TECHNICAL DIVISION
SAVANNAH RIVER LABORATORY
MECHANICAL DEVELOPMENT GROUP

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Derivative Classifier: Richard G. Wallace

CC: C. W. Smith
J. R. Knight
H. F. Sturm
M. D. Boersma
C. T. Randall
L. F. Landon
J. T. Carter
M. J. Plodinec
P. M. Allen
D. N. Cowart
H. P. Gibson
GTG (9)
SRL Records (4)

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April 14, 1989

TO: D. W. Wilkerson

FROM: D. L. Mensink D.L.M.

BUILDING 774A MINI-MELTER RESTORATION (U)

SUMMARY

Large scale mechanical improvements were made on the 100th scale glass melter in building 774A following a shutdown in November, 1988. The circumstances regarding that shutdown were reported by P. M. Allen in DPST-89-345. By request, the Mechanical Development Group assumed responsibility for the work on SRL Service order DS-87042. This report describes the changes which were made, their purpose, and observations as to their effectiveness after approximately 4 weeks of operating with the improvements in-place. Recommendations for further improving the equipment are also noted.

The old melter design, now superceded, is documented in drawings ST5-23838 through ST5-23847. As-built drawing arrangements and details for the new work is shown in drawings SK5-6191-LD through SK5-6197-LD. Other design details are referenced in the drawings which were developed for the new shielded cells Research Melter, ST5-25111 through ST5-25124.

Most of design concepts used to modify the Mini-Melter were replicated from the new Research Melter, a Mechanical Development Group project that was commissioned earlier on SRL service order DS-87028. These improvements were possible, mostly in part, due to available spare parts and documented design for the new generation Research Melter.

This work represents over 80 man-days of Mechanical Development effort (Project Assistant effort included) committed to the DWPF research program within the period from December 1988 to February 1989. Clearly, this obligation to DWPF was essential in meeting their desired target time period of 8 weeks from initial review. In spite of the holiday season, the work was completed within one week of projection. Exceptional support from the SRL shops and the use of Computer Aided Design tools were essential factors.

DESIGN MODIFICATIONS

Reduced air in-leakage

The problem of excessive air in-leakage in the melter has been well documented. The primary source was the pour chamber and door. Air was drawn directly in around the door, through the pour chamber and into the plenum. Air could also be drawn into the plenum through leaks around the penetrations for each of 3 Silicon Carbide bayonet heaters used to heat the Pour Chamber.

Air in-leakage through the pour chamber is blocked by isolating the pour chamber within a 1/8" thick stainless steel box. The box measures 12" wide x 18" high x 8" deep. Edges around the open side in front of the box are seal welded where they intersect with the lower half of the melter shell. Leaks between the box and the insulation filled lid are restricted by close fits (see reference SK5-6191-LD, front view of melter). Slack sections between those surfaces are packed with Kaowool bulk fiber wool and paper products. A seal is established in the space above the top of the box with two rows of compressed packing constructed by loose rolling 1/8" Kaowool 2300 paper into 3/4" Dia. x 1/4" wall tubular lengths.

A secondary source of air in-leakage existed at the opening for the bayonet lid heaters. There was an approximately 4" high x 10" long rectangular opening in the side shell of the lid. This opening exposed the ends of (2) 1.5" Dia. mullite refractory sleeves loosely fit into holes through insulation in the lid. 3/4" Dia. silicon carbide bayonet lid heaters rested loosely in these sleeves. The ends of the sleeves tubes and openings in the insulation provided in-leakage direct to the plenum. This is corrected by redesign of the lid heaters.

Recommendation:

Because the melter system presently has no means for determining vacuum levels in the plenum, there is no adequate method to evaluate the magnitude or acceptability of in-leakage levels. In light of our desire to emulate DWPF air to glass ratios, the future addition of a vacuum measuring device for the plenum is recommended in order to properly assess leak rates and establish design direction. The unused sampling port in the lid would be a good location for installing a manometer.

Improved Lid Heater Design

The lid heaters were redesigned in the same fashion as the new Research Melter, including an improved mounting method (see reference ST5-25114). A 3/4" Dia. silicon carbide bayonet heater is inserted into a protective McDaniel mullite tubular sleeve and the terminal end is cast into a stainless steel housing with Saueriesen No. 31 Cement. This forms a modular cartridge which is then gasketed and bolted, air tight, to the melter shell. Housings are constructed of a gasket seating flange ring welded to a short length of corrugated stainless steel hose. The hose corrugations keep the terminals cool. The heaters were purchased with longer active heating lengths (corresponding with an enlarged plenum space) for improved start-up heating.

Each lid heater is now supported concentrically within its protective sleeve by stacks of Kaowool paper rings located at inactive regions at the ends. This attenuates an undesirable condition in which the heaters rested in contact with the bottom of their protective sleeves. This point was brought to our attention by Carborundum, the manufacturer of the heating elements. Reduced heater life and premature failures were cited.

Improved glass pouring and pour chamber heating

The shutdown of the Mini-Melter was attributed in a large part to problems in pouring. Other similar problems in the past have resulted in many aborted runs. The correction of these problems was a primary objective in the design of the new Research Melter. Many of those design solutions for improved glass pouring in the Research Melter were incorporated into the rebuild of the Mini-Melter.

The inside diameter of the pour spout, though which glass flows, has been enlarged from 1/2" to over 0.8". A slot for venting has also been placed over top of the exiting leg section of the spout in order to prevent possible vapor lock in the bend.

Recommendation:

A similar slot should be added to the Research Melter. Vapor lock in the neck was not considered at the time that design was developed.

Heat losses to the Pour Chamber have been reduced greatly. Direct chimney losses into the plenum were eliminated by isolating the pour chamber as discussed earlier. The pour chamber has been shortened flush to the front of the melter so as to reduce convective losses at the exposed sides of the extension. This measure also reduces the amount of pour chamber volume to be heated.

Three 1/2" Dia. x 6" long silicon carbide bayonet heaters were used to heat the pour chamber. They were fragile and often broke during installation. Cantilever supported at the front of the melter, they were constantly stressed by their own dead weight and subject to mechanical abuse from canister handling operations as well as normal movements and vibrations of the melter structure. Their maximum combined heat output was 750 watts @ 117 VAC max. input. The 117 VAC max. input rating caused difficulties in balancing the 3 phase transformer which services the melter, a practice essential to efficient transformer operation.

Two highly durable semi-circular ceramic plate heaters were installed in the pour chamber. Total heating capacity is now 1500 watts. Their input voltage is 220 VAC which matches the lid heaters. This match simplifies load balancing on the transformer. In advantage of their semi-circular shape, we have oriented them in manner that the pour spout, the most critical surface, occurs at the focal point of heating. In short, we now deliver 100% more heat to 50% less pour chamber volume with far fewer heat losses in order to facilitate improved pouring.

Upper Shell (Lid) Repairs

Restoration of the Mini-Melter included complete removal of all internals from the shell including insulation. Upon examination of the empty shell we discovered severe stress corrosion cracking in the top of lid. This conclusion was confirmed by D. Bickford. Repairs were made consisting of a 1/8" stainless steel plate patch (see figure 1) welded to the inside of the lid.

