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**DWPF GLASS MELTER TECHNOLOGY MANUAL (U)
VOLUMES 1 - 4**

by

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DOE Contract No. DE-AC09-89SR18035

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WSRC-TR-93-587-Vol. 1
Revision 0
5 November 1993

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DWPF GLASS MELTER TECHNOLOGY MANUAL

VOLUME 1 - DESIGN BASIS

J. D. Gutmann, Jr
March 1989

Preface

The glass melter design for the Defense Waste Processing Facility was an active program in the DuPont Engineering Department from 1976 through the first quarter of 1989. During this time, the melter configuration evolved as additional process requirements and melter operating experience became available. Typically, the design for a component progressed through a series of conceptual studies and calculations before the final configuration was established. In addition to these paper studies, a considerable amount of melter design verification was based on tests, ranging from laboratory tests on individual components up to an operating 2/3 geometric scale prototype of the DWPF melter.

Several years ago, I recognized that a manual documenting the history and development of the DWPF glass melter would be useful as a reference for design verification and evaluating potential design changes. Information was obtained from the Engineering Department records center and from personal files of other engineers and consultants. Similar records were kept up-to-date as design and fabrication of the DWPF melter progressed. The final job of condensing this material, creating the illustrations, and preparing the manuscript was completed during the first quarter of 1989. The result is a four volume set: Volume 1 describes the design basis for the DWPF glass melter in 10 sections, Volumes 2 and 3 contain copies of the references, and Volume 4 contains drawing and parts lists for the Project 1941, Scale, and DWPF melters, and copies of the DWPF melter order specifications.

Although the manual describes how the glass melter design evolved, its primary purpose is to serve as a guide for evaluating proposed design changes for future melters. Although I do not expect changes to be made to the fundamental configuration, cold run experience with Melter #1 may dictate desirable minor changes to some of the components. Before such changes can be evaluated and considered, the basis and intent of the current design must be understood and appreciated.

In line with these objectives, I have included descriptions of ideas and configurations that did not work, or fell short of meeting all objectives. There were some unexpected problems during the design development phase, but the knowledge gained from these resulted in improved component designs for the DWPF melter. Tests conducted with the Scale melter were very valuable in this respect. As a result, I am confident that Melter #1 will go through a smooth start-up and cold run test sequence.

The scope of this work is restricted to the glass melter vessels and melter components that were the responsibility of the Engineering Department. Extensive work by SRP, SRL, and Bechtel on the off-gas system and other related equipment is covered in other publications.

Although this has been a most challenging and difficult project for many of us, it has also been the most rewarding. On behalf of the melter design and engineering team at Louviers and Bucks County, I want to extend best wishes to our team members at the Savannah River Plant for a successful start-up of the DWPF facility.

Joseph D. Gutmann, Jr.

Acknowledgments

As on any large project, a considerable number of people have played a part in the design, development, and fabrication of the first two DWPF melter assemblies. This is particularly true of the melter vessel and its components, as there were numerous changes in people and responsibilities during the long development history. It is not possible to list everyone who participated, but I would like to acknowledge the contributions of those who were most closely involved and played key roles in the successful completion of this program:

The Mechanical design team at Bucks County, under the direction of J. S. Clayton, provided all of the drawings from early conceptual studies to final fabrication drawings for the glass melter program. This effort included the designs for all of following equipment:

- Project S-1941 melter prototype
- Project S-4234 Scale melter (2/3 scale of DWPF)
- Project S-1780 DWPF Melters 1 and 2
- half and full size working models of the DWPF melter top head and components
- components for all melters
- refractory fixtures for all melters
- alignment fixtures for DWPF components
- melter envelope drawings for Bechtel to support their design effort

In addition to the drawings, the design team made many calculations for weight, thermal expansion, and other design related requirements. A considerable amount of work was accomplished during a period of many design and scope changes. For all of this effort, our thanks to the primary Allstates design team at Bucks County : J. S. Clayton, O. M. Parks, E. W. Grey, R. P. Viccaro, and T. E. Racz.

J. E. Savoy and R. T. Britt were the lead designers at Louviers, and were responsible for following up and checking many details related to the design. J. E. Savoy sized the heating elements for the dome heaters, riser/pour spout heater, and drain valve. Together with O. M. Parks, he originated many of the concepts for remote handling. R. T. Britt provided most of the fabrication followup on the melter components, and calculations for Melters 1 through 3.

On the Louviers Mechanical Engineering team, A. W. Fretz and W. F. Senkowsky completed the original work on the Project S-1941 melter. W. F. Senkowsky and J. E. Savoy continued with the conceptual design of the DWPF melter until mid 1982.

J. D. Gutmann, Jr. was the lead engineer for the melter program beginning in the second quarter of 1982, and was responsible for preparing the initial order specifications and placing the orders for the Scale and DWPF melter vessels and components. Continued responsibilities on the DWPF

Acknowledgments

melter included the melter vessel and refractory, coordinating the design efforts for the bottom refractory, electrodes, dome heaters and riser/pour spout heater configurations, contributing information to the installation procedure package, and assisting SRP Construction with the refractory dry out and installation of shell components on Melter #1. Fabrication follow-up of the #2 melter vessel and refractory continued through February, 1989.

J. Scafaria followed up the fabrication of the major melter components during a period of many design changes, and together with J. E. Savoy and R. T. Britt prepared the extensive procedure package for installing Melter #1 and #2 components. This same group and O. M. Parks assisted Construction with the installation of the melter top head components on Melter #1.

B. J. Etienne followed through with design completion of the drain valve and pour spout bellows, writing test and installation procedures, and coordinating the test programs to prove out these components.

E. S. Mazanek was involved with the early drain valve studies, the full size top head working model, and the recent IDMS melter project.

J. S. Duskas contributed a number of suggestions and ideas to improve melter components.

Our task was made easier with the assistance provided by consultants and specialists at Louviers. These included F. W. Thompson, R. N. McCormick, H. F. Hublein, V. E. Mello, E. H. Perez, R. C. Yohn, R. J. Thomas, J. C. Cahill, R. J. Bolen, B. J. Schaaf, F. T. Wyman, W. F. Morrison, J. J. Kvochak, B. J. Tilley, J. R. Casper, S. L. Thaw, C. J. Erickson, T. R. Vick Roy, A. Q. Haideri and L. A. DeFrate.

Assistance was also provided behind the scenes by our Quality Assurance Field Representatives, who followed up fabrication details on all of the orders. Special thanks to P. W. Downs, H. C. Clark, and E. Vogel for their long-term commitments to our major orders.

The contributions by our fabrication vendors deserves mention. At no time did we have any difficulties or problems, either financial or technical, while working with the many vendors that furnished equipment on Engineering Department orders for Melters #1 and #2. There was a universal spirit of cooperation and assistance that made it a pleasure to work with these people. The overall quality was outstanding and represented the best efforts of many craftsmen. A list of our vendors is included in Section 10.

Many contributions to the glass melter program were made by various individuals at the Savannah River Plant. Among those who helped us directly with the 1941 and Scale melter testing and development were M. B. Cosper, A. F. Weisman, M. R. Baron, C. T. Randall and other members of the TNX group. Assistance with the assembly of Melter #1 was provided by T. G. Powell, J. N. Odum and others in the Construction crew, and B. K. Parsons, Bechtel National.

Special thanks to W. H. Harlow, R. G. Strauss and the mock-up shop crew for their cooperation and assistance during the component installation phase on Melter #1.

Credits

Manual Preparation

Several individuals contributed their time to assist with the preparation of this manual. Special thanks to E. W. Grey, J. E. Savoy, and Patti Caudell for many hours of sustained effort to help put this together. Other contributors were R. T. Britt, J. S. Scafaria, Karla Gutmann, and Pauline Kenyon.

Cover Art

The color drawing of the melter section appearing on the cover of each manual volume was created using a combination of traditional and new technology methods. The original artwork was arrangement drawing W-732366 made at Bucks County. This was run through a large scanner at SRL to create a bit mapped image, transferred to tape, and returned to Louviers for editing and adding section lines and titles using the Intergraph CAD system. Each major component or material was drawn in a separate layer and assigned a color. The master was printed with a color dot matrix printer on an 11 x 17 inch sheet and reduced with a Cannon color laser copier. A Macintosh computer and LaserWriter NTX printer were used to make the master for the title and text, a copy of the color melter drawing was pasted on the master, and the final reproduced again with the Cannon copier. M. J. Cochran, C. E. Engle, and J. E. Savoy worked as a team to create the original master drawing.

Illustrations

Most of the illustrations are a combination of reductions from original drawings and new drawings created expressly for the manual on the Intergraph CAD system. Most of the CAD drawings appearing in the DWPF melter sections were made by E. W. Grey, Allstates Design, with assistance from O. M. Parks. J. E. Savoy constructed the remaining drawings by cleaning up the originals, mounting them on the title sheets, and adding labels.

Several drawings were created in Superpaint MacDraw by J. D. Gutmann, Jr., including the refractory fabrication sequence drawings and refractory dry out illustrations in Section 5.

Photographs were donated by SRP Construction, CBI Services, Harbison-Walker Refractories, Didier-Taylor Refractories Corporation, and The Carborundum Company. Most of the Monofrax® K-3 refractory photographs in Section 5 were contributed by E. Vogel.

Text

The manuscript, including title pages for the illustrations and photographs, was written by J. D. Gutmann, Jr. using the Ragtime 2 page layout program on a Macintosh II computer. Masters were printed on a LaserWriter NTX printer. The Times® Roman font was used for the body text, Helvetica® for the illustration titles and labels, and ITC Garamond® for the section headings.

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Section 1

DWPF Glass Melter Overview

The defense waste processing facility at SRP is designed to immobilize high-level radioactive waste by converting it into a stable borosilicate glass form.¹ The heart of this conversion process takes place in the glass melter, Figures 1.1 and 1.2. This is a refractory-lined water-cooled vessel designed for a production rate of 225 pounds of glass per hour. Design and fabrication follow-up of the first two melter vessels, refractory linings, and melter components were the responsibility of the Engineering Department of E. I. duPont de Nemours & Co., Inc.

Energy for the glass melt is provided by passing electric current between two pair of plate electrodes immersed in the glass. The resistance of the glass to current flow generates heat by the joule effect ($q=I^2R$). Additional heat energy is furnished by eight dome heaters located above the melt pool. Molten glass is poured via differential pressure from the melter pour spout into stainless steel canisters.

The feed material consists of a slurry of approximately 23% waste material, 25% glass frit, and 52% water. This is metered at a gallon per minute through two feed tubes to the glass melt. The feed is continuous during the canister fill cycle. After a canister is filled, the feed is stopped while a new empty canister is rotated into position by the pour turntable.

All top head mounted instruments are designed to be removed and replaced by remote control using the standard SRP canyon impact wrench and overhead crane technique. Required process and electrical power are supplied by jumpers that connect each component to the wall nozzles in the melt cell.

The melter vessel is assembled into a large frame that provides the lifting lugs for installation and connectors for the process and electrical jumpers, Figure 1.3. The vessel is hard-piped to the frame and becomes a permanent part of it. The frame assembly includes the dome heater transformers, electrode bus bars, and the off-gas system seal pot. Figures 1.4 through 1.7 show a simplified model of the frame sections and melter vessel. Design and fabrication follow-up of the first two melter frames and frame-mounted components were the responsibility of Bechtel National, Inc.

Assembly of the vessel with the frame is accomplished in two stages. At the vendor's shop, the work includes:

- preliminary piping and electrical runs in the upper frame before the vessel is installed
- mounting the vessel shell on the lower frame
- installing refractory lining in the vessel shell and top head (by another contractor)
- assembling the upper frame
- completing piping connections to the vessel shell
- extending electrical leads to the termination points

Figures 1.8 and 1.9 show the #1 melter at CBI just after the refractory lined shell was assembled with the upper frame. The lifting yoke in Figure 1.8 is used for all handling of the assembly, including melt cell installation and removal.

After the vendor's piping and electrical work is completed, the assembly is shipped to the Savannah River Plant mock-up shop for final assembly. Figures 1.10 through 1.13 show the sequence of unloading, transporting and installing Melter #1 in the mock-up shop. Final assembly at this location includes:

- installing the shell components and vessel top head
- installing of top head components to check fit and alignment
- connecting cooling water piping to the top head
- connecting water and electrical lines to the components
- pressure testing cooling water piping and balancing cooling flow circuits with orifices
- installing jumpers to verify fit and alignment with the melter frame and top head connectors
- removing top head components except the two melt thermowells
- installing a layer of glass frit in the melter for start-up

Installation of the components in the first melter was the responsibility of SRP Construction, assisted by the DuPont Engineering Department and Bechtel National.

A view of the assembly in the SRP mock-up shop is shown in Figure 1.14. The completed assembly is loaded on a flat bed truck, transported to the vitrification building, and installed in the melt cell using the main process cell crane, Figures 1.15 and 1.16.

Figures 1.17 and 1.18. show elevation and plan views of the melter assembly and auxiliary equipment as installed in the melt cell. Photographs of the melt cell model are shown in Figure 1.19.

A general description of the DWPF facility is described in Reference 1. Operation of the melter and its auxiliary systems is described in Reference 2.

References - Section 1 - DWPF Melter Overview

1. *The Defense Waste Processing Facility Project at the Savannah River Plant* by R. G. Baxter, R. Maher, J. B. Mellen, L. F. Shafranek, and W. R. Stevens, III - Waste Management '84 Symposium, Session XIV - Status of Defense Waste Disposal at Tucson, Arizona - March 11 - 15, 1984 - Document Number DP-MS-84-19.
2. *DWPF Process Description, Chapter G - Melt Cell* - February 2, 1987 - Document Number DPSOP 257-1.

Figure 1.1

DWPF GLASS MELTER ELEVATION

DWPF GLASS MELTER SECTION

Figure 1.2

HEIGHT: 17'- 7"

LENGTH: 22' - 11"

WIDTH: 11' - 0'

WEIGHT: 85 TONS

Figure 1.3
DWPF MELTER ASSEMBLY

Figure 1.4

MELTER SUPPORT FRAME

Figure 1.5

ASSEMBLY OF SHELL WITH SUPPORT FRAME

Figure 1.6
UPPER FRAME

Figure 1.7

ASSEMBLY OF MELTER VESSEL WITH UPPER AND LOWER FRAME

This photograph shows the lifting yoke supporting the melter frame and shell after completion of the shop assembly at CBI Services. This yoke is used for all handling of the melter assembly, including remote melt cell installation and removal.

Figure 1.8

MELTER ASSEMBLY SUPPORTED BY LIFTING YOKE

This view shows part of the refractory lining in the #1 melter shell. The dark material with the match mark lettering is the Monofrax® K-3 refractory. Korundal® superstructure refractory is used in the upper section above the glass melt. Incomplete piping runs (red caps) are the water cooling supply and return lines for the melter. These were completed at SRP after the top head was installed.

Figure 1.9

VIEW OF REFRACTORY-LINED SHELL IN FRAME

Special arrangements were made for transporting the melter assembly from Cordova, Al to SRP. Flat cars with cushioned couplings were used to protect the assembly from shock loads, and all couplings were closed manually. CBI personnel rode in the caboose to monitor the entire trip.

Figure 1.10

ARRIVAL OF MELTER ASSEMBLY AT SRP

Figure 1.11

TRANSFERRING THE MELTER ASSEMBLY TO A TRUCK

Figure 1.12
READY FOR TRANSPORT TO THE MOCK-UP SHOP

The melter frame is ready to be lowered and positioned on the support beams shown in the lower left. Connectors on the far side are located at the same positions as those in the melt cell. Jumpers will be installed to check fit up and alignment with connectors on the melter frame and top head components.

Figure 1.13

INSTALLING THE ASSEMBLY INTO THE MELT CELL MOCK-UP FACILITY

This photograph was taken in the SRP 717-F mock-up shop during final assembly. Some of the top head components have been installed, and work on the water cooling circuits is in progress. After this phase was completed, the jumpers were installed to check alignment and fit.

Figure 1.14

NEARING COMPLETION OF COMPONENT INSTALLATION AT SRP

This view shows the completed drain valve assembly. The frame over the top of the riser protects the riser heater thermocouple and electrical connections from contact with the impact wrench during remote handling operations.

Figure 1.15

INSTALLING THE COMPLETED ASSEMBLY INTO THE MELT CELL

The forest of dowels and studs on the top head are used to position and fasten the top head components. Before the assembly leaves the mock-up shop, the melt thermowells must be installed and glass frit added for start-up. The thermowells are visible at the center and left rear of the head. Remaining components are installed after the assembly is set in the melt cell.

Figure 1.16

MELTER ASSEMBLY LOWERED INTO MELT CELL

MELT CELL ELEVATION VIEW

Figure 1.17

This view shows the relationship between the melter assembly and canister turntables. The canisters are indexed by the turntables to align them with the melter for glass pouring during normal operation, and for draining residual glass before the melter is removed from the cell.

This view shows the jumper connections from the wall nozzles to the melter frame and top head components. Half and full scale models of the top head with removable components were used to verify access to the components for remote removal and replacement with the impact wrench and overhead crane.

Figure 1.18
MELT CELL PLAN VIEW

These photographs show the melt cell model constructed by Bechtel. Due to the complexity of the melter assembly, a larger scale model of the melter and frame was constructed and used for approval of piping and electrical layouts.

Top: The melter is oriented with the riser facing down. The orange structures to the rear are the off-gas and back up off-gas pipes.

Bottom: An elevation view looking toward the riser showing the routing of jumpers from the wall nozzles to the melter frame and melter top head components.

Figure 1.19

MELT CELL MODEL PHOTOGRAPHS

Section 2

Project S-1941 Glass Melter

2.1 Background

Development of the current DWPF glass melter configuration dates back to 1976, when the Engineering Department and SRP began work on the first prototype melter system under Project S-1941. This was an outgrowth of previous glass melter experiments by Pacific Northwest Laboratory (PNL), SRP, and others.¹ Since DuPont had limited experience with the design and operation of glass melters, initial data was obtained through an extensive literature search, technology from PNL, and meetings with various glass industry consultants.² This information, combined with Engineering Department design and operating experience with refractory lined vessels in DuPont chemical plants, led to the configuration of the 1941 melter.

2.2 Design Basis

A section view of the 1941 melter is shown in Figure 2.1. Some of the differences between this configuration and the DWPF version are due to the Project 1941 design basis:

- The melter was fed with dry product from a calciner located above the vessel. (Later in the program, slurry feeding was demonstrated.)
- Glass penetration into refractory joints had to be frozen in Monofrax® K-3 refractory. This dictated the ratio of refractory to insulation thickness.
- No nozzle penetrations were permitted in the vessel below the glass melt surface except the drain valve, which had a mechanical plug.
- Minimum life for the melter and its components was two years.

2.3 Materials

As a result of visits to PNL and Penberthy Electromelt in 1976, SRL recommended using Monofrax® K-3 for the glass contacting refractory, and Inconel® 690 for the electrodes.² Later tests confirmed that Monofrax® K-3 had the best corrosion resistance to the SRP glass compared to other commercially available refractories.³ Similiar tests established that Inconel® 690 had the best corrosion resistance of commercial metals. This past experience dictated use of these materials for the DWPF melter.

2.4 Vessel Configuration

Cylindrical Shape

The 1941 melter vessel configuration, Figure 2.1, was a water-cooled cylindrical vessel with ASME flanged and dished heads. All interior surfaces and nozzles were machined to close tolerances to control fit-up of the refractory lining. This design concept was originally recommended by F. W. Thompson.

*Inconel is a registered trademark of Inco Alloys Incorporated, Huntington, WV.

*Monofrax is a registered trademark of The Carborundum Company, Falconer, NY.

Figure 2.1
PROJECT S-1941 GLASS MELTER

Historically, large furnaces in the glass industry have been built in a rectangular shape for process reasons. Since the principle mode of glass melting requires heat transfer by radiation from hot gases to the melt, a large surface area is required. These furnaces are constructed with flat floors and walls but usually have an arched roof to keep the superstructure refractory in compression.⁴ An example of this configuration is shown in Figure 2.2.

Most of the waste vitrification melter designs used by others are scaled down versions of this rectangular format. Figure 2.3, an early experimental melter used at PNL, is a typical example.

The cylindrical, water-cooled configuration for the 1941 melter created some controversy, since it appeared to be a radical departure from glass industry practice. From the Engineering Department's view, it was the correct approach to insure maximum stability of the refractory lining. This was based on many years of experience operating refractory lined vessels in DuPont chemical plants: incinerators, pump tanks for sulphuric acid plants, rotary kilns, chlorinators, and dryers for the titanium dioxide process. In many cases, the refractory must operate in a hostile environment, including severe thermal stresses and mechanical vibration. Our consultants have seen many failures of brick-lined equipment where straight wall construction has been subjected to severe thermal stresses. In contrast, the performance of refractory lined cylindrical vessels with dished heads has been exceptional.

This observed difference in performance between cylindrical and rectangular construction is due to the fact that refractory materials are much stronger in compression than tension. The cylindrical shape maintains the refractory in compression, while the rectangular shape can result in significant bending moments that put the refractory walls in tension. In addition, the cylindrical construction results in lower stresses in the vessel wall that are uniformly distributed.⁴ The advantages of this design were independently verified by an industry consultant.⁵

Stress and heat transfer analyses were made to evaluate the proposed vessel and refractory configuration. A finite element analysis by E. H. Perez verified that the sidewall stresses were within allowable limits.⁶ For this type of analysis, it is important to use the correct assumptions for the refractory block model. If the refractory is treated as a single monolithic structure, the resulting stress analysis will predict excessive stresses in the vessel wall. The approach used by Perez recognized that the individual refractory block construction prevents tensile stresses from occurring in the outer perimeter. Whenever the computer model predicted tensile stresses, the assumptions at the brick boundary were changed after each calculation until the tensile stresses disappeared.

Additional finite element analyses by E. H. Perez and R. J. Thomas resulted in the suggestion to reinforce the sidewall at the intersection with the riser to reduce stresses in this area.⁷ Heat transfer calculations using a two dimensional model were made by H. F. Hublein, ESD, to establish temperature profiles for these analyses.⁸ The final vessel configuration is shown in Figure 2.4.

These calculations established the high stress zones in this type of vessel. The same approach was used later for the DWPF vessel.

1. SIDEWALL BLOCK
2. ELECTRODE SIDEWALL BLOCK
3. FLOOR
4. BOTTOM ELECTRODE BLOCK
5. THROAT
6. RISER
7. REFINER

This is typical of the large rectangular flat wall furnaces used in the glass industry. The arched roof is not shown in this view.

Figure 2.2
CONVENTIONAL GLASS INDUSTRY FURNACE

This early PNL experimental melter design is typical of most glass vitrification melters. The melt chamber is rectangular, and all refractory lined surfaces are flat.

Figure 2.3
RECTANGULAR MELTER

INSIDE SURFACES OF VESSEL AND
NOZZLES ARE COATED WITH FOUR
LAYERS OF DUPONT CORLAR® EPOXY
(16 MILS TOTAL)

REFERENCE: D178942

Figure 2.4
1941 MELTER VESSEL

Water Cooling

The decision to water-cool the 1941 melter vessel exterior was based primarily on vessel and refractory stability considerations:

- As the refractory expands on heat up, the combination of vessel shape and cooled walls forces the refractory blocks into compression and locks them in place.
- Interior (hot face) joints between the refractory blocks are forced to close and prevent glass penetration.
- The vessel structure is stabilized by keeping all surfaces at a uniform temperature.

For canyon operation in DWPF, equipment external surface temperatures must be maintained at 50° C to prevent thermal updrafts from contaminating other areas when cell covers are removed. This requirement alone would have dictated using water cooling on the DWPF melter, but the original intent was to enhance structural stability.

On the 1941 melter, the water cooling channels were formed by welding half pipe over the entire vessel. This approach was used instead of water jackets to simplify shell construction and manifolding. Half pipes provide adequate cooling, even though water is not covering all exterior surfaces, due to the high conductivity of the metal.

Slant Riser

The riser is the zone where glass flows from the melt pool to the pour point. This is another area where the 1941 melter configuration differs from other experimental glass melter designs. As shown in Figure 2.3, the conventional riser is vertical or near vertical, followed by a horizontal trough leading to the pour point. There are inherent drawbacks to this configuration:

- The vertical construction allows glass to contact both sides of the refractory wall above the throat (entrance to the riser). This subjects the critical throat area to glass corrosion on the inner and outer walls, doubling the corrosion rate.
- Monofrax® K-3 refractory will corrode at an accelerated rate if it is in the path of electric current or in the flux field between electrodes. With a vertical riser, the throat wall is in the direct path of any electric current passing from melt pool electrodes to the riser heater. Cracks and openings in the unconstrained throat blocks will increase the occurrence of electrical short circuits.

These considerations led to the slant riser design.⁹ Later, severe attack of Monofrax® K-3 throat blocks occurred on two experimental melters that had a vertical riser design. These were due to the combination of geometry and electrical effects noted above.¹⁰

2.5 Insulation

Configuration

Figure 2.5 shows the insulation configuration. The bottom and riser are insulated with Fiberfrax® T-30, a lamination of ceramic fiber paper layers bonded with a resin. A special fixture was

® Fiberfrax is a registered trademark of The Carborundum Company, Niagara Falls, NY.

REFERENCE: W709935

Figure 2.5
1941 MELTER INSULATION

designed and constructed to form the Fiberfrax® to fit the annulus between vessel bottom and Monofrax® K-3 blocks. Fabrication details for the DWPF liner are described on page 6.32.

Sidewalls above the glass melt and the top head are insulated with two layers of Fiberfrax® 970 ceramic fiber paper.

DSM-24

As shown in Figure 2.5, the sidewall zone below the glass melt surface is insulated with a nominal 1/2 inch thickness of DSM-24 material. The selection of DSM was based on a combination of desired properties:

- low thermal conductivity
- ability to conform to and completely fill the annulus between the O.D. of the refractory and the I.D. of the shell (allows for variations in block thickness and roughness in as-cast surfaces)
- ability to compress when the refractory expands (limits hoop stresses in the sidewall)

The material chosen for this application is a special formulation of Carborundum's LDS Moldable™, a dispersion of ceramic fibers in a water-based silica binder. Approximate physical requirements were determined by calculating the relative difference between the Monofrax® K-3 and vessel wall radial growth and converting this to percent compression. For the 1941 melter, the desired pressure was in the 250 to 300 psi range.⁶

A series of tests were run on different solids levels of LDS Moldable™ at the Carborundum Niagara Falls plant, and the results showed that a 24% solids level met the requirements.¹¹ To identify this as a special formulation, Carborundum chose DSM-24, DSM standing for "DuPont Special Material." Since this material is ordered in small quantities spaced several years apart, we have found that Carborundum has to be reminded on each order that DSM-24 is a special 24% solids version of LDS Moldable™ (the standard version has 55% solids). The reduced solids level of DSM-24 lowers the viscosity and permits the material to be installed with a high pressure pump.

Since DSM-24 has a finite shelf life, it must be ordered no earlier than 3 months before it will be installed. It must also be protected from freezing temperatures during handling and storage.

During installation, the DSM is pumped and rodded into the annulus between the Monofrax® K-3 and melter shell. Installation details are described in Section 6, reference 8.

Fiberfrax Durablanket® at Shell to Head Joint

Several layers of Fiberfrax Durablanket® are used in the joint between the sidewall and top head refractory, Figure 2.5. This compressible layer is designed to absorb vertical thermal expansion of the sidewall refractory and limit loads on the top head and flange. A value of 150 psi was selected to keep the refractory in compression without exceeding allowable limits on the head.

Compression tests were run on Fiberfrax Durablanket® at the Engineering Test Center to determine the compression vs. load characteristics.¹² This data was used to define the thickness of installed blanket to limit the load to 150 psi at operating conditions. A similiar test was repeated later for Melter #1, page 5.27.

Fiberfrax Durablanket® is also used at the upper end of the riser to absorb expansion of the riser blocks during start-up.

Epoxy Coating

Under the best of refractory construction conditions there will be a tendency for glass, salts, and other materials to migrate into the joints between the blocks. Since these materials may conduct electricity (glass conduction is dependent on temperature) they could short out the electrode power supply if they penetrated through the refractory and insulation to the grounded vessel wall. Although the chance of this occurring was judged to be very small on the 1941 melter, an electrical insulation barrier was added by coating the entire interior vessel surface, including nozzles, with four layers of Corlar® epoxy.

2.6 Refractory

Configuration

Figure 2.6 shows the refractory construction used on the 1941 melter. The biggest difference between this configuration and DWPF is the construction of the bottom layer - in DWPF there is a layer of Zirmul® refractory between the Monofrax® K-3 and the Fiberfrax® insulation (paragraphs 4.3 & 6.3). The bottom construction on the 1941 melter was based on meeting the requirement to freeze glass in the Monofrax® K-3 material.

Monofrax® K-3 Design

A maximum acceptable glass freezing temperature is generally considered to be in the range of 600-650°C, where the viscosity becomes so high that the glass cannot penetrate any further into the joint. Previous tests at SRP showed that glass movement was effectively stopped around 700°C. If the insulation thickness is increased, the temperature of the outside (cold) face of the refractory will increase, and the glass will penetrate closer to the insulation. The thickness of refractory and insulation must be balanced to position this freeze point temperature in the refractory. The final 1941 configuration used 8" of Monofrax® K-3 and 1/2" of Fiberfrax® T-30 insulation in the bottom. Although it is theoretically possible to attain the same result by using thicker Monofrax® K-3 blocks and thinner insulation, it is not practical due to the low insulating value of Monofrax® K-3. The required block thickness would increase the vessel height and weight to impractical limits.

® Corlar is a registered trademark of E. I. du Pont de Nemours & Co., Wilmington, DE.

® Zirmul is a registered trademark of Didier-Taylor Refractories Corp., Cincinnati, OH.

REFERENCE: W709935

Figure 2.6
1941 MELTER REFRACTORY

During the development of the vessel/refractory configuration a series of engineering analyses and tests were run to verify the integrity of the design. Small sample compression tests of Monofrax® K-3 refractory were run to establish mechanical property values for the initial analyses.⁵ Later in 1978, a complete test series was run at the Engineering Test Center.¹³

To prove that the Monofrax® K-3 would withstand the temperature gradient from glass contact to the cooled outer surface, a test stand was fabricated and run in a furnace at the Engineering Test Center. A block of Monofrax® K-3 was installed against a water cooled surface, and insulated to reduce heat losses from the top and bottom surfaces, simulating the condition in the sidewall structure. The surface opposite the cooled surface was exposed to the furnace temperature. No problems due to the temperature gradient were observed.¹⁴

During development of the DWPF design in 1982, the effect of temperature gradient on refractory stress was raised. An analysis proved that the temperature gradient does not create thermal stresses.¹⁵ Final proof of this design concept is the excellent performance and integrity of Monofrax® K-3 refractory in the 1941 and Scale melters.

Block Size

In Reference 5, H. R. Kraner remarked that the smaller the refractory blocks the less chance there is of cracking in any block. This is generally the case in most refractories, but our experience with the fusion cast Monofrax® K-3 has been the opposite. Small cracks appear in the original castings due to thermal stresses as the blocks cool down. When the larger DWPF blocks were cast (riser blocks have the most volume) Carborundum found that the block quality improved with the larger shapes. This is apparently due to the longer and more gradual cooling cycle that is required for the larger mass.

For the lining in the melt pool, it is better to use larger blocks and have fewer joints to grind and fit. Generally, cracks normal or parallel to the inside face will not fail in service since the compressive forces will hold the block together.

The best Monofrax® K-3 block quality is obtained by using the end poured inhibited cavity (EPIC-3) technique. With this process, carefully timed multiple pourings are made into oversized molds, forcing the shrinkage cavities to appear in the upper portion of the casting (header). When the refractory is cool, the header is removed with a diamond saw. The remaining lower part of the casting is relatively free of voids and has superior crystalline uniformity. Carborundum recommends using EPIC-3 castings for the most critical glass furnace areas, including throat and electrode blocks. All blocks for the 1941, Scale, and DWPF melters were cast with this process.

Mortar

With a proper design that keeps the refractory in compression, mortar is used to "hold the blocks apart," not to cement them together. The mortar is used strictly as a gap filler. Since K-3 mortar is not as resistant to glass corrosion as the cast material, the ideal construction is one having ground, accurately fitted joints that do not require mortar. Relatively little mortar was used in the 1941 melter.

Monofrax® K-3 Fabrication

The refractory configuration for the 1941 melter represented a breakthrough in Monofrax® K-3 refractory manufacturing techniques. Up to this time, Carborundum had no experience casting curved block segments to the tolerances demanded for the melter. This was particularly true of the bottom block construction which required casting blocks to fit the dished shape. There was some initial reluctance to attempt making the required shapes as there was concern about meeting the specification requirements. Manufacturing decided that the objectives would be difficult but attainable. In order to insure that the blocks would fit properly in the melter, a steel fit-up fixture was constructed to match the vessel contours, including the slant riser.

Maximum allowable gap size for the flat ground vertical and horizontal sidewall joints was set at 1/16 inch. This was based on an analysis by L. A. DeFrate which suggested that glass could not be frozen in the refractory if the gap were 1/8 inch or larger. For a sidewall joint, filling a large gap with mortar does not prevent penetration. The glass will react with the less resistant mortar and form corrosion products that will be washed out by glass circulation. Fresh glass will fill the void and continue the cycle.

Vertical radial joints in the bottom blocks were also ground to the 1/16 inch maximum gap, since these are flat surfaces.

One exception to the 1/16 inch rule is permitted—it is not applied to the curved circumferential joints between adjacent bottom block rings. There is no practical way to grind these surfaces, and they must remain as-cast. The allowance for the gap tolerance in these joints was set at 3/16 inch maximum. This larger tolerance was justified by the bottom being less critical for glass penetration as mortar cannot be washed out of these joints. The glass has nowhere to go and will freeze in the mortar.

At the time the 1941 melter was constructed, Carborundum did not have blanchard grinders to gang machine each ring of sidewall blocks. As a result, the blocks had to be individually milled and ground to fit with each other. Blocks were positioned on sidewheel grinders using spirit levels and shims. This made the height of each block slightly different, and increased the difficulty of maintaining parallelism and squareness on the mating block surfaces. In spite of this, the final results exceeded expectations and more than met the minimum requirements.

Today, improved manufacturing techniques have made the block fitting procedure much easier and fabricating special shapes has become an important part of Carborundum's business. During inspection trips, we have seen special block shapes for other applications, including a set of curved blocks for another cylindrical melter.

For Monofrax® K-3 refractory design, it is desirable to have all glass contacting surfaces be as-cast instead of machined. The surface against the mold has a denser, finer grain structure from cooling at a faster rate, and this results in higher resistance to corrosion. Since the riser design for the 1941 melter had glass contacting the inside surface of the hole in the cylindrical blocks, and it was not practical to cast a Monofrax® K-3 block with a hole, each riser block was cast in four equal segments. These were temporarily bonded with epoxy to keep the segments together during handling, machining the outside diameter, and installation. Once the riser blocks were installed in

the vessel, the bond was not needed since the design keeps the refractory in compression. R. N. Mc Cormick and B. N. Zolin developed the bonding procedure.¹⁸ This epoxy can also be used to repair cracked or broken blocks, but the decision to use this technique must be based on the nature of the defect and its location.

Two surfaces on the 1941 riser blocks required special machining to meet the fit-up tolerances: the outside diameter, and the radial joint at the interface of the lower riser block with the sidewall throat block. Both of these surfaces require a high degree of accuracy, and this is compounded by the difficulty of machining K-3 due to its high hardness. Diamond tooling is normally required along with proper machining techniques to avoid cracking this brittle material.

A search was conducted to find vendors having the necessary equipment and experience, and the final selection was narrowed to Hardface Welding & Machine Co., Buffalo, NY, and Rock of Ages, Barre, VT. Hardface Welding developed a technique to grind the outside diameters of the riser blocks, while Rock of Ages adapted their wire cutting experience to contour the radial surfaces at the riser/throat block interface.

Wire cutting is a routine technique used at Rock of Ages to cut large granite blocks to size using a continuous braided steel wire running in an abrasive slurry. The standard wire-cutting machine was adapted to the refractory blocks using fixtures to hold and orient the blocks during the operation. Although wire cutting produced an accurate shape, the as-cut surface had fine ridges produced by small variations in the wire path. These were removed on a contour grinder using wood templates to control the grind path. The end result was a very smooth, accurate surface. The same technique was used on the Scale and DWPF melter riser blocks except the templates were made of metal for greater accuracy. In all cases, the wire-cutting fixtures were also used to position the blocks on the contour grinder.

Castable Refractories

The combination of machined K-3 shapes coupled with a machined vessel interior increases fabrication complexity compared with more conventional rectangular melter designs. One suggested design change for future melters is to use a rolled and welded cylinder having a larger diameter and filling the void between vessel wall and K-3 with castable refractory. This approach does not require machining the vessel interior to close tolerances.

Castable materials were not used in the 1941 or DWPF melters because of their inherent lack of stability. By definition, the casting is a one-piece monolith that will crack as it goes into tension during heat-up. An example of this phenomena is shown in Figure 2.7

This experimental castable liner is one of several that were evaluated for service up to 1000°C. All failed by cracking, even when the lining was constructed with two separate concentric cylinders to reduce stresses. Because of this unstable nature, castable materials were not used in the 1941, Scale or DWPF melter.

Figure 2.7

FAILED CASTABLE REFRACTORY LINER

Superstructure Refractory

Although K-3 must be used for the glass contacting surfaces, the requirements for the lining above the glass melt in the sidewall and top head are not as critical. Carborundum's Mullfrax® 202 was used in the 1941 melter.

The outer ring of blocks in the top head must be a snug fit in the knuckle radius zone, since this ring keys the entire top head refractory structure. Insulation was limited to a thin layer of Fiberfrax® paper to restrict movement. With this self-locking design, the head can be rotated to the upright position and installed on the shell without danger of the blocks falling out.

It is also important to maintain concentricity in the rings of blocks making up the structure. If the rings are overlapped, the transfer of load from one ring to another may unload adjacent blocks and allow them to shift.

It is very difficult to achieve a stable refractory configuration with a flat roof design. There has been a history of losing refractory from the roof with this type of construction.¹⁰

2.7 Electrical Isolation

Electrical isolation is required between all components that contact the glass and the grounded vessel. In addition to having high dielectric value, the material for this service must also satisfy other requirements:

- ability to withstand 1100°C heater temperatures
- high compressive strength for bolted flanged joints
- ability to be machined or ground flat for sealing surfaces
- capable of being formed and ground into cylindrical shapes for isolating bolts, riser heater internals, and other round shapes

A high alumina ceramic met all of these requirements and was selected for the 1941 melter. Coors Porcelain furnished the alumina parts for the 1941 melter. The success of this application led to the use of alumina in the Scale and DWPF melters.

2.8 Electrodes

The electrode configuration for the 1941 melter, Figure 2.8, consisted of four vertical 6 inch diameter Inconel® 690 bars installed through the top head. Cooling air was circulated through the central annular channel.

At the time, the basic data did not permit penetrations in the vessel below the glass level as there was considerable concern about glass containment. In addition to meeting this requirement, the vertical rod design offered the potential advantage of stronger convection currents to promote mixing. A paper on electrode shapes and their characteristics verified the conclusions used to support the 1941 electrode configuration.¹⁷ Note that rod electrodes in the glass industry are usually installed in the bottom of the tank.

® Mullfrax is a registered trademark of The Carborundum Company, Keasbey, NJ.

REF DRAWING D-178968

Figure 2.8
1941 MELTER ELECTRODE

2.9 Riser & Pour Spout Heater

The 1941 melter riser heater, Figure 2.9, is a double wall resistance heater made of Inconel® 690. It is installed in the center of the glass flow path formed by the cast hole in the K-3 refractory blocks. Current flows down the heavier center wall to the tip, then up through the thinner outer wall that is the heating element. Since the heater is cantilevered and exposed along its length to the glass temperature, a creep analysis was made to verify that the design met the two year life requirement.¹⁸ One of the conclusions is the recommendation to make the core hollow to reduce weight and stresses to increase life. Since glass is in direct contact with the heating element, the life is also affected by corrosion. The DWPF configuration avoids these restrictions by isolating the heating element from contact with the glass, and supporting the riser heater shell on the refractory.

A section of the 1941 melter pour spout heater is shown in Figure 2.10. The heating element surrounds the pour point to maintain the high temperatures required to keep the glass molten.

Transformers for both the riser and pour spout heaters had to be close coupled and were mounted directly on the end of the riser.

During startup, the riser heater was overpowered and burned out. This was replaced with a duplicate heater that ran for the remainder of the test period. A backup heater design having heavier sections was fabricated but never used.

2.10 Dome Heaters

During the early design development stage of the 1941 melter there was no provision for heaters in the vapor area above the glass. Experiments with small melters at SRP showed that additional heat in the vapor area was necessary to prevent material from plugging the off-gas line.

Experiments with slurry feeding were also in progress, and this would require additional heat in the vapor space to vaporize the water. It was desirable to add as much heating capacity as practical in the melter, and the final design used six heaters mounted in the upper section of the melter shell, Figure 2.11. This was the optimum arrangement to fit the vessel geometry and provide space between the heaters for the calcine feed.

The original design used type CR silicon carbide Global® heaters manufactured by the graphite products division of Carborundum. The first set failed during startup due to corrosion and other factors. A second set failed by corrosion after 35 hours.¹⁹ The design was modified by installing the Global® units inside Inconel® 690 tubes for corrosion protection, Figure 2.11, although this required using smaller diameter heaters. During one of the slurry feed runs four of these heaters failed. As a result of this experience, the DWPF dome heater design uses Inconel® 690 tubes without cartridge heaters.

REF DRAWING W-710760

Figure 2.9
1941 MELTER RISER HEATER

REF DRAWING W-711123

Figure 2.10
1941 MELTER POUR SPOUT HEATER

Figure 2.11
1941 MELTER DOME HEATERS

2.11 Feed Tube

The 1941 melter was originally started up and run with dry calcine feed. It was recognized that slurry feeding had several advantages²⁰, and small scale melter tests were run at SRP to demonstrate the process. Among the advantages for the DWPF facility is elimination of equipment above the melter, allowing free access to the melter top head for remote installation and removal of instrument assemblies.

One disadvantage of slurry feeding is the potential for spraying cool slurry water on the hot Monofrax® K-3 surfaces, since the thermal shock can crack the blocks and cause spalling. This effect was observed on the LSFM melter at the end of the test run, and is believed due to the close proximity of the feed tube to the refractory wall (page 3.2). The DWPF design locates the feed tube at a greater distance.

The 1941 melter was modified for slurry feeding by installing a feed tube in the original calcine feed/off-gas nozzle, Figure 2.12. Annular construction is used to jacket the internal slurry tube with water, followed by Fiberfrax® insulation and an outer tube of Inconel® 690. The critical requirement for feed tube design is to manifold the water down to the bottom of the tube. If the tube is not cooled, glass particles will stick to the bottom and plug the feed channel. This same construction was used for the Scale and DWPF melters.

2.12 Drain Valve

The drain valve assembly is shown in Figure 2.13. This was designed to continuously drain the entire melter contents into a large can at the end of the testing period. There was no provision to stop the flow after draining was initiated.

The drain bore is plugged with a glass rod that was installed in the bore prior to melter start up, and melted in place with the valve heater. An additional mechanical seal is provided at the bottom of the bore by a ceramic disk loaded with an air cylinder and link assembly. Draining is initiated by rotating the ceramic disk out of the way with the cylinder, and turning on the heater to melt the glass plug. Not shown is an air cylinder powered mechanical probe mounted below the valve. This was designed to run through the bore after the glass plug melted in case the bore was plugged by deposits on the melter bottom.

2.13 Differential Pressure Pouring

As originally designed, the glass was poured from the melter by tilting the vessel. The entire melter assembly was suspended from the frame on shafts and bearings and tilted with a hydraulic cylinder, Figure 2.1. Tilt pouring has two major disadvantages for remote canyon operation: it is difficult to control the pour path to the canister, and flexibility is needed in the process and instrumentation connections. J. S. Duskas recommended using differential pressure for glass pouring on DWPF to eliminate the mechanical tilting arrangement.²¹ This was demonstrated on the 1941 melter and continued on the Scale and DWPF melters. The ASME type construction of the vessel is an advantage for this concept, since it permits better sealing and reduces the amount of air inleakage.

Figure 2.12
1941 MELTER FEED TUBE

REF DRAWING W - 712221

Figure 2.13
1941 MELTER DRAIN VALVE

2.14 1941 Melter Test Results

The 1941 melter was run in campaigns from August 1980 to September 1981. A total of 74 tons of glass were produced—54 with dry feeding and 20 with slurry feeding.

The melter was started up by Hotwork, Inc. using a burner to heat the interior. This was considered the safest and most conservative method to heat up all refractory surfaces uniformly at a slow, controlled rate. After the vessel was at operating temperature, the dry feed was introduced.

During the initial glass melting start-up period, instrumentation problems resulted in variations in the glass melt temperature.²² A layer of spinel²³ approximately 7 inches deep formed in the bottom of the melter. This was attributed to a combination of the melter bottom temperature and the periods of high and low bulk glass temperature, but was primarily a result of operating the glass melt below the glass liquidus temperature. Due to the depth of this layer, the dump valve probe was not able to penetrate it completely, and manual rodding was required to clear the obstruction and drain the melter. An analysis of the spinel buildup showed that the formation correlated with the glass temperature history.²⁴ As a result of this experience, a considerable amount of analyses and tests were run to verify the refractory design in the bottom of the DWPF melter.

Examination of the 1941 melter refractory after shutdown showed that it was in excellent shape, Figures 2.14 and 2.15. Representatives from the glass industry agreed that the condition of the K-3 indicated that the life would easily exceed the two year design requirement.²⁵

An analysis of the Inconel® 690 components concluded that the observed wear supported the two year life requirement.²⁶

All of this early corrosion data was based on the frit 131 glass formulation. Since this time, development of the frit chemistry has resulted in a formula that is much less corrosive on both K-3 and Inconel® 690.

2.15 Conclusions

After analyzing the operating results and conducting a post mortem examination of the Project 1941 melter, the following conclusions were reached:

1. The design concept was sound, and demonstrated superior performance in thermal, mechanical, and electrical stability compared with other experimental melters.
2. The basic design was a satisfactory prototype for future experimental melters.
3. At proper operating conditions, the melter produced an acceptable glass at the required rate.

This photograph of the 1941 melter top head interior shows the condition of the refractory after the test campaigns were completed. The general condition was excellent, and allowed the head to be used on the DWPF prototype Scale melter without replacing the refractory.

Figure 2.14

1941 MELTER TOP HEAD REFRACTORY

This close-up view shows details of the block and joint construction. Note how the nozzle blocks are made in two pieces divided in the middle. This same approach was used on the DWPF melter head refractory.

Figure 2.15

1941 MELTER - TOP HEAD REFRACTORY DETAIL

The 1941 melter shell refractory was also in excellent condition at the end of the campaign. This view shows the riser opening and the accumulation of spinel on the bottom. Depressions in the spinel from the electrodes are visible.

Figure 2.16

1941 MELTER SHELL REFRACTORY

This photograph of the Monofrax® K-3 refractory was taken at the glass melt elevation. Above the melt, the refractory surface is coated with glass. Note the tight joints between blocks. Since the blocks were ground individually, the horizontal and vertical joints do not line up precisely, see page 2.13.

The moth was charged with entering the vessel without a permit.

Figure 2.17

1941 MELTER - SHELL REFRACTORY DETAIL

This close-up shows the spinel at the bottom of the melter. The large depression is from an electrode; the smaller one to the left is from a thermowell. The Monofrax® K-3 refractory block cracked vertically, but the round water-cooled vessel kept the refractory in compression and prevented the crack from opening. For this type of construction a crack becomes another joint, see Figure 2.16 for comparison.

Figure 2.18

1941 MELTER - BOTTOM DETAIL

References - Section 2 - Project S-1941 Melter

1. *Waste Vittrification: A Historical Perspective* by J. L. McElroy, W. J. Bjorklund and W. F. Bonner - Proceedings of the ANS Topical Meeting on the Treatment and Handling of Radioactive Wastes - April 1982.
2. Memo to R. H. Cornwall from E. J. Siegwarth dated February 20, 1979 - *Glass Melter Design Basis, Summary of Contacts With Glass Industry*.
3. Memo to M. J. Plodinec from W. N. Rankin dated July 15, 1981 - *Trip Report - The Carborundum Company Refractory Products Division - May 13 & 14, 1981* - Document Number DPST-81-553.
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5. Memo to R. H. Cornwall from A. W. Fretz dated July 31, 1978 - *Trip Report on Meeting With Hobart M. Kraner, Refractory Consultant*.
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7. Letter to W. F. Senkowsky from R. J. Thomas dated September 29, 1978 - *TNX Melter System - Shell Stress Analysis*.
8. Memo to J. W. Duskas from H. F. Hublein dated July 3, 1979 - *Heat Transfer - Defense Waste Processing Facility - Glass Melter*.
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11. Letter to F. Thompson & W. Senkowsky from Russell D. Smith (Carborundum) dated July 24, 1978 - *Revised Data Regarding Compressive Behavior of LDS*.
12. Table - Fiberfrax Durablanket® - Compression/Deflection Test from Engineering Test Center.
13. Memo to F. W. Thompson from B. M. Ciosek dated December 11, 1978 - *Testing - Compression - Monofrax®K-3*.
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Tables from Engineering Test Center dated May 1, 1978.

