SAFETY ANALYSIS REPORT

FOR

MODEL NES-5 PACKAGE

TO

10 CFR 71 TYPE B(U) PACKAGING REQUIREMENTS

(REVISION 7)

SUBMITTED BY:

NUCLEAR ENERGY SERVICES, INC.

SHELTER ROCK ROAD

DANBURY, CT 06810

MARCH 1985

TABLE 2.3-1
Mechanical Properties of Materials

Material	Grade or Type	Temperature F^o	Strength (ksi) Yield (1)	Strength (ksi) Ultimate (2)	Strength (ksi) Allowable (Sm) (3)	Elastic Modulus (x106psi) (4)	Thermal Expansion Coefficient (x10-6 in/in. (5)
ASTM-A240 Plate (Shells)		70			20.0	28.3	
	304	100	30.0	75.0	20.0	28.3	8.03
		200	25.0	71.0	20.0	27.7	8.37
ASTM-A182 Forging (Bolt Ring)	F304	300	22.5	66.0	20.0	27.1	8.70
	400	400	20.7	64.4	18.7	26.6	8.97
	7	500	19.4	63.5	17.5	26.1	9.23
ASTM-A479 Bar, Round (Bosses & Lid Lug)		70			20.0	28.3	
	304	100	30.0	75.0	20.0	28.3	8.03
		200	25.0	71.0	20.0	27.7	8.37
		300	22.5	66.0	20.0	27.1	8.70
		400	20.7	64.4	18.7	26.6	8.97
ASTM-A514 Plate (Tiedown Frame)	B or H	70	100 (8)	110 (8)	-	29.9	6.07
ASTM-A414 Sheet Impact Limiter Shell)		70			-		
	C	100	30.0	55.0	13.7	29.9	6.07
		200					
		300	(8)	(8)			
		400					
ASTM-A354 Bolts (Closure Bolts) SAE J429	BD (8)	70	125 (9)	150 (9)	-	29.9	6.07
ASTM B-29-79 (Lead Shielding)	—	70	5.0 Dynamic Compression Min (6)	10.0	2.3 (yield) (6)	2.0	16.4 (50^o-212^oF) (7)

The maximum load was found to be in Element No. 29 in the outer shell just below the reinforcing ring. The maximum stress intensity is 19,006 psi.

Considering that ten times the weight of the cask was assumed in the analysis, the factor of safety is very large.

2.4.3.3 Lid Lifting Lugs

The maximum lifting load exerted on the lid lifting lugs is based on:

W_L = 3725 (Wt. of Lid)

P = 3725 ÷ 4 (the weight carried by each of the 4 lugs)

= 931.3 lbs

1. Tension in each lifting lug:

$$\sigma_t = \frac{P}{2A}$$

$$A = \frac{\pi}{4}(0.75)^2 = 0.4418 \text{ in}^2$$

$$\sigma_t^2 = \frac{931.3}{2 \times 0.4418} = 1{,}054 \text{ psi}$$

7

$$\text{Safety Factor} = \frac{30{,}000}{1{,}054} = 28.46$$

2. Welding around lifting lug:

$$A_{eft} = \pi D t_{eff} = \pi\,(0.75)\,0.707 \times 2 \times ¼ = 0.8329 \text{ in}^2$$

$$\sigma_s = \frac{P}{2A_{eff}} = \frac{931.3}{2 \times 0.8329} = 559.03 \text{ psi}$$

$$\text{Safety Factor} = \frac{20200}{559.03} = 36.1$$

3. 3/4" - 10 UNC Bolt:

Stress Area A = 0.334 in^2

$$\sigma_s = \frac{P}{2A} = \frac{931.3}{2x0.334} = 1{,}394.1 \text{ psi}$$

$$\text{Safety Factor} = \frac{30{,}000}{1{,}394.1} = 21.5$$

4. 6 3/4" x 2" x 3/4" Plate:

$$\text{Max. Moment} = \frac{931.3}{2} \left(\frac{5.125-2.625}{2}\right) = 582 \text{ lbs-in}$$