Plenum Residence Time

As in the Research Melter the plenum volume is enlarged slightly to match the DWPF melter residence time. This is an important factor in off-gas characterization studies.

Improved Plenum Heating

Two lid heaters, located in the plenum, supplied heat necessary for start-up. During operation they provide trim heating to stabilize the melting process and they maintain the melt during electrode outages. Before, the net available amount of heat was insufficient to assure smooth start-up of the unit.

The heaters were replaced with a new design outlined earlier in this report. Additionally, (2) extra heaters were installed from

the opposite side of the lid. The Mini-Melter now has a total of (4) lid.

The heating improvements, combined with air in-leakage reductions, are credited for the "effortless" start-up of the Mini-Melter this March.

Improved Tilt Mechanism

The current melters are tilted to pour. The present design of the tilting mechanism is inadequate. Premature failure of air actuating cylinders and jerking action during tilt have been cited. An improved tilting mechanism for the melters has been developed by D. N. Cowart in the LSD Mechanical Development Group. Dave plans to present his solution separately in another report.

Spill Protection

The old Mini-Melter had no means for containing glass in the event of melt chamber overflow. Correspondingly, there was no provision to avoid breech of electrical isolation between Melt potential and the outer shell of the melter.

A containment weir has been installed in the forward half of the secondary container. This weir will provide partial spill containment up to an estimated 15% of the melt volume. Although unlikely, overflows exceeding this margin will then be diverted away from structures which are connected to the shell.

This is not a problem in the new Research Melter.

Recommendation:

Development of a glass level indicating device in the melt chamber is recommended. This is consistent with strategies for avoiding overflow conditions and reducing demands for surveillance. Similarly, a device or system for indication of a full level in canisters should be investigated and then integrated into a reliable response system.

COMPARISON OF DESIGN - RESEARCH MELTER vs MINI-MELTER

In light of feature similarities between new Research Melter and restored mini-melter, a comparison of differences follows to place future melter performance evaluations in correct perspective. Because the new design holds several outstanding advantages, a continued program to replace the Mini-Melter is still recommended.

Both melters address the need for higher peak heating in the plenum. However, they differ in approach. The Mini-Melter has two extra heaters whereas the Research Melter is equipped with an Inconel 690 plate ceiling in the cover assembly. I anticipate significant amount of heat reflection will occur back into the plenum as a result of this ceiling.

The Research Melter is believed to be more air tight. The lid is seated in a more reliable manner. Although improved, the Mini-Melter envelope is compromised somewhat by a difficult seam between the lid and the upper portion of the pour chamber. This is avoided in the Research Melter by relocating the lid flange and casting the pour chamber into a separate shell. This new technique should enhance leak tightness between plenum and pour chamber.

Feed entrainment in the off-gas flow should be less of a problem in the new Research Melter. Here the off-gas nozzle is moved 2" further away from the feeding inlet. This may be important for demonstrating new feed atomization techniques in the melters.

The Research Melter pour spout has a bubble pump to assist pouring. The Mini-Melter does not.

Viewing the melt surface should be easier in the new Research Melter. The old sample port location is superceded with an additional sight viewing port. Both sight ports have larger diameters and are shortened to increase the view angle.

Door Modifications

A tightly gasketed door has been provided, an improvement which may enable the future development of differential pressure unloading. The door has been equipped with a sight glass for viewing the pour stream. Previously, no sight glass in the door existed. Operators were required to open the door in able to check canister levels and pouring status. Consequently, the new arrangement will conserve valuable plenum heat.

The door makes up to a stiff frame constructed of 1 5/8" stainless steel unistrut. Four quick make-up Destaco type clamps provide up to 600 lbf each for seating the door tightly closed. A special hinged davit has been provided for smooth door operations. When opened, the door can be quickly swung out of the working area, a very desirable feature for canister handling.

The door unexpectedly warped upon start-up of the Mini-Melter. This problem is typical of residually stressed 304 stainless steel plate products. I have presented, to P. M. Allen, a correction which involves the addition of stiffening structures. Logically, this recommendation should be implemented on both melters.

MISCELLANEOUS IMPROVEMENTS

Special sealing and insulating electrical feed-thru fittings were purchased from the Conax Corp. to assure leak-proof electrical connections to the new pour chamber heaters. The feed-thru's are constructed of 1/4" Dia. Nickel rods threaded at each end for 1/4-20 nickel jam nuts. Nickel provides good conductivity at the high pour chamber temperatures and good corrosion resistance. The

nickel parts were purchased from Standard Nut and Bolt in Cumberland, NY. I found them to be very economical.

Two additional feed-thru ports were provided in the door frame as spare ports for future use.

New Inconel 690 Electrodes were fabricated in the SRL shops as part of the work. As with the new Research Melter, their design is essentially duplicated from earlier documentation. During inspection of the welded assemblies it was found that joints in the 3/8" X 1/2" bus bars were not full penetration welded. They were butted without beveling and the seams were fused in manner which produced only partial penetration. Uncorrect, their current carrying capacity would have been severely limited. The deficiency is now corrected.

Five holes were drilled in the K-3 casting in the bottom of the Melt chamber and 5/8" OD x 1/4" ID x 1/2" deep ceramic wells were installed into those holes in conjunction with requirements of the noble metals campaign.

The Mini-Melter was restarted under power from a new electrical power supply. This is discussed elsewhere.

Special precautions were observed in handling of the Kaowool Refractory Ceramic Fiber (RCF) insulation. The procedures paralleled those required for asbestos handling.

Recommendation:

> **Investigation of suitable replacement insulating materials is recommended due to the high degree of health protection precautions mandated by the use of RCFs. Future DWPF programs will continue to demand the use of high performance insulation forms. Industry developments as well site policies concerning the health status of these materials should be closely monitored.**