References - Section 2 - Project S-1941 Melter

15. Memo to J. D. Gutmann from E. H. Perez dated October 29, 1982 - *Refractory Structural Behavior - Thermal Stresses*.
16. Memo to W. F. Senkowsky from B. I. Zolin dated February 5, 1979 - *Adhesive Bonding of Monofrax® Bricks*.
17. Letter to J. F. Proctor from L. T. Finnicum dated March 7, 1978 - *Glass Melter - Electrode Design*.
18. Memo to W. F. Senkowsky from E. H. Perez dated August 22, 1978 - *Creep Analysis of Melter Electrodes*.
19. Memo to M. J. Plodinec from W. N. Rankin dated August 3, 1981 - *Trip Report - The Carborundum Company Graphite Products Division - May 14, 1981* - Document Number DPST-81-621.
20. Memo to J. A. Kelley from G. G. Wicks dated August 16, 1979 - *Slurry Feeding* - Document Number DPST-79-471.
21. Letter to J. F. Proctor from J. W. Duskas & A. M. Eisenberg dated April 20, 1979 - *Elimination of Melter Tilting Requirement*.
22. Memo to F. H. Brown from M. B. Cosper dated October 27, 1981 - *1941 Melter - Temperature and Production History* - Document Number DPST-81-814.
23. Memo to W. R. Stevens from M. J. Plodinec dated September 22, 1983 - *DWPF Glass Chemistry - Consequences and Control of Spinel Formation*.
24. Memo to M. J. Plodinec from W. N. Rankin, et al dated March 31, 1982 - *Evaluation of Corrosion and Deposition in the 1941 Melter* - Document Number DPST-82-231.
25. Letter to J. C. Davis from J. B. Mellen dated January 26, 1982 - DA S-350 - *Trip Reports on Inspection of the TNX Melter* - Document Number PD 0000320.
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Section 3

LSFM Glass Melter

3.1 LSFM Configuration

The second large scale melter tested at TNX for the DWPF program was the Large Slurry Fed Melter (LSFM), Figures 3.1 and 3.2. During the design phase at SRL, this was also called the Joule Heated Research Melter. Primary objectives of this design were to evaluate the slurry feed operation with glass formulations and off-gas components.¹ It was also a test vehicle for several components, including a new electrode configuration.

The vessel is cylindrical with a flat floor and roof. Several layers of backup refractory and insulation board were used, as the vessel was not water cooled. These included Zirmul®, firebrick, Fiberfrax® Hotboard, and Alfrax® castable refractory. Monofrax® K-3 refractory and Inconel® 690 were used for the glass contacting materials.

Glass was poured by tilting the vessel. Differential pressure pouring was not feasible due to the amount of air inleakage under vacuum.

Among the components tested in the LSFM, three were near prototypes of the DWPF configurations: electrodes, off-gas film cooler, and a thick wall thermowell.

3.2 Electrodes

As shown in Figure 3.2, the melt chamber is octagonal with four plate electrodes 90° apart. Each pair of opposed electrodes has an independent power supply for more flexibility in controlling the melt pool temperature.

A section view of the electrode is shown in Figure 3.3. External fins provide cooling to aid in freezing glass within the refractory. In addition, the design physically isolates the vessel wall from the glass by combining a large nozzle with a labyrinth path in the refractory. Although provisions were included for air cooling the electrode plate, this was found to be unnecessary and the air cooling feature was not used during operation.

Two of the four electrodes have an extension on the bottom making them L shaped, Figure 3.4. The intended purpose of the L shape was to force more electric current through the bottom layer of glass to maintain bottom temperatures above 1000° C. This feature was called power skewing, and was aided by independent control of the power to the L vs. rectangular plate electrodes.

3.3 Thermowell and Film Cooler

A DWPF type heavy wall thermowell and off-gas film cooler were tested in the LSFM. The development history of these items is covered in paragraphs 8.5 and 8.8.

Alfrax® is a registered trademark of The Carborundum Company, Keasbey, NJ.

3.4 LSFM Melter Test Results

The LSFM melter was run in campaigns over a period of 749 days. During this time, the melter was operated with slurry feeding for 193 days. A total of 234 tons of glass were produced.

While the L shaped electrodes did demonstrate some ability to increase power to the bottom of the glass melt, it was not enough to achieve the desired control. This result led directly to the use of separate electrodes with independent power supplies on the DWPF melter.

An analysis of the Monofrax® K-3 refractory was made at the conclusion of the run by the Carborundum Company. The refractory was in good shape, but some spalling occurred in the blocks located closest to the slurry feed tube. This was assumed to be thermal shock fracturing caused by slurry feed water contacting the hot refractory.² This is not expected to occur in the DWPF melter for two reasons:

- The DWPF melter feed tube is 20 inches from the refractory wall vs. 8 to 12 inches in the LSFM melter. For comparison, the centrally located feed tube in the 1941 and Scale melters was 24 inches from the wall.
- Based on the LSFM experience, Carborundum suggested lining the Monofrax® K-3 sidewalls in future melters with layers of Fiberfrax® paper. This acts as a sacrificial thermal barrier to protect the refractory from thermal shock during a slurry feed start-up. This technique was used for the Scale melter start-up, and is part of the DWPF melter component installation procedure.

References - Section 3 - LSFM Melter

1. *Savannah River Laboratory's Operating Experience with Glass Melters* by F. Houston Brown, C. T. Randall, M. B. Cosper, and J. P. Mosley - Proceedings of the ANS Topical Meeting on the Treatment and Handling of Radioactive Wastes - April 1982.
2. Letter to F. W. Thompson from J. D. Gutmann, Jr. dated December 7, 1984 - *Analysis of the LSFM Melter K-3 Monofrax® Refractory* - Document Number DS 0000210.

Figure 3.1
LSFM MELTER ELEVATION

Figure 3.2
LSFM MELTER PLAN VIEW

A view of the L shaped electrode tested in the LSFM melter. This photograph was taken at the end of the test run after the refractory had been removed. The characteristic overlap pattern is still visible on the weld bead at the base of the electrode, indicating a low corrosion rate in this area.

Figure 3.4

LSFM MELTER L SHAPED ELECTRODE

References - Section 3 - LSFM Melter

1. *Savannah River Laboratory's Operating Experience with Glass Melters* by F. Houston Brown, C. T. Randall, M. B. Cosper, and J. P. Mosley - Proceedings of the ANS Topical Meeting on the Treatment and Handling of Radioactive Wastes - April 1982.
2. Letter to F. W. Thompson from J. D. Gutmann, Jr. dated December 7, 1984 - *Analysis of the LSFM Melter K-3 Monofrax® Refractory* - Document Number DS 0000210.

Section 4

Project S-4234 Scale Glass Melter

4.1 Background

In mid 1982, it was apparent that the configurations of many DWPF melter components would differ from those tested in the 1941 and LSFM melters. As part of the general plan to verify new designs through tests of full scale and prototype configurations, Project S-4234 was approved to convert the 1941 melter vessel to the DWPF configuration. This Scale melter provided valuable experience with component development and melter operation.

The primary objective of the Scale melter program was to verify operation of DWPF melter equipment designs. These included the following:

- melter components — electrodes, dome heaters, riser/pour spout heater, pour spout bellows, thermowell, feed tube, level dip tube, and T.V. camera/borescope
- bottom refractory and insulation design
- vacuum pouring
- recirculating loop slurry feed system
- off-gas system equipment

The 1941 melter had a 4 foot melt pool diameter, a $2/3$ geometric scale of the 6 foot DWPF design. This same $2/3$ ratio was applied to the electrodes and melt pool depth to simulate the DWPF glass melting process and control of glass temperature. Scaling was not applied to the external dimensions of the dome heaters, riser/pour spout heater, and thermowells, since it was desirable to test electrical heating assemblies at the full size cross section.

At this time the DWPF drain valve design was not developed sufficiently to include a true prototype, but the installed valve simulated several DWPF design features. Later, tests of the DWPF drain valve configuration were run on a test stand at TNX, paragraph 7.6.

Since the Scale melter components and bottom configuration were based on those designed for DWPF, design development for both were done at the same time. To avoid repetition, details of the design basis and history will be covered in the DWPF melter descriptions, Sections 6 through 8. This section will limit discussion to a description of the Scale melter components, and any differences between these and the DWPF versions.

For additional details of Scale vs. DWPF melter differences, refer to Reference 1.

4.2 Scale Melter Configuration

A section view of the Scale Melter is shown in Figure 4.1. Modifications to the original 1941 melter vessel included adding nozzles for the side entering electrodes, fabricating a new riser section, and reducing the dome heater nozzles from six to four. The vessel configuration is shown in Figure 4.2.

Figure 4.1

PROJECT S-4234 SCALE GLASS MELTER

REFERENCE: D182472
BPF 213987

INSIDE SURFACES OF VESSEL AND
NOZZLES ARE COATED WITH FOUR
LAYERS OF DUPONT CORLAR® EPOXY
(16 MILS TOTAL)

Figure 4.2
SCALE MELTER VESSEL

4.3 Refractory and Insulation

The insulation and refractory design for the Scale melter duplicated the DWPF design as closely as possible. Figures 4.3 and 4.4 show the Scale melter configuration for the insulation and refractory. There are some minor differences between the Scale and DWPF refractory geometry due to vessel geometry, thermal scaling requirements, and other considerations. These are described in the following paragraphs.

Top Head

The 1941 melter top head and refractory were examined and found to be in excellent condition. There was no justification to completely replace the refractory in this assembly since it would be representative of the material used in the DWPF melter.

Riser and Upper Sidewall

When the 1941 melter was constructed, a spare set of refractory blocks was manufactured but never used. The spare refractory was in excellent condition, and the decision was made to use this material on the Scale melter where practical. From the K-3 refractory set, only the wire cut and ground Monofrax® K-3 riser block was selected. All of the Mullfrax® 202 bricks for the upper side wall (except the dome heater blocks) were also selected. New Mullfrax® dome heater blocks were ordered, but the vendor had problems with cracks in several sets of castings. The reasons for this were not clear, particularly since there were no similar problems with the Mullfrax® made for the 1941 melter. As a backup, an additional set of dome heater blocks was ordered from Babcock and Wilcox in Augusta, Ga. The very first set of B & W blocks had excellent quality, including a very smooth, dense surface finish. These were installed in the Scale melter.

Although acceptable Mullfrax® blocks were eventually produced, they did not match the quality of the B & W versions. Due to the history of quality problems with the large Mullfrax® Scale melter blocks, this material was not selected for use in the DWPF melter.

Lower Sidewall

At an early stage of the Scale melter design, a meeting was held at Carborundum to discuss the Monofrax® K-3 requirements and tolerances. Carborundum had recently installed two Blanchard grinding machines in the manufacturing area to machine blocks to a greater degree of precision. With these machines, an entire ring of blocks can be set up and ground simultaneously, producing a set that has the same height within .010 inches or less. With individual block fixtures, the Blanchards can also be used to grind the vertical radial joints on the sidewall blocks. This was a considerable improvement over the earlier method of fitting blocks of varying heights using a repetitive fit and grind sequence. In addition to achieving higher quality, less handling of the blocks was required between the fit-up fixture and grinding machine. When these blocks were assembled into the Scale melter, the joints were tighter and measurably better than the previous "best possible" achieved on the 1941 melter.

REFERENCE: W732075

Figure 4.3
SCALE MELTER INSULATION

REFERENCE: W732075

Figure 4.4
SCALE MELTER REFRACTORY

Bottom Construction

A considerable amount of studies and tests were used to establish the bottom refractory design for the DWPF and Scale melter. The Scale melter bottom configuration was based on the DWPF design, but there are minor differences in the geometry. Insulation thickness could not be scaled geometrically, but had to be sized to offset corner heat losses to match the DWPF bottom temperature. As a result, the Scale melter has proportionally more insulation. Design development of the melter bottom refractory and insulation configuration is described on page 6.4.

4.4 Electrodes

The electrode design is directly related to and influenced by the bottom construction of the melter and the requirement to maintain the bottom temperatures at 1050°C. First, the electrode configuration had to be designed to meet the requirements for DWPF, then reduced in size by the 2/3 geometric scaling ratio for the Scale melter. The final configuration is shown in Figures 4.5 and 4.6. With the smaller Scale melter, it was feasible to keep the inside surface of the refractory round, and shape the electrode to fit this curved shape by machining a thick Inconel® plate. On the DWPF melter, this design was modified by using a flat plate to keep the electrode size and weight at reasonable limits. Electrode design development is described on page 7.1.

4.5 Riser/Pour Spout Heater

A section view of the Scale melter riser/pour spout heater is shown in Figure 4.7. This is almost a duplicate of the DWPF configuration, with two exceptions—the length of the DWPF riser section is longer, and the inside diameter of the DWPF riser bore is 4.0 inches vs. the Scale melter's 2.66 inch diameter. The longer DWPF riser section is due to the combination of lower riser angle and extended pour point location to align with the canister position on the turntable. The smaller Scale melter bore was a deliberate choice to suit the lower glass production rate (based on melt pool area) and match the average glass velocity of the DWPF version. Making the glass velocity the same was judged important to simulate the overflow condition to the vertical pour spout, and the effect of glass velocity on erosion. It was assumed that the Inconel® Scale melter components would be analyzed for corrosion at the end of the test like those in the 1941 and LSFM melter.

During initial start up, the Scale melter riser heater element was overpowered and failed. This was a result of the heater thermocouple location, which was too close to the cooler connector extension. The extension acted as a heat sink, resulted in an artificially low temperature readout, and the demand for more power increased current until the heater burned out.² At this time the internal melter temperature had only reached 700°C and had not melted the frit, so the riser heater was relatively easy to remove. Both heater core and thermocouple layout were redesigned to provide more temperature sensing locations, and a current limit was added to the power supply to prevent a reoccurrence of overpowering the heater element.

There were also initial problems with glass plugs forming at the base of the pour spout, and the formation of glass fibers at the end of a pour. Additional design changes were made to correct all of these problems, the performance was verified on the Scale melter, and all changes were included in the DWPF design. Riser/pour spout heater design development is covered on page 7.16.

Figure 4.5

SCALE MELTER ELECTRODE ARRANGEMENT

REFERENCE: W729785
W739535

Figure 4.6
SCALE MELTER ELECTRODE SECTION

REFERENCE: W732726
W744810

4.10

Figure 4.7
SCALE MELTER RISER/POUR SPOUT HEATER

4.6 Dome Heaters

Plan and section views of the Scale melter dome heaters are shown in Figures 4.8 and 4.9. These are based on the DWPF geometry described in Paragraph 7.4. A total of four heater tubes are used vs. eight in DWPF. The 3.25 inch O.D. is identical to the DWPF versions. Since the 1941 melter had six smaller heaters, the vessel was modified by plugging the center nozzles and reworking the upper and lower nozzles to suit the new configuration. The ratio of dome heater area relative to the melt pool area is 1.42 for the DWPF and 1.10 for the Scale melter. The smaller Scale melter ratio represents a conservative test of the configuration for total heat output.

After the riser heater had been redesigned, repaired and installed, the melter was started up for operation. During the initial start up of the Scale melter, a request to increase the heater temperature from 950°C to 1050°C (see page 4.16) resulted in the discovery of a "hot spot" at the center of the solid end stems of the lid heater. Temperatures in this zone exceeded the surface temperature of the tube surface that was supposed to be the hottest area. Although this did not impair performance of the heaters, this is too close to the long term creep limits for Inconel® 690. The DWPF dome heater design was revised to have a nickel core in the center of the end stem to reduce electrical resistance and lower the internal stem temperature. Dome heater design development is covered in Paragraph 7.3

4.7 Pour Spout Bellows

The pour spout bellows couples the bottom of the pour spout to the canister. Included as part of the pour spout bellows is the vacuum connection for creating the differential pressure for pouring. Figure 4.10 shows the original design installed and operated on the Scale melter.

During the initial test phase, glass fibers (caused by low temperatures at the end of the pour spout) would accumulate in the vacuum line and cause periodic plugs. These fibers, coupled with an unstable glass pour stream, also accumulated on the inside surface of the bellows.

All of these difficulties were solved through a combination of design changes that resulted in the DWPF version of the pour spout bellows assembly. The DWPF design was installed on the Scale melter and tested successfully. Pour spout bellows design development is covered in paragraph 7.5.

4.8 Drain Valve

At the time the Scale melter components were being designed, the DWPF drain valve was still in the conceptual design stage. Although it was possible to model the upper two heater zones of the DWPF design, other features that were not completed could not be included. Testing of the DWPF drain valve configuration was accomplished on a special test stand at a later date, see Paragraph 7.6.

The Scale melter drain valve design was simplified by making the drain bore vertical (the DWPF drain bore is an off-set Z shape). The valve was also designed to drain the entire contents of the melter into a large can at the end of the run, with no provision to mechanically stop the flow. In this sense, the operation was similar to that used on the 1941 melter, page 2.22.

Figure 4.8

SCALE MELTER DOME HEATER ASSEMBLY

Figure 4.9
SCALE MELTER DOME HEATER SECTION

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ASSEMBLY SHOWN IN NORMAL OPERATING MODE

The pour spout bellows flange is held against the melter pour spout nozzle by the spring assembly. This design assures positive contact of the flange surfaces at all times.

The canister bellows flange is held against the canister flange by air pressure in the bellows. A relief valve maintains constant pressure as the canister grows upward thermally. Counterweights raise the flange when air pressure is released.

Screws compress and lock the bellows position during installation and removal of the assembly. This simulates DWPF requirements for remote handling.

Figure 4.10

SCALE MELTER POUR SPOUT BELLOWS

Assembly and section views of the Scale melter drain valve are shown in Figures 4.11 and 4.12. Note the small heater in zone 1 at the top of the valve—this is designed to cancel the heat sink effect of the valve body on the surrounding refractory, see page 6.5.

The valve is actuated by powering the heaters, letting the drain valve bore come up to temperature, and activating the probe to initiate draining. During the first attempt to drain the Scale melter, glass flow could not be established because the bottom of the drain bore was not hot enough, and glass solidified in the bore. Insulation was added to the bottom half to reduce heat loss, and the melter was drained successfully. The DWPF drain valve has a different design at the bottom that recesses the pour lip higher into the valve, and prevents the heat sink effect seen on the Scale melter. Drain valve design development is covered in paragraph 7.6

4.9 Off-Gas Film Cooler

Film cooler evaluation continued on the Scale melter based on the LSFM melter tests. Design development is described in paragraph 8.8.

4.10 Other Components

The Scale melter thermowells and feed tube were identical to the DWPF configurations. Design changes were made to the level dip tube to eliminate a weld joint that failed during the test phase. Design development of these items is covered in paragraphs 8.4 through 8.7.

4.11 Scale Melter Start-up

After the failed riser/pour spout heater assembly had been removed, repairs were needed to the riser refractory, Figure 4.13. One of the four lower block segments had shifted as a result of the heat up and cool down cycle. In addition, a piece was broken from the end of the riser as the heater was being removed. Repairs were made on site by Toledo Engineering.

The riser block shift was due to the combination of using the original cast, segmented block from the 1941 melter, and the more rapid heat-up of the riser assembly relative to the interior melter refractory. This is not expected to occur on DWPF, since the riser blocks are one-piece castings, and the start-up procedure has been revised to heat up the melter cavity before the riser heater is brought up to temperature.

Although the riser blocks were repositioned correctly, and the broken piece repaired with epoxy, the repair work apparently disturbed the frit layer and resulted in the frit covering one lower electrode, Figure 4.14. It was during this start-up attempt when the dome heater surface temperatures were increased above 1000°C and the “hot spot” in the heater stem was revealed.

Start-up was achieved by adding more frit to reach the upper electrode layer, and heating the surface with the dome heaters. Additional frit had to be added after the partially melted frit slumped and lost contact with the electrode. This was a predicted result, and the reason for using a shallow frit layer at the lower electrode level. A restart using the DWPF procedure was demonstrated at the end of the test run.

Figure 4.11

SCALE MELTER DRAIN VALVE ASSEMBLY

Figure 4.12

SCALE MELTER DRAIN VALVE SECTION

The riser refractory had shifted after the heat-up to 700° C and rapid cool down cycle following failure of the riser heater element. This was due to the segmented construction of the riser block (1941 melter vintage) and the faster heat-up of the riser heater relative to the melter sidewall refractory. The spall, which was broken off during extraction of the riser heater, was repaired with epoxy. Based on the difficulty of removing the angled heater assembly with an overhead crane, an installation fixture was provided with the DWPF assembly, see Figure 7.10, page 7.15.

This event will not occur with the DWPF melter. The riser blocks are one-piece castings, and the start-up procedure has been modified to heat the melter interior before the riser heater is energized.

Figure 4.13
CONDITION OF SCALE MELTER REFRACTORY AFTER SHUTDOWN

FRIT LEVEL AFTER RISER REPAIR

FRIT LEVEL AT START-UP

The start-up frit layer was supposed to be level near the top of the lower electrode. Repairs to the riser refractory apparently resulted in shifting the frit and covering one electrode. The melter could not be started under this condition, and a modified start-up was achieved by adding more frit to reach the upper electrodes. As the frit was heated, it fused and slumped down (dark line). Additional frit had to be added to keep the material in contact with the electrodes.

At the conclusion of the Scale melter test run, the melter was drained, frit was added to the correct level at the lower electrode, and a simulated DWPF start-up was successfully demonstrated.

Figure 4.14

SCALE MELTER FRIT CONDITION AT START-UP

4.12 Scale Melter Test Results and Conclusions

The Scale melter test program successfully verified many component designs and process operating features of the DWPF melter system. Glass melter accomplishments include the following significant demonstrations:

- The electrode configuration, power supply, and control system worked flawlessly throughout the test period. This verified the combination of electrode and melter bottom design for DWPF.
- Limitations of the riser/pour spout heater were uncovered, corrected with design changes, and verified with additional tests. The improved temperature profiles resulted in a very stable glass pour stream.
- Design improvements to the pour spout bellows also improved stability of the pour stream and eliminated glass fiber plugs in the vacuum line.
- An internal tube failure in the level dip tube revealed an area of high stress caused by differential thermal expansion. The design was changed to eliminate the tubing, and new dip tube assemblies were fabricated for the DWPF melters.
- After testing was completed, the glass was drained from the melter, frit was added, and a DWPF start-up using the dome heaters to melt the upper frit surface layer was demonstrated. After power to the electrodes was established, the glass volume was increased to normal limits with slurry feeding.
- The last test was a demonstration of restart capability. Power to the dome heaters and electrodes was turned off, the glass was allowed to freeze, and the melter was restarted using the dome heaters to melt the surface and gradually increasing power to the electrodes. This was the first time that this restart technique was demonstrated with a large melter.

References - Section 4 - Project S-4234 Scale Melter

1. Letter to D. C. Nichols from J. R. Knight dated October 12, 1987 - *Design Comparison of the Scale Melter to the DWPF Melter* - Document Number DPST-87-688-TL.
2. Memo to J. R. Glasscock from J. L. Mahoney and A. F. Weisman dated September 4, 1985 - *Failure of the Riser Heater in the Scale Glass Melter* - Document Number DPST-85-734.

Section 5

DWPF Glass Melter Vessel

5.1 Basic Data

The melter size was influenced by a combination of melt rate requirements, refractory corrosion allowances, and considerations for transport. Earlier tests at SRP established a minimum instantaneous melting rate of 8 pounds/hr/ft² of glass melt surface area, and a minimum total instantaneous melting rate of 228 lbs/hr.¹ This translates to an approximate melt pool diameter of 6 feet. Refractory corrosion allowances dictated a nominal refractory sidewall thickness of 1 foot, increasing the vessel inside diameter to 8 feet. Allowances for insulation, vessel wall thickness, and water cooling jackets brought the vessel outside diameter to 8 1/2 feet, excluding flanges.

This was getting close to the maximum permissible limits. The possibility of having to transport the vessel/frame assembly off of the site dictated a maximum width across the assembly of 11 feet.² This influenced many design details, including orientation of the dome heaters and, to a lesser degree, angular positioning of the electrodes.

5.2 Materials

Type 304L stainless steel was specified for the vessel. This choice was based on the melt cell environment for external surfaces, and the protection offered to the internal surfaces by the combination of refractory, insulation, and epoxy coating. For the same reasons, corrosion evaluation was not required.

Inconel® 690 material is used for the two off-gas nozzles and flanges. These are the only vessel surfaces directly exposed to the off-gas vapor, and this is minimized by the fact that the vapor flows through the installed film cooler, not the vessel nozzle. Vapor corrosion tests of Inconel® alloys conducted at PNI verified that Inconel® 690 was the most corrosion resistant material.³

The chromium content range for Inconel® 690 is 29 to 31 percent by weight. To ensure maximum resistance to corrosion for DWPF, a minimum amount of 29 percent chromium was recommended. This requirement was included in the order specifications and verified by a chemical analysis of each heat. B. S. Schaff, ESD, recommended using a modified 690 weld filler material for Inconel® 690. The chromium content for this material was increased to 30-32 percent to allow for losses across the arc.⁴

The interior surfaces of the vessel and nozzles are coated with four layers of Keeler and Long, Inc. nuclear grade epoxy for the electrical insulation barrier (see description on page 2.10). Surface preparation and coating procedures are covered in DuPont painting system specification SR-404.⁵

5.3 Vessel Configuration

Elevation and section views of the DWPF melter are shown in Figures 5.1 and 5.2. The design is based on the same refractory stability principles described previously for the Project S-1941 melter in Section 2 – a cylindrical water-cooled vessel with dished heads and a slant riser.

Figure 5.1

DWPF MELTER ELEVATION

Figure 5.2
DWPF MELTER SECTION

The final vessel design, Figure 5.3, is based on calculations similar to those used to size the 1941 melter. Since the DWPF melter is not a tilt pouring design, the vessel is supported on the bottom. With this design, the junction where the bottom head meets the sidewall is a high stress zone, and it would be undesirable to have a welded joint at this location. A one-piece forged ring was the solution, Figure 5.4. The forging provided improved grain structure at the critical joint and allowed the weld to be located away from the corner. Stresses were reduced further by using generous radii to gradually blend the vertical skirt into the bottom head.

Previous stress analyses of the 1941 melter showed a high stress zone at the riser junction, Section 2, Reference 7. This area was reinforced with a 3 inch thick forged boss on DWPF. Side and top edges of the boss are tapered gradually to blend with the nominal 1 1/2 inch thick sidewall (see Figure 5.12, page 5.17).

The DWPF top head contour is shaped similar to the 1941 melter configuration for a keyed refractory assembly. A considerable amount of design time and effort was spent on the DWPF top head to resolve conflicting space requirements for the water cooling jackets, nozzle layout, and access for remote handling of the top head components. The remote handling aspect is discussed in paragraph 8.2.

5.4 Water Cooling

At an early point in the DWPF melter design, two independent water cooling circuits were suggested to protect the melter from a single failure in the cooling water supply system. The melter has two independent cooling channels designated "A" and "B" on the drawings. Each channel has its own pump, supply jumper, and return jumper. If there is a loss of water flow in either channel, water is retained in the melter cooling channels since the melter is located below the supply and return lines.

On the bottom head, the "A" and "B" channels are half pipes formed into helical coils, Figure 5.5. A vertical channel configuration was selected for the sidewall to vent the system in the unlikely event that all water flow is lost, see page 5.10. Another advantage of vertical channels is the ability to fit them up close to the nozzles and surround the nozzle base with water, Figure 5.6.

A section view of the sidewall jacket construction is shown in Figure 5.7. For the same reasons, jackets were also used on the top head instead of half pipes.

Water distribution is provided by a combination of manifolds and internal orifices. All internal orifice sizes were calculated for ideal distribution.⁶ In a few cases, the orifice geometry was varied slightly to suit fabrication requirements.

Total water flow to the melter in each channel is 180 gallons per minute. This is a very conservative design, as the flow rate is large compared to the energy absorbing requirements. One of the questions raised during the conceptual design stage concerned the effect of losing flow in one channel due to a pump, valve, or jumper failure. Heat transfer calculations showed that energy absorption by the operating water channel keeps water temperature in the adjacent (stagnant) channel below the boiling point.⁷ Representative temperatures are also shown in Figure 5.7.

REFERENCE: BPF 215605

Figure 5.3
DWPF MELTER VESSEL

A forged ring is used at the critical interface between the vessel sidewall and bottom head. The forging shape provides improved grain structure and removes welds from the higher stress area. Stress concentrations are reduced by using large radii to blend the skirt into the bottom head.

Figure 5.4
BOTTOM RING FORGING

A and B water channels on the vessel bottom are formed by welding half pipes into helical coils. In this view, the two channels are temporarily tied together with a U shaped pipe for hydrotesting.

Figure 5.5
BOTTOM COOLING COILS

The vertical sidewall water channels are formed by welding T shaped ribs to the vessel. This photograph shows how the ribs are shaped to fit around the riser. Each dome heater nozzle has an A channel on one half and a B channel on the other. The same arrangement is used for the electrode nozzles (Figure 5.5).

Figure 5.6
SHELL WATER JACKET

The independent cooling channels provide protection against overheating if water flow is lost in one channel. Heat transfer calculations predict that water flow in one channel is sufficient to keep water temperatures in the adjacent stagnant channel below the boiling point. Temperatures shown are at the lower sidewall section adjacent to the glass melt, where the heat flux is highest (See Reference 6 for the original data).

Figure 5.7

SIDEWALL WATER JACKET CONSTRUCTION

The water jackets, coils, and manifolds are designed for 60 psig service. Both leak testing and hydrotesting are required procedures. To allow access for leak checks and potential repairs, the vessel shell water channels were installed and tested in the following sequence:

1. weld B manifolds and jacket covers
2. halide leak test at 15 psig
3. hydrostatic test at 90 psig
4. add the A manifolds and jacket covers
5. repeat leak check and hydrostatic test on A channel
6. weld A and B channel coils on the bottom head and repeat the leak and hydrostatic tests

Top head manifolds and jacket covers are installed and tested per steps 1 through 5.

5.5 Vessel Stress Analyses

Vessel design for the glass melter is a special case compared to a more conventional process vessel since the loads on the vessel walls are produced by thermal conditions only, not by operating pressures. Normal operating melter pressure during glass pouring is several inches of water vacuum. A vessel designed for this service would have a relatively thin wall.

The heavy walls on the DWPF vessel are necessary to withstand stresses produced by the expansion of the refractory. This is a thermal stress and is self limiting, i.e. if the stress reaches yield, the material will yield at this local area and the stress will disappear. For these secondary stresses, the ASME Section 8 Division 2 code permits higher allowable stresses. A number of finite element analyses have established that the vessel will operate well within these limits.

Loss of Coolant

The worst case stress condition for the DWPF melter occurs if cooling water flow is lost through multiple failures. A finite element stress analysis for this condition showed that the vessel will yield if all cooling water flow is lost, but will not crack or rupture.⁸ This analysis was based on a heat transfer study that showed water in the sidewall cooling channels below the glass melt surface would exceed the boiling temperature at steady state.⁹

To reduce distortion of the shell and skirt for this condition, the melter support was designed for free growth in the radial direction, Figure 5.8. Dowels in the lower frame engage the melter base plate on the inside edge, allowing the support to grow away from the dowels. The base plate is fastened to the frame with a shoulder bolt and washer combination that provides a clearance gap after the bolts are tightened. Figure 5.9 shows the dowel and slotted hole arrangement on the frame.

B. J. Tilley, ESD, calculated that the maximum pressure developed in the water jackets from this worst case steam generation is less than 30 psi. The model simulated the piping configuration from the vessel to the water tank.¹⁰

Figure 5.8
METHOD OF FASTENING MELTER SHELL TO LOWER FRAME

This photograph shows the completed lower frame. The melter shell is installed on the circular ring, aligned with four dowels, and fastened with four shoulder bolts through the slotted holes. This construction permits free radial growth of the melter support if all cooling water flow is lost.

Figure 5.9

LOWER FRAME CONSTRUCTION

The possibility of losing all coolant to the DWPF melter is considered to be very remote due to the redundant system and our experience with the reliability of cooling systems. This includes our favorable experience with the water-cooled 1941 and Scale melters, which were successfully operated for several years at the SRP test facility in TNX.

Steam and Chemical Explosion Analyses

In 1983, Fauske & Associates analyzed the effects of a potential steam explosion occurring in the melter due to interaction of glass with water or molten salts. It was concluded that there is no threat to the vessel integrity due to dynamic loads resulting from a vapor explosion, or to long-term pressures and temperatures from steam generation while the melt cools.¹¹ A similar study for a hypothetical chemical combustion due to loss of slurry feed water also concluded that there was no threat to the vessel integrity.¹²

Normal Operation

Finite element stress analyses were run to determine stresses at the intersection of the bottom and sidewall for the 1 1/2 inch thick sidewall and the 3 inch thick riser zone. Under normal operating conditions, the stresses are well below the allowable limits.^{13, 14} Similar analyses verified the top head and upper sidewall stresses are within allowable limits. These were recently analyzed again using the newer Patran program to show additional detail.^{15, 16}

Forces imposed by the off-gas pipes on the melter nozzles were analyzed for stress and deflection. Stresses were within allowable limits, and an additional study verified that the deflections would not create binding of the alignment dowels when the off-gas pipes were removed.^{17, 18}

At Bechtel's request, an analysis of piping loads on the vessel cooling water nozzles was reviewed and approved by S. L. Thaw and J. R. Casper.¹⁹

5.6 Fabrication History

Tolerances

Fabricating the DWPF vessel to the drawing tolerances proved to be a much more difficult task than anyone expected. As on other DWPF equipment, there was the problem of coping with the unstable nature of stainless steel. This was made more difficult by the requirement to hold a dimension within 20 to 40 mils over a span of several feet. Thermal distortion from welding magnified the problem. We soon learned that standard shop practices used to control distortion were not sufficient to meet DWPF standards. Everyone involved with fabrication of a stainless steel weldment faced this to some degree. CBI Services experienced an unusual case with the first melter frame, as the material kept moving and creating small changes in the dimensions. At one point, work on the frame was stopped, and it was set aside on the shop floor for one week to allow the residual stresses to work themselves out.

Melter Shell

Several innovative techniques and procedures were used to control the contours in the vessel shell.

It was recognized that welding the half pipe coils on the bottom of the shell would distort the bottom contour if there were no restraints. To keep distortion to a minimum, heavy bracing was temporarily welded to the bottom before the coils were welded in place. After the coils were installed, the bottom was welded to the forged support skirt, Figure 5.10. This created a rigid structure to maintain stability when the forged ring was welded to the sidewall.

After the electrode and dome heater nozzles were welded on Melter #1, a dimensional check revealed that the vessel was out of round to the point where it could not be machined internally to the final drawing dimensions and minimum wall thickness.

The problem was resolved with a shrink fit procedure. The bottom area of the shell was within tolerance and only needed restraint to hold the existing shape. Split rings were installed in the bottom, hydraulically jacked apart, and welded together. Additional one-piece rings were machined out of carbon steel to suit the as-formed inside diameter, the vessel was heated in an oven to 1000°F, the center and top ring were installed, and the vessel was allowed to cool and shrink down on the rings. After the vessel cooled, vertical tubes were welded between the rings to tie them together.

The "roundout ring" setup is shown in Figure 5.11. Carbon steel was used because the difference in thermal expansion of the rings and stainless steel shell provided the required control for the shrink fit. Contamination of the stainless surface with carbon steel was not an issue, since the inside surface would be machined to the final dimensions after the rings were removed.

Figure 5.12 shows the shell just after the rings were installed. The 5 inch thick center ring can be seen through the opening for the riser nozzle. Details of the internal bracing are shown in Figures 5.13 and 5.14.

After all nozzles were welded, the shell was stress relieved by a controlled heating and cooling procedure.²⁰ Additional bracing was added to the dome heater nozzles to prevent them from warping during this operation, Figure 5.15.

The following procedure was used to maintain dimensional control for the remaining fabrication sequence:

1. remove head bracing and rings and rough machine inside surface
2. rework and reinstall rings
3. weld water jackets to the shell exterior
4. stress relieve, remove rings, and machine interior to final dimensions

The combination of rings, bottom head bracing, and stress relieving maintained the correct contours through the fabrication cycle and was used with equal success on Melter #2.

Final fabrication stages of the melter shell are shown in Figure 5.16.

Despite the procedures to control weld distortion, there were instances where weld overlay had to be applied to selected areas to meet minimum thickness requirements before final machining.

The bottom head is fabricated as a subassembly before it is welded to the shell sidewall. This view shows the completed structure with the bottom head bracing and forged support skirt. Half pipe cooling coils are underneath and not visible.

Figure 5.10
BOTTOM HEAD SUBASSEMBLY

The bottom rings were split after machining, installed in the shell in two pieces, and fitted to the shell with hydraulic jacks. After installation, the rings were welded together.

Clips were attached to the shell to support the middle ring. The shell was heated to 1000°F, removed from the oven, and the middle ring lowered in place. Top rings were set in place ten minutes later.

Figure 5.11
SHELL ROUNDOUT RINGS

This photograph was taken shortly after the rings were installed. The 5 inch thick center ring is barely visible through the opening for the riser nozzle. At this stage, the electrode nozzles are in place, and the dome heater nozzles are nearing completion. This is a good view of the heavy forging that reinforces the riser nozzle intersection. Note how the edge of the forging are tapered to blend with the sidewall.

Figure 5.12

SHELL AT EARLY FABRICATION STAGE

Bottom head bracing and all three rings are visible in this view. This technique maintained the shell contours and reduced weld distortion during installation of the nozzles and water jackets.

Figure 5.13

SHELL AND BOTTOM HEAD BRACING

Sidewall rings are joined with welded vertical tubes. This view shows the assembly at the electrode nozzles. Note lifting lug on the center ring for handling and installation.

Detail of bottom head bracing. The rough machined bore for the drain valve is visible at the center

Figure 5.14

DETAIL OF SHELL BRACING

These photographs show the external bracing that was installed on the dome heater nozzles prior to the first stress relief. All nozzles are now welded to the shell. Temporary lifting lugs have been welded to the exterior for handling and positioning.

Figure 5.15
EXTERIOR BRACING

This view shows the shell after the water jackets have been completed. The riser end section has been installed to check alignment. Dome heater nozzle flanges have not been installed.

All machining of interior surfaces and nozzle flanges has been completed. The shell is now ready for installation of the refractory lining. The top head has been installed on the turning fixture and is visible in the background to the right.

Figure 5.16

SHELL FABRICATION

Melter Top Head

Fabrication problems were also encountered with the top head. The dished heads for both melters were fabricated by another vendor, and only one of them met the final requirements for contour and thickness. Repairs were attempted by reforming the head to the proper contour, but this resulted in making the drawn area thinner. CBI had to scrap this head and fabricate another one by forming pie shaped segments and welding them together. On both heads, heavy stiffeners were installed in the head prior to welding the nozzles in place. The stiffener configuration was similar to that used on the bottom head shown in Figure 5.11. Both heads were stress relieved using the same procedure developed for the shell.²¹

After final machining of the Melter #1 top head nozzles, a dimensional check revealed that some nozzle centers were outside the allowable 10 mil radius tolerance. Since the deviations were small, the as-built nozzle locations were accepted as the standard for all future melters to maintain consistency. Theoretical nozzle center locations for Melter #2 were calculated to keep the new locations as close to the original as possible. This approach, shown in Figure 5.17, was suggested by J. E. Savoy.

The variation in the machined nozzle center locations was a frustrating experience since a considerable amount of effort went into setting up the vertical boring mill and checking out the computer program for accuracy. The cause was later traced to longer cables that were added between the vertical boring mill and control center. Although the cables were shielded, a small amount of electrical interference produced random variations in the signal from the control center. A different cable construction cured the problem.

Photographs of the top head in preliminary fabrication stages are shown in Figure 5.18.

Top Head Turning Fixture

The top head must be supported and capable of being rotated to suit two conditions. During refractory installation and shipping to the SRP, the head must be upside down. Before it can be installed on the melter shell it must be rotated to the upright position. On the 1941 and Scale melters, the head was compact enough to use a crane and rigging for handling and rotation.

This method was not considered suitable for the DWPF melter due to the increased size and weight of the head, and the need to protect studs and dowels welded to the off-gas flanges. Studs and dowels align components for remote handling and must meet tight tolerances for location and squareness. An initial concept for a combined turning and shipping fixture was made by J. D. Gutmann and J. E. Savoy, Figure 5.19. This envisioned using a shop crane to perform the rotation. After discussions with Keller Technology, an electric drive was added to gain better control of the rotating operation. B. J. Etienne worked with Keller to produce the final configuration, Figure 5.20. Safety and convenience features for the refractory installer include guards, handrails, and platforms.

Figure 5.17

TOP HEAD NOZZLE CENTER ADJUSTMENT

Nozzle openings have been rough machined and several nozzles have been installed. This photo was composed to gain highlights from late afternoon sunlight. CBI said there would not be an extra charge for the gold plating.

All nozzles have been installed and the ribs for the water jackets are in place. After all jacket covers are installed, the inside contour is machined to the final dimensions.

Figure 5.18

TOP HEAD FABRICATION

Figure 5.19

TOP HEAD TURNING FIXTURE CONCEPT

The top head turning fixture with the head installed in the upright position. Included with the fixture, but not installed in this view, are guards and handrails to protect the refractory installer.

This view shows the completed top head after all machining has been completed.

Figure 5.20

TOP HEAD TURNING FIXTURE

5.7 Top Head Installation

Fiberfrax Durablanket® Installation

Since the original test data for the Durablanket® compression characteristics were last run in 1981 (Section 2, Reference 12), J. D. Gutmann asked W. H. Harlow, SRP Construction, to run a quick test at the mockup shop to verify the data. The original and new data were in perfect agreement. Calculations verified that an uncompressed layer of 3 inches would produce 150 psi at operating temperature.²² A check of the furnished insulation, ordered at a nominal 1/2 inch thickness, showed that the actual thickness was somewhat larger. Five layers of "1/2 inch" blanket produced the desired 3 inch uncompressed layer for installation.

Top Head Stud Torque

The top head is fastened to the shell with studs and sealed with a stainless steel O ring, Figure 5.21. Shell and head flanges are designed to seat metal to metal to make the seal. Calculations for torquing the nuts were based on O ring compression values in the vendor's catalog.

When the head was installed on melter #1 at SRP, the flanges did not seat at the calculated torque of 215 ft. lbs. R. T. Britt calculated that the maximum safe torque for the stud material was 420 ft. lbs., which would theoretically develop a tensile stress of 45,000 psi in the studs. This is below the minimum 50,000 psi yield of the SA 193 GRB8S stud material.

To verify that stresses in the studs were well below yield, R. T. Britt arranged a test at CBI to measure the actual stress on the Melter #2 studs as the head was installed for the hydrostatic test. This would also measure the O ring seating force without the influence of the Fiberfrax Durablanket®. The results showed that average stress in the studs at 420 ft. lbs. was 36,533 psi, which is 73% of the yield strength. An additional torque experiment was run using a test piece that simulated the flanged joint. At 640 ft. lbs. the stress was still below yield at 48,135 psi.²³

These tests proved that the stud material is acceptable for the melter top head design.

This section view shows the components that make up the assembly of the top head to the shell. A total of 56 nuts are torqued to 420 ft. lbs. to compress the O ring and seat the flanges metal to metal. The Fiberfrax® blanket absorbs vertical expansion of the sidewall refractory during start-up and limits loading on the head to 150 psi.

Figure 5.21
ASSEMBLY OF TOP HEAD TO SHELL

References - Section 5 - DWPF Melter Vessel

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3. Letter to J. T. Granaghan from J. F. Ortaldo dated September 16, 1983 - *Hot Corrosion of Inconel® Plenum Heater Thimbles* - Document Number DPST-83-606-TL.
4. Letter to B. Young from B. W. Schaaf dated March 6, 1987 - *Weld Filler of Near Matching Composition to Inconel® 690*.
5. DuPont painting system specification SR-404, Revision 0, dated June, 1985.
6. Letter to J. E. Savoy from B. J. Tilley dated May 6, 1985 - *Fluid Flow - DWPF Glass Melter Cooling Jacket Flow Distribution*.
7. Heat transfer study by H. F. Hublein dated June 14, 1985, showing water temperatures in the shell jackets when one water circuit is not flowing.
8. Letter to W. F. Senkowsky from E. H. Perez dated April 28, 1982 - *DWPF Stage 1 Melter - Thermal Stress Analysis*.
9. Heat transfer analysis by H. F. Hublein dated March 8, 1982, showing water temperatures above boiling in the shell jackets when all water flow is lost.
10. Sketch of melter cooling water piping from water tank to melter.
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13. Letter to J. D. Gutmann, Jr. from R. C. Yohn dated January 21, 1983 - *Stress Analysis of Shell at Discharge Nozzle*.
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References - Section 5 - DWPF Melter Vessel

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17. Letter to J. C. Davis from J. D. Gutmann, Jr. dated September 30, 1985 - *Deflection Analysis of Melter Vessel Off-Gas and Back-Up Off-Gas Nozzles* - Document Number DD 0004592.
18. Letter to J. C. Davis from K. G. Miller dated January 28, 1986 - *Deflection Analysis of Melter Vessel Off-Gas and Back-Up Off-Gas Nozzles* - Document Number BD-6988.
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20. *Post Form/Post Weld Heat Treatment, Glass Melter Vessel Assembly, Rev. 1*, dated April 30, 1986, Document Number BPF 215605, Sheet 181.
21. *Post Form/Post Weld Heat Treatment, Glass Melter Vessel Top Head, Rev. 3*, dated January 5, 1987, Document Number BPF 215605.
22. Letter to T. G. Powell, B. K. Parsons, and W. F. Harlow from J. D. Gutmann, Jr. dated October 23, 1987 - *Revised Installation Procedures for Melter #1 Top Head*.
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Section 6

DWPF Glass Melter Refractory Lining

6.1 Basic Data

Basic data requirements for the melter refractory included a design corrosion rate of 5.4 mils per day for the Monofrax® K-3 sidewall surface, Section 5, Reference 1. This rate translates to a loss of four inches over the two year design life and was the basis for selecting a twelve inch thickness for the sidewall and bottom. This was considered to be a very conservative approach, since corrosion rate data from other melters was lower. The higher values may have resulted from earlier research melter data where the throat refractory was eroded by electric current.¹ Recent data with the current glass formulation indicates that the corrosion rates for Monofrax® K-3 are some five times lower than the original basic data values.

Nominal glass melt temperature is 1100° C with lower and upper limits at 1050 and 1150° C. The lower limit, based on past experience, is above the glass liquidus temperature to avoid spinel formation. The 1150° C upper limit is based on limitations of mechanical properties and corrosion rates for Inconel® and Monofrax® K-3.

6.2 Insulation Configuration

Insulation materials for the DWPF melter are the same used in the 1941 melter and similar in geometry, Figure 6.1. The only difference is the larger size and additional thickness used on DWPF to reduce heat losses.

Fiberfrax® T-30 was chosen for the bottom insulation liner since it could be shaped with a fixture to match the vessel and refractory contours. The same material was also added to the spherical portion of the top head. Insulation in the critical knuckle radius zone is the same 1/4 inch Fiberfrax® paper used on the 1941 melter and for the same reason—to restrict movement of the outer ring of refractory blocks, since these key the entire top head refractory structure (page 2.16). A comparison of the top head insulation for the DWPF and 1941/Scale melters is shown in Figure 6.2.

As before, DSM-24 was selected for the sidewall insulation (page 2.9). The installed 3/4 inch thickness is based on the larger refractory diameter and corresponding amount of thermal expansion.

Another design element of the 1941 melter used on the DWPF and Scale melters is the use of Fiberfrax Durablanker® at the joint between sidewall and top head refractory. This limits compressive loading on the head due to vertical thermal expansion of the sidewall refractory, page 2.10. A description of the blanket thickness calculations for Melter #1 is included in Section 5, Reference 22.

Fiberfrax Durablanker® is also installed at the upper end of the riser to absorb thermal expansion of the riser blocks.

REFERENCE: W737669

Figure 6.1
DWPF MELTER INSULATION

SCALE MELTER TOP HEAD **DWPF MELTER TOP HEAD**

Figure 6.2

DWPF VS SCALE MELTER TOP HEAD INSULATION

6.3 Refractory Configuration

The DWPF refractory configuration is shown in Figure 6.3. The design is based on the same principles used on the 1941 melter to lock the refractory blocks in place to insure stability, see paragraph 2.4 page 2.1. Since the Scale melter version was dependent on the final DWPF design, heat transfer and modeling studies for both were done simultaneously.

Zirmul® refractory was chosen for the intermediate layer between the Monofrax® K-3 and insulation, based on the requirements for this intermediate layer:

- low thermal conductivity
- resistance to glass corrosion
- high compressive strength

Previous experience at SRL with the LSFM melter had shown that the reaction of glass with Zirmul® creates a very viscous product that prevents further penetration.

