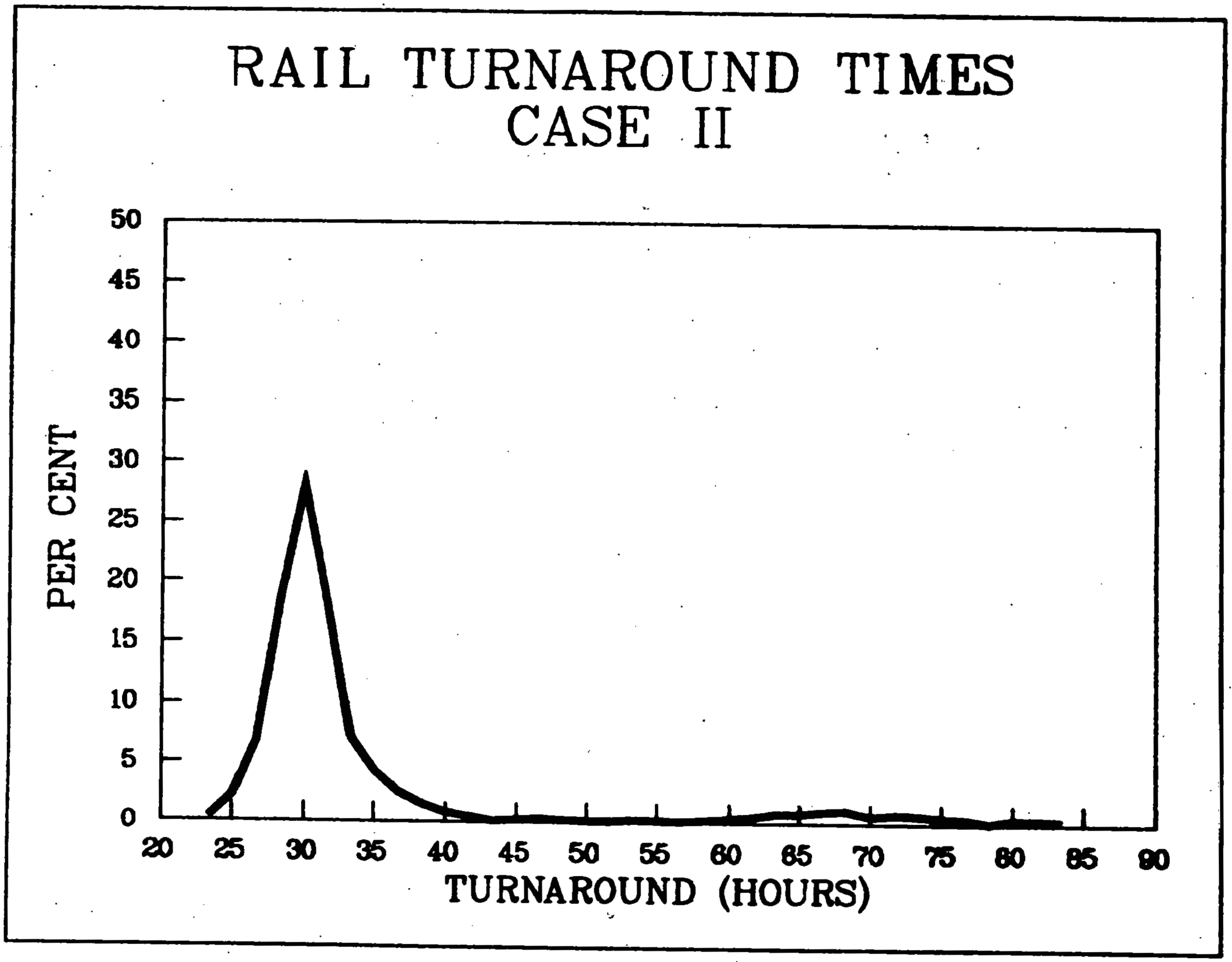
TRUCK TURNAROUND TIMES - CASE I

FIGURE 3-2



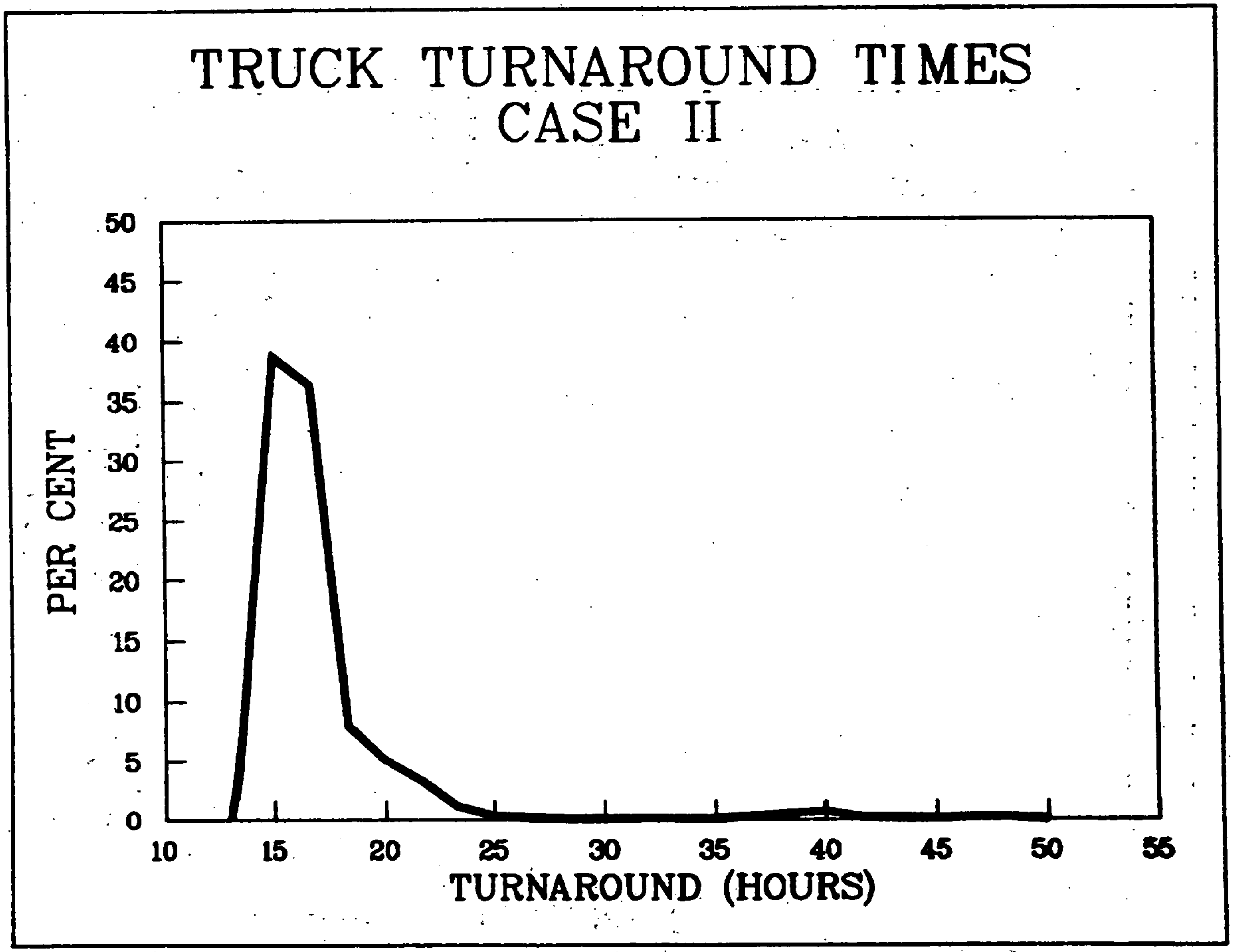
PIT OCCUPANCY - CASE I

FIGURE 3-3



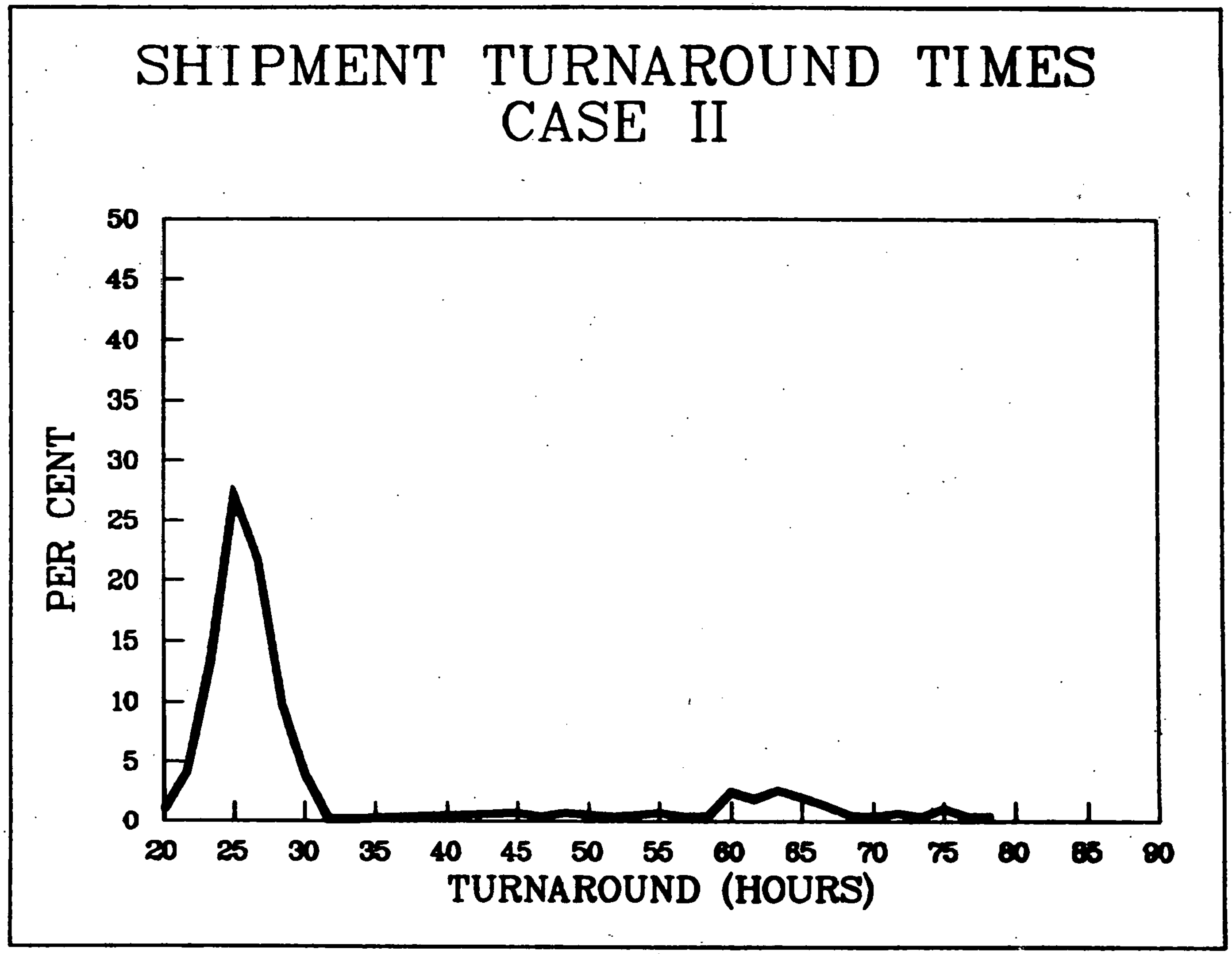
RAIL TURNAROUND TIMES - CASE II

FIGURE 3-4



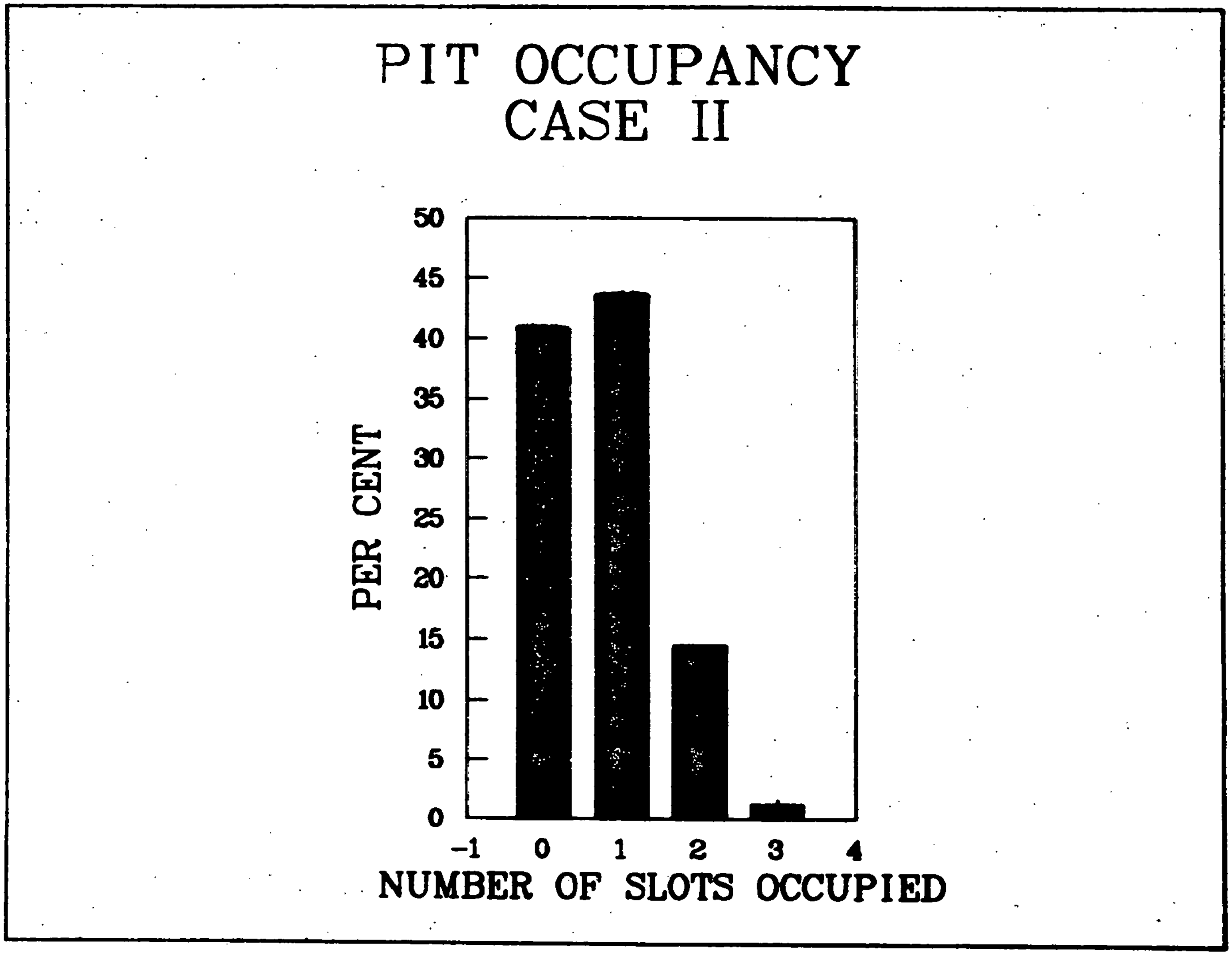
TRUCK TURNAROUND TIMES - CASE II

FIGURE 3-5



SHIPMENT TURNAROUND TIMES - CASE II

FIGURE 3-6



PIT OCCUPANCY - CASE II

FIGURE 3-7

4.0 COST ANALYSIS

4.1 Scope

This estimate covers the project costs for the construction of a 600 MTU/year Colocated Fleet Servicing Facility for receiving, inspecting, and servicing spent fuel casks and vehicles. This includes all facilities and equipment necessary for preventative/corrective maintenance and license compliance inspection services on casks, rail cars, and tractor trailer systems.

The methodology of the cost estimate is taken directly from Section 5.2 of Reference 2. This assures a continuity of assumptions, etc., and provides for easy comparison with the larger facility.

Facilities and services that normally are required and supplied at spent fuel receiving stations are not included in this estimate, because of the colocated/attached nature of the concept.

4.2 Assumptions

(1) Facility is to be colocated with the BNFP, FRSS, Barnwell, South Carolina.

(2) The companion facility, BNFP, is designed for wet loading and unloading.

(3) No special provisions are made for receiving extensively damaged casks but, once received, will be examined and the future course of action made on a case-by-case basis.

(4) The facility will handle United States certified casks as well as those currently in the certification process.

(5) The facility will be Government owned; casks and carriers privately owned.

4.3 Method of Estimating

The estimate is based on sketches and specifications, conceptual design descriptions, and other backup information provided by Design Engineers.

Material take-offs were made wherever sufficient detail was shown on the drawings. For certain work such as painting and finish items, allowances were included based on historical data.

Labor rates were based on a typical southeast location. Detail and support for these rates are included in Reference 2. Construction of the facilities has been assumed to be on a standard 40-hour work week and no allowance has been made for overtime or additional shifts.

Modifications to existing facilities (BNFP, FRSS) are to be accomplished while off-stream.

The cost of all material and equipment if FOB job-site, to be erected by an on-site contractor. Pricing for construction materials and equipment was based on historical information from similar southeast construction sites.

Sales tax, at 5% on materials, has been included in indirect costs.

Indirect costs, including field distributables and payroll, burdens and markup (Fees), are approximately 45% and 3%.

All prices are based on third quarter FY 1980. Costs have not been escalated beyond that point. Table 4-1 provides a comparison between the total 1980 cost and costs adjusted to one year earlier for comparison with Reference 2.

A contingency of approximately 30% was applied to the project as presently defined. It is not intended to cover changes in scope, changes in Federal or State regulations, changes in location or changes in schedule.

Excluded from cost considerations are the following:

(1) Permits and Licenses

(2) Costs of any additional land

(3) Spare parts (except for installed equipment as listed and recommended by the manufacturer)

(4) Construction models of facilities or equipment

(5) Research and development except where considered a part of a purchase order to a vendor

(6) Government's administrative costs

(7) Tornado resistant construction

(8) Utility tie-ins to be done by the Operating Contractor

(9) Safeguard requirements in addition to those provided by the parent facility (FRSS).

The method of contracting assumed is that the project will be let to a Cost Plus Fixed Fee Contractor with certain portions of the work subcontracted.

Detailed cost schedules appear in Appendix B.

4.4 Cost Comparisons with 2000 MTU/Year FSF

In terms of third quarter CY 1979 dollars, the various FSF concepts are estimated to cost:

2000 MTU/year Independent	$26 M
2000 MTU/year Integrated	13 M
2000 MTU/year Colocated	16 M
600 MTU/year Colocated	10 M

A breakdown of the cost of the 600 MTU/year facility is given in Table 4-1.

4.5 References

(1) McCreery, P. N., et al, The Conceptual Design of a Spent Fuel Cask Fleet Servicing Facility, Allied-General Nuclear Services, AGNS-1040-1.5-48 (September 1978).

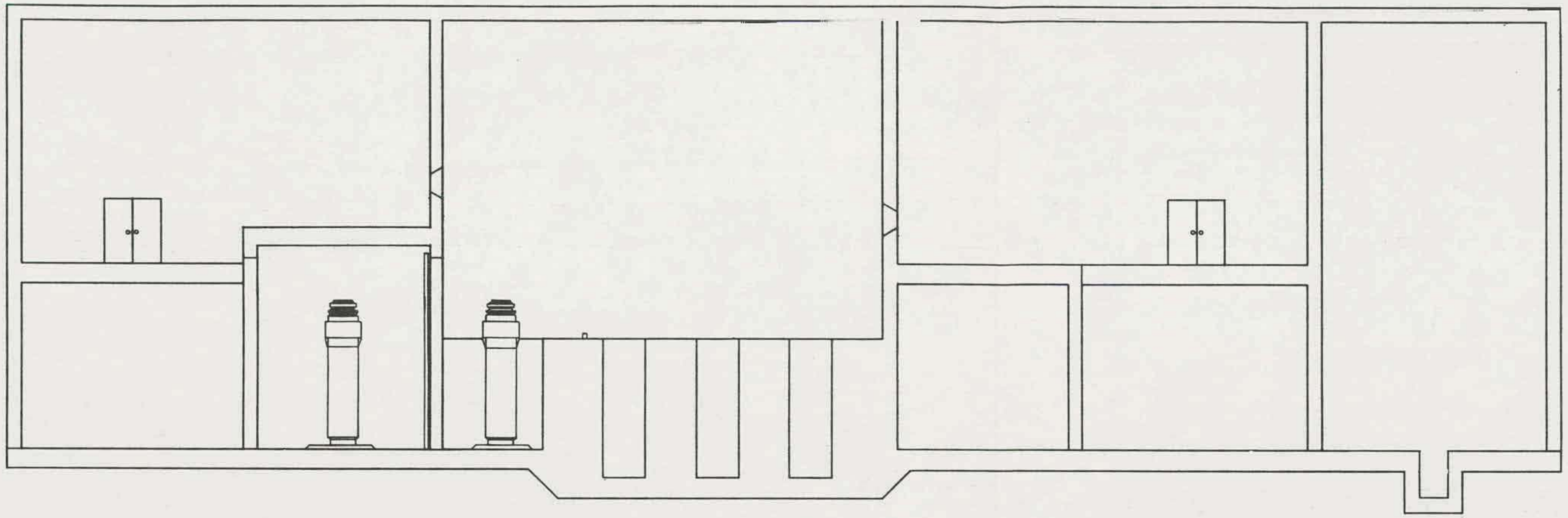
(2) Watson, C. D., et al, Fleet Servicing Facilities for Servicing, Maintaining, and Testing Rail and Truck Radioactive Waste Systems, Oak Ridge National Laboratories, ORNL/Sub-79/13866/1 (May 1980).

(3) Personal Communication - Watson, C. D. and Hudson, B., (ORNL) to McCreery, P. N., (AGNS), (June 1980).

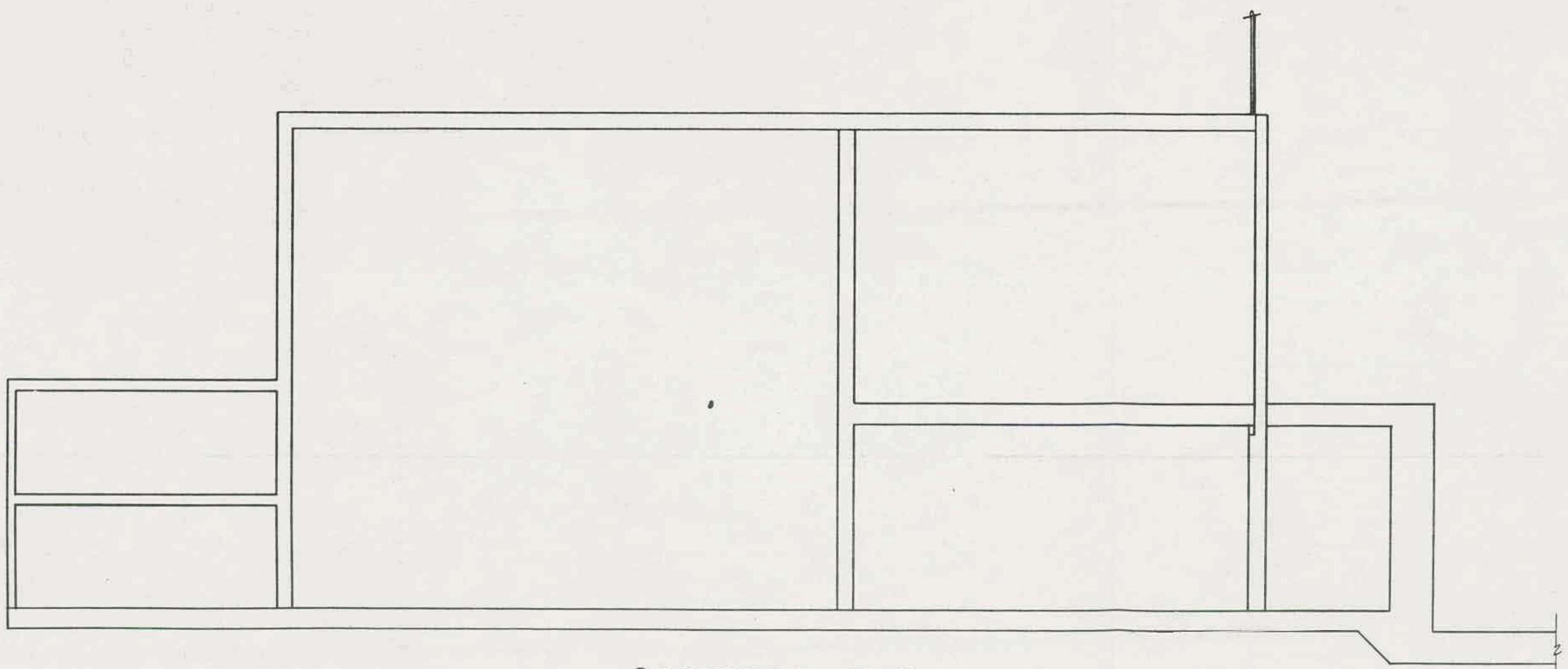
TABLE 4-1

COLOCATED FSF DESIGN CONCEPT PROJECT SUMMARY

		Total $ in Thousands Third Quarter - FY 1980
Engineering Design Land & Land Rights		$ 1,450
Construction		
Improvements to Land	$ 345	
New Building Costs	2,210	
Building Modifications	11	
Special Facilities	1,788	
Outside Utilities	259	
Standard Equipment	52	
Indirects and Fees	2,350	
Contingency at 30%, Approximately		$ 2,600
TOTAL PROJECT IN THIRD QUARTER FY 1980 IN THOUSANDS		$11,100
Adjusted to Third Quarter 1979 for Comparison		$10,080



SECTION A-A



SECTION B-B

ISSUE NO.	DATE	DESCRIPTION	BY	CHK	DESIGN ENG.	DESIGN MGR.	APP'L	APP'L	APP'L
A	3-17-80	ISSUED FOR CONCEPTUAL DESIGN	TCC	RBS M	EME	[illegible]	PNM		