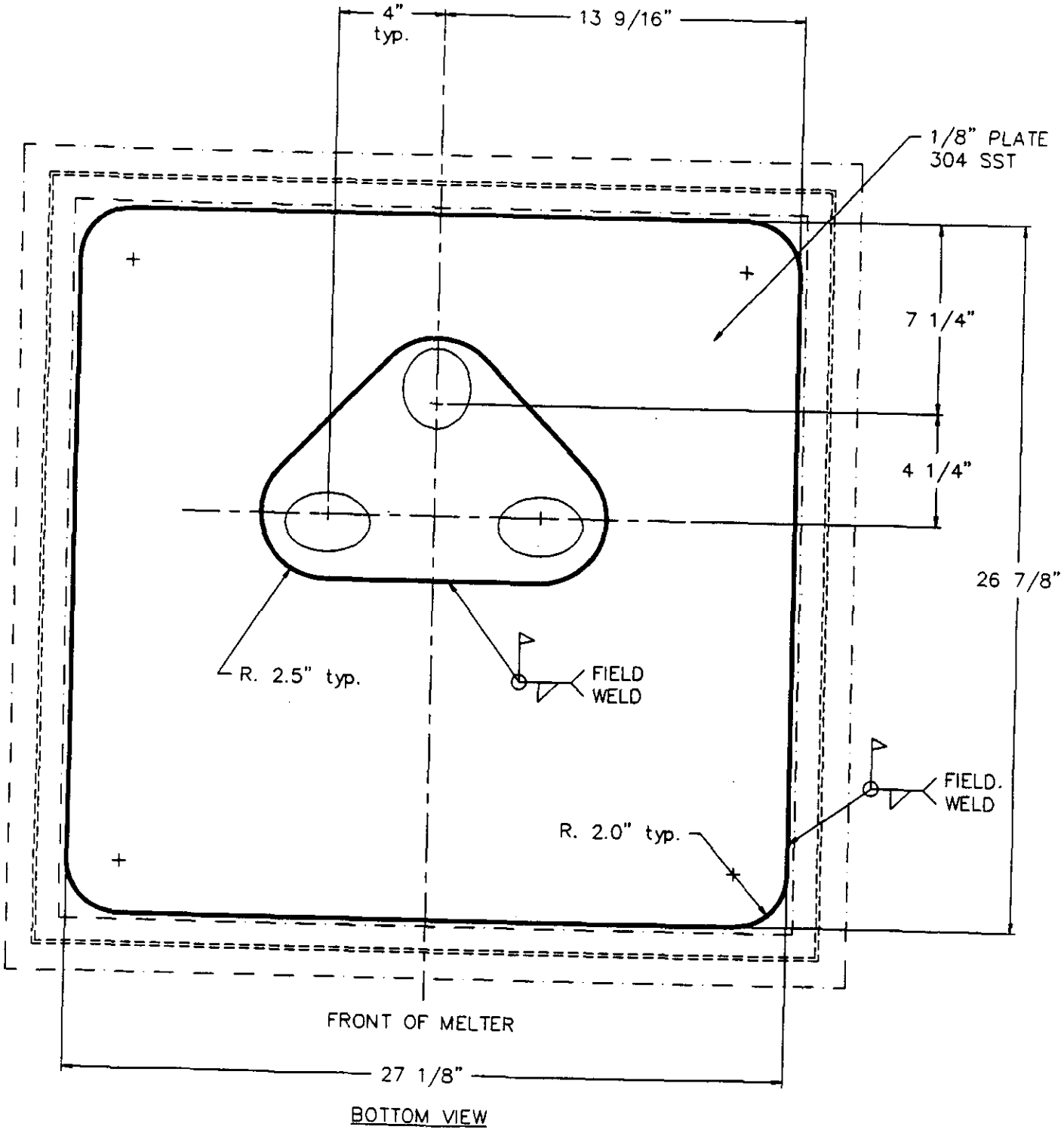
As illustrated by the door, this work has granted us an opportunity for evaluating new design changes pertinent to the Research Melter before it is commissioned to the Shielded Cells.

ACKNOWLEDGEMENTS

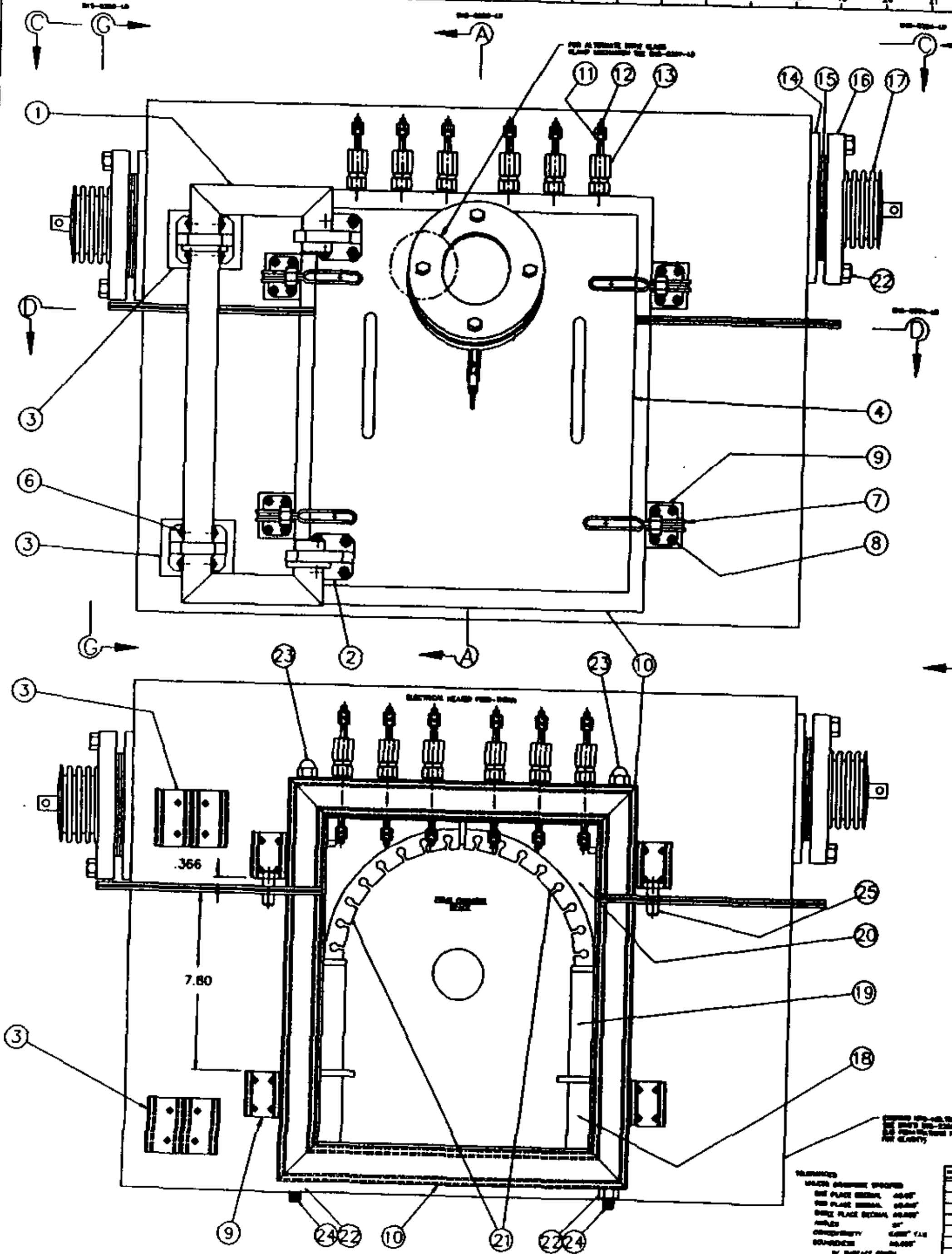
The success and timeliness of the work was due in large part to excellent support from the Melter Task Team. Special recognition is also warranted for the following individuals for their contributions which were absolutely essential for meeting this objective: Don Diamond and George Hammack for melter construction and help in project coordination; Ron Blessing for documenting the work and aiding in construction; David Healy for help with the insulation; and Mike Stowell, Jerry Okeson, Jeff Cunningham, Bobby

Bryant and the SRL shops for the timeliness and quality of part fabrication.