7

$$\text{Section Modulus} = (2-0.875)\frac{(0.75)^2}{6} = .1055 \text{ in}^3$$

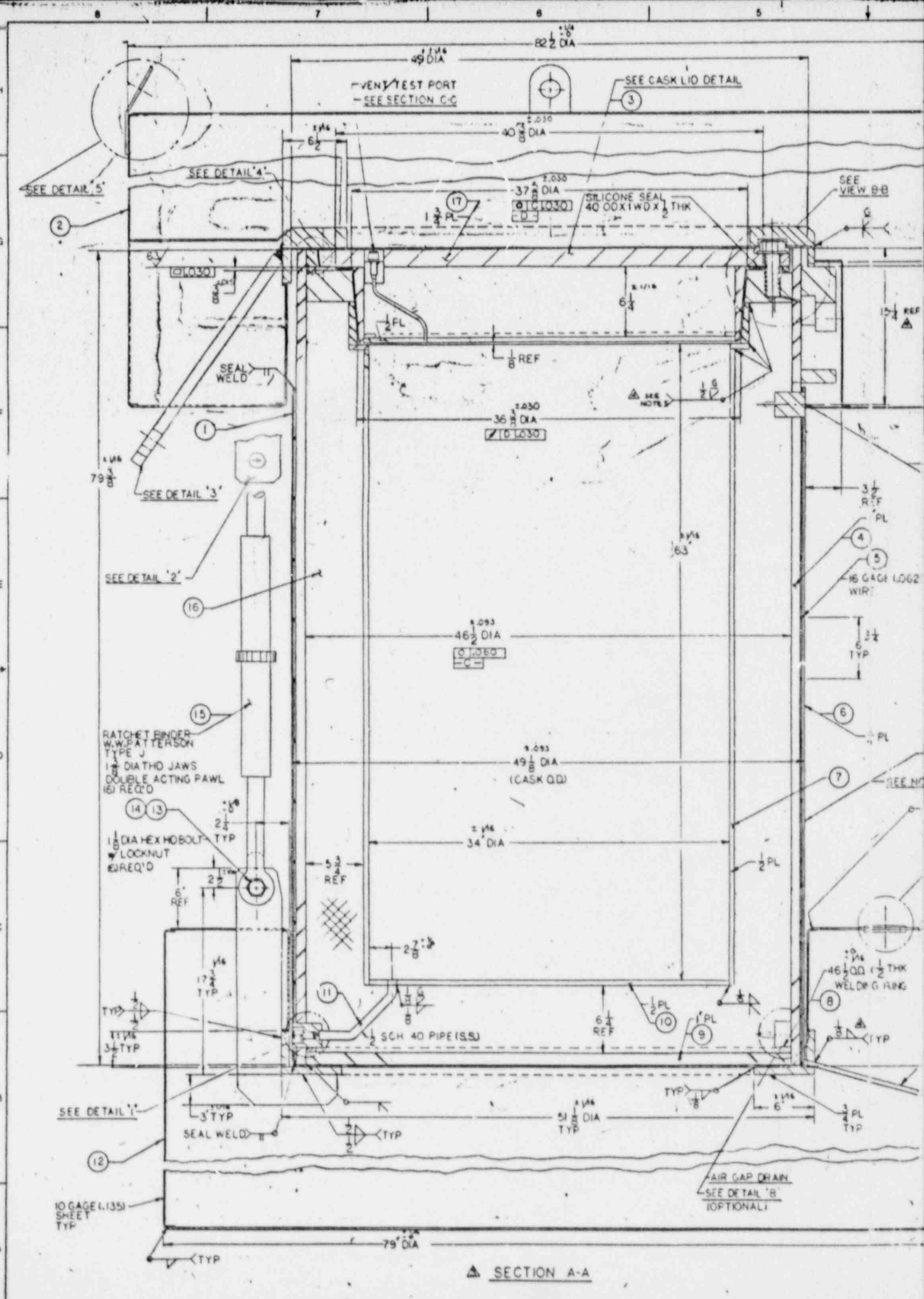
$$\text{Max. Bending Stress} = \frac{582}{0.1055} = 5{,}516.9 \text{ psi}$$

$$\text{Safety Factor} = \frac{30{,}000}{5{,}516.9} = 5.4$$

2.4.4 Tie-Downs

The tie-down system for transporting the package is designed to the load conditions defined in 10 CFR 71.45. This load condition is defined as follows: ". . . The system shall be capable of withstanding, without generating stress in any material of the package in excess of its yield strength, a static force applied to the center of gravity of the package having a vertical component of two times the weight of the package and its contents, a horizontal component along the direction in which the vehicle travels of 10 times the weight of the package with its contents and a horizontal component in the transverse direction of 5 times the weight of the package with its contents."

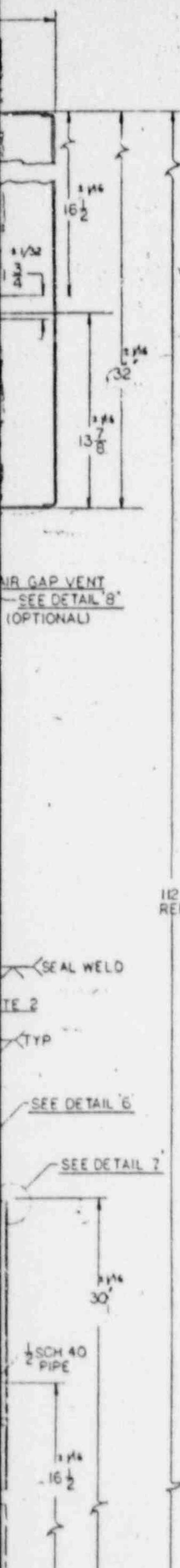
The Model NES-5 Package has been provided with a tie-down frame which is integral with the top impact limiter (overpack). The tie-down lugs extend through pockets in the upper impact limiter which serve to surround each lug with an air space to accommodate failure or distortion of the lug. The impact limiters surround the package ends and are attached together by six (6) 1-3/8" diameter ratchet binders. These ratchet binders primarily carry inertial loads only because both end impact loads and tie-down loads are reacted by direct compression of the impact limiter and the integral tie-down frame upon the body of the package.