6.4 Bottom Refractory Design Development

Heat Transfer Studies

The combined insulation and refractory design for the melter sidewall and top head was accepted by SRP at an early stage. Most of the design and test effort was concentrated on the bottom configuration. SRL was very concerned about bottom heat losses and maintaining the Monofrax® K-3 surface temperature hot enough (1050°C minimum) to prevent spinel formation.

As noted previously on page 2.10, it is important to maintain the correct balance between refractory and insulation to insure the glass will freeze in the refractory. This had to be balanced against the desired 1050°C hot face temperature. A number of two-dimensional heat transfer studies were run to evaluate temperature profiles in the glass melt and through the refractory for various combinations of refractory and insulation:

1. original design – 12 inches Monofrax® K-3, 3/4 inches of Fiberfrax® T-30
2. modified design – 12 inches Monofrax® K-3, 6 inches Zirmul®, 1 1/4 inches Fiberfrax® T-30 ²
3. same as modified design above with a 1 1/4 inch ring of Fiberfrax® T-30 in the corner ³

The optimum design is configuration #3 as shown in Figure 6.3.

The same approach was applied to the Scale melter bottom design. One of the interesting results of this study was the measurable dependence of the bottom refractory/insulation design on vessel diameter. As the vessel (and melt pool) diameter gets smaller, it becomes more difficult to keep glass temperatures hot at the bottom corner, Figure 6.4. In this zone, glass loses heat over a 90° arc to the vessel side and bottom. As the vessel diameter is reduced, the proportional heat losses to the corner become greater. For the Scale melter, the thickness of Zirmul® and Fiberfrax® T-30 had to be greater than the DWPF values in order to duplicate the refractory hot face temperature and glass temperatures at the bottom.

REFERENCE: W737669

Figure 6.3
DWPF MELTER REFRACTORY

MATERIAL	DWPF MELTER	SCALE MELTER
MONOFRAX K-3 REFRACTORY	12"	8"
ZIRMUL REFRACTORY	6"	7 3/4"
FIBERFRAX T-30 BOTTOM LINER	1 1/4"	2.0"
FIBERFRAX T-30 CORNER LINER	1 1/4"	2.0"

Glass in the corner where the bottom refractory meets the sidewall will always be at a cooler temperature. This small zone radiates heat over a 90° arc to the relatively large surface area on the vessel side and bottom.

If the bottom corner shape of the vessel remains the same and the vessel diameter (and melt pool) is decreased, the corner becomes a greater proportion of the total radiating area. More heat energy is lost, and the result is a lower glass temperature in the corner zone. To keep the glass at a higher temperature, the corner area of a smaller vessel must have more insulation.

Figure 6.4
BOTTOM CORNER HEAT LOSSES

The predicted refractory temperature in the bottom corner is 962° C for DWPF and 931° C for the Scale melter.^{3, 4} This is due to the conservative heat transfer model, which assumes that glass near the bottom is stagnant, i.e. no convection currents to even out temperature differences. In the actual melter, glass temperatures and refractory surfaces in this region will be higher. To illustrate this, a similar analysis was made of the LSFM melter bottom design, which had a heavily insulated bottom and did not show any spinel accumulation. The model predicted a 964° C glass temperature in the corner.⁵ A comparison of the refractory bottom temperatures for the Scale, LSFM, and DWPF melters is shown in Figure 6.5.

Another important discovery was the heat sink effect due to the Inconel® 690 drain valve. Earlier heat transfer studies of the melter bottom did not include the drain valve Inconel® tube. When the drain valve is added to the model, the adjacent refractory surface temperature drops from 1000° C to 970° C for the DWPF design, and from 1010° C to 900° C for the scale melter.⁶ This is due to heat loss through the Inconel® 690 valve tube to the outside of the melter. (In these early studies, the insulating effects of Alfrax® versus Zirmul® were included. Since the difference was negligible and the properties of Zirmul® were more favorable, this material was selected for the backup refractory.)

After reviewing this data, J. D. Gutmann, Jr. requested a temperature probe of the operating LSFM melter near the drain valve to verify this effect. Temperatures measured on the bottom near the valve were measurably lower than those measured some distance away. To reduce this heat sink effect, the valve air cooling flow rate was reduced. The temperature difference was more pronounced in the LSFM because the valve occupied a larger proportional area of the floor.

For the Scale and DWPF melters, the solution to the drain valve heat loss effect was to add a small heater to the top of the drain valve. This heater is run continuously while the melter is operating to keep the upper refractory surface temperatures at 1050°C.

Physical Model Studies

Additional tests were run by M. B. Cospers at the SRL TNX facility to verify the DWPF and Scale melter bottom refractory designs. These experiments were carried out with plastic scale models that simulated the entire melter refractory, insulation, and electrode system. Glass was modeled with glycerine, doped with lithium chloride to make it conducting, and joule heating in the "glass" was generated by applying electric power to copper plate electrodes. Heat loss through the refractory and insulation was simulated by circulating temperature-controlled water around the sides and bottom of the melter model. Four independently controlled water jackets permitted the relative heat losses from side to bottom to be modeled to match those on the actual melter. Temperature profiles throughout the glycerine bath were measured with an array of thermocouples.

These tests concluded that the proposed bottom design for the DWPF melter met the requirement for the 1050°C minimum glass temperature. A second model was constructed and tested to verify the Scale melter bottom configuration. A description of the physical models and test results is in Section 7, References 4 and 5.

MELTER	BOTTOM REFRACTORY TEMPERATURE IN °C					
DWPF MELTER	1050	1060	1065	1050	1020	962
SCALE MELTER	1015	1021	1024	1011	983	931
LSFM MELTER	1036	1033	1026	1014	995	964

These curves show the influence of corner heat losses on refractory bottom temperatures for the DWPF, Scale, and LSFM melters. Bulk glass temperature is assumed to be at 1150° C. For the DWPF and Scale melters, the glass in the dished area below the electrodes is assumed to be stagnant. On the LSFM melter, the glass temperature is assumed to be at 1150° C on the bottom, since the bottom is flat. Temperatures shown are in the center of the model refractory cell height, which is 0.5" for DWPF, 0.33" for the Scale melter, and 0.25" for the LSFM melter. The model for these curves does not include the heat sink influence of the drain valve (see discussion on page 6.8, and References 3, 4, and 5).

Figure 6.5

COMPARISON OF BOTTOM REFRACTORY TEMPERATURE PROFILES

6.5 Refractory and Insulation Fabrication

Fixtures

Both the melter vessel and refractory are designed and fabricated to close tolerances to control fit-up clearances and keep the vessel stresses within allowable limits. This degree of precision requires fixtures that duplicate the size and contour of the surface that the insulation or refractory must match at final assembly. Additional fixtures are necessary for fabrication, installation and shipping requirements.

The DWPF melter design required several sets of fixtures to satisfy the design tolerance requirements. These include:

1. Fabrication fixtures
 - blanchard grinding fixtures for all of the individual Monofrax® K-3 blocks
 - wire-cutting and grinding fixtures for the Monofrax® K-3 throat and riser blocks
 - forming fixtures for the top head, bottom head, and bottom corner Fiberfrax® T-30 liners
2. Fit-up fixtures
 - Monofrax® K-3 gaging fixture
 - Zirmul® gaging fixture
 - Korundal® top head gaging fixture
3. Installation & shipping fixtures
 - bottom center post for the K-3 center blocks
 - dummy riser/pour spout

All of these fixtures are described by function and drawing number in Section 10.

Monofrax® K-3 Fabrication

Monofrax® K-3 refractory for the DWPF melter was manufactured by The Carborundum Company at their Falconer, New York plant.

Carborundum established a procedure using the Blanchard grinders that provided an excellent fit-up of the refractory blocks for the Scale melter. The same approach could have been used for the DWPF melter, but there was a difference: the DWPF project would require at least several melter assemblies to process the waste at SRP. Since multiple sets of refractory would have to be manufactured, it would be sensible to provide additional fixtures that would improve quality or reduce the multiple grind and fit procedure.

F. W. Thompson suggested fabricating a set of individual block fixtures that would guarantee the squareness of all machined surfaces with the cast outside diameter. Although the Blanchard grinders produced very flat and parallel surfaces, the perpendicularity of these surfaces to the outside diameter was dependent on the initial set-up in the machine.

Individual block fixtures were designed and fabricated by Keller Technology to Carborundum's specifications. These fixtures measurably improved the entire fabrication process. Regrinds were reduced considerably, which meant less handling of the blocks between the grinder and gaging fixture. The overall assembly was excellent and had tighter joints on average than those achieved on the Scale melter. The assembly for Melter #2 had an even closer average fit. All assemblies were well within the required tolerances for joint gaps and alignment.

Fabricating the Monofrax® K-3 refractory was a complex task that involved close cooperation and coordination among DuPont, the Carborundum Company, Hardface Welding & Machine Corp., and Rock of Ages Co. The fabrication sequence is shown in Figures 6.6 and 6.7. Photographs of the fixture and assembly steps are shown in Figures 6.8 through 6.13.

Acceptance Criteria

All refractories have characteristic flaws that are inherent in the manufacturing process and due to the brittle nature of the material. These defects must be understood and recognized by the Quality Assurance representatives that will inspect the blocks for acceptance, or some blocks that are acceptable may be rejected. When the first set of Monofrax® K-3 arrived at CBI for installation, the visible defects were initially blamed on shipping damage, Figure 6.15. There was nothing wrong with the refractory – this was the original condition of the blocks as they were accepted at Carborundum.

All of the DuPont refractory order specifications included descriptions of defects as they are used in the industry, and the size and number of these that would be acceptable. R. N. McCormick and F. W. Thompson assisted the inspectors with preliminary and final inspections of all refractory.

Examples of acceptable Monofrax® K-3 edge spalls and surface voids are shown in Figure 6.15.

Acceptance criteria for Monofrax® K-3 refractory are in Volume 4 of the DWPF Glass Manual Technology Manual, DuPont order specification AXC 6846-W.

1. CAST BLOCKS IN MOLDS AND CUT OFF HEADER

2. SET UP BLOCKS ON PRIMARY FIXTURES & GRIND FLATS PARALLEL TO BACK SURFACE

3. SET UP BLOCKS ON SECONDARY FIXTURES & GRIND OTHER SURFACES PERPENDICULAR TO THE FLATS

4. BLANCHARD GRIND BLOCKS IN COMPLETE RINGS TO OBTAIN EQUAL HEIGHTS

5. DIAMOND DRILL BORE IN RISER BLOCKS

6. GRIND OUTSIDE DIAMETER OF RISER BLOCKS CONCENTRIC WITH BORE

Figure 6.6 - Monofrax® K-3 Refractory
FABRICATION SEQUENCE - SHEET 1

6. SET UP THROAT BLOCK, LOCATE AND SCRIBE RADIUS

7. MOUNT THROAT BLOCK ON WIRE-CUTTING FIXTURE
& WIRE-CUT RADIUS AT ROCK OF AGES

8. SET UP THROAT BLOCK & RISER V1 BLOCK ON FIXTURE
& SCRIBE HOLE LOCATION ON THROAT BLOCK

9. FIT UP BLOCKS & LOCATE ELECTRODE HOLE CENTERS
WITH FIXTURE TEMPLATES

10. DIAMOND DRILL HOLES IN ELECTRODE & THROAT BLOCKS

MONOFRAX K-3 FABRICATION SEQUENCE - SHEET 2

11. INSTALL DRILLED BLOCKS, CHECK ALIGNMENT, & MATCHMARK

Figure 6.7 - Monofrax® K-3 Refractory
FABRICATION SEQUENCE - SHEET 2

The K-3 refractory fixture includes a machined steel center block that acts as the guide around which all the bottom rings are arranged. A vertical post in the center supports the trammel (Figure 6.10) used to gage the inside and outside diameters of the sidewalls. The opening at the fixture sidewall allows clearance for the as-cast throat block (Figure 6.11).

Figure 6.8 - Monofrax® K-3 Refractory
FITTING UP THE BOTTOM BLOCKS IN THE K-3 FIXTURE

Note the precision fits obtained with the grinding procedures and fixtures. Most joints are .010 inches or less after final grinding.

Figure 6.9 - Monofrax® K-3 Refractory
CLOSE UP VIEW OF BOTTOM RING FIT-UP

The top view shows the pivoting trammel mounted on the center post. This is used to gage the inside and outside diameters of the sidewalls as each ring is installed. The bottom view shows the close fit of the D ring within the fixture.

Figure 6.10 - Monofrax® K-3 Refractory
FITTING UP THE OUTER RING OF D BLOCKS

This view shows the throat block in place. The block is cast oversize to allow for finishing to the exact outside radius. After marking, the block is sent to Rock of Ages for wire-cutting to the final dimension.

Figure 6.11 - Monofrax® K-3 Refractory
FIRST RING OF SIDEWALL BLOCKS IN PLACE

The sidewall rings are completed after the throat block is removed. After all blocks are in place the electrode templates are installed, a centering gage is inserted into the template bores, and the electrode center positions are marked. The electrode blocks are removed and sent to Hardface Welding where the holes are diamond drilled.

Figure 6.12 - Monofrax® K-3 Refractory

ALL SIDEWALL BLOCKS IN PLACE

This view shows the set-up nearing final completion after all blocks have been machined. The upper riser block has been temporarily strapped in place at a higher elevation to permit the lower block to be rotated into position against the throat block.

Figure 6.13 - Monofrax® K-3 Refractory
FINAL ASSEMBLY STAGE

These photographs show the excellent fit-up at the riser/throat block interface. Despite the complexity of the compound curve, the combination of quality workmanship and custom fixtures resulted in a near-perfect fit. The gap was less than 10 mils.

Figure 6.14 - Monofrax® K-3 Refractory
RISER AND THROAT BLOCK ASSEMBLY

Circled areas highlight acceptable edge spalls and surface voids on these blocks. These are characteristic of this material. Acceptance criteria for defects is included in the order specifications.

Figure 6.15 - Monofrax® K-3 Refractory
ACCEPTABLE CORNER SPALLS AND SURFACE VOIDS

Zirmul® Refractory Fabrication

Zirmul® refractory for the DWPF melter was manufactured by Didier-Taylor Refractories Corporation at their South Shore, Kentucky plant.

Blocks were formed by casting the Zirmul® slurry into molds, firing the blocks in a furnace, and grinding to final size. Although the fabrication sequence was not as complex as that required for Monofrax® K-3, the grinding and fitting operation required the same degree of care and precision.

The first set of Zirmul® blocks were cast into steel molds made by an outside contractor. Numerous attempts were made to fit the blocks into the fixture, but tolerances remained outside of the acceptable limits. The problem was solved by using the fixture base as a gage for casting a master mold in plaster. This master was used to make a set of female molds for the final castings, which guaranteed a perfect fit with the dished bottom of the fixture.

Figure 6.16 shows the fabrication sequence for making the Zirmul® blocks. Photographs of the fixture and block fit-up for Melter #1 are shown in Figures 6.17 and 6.18. The joints were very tight and easily exceeded the specification tolerance allowances.

The final step in the Zirmul® fabrication sequence was final grinding of the top outside surface at Rock of Ages. The fixture is designed for shipping with the addition of a cover plate and protective materials. Once the Zirmul® is accepted at Didier-Taylor, it remains in the fixture until it is removed for installation in the vessel.

Grinding the top surface was a critical step since the height of this surface set the elevation of the riser and electrode holes in the Monofrax® K-3 blocks. If these holes did not line up with the respective vessel nozzles at assembly, a major rework of the refractory would have been necessary.

A review of the refractory assembly by J. D. Gutmann, Jr. concluded that this elevation could not be controlled by tolerances alone since there were too many individual components. The decision was made to let the outside Zirmul® top surface “float” by casting the blocks with extra material, and then grinding this surface to suit the *as-built* dimensions of the following components:

1. elevation of vessel electrode nozzle centers from the center of the bottom head
2. elevation of vessel riser nozzle at bottom center from the bottom head
3. thickness of the bottom head Fiberfrax® T-30 liner and Fiberfrax® T-30 riser liner
4. height of Monofrax® K-3 D ring blocks
5. height of Monofrax® K-3 throat block from bottom surface to the bottom center of the hole
6. height of electrode block from bottom surface to the center of the hole (both blocks)
7. height of Zirmul fixture from bottom center to the top surface of the sidewall

Arrangements were made with the vendors to obtain these dimensions. Final grind height above the Zirmul fixture was calculated from the geometry.⁷ These precautions paid off, as the alignment of refractory block holes with the nozzles on Melters 1 and 2 were right on target.

See page 6.10 for general comments on refractory acceptance criteria, and Figures 6.19 and 6.20 for examples of acceptable Zirmul® defects. Zirmul® acceptance criteria is in Volume 4 of the DWPF Glass Manual Technology Manual, DuPont order specification AXC 6848-W.

1. CAST PLASTER PATTERN USING FIXTURE
SURFACE FOR BOTTOM CONTOUR

2. MAKE PLASTER MOLDS FROM PATTERNS
AND CAST ZIRMUL BLOCKS

3. FIRE BLOCKS IN FURNACE

4. GRIND BLOCKS TO FIT IN FIXTURE

5. GRIND TOP SURFACE OF OUTER RING
(SETS ELEVATION OF K-3 SIDEWALL)

Figure 6.16 - Zirmul® Refractory
FABRICATION SEQUENCE

The assembled fixture is shown in the top view. To the right is the trammel used as an aid for match-marking the blocks after assembly. A rotating contour gage checks the profile of the top surface. In the bottom view, the blocks have been assembled and match-marked.

Figure 6.17 - Zirmul® Refractory
FITTING UP BLOCKS IN THE ZIRMUL® FIXTURE

The top view shows the top surface during final inspection with the contour gage. To reduce deflection of the gage, the outer end is supported on a precision cam roller that rides on the machined top edge of the fixture. The wood section marked "new" is a temporary wood piece cut to clear the as-cast flat surface at the edge of the outer ring of blocks.

The Zirmul® assembly is shipped in the fixture to Rock of Ages for final grinding of the outer surface parallel with the top of the fixture. This is a critical step, since the height of this surface establishes final alignment of the Monofrax® K-3 riser and electrode blocks with their respective nozzles in the vessel.

One block is removed in the lower view to show the precision fit of the ground joints. The blocks are such a snug fit in the fixture that a bolt is used to jack up the first block for removal.

Figure 6.18 - Zirmul® Refractory

CLOSE-UP VIEWS OF THE ASSEMBLED REFRACTORY

Small voids and checks in the surface are characteristic of this material. Acceptable limits for defects are described in the order specifications.

Figure 6.19 - Zirmul® Refractory
ACCEPTABLE SURFACE VOIDS AND CHECKS

Figure 6.20 - Zirmul® Refractory
ACCEPTABLE EDGE AND CORNER SPALLS

Korundal® Refractory Fabrication

Korundal® refractory for the DWPF melter was manufactured by Harbison-Walker Refractories at their Vandalia, Missouri plant.

Blocks were formed by mechanically tamping the material into breakaway steel molds, firing the blocks in a furnace, and grinding to final shape. This was the most complex refractory structure of the group since the blocks had to fit around all of the nozzle inserts as well as match the dished shape of the fixture. Harbison-Walker did an outstanding job on both melter superstructure assemblies.

Figure 6.21 shows the fabrication sequence for making the Korundal® blocks. Photographs of the fixture and block fit-up for Melter #1 are shown in Figures 6.22 through 6.24.

The cylindrical shape of the upper sidewall assembly did not require a fixture. The entire wall structure was assembled on plywood panels positioned on the shop floor, Figure 6.24. Inside and outside diameters were checked and found to be within tolerance.

All eight dome heater blocks are cast with 1 inch of additional material on the bottom. During installation, this surface is ground to correct the elevation and align the hole centers with the respective vessel nozzles. For the shop set-up, plywood was added between the rings of smaller blocks to make up the 1 inch difference, Figure 6.24.

See page 6.10 for general comments on refractory acceptance criteria. Korundal® acceptance criteria is in Volume 4 of the DWPF Glass Manual Technology Manual, DuPont order specification AXC 6847-W.

1. TAMP MIX IN MOLD

2. FIRE BLOCKS IN FURNACE

3. GRIND AND FIT BLOCKS IN FIXTURE

Figure 6.21 - Korundal® Refractory
FABRICATION SEQUENCE

The top head gaging fixture represents the melter head turned upside down. It was machined to match the profile of the installed Fiberfrax® paper and insulation, and includes bolt-on inserts that are centered at the nozzle positions. For initial fit-up, the nozzle half-blocks were positioned around the inserts and aligned radially. Remaining blocks were ground to fit in between to close the ring.

Figure 6.22 - Korundal® Refractory
INITIAL FIT-UP IN GAGING FIXTURE

All blocks are in place and match-marked for installation. Fit-up of the blocks was excellent, with hardly any space in the joints. When the blocks were assembled into the top head, the holes in the blocks aligned perfectly with the head nozzles.

Figure 6.23 - Korundal® Refractory
ASSEMBLY AT FINAL INSPECTION

Blocks for the upper sidewall were assembled on plywood panels on the floor. Layers of plywood were inserted between the dome heater blocks to make up the difference between these blocks and the smaller bricks. The dome heater blocks are cast oversize in height so they can be ground at final assembly to match the elevation of the vessel dome heater nozzles.

Figure 6.24 - Korunda® Refractory
UPPER SIDEWALL ASSEMBLY

Fiberfrax® T-30 Fabrication

Fiberfrax® insulation liners for the DWPF melter were manufactured by Metaullics Systems at their Solon, Ohio plant. The liners were formed by laying up sheets of Fiberfrax® paper in a forming fixture, bonding the sheets together with resin, clamping the fixture top to set the thickness, and curing the assembly in an oven.

Figure 6.25 shows the fabrication sequence. A total of three fixtures were required to form the top head, bottom head, and bottom corner liners.

6.6 Refractory Installation

The 1941 and Scale melters were small enough to be shipped on a flatbed truck without special arrangements for wide-load hauling. This made it convenient to ship both vessel and refractory to Toledo Engineering Co. (TECO) and install the refractory in TECO's warehouse in Toledo, Ohio. The refractory-lined shell and top head were then shipped to SRP for installation in the TNX facility.

This procedure was not feasible for DWPF due to the large size and weight of the melter and frame assembly. Arrangements were made to have TECO install the refractory at the CBI Services plant in Cordova, Alabama. Dedicated space with services and a jib crane was provided for the installation.

Installation of the refractory in Melter #1 was completed in June, 1988. Photographs of the installation sequence are shown in Reference 8. All blocks fitted perfectly, and all holes were aligned with their respective shell and top head nozzles. This smooth installation was the result of a coordinated team effort among DuPont Engineering Department, the refractory vendors, TECO, and CBI.⁹

Refractory was installed in Melter #2 in February, 1989. The only unexpected event was the cold weather that drove the shop temperature down into the 40's. This was not warm enough for the materials, particularly the DSM-24. There was also the danger of freezing water in the mortar and DSM-24 overnight. This was resolved by moving the melter and materials to the temperature-controlled inspection room for the installation.

From the time the refractory is installed until it is dried out, the melter and refractory materials must remain above freezing, preferably at 50° F or above.

1. CUT FIBERFRAX® BLANKET TO SIZE

2. LAY UP SHEETS IN BOTTOM FIXTURE AND COAT WITH ADHESIVE

3. ASSEMBLE TOP FIXTURE AND CLAMP

4. CURE IN OVEN

5. FORMED LAMINATED LINER

Figure 6.25 - Fiberfrax® T-30 Insulation
FABRICATION SEQUENCE

6.7 Refractory Dry Out

After the refractory and insulation is installed in the shell, the system must be heated and cooled under controlled conditions to dry the water out of the DSM-24. On melter #1, this was not done initially, and the residual moisture defeated the electrical isolation on the electrodes. After the electrodes were installed in the mock-up shop, a continuity check indicated one was nearly grounded to the melter shell. By the next morning, all four electrodes were indicating a dead short to ground. The electrodes were removed and arrangements were made with Hotwork, Inc. Lexington, Kentucky to perform the drying operation at the SRP mock-up shop using their standard burner technique. Setup procedures were furnished by J. D. Gutmann, Jr. based on recommendations from N. R. Severin, Hotwork, and H. F. Hublein. Figure 6.26 shows the burner and insulated cover arrangement used on Melter #1.

The critical step during the dry out is to raise the DSM-24 temperature above 212° F without exceeding 350° F on the inner shell wall surface. The 350° F limit was recommended by Keeler and Long to protect the epoxy coating, with a preferred limit of 300° F for a larger safety factor.

Hotwork's past experience with drying refractory linings showed that most of the residual water was driven out of the bottom. The bottom portion of the drain valve nozzle was left clear for this purpose. Insulation was added to the outside of the bottom head to insure that the Fiberfrax® T-30 liner would be thoroughly dried. A small opening was left in this insulation at the drain valve nozzle to let water escape.

During the initial heat up, the burner was set to make the internal temperature 600° F. This was increased to 700° F for a short period, but had to be backed off to 350° to keep shell temperatures below the 350° limit. Both DSM-24 and shell temperatures started to increase at a measurable rate at this point after most of the moisture had been driven out. After the bottom temperature reached 300°, the internal temperature was gradually raised to increase DSM temperature at the electrodes to 212°. This condition was reached at an internal temperature of 500°. Maximum measured temperature at the bottom nozzle was 330° at this steady state condition.¹⁰

Melter #1 was successfully dried with this first procedure, but our experience suggested that the insulation should be *added* to the sidewall electrode area and *removed* from the bottom center to even out temperatures. A revised dry out procedure was submitted by J. D. Gutmann, Jr. for Melter #2 and future melters.¹¹ Details of the general setup, preparation, and instrumentation are shown in Figures 6.27 through 6.31.

Melter #2 and future melters will have the refractory dried out at the proper time and location: at the vessel vendor's shop after the refractory is installed.

A review of the history of the 1941 and Scale melters revealed that a limited drying operation was run by Toledo Engineering at their warehouse before the melters were shipped, but this was a precaution to prevent water in the DSM from freezing during shipping in winter weather. The necessity to remove the water for electrical isolation reasons had not been considered, and explains why the effect of moisture in Melter #1 was not anticipated.

This view shows the insulated cover and burner/exhaust duct arrangement used on Melter #1. Since the moisture is primarily in the DSM-24 insulation, the 500° F internal temperature is confined to the lower portion of the shell with an insulated cover. This prevents the less insulated upper section of the shell from exceeding the epoxy coating's 300° F limit.

This first drying operation was performed in the SRP mock-up shop. Future melters will have the refractory dried out at the vendor's shop before the assembly is shipped to the plant.

Figure 6.26

REFRACTORY DRY OUT - MELTER #1

Figure 6.27 - Refractory Dry Out
SECTION VIEW

See figures 6.30 and 6.31 for details of thermocouple installation

Figure 6.28 - Refractory Dry Out
PLAN VIEW

Insulate exterior of melter shell as shown, using 3" thick fiberglass without a vapor barrier. Center insulation on electrode nozzles (two sides). Do not insulate the manifold or support ring. Leave a 36" diameter opening on the bottom centered on the bottom nozzle.

This selective insulation evens out temperature differences due to different refractory thicknesses, and concentrates the heat near the bottom to dry the fiberfrax liner.

Figure 6.29 - Refractory Dry Out
EXTERIOR INSULATION DETAILS

THERMOCOUPLE REQUIREMENTS FOR TEMPERATURE CONTROL

In this view, the exhaust duct, electrode nozzles, and refractory thermocouple nozzles are rotated for clarity. See Figure 6.28 (plan view) for correct orientation. Thermocouple installation details are shown in Figure 6.31.

- (1) (2) Shell surface, one on each side in lower dome heater nozzle. (For info only - not for control)
- (2) (2) Shell surface in refractory T.C. nozzle, inserted into DSM insulation.
- (3) (4) Shell surface, one in each electrode nozzle, inserted into DSM insulation.
- (4) (1) Shell surface in drain valve nozzle, inserted into fiberfrax insulation.
- (A) (4) Temp. control, inserted thru electrode nozzles, extended 2" from inside wall.
- (B) (1) Temp. control inserted thru drain valve nozzle, between stainless steel plate & K-3 refractory.

All thermocouples furnished by Hotwork, Inc. Item (A) T.C.s are 24" long, all others are 18" long.

* For information only, install four additional thermocouples to outer surfaces as follows: Install two where there is no insulation - one near the refractory thermocouple nozzle, and one on the support ring. Install two on the insulated surfaces - one near the electrode nozzle, and on the bottom 2 feet from the nozzle. Hotwork will install these via capacitive discharge.

Figure 6.30 - Refractory Dry Out
THERMOCOUPLE REQUIREMENTS

In this view, the exhaust duct, electrode nozzles, and refractory thermocouple nozzles are rotated for clarity. See figure 6.28 (plan view) for the correct orientation. Install thermocouples close up against the melter shell with a 1/2 inch length contact as shown. Install with care to avoid scratching the epoxy coating inside the nozzles and shell. A leg shorter than 1/2 inch may be necessary on the two refractory thermowell T/Cs due to the small nozzle I.D.

Figure 6.31 - Refractory Dry Out
THERMOCOUPLE INSTALLATION DETAILS

References - Section 6 - DWPF Melter Refractory

1. Letter to J. Duskas and W. F. Senkowsky from F. W. Thompson dated June 18, 1982 - *Defense Waste Glass Melter - Corrosion of Refractory*.
2. Heat transfer study by H. F. Hublein dated January 26, 1983, showing temperature distribution in the DWPF melter preliminary bottom design (no corner insulation).
3. Heat transfer study by H. F. Hublein dated January 26, 1983, showing temperature distribution in the DWPF melter final bottom design (with corner insulation).
4. Heat transfer study by H. F. Hublein dated July 17, 1985, showing temperature distribution in the Scale melter bottom design.
5. Heat transfer study by H. F. Hublein dated January 24, 1983, showing temperature distribution in the LSFM melter bottom design.
6. Heat transfer study by H. F. Hublein dated January 26, 1983, showing the effect of the drain valve on the temperature distribution in the DWPF melter preliminary bottom design (includes curves for showing profiles of the DWPF and Scale melters with and without the drain valve).
7. Letter to Dennis Merchant from J. D. Gutmann, Jr. dated September 24, 1986 - *Zirmul® Grinding* - Document Number DV 0000517

Calculations by J. D. Gutmann, Jr. to determine Zirmul® grind height for Melters #1 and #2.
8. *Construction Progress Photographs - Project N0 9S 1780 - DWPF Glass Melter Refractory Installation - P. O. No. AXC 6854-W, TECO No. 8558, May/June 1987.*
9. Letter to J. D. Gutmann, Jr. from F. W. Thompson dated July 6, 1987 - *Assembly of Refractory in DWPF No. 1 Melter.*

Letter to G. E. Miller from J. D. Gutmann, Jr. dated June 1, 1987 - *Refractory Installation in Melter #1* - Document Number DD 0005603.
10. Graph of temperature profile history for refractory dry out of Melter #1.
11. Letter to D. L. Kinnsch from J. D. Gutmann, Jr. dated October 5, 1988 - *Refractory Dry Out Procedures for Melters 2 & 3* - Document number DB 0009796.

(See Section 7, References 4 & 5, for physical model data on the DWPF refractory bottom design.)

Section 7

DWPF Glass Melter Shell Components

7.1 Electrodes

Purpose

The electrodes are the primary source of electric power for melting the glass frit and maintaining the melt pool within the design temperature range of 1050 to 1150° C.

Basic Data

Basic data requirements for the melter electrodes are covered in Section 5, Reference 1. These include the following:

- two year minimum life
- Inconel® 690 construction
- 5 amps/sq. in. maximum current density on the electrode face

Configuration

Plan and elevation section views of the DWPF melter electrode configuration are shown in Figures 7.1 and 7.2. A photograph of the completed assembly is shown in Figure 7.3.

The electrode support stem is water-cooled to freeze glass that migrates into the annulus between the stem and refractory clearance hole. Additional cooling is provided by the annular cavity surrounding the vessel nozzle.

The chance of glass penetration is further reduced by isolating the vessel wall from the clearance annulus with a labyrinth barrier seal. This was recommended by J. D. Gutmann, Jr. after a review of the LSFM melter electrode design, page 3.1. The barrier is an alumina sleeve that is cushioned at both ends with Fiberfrax Durablanket® gaskets, and backed with a thick ring of Fiberfrax Durablanket® using an arrangement similar to a packing gland. At assembly, adjusting screws are tightened against a metal back-up ring to partially compress the blanket and seat the alumina sleeve against the Monofrax® K-3 refractory block. On start-up, the blanket ring absorbs radial thermal expansion of the refractory block to prevent loading the flanged joint.

Electrical isolation from the melter shell nozzle is provided by alumina sleeves and washers. Isolators at the nozzle flange joints have gaskets on both sides to cushion and seal the assembly. This construction is typical for all of the melter components that require electrical isolation.

Silver plating is applied on the outside diameter of the stem to improve electrical conductivity at the bus bar connector interface. Handling and shipping procedures must provide protection for these plated surfaces until the connector clamp is installed at final assembly.

A thermocouple in the central deep-drilled hole monitors electrode temperature during operation.

Figure 7.1

DWPF MELTER ELECTRODE ARRANGEMENT

REFERENCE: W743909

Figure 7.2
DWPF MELTER ELECTRODE SECTION

This photograph of the electrodes for Melter #1 was taken at the SRP mock-up shop just before they were installed. Chamfers on the rear edges of the electrode plate clear the round refractory wall on either side. Excellent surface finishes and high quality fabrication were evident on all of the components manufactured by Keller Technology.

Figure 7.3
COMPLETED ELECTRODE ASSEMBLIES

Electrode Design Development

The DWPF electrode design was the result of many theoretical studies, model tests, and operating experience with other melters. SRL was particularly interested in a design that would provide control of the relative amount of electrical power distributed in the bottom half of the melter. Since the LSFM experience showed that a single electrode did not attain the desired "power skewing" ratio, it was a natural progression to use two pair of electrodes having independent power supplies.

Additional electrode configurations were considered that included a fifth central electrode in the bottom, Figure 7.4. This was abandoned in favor of the four electrode version, since the latter offered greater flexibility for adjusting the vertical power profile.

Nastran Computer Program Studies

The initial design chosen for evaluation had equally sized electrodes for the top and bottom, each 8 inches high with an 8 inch space between them. This was known as the 8-8-8 design, and was analyzed by T. R. Vick Roy and R. J. Thomas using the Nastran computer program. Since the Nastran program was not originally designed to do this type of analysis, some manual calculations were necessary to obtain the final result.

Boundary conditions and equations were set up to calculate power density in each cell for three conditions: equal power to both top and bottom electrodes, power to the top electrode only, and power to the bottom electrode only. The power density values in each cell were manually converted to current density in amps/sq. in. and tabulated on elevation and section views of the model grid pattern. This initial study showed that some areas of the electrodes exceeded the maximum 5 amps/sq. in. current density, and ranged up to 7.9.¹ The electrode area was not sufficient at an 8 inch height for the required power levels.

A second series was run with 10 inch high electrodes spaced 10 inches apart. Results were more favorable with this configuration, as the model predicted the current density would be less than the 5 amps/sq. in. limit.²

A similar analysis was made for the Scale melter. The 10 inch DWPF dimension became 6.67 inches at the 2/3 size ratio. The model predicted success for this design also.³

Physical Model Studies

The next verification phase of the electrode design was a series of model tests at SRL, using the physical model described previously on page 6.7. The results of this study confirmed the overall refractory bottom and electrode design, but indicated that the current density on the lower electrode was close to the 5 amps/sq. in. limit for certain operating conditions. A 20 to 25 % increase in the lower electrode area was recommended.⁴ A 12 inch height was selected, and a new arrangement drawing issued. We now had a "firm" design with a 10-10-12 configuration. This lasted about a month (see Restart Capability).

Modifications to the model electrodes were made to suit the new design, and a second series of tests verified that this configuration was optimum.⁵ These model tests also verified the bottom refractory design.

This arrangement drawing shows concepts for the melter and components during design development in 1981. There are four electrodes on the side walls, and a central electrode combined with a drain valve at bottom center. This drawing also shows earlier concepts for the dome heaters, bottom design, drain valve, riser nozzle and riser heater.

Figure 7.4
BOTTOM ELECTRODE CONCEPT

Heat Transfer Studies

Two dimensional heat transfer models were used to evaluate temperature profiles through the electrode section and surrounding refractory. Of particular interest was the glass temperature profile in the clearance annulus between the support stem and the hole in the refractory, as this is the most direct path from the melt pool to the shell sidewall. A two dimensional heat transfer study verified that glass would freeze well away from the vessel sidewall.⁶ A similar study verified that the Scale melter electrode design would also freeze the glass away from the sidewall.⁷

Additional studies of electrode vs. dome heater power requirements were made by V. E. Mello with a heat balance computer program, see description on page 7.25. These results were the basis for sizing the electrode power supplies.^{8, 9}

Restart Capability

During this time, SRL was experimenting with techniques to restart a frozen melter. This assumes that all power to the melter electrodes and dome heaters is lost long enough to allow the glass melt to cool below 650 °C. At this temperature, glass will not conduct and the electrodes cannot be fired.

Small melter tests were run to evaluate the feasibility of restarting a melter using a conducting layer of graphite on the frozen glass surface. This was modified by using a graphite slurry to obtain a uniform continuous layer of conducting material. In order for this to work, a portion of the electrode must project above the glass surface and be in contact with the graphite.

SRL recommended increasing the upper electrode height to have 3 inches above the glass pool for future restart capability (all melt pool levels are based on atmospheric conditions when the melter is idling – during vacuum pouring, the glass drops approximately 2 inches, exposing 5 inches of the upper electrode). If the electrode remained a rectangular shape, the weight would have increased by fifty percent. An agreement was reached to have only a portion of the 40 inch width above the glass, permitting the upper corners to be machined at an angle. The same design was applied to the Scale melter electrodes, pages 4.8 and 4.9.

All phases of this electrode design, including power control, were evaluated and proven out during the Scale melter test series. The system functioned as intended and provided the ability to control the power and glass temperature within the required limits. An added bonus was the demonstration that a frozen melter can be restarted, without adding conducting material, by using the dome heaters to melt the surface layer.

7.2 Riser/Pour Spout Heater

Purpose

The primary requirement of the riser/pour spout heater design is to maintain glass temperature throughout the heater at the minimum 1050° C temperature. This temperature is required to keep the viscosity low enough to maintain pouring control and flow stability.

Basic Data

Basic data for the riser/pour spout heater is covered in Section 5, Reference 1. The primary requirements include:

- Inconel® 690 material – thickness sized for two year life
- maintain pour spout temperature at 1050° C minimum

Configuration

A cross section of the final DWPF riser/pour spout heater assembly is shown in Figure 7.5. The entire glass flow channel is a machined Inconel® 690 core with thick walls for maximum corrosion life. Serpentine heating elements surround the core and are electrically isolated from it by a series of machined alumina sleeves. The surrounding heater design insures that the glass temperature will be within a few degrees of the heating element temperature. As we learned on the Scale melter, attaining uniform heater temperature along the length of the riser and pour spout required a considerable amount of development work and design changes.

There are several important advantages offered by the serpentine heater configuration:

- The low current requirement for the heaters allows power to be distributed through jumper wiring. This eliminates the need for close-coupled transformers, as used on the 1941 melter, and permits the transformers to be located outside the melt cell.
- Heating elements are physically removed from contact with molten glass. This eliminates corrosion, and insures that the electrical characteristics will not vary with time.
- Power requirements are reduced since the heater demand is limited to making up small losses through the insulated sheath. With former designs, the heaters had to provide additional energy due to losses from the glass into the surrounding refractory.

Riser - Bottom End

A detail of the bottom (glass entrance) end of the riser heater is shown in Figure 7.6. Note that the outer Inconel® 690 sheath necks down to a thinner section several inches from the glass inlet. Originally, the sheath was a constant thinner section, but was revised by J. D. Gutmann, Jr. to increase corrosion life. At first it was assumed that a heavy cross section along the entire length of the riser would be the best design, but Scale melter heat transfer studies showed this would increase heat flow and result in higher sheath temperatures.^{10, 11} This would have allowed glass to penetrate to a higher elevation in the riser, and increase the risk of glass reaching the exposed interface between the riser and pour spout sheaths (the sheaths cannot be seal welded at this intersection because they must be free for thermal growth). Additional studies resulted in the optimum DWPF design shown, where a balance between corrosion resistance and glass penetration distance was achieved.¹² This concept was verified in the Scale melter.

Figure 7.5
DWPF MELTER RISER/POUR SPOUT SECTION

REFERENCE:

W748706

W748709

This view shows the annular construction of the heavy wall core, heating element, alumina isolators, insulation, and outer sheath. The reduction in sheath cross section is designed to reduce heat flow and limit the distance that glass can penetrate into the clearance gap (see discussion on page 7.9).

Figure 7.6

RISER HEATER DETAIL - BOTTOM END

Riser - Top End

The top end of the riser is shown in Figure 7.7. This area is heavily insulated with Zircar® to reduce heat loss and maintain high temperatures in the glass at the overflow point. Zircar® was selected for insulating several melter components due to its combination of low thermal conductivity and ability to withstand high temperatures.

A layer of Fiberfrax® Durablanket at the upper end of the riser absorbs thermal expansion of the Monofrax® K-3 riser blocks.

In the conceptual design stage, it was recognized that a pressure upset in the melter might result in glass completely filling the pour spout channel. This would create a siphon effect that would drain most of the glass from the melter with no means of stopping the flow. An inert gas purge was added to prevent the possibility of this happening. The coil spring shape in the purge tubing acts as a thermal expansion joint.

Figure 7.8 shows the U shape of the pour spout heater extension. This acts as a spring to allow thermal expansion at low stress levels. Electrical connections to the riser and pour spout heater leads are made up with split clamps. We found that the standard electrical clamp diameter was not compatible with the heater lead diameter, and the clamps must be machined at assembly to fit properly. (Changing the heater lead diameter would be a major revision, as it would require alterations to many other parts that make up the assembly.)

Pour Spout Bottom

Details of the pour spout bottom construction are shown in Figure 7.9. Zircar® and Fiberfrax® insulation reduce radiant heat transfer to the cooled flange and down to the canister. This maintains the glass above 1000° C for pouring stability.

Installation Fixture

The completed riser/pour spout heater is assembled with a combined shipping and installation fixture, Figure 7.10. The fixture is suspended from the lift point by a crane in the vendor's shop and trimmed with weights until the pour spout section is vertical. This automatically positions the riser section at the correct angle for installation into the machined hole in the refractory. Details of the assembly procedures are described in Section 10.

The upper riser section is heavily insulated to reduce heat loss and keep the glass hot at the overflow to the pour spout. A continuous inert gas purge is metered into the top of the riser core to prevent glass from filling the pour spout cavity during any pressure surges. If the cavity filled with glass, the siphon effect would drain the melter.

Figure 7.7
RISER HEATER DETAIL - TOP END

The U shape in the pour spout heater extension is an expansion joint for thermal growth during start-up. This view shows the temporary shipping fixture attached to the end of the riser section. At field assembly, electrical connectors are machined to fit the round heater extensions and clamped in place. Silver plating is applied to the connector area to improve electrical conductivity at the interface.

Figure 7.8

POUR SPOUT HEATER LEAD CONFIGURATION

REFERENCE: W748706
W748709

The bottom end of the pour spout is heavily insulated to reduce radiation heat losses to the cooled vessel flange and the canister below. Without the insulation, the heat sink effect will cool the bottom end below the freezing temperature of the glass.

Figure 7.9

POUR SPOUT - BOTTOM END

This view shows the assembly of the heater with the shipping and installation fixture. Prior to shipping, the assembly is suspended by a crane at the vendor's shop and trimmed with weights until the pour spout section is vertical. This positions the riser section at the proper angle for field installation.

Figure 7.10

RISER/POUR HEATER ASSEMBLY READY FOR INSTALLATION

Riser/Pour Spout Heater Design Development

The DWPF riser/pour spout heater concept was originally a joule heated configuration with two parallel Inconel® 690 plates along the length of the riser. Electric current passed from one plate to the other through the glass in the same manner as the electrode system. This design is shown in Figure 7.4, page 7.6. The glass flows through a hole in the Monofrax® K-3 riser blocks, similar to the 1941 melter design concept. Also shown on this drawing is an Inconel® 690 liner in the Monofrax® K-3 throat block to increase corrosion resistance in the throat area.

A second concept was the new arrangement with an Inconel® 690 core surrounded by a serpentine ribbon heater, Figure 7.1. After evaluating the two designs, the joule riser heater was abandoned for several reasons:

- marginal capability for restart if power were lost and the glass solidified
- heater elements were exposed to glass contact – corrosion would shorten life and change resistance characteristics with time

The major potential drawback of the new design was its complexity. The joule riser heater is simple by comparison. Efforts were now concentrated on developing the new design for DWPF and the Scale melter.

The riser /pour spout heater progressed through a series of modifications as we went through a learning curve during the Scale melter test series. The Scale melter was invaluable for this effort and resulted in a much improved design that met all requirements for glass pouring control.

Riser Heater Element Failure

During the first attempt to start up the Scale melter electrical continuity was lost on the riser heater element. System checks indicated an open circuit failure in the heater element. Fortunately, the melter had not been heated long enough to melt the frit and encapsulate the bottom end of the heater. The system was shut down and the heater assembly was removed and sent to Keller Technology for disassembly and examination (see Section 4, Reference 2 for additional information on this subject).

Before disassembly, a series of radiographs were taken around the periphery of the riser section to see if the failure zone could be detected. These indicated that one strip of the riser heater element had separated near the riser/pour spout interface. When the outer alumina sleeve was removed to expose the heater, the failure area was verified, Figures 7.11 and 7.12. Although the element had been heated to the melting point, it discolored but did not damage the inner or outer alumina isolator sleeves, Figure 7.13. During the disassembly operation, one of the 1/4 inch thick alumina heater separator strips was accidentally dropped on the floor from table height. It rang like a piece of steel, but did not crack or break. These "tests" proved that this industrial ceramic material is very durable and capable of withstanding extreme conditions.

The outer sheath, insulation, and outer alumina sleeves have been removed from the pour spout section and wire has been temporarily tied around the pour spout heater elements to keep them in place. Outer alumina sleeves on the riser section are being moved to the right to expose the failure area. Note the discoloration from high temperature on the alumina ribs that separate the heater element strips – only every other rib is discolored as these are part of the inner alumina sleeve that reached the highest temperature (see Figures 7.12 and 7.13). Alternate ribs are separate pieces.

Figure 7.11

DISASSEMBLY OF SCALE MELTER RISER HEATER

AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

3 of 6

Evidence of melting due to excessive heat is obvious. The melting temperature range of Inconel® 690 is 1340 - 1377° C. Despite the concentrated high temperature in this zone, there were no cracks or other damage to the alumina isolator sleeves (see Figure 7.13)

Figure 7.12

CLOSE-UP VIEW OF FAILED HEATER ELEMENT

These are the alumina sleeves from the heater failure zone. The elliptical discolored area on the inside surface of the inner sleeve (top photo) is the failure point. No damage was evident, and the sleeves were cleaned and installed in the modified Scale melter riser/pour spout heater assembly.

Figure 7.13

APPEARANCE OF INNER AND OUTER ALUMINA ISOLATOR SLEEVES

Riser Heater Failure Analysis

An analysis of the failure showed that the heater thermocouples were too close to the connector extensions, which acted as a heat sink. The thermocouples indicated an artificially low temperature, demanded more power, and the power supplies furnished enough current to bring the element to the melting temperature. One of the lessons learned from this was to install current limiters in the riser and pour spout heater circuits. This will protect the heaters even if the thermocouples fail.

Additional thermocouples were needed to monitor more heater locations. R. G. Foster suggested machining grooves on the outside of the Inconel® 690 core to locate the thermocouples. This had the added advantage of positioning the thermocouples parallel to the heater element, increasing the accuracy of the temperature readout. Past experience had shown that a thermocouple normal to the surface will indicate a temperature about 100° C lower than the actual value.

A plastic model of the core was used to lay out the groove contours for the thermocouples. This was sent to Keller Technology, and a computer controlled milling machine was programmed to machine the grooves in three dimensions. The program was verified for accuracy by machining a full size aluminum model of the heater core. This was a prudent decision, since there was a program error that caused the milling cutter to plunge too deep in one area. Corrections were made, and the Scale melter Inconel® heater core was machined without any difficulties.

The final design is shown in Figure 7.14. Two thermocouples were positioned where the original failure occurred to have redundancy at this hotter zone. A total of six thermocouples were installed, four on the riser heater and two on the pour spout heater. This was the maximum number of thermocouples that could be physically installed and routed through the riser cover.

This heater instrument system has been verified by extensive testing on the Scale melter. The same design is used on the DWPF assembly.

Pour Spout Development

After the riser/pour spout heater was repaired, it was installed in the melter and start-up was initiated. When glass pouring was initiated, there were a series of glass plugs that formed in the bottom of the pour spout cavity. These had to be removed mechanically. SRL installed a thermocouple array in the pour spout cavity and verified that there was a pronounced temperature profile, Figure 7.15.. Heat sink effects at the upper and lower ends resulted in lower temperatures in these areas. The relatively large difference between the center and bottom temperatures is due to the insulation configuration. Radial heat losses are low due to the excellent insulation properties of Zircar®. When coupled with high radiant losses at either end, the result is a curved temperature profile.