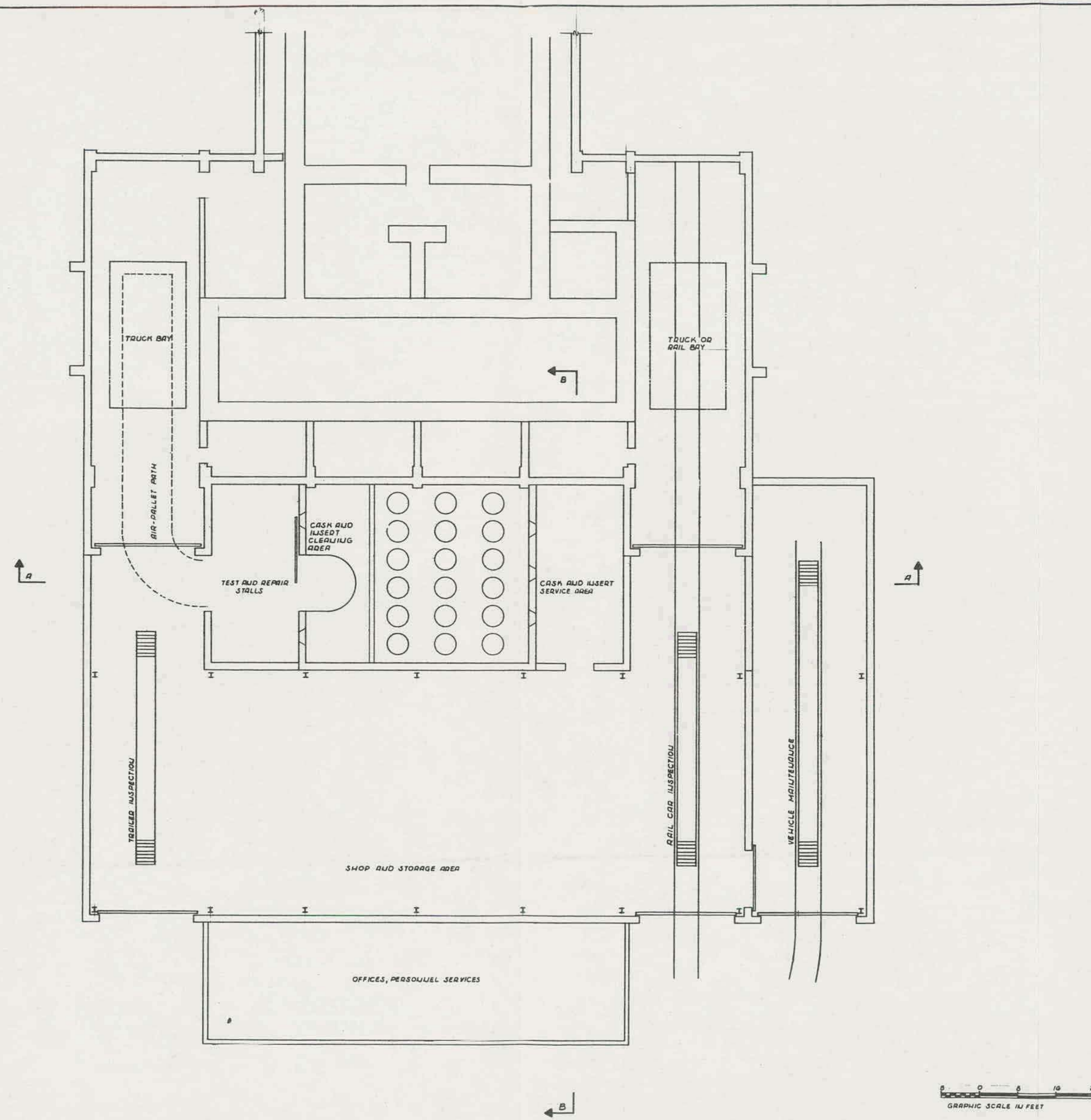
REFERENCE DRAWINGS

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
BARNWELL SOUTH CAROLINA

AGNS DESIGN ENGINEERING DEPARTMENT
P. O. BOX 847
BARNWELL, S. C. 29812

600 MTU/YR FUEL CASK
FLEET SERVICING FACILITY
CONCEPTUAL DESIGN ~ SECTIONS

SCALE	FACILITY	DRAWING NO.	ISSUE
1/8" = 1'-0"	3051001	520D-A-5022	A
DWG. TYPE			
PROCESS			



ISSUE NO.	DATE	DESCRIPTION	BY	CHK	DESIGN ENG.	DESIGN MGR.	APP'L	APP'L	APP'L
A	3-17-80	ISSUED FOR CONCEPTUAL DESIGN	TCC						

REFERENCE DRAWINGS

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
BARNWELL SOUTH CAROLINA

AGNS DESIGN ENGINEERING DEPARTMENT
P. O. BOX 847
BARNWELL, S. C. 29812

600 MTU/YR FUEL CASK
FLEET SERVICING FACILITY
CONCEPTUAL DESIGN ~ PLAN

SCALE	FACILITY	DRAWING NO.	ISSUE
1/16"=1'-0"	3051001	520E-A-5023	A

REPORT NO. AGNS-35900-1.1-106

FLEET SERVICING FACILITY FOR A 600-MTU/YEAR AFR

APPENDIX A TO VOLUME III

GENERIC CASK HANDLING PROCEDURE FOR THE FSF/FRSS

Paul N. McCreery

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

INTRODUCTION

The concept of the Fleet Servicing Facility (FSF) is unique only in that the requisite cask servicing is performed under a central control system rather than by individual cask owners. A logical extension of this function in a colocated facility is to merge cask servicing control and operations scheduling. This operating procedure is premised on that type of organization.

The maintenance and the requirements for continuing requalification of each cask are peculiar to each cask model and these are delineated in the Safety Analysis Report of that model. Each cask owner will have prepared standard testing procedures along with specific acceptance criteria for his casks. These procedures become a part of the FSF's operating procedure when servicing any given cask. Transportation vehicles shall be inspected to owner-approved (or owner-supplied) standards.

This operating procedure further assumes an automated data system which provides individually or collectively the due dates for inspection or requalification of each component of each cask, continuously updated as inspections are satisfactorily performed. This would provide an appropriate agency an independent check of all operating transportation systems which can, in turn, be used to assure various state agencies that standards have been met. (These procedures apply whether the FSF is Independent, Integrated, or Colocated.)

PROCEDURE

1.0 Incoming Inspection

1.1 Verify that the Bill of Lading and the Trip Pack* information is that of the vehicle being readied for receipt.

1.2 Visually check the cask/vehicle system for damage. If safety-related damage is noted, notify FSF supervisor for instructions regarding continuing work or removal from queue awaiting concurrence of cask owner for course of action. Advise Scheduler of nonsafety-related damage so that action may be initiated to accomplish the necessary repairs.

1.3 Perform an initial instrument survey (β, γ, n) of the cask/vehicle system. Compare readings with those on the Trip Pack and notify supervisor of differences greater than two times shipper's value or in excess of DOT limits.

1.4 Weather permitting, take initial contamination smears (α, β, γ) of cask and vehicle while the system is still outside the building. If system is wet or covered with ice, it will be brought into the washdown bay to thaw and/or dry before smears are taken. (Do not wash down the system to expedite thawing.) The system will not be washed down before smears are taken.

1.5 Remove security seals from the personnel barrier and compare with Trip Pack information.**

1.6 The Scheduling group shall assign a processing sequence number and identify the cask model that this number represents. This group will then issue instructions for assembling at various locations the appropriate operating procedures, test instructions, and certification forms, check lists, and tools to be used.

2.0 Washdown

NOTE: If cask/vehicle contamination exceeds DOT limits, the routine washdown operation is omitted and the cask and vehicle are decontaminated separately. See Section 12.0.

2.1 Thoroughly wash the cask and vehicle with water, using no greater flow or pressure than is necessary to dislodge and remove road

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*This terminology is used to identify the paperwork relating to cask and vehicle radiation physics data for a given trip.

**Throughout this procedure it is understood that when comparisons of this type result in conflicting data, the supervisor is to be consulted for instructions prior to proceeding.

dirt. Road tar, etc., is to be removed by manual cleaning using appropriate solvents.

3.0 Removal of Impact Limiters, Etc.

3.1 With the vehicle positioned in the outer bay, use the 15-ton crane to remove impactor limiters and (if removable) personnel barriers.

3.2 As appurtenances are being removed, check them for damage and notify Scheduling if repairs or replacements are needed.

3.3 Store appurtenances in the area assigned to this use.

4.0 Off-loading from Vehicle

4.1 Attach to the appropriate lifting hook the cask lifting yoke required for the cask to be off-loaded.

4.2 Following procedures based on the cask owner's instructions, lift the cask from the vehicle. Transport it without delay to the designated area in the handling pit.

5.0 Preparation for Unloading Fuel

5.1 Compare head security seal identification with information given in the Trip Pack.

5.2 Verify that the assembled set of tools is the appropriate set for the cask being processed.

5.3 As each part is handled, visually examine it for damage or excessive wear. Advise the Scheduler of deficiencies via an intercom system so that repairs or replacements can be arranged.

5.4 Obtain cavity pressure readings to ascertain that damaged fuel has not resulted in higher-than-normal pressures.

5.5 Obtain samples of cavity fluids as required. Do not proceed until sample analysis results are available and instructions are given by the supervisor for the disposition of the fluids.

5.6 Remove outer head (if one is used) and place it on the appropriate head stand. Be careful not to damage the seal or the sealing surface. Assume that the underside of this head is heavily contaminated and handle it accordingly. Repeat Steps 5.2 to 5.5 for two-headed casks.

5.7 Cooldown and/or flush the cask as instructed by Scheduling.

5.8 Fit the contamination barrier over the cask.

5.9 Loosen head fasteners, attach head lifting devices, install head guide pins plus any other remote handling aids.

5.10 Move the cask into the CUP.

5.11 Raise yoke from the CUP, bringing the cask head with it.

5.12 Unload the fuel.

6.0 Cask Removal from CUP

6.1 Vacuum loose particulate matter from the exposed cask surfaces. Be especially certain to remove matter from the sealing surfaces.

6.2 Replace the head onto the cask prior to lifting the cask from the CUP.

6.3 Transport the cask to a work station in the T&D pit.

6.4 Decontaminate exposed cask surfaces as required to meet release limits.

6.5 Remove the contamination barrier from the cask.

6.6 Flush cask interior, then drain.

6.7 Install the outer head (if one is used).

6.8 Fit the appropriate lifting yoke onto the crane.

6.9 Attach the yoke to the cask and lift the cask from the pit.

7.0 On-Loading Empty Cask Onto Vehicle

NOTE: During the interval in which the cask has been separated from the vehicle the latter will have been inspected and its roadworthiness assured. The vehicle maintenance procedure is delineated in Section 11.0. Chronologically it precedes this section.

7.1 Position the vehicle to receive the cask.

7.2 Place cask on vehicle and move the cask/vehicle to a maintenance bay.

8.0 Replacement of Impact Limiters, Etc.

8.1 Assemble impact limiters, personnel barrier, etc., in accordance with cask owner's instructions.

8.2 Get final smears of cask and vehicle prior to release.

8.3 Record radiation data on a new Trip Pack which has been supplied by scheduling for this specific cask.

8.4 Place security seals on personnel barrier and record seal numbers on the Trip Pack in the space provided.

9.0 Release Authorization

9.1 Prior to releasing a cask system, the appropriate records for each component of the cask system will have been updated and monitored for exceptions. Cask history files shall have been updated within 24 hours of the completion of the final inspection step.

9.2 The Trip Pack which was initiated by Scheduling shall be signed off by a representative of the Health Physics group, certifying that contamination levels of the system are within release limits. It also shall be signed off by a representative of Quality Assurance certifying that all tests and inspections have been performed in accordance with current procedures, the results of these inspections meet or exceed the stated acceptance criteria, and that the cask meets all certification requirements and will continue to do so for a time appropriate to the maximum anticipated duration of its assigned trip.

9.3 If a cask is to be delayed in departing to its next assignment, Scheduling shall review needed upcoming tests and, with the concurrence of the cask owner, use this available dead time for requalification testing.

10.0 Cask Testing and Inspection

10.1 When a cask system enters the receiving queue (Step 1), the Scheduler will provide each operating section with the procedure to be used in processing that particular cask. Accompanying each procedure will be a checklist to be initialed by an assigned person immediately following the successful completion of a particular phase of work. Included in these procedures and checklists will be the maintenance checks and tests to be performed during routine handling. If the test or inspection involves the measurement of some value, then the value upon which acceptance or rejection of the test is judged will be entered on the checklist. These checklists then become a part of the permanent record of the given cask component.

10.2 Requalification tests will be performed at such intervals that certification will not expire while the cask is in normal operation.

10.3 If a cask is out-of-service for an extended period of time, test due dates will be postponed until the cask is scheduled to return to service.

10.4 Requalification tests will be performed in accordance with a procedure approved in writing by the cask owner.

10.5 The Quality Assurance program of the FSF will conform to 10 CFR 71, Appendix E.

10.6 Data and history pertaining to cask components will be available through the data system. In addition, periodic printouts of services to be performed within given time intervals will be generated routinely for use in scheduling.

10.7 Specifications for spare parts and procedures for cask repairs will be furnished by the cask owners.

10.8 If more than one FSF is in operation at any given time, provision will be made for a mutual updating of records of services performed.

11.0 Vehicle Maintenance and Repair

11.1 The same provisions for casks, as delineated in Section 9.1, will apply to vehicles.

11.2 Rail car maintenance and repair is performed in accordance with AAR directives.

11.3 Maintenance of ancillary equipment (diesel-powered cooling systems, etc.) is in accordance with procedures furnished by the vehicle owner after concurrence with FSF Operators.

11.4 NDE's will be substantiated with photographic evidence unless specifically exempted.

11.5 Vehicle maintenance and repair will be included in the quality assurance program and in the data-base system in effect for cask maintenance.

12.0 Receipt of Excessively Contaminated Casks/Vehicles

12.1 If contamination levels exceed the limits acceptable for routine receipt, the cask system is moved into the washdown bay without normal washdown.

12.2 If the excessive contamination is localized, spot cleaning techniques are used to decontaminate without generating free liquids.

12.3 If spot cleaning is successful, the transportation system is queued into the routine receiving operation beginning with the washdown step.

12.4 If spot cleaning cannot be used or is ineffective, the cask system is moved directly to the off-loading bay. Appropriate precautions are taken to prevent spread of contamination as the vehicle is being moved.

12.5 Off-load cask and move it directly to the air pallet in the west bay. Caution: Do not initiate this move until the bay is empty and the air pallet is in place.

12.6 The cask is transferred to the cask and insert cleaning stall for decontamination. When contamination is reduced to an acceptable level, the cask is queued for fuel unloading.

12.7 The vehicle is returned to the washdown area and decontaminated without the generation of free liquid. Any additional road dirt is hosed away, followed by queuing the vehicle into the vehicle inspection bay.

12.8 Once a cask or vehicle enters a routine queue, the appropriate standard procedures are followed from then on.

13.0 Receipt of Damaged Casks

It is expected that the FSF will be capable of repairing damaged casks. However, casks damaged so severely that they cannot be opened in a normal way will be considered on a case-by-case basis. The contents of the casks; spent fuel, high level wastes, etc., will be a major consideration as to how it is opened and the kind of area needed to perform the opening or repair operations. The E-MAD Facility in Jackass Flats, Nevada, might serve as a central repair station.

REPORT NO. AGNS-35900-1.1-106

FLEET SERVICING FACILITY FOR A 600-MTU/YEAR AFR

APPENDIX B TO VOLUME III

COST ESTIMATES - 600 MTU/YEAR FLEET SERVICING FACILITY AT BNFP

(Summary in Section 4.0)

Paul N. McCreery

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

ESTIMATE SUMMARY

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

PROJECT SUMMARY

ESTIMATE NO.

SHEET NO. 1 of 2

PREPARED BY: EME,PNM DATE:

CHECKED BY: DATE:

MAIN ACCOUNT	DESCRIPTION	QUANTITY	MATERIALS UNIT PRICE	MATERIALS AMOUNT	LABOR UNIT M.H.	LABOR TOTAL M.H.	LABOR RATE	LABOR AMOUNT	SUB-CONTRACT UNIT PRICE	SUB-CONTRACT AMOUNT	TOTAL $ x 10^3
	DIRECTS										4,700
	INDIRECTS 45% & FEE 3%										2,350
	CONSTRUCTION SUBTOTAL										7,050
	ENGINEERING @ 20%										1,450
	TOTAL ENGINEERING & CONSTRUCTION										8,500
	CONTINGENCY 30%										2,600
	TOTAL 3RD QTR. FY'80 $ IN THOUSANDS										11,100

ESTIMATE SUMMARY

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

DIRECT COST SUMMARY

ESTIMATE NO.

SHEET NO. 2 of 2

PREPARED BY: EME, PNM DATE:

CHECKED BY: DATE:

MAIN ACCOUNT	DESCRIPTION	QUANTITY	MATERIALS UNIT PRICE	MATERIALS AMOUNT	LABOR UNIT M.H.	LABOR TOTAL M.H.	LABOR RATE	LABOR AMOUNT	SUB-CONTRACT UNIT PRICE	SUB-CONTRACT AMOUNT	TOTAL $ x 10^3
	IMPROVEMENTS TO LAND	PG. 1		103				169		82	354
	NEW BUILDING	PG. 4		944				967		299	2,210
	BUILDING MODIFICATIONS	PG. 5		5				6		--	11
	SPECIAL FACILITIES	PG. 8		1,307				428		53	1,788
	OUTSIDE UTILITIES	PG. 10		117				87		55	259
	STANDARD EQUIPMENT	PG. 11		14				2		36	52
	TOTAL DIRECTS			2,490				1,659		525	4,674
										SAY	4,700

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT: IMPROVEMENTS TO LAND

ESTIMATE NO.

SHEET NO. 1 of 11

PREPARED BY: EME, PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Demolition Exterior of Existing Bldg.										
Earth Berm Removal	7,000 C.Y.	.83	5,810	.10	700	12.03	8,450	--	--	14,260
Steel Sheet Piling, New	5,200 S.F.		--		--		--	12.32	64,000	64,000
Storm Drainage Removal										
8"ϕ Pipe & 12"ϕ Pipe	280 L.F.	.68	190		40					
Catch Basin	3 units	13.00	40		20					
Roof Drains & Downspouts	2 each	120.00	240		40					
SUBTOTALS			470		100	13.44	1,340		--	1,810
Reinforced Concrete Retaining Walls	900 C.Y.	16.80	15,100	2.67	2,400	8.72	20,900		--	36,000
Asphalt Pavement	15,800 S.F.	.08	1,260		140	12.03	1,680		--	2,940
Replace Earth Berm	3,900 C.Y.	1.35	5,260		1,000	12.03	12,100		--	17,360
New Storm Drainage										
8"ϕ Pipe	340 L.F.	2.24	760		60					
12"ϕ Pipe	140 L.F.	3.36	470		36					
Catch Basin	3 each	336.00	1,000		64					
Trenching	500 L.F.	1.80	900		40					
SUBTOTALS			3,130		200	13.44	2,700		--	5,830
Rework West Drainage Ditch	500 L.F.	11.20	5,600		1,400	9.83	13,800		--	19,400
New Concrete Retaining Wall	420 C.Y.	135.00	56,700		8,400	9.83	93,400	11.10	4,700	154,800
Repair Asphalt Paving	7,000 S.F.		--		--		--	.84	5,900	5,900
Miscellaneous	1 lot		9,670		1,460		14,630		7,500	31,800
TOTAL IMPROVEMENTS TO LAND			103,000		15,800		169,000		82,100	354,100

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT:

NEW BUILDING

ESTIMATE NO.

SHEET NO. 2 of 11

PREPARED BY: EME,PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Excavation & Backfill (Within Building 5-foot Line)										
Excavation - Machine										
Building Area	2,150 C.Y.	.68	1,500	.10	215					
Excavation Grade Beams	420 C.Y.	.90	380	.15	65					
Backfill Grade Beams	370 C.Y.	2.02	750	.25	95					
Stabilized Fill Under Slab	390 C.Y.	4.65	1,820	.20	80					
Fine Grading Under Slab	18,000 S.F.	.06	1,150	.02	360					
Miscellaneous	1 lot		600		135					
SUBTOTALS			6,200		950	12.03	11,500		--	17,700

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT: NEW BUILDING

ESTIMATE NO.

SHEET NO. 3 of 11

PREPARED BY: EME, PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS UNIT PRICE	MATERIALS AMOUNT	LABOR UNIT M.H.	LABOR TOTAL M.H.	LABOR RATE	LABOR AMOUNT	SUB-CONTRACT UNIT PRICE	SUB-CONTRACT AMOUNT	TOTAL
Concrete										
Structural Foundations	215 C.Y.	90.00	19,400	20	4,300					
Floor Slabs (On-Grade)	1,041 C.Y.	157.00	163,500	15	15,650					
Elevated Floor Slabs	320 C.Y.	168.00	53,800	25	8,000					
Walls	610 C.Y.	168.00	102,500	30	18,300					
Test and Inspection Pits	61 C.Y.	168.00	10,300	45	2,750					
Cask Pit	22 C.Y.	168.00	3,700	45	1,000					
Cask Insert Pits	714 C.Y.	140.00	100,000	24	17,200					
Precast Pit Covers	18 units	450.00	8,100	40	750					
Miscellaneous Concrete	60 C.Y.	157.00	9,500	35	2,100					
Floor Hardener	22,000 S.F.	.25	5,500	.04	900					
SUBTOTALS			476,300		70,950	9.83	697,500		--	1,173,800
Other Building Components										
Structural Steel	225 T.	1,120.00	252,000	36	8,100	13.20	107,000		--	
Insulated Siding	100 Sq.		--		--		--	740.00	74,000	
Insulated Roofing	155 Sq.		--		--		--	190.00	29,500	
Built-Up Roof	190 Sq.		--		--		--	190.00	36,100	
Overhead Doors - 16'x22"	3 each		--		--		--	4,900.00	14,700	
M.O. Steel Roll-12'x20"	1 each		--		--		--	2,600.00	2,600	
Up - 8'x10"	1 each		--		--		--	2,300.00	2,300	
Windows	10 each	170.00	1,700	6	60	9.00	600		--	
Doors and Hardware	45 each	400.00	18,000	8	360	9.00	3,300			
SPL Hardware	10 each	600.00	6,000	8	80	9.00	700			
Suspended Ceilings	5,000 S.F.		--		--		--	1.85	9,300	
Floor Tile	5,000 S.F.		--		--		--	1.25	6,300	
Masonry-Exterior	2,300 S.F.		--		--		--	3.53	8,100	
Masonry-Interior	7,200 S.F.		--		--		--	2.35	17,000	
Roof Downspouts	12 each	135.00	1,600	8	96	12.15	1,200		--	
Sprinklers - (Except Cell)	200 Hds							170.00	34,000	
Office Partitions	2,000 S.F.							9.00	18,000	
Miscellaneous			28,700		904		11,200		25,100	
SUBTOTALS			308,000		9,600		124,000		277,000	709,000

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT: NEW BUILDING

ESTIMATE NO.

SHEET NO. 4 of 11

PREPARED BY: EME,PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Painting and Insulation	1 lot		--		--		--		22,000	22,000
Piping										
Supply and Drains	1 lot		9,000		1,620					
Fixtures	24 each	620.00	14,900		380					
Miscellaneous	1 lot		2,400		200					
			26,300		2,200	14.40	31,700		--	58,000
Electrical (Including Fire Alarm and Communication System)	1 lot		90,000		4,000	13.75	55,000		--	145,000
HVAC										
Office	5,000 S.F.	4.50	22,500		1,000					
Shop and Storage	2,400 S.F.	2.00	4,800		2,400					
Smoke Vents	10 each	560.00	5,600		100					
Miscellaneous			4,100		350					
			37,000		3,850	12.20	47,000			84,000
TOTAL NEW BUILDING			943,800		91,550		966,700		299,000	2,209,500

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT:

MODIFICATIONS TO (EXISTING) BUILDING

ESTIMATE NO.

SHEET NO. 5 of 11

PREPARED BY: EME, PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Demolition, Removal and/or Relocation										
(Within Confines of BNFP Building)										
Cut Door Opening and Patch - (6'x7')										
at Elev. 274'-0"	2 each	2,500	5,000	300	600	9.83	5,900		--	10,900
TOTAL BUILDING MODIFICATIONS			5,000		600		5,900			10,900

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT: SPECIAL FACILITIES

ESTIMATE NO.

SHEET NO. 6 of 11

PREPARED BY: EME,PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Process Equipment										
Tanks										
Deionized Water Storage Tank	1 each		7,000		50					
Filter Regeneration Tank	1 each		1,700		35					
Washdown Area Sump Tank	1 each		8,300		100					
Miscellaneous	1 lot		1,700		15					
SUBTOTALS			18,700		200	11.60	2,300		--	21,000
Pumps										
High Pressure Cleaning Pump	1 each		43,000		110					
Cask Jet Pump	1 each		4,900		40					
Deionizer Supply Pump	1 each		2,500		40					
Filter Waste Pump	1 each		2,500		40					
Slurry Pump	1 each		4,900		40					
Sump Pumps	3 each	6,200	18,600	60	180					
Spare Parts and Vendor Reps.	1 lot		7,700		--					
Miscellaneous	1 lot		8,400		50					
SUBTOTALS			92,500		500	11.60	5,800			98,300
Vacuum Equipment										
Sump Ejector	1 each		750		40					
Vacuum Cleaning Jet	1 each		2,500		40					
Miscellaneous	1 lot		350		10					
SUBTOTALS			3,600		100	11.60	1,200			4,800
Compressor and Blowers										
Filter Blowdown Compressor & Tank	1 unit		740		50					
Blower	1 each		4,440		75					
Spare Parts & Vendor Reps.	1 lot		520		--					
Miscellaneous	1 lot		550		15					
SUBTOTALS			6,250		140	11.60	1,650			7,900

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT: SPECIAL FACILITIES

ESTIMATE NO.