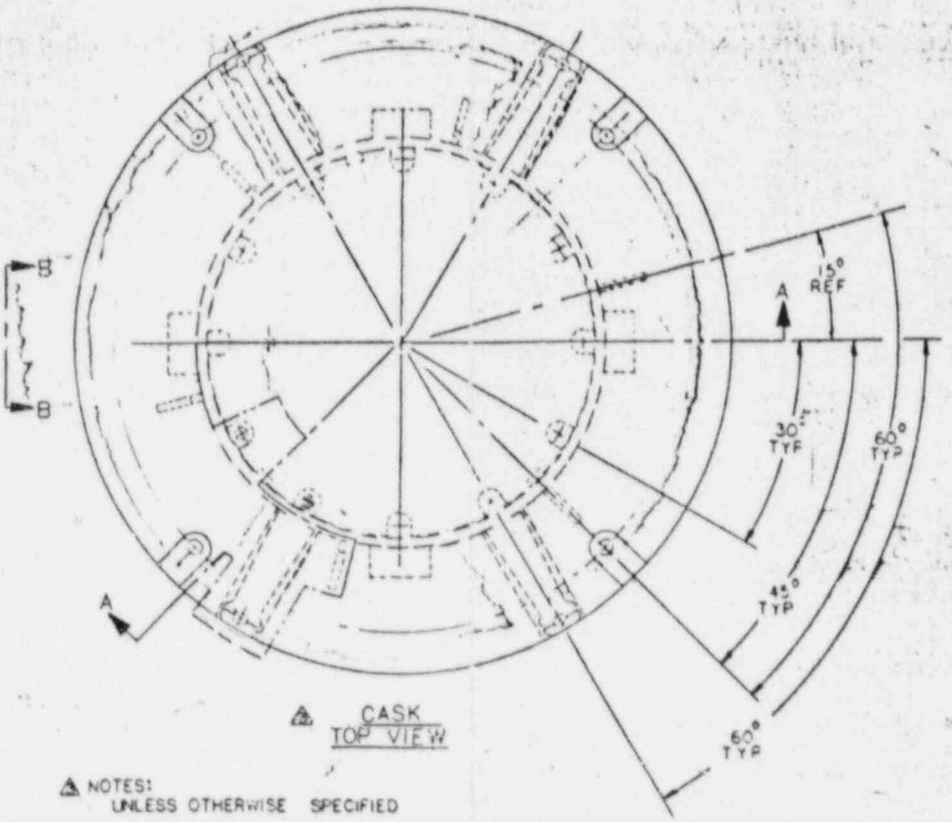


VENT/TEST PORT
SEE SECTION C-C
SEE CASK LID DETAIL
82 1/2 DIA
49 DIA
40 3/8 DIA
37 5/8 DIA
SILICONE SEAL 40 OD X 1 WD X 1/2 THK
SEE VIEW B-B
SEE DETAIL '5'
SEE DETAIL '4'
SEE DETAIL '3'
SEE DETAIL '2'
SEE DETAIL '1'
SEAL WELD
36 3/8 DIA
46 1/2 DIA
49 1/2 DIA
(CASK O.D.)
34 DIA
79 3/8
63
16 GAGE (.062) WIRE
RATCHET BINDER W.W. PATTERSON TYPE J
1 1/8 DIA THD JAWS
DOUBLE ACTING PAWL
(6) REQ'D
1 1/8 DIA HEX HD BOLT W/ LOCKNUT
(6) REQ'D
1/2 SCH 40 PIPE (S.S.)
46 1/2 O.D. x 1/2 THK WELDING RING
51 1/8 DIA
AIR GAP DRAIN
SEE DETAIL '8' (OPTIONAL)
10 GAGE (.135) SHEET TYP
79 DIA
TYP

SECTION A-A

ZONE	NO.	DESCRIPTION	DRAWN	DATE	CHECKED	APPROVED
—	1-2	NO CRA, REF: WMS 402			JCD	
AS SPEC	3	GENERAL THROUGHOUT SEE CRA 4958			JCD	
AS SPEC	4	GENERAL THROUGHOUT - SEE CRA 5647	JDH	7-1-87	JCD	
AS SPEC	5	GENERAL THROUGHOUT - CRA 6613	JCD	9-16-87	JCD	
All	6	REVISED PER CRA 6673 PROPRIETY STATEMENT REMOVED	AJR	1-5-88	WRM	