FIGURE 1
MINI-MELTER RESTORATION
PATCH PLATE FOR LID



BOTTOM VIEW



VIEW F - F

VIEW F - F
(DOOR REMOVED FOR CLARITY)

ITEM	QUAN.	PART/DRWG	DESCRIPTION	MAT'L
25	2	COMM'L	DOWEL PIN, 3/8" D. x 1.5" LONG	304 SST
24	4	COMM'L	ROD, 1/2-13UNC THREADED x 10.5" LONG	ASTM A193-B7
23	4	COMM'L	NUT, 1/2-13UNC, ACORN TYPE	304 SST
22	8	COMM'L	NUT, 1/2-13UNC, HEAVY HEX	304 SST
21	2	COMM'L	THERMCRAFT QUARTER SECTION PLATE HEATER	P/N 3000
20	1	COMM'L	INSULATING PACKING	KAOWOOL
19	2	COMM'L	M-BOARD, 1" THK x 6 1/4" x 6"	KAOWOOL
18	2	COMM'L	M-BOARD, 1" THK x 1 5/8" x 6"	KAOWOOL
17	4	STD-[illegible]114	LID HEATER SUB-ASSEMBLY	VARIES
16	4	STD-[illegible]114	LID HEATER ANCHOR PLATE	304 SST
15	4	[illegible]	4 1/2" O.D. x 1 3/4" I.D. x 1/8" THK.	KAOWOOL
14	2	SK5-6297-LD	LID HEATER END PLATE	304 SST
13	6	COMM'L	CONAX FEEDTHRU, P/N [illegible]-A-[illegible]	VARIES
12	6	COMM'L	[illegible]	NICKEL 80
11	24	COMM'L	NUT, 1/4-20UNC, HEAVY HEX	NICKEL 80
10	1	SK5-6297-LD	DOOR FRAME DETAIL	304 SST
9	4	SK5-6298-LD	CLAMP MOUNT	304 SST
8	10	COMM'L	SCREW, SOCKET HEAD CAP, 1/4-20UNC-1/2"LONG	304 SST
7	4	COMM'L	DESTACO CLAMP, #207-U[illegible]	304 SST
6	10	COMM'L	NUT, 1/4-20UNC	304 SST
5	1	SK5-6297-LD	DOOR GASKET	KAOWOOL
4	1	SK5-6297-LD	PART C, DOOR SUB-ASSEMBLY	304 SST
3	2	SK5-6298-LD	HINGE MOUNT	304 SST
2	2	SK5-6297-LD	PART B, DOOR HINGE	304 SST
1	1	SK5-6297-LD	PART A, HINGE ARM SUB-ASSEMBLY	304 SST

SK5-6291-LD

REVISIONS

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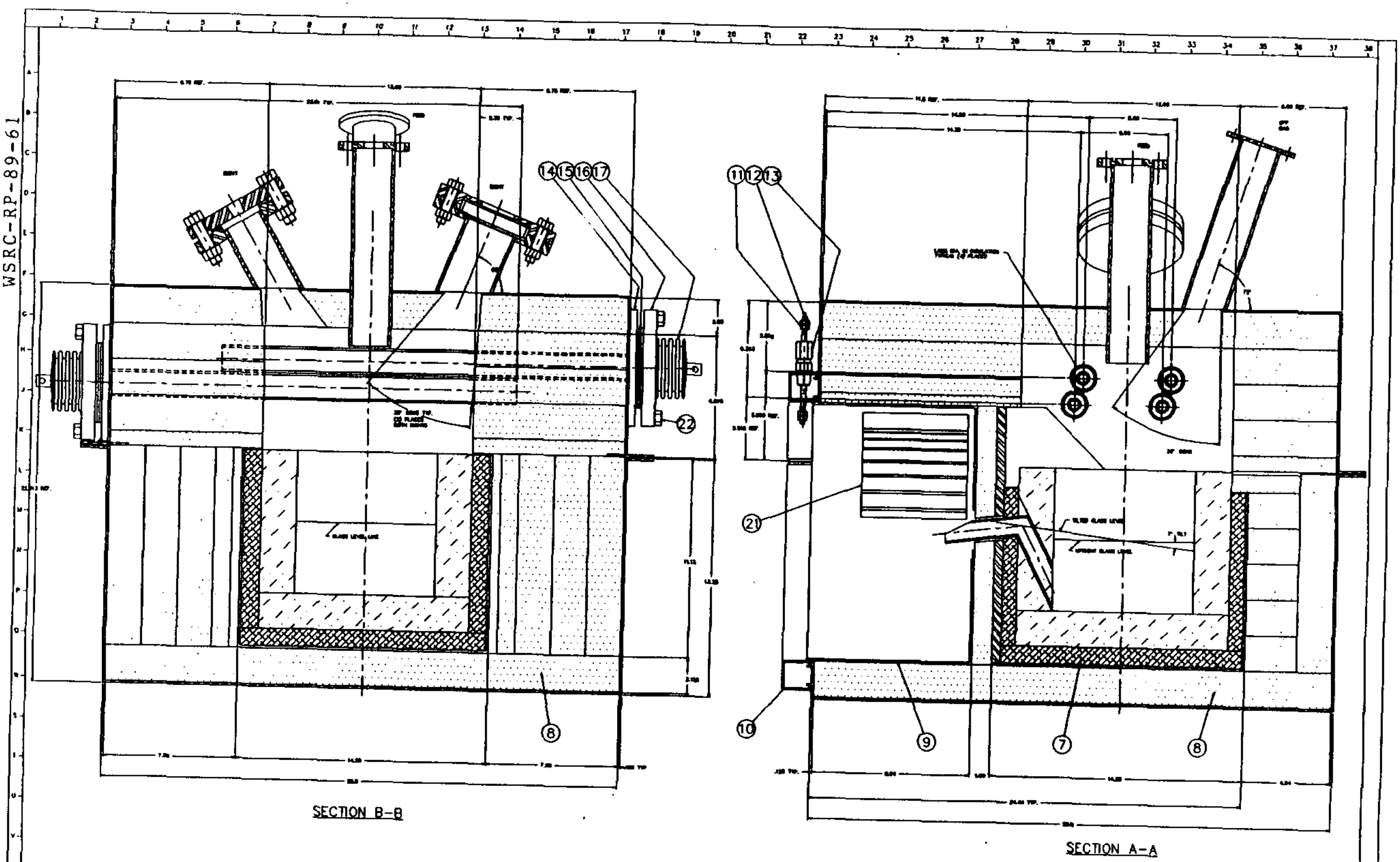
SAVANNAH RIVER PLANT