SHEET NO. 7 of 11

PREPARED BY: EME, PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS UNIT PRICE	MATERIALS AMOUNT	LABOR UNIT M.H.	LABOR TOTAL M.H.	LABOR RATE	LABOR AMOUNT	SUB-CONTRACT UNIT PRICE	SUB-CONTRACT AMOUNT	TOTAL
Process Equipment (Continued)										
Special Equipment										
Deionizer Package	1 unit		53,600		300					
Filter	1 each		43,100		130					
Separator	1 each		1,250		50					
Parts Cleaner	1 each		900		20					
Ultrasonic Cleaner	1 each		1,750		40					
High Pressure Spray Unit	1 each		800		40					
Sinks and Benches	1 lot		6,200		200					
Spray Booth and Hood	1 lot		6,200		140					
Bridge and Trolley Crane - 10T. (Cask and Insert)	1 unit		67,800		600					
Jib Cranes	3 each	6,200	18,600	100	300					
Air Pallets	3 each	14,600	43,800	40	120					
Storage Bay and T&I Crane-15T.	1 unit		96,000		800					
Hydraulic Lift Truck	1 each		6,800		--					
Pallet Walker	1 each		6,200		--					
Spare Parts and Vendor Reps.	1 lot		34,300		--					
Miscellaneous	1 lot		38,800		300					
SUBTOTALS			426,100		3,040	11.60	35,300			461,400
Shop Equipment										
Wire Rope Swaging Tool and Dies	1 lot		1,400		100					
Misc. Measuring Tools	1 lot		12,400		100					
Miscellaneous	1 lot		1,400		20					
SUBTOTALS			15,200		220	11.60	2,600			17,800
Viewing Equipment										
Shielding Windows	5 each	28,000	140,000	200	1,000	11.60	11,600			
SUBTOTALS			140,000		1,000		11,600			151,600
SUBTOTAL PROCESS EQUIPMENT			702,350		5,200		60,450			762,800
Subtotal Process Equipment			702,350		5,200		60,450			762,800
Less Cranes, Shop & Viewing Equipment			(451,150)*							

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT:

SPECIAL FACILITIES

ESTIMATE NO.

PREPARED BY: EME,PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS UNIT PRICE	MATERIALS AMOUNT	LABOR UNIT M.H.	LABOR TOTAL M.H.	LABOR RATE	LABOR AMOUNT	SUB-CONTRACT UNIT PRICE	SUB-CONTRACT AMOUNT	TOTAL
Process Instrumentation 20%* x 1.14	1 lot		71,000		2,350	13.60	32,000		--	103,000
Process Piping 33%* x 1.14	1 lot		75,800		6,900	13.60	94,000			169,800
Miscellaneous Structural Steel & Liners										
Crane Rails	23T.	1,230	28,300	30	690					
Equipment Supports	9T.	4,250	38,300	100	900					
Platforms and Handrail	10T.	2,130	21,300	80	800					
Pipe Racks	5T.	1,680	8,400	100	500					
Pit Liners	30T.	5,600	168,000	150	4,500					
Miscellaneous			26,500		740					
SUBTOTALS			290,800		8,130	13.20	107,300		--	398,100
Process Electrical 20%*x 1.14	1 lot		44,000		4,570	12.90	59,000		--	103,000
Painting & Insulation Incl. Spl.Coatings	1 lot		31,600		2,380	12.90	30,700		--	62,300
Fire Protection - Cell	1 lot		--		--		--		53,000	53,000
Heating,Ventilation & Air Conditioning										
Equipment,HEPA Filter,Duct & Controls	1 lot		39,500		2,810	12.10	34,000		--	73,500
Radiation Monitoring & Alarm System	1 lot		29,000		340	13.60	4,600		--	33,600
Security Detection System	1 lot		22,500		440	13.60	6,000		--	28,500
TOTAL SPECIAL FACILITIES			1,306,550		33,120		428,050		53,000	1,787,600

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT:

OUTSIDE UTILITIES

ESTIMATE NO.

PREPARED BY: EME, PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Demolition and Relocation Exterior of Building										
Fire Protection Removal										
8"ϕ & 6"ϕ (AF2U) Welded (C&W) (Including PIV & Valve Boxes)	324 L.F.	1.55	500	.40	130	13.50	1,750		--	2,250
Railroad Track Removal										
In Concrete	130 L.F.	2.50	320	1.70	220					
In Asphalt	150 L.F.	1.25	190	.80	120					
SUBTOTALS			510		340	8.75	3,000		--	3,510
Electrical Removal										
30' Light Pole	4 each		--	4	16					
Roof Mounted Lights	2 each		--	2	4					
Receptacles	1 each		--	2	2					
1"ϕ Conduit in Concrete (3'deep)	700 L.F.	2.45	1,700	.35	240					
1"ϕ Conduit Above Ground	30 L.F.		--	.20	6					
Concrete Duct Bank, 3-1"ϕ Conduits and 2-2"ϕ Conduits	150 L.F.	2.25	340	.40	60					
SUBTOTALS			2,040		328	13.00	4,260		--	6,300
Relocation Outside Confines of New Building										
New Fire Protection Trenching Cut & Patch	1,150 L.F.	5.60	6,440	.60	690					
10"ϕ Sch.40 Pipe (Welded C&W)	210 L.F.	40.00	8,400	1.00	210					
8"ϕ " " " "	565 L.F.	28.00	15,800	.60	340					
6"ϕ " " " "	375 L.F.	24.00	9,000	.45	170					
10"ϕ PIV	1 each	1,200.00	1,200	10	10					
8"ϕ PIV	2 each	700.00	1,400	7	14					
6"ϕ PIV	5 each	430.00	2,150	6	30					
SUBTOTALS			44,390		1,464	13.50	19,810		--	64,200

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT:

OUTSIDE UTILITIES

ESTIMATE NO.

SHEET NO. 10 of 11

PREPARED BY: EME,PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
New Electrical Instrument Lines										
Concrete Duct Bank, 3-1"ϕ Conduits										
and 2-2"ϕ Conduits plus 1 manhole	200 L.F.	25.00	5,000	2.5	500	13.20	6,600		--	11,600
Railroads										
New Single Track (100# Relay),										
Concrete Ties	500 L.F.		--		--		--	64.00	32,000	
Turnouts #6	1 unit		--		--		--	10,000	10,000	
SUBTOTALS			--		--		--		42,000	42,000
New Electrical										
Power Cable	250 L.F.	28.00	7,000		320					
Conc. Duct Bank To Exist.750 KVA Trf.	200 L.F.	25.00	5,000		400					
Lighting, 3 new 30' poles	6 each		2,500		120					
Conduit and Wire	400 L.F.	6.00	2,400		120					
SUBTOTALS			16,900		960	12.90	12,400			29,300
Steam,Potable & Chilled Water Supply	1,500 L.F.	25.00	37,500		2,400	13.50	32,400		--	69,900
Miscellaneous			10,000				7,000		12,600	29,600
TOTAL OUTSIDE UTILITIES			116,840				87,220		54,600	258,660

ESTIMATE DETAILS

PROJECT: SPENT FUEL CASK FSF - COLOCATED (BNFP) - 600 MTU

ACCOUNT:

STANDARD EQUIPMENT

ESTIMATE NO.

SHEET NO. 11 of 11

PREPARED BY: EME, PNM DATE:

CHECKED BY: DATE:

DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
		UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Standard Equipment										
Office Furniture & Fixtures	8 each		--				--	3,700	29,600	
Standard Shop Tools & Equipment	1 lot		12,000		150					
Miscellaneous	1 lot		2,000		20				5,800	
TOTAL STANDARD EQUIPMENT			14,000		170	11.60	2,000		35,400	51,400

REPORT NO. AGNS-35900-1.1-106

CASK HANDLING EQUIPMENT STANDARDIZATION

VOLUME IV

PROCEDURE S-COP-01-10
FSV-1 (TRUCK) CASK CHECKOUT

Moylen Young

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

SECTION	NUMBER	REVISION	DATE
SEPARATIONS	S-COP-01-10	0	

TITLE
FSV-1 (TRUCK) CASK CHECKOUT

PREPARED BY	EFFECTIVE TO	PAGE
M. YOUNG	INDEFINITE	1 OF 14

1.0 INTRODUCTION

Spent fuel assemblies transported to BNFP will be received in shielded licensed casks on truck or rail transporting equipment. The cask to be checked out is the Fort St. Vrain FSV-1. The checkout will provide data from which an operating procedure will be developed.

2.0 PURPOSE

The purpose of this document is to establish procedural steps for the movement of the FSV-1 spent fuel shipping cask from the road transport vehicle. All required phases of cask handling will be accomplished either by actual cask and equipment manipulation or by simulation as in the case of cask cooldown, fuel assembly unloading, and cask sampling. This checkout is to demonstrate that the cask and equipment can be handled in the FRSS area and to verify the equipment used is satisfactory for use at the BNFP. Operating personnel will become familiar with this equipment and provide data for preparing operating procedures.

3.0 SCOPE

3.1 Areas Involved

3.1.1 Yard
3.1.2 Washdown Area
3.1.3 Unloading Bay
3.1.4 Test and Decontamination Pit
3.1.5 Cask Unloading Pool.

3.2 Principal Equipment

3.2.1 FSV-1 Cask and Trailer
3.2.2 Trailer Jockey
3.2.3 Waste Water Pump
3.2.4 Cask Handling Crane
3.2.5 Cask Unloading Crane.

REVIEWED BY — DATE	REVIEWED BY — DATE	REVIEWED BY — DATE	APPROVED BY — DATE
			Director, Operations
			Manager, QA and Lic Compliance
			Chairman, Oper Safety Committee
			Cognizant Oper Div Dept Manager

3.3 Reference Procedures (AGNS)

3.3.1 S-POP-01-3, Trailer Jockey Operation
3.3.2 S-POP-01-4, Outside Wash Station
3.3.3 S-POP-02-4, Cask Handling Crane and Auxiliary Unit
3.3.4 S-POP-05-1, Canister Crane
3.3.5 S-POP-05-2, Cask Unloading Pool Crane
3.3.6 S-POP-05-4, Fuel Handling Grapple Operation
3.3.7 S-POP-00-2, Underwater Pool Lighting
3.3.8 S-POP-00-6, Underwater TV Camera Operation.

3.4 Acceptance Criteria

3.4.1 Demonstrate ability to receive cask in FRSS.

3.4.2 Demonstrate cask handling techniques required for cask receiving and shipping.

4.0 PREREQUISITES

4.1 Utilities Required

4.1.1 Electrical power
4.1.2 Utility water
4.1.3 Demineralized water
4.1.4 Utility air or instrument air.

4.2 Equipment and Materials Required

4.2.1 Trailer, cask, and yoke
4.2.2 Cask handling crane (05-T-004)
4.2.3 Cask unloading crane (05-T-005)
4.2.4 Miscellaneous hand tools
4.2.5 FSV-1 special tools.

4.3 Personnel Requirements

4.3.1 Crane Operators
4.3.2 Maintenance Electrician as required
4.3.3 Maintenance Mechanic as required
4.3.4 Production Supervision
4.3.5 Safety and Environmental Control Technician

Prerequisites have been met. Cog. Eng. __________ Date ________

5.0 PRECAUTIONS

5.1 Only authorized personnel shall operate the cranes.

5.2 The cask, handling tools, and equipment are massive. Many pinch point hazards exist. A very slow swing of the suspended cask will contain a large amount of energy.

5.3 The cask is upright and 17 feet 6 inches high, which constitutes a fall hazard. Improper rigging can cause a cask or equipment drop.

5.4 It is imperative that the cask handling crew become thoroughly familiar with the cask equipment, potential hazards, and proper handling procedure.

5.5 Avoid excessive "jerky" motion of crane when carrying cask and prevent unnecessary swinging action.

5.6 Always insure adequate clearance exists between the bottom of cask and obstructions or pool walls prior to moving cask horizontally.

5.7 Whenever the lifting yoke or special service tools are being moved underwater, at least one person other than the man controlling the crane should be observing the operation and assisting the crane operator.

5.8 Do not attempt to rotate the cask onto or from the trailer with the yoke adaptor in place.

6.0 PROCEDURE

NOTE: List and describe all deficiencies on comment sheet at the end of this procedure.

6.1 Notification that the FSV-1 cask has arrived will be given to the Shift Supervisor or his designated representative. He will provide an escort for the driver who will spot the trailer in the FRSS parking lot.

6.2 Request Health Physics to monitor the tractor, complete the release form, and make copies for driver, Operations, Health Physics, and Security. Obtain a clearance pass from the Supervisor, then escort driver to the main gate.

6.3 Inspect the unit for obvious damage. Report any damage to the Supervisor.

6.4 Remove the personnel barrier (if used) and request Health Physics to survey cask. When notified of results, wash cask and trailer unless survey indicates results over 2200 dpm/beta/gamma or 220 dpm alpha. Should these levels be exceeded, washdown will be done inside the truck bay.

6.5 Move the trailer using the trailer jockey per S-POP-01-3 to the washdown pad and wash cask and trailer.

6.6 Back cask trailer into FRSS unloading bay. Block wheels on trailer against movement in either direction and leave tractor attached. After cask is removed, the trailer may be moved to the parking area at the discretion of the Supervisor.

NOTE: For cold testing only, remove the bottom sample (drain) cover per Appendix B.

6.7 Remove lockwires and loosen the four 1 1/4-inch socket head bolts between the bottom support structure and the cask. DO NOT REMOVE!

6.8 Tighten the four 1 1/4-inch socket head bolts only to contact (zero torque).

6.9 Remove the tie-down from the cask top support structure by unbolting four 3/4-inch hex bolts, nuts, and lock washers and store on trailer.

6.10 Remove six 1/2-inch hex locknuts and flat washers from the mounting studs for the impact limiter mounting ring.

6.11 Slide the mounting ring off the studs.

6.12 Attach the lifting bar for the impact limiter to the overhead crane and connect to the eyebolts in the impact limiter.

6.13 Place the work platform on the trailer and remove the impact limiter from the cask and store on the floor.

6.14 Attach the cask lifting yoke to the overhead crane.

6.15 Engage the cask lifting yoke into the lifting sockets near the top of the cask. See Appendix A for detailed procedure for yoke setup (Sections 4.3, 4.6, and 4.10).

6.16 Raise the shipping cask about 20 inches above the top support structure and slide the impact limiter mounting ring to the bottom of the cask.

CAUTION: Keep the crane trolley directly over the cask lifting sockets while hoisting to prevent lifting or moving the trailer. The cask is still bolted to the trailer through the bottom support structure. Keep the load line plumb.

6.17 Raise the shipping cask carefully to a vertical position and position the mounting ring on the dished head of the bottom support structure.

6.18 Remove two 1/2-inch hex head bolts holding the locking block on the trailer. Install the locking block on the inside of the left trunnion using the same bolts.

6.19 Disengage the fuel shipping cask from the trailer and the bottom support structure by removing the four 1 1/4-inch socket head bolts.

6.20 Raise the cask from the bottom support structure and transfer to the Test and Decontamination (T&D) Pit center (one of two) position.

6.21 Set the cask on a protective base in the T&D pit.

6.22 Disengage the cask lifting yoke.

6.23 Move the working platform into position.

6.24 Remove the cask closure head (1050 pounds) by removing the lock-wire and the twenty-four 1 1/4-inch socket head cap screws from the cask closure head (Figure FSV-3).

6.25 Remove the three 3/4-inch socket head set screws from the cask closure head and replace with three 3/4-inch shouldered eyebolts.

6.26 Using a three-legged sling attached to the crane, remove the closure head and store. Be careful to protect the seals.

<u>NOTE</u>: The following will be performed only on the uncontaminated cask container. This will allow the water to drain from the cask as part of this checkout.

6.26.1 Install the three 1/2-inch long shouldered eyebolts in the container lid.

6.26.2 Using a three-legged sling (rated for at least 2,000 pounds) attached to the crane and the eyebolts, carefully raise the container out of the cask.

6.26.3 Remove the 1/2-inch plug from the bottom of the container. Tag and store the plug for reinsertion later.

6.26.4 Carefully lower the container back into the cask cavity.

6.26.5 Remove the three 1/2-inch eyebolts and sling.

6.27 Simulate sampling the cask cavity as per Steps 6.27.1 through 6.27.6.

6.27.1 Remove the 1/2-inch hex head plug from the sampling port in the container lid.

6.27.2 Remove the seal plug assembly from the interior threads of the sampling port.

6.27.3 Install the sampling plug assembly into the gas sampling port in the container lid. Verify the shutoff valve is closed (Figure FSV-1&2).

6.27.4 Attach the evacuated sample bomb to the sampling assembly. Open shutoff valve and draw a sample. (Omit if sample bomb is not available.) Close shutoff valve and remove sample bomb.

6.27.5 Disconnect sampling plug assembly and replace the seal plug assembly.

6.27.6 Replace the 1/2-inch hex head plug in the sampling port.

6.28 Remove the twelve 1/2-inch socket head bolts from the spent fuel container lid. If attachments on the lifting yoke are available for underwater head removal, follow Steps 4.11 through 4.24 of Appendix A.

NOTE: Should the attachments for underwater head removal not be available, remove the container head while the cask is in the T&D pit. This only applies for the cold uncontaminated cask operation.

6.28.1 Attach the three-legged sling to the auxiliary crane hook and the three eyebolts.

6.28.2 Remove the container head (1370 pounds) carefully to protect the seals.

6.28.3 Request Health Physics to survey inner cavity opening (precautionary, no contamination or radiation is expected).

6.28.4 Inspect the container head seals.

6.28.5 Store the container head being careful to protect the seals.

6.28.6 Inspect the sealing surface of the cask top for defects. Notify supervisor if defects are noted.

6.28.7 Fill the cask with water.

6.29 Raise the cask just high enough to clear the hand rails then move into position over the Cask Unloading Pool (CUP) and lower cask to bottom of the CUP.

6.30 Disengage the cask yoke from the cask and carefully raise it out of the water. Wash the yoke and head (if attached) with demineralized water as it comes out of the CUP. Let drip for a few minutes.

6.31 Carefully move the yoke and head (if attached) to the T&D pit. Follow Steps 6.28.4 and 6.28.5 above if head is attached to the yoke.

6.32 Engage fuel grapple, GE type, simulate fuel removal.

6.33 Return grapple to grapple storage rack and disengage from crane.

6.34 Return yoke and head, if attached, to the CUP and carefully position over the cask. Utilize the underwater TV while performing Steps 6.35 through 6.37, if available.

6.35 As the decending yoke nears the cask, maneuver the crane until the longer guide pin engages the guide hole in the head. Descend farther and engage the second guide pin.

6.36 Descend farther, visually guarding against head cocking, until the head seats properly on the cask and the yoke adapter bottoms out on the head.

6.37 Close the lifting arms to engage the lifting sockets. Confirm visually.

6.38 Lift the cask to the surface, washing as it emerges from the pool. Let drip for a few minutes and transport it to the T&D pit.

6.39 With the cask about one foot above the setdown stand, attach a drain hose with the mating quick-disconnect fitting to the sampler fitting in the bottom of the cask.

6.40 Carefully set the cask on the setdown stand. Make sure the drain hose fits properly in the slot of the stand.

6.41 Remove adaptor, studs, and guide pins from the cask and store for the next use of a FSV cask.

<u>CAUTION</u>: Do not attempt to rotate the cask onto or from the trailer with the yoke adaptor in place.

6.42 Allow the cask to drain by installing the top sampling fittings. Follow Steps 6.24.1 through 6.24.3 and open the shutoff valve. Replace the twelve 1/2-inch socket head bolts in the container lid and torque to 15 to 20 foot pounds.

6.43 Remove the sampling fittings when the cask cavity has drained.

6.44 Install the seal test adapter into the test/sample port and connect vacuum line, shut off valve, and gauge to the vacuum pump (Figure FSV-2).

6.45 Evacuate the lid seal interspace to one millimeter of mercury absolute and close the shutoff valve.

6.46 Read the vacuum/pressure gauge when two minutes have elasped. The maximum allowable pressure increase in two minutes is 6.5 millimeters mercury absolute.

6.47 Replace the container lid gasket assembly per procedure in Appendix C and the primary plug seals if the pressure rise exceeds the allowable. Test replacement gasket assembly per Appendix D.

6.48 Vent and remove the leak test assembly and the seal test adapter. Replace the 5/8-inch hex shipping plug in the test/sample port.

6.49 Replace the closure head using the three-legged sling and overhead crane. Manually align the bolt holes.

6.50 Replace the twenty-four 1 1/4-inch socket head caps in the cask closure head and torque to 90 to 100 foot pounds.

6.51 Remove the three-legged sling and the three eyebolts and install the three socket head screws in the closure head.

6.52 Leak test the closure head seal as follows:

6.52.1 Remove the 5/8-inch hex shipping plug from the test port in the closure head.

6.52.2 Install the seal test adapter in the test port and connect seal test assembly to the test port and the vacuum supply.

6.52.3 Evacuate the seal interspace to one millimeter mercury absolute and close the shutoff valve.

6.52.4 Read the vacuum/pressure gauge when two minutes have elapsed. The maximum allowable pressure rise in two minutes is to 6.5 millimeters mercury absolute. If pressure rise exceeds the allowable, the closure head gasket must be replaced and leak tested following the procedure of Appendix E.

6.25.5 Vent the seal interspace and remove the test assembly and the seal test adapter.

6.25.6 Install the 5/8-inch hex shipping plug in the test port of the closure head.

6.53 Wipe down cask as required.

6.54 Attach the cask lifting yoke to the crane.

6.55 Raise the cask out of the T&D pit and transfer to the trailer.

6.56 Transfer the cask to a position directly over the cask bottom support structure on the transport trailer.

6.57 Verify that the impact limiter mounting ring is in place on the dished head of the bottom support structure.

6.58 Lower the cask to seat in the bottom support structure, rotating the cask as required to align the keyway in the cask base with the key in the bottom support structure.

<u>CAUTION:</u> Do not tilt the fuel shipping cask while the locking block is installed on the trunnion.

6.59 Install the four 1 1/4-inch socket head bolts and lock washers to secure the cask to the bottom support structure. Torque to 500 to 600 foot pounds.

6.60 Remove the two 1/2-inch hex head bolts and the locking block from the left trunnion of the bottom support structure. Attach onto the trailer storage position with the same bolts.

6.61 Lower the cask until approximately 20 inches above the top support structure.

6.62 Request Health Physics to survey cask surface and decontaminate, if required.

6.63 Slide impact limiter mounting ring to the shoulder of the top of the cask.

6.64 Lower the cask to seat in the top support structure.

6.65 Disengage the lifting yoke from the cask.

6.66 Lift the impact limiter using the crane and the impact limiter lifting bar and install on the cask.

6.67 Locate the mounting ring on the 1/2-inch mounting studs of the impact limiter and secure with nuts and lock washers.

6.68 Replace the cask tie-down on the cask top support structure and secure with four 3/4-inch hex bolts, nuts, and lock washers. Torque to 120 to 130 foot pounds.

6.69 Replace the base cover plate following the procedures in Appendix B.

6.70 Remove the work platform from the deck of the fuel shipping trailer.

6.71 Request Health Physics for a release radiological survey of the fuel shipping cask.

6.72 Move the trailer to the outside parking area and spot trailer. Notify supervisor or his designee when this is completed.