CASK
TOP VIEW

NOTES:
UNLESS OTHERWISE SPECIFIED

1. MATERIAL:
   A) CASK - STAINLESS STEEL
      PLATE - ASTM - A 240, TYPE 304; FORGING - ASTM A182, F304
      BAR ROUND - ASTM - A 479, TYPE 304
      BAR SQUARE - ASTM - A 276, TYPE 304
      PIPE - ASTM A 312, TYPE 304
      WIRE - 308 WELD WIRE, SFA 5.9 OR ASTM A479, 304
   B) BOLTS - ASTM - A 354, GRADE BD
   C) IMPACT LIMITERS - (UPPER & LOWER)
      PLATE - ASTM - A 514 GRADE B OR GRADE H
      SHEET - ASTM - A 414, GRADE C OR ASTM - A 240, TYPE 304
      PIPE - ASTM - A120 OR ASTM - A 312, TYPE 304
      FOAM FILL - RIGID POLYURETHANE (DENSITY: 19 PCF)
   D) SHIELDING — LEAD, ASTM B29-79
2. ALL WELDING TO BE IN ACCORDANCE WITH ASME SECT IX.
   (CONTAINMENT VESSEL WELDS, AND THE SEAM WELDS FOR INNER SHELL, OUTER SHELL, AND FIRE SHIELD, SHALL BE VERIFIED BY LIQUID PENETRANT INSPECTION PER ASME, SECTION V. ACCEPTANCE CRITERIA SHALL BE PER ASME, SECTION III - SUBSECTION NF-5000.)
3. REQUIRED TORQUE ON BOLTS:
   A) LID CLOSURE BOLTS: 375 FT-LBS
   B) VENT/DRAIN PLUGS: 50 FT-LBS
4. SEE NES SPECIFICATION 83A0344.
5. FULL PENETRATION DOUBLE BEVEL GROOVE WELDS MAY BE USED IN LIEU OF THE 1/2 GROOVE WELD. THE BEVEL WELD ON I.D. OF CASK SHALL BE GROUND FLUSH. THIS OPTION APPLIES TO THE TRANSITION FROM THE BOLT RING TO INNER SHELL.