MINI-MELTER
REPAIRS & MODIFICATIONS
FRONT VIEWS
VIEW F-F

LATEST REVISION ON THIS DRAWING



ITEM	QUAN	PART/DRWG	DESCRIPTION	MATL
22	8	COMM'L	NUT, 1/2-13UNC, HEAVY HEX	304 SST
21	2	COMM'L	THERMCRAFT QUARTER SECTION PLATE HEATER	P/N 2086
17	4	STS-25114	LID HEATER SUB-ASSEMBLY	VARIES
16	4	STS-25114	LID HEATER ANCHOR PLATE	304 SST
15	4	GASKET	4 1/2" O.D. x 1 3/4" I.D. x 1/8" THK.	KAOWOOL
14	4	SK5-6297-LD	LID HEATER STUD PLATE	304 SST
13	6	COMM'L	CONAX FEEDTHRU, P/N EG250-A-SS-L	VARIES
12	6	COMM'L	[illegible]	NICKEL 60
11	24	COMM'L	NUT, 1/4-20UNC, HEAVY HEX	NICKEL 60
10	1	SK5-6297-LD	DOOR FRAME DETAIL	304 SST
9	1	SK5-6295-LD	POUR CHAMBER SUB-ASSEMBLY	304 SST
8	AS REQ'D	COMM'L	INSULATION 1/2, 1, 1 1/2, & 2" THK.	
7	1	SK5-6296-LD	MELT CHAMBER SUB-ASSEMBLY	304 SST

SK5-6292-LD

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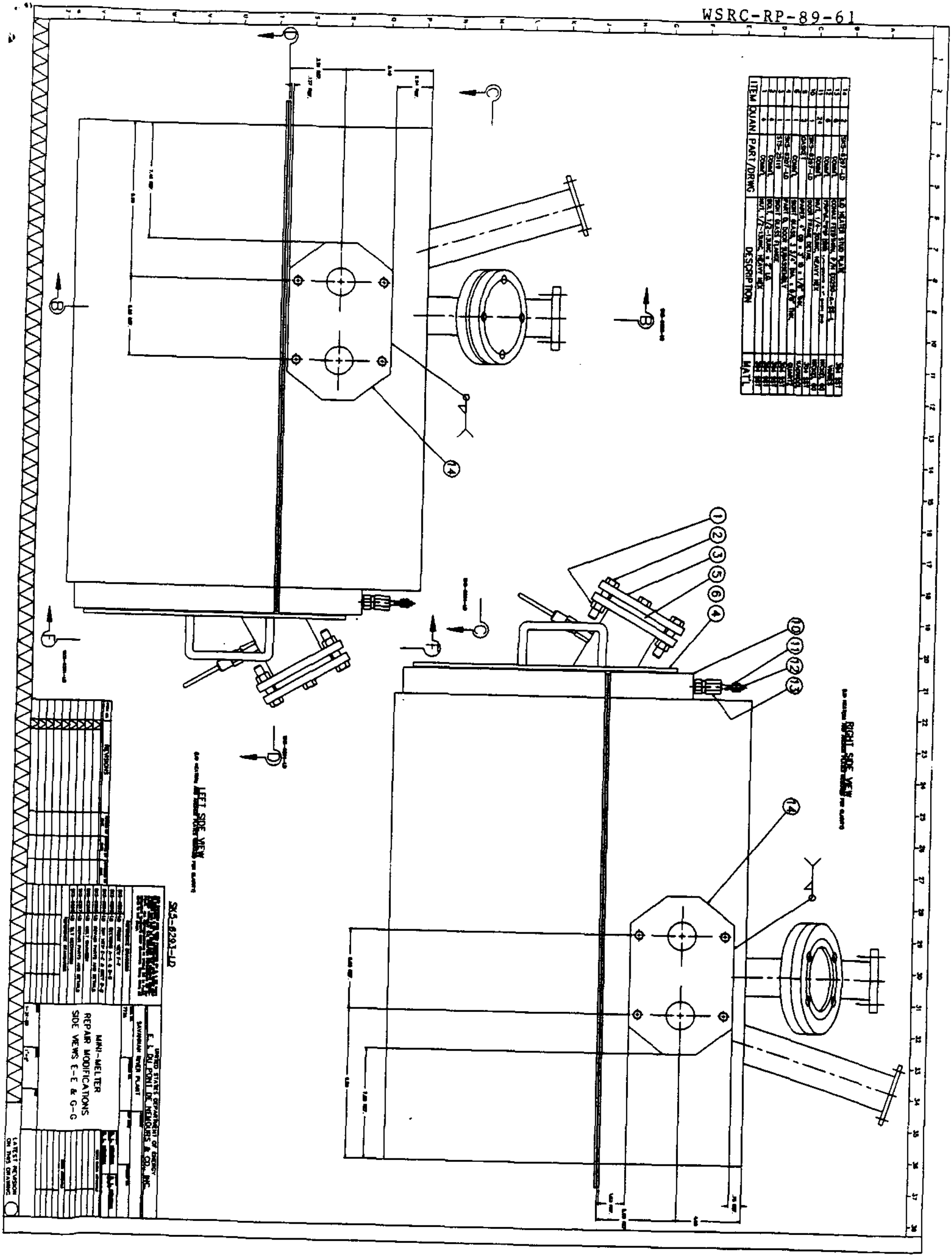
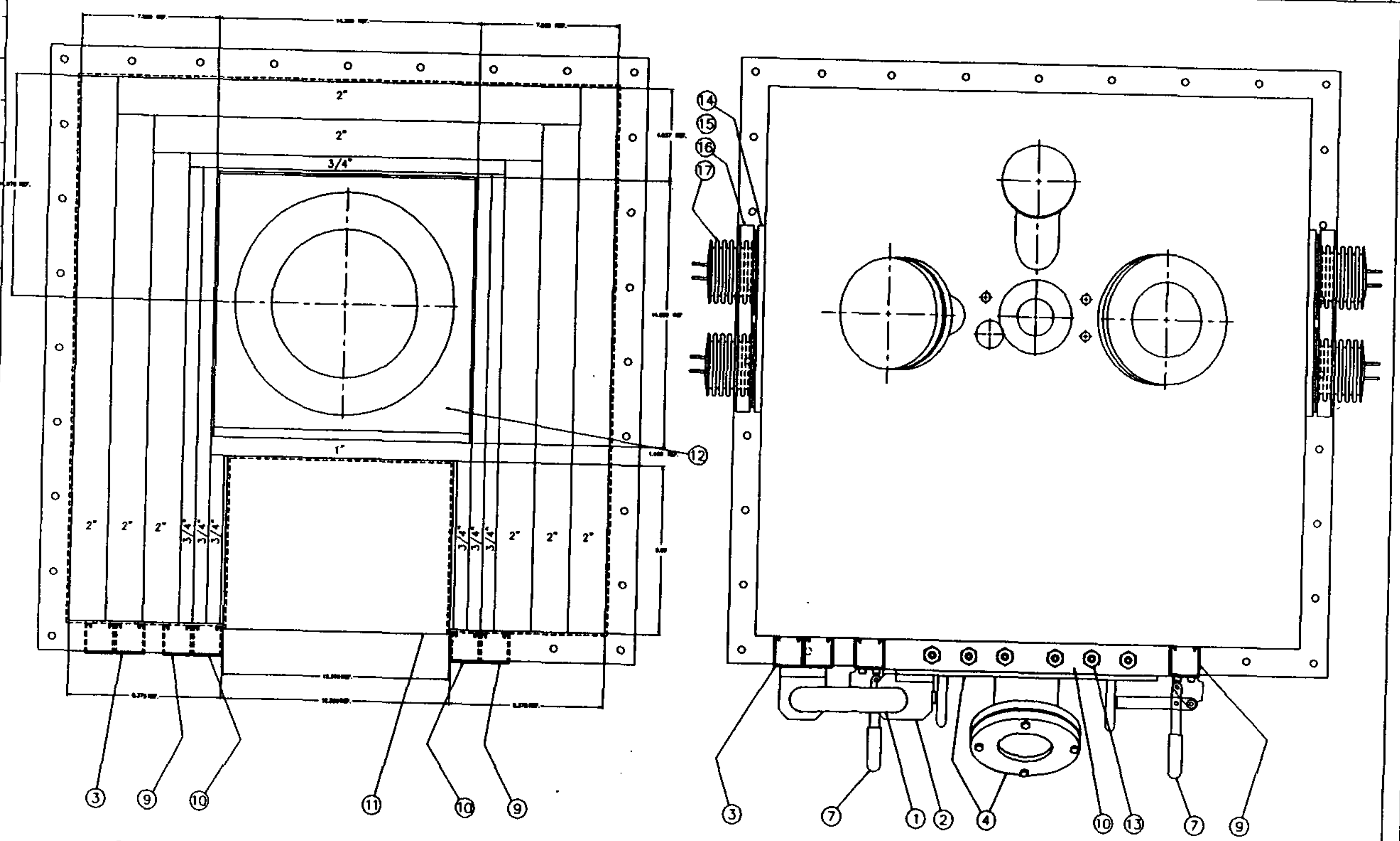
SAVANNAH RIVER PLANT