7.0 APPENDICES

Appendix A -- Cask Lifting Yoke

Appendix B -- Removal and Placement of Cask Bottom Sample Cover

Appendix C -- Replacement of Container Lid Gasket

Appendix D -- Leak Testing the Spent Fuel Container Lid Gasket Assembly

Appendix E -- Replacing the Closure Head Gasket Assembly

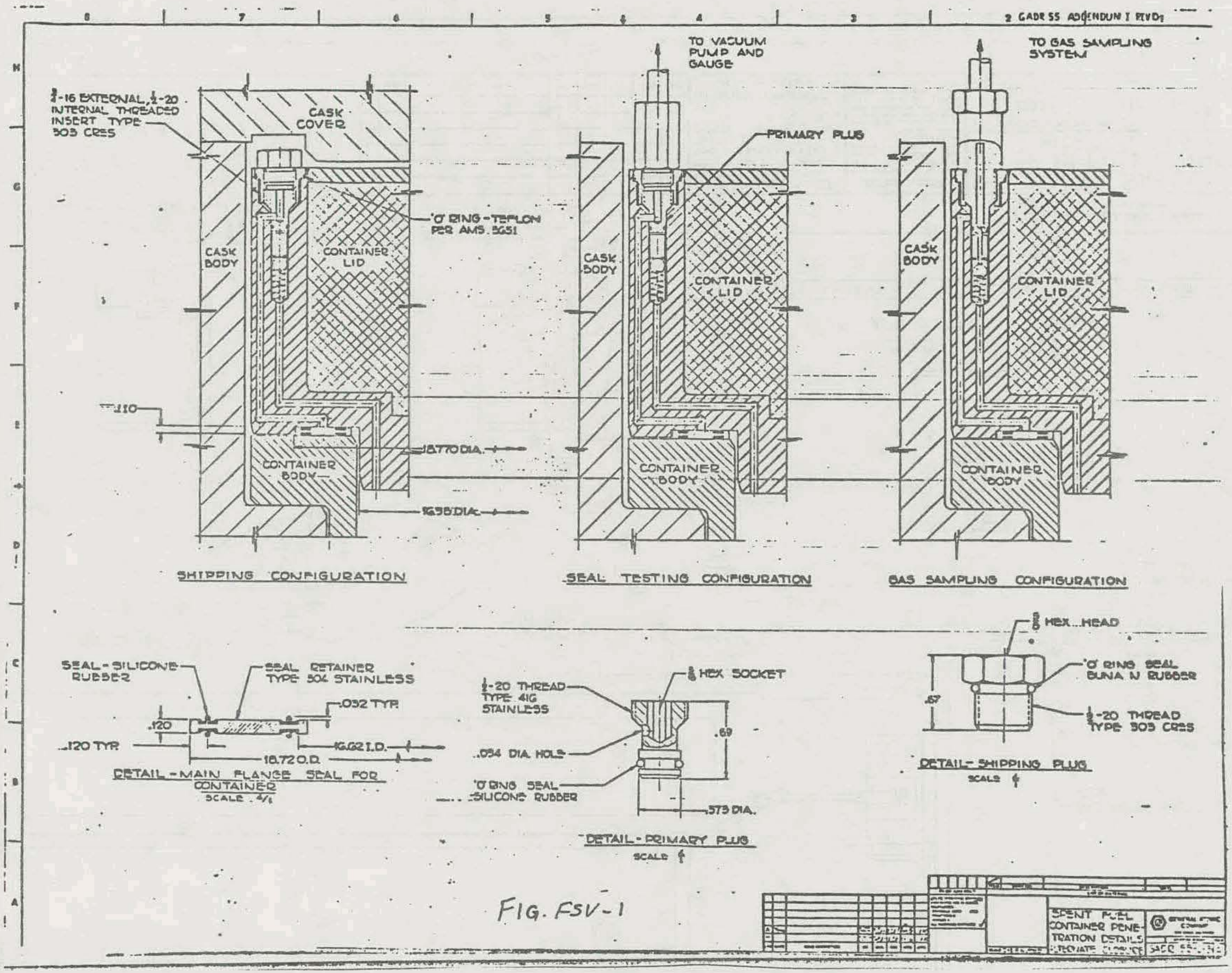
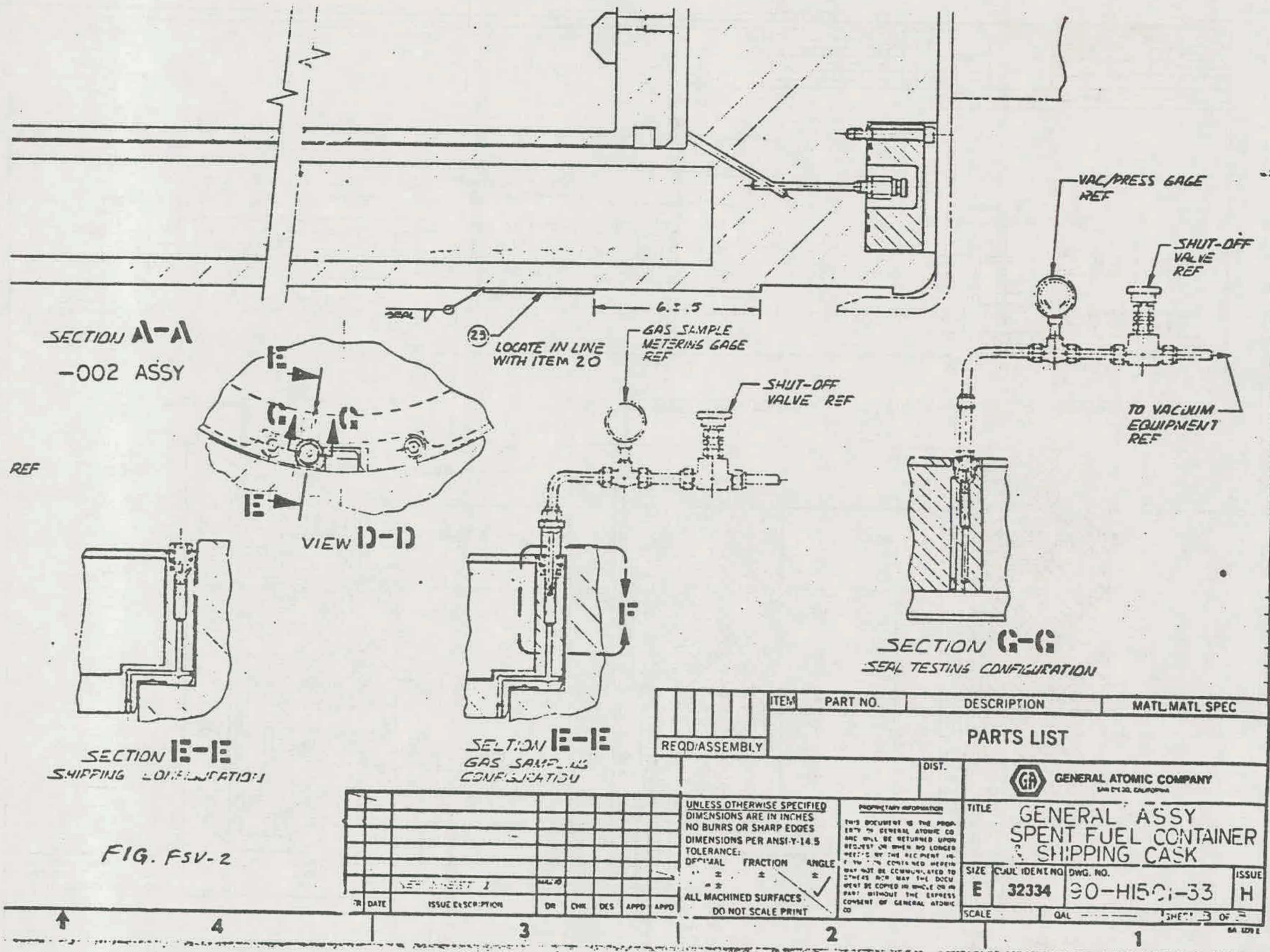


FIG. FSV-1

80-68


SECTION A-A
-002 ASSY
SEAL
23 LOCATE IN LINE WITH ITEM 20
6.2.5
GAS SAMPLE METERING GAGE REF
SHUT-OFF VALVE REF
VAC/PRESS GAGE REF
SHUT-OFF VALVE REF
TO VACUUM EQUIPMENT REF
REF
VIEW D-D
SECTION E-E
SHIPPING CONFIGURATION
SECTION E-E
GAS SAMPLING CONFIGURATION
SECTION G-G
SEAL TESTING CONFIGURATION
ITEM
PART NO.
DESCRIPTION
MATL MATL SPEC
REQD/ASSEMBLY
PARTS LIST
DIST.
GENERAL ATOMIC COMPANY
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
NO BURRS OR SHARP EDGES
DIMENSIONS PER ANSI-Y-14.5
TOLERANCE:
DECIMAL FRACTION ANGLE
ALL MACHINED SURFACES
DO NOT SCALE PRINT
TITLE
GENERAL ASSY
SPENT FUEL CONTAINER
& SHIPPING CASK
SIZE E
CODE IDENT NO 32334
DWG. NO. 90-H15?1-33
ISSUE H
SCALE
DATE
ISSUE DESCRIPTION
DR
CHK
DES
APPD
APPD
4
3
2
1
FIG. FSV-2

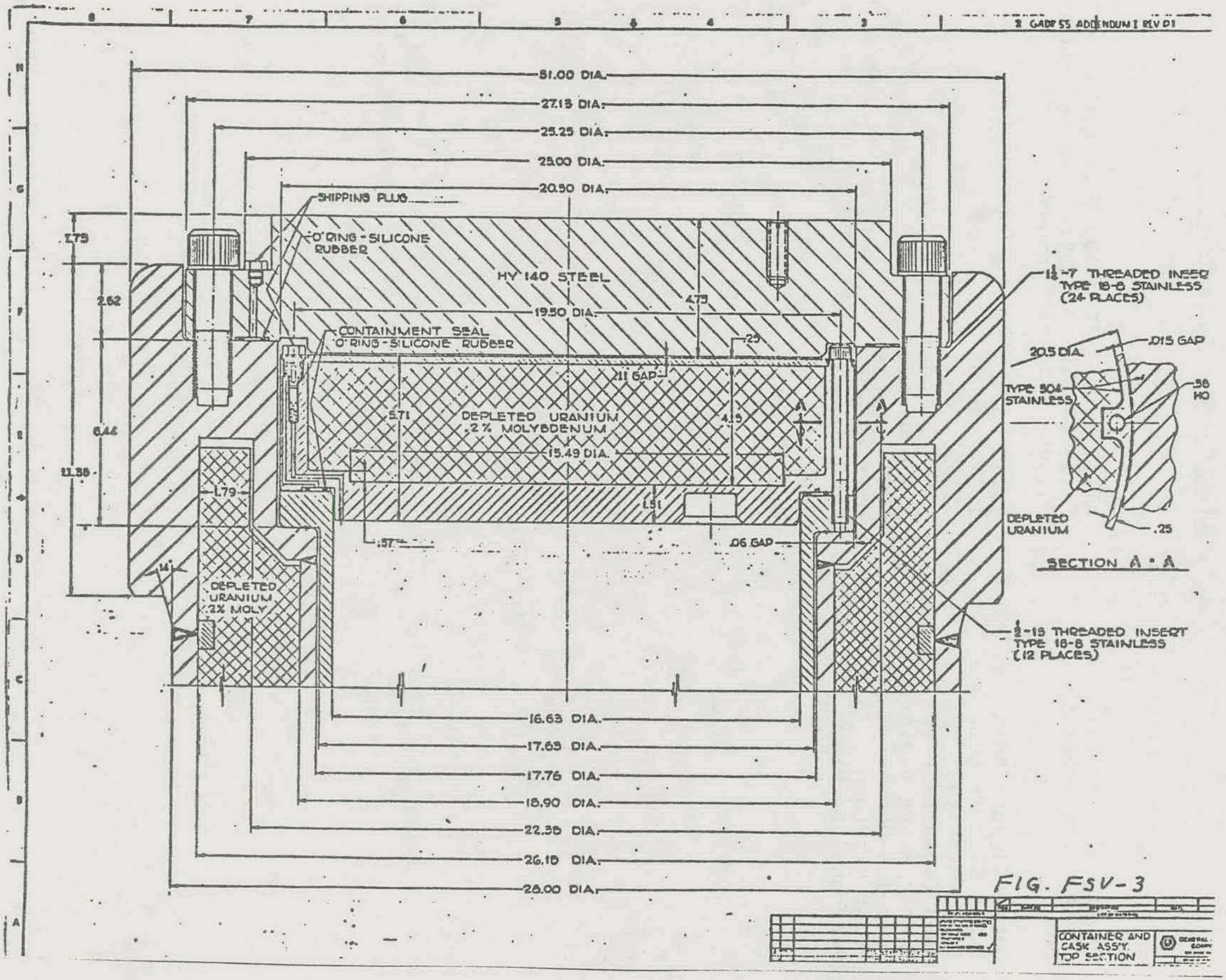

2 GAD ESS ADDENDUM I REV 01
31.00 DIA.
27.15 DIA.
25.25 DIA.
23.00 DIA.
20.50 DIA.
SHIPPING PLUG
O RING - SILICONE RUBBER
HY 140 STEEL
19.50 DIA.
CONTAINMENT SEAL
O RING - SILICONE RUBBER
.11 GAP
DEPLETED URANIUM
.2% MOLYBDENUM
15.49 DIA.
.57
.06 GAP
DEPLETED URANIUM
.2% MOLY
1¼-7 THREADED INSERT
TYPE 18-8 STAINLESS
(24 PLACES)
20.5 DIA.
.015 GAP
TYPE 304 STAINLESS
DEPLETED URANIUM
SECTION A - A
½-13 THREADED INSERT
TYPE 18-8 STAINLESS
(12 PLACES)
16.63 DIA.
17.63 DIA.
17.76 DIA.
18.90 DIA.
22.35 DIA.
26.10 DIA.
28.00 DIA.
CONTAINER AND CASK ASS'Y. TOP SECTION

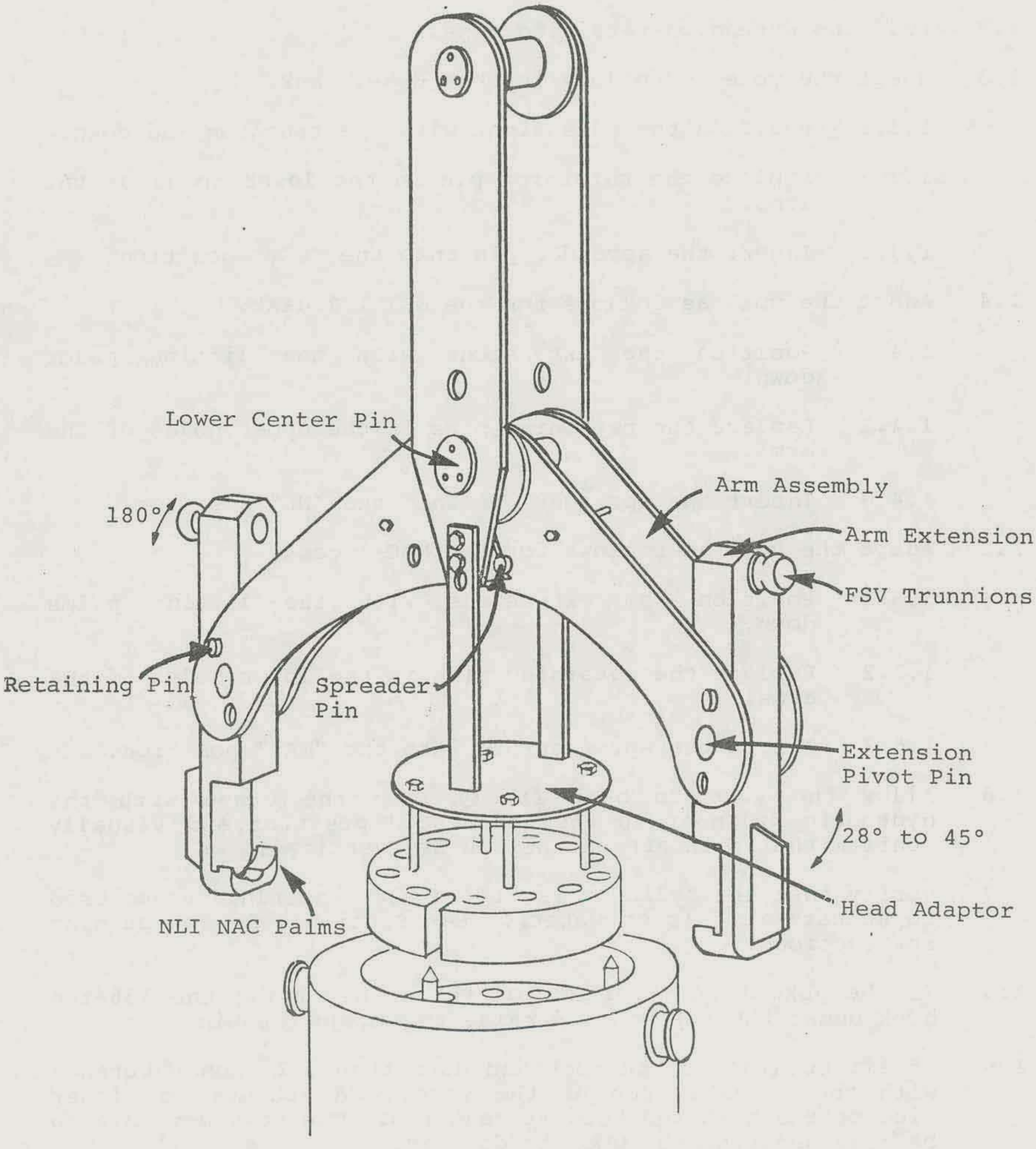
FIG. FSV-3

TABLE FSV-1

FSV-1 CASK DATA

Cavity Size (cask)	17.76 inches ID x 192.5 inches long
Cavity Size (container)	16.63 inches ID x 187.6 inches long
GVW	74,000 to 76,000 pounds
Outer Closure Head	1,035 pounds
Inner Closure Head	1,370 pounds
Impact Limiter	1,060 pounds
Fuel Canister - PWR	500 pounds
Spacer - PWR Canister	650 pounds
Rear Tie-Down	1,120 pounds
Front Tie-Down	370 pounds
Personnel Barrier	600 pounds

CASK LIFTING YOKE



1.0 OPERATING PROCEDURE FOR LIFTING YOKE

1.1 Determine which cask model is to be lifted.

1.2 Pull the extension retaining pins.

1.3 Adapt the yoke as follows for the FSV-1 cask.

1.3.1 Position the extensions with the trunnion end down.

1.3.2 Replace the retaining pin in the lower holes of the arms.

1.3.3 Insert the spreader pin into the "FSV" position.

1.4 Adapt the yoke as follows for the NLI 1/2 cask.

1.4.1 Position the extensions with the lifting palms down.

1.4.2 Replace the retaining pins in the upper holes of the arms.

1.4.3 Insert the spreader pin into the "NL" position.

1.5 Adapt the yoke as follows for the NAC-1 cask.

1.5.1 Position the extensions with the lifting palms down.

1.5.2 Replace the retaining pins in the lower holes of the arms.

1.5.3 Insert the spreader pin into the "NAC" position.

1.6 Allow the yoke to hang freely from the crane with the hydraulic cylinder in the contracted position and visually confirm that both arm extensions are vertical.

1.7 Verify that the cylinder is filled with the fluid to be used to actuate it (air or water). See Section 1.31 for purging instructions.

1.8 If the yoke is not already on the crane, bring the 135-ton hook under the top pin and raise to engage the pin.

1.9 If either side of the hook has more than 1/2 inch clearance with the inboard edge of the yoke, add spacers to either side of the hook and keep it centered. The yoke may have to be released from the hook to do this.

1.10 When an operator can work in the immediate vicinity of the yoke (e.g., cask on trailer), the arm extensions may be moved manually (rather than by hydraulic system) by removing the retaining pin(s), pivoting the extension until it clears the trunnion, and once free of trunnion interference, returning the extensions to their lifting position and reinserting the pin(s).

1.11 When the cask is upright in the work area with the (inner) head accessible and the cask is ready to go into the pool, screw the required number of studs into the head (pin the studs to the NL cask).

1.12 Screw head guide pins into the cask.

1.13 Attach the adapter, unique to the cask being processed, to the yoke. Open the yoke arms.

1.14 Bring the yoke and adaptor over the cask. Lower them carefully* and guide the head studs through the holes in the adaptor. Allow the adaptor to "bottom out" on the head.

1.15 In this position, the operator should close and open the arms to verify that trunnion engagement and disengagement is functioning without interference. Open the yoke arms.

1.16 Run a standard nut and a locknut onto each stud until the top of the stud is flush with the upper side of the upper nut.

1.17 Slowly raise the yoke until the adaptor is very near, but not touching, the lowest nut. Run all standard nuts down on the stud until it just makes contact with the adaptor.

1.18 Run all locknuts down on the stud until they seat against the standard nut.

NOTE: This step, once performed, should not have to be repeated for a given adaptor/head makeup.

1.19 Return the yoke and adaptor to the "bottom out" position and close the yoke arms. Attach external hydraulic system.

---

*If the block has a tendency to cock due to the direction of rotation of the sheaves, try to manually turn its position before it engages the studs.

1.20 Move the cask to the pool floor. Continue downward motion of the block until the yoke adaptor bottoms-out on the head.

1.21 Open the yoke arms. Visually verify that they are in the full open position.

1.22 Slowly raise yoke until the head clears the cask and guide pins.

1.23 Wash down yoke and head as they emerge from the pool.

1.24 The head may be stored on a suitable stand with the adaptor left in place with the head. Detach the adaptor from the yoke by removing the four socket head cap screws which secure the adaptor to the yoke. The yoke is then available for other uses.

1.25 The cask is retrieved from the pool with the yoke/adaptor/head in the configuration of Step 1.23.

1.26 As the descending yoke nears the cask, maneuver the crane until the longer guide pin engages the guide hole on the head. Descend further and engage the second guide pin.

1.27 Descend further, visually guarding against head cocking, until the head sets properly on the cask and the yoke adaptor bottoms out on the head.

1.28 Close the lifting arms to engage the lifting trunnions or sockets. Confirm visually.

1.29 Lift the cask to the surface, washing as it emerges from the pool, and transport it to the work area.

<u>CAUTION</u>: Do not attempt to rotate the cask onto or from the trailer with the yoke adaptor in place.

1.30 Remove adaptor, studs, and guide pins from the cask and store for the next use of a similar cask model.

1.31 To purge the actuating cylinder of one fluid by another (see Figure X):

1.31.1 Open the bypass valve.

1.31.2 Attach one line to the source of the desired fluid. Direct the open end of the other line to a suitable drain or off-gas venting system.

1.31.3 Rotate the cylinder assembly about the base pin until the piston is horizontal, with the inlet/outlet ports down when purging water from the system or with the ports in the highest position when purging air from the system.

1.31.4 Start the flow of the desired fluid.

1.31.5 Manually force the piston back and forth while observing the effluent. Continue this operation until the effluent is free of the fluid being purged. Stop the flow at its source.

1.31.6 Close the bypass valve.

1.31.7 Connect the two lines to the desired fluid source.

1.31.8 Rotate the cylinder assembly to its normal position and secure the piston end retaining pin.

2.0 MAINTENANCE AND REPAIR

2.1 Enough Neoluble® may be applied to the bearing surfaces of the lower center pin as needed to cover the bearing surface.

2.2 Any component of this system may be replaced with a similar component which has been manufactured and tested to the same specifications as the latest accepted revision of this design.

2.3 All repairs to components shall be subject to the following conditions.

2.3.1 The damage shall be described in writing, along with the recommended repair procedure.

2.3.2 Repair procedures must have the approval of the designer or the yoke custodian.

2.3.3 Repairs shall be subject to the same specifications as applicable to the latest revision of the yoke design, including stress analysis, fabrication, testing, etc.

2.4 A record of any component replacement or repair shall become a part of the permanent record of each yoke.

2.5 Adaptors will have separate, individual history files.

REMOVAL AND REPLACEMENT OF CASK BOTTOM SAMPLE COVER

1.0 REMOVAL OF CASK BOTTOM SAMPLE COVER

1.1 Remove the seal and lockwire.

1.2 Remove the three 3/8-inch socket head screws and lift off the base cover plate.

1.3 Store items from Step 1.2 until they are installed when the cask is returned to the trailer following unloading.

2.0 REPLACEMENT OF CASK BOTTOM SAMPLE COVER

2.1 Install the base cover plate and secure in place with the three 3/8-inch socket head screws. Torque to 20 foot pounds.

2.2 Lockwire the socket head screws.

REPLACEMENT OF CONTAINER LID GASKET

1. Remove the three countersunk head screws and the container lid gasket assembly.

2. Examine the gasket sealing surfaces of the container lid for defects. Notify supervisor if defects are noted.

3. Install a new gasket assembly on the container lid using the three countersunk head screws.

LEAK TESTING THE SPENT FUEL CONTAINER LID GASKET ASSEMBLY

1. Verify that the correct components are used and are properly installed and connected to the vacuum supply.

2. Evacuate the seal interspace to one millimeter mercury absolute and close the shutoff valve.

3. Read the vacuum/pressure gauge when five minutes have elapsed. The maximum allowable pressure rise in five minutes is to be 6.7 millimeters mercury absolute. If the pressure rise exceeds the allowable, the container lid gasket assembly must be replaced following the procedure in Appendix C.

REPLACING THE CLOSURE HEAD GASKET ASSEMBLY

1. Place the closure head on blocks with the gasket face up.

2. Remove the three countersunk head screws and the closure head gasket assembly.

3. Examine the gasket sealing surfaces of the closure head for defects. Notify supervision if defects are noted.

4. Install a new gasket assembly on the closure head using the three countersunk head screws. Test the assembly per Appendix D of this procedure.

REPORT NO. AGNS-35900-1.1-106

CASK HANDLING EQUIPMENT STANDARDIZATION

VOLUME V

ANALYTICAL CHEMICAL SUPPORT OF A FUEL RECEIVING FACILITY

Ernie J. Lang
George A. Huff
Lou G. Jordan
R. Steve Lee

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

ABSTRACT

This report describes the radiochemical and chemical analyses to be performed in support of a spent nuclear fuel receiving facility. It assumes that fuel casks will be received with both dry- and water-filled cavities, and that fuel unloading will be performed underwater. The preferred analytical techniques are included, whether developed by AGNS or by another agency.

TABLE OF CONTENTS

1.0 RADIOCHEMISTRY SUPPORT FOR OPERATION OF A FUEL RECEIVING AND STORAGE STATION (FRSS)

As a result of the exchange of ideas with personnel at the Idaho Chemical Processing Plant and the General Electric Fuel Storage Facility (Morris, Illinois), the following radiochemical and chemical analyses will be performed in support of the operation of an FRSS.

(1) gross beta counting
(2) tritium determination
(3) strontium-90 determination
(4) gamma-scan of pool water and air (gas) samples

1.1 Recommended Radiochemical Analyses for the Environmental Control of the FRSS Storage Facility

The types of radiochemical analyses and the frequency of sampling are presented below:

TABLE 1

POOL WATER

Analysis	Frequency
Gross Beta	weekly
Tritium	weekly
Strontium-90	monthly
Gamma-scan	weekly

TABLE 2

AIR (GAS)

Analysis	Frequency
Krypton-85	Continually (when needed)
Iodine-131	daily
Tritium	weekly
Gross beta	daily

These analyses must be performed to ensure the integrity of the fuel elements in the FRSS and the radiological safety of personnel. Corrective measures can then be instituted if a prescribed activity level is exceeded. Procedures referenced in the Methodology sections which follow are appended to this report.

1.1.1 Methodology for Pool Water Analyses

(1) Gross beta activity - An aliquot of the pool water, after dilution to an appropriate activity range, is evaporated to near dryness. The residue is quantitatively transferred to a planchet, and the planchet is counted using a beta proportional counter. Two methods will be used for these analyses, BETA-RC-1-B, "Determination of Gross Beta Activity," and BETA-RC-2-A, "Determination of Beta Activity in Liquid Sample from the FRSS."

(2) Tritium - An aliquot of the pool water is added to a prepared scintillation mixture and counted in a liquid scintillation system using method H3-RC-1-A, "Determination of Tritium by Liquid Scintillation."

(3) Strontium-90 - An aliquot of the pool water is analyzed according to the procedure for strontium-90 found in the Environmental Protection Agency publication "Interim Radiochemical Methodology for Drinking Water," EPA-600/4-75-008 (revised March 1976). In this procedure, the radioactive strontium is separated from other radioactive elements by precipitation as strontium nitrate from a fuming nitric acid solution. It is then precipitated as strontium carbonate and counted with a beta proportional counter.

(4) Gamma-scan - An aliquot of the pool water is transferred to a polyethylene bottle and counted with a Ge(Li) detector to identify the various gamma-ray emitters. The procedure that will be used is GAMMA-RC-3-A, "Determination of Radioactive Isotopes by Scanning Gamma-Ray Spectroscopy."