WEIGHTS:
CASK BODY: 31,088 LBS
CASK LID: 3,725 LBS
IMPACT LIMITERS: 5,693 LBS

PAY LOAD: 10,000 LBS
TOTAL GROSS: 50,506 LBS

8801260493-01

nes

MODEL NES-5 PACKAGE
GENERAL ARRANGEMENT

SIZE	FSCM NO.	DRAWING NO.	REV
E	53603	83 0337	6

SCALE NONE

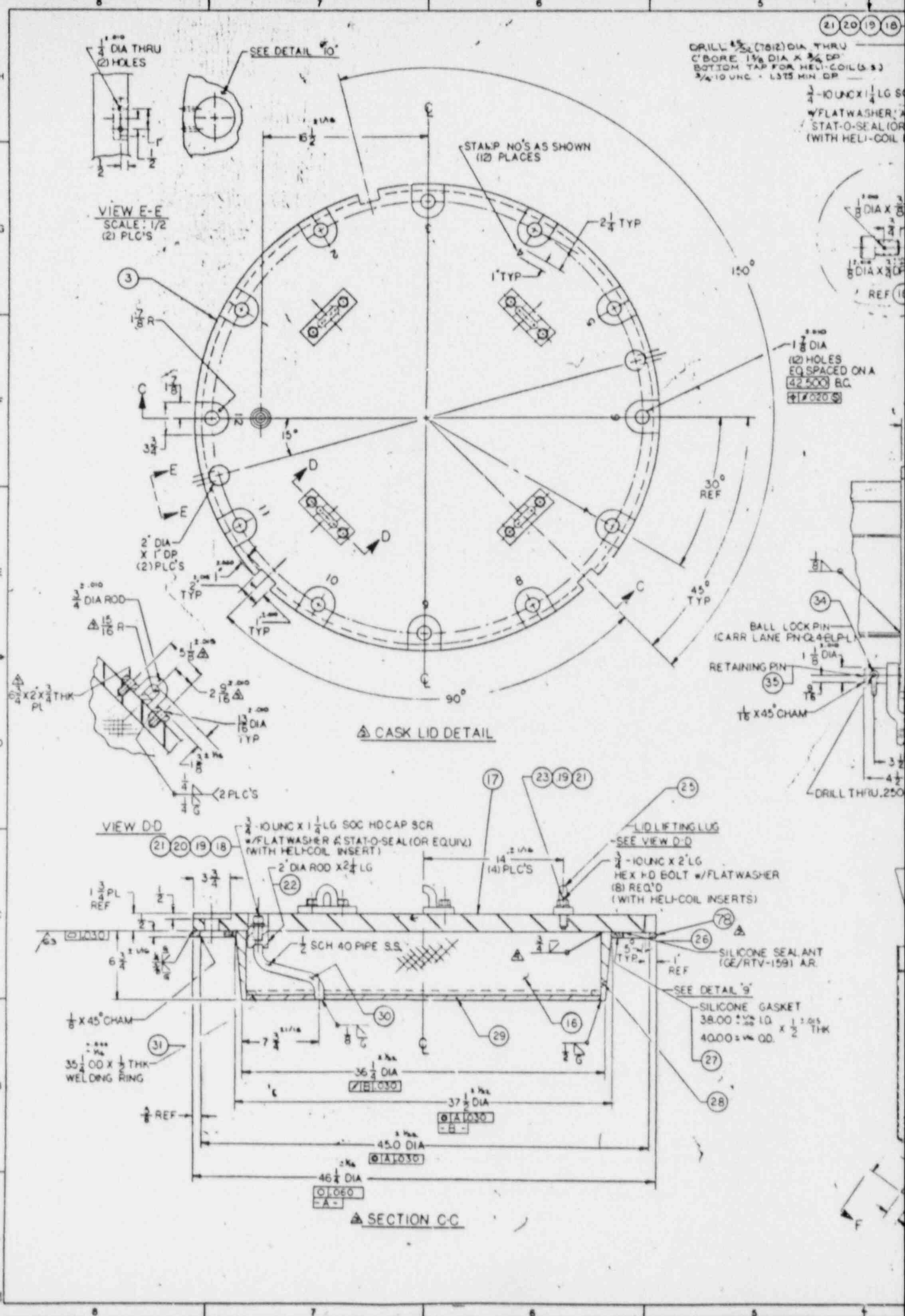
6423-310

83E0337

TI
APERTURE
CARD

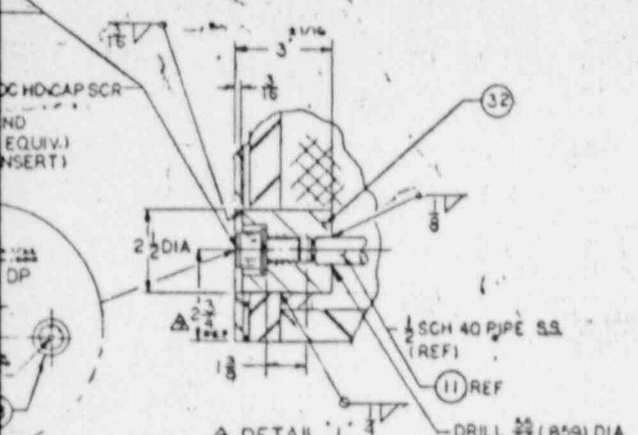
Also Available On
Aperture Card

2-66



VIEW E-E
SCALE: 1/2
(2) PLC'S
SEE DETAIL "10"
STAMP NO'S AS SHOWN
(12) PLACES
1" TYP
150°
1 7/8 DIA
(12) HOLES
EQ SPACED ON A
42.500 B.C.
30° REF
45° TYP
90°
15°
2" DIA X 1" DP
(2) PLC'S
3/4 DIA ROD
6 3/4 X 2 X 3/4 THK PL
CASK LID DETAIL
DRILL 25/32 (.7812) DIA THRU
C'BORE 1 1/8 DIA X 3/4 DP
BOTTOM TAP FOR HELI-COIL (S.S.)
3/4-10 UNC X 1 1/4 LG SOC HD CAP SCR
w/FLATWASHER & STAT-O-SEAL (OR EQUIV.)
(WITH HELI-COIL INSERT)
BALL LOCK PIN
(CARR LANE PN-CL-4-BLP-L)
RETAINING PIN
1/16 X 45° CHAM
DRILL THRU .250
VIEW D-D
2" DIA ROD X 2 1/4 LG
14" (4) PLC'S
LID LIFTING LUG
SEE VIEW D-D
3/4-10 UNC X 2" LG
HEX HD BOLT w/FLATWASHER
(8) REQ'D
(WITH HELI-COIL INSERTS)
1 3/4 PL REF
1/2 SCH 40 PIPE S.S.
SILICONE SEALANT
(GE/RTV-159) A.R.
SEE DETAIL "9"
SILICONE GASKET
38.00 I.D. X 1/2 THK
40.00 O.D.
1/8 X 45° CHAM
35 1/4 OD X 1/2 THK
WELDING RING
36 1/4 DIA
37 1/2 DIA
45.0 DIA
46 1/4 DIA
SECTION C-C

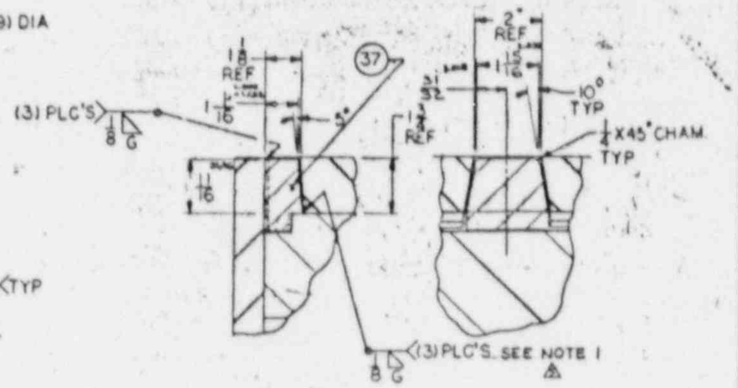
ZONE	NO.	DESCRIPTION	DRAWN	DATE	CHECKED	APPROVED
—	1-2	NO CRA, REF: W.M.S. 402	[illegible]	[illegible]	JOD	[illegible]
AS SPEC	3	GENERAL THROUGHOUT SEE CRA 4959	[illegible]	[illegible] 85	[illegible]	[illegible]
C-6	4	3/4 WELD WAS 5/8 WELD SEE CRA 5005	[illegible]	[illegible]	JOD	[illegible]
[illegible]	5	GENERAL THROUGHOUT SEE CRA 5649	JDH	7-2-87	JOD	[illegible]
A1	6	REVISED PER CRA [illegible] PROPRIETARY STATEMENT REMOVED	RJR	1-5-88	[illegible]	[illegible]