MINI-MELTER
REPAIR MODIFICATIONS
SECTIONS A-A & B-B

LATEST REVISION ON THIS DRAWING


ITEM
QUAN
PART/DRWG
DESCRIPTION
MAT'L
RIGHT SIDE VIEW
LEFT SIDE VIEW
REVISIONS
SK5-8293-LD
UNITED STATES DEPARTMENT OF ENERGY
E. I. DU PONT DE NEMOURS & CO., INC.
SAVANNAH RIVER PLANT
MINI-MELTER
REPAIR MODIFICATIONS
SIDE VIEWS E-E & G-G
LATEST REVISION ON THIS DRAWING



ITEM	QUAN	PART/DRWG	DESCRIPTION	MAT'L
17	4	STS-25114	LID HEATER SUB-ASSEMBLY	VARIES
16	4	STS-28114	LID HEATER ANCHOR PLATE	304 SST
15	4	GASKET	4 1/2" O.D. x 1 3/4" I.D. x 1/8" THK.	KAOWOOL
14	1	SK5-6207-LD	LID HEATER STUD PLATE	304 SST
13	6	COMM'L	CONAX FEEDTHRU, P/N EG250-A-SS-L	VARIES
12	1	SK5-6296-LD	MELT CHAMBER SUB-ASSEMBLY	VARIES
11	1	SK5-6295-LD	POUR CHAMBER SUB-ASSEMBLY	304 SST
10	1	SK5-6297-LD	DOOR FRAME DETAIL	304 SST
9	4	SK5-6293-LD	CLAMP MOUNT	304 SST
7	4	COMM'L	DESTACO CLAMP, #207-UBS	304 SST
4	1	SK5-6207-LD	PART D, DOOR SUB-ASSEMBLY	304 SST
3	1	SK5-6295-LD	HINGE MOUNT	304 SST
2	2	SK5-6207-LD	PART B, DOOR HINGE	304 SST
1	1	SK5-6207-LD	PART A, HINGE ARM SUB-ASSEMBLY	304 SST

SK5-6294-LD

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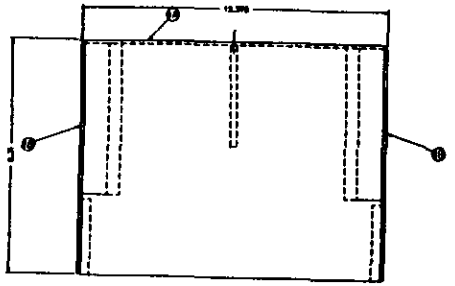
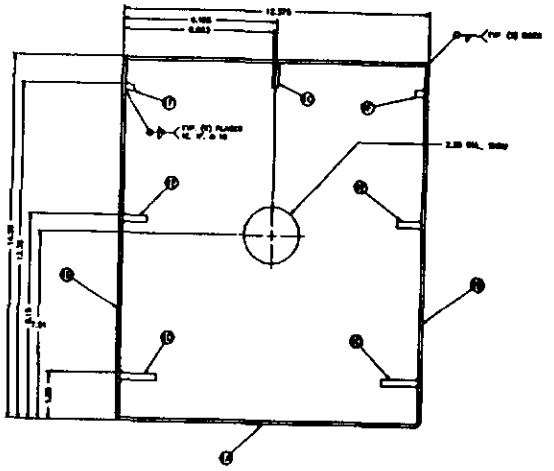
SAVANNAH RIVER PLANT

MINI-MELTER
REPAIR MODIFICATIONS
VIEWS D-D & C-C

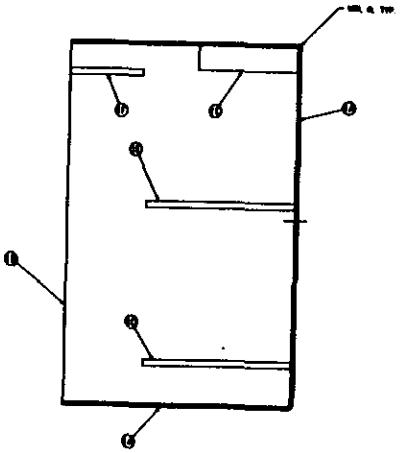
LATEST REVISION ON THIS DRAWING

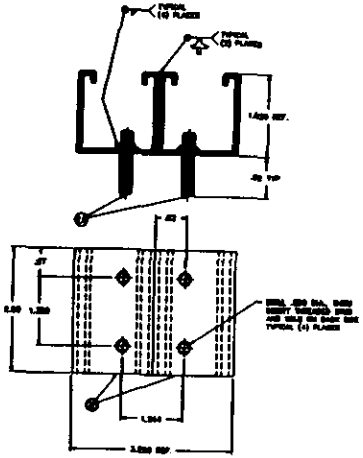
WSRC-RP-89-61



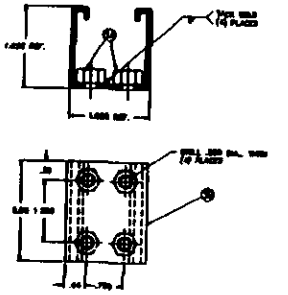


POUR CHAMBER
(1) REQ'D





HINGE MOUNT
(2) REQ'D



CLAMP MOUNT
(4) REQ'D

ITEM	QUAN	PART/DRWG	DESCRIPTION	MATL
25	1			
24	1			
23	1			
22	1			
21	2			
20	2			
19	2			
18	1			
17	1			
16	2			
15	1			