1.1.2 Methodology for Air (Gas) Analyses

(1) Krypton-85 - Procedure GAMMA-RC-2-A, "Determination of Gamma Activity in Cask Coolant Gas," will be followed for the determination of gamma activity in cask coolant gas. Stainless steel sample containers that will withstand the gas pressures in the spent fuel cask are available from the Whitey Company. These containers are available in 100-ml sizes and are compatible with the BNFP counting room geometries. In addition, Kr-85 will be continually monitored in the air by use of the stack monitor.

(2) Iodine-131 - To determine the concentration of I-131 in the FRSS, an air sample will be collected on a silver-zeolite charcoal cartridge and counted using a NaI(Tl) system. The procedure to be followed will be GAMMA-RC-3-A, "Determination of Radioactive Isotopes by Scanning Gamma-Ray Spectroscopy." Where other volatile radionuclides are analyzed, the charcoal cartridge will be counted using a Ge(Li) system which gives much better resolution of the gamma ray energies but requires much longer counting times to obtain the necessary activity levels.

(3) Tritium - Air will be passed through a silica-gel column which will absorb the moisture in the air. The column is then heated, and the tritium content of the distilled water is determined with a liquid scintillation system using procedure H3-RC-1-A, "Determination of Tritium by Liquid Scintillation."

(4) Gross Beta - For the determination of gross beta, an air particulate filter is placed in front of a charcoal cartridge and counted using a proportional beta counter. The procedure to be followed will be BETA-RC-2-A, "Determination of Beta Activity in Liquid Samples from the FRSS."

1.2 Recommended Chemical Assay Techniques for Determining Pool Water Quality

The types of chemical analyses and the frequency of sampling are presented below. These analyses can be performed without difficulty and do not require sophisticated instrumentation.

TABLE 3

POOL WATER

Analysis	Frequency
Chloride	weekly
pH	weekly
Temperature	weekly
Conductivity	weekly
Turbidity	weekly

1.2.1 Methodology

(1) Chloride - Chloride in aqueous solutions can be readily measured using a nephelometric technique which involves the turbidity produced by the presence of chlorides in solution. A more detailed description of the technique may be found in method CL-TURB-1-A, "Turbidimetric Determination of Chloride in Aqueous Solutions."

(2) pH - The pH of the pool water will be determined on an aliquot of the pool water using Procedure B-ACLOP-80A-5, "Orion pH Meter Operating Procedure."

(3) Conductivity - The conductivity of the pool water will be determined on an aliquot of the pool water using Procedure B-ACLOP-80A-37, "CDM3 Conductivity Meter Operating Procedure."

(4) Turbidity - The turbidity of the pool water will be determined using the Hach Low Range Turbidimeter Model 1720A. This procedure involves the scattering of light from a source to a photocell by the suspended particulate matter in the pool water. This

measurement may be conducted continually if desired using available instrumentation at the BNFP. A procedure is being written.

1.3 Recommended Biological Analyses for the Pool Water

Techniques and procedures for biological measurements that may be necessary, such as BOD and COD, will be as those described in "Standard Methods for the Examination of Water and Waste Water," published by the American Public Health Association, 14th Edition, 1975. The instruments for these analyses are presently in house.

1.4 Quality Control

Quality control standards will be analyzed to assure that each analytical system is in control before the method is used for routine analyses. Calibration standards are prepared by the Analytical Services Standards Laboratory and are traceable to the National Bureau of Standards where required.

1.5 Preparation of Radioactive Samples and Waste

The activity of some samples may be too high to be transferred to or handled in the Hot and Cold Laboratory Area. Preliminary preparation, e.g., subdividing or diluting, of these samples will be performed in the Fuel Receiving Area Laboratory. Temporary shielding, to reduce exposure to personnel, will be provided in the fume hood located in this laboratory.

Samples and sample aliquots diluted with nitric acid will be disposed of via the fume hood drain located in the Fuel Receiving Area Laboratory. This drain will connect to the FRSS waste water sump. Sample aliquots which have been treated with reagents other than acid will be collected and solidified in the Hot and Cold Laboratory Area and the Fuel Receiving Area Laboratory in accordance with the provisions of A-ODAP-32, "Handling and Shipping of Low Level Radioactive Waste," and B-ACLOP-82A-5, "Solidification of Liquid Radwaste Generated in BNFP Laboratories."

REPORT NO. AGNS-35900-1.1-106

ANALYTICAL CHEMICAL SUPPORT OF A FUEL RECEIVING FACILITY

APPENDIX A TO VOLUME V

REFERENCED ANALYTICAL PROCEDURES

October 1980

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

NO	REV	DATE OF THIS ISSUE	PAGE
BETA-RC-1-B	B	4/27/79	1 of 4

TITLE

DETERMINATION OF GROSS BETA ACTIVITY

1.0 Scope

This method is applicable to the determination of gross beta activity in liquid samples that normally contain high levels of activity.

2.0 Summary

Following dilution of the sample to an appropriate activity range, an aliquot is evaporated to dryness on a 1-inch microscope coverglass and counted with a beta counter.

3.0 Interferences

Extreme care must be exercised to avoid contamination. Cross-contamination of samples could result if the equipment and preparation area are not kept free of contamination.

4.0 Apparatus

4.1 Masking tape - Double-coated, two inches wide.

4.2 Microscope coverglasses - One-inch diameter.

4.3 Mounting plates - Aluminum, 2.50 by 3.25 in.

4.4 Pipets - Micro, assorted sizes.

4.5 Saran wrap (or equivalent plastic material).

4.6 Template - Aluminum mounting plates with a 1-inch diameter hole in the center.

5.0 Reagents

5.1 Purity of reagents - Unless otherwise stated, reagent grade chemicals shall be used, where available. All reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS), where such specifications are available.

REVIEWED BY		APPROVED BY	
C E Walker 3/23/79		G K Honey	3/23/79
Spec., License Compliance		Plant Manager	
3/19/79		W R Cole	
J P Clark 3/20/79		Manager, Quality Assurance	
K Hofstetter 3/29/79		W R Cole	
		Chairman, Oper. Safety Committee	
		G. A. Huff	3-21-79
		Cognizant Oper. Div. Dept. Manager	

FORM OD-1

5.2 Purity of water - Unless otherwise indicated, all references to water shall be understood to mean distilled or demineralized (deionized) water.

5.3 Nitric acid - (HNO_3) - 0.1M - Prepare by adding 6.5 ml of concentrated HNO_3 to 500 ml of water and diluting to 1 liter.

Caution: Special care should be used to ensure contamination-free acid. Discard this reagent if 1 ml, carried through the procedure, gives a counting rate that exceeds the background counting rate by more than 10%.

6.0 Safety

6.1 Frequently monitor the area and all equipment to detect any contamination. Monitor equipment before removal from the fume hood. Monitor hands and arms immediately after withdrawal from the glovebox or fume hood. If any contamination is found, notify the supervisor immediately and decontaminate according to the proper procedures.

6.2 Monitor the sample for radiation dose rate. If the dose rate exceeds the limits in the SEC Policy Manual, contact your supervisor for proper handling procedures. Comply with established procedures when handling radioactive samples.

7.0 Calibration

7.1 Background

7.1.1 Mount a microscope coverglass as described in Step 8.4 and place it in the counting chamber.

7.1.2 Activate the counter and allow it to operate for 20 minutes. Calculate the background as counts per minute.

7.2 Blank

Pipet 1 ml of the 0.1M HNO_3 reagent onto a microscope coverglass and proceed according to Section 8.3. If the counting rate exceeds the background by 10%, repeat the blank analysis using a new pipet. If the counting rate remains high, obtain new reagent and a new pipet.

7.3 Efficiency Factor

Place the gross beta calibration standard in the counting chamber and activate the counter. Allow the counter to accumulate 10,000 counts. Divide the net counts per minute by the known disintegration rate of the standard to obtain the efficiency factor.

8.0 Procedure

8.1 Measure the total beta-gamma radiation level of the sample at contact with a portable survey instrument. Dilute 1000 fold for each R of activity by pipeting an aliquot of the sample into a volumetric flask and diluting to volume with 0.1M HNO_3.

Caution: Perform the entire procedure in a glovebox.

8.2 Pipet a 1-ml aliquot of the diluted sample onto a microscope coverglass.

Caution: Monitor the working area and equipment for alpha activity.

8.3 Evaporate slowly (without spattering) to dryness under the infra-red lamps. In order to avoid spattering, the sample should be evaporated almost to dryness with the heat lamp set on low. When the sample is almost dry, turn the lamps to high for about two minutes to ensure thorough drying.

8.4 Mount the microscope coverglass in the aluminum plate as follows:

8.4.1 Using the template, inscribe a one-inch diameter circle on the aluminum mounting plate.

8.4.2 Attach a strip of double-coated masking tape over the inscribed circle.

8.4.3 Place the microscope coverglass containing the evaporated sample on the inscribed circle.

8.4.4 Cover the microscope coverglass with a piece of Saran Wrap and press down firmly to the masking tape.

Caution: Monitor hands and arms immediately after withdrawal from glovebox.

8.5 Count the sample with the beta counter to an integrated count of 10,000 counts or a minimum of 10 minutes. If the count rate exceeds 10,000 counts per minute -- the linearity limit of the counter -- start over at Step 8.1 with appropriately smaller aliquots.

8.6 The allowable range for duplicate samples is 10%. If this is exceeded, the entire analysis should be repeated. The range is calculated as follows:

$$R = \frac{X_1 - X_2}{X} \; 100$$

where:

X_1 = highest sample count,
X_2 = lowest sample count,
X = the mean of all the sample counts, and
100 = the factor to convert to percent.

9.0 Calculations

9.1 Calculate the beta activity per sample aliquot as follows:

$$\beta = \frac{C - B}{(V)(E)}$$

where:

β = beta activity of sample in dpm/ml,

C = total beta activity of disks in cpm,

B = background in cpm,

E = efficiency factor for beta counter to convert from cpm to dpm, obtained by dividing net cpm obtained on a standard by the known dpm for the standard, and

V = volume of sample aliquot in ml.

9.2 Typical Calculation

C = 8.0×10^3 cpm
B = 11 cpm
E = 0.1 c/d
V = 0.5 ml

$$\beta = \frac{C - B}{(V)(E)}$$

$$\beta = \frac{(8.0 \times 10^3 \text{ cpm}) - (11 \text{ cpm})}{(0.5 \text{ ml})\ (0.1 \text{ c/d})}$$

$$\beta = 1.60 \times 10^5 \text{ dpm/ml}$$

10.0 References

10.1 Idaho Nuclear Corporation Analytical Manual Act-2, March 1965.

10.2 Savannah River Plant Works Technical Manual, DPSOP 82-1, Standard Procedures, Gross Beta and Gross Gamma Activity Counting Method, July 1970.

DETERMINATION OF BETA ACTIVITY IN LIQUID SAMPLES FROM THE FRSS

1. Scope

1.1 This method is applicable to the determination of beta activity in liquid samples from the Fuel Receiving and Storage Station (FRSS). These samples include storage pool samples, pool sump samples, and cask cooldown liquid samples. The range of activity in the sample is normally 10^{-4} to 5 μCi/ml.

2. Summary

2.1 An aliquot of the sample is evaporated on a counting planchet and total beta-alpha activity determined with a proportional counter. If activity exceeds the specified limits for the sample, the radionuclides present are identified using gamma spectrometry techniques. If the beta activity present in the sample exceeds the level calculated from the gamma spectrometry measurements, the sample is analyzed for ^{90}Sr using radiochemical separation techniques. Alpha activity is not normally present; however, the sample is counted to determine if any alpha activity is present. If alpha activity is found and is above specified limits for the sample, the sample will be examined using alpha spectrometry techniques.

3. Interferences

3.1 Extreme care must be exercised to avoid contamination. Cross-contamination of samples can result if the equipment and preparation area are not kept free of activity.

4. Apparatus

4.1 Planchets - 1-inch, rimmed stainless steel.

4.2 Saran wrap - Or equivalent plastic material.

4.3 Planchet forceps.

4.4 Alpha-beta counter - Low background proportional detector.

5. Reagents

5.1 Purity of reagents - Unless otherwise stated, reagent grade chemicals shall be used.

5.2 Purity of water - Unless otherwise indicated, all references to water shall be understood to mean distilled water.

5.3 Nitric acid - (HNO_3) - 0.1M - Prepare by adding 6.5 ml of concentrated HNO_3 to 500 ml of water and diluting to 1 liter. Special care should be used to ensure contamination-free acid. Discard the reagent if 1 ml carried through the procedure gives a counting rate more than 10% above background.

6. Safety

6.1 Monitor sample for beta-gamma activity. Samples reading less than 100 mR/hr or 500 mrad/hr at contact may be handled with self-monitoring. If the radiation exceeds either of these values, contact your supervisor for handling procedures. Comply with the established safety procedures when handling any radioactive sample.

6.2 Frequently monitor the working area and all equipment to detect any contamination. Monitor equipment before removal from the fume hood. Monitor hands and arms immediately after withdrawal from the glove box. If any contamination is found, notify the supervisor immediately and decontaminate according to proper procedure.

7. Calibration

7.1 Place a clean planchet in the counting chamber.

7.2 Start the counter and count for 10 minutes. Calculate the background (B) in counts per minute.

7.3 Place a gross beta standard planchet containing 0.01 μCi of ^{137}Cs in the counting chamber and count until 10,000 counts have been accumulated.

7.4 Calculate the beta counting efficiency factor (E) by dividing the determined counts per minute (corrected for background) by the known disintegrations per minute for the standard.

8. Procedure

8.1 Make any necessary sample dilution with 0.1N HNO_3. The sample aliquot transferred to the planchet should not exceed 50,000 cpm to prevent excessive dead-time losses. A counting rate of 5,000 cpm is the desired activity range.

8.2 Pipet a sample aliquot, not to exceed 1 ml, onto a counting planchet using a disposable tip micropipet.

8.3 Evaporate slowly (without spattering) to dryness under an infrared lamp.

8.4 Using the planchet forceps, mount the planchet in a planchet holder.

8.5 Place the planchet in the counting chamber and count for 10 minutes or until 10,000 counts have been accumulated.

8.6 Calculate the total activity as beta activity. If the activity exceeds the specified limits for the sample, place an alpha absorber over the sample and determine the beta activity. If the difference in counts with and without the absorber indicates the presence of alpha activity, determine the alpha emitters by alpha spectrometry using a surface barrier detector. If the beta activity is above specified limits for the sample and exceeds the value calculated from gamma spectrometry measurements on the sample, process a separate sample aliquot for ^{90}Sr analysis by the specified method.

9. Calculations

9.1 Calculate the beta activity of the sample as follows:

$$\beta = \frac{(C - B) \times F}{V \times E \times 2.22 \times 10^6}$$

where:

β = beta activity of the sample in μCi/ml,

C = activity of the planchet in counts per minute,

B = background activity in counts per minute,

V = volume of sample aliquot transferred to the planchet in ml,

F = dilution factor if sample was diluted,

E = efficiency factor for the beta counter to convert counts per minute to disintegrations per minute, and

2.22×10^6 = factor to convert dpm to µCi.

9.2. Typical Calculation

$C = 8.0 \times 10^3$ cpm

B = 11 cpm

F = 1

V = 1 ml

E = 0.5 c/d

$$\beta = \frac{(C - B) \times F}{V \times E \times 2.22 \times 10^6}$$

$$\beta = \frac{(8.0 \times 10^3 \text{ cpm} - 11 \text{ cpm}) \times 1}{1 \text{ ml} \times 0.5 \text{ c/d} \times 2.22 \times 10^6 \text{ dpm/}\mu\text{Ci}}$$

$\beta = 0.0072$ µCi/ml

DETERMINATION OF TRITIUM BY LIQUID SCINTILLATION

1. Scope

1.1 This method can be used for both high- and low-level tritium determinations in various process streams and stack gas condensate samples.

The lower limit of detection for tritium in water is 0.5 nCi/liter. The relative standard deviation is less than 10% when a 30-minute counting period is used. At higher levels of tritium, a corresponding improvement in precision is obtainable due to better counting statistics.

2. Summary

2.1 The sample is distilled, if necessary, to remove interferences and an aliquot is mixed with a scintillation mixture in a polyethylene bottle away from sunlight and strong artificial light. The sample is counted for about 30 minutes, depending upon the sensitivity required and the activity level. Distilled water blanks and tritium standards are processed along with each group of samples. After subtraction of the blank counts per minute from the sample, the tritium content of the sample is calculated by comparison with a standard.

3. Interferences

3.1 Contaminating radionuclides interfere by contributing to the low energy spectrum. The presence of these emitters can be detected by use of a monitor channel adjacent to the sample channel and comparison of the counting ratio obtained with that of pure tritium. These interferences can usually be removed by distillation (1).

3.2 Suspended solids and color in samples can interfere. The effect of both can be corrected by use of an internal standard (1). The sample is counted before and after the addition of the known standard to get an efficiency factor, which is then applied to the counts per minute obtained before the addition of the standard.

3.3 Another type of interference occurs when the tritium is chemically bound in such a manner that dissolution does not occur in the scintillation mixture. This type of interference can occur in substances such as biological tissue and other insoluble organic compounds. These samples must be oxidized prior to liquid scintillation counting (2).

3.4 Counting efficiency is reduced for samples containing more than 0.1M acid (nitric acid or hydrochloric acid); therefore, control of acid content is necessary.

4. Apparatus

4.1 Liquid scintillation spectrometer.

4.2 Special low-blank polyethylene sample vials.

4.3 Pipets - Micro, various sizes.

4.4 Pipets - Macro, 3- and 10-ml.

4.5 Pipet - Macro, graduated, 0-3 ml.

4.6 Distillation apparatus - Pyrex, Fisher Catalog No. 9-126 A, or equivalent.

5. Reagents

5.1 Purity of reagents - Reagent grade.

Note: Use specified reagent as there is a wide variation in performance among products of various manufacturers.

5.2 Purity of water - Unless otherwise indicated, all references to water shall be understood to mean distilled water.

5.3 P-Dioxane - Eastman Organic Chemicals, Rochester, N. Y., mp 10.5°-11.0°C.

5.4 2,5-diphenyloxazole - (PPO) - Scintillation grade, Pilot Chemicals, Watertown, Mass.

5.5 p-bis [2-(5-phenyloxazolyl)] benzine - (POPOP) - Scintillation grade, Pilot Chemicals, Watertown, Mass.

5.6 Naphthalene - Recrystallized from alcohol by Eastman Organic Chemicals.

5.7 Scintillation mixture - Combine 4.00 g of PPO, 0.050 g of POPOP, and 120.0 g of naphthalene. Add mixture to 1 liter of p-dioxane. Store in a refrigerator in a brown glass bottle.

5.8 Sodium carbonate - (Na_2CO_3) - Anhydrous granular.

6. Safety

6.1 See the Safety Manual for special precautions before analysis of any sample requiring wet oxidation.

6.2 Because p-dioxane is extremely toxic, all preparation of samples and reagents must be carried out in a hood designated for organic solvents. Rubber gloves must be worn during the preparation of scintillation solution.

7. Sampling

7.1 See Section 3 for pretreatment of samples, where necessary.

7.2 For low-level samples, pipet 3 ml of the sample directly into the counting vial.

7.3 For high-level samples, use a micropipet to transfer the optimum sample size (approximately 1,000-10,000 cpm) to the sample vial. Use a graduated 0-3 ml pipet to add enough water to the sample vial so that the final volume of the aqueous solution will be 3.00 ml.

8. Calibration

8.1 Process a distilled water blank and a tritium standard (of similar range to samples) with each group of samples.

8.2 Process a bench standard with each set of samples. Limits will be specified by the Quality Control Laboratory.

9. Procedure

9.1 Distillation

9.1.1 Distill all samples not previously shown to be interference-free.

9.1.1.1 For low-level samples, place 10 to 50 ml of the sample in the distillation apparatus (see 4.6), add approximately 1.5 g of anhydrous granular Na_2CO_3, and distill just to dryness -- collecting the distillate in a small container. Proceed directly to 9.2.

9.1.1.2 For high-level samples, accurately pipet a volume containing 8,000 to 80,000 cpm tritium to the distillation apparatus (see 4.6) and add water to bring the total volume to approximately 20 ml. Add approximately 1.5 g of anhydrous granular Na_2CO_3 and distill just to dryness, collecting the distillate in a 25-ml volumetric flask. Dilute to the mark with water and mix. Proceed directly to 9.2.

9.1.2 Test a sample for interference by processing an aliquot without distillation. If results with and without distillation agree within the stated accuracy of the method, the distillation step may be omitted on subsequent similar samples.

9.2 Analysis

9.2.1 Dispense 3 ml of water sample (see Section 7) and 13 ml of the scintillation mixture into a polyethylene sample vial. Eliminate sunlight and use a minimum of artificial light.

9.2.2 Place the sample in position in the counting chamber.

9.2.3 Let the sample cool for at least 30 minutes.

9.2.4 Count the sample for sufficient time to obtain at least 10,000 counts (standard deviation = 1%), where practical.

9.2.5 If the radiochemical purity of the sample is not known, count the sample in the monitor channel also. If contaminants are present, a smaller ratio is obtained for the sample than for the tritium standard -- depending on the quantity of contaminants present. Depending on the given instrument and counting conditions, the value of this ratio is approximately 14. To eliminate radiochemical impurities, perform a chemical separation such as distillation.

10. Calculations

10.1 Correction for Dilution of Distilled Samples

Note: Applies only to samples processed by 9.1.1.2.

$$V = \frac{P \times A}{B}$$

where:

V = corrected volume of sample in ml,

P = volume of sample used (see 9.1.1.2),

A = volume of aliquot used (see 9.2.1) in ml, and

B = volume of flask used (see 9.1.1.2) in ml.

10.2 Tritium Concentration

$$T = \frac{(S - B) \times 1000 \times C}{(A - B) \times V}$$

where:

T = tritium concentration in μCi/liter,

S = sample cpm,

B = blank cpm,

C = total tritium content of standard in μCi,

A = standard cpm,

V = volume of sample in ml, and

1000 = factor to convert ml to liters.

10.3 Ratio, cpm analyzer/monitor channels

$$R = \frac{S_a - B_a}{S_m - B_m}$$

where:

R = ratio of cpm analyzer/monitor channels,

S_a = sample cpm in analyzer channel,

B_a = blank cpm in analyzer channel,

S_m = sample cpm in monitor channel, and

B_m = blank cpm in monitor channel.

10.4 Typical Calculation

10.4.1 Correction for Dilution

P = 0.250 ml

A = 3.00 ml

B = 25.00 ml

$$V = \frac{P \times A}{B}$$

$$V = \frac{(0.250 \text{ ml})\ (3.00 \text{ ml})}{25.00 \text{ ml}}$$

V = 0.030 ml

10.4.2 Tritium Concentration

S = 7856 cpm

B = 69 cpm

C = 0.00153 μCi

A = 6514 cpm

V = 3.00 ml

$$T = \frac{(S - B) \times 1000 \times C}{(A - B) \times V}$$

$$T = \frac{(7856 \text{ cpm} - 69 \text{ cpm})\ (1000 \text{ ml}/\ell)\ (0.00153\ \mu\text{Ci})}{(6514 \text{ cpm} - 69 \text{ cpm})\ (3.00 \text{ ml})}$$

$$T = 0.616\ \mu\text{Ci}/\ell$$

10.4.3 Ratio, analyzer/monitor channels

S_a = 7856 cpm

B_a = 69 cpm

S_m = 593 cpm

B_m = 31 cpm

$$R = \frac{S_a - B_a}{S_m - B_m}$$

$$R = \frac{(7856 \text{ cpm} - 69 \text{ cpm})}{(593 \text{ cpm} - 31 \text{ cpm})}$$

$$R = 13.9$$

References

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(3) Edward Rapkin, "The Determination of Radioactivity in Aqueous Solution," Technical Bulletin No. 6, Packard Instrument Co., Inc. (1963).

(4) Peterson, et al, Analytical Biochemistry, 31, 189 and 204 (1969).

EPA-600/4-75-008(Revised)
March 1976

INTERIM RADIOCHEMICAL METHODOLOGY FOR DRINKING WATER

by

Herman L. Krieger
Radiochemistry & Nuclear Engineering Branch
Environmental Monitoring and Support Laboratory
Cincinnati, Ohio 45268

Program Element No. 2FH120/1HA327

Prepared for

Office of Radiation Programs
U.S. Environmental Protection Agency
Washington, D.C. 20460

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING AND SUPPORT LABORATORY
CINCINNATI, OHIO 45268

Principle of Method

Strontium carrier is added to the drinking water sample, collected as the soluble carbonate, and separated from most of the calcium as the nitrate. Impurities are removed by an hydroxide scavenge. After the barium is removed as the chromate, the strontium is purified as $SrCO_3$ for counting.

Procedure Time

Four samples in 6 hours.

Reagents

Ammonium acetate buffer, (CH_3COOH-CH_3COONH_4): pH 5.0
Ammonium hydroxide, NH_4OH: 15 N (conc.), 6 N
Barium carrier: 16 mg/ml
Ethanol, C_2H_5OH: 95%
Hydrochloric acid, HCl: 1 N
Indicator, methyl red: 0.1%
Iron chloride, $FeCl_3$: 0.1 M
Nitric acid, HNO_3: 16 N (conc.), 6 N, 1 N
Oxalic acid, $H_2C_2O_4$: saturated
Sodium carbonate, Na_2CO_3: 1.5 M
Sodium chromate, Na_2CrO_4: 0.5 M
Sodium hydroxide, NaOH: 6 N
Strontium carrier: 20 mg/ml
Yttrium carrier: 10 mg/ml

Procedure

1. To a 1000-ml drinking water sample, add 1.0 ml strontium carrier and 1 ml barium carrier.
2. Make basic with 5 to 10 ml 6 N NaOH and heat to boiling.
3. Add 5 ml 1.5 M Na_2CO_3, stir, and digest until $SrCO_3$ coagulates, cool, centrifuge, and discard supernatant.
4. Wash precipitate with 15 ml water and discard wash solution.
5. Dissolve precipitate with 1 ml 6 N HNO_3.
6. Add 25 ml 16 N HNO_3, stir, and cool in an ice bath 5 minutes.
7. Centrifuge, discard supernatant, and let drain a few minutes (Note 1).
8. Dissolve precipitate with 10 ml water and add 0.5 ml 0.1 M $FeCl_3$.
9. Heat to near boiling in water bath and add 6 N NH_4OH dropwise until $Fe(OH)_3$ precipitates.