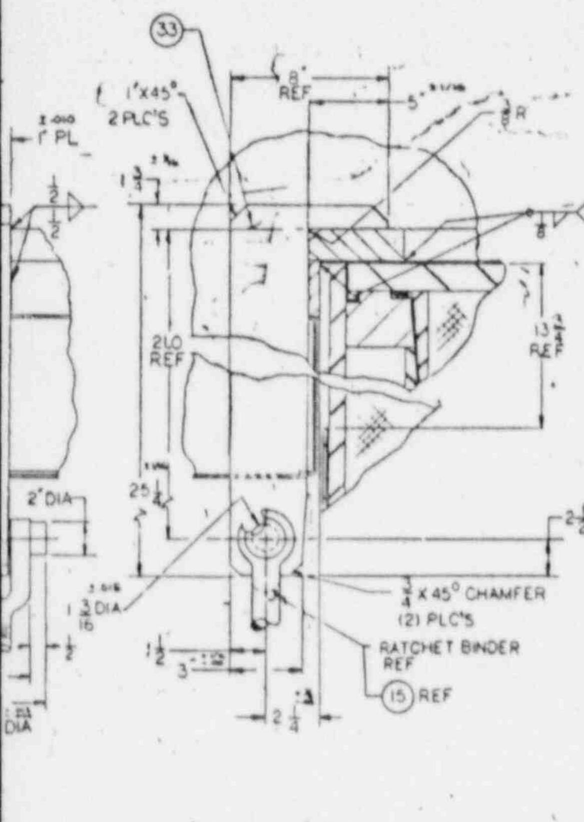
DETAIL '1'
SCALE: 1/2

NOTES:

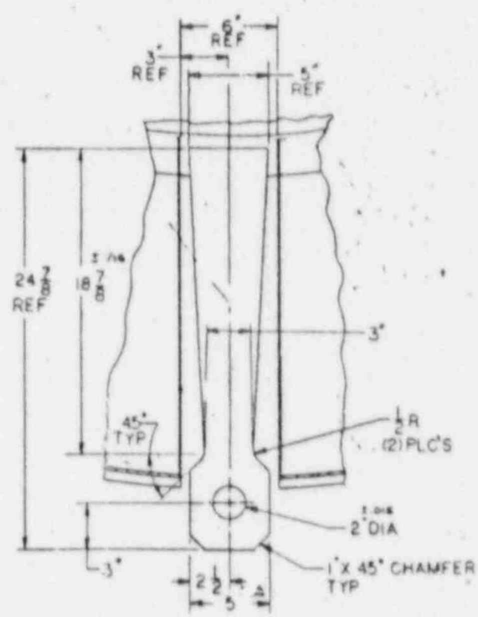
1. IF WELDER ACCESIBITY IS A PROBLEM, A 1/8 FILLET WELD MAY BE SUBSTITUTED AS REQUIRED. WHERE FILLET WELD IS EMPLOYED GRIND 3/16 MAXIMUM CHAMFER ON LID TO ELIMINATE INTERFERENCE (PN 37).
2. AS AN OPTION, THE LID KEY (ITEM 78) AND LID TOP PLATE (ITEM 17) CAN BE MACHINED FROM ONE PIECE OF PLATE INSTEAD OF WELDING AS SHOWN.



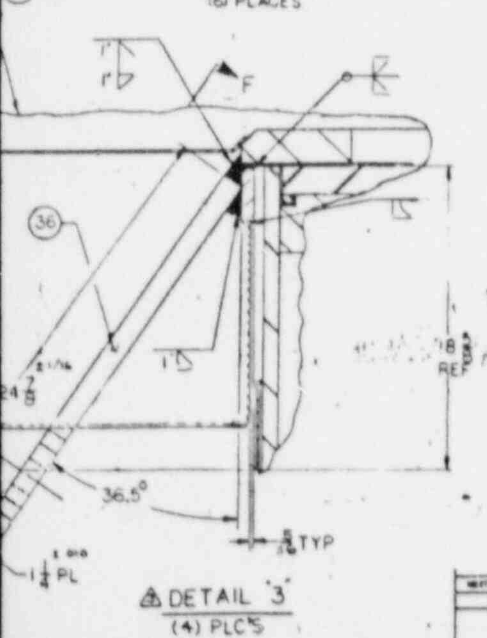
DETAIL '4'
SCALE: 1/2
(CASK LID KEY)
(3) REQ'D



DETAIL '2'
(6) PLACES



VIEW F-F



DETAIL '3'
(4) PLC'S

8801260493-02

TOLERANCES UNLESS OTHERWISE SPECIFIED: ± 1/32; ± .020; ± 1/64; ± 30'; ± 1/16

APPROVALS	DATE
DRAWN [illegible]	[illegible]
CHECKED JRD	[illegible]
SHIELD [illegible]	[illegible]
STRUCT [illegible]	[illegible]
THERM [illegible]	[illegible]
P.M. [illegible]	[illegible]
Q.M., WMS [illegible]	[illegible]
Q.A. [illegible]	[illegible]