The immediate solution was to add insulation on the bottom of the heater surface to reduce radiant heat losses. J. R. Cherney calculated that a 2 inch thick insulation layer would be sufficient to raise the pour spout bottom temperatures to 1000° C. A test at SRL with insulation added to the bottom melted the glass plug and allowed the pouring experiments to continue.

After the inner core of the heater assembly is complete, six thermocouple clearance grooves are machined on the surface by a three axis computer-controlled milling machine. Type B platinum sheathed thermocouples are carefully formed to fit the groove contours and are temporarily held in place while the inner alumina isolator sleeves are installed. The sleeves hold the thermocouples captive in the grooves.

Figure 7.14
THERMOCOUPLE INSTALLATION ON THE HEATER CORE

Insulated Riser Top

The thermocouple test at SRL showed that the upper end of the pour spout cavity was approximately 860° C. Although it would have been possible to remove the riser cover and add insulation, this would have required a major disassembly of the instrument leads and other connections. SRL recommended using a foaming type Babcock and Wilcox insulation called Cease Fire 2000.™ A demonstration was arranged at B & W that proved the system would work, and the Cease Fire 2000™ was installed in the upper end of the riser through one of the former thermocouple access holes.^{13, 14} A temperature survey after the installation showed that the temperature at the top of the pour spout cavity was increased to 960° C, Figure 7.15. On DWPF, Zircar® shapes were used to insulate the top riser cavity, Figure 7.7, page 7.12.

Recessed Pour Lip

Although adding insulation to the bottom of the pour spout improved glass pouring performance, the temperatures were still marginal for good pouring control. There was also a tendency at the end of a pour for residual glass to attach to the bottom surface of the pour spout core. The glass would flow horizontally a short distance before dropping vertically. Higher temperatures were needed to reduce the glass viscosity.

While discussing potential improvements to the Scale melter, J. E. Savoy suggested a test fixture that would extend the pour spout heater and insulation below the pour point. J. D. Gutmann, Jr. reversed this approach by recessing the pour lip up into the region where the temperature was higher. To insure that the glass would drop vertically, a reverse 45° angle was added to the pour lip, Figure 7.16.

Removal of the riser/pour spout from the Scale melter for this modification would have been a difficult procedure and a major interruption to the test program. Keller Technology was requested to run a test at their shop to determine if a field set-up with a milling head would be feasible. The test was successful, and SRL made arrangements for machining the pour spout in place. For maximum temperature conditions (1100° C), the pour lip would have to be machined 12 to 16 inches from the bottom of the pour spout, Figure 7.15. Keller recommended keeping the depth to the minimum practical length for machining control and a reasonable amount of downtime. A distance of 7 inches from the bottom (1050° C) was selected.

The improvement with the recessed pour lip was dramatic. With the original pour spout design, residual glass in the channel was drawn into fibers at the end of a pour. With the recessed pour lip, residual glass formed into small, round drops that fell vertically into the canister. This difference is due to the decreased glass viscosity at the higher temperature disengagement surface.¹⁴ A demonstration of DWPF pouring rates showed an even greater improvement in glass stream stability.

A recessed pour lip was added to the DWPF riser/pour spout heater. SRL suggested keeping the vertical distance from the overflow to the lip to a minimum, as this reduces the amount of glass "inventory" at the end of a pour. The optimum location of the DWPF pour lip is the shortest vertical distance from the overflow that is within the 1050° C region.

SRL designed a test thermocouple array that was used to measure temperature profiles in the Scale melter pour spout channel. This graph shows the improvement made to the profile by adding insulation at the top of the riser and bottom of the pour spout channel. Temperatures were increased sufficiently to eliminate the initial problems with glass plugs at the bottom of the pour spout. Bottom insulation details are shown in Figure 7.16.

Figure 7.15

SCALE MELTER POUR SPOUT TEMPERATURE PROFILES

Glass flow instability and generation of glass fibers at the end of a pour were eliminated by recessing the pour lip into the high temperature zone in the pour spout channel. To prevent glass from wicking horizontally at the pour point, a reverse 45° angle was added. After this change, glass pouring stability improved dramatically. For comparison with the DWPF version see Figure 7.5, page 7.9, and Figure 7.9, page 7.14.

Figure 7.16

FINAL SCALE MELTER POUR SPOUT DESIGN WITH RECESSED POUR LIP

7.3 Dome Heaters

Purpose

The dome heaters are an energy supplement to the electrodes for glass melting and maintaining rates. They are the primary energy source for evaporating water from the feed slurry during normal operation, and also provide energy to melt the glass frit surface at start-up. Once the glass reaches the molten state on the surface, the electrodes can be fired to initiate formation of the melt pool.

Basic Data

Basic data requirements for the melter dome heaters are covered in Section 5, Reference 1. These include the following:

- two year minimum life
- ability to heat the melter vapor space to a minimum 650° C temperature for start-up
- maintain plenum at 650 - 800° C during normal operation to burn off organic material and prevent formation of glass fibers in the vapor space

The dome heaters are designed to be operated continuously at a surface temperature of 950° C. At this condition, the calculated vapor space temperature is approximately 725° C.

Configuration

Plan and elevation section views of the DWPF melter dome heaters are shown in Figures 7.17 and 7.18. A photograph of the completed assemblies is shown in Figure 7.19.

There are a total of eight heater tubes arranged in two rows of four. The heaters are grouped electrically into pairs of two tubes in series, each having its own transformer and power supply, thus there are four independent sets. The heater pairs are mechanically joined by large Inconel® 690 bars called jumpers. Bolts that clamp the jumpers to the heater stems are a special order alloy that has the same thermal expansion coefficient as Inconel® 690.

The division of heaters into four independent sets provides redundancy to the system. Failure of an individual heater, transformer, or power supply will shut down only one of the four units (two of the eight tubes). With 75% of the capacity remaining, the melter can continue to be operated at reduced rates.

The heater end stems consist of a nickel core surrounded by an Inconel® 690 sleeve. As described on page 7.29, this construction prevents temperatures in the end stems from exceeding the heater tube operating temperature. The Inconel® 690 sleeves protect the end stems from corrosive vapors above the glass. In addition, Fiberfrax® blanket is packed into the clearance annulus between the heater and refractory to prevent the vapor from condensing on the stem, as this would accelerate corrosion of the Inconel® by sulfidation (see page 7.28).

Electrical isolation from the melter nozzles is provided by alumina sleeves and washers similar to the construction used on the electrodes. Silver plating is applied to the bus bar connectors and to end stems and jumpers at the opposite end to reduce electrical resistance at the connection interface.

The dome heaters consist of eight resistance heating tubes. These are grouped into four independent heating assemblies, each consisting of two heaters connected in series by a jumper. Power is fed to the connector end through water-cooled copper bus bars.

Heat is generated by the resistance to electric current flowing through the tubular section inside the melter plenum. Normal operating temperature is 950° C.

Figure 7.17

DWPF MELTER DOME HEATER ARRANGEMENT

BUS BAR CONNECTION END **JUMPER END**

The end stem is a weldment that consists of a nickel core covered by an Inconel® 690 sleeve. At the jumper end, the connection zone is a weld overlay to improve electrical conductivity. Nickel provides a lower resistance path for the electric current to keep temperatures at the center of the end stem from exceeding the 950° C limit. Since accelerated corrosion (sulphidation) will occur if vapor space salts condense on the stems, the stems are protected from vapor contact by the combination of Inconel® 690 and Fiberfrax® rope packing.

Figure 7.18

DWPF MELTER DOME HEATER SECTION

This photograph of the dome heaters for Melter #1 was taken at the SRP mock-up shop prior to installation. The flanged ends are connected to frame-mounted transformers with water-cooled bus bars. Thermocouples for heater temperature monitoring and control are installed in the two holes visible at the end of the heater stem. At the opposite (plain) end, a jumper is installed to join two heater tubes in series. Note the protective covering around the silver-plated electrical connector surfaces.

Figure 7.19

COMPLETED DOME HEATER ASSEMBLIES

Dome Heater Design Development

On preliminary DWPF melter designs, the dome heaters centers were normal to the riser, i.e. oriented 180° from the present position. This configuration makes life easier for the fabrication shop, since the riser nozzle is not in the way when the heater nozzles are machined. For this reason, CBI Services suggested that future melters have the dome heaters installed normal to the riser position. Interference from the riser forced CBI to line bore the nozzles across the width of the vessel.

The heater orientation must be parallel to the riser as designed to satisfy space considerations. The 11 foot limit for the melter and frame assembly dictated this configuration (see page 5.1).

Temperature Limitations

At an early stage, it was recognized that the dome heaters would be temperature limited due to long-term creep requirements. Studies by E. H. Perez indicated that the permanent deflection of the heaters after two years of operation would be negligible at 900°C , but would increase to several inches if the temperature were increased to 1050°C . On this basis, 950°C was selected as the upper limit for long-term operation. A recent calculation for several temperatures shows the dramatic increase in deflection as the temperature is increased above 1000°C .¹⁵

Power Requirements

Power requirements for the combined effects of dome heaters and electrodes were determined with a heat balance computer program originally developed by J. M. Prober, Engineering Physics Laboratory. Calculations with this program were made by V. E. Mello to establish the heater performance. All conditions were run with the heaters operating at 950°C .

During normal operation, most of the melt surface is covered by a cold cap (crust) composed of waste calcine and frit. The rate of feed is typically adjusted so the cold cap covers 90 percent of the surface, and this value was used for the heat balance calculations. The open area permits vapors to escape from the melt surface into the vapor space.

In 1982, the melter design had four dome heaters in a single layer. Calculations with the heat balance program had determined that this would meet the 650°C vapor space temperature, but there was no margin for attaining higher temperatures. Tests at SRL indicated that higher vapor space temperatures were beneficial for improving melt rate, and for burning off hydrocarbons in the feed that are not consumed within the cold cap. The four heating tube design was marginal for these requirements. Before increased dome heater area could be evaluated, the computer model had to be revised to accept this change.^{16, 17} An additional refinement was made by increasing the number of zones in the model from 6 to 37.¹⁸

Numerous studies were made with the revised heat balance program to determine how much heater surface area would be required. Heater tube sizes up to 4 inches in diameter were considered, but a small model study by J. E. Savoy showed this size would crowd the melter area and severely limit the field of view of the T. V. camera. These practical considerations led to a

decision to limit the tube diameter to 3 1/4 inches. For this diameter heater at 950° C, there was only one solution to meet the higher vapor space temperatures – add another layer of four heater tubes for a total of eight.

This new design change created some excitement at the Bechtel office in San Francisco. The melter had already been increased in height and weight with the addition of Zirmul® refractory. Now we were adding another 12 inches in height, plus the additional weight of the vessel and superstructure refractory. At this point, the main process cell crane capacity was changed from the latest tonnage figure to “the biggest crane that will fit in the building.” This was a satisfactory solution for the new melter/frame assembly.

Calculations showed that eight heaters would meet the new requirements. With this design, the vapor space can be heated to 725° C at normal operation. Vapor space temperature is relatively insensitive to the amount of air inleakage over a broad range.^{19,20} These results were the basis for sizing the dome heater power supplies and transformers.²¹

Similar studies were made for the Scale melter. Since the Scale melter has less proportional dome heater area relative to the melt pool, the test results for dome heater performance are considered conservative (see Section 4, Reference 1, page 8).

End Stem Temperature

During the Scale melter start-up, the dome heaters were not able to melt the frit surface and permit the electrodes to fire. This was caused by the uneven frit layer, page 4.15. Before the frit problem was known, SRL asked if the dome heaters could be run at a higher temperature, around 1050 to 1100° C in case this added temperature was needed for start-up. The original heat transfer study was run again, and we discovered that the center of the end stem would actually exceed the tubular heating surface temperature by 75° C at higher power levels.²² Previous runs at lower power levels showed that the center of the stem was slightly lower than the heating tube surface temperature.

Thermocouples were installed in the jumper end of the Scale melter heater stems to monitor performance, and the results verified that the center stem temperature was running about 75° C hotter, Figure 7.20. Additional studies showed that cooling the jumper or the heater enclosure would not have any effect. Since the Scale melter could be run normally with the heaters at 950° C, the slightly higher temperature in the stem was judged to be acceptable for the test runs, but not acceptable for the DWPF melter.

SRL suggested using a nickel core in the stem to reduce electrical resistance and lower the temperature. Since Inconel® 690 is a high nickel alloy, it is compatible with nickel for welding and thermal expansion characteristics. Heat transfer studies verified that the nickel core solved the problem. With the solid Inconel® 690 construction, temperatures at the center of the stem ranged from 889 to 1147 ° C with the heating section at 937° C.²³ Adding the nickel core reduced the maximum stem temperature to 778° C.²⁴

The DWPF dome heater design was modified to include this feature. Keller Technology was able to make a fast turnaround on this late change without causing a delay in the fabrication schedule. A comparison of the original and modified DWPF design is shown in Figure 7.21.

This graph shows the temperature profile throughout the stem of the Scale melter dome heater. Profiles were obtained by positioning a thermocouple at different depths in the stem. The DWPF dome heater stem temperatures were reduced by adding a nickel core in the center to reduce electrical resistance.

Figure 7.20

SCALE MELTER DOME HEATER TEMPERATURE PROFILE

ORIGINAL DESIGN - SOLID INCONEL® 690 END STEM

MODIFIED DESIGN - NICKEL CORE WITH INCONEL®690 SLEEVE

Figure 7.21

DWPF MELTER DOME HEATERS - ORIGINAL AND MODIFIED DESIGNS - JUMPER END

Protection from Sulfidation

As a result of a sulfidation failure of Inconel® 690 in another melter, SRP recommended sealing the annulus between the dome heater stem and refractory clearance hole to protect the stems from condensing salts.²⁵ At final assembly in the mock-up shop, Fiberfrax® rope was formed into rings to fit the heater diameter, and packed into the clearance annulus. A heat transfer analysis verified that the Fiberfrax® rope had no adverse effect on the stem temperature profile.²⁴

Increased Insulation in the Upper Sidewall and Top Head

A study was requested by SRP to analyze the potential benefit of adding more insulation in the upper sidewall and top head of the DWPF melter. Of interest was the effect on vapor space temperature and dome heater power requirements.

The heat balance program predicted that the effect of having a perfectly insulated (no heat loss) upper structure would be marginal for normal operation. The vapor space temperature increase was only 15° C with a corresponding decrease in dome heater power of 12 kw.²⁶ A similar study for start-up conditions indicated that the reduction of power to the dome heaters was 10 kw with an increase in vapor space temperature of 30 to 35° C.²⁷

These small differences did not warrant changing the DWPF design, particularly since the model assumed an ideal condition of no heat loss. Actual differences would be even smaller.

7.4 Pour Spout Bellows

Purpose

The pour spout bellows assembly couples the bottom of the melter adapter flange to the throat protector installed in the canister. Included as part of this assembly is a vacuum connection to the off-gas system that provides differential pressure for pouring.

Basic Data

Basic data requires the pour spout bellows to be vented to the off-gas system during pouring.

Configuration

The pour spout bellows is a remotely replaceable assembly that is installed on the pour turntable neutron detector assembly. Figure 7.22 shows the assembly in the installation and removal mode, in which the bellows are held in compression to clear the adapter flange (under the pour spout) and canister/throat protector flanges. The bellows are locked in this position with threaded screws. After the pour spout bellows assembly is installed, the screws are rotated by the impact wrench to free the actuator arms and seat the pour spout and canister bellows against the respective adapter and canister throat protector flanges, Figure 7.23.

The canister bellows counterweight is mechanically connected (not shown in this drawing) to the actuating arm. Air pressure applied to the actuator bellows lifts the counterweight, rotates the

The pour spout and canister bellows are positioned by the two actuator arms. During installation and removal the bellows are compressed and locked in place with screws. After the assembly is installed on the turntable neutron detector, the screws are retracted with the impact wrench. See Figure 7.23 for the operating mode position.

Figure 7.22

DWPF MELTER POUR SPOUT BELLOWS - INSTALLATION MODE

After the locking screws are retracted by the impact wrench, rotating actuator arms position the pour spout and canister bellows against the adapter and throat protector flanges. The pour spout bellows flange is seated by compression springs. The canister bellows flange is seated by raising the counterweight with air pressure in the actuator bellows. If air pressure is lost, or the actuator bellows fails, the counterweight will drop and disengage the canister bellows, permitting the turntable to rotate the canister out of the way.

Figure 7.23

DWPF MELTER POUR SPOUT BELLOWS - OPERATING MODE

arm, and seats the bellows against the canister throat protector. If the air system or bellows fails, the counterweight drops down and raises the canister bellows, permitting the turntable to rotate the canister out of the way.

When the pour spout bellows locking screw is released, the actuator arm is loaded by compression springs to seat the bellows against the adapter flange.

The pour spout bellows assembly also includes a sight glass to permit the pouring glass stream to be viewed through one of the melt cell viewing windows. Pouring tests on the Scale melter proved that the ability to see the appearance and behavior of the glass stream was invaluable for adjusting and controlling conditions. This is particularly important for evaluating the stability of the glass stream at different pouring rates.

A schematic diagram of the sight glass and mirror system is shown in Figure 7.24. Operability features include:

- an air sweep across the sight glass to keep it clean
- provisions for cleaning the glass in place using a scraping tool
- ability to remove and replace the glass with the melt cell manipulator

Pour Spout Bellows Design Development

During the Scale melter start-up period, several problems were encountered with operation of the initial pour spout bellows design. These were exaggerated by the glass pouring difficulties caused by the low pour spout temperatures before insulation was added and the pour lip was recessed.

- Residual glass at the end of the pour was drawn into fibers and filled the bellows chamber with a glass "birds nest." The inner bellows became coated with glass.
- Glass fibers were sucked into the differential pressure vacuum line and plugged the pipe.

A discussion between B. J. Etienne and J. D. Gutmann, Jr. on the bellows glass coating problem led to the decision to protect the bellows with telescoping shields. Plugging of the vacuum line was due in part to the formation of glass fibers, but also to glass stream instability caused by the configuration of the vacuum port.

In the original design, the vacuum port was located at one side of the bellows chamber. Air leaking at the canister interface had to sweep across the glass stream to enter the vacuum port, disrupting the glass stream and causing unstable flow conditions. B. J. Etienne proposed using a baffle that would force the air flow around the glass stream in an even pattern. This concept was first tested in the Scale melter pour spout bellows using a funnel-shaped distributor, and the test verified that the distributor kept the vacuum line free of glass fibers.²⁸ The design was refined for DWPF by combining an orifice ring with the baffle to keep leaking air away from the glass stream, Figure 7.25. A section through the entire assembly is shown in Figure 7.26.

The DWPF pour spout bellows assembly was installed on the Scale melter for operability testing on Scale melter run SGM-8. This test series was successful and verified the configuration for operation in the melt cell.²⁹

This view shows a simplified concept for the sight glass arrangement. In the final arrangement, there may be minor changes to the mirrors and sight path.

Figure 7.24

POUR SPOUT BELLOWS SIGHT GLASS CONCEPT

Experience with the Scale Melter resulted in the configuration shown for the DWPF pour spout bellows assembly. Telescoping shields prevent the glass from contacting the bellows, and the glass pour stream is protected from crosscurrent air flow by the baffle and orifice ring assembly. Sources of potential leaks and their flow paths are shown.

Figure 7.25

DETAIL OF POUR SPOUT BELLOWS CHAMBER

REFERENCE: W801823

Figure 7.26
DWPF MELTER POUR SPOUT BELLOWS - SECTION VIEW

Bellows Design Development

The metal bellows are critical components of the pour spout bellows and drain valve assemblies. It was recognized that metal bellows fabrication is a highly specialized field that is limited to a small number of vendors. Of these, only Metal Bellows Corporation in Moorpark, California had the experience and capability to fabricate bellows to our requirements. This same experience was repeated on Project 9S 2659 for the IDMS melter.³⁰ On this basis, Metal Bellows Corporation is the recommended single source for fabricating future DWPF melter metal bellows assemblies.

Bellows material selection was made based on the operating environment, spring rate requirements, and fabrication considerations. The actuator bellows is not exposed to corrosive conditions and is fabricated from 304 L stainless steel, the standard material used by Metal Bellows Corporation.

Both pour spout and canister bellows are exposed to corrosive vapors from the glass, similar to off-gas conditions. The material normally recommended for off-gas service is C-276 alloy, but this was not suitable for bellows construction due to difficulties in welding. Alloy 625 was the best candidate for this service and was selected for the pour spout and canister bellows.³¹

Under normal conditions, bellows life is governed by fatigue. Arrangements were made to run life cycle tests at the Engineering Test Center to verify that the bellows would meet the design fatigue life. Tests were conducted on the pour spout canister bellows and actuator bellows, as these were considered the most likely to fail in service due to frequent cycling. Both bellows were cycled well beyond the design fatigue life.³²

Stress calculations performed by Metal Bellows Corporation for the actuator, pour spout, and canister bellows are documented in DuPont BPF 218813 (Ref. DuPont Order AXC-1992-W).

Additional technical data on the pour spout bellows was covered in design review meetings and documented responses to action items.³³

To avoid lateral forces from the canister on the canister bellows, the canister must be held in a fixed position prior to and during any bellows engagement. This is accomplished with the Bechtel designed canister positioning arm which is mounted on the melter frame.

7.5 Drain Valve

Purpose

At the end of the melter's useful life, the glass must be drained before the melter is removed from the melt cell. The intent is to remove as much of the highly radioactive material as possible. Normally, the bulk of the glass is first removed by differential pressure pouring until the glass level reaches the riser entrance. This breaks the vacuum seal, preventing further pouring, and the drain valve must remove the remaining glass. In the event that glass cannot be poured through the riser/pour spout system, the drain valve must empty the entire melter contents into the drain canisters positioned under the melter assembly. Glass flow through the drain system must be initiated and stopped for each canister fill cycle.

Basic Data

Basic data requirements for the drain valve are covered in Section 5, Reference 1. These include the following:

- ability to cycle enough times to drain the melter contents into standard canisters
- a mechanical means to initiate and stop the flow
- a secondary or emergency shut off to stop glass flow

Configuration

A section view of the drain valve assembly is shown in Figure 7.27. The construction is similar to the annular configuration used in the riser/pour spout heater, with serpentine heating elements, alumina isolator sleeves, Zircar® insulation, and an outer metal sheath.

Metal bellows similar to those used on the pour spout bellows assembly actuate the drain probe and shut off plug. A bellows is also used to couple the bottom of the drain valve to the drain canister.

All of the mechanical operating features on the drain valve are designed for fail-safe operation:

- Pressure is required in the probe bellows to raise the probe into the drain position. If air pressure is lost, or the bellows fails, the probe will close and stop glass flow.
- Pressure is required in the plug bellows to hold the plug up in the open (drain) position. If air pressure is lost, or the bellows fails, the plug will close down and stop glass flow.
- Springs hold the canister bellows up in the open position for turntable indexing. Pressure is required to lower the bellows flange to the drain position. If air pressure is lost, or the bellows fails, the canister bellows will raise up to permit the turntable to be indexed.

The following general sequence is used for draining the melter:

- Differential pouring is used to drain as much glass from the melter as possible.
- Drain valve heaters are turned on and gradually increased in temperature to the operating limit of 1100° C. Time is required to allow the internal core to reach operating temperature.
- The canister bellows is pressurized to engage the bellows flange with the canister.
- Air pressure is applied to the plug bellows to raise the plug and open the channel.
- Air pressure is applied to the probe bellows to raise the probe and initiate draining.
- When the first canister is filled, the probe is retracted and time is allowed for residual glass to drain out. The plug may be closed as a back up to the probe shut off.
- The turntable indexes the next canister into position and the canister bellows is actuated. The plug is raised (if closed), and the probe raised to start the next drain cycle.

If the probe fails to retract at any time, the shut off plug is lowered to stop glass flow.

The offset configuration of the drain valve was designed to meet physical requirements for the drain probe and secondary shut off plug. After the heaters have brought the inner core up to temperature, draining is initiated by raising the plug with the plug bellows, then raising the probe with the probe bellows. Under normal operation, glass flow is stopped by retracting the probe. If the probe fails to close, glass flow is stopped with the plug. Both the probe and plug are designed for a fail safe closed condition. If air pressure is lost, or the bellows fail, the probe and plug will move down to the closed position to stop glass flow.

Figure 7.27

DWPF MELTER DRAIN VALVE

Figure 7.28 shows the construction details of the top section of the valve with the probe and heating zones 1 and 2. The zone 1 heater is designed to be operated continuously to compensate for heat losses to the valve exterior. As described on page 6.7, with no auxiliary heat source, the drain valve outer sheath conducts heat from the surrounding refractory and lowers the bottom refractory surface temperature.

Details of the remaining heating zones are shown in Figures 7.29 through 7.31.

Drain Valve Design Development

Experience with the Scale melter riser heater showed that thermocouples installed normal to the heating elements would indicate a temperature about 100° C lower than a thermocouple parallel to the element. The only drain valve thermocouples that were parallel to the heating element were in zone 1 (top section). At this time the drain valve design had been completed, and it was not feasible to change thermocouple layout in zones 2 through 5, due to the complexity of the revision and the effect it would have on schedule. These thermocouples remained normal to the heaters, and it was agreed that a test of the drain valve would be used to establish the relationship between as-built thermocouple readout vs. parallel test thermocouples installed in the channels where practical. This test was included in the operability demonstration, page 7.48.

Heat transfer studies were made to evaluate temperature profiles at the various heating zones after the design was firm.³⁴ Additional insulation was added to the bottom section (zone 5) to keep the pour lip area at elevated temperatures.

Calculations for sizing the drain valve heater power and transformer requirements were transmitted to Bechtel for procurement information.³⁵

Bellows Design Development

Bellows development for the drain valve was part of the same program used for the pour spout bellows, page 7.40.

Following are the materials selected for the drain valve bellows:

- probe and plug bellows: AM 350 (required to satisfy spring rate requirements, corrosion and temperature not a problem in this area)
- inner canister bellows: Inconel® 718 (required to satisfy spring rate, resist corrosion from off-gases, and be compatible with strength of the AM 350 outer bellows)
- outer canister bellows: AM 350 (required to satisfy spring rate requirements, be compatible with Inconel® 718 inner bellows, corrosion and temperature not a problem in this area)
- transition seal bellows: Inconel® 625 (resistance to corrosion and high temperature required)

Stress calculations performed by Metal Bellows Corporation for all of these bellows are documented in DuPont BPF 218892 (Reference DuPont order AXC 613-W).

The zone 1 heater is designed to keep the bottom surface of the refractory hot to retard spinel formation. Since some spinel may accumulate over a long operating period, the probe is designed to extend 3.5 inches above the refractory bottom surface to reach molten glass. The glass inlet to the probe is horizontal to prevent spinel from plugging the opening (See Section 2, Reference 23 for a discussion on spinel).

Figure 7.28

DRAIN VALVE ZONES 1 & 2 DETAILS

This view shows details of the probe and probe guide mechanism. Note that when the probe is lowered to the closed position, it automatically blocks the entrance to the angled section. This reduces the amount of residual glass that must drain at the end of a canister fill cycle. When the probe is raised for draining, the probe flow channel exit lines up with the angled channel.

Figure 7.29
DRAIN VALVE ZONE 3 DETAILS

REFERENCE: W812252

Figure 7.30
DRAIN VALVE ZONE 4 DETAILS

REFERENCE: W812252

Details of the drain valve canister bellows, plug, and glass pour lip are shown in this view. The bottom exit is internally insulated with Zircar® to keep the glass pour lip at elevated temperatures. Telescoping shields inside the inner bellows protect the bellows from glass contact, prevent entrained air from flowing across the glass stream, and serve as a baffle to cool the bellows with entrained air. The transition seal bellows is a flexible connector for thermal expansion, and allows the drain valve to grow to the left when heated without disturbing the canister bellows position.

Figure 7.31

DRAIN VALVE ZONE 5 DETAILS

Operability Tests

Since the DWPF drain valve design could not be completed in time for evaluation on the Scale melter, arrangements were made with SRL to construct a drain valve test stand that would simulate the melter bottom. A furnace was constructed around an Inconel® kettle to provide a source of molten glass for the tests. The tests verified operation of all drain valve components over a range of glass viscosities, including a drain test with a layer of spinel on the bottom. In addition to establishing operational guidelines for current limits to the heaters, the test results disclosed that additional insulation was required at the junction of zones 4 and 5. This change was included on the DWPF drain valves for melters 1 and 2.³⁶

This operational test was a significant accomplishment, considering that this was the first time the DWPF configuration was started up. All components of this complex assembly functioned as designed, with no mechanical problems.

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30. Letter to J. R. Glasscock from B. J. Etienne dated February 3, 1988 - *DA S350 - Pour Spout and Drain Valve Assemblies* - Document Number DP 0002533.
31. Letter to B. J. Etienne from J. J. Kvochak dated June 30, 1986 - *Welded Metal Diaphragm Bellows/Materials of Construction* - Document Number SD 0000155.
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33. Letter to D. L. Ketcham from B. J. Etienne dated June 18, 1986 - *DA S350 - Glass Melter Pour Spout Bellows Assembly - Actual and Summary Responses to Action Items*.
34. Heat transfer calculations by H. F. Hublein dated September - October 1984 showing temperature profiles at the drain valve heating zones.
35. Letter to D. W. Campbell from A. Q. Haideri dated December 4, 1984 - *Drain Valve Heaters - Zone I through Zone V* - Document Number DB 0005151.
36. *Operability Testing of a Prototype DWPF Melter Drain Valve* by Jill Glascock - December, 1988 - Document Number DP-1772

Section 8

DWPF Glass Melter Top Head Components

8.1 Basic Data

Basic data requirements for the melter top head components is covered in Section 5, Reference 1. The primary requirements included:

- two independent continuous feed ports with provisions for cooling, including cooling during removal or replacement
- glass temperature measurement at three depths in two locations, using as many thermocouples as practical for redundancy
- vapor temperature measurement at one location
- one voltage probe to indicate when foam or the cold cap is too high
- glass level measurement at one location using nitrogen as a bubbler gas
- remote viewing of the glass surface with CCTV cameras – viewing area to include the two entry feed ports, the cold cap between one feed point and the nearest sidewall, and a portion of the sidewall
- one bottom drain valve, capable of cycling enough times to drain the glass into standard canisters, with a positive mechanical means to initiate draining and stop the glass flow

8.2 Configuration

Plan and section views of the top head layout are shown in Figures 8.1 and 8.2. As described in the following paragraphs, this arrangement was the result of many studies and model verification to obtain the optimum component positions.

8.3 Remote Handling

Requirements

All of the top head components were designed for remote removal and replacement using the standard SRP canyon crane and impact wrench procedure. Both impact wrench and lifting hook are suspended from an overhead crane and must be guided in place by the operator with the aid of several closed circuit T. V. cameras mounted on the crane plus additional cameras in the melt cell.

Each component is guided in place by a pair of dowels that extend high enough to engage the component flange before the body of the component reaches the vessel nozzle. One dowel, designated the master, is several inches higher than the other. After initial engagement with the master dowel, the component is rotated by the crane to align and engage the second dowel. After the component is lowered and seated on the nozzle anchor flange, it is fastened to the top head using an impact wrench to tighten acme threaded nuts on studs. Figure 1.16, page 1.18, shows the dowel and stud arrangement on the melter head. The acme nuts, painted yellow for visibility, are visible near the top of the studs. The dowel tops are also painted yellow.

This view shows the final top head arrangement with all remotely removable components installed. These consist of two feed tubes, two CCTV camera/borescope assemblies, three thermowells, two film coolers, and a melt level dip tube.

Figure 8.1

DWPF MELTER - TOP HEAD COMPONENT LAYOUT

Figure 8.2

DWPF MELTER - TOP HEAD COMPONENT LAYOUT - SECTION VIEW

A considerable amount of effort was required to design this layout due to the number of assemblies that had to fit in a relatively small area. The goal of the design was to permit independent removal and replacement of any component without having to remove any other component or its jumper for access. At the same time, the feed tubes and thermowells had to be positioned to clear the dome heaters and electrodes. A minimum 1/2 inch was specified by SRP operations for impact wrench clearance.

Half Scale Working Model

During the conceptual layout design stage, it became clear that the design requirements could not be satisfied using the standard designs and procedures. Under recommendations from J. E. Savoy, the design team at Allstates - Trenton concluded that the design goals *could* be met under the following conditions:

- add rotators to the 15 ton (equipment lifting) and 1 ton (impact wrench) hooks on the main process cell crane (required for access to all acme nuts and lifting bails)
- separate thermowells and other dip tubes from the jumper (see page 8.13)
- fasten all components (except the off-gas equipment) with two acme studs (required to fit the components in the available space - the standard canyon design uses at least 3 studs)
- use two narrow kickplates for disengaging two out of the three Hanford connector jaws during jumper removal, Figure 8.3 (the standard Hanford connector requires a 12 inch diameter kickplate to release all three jaws during removal - this would interfere with wrench access)

In the early stages of developing the top head layout, the design team suggested building a wooden half scale working model to assist them with planning the layout and checking the clearances in three dimensions. Of equal importance was using the model to demonstrate the necessity for using the rotating crane hook and non-standard stud and Hanford connector kickplate arrangement. This model, shown in Figures 8.4 through 8.6, was a valuable tool for both purposes.

In January, 1983, J. D. Gutmann, Jr., assisted by J. E. Savoy, arranged a meeting with participants from the Engineering Department, Bechtel, and SRP to describe the top head design and demonstrate simulated remote handling of the components using the half scale model.¹ The layout and operating conditions for remote handling were accepted by SRP.²

At Trenton a state of euphoria lasted about three months, until the basic data was revised to convert the former melter vent line to a parallel off-gas line.³ For the melter top head, this involved rotating the angled vent nozzle to a vertical position for film cooler capability. What started out as an innocuous change followed Murphy's law by cascading into a complete redesign of the nozzle centers and component envelopes. We learned that the numerous conditions that had to be satisfied for an operable assembly made the layout very sensitive to changes. A total of six designers working with J. E. Savoy spent approximately four months on this task, which included revising completed designs for half and full scale models. Beware of changes to the top head layout or its components!

STANDARD CANYON CONFIGURATION

To remove a jumper, the impact wrench turns the hex head screw on the Hanford connector and lowers the jaws down to the kick plate. When the jaws bottom out on the kick plate, additional turns of the screw raise the jumper connector away from the top of the component. With three jaws resting on the kick plate, the jumper remains stable and in place while the lift hook is being attached to the jumper bail.

Using two narrow kick plates for the DWPF melter provides sufficient jumper stability. The "missing" sections of the kick plate allow clearance for the impact wrench to drop down and engage the acme nuts that fasten the component to the vessel (see Figure 8.10, page 8.15).

Figure 8.3

HANFORD JUMPER CONNECTOR

The feed tube to the left is in the operating position with the jumper connected. The feed tube to the right is shown in the parked position at initial installation. This allows cooling water to be connected and started before the feed tube is lowered into the melter. Off-gas and back up off-gas pipe connections are shown in blue.

Figure 8.4

HALF SCALE TOP HEAD MODEL

The two rectangular boxes in the foreground are housings for the T. V. cameras. The cameras are aligned with an optical system and borescope to view the melt pool surface.

Figure 8.5

HALF SCALE TOP HEAD MODEL - VIEW FROM RISER END

This view shows the impact wrench positioned on one of the acme nuts for the T. V. camera carrier frame. Clearances were verified by tying a cord on the impact wrench lifting bale and lowering it down to each acme nut. A demonstration of this technique was the basis for acceptance of the top head layout by SRP.

Figure 8.6

HALF SCALE TOP HEAD MODEL - VIEW FROM TOP

Full Scale Working Model

Although the half scale model provided assurance that the design was acceptable for remote handling, it was agreed that the concept required a full scale test to simulate the melt cell operation as closely as possible. A full scale carbon steel model of the top head and components was constructed for this purpose, with E. S. Mazanek following up procurement activity. The model was built to the new configuration for the parallel off-gas line, and included working mechanical features of all components. Simulated remote removal and installation of the components were conducted in the mock-up shop at SRP, using this model with simulated jumpers and an overhead T. V. camera. The manual crane was positioned and run based on verbal instructions from an operator viewing the T. V. monitor. These tests confirmed the general component layout for access and visibility. Some minor revisions were recommended to eliminate potential interferences or hang points, and these were included in the final design.

Jumper Location Requirements

Any component that will be connected to a jumper must be designed to position the top connector within an allowable envelope in horizontal and vertical planes. Standard canyon practice requires the connector elevation to be positioned within ± 0.125 inches from the support surface, and within 0.30 inches in the horizontal planes. This requires tight tolerances on the location of the vessel, nozzle centers, nozzle elevations, and alignment dowels.

Controlling three plane locations of the DWPF connectors was a difficult task, since multiple layers of parts created tolerance accumulations that exceeded the total allowables. A typical SRP vessel is a one-piece welded structure supported on the cell floor, thus the nozzle elevation can be controlled by the distance from the support pad.

A study by J. D. Gutmann, Jr. showed that elevations of the DWPF component mounting anchor flanges were influenced by height variations of the support beams, lower frame, shell, bolted top head, anchor flanges, gaskets, and alumina isolators. These could not be controlled strictly by tolerances, as the allowable variations would be too tight for this type of equipment.

The problem was solved by using the vessel *assembly* for control instead of attempting to have interchangeable parts. The order specification requirements for machining the nozzle flanges required final machining with the head and shell assembled to the lower frame. Height control was maintained within $\pm .010$ inches by indexing the nozzle surfaces to the lower frame support pads.

8.4 Anchor Flanges

Purpose

Vessels that require equipment to be remotely installed on a nozzle normally have the studs and dowels mounted directly to the nozzle flange. The DWPF melter was a special case, since the electrically hot components had to be isolated from the grounded vessel. All thermowells and other devices that penetrated into the melter interior fell into this category.

Electrical isolation on the DWPF melter top head was achieved by installing the studs and dowels on a separate anchor flange and separating this from the vessel nozzle with an alumina plate. Alumina sleeves and washers isolated the bolts fastening the two flanges.

Configuration

The anchor flange arrangement on the melter top head is shown in Figures 8.7 and 8.8. A section view showing details of the alumina isolators and bolting arrangement is shown in Figure 8.9.

Since electrical isolation is not required for the off-gas and backup off-gas nozzles, the studs and dowels are directly mounted to the nozzle flanges. These are visible in Figure 5.20, page 5.26.

Anchor Flange Fixtures

When the anchor flanges are installed at final assembly, they must be positioned laterally in the horizontal plane and rotated to the correct angle. Both conditions must be satisfied to insure the dowels will align the component with the nozzle center, and position the component at the required angle for wrench access. Since electrical isolation does not permit metal dowels between the anchor and nozzle flanges, the alignment must be made by other means. Clearances required for the bolts and isolators do not permit alignment to be achieved through tolerances alone.

Although it would be possible to align the flanges with optical tooling, this was expected to be a time consuming and difficult operation. A set of mechanical fixtures was designed under the direction of Bud Parks, Allstates-Trenton, to align the flanges in the horizontal plane to the nozzle centers, and to rotate the flange to the correct position. These fixtures are identified in Section 10, "Fixtures", with instructions for their use covered in Section 9, "Melter #2 Installation Procedures".

The anchor flanges provide the surface on which the remotely installed top head components are fastened. This plan view shows the melter top head nozzles prior to installing the anchor flanges.

Figure 8.7

DWPF MELTER TOP HEAD - NOZZLE LAYOUT

This plan and section view of the anchor flanges shows the arrangement of studs and dowels required for remote installation. Dowels engage and guide the components to ensure that the component and nozzle centers are in line prior to insertion.

Figure 8.8

DWPF MELTER TOP HEAD - ANCHOR FLANGE INSTALLATION

REFERENCE: W807736
W807737

Since the glass melt is conducting electricity, components that are in contact with (or close to) the glass melt surface must be electrically isolated from the vessel to prevent a direct short circuit. The anchor flanges provide the isolation using industrial grade alumina sleeves, washers, and plates. This view is typical of the isolation configuration used on the anchor flanges.

Isolators are not required for the off-gas, back up off-gas, or T. V camera nozzles, since the components in these locations do not project down into the melter interior.

Figure 8.9

DWPF MELTER ANCHOR FLANGE - SECTION VIEW

8.5 Bail Configuration

In normal SRP canyon practice, thermowells and other dip tubes are an integral part of the jumper. Coupled with large vessel nozzles, this design allows ample clearance for movement when the jumper is installed or removed.

On the DWPF melter, the number of components required in the available space, plus the additional requirement for electrical isolation, resulted in smaller nozzle clearances and dictated more stringent handling requirements. As a result, any component extending through the melter top head was divorced from the jumper and had to be mounted directly to the melter structure.

These close clearances demanded a plumb lift of the component during installation or removal. In addition to balancing the assembly, this required the lifting bail to be aligned with the vertical center of the component shaft to eliminate turning moments. In turn, this required a pivoting bail to provide access to the top of the component for connecting the jumper, Figure 8.10.

The original bail calculations were verified by finite element stress analyses.^{4, 5, 6}

8.6 Component Isolation

Although the anchor flanges electrically isolated the component flange from the vessel nozzle surface, Figure 8.9, an additional alumina sleeve was required along the inside length of the nozzle, Figure 8.11. The sleeve is supported by an Inconel® 690 split collar.

8.7 Feed Tube

Purpose

The feed tubes convey melter slurry down to the release point 12 inches above the melt surface.

Basic Data

Basic data requirements for the feed tubes and feed lines are covered in Section 5, Reference 1. The primary requirement was a system having two feed ports located at opposite sides of the melter to introduce slurry close to the melt surface.

Configuration

A section view of the feed tube arrangement in the melter is shown in Figure 8.12. The tubes are spaced 32 inches apart, 20 inches away from the Monofrax® K-3 refractory wall surface, and 12 inches above the glass melt. The 20 inch distance from the sidewall is sufficient to prevent spalling of the refractory surface, see page 3.2.

Details of the feed tube are shown in Figures 8.13 through 8.16. The procedure for installation to allow cooling water to be connected is shown in Figure 8.15. Experience with the 1941 and LSM melters had shown that cooling water must be operating before the feed tube is inserted into the melter. This prevents the slurry water from evaporating and creating a plug in the tube.

All top head components have a pivoting lifting bale arrangement. This view shows the bail configuration used on the thermowell. Since the components are installed and removed with an overhead crane, they must be balanced to hang vertically. To insure a plumb lift during installation and removal, the bail is aligned with the center of the component. This restriction requires the bail to pivot down to provide access to the top of the component for connecting the jumper.

Figure 8.10
TOP HEAD COMPONENT BAIL CONFIGURATION

Since the anchor flanges are electrically isolated from the vessel nozzle (Figure 8.8) the component flange rests on the anchor flange metal to metal. To avoid potential contact of the component tube to the inside of the nozzle, an alumina sleeve is installed as shown. This construction is typical for all components that extend down into the melter interior.

Figure 8.11

TOP HEAD COMPONENT ISOLATION

REFERENCE: W800559

The melter feed material is a slurry of 23% waste material, 25% glass frit, and 52% water. This is metered to the melt pool at a gallon per minute under normal operation. The flow is equally divided between two feed tubes that are arranged to provide an even dispersion of the slurry. The feed tube is an integral assembly with the support frame.

Figure 8.12

DWPF MELTER FEED TUBE ASSEMBLY

The feed tube is fabricated as a subassembly that can slide up and down in the support frame, see Figure 8.14. Guide pins locate the feed tube in the support frame tracks. The feed tube flange is fastened to the nozzle anchor flange.

The feed tube is electrically isolated from the jumper with Kapton® tape as shown in Detail A. The split ring holds the Kapton® in place and provides a bearing surface for the Hanford connector jaws.

Figure 8.13
FEED TUBE SUBASSEMBLY

Details of the support frame are shown in this plan and elevation view. The frame is fastened to two support pads on the top head.

Figure 8.14
FEED TUBE SUPPORT FRAME

STEP 2 - LOWERED INTO MELTER
(SIDE VIEW)

STEP 1 - PARKED POSITION
(END VIEW)

Installation of the feed tube into the melter is a two stage operation. The assembly is installed on the melter head in the parked position to allow connection of the cooling water lines. After water flow is established, the feed tube is lowered into the melter to the operating height.

Figure 8.15
FEED TUBE INSTALLATION

This view shows details of the annular construction of the feed tube. Slurry is fed through a .44 inch I. D. Hastelloy® C-276 tube. Inconel® 690 is used at the bottom for corrosion resistance to the glass. The annular water cooling channel must extend down to the bottom as shown to keep slurry temperatures low. If cooling is not adequate, the slurry will adhere to the tube and cause a plug. Milled Fiberfrax® insulation is poured into the outer casing at final assembly, backed by Fiberfrax® blanket and a cover plate. The outer sleeve is free to expand upward as it is heated in the melter.

Figure 8.16
FEED TUBE - SECTION VIEW

Feed Tube Design Development

Tests run with the LSFM and Scale melters showed a tendency for the feed tubes to plug at intervals. For these experimental melters, the hands-on operation allowed manual rodding of the feed tube to clear the plugs. Some type of mechanical feed tube reamer was proposed for DWPF, but this was not deemed practical. The reaming rod would have to be about 3/8 inches in diameter and extend some ten feet above the top of the feed tube.

One of the objectives of the Scale melter test program at SRL was to determine what events would cause the feed tube to plug, and recommended procedures to avoid these conditions. The feed tube was flushed with water every six hours during the fourth melter run and every three hours during the fifth run. Only partial plugging occurred during the two campaigns, and manual rodding was not required.⁷ During campaigns 6 and 7, it was concluded that routine flushing was not very effective, and the key to preventing plugs was to minimize lag time between feed loss and subsequent flushing. Additional tests determined that a minimum cooling water rate of 4 gpm was optimum.⁸ Actual flow rate established on Melter #1 was 6.7 gpm.⁹

Heat transfer calculations verified that the combined slurry feed and water cooling system maintained the slurry tube temperatures below 100° C up to 5/8 inch from the exit.¹⁰

8.8 Melt Thermowells

Purpose

Melt thermowells monitor the melt pool temperature and provide control signals for the electrode power supplies.

Basic Data

Basic data requirements for the melt thermowells are covered in Section 5, Reference 1. These include the following:

- glass temperature measurement at three depths in two locations
- multiple thermocouples at each location for redundancy

Configuration

A section view of the DWPF melter thermowells is shown in Figure 8.17. These are 3 inch diameter Inconel® 690 bars with 1 inch diameter holes in the center. Six Type B platinum sheathed thermocouples are installed in each thermowell at final assembly to the three depths shown. The 1 inch thick wall section was considered a reasonable balance for corrosion resistance and internal space for thermocouples.

In addition to the alumina isolators on the anchor flange (Figure 8.8) and at the vessel nozzle location (Figure 8.10), the thermowells also have an isolated flanged joint above the melter top head. This is shown in Figure 8.18.

REFERENCE:

W 746741

W 812984

DWPF MELTER THERMOWELL ASSEMBLY - GLASS MELT TEMPERATURE

Figure 8.17

A total of six thermocouples are installed in each melt thermowell, positioned in groups of two at the top, middle, and bottom of the glass melt. During glass pouring, the melt level drops approximately 2 inches, which places the upper thermowells 10 inches below the surface. The central thermowell is 4 inches above the bottom of the refractory to clear the drain valve probe when it is raised.

DETAIL A
THERMOWELL TUBE ISOLATION

Both melt and vapor thermowells (Figure 8.18) are electrically isolated in the main tube below the jumper connector. This provides protection against current flow to the jumper.

Figure 8.18
THERMOWELL - ISOLATION DETAILS

Design Development

The DWPF thick wall thermocouple design was a duplication of similar units tested previously in the LSFM and Scale melter. The DWPF version differed only in the configuration above the top head for remote handling. Heat transfer calculations verified that temperatures at the connector interface were below 40° C.¹¹

An unexpected problem was observed on the Scale melter following campaign SGM-8, when a thermowell was removed after 20 months of continuous service. The tube had a pronounced J shape in the immersed section, which was attributed to glass convection currents exerting enough force to yield the Inconel® 690 tube at 1150° C.⁹ This phenomena was not known at the time the thermowells were designed.

Considerations for Long Term Operation

Thermowells were intended to be replaced every two years, but SRL has recommended reducing this time to one year based on the Scale melter experience. Even one year may be too long, since a slight bend at the bottom may make the vertical extraction difficult. The radial clearance between the 3 inch tube and the 4.38 inch nozzle I. D. is 0.69 inches nominal, and this does not allow for the thickness of residual glass on the tube.

Another point to consider is the risk of having molten glass drip on the top of the nozzle when a melt thermowell is extracted from the DWPF melter. If the glass cannot be removed, the C ring on the replacement assembly flange will not seal on the anchor flange. Presumably, the thermowell will have to be partially extracted and allowed to hang long enough for the residual glass to run off the tube into the melt.

Even if the glass does not drip on the nozzle, there will be a limited time to extract the thermowell and insert it into the carrying tube. On the Scale melter, the residual glass on an extracted thermo-well shattered into pieces after it had cooled for several minutes.