10. Cool, centrifuge, and transfer supernatant to a clean centrifuge tube. Discard precipitate. Note time of last precipitation; this is the beginning of yttrium ingrowth. (Complete steps 11 through 18 without delay to minimize ingrowth of ^{90}Y.)
11. Add 3 drops methyl red indicator, and adjust pH to near 5 with a few drops 1 N HCl. (Color change is from yellow to red.)
12. Add 5 ml ammonium acetate buffer solution and heat in water bath.
13. Slowly add 1 ml 0.5 M Na_2CrO_4. Stir, heat, and centrifuge. Transfer supernatant to a clean centrifuge tube; discard residue.
14. Add 2 ml 15 N NH_4OH to the supernatant, heat in water bath, and slowly add, with stirring, 5 ml 1.5 M Na_2CO_3. Digest until precipitation is complete, cool, centrifuge, and discard supernatant.
15. Dissolve precipitate with 5 ml 1 N HCl, add 10 ml water, and repeat step 14.
16. Wash the strontium carbonate precipitate with 20 ml water, and discard wash solution.
17. Slurry the precipitate with minimum of water and transfer to a tared stainless-steel planchet. Dry under infra-red lamps.
18. Cool, weigh, and beta count immediately (Note 2).

Calculation

Calculate the concentration, D, of the strontium activity in picocuries per liter as follows:

$$D = \frac{C}{2.22 \times EVR}$$

where:

C = net count rate, counts/minute,
E = counter efficiency,
V = liters of sample used,
R = fractional chemical yield, and
2.22 = conversion factor from disintegrations/minute to picocuries.

Notes:

1. If the drinking water samples contain much $CaCO_3$ (hardness), it will be necessary to repeat steps 5, 6, and 7 until it is all eliminated from the $Sr(NO_3)_2$ precipitate.
2. The counting result, immediately ascertained, represents the total strontium activity (^{90}Sr + ^{89}Sr) plus an insignificant fraction of the

^{90}Y that has grown in from the separated ^{90}Sr. To determine the ^{89}Sr and ^{90}Sr with a greater precision, the planchet should be stored at least 2 weeks so that the ^{90}Sr-^{90}Y activity will be in equilibrium. At this point, steps 19-39 are performed on the precipitate to separate the yttrium from the strontium and determine the ^{90}Sr activity.

19. After the period for ^{90}Y ingrowth, slurry the precipitate on the planchet with 2 ml water and transfer to a centrifuge tube with the aid of a rubber policeman. To make the transfer quantitative, wash the residue from the planchet with a small amount of 1 N HNO_3. Dissolve the precipitate in the tube with sufficient 1 N HNO_3, and dilute with water to 10 ml.
20. Add 1.0 ml yttrium carrier and stir.
21. Boil to expel dissolved carbon dioxide; cool to room temperature.
22. Replace in water bath and make basic with 2 to 3 ml 15 N NH_4OH. Stir and digest until the yttrium hydroxide precipitation is complete.
23. Cool, centrifuge, and decant supernatant into a 100-ml beaker. Note time of last precipitation; this is the end of ^{90}Y ingrowth and the beginning of ^{90}Y decay.
24. Dissolve precipitate in 1 ml 1 N HNO_3 and dilute with water to 10 ml.
25. Reprecipitate yttrium by dropwise addition of 15 N NH_4OH.
26. Centrifuge and combine supernatant with solution in the 100-ml beaker (step 23).
27. Repeat steps 24, 25, and 26. Save the combined supernatant solutions in the beaker for strontium activity and gravimetric yield determination, step 35 (Note 3).
28. Add 2 ml 1 N HNO_3 to the $Y(OH)_3$ precipitate from step 26 and dissolve. Dilute to 5 ml with water. Filter through Whatman #42 filter paper and collect filtrate in a centrifuge tube.
29. Slowly add 5 ml saturated $H_2C_2O_4$, with stirring, and digest in hot-water bath for 10 minutes.
30. Cool in an ice bath to room temperature.
31. Centrifuge and discard supernatant.
32. Wash precipitate twice with 10 ml hot water. Centrifuge and discard wash solutions.
33. Filter the yttrium oxalate on a tared glass-fiber filter. Wash with hot water and ethanol.

34. Dry, cool, weigh, mount, and beta count the ^{90}Y immediately.

35. Warm the combined supernatant solution from step 27, add 5 ml 1.5 M Na_2CO_3, and digest for 10 minutes.

36. Cool, centrifuge, and discard supernatant.

37. Wash the $SrCO_3$ with 15 ml water and discard wash solution.

38. Slurry with a few ml water and transfer quantitatively to a tared stainless-steel planchet. Dry under infra-red lamps.

39. Cool, weigh, and beta count immediately.

Calculation

Calculate the concentration of ^{89}Sr and ^{90}Sr in picocuries per liter as follows:

1. ^{90}Y c/m (corrected) $= \dfrac{c/m}{A \times B_1 \times C}$

2. ^{90}Sr c/m $=$ ^{90}Y c/m (corrected) $\times \dfrac{D}{E}$

3. ^{90}Y c/m $= \dfrac{^{90}Y \text{ c/m (corrected)} \times G \times B_2}{E}$

4. ^{89}Sr c/m $= (R - {}^{90}Sr \text{ c/m} - {}^{90}Y \text{ c/m}) \dfrac{1}{F}$

5. ^{90}Sr activity $= \dfrac{^{90}Y \text{ c/m (corrected)}}{2.22 \times EIV}$

6. ^{89}Sr activity $= \dfrac{^{89}Sr \text{ c/m}}{2.22 \times HIV}$

where:

A = decay factor for ^{90}Y from step 23 to counting time,
B_1 = ingrowth factor of ^{90}Y from time of strontium purification to yttrium separation,
B_2 = ingrowth factor of ^{90}Y from time of yttrium separation to time of total strontium count,
C = fractional chemical yield for yttrium,
D = ^{90}Sr efficiency for counter in which radiostrontium is counted,
E = ^{90}Y efficiency for counter in which ^{90}Y is counted,
F = decay factor for ^{89}Sr from sample collection to counting time,
G = ^{90}Y efficiency for counter in which radiostrontium is counted,
H = ^{89}Sr efficiency for counter in which radiostrontium is counted,
I = fractional chemical yield for strontium,
R = observed count rate of total radiostrontium fraction (steps 18 or 39),
V = liters of sample used, and
2.22 = conversion factor from disintegrations/minute to picocuries.

Note:

3. Steps 35-39 are a repeat of the strontium carbonate precipitation to determine chemical yield after the yttrium has been removed. The beta activity should be comparable to that obtained previously for the precipitate from step 18. It is a more accurate result, however, since the only correction that need be made is that for the ingrowth of ^{90}Y from the time of yttrium separation (step 27) to the time of the total strontium count.

Literature:

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DETERMINATION OF RADIOACTIVE ISOTOPES BY SCANNING GAMMA-RAY SPECTROSCOPY

1. Scope

1.1 This method is applicable to the measurement of gamma ray emitting isotopes present in liquid or solid samples. The expected precision for a single scan varies with the isotopic composition of the sample. The range of sensitivity for this technique varies from 0.01 to 50 microcuries per sample.

2. Summary

2.1 An aliquot of the sample is transferred to a polyethylene ampoule or a planchet and the radionuclides present are determined using a lithium drifted germanium detector and the computer based multichannel analyzer. The radionuclides present in the sample are determined by gamma ray spectroscopic techniques.

3. Interferences

3.1 Extreme care must be exercised to avoid contamination. Cross-contamination of samples could result if the equipment and preparation area are not kept free of radioactive contamination.

4. Apparatus

4.1 Counting vials - Polyethylene - 1/2, 2, and 7-dram and 10 ml capacity.

4.2 Gamma Ray Detector - Ge(Li) semiconductor detector with associated electronics.

4.3 Multichannel Analyzer - Computer based TP-5000 system with associated peripherals.

4.4 Ampoule Sealer.

4.5 Silicone Spray Lubricant.

4.6 Hot Plate.

4.7 Heating Lamp.

4.8 Pipets - Assorted micropipets and controller.

4.9 Planchets - 2-inch diameter stainless steel.

5. Reagents

5.1 Purity of reagents - Unless otherwise stated, reagent grade chemicals shall be used.

5.2 Purity of water - Unless otherwise indicated, all references to water shall be understood to mean distilled water.

5.3 Nitric acid (HNO_3) - 0.1M - Prepare by adding 6.5 ml of concentrated HNO_3 to 500 ml of water and diluting to 1 liter.

5.4 Collodion solution - 0.4 mg total solids - Prepare by dissolving 4 g of solid collodion in one liter of solution which is ten percent (by volume) ethanol in diethyl ether. This solution should be stored in the refrigerator (See B-ODAP-6). A 50 ml dropping bottle should be used in the laboratory to dispense the solution.

6. Safety

6.1 Frequently monitor the area and all equipment to detect any contamination. Monitor equipment before removal from the fume hood. Monitor hands and arms immediately after withdrawal from the glove box or fume hood. If any contamination is found, notify the supervisor and SEC immediately and decontaminate according to instructions.

6.2 Monitor the sample for beta-gamma activity. Samples reading less than 100 mrem/hr at contact may be handled without special instructions by self-monitors. If the radiation level exceeds the above limit, contact your supervisor for special instructions.

7. Calibration

7.1 Place a clean polyvial filled with water, the same size as the sample vial, in the appropriate sample holder and place it in geometry position three in the source holder tray. Close the roll top door to the Ge(Li) barricade. Record a background spectrum for ten minutes. Run the Background Check program, PROG,4.

7.2 The Ge(Li) detector has been calibrated using NBS and secondary standards encapsulated in the sample configurations (i.e., 1/2-dram samples doubly encapsulated in polyvials, 10-ml samples doubly encapsulated in polyvials, and samples evaporated on 2-inch diameter planchets). The various standard samples have been used to generate calibration curves for the ten source positions of the detector system. Make sure that the proper calibration factors for the sample are used in the analysis.

7.3 Place a ^{60}Co standard which duplicates the sample polyvial in the same geometry position as the sample and count for 10 minutes to check the calibration. Run an ISOTYPE analysis of the gamma spectrum. Make sure that the results are within the control limits for the system.

8. Procedure for Liquid Samples

8.1 Pipet a known aliquot of the sample into the 1/2-dram or 10-ml polyvial. Fill the remaining volume with nitric acid.

8.2 Seal the polyvial using the ampoule sealer.

8.3 Place the sample vial into the secondary containment polyvial and seal.

8.4 Place the sealed sample in the appropriate source holder and insert it into the source holder tray.

8.5 Accumulate a spectrum. If the dead time is greater than ten percent move the source to a geometry position farther from the detector. If the dead time is greater than ten percent in source position 10, make up another sample using a smaller aliquot or dilute the sample using nitric acid.

8.6 Perform an ISOTYPE analysis of the spectrum after 10,000 counts are obtained in the intense γ-ray peaks in the spectrum. The counting time should normally not take more than 1000 sec. If so, take a larger aliquot of the sample or move the source nearer the detector.

9. <u>Procedure for Planchet Samples</u>

9.1 Most radioisotopic scans will be performed on liquid samples using polyvials. If planchet samples are required, the following procedure shall be used.

9.2 Place an aliquot of the sample onto a 2-inch diameter stainless steel planchet. (500 μl maximum in one delivery)

9.3 Dry the planchet under a heat lamp.

9.4 Put a drop of collodion solution on the planchet to seal the sample after the planchet has cooled.

9.5 Dry the planchet under a heat lamp.

9.6 Place the planchet in the appropriate holder and count the sample. Prepare a background planchet by the above procedure using water and count.

<u>NOTE:</u> The planchet standards shall be used to calculate the efficiency for the sample.

9.7 Proceed with step 8.5 and subsequent steps for analysis.

10. <u>Calculations</u>

10.1 All calculations will be performed by the computer after information concerning the sample has been entered. The following describes the general calculation method. for determining the amount of a single isotope in a sample.

$$\gamma = \frac{A - B}{V \times E \times R \times 2.22 \times 10^6 \times T}$$

where:

γ = gamma activity of the sample for one particular isotope in μCi/ml,

A = area under the γ-ray peak known to belong to that isotope in counts,

B = background under the γ-ray peak in counts,

V = volume of sample in ml,

E = efficiency of the detector at that energy in c/d,

R = fraction of decays leading to that particular γ-ray for that isotope in gammas/d,

T = the live time in minutes, and

2.22×10^6 = factor to convert dpm to μCi.

10.2 Typical calculation

A = 339493 counts

B = 13422 counts

V = 1 ml

E = 1.2×10^{-3} c/d

R = 0.851

and T = 10 min

$$\gamma = \frac{(A - B)}{V \times E \times R \times T \times 2.22 \times 10^6}$$

$$\gamma = \frac{339493 \text{ c} - 13422 \text{ c}}{(1 \text{ ml})(1.2 \times 10^{-3} \text{ c/d})(0.851)(10 \text{ m})(2.22 \times 10^6)}$$

γ = 14.38 μCi/ml of that isotope

DETERMINATION OF GAMMA ACTIVITY IN CASK COOLANT GAS

1. Scope

1.1 This method is applicable to the determination of gamma activity in samples of coolant gas from fuel casks.

2. Summary

2.1 A sample of the fuel cask coolant gas is filtered through a millipore filter and collected in a gas sample cylinder in the FRSS. A portion of the gas sample is transferred to a gas counting cell and the gamma activity measured using a well-type NaI(Tl) scintillation detector. Krypton-85 is used as a standard to calibrate the counting equipment. If the activity level is above specified limits for the sample, the radionuclides present are identified using a Ge(Li) detector and gamma spectrometry techniques.

2.2 The activity level on the millipore filter associated with the gas sample is determined by gross beta counting in the FRSS. If the activity level is above specified limits, the filter is sent to the laboratory with the gas sample and the radionuclides on the filter are identified.

3. Interferences

3.1 Extreme care must be exercised to avoid contamination. Cross-contamination of samples could result if the equipment and preparation area are not kept free of activity.

4. Apparatus

4.1 Gas counting cell - Glass cell with Teflon stopcock, approximately 15 cc volume.

4.2 Gas sampling manifold - Special manifold for transferring, diluting, and measuring pressure of gas samples.

4.3 Gross gamma counter - NaI(Tl) scintillation detector, 3 inch x 3 inch, well-type.

4.4 Gamma-spectrometer - Multichannel analyzer with a Ge(Li) detector.

5. Reagents

5.1 Krypton-85 - Gaseous standard in a sealed gas cell containing approximately 0.01 μCi of ^{85}Kr.

6. Safety

6.1 Frequently monitor the area and all equipment to detect any contamination. Monitor equipment before removal from the fume hood. Monitor hands and arms immediately after withdrawal from the glove box or fume hood. If any contamination is found, notify the supervisor immediately and decontaminate according to the proper procedures.

6.2 Monitor the sample for beta-gamma activity. Samples reading less than 100 mR/hr or 500 mrad/hr at contact may be handled with self-monitoring. If the radiation exceeds either of these values, contact your supervisor for handling procedures. Comply with established procedures when handling any radioactive sample.

7. Calibration

7.1 Place a clean evacuated gas counting cell in the counting well and count for 10 minutes. Calculate the background in cpm.

7.2 Place the gas cell containing the ^{85}Kr standard in the counting well and count until 10,000 counts have been accumulated.

7.3 Calculate the efficiency factor (E) for ^{85}Kr by dividing the determined net counts per minute by the known disintegrations per minute of the standard.

8. Procedure

8.1 If a filter sample is received with the gas sample, place it in a plastic holder and obtain a gamma spectrum of the sample using a Ge(Li) detector. Identify the radionuclides present and report these with the gas analysis. If the beta activity present cannot be accounted for by the nuclides identified in the gamma scan, analyze the sample for ^{90}Sr.

8.2 Connect the gas sample cylinder to the sample manifold.

8.3 Connect a clean gas counting cell to the gas manifold.

8.4 Evacuate the manifold and counting cell.

8.5 Open the valve on the sample cylinder slowly and allow the pressure in the manifold to reach atmospheric or room pressure.

8.6 Close the sample cylinder valve and remove the sample cylinder and counting cell from the manifold.

8.7 Place the counting cell in the well detector and count the gamma activity for 10 minutes or until 10,000 cpm have been accumulated.

8.8 Calculate the activity as ^{85}Kr. If the activity level exceeds the activity limits established for the sample, identify the radionuclides present using a Ge(Li) detector and gamma spectrometer.

9. <u>Calculations</u>

9.1 Calculate the gamma activity of the gas sample as follows:

$$\gamma = \frac{(C - \bar{B}) \times F}{V \times E \times 2.22 \times 10^6}$$

where:

γ = gamma activity of the sample in µCi/ml calculated as ^{85}Kr,

C = gamma activity of sample in counting cell in cpm,

B = background activity in cpm,

F = factor to convert sample volume to a standard temperature and pressure (STP) conditions, i.e.:

$$F = \frac{\text{spl temp in °C} + 273}{273} \times \frac{760 \text{ mm Hg}}{\text{spl pressure in mm Hg}}$$

V = volume of counting cell in ml,

E = efficiency factor of counting for ^{85}Kr (see 7.3), and

2.22×10^6 = factor to convert dpm to μCi.

9.2 Typical Calculation

C = 2518 cpm

B = 80 cpm

$$F = \frac{303°}{273°} \times \frac{760 \text{ mm Hg}}{745 \text{ mm Hg}} = 1.13$$

V = 15 ml

E = 0.45 c/d

$$\gamma = \frac{(C - B) \times F}{V \times E \times 2.22 \times 10^6}$$

$$\gamma = \frac{(2518 - 80) \text{ cpm} \times 1.13}{15 \text{ ml} \times 0.45 \text{ c/d} \times 2.22 \times 10^6 \text{ dpm/μCi}}$$

$$\gamma = 1.8 \times 10^{-4} \text{ μCi/ml (STP)}$$

TURBIDIMETRIC DETERMINATION OF CHLORIDE IN AQUEOUS SOLUTIONS

1. Scope

This method is applicable to the determination of chloride in both acidic and basic aqueous samples. The method is useful for semi-quantitative determinations in samples that contain <50 ppm chloride.

2. Summary

Silver nitrate is added to an acidified sample solution, to precipitate AgCl, and the resulting turbidity is compared to that of known standards.

3. Apparatus

3.1 Graduated cylinder - 25-ml.

3.2 Medicine droppers.

3.3 Turbidity tubes - Tubes to fit the Haake Model 2100 A turbidimeter.

3.4 Turbidimeter - Haake Model 2100 A or equivalent.

3.5 Vortex mixer - Equipped with a test tube shaker head.

4. Reagents

4.1 Purity of reagents - Unless otherwise stated, ACS reagent grade chemicals, where applicable, shall be used.

4.2 Purity of water - Unless otherwise indicated, all references to water shall be understood to mean demineralized water.

4.3 Nitric acid - (HNO_3) - 8M - Prepare by carefully adding 250 ml of 68% HNO_3 to 200 ml of water in a 500-ml volumetric flask, swirl to mix, and dilute to volume after cooling.

4.4 pH Indicating Paper - 2 to 12 pH range.

4.5 Sodium chloride standard solution - (NaCl) - (100 mg Cl/ℓ) - Prepare by drying several grams of NaCl for one hour at 600°C. Prepare a stock solution by dissolving exactly 16.486 g of the dry salt in water and diluting to one liter. Prepare the standard solution by diluting 10 ml of the stock solution to one liter with water. The resulting standard contains 100 mg chloride ion per liter (100 ppm).

4.6 Silver nitrate - ($AgNO_3$) - 0.1M - Prepare by dissolving 17 g of $AgNO_3$ in 500 ml of water and diluting to one liter with water. Store in a brown bottle.

5. Calibration

5.1 Prepare chloride standards by pipeting 10 and 50 ml of the 100-ppm standard solution into a 100-ml volumetric flask and diluting to volume with water. These represent Cl^- concentrations of 10 and 50 ppm, respectively.

5.2 Carry these standards through procedure starting with 6.3.

6. Procedure

6.1 If the sample is turbid, centrifuge 25 ml before proceding.

6.2 Pour 15 ml of the sample into a 25-ml graduated cylinder. Check the pH of the sample with pH indicating paper. If the pH is less than 7, proceed to step 6.3.

6.2.1 For samples with a pH of greater than 7, add 8M HNO_3 dropwise to the sample and swirl until the pH is about 7.

NOTE: If over 1 ml of 8M HNO_3 must be used to neutralize the basic sample, dilute the sample accordingly and reanalyze.

6.3 Transfer the sample (or 15 ml of the standards) to separate turbidity tubes, add 1 or 2 drops of 8M HNO_3, and 1 or 2 drops of the 0.1M $AgNO_3$.

6.4 Gently mix the contents of the tubes on a vortex mixer and visually compare the turbidities of the standards and sample. If the turbidity of the sample is not distinctly less than the standards, use the Model 2100 A turbidimeter to make this comparison.

7. Calculations

7.1 If the turbidity of the sample is less than the 10-ppm Cl^- standard, report <10 ppm Cl^-.

7.2 If the turbidity of the sample is greater than the 10-ppm Cl^- standard but less than the 50-ppm Cl^- standard, report >10 ppm Cl^- <50 ppm Cl^-.

7.3 If the turbidity of the sample is greater than the 50-ppm Cl^- standard, report >50 ppm Cl^-.

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B-ACLOP-80A-5	0	6-10-75	C. H. Jackson	1 of 2

TITLE

ORION pH METER OPERATING PROCEDURE

1.0 PURPOSE

The purpose of this procedure is to provide an uniform operating procedure for the Orion pH Meter.

2.0 SCOPE

2.1 This procedure is applicable to the Orion Model 701 pH Meter. The Orion Model 701 is a solid state instrument with an electronic digital display system. The function switch allows the selection of five different functions as follows:

2.1.1 mV - Allows electrode potential measurements in absolute millivolts precise to 1 mV, between -1999 and +1999 mV.

2.1.2 Relative mV - Used for millivolt readings between -1999 and +1999 mV when the display has been off-set by use of the calibration control.

2.1.3 Expanded mV - Expands relative millivolt readings to 0.1 mV precision between -199.9 and +199.9 mV. These readings are equivalent to those of Relative mV but accurate to one more significant digit.

2.1.4 pH - Allows pH measurements precise to 0.01 pH units between pH 0.00 and pH 13.99.

2.1.5 Expanded pH - Expands pH resolution to 0.001 pH units between pH 6.000 and 7.999.

2.2 The calibration control is used to off-set the display in relative and expanded millivolts up to ± 220 mV and to off-set the pH reading up to ± 3.7 pH units.

3.0 OPERATION

3.1 pH measurements

3.1.1 Plug both the reference and pH electrodes into the appropriate electrode jacks.

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Spec., License Compliance	5/20/75	Plant Manager	
		Manager, Quality Assurance	6/4/75
		Chairman, Oper. Safety Committee	5-30-75
		Cognizant Oper. Div. Dept. Manager	5-20-75

3.1.2 Check to be sure that the reference electrode is filled. If necessary, fill the electrode with the reference electrode filling solution.

3.1.3 Immerse the electrodes in a pH 7.00 buffer solution. Turn the function switch to "pH".

3.1.4 Turn the "calibration" control to obtain a display of 7.00. Turn the function switch to "standby".

3.1.5 Rinse the electrodes with water and blot dry.

3.1.6 Immerse the electrodes in the unknown solution.

3.1.7 Turn the function switch to "pH".

3.1.8 Record the pH reading of the unknown.

3.1.9 Throughly rinse and store the electrodes in distilled water after use.

3.2 Specific Ion Measurement

3.2.1 Plug both the reference electrode and the specific ion electrode securely into the appropriate electrode jacks.

3.2.2 Check to be sure that the reference electrode is filled. If necessary, fill the electrode with the reference electrode filling solution.

3.2.3 Rinse the electrodes with water and blot dry.

3.2.4 Prepare a series of standards in the range of the unknowns. Immerse the electrodes in the standard having the largest potential value without regard to sign. Set the function switch to expanded mV. Measure the developed potential of each standard solution while mixing.

3.2.5 Let the electrode remain in the solutions until the readings stabilize.

3.2.6 Using semi-logarithmic graph paper, plot the values of the standard solutions (log axis) against the electrode potentials developed in the solutions (linear axis).

3.2.7 Immerse the electrodes in the unknown solution. Measure the developed potential of the unknown while mixing. Determine the unknown concentration by using the calibration curve.

3.2.8 Throughly rinse and store the electrodes in distilled water after use.

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B-ACLOP-80A-37	0	February 20, 1976 DATE OF PREV. ISSUE	D. R. Matthews	1 of 4

TITLE

CDM3 CONDUCTIVITY METER OPERATING PROCEDURE

1.0 PURPOSE

This procedure provides uniform operating instructions for the CDM3 conductivity meter.

2.0 SCOPE

This procedure explains the operation of the CDM3 conductivity meter. Instructions are given for setting-up the instrument, instrument calibration, and sample measurement.

3.0 SAFETY

No safety hazards are presented to laboratory personnel by this instrument.

4.0 OPERATION

4.1 Connect the power cable to a 110 V ± 10%, 50/60 Hz grounded receptacle.

4.2 Switch the ON/OFF toggle switch to the ON position.

4.3 Push the T.C. COMPENSATION selector to the OFF position.

4.4 Connect the conductivity cell to the terminal marked MEASURING CELL located on the rear panel of the instrument.

4.5 Set the CELL CONSTANT indicator to the appropriate position as written on the cell (either 1.00 or 0.316 cm).

4.6 Turn the METER RANGE selector to position 1.5 μS for cells having 1.00 cm constants and to position 5 μS for cells with 0.316 cm constants. Suspend the cell in air.