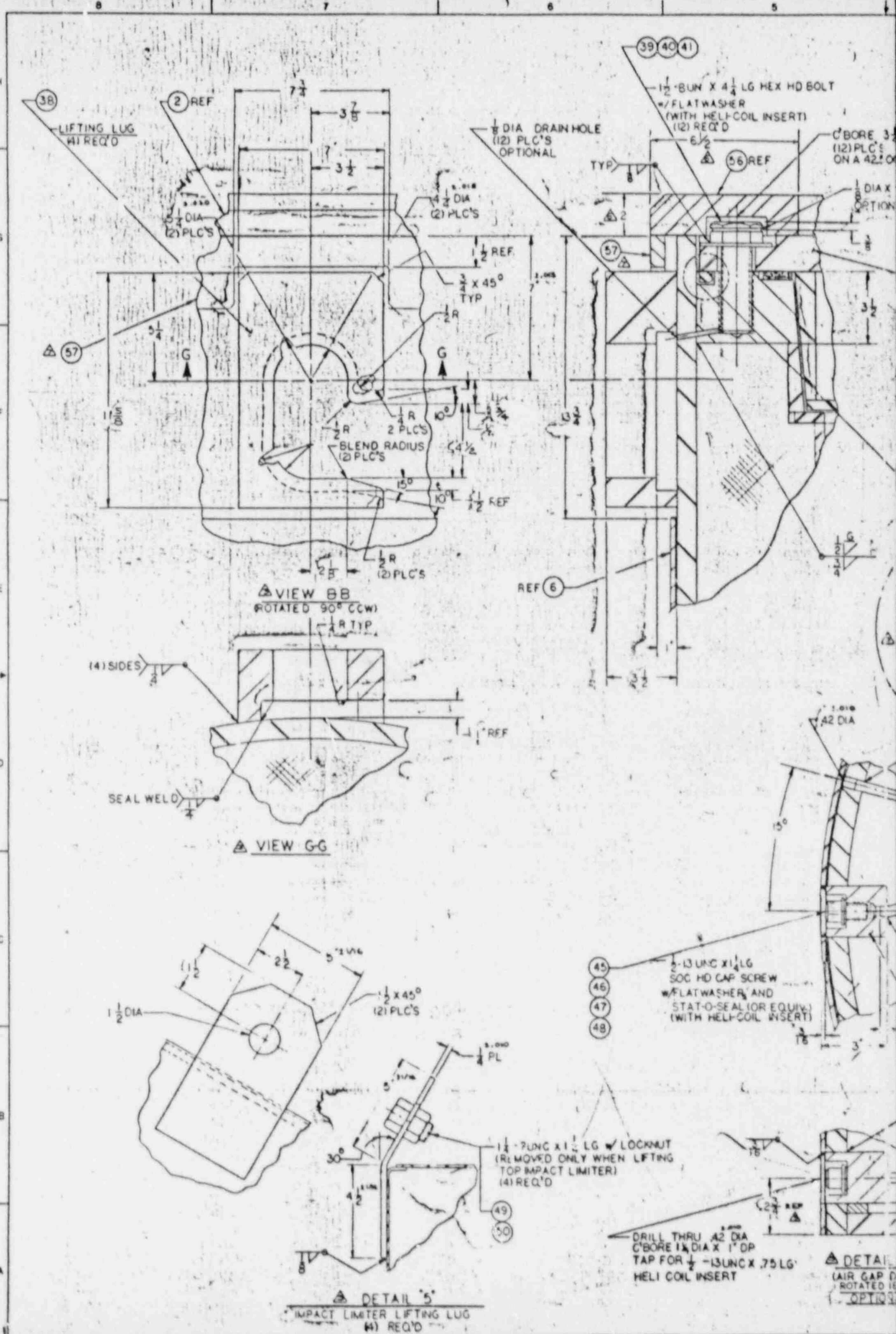
nes

TITLE: DETAILS: SHEET 1
MODEL: NES-5 PACKAGE

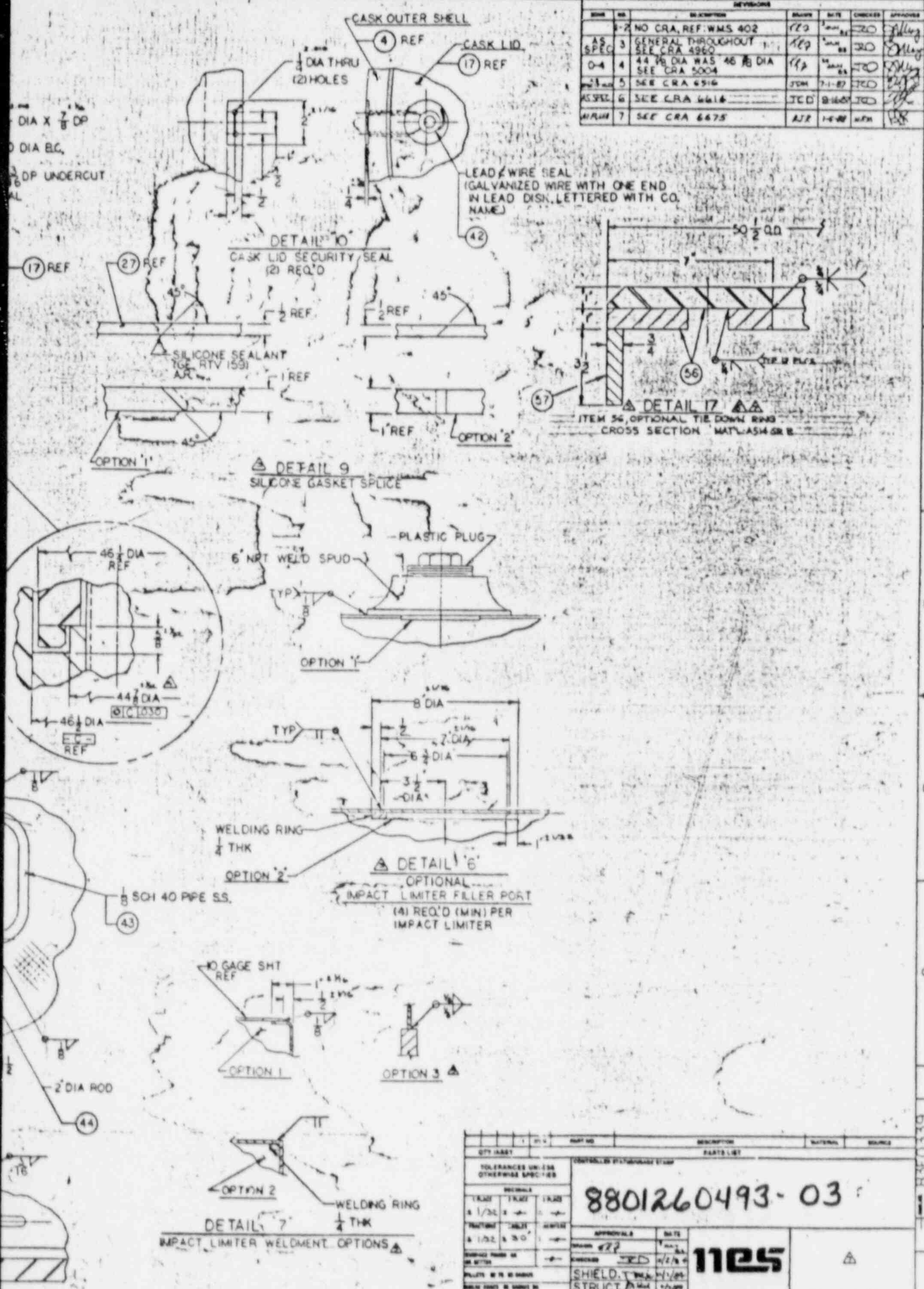
SIZE	FSCM NO.	DRAWING NO.	REV
E	53603	83E0338	6

PROJECT/TASK 6423-310 SCALE 1/4

2-67



LIFTING LUG (4) REQ'D
REF
VIEW BB (ROTATED 90° CCW)
VIEW G-G
SEAL WELD
(4) SIDES
BLEND RADIUS (2) PLC'S
1 1/2 DIA
(2) PLC'S
DETAIL 'S' IMPACT LIMITER LIFTING LUG (4) REQ'D
1 1/4 - 7UNC X 1 1/2 LG w/ LOCKNUT (REMOVED ONLY WHEN LIFTING TOP IMPACT LIMITER) (4) REQ'D
1/8 DIA DRAIN HOLE (12) PLC'S OPTIONAL
1 1/2 - 8UN X 4 1/4 LG HEX HD BOLT w/ FLATWASHER (WITH HELI-COIL INSERT) (12) REQ'D
REF 6
1/2 - 13 UNC X 1 1/4 LG SOC HD CAP SCREW w/FLATWASHER AND STAT-O-SEAL (OR EQUIV.) (WITH HELI-COIL INSERT)
DRILL THRU .42 DIA C'BORE 1 1/8 DIA X 1" DP TAP FOR 1/2 - 13UNC X .75 LG HELI COIL INSERT
.42 DIA
DETAIL
(AIR GAP D



REVISIONS

ZONE	NO.	DESCRIPTION	DRAWN	DATE	CHECKED	APPROVED
	1-2	NO CRA, REF: WMS 402				
AS SPEC	3	GENERAL THROUGHOUT SEE CRA 4960				
D-4	4	44 7/8 DIA WAS 46 7/8 DIA SEE CRA 5004				
	5	SEE CRA 6516	JDM	7-1-87		
AS SPEC	6	SEE CRA 6616	JCD	8-16-87		
	7	SEE CRA 6675	AJR	1-6-88		

PARTS LIST

TOLERANCES UNLESS OTHERWISE SPECIFIED

8801260493-03

APPROVALS

SHIELD.
STRUCT.
THERM.
P.M.
Q.M. WMS
Q.A.

nes

DETAILS: SHEET 2
MODEL NES-5 PACKAGE

E 53603 83E0339 7

6423-310

SCALE 1/2

83E0339

TI
APERTURE
CARD

Also Available On
Aperture Card