For the above reasons, the technique of remotely removing a melt thermowell from glass must be demonstrated during the cold run. If it is difficult to extract a melt thermowell on the DWPF melter, it may not be worth the risk to replace a thermowell during hot operation.

Thermowell replacement may not be needed in any event. The recent experience showing greatly reduced corrosion with the current frit formula indicates a much longer service life of the Inconel® 690 tube. In addition, the experience with Type B thermocouples has shown them to be very reliable.

8.9 Vapor Thermowell/Conductivity Probe

Purpose

The vapor thermowell is a dual purpose instrument. Vapor space temperature is monitored by three internal thermocouples, and the probe extension acts as a voltage probe to detect foam buildup or an increase in the cold cap height.

Basic Data

Basic data for vapor temperature and a conductivity probe is covered in Section 5, Reference 1. The primary requirements are:

- vapor temperature measurement 15 inches above the glass melt surface at one location using redundant thermocouples
- one voltage probe to indicate when foam or the cold cap is too high

Configuration

The vapor thermowell and conductivity probe were combined into one assembly, Figure 8.19. Three Type B platinum sheathed thermocouples are located at one elevation as shown to monitor vapor space temperature.

The conductivity probe is an extension of the thermowell down to within 6 inches of the melt surface. If foaming occurs, or the cold cap rises, contact of this conducting material with the probe will trigger an alarm at the main control panel. The electrical connection from the probe tube to the connector is shown in Figure 8.20.

An identical assembly was tested and proven out on the Scale melter. The only difference in the DWPF unit is the offset probe configuration required to clear the refractory wall at the electrode location.

8.10 Level Dip Tube

Purpose

The level dip tube monitors the elevation of the glass melt surface.

Basic Data

The basic data requires glass level measurement using nitrogen as a bubbler gas.

Configuration

The DWPF level dip tube is shown in Figure 8.21. Bubbler gas ports are provided by deep drilling holes in a solid Inconel® 690 bar, with one port in the vapor area and the other extended down to the bottom of the tube. Glass depth is gaged by sensing the differential pressure between the vapor and glass ports.

Design Development

An earlier configuration of the level dip tube provided one vapor port and two ports at different levels in the glass. The intent was to provide a measure of glass density (by comparing the difference in pressures between the two glass ports) as well as glass level. Since it was not feasible to deep-drill three holes for this design, the ports were constructed of tubing inside a central 1 inch diameter hole. The tubing was welded to a solid bar at the bottom end, and this joint failed in the Scale melter on two occasions shortly after installation.^{12, 13}

REFERENCE: W746742

The vapor thermowell is a dual purpose instrument. Three thermocouples installed in the well portion monitor the vapor temperature. The lower extension extends down to 6 inches above the melt surface. If foaming occurs, or the cold cap rises, a warning signal is triggered when the conducting material touches the probe. The offset shape clears the refractory at the electrode location (see Figure 7.1, page 7.2).

Figure 8.19

DWPF MELTER VAPOR THERMOWELL/CONDUCTIVITY PROBE

Electrically charged foam contacting the probe sends current to the control panel alarm through an insulated wire. The wire is attached to the probe as shown and routed to the connector at the top of the thermowell/conductivity probe. The circuit is continued through the jumper.

Figure 8.20
CONDUCTIVITY PROBE WIRING DETAIL

SEE DETAIL A
FIGURE 8.13, PAGE 8.18

REFERENCE: W839573

The height of the glass melt is gaged by sensing pressure differential between the vapor space and the glass port at the bottom of the dip tube. Nitrogen gas flow in the system provides the means to measure pressure.

Figure 8.21
DWPF MELTER LEVEL DIP TUBE

After the second failure, the dip tube was redesigned to eliminate the tubing. A deep-drilled configuration offered the most rugged and fail safe design, but there was room for only two holes in the 3 inch diameter bar. Since the experiments for gaging glass density were not successful due to the relative insensitivity of the differential pressure method, SRP agreed to waive this requirement. This eliminated the need for the third port, and the configuration shown in Figure 8.21 was the result.

In the earlier designs, the glass port exited at an angle to one side of the tube, and the zone above the exit port was selectively eroded from the agitated glass. The bottom exit design should provide more erosion allowance by evenly distributing the gas flow over the tube circumference.

8.11 T. V. Camera Carrier/Borescope Assembly

Purpose

The T. V. camera/borescope assembly permits remote viewing of the melter interior during operation. This is used to monitor slurry feeding and the condition of the cold cap.

Basic Data

Basic data requirements for the melter T. V. assemblies are covered in Section 5, Reference 1. These include:

- viewing area must include the two feed entry points, the cold cap between one feed point and the nearest sidewall, and a portion of the sidewall
- cooling of the cameras and borescope at all times including installation and removal

Configuration

The T. V. system for viewing the melter interior consists of three subsystems: a handling and support frame, a camera system with optics enclosed in a housing, and a borescope to provide the required field of view. The assembly and borescope details are shown in Figures 8.22 and 8.23. Close cooperation among several groups was required for this equipment, since the borescope was being developed by SRL, the carrier frame was designed and furnished by the DuPont Engineering Department, and the T. V. camera, optics, and housing were the responsibility of Bechtel. Several coordination meetings were held during the course of the design to confirm details of the interface points.

One of the system requirements is to provide cooling air flow in the borescope before it is inserted into the melter nozzle. A similar requirement was resolved for the feed tube by installing it in two stages to allow the water supply to be connected, page 8.20. Since the borescope used air, it was not necessary to have a leak tight connection. The design takes advantage of this by using a "floating" manifold that is free to slide in the vertical direction. During installation, the manifold hangs down below the borescope and makes contact with the flange surface at the air supply ports. Flow is automatically started, and the weight of the manifold is sufficient to seal well enough to keep air leaks to a minimum. This concept permits the assembly to be installed in one step.

REFERENCE: W748396

The borescope lens views the bottom ends of both feed tubes, and approximately 40 percent of the cold cap edge. The remaining portion of the cold cap edge is obscured by the dome heaters. Each camera views the same amount of surface area, but the views are opposite hand with the feed tubes at the center.

During installation, a "floating" manifold hangs below the borescope. The manifold engages air supply ports on the anchor flange and starts cooling flow in the borescope before it enters the nozzle.

Figure 8.22

DWPF MELTER T. V. CAMERA/BORESCOPE ASSEMBLY

Cooling air for the borescope and lens is supplied through the floating manifold and exhausted to the melt cell. The lens purge air, designed to keep particulates away from the lens cover glass, is fed from a separate source through the manifold and down the clearance gap between the borescope and Inconel® 690 tube. The junction of the borescope and tube forms an annular orifice to direct the air stream on the lens. Steam is occasionally injected into this stream to clean the cover glass.

Figure 8.23
BORESCOPE DETAILS

Design Development

The borescope arrangement was developed by SRL starting with the LSFM melter, and continuing with the Scale melter. These tests established the necessity to have an air purge to keep the lens clean, and later verified that an occasional injection of steam was also required.

The scale-up of this system to DWPF was complicated by the system requirements for remote handling and the field of view, and the need to combine several subassemblies from different sources into one structure.

J. E. Savoy located the nozzles for the T. V./borescope system with a small scale model of the melter upper vapor space and dome heater arrangement. A viewing tube with a pinhole "lens" was positioned in several locations to determine the optimum position for viewing both feed tubes and the largest surface of the cold cap. These studies also showed the sensitivity of the field of view to the dome heater tube diameter. At one point a 4 inch diameter tube was being considered to gain more surface area, but this larger size severely reduced the area of the cold cap that could be seen by the borescope.

Fine tuning of the borescope viewing requirements was completed by SRL at the SRP mock-up shop using the full scale top head working model described on page 8.9.

Design development included heat transfer studies to determine the temperature profile at the borescope lens, and calculate the amount of thermal expansion of the borescope components.¹⁴

8.12 Off-Gas Film Coolers

Purpose

The off-gas film coolers use an air/steam mixture to cool the melter vapor temperatures from the nominal 725 to less than 400° C. Past experience with the 1941 and LSFM melters had shown that deposits in the exhaust stream, plus spatter from the melt surface, would stick to the nozzle walls and create a plug unless the walls were kept cool enough to prevent the material from sticking.

Basic Data

Basic data for the off-gas film cooler is included in Section 5, Reference 1. The primary requirement is to reduce build up of deposits at the off-gas line entrance by reducing the temperature of the vapor stream from 725° C to less than 400° C.

Configuration

The DWPF off-gas cooler assembly and its relationship to the vessel and off-gas pipe is shown in Figure 8.24. Details of the film cooler construction are shown in Figure 8.25.

An internal manifold in the film cooler directs the air/steam flow down to the bottom of the cooler, then out through a series of annular slots. This design insures that the coolest fluid is

REFERENCE: WB18428

A mixture of air and steam is fed to the manifold under the off-gas nozzle. The flow is distributed to the film cooler supply manifold through a set of holes in the nozzle flange. The arrangement for the back up off-gas film cooler is identical.

Figure 8.24

OFF-GAS FILM COOLER ASSEMBLY

The air/steam mixture in the film cooler supply manifold flows to the lower end of the cooler through channels at the outer wall, then flows up through the annular orifices formed by machined rings. The system is designed to cool the inner surface of the rings with a laminar flow profile. This retards the buildup of deposits.

Figure 8.25
OFF-GAS FILM COOLER

directed to the bottom where the film cooler is exposed to the radiant energy from the glass melt and vapor. Since the inside wall surface is the area where build up can occur, the annular slots are designed to direct the flow along the wall surface.

During normal operation, the melter vapor is exhausted through the off-gas line, while the backup line is in a standby mode. If the primary line must be replaced or requires downtime for maintenance, the vapor is routed through the backup line.

A film cooler is also installed in the backup line, but the cooling slots are vertical and arranged to enter tangentially to the inside diameter, Figure 8.26.

Design Development

Plugging of the off-gas line by glassy deposits was a major problem during early test work at SRL. Tests with film cooler devices to retard glass buildup in the line were conducted on the LSFM melter using a configuration based on a mathematical study by CHAM of North America, Inc. CHAM reports H3530/1 and H3551/4 document the study and recommendations.

The combination of the mathematical model and tests on the LSFM melter led to the design requirement to keep the inlet nozzle walls cool with a laminar flow of air to prevent glass particles from sticking.¹⁵

Additional tests were conducted on the Scale melter.^{16, 17} One of the improvements made to the Scale melter film cooler was a manifold that routed the air down to the bottom before it exhausted through the annular slots. This was based on a recommendation by J. W. Duskas. Although the film cooler reduced buildup considerably, it did not eliminate buildup from spatter caused by vapor venting from the glass through the cold cap. In addition to the film cooler, a brush reamer was developed to keep the vertical section of the off-gas nozzle free of deposits.

When the backup off-gas line became a requirement, a film cooler design was required for this service also.¹⁸ Since the backup line is normally on standby, there is no flow in the line during normal operation. The flow from the backup off-gas film cooler is exhausted down into the melter vapor area where it is entrained into the primary off-gas line. This difference in flow direction resulted in the tangential slot design to create a vortex and prevent buildup on the walls from spatter.

Heat transfer calculations verified the temperature profiles at the film cooler and vessel nozzle for normal operation and operation without air/steam flow in the film cooler.¹⁹

The DWPF film cooler designs were scaled up by W. E. Guenther from the configurations tested on the Scale melter.

The air/steam mixture in the back up film cooler supply manifold flows down to the lower end of the cooler through an annular channel, then out through tangential slots into the center of the film cooler. During normal operation, the back up film cooler is vented to the seal pot, and the air/steam mixture flows into the melter vapor space and out through the off-gas cooler.

Figure 8.26
BACK UP OFF-GAS FILM COOLER

References - Section 8 - DWPF Melter Top Head Components

1. Letter to L. F. Shafranek et al from J. D. Gutmann, Jr. dated January 17, 1983 - *Melter Top Head - Review of Half Scale Model* - Document Number DD-0001746.
2. Letter to R. D. Leedle from J. E. Savoy dated June 19, 1986 - *Impact Wrench and Rotator Assembly vs. Top Head Access* - Document Number DD-0005285.
3. Letter to R. F. Schneider from R. J. Cunningham dated May 2, 1983 - *Revised Design Basis DA 350 - Sludge Preparation and Glass Melting* - Document Number DB-0003400.
4. Letter to R. T. Britt from R. J Thomas and J. M. Cahill dated August 29, 1988 - *Lifting Bail D-189701 - Stress Analysis - Design Load Rating* (feed tube).
5. Letter to R. T. Britt from R. J Thomas and J. M. Cahill dated August 31, 1988 - *Lifting Bails - Stress Analysis - Design Load Rating* (thermowells, film coolers, & T. V. camera carrier).
6. Letter to W. D. Kerley from B. J. Etienne dated September 15, 1988 - *Pour Spout Bellows Assembly Bail* - Document Number DP 0002628.
7. *Summary of Campaigns SGM-4 and SGM-5 of the DWPF Scale Glass Melter* - March 24, 1987 - Document Number DPST-87-247, pages 8 - 10.
8. *Summary of Campaigns SGM-6 and SGM-7 of the DWPF Scale Glass Melter* - September 11, 1987 - Document Number DPST-87-532, pages 22 - 24.
9. Letter to B. K. Parsons from J. D. Gutmann, Jr. dated March 2, 1988 - *Feed Tube Cooling Water Rates*.
10. Heat transfer calculations by H. F. Hublein dated August 19, 1982 showing temperature profiles in the feed tube.
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12. *Summary of Campaign SGM-8 of the DWPF Scale Glass Melter* - December 31, 1987 - Document Number DPST-87-850, pages 8 - 11.
13. *Level Dip Tube Failure* by C. F. Jenkins and M. W. Loibl - July 15, 1988 - Document Number EED 880575.
14. Letter to F. M. Heckendorn from T. R. Vick Roy dated April 17, 1986 - *Design Area 350 - Melter Borescope Design* - Document Number DP 0002107.

References - Section 8 - DWPF Melter Top Head Components

15. *Off-Gas System for the Savannah River Plant Defense Waste Processing Facility* by C. T. Randall and D. M. Sabatino - ANS Spectrum '86 International Meeting: Low - Intermediate and High Level Waste Management Decontamination and Decommissioning - Niagara Falls, New York - September 14 - 18, 1986 - Document Number DP-MS-86-135.
16. *Summary of Campaigns SGM-4 and SGM-5 of the DWPF Scale Glass Melter* - March 24, 1987 - Document Number DPST-87-247, pages 50 - 56.
17. *Summary of Campaigns SGM-6 and SGM-7 of the DWPF Scale Glass Melter* - September 30, 1987 - Document Number DPST-87-532, pages 59 - 63.
18. Letter to D. M. Bove' from R. B. Ferguson dated May 29, 1984 - *DWPF Scale Melter - Backup Off-Gas Film Cooler* - Document Number DPST-84-460-TL.
19. Heat transfer calculations by H. F. Hublein dated March 1, 1988 showing temperature profiles at the film cooler with and without air/steam flow.

Section 9 - Melter Component Installation

After the #1 melter shell and frame assembly was completed at the CBI Services plant in Cordova, Alabama, the assembly was shipped to the Savannah River Plant mock-up shop for installation of the shell and top head components. The components were installed using an extensive written procedure prepared by J. Scafaria, R. T. Britt, J. E. Savoy, J. D. Gutmann, Jr., and B. J. Etienne. This same group, with O. M. Parks, assisted SRP Construction with the installation. T. G. Powell, SRP, and B. K. Parsons, Bechtel National, also provided assistance with these components and other items that were the responsibility of Bechtel. These included completion and testing of the cooling water piping, final electrical and instrument connections, and the installation of dome heater transformers, bus bars, and other auxiliary equipment.

As this was the first experience with final assembly of the DWPF components, there were instances where minor field rework was required, or details of the installation procedure or sequence were modified from the original. B. K. Parsons kept a record of these changes and documented the Melter #1 assembly in the first reference, *Shop Completion of Melter Vessel Assembly No. 1 for the Defense Waste Processing Facility at the Savannah River Plant*.

From the experience and information gained from this assembly, a few minor changes were made to Melter #2 components, and the installation procedure for Melter #2 was revised and reissued. The final version is the second reference, *Installation Procedures for Melter #1 and #2 Components*.

**SHOP COMPLETION OF MELTER VESSEL ASSEMBLY NO. 1
FOR THE DEFENSE WASTE PROCESSING FACILITY AT
SAVANNAH RIVER PLANT**

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I. INTRODUCTION

The Defense Waste Processing Facility (DWPF) is currently under construction at Savannah River Plant near Aiken, South Carolina. The facility will take high level waste accumulated from thirty years of special nuclear materials processing and reduce it to a vitrified inert form suitable for disposal in a geologic repository.

The Melter Vessel Assembly represents the heart of the vitrification process. It is in the Melter Vessel that a slurry of radioactive sludge and formulations of glass frit are melted through Joule heating to form borosilicate glass. This glass is then poured into stainless steel canisters which will ultimately be interred at an underground storage site.

The major components of the Assembly are the melter vessel and the support frame. The frame serves to carry the vessel and to provide a structure to support the extensive piping and electrical systems required to operate and monitor melter operation. The largest element of the piping network is a cooling water distribution system which maintains the outside temperature of the refractory lined vessel at under 50° C (120° F) despite the 1100° C (2000° F) internal temperatures. The electrical system provides the power required to melt the slurry and maintain the glass at pour temperature until it leaves the vessel pour spout. Instrumentation is provided to monitor vessel, heater and melt pool temperatures, to view the vessel interior and to status the position of drain valve components. The support frame also serves as a platform for the more than forty remotely connected interface points which allow installation of the assembly into a radioactive processing cell.

The Melter Vessel Assembly (see figures 1 and 2) was fabricated under three separate contracts covering the melter vessel, the melter frame and the assembly of these two components. The partially completed

assembly was shipped by dedicated rail car from Cordova, Alabama to Savannah River Plant (SRP) in August of 1987. The planned scope of work at SRP was to be a three month effort and included the following major activities:

- o Installation of the Riser/Pour Spout
- o Installation of the Drain Valve
- o Installation of Electrodes and Dome Heaters
- o Installation of the Top Head and Top Head Components
- o Completion of piping and wiring to the above equipment
- o Component testing to demonstrate functionality

In addition to the items listed, there were several dozen related activities required to bring the Assembly to a point where it was ready for installation in the DWPF Vitrification building.

While the DWPF melter represents the result of a decade of development, it is the first melter of its particular configuration. As such a number of difficulties were experienced in conducting the final assembly of this equipment and, ultimately, the assembly proved to take twice the anticipated time. This report describes the completion effort with emphasis on certain of these difficulties.

II. ASSEMBLY

When the partially completed Assembly arrived at Savannah River Plant it was moved by truck from the receiving area to the mockup shop at 717F and set in place in the melt cell mockup area atop its support columns. These held the Assembly with its base about 15 feet above floor level. The equipment was dimensionally inspected and no shipping damage or dimensional change was discovered. Assembly work commenced.

A. Drain Valve

The first assembly activity was the installation of the drain valve. As a result of the pouring configuration, a significant waste volume cannot be removed through normal pouring at the end of the melter's operating life. The drain valve provides a means of deinventorying the vessel to reduce as much as possible the amount of waste which is left in the melter. It is intended to be used only at this time. The valve is located on the bottom of the vessel and gravity drains glass waste into canisters on the drain turntable.

Figure 2.

The drain valve was raised into place in the following manner. Structural steel was added to the shipping frame of the drain valve. This provided lift points at each corner to which manually operated chain hoists were attached. The chain hoists were suspended from lifting eyes built into the bottom head of the melter vessel. With a worker operating each hoist and using verbal signals, the valve was lifted from floor level to its position under the melter. Dowel pins guided the final travel of the valve.

Once the valve was in approximate position, bolted connections were made to hold it in place. Some difficulties were experienced in this operation because of minor interferences in assembly parts. As a result, changes in the dowel attachment have been incorporated into subsequent designs. It was also found that a slight oversize diameter in one bolt prevented assembly of an electrically isolated joint. The stock bolt was sufficiently oversize to prevent its installation in a ceramic isolator. This bolt was machined to exact nominal diameter and assembly was then possible.

B. Electrodes

Installation of the four main electrodes began at this time. Each electrode was rigged with a soft sling around its face and balanced so that it hung level. A manually operated chain hoist was hung between the bridge crane and the electrode and was used to provide fine control of electrode elevation. The electrode was then lifted into the melter interior and the stem guided outward through the bore in the melter sidewall. The lower electrodes were installed first. Immediately prior to insertion, it was necessary to clean each bore of DSM-24®, a pumpable insulation material which formed a thermal barrier between the vessel wall and the internal refractory. This material is injected as a slurry into the annular space between the wall and refractory just after refractory installation. With the electrode stem centered in the nozzle bore, the electrode face was supported at the appropriate elevation. For this, wooden wedges were used; off the melter floor for the lower electrodes and off a wooden frame built up from the floor for the upper electrodes.

After each electrode had been anchored in place, it was tested for electrical isolation from the melter vessel. The acceptance criteria were not less than 10 megohms at 500 volts. Three electrodes showed resistance levels in the range of 1,000 to 2,000 megohms. The fourth electrode showed a much lower level of about 4 megohms. It was postulated that this was a result of some moisture which had infiltrated the electrode

assembly and was providing a current path. A quartz lamp was set to impinge on the anchoring components in an attempt to dry them and raise the isolation level. Subsequent measurements showed a continued drop in resistance. After initial measurements, similar deterioration was observed in the other three electrodes until all were displaying values near 150 kilohms.

In order to explain this phenomenon, The fabrication history of the scale melter, the predecessor to the DWPF melter, was reviewed. This melter had essentially identical geometry to the DWPF melter yet had not shown like behavior. It was discovered that, due to concern of residual moisture in the DSM-24® thermal insulation layer freezing during the midwinter shipment of the scale melter, that melter had been put through a heating process to dry this material. It was deduced that this moisture, which remained in the DWPF melter, was penetrating the electrode assembly and providing a grounding path. It was also hypothesized that some insulating material suspended in the moisture may have been finding its way into the clearance gaps in the electrode assembly and compromising the air spaces included for thermal expansion allowances.

As a result, it was decided that proper operation of the DWPF melter could not be assured unless a dryout procedure like that used on the scale melter was performed. The electrodes and drain valve were removed and arrangements made to heat the vessel. Examination of the disassembled parts confirmed that DSM-24® had infiltrated the air spaces.

C. Melter Dryout

The melter was prepared by constructing and installing a top plate which fit at the top of the K3 refractory inside the vessel (see figure 3). A propane burner was mounted in the center of this plate. A 12" diameter exhaust stack was also built into the top plate and ducted outdoors. The top plate and bottom head were insulated to help maintain melter temperatures. All openings in the vessel were insulated and blocked over. Thermocouples were installed in 14 locations (see figure 4) to provide constant temperature monitoring. All thermocouples were routed to a strip chart recorder which provided a hardcopy record of the heating cycle. A catch tank was provided below the drain valve nozzle to catch runoff from the DSM-24®.

The limiting temperature for the drying process was to be 177° C (350° F) at the DSM-24®. This was determined to be the maximum sustained temperature which could be endured by the epoxy coating which

SETUP FOR DRYING OUT MELTER REFRACTORY

THERMOCOUPLE REQUIREMENTS FOR TEMPERATURE CONTROL

- ① (2) SHELL SURFACE, ONE ON EACH SIDE IN LOWER DOME HEATER NOZZLE
- ② (2) SHELL SURFACE IN REFRACTORY T.C. NOZZLES, INSERTED INTO DSM INSULATION
- ③ (4) SHELL SURFACE, ONE IN EACH ELECTRODE NOZZLE, INSERTED INTO DSM INSULATION
- ④ (1) SHELL SURFACE IN DRAIN VALVE NOZZLE, INSERTED INTO FIBERFRAX INSULATION
- A (4) TEMP CONTROL THRU ELECTRODE NOZZLES, EXTENDED 2" FROM INSIDE WALL
- B (1) TEMP CONTROL THRU DRAIN VALVE NOZZLE, BETWEEN STEEL PLATE & K-3 REFRACTORY

Figure 3.

THERMOCOUPLE INSTALLATION FOR DRYING OUT MELTER REFRACTORY

INSTALL THERMOCOUPLES CLOSE UP AGAINST THE MELTER SHELL WITH A 1/2 INCH LENGTH CONTACT AS SHOWN. DO NOT SCRATCH THE EPOXY COATING DURING INSTALLATION. A LEG SHORTER THAN 1/2 INCH MAY BE NECESSARY ON THE TWO REFRACTORY THERMOWELL T.C.'S DUE TO THE SMALL NOZZLE I.D.

Figure 4.

lined the inside of the melter shell. The heatup began on September 10. The melter internal temperature was raised by about 9° C (16° F) per hour to about 243° C (470° F). This resulted in temperatures ranging from 96° C to 157° C (205° F to 315° F) in the DSM-24®. A small amount of liquid was collected in the catch tank but the majority of the moisture was driven off in vaporous form. The melter was maintained at temperature for six days and then allowed to cool for an additional four days before work recommenced. At the end of this period, the DSM-24® insulation which was visible in the electrode nozzles had hardened substantially and now showed a chalklike consistency. It was agreed that although some moisture still remained and would probably still show some leaching into assembly gaps, this relatively small amount would be driven off during initial startup heating of the melter and would not compromise melter operation.

D. Drain Valve Reinstallation

After completion of the dryout, the drain valve was reinstalled in the manner previously described and functional testing was begun. The drain probe, which provides an opening in the melter bottom much like a bathtub drain, and canister bellows, which forms a shroud to collect off gasses from the filling canister, functioned per design. It was apparent, however, that the travel of the plug bellows was being restricted. The plug acts as a secondary valve to stop glass flow in the event of probe failure. With bellows pressure at maximum, the plug was not moving to its uppermost position. The nature of plug motion prior to reaching its upward limit of travel implied that binding of the plug in the plug bore was occurring. In order to disassemble and inspect the plug, it was necessary to remove the drain valve and lower it to the floor.

Upon disassembly, significant galling of the plug and plug bore was discovered. This was believed to have been caused by some foreign material which may have entered the valve through the probe and lodged in the plug bore. The bore and plug were smoothed and the valve reassembled. When retested, it was evident that the parts were continuing to bind. After continued inspection and analysis, it was found that there was a misalignment between the plug and bore and that foreign matter was not the likely cause of the galling. This misalignment was apparently due to a combination of effects including i) too rigid a connection between the plug and its mounting plate, ii) a support system during testing that differed from the installed condition of the valve and iii) a lower than optimum compression in the plug bellows spring supports. Due to the fact that the valve is designed to operate while containing molten glass at 1050° C, it is difficult to exactly simulate operating conditions during testing.

As a result of this investigation, redesign and fabrication of several plug assembly parts was performed. The effect of this rework was to allow a greater degree of freedom of the plug in finding its center in the bore and to increase the support of the plug assembly. The resulting modifications to the plug support and alignment were successful in allowing unobstructed plug travel. The drain valve was subsequently reinstalled and all wiring, instrument and piping connections made and successfully tested.

E. Electrode Reinstallation

Concurrent with drain valve rework, the main electrodes were again installed. Due to some minor scoring of silver plated surfaces and damage to threaded fasteners as a result of tack-welding, the original electrodes were returned to the fabricator for rework and those intended for the second Melter Vessel Assembly were installed in their place. It was agreed that, as a precaution against oxidation, silver plated surfaces would be thinly coated with petroleum jelly prior to component assembly. Such treatment of similar equipment at Savannah River Plant has previously been shown to be effective.

F. Dome Heater Installation

The DWPF melter has four sets of dome heaters, each set consisting of two heater elements. At the south side of the melter each heater set is provided with a water-cooled transformer. The heater elements are connected to the transformer secondary windings by water-cooled bus bars, 12 to 18 inches long. At the opposite side, each pair of elements is cross-connected by an Inconel® jumper.

The heater elements were slung, one at a time, into position above the the previously installed lower pair of transformers. Using a series of hoists and supports along its length, each element was inserted through the vessel and bolted at the transformer end. The jumper end is designed to be unrestrained so that the heater can thermally expand during operation.

With the heater elements in place it was found that the transformer secondaries were not located sufficiently close to their design location to permit fit-up of the dome heater bus bars. In all cases it was necessary to reposition the transformer, modify the support structure or rework the transformer in order to permit assembly. Insufficient monitoring of the supplier had allowed the shipping of equipment that was functionally adequate but did not match dimensional criteria closely. It is planned that

future Assemblies will make use of a jig which can verify dimensional accuracy of the transformers to assure proper fitup. Modularization of the transformers to further speed assembly and simplify connections is being considered.

G. Riser/Pour Spout Installation

The Riser/Pour Spout Heater assembly was shipped to Savannah River Plant within a counter-balanced lifting fixture. This allowed the heater assembly to be raised using a single point lift into a position aligned with the bore of the melter riser. The fixture/heater unit was lifted by a bridge crane with a chain hoist set between the crane hook and the unit lift point (see figure 5). From the point of alignment with the bore, the unit was lowered and translated in a stepwise fashion until it reached the bottom of the bore. It was then necessary to transfer the lifting force from the fixture/heater unit lift point to the lift point for the fixture alone. This was accomplished by gradually loading a second chain hoist also suspended from the bridge crane hook and attached to the fixture lift point while easing the original chain hoist. With the fixture supported, it was unbolted and removed, leaving the heater assembly in place.

RISER/POUR SPOUT HEATER INSTALLATION

Figure 5.

With the riser end in place, the internal insulators, the end cover and the terminal mounts were installed. At various points during this activity, the isolation of the components and the heater body from the melter shell was checked. It was found early on that the heater body was showing low isolation levels (ca. 1 megohm at 500 Volts). It was suggested that this was a result of residual moisture from the drying process trapped in the Fiberfrax® which filled an annular space just inside the riser wall. As can be seen in Figure 3, insulation inserted into the riser bore kept the dryout heat from reaching the riser. This may have allowed moisture traveling on the inside of the melter wall to condense and collect in the Fiberfrax® liner. To test this hypothesis, hot air was blown up around the heater body to dry its exterior. Isolation levels climbed to near 25 megohms. When air flow was discontinued, resistance would again fall, indicating that moisture would return to proximity with the heater body. It was decided that the small reservoir of moisture available could be driven off during startup of the vessel and did not represent a grounding threat to melter operation. In future, only the uppermost end of the riser will be insulated during dryout. This will alleviate the collection of moisture in this area.

Once assembly of the riser/pour spout was complete, the unit was 'bump' tested, (i.e. tested at some fraction of its rated operating load), to verify proper heater and thermocouple operation. It was found that at a load fraction of 15% the heaters did show the expected current/voltage relationship but the heating effect was too low to register on the installed thermocouples. It was eventually necessary to go to 50% of the operating condition to get positive thermocouple response.

H. Top Head Installation

The top head for the vessel had been shipped to SRP in its turning fixture. The turning fixture is a structural steel frame with a motor driven mount to which the top head is attached. This allows the head to be handled in an inverted position during refractory installation and shipping and rotated to its right-side-up position for placement on the vessel.

With all internals in place, the melter top head was installed. Prior to installation, it was necessary to clean the mating surface of the head/shell interface and the bores of several head nozzles of residual refractory grout. Cleaning of the nozzle bores was done with care so that no damage to the epoxy lining of the vessel occurred.

The seal at the junction of the shell and head (see figure 6) was affected by a stainless steel o-ring which was set in a groove in the vessel

TOP HEAD JOINT CONFIGURATION

Figure 6.

flange and would be crushed to seal when the head was bolted in place. The gap between shell and head refractory was filled with half-inch layers of Fiberfrax® blanket. Specifications called for six layers, nominally three inches of Fiberfrax® blanket. With this blanket in place the head was lowered into place and the 56 retaining nuts sequentially tightened. After being torqued to the specified value of 285 ft-lbs, the head had not fully seated. It appeared that the Fiberfrax® blanket was preventing the head from seating in the proper manner.

Samples of the blanket were tested for nominal thickness and compression behavior. This was done by incrementally compressing stacks of Fiberfrax® with loads up to 150 psi and measuring the compressed thickness. It was determined that, although the blanket was compressing as predicted by manufacturers data, each uncompressed layer was nominally 1/8" thicker than anticipated. This meant that only five layers were required to make up the specified uncompressed thickness. The head was lifted, one layer of Fiberfrax® removed and the head returned to position. Upon retorquing, the head still had not seated. It was evident that the specified bolt torque was insufficient to close the flange.

The specified torque had been determined based on assumed joint efficiencies and bolting friction factors. It had been calculated as the torque which would provide sufficient clamping force to crush the metal o-ring and form a seal. An estimated frictional coefficient of 0.20 ('normal' friction) had been used. Evidence was indicating that this value was

significantly below that actually experienced in the vessel joint, and that the higher friction factor was preventing adequate axial load from developing. To reduce the friction coefficient, studs and nuts were lubricated with a molybdenum disulfide grease and washers were placed under each nut. The intent of the washer was to reduce the torque lost in friction between the nut and the bearing surface of the top head flange (in future melters the flange will be spotfaced to provide a smooth surface at the nut bearing point). Even after these steps were taken it still proved necessary to increase the torque to 420 ft-lbs to effect a metal-to-metal seat. It is being investigated as to whether the published crushing force specified for the stainless steel o-ring is accurate for the flange configuration used in the melter vessel. As o-rings in the top head and in a similar joint in the riser end cover showed identical behavior, there is a strong indication that more force than believed is required to make this seal. In the case of the riser end cover, respecification of bolt torque from 135 ft-lbs to 270 ft-lbs was required in order to achieve metal-to-metal contact and an effective seal. Indications are that the o-ring groove design offers such additional support to the o-ring that substantially higher loads are required for compression. Some of the melter joints (those between the top head components and the anchor flanges) are being reconfigured using c-rings rather than o-rings to provide for more suitable compression behavior.

I. Assembly Piping

With all major components installed, it was then possible to complete the assembly of cooling water and service piping. Service piping included in part steam piping to the off-gas and backup off-gas film coolers, cooling air and purge steam piping to melter television cameras, argon to the pour spout syphon break and operating air to the drain valve bellows.

Due to the electrical nature of melter operation, it was necessary to provide for electrical isolation within the piping network when plumbing to electrical components or to components in contact with the melt pool. Without such isolation, melt pool potential could be grounded, shutting down the melter. Typical dielectric couplings for piping are intended for the low voltages associated with corrosion processes and not for the 50 to 480 Volt applications seen in the Melter Assembly. It was then necessary to design and test an isolation joint suitable for this service. The result (shown in figure 7) was used extensively in the Assembly. Cooling water lines to the dome heater transformers and the melter electrodes as well as air and argon piping to the drain valve and pour spout contained such joints.

PIPING ISOLATION JOINT

Figure 7.

The joint consists of a hose bridging a two inch gap in the piping. The length of gap was determined as being the optimum for the conflicting requirements of minimizing the voltage gradient across the gap and also minimizing the length of the comparatively less substantial section of assembly piping. The hose used was of two types; Inductotherm® High Resistance and Gates Ohmega®. Both hose types were radiation tested to a total integrated dosage of 2×10^8 rads, approximately ten times the design dosage for the Assembly. Each end of the hose was sealed with redundant stainless steel hose clamps. To protect the hose from incidental damage, the isolation section was then covered with impact resistant Lexan® tubing and again with Raychem WCSF-N® heat-shrinkable tubing. This also provides a secondary seal against minor leakage in the low pressure (25 psig) operating condition.

Cooling water flow to the melter vessel is provided through two redundant cooling paths, each with a single three inch inlet line and several internal paths and outlet lines. In order to ensure proper distribution of flow within this network, it was necessary to measure and adjust piping flow rates. To determine flows, Clamptronic Model 240 ultrasonic flow measuring equipment manufactured by Controlotron Corporation of Hauppauge, New York was used. The equipment employs two opposed transducers and signal processing hardware to calculate flow rates by comparing travel times for sound waves travelling up- and downstream. The system uses transducer sets and a plug-in 'scale card' tailored to a

specific pipe size, schedule and material to provide direct readout in gallons per minute. The design of the piping network within the Melter Assembly had included gaps for the installation of orifices to adjust the flow to the required rates.

The typical shell cooling path (see figure 8) consists of a three inch inlet line, a three inch shell supply line requiring 150 gpm, a two inch top head supply line requiring 20 gpm, an 1-1/2 inch bottom head supply line requiring 10 gpm and a 3/4 inch supply to the dome heater covers requiring approximately five gallons per minute. Flows in each line were measured directly except for the 3/4 inch line for which no transducer/scale card set was available. This flow was then calculated as the difference between flow volumes measured above and below the 3/4 inch takeoff from a larger line.

MELTER COOLING WATER DISTRIBUTION
(Inlet Side Only Shown)

Figure 8.

Flow was provided in a recirculating system through temporary connections to the Assembly. The recirculation system consisted of a 1000 gallon water reservoir, a 5 hp centrifugal pump, a gate-type throttling valve and supply and return connections to the Assembly through flexible hoses (firehose type). Flow in each path was measured and then orifice sizes estimated to bring flow to the appropriate distribution. An iterative process was required, retesting and tuning of orifice sizes being done until the all flows were within required limits. The orifice configuration used in testing and the final welded-in form are shown in figure 9. It was found during testing that when nearing the final flow distribution, the flow pattern was extremely sensitive to small changes in orifice diameter. Diameter changes as small as 1/32 to 1/64 inch could, in some cases, result in a flow rate change as large as 30%. Ultimately, however, it was possible to balance each path at a flow within five percent of the target value.

CONFIGURATION DURING TESTING

FINAL ORIFICE CONFIGURATION

FLOW TEST ORIFICE CONFIGURATIONS

Figure 9.

In addition to the shell distribution, it was also necessary to balance flow to the four melter electrodes. These were fed from a single one inch line which branched to four 1/2 inch lines, one to each electrode. Each line was to carry two gallons per minute. Because of the small line size and flow rate, a simple catch-and-weigh method was used. Flows through each electrode were evaluated and orificed until four catch tanks, one on each branch, were filled at essentially identical rates. Exact flow rates were calculated from the weight of water collected in a unit time. The final orifice sizes and locations are shown in figure 10.

ELECTRODE COOLING WATER DISTRIBUTION
(Inlet Side Only Shown)

Figure 10.

J. Melter Topworks Installation

Melter topwork components include those remoteable items mounted in the head of the melter vessel. This includes two television cameras, two feed tube assemblies, three thermowells and one level dip tube. Some off-gas components are also mounted to the top head but were not included in the scope of this assembly effort. Preparatory to installing the topworks, it was necessary to assemble and locate the topwork anchor flanges. These flanges serve as an attachment base for the thermowells etc., and are electrically isolated from the vessel shell. As the thermowells, feed tubes and level dip tube all contact or potentially contact the melt pool, they must be insulated from the vessel itself in order to prevent grounding.

The most effective method of installation proved to be to locate and orient the anchor flange using optical precision transits while using a centering mount to achieve and maintain concentricity of the anchor flange and isolation/gasketing components. An alignment fixture was used to ensure the proper relative position of the three support surfaces which locate each feed tube assembly.

With anchor flanges installed, the topwork components were placed in position and electrical isolation was verified. On the three thermowells it was discovered that, with the lifting bails in the lowered position, there was a potential contact between the bail and dowels on the anchor flange. As the anchor flange was at melt pool potential and the bail was grounded, such contact could cause a shorting of the melter. The three bails were modified to increase the clearance and prevent such an occurrence.

III. ASSEMBLY MOCKUP

After completion of the major assembly activities, the mockup effort commenced. At Savannah River Plant most equipment intended for installation into a radioactive canyon undergoes a trial assembly in a clean area which physically duplicates the canyon configuration. This provides an opportunity to confirm the ability to remotely install the equipment and to uncover and correct any unforeseen interferences prior to placement in the contaminated environment. In this case, mockup activities included the remote installation of the topwork components, the off-gas seal pot and the more than fifty piping and electrical jumpers which provide service to the assembly.

The most significant discovery made during mockup was that despite being in tolerance both at the vendors shop and when inspected at SRP, support pads for the seal pot were significantly out of position at the time the seal pot was first installed. One of the four support pads was well out of level, showing an elevation difference of 3/16 inches. The tolerance on the vertical position of this pad was .010 inches. It was apparent that the structure of the stainless steel frame at this point was not sufficiently reinforced to maintain dimensional stability over the long term. The frame structure was braced and stiffened at the support pads to provide additional support and will be built up substantially in subsequent Assemblies.

IV. SCHEDULE CONSIDERATIONS

The original assembly schedule had been planned as a three month effort. The actual duration was from mid-August 1987 to February 1988, a period of close to six months. As indicated, there were a number of difficulties encountered which impacted schedule. The most significant single delay was that resulting from the melter dryout. Approximately two weeks of assembly work had been performed prior to the determination that the dryout procedure was required. Disassembly, preparation, vessel dryout, demobilization, cool-down and recovery of the previously performed work brought the time lost from this activity to one month.

Rework of the drain valve plug components also caused a notable schedule impact. Work performed in resmoothing the plug and plug bore, as well as assembly, disassembly and time lost in redesign and fabrication of drain valve parts ultimately amounted to a delay of about three weeks. Additionally, time was lost in resetting dome heater transformers, returning the riser end for rework, setting the top head and preparing for testing. Also, the flow balancing procedure took substantially longer than anticipated.

Some of these and other delays not specifically addressed were concurrent but it can be seen that the net effect was a significant impact on the Assembly completion plan. It is felt that while the original three month schedule was optimistic for the first Assembly, the substantial amount of knowledge gained from this work will make it possible to complete subsequent Assemblies in a much shorter period of time.

V. CONCLUSIONS

The Melter Vessel Assembly, essentially the heart of the vitrification process at Savannah River Plant, represents the result of more than four years of engineering, procurement and fabrication. Over thirty separate purchase orders were required to provide the various components that made up this Assembly. It is evident that the scope of work associated with completion of a Melter Vessel Assembly is substantial. In light of this complexity, and especially considering that this Assembly is the first of its configuration, it is not surprising that inconsistencies in design and fabrication would occur and that these would result in delays in an optimized assembly schedule.

Despite the described efforts in modification and rework, the comparatively small scope of those activities serves to show that the bulk

of the design effort was sound and well coordinated. As with any work of this magnitude, there were errors and oversights but these proved to be minor in nature and did not jeopardize the integrity of the Assembly.

From this document it can be seen that a wealth of information has been gained from this assembly effort. The focus of work now shifts to the incorporation of this knowledge into the documents which describe this equipment. As the ephemeral nature of the Melter dictates that Assemblies must be produced approximately every two years, it is critical to project cost effectiveness that this recurrent assembly work be conducted as efficiently as possible.

VI. ACKNOWLEDGEMENT

The work described herein was performed by Savannah River Plant Construction personnel. This effort was under the engineering guidance of Bechtel National Inc. and E. I. du Pont de Nemours and Co. Savannah River Plant is operated for the United States Department of Energy by E. I. du Pont de Nemours and Co. Bechtel National Inc. is the engineering subcontractor for the Defence Waste Processing Facility at SRP.

Figures 2, 3 and 4 of this report are the work of J. D. Gutmann, Jr. of E. I. du Pont de Nemours and Co., Newark, Delaware.

E. I. DU PONT DE NEMOURS & COMPANY
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ENGINEERING DEPARTMENT
LOUVIERS BUILDING

November 30, 1988

*D. L. KINNSCH
BECHTEL REGIONAL DESIGN OFFICE
SAVANNAH RIVER CONSTRUCTION
BUILDING S-2

PROJECT 9S1780 - SAVANNAH RIVER PLANT
DWPf GLASS MELTER
INSTALLATION PROCEDURES FOR MELTER #1 AND #2 COMPONENTS

Attached is a copy of Specification 9067, Revision 3, covering procedures for installing all melter components: drain valve, electrodes, riser/pour spout heater, dome heaters, refractory thermocouples, top head, anchor flanges, and top head components. This Revision 3 version, dated November 30, 1988, replaces all other revisions and marked copies previously issued, dated July 15, 1987, September 18, 1987 and November 10, 1987. Please discard all of these previous issues.

The installation drawings will also be revised to agree with Revision 3 procedures. A list of these drawings and revision numbers is included in Section 1, Sub-section A, Page 1.1. Additional copies will follow via the normal transmittal procedure. Please note that most tracings for Melters #1 and #2 have already been transferred to SRP. Therefore, marked prints will be sent to you for applicable revisions to be made by Bechtel at SRP.

Our thanks to J. E. Savoy for his special effort and to the following people who assisted us with the original preparation and final update of these procedures and the drawing package:
R. T. Britt - Louviers; J. S. Clayton, O. M. Parks, E. W. Grey, R. P. Viccaro, and T. E. Racz - Allstates Design Group, Bucks County.

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J. Scafaria
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DB 0010002

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J. D. Gutmann, Jr.
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AIM

Association for Information and Image Management

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Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

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PROJECT 9S1780 - SAVANNAH RIVER PLANT
DEFENSE WASTE PROCESSING FACILITY

COMPONENT INSTALLATION PROCEDURES
for
DWPF GLASS MELTERS 1 & 2

DuPont Engineering Department

J. Scafaria
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DWPF GLASS MELTER
SECTION VIEW

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DEFENSE WASTE PROCESSING FACILITY
INSTALLATION PROCEDURE FOR GLASS MELTER COMPONENTS

INTRODUCTION

This procedure outlines the steps necessary for construction field forces to assemble the various components into the refractory-lined melter vessel at the Mock-Shop (717F).

Two melters will be assembled at the Mock-Shop initially. Melter #1 has been assembled and transferred to the canyon melt cell to be part of the cold-run start-up. Melter #2 will be assembled and stored as a spare for Melter #1.

The Engineering Numbers of both melters have been listed in the Table of Contents and in the Identification Area of each section throughout this procedure.

This installation procedure and its listed drawings supercede the installation procedures DWPF-AP-01 thru 07 and their related Drawings W801351 thru W801376 and W801995. The superceded information was issued to Bechtel on an interim basis for procurement purposes when the components were to have been installed in the melter at a vendor's shop. These superceded drawings were used in conjunction with Bechtel Specification M-246 (Technical Specification for Melter Vessel Assembly); Sections 7.0, 9.0, Appendix A, and related DS-M-246 sketches.

References to M-246 have been made throughout this specification and it is to be construed as supplemental information supporting this specification. However, whenever the supplemental information is in conflict with this specification, this specification takes precedence.