4.7 Turn the CABLE CAP. COMP. knob to produce minimum meter deflection.

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[signature] Spec.. License Compliance	2/17/76	[signature] Plant Manager	
		[signature] Manager, Quality Assurance	
		[signature] Chairman, Oper. Safety Committee	
		[signature] Cognizant Oper. Div. Dept. Manager	2-12-76

4.8 Turn the CELL CONST. CORR. % knob to the same value as that engraved on the metal part of the conductivity cell, and lock the knob with the LOCK screw.

4.9 Immerse the conductivity cell in the solution to be measured. Select the proper meter range, and read the meter when the pointer has settled. The meter readings may be microsiemens (μS) or millisiemens (mS).

4.10 Rinse the cell in demineralized water and shake the excess water from the cell between measurements. Always rinse the cell in demineralized water before storage.

4.11 The cells may be kept clean by storing in demineralized water.

5.0 ROUTINE MAINTENANCE

5.1 The cell constant correction (engraved on the metal part of the cell) can be checked by measuring the specific conductivity of a 0.01000N KCl solution.

5.1.1 Prepare the 0.01000N KCl standard by dissolving exactly 0.7455 g of analytical grade KCl in demineralized water which has a specific conductivity less than 1 μS and diluting to exactly one liter with the demineralized water.

5.1.2 Soak the cell in this KCl standard for 24 hours before measuring. Just before measuring remove the cell from the solution and shake excess solution from the cell.

5.1.3 Turn the CELL CONST. CORR. % knob to 0%, and lock the knob in this position.

5.1.4 Measure the specific conductivity of the 0.01000N KCl per section 4.0 (except leave the CELL CONST. CORR. % on 0% for this standard measurement). Measure the temperature of the KCl solution to within ± 0.05 °C.

5.1.5 Calculate the cell constant correction using the following equation:

$$X = \left[\left(\frac{S_R}{S_M}\right) - 1\right] \times 100$$

where:

X = cell constant correction %,

S_M = measured value from step 5.1.4, and

S_R = specific conductivity at the measuring temperature found in Table 1.

5.1.6 Record the date and the values of X, S_M, and S_R in a calibration log book for the CDM3 meter.

5.1.7 If the value for X differs from that engraved on the cell, notify your supervisor.

TABLE 1

SPECIFIC CONDUCTIVITY OF 0.01N KCl

Temp. °C	Spec. Conduct. µS	Temp. °C	Spec. Conduct. µS	Temp. °C	Spec. Conduct. µS
20.0	1278	24.0	1386	28.0	1494
20.1	1281	24.1	1389	28.1	1497
20.2	1283	24.2	1391	28.2	1500
20.3	1286	24.3	1394	28.3	1502
20.4	1289	24.4	1397	28.4	1505
20.5	1292	24.5	1400	28.5	1508
20.6	1294	24.6	1402	28.6	1511
20.7	1297	24.7	1405	28.7	1513
20.8	1300	24.8	1408	28.8	1516
20.9	1302	24.9	1410	28.9	1519
21.0	1305	25.0	1413	29.0	1522
21.1	1308	25.1	1416	29.1	1524
21.2	1310	25.2	1418	29.2	1527
21.3	1313	25.3	1421	29.3	1530
21.4	1316	25.4	1424	29.4	1532
21.5	1319	25.5	1427	29.5	1535
21.6	1321	25.6	1429	29.6	1538
21.7	1324	25.7	1432	29.7	1541
21.8	1327	25.8	1435	29.8	1543
21.9	1329	25.9	1437	29.9	1546
				30.0	1549
22.0	1332	26.0	1440		
22.1	1335	26.1	1443		
22.2	1337	26.2	1445		
22.3	1340	26.3	1448		
22.4	1343	26.4	1451		
22.5	1346	26.5	1453		
22.6	1348	26.6	1456		
22.7	1351	26.7	1459		
22.8	1354	26.8	1462		
22.9	1356	26.9	1464		
23.0	1359	27.0	1467		
23.1	1362	27.1	1470		
23.2	1364	27.2	1472		
23.3	1367	27.3	1475		
23.4	1370	27.4	1478		
23.5	1373	27.5	1481		
23.6	1375	27.6	1483		
23.7	1378	27.7	1486		
23.8	1381	27.8	1489		
23.9	1383	27.9	1492		

OPERATIONS DIVISION ADMINISTRATIVE PROCEDURE

AGNS

SECTION	NUMBER	REVISION	DATE
	A-ODAP-32	2	8/18/80

TITLE
HANDLING AND SHIPPING OF LOW-LEVEL RADIOACTIVE WASTES

PREPARED BY	EFFECTIVE TO	PAGE
J. B. Maier/K. E. Plummer		1 OF 14

1.0 PURPOSE

The purpose of this procedure is to define the handling and shipping requirements and guidelines for low-level radioactive wastes generated at the Barnwell Nuclear Fuel Plant.

2.0 SCOPE

This procedure applies to all personnel involved in the generation, transfer, packaging, and shipping of low-level radioactive wastes at the Barnwell Nuclear Fuel Plant.

3.0 DEFINITIONS

3.1 Hazardous Materials Specialist (HMS) - An AGNS employee charged with the responsibility of providing information necessary to comply with regulations governing the packaging, certification, labeling, placarding, and shipping of hazardous materials. In the absence of the HMS, an Operational Safety Supervisor shall act in his behalf.

3.2 Compactible Waste - Dry trash consisting of rags, paper products, rubber, glass except pyramid sample bottles, and plastic materials that are not rigid and have been contaminated with natural or depleted uranium and thorium wastes.

3.3 Noncompactible Waste - Metal scrap and pipe, wood, glass pyramid sample bottles, aerosol cans, liquids (aqueous or organic), or liquids with absorbent material, any waste contaminated with transuranic elements, and material exceeding the definition of low-level radioactive wastes.

3.4 Transuranic (TRU) Waste - Radioactive wastes that contain greater than or equal to 10 nCi of transuranic elements per gram of waste. These wastes require special off-site shipping arrangements. Solid wastes, which have the potential for being

REVIEWED BY		APPROVED BY	
C. Walker 8-13-80 Spec., License Compliance		R. G. Christopher 8/14/80 ~~Plant Manager~~ Director, Operations	
		W. F. Kelly /FBJ 8/18/80 Manager, Quality Assurance	
		J. T. Stahl 8/14/80 Chairman, Oper. Safety Committee	
		M Hawkins 8/11/80 Cognizant Oper. Div. Dept. Manager	

FORM OD-1

contaminated with transuranics and cannot be surveyed or easily sampled shall be considered TRU waste.

Wastes contaminated with U-233, U-235, and plutonium isotopes shall also meet the following requirements:

- The combined weight of U-235, U-233, and plutonium shall never exceed 15 grams per cubic foot of package.

- The total isotopic concentration per single package shall not exceed:

  100 grams U-235
  60 grams U-233
  60 grams plutonium

  If more than one such isotope is included in the package, the sum of contained

  $$\frac{\text{gram of U-235}}{100} \qquad \frac{\text{gram of U-233}}{60} \qquad \frac{\text{gram of plutonium}}{60}$$

  shall not exceed unity.

- The combined total curie content, for all radionuclides present, shall not exceed 1 curie per cubic foot and no single package shall contain more than 20 curies.

- Materials exceeding these isotopic concentrations cannot be shipped to licensed waste burial sites.

3.5 Nontransuranic (Non-TRU) Waste - Radioactive wastes that contain less than 10 nCi of transuranic elements per gram of waste.

3.6 Low-Level Radioactive Wastes (LLW) - Solid waste (TRU and Non-TRU) that is < 200 mrem/hour at contact and < 10 mrem/hour at 3 feet from the final shipping container surfaces.

3.7 Radioactive Waste Transfer Record - A form completed by the waste originator which describes the waste package contents received at the WTEG or designated storage area (Attachment 1). This form provides the basis for assigning sequential numbers to waste containers. (AGNS Form No. OD-73)

3.8 Radioactive Waste Inspection Checklist - A form used to document the packaging, labeling, and loading inspections performed prior to off-site shipment to Chem-Nuclear (Attachment 2). (AGNS Form No. OD-74)

3.9 Chem-Nuclear Radioactive Shipment Record Form - A record identifying the waste materials which must be completed by AGNS personnel and presented to the carrier before off-site transfer to the contract Low-Level Waste Burial Site (Attachment 3).

3.10 AGNS Clearance Pass - A security form authorizing the removal of materials or equipment from the controlled areas (Attachment 4). The Chem-Nuclear Radioactive Shipment Record form shall be an additional requirement for the removal of radioactive wastes.

3.11 HP - The Health Physics section of the Safety and Environmental Control Department.

3.12 Organic Radioactive Waste - Any liquid waste composed of any hydrocarbon solvent and containing radionuclides. Organic wastes may be either TRU or Non-TRU, based on the 10 nCi/gram limit.

3.13 Shipment Coordinator - An individual designated in writing by his department manager who is responsible for: (1) coordinating shipment activities with the HMS: (2) generating, as required, a purchase requisition for shipment services; AGNS work request input to the HMS; (3) dissemination of pertinent low-level radioactive waste shipping/handling information (procedure, policy, and regulation requirements) supervising the loading operation; and (4) completion of the Radioactive Waste Inspection Checklist (Attachment 2).

3.14 Interim Storage Areas - The temporary interim storage areas for Non-TRU and TRU wastes are the Waste Tank Equipment Gallery and the UF_6 Facility, respectively. Solidified waste from the temporary waste evaporator system shall be stored in the yard area adjacent to the temporary waste evaporator. The use of other waste areas shall be approved by SEC and identified on an approved AGNS Work Request.

3.15 Transport Group I Radionuclides - Radionuclides having an Atomic Number 82 and over with a radioactive half-life of zero days up to 10 years are Transport Group I Radionuclides.

3.16 DOT Specification 17H Drum - Shall include any new drum fabricated to DOT Specification 17C, 17E, and 17H or any reconditioned drum marked DOT R___ ___ ___ ___ (four digit registration number, for example DOT R-1001 or DOT R-1109). The color of the drums shall be orange.

3.17 Form RHA-PNC - A South Carolina Department of Health and Environmental Control Radioactive Waste Shipment Prior Notification and Manifest form. A copy must be submitted at least 72 hours before transporting each waste shipment (Attachment 5).

3.18 PNP Form - A Chem-Nuclear Prior Notification Plan form. A copy must be submitted before transporting each waste shipment (Attachment 6).

4.0 LOW-LEVEL WASTE HANDLING

4.1 General

4.1.1 Personnel involved in activities that produce low-level wastes shall take whatever steps available within procedure guidelines to minimize the volume of low-level waste generated. These actions include, but are not limited to, minimizing volumes of flush solutions and decontamination supplies used, and using low-level radioactive waste collection containers for contaminated waste only.

4.1.2 Nuclear Material Control requirements as outlined in Procedure NMC-030, "Pre-Operational Nuclear Materials Control Accounting Procedure," shall be applied, where applicable, to waste transfers described in this procedure.

4.2 Solid Low-Level Wastes

4.2.1 Solid Low-Level Waste Collection Containers

4.2.1.1 Cardboard Boxes - Cardboard boxes are used for the collection of compactible LLW only and are to be lined with a polyethylene bag. These boxes have a nominal capacity of 7-1/2 cubic feet and a 65-pound maximum load capacity. These boxes are not to be used to collect wastes having sharp edges. Ultimate off-site disposal of contaminated cardboard containers shall be by compaction into metal drums or packaging into wooden boxes.

4.2.1.2 Metal Drums - Orange metal drums are used for the collection and for off-site shipment of low-level radioactive compacted and noncompactible wastes (TRU and Non-TRU). Such drums shall meet DOT Specification 17H. With the exception of compacted waste drums, drums shall be lined with a plastic bag.

4.2.1.3 Other Containers - Containers or packaging requirements for noncompactible waste that cannot be contained within a 55-gallon metal drum (DOT Specification 17H) shall be packaged as directed in writing by the HMS via an AGNS Work Request.

Temporary collection containers other than cardboard boxes may be used at the discretion of the cognizant department. These containers shall be lined with a polyethylene bag. The waste collected in these containers shall be repacked into an acceptable shipping container (i.e., DOT Specification 17H drum) prior to interim storage or off-site shipping.

4.2.1.4 Labeling - LLW solid waste containers shall be stenciled, at the time of use, with the words "RADIOACTIVE WASTE ONLY," in 1/2-inch or larger letters of a contrasting color, on the upper 1/3 of two opposite sides of the container. Prior to using this container for a shipping container, the words "WASTE ONLY" must be painted over; any additional DOT labeling requirements shall be specified by the HMS prior to loading. Information only tags shall be placed on TRU and solidified organic waste collection containers. These tags shall identify the waste. For example, label as "TRU" or "solidified organic" and "Not for Shipment to Chem-Nuclear." These containers shall not be shipped to Chem-Nuclear Systems, Inc.

4.2.2 Waste Collection

4.2.2.1 Solid low-level radioactive wastes generated at the Barnwell Nuclear Fuel Plant shall be segregated at the point of origin into the following types:

- Compactible
- Noncompactible
- TRU
- Organic liquids (subdivided as TRU or Non-TRU)

NOTE: Inorganic and organic TRU waste may be combined.

4.2.2.2 The department generating the solid waste shall be responsible for:

- Providing proper type and number of waste containers at appropriate work locations

- Properly labeling the waste collection and shipping containers (see Sections 4.2.1.4 and 4.4)
- Maintaining waste containers in serviceable condition (free of structural defects and dry)
- Maintaining a record of filled waste containers and assigning sequential numbers using the Radioactive Waste Transfer Record
- Delivering waste to the interim storage area.

4.2.2.3 Collection containers shall not be overfilled.

4.2.3 Compactible Wastes

4.2.3.1 Compactible wastes, as defined in Section 3.2, shall be compacted using the Radwaste Compactor 40Z408. Operation of the Radwaste compactor is covered by Separations Production Department procedures.

4.2.3.2 All compactible wastes shall be prepackaged. When plastic bags are used, the size of these plastic bags shall not exceed a nominal capacity of 30 gallons. If larger bags are used, they should not be filled to more than approximately 30-gallon capacity. When full, these bags must be securely taped shut by twisting the top of the bag and wrapping tape around the twisted portion.

4.2.3.3 When the waste collection containers (drums or boxes) are full, they shall be moved to the Waste Tank Equipment Gallery (WTEG) for temporary storage. These containers shall be tagged with the date filled, originating department, and the words "for compaction." Stencil the container with the words "RADIOACTIVE WASTE ONLY" on two opposite sides. Separations Production Shift Supervisor is to be notified that there is waste for compaction, and a copy of the radioactive waste transfer record shall be transferred to him from the originating department.

4.2.3.4 Separations Production personnel shall move the container to the Cask Loading Station (CLS) and perform the compaction and packaging for shipment.

4.2.3.5 Containers of compactible waste that have not been prepackaged shall be returned to the originating department for repackaging per Section 4.2.3.2.

4.2.3.6 Following compaction of contained waste, drums used for the collection of compactible waste shall be surveyed by SEC and decontaminated, as required, prior to being either returned to the originating department or used for compacting other wastes. In either case, the original sequential number will be painted over following compaction of the waste.

4.2.3.7 A record of compactible waste activities (Radioactive Waste Transfer Record) (Attachment No. 1) shall be maintained at the waste compaction area by the Separations Production Department personnel.

4.2.4 Noncompactible Waste - Noncompactible waste shall be collected and packaged separately from compactible wastes. Specific instructions for packaging large bulky items (waste that will not fit into a 55-gallon 17H drum) shall be issued, in writing, on a case-by-case basis by the HMS. A record of noncompactible waste (Radioactive Waste Transfer Record) will be maintained by the originating department.

4.2.5 Transuranic Waste - TRU waste handling is covered by the following procedures:

- B-ACLOP-80-3, "Procedure for Plutonium Handling in the HCLA prior to obtaining a Federal License for Hot Operations of the Separations Facility"
- B-ACLOP-82A-5, "Solidification of Liquid Radwaste Generated in BNFP Laboratories"
- B-ODAP-6, "Analytical Services Laboratory Safety."

4.2.6 Low-Level Waste Container Handling and Inspection

4.2.6.1 Cardboard containers stored in areas lacking sufficient weather protection shall be suitably protected from weather damage.

4.2.6.2 In order to prevent in-leakage of rain water, metal drums stored outside shall be covered, in addition to the drum lid, with plastic lid covers or plastic bags.

4.2.6.3 Within 48 hours prior to loading for off-site shipment, drums shall be inspected by the department responsible for shipping using the Radioactive Waste Inspection Checklist (Attachment 2). Corrective actions are the responsibility of the originating department. The originating department for compacted waste is the Separations Production Department.

4.2.6.4 A record of inspections, defects, and corrective actions shall be maintained by the department responsible for transfer/shipping. The Radioactive Waste Inspection Checklist and department shift logs shall be used to maintain this record.

4.3 Liquid Wastes - All liquid low-level radioactive wastes shall be solidified prior to being shipped off-site for disposal at a commercial low-level waste burial facility.

4.3.1 Solidification of Liquid Wastes

4.3.1.1 Large volumes of aqueous (TRU and Non-TRU) liquid low-level radioactive wastes shall be solidified with cement using approved procedures or work instructions.

4.3.1.2 Large volumes of organic low-level radioactive waste solutions (TRU and Non-TRU) shall be absorbed on an absorbent material approved by the HMS. The solidification of organic liquids shall be conducted using approved AGNS Work Request.

4.3.1.3 Small quantities of liquid aqueous and organic low-level radioactive wastes (TRU and Non-TRU), generated in BNFP laboratories, shall be batch solidified using procedures specified in B-ACLOP-82A-5.

4.3.2 Solidified Waste Packaging

4.3.2.1 All solidified liquid waste shall be packaged for shipment in DOT Type 17H orange metal drums. Each drum shall have a plastic bag liner.

4.3.2.2 Waste drums containing Transport Group I radionuclides equal to or greater than 1 millicurie per waste drum require special transportation arrangements.

4.3.3 Waste Drum Handling and Inspection

4.3.3.1 Where large quantities of waste solutions are solidified in 55-gallon drums, these drums shall be inspected by the originating department within 48 hours prior to loading for shipment. This inspection is for drum integrity, proper labeling, hardness of cement, absence of water, and lids properly secured.

4.3.3.2 If, upon such inspection, drums are found with cement that can be manually compressed, they cannot be shipped, and shall be specially handled (treated) by the originating department. Specially handled drums shall be reinspected prior to shipping. Special handling instructions shall be issued by the originating department on a case-by-case basis using approved AGNS Work Requests.

4.3.3.3 During inspection, any drum containing liquid shall receive special handling. These specially handled drums shall be reinspected by the originating departmental supervisor or cognizant engineer prior to shipping. (Special handling instructions shall be issued by the originating department on a case-by-case basis using approved AGNS Work Requests.)

4.3.3.4 A Radioactive Waste Inspection Checklist shall be completed for shipment by the department performing the shipping.

4.3.3.5 No drum shall be loaded onto a truck for shipment that has not been inspected.

4.3.3.6 Filled waste drums stored in areas lacking sufficient weather protection shall be protected from in-leakage of rain water or other liquids by a plastic lid cover.

4.4 Numbering of Waste Drums

4.4.1 All waste containers, except those used for collection only, shall be numbered in accordance with the following alpha-numeric system:

$X_1X_2 - X_3X_4X_5$

X_1 = Area/waste designation

A = Analytical Services Department Radioactive Waste
C = Compacted Radioactive Waste
F = FRSS Radioactive Waste
M = Maintenance Radioactive Waste
N = Nuclear Technology Laboratory Radioactive Waste
S = Separations Facility Radioactive Waste
T = UF_6 Facility Radioactive Waste
W = WTEG Radioactive Waste

X_2 = Last digit of current year.
Example: for 1979, X_2 = 9

$X_3X_4X_5$ = Sequential number assigned by the originating department. Compacted waste drum numbers are assigned by Separations Production Department. One series of sequential numbers shall be maintained by each originating department regardless of the class affiliation of waste (see Section 4.4.3).

4.4.2 These numbers shall be a minimum of 1/2 inch high and applied to the outside of the drum at two locations, on opposite sides. The number shall be placed at the container midsection in a contrasting color.

4.4.3 The originating department shall maintain a record of sequential numbers assigned to waste packages using the Radioactive Waste Transfer Record.

5.0 RADIOACTIVE WASTE SHIPMENTS

5.1 Each department shall designate in writing by memo to the HMS a person to act as shipment coordinator for low-level radioactive waste shipments. The HMS shall disseminate procedure, policy, and regulation changes and other pertinent low-level radioactive waste shipping/handling information to the designated radioactive shipment coordinators.

5.2 Shipments Transported to Chem-Nuclear Waste Management Facility

5.2.1 The responsible shipment coordinator shall notify the HMS when off-site transportation is desired.

5.2.2 The HMS shall contact a carrier, schedule a shipping date, and relay the information to the Operations Shift Supervisor and the Operational Safety Supervisor. The HMS shall complete the Prior Notification Plan forms for distribution to the South Carolina Department of Health and Environmental Control and Chem-Nuclear Systems, Inc.

5.2.3 Within 48 hours prior to the scheduled loading date, a final inspection of the shipping containers and their contents shall be performed by the department responsible for shipping. The inspection results shall be documented on the Radioactive Waste Inspection Checklist record and verified by the HMS before the certification statement on the Chem-Nuclear Radioactive Shipment Record Form (Attachment 3) is completed.

5.2.4 HP shall perform a radiological survey of the waste containers within 24 hours prior to the scheduled loading date and complete the applicable sections of the Chem-Nuclear Radioactive Shipment Record Form (Attachment 3). HP shall perform an incoming survey of the carrier's trailer prior to loading of the waste shipment.

5.2.5 The HMS shall review the waste packaging information, waste inspection criteria, and survey results to determine proper labeling and shipping requirements. After verifying the completion of these requirements, the HMS shall sign the disclaimer and certification statements on the Chem-Nuclear Radioactive Shipment Record Form (Attachment 3).

5.2.6 Copies of the Chem-Nuclear Radioactive Shipment Record Form (Attachment 3) shall be duplicated and distributed to the Operations Shift Supervisor and Nuclear Material Control Department. The original document shall remain in the HP office until the carrier arrives.

5.2.7 The Operations Shift Supervisor shall have the responsibility of assigning a carrier escort and approving a Materials Clearance Pass (Attachment 4) for the shipment.

5.2.8 The carrier escort shall contact HP for final inspection of the loaded waste shipment, radiological release survey, and shipping record completion.

5.2.9 HP shall placard the front of the motor vehicle, perform the final radiological release survey, visually inspect the loaded trailer, and secure the trailer door with an Allied-General security seal.

5.2.10 HP shall enter the vehicle survey results on all of the multicopy sheets of the Radioactive Shipment Record. After obtaining the driver's signature, HP shall detach the completed pink copy and route to the HMS.

5.2.11 The carrier escort shall accompany the vehicle and driver to the main gate and present the yellow copy of the completed Chem-Nuclear Radioactive Materials Shipment Record Form and an approved Materials Clearance Pass to Security.

5.3 Transuranic (TRU) Waste Shipments - TRU waste shall be shipped in special licensed nuclear material transporters to the burial site in Richland, Washington, for disposal. A maximum quantity of 15 55-gallon DOT 17-H drums with a maximum gross weight of 5000 pounds are limitations imposed on each shipment. Full load shipments should be planned to justify the transportation costs.

5.3.1 The HMS shall provide the necessary shipping information required on the purchase requisition to the shipment coordinator. The shipment coordinator shall initiate a purchase requisition for shipping prior to the desired shipping date. The shipment coordinator shall be designated on the purchase order as the AGNS contact for the shipper.

5.3.2 The HMS shall register the company as a shipper and obtain license and transporter documents required by Federal Regulations once the shipping date has been confirmed. The HMS shall notify NMC when these requirements have been completed.

5.3.3 Upon receipt of the "Nuclear Material Transporter Certificate of Compliance" and inspection checklist, the HMS shall generate an AGNS Work Request describing the loading and inspection requirements. The Shipment Coordinator shall issue the AGNS Work Request at least 48 hours prior to the scheduled loading date.

5.3.4 Within 48 hours prior to the scheduled loading date, the TRU waste shall be inspected, surveyed, and labeled as directed by the shipment coordinator and the HMS.

5.3.5 The loading of the waste transporter shall be completed as outlined in the approved AGNS Work Request and shall be witnessed by the shipment coordinator and HMS.

5.3.6 The HMS shall complete the radioactive material shipping documents and notifications required to transport the shipment off-site.

5.4 Solidified Organic Radioactive Waste Shipments - Low-level radioactive solidified organic materials shall be transported to an approved burial site for disposal. A gross weight limit of 40,000 pounds is the vehicle full load capacity.

5.4.1 The HMS shall provide shipping information to the shipment coordinator who shall generate an AGNS purchase requisition.

5.4.2 The HMS shall obtain the necessary license documents required by Federal Regulations once the shipping date has been confirmed. The HMS shall notify NMC when these requirements have been completed.

5.4.3 Within 48 hours prior to the scheduled loading date, the waste shall be inspected, surveyed, and labeled as directed by the shipment coordinator and the HMS.

5.4.4 HP shall perform a radiological survey of the waste containers within 24 hours prior to the scheduled loading date and complete the applicable sections of the Chem-Nuclear Radioactive Shipment Record Form (Attachment 3). HP shall perform an incoming survey of the carrier's trailer prior to loading of the waste shipment.

5.4.5 The shipment coordinator shall supervise the waste loading operations.

5.4.6 The HMS shall complete the radioactive material shipping documents and notifications required to transport the shipment off-site.

5.4.7 The Operations Shift Supervisor shall have the responsibility of assigning a carrier escort and approving a Materials Clearance Pass (Attachment 4) for the shipment.

5.4.8 The carrier escort shall contact HP for final inspection of the loaded waste shipment, radiological release survey, and shipping record.

5.4.9 HP shall visually inspect the shipment and secure the trailer door with a seal, perform the carrier survey and document the results, obtain the driver's signature on the record, and route the pink copy of the completed Radioactive Materials Shipment Record Form (Attachment 3) to the HMS.

5.4.10 The carrier escort shall accompany the vehicle and driver to the main gate and present the yellow copy of the completed Radioactive Materials Shipment Record Form and an approved Materials Clearance Pass to Security.