SK5-6295-LD

REVISION

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SAVANNAH RIVER PLANT

MRN-MELTER
REPAIR MODIFICATIONS
MISC. NEW PARTS AND DETAILS

LATEST REVISION ON THIS DRAWING

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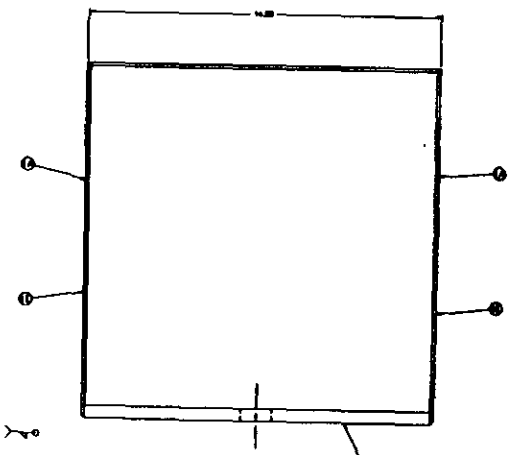
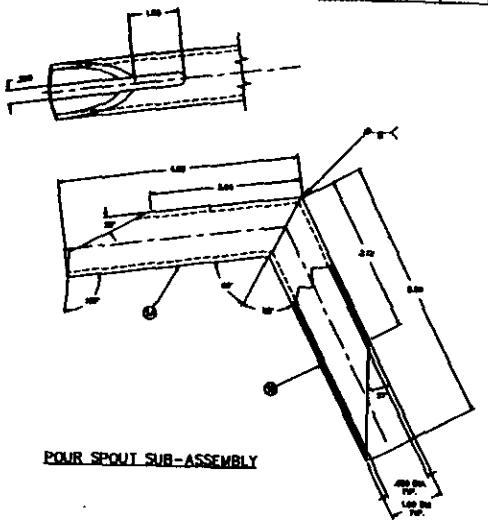
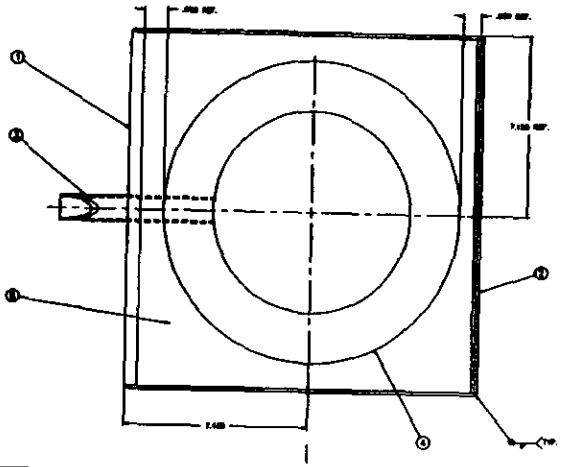
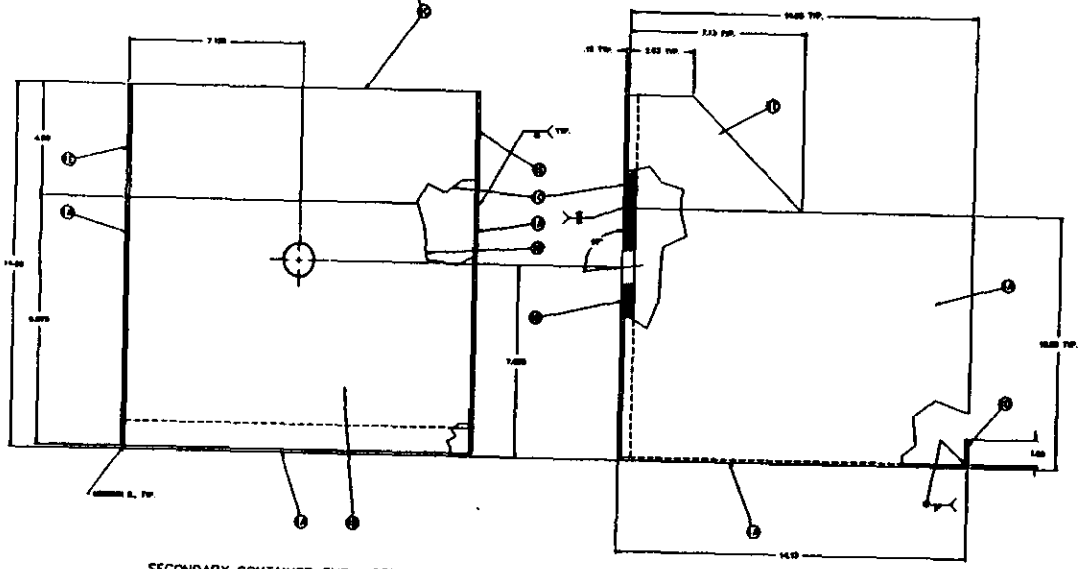


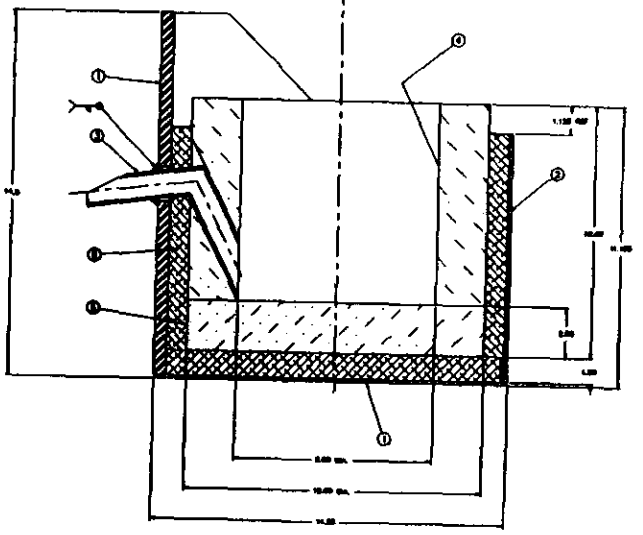


POUR SPOUT SUB-ASSEMBLY





SECONDARY CONTAINER SUB-ASSEMBLY



MELT CHAMBER SUB-ASSEMBLY

ITEM	QUAN	PART/DRWG	DESCRIPTION	MATL
9	1			
8	1	MELT CHAMBER CASTING		
7	1			
6	1	POUR SPOUT		
5	1			
4	1	CONTAINER BODY WELD		
3	1	SECONDARY CONTAINER		
2	1			
1	1			