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-----	-----	Drawing List	1
-----	-----	General Notes & Precautions	2
S350-185-10	S999-350-10	Preparation of Melter Vessel for Component Installation	3
S350-185-19	S999-350-19	Drain Valve (Noz.: N)	4
S350-185-14	S999-350-14	Electrodes (Noz.: L ₁ thru L ₄)	5
S350-185-18	S999-350-18	Riser/Pour Spout Heater (Noz.: H, K, H ₁ & K ₁)	6
S350-185-16	S999-350-16	Dome Heater Assembly (Noz.: M ₁ thru M ₁₆)	7
S350-2964-TE- A & B	S999-2964-TE- A & B	Refractory Thermocouples (Noz.: C ₆ & C ₇)	8
S350-185-10	S999-350-10	Melter Top Head	9
S350-185-10-3	S999-350-10-3	Anchor Flanges (Noz.: B ₁ , B ₂ , C ₂ , C ₃ , C ₄ , D, D ₁ , & E)	10
S999-350-50-43	S999-350-50-43	Inspection & Assembly Fixture for Top Head Components	11
S350-185-15	S999-350-15	Thermowell (Melt) (Noz.: E)	12
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S350-185-15-30	S999-350-15-30	TV Camera/Borescope (Noz.: D & D ₁)	14
S350-185-15-20	S999-350-15-21	Level Dip Tube (Melt) (Noz.: C ₂)	15
S350-185-15-10	S999-350-15-10	Thermowell/Cond. Probe (Vapor) (Noz.: C ₃)	16
S350-185-15-5	S999-350-15-5	Thermowell (Melt) (Noz.: C ₄)	17
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SECTION 1 - DRAWING LIST

A. Installation Drawings

<u>Drawing Number</u>	<u>Rev.</u>	<u>Description</u>
W743909	46	Electrode Assembly - Upper & Lower
W743911	1	Section Through Dome Heaters
W748706	47	Riser Pour Spout Heater - Sh 1
W748707	43	Riser Pour Spout Heater - Sh 2
W748708	15	Riser Pour Spout Heater - Sh 3
W804860	12	Side Elevation - Melter
W804887	3	Sections Through Electrodes
W805066	4	Plan View - Melter
W805377	3	Connection Schedule - Primary
W805378	4	Connection Schedule - Auxiliary
W807736	18	Anchor Flange Mounting Assembly, Sh 1
W807737	16	Anchor Flange Mounting Assembly, Sh 2
W807889	24	Drain Valve Assembly - Sh 3 (Installation)
W809440	8	Drain Valve Assembly - Sh 7 (Installation)
W809826	7	Drain Valve Assembly - Sh 6 (Installation)
W810639	10	Drain Valve Assembly - Sh 4 (Installation)
W810641	10	Drain Valve Assembly - Sh 2 (Installation)
W810642	16	Drain Valve Assembly - Sh 1 (Installation)
W812311	6	Drain Valve Assembly - Sh 5 (Installation)
W812348	2	Thermocouple Mt'g Assembly - Drain Valve
W812971	6	Dome Heater Assembly
W812984	64	Aux. Equipment Thermocouple Information
W819165	1	General Index
W823832	0	Alignment Fixture (Anchor Flg Installation) - Sh 1
W823833	2	Alignment Fixture (Anchor Flg Installation) - Sh 2
W824062	4	Alignment Fixture (Anchor Flg Installation) - Sh 3
W824063	5	Alignment Fixture (Anchor Flg Installation) - Sh 4
W824064	5	Alignment Fixture (Anchor Flg Installation) - Sh 5
W824065	5	Alignment Fixture (Anchor Flg Installation) - Sh 6
W826534	3	Inspection & Assembly Fixture - Sh 1

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B. Reference Drawings

<u>Drawing No.</u>	<u>Rev.</u>	<u>Description</u>
W736915	6	Refractory Assembly - Sh 2
W745987	57	Level Dip Tube Assembly "C ₂ " Nozzle
W746741	81	T.W. Assembly for "E" Nozzle
W746742	85	T.W. & Conductivity Probe Assembly "C ₃ " Nozzle
W746743	77	T.W. Assembly for "C ₄ "
W747380	32	Feed Tube Assembly - Sheet 1 of 2
W747898	28	Support Frame Assembly - Sh 1
W748395	38	T.V. Camera Support Frame Assembly - Sh 2
W748396	55	T.V. Camera Support Frame Assembly - Sh 1
W748709	32	Riser Pour Spout Heater Assembly
W748710	12	Shipping Bracket Assembly
W800559	39	Feed Tube & Support Frame Assembly
W808478	3	Drain Valve Assembly - Sh 2
W809842	12	Drain Valve Assembly - Sh 8
W809848	12	Drain Valve Assembly - Sh 7
W810607	12	Drain Valve Assembly - Sh 6
W810640	9	Drain Valve Assembly - Sh 5
W810644	24	Drain Valve Shipping Assembly - Sh 1 of 2
W812256	18	Plug Bellows Installation Assembly
W812260	5	Drain Valve Shipping Assembly - Sh 2 of 2
W814474	20	T.V. Camera Support Frame Assembly, Sh 3
W816579	1	Probe Bellows Shipping & Handling Assembly
W816580	1	Plug Bellows Shipping & Handling Assembly
W816581	1	Canister Bellows Shipping & Handling Assembly
W817437	0	Canister Bellows Assembly - Sh 1 of 2
W820788	5	Centering Mount Assemblies
W820958	8	Feed Tube Assembly, Sh 2
W822027	4	Traverse Indicating Assembly
W823831	1	Rotating Indicator Assembly
(C) W824056	3	Cartridge Assembly
W826813	1	Shipping-Storage Fixture (Feed Tube)
W839573	2	Level Dip Tube Assy-C ₂ Nozzle (Latest Design)

C. Vendor Blueprint File Drawings

<u>Drawing No.</u>	<u>Rev.</u>	<u>Description</u>
BPF 215605		Melter #1 Shell & Top Head
BPF 219118		Spring Loaded Thermocouple Mountings

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<u>Drawing No.</u>	<u>Rev.</u>	<u>Description</u>
BPF 216333		Melter #2 Shell & Top Head
BPF 217829		Shipping Frame Assembly (Riser/Heater) and C-Rings & Clips (Top Head Components)
BPF 219624		C-Rings & Clips (Film Coolers)
BPF 218879		Top Head Handling and Shipping Fixture

D. Bechtel Drawings

<u>Drawing No.</u>	<u>Rev.</u>	<u>Description</u>
W750230	10	Piping & Instrumentation Diagram - Sh 1
W750236	9	Piping & Instrumentation Diagram - Sh 2
W750296	13	Piping & Instrumentation Diagram - Sh 3
W750302	4	Piping & Instrumentation Diagram - Sh 4
M-246		Technical Specification for Melter Vessel Assembly

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SECTION 2 - GENERAL NOTES AND PRECAUTIONS

I. SAFETY

The following items are made with ceramic fibers and require special handling:

1. Fiberfrax Paper
2. Fiberfrax Blanket
3. Fiberfrax Square Braid

Fiberfrax paper is used as a protective thermal barrier on the inside surface of the K-3 refractory (Section 5).

Fiberfrax blanket is used as a gasket material for the electrodes, (Section 5), riser heater (Section 6) and vessel top head (Section 9).

Fiberfrax square braid is used as packing to seal the annulus between the dome heaters and refractory clearance hole (Section 7).

These materials are similar to fiberglass insulation. When they are cut, fine fiber particles are released into the air. The manufacturer, Standard Oil Engineered Materials/Carborundum, recommends that protective clothing and filter masks be worn, and adequate ventilation provided in the working area. Safety data sheets for these products are included as Appendix "A", Section 20; please review these for additional information.

II. HARDWARE TORQUE REQUIREMENTS

During operation, the melter will be run under a vacuum. To maintain the required internal temperatures, all nozzles and flanges must be sealed to prevent air in-leakage. All bolts and nuts on the melter must be tightened with a torque wrench, to the torque tolerances shown on the drawings. In addition, the bolts must be tightened in stages, using the sequential tightening pattern shown in Du Pont Standard PP25; this is particularly important where ceramic isolators are sandwiched between bolted surfaces, since uneven loading may break the ceramic.

Wherever torque values are specified on installation drawings, all bolts and nuts shall be lubricated.

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III. PRECAUTIONS

A. Parts Handling and Control

1. General

All of the parts and subassemblies that make up the melter assembly are manufactured to tight tolerances for fit and surface finish. Due to the high cost of these items, page 2.4, no spares have been furnished.

Exceptional care must be taken during the assembly process to:

- o Maintain tight control of parts quantities and location;
- o Use proper handling procedures and precautions to avoid damage.

2. Refractory

The exposed refractory lining in the melter consists of fusion cast K-3 in the bottom and lower side walls, and oven fired Korundal alumina in the upper side walls and top head.

These materials are brittle, and will crack or chip if struck with a hard object. The edges are very sensitive to chipping and spalling.

Care must be taken to avoid hitting the refractory surface with tools, rigging, etc. The melter bottom and top surface of the side wall refractory should be covered with protective material until the top head is installed.

3. Ceramics

There are many high density alumina ceramic components that are used for electrical isolation. These are brittle, and may crack or break if they are dropped or hit with a tool.

Workers hands should be clean and dry when handling isolators. Contamination can affect isolation reliability by possibly creating an electrical path across the isolator. Use of clean cotton gloves should be considered.

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4. Fiberfrax Blanket

This material is used for gaskets on ceramic parts for the electrodes and riser heater. Since there is no bonding agent to glue the fibers together, these are fragile and must be handled carefully.

5. Zircar Insulation

This is a high temperature insulation used in the riser/pour spout heater. It is soft and easily damaged (similar to styrofoam).

6. Surface Finishes

a. Machined Surfaces

There are numerous locations on the vessel and vessel components that have ground or machined surfaces for gaskets or O rings. The fine finish is necessary to seal the joints, and prevent air from leaking into the melter during operation. All of these critical surfaces must be protected from grit and scratches to maintain the seal integrity.

b. Plated Surfaces

Several components have a very thin silver plating to reduce electrical resistance. These areas must be protected during installation, and exposed only when the mating part will be connected. Plated surfaces are on the electrode end stems (Section 5), drain valve and riser/pour spout heater heads (Sections 4 & 6), and both ends of the dome heaters (Section 7).

7. Thermocouples

The drain valve and riser/pour spout heater assemblies (Sections 4 and 6) include thermocouples that monitor and control the internal heating elements. These are "buried" in the assembly, and cannot be replaced in the field.

Leads must be protected during installation, and handled with care during the wiring phase. The platinum wires are brittle and cannot tolerate being bent very many times as is the case with copper wires.

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8. Drain Valve

After the drain valve is installed, the exposed top surface inside the melter must be protected. Keep this covered during installation of the remaining components until you are ready to install the top head. This will protect the valve surfaces, and prevent grit from accumulating in the annulus between the center plug and valve body, and between the valve body and refractory.

B. Water Cooling System

The melter shell and top head have dual channel cooling passages that include small internal orifices to distribute the flow. Exceptional care is required to protect these orifices from debris whenever a pipe line is welded or disconnected. All water lines and jumpers for the melter cooling system must be thoroughly cleaned before they are connected to the system.

All field connections made to cooling water lines are to be inspected and tested per Bechtel Spec. M-246, Sections 8.0 and 9.0. Drains have been provided for jacket cavities after testing, and location can be found on BPF 215605 (Melter #1) - Sheets 24, 40, 116 and 162 [BPF 216333 (Melter #2) - Sheets 5, 21, 104 and 111]. All drain plugs are to be seal welded after all testing has been satisfactorily completed.

C. Electrical Isolation

The melt pool and all melter components in contact with the melt pool are electrically hot and must be electrically isolated from the melter shell and main frame which are grounded.

Electrical isolation test points have been identified throughout the installation sequence. Performing these checks where identified should minimize the need to remove excessive number of parts previously installed should the test fail. Acceptable limit is 10 megohms or higher at 500 volts.

All piping, electrical wiring conduits, instrument wiring conduit, etc terminating at any electrically hot melter component must have an electrical isolation break in the run between the component and grounded contact with shell or main frame.

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In addition to isolation tests, electrical continuity testing must be made on the conductivity probe wiring, on heater leads (in and out), and pin block pins in electrical lower holders for each thermocouple in top head thermowells.

D. Fastener and Threaded Connection Locking

All fasteners are to be tack welded or wired in place to maintain their proper setting, unless otherwise noted. In addition, instrumentation threaded connections are to be tack welded wherever specified. See Section 4-VII for drain valve requirements.

Although locking requirements have been identified with their related assemblies throughout the installation sequence (and on related drawings), it is recommended that most of the locking be done towards the very end of the overall installation. Inaccessible locations, such as at the power end of dome heaters, will probably have to be done early.

E. Seal Welding

All threaded connections in piping to be seal welded unless otherwise noted.

F. Electrical Connections

As a precaution against oxidation, all silver plated electrical connecting surfaces should be coated with a thin layer of petroleum jelly prior to component's connection to electrical supply except where noted otherwise.

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VALUE OF ONE MELTER VESSEL & COMPONENTS AS RECEIVED AT SRP

ITEM	VALUE
MELTER VESSEL & RELATED COMPONENTS	\$1,061,200
REFRACTORY LINING	\$1,089,900
MELTER FRAME, FRAME COMPONENTS, & VENDOR ASSY	\$1,467,000
INCONEL 690 MATERIAL	\$508,150
CERAMIC ISOLATORS - FIELD INSTALLED	\$48,300
ELECTRODES	\$63,700
DOME HEATERS	\$86,800
RISER / POUR SPOUT HEATER	\$244,500
DRAIN VALVE	\$463,620
TOP HEAD COMPONENTS & ANCHOR FLANGES	\$605,480
PLATINUM THERMOCOUPLES - FIELD INSTALLED	\$173,510
POUR SPOUT BELLOWS	\$264,300
TOTAL VALUE - MELTER COMPONENTS	\$6,076,460

NOTES:

1. Costs shown are as-built prices for Melters 1 & 2 components.
2. Riser heater and drain valve costs include vendor installed ceramic isolators and thermocouples.
3. Top head component costs include the two T.V. camera housing assemblies.
4. The pour spout bellows is installed on the turntable - see Bechtel procedures for installation.

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Section 3 - Preparation for Component Installation

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SECTION 3 - PREPARATION OF MELTER VESSEL FOR COMPONENT INSTALLATION

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-10 (Melter #1)	Melter Vessel
S999-350-10 (Melter #2)	Melter Vessel

II. GENERAL

This document covers procedures for preparing the melter vessel for component installation. These steps must be completed before the first component (drain valve) is installed.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
BPF-215605 (CBI)		Melter #1 Shell and Head
BPF-216333 (CBI)		Melter #2 Shell and Head
W736915	10	Refractory Assembly Sheet 2
W748249		Dummy Heater

IV. PREPARATION PROCEDURES

- The shell will be shipped with the following items in place. Refer to drawing W736915, refractory assembly, sheet 2.
 - o Refractory lining.
 - o Dummy heater (W748249) in riser nozzle H.
 - o Post (D186816-D), nut (D186811-D), and B/M item 10 (W736915 plywood washer, installed in bottom nozzle N.
 - o A steel cover on top of the shell.
 - o Plywood covers on all other nozzle flanges and pads.
 - o Wood plugs in electrode nozzles L₁ through L₄.
- Remove steel cover on top of shell.
- Install protective material on the top surfaces of the melter shell flange, sidewall refractory and bottom refractory.
- Remove plywood cover on riser flange and remove dummy heater (W748249). Carefully remove fiberfrax blanket and put aside for later installation. (See Section 6, Para V-B-8)

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5. Remove post (D186816-D) from bottom nozzle N. Send post and nut to S-Area fixture storage area. These will be sent to the fabricator whenever the next melter vessel is fabricated.
6. The joint between K-3 throat block F and riser K-3 block V1 was not grouted during assembly of refractory at CBI. This must be grouted, and any damaged areas repaired by Toledo Engineering, prior to installation of any components.
7. Test for electrical isolation between refractory (K3) and melter shell in the main vessel area and in the riser area. Riser readings should be taken in valley of bore and at refractory joint (at least one).
8. Verify that all nozzles, nozzle flange faces, shell flange face, and top head flange face are free of any refractory installation materials (grout, DSM, etc).

Care must be taken when removing any grout, etc from nozzle walls so as not to damage the epoxy coating. Likewise, flange faces require special attention to prevent damage to sealing surface (see Item III-A-6a, Section 2).

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Section 4 - Drain Valve

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SECTION 4 - DRAIN VALVE PROCEDURE

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-19 (Melter #1)	Drain Valve Assembly
S999-350-19 (Melter #2)	Drain Valve Assembly

II. GENERAL

This section outlines the procedure for installing the drain valve assembly under the melter into nozzle N. The parts required, including dowels used to align the drain valve assembly as it is inserted and bolted to the melter vessel, will be included with the drain valve when shipped in accordance with comments provided in sub-section IV.

As received, the drain valve assembly will include miscellaneous components needed to secure and protect the various springs and pneumatic metal bellows during shipment. The specific parts in question are shown on drawings referenced in sub-section III. Sub-section V outlines specific precautions to be observed during valve handling along with detailed guidelines for valve installation, removal of miscellaneous shipping components and connection of instrument, electrical and air services.

Drain valve testing will be called for as needed in sub-section V but specifically detailed in sub-section VI.

III. DRAWING LIST

A. Installation Drawings

<u>Drawing No.</u>	<u>Description</u>	<u>Comment</u>
W807889	Melter Component Installation Drain Valve Assembly - Sh 3	Valve Attachment to Melter
W809440	Melter Component Installation Drain Valve Assembly - Sh 7	Heater, Thermocouples, Air and Exhaust Locations
W809826	Melter Component Installation Drain Valve Assembly - Sh 6	Heater & Thermocouple Locations
W810639	Melter Component Installation Drain Valve Assembly - Sh 4	Valve As Shipped
W810641	Melter Component Installation Drain Valve Assembly - Sh 2	Correct Valve Installation
W810642	Melter Component Installation Drain Valve Assembly - Sh 1	Correct Valve Installation

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<u>Drawing No.</u>	<u>Description</u>	<u>Comment</u>
W810644	Drain Valve Shipping Assembly - Sh 1	Valve As Shipped
W812311	Melter Component Installation	Heater & Thermocouple
	Drain Valve Assembly - Sh 5	Locations
W812348	Thermocouple Mounting Assembly	Thermocouple Connection
W812984	Aux. Equip. Thermocouple Information	Thermocouple Information
		Tabulations II & III

B. Reference Drawings

W808478	Drain Valve Assembly - Sh 2	Limit Switch Locations
W809842	Drain Valve Assembly - Sh 8	Limit Switch Connections
W809848	Drain Valve Assembly - Sh 7	Limit Switch Connections
W810607	Drain Valve Assembly - Sh 6	Limit Switch Connections
W810640	Drain Valve Assembly - Sh 5	Lower Probe Bellows
		Location
W812256	Plug Bellows Installation Assembly	Upper Plug Bellows
		Location
W812260	Drain Valve Shipping Assembly - Sh 2	Valve As Shipped
W816578	Adapter Bellows Shipping & Handling	
W816579	Probe Bellows Shipping & Handling	Bellows Spacer Removal
	Assembly (Lower)	Reference
W816580	Plug Bellows Shipping & Handling Assy	Bellows Spacer Removal Ref
W816581	Canister Bellows Shipping & Handling	Bellows Spacer Removal Ref
	Assembly	
W817437	Canister Bellows Assembly - Sh 1	Canister Bellows Locations
D187871	Isolator	
D188464	Gasket	
D188475	Retaining Washer	
D189451	Isolator	
D198180	Drain Valve Lower Frame	
D198560	Dowel - Drain Valve Assembly	
D199102	Lifting and Shipping Bracket	
D808583	Shipping Plate Details	
D808584	Shipping Details	
D816890	Details (Drain Valve)	

C. Vendor Blueprint File Drawings

BPF215605	Melter #1 Details - Shs 59 & 60	Gusset & Pad Details
BPF216333	Melter #2 Details - Shs 47 & 48	Gusset & Pad Details
BPF219118	Spring Loaded Thermocouple Mounting	Ref. Only

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D. Bechtel Drawings

W750230	Piping & Instrument Diagram - Sh 1	Bechtel Connections
W750236	Piping & Instrument Diagram - Sh 2	Bechtel Connections
W750296	Piping & Instrument Diagram	Bechtel Connections
W750302	Piping & Instrument Diagram - Sh 4	Bechtel Connections
DS-M-246	Melter Assembly	

IV. PARTS REQUIRED TO INSTALL ONE DRAIN VALVE

Drawings W810641 and W810642 show drain valve assembly correctly installed under the melter. All parts and bill of material items required to effect this installation are shown on W807889 and W812984 and listed below along with specific comments regarding each.

A. Items Furnished by Du Pont Engineering Department - Mechanical

<u>Part No.</u>	<u>Quantity</u>	<u>Description</u>	<u>Comment</u>
		Melter Component Installation	
W810642	B/M items 1-3	Drain Valve Assembly - Sh 1	By Constr.
<u>W807889</u>		Melter Component Installation	
		Drain Valve Assembly - Sh 3	Reference
D187871D	4	Isolator	With Equip.
D187871L	8	Isolator	With Equip.
D187871T	4	Isolator	With Equip.
D187871V	4	Isolator	With Equip.
D187871X	1	Isolator	With Equip.
D188464D	8	Gasket	With Equip.
D188464F	16	Gasket	With Equip.
D188464G	1	Gasket	With Equip.
D188464K	1	Gasket	With Equip.
D188475A	4	Retainer Washer	With Equip.
D188475B	4	Retainer Washer	With Equip.
D188475D	4	Retainer Washer	With Equip.
D189451D	1	Isolator	With Equip.
D198560A	1	Dowel	With Equip.
D198560B	1	Dowel	With Equip.
D816890A	1	Bracket	With Equip.
D816890B	1	Bracket	With Equip.

All parts indicated as with equipment will be included in the wood shipping crate with the drain valve assembly.

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b. Valve mounting flange using leveling screw shown on W810639. End opposite screw may have to be weighted to keep flange from rising.

c. Top plate of plug bellows using leveling nut shown on W810639.

After last surface has been leveled, verify that other surfaces have not changed.

6. Remove all bellows shipping and handling spacer assemblies (painted yellow) shown on W816578 thru W816581. Store in shipping crate.

7. Conduct bellows cycle test in accordance with sub-section VI, Part B.

Connect temporary wiring to bellows limit switches shown on W810607 (plug), W809842 (probe) and W809848 (canister). Verify that switch action meets criteria specified on drawing.

8. Conduct heater/thermocouple test in accordance with sub-section VI, Part A.

9. Test for electrical isolation between heater leads and drain valve core, and between heater leads and drain valve outer casing.

10. Reinstall heater support assembly (D808583A & B, D808584A, B, & C) shown on W812260.

11. The drain valve is ready to be mounted onto the melter bottom. It should be oriented under the melter per W807889 in preparation for installation as outlined in the following sub-section V, Part C.

C. Installation

1. Inspect melter to insure that the threaded studs, tapped mounting holes, nozzle N mounting face, holes and the refractory opening are clean, free of nicks and burrs, and that there are no obstructions that might interfere with drain valve installation.

2. Remove parts described in sub-section IV from shipping crate in preparation for drain valve installation.

3. Install drain valve in accordance with enlarged Section A, enlarged Section B, Section C-C and Section D-D as shown on drawing W807889.

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4. Insert part D187871X, D188464K, D189451D and D188464G over top of valve extension as shown on W807889, enlarged Section A. Insert parts D187871V through flange holes with bottoms flush with bottom of flange face and hold them in place with masking tape until parts can be secured by bolts. The resulting protrusion of part D187871V upward above part D189451D will help to position and orient gasket parts D188464G and K.
5. Similarly, assemble parts D188464F, D187871L and D188475D into subassemblies as shown on W807889, enlarged Section B and mount to top of frame at support holes. Hold them in place with masking tape until assembly is mated to melter pad studs.
6. Slowly raise drain valve assembly until it is within 1/2 inch from mounting surfaces using 2 inch dowels (previously attached to melter bottom) to help align the assembly. Keep unit level at all times as it is being raised so that there will be no side forces exerted onto the probe housing as it passes through the refractory opening inside the vessel.
7. At frame supports, remove masking tape from upper isolator assembly and install remaining isolators, gaskets, washer and nut per enlarged Section B and W807889. Hand tighten nut.
8. At probe housing flange, carefully remove masking tape holding isolators in place so that sleeve in bolt hole does not drop out. Install remaining isolator, gaskets, washer, bolt bracket and bolt per enlarged Section A and Section C-C on W807889. Hand tighten bolt.
9. Using support stud nuts as jacks and keeping unit level, raise the valve frame into position. As it approaches firm contact with melter pads, verify that top of valve probe housing is centered in the refractory hole (radial clearance of $0.6 \pm .03$ inches all around). When position is firmed, sequentially tighten nuts to torque values shown in enlarged Section B on W807889.
10. Sequentially tighten bolts, B/M item #3 to torque values shown in enlarged Section A on W807889. Recheck position of drain valve top of heater in melter refractory to insure that it has not moved. If position has changed, loosen bolts and reposition to obtain a radial clearance of $.06 \pm .03$ inches all around.
- (C) 11. Test for electrical isolation between drain valve assembly and melter shell. (If either of the dowels is touching drain valve frame, it must be removed prior to performing this test).

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B. Items Furnished by Du Pont Engineering Department - Instruments

<u>Melter #1</u> <u>Engg. No. (EN)</u>	<u>Melter #2</u> <u>Engg. No. (EN)</u>	<u>Description</u>	<u>Quantity</u>
S350-2942-TE	S999-2942-TE	Thermocouple (Spring Loaded Mounting)	1
S350-2943-TE	S999-2943-TE	" " " "	1
S350-2944-TE	S999-2944-TE	" " " "	1
S350-2948-TE	S999-2948-TE	" " " "	1
S350-2947-TE	S999-2947-TE	" " " "	1
S350-2949-TE	S999-2949-TE	" " " "	1
S350-2955-TE	S999-2955-TE	" " " "	1
S350-2956-TE	S999-2956-TE	" " " "	1

Thermocouples ordered on AXC 13I-1987 will be shipped to vendor for use on AXC 13I-2101W (BPF 219118).

V. INSTALLATION PROCEDURE

A. Precautions

1. The drain valve assembly contains external ceramic parts as shown on W812348 used to isolate electrical conductivity and requires ceramic parts for installation under the melter as shown on W807889. These ceramic parts are fragile and must be handled with care.
2. Electrical contact leads shown on W809440, W809826 and W812311 are silver plated to enhance electrical conduction. These contact leads must be protected at all times during drain valve installation.
3. Thermocouples for drain valve zone I heaters shown in Tabulation III of W812984 have already been installed in locations shown on W809826 and W812311 as HH4 and HH5. These thermocouples must be protected at all times during drain valve installation.
4. Pressurized metal bellows are utilized to actuate certain components of the drain valve as shown on W807889 and nearly all other arrangement drawings. These are made of very thin material which are extremely sensitive to punctures, scratches, mechanical distortion, over-extension, weld spatter, dirt and shock. Extreme care must be taken to protect these bellows at all times during installation of the drain valve assembly and when making electrical, instrument and air connections.

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5. Assembly of drain valve in nozzle N as shown on W807889 should be such as to insure that the top of the drain valve heater is centered in the melter refractory hole with a radial clearance of $.06 \pm .03$ inches all around. Extreme care must be taken to prevent damage of refractory when inserting drain valve into melter.

NOTE: For Melter #2, dowels D198560A & B should have been modified per D198560, Revision 8 (see memo DB0009871, dated 10/17/88 to D. L. Kinnsch, Bechtel).

6. Use only instrument air or clean dry nitrogen to test or pneumatically operate metal bellows.
7. After the drain valve is installed, the exposed top surface inside the melter must be protected. Keep this covered until you are ready to install the top head. This will protect the valve surfaces, and prevent grit from accumulating in the annular clearances for the center plug and the valve body.

B. Preparation for Installation

1. Identify plates 46-1 through 4 for pad assemblies 45-A through D as described on vendor drawings [EPF 215605 (Melter #1) - Shts 59 & 60 and BPF 216333 (Melter #2) - Shts 47 & 48]. If shipped separately, attach plates to melter bottom gussets in accordance with vendor drawings using 3/8-16 UNC stainless steel socket head cap screws (vessel vendor supplied), torque to 17 ± 3 ft-lbs and then tack weld. (Note: Screws lengths for detail 45-A may vary from others, see vendor prints.)
2. Verify that dowels D198560A & B have been modified per D198560, Revision 8. Install dowels under melter as shown in Section D-D on W807889 using bill of material item #1 shown on W810642.
3. Remove drain valve assembly from shipping crate using lifting lugs on lower frame (D832214A) as shown on W810644 and locate in melter assembly staging area.
4. Remove lifting and shipping bracket (D199102A) shown on W810644 and heater support assembly (D808583A & B, D808584A, B, & C) shown on W812260. Return pieces and related hardware to shipping crate.
5. Using hand level, level the following surfaces:
 - a. Top surface of frame mounting pads (4).

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12. Remove heater support assembly (D808583A & B, D808584A, B & C) and related hardware shown in View Z on W812260. Since parts D808584A, B, & C are separate, removal of part D808583B first will make the disassembly more manageable. Return all parts to shipping crate.
13. Conduct bellows cycle test in accordance with Part B of sub-section VI.
14. Tack weld mounting fasteners as shown in enlarged Sections A and B on W807889. See sub-section VII.
15. Remove shipping frame D832214 as shown on W810644 and dowels D198560A & B as shown on W807889. Return all parts to shipping crate.

NOTE: Dowels must be removed in order to prevent the possibility of an electrical path between the drain valve frame (electrically hot) and the melter shell.

16. Completely disengage valve mounting flange leveling screw and plug bellows top plate leveling nut per W810642.
17. Cover exposed top surface of the valve body inside the melter. (See Para. V-A-7).
- (C) 18. Connect instrument wiring to bellows switches shown on W810607 (plug), W809842 (probe) and W809848 (canister) located on drain valve assembly W808478. Wiring from switches ZZ1 through ZZ12 on drain valve assembly to melter frame is to be in accordance with Bechtel drawing W750296. Test for electrical isolation (see Para. 23).
- (C) 19. Connect instrument air piping to pipe terminations on drain valve indicated as XA3, XA4, XA5, XA8 and XA10 on drawing W809440 in accordance with Bechtel drawing W750296. (Note: See Para. V-A-4 for precautions regarding welding in bellows areas). Test for electrical isolation (see Para. 23).
- (C) 20. Connect gas vent line to pipe termination on drain valve indicated as NN on drawing W809440 in accordance with Bechtel drawing W750296. (Note: See Para. V-A-4 for precautions regarding welding in bellows areas). Test for electrical isolation (see Para. 23).

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- (C) 21. Connect electrical wiring to heater leads indicated as EE10, EE11, EE14, EE15, EE18, EE19, EE29, EE30, EE31 and EE32 on drawings W809440, W809826 and W812311 in accordance with Bechtel drawing W750230 and W750302. Test for electrical isolation (see Para. 23).
22. Install thermocouples (AXC 13I-2101W/BPF-219118) as shown on W812984, tabulation II, HH₆ through HH₁₃ (physical location shown on drawings W809440, W809826 and W812311) and wire in accordance with Bechtel drawing W750236. When installed in mounting for heater zones II, III, IV and V as shown on W812348, thermocouples will be touching heaters when cold (Spring in thermocouple assembly should be compressed 1/4 inch when installed. Field to adjust nipple length as outlined on drawing W812984).

Spring loading in holder will then permit thermocouple to extend an additional 1/4 inch or be further compressed another 1/4 inch. Once installed, no adjustment to the thermocouple mountings should be necessary.

- (C) Test for electrical isolation between thermocouple and drain valve casing. Also, see Para. 23 for additional isolation testing requirements. Test for continuity between thermocouple and related heater lead.

Tack weld per notation on W812984.

23. Test to verify that all piping, electrical wiring conduits, instrument wiring conduits, etc terminating at the drain valve assembly have an electrical isolation break in the run between the assembly (valve body or valve frame) and grounded contact with shell or main frame.
24. Remove all structural support, weld shielding, or dunnage inserted in and around drain valve assembly.

VI. TESTING

A. Heater/Thermocouple Testing (Ref. Appendix A, Item I, Bechtel Spec. M-246)

Test all five drain valve heaters to verify proper heater and thermocouple operation. Since the heater resistance is very low (in milli-ohms), accurate measurement with an ohmmeter is difficult; therefore, a small voltage is to be applied and current measured by an AC ammeter. Apply the voltage by using an AC power supply up to 50 amps size or a variac. Circuit connections and voltage settings are shown in the following table.

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Heater	Resistance ohms	Req'd Power Watts	Rated Current Amps	Voltage Setting	Current at set Voltage
Zone I	.023	400	131	1 Volt AC	43.5 amps
Zone II	.085	2000	158	2	24 amps
Zone III	.0715	1400	140	2	28 amps
Zone IV	0.117	1200	100	2	17 amps
Zone V	0.145	1300	9.5	2	14 amps

After heater testing has been completed, see Paragraph V-B-9 (pre-installation) for continuation.

B. Bellows Cycle Testing

Cycle test drain valve probe, plug and canister bellows using equipment furnished with drain valve shown on Attachment A (page 4.13) in accordance with paragraphs 1 through 4 below. (Note: Equipment furnished with drain valve may not exactly duplicate that shown on Attachment A but will be suitable for use when received). Caution: Use only instrument air or clean dry nitrogen to operate metal bellows.

1. General

The bellows on each valve is to be tested twice: once during preparation for installation and then after installation in the melter.

Maximum rate of raising pressure in any of the bellows shall not exceed 2 psig increment. Set system pressure at 15 psig. Pressurize each bellows as required in paragraphs 2 through 4.

At the completion of all bellows testing, remove testing equipment and store in shipping crate.

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2. Probe

Verify that the probe is seated in the down position (center plate guide stops resting against the top of the lower plate as shown on W810644).

Connect test piping to lower probe bellows and slowly open manual (4-way) valve to pressurize (maximum 2 psig increments) bellows to raise the probe. Movement should start between 2 and 4 psig and should be slow and smooth (increase pressure slowly). Movement should continue slowly and smoothly as pressure is increased until the center plate guide stops are against the bottom of the upper plate; which should occur between 9 and 12 psig.

Releasing the pressure in the lower probe bellows will allow the probe to return to the down position. Verify that center plate guide stops are resting on lower plate; if not, disconnect piping from lower probe bellows and reconnect to upper probe bellows. Pressurize (maximum 2 psig increments) bellows until center plate guide stops rest on lower plate. This action should require approximately 5 psig pressure.

3. Plug

Verify that the plug is fully seated in the down position (center plate guide stops resting against the top of the lower plate as shown on W810642).

Connect test piping to lower plug bellows and slowly open manual (4-way) valve to pressurize (maximum 2 psig increments) bellows to raise the plug. Movement should start between 4 and 5 psig and should be slow and smooth (increase pressure slowly). Movement should continue slowly and smoothly as pressure is increased until the center plate guide stops are against the bottom of the upper plate; which should occur between 9 and 12 psig.

Releasing the pressure in the lower plug bellows will allow the plug to return to the down position. Verify that center plate guide stops are resting on lower plate; if not, disconnect piping from lower plug bellows and reconnect to upper plug bellows. Pressurize (maximum 2 psig increments) bellows until center plate guide stops rest on lower plate. This action should require approximately 5 psig pressure.

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4. Canister

Verify that the canister shroud D818792-A is in raised position [top side of lower bellows plate to be against spring housing as shown in Section Z-Z on W817438 (NOTE: DO NOT USE PIN AT BOTTOM OF GUIDE SLOT AS VERIFICATION)].

Connect test piping to canister bellows and slowly open manual (4-way) valve to pressurize (maximum 2 psig increments) bellows to lower canister shroud. Movement should start between 2 and 4 psig and should be slow and smooth. Movement should continue slowly and smoothly as pressure is increased until top of guide slot comes to rest on pin in spring housing; which should occur at approximately 7 psig.

Releasing the pressure in the bellows will allow the canister shroud to return to its normal raised position. Verify that top side of lower bellows plate is against spring housing.

- (C) 5. After bellows cycle testing has been completed, return to Paragraph V-B-8 (pre-installation) or V-C-14 (installation) for continuation.

VII. FASTENER LOCKING

Melter #1

Fasteners specified in Para. V-C-14 (Page 4.11) are to be locked at assembly in the mock shop.

All other fasteners, particularly those in the area of the bellows and limit switches, are to be locked after the canyon cold run has been completed.

Melter #2

All fasteners are to be locked at assembly in the Mock Shop.

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ATTACHMENT A
BELLOWS PNEUMATIC TEST SCHEMATIC

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Section 5 - Electrodes

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SECTION 5 - ELECTRODES

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-14 (Melter #1)	Electrode Assembly
S999-350-14 (Melter #2)	Electrode Assembly

II. GENERAL

This section covers the procedure for installing Side Electrodes in DWPF melter, nozzles L₁ through L₄, and cementing fiberfrax paper on the sidewall K-3 refractory.

III. INSTALLATION DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W819165		General Index - Melter
W804887		Section through Electrodes
W743909	1 thru 12	Electrode Assembly
W804860		Side Elevation - Melter
W812984		Aux. Equip. Thermocouple Info.
W805378		Connection Schedule - Aux.

IV. PARTS REQUIRED (SPARES NOT INCLUDED)

A. Items Furnished by Du Pont Engineering Department - Mechanical

B/M items listed above, paragraph III.
 1/16 inch thick Fiberfrax paper furnished in rolls 4 feet wide x 125 feet long.

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D187373-A	Side Electrodes - Lower	2
D187373-B	Side Electrodes - Upper	2
D188463-B	Isolators	4
D188463-C	Isolators	4
D188465-B	Gaskets	8
D188474-B	Packing Followers	4
D188474-A	Adaptor Flanges	4

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<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D188464-B	Gaskets	4
D188464-A	Gaskets	8
D188463-A	Isolators	4
D187634-A	Electrode Retainers	4
D187871-A	Isolators	16
D188464-D	Gaskets	32
D187871-B	Isolators	16
D188475-C	Washers	16
D187634-C	Gland Followers	4
D187634-B	Electrode Clamps	4

B. Items Furnished by Du Pont Engineering Department - Instruments

<u>Melter #1</u> <u>Engg. No. (EN)</u>	<u>Melter #2</u> <u>Engg. No. (EN)</u>	<u>Order No.</u>	<u>Description</u>	<u>Quantity</u>
S350-2920-TE	S999-2920-TE	AXC 1987W	Electrode Thermocouple	1
S350-2921-TE	S999-2921-TE		" "	1
S350-2930-TE	S999-2930-TE		" "	1
S350-2931-TE	S999-2931-TE		" "	1

C. Items by Field

Stainless steel lock wire
 Duco Cement
 Water glass (sodium silicate)

D. Items Furnished by Others

Terminal clamps supplied by Bechtel

V. INSTALLATION PROCEDURE

A. Precautions

1. The ceramic isolators and Fiberfrax gaskets are fragile and must be handled with care.
2. Care must be taken with the silver plated surfaces on the electrode stems and terminal clamps. The silver plated area on the electrode stems must be covered prior to installation.
3. See Appendix A, Section 20 (safety data sheets), for instructions on handling Fiberfrax paper and blanket.

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4. Follow area rules for working with sodium silicate.
5. Do not install zinc foil washers supplied with packing rings (B/M item 9, W743909).

B. Side Electrode - Lower

1. Install (4) water pipes (188474-C) to nozzles L_1 through L_4 as shown on W804860. CBI has already installed the inlet water pipes.
2. Remove wood plugs from nozzles.
3. Using nonmetallic lifting straps, lower side electrode (D187373-A) into the melter, insert stem through opening in K-3 refractory, and move it horizontally back against the refractory. Do not use hydraulic jacks to seat the electrodes against the refractory. Excessive force will shift the refractory blocks out of line.

Support electrode inside melter so that cantilevered stem is horizontal and remains centered in the shell nozzle. The stem must be centered within $\pm .050$ inches of the nozzle center at final assembly.

4. Install isolator (D188463-B) onto the stem, positioning it against the stepped shoulder of the stem.
5. On each end of isolator (D188463-C), glue one gasket (D188465-B) using Duco cement. Install this gasketed isolator over isolator (D188463-B).
6. Cut Fiberfrax blanket (Item No. 10, W743909) to size, and install with the packing follower (D188474-B). See Appendix A, Section 20, for safety instructions.
7. Install the (4) set screws (Item No. 4, W743909) on the adaptor flange (D188474-A) so that they project approximately $1/4$ " to the outside from the face of the flange.
8. Insert gasket (D188464-B) between the melter electrode flange and the adaptor flange (D188474-A), align, and tighten four cap screws (Item No. 3, W743909) to the torque range shown on W743909. Tack weld top of cap screw to adaptor flange (D188474-A). Do not allow weld material to protrude above the face of the flange. Advance set screws (Item No. 4, W743909) sequentially until the top of each screw is $1/8$ " below flange surface. Tack weld set screws in

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place. Do not allow weld material to protrude above the face of the flange. Test for electrical isolation between electrode stem and melter shell.

9. Make sure electrode stem is centered per paragraph B.3, page 5.3
 10. Install one isolator (D187871-A) over each stud between the parts installed in the previous step.
 11. Install gasket (D188464-D), isolator (D187871-B), gasket (D188464-D) and washer (D188475-C) onto each stud. Hand tighten one hex nut (Item No. 2, W743909) on each stud.
 12. Tighten the hex nuts (Item No. 2, W743909) to the torque range shown on W743907. Tack weld the hex nuts to the studs.
 13. Place a bubble level on the top face of the electrode. Rotate the electrode to level the top with horizontal.
 14. Insert two rings of packing (Item No. 9, W743909) in the annulus space between the electrode and the electrode retainer (D187634-A). Push the packing rings in with the gland follower (D187634-C). Caution: Do not use zinc foil washers supplied with packing rings.
- Caution: Make sure cut ends of the two packing rings are 180 degrees apart.
15. Position electrode clamp (D187634-B), install hardware item nos. 1, 6 and 7 and 12 (W743909), and tighten to the torque range shown on W743909. Check bubble level as tightening progresses. Lock wire the bolt heads and nuts (or tack weld).
 16. Insert two of the four 1/4" straight pins (Item No. 8, W743909) into the electrode clamp (D187634-B) and the other (2) into the electrode retainer (D187634-A).
 17. Install one each - 3/8" socket set screws (Item No. 5, W743909) on each of the threaded holes on the electrode clamp (D187634-B) and the electrode retainer (D187634-A), as shown on W743909 to compress the packing rings. Install the second set of 3/8" socket set screws to lock each of the above set screws in place. Tack weld set screws in place.

Test for electrical isolation between electrode stem and melter shell.

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18. Repeat the above procedure, paragraph V.B.1 through V.B.17, for the other Lower electrode.

C. Side Electrode - Upper

Use the same procedure to install the two upper electrodes (Sub-Section B). In this case:

<u>Part No.</u>	<u>Replaced By</u>
D187373-A	D187373-B

D. Terminal Clamps

1. Connect terminal clamps onto the lower electrodes. (Reference: Bechtel DS-M-246-12)
2. Provide a clearance of 3/8" between the terminal clamps and the electrode retainers (refer to drawing W743909).
3. Tighten the terminal clamps in place using the hardware provided.
4. Repeat the above procedure, Paragraphs V.D.1 through V.D.3, for terminal clamps - upper electrodes (Part No. 26).

E. Fiberfrax Paper

1. The fiberfrax paper is installed after the electrodes are in place. See Appendix A, Section 20, for safety instructions.
2. Vacuum the exposed side wall K-3 refractory to remove residual dust (46 inches above melter floor).
3. Install 1/16 inch thick Fiberfrax paper, on side wall of refractory only, to a height of 34 inches as shown on page 5.0. Cut the paper with scissors to fit around the electrodes. Do not attempt to fit paper behind the electrodes.
4. Cement the paper by brushing a coat of water glass (sodium silicate) on the refractory, then pressing the paper in place. Follow area requirements for ventilation when using sodium silicate.

F. Thermocouples

1. Install thermocouples in the electrode stems as shown on W812984, Tabulation V, CC1 through CC4.

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Note: Installation should be left until all other activity adjacent to the electrodes has been completed to avoid damage.

2. Wire thermocouples per Bechtel Specification M-246.
3. Test for electrical isolation between thermocouple connector and main conduit run.
4. Tack weld per notation on W812984.

G. Power and Water Connection

1. Connect cooling water piping and electrical connections per Bechtel DS-M-246-12.
2. Test for electrical isolation between piping at electrode stem end and piping on shell mounting pad.
3. After power connections have been completed, test for electrical isolation between power supplied stem and melter shell.
4. Seal weld threaded joints.

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Section 6 - Riser / Pour Spout Heater

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SECTION 6 - RISER/POUR SPOUT HEATER

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-18 (Melter #1)	Riser/Pour Spout Heater Assy
S999-350-18 (Melter #2)	Riser/Pour Spout Heater Assy

II. GENERAL

This section covers the procedure for installing the riser/pour spout heater assembly in DWPF Melter (nozzles H, K, H₁ and K₁).

III. DRAWINGS

A. Installation

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W819165		General Index - Melter
W748706		Riser/Pour Spout Heater - Sh 1
W748707	1 thru 15	Riser/Pour Spout Heater - Sh 2
W748708		Riser/Pour Spout Heater - Sh 3
W812984		Aux. Equip. Thermocouple Information
W805377		Connection Schedule - Primary
W805066		Plan View - Melter

B. Reference

W736915	Refractory Assembly - Sh 2
W748709	Riser/Pour Spout Heater Assembly
W748710	Shipping Bracket Assembly
BPF 217829 (Note: Body of write-up refers to vendor drawing numbers K-1581-75, etc)	Shipping Frame Assembly (Keller Tech)

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IV. PARTS REQUIRED (Spares not Included)

A. Items Furnished by Du Pont Engineering Department - Mechanical

B/M items listed above, paragraph III.

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
BPF215605 Sh 50	Riser End	1 (shipped with melter assembly)
188383-D	Isolator Holder	1
188383-E	Retainer	1
188475-B	Retaining Washer	10
188785-A	Cover	1
188800-A	Adapter	1
188800-C	Flange	4
188800-D	Shield	1
808600-A	Riser Lead Clamp	2
808600-B	Pour Spout Lead Clamp	3
808600-C	Packing Follower	2
808600-D	Packing Follower	3
815444-A	Support Bracket	1
187164-A	Gasket (Asbestos)	1
187164-B	Gasket (Asbestos)	3
187164-C	Gasket (Asbestos)	2
187164-E	Gasket (Asbestos)	4
188464-D	Gasket (Asbestos)	20
188464-E	Gasket (Asbestos)	1
188465-A	Gasket (Fiberfrax)	2
188792-A	Collar	1
187871-D	Isolator	10
187871-E	Isolator	3
187871-F	Isolator	2
187871-G	Isolator	10
187871-AA	Isolator	1
188379-B	Isolator Sleeve	1
188379-D	Pour Spout Lead Isolator	1
188787-E	Sleeve	1
188787-F	Sleeve	1
819502-A	Insulator	1
819502-B	Insulator	1
819502-C	Insulator	1
819588-A	Insulator	1
819588-C	Insulator	1
819588-E	Insulator	2
819588-F	Insulator	2
819589-A	Insulator Sleeve	1

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<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
819589-B	Insulator Ring	1
819589-C	Insulator Sleeve	1
819589-D	Insulator	1

B. Items by Field

Stainless steel lockwire
Duco Cement
Riser Guard (Bechtel Drawing W753353)
Neolube thread sealant - #100 nuclear grade

V. INSTALLATION PROCEDURE

A. Precautions

1. Ceramic isolators are fragile and must be handled with care.
2. Zircar insulation is soft and weak (like styrofoam) and must be handled with care.
3. Silver-plated area of heater leads must be protected during installation. Extreme care must be taken not to damage leads during installation.
4. Six thermocouples have been installed in the heater assembly by the heater vendor. Care must be taken not to damage these during installation, as they cannot be removed and replaced in the field.

Note: Small diameter rigid protection tubes should be put on them to prevent damage to the fragile wires at the end. These should be temporarily installed after shipping bracket assembly has been removed.

5. Check continuity of heaters immediately after the shipping frame K-1381-75 and shipping assembly have been removed. Also check electrical isolation of heater leads to heater shell.

Do not proceed with any other installation steps until this test is completed.

6. See Appendix A, Section 20 (safety data sheets), for instructions on handling Fiberfrax blanket.

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B. Riser/Pour Spout Heater

1. The dummy heater was removed previously per Section 3, page 3.1. Before the riser/pour spout heater is installed, the joint between the K-3 riser and throat blocks must be grouted per Section 3, page 3.1.

Recheck electrical isolation between riser refractory and melter shell.

2. If blanket was damaged during removal, a new blanket (81b/ft^3) should be cut using damaged blanket (or open riser end) as template. Uncompressed blanket to be 2" thick.
3. Lift Riser/Pour Spout Heater (W748709) using shipping frame assembly (K-1581-75). Using the front eyebolt (only) on shipping frame assembly (approx. 8" from center axis of pour spout heater) slowly insert the riser end of heater into the riser cavity, stopping with the heater approximately 2 inches from its final position. Shore heater from inside melter to hold in this temporary position.
4. Transfer lifting force from front eyebolt to back eyebolt while supporting shipping frame (K-1581-75). (This is over the counterweight on the frame).
5. Referencing shipping frame assembly (K-1581-75), loosen 3/8 hex head bolts (two places) at bracket (K-1581-77E) and loosen 3/8 socket head cap screws (two places) in spacer ring (K-1581-83A).

With above pieces still attached, remove support bracket (K-1581-84A) by removing 4-1/2 hex head bolts.

Remove two brackets (K-1581-77B) as shown in view A-A on Drawing K-1581-75. Unbolt from both the main shipping frame and the heater shipping bracket assembly (W748710), remove shipping frame assembly.

6. Referencing shipping bracket assembly (W748710), loosen 3/8 cap screws (items 3 & 4) and remove the lead clamps (188791-B & C). Remove 5/16 hex head bolts (item 2), with washers and nuts, adapter plate (808599-A), and pipes (item 9). Remove 5/16 hex nut (item 5), loosen 5/16 hex head cap screw (item 8), and remove support tube (188791-A) and neoprene sleeve (item 7). Remove 5/16 threaded rods (item 1) and 5/16 hex nuts (item 5).

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Install temporary tubing to protect thermowell wire. See Paragraph A-4, this section.

7. Check continuity of heater leads before proceeding with the installation. Also check for electrical isolation of heater shell to melter shell at this time.
8. Referencing riser/pour spout heater sheet 1 (W748706), install 2" thick fiberfrax durablanket (paragraph 2), fiberfrax collar (188792-A) and Zircar sleeve (188787-E). (Note: Sleeve must be flush with nozzle flange.) Remove shoring and allow the riser/pour spout heater assembly to slide all the way into position.
9. Install asbestos gasket (187164-A) and insulators (819502 A&B taped together on outboard face). Install stud in top bolt hole on melter flange (Nozzle H) and remove wood spacer between pour spout heater leads and insulators. Slide the riser end enclosure (BPF 215605 sheet 50) over the heater and into position using the (2) .75 ϕ dowels in the riser flange to locate the end enclosure. Note: care must be taken when installing the riser end enclosure to protect all protruding thermocouples. Install (24) 7/8 studs and (50) 7/8 hex nuts (items 14 and 15 on W748707 sheet 2). Lubricate studs and washers. Sequentially tighten all hex nuts to the torque range shown on W748706.
10. Remove tape from insulators 819502-A&B. Trim bottom of asbestos gasket (187164-A) flush with flange face of riser and the end enclosure.
11. Referencing W748706, assemble alumina isolator (187871-AA), Zircar insulator (188787-F & 819502-C), and shield (188800-D) in adapter (188800-A). Remove tape from Zircar insulator (188787-E) prior to mounting adapter. Install 1" thick fiberfrax blanket on top of Zircar insulator (cut to same ID/OD as insulator.) Using asbestos gasket (188464-E) and (16) 3/4 hex head cap screws (item 11 on W748707) mount the adapter to the bottom face of pour spout and end enclosure. Sequentially tighten the screws to the torque range shown on drawing W748706.
12. Check electrical isolation of shield (188800-D) to melter shell. Also check to insure that the heater is electrically isolated from the melter. If it is not isolated, the contact must be found, and isolation obtained before continuing with the installation. Lockwire all bolt heads.