6.0 ATTACHMENTS

Attachment 1 - Radioactive Waste Transfer Record

Attachment 2 - Radioactive Waste Inspection Checklist

Attachment 3 - Radioactive Shipment Record Form

Attachment 4 - Materials Clearance Pass

Attachment 5 - State Prior Notification Plan

Attachment 6 - Burial Site Prior Notification Plan

RADIOACTIVE WASTE TRANSFER RECORD

DATE OF TRANSFER	TRANSFERRED TO	PACKAGE/ DRUM NO.	GENERAL DESCRIPTION OF WASTE COMPONENTS	CHEMICAL FORM OF ISOTOPES AND MATERIALS	COMMENTS*	TRANSFERRED BY
	EXAMPLES		EXAMPLES	EXAMPLES		EXAMPLES
12/15/79	WTEG	S901	Solidified Process Liquids	Uranyl Nitrate in Cement		John Operations
12/15/79	WTEG	A901	Laboratory Trash	Uranium Oxides and Neptunium Sulfate in Cement	<10 nCi/gm Neptunium	John Analytical
12/15/79	WTEG	A901	HEPA Filters	Cesium Sulfate	Cs-134 ~1 μCi Cs-137 ~5 μCi	John Analytical
12/15/79	WTEG	C901	Compacted Analytical Trash	Plastic and Paper Contamination with Natural Uranium		John Operations
12/15/79	WTEG	C902	Compacted Analytical Trash	Paper and Plastic Contamination with Natural Uranium		John Operations
12/15/79	WTEG	C903	Compacted Analytical Trash	Paper and Plastic Contamination with Natural Uranium		John Operations
12/15/79	WTEG	C904	Compacted Analytical Trash	Paper and Plastic Contamination with Natural Uranium		John Operations

*The type and quantity of isotopes other than natural uranium/thorium must be identified in the comment column.

AGNS FORM OD-73

Number of Waste Drums Inspected ________
(List Specific Drums Inspected on Reverse Side)

RADIOACTIVE WASTE INSPECTION CHECKLIST

Date: ____________________

1. Within 48 hours of the scheduled loading date, all drums have been opened, visually inspected, and do not contain any unsolidified liquid, organic, or free-flowing liquid. ________
2. The chime (rim) and lid are free of obvious damage which might prevent proper closure. The orange colored exterior drum surfaces are free of blistered, bubbled, or rusted areas and all bungs are in place. ________
3. Glassware, empty bottles, and empty containers have been thoroughly dried. Inverting packages or bags containing these items has not produced free-standing liquid. ________
4. Drums with visible stains, water marks, or moisture on the exterior surfaces have been inspected for pinhole leaks (obvious breach of drum integrity). ________
5. The lid has been secured by a threaded bolt-type locking ring on each orange drum. ________
6. Wooden boxes have been secured with at least two steel bands around the exterior surfaces. ________
7. Each container has the words "RADIOACTIVE-LSA" in a contrasting color, stenciled in 1/2-inch (or larger) letters on two opposite sides. Each container has a sequential number stenciled below the words "RADIOACTIVE-LSA." ________
8. Containers weighing in excess of 600 pounds have been palleted for loading. ________
9. Containers weighing in excess of 200 pounds have been segregated to prevent double stacking during loading operations. ________
10. Prior to loading, the operator has verified the completion of the HP trailer inspection and container survey, and the quantity and location of the containers to be loaded. ________
11. Drums have been loaded upright in a sturdy array; if stacked, the tiers of containers have been separated by boards or pallets and braced or chained to prevent shifting. ________
12. The shipment was loaded without damage to the containers or trailer. ________
13. The loaded trailer is placarded "RADIOACTIVE" on both sides and at rear of trailer. ________

REPORT DISCREPANCIES TO COGNIZANT SUPERVISOR OR ENGINEER.

Completed by: ______________________________

SEC Survey Number ______________

Waste Drum Number	Inspection Discrepancies	mr/hr Contact	mr/hr 3'	Net NaI CPM	mci

H.P. Tech Initials ______________

: Company Name: ____________________
Contact: ____________________
Address: ____________________
____
____
Telephone # ____________________
____
____

BARNWELL WASTE MANAGEMENT FACILITY

Operated by: CHEM-NUCLEAR SYSTEMS, INC.

P. O. Box 726, Barnwell, South Carolina 29812
(803) 259-1781

RADIOACTIVE SHIPMENT RECORD FORM

Page ________ of ________

Carrier Name ____________________
Driver Signature ____________________
Date & Time Rec'd ____________________

Shipping Date ____________________

Customer Survey No. ____________

(16)

Type of Cask ____________
Trailer # ____________

CNSI USE ONLY

Arrival Date ________ Survey No. ____
Date Buried ________ By ____
Radiation Reading ________ Weigh
Trench No. ________ WCC ____
LOC Code ________ Items ____
Total PERS EXP. ____________

(1) Item Number	(2) Radio-nuclide	(3) Physical Form	(4) Chemical Form	(5) Waste Description	(6) SNM (Grams)	(7) Source (Pounds)	(8) Activity (Millicuries)	(9) Gross Weight	(10) Trans-port Group	(11) Container Cu. Ft.³	(12) Container Spec.	(13) Rad. Level (mR/HR) Surface	3 ft.	(14) External Removable Contamination DPM/100cm² α	β/γ	(15) La Us

ANT: "This is to certify that the above-named materials are properly classified, described, packaged, nd labeled, and are in proper condition for transportation according to the applicable regulations of the nt of Transportation."

____

____________________ Date ____________

(See Reverse Side for Instructions for Completing This Form)

Copies: White-Accompany Shipment; Canary-Customer; Pink-Carrier

"Certification is hereby made to the South Carolina Department of Health and Environmental Control that this shipment of low-level radioactive waste inspected in accordance with the requirements of South Carolina Radioactive Material License No 097 as amended, and the Nuclear R Commission's License No. 46-13536-01 as amended, and the effective Barnwell Site Disposal Criteria with 48 hours prior to shipment, and further ce is made that the inspection revealed no items of non-compliance with all applicable laws, rules and regulations."

Date: ____________________ By: ____________________

Title and Organization ____________________

Telephone No. (____) ____________________

Form No. CNS-201
(9.79)

ATTACHMENT 3
A-ODAP-32

CLEARANCE PASS
ALLIED-GENERAL NUCLEAR SERVICES

№ 4281

DATE ________________

VALID FOR: From ________ To ________

( ) Material ( ) Tool ( ) Package ( ) Equipment ( ) Other

TO: Patrol Officer

Please pass ____________________ Badge No. ________

with ____

____

Authorized By ____________________

Patrol Officer ____________________

Form RHA-PNC
(5/80)

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTRL
Radioactive Waste Shipment Prior Notification and Manifest Form

See Reverse Side for Instructions

1. Name and Address of Shipper:

2. Person Responsible for Radioactive Waste Shipment:
(a) Name
(b) Title
(c) Telephone No. (   )

3. Radioactive Waste Transport Permit No.

4. Shipment Identification No.:

5. Location from which waste will be shipped:

6. Name and Address of Consignee

7. Scheduled Date of Departure of Shipment:

8. Estimated Date of Arrival of Shipment:

9. Carrier:

10. Type of Transport Vehicle:

11. Trailer No. and Owner

12. Routes shipment will follow in State of South Carolina (Be Specific):

Manifest Summary

13. Type Container or Cask:

14. Container Spec.

15. Total No. of Containers

16. Waste Description; Physical and Chemical Form

17. Prominent Radionuclides:

18. Total Curies:

19. Transport Group:

20. Total Cubic Feet:

21. Waste Classification:

		Normal Form	Special Form	Fissile
[] Radioactive LSA	[] Bulk LSA			
[] Radioactive LSA greater than Type A quantities	[] Limited quantities and radioactive devices	[] Type A quantity [] Type B quantity [] Large quantity	[] Type A quantity [] Type B quantity [] Large quantity	[] Class I [] Class II [] Class III

CERTIFICATION

I hereby certify on behalf of the above-named shipper to the South Carolina Department of Health and Environmental Control that the information provided herein is complete and correct to the best of my knowledge; and that the shipper has complied with all the provisions as required by Act No. 499 of 1980, the South Carolina Radioactive Waste Transportation and Disposal Act.

Date ______________________

____
Typed Name and Title of Agent of Shipper

____
Signature

CONSIGNEE ACKNOWLEDGEMENT

This acknowledges to the South Carolina Department of Health and Environmental Control that the above-described radioactive waste shipment was received.

____
Date of Delivery

____
Signature of Consignee or authorized Agent

____
Typed or Printed Name and Title

DHEC 802
(5/80)

(Copies of this form may be reproduced locally as needed)

General Instructions and Information

1. This form is to be used to provide the Department with prior notification of radioactive waste shipments transported into or within the State of South Carolina. This notification is to be made 72 hours before the expected date of arrival in the State. All written notices should be mailed to:

   Bureau of Radiological Health
   Radioactive Waste Management Section
   S.C. Dept. of Health and Environmental Control
   2600 Bull Street
   Columbia, South Carolina 29201

2. A separate form shall be submitted for each radioactive waste shipment.

3. Prior notification is required of all radioactive waste shipments as defined in paragraph 2 of Interim Regulations for the Transportation of Radioactive Waste into or within South Carolina except as provided in paragraph 4.1.2 of the Regulation.

4. The "Manifest Summary" portion of this form will satisfy requirements of providing the Department with a shipping manifest, however, it does not satisfy the requirements of shipping documents which shall accompany the shipments as required by DOT Regulations and the disposal facility's license and criteria.

5. A copy of this completed form shall be provided to the carrier and all drivers of the radioactive waste shipment.

6. Upon delivery of the shipment to the consignee, acknowledgement of receipt shall be obtained, and a copy of this form and the shipper/carrier's certification form shall be returned to the Department.

Specific Instructions

Item Number

1. Self Explanatory
2. Self Explanatory
3. This item applies to all shipments of radioactive waste transported to and within the State of South Carolina.
4. Each shipment of radioactive waste shall be identified in some manner by the shipper. This number can be a radioactive shipment record number, bill of lading number, allocation number, etc. The identification number shall only be used once to identify the one shipment for which notification is being made.
5. Self Explanatory
6. Indicate in this item the disposal facility, company, organization, etc., to which this shipment has been consigned.
7. Self Explanatory
8. For through shipments, indicate in this item estimated date shipment will pass through the state.
9. Self Explanatory

10.& 11. Applies only to exclusive use, sole use, and full load shipments.

12. All routing information must be specific. You should check with carrier to insure routes you prescribe are appropriate. The carrier is responsible to inform the Department of any changes of routes in South Carolina after departure.

3 thru 21. Self Explanatory

Certification: To be signed only by an authorized representative or agent of the shipper and carrier.

CHEM-NUCLEAR SYSTEMS, INC.
P.O. BOX 726
BARNWELL, S.C. 29812
Telephone (803) 259-3577 or 259-3578

PNP FORM

1. Category of Shipment:	2. Date:
	Revised Date:
3. Shipper's Name:	Street Address:
City:	State: / Zip:
4. Emergency Contact Person:	Emergency Telephone No.
5. Carrier's Name:	Street Address:
City:	State: / Zip:
6. Emergency Contact Person	Emergency Telephone No.

7. Volume of Shipment: Cubic Feet:	8. Estimated Total Activity (For Type B & Large Quantity)

9. Estimated Date of Shipment:

10. Estimated Date of Arrival of Shipment:

11. Routes Shipment Will Follow In State Of South Carolina (Be Specific):

12. ______________________
Signature/Name of Person Completing Form

13. ______________________
Telephone Number

Copy #1: Chem-Nuclear Systems, Inc.
Copy #2: State of South Carolina, DHEC
Copy #3: Attach to RSR Form
Copy #4: Shipper's Copy

DEFINITIONS

The Prior Notification Plan (PNP) is required by the State of South Carolina. Prior notification is required for shipments falling into the following categories:

Category of Shipments:

Category I: Shipments containing Type B or Larger Quantity Packages (twelve days notice required).
Category II: All Cask Shipments (Five day s notice required).
Category III: Non-Cask shipments greater than 75 cubic feet (ten 55-gallon drums) (Five days notice required).

Specific items as per front of form:

Item (1) Category of shipment (see above).
(2) Date: the date this form is filled out or revised.
(3) Shipper's name: Specific company and plant name, location by name of street, city, state, and zip code.
(4) Name of person to be contacted in case of an emergency with the shipment, with the appropriate EMERGENCY telephone number.
(5) Name of transportation company picking up this shipment for delivery with street address, city, state, and zip code of major home office.
(6) Name of the person to be contacted in case of an emergency with the shipment, with the appropriate EMERGENCY telephone number.
(7) External volume of the liner, box, container used to contain the radioactive material during shipment. (The actual volume of the package to be disposed of).
(8) The estimated total activity for Category I (Type B or Larger Quantity packages). The actual computed activity must be telephoned to Chem-Nuclear Systems, Inc. on the day of actual shipment.
(9) The "estimated date of shipment". The actual date will be provided by telephone on the date of shipment.
(10) The "estimated date of shipment ARRIVAL". This date will be revised when the "actual shipment date" is determined and telephoned to Chem-Nuclear Systems, Inc. Additionally, if the shipment is delayed enroute and will not arrive on the estimated date, CNSI will be advised by the shipper of the "revised estimated arrival date".
(11) Specify the route that the shipment will follow during its travel in the State of South Carolina.
(12) Signature and name (printed) of the person completing this form with office telephone number.

SPECIAL NOTE:

Receipt of mailgram or letter must be twelve (12) business days prior to shipment of Category I, and five (5) business days prior to shipment of Category II and III shipments. Send to:

CHEM-NUCLEAR SYSTEMS, INC.
Post Office Box 726
Barnwell, South Carolina 29812

Telephone No: (803) 259-3577 or 259-3578

ALLIED-GENERAL NUCLEAR SERVICES

Barnwell Nuclear Fuel Plant

NO	REV	DATE OF THIS ISSUE	PREPARED BY	PAGE
B-ACLOP-82A-5	0	12/6/79 DATE OF PREV. ISSUE	J. C. Neace	1 of 6

TITLE

SOLIDIFICATION OF LIQUID RADWASTE GENERATED IN BNFP LABORATORIES

1.0 PURPOSE

The purpose of this procedure is to establish a uniform method for solidification and disposal of low-level radioactive liquid waste generated in the Analytical Chemistry and Nuclear Technology laboratories in the HCLA.

2.0 SCOPE

2.1 This procedure is applicable to three types of liquid waste:

2.1.1 Non-TRU, defined as any liquid radwaste in which the final solidified form will contain <10nCi transuranium elements per gram solid waste.

2.1.2 TRU, defined as any liquid radwaste in which the final solidified form will contain >10nCi transuranium elements per gram solid waste. Off-site transportation of TRU waste shall require special shipping arrangements.

2.1.3 Organic, defined as any liquid waste composed of any hydrocarbon compound and containing radionuclides. Organic wastes may be either TRU or non-TRU based on the 10nCi/gram limit.

2.1.4 Of these, 2.1.1 and 2.1.2 are solidified as cement, and 2.1.3 is solidified by a sorbent.

2.1.5 The following conditions must be met during solidification of all low-level liquid waste:

2.1.5.1 The combined weight of U-235, U-233, and plutonium shall never exceed 15 grams per cubic foot of cement. No single package shall contain more than 100 g U-235, 60 g U-233, or 60 g plutonium and, if more than one such isotope is included in the

REVIEWED BY	APPROVED BY	
C. E. Walker 11-27-79	[signature]	11/21/79
Spec., License Compliance	Plant Manager	
	W. F. Kelley	11/23/79
	Manager, Quality Assurance	
	[signature]	11/29/79
	Chairman, Oper. Safety Committee	
	G. A. Huff	11-27-79
	Cognizant Oper. Div. Dept. Manager	

FORM OD-1

package, the sum of contained

$$\frac{\text{g of U-235}}{100} + \frac{\text{g of U-233}}{60} + \frac{\text{g of Pu}}{60}$$

shall not exceed unity.

2.1.5.2 The combined total curie content of the cement, for all radionuclides present, shall not exceed 1 curie per cubic foot and no single package shall contain more than 20 curies.

2.1.5.3 The dose rate shall not exceed 200 mr/hr at contact (unshielded) at the storage container surface.

2.1.6 NMC-030 (Pre-Operational Nuclear Materials Control Accounting Procedure) shall apply.

3.0 FACILITIES

For solidification of radwaste containing alpha emitters other than source material, a fume hood, a glovebox, or an SEC-approved housing is required.

4.0 SPECIAL EQUIPMENT

4.1 The required equipment includes the following:

4.1.1 A means for determining weights and volumes shall be provided.

4.1.2 A primary container of appropriate size which may consist of polyethylene, or mild steel lined with a polyethylene bag. The bag should be folded over the sides of the metal container and should be long enough so that it can later be twist-sealed. Appropriate size shall mean any container which can be conveniently handled but in no case may the container exceed a 55-gallon drum. If a 55-gallon drum is to be used, it shall be the final packaging container referenced in Section 4.2 below.

4.1.3 A suitable means for mixing the cement within the container.

4.2 Shipping or final packaging container shall be an orange DOT specification 17H 55-gallon drum.

5.0 REAGENTS

5.1 The required reagents for aqueous phase samples include the following:

5.1.1 Portland cement.

5.1.2 Lime (CaO), also called burnt lime or masonry lime.

[NOTE: Limestone ($CaCO_3$) shall not be used.]

5.1.3 Clean water.

5.2 The required reagent for organic samples is Florco-X.

6.0 TRANSPORT GROUP I SHIPPING REGULATIONS

The DOT shipping regulations for Transport Group I elements (all radionuclides above atomic number 87, except source material and enriched uranium) require special shipping arrangements when the contents of a shipping package exceed 1 mCi. Therefore, when possible, limit the contents of a shipping package by blending or reducing the volume to keep the activity level below 1 mCi.

7.0 CALCULATIONS

7.1 For aqueous waste with a free acid content not exceeding 0.5 N, the nominal composition of the blend consists of the appropriate multiple of the following suggested ratio: 12 grams lime, 30 ml liquid waste, 24 grams cement.

7.1.1 The final volume of the blend will be approximately 42 ml when the above listed base quantities of reagents are used.

7.1.2 For calculation purposes, the capacity of a given container for the blend shall be limited to 80% of the total container volume. This will allow room to seal the polyethylene interliner and also provide for minor adjustment in volume when more liquid or cement are required (Section 8.4.4).

7.2 Specimen calculations (aqueous waste):

7.2.1 An aqueous waste solution, 0.5 N in free acid is to be solidified as cement. Calculate the quantity of lime, waste liquid, and cement to be added to a one-gallon bucket container.

1 gallon = 3785 ml
0.8 x 3785 ml = 3028 ml
3028 ml/42 ml = 72.1 (dimensionless)
72.1 x 12 g lime = 865 g lime
72.1 x 30 ml liquid = 2163 ml liquid
72.1 x 24 g cement = 1730 g cement

7.2.2 Estimate the nCi/g of the above waste form if the density of the starting liquid was 1.05 g/ml and the concentration of Np-237 in the liquid was 20 nCi/g.

30 ml x 1.05 g/ml = 31.5 g
31.5 g x 20 nCi/g = 630 nCi
31.5 g + 12 g + 24 g = 67.5 g
630 nCi/67.5 g = 9.3 nCi/g

8.0 PROCEDURE

8.1 Aqueous samples containing up to 0.5 N free acid may be processed. Higher concentrations of acid may be processed provided the aqueous solution is first diluted with water (or low-acid waste) or partially neutralized to bring the acid level to 0.5 N or lower.

CAUTION: Lime or a solution of sodium hydroxide may be used to neutralize acidic wastes. Solid sodium hydroxide should not be used due to the possibility of an accumulation of undissolved NaOH. This could lead to localized high temperatures and an eruption due to the formation of steam. The lime or sodium hydroxide should be added cautiously and slowly with constant stirring. When neutralizing highly acid solutions, a large amount of heat will be generated. The temperature should not be allowed to rise to a point where it is unsafe to handle or, if in a plastic container, the container is weakened.

8.2 For all types of liquid waste to be solidified in a metal container, first line the container with a loose fitting polyethylene bag of appropriate size. Fold the top of the bag over the side of the metal container for sufficient distance to allow for sealing. Using tape, make a temporary attachment to prevent slippage of the bag.

8.3 Notify the Material Control Area (MCA) Custodian, or his delegate (identified in writing), prior to the solidification of the material, if the batch contains greater than the quantities of SNM or source material specified in Section 5.3.2 of NMC-030, which is as follows:

NMC-030, 5.3.2 "...Source Material: (natural or depleted...0.1 kg uranium, and thorium)
Special Nuclear Material:
Enriched U -- 1 gram U-235
Plutonium -- 1 gram
U-233 -- 1 gram

8.4 For aqueous liquid waste, calculate the quantity of lime, liquid, and cement required, using the instructions given in Section 7.0. Use Form AS-44, shown as Attachment 1, to record data and proceed with the following steps. (NOTE: Steps 8.4.1 and 8.4.2 may be performed out of sequence.)

8.4.1 Add all of the lime to the container.

8.4.2 Pour the liquid waste into the lime and mix.

8.4.3 Immediately follow with the entire lot of cement, added rapidly.

8.4.4 Continue mixing until blended. Should the blend appear too thick for proper mixing, add up to 10% more liquid waste, keeping account of the total liquid waste added. Should the blend appear too thin for proper hardening of the cement, add up to 10% more cement.

8.4.5 Place the container where intrusion by unwanted substances cannot occur and allow the cement to solidify.

8.4.6 After the cement has set for a minimum of 24 hours, visually inspect for absence of free liquid. If free liquid is found, add sufficient cement to solidify. Seal the liner by twisting the top and wrap tape around the twisted portion of the liner. Attach the cover to the container.

8.4.6.1 When polyethylene bottles have been used as primary containers, fasten the bottle cap. These containers will be placed in a polyethylene lined drum. When the drum is suitably filled, seal the liner as described in Section 8.4.6.

8.4.6.2 Check Form AS-44 for completeness. Where entries are not required, enter "NA" and initial.

8.4.6.3 Performing personnel shall sign and date Form AS-44 and obtain the supervisor's approval signature.

8.5 For the solidification of organic waste, as a minimum, use sufficient sorbent to immobilize the liquid. Seal the plastic bag and attach the cover or place the cap on the bottle. Place the primary container into a secondary container. There should be no liquid phase in the container. AS-44 form must be completed for organic waste.

NOTE: Organic sorbed waste will be stored in a sealed container stored on-site until such time as an acceptable procedure has been developed for off-site disposal. The storage area for these containers is to be approved by the SEC Department.

8.6 The MCA Custodian shall fill out an NMC-3 form for each shipping container as identified on AS-44 form. The completed NMC-3 and AS-44 forms are to remain with the container until such time as the container is moved from the MCA. When the container is removed from the MCA, the MCA Custodians of both areas shall sign the NMC-3 form as required. The NMC-3 and a copy of the AS-44 form shall then be forwarded to NMC. A copy of the AS-44 form shall stay with the container (attached to the drum in a plastic folder or envelope) until it is shipped off-site at which time it shall be forwarded to the RMSS.

9.0 SAFETY

9.1 Health Physics shall be notified before the start of the solidification of >1 mg TRU outside of a glovebox. Radiation Work Permits (RWP) shall be prepared when requested by SEC.

9.2 Safety requirements listed in A-ODAP-27, B-ACLOP-80-3, and B-ODAP-6 shall be followed.

ATTACHMENT 1
B-ACLOP-82A-5

LIQUID RADWASTE SOLIDIFICATION WORKSHEET

Gross Weight of Container ________ kg   Date Prepared ________   Location ________

Tare Weight of Container ________ kg   Shipping Container No. ________   Department ________

New Weight of Contents ________ kg   Size of Container ________   Dose Rate at Contact ____ mr/hr

List Weight, or volume, of all liquids solidified, including water and list all radionuclides present in each sample.

Sample No.	kg or ℓ	Radionuclides Present	Radionuclide Concentration: Activity Ci/kg or Ci/ℓ	Radionuclide Concentration: (g/kg) or (g/ℓ)	Total** Activity	Radionuclide Total Weight	SNM (g)	TRU (n Ci)
				TOTALS	____	____	____	____ (B)

Total kg or of liquid waste ________ kg = A

Total weight of lime added ________ kg = C

Total weight of cement added ________ kg = D

Total TRU activity as nCi = B

Calculation: *Use formula nCi TRU = $\frac{B}{(A+C+D) \times 1000}$, show calculation below.

nCi TRU/g = ____________________ = ________

Inspection for absence of free liquid: ________ / ________   ________ / ________
Performing Technician Date   Supervisor's Approval Date

____

NA = Not Applicable.
*Net weight may be used in place of (A+C+D).
**Specific activities are provided in Attachment 2 for purposes of conversion to total activity, if required.

FORM AS-44

Nuclide	Sp. Act. (Ci/gm)
^{228}Th	8.20×10^{2}
^{232}Th	1.09×10^{-7}
^{232}U	2.14×10^{1}
^{233}U	9.64×10^{-3}
^{234}U	6.25×10^{-3}
^{235}U	2.14×10^{-6}
^{236}U	6.47×10^{-5}
^{238}U	3.36×10^{-7}
^{237}Np	7.05×10^{-4}
^{238}Pu	1.71×10^{1}
^{239}Pu	6.14×10^{-2}
^{240}Pu	2.28×10^{-1}
^{241}Pu	1.03×10^{2}
^{242}Pu	3.82×10^{-3}
^{241}Am	3.43
^{243}Am	2.00×10^{-1}

For all nuclides:

$$\text{Sp Act (Ci/gm)} = \frac{3.5776 \times 10^{5}}{t_{1/2}(\text{yr}) \text{ at weight}}$$

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Nuclear Fuel Cycle Technology Development
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Sandia Laboratories
Albuquerque, New Mexico 87115

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Niagara Mohawk
300 Erie Boulevard
Syracuse, New York 13202

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Transportation Branch
U. S. Department of Energy
Mail No. B-107
Washington, D. C. 20545

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Materials Transportation Bureau
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