SK5-6298-LD

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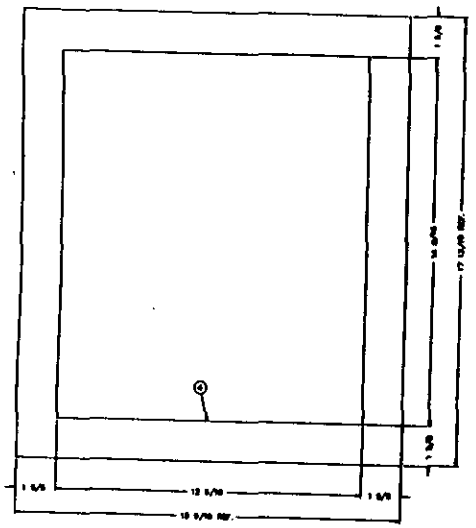
SAVANNAH RIVER PLANT

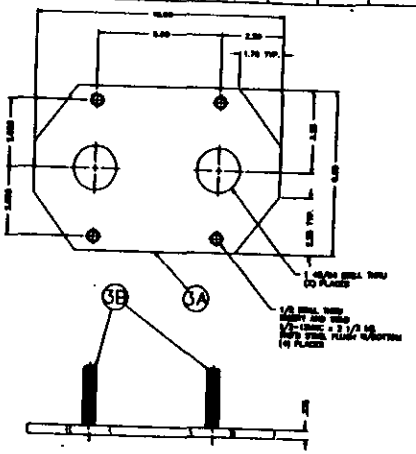
MINI-MELTER
REPAIR MODIFICATIONS
MELT CHAMBER
SUB-ASSEMBLY

LATEST REVISION ON THIS DRAWING

WSRC-RP-89-61

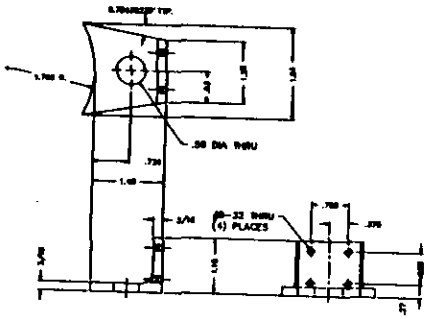


DOOR GASKET

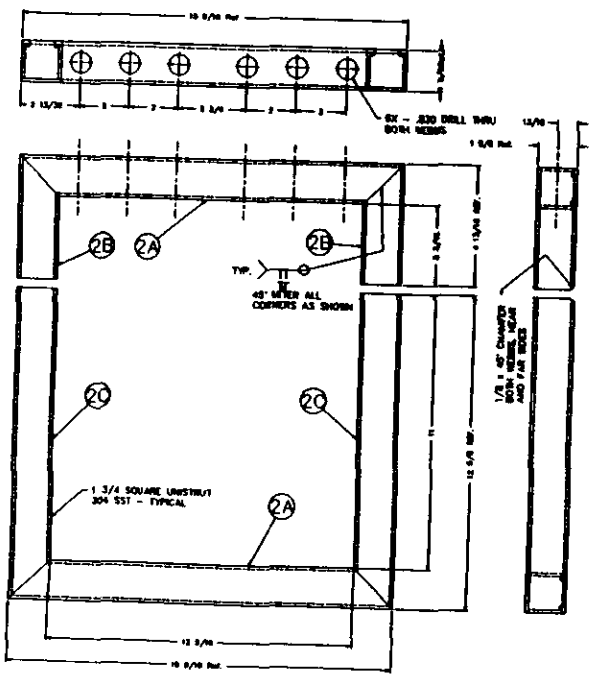


LID HEATER STUD PLATE SUB-ASSEMBLY
(2) REQ'D

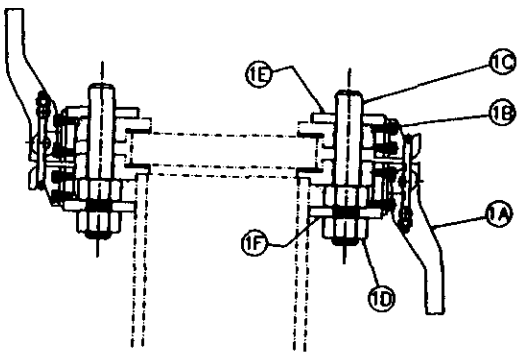
ITEM	QUAN	PART/DRWG	DESCRIPTION	MAT'L
4	1	DOOR GASKET	18 9/16±.17 13/16 O.S.I.† 5/8 WIDE†1/8 THK	
3B	4	LID HEATER		
3A	4	STUD PLATE	PLATE, 10.00 x 6.50 x .375 THK.	304 SST
2C	2	DOOR FRAME		304 SST
2B	2	" "	UNISTRUT, 1 5/8 x 1 5/8 x 12 5/8 LG.	304 SST
2A	2	" "	UNISTRUT, 1 5/8 x 1 5/8 x 6 13/16 LG.	304 SST
1F	1	PART "A"	UNISTRUT, 1 5/8 x 1 5/8 x 18 6/16 LG.	304 SST
1E	1	PART "B"	SEE DETAIL	304 SST
1D	1	COMM'L	SEE DETAIL	304 SST
1C	1	COMM'L	NUT, 1/2-13	304 SST
1B	6	COMM'L	THREADED STUD BOLT 1/2-13 x 3" LG	304 SST
1A	6	COMM'L	BACK #8-32 x .25" LONG	304 SST
	1	COMM'L	DESTACO CLAMP, #333-SS	304 SST



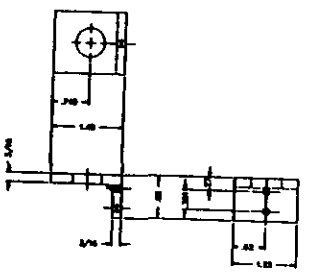
PART A
1 REQ'D/LOT
1.5" x 1.5" x 3/16" THK ANGLE
304 SST



DOOR FRAME SUB-ASSEMBLY



ALTERNATE SIGHT GLASS
CLAMP ARRANGEMENT



PART B
1 REQ'D/LOT
1.5" x 1.5" x 3/16" THK ANGLE
304 SST

SK5-8297-LD

UNITED STATES DEPARTMENT OF ENERGY
E. I. DU PONT DE NEMOURS & CO., INC.
SAVANNAH RIVER PLANT

MINI-MELTER
REPAIR MODIFICATIONS
REPAIR PARTS
AND DETAILS

REVISIONS

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Westinghouse
Savannah River Company

P.O. Box 616
Aiken, SC 29802

CC: W. F. Perrin, DOE-SR (1)
File(WSRC-RP-89-61)
BSF-ISG-89-0015

May 4, 1989

Ms. W. F. Perrin, Technical Information Officer
U. S. Department of Energy
Savannah River Operations Office
Aiken, SC 29801

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C. W. Smith, Manager
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(See SRP Procedures Manual Item 101)

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UC or C Number

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AUTHOR(S) D. L. MENSINK PHONE NO. 53367

TYPE: ☒ INTERNAL DOCUMENT ☐ EXTERNAL DOCUMENT
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