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13. Install Zircar insulators into nozzle cavity per sections R, S & V on W748707 and W748708. Accessibility dictates that outer sleeve (819589-A) should be verified for fit before starting assembling pieces. After outer sleeve's fit has been confirmed, proceed to install Zircar insulators in order: 819589-C, 819589-D, (2) 819588-E, (2) 819588-F, 819588-A, and 819589-A (last). Install pour spout lead isolator (188379-D) and isolator holder (188383-D).
14. Referencing section U on W748707, install insulator (819588-C), retainer (188383-E), shim washer (item 4), (2) fiberfrax gaskets (188465-A), and isolator (188379-B). Fiberfrax gaskets are to be cemented to isolator (188379-B) with Duco cement. Note: Machine shim washer (item 4) to proper thickness to maintain the .19 dimension between the top gasket and the cover. (See note B2 on W748707). Install insulator ring (819589-B).
15. Referencing W748706, W748707, and W812984, inspect the end enclosure flange and cover (188785-A) prior to installing cover to make sure they are clean and free from any debris. Insert Metallic-O-Ring (item 13) into O-Ring groove in cover. Slide the cover over the heater leads and thermocouples and bolt the cover to the riser end enclosure using (16) 1.0 hex head cap screws (item 12). Lubricate bolts. Note: Bolts to be only finger tight at this time.
16. Referencing exploded view of thermocouple glands on W812984, install the glands as follows:

With "Conax" gland seat, gland, and gland follower removed from thermocouple glands (C12, 13 & 14), screw "Conax" fitting housings into cover and tighten. Alignment pin slot in inside wall of housing must be positioned so that the pin slot of the gland follower will be opposite the housing slot when the gland follower is installed over the thermocouples. Housing threads to be sealed using neolube thread sealant (#100 nuclear grade).

Check for electrical isolation between heater core and melter shell, and between thermocouples and shell. Pipe through cover must not touch cover.

Remove protection tubing over the thermocouple wires, and install "Conax" fitting internals in proper sequence (gland seat, gland, gland follower, and pin). Install cap and hand tighten.

Reinstall temporary protection tubing.

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17. Referencing sections V, W. and X on W748708, slide isolator sleeves (187871 E&F) over their appropriate leads. Slide asbestos gaskets (187164-B&C) and lead clamps (packing housing) (808600-A&B) over their respective leads. Using isolators (187871-D&G), asbestos gaskets (188464-D), retainers (188475-B), Belleville washers (item 5 - W748707), and 3/4 hex head cap screws (item 2 - W748707); bolt all lead clamps (packing housings) to the cover. Note: Bolts to be only finger tight at this time. Place grafoil packing ring (items 6&7 - W748707) in their appropriate lead clamps (housings). Place washers (items 1&3) and packing followers (808600-C&D) over their respective leads. Only hand tighten all packing followers at this time.
18. Check to insure that all leads, thermocouples and gas piping passing through cover are electrically isolated from the melter shell. If it is not isolated, the contact must be found, and isolation obtained before continuing.
19. After completing the electrical isolation tests, sequentially tighten all cover mounting bolts (item 12 - W748707) to the torque range shown on W748706, then lock wire all cover bolt heads. Note: Care must be taken to insure that the wire does not contact any of the lead clamps (housings).
20. After cover bolts have been tightened, tighten all clamp (packing housing) bolts (item 2 - W748708) to the torque range shown on W748707, then lock wire all bolt heads. To avoid any possible grounding with the heater terminal, do not wire any two bolts on the same clamp (packing housing) to each other. Tighten all packing followers to compress packing. Check electrical isolation of heater leads and inert gas piping. Tack weld all the packing followers to the lead clamps - 2 places on each clamp (after isolation check).

Set two upper inboard thermocouples (HH18 and HH19) to proper location by bottoming out the couples and then retracting them one (1.0) inch. Lock at that position by tightening the (Conax) fitting cap to full compression. Tighten remaining Conax fitting caps to full compression. Check for electrical isolation of thermocouples to shell. Then tack weld all fittings to cover and nuts to fittings.
21. Tack weld all hex nuts bolting the riser end enclosure to the riser (nuts to stud on one side and nuts to flange on other side). See Paragraph III-D in Section 2.
22. Lock wire all bolt heads on the adapter (188800-A).

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23. Referencing W748706, attach (4) flanges (188800-C) with asbestos gaskets (187164-B) to nozzles C₈, C₉, C₁₀ and C₁₁ using 1/2 hex head cap screws (item 10 - W748707). Tighten screws to the torque range shown on the drawing, and lock wire all screw heads.

Note: This step does not apply to Melter #2.

24. Check to insure that all leads and gas piping passing through cover are electrically isolated from melter shell.
25. Connect jacket water piping at lower flange to end enclosure. Seal weld threaded joints before pressure testing field run piping.

C. Thermocouples

1. Referencing view Y-Y on W748707, use (2) 3/8 hex head cap screws and (2) washers (items 8&9 - W748707) and bolt the thermocouple support bracket (815444-A) to the riser cover. Referencing W812984 (Tabulation VII), slide proper thermocouple fittings over thermocouples and to the bracket. Note: Care must be taken when routing thermocouples to insure that thermocouples do not contact each other, heater leads, or clamps. After all thermocouples are properly routed, tighten thermocouple fittings.
2. Repeat B24 - also verify that all thermocouples are electrically isolated from main frame conduit when wiring is completed.

Tack weld all threaded joints.

D. Argon Connection

1. Connect argon piping per Bechtel DS-M-246-24. Note: Verify that Argon piping at heater is isolated from piping run on frame. Connections on isolator hose should be hydrostatically tested before final connection is made at heater piping. Final weld connection to be dye checked and visually inspected. Seal weld threaded joints.

E. Heater/Thermocouple Testing

1. Test both heaters to verify proper heater and thermocouple operation as follows:
 - a. Pour spout heater at 15% of rated voltage.
 - b. Riser heater at 50% of rated voltage.

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F. Power Connections

1. Connect heater power cables (with special terminal connectors) to the heater terminals.

G. Riser Guard

1. After completing all connections at riser end, install the riser guard (Bechtel drawing W753353) per Bechtel DS-M-246-19.

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Section 7 - Dome Heaters

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SECTION 7 - DOME HEATERS

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-16 (Melter #1)	Dome Heater Assembly
S999-350-16 (Melter #2)	Dome Heater Assembly

II. GENERAL

This section covers the procedure for installing Dome Heaters in DWPF Melter, nozzles M_1 through M_{16} .

The melter has four sets of dome heaters, each consisting of two heater elements and one jumper.

The fixed ends of each set of heater elements are connected to a water-cooled transformer by water-cooled bus bars. The jumper is utilized at the floating ends to connect the elements in series. Two sets are arranged above two lower sets as shown on W743911.

The dome heaters will be assembled without the upper heater transformers in place. Assembly of transformers and bus bars is covered in Bechtel data sheets DS-M-246-9 and DS-M-246-10.

III. INSTALLATION DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W819165		General Index - Melter
W805066		Plan View - Melter
W804860	1	Side Elevation - Melter
W743911		Section Through Dome Heaters
W812971	1 thru 4	Dome Heater Assembly
W812984		Aux. Equip. Thermocouple Information
W805378		Connection Scheduled - Aux.

IV. PARTS REQUIRED PER MELTER (SPARES NOT INCLUDED)

A. Items Furnished by Du Pont Engineering Department - Mechanical

B/M items listed above, paragraph III.

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D18602-A	Dome Heaters	4
D187602-B	Dome Heaters	4

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D198210-F	Isolators	4
D198210-E	Isolators	4
W812971	Pieces of Inconel Welding Rod	8
D198216-A	Gaskets	16
D198210-B	Isolators	8
D198210-D	Isolators	4
D198210-C	Isolators	4
D187871-D	Isolators	32
D187871-Y	Isolators	32
D188464-D	Gaskets	64
D188475-B	Washers	32
D187621-A	Jumpers	4
D198210-A	Isolators	8
D198216-B	Gaskets	2
D198209-A	Jumper Box Covers	2
D198215-A	Retainer	8
-----	1/4" Fiberfrax Square Braid	
-----	3/8" Fiberfrax Square Braid	

B. Items Furnished by Du Pont Engineering Department - Instruments

<u>Melter #1</u> <u>Engg. No. (EN)</u>	<u>Melter #2</u> <u>Engg. No. (EN)</u>	<u>Order No.</u>	<u>Description</u>	<u>Quantity</u>
S350-2960-TE	S999-2960-TE	AXC-1987W	Dome Heater	1
S350-2961-TE	S999-2961-TE		Thermocouple	1
S350-2962-TE	S999-2962-TE			1
S350-2963-TE	S999-2963-TE			1
S350-2968-TE	S999-2968-TE			1
S350-2969-TE	S999-2969-TE			1
S350-2970-TE	S999-2970-TE			1
S350-2971-TE	S999-2971-TE			1
S350-2972-TE	S999-2972-TE			1
S350-2973-TE	S999-2973-TE			1
S350-2974-TE	S999-2974-TE			1
S350-2975-TE	S999-2975-TE			1
S350-3800-TE	S999-3800-TE			1
S350-3801-TE	S999-3801-TE			1
S350-3802-TE	S999-3802-TE			1
S350-3803-TE	S999-3803-TE			1

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V. INSTALLATION PROCEDURE

A. Precautions

1. The ceramic isolators are fragile and must be handled with care.
2. Be careful not to damage silver plated surfaces of the heater end stems and jumpers. Silver-plated area on stems must be protected prior and during installation until step 8 of the installation.
3. Use non-metallic straps when handling heaters to protect heater surfaces. Indentation of heater surface can create hot-spots during operation leading to premature failure.
4. See Appendix A, Section 20 (safety data sheets), for instructions on handling Fiberfrax square braid.
5. Lower dome heater sets are to be installed first.
6. Insertion depth of thermocouples is critical.

B. Dome Heaters

Each set of dome heaters to be installed, per W743911 and W812971 (all four sets shown), as follows:

1. To minimize possibility of damage to silver coated surfaces, each heater set should have its jumper pre-fitted prior to actual installation in the melter.

Allocate work area and identify the two heater elements and jumper to be installed as a heater set [D187602-A (1), D187602-B (1), and D187621-A (1)] per W812971.

Using vendor installed jacking bolts, spread gaps on jumper an additional 1/32 inch. If these gaps will not allow jumper to slip freely onto heater element, adjust each gap in increments of 1/64 inch until this can be accomplished without damaging silver coatings, at which time, the selected heater set is ready for preparation and assembly into melter.

2. On heater element (D187602-A) install isolator (D198210-F) and on heater element (D187602-B) install isolator (D198210-E). Each isolator to be retained by 1/8 inch diameter x 1/2 inch long segment of Inconel 690 welding rod welded to element as shown on W812971.

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3. Slide gasket (D198216-A), isolator (D198210-B) and gasket (D198216-A) over previously installed isolator and position against heater element mounting flange.
4. Insert heater elements into melter nozzles. Element must be inserted from the end opposite the riser. Lower units to be installed first.
5. With gaskets, isolator and heater element flange holes aligned, install mounting hardware as shown (and identified) in Section X-X on W812971. Hand tighten the cap screws at this time.
6. At jumper end of heater element D187602-A, install support isolator (D198210-A) into retainer at base of nozzle. Install isolator (D198210-D) onto end of element and carefully guide it through melter shell nozzle so that it rests on the support isolator.
7. Repeat previous step for D187602-B using isolators D198210-A and D187210-C.

Test for electrical isolation between heater elements and melter shell.

8. Using temporary rigging overhead, nonmetallic strap at center, and small hoist; raise selected jumper into position and slip onto heater elements (do not use petroleum jelly on these joints).

Note: Mounting cap screws at fixed end of each element should be backed off 1/8 inch or so to allow for freedom of movement at jumper end during this operation.

9. Final position of jumper to be located from end of the elements as shown on W812971.
10. At the connector end of the heater elements, sequentially tighten cap screws (item no. 2, W812971) to the torque range shown in Section X-X on W812971. Tack weld the cap screw to the nozzle flange.

Caution: Do not damage isolators (D187871-D).

11. At the jumper end, remove the jack bolts and install (6) cap screws (B/M item no. 3, W812971). Verify jumper is positioned per W812971. Tighten to the torque range shown on W812971.

Test for electrical continuity and verify that electrical isolation still exists.

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12. Repeat Items 1 through 11 for installation of other three sets of heaters.
- (c) 13. The nominal 3/8 inch annulus between the dome heater O.D. and refractory clearance hole ID must be sealed with Fiberfrax square packing. This material will be furnished in coils, and must be cut to length to fit around the dome heater. Install this, at each end of the dome heater elements, like packing for a pump or valve - cut at a 45 degree angle, and stagger the position of the cut as each ring is installed. Install to depths shown on W812971. Since the annulus gap may vary, both 3/8 and 1/4 inch wide braid have been provided. Use the size that fits best. See Appendix A, Section 20, for safety instructions. Also see Bechtel's Spec. M-246, Appendix A, Item II.
14. Attach (8) retainers (D198215-A) with hex head cap screws (item no. 1, W812971) at the connector side of the melter as shown on W812971. Tack weld the screw heads.
15. Install two dome heater jumper end enclosures (jumper box D198209-A with gasket D198216-B) as shown in detail "V" on W804860. Sequentially tighten cap screws to the torque specified on drawing.

Verify that electrical isolation between each pair of heaters and melter shell still exists.

Tack weld bolt heads.

C. Thermocouples

1. Install thermocouples in the connector (transformer) end per W812984, Tabulation VI, XF1 through XF16. The insertion depth "J" of these thermocouples is critical to insure accurate temperature readings. Note that the insertion distance is different for inboard vs outboard heaters.
2. Wire thermocouples per Bechtel DS-M-246-16.
3. Test for electrical isolation between thermocouple connector and main conduit run.
4. Tack weld per notation on W812984.

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D. Power and Water Connection

1. Connect transformer bus bars per Bechtel DS-M-246-9.

Connect bus bar cooling water piping per Bechtel DS-M-246-10.

Test for electrical isolation between piping on transformer/bus bar assembly and melter shell.

Seal weld any threaded connections.

2. After power connections have been completed, test for electrical isolation between power supplied heater and melter shell.
3. Connect cooling water piping to jumper end enclosure cooling coils per Bechtel drawings.

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Section 8 - Refractory Thermocouples

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SECTION 8 - REFRACTORY THERMOCOUPLES

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-2964-TE-A (Melter #1)	Spring Loaded Thermocouple & Fittings
S350-2964-TE-B (Melter #1)	Spring Loaded Thermocouple & Fittings
S999-2964-TE-A (Melter #2)	Spring Loaded Thermocouple & Fittings
S999-2964-TE-B (Melter #2)	Spring Loaded Thermocouple & Fittings

II. GENERAL

This section covers the procedure for installing refractory thermocouples in DWPF Melter, nozzles C₆ and C₇.

III. INSTALLATION DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W819165		General Index - Melter
W804860	2	Side Elevation - Melter
W812984		Aux. Equip. Thermocouple Information
W805377		Connection Schedule - Primary

IV. PARTS REQUIRED (Spares not Included)

A. Items Furnished by Du Pont Engineering Department - Mechanical

B/M items listed above, parargaph III.

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D188475-A	Retaining Washer	4
D188800-B	Retaining Plate	2
D187164-D	Gasket	4
D188464-F	Gasket	8
D187871-H	Isolator	2
D187871-K	Isolator	4
D187871-L	Isolator	4
D187871-U	Isolator	2

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B. Items Furnished by Du Pont Engineering Department - Instruments

<u>Melter #1</u> <u>Engg. No. (EN)</u>	<u>Melter #2</u> <u>Engg. No. (EN)</u>	<u>Order No.</u>	<u>Description</u>	<u>Quantity</u>
S350-2964-TE-A/B	S999-2964-TE-A/B	AXC 13I-1989	Spring Loaded Thermocouple	1 ea

V. INSTALLATION PROCEDURE

1. Remove protective covers from nozzle C₆.
2. Refer to section ZZ on W804860. Make sure there is a clearance hole through the DSM-24 insulation as shown. The thermocouple must contact the back surface of the refractory block. Insert isolator (187871-U) into nozzle.
3. Assemble retaining washer (188475-A), gasket (188464-F), isolator (187871-L), gasket (188464-F and isolator (187871-K) on each socket head screw B/M item 2.
4. Assemble asbestos gaskets (187164-D) with isolator (187871-H) and retaining plate (188800-B) and position on nozzle flange. Torque screws to the value shown on W804860, section ZZ. Tack weld screws to back of flange.
5. Install thermocouples as shown on W812984, Tabulation IV. Thermocouple wiring is covered in Bechtel data sheet DS-M-246-16. Note: Thermocouple must be installed with slight spring compression (as specified on W812984) so that maximum spring travel is available when refractory expands towards melter shell.

Tack weld per notation on W812984.

6. Test for electrical isolation between thermocouple assembly and melter shell after all wiring is complete.

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Section 9 - Top Head

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SECTION 9 - TOP HEAD

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-10 (Melter #1)	Melter Head Assembly
S999-350-10 (Melter #2)	Melter Head Assembly

II. GENERAL

This document covers the procedure for the assembly of the Melter Head on the melter.

III. INSTALLATION DRAWINGS

<u>Drawing No.</u>	<u>Description</u>
W804860	Side Elevation - Melter
W736915	Refractory Assembly - Sheet 2
BPF 218879	Top Head Handling & Shipping Fixture

IV. PARTS REQUIRED PER MELTER (Spares not Included)

<u>Part No.</u>	<u>Description</u>	<u>No. Required</u>
CB&I Drawing No. 6 (BPF 215605)	Melter Top Head	1
BPF 217864	Shell Flange O-Ring	1
CB&I Drawing No. 41 (BPF 215605)	Hex Nuts	56
CB&I Drawing No. 41 (BPF 215605)	Studs	56

1/2" thick fiberfrax blanket (8 lb per cubic foot density) segments cut to size (furnished by Toledo Engineering Co. per W736915).

V. ASSEMBLY PROCEDURE

Reference Drawing: W804860

1. Install 56 studs (furnished by CBI) in the shell top flange.
2. Inspect mating surfaces and "O" ring groove for any damages and cleanliness from foreign objects. If necessary, clean the surfaces and groove free from any coatings or deposits. Care must be taken not to scratch the sealing surfaces during the cleaning operation.

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3. Inspect the stainless steel "O" ring (BPF 217684) for shape and cleanliness. Clean if necessary. Care must be taken not to scratch the surface as it is silver plated.
4. On top of the refractory in the shell (1" below flange), install sufficient (5 or 6) layers of fiberfrax blanket to provide an uncompressed thickness of 3 inches. Adjust size of O.D. of existing material per note #4 on W736915, Rev. 7.

This material is made of ceramic fibers and the material supplier recommends that installers wear filter masks and have adequate ventilation in the area where the material is handled. See Appendix A, Section 20, for safety instructions.

The fiberfrax blanket will compress to 1" thick when the head is installed. Make sure that it is properly positioned along the entire periphery of the ID of the refractory.

5. Place the "O" ring (BPF 217684) in the "O" ring groove located in the top flange of the shell. Inspect for proper fit of "O" ring in the groove.
6. Rotate the head to the upright position using the rotating fixture provided (BPF 218879). Follow the operating instructions that are posted on the fixture.
7. Lift the melter head at the designated lift points. Note: To prevent unequal forces on the refractory, top head lifting lugs were designed for vertical lifting only, once the refractory is installed. This requires use of a 4-point spreader system to eliminate any side loading on lugs. If sling is used as an option, the sling legs must be a minimum of 20 feet long. Align the two 1" diameter holes in the head flange with the 1" diameter dowels in the shell flange. Check to make sure that the "O" ring is positioned correctly in place. Continue observation while slowly lowering head on to shell flange.

Caution: The head must be lowered with an offset to clear piping on the frame, then moved laterally to align the dowels.

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8. Install (56) nuts and washers furnished on BPF 215605, Drawing 41 (Chicago Bridge and Iron). Lubricate nuts and washers. Step tighten to a torque value as shown on W804860 per Standard PP25, paragraphs 6 and 7.2.2.

Tack weld nuts to studs and nuts to flange.

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Section 10 - Anchor Flanges

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SECTION 10 - ANCHOR FLANGES

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-10-3 (Melter #1)	Anchor Flanges
S999-350-10-3 (Melter #2)	Anchor Flanges

II. GENERAL

This section covers the procedure for installing the anchor flanges to the DWPF Melter Top Head; nozzles B₁, B₂, C₂, C₃, C₄, D, D₁ and E; and feed tube support pads B₁A, B₂A, B₁B and B₂B.

III. DRAWINGS

A. Installation Drawings

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W819165		General Index
W807736		Anchor Flange Mtg. Assembly - Sh 1 of 2
W807737	1 thru 5	Anchor Flange Mtg. Assembly - Sh 2 of 2
W823832	1 thru 7	Alignment Fixture (Anchor Flg Installation) - Sh 1
W823833		Alignment Fixture - Sh 2 (Nozzles C ₂ & E)
W824062		Alignment Fixture - Sh 3 (Nozzles D ₂ & D ₁)
W824063		Alignment Fixture - Sh 4 (Nozzles C ₃ & C ₄)
W824064		Alignment Fixture - Sh 5 (Nozzles B ₁ & B ₂ and Pads B ₁ A, B ₂ A, B ₁ B & B ₂ B)
W824065		Alignment Fixture - Sh 6 (Nozzles C ₂ & E)

B. Reference Drawings

W820788	Centering Mount Assemblies (Universal, Nozzle C ₂ & E)
W824056	Carriage Assembly
W822027	Traverse Indicating Assembly
W823831	Rotating Indicator Assembly

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IV. PARTS REQUIRED (Spares not Included)

A. Items Furnished by Du Pont Engineering Department - Mechanical

1. Anchor Flanges and Installation Parts including
B/M items listed in paragraph III-A.

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D187870-A	Anchor Flange	3
D187870-B	Anchor Flange	2
D187870-C	Anchor Flange	1
D188475-B	Retaining Washer	50
D188679-A	Anchor Flange	1
D188679-B	Anchor Flange	1
D188681-A	Anchor Flange	2
D188688-N	2" Acme Nut	20
D188694-A	TV Anchor Flange	2
D198919-A	Shim	1
D198919-B	Shim	2
D198919-C	Shim	1
D188464-D	Gasket	100
D198918-A	Gasket	1
D198918-B	Gasket	2
D198918-C	Gasket	10
D198918-D	Gasket	4
D198918-E	Gasket	1
D187871-D	Isolator	50
D187871-G	Isolator	14
D187871-Y	Isolator	36
D187872-A	Isolator	4
D187872-B	Isolator	2

2. Alignment Fixture Parts

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
W822027	Traverse Indicating Assembly	1
W820788-A	Centering Mount (Universal)	2
W820788-B	Centering Mount (Nozzle E)	*
W820788-C	Centering Mount (Nozzle C ₂)	*
W823831	Rotating Indicator Assembly	1
W824056	Carriage Assembly	*
D819505-A	Positioning Plate	1
D819505-B	Positioning Plate	1
D822019-A	Position Plate (Nozzles E & C ₂)	1
D822019-B	Indicating Bar	1
D822019-C	Indicating Bar	1
D822019-D	Wrench	1

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<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D822019-E	Gage Bar	1
D822019-F	Gage Bar	1
D822019-G	Lifting Yoke	1
D822019-H	Gage Bar	1
D822024-A	Positioning Fixture	1

*Shipped separately and assembled per W823833.

V. INSTALLATION PROCEDURE

A. Precautions

1. Ceramic isolators are fragile and must be handled with care.
2. Care must be taken to protect and to keep clean all finished surfaces of the anchor flanges and nozzles.

B. Anchor Flanges

1. Identify all the alignment fixture parts required for installation of anchor flanges per W823832, sh 1.
2. Collect all anchor flange components per W807736 and W807737.
3. Install anchor flanges in steps shown on W823832 and the following related drawings:

W823833, Sh 2
W824062, Sh 3
W824063, Sh 4
W824064, Sh 5
W824065, Sh 6
4. Test for electrical isolation between each anchor flange and shell where applicable, namely, those which have ceramic isolators at nozzles. In addition, all feed tube support pads shall be tested.
5. Since locknuts are used in this application, tack welding or wiring of nuts is not required.

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Sections 11 through 19 - Top Head Components

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SECTION 11 - INSPECTION & ASSEMBLY FIXTURE

I. IDENTIFICATION

	<u>Engg. No. (EN)</u>	<u>Description</u>
(C)	S999-350-50-43 (All Melters)	Inspection & Assembly Fixture

II. GENERAL

This section covers calibration of inspection and assembly fixture required for alignment of TV camera assemblies, thermowell and conductivity probe and thermowell.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W826534	1, 2, 3 & 4	Inspection & Assembly Fixture - Sh 1

IV. PARTS REQUIRED

A. Items furnished by Du Pont Engineering Department - Mechanical

The inspection and assembly fixture will be shipped from vendor completely assembled except for B/M items 1, 2, 3 and 4 which will be shipped separately along with the following items:

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D822992-A	TV Positioning Plate	1
D822992-B	Bushing	1
D822992-C	Bushing	1
D822992-D	Bushing	1
D822996-A	Gaging Bar	1
D822998-A	Lower Gaging Standard	1
D822998-B	Upper Gaging Standard	1
D822998-C	Gage Block	1
D822998-D	Gage Block	1
D822998-E	Gaging Sleeve	1

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V. CALIBRATION OF INSPECTION AND ASSEMBLY FIXTURE

A. Precautions:

Care must be taken not to damage the hinge plates, base plates and gaging sleeves. All surfaces should be clean and free of burrs and chips.

B. Calibration of Fixture:

Make sure top of base plate is level within .005 per foot. Carefully position the lower gaging standard D822998-A on the base plate. Place the lower gaging plate in the horizontal position. Insert the gaging sleeve (D822998-E) into the gaging plate. Continue to insert the gaging sleeve until the ID of the gaging sleeve passes over the top of the gaging standard. Remove gaging sleeve and place the lower gaging plate in the retracted position. Place the upper gaging standard on the lower gaging standard. Place the upper gaging plate in the horizontal position. Insert the gaging sleeve into the gaging plate. Continue to insert the gaging sleeve until the ID of the gaging sleeve passes over the top OD of the gaging standard.

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SECTION 12 - THERMOWELL

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-15 (Melter #1)	Thermowell in Nozzle E
S999-350-15 (Melter #2)	Thermowell in Nozzle E

II. GENERAL

This section covers the following:

- A. Procedure for disassembling and reassembling of the thermowell assembly W746741 for the installation of the thermocouples.
- B. Procedure for the installation of the thermowell assembly W746741 into nozzle E in the top head of the melter as shown in plan view drawing W805066.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W746741	3, 4, 5	Thermowell Assembly
W805066		Plan View - Melter
W826534		Inspection & Assembly Fixture
W812984		Auxiliary Equipment
		Thermocouple Information

IV. PARTS REQUIRED (SPARES NOT INCLUDED)

A. Items Furnished by Du Pont Engineering Department - Mechanical

Assembly W746741 will be shipped from fabrication vendor completely assembled except for B/M Items 3, 4 and 5 which will be shipped separately along with the following items:

<u>Drawing No.</u>	<u>Description</u>	<u>No. Required</u>
D188688-N	2" Acme Nut	2 (furnished with anchor flanges)
D187871-C	Isolator	1
D199660-C	Support Sleeve	1
D199660-D	Retainer	1
D199660-E	Retainer Ring	1

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B. Items Furnished by Du Pont Engineering Department - Instruments

<u>Engg. No. (EN)</u>	<u>Description</u>	<u>Quantity</u>
S350-3271-TE-A/B (Melter #1)	Thermocouples	2
S999-3271-TE-A/B (Melter #2)	Thermocouples	2
S350-3273-TE-A/B (Melter #1)	Thermocouples	2
S999-3273-TE-A/B (Melter #2)	Thermocouples	2
S350-3275-TE-A/B (Melter #1)	Thermocouples	2
S999-3275-TE-A/B (Melter #2)	Thermocouples	2

V. INSTALLATION PROCEDURE

A. Precautions

1. Make sure top of the base plate of inspection and assembly fixture (W826534) and raised face (surface U-W746741) are clean and free from chips and burrs.
2. Make sure top of connector is not damaged during the installation of the thermocouples.
3. Care must be taken not to damage the thermocouples during installation.
4. Ceramic isolators are fragile and must be handled with care.
5. Make sure the top of raised face of the anchor flange and the raised face (surface U-W746741) are free of burrs and chips.
6. Extreme care must be taken not to damage the "C" ring groove on the thermowell assembly and its mating surface on the anchor flange. B/M Items 3, 4 and 5 are not to be installed until final installation of assembly into melter. (Check with Operations).

B. Thermocouples (into Thermowell)

1. Disassemble electrical connector (D188380-A) from D188381-A as shown on W746741, Section W-W.
2. Install thermocouples per W812984, tabulation I, nozzle E and Bechtel Spec. M-246, Appendix A, Item III (Melter Thermocouple Installation Guidelines).

With well in horizontal position, insert all thermocouples to proper depth and tighten gland nut. Tack weld Conax fitting per drawing.

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3. Reassemble D188380-A and D188381-A as shown on W746741, Section W-W. Do not fully torque nuts at this time.
4. Wire thermocouples per Bechtel DS-M-246-4 and 17. Install retaining ring (furnished by Bechtel). Verify electrical continuity at pin block pins for each thermocouple.
5. Test for electrical isolation between upper and lower sections.
6. Align the assembly per W826534, Steps 5A through 5F.

C. Thermowell (into Melter)

1. Remove thermowell assembly from the inspection and assembly fixture.
2. Install isolator (D187871-C), support sleeve (D199660-C), retainer (D199660-D) and retainer ring (D199660-E) as shown on W746741.
3. Verify that top of anchor flange on nozzle E is clean and free of burrs. Bail and nut block orientation must be as shown on W805066. Slowly lower thermowell assembly W746741 into nozzle E until surface U (W746741), raised face on bridge flange, rests on the anchor flange. Lubricate studs and install 2" Acme nuts (2) with impact wrench. Continue impacting for 8 to 12 seconds.
4. Test for electrical isolation between lower section of thermowell and melter shell.
5. Install C-Ring (when unit is to be inserted into melter for last time prior to frit charging).

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SECTION 13 - FEED TUBE ASSEMBLY

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-13 (Melter #1)	Feed Tube Assembly (Qty 2)
S999-350-13 (Melter #2)	Feed Tube Assembly (Qty 2)

II. GENERAL

This section covers the procedure for the assembly of feed tubes in the DWPF Melter. The feed tubes will be installed in melter nozzles B₁ and B₂, with the support frame mounted on anchor flanges bolted on feed tube support pads B₁A, B₁B, B₂A and B₂B as shown in plan view drawing W805066.

CAUTION - NOTE TO OPERATIONS

This procedure covers installation at the Mock-Shop as previously stated in the introduction. However, when a feed tube is to be installed in a thermally hot melter, the design requires the cooling water to be running through the tube (while at the rest position on the assembly) before it is inserted into the hot vapor space of the melter.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W747380		Feed Tube Assembly Sh 1 of 2
W820958	4, 5 & 6	Feed Tube Assembly Sh 2 of 2
W800559		Feed Tube & Support Frame Assembly
W826813		Shipping-Storage Fixture
W805066		Plan View

IV. PARTS REQUIRED (spares not included)

Items furnished by Du Pont Engineering Department - Mechanical

Assembly W800559 will be shipped from fabricator completely assembled except for B/M items 4, 5 and 6 which will be shipped separately along with the following items:

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D188688-N	Acme Nut	8 (furnished with anchor flanges)

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V. INSTALLATION PROCEDURE

A. Precautions:

1. Ceramic isolators are fragile and must be handled with care.
2. Care must be taken not to damage the feed tube, and to keep all finished surfaces of the feed tube and support frame and their respective anchor flanges clean and free of all debris in order to insure proper seating.
3. Care must be taken not to damage the connectors during installation.
4. Extreme care must be taken not to damage the "C"-ring groove on the feed tube and support frame assembly and its mating surface on the anchor flange. B/M items 4, 5 and 6 are not to be installed until final installation of assembly into melter. (Check with Operations).

B. Feed Tube (into Melter): (Bechtel Ref.: DS-M-246-6)

1. Remove the feed tube and support frame assembly from the shipping and storage fixture per W826813, removal sequence, Steps 1 through 8.
2. Verify signal flag position.

NOTE: When assembly is in carrying mode (support frame suspended from feed tube), the signal flag (on frame) will have rotated from a vertical position to the horizontal position when the assembly was picked up and will remain that way while assembly is lifted.

3. Verify that all fasteners have been locked.

NOTE: Fasteners on underside of feed tube and water connector flanges holding electrical isolation ring must not be tack welded or wired.

4. Verify that all threaded connections on piping have been seal welded.

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5. Position the suspended assembly over its melter location and carefully lower it until the support frame engages the anchor flange dowels and is seated on the anchor flange surfaces. Continue to lower feed tube approximately 10 inches until it comes to rest on the frame latches (rest position). Cable holding bail will become slack at this point.

Verify signal flag action during this step.

NOTE: Flag should drop after tube has been lowered approximately 1/2 inch and remain that way until feed tube has come to rest on the frame latches.

6. To verify signal flag action while going from the rest position to lift mode, lift the tube until it contacts upper frame brackets and raises frame slightly.

NOTE: Flag should have rotated to horizontal position almost immediately, remaining in that position for 3 to 3 1/2 inches of tube travel, after which it drops to vertical position. It remains in vertical position until tube is within approximately 1/2 inch from contact, at which time the flag returns to the horizontal position and remains that way.

7. Lower the assembly until the support frame is seated on the anchor flange surfaces. Continue to lower feed tube until it comes to rest on the frame latches (rest position). Cable holding bail will become slack at this point.
8. Disconnect lift cable and move impact wrench into position. After lubricating the 2 inch Acme studs and nuts at the support frame, torque nuts with impact wrench for 8 to 12 seconds.
9. Reconnect lift cable to the feed tube. Raise feed tube (flag goes horizontal). Stop lifting the tube when it has traveled 1 inch beyond the point that the flag has dropped to vertical position. The total travel of tube will have been approximately 5 inches.

NOTE: Flag should have rotated to horizontal position almost immediately as feed tube is raised from its rest position. Flag remains in horizontal position for approximately 3 1/2 inches of tube travel, after which it drops to vertical position. (Approximately 5 additional inches of upward travel of the feed tube is available before

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flag rotates back to horizontal position. Whenever the flag is in the horizontal position, the tube cannot be lowered past the rest position.

Proceed to lower the feed tube approximately 2 feet and stop.

10. To verify signal flag action when removing feed tube from melter, lift the tube until the signal flag rotates to horizontal position (indicating that the tube can be lowered to the rest position), then lower tube to rest position. When lowering the tube, the flag drops immediately before the tube seats on the latches at the rest position.

NOTE: Flag should have rotated to horizontal position after feed tube is raised past the rest position (continuing to raise the tube an additional 3 1/2 inches causes the flag to drop to vertical position, indicating that feed tube will not stop at rest position when lowered).

11. Raise feed tube (flag goes horizontal). Stop lifting tube when it has traveled 1 inch beyond point that the flag has dropped from the horizontal position. Lower feed tube until it is seated on the anchor flange surface.
12. Disconnect lift cable and move impact wrench into position. After lubricating the 2 inch Acme studs and nuts, torque nuts with impact wrench for 8 to 12 seconds.

NOTE: Bail must be vertical when impacting nut on side that bail swings down to rest.

13. Test for electrical isolation between:

- a. Feed tube and melter shell.
- b. Support frame and melter shell.
- c. Underside feed tube connector flange and feed tube.
- d. Underside water connector flange and support frame.

NOTE: In Items C and D, both sections of isolator ring on underside of connector flange must be tested.

14. After Mock-Shop work has been completed, the feed tube assembly must be removed from melter and reinstalled after melter is installed in the vitrification building.
15. Install C-Ring (when unit is to be inserted into melter for last time prior to its operation).

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SECTION 14 -TV CAMERA/BORESCOPE ASSEMBLY PROCEDURE

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-15-30 (Melter #1)	TV Camera/Borescope Assy (Qty 2)
S999-350-15-30 (Melter #2)	TV Camera/Borescope Assy (Qty 2)

II. GENERAL

This section covers the following:

- A. The procedures for installing electrical connector and the TV camera on the TV camera support frame assembly.
- B. The procedure for the installation of the TV camera support frame assembly (W748396) into nozzles D and D₁ on the top head of the melter as shown in plan view drawing W805066.

CAUTION - NOTE TO OPERATIONS

This procedure covers installation at the Mock-Shop as previously stated in the introduction. However, when the TV Camera/Borescope Assembly is to be installed in a thermally hot melter, the design requires that the cooling air and purge air be flowing before the floating manifold is seated on the anchor flange.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W748396	18,19,20,&21	TV Camera Support Frame Assembly - Sh 1
W748395		TV Camera Support Frame Assembly - Sh 2
W814474		TV Camera Support Frame Assembly - Sh 3
W805066		Plan View Melter
W826534		Inspection & Assembly Fixture

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IV. PARTS REQUIRED

A. Items furnished by Du Pont Engineering Department - Mechanical

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
D188688-N	Acme Nut	4 (furnished with anchor flanges)
D188695-A	Electrical Connector	2
D815449-A	"K"-Ring Seal	4
W748396,B/M 10	Soc. Hd Cap Screw	4

B. Items Furnished by Bechtel

Assembly W748396 (except electrical connector D188695-A) will be shipped from the "TV camera" vendor completely assembled with the borescope in place except for B/M items 18, 19, 20 and 21 which will be shipped separately along with the following items:

<u>Drawing No.</u>	<u>Description</u>	<u>Quantity</u>
-----	TV Camera	2
-----	Electrical Harness (installed between TV camera housing and electrical connector)	2

V. INSTALLATION PROCEDURE

A. Precautions

1. Care must be taken not to damage or excessively jar the TV camera borescope assembly.
2. Make sure the top of the base plate of the inspection and assembly fixture (W826534) and surface "U" of the TV camera support frame assembly (W748396) are clean and free of all debris.
3. Care must be taken not to damage the TV camera during installation into the camera housing.
4. Care must be taken not to damage the electrical connector.
5. Extreme care must be taken while installing the electrical harness between electrical connector and the TV camera housing not to damage the pins, wire connections, etc.

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6. Make sure that the TV anchor flanges and the TV camera support frame are clean and free of debris.
7. Extreme care must be taken not to damage the "C"-ring groove, its mating surface on the anchor flange and the mating surfaces on the TV camera support assembly and anchor flange for seals D815449-A. B/M items 18, 19, 20 and 21 on W748396 and seals D815449-A are not to be installed until final installation of assembly into melter. (Check with Operations).

B. Electrical Connector, Electrical Harness and TV Camera

1. Install electrical harness into electrical connector (188695-A).

Verify continuity of wiring from each prong of plug to its pin block pins in upper end of connector.

2. Install the electrical connector to the TV camera support frame as shown on W748396 and W826534, steps 1A through 1G for alignment and parallelism.
3. Install TV camera into housing.

**C. TV Camera/Borescope Assembly (into Melter)
(Including TV Camera and Borescope)**

1. Remove TV camera support frame assembly (W748396) from the inspection and assembly fixture.
2. Make sure the "K"-ring groove, surface U and the bottom of the floating air manifold are clean and free of all debris.
3. Make sure that the TV anchor flange is clean and free of all debris. Slowly lower the TV camera support frame assembly into nozzle D or D₁. Make sure the floating air manifold is in position over the .75 dia. locating dowels, continue lowering the TV assembly until it rests on the anchor flange.
4. Lubricate studs and install (2) Acme nuts with impact wrench. Continue impacting for 8 to 12 seconds.
5. After Mock-Shop work has been completed, the TV Camera/Borescope Assembly must be removed from melter and reinstalled after melter is installed in vitrification building.
6. Install C-Ring and K-Rings (when unit is to be inserted into melter for last time prior to its operation).

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SECTION 15 - LEVEL DIP TUBE PROCEDURE

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-15-20 (Melter #1)	Level Dip Tube (Melt)
S999-350-15-21 (Melter #2)	Level Dip Tube (Melt)

II. GENERAL

This section covers the following:

- A. Procedure for the installation of the level dip tube assembly W745987 into Nozzle C₂ in the top head of the Melter #1 as shown in plan view drawing W805066.
- B. Procedure for the installation of the level dip tube assembly W839573 into Nozzle C₂ in the top head of the Melter #2 as shown in plan view drawing W805066.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W745987 (Melter #1)	3, 4, & 5	Level Dip Tube Assembly
W839573 (Melter #2)	1, 2, & 3	Level Dip Tube Assembly
W805066		Plan View - Melter

IV. PARTS REQUIRED (SPARES NOT INCLUDED)

A. Items furnished by Du Pont Engineering Department - Mechanical

The assembly as shown on assembly drawing will be shipped from fabrication vendor completely assembled except for B/M items listed above which will be shipped separately along with the following items.

<u>Drawing No.</u>	<u>Description</u>	<u>No. Required</u>
D188688-N	2" Acme nut	2 (furnished with anchor flanges)

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V. INSTALLATION PROCEDURE

A. Precautions

1. Make sure top of connector is not damaged during installation into melter. Note: Fasteners on underside of connector flange must not be tack welded (or wired).
2. Make sure the top of raised face of the anchor flange and the raised face on the dip tube bridge flange are free from burrs and chips.
3. Extreme care must be taken not to damage the "C" ring groove on the level dip tube assembly and its mating surface on the anchor flange. Loose B/M items are not to be installed until final installation of assembly into melter (check with Operations).

B. Level Dip Tube (into Melter) (Bechtel Ref.: DS-M-246-3)

1. Verify that top of anchor flange on Nozzle C₂ is clean and free of burrs. Bail and nut block orientation must be as shown on W805066. Slowly lower the level dip tube assembly into Nozzle C₂ until the raised face on bridge flange, rests on the anchor flange. Lubricate studs and install 2 inch Acme nuts (2) with impact wrench. Continue impacting for 8 to 12 seconds.
2. Test for electrical isolation between:
 - a. Dip tube and melter shell
 - b. Underside of dip tube connector flange (Isolator Split Rings) and dip tube
3. Install C-Ring (when unit is to be inserted into melter for last time prior to frit charging).

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SECTION 16 - THERMOWELL AND CONDUCTIVITY PROBE PROCEDURE

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-15-10 (Melter #1)	Thermowell and Conductivity Probe
S999-350-15-10 (Melter #2)	Thermowell and Conductivity Probe

II. GENERAL

This section covers the following:

- A. Procedure for disassembling and reassembling of the thermowell and conductivity probe assembly W746742 for the installation of the conductivity probe wiring and thermocouples.
- B. Procedure for the installation of the thermowell and conductivity probe assembly W746742 into Nozzle C₃ in the top head of the melter as shown in plan view drawing W805066.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W746742	3, 4, and 5	Thermowell and Conductivity Probe Assembly
W805066		Plan View - Melter
W826534		Inspection and Assembly Fixture
W812984		Auxiliary Equipment Thermocouple Information

IV. PARTS REQUIRED (spares not included)

A. Items furnished by Du Pont Engineering Department - Mechanical

Assembly W746742 will be shipped from fabrication vendor completely assembled except for B/M Items 3, 4, and 5 which will be shipped separately along with the following items:

<u>Drawings No.</u>	<u>Description</u>	<u>No. Required</u>
D188688-N	2" Acme Nut	2 (furnished with anchor flanges)
D187871-C	Isolator	1

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<u>Drawings No.</u>	<u>Description</u>	<u>No. Required</u>
D199660-C	Support Sleeve	1
D199660-D	Retainer	1
D199660-E	Retainer Ring	1

B. Items furnished by Du Pont Engineering Department - Instruments

<u>Engg No. (EN)</u>	<u>Description</u>	<u>No. Required</u>
S350-4085-TE-A (Melter #1)	Thermocouple	1
S350-4085-TE-B (Melter #1)	Thermocouple	1
S350-4085-TE-C (Melter #1)	Thermocouple	1
S350-4084-LE (Melter #1)	Conductivity Probe	1
S999-4085-TE-A (Melter #2)	Thermocouple	1
S999-4085-TE-B (Melter #2)	Thermocouple	1
S999-4085-TE-C (Melter #2)	Thermocouple	1
(C) S999-4084-LE (Melter #2)	Conductivity Probe	1

V. INSTALLATION PROCEDURE

A. Precautions

1. Make sure top of the base plate of inspection and assembly fixture (W826534) and raised face (Surface U, W746742) are clean and free from chips and burrs.
2. Make sure top of connector is not damaged during the installation of the thermocouple and conductivity probe.
3. Care must be taken not to damage the thermocouples and conductivity probe during installation.
4. Ceramic isolators are fragile and must be handled with care.
5. Make sure the top of the raised face of the anchor flange and the raised face (Surface U, W746742) are free of burrs and chips.
6. Extreme care must be taken not to damage the "C" ring groove on the thermowell and conductivity probe assembly and its mating surface on the anchor flange. B/M Items 3, 4, and 5 are not to be installed until final installation of assembly into melter. (Check with Operations).

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B. Thermocouples and Conductivity Probe

1. Disassemble electrical connector (D188380-B) from D188377-A as shown on W746742 (Section W-W).
2. Install thermocouples per W812984, Tabulation I, Nozzle C₃ and Bechtel Spec. M-246, Appendix A, Item III (Melter Thermocouple Installation Guidelines).

With well in horizontal position, insert all thermocouples to proper depth and tighten gland nut. Tack weld Conax fitting per drawing.

3. Install conductivity probe wiring per Bechtel's design.
Caution: Wire must pass through 1/2 inch OD tube at flange.
4. Reassemble D188380-B and D188377-A as shown on W746742, Section W-W. Do not fully torque nuts at this time.

As upper section is reassembled over thermocouples onto lower section, pass terminal end of conductivity wire through 1/2 inch hole in isolator and flange of lower section. Attach wire to body of lower section at 1/4 inch tapped hole. Verify electrical continuity. Tack weld fastener to body.

5. Attach conductivity wire and thermocouple wires to underside of pin assembly and install into upper section per Bechtel DS-M-246-4 and 17. Install retaining ring (by Bechtel).

Verify electrical continuity at pin block pins for each thermocouple and the conductivity wire.

6. Test for electrical isolation between:
 - a. Upper section and lower section
 - b. Conductivity probe wiring pin block pin in electrical lower holder to lower holder body (upper section)
7. Test conductivity probe wiring for continuity from pin block in electrical lower holder to lower section of assembly.
8. Align the assembly per W826534, Steps 3A through 3F. Also verify that top of bail is 1 inch $\pm$ 1/4 inch below top of electrical connector. If high, grind stop to suit.

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C. Thermowell and Conductivity Probe (into Melter)

1. Remove thermowell assembly from the inspection and assembly fixture.
2. Install isolator (D187871-C), support sleeve (D199660-C), retainer (D199660-D), and retainer ring (D199660-E) as shown on W746742.
3. Verify that top of anchor flange on Nozzle C₃ is clean and free of burrs. Bail and nut block orientation must be as shown on W805066. Slowly lower thermowell and conductivity probe assembly W746742 into Nozzle C₃ until Surface U (W746742), raised face on bridge flange, rests on the anchor flange. Lubricate studs and install 2 inch Acme nuts (2) with impact wrench. Continue impacting for 8 to 12 seconds.
4. Test for electrical isolation between lower section of thermowell and melter shell.
5. Install C-Ring (when unit is to be inserted into melter for last time prior to its operation).

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SECTION 17 - THERMOWELL PROCEDURE

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-15-5 (Melter #1)	Thermowell in Nozzle C ₄
S999-350-15-5 (Melter #2)	Thermowell in Nozzle C ₄

II. GENERAL

This section covers the following:

- A. Procedure for disassembling and reassembling of the thermowell assembly W746743 for the installation of the thermocouples.
- B. Procedure for the installation of the thermowell assembly W746743 into Nozzle C₄ in the top head of the melter as shown in plan view drawing W805066.

III. REFERENCE DRAWINGS

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W746743	3, 4, & 5	Thermowell Assembly
W805066		Plan View - Melter
W826534		Inspection and Assembly Fixture
W812984		Auxiliary Equipment Thermocouple Information

IV. PARTS REQUIRED (spares not included)

A. Items furnished by Du Pont Engineering Department - Mechanical

Assembly W746743 will be shipped from fabrication vendor completely assembled except for B/M Items 3, 4, and 5 which will be shipped separately along with the following items:

<u>Drawings No.</u>	<u>Description</u>	<u>No. Required</u>
D188688-N	2" Acme Nut	2 (furnished with anchor flanges)
D187871-C	Isolator	1

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<u>Drawings No.</u>	<u>Description</u>	<u>No. Required</u>
D199660-C	Support Sleeve	1
D199660-D	Retainer	1
D199660-E	Retainer Ring	1

B. Items furnished by Du Pont Engineering Department - Instruments

<u>Engg No. (EN)</u>	<u>Description</u>	<u>No. Required</u>
S350-3272-TE-A/B (Melter #1)	Thermocouples	2
S999-3272-TE-A/B (Melter #2)	Thermocouples	2
S350-3274-TE-A/B (Melter #1)	Thermocouples	2
S999-3274-TE-A/B (Melter #2)	Thermocouples	2
S350-3276-TE-A/B (Melter #1)	Thermocouples	2
S999-3276-TE-A/B (Melter #2)	Thermocouples	2

V. INSTALLATION PROCEDURE

A. Precautions

1. Make sure top of the base plate of inspection and assembly fixture (W826534) and raised face (Surface U, W746743) are clean and free from chips and burrs.
2. Make sure top of connector is not damaged during the installation of the thermocouples.
3. Care must be taken not to damage the thermocouples during installation.
4. Ceramic isolators are fragile and must be handled with care.
5. Make sure the top of raised face of the anchor flange and the raised face (Surface U, W746743) are free of burrs and chips.
6. Extreme care must be taken not to damage the "C" ring groove on the thermowell assembly and its mating surface on the anchor flange. B/M Items 3, 4, and 5 are not to be installed until final installation of assembly into melter. (Check with Operations.)

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B. Thermocouples (into Thermowell)

1. Disassemble electrical connector (D188380-A) from D188378-A as shown on W746743 (Section W-W).
2. Install thermocouples per W812984, Tabulation I, Nozzle C₄ and Bechtel Spec. M-246, Appendix A, Item III (Melter Thermocouple Installation Guidelines).

With well in horizontal position, insert all thermocouples to proper depth and tighten gland nut. Tack weld Conax fitting per drawing.

3. Reassemble D188380-A and D188378-A as shown on W746743, Section W-W. Do not fully torque nuts at this time.
4. Wire thermocouples per Bechtel DS-M-246-4 and 17. Install retaining ring (furnished by Bechtel). Verify electrical continuity at pin block pins for each thermocouple.
5. Test for electrical isolation between upper and lower sections.
6. Align the assembly per W826534, Steps 3A through 3F. Also verify that top of bail is 1 inch $\pm$ 1/4 inch below top of electrical connector. If high, grind stop to suit.

C. Thermowell (into Melter)

1. Remove thermowell assembly from the inspection and assembly fixture.
2. Install isolator (D187871-C), support sleeve (D199660-C), retainer (D199660-D), and retainer ring (D199660-E) as shown on W746743.
3. Verify that top of anchor flange on Nozzle C₄ is clean and free of burrs. Bail and nut block orientation must be as shown on W805066. Slowly lower thermowell assembly W746743 into Nozzle C₄ until Surface U(W746743), raised face on bridge flange, rests on the anchor flange. Lubricate studs and install 2 inch Acme nuts (2) with impact wrench. Continue impacting for 8 to 12 seconds.
4. Test for electrical isolation between lower section of thermowell and melter shell.
5. Install C-Ring (when unit is to be inserted into melter for last time prior to its operation).

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SECTION 18 - OFF-GAS FILM COOLERS

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-15-40 (Melter #1)	Off-Gas Film Cooler Assembly
S999-350-15-40 (Melter #2)	Off-Gas Film Cooler Assembly

II. GENERAL

This section covers the procedure for preparing and inserting the off-gas film cooler into Nozzle "A" on the melter as shown in plan view drawing W805066 and side elevation drawing W804860. The off-gas film cooler must be in place before the main off-gas jumper (piping) is installed.

III. DRAWINGS

A. Installation Drawings

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W819165		General Index
W804860		Side Elevation - Melter
W805066		Plan View - Melter

B. Reference Drawings

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W818428	1 thru 5	Off-Gas Film Cooler Assembly

C. Vendor Blueprint File Drawings

<u>Drawing No.</u>	<u>Description</u>
BPF 219624	C-Ring Gaskets and Clips

D. Bechtel Drawings

<u>Drawing No.</u>	<u>Description</u>
W750203	Piping & Instrument Diagram - Melter/Quencher
W753008	Plan - Melt Cell - Jumper Arrangement
W753113	Melt Cell Section "E"

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IV. PARTS REQUIRED

A. Items furnished by Du Pont Engineering Department - Mechanical

Assembly W818428 will be shipped from fabrication vendor completely assembled except for C-Rings and attaching hardware (B/M Items 1 thru 4) which will be shipped separately along with the following items:

<u>Drawing No.</u>	<u>Description</u>	<u>Quantity</u>
D188688-N	2" Acme Nut	4 (furnished with melter vessel)

V. INSTALLATION PROCEDURE

A. Precautions

1. Care must be taken to protect and to keep clean all surfaces of the film cooler. Internal horizontal circular slots are quite narrow and could become plugged.
2. Extreme care must be taken not to damage the "C" Ring grooves in top and underside of flange. B/M Items 1 thru 4 are not to be installed until final installation of assembly into melter. (Check with operations.)
3. Make sure the top of raised faces on the flange are free of burrs and chips. This also applies to the flanges on the off-gas jumper and melter (Nozzle A).

B. Film Cooler

1. Install cooler into Nozzle A for fit-up check.
2. Install C-Rings (when unit is to be inserted into melter for last time prior to its operation).

NOTE: Installation of 2 inch Acme nuts occurs after off-gas jumper and off-gas line brush are installed.

Plant: Savannah River
 Project: 9S1780
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SECTION 19 - BACK-UP OFF-GAS FILM COOLERS

I. IDENTIFICATION

<u>Engg. No. (EN)</u>	<u>Description</u>
S350-185-15-50 (Melter #1)	Back-Up Off-Gas Film Cooler Assembly
S999-350-15-50 (Melter #2)	Back-Up Off-Gas Film Cooler Assembly

II. GENERAL

This section covers the procedure for preparing and inserting the back-up off-gas film cooler into Nozzle "T" on the melter as shown in plan view drawing W805066 and side elevation drawing W804860. The off-gas film cooler must be in place before the main off-gas jumper (piping) is installed.

III. DRAWINGS

A. Installation Drawings

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W819165		General Index
W804860		Side Elevation - Melter
W805066		Plan View - Melter

B. Reference Drawings

<u>Drawing No.</u>	<u>B/M Items</u>	<u>Description</u>
W818429	1 thru 5	Back-Up Off-Gas Film Cooler Assembly

C. Vendor Blueprint File Drawings

<u>Drawing No.</u>	<u>Description</u>
BPF 219624	C-Ring Gaskets and Clips

D. Bechtel Drawings

<u>Drawing No.</u>	<u>Description</u>
W750115	Piping & Instrument Diagram - Melter/Seal Pot
W753008	Plan - Melt Cell - Jumper Arrangement
W753119	Melt Cell Section "D"

Plant: Savannah River
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IV. PARTS REQUIRED

A. Items furnished by Du Pont Engineering Department - Mechanical

Assembly W818428 will be shipped from fabrication vendor completely assembled except for C-Rings and attaching hardware (B/M Items 1 thru 4) which will be shipped separately along with the following items:

<u>Drawing No.</u>	<u>Description</u>	<u>Quantity</u>
D188688-N	2" Acme Nut	4 (furnished with melter vessel)

V. INSTALLATION PROCEDURE

A. Precautions

1. Care must be taken to protect and to keep clean all surfaces of the film cooler.
2. Extreme care must be taken not to damage the "C" Ring grooves in top and underside of flange. B/M Items 1 thru 4 are not to be installed until final installation of assembly into melter. (Check with operations.)
3. Make sure the top of raised faces on the flange are free of burrs and chips. This also applies to the flanges on the back-up off-gas jumper and melter (Nozzle A).

B. Film Cooler

1. Install cooler into Nozzle T for fit-up check.
2. Install C-Rings (when unit is to be inserted into melter for last time prior to its operation).

NOTE: Installation of 2 inch Acme nuts occurs after back-up off-gas jumper and back-up off-gas line brush are installed.

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PROJECT: 9S1780
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REV: 3
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SOHIO CARBORUNDUM

MATERIAL SAFETY DATA SHEET

Sohio Emergency Phone (Toll-Free)

In Ohio: 800-362-8059

Outside Ohio: 800-321-8642

CHEMTREC Assist: 800-424-9300

Other Product Safety Info.: 216-575-8024

MANUFACTURER: Sohio Engineered Materials Company - Fibers Division
ADDRESS: P.O. Box 808, Niagara Falls, New York 14302

PRODUCT IDENTIFICATION

TRADE NAME: FIBERFRAX[®] SQUARE BRAID

CAS NUMBER: NA

SYNONYM(S): Ceramic Fiber; Refractory Fiber; MMVF

CHEMICAL FAMILY: Vitreous Aluminosilicate Fibers

MOLECULAR FORMULA: NA

MOLECULAR WEIGHT: NA

SOHIO PRODUCT CODE: NA

HIERARCHY: NA

MSDS NUMBER: BLS

PRODUCT HAZARD SUMMARY

HEALTH WARNING!
 MAY BE HARMFUL IF INHALED
 MAY BE IRRITATING TO THE SKIN, EYES AND RESPIRATORY TRACT
 POSSIBLE CANCER HAZARD BASED ON TESTS WITH LABORATORY ANIMALS

FIRE NON-COMBUSTIBLE

REACTIVITY STABLE

PRODUCT HEALTH HAZARD INFORMATION

ROUTE OF EXPOSURE

INGESTION:

May cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting and diarrhea.

SKIN:

SLIGHTLY TO MODERATELY IRRITATING. May cause irritation and inflammation due to mechanical reaction to sharp, broken ends of fibers.

EYE:

SLIGHTLY TO MODERATELY IRRITATING. Abrasive action may cause damage to the outer surface of the eye.

EFFECTS OF OVEREXPOSURE

INHALATION:

May cause respiratory tract irritation. Pre-existing medical conditions may be aggravated by exposure: specifically, bronchial, hyper-reactivity and chronic bronchial or lung disease.

SPECIAL TOXIC EFFECTS:

Currently, there are no known chronic health effects in humans from long-term exposure to ceramic fibers.

In animal studies, refractory ceramic fibers injected into the peritoneal (abdominal) cavity have caused acute abdominal hemorrhage in hamsters but not in rats. Such injections have also produced tumors in life-time rat studies. In fact, similar results have been observed with numerous other fibrous materials. In such experiments, this abnormally sensitive injection technique is a non-physiological method of exposure, bypassing both normal pulmonary protective and clearance mechanisms.

Recently published inhalation studies have provided contradictory results. One study, which used rats as the experimental animal, reported lung damage consisting of alveolar proteinosis and interstitial fibrosis, whereas, another study using a different strain of rat, showed no similar effects.

Similarly, the pulmonary tumor-causing potential of refractory ceramic fibers in animals when inhaled is unclear. Two studies suggest a low-order potential in inducing pulmonary tumors in animals, while two other studies suggest ceramic fibers are not tumorigenic in animals.

Further animal and human health studies are planned. Pending the results of these studies, strict adherence to recommended safe work practices described elsewhere in this data sheet is advised.

FIRST AID

INGESTION:

Do not induce vomiting. Get medical attention if irritation persists.

SKIN CONTACT:

Wash area of contact thoroughly with soap and water. Do not rub or scratch exposed skin. Using a skin cream or lotion after washing may be helpful. Get medical attention if irritation persists.

EYE CONTACT:

Flush immediately with large amounts of water. Eye lids should be held away from the eyeball to ensure thorough rinsing. Do not rub eyes. Get medical attention if irritation persists.

INHALATION:

Remove affected person from source of exposure. Get medical attention.

AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

5 of 6

PERSONAL PROTECTION INFORMATION

The following personal protective guidelines should be followed, especially where engineering controls (e.g. mechanical dust collection and other means of exhaust ventilation) are not technically feasible or do not reduce airborne fiber concentrations to below 2 fibers/cc.

EYE PROTECTION:

Wear safety glasses or chemical goggles to prevent eye contact. Do not wear contact lenses when working with this substance. Have eye baths readily available where eye contact can occur.

SKIN PROTECTION:

Wear gloves, hats and full body clothing to prevent skin contact. Use separate lockers for work clothes to prevent fiber transfer to street clothes. Avoid taking unwashed work clothes home or provide disposable work clothing. Wash work clothes separately from other clothing. Rinse washing machine thoroughly after use. If clothing is to be laundered by someone else, inform launderer of proper procedures.

RESPIRATORY PROTECTION:

Use NIOSH or MSHA approved equipment when airborne exposure limits are exceeded. NIOSH/MSHA approved breathing equipment may be required for non-routine and emergency use. Ventilation may be used to control or reduce airborne concentrations. Acceptable respirators recommended for airborne ceramic fiber concentrations exceeding 2 fibers/cc are:

<u>Concentration</u>	<u>Respirator Type</u>
2.0 - 5.0 f/cc	3M 8710 or equivalent.
5.0 - 50.0 f/cc	Survivair full face piece with high efficiency filter 1090-00 or equivalent.
> 50.0 f/cc	MSA 01-00-06 full face piece type C supplied-air or equivalent. OSHA approved air source required.

Pending the results of long-term health effects studies, engineering control of airborne fibers to the lowest levels attainable is advised.

PHYSICAL PROPERTIES

BOILING POINT, C (F): NA
MELTING POINT, C (F): ND
VAPOR PRESSURE, mm Hg: NA
VAPOR DENSITY (AIR=1): NA
SOLUBILITY IN WATER, %: NA

SPECIFIC GRAVITY: ND
% VOLATILE: ND
EVAPORATION RATE (BUTYL ACETATE=1): NA
VISCOSITY, SUS: NA
POUR POINT: NA
pH: NA

APPEARANCE/ODOR: ND

FIRE AND EXPLOSION DATA

FLASH POINT, C (F): None
AUTOIGNITION TEMPERATURE, C (F): None

ND = No Data
NA = Not Applicable

FLAMMABILITY LIMITS IN AIR (% BY VOL.): LOWER: NA

UPPER: NA

BASIC FIREFIGHTING PROCEDURES: Use extinguishing agent suitable for type of surrounding fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: NA

REACTIVITY DATA

STABILITY/INCOMPATIBILITY:

Stable under normal conditions of use. Incompatible with hydrofluoric acid and concentrated alkali.

HAZARDOUS REACTIONS/DECOMPOSITION PRODUCTS:

NA

ENVIRONMENTAL INFORMATION

SPILL OR RELEASE TO THE ENVIRONMENT:

Where possible, use vacuum suction to clean up spilled material. Use dust suppressant where sweeping is necessary. Avoid clean up procedures that may result in water pollution. Personal safety and exposure recommendations described elsewhere in this data sheet apply to exposure during clean up of spilled material.

WASTE DISPOSAL:

This substance, when discarded or disposed of, is not specifically listed as a hazardous waste in Federal regulations; however it could be hazardous if it is considered toxic, corrosive, ignitable, or reactive according to Federal definitions (40 CFR 261). Additionally, it could be designated as hazardous according to state regulations. This substance could also become a hazardous waste if it is mixed with or comes in contact with a hazardous waste. If such contact or mixing may have occurred, check 40 CFR 261 to determine whether it is a hazardous waste. If it is a hazardous waste, regulations at 40 CFR 262, 263, and 264 apply.

The transportation, storage, treatment, and disposal of this waste material must be conducted in compliance with all applicable Federal, state, and local regulations.

ADDITIONAL ENVIRONMENTAL REGULATORY INFORMATION:

There may be specific regulations at the local, regional or state level that pertain to this material.

SPECIAL PRECAUTIONS/SUPPLEMENTAL INFORMATION

HANDLING/STORAGE:

Carbon monoxide, carbon dioxide, oxides of nitrogen, reactive hydrocarbons and a small amount of formaldehyde may accompany binder burnoff during first heat. Use adequate ventilation or other precautions to eliminate vapors resulting from binder burnoff. Exposure to burnoff fumes may cause respiratory tract irritation, bronchial hyper-reactivity and asthmatic response.

Product which has been in service at elevated temperatures (greater than 1600 F) may undergo partial conversion to cristobalite, a form of crystalline silica which can cause severe respiratory disease--"Pneumoconiosis". The amount of cristobalite present will depend on the temperature and length in service.

The permissible exposure limit (PEL) for mineral dusts containing cristobalite is determined by one half the value calculated from the mass formula, $(10 \text{ mg/M}^3)/(\% \text{ SiO}_2 + 2)$, i.e. 18% cristobalite; $1/2(10)/(18+2) = 0.25 \text{ mg/M}^3$ (OSHA 1978). Particular care should be taken when working with "used" material to minimize generation of dust. When removing and handling ceramic fiber used in high temperature applications, special caution should be taken to avoid unnecessary cutting and tearing of the used material to minimize generation of airborne dust. Use NIOSH or MSHA approved equipment when airborne exposure limits may be exceeded, especially in confined areas with inadequate ventilation or other areas. Acceptable respirators recommended for given airborne cristobalite concentrations are:

<u>Concentration</u>	<u>Respirator Type</u>
Up to 10 times PEL	3M 8710 or equivalent.
10 to 100 times PEL	Survivair full face piece with high efficiency filter 1090-00 or equivalent.
> 100 times PEL	MSA 01-00-06 full face piece type C supplied-air or equivalent. OSHA approved air source required.

TRANSPORTATION REQUIREMENTS

D.O.T. HAZARD CLASS (49 CFR 172.101): NA
 D.O.T. PROPER SHIPPING NAME (49 CFR 172.101): NA
 D.O.T. LABELS REQUIRED (49 CFR 172.101): NA
 D.O.T. PLACARDS REQUIRED: NA
 BILL OF LADING DESCRIPTION: NO
 UN/NA CODE: NA

INGREDIENT/HEALTH HAZARD INFORMATION

<u>COMPONENT</u>	<u>CAS NO.</u>	<u>%</u>	<u>EXPOSURE LIMITS - REFERENCE</u>
Aluminosilicate (vitreous)	NA	75-85	2 fibers/cc TWA (SOHIO) [®] ; 10 fibers/cc CL (SOHIO) [®]
Organic carrier fiber	NA	15-25	NA

COMPONENT	CAS NO.	%	EXPOSURE LIMITS - REFERENCE
Remaining components not determined hazardous and/or hazardous components present at less than 1.0% (0.1% for carcinogens).	Mixture	Trace	NA

*Pending the results of chronic health effects studies, airborne exposures should be controlled at or below the SOHIO recommended exposure limits listed above.

REVISION DATE: 9/20/85
REPLACES SHEET DATED:

COMPLETED BY: G. R. Krautter
APPROVED BY: *R. W. Mest*

NOTICE: The information presented herein is based on data considered to be accurate as of the date of preparation of this Material Safety Data Sheet. However, no warranty or representation, express or implied, is made as to the accuracy or completeness of the foregoing data and safety information, nor is any authorization given or implied to practice any patented invention without a license. In addition, no responsibility can be assumed by vendor for any damage or injury resulting from abnormal use, from any failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

SOHIO CARBORUNDUM **MATERIAL SAFETY DATA SHEET**

Sohio Emergency Phone (Toll-Free)

In Ohio: 800-362-8054

Outside Ohio: 800-321-8642

CHEMTREC Assist: 800-424-9300

Other Product Safety Info.: 216-575-8024

MANUFACTURER: Sohio Engineered Materials Company - Fibers Division

ADDRESS: P.O. Box 808, Niagara Falls, New York 14302

PRODUCT IDENTIFICATIONTRADE NAME: **FIBERFRAX^R 970 A, F & J PAPER**

CAS NUMBER: NA

SYNONYM(S): Ceramic Fiber; Refractory Fiber; MMVF

CHEMICAL FAMILY: Vitreous Aluminosilicate Fibers

MOLECULAR FORMULA: NA

MOLECULAR WEIGHT: NA

SOHIO PRODUCT CODE: NA

HIERARCHY: NA

MSDS NUMBER: BK2

PRODUCT HAZARD SUMMARY**HEALTH****WARNING!**

MAY BE HARMFUL IF INHALED

MAY BE IRRITATING TO THE SKIN, EYES AND RESPIRATORY TRACT

POSSIBLE CANCER HAZARD BASED ON TESTS WITH LABORATORY ANIMALS

FIRE

NON-COMBUSTIBLE

REACTIVITY

STABLE

PRODUCT HEALTH HAZARD INFORMATION**ROUTE OF EXPOSURE****EFFECTS OF OVEREXPOSURE****INGESTION:**

May cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting and diarrhea.

SKIN:

SLIGHTLY TO MODERATELY IRRITATING. May cause irritation and inflammation due to mechanical reaction to sharp, broken ends of fibers.

EYE:

SLIGHTLY TO MODERATELY IRRITATING. Abrasive action may cause damage to the outer surface of the eye.

INHALATION:

May cause respiratory tract irritation. Pre-existing medical conditions may be aggravated by exposure: specifically, bronchial, hyper-reactivity and chronic bronchial or lung disease.

SPECIAL TOXIC EFFECTS:

Currently, there are no known chronic health effects in humans from long-term exposure to ceramic fibers.

In animal studies, refractory ceramic fibers injected into the peritoneal (abdominal) cavity have caused acute abdominal hemorrhage in hamsters but not in rats. Such injections have also produced tumors in life-time rat studies. In fact, similar results have been observed with numerous other fibrous materials. In such experiments, this abnormally sensitive injection technique is a non-physiological method of exposure, bypassing both normal pulmonary protective and clearance mechanisms.

Recently published inhalation studies have provided contradictory results. One study, which used rats as the experimental animal, reported lung damage consisting of alveolar proteinosis and interstitial fibrosis, whereas, another study using a different strain of rat, showed no similar effects.

Similarly, the pulmonary tumor-causing potential of refractory ceramic fibers in animals when inhaled is unclear. Two studies suggest a low-order potential in inducing pulmonary tumors in animals, while two other studies suggest ceramic fibers are not tumorigenic in animals.

Further animal and human health studies are planned. Pending the results of these studies, strict adherence to recommended safe work practices described elsewhere in this data sheet is advised.

FIRST AID**INGESTION:**

Do not induce vomiting. Get medical attention if irritation persists.

SKIN CONTACT:

Wash area of contact thoroughly with soap and water. Do not rub or scratch exposed skin. Using a skin cream or lotion after washing may be helpful. Get medical attention if irritation persists.

EYE CONTACT:

Flush immediately with large amounts of water. Eye lids should be held away from the eyeball to ensure thorough rinsing. Do not rub eyes. Get medical attention if irritation persists.

INHALATION:

Remove affected person from source of exposure. Get medical attention.

PERSONAL PROTECTION INFORMATION

The following personal protective guidelines should be followed, especially where engineering controls (e.g. mechanical dust collection and other means of exhaust ventilation) are not technically feasible or do not reduce airborne fiber concentrations to below 2 fibers/cc.

EYE PROTECTION:

Wear safety glasses or chemical goggles to prevent eye contact. Do not wear contact lenses when working with this substance. Have eye baths readily available where eye contact can occur.

SKIN PROTECTION:

Wear gloves, hats and full body clothing to prevent skin contact. Use separate lockers for work clothes to prevent fiber transfer to street clothes. Avoid taking unwashed work clothes home or provide disposable work clothing. Wash work clothes separately from other clothing. Rinse washing machine thoroughly after use. If clothing is to be laundered by someone else, inform launderer of proper procedures.

RESPIRATORY PROTECTION:

Use NIOSH or MSHA approved equipment when airborne exposure limits are exceeded. NIOSH/MSHA approved breathing equipment may be required for non-routine and emergency use. Ventilation may be used to control or reduce airborne concentrations. Acceptable respirators recommended for airborne ceramic fiber concentrations exceeding 2 fibers/cc are:

Concentration
2.0 - 5.0 f/cc
5.0 - 50.0 f/cc

> 50.0 f/cc

Respirator Type
3M 8710 or equivalent.
Survivair full face piece with high efficiency filter 1090-00 or equivalent.
MSA 01-00-06 full face piece type C supplied-air or equivalent. OSHA approved air source required.

Pending the results of long-term health effects studies, engineering control of airborne fibers to the lowest levels attainable is advised.

PHYSICAL PROPERTIES

BOILING POINT, C (F): NA
MELTING POINT, C (F): ND
VAPOR PRESSURE, mm Hg: NA
VAPOR DENSITY (AIR=1): NA
SOLUBILITY IN WATER, %: NA

SPECIFIC GRAVITY: ND
% VOLATILE: ND
EVAPORATION RATE (BUTYL ACETATE=1): NA
VISCOSITY, SUS: NA
POUR POINT: NA
pH: NA

APPEARANCE/ODOR: ND

FIRE AND EXPLOSION DATA

FLASH POINT, C (F): None
AUTOIGNITION TEMPERATURE, C (F): None

● **FLAMMABILITY LIMITS IN AIR (% BY VOL.):** LOWER: NA UPPER: NA
● **TYPICAL FIREFIGHTING PROCEDURES:** Use extinguishing agent suitable for type of surrounding fire.
UNUSUAL FIRE AND EXPLOSION HAZARDS: NA

REACTIVITY DATA

STABILITY/INCOMPATIBILITY:

Stable under normal conditions of use. Incompatible with hydrofluoric acid and concentrated alkali.

HAZARDOUS REACTIONS/DECOMPOSITION PRODUCTS:

NA

ENVIRONMENTAL INFORMATION

SPILL OR RELEASE TO THE ENVIRONMENT:

Where possible, use vacuum suction to clean up spilled material. Use dust suppressant where sweeping is necessary. Avoid clean up procedures that may result in water pollution. Personal safety and exposure recommendations described elsewhere in this data sheet apply to exposure during clean up of spilled material.

WASTE DISPOSAL:

● This substance, when discarded or disposed of, is not specifically listed as a hazardous waste in Federal regulations; however it could be hazardous if it is considered toxic, corrosive, ignitable, or reactive according to Federal definitions (40 CFR 261). Additionally, it could be designated as hazardous according to state regulations. This substance could also become a hazardous waste if it is mixed with or comes in contact with a hazardous waste. If such contact or mixing may have occurred, check 40 CFR 261 to determine whether it is a hazardous waste. If it is a hazardous waste, regulations at 40 CFR 262, 263, and 264 apply.

The transportation, storage, treatment, and disposal of this waste material must be conducted in compliance with all applicable Federal, state, and local regulations.

ADDITIONAL ENVIRONMENTAL REGULATORY INFORMATION:

There may be specific regulations at the local, regional or state level that pertain to this material.

SPECIAL PRECAUTIONS/SUPPLEMENTAL INFORMATION

HANDLING/STORAGE:

● Carbon monoxide, carbon dioxide, oxides of nitrogen, reactive hydrocarbons and a small amount of formaldehyde may accompany binder burnoff during first heat. Use adequate ventilation or other precautions to eliminate vapors resulting from binder burnoff. Exposure to burnoff fumes may cause respiratory tract irritation, bronchial hyper-reactivity and asthmatic response.

Product which has been in service at elevated temperatures (greater than 1600 F) may undergo partial conversion to cristobalite, a form of crystalline silica which can cause severe respiratory disease--"Pneumoconiosis". The amount of cristobalite present will depend on the temperature and length in service.

The permissible exposure limit (PEL) for mineral dusts containing cristobalite is determined by one half the value calculated from the mass formula, $(10 \text{ mg/M}^3)/(\% \text{ SiO}_2 + 2)$, i.e. 18% cristobalite; $1/2(10)/(18+2) = 0.25 \text{ mg/M}^3$ (OSHA 1978). The ACGIH recommends an 8 hour time weighted average TWA threshold limit value of 0.05 mg/M^3 for cristobalite. (ACGIH 1986-87) Particular care should be taken when working with "used" material to minimize generation of dust. When removing and handling ceramic fiber used in high temperature applications, special caution should be taken to avoid unnecessary cutting and tearing of the used material to minimize generation of airborne dust. Use NIOSH or MSHA approved equipment when airborne exposure limits may be exceeded, especially in confined areas with inadequate ventilation or other areas. Acceptable respirators recommended for given airborne cristobalite concentrations are:

Concentration
Up to 10 times PEL
10 to 100 times PEL

> 100 times PEL

Respirator Type
3M 8710 or equivalent.
Survivair full face piece with high efficiency filter 1090-00 or equivalent.
MSA 01-00-06 full face piece type C supplied-air or equivalent. OSHA approved air source required.

TRANSPORTATION REQUIREMENTS

D.O.T. HAZARD CLASS (49 CFR 172.101): NA
D.O.T. PROPER SHIPPING NAME (49 CFR 172.101): NA
D.O.T. LABELS REQUIRED (49 CFR 172.101): NA
D.O.T. PLACARDS REQUIRED: NA
BILL OF LADING DESCRIPTION: ND
UN/NA CODE: NA

INGREDIENT/HEALTH HAZARD INFORMATION

COMPONENT	CAS NO.	%	EXPOSURE LIMITS - REFERENCE
Aluminosilicate (vitreous)	NA	85-90	2 fibers/cc TWA (SOHIO)*; 10 fibers/cc C (SOHIO)
Organic binder**	NA	10-15	None established

COMPONENT	CAS NO.	%	EXPOSURE LIMITS - REFERENCE
Remaining components not determined hazardous and/or hazardous components present at less than 1.0% (0.1% for carcinogens).	Mixture	Trace	NA

*No OSHA or ACGIH exposure limits have been established for these materials. Pending the results of chronic health effects studies, airborne exposures should be controlled at or below the SOHIO recommended exposure limits listed above.

**Identity is a trade secret.

REVISION DATE: 4/14/87
REPLACES SHEET DATED: 9/20/85

COMPLETED BY: F. T. Benkalowycz
APPROVED BY: *RW*

NOTICE: The information presented herein is based on data considered to be accurate as of the date of preparation of this Material Safety Data Sheet. However, no warranty or representation, express or implied, is made as to the accuracy or completeness of the foregoing data and safety information, nor is any authorization given or implied to practice any patented invention without a license. In addition, no responsibility can be assumed by vendor for any damage or injury resulting from abnormal use, from any failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

SOHIO CARBORUNDUM

SPEC: 9067
PAGE: 20.12

MATERIAL SAFETY DATA SHEET

Sohio Emergency Phone (Toll-Free)

In Ohio: 800-362-8056

Outside Ohio: 800-321-8642

CHEMTREC Assist: 800-424-9300

Other Product Safety Info.: 216-586-8024

MANUFACTURER: Sohio Engineered Materials Company - Fibers Division
ADDRESS: P.O. Box 808, Niagara Falls, New York 14302

PRODUCT IDENTIFICATION

TRADE NAME: FIBERFRAX^R DURABLANKET^R S

CAS NUMBER: NA

SYNONYM(S): Ceramic Fiber; Refractory Fiber; MMVF

CHEMICAL FAMILY: Vitreous Aluminosilicate Fibers

MOLECULAR FORMULA: NA

MOLECULAR WEIGHT: NA

SOHIO PRODUCT CODE: NA

HIERARCHY: NA

MSDS NUMBER: AV2

PRODUCT HAZARD SUMMARY

HEALTH WARNING!
MAY BE HARMFUL IF INHALED
MAY BE IRRITATING TO THE SKIN, EYES AND RESPIRATORY TRACT
POSSIBLE CANCER HAZARD BASED ON TESTS WITH LABORATORY ANIMALS

FIRE NON-COMBUSTIBLE

REACTIVITY STABLE

PRODUCT HEALTH HAZARD INFORMATION

ROUTE OF EXPOSURE

EFFECTS OF OVEREXPOSURE

INGESTION:

May cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting and diarrhea.

SKIN:

SLIGHTLY TO MODERATELY IRRITATING. May cause irritation and inflammation due to mechanical reaction to sharp, broken ends of fibers.

EYE:

SLIGHTLY TO MODERATELY IRRITATING. Abrasive action may cause damage to the outer surface of the eye.

INHALATION:

May cause respiratory tract irritation. Pre-existing medical conditions may be aggravated by exposure: specifically, bronchial hyper-reactivity and chronic bronchial or lung disease.

SPECIAL TOXIC EFFECTS:

Currently, there are no known chronic health effects in humans from long-term exposure to ceramic fibers.

In animal studies, refractory ceramic fibers injected into the peritoneal (abdominal) cavity have caused acute abdominal hemorrhage in hamsters but not in rats. Such injections have also produced tumors in life-time rat studies. In fact, similar results have been observed with numerous other fibrous materials. In such experiments, this abnormally sensitive injection technique is a non-physiological method of exposure, bypassing both normal pulmonary protective and clearance mechanisms.

Recently published inhalation studies have provided contradictory results. One study, which used rats as the experimental animal, reported lung damage consisting of alveolar proteinosis and interstitial fibrosis, whereas, another study using a different strain of rat, showed no similar effects.

Similarly, the pulmonary tumor-causing potential of refractory ceramic fibers in animals when inhaled is unclear. Two studies suggest a low-order potential in inducing pulmonary tumors in animals, while two other studies suggest ceramic fibers are not tumorigenic in animals.

Further animal and human health studies are planned. Pending the results of these studies, strict adherence to recommended safe work practices described elsewhere in this data sheet is advised.

FIRST AID

INGESTION:

Do not induce vomiting. Get medical attention if irritation persists.

SKIN CONTACT:

Wash area of contact thoroughly with soap and water. Do not rub or scratch exposed skin. Using a skin cream or lotion after washing may be helpful. Get medical attention if irritation persists.

EYE CONTACT:

Flush immediately with large amounts of water. Eye lids should be held away from the eyeball to ensure thorough rinsing. Do not rub eyes. Get medical attention if irritation persists.

INHALATION:

Remove affected person from source of exposure. Get medical attention.

PERSONAL PROTECTION INFORMATION

The following personal protective guidelines should be followed, especially where engineering controls (e.g. mechanical dust collection and other means of exhaust ventilation) are not technically feasible or do not reduce airborne fiber concentrations to below 2 fibers/cc.

EYE PROTECTION:

Wear safety glasses or chemical goggles to prevent eye contact. Do not wear contact lenses when working with this substance. Have eye baths readily available where eye contact can occur.

SKIN PROTECTION:

Wear gloves, hats and full body clothing to prevent skin contact. Use separate lockers for work clothes to prevent fiber transfer to street clothes. Avoid taking unwashed work clothes home or provide disposable work clothing. Wash work clothes separately from other clothing. Rinse washing machine thoroughly after use. If clothing is to be laundered by someone else, inform launderer of proper procedures.

RESPIRATORY PROTECTION:

Use NIOSH or MSHA approved equipment when airborne exposure limits are exceeded. NIOSH/MSHA approved breathing equipment may be required for non-routine and emergency use. Ventilation may be used to control or reduce airborne concentrations. Acceptable respirators recommended for airborne ceramic fiber concentrations exceeding 2 fibers/cc are:

<u>Concentration</u>	<u>Respirator Type</u>
2.0 - 5.0 f/cc	3M 8710 or equivalent.
5.0 - 50.0 f/cc	Survivair full face piece with high efficiency filter 1090-00 or equivalent.
> 50.0 f/cc	MSA 01-00-06 full face piece type C supplied-air or equivalent. OSHA approved air source required.

Pending the results of long-term health effects studies, engineering control of airborne fibers to the lowest levels attainable is advised.

PHYSICAL PROPERTIES

BOILING POINT, C (F): NA
MELTING POINT, C (F): ND
VAPOR PRESSURE, mm Hg: NA
VAPOR DENSITY (AIR=1): NA
SOLUBILITY IN WATER, %: NA

APPEARANCE/ODOR: ND

SPECIFIC GRAVITY: ND
% VOLATILE: NA
EVAPORATION RATE (BUTYL ACETATE=1): NA
VISCOSITY, SUS: NA
POUR POINT: NA
pH: NA

FIRE AND EXPLOSION DATA

FLASH POINT, C (F): None
AUTOIGNITION TEMPERATURE, C (F): None

FLAMMABILITY LIMITS IN AIR (% BY VOL.): LOWER: NA UPPER: NA
BASIC FIREFIGHTING PROCEDURES: Use extinguishing agent suitable for type of surrounding fire.
UNUSUAL FIRE AND EXPLOSION HAZARDS: NA

REACTIVITY DATA

STABILITY/INCOMPATIBILITY:

Stable under normal conditions of use. Incompatible with hydrofluoric acid and concentrated alkali.

HAZARDOUS REACTIONS/DECOMPOSITION PRODUCTS:

NA

ENVIRONMENTAL INFORMATION

SPILL OR RELEASE TO THE ENVIRONMENT:

Where possible, use vacuum suction to clean up spilled material. Use dust suppressant where sweeping is necessary. Avoid clean up procedures that may result in water pollution. Personal safety and exposure recommendations described elsewhere in this data sheet apply to exposure during clean up of spilled material.

WASTE DISPOSAL:

This substance, when discarded or disposed of, is not specifically listed as a hazardous waste in Federal regulations; however it could be hazardous if it is considered toxic, corrosive, ignitable, or reactive according to Federal definitions (40 CFR 261).

Additionally, it could be designated as hazardous according to state regulations. This substance could also become a hazardous waste if it is mixed with or comes in contact with a hazardous waste. If such contact or mixing may have occurred, check 40 CFR 261 to determine whether it is a hazardous waste. If it is a hazardous waste, regulations at 40 CFR 262, 263, and 264 apply.

The transportation, storage, treatment, and disposal of this waste material must be conducted in compliance with all applicable Federal, state, and local regulations.

ADDITIONAL ENVIRONMENTAL REGULATORY INFORMATION:

There may be specific regulations at the local, regional or state level that pertain to this material.

SPECIAL PRECAUTIONS/SUPPLEMENTAL INFORMATION

HANDLING/STORAGE:

Product which has been in service at elevated temperatures (greater than 1600 F) may undergo partial conversion to cristobalite, a form of crystalline silica which can cause severe respiratory disease--"Pneumoconiosis". The amount of cristobalite present will depend on the temperature and length in service.

The permissible exposure limit (PEL) for mineral dusts containing cristobalite is determined by one half the value calculated from the mass formula, $(10 \text{ mg/M}^3)/(\% \text{ SiO}_2 + 2)$, i.e. 18% cristobalite; $1/2(10)/(18+2) = 0.25 \text{ mg/M}^3$ (OSHA 1978). The ACGIH recommends an 8 hour time weighted average TWA threshold limit value of 0.05 mg/M^3 for cristobalite. (ACGIH 1986-87) Particular care should be taken when working with "used" material to minimize generation of dust. When removing and handling ceramic fiber used in high temperature applications, special caution should be taken to avoid unnecessary cutting and tearing of the used material to minimize generation of airborne dust. Use

ND = No Data

NA = Not Applicable

NIOSH or MSHA approved equipment when airborne exposure limits may be exceeded, especially in confined areas with inadequate ventilation or other areas. Acceptable respirators recommended for given airborne cristobalite concentrations are:

<u>Concentration</u>	<u>Respirator Type</u>
Up to 10 times PEL	3M 8710 or equivalent.
10 to 100 times PEL	Survivair full face piece with high efficiency filter 1090-00 or equivalent.
> 100 times PEL	MSA 01-00-06 full face piece type C supplied-air or equivalent. OSHA approved air source required.

TRANSPORTATION REQUIREMENTS

D.O.T. HAZARD CLASS (49 CFR 172.101): NA
D.O.T. PROPER SHIPPING NAME (49 CFR 172.101): NA
D.O.T. LABELS REQUIRED (49 CFR 172.101): NA
D.O.T. PLACARDS REQUIRED: NA
BILL OF LADING DESCRIPTION: ND
UN/NA CODE: NA

INGREDIENT/HEALTH HAZARD INFORMATION

COMPONENT	CAS NO.	%	EXPOSURE LIMITS - REFERENCE
Aluminosilicate (vitreous)	NA	99+	2 fibers/cc TWA (SOHIO)* 10 fibers/cc C (SOHIO)
Remaining components not determined hazardous and/or hazardous components present at less than 1.0% (0.1% for carcinogens).	Mixture	Trace	NA

*No OSHA or ACGIH exposure limits have been established for these materials. Pending the results of chronic health effects studies, airborne exposures should be controlled at or below the SOHIO recommended exposure limit listed above.

EFFECTIVE DATE: 4/14/87
REPLACES SHEET DATED: 9/20/85

REVISED BY: F. T. Benkalowycz
APPROVED BY: *RW*

NOTICE: The information presented herein is based on data considered to be accurate as of the date of preparation of this Material Safety Data Sheet. However, no warranty or representation, express or implied, is made as to the accuracy or completeness of the foregoing data and safety information, nor is any authorization given or implied to practice any patented invention without a license. In addition, no responsibility can be assumed by vendor for any damage or injury resulting from abnormal use, from any failure to adhere to recommended practices, or from any hazards inherent in the nature of the product.

Section 10 - Project Data

This section includes cost , schedule, and technical data that was developed during the procurement and construction of Melters #1 and #2. Following is a list of this information:

1. Melter Cost

Letter to D. C. Nichols from J. D. Gutmann, Jr. and R. D. Crecco dated December 9, 1988 - *Melter 1 vs. 3 Cost Summary and Details* - Document Number DP 0002621.

2. Melter Schedule

Letter to J. M. Mc Kibben from J. D. Gutmann, Jr. dated January 18, 1988 - *Minutes of Melter #3 Planning Meeting* - Document Number DD 0005743.

3. Melter Fixtures

Letter to D. L. Kinnsch from J. D. Gutmann, Jr. dated November 7, 1988 - *Melter Fixtures - Identification, Description, and Location* - Document Number DB 0009949.

4. Melter Weight

Letter to Larry hall from J. D. Gutmann, Jr. dated June 4, 1986 - *Component Weights for Melter Assembly* - Document Number DV 0000485.

5. Inconel® 690 Material

Letter to D. L. Kinnsch from J. D. Gutmann, Jr. dated October 13, 1988 - *Inconel® 690 Material Takeoff for Melters 1 and 2* - Document Number DB 0009872.

6. Order List

Letter to J. E. Meunier from J. D. Gutmann, Jr. dated March 2, 1988 - *Melter #3 Program - Information on Engineering Department Orders for Melter #1* - Document Number DB 0009622.

7. Vendor List

Letter to D. L. Kinnsch from J. D. Gutmann, Jr. dated October 24, 1988 - *Vendor List for DWPF Melters 1 and 2* - Document Number 0009873.

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED

P. O. Box 6090
NEWARK, DE 19714-6090

DP-0002621

ENGINEERING DEPARTMENT
LOUVIERS BUILDING

December 9, 1988

CC: W. R. Frazer-BRDO-SRC-S2
D. L. Ketcham-BRDO-SRC-S2
D. L. Kinnsch-BRDO-SRC-S2
D. T. Teschner-BRDO-SRC-S2
L. M. Papouchado-AED-PD-SRP-704S
J. B. Mellen-AED-PD-SRP-704S
J. C. Davis-AED-ED-SRC-S1
J. M. McKibben-AED-ED-SRC-S1
L. F. Shafranek-AED-L3303
N. R. Levins-AED-L2324
G. E. Miller-AED-L3311
P. A. Norman-AED-L3353
W. E. Guenthner-AED-L3331
J. Scafaria-AED-L3320
R. T. Britt-AED-L33W74
J. E. Savoy-A/S-L33W51
IC 33 (2)

D. C. NICHOLS
PETROCHEMICALS DEPARTMENT
ATOMIC ENERGY DIVISION
SAVANNAH RIVER PLANT
BUILDING 704-S

PROJECT 9S3420 - SAVANNAH RIVER PLANT
DWPf GLASS MELTER #3
MELTER 1 VS 3 COST SUMMARY AND DETAILS

References:

- 1) Melter #3 CAB estimate transmittal, letter to J. L. Lear from L. F. Shafranek, "Current Appraisal for Capitol Equipment Budget", October 31, 1988.
- 2) DD 0005743, letter to J. M. McKibben from J. D. Gutmann, Jr., "Minutes of Melter #3 Planning Meeting", January 18, 1988.
- 3) DB 0009622, letter to J. E. Meunier from J. D. Gutmann, Jr., "Information on Engineering Department Orders for Melter #1", March 2, 1988.

Attachments:

- 1) Tables 1 through 6, Melter Cost Summaries
- 2) Project 9S3420, CAB estimate for Melter #3, October 25, 1988, Pages 1-22.

SUMMARY

The advertised cost of the West Valley melter is \$2 million, and this is apparently being compared to the \$19 million project cost of Melter #3. This is not a valid comparison for the following reasons:

- o The West Valley cost is based on yesterday's prices for labor and material. Melter #3 costs are indexed for inflation to future delivery dates.
- o The Melter #3 cost is at the project level that includes field costs and allowances that are not part of the West Valley cost picture.
- o DWPF melter equipment costs include items that are not included in the West Valley design - frame, drain valve, dome heaters, etc.
- o A comparison is being made between melters having different capacities. The DWPF melter has approximately 3X the capacity of the West Valley unit.
- o The DWPF melter is designed for a longer service life.
- o The DWPF process will require operation over a period of years using several melter assemblies. This requires high tolerances to insure interchangeability between components and jumpers with any melter assembly.

For the above reasons, a valid cost comparison between the DWPF and West Valley melters must be based on the following:

1. Compare West Valley equipment costs with those for Melter #1, since these melters were constructed during the same time period. (Melter #3 costs include allowances and indexing for future pricing).
2. Separate equipment costs from allowances (and other project level costs) and itemize these in detail.
3. Subtract costs for Melter #1 equipment that are not included in the West Valley assembly, including added redundancy in removable instruments.
4. Include an allowance to adjust for the difference in capacity between DWPF and West Valley melters.
5. Include allowances to adjust for differences due to design life requirements and tolerances.

When the comparison is made per the above criteria, the equivalent equipment cost of Melter #1 is reduced from \$6.1 to \$1.6 million. This compares favorably with the \$2.0 million cost for West Valley.

DISCUSSION

This letter follows up your request to provide the following melter cost information:

- o Melter #1 equipment costs by summary and details.

- o Melter #3 equipment costs by summary and details, and how this escalates to the \$19,000,000 project level cost.

We understand that this information is needed by Don Fulmer, DOE, to provide a realistic basis for comparing DWPF vs. West Valley melter costs.

A. Cost Tables

To provide the requested cost information, it was necessary to group item costs for each melter component assembly. This was accomplished with J. D. Gutmann's MacIntosh OverVUE database program, used previously to prepare Melter #1 cost and timing information for Bechtel and Investment Engineering, References 2 and 3. In all cases, Melter #1 costs are as built, and Melter #3 costs are taken directly from the CAB. This data was sorted and grouped to provide the following:

- Table 1 - Summary of equipment costs, by primary equipment group, for Melters 1 and 3. As noted, prices for the Melter #3 vessel and frame are based on budget prices from CBI. Inconel 690 costs include use of remaining material from Project 9S1780, and all other costs are escalated from the Melter #1 order date to 4Q88.
- Table 2 - Provides a finer breakdown in which costs of the top head and shell component assemblies are shown individually.
- Table 3 - Provides a detailed breakdown of each assembly by item. This is at the same level of detail shown in the CAB. As noted on Table 1, the CAB groups items by purchase order: thermocouples, bellows, ceramic isolators, etc. In Tables 1 through 4, these items and their cost have been grouped with their respective vessel and component assemblies. The CAB page and line numbers and Engineering Numbers for each item are included to permit a cross reference with the CAB.
- Table 4 - Summary of equipment costs for Melter #3, showing the general breakdown of the \$8,246,280 equipment cost, and how this is increased by field costs and allowances to the \$10,370,480 design area net total. This net total number appears on page 19, line 30 of the CAB, and is carried over to page 9, line 3. (The \$8.2 million equipment cost does not appear in the CAB, since the cumulative total on each page includes other costs and allowances).
- Table 5 - Summary of the Melter #3 project costs, showing grossing from the \$10,370,480 design area net total to the \$19,000,000 grand total at project level. Included in this estimate is a total cost of \$3.2 million for quality assurance related items - inspections, SRQA, etc.
- Table 6 - Curves for cost vs. capacity using the exponential rule. (See paragraph B3 on page 7).

The information in these six tables will permit an accurate cost comparison with the West Valley melter, provided the West Valley costs are broken down to the same level of detail. Following are considerations for cost comparisons between the DWPF and West Valley melters.

B. Considerations For Cost Comparison - DWPF vs. West Valley Melters

1. Design Criteria and Approach

The DWPF and West Valley melter designs were based on different criteria and objectives. These have a major influence on equipment costs.

For West Valley, the limited amount of waste permits the use of one melter to convert all of the waste in six months.

For DWPF, the much larger amount of waste will require processing over a period of 20 years. Each melter assembly has a two year minimum operating life requirement, and the melter assemblies must be built to high tolerances to permit remote removal and installation.

This difference in objectives is reflected in the respective designs. Four examples follow:

a. Replacement Time

Since the intent at West Valley is to run hot with only one melter, the melter does not have an interchangeable cartridge design like the DWPF melter/frame assembly. Some of the West Valley equipment is hard piped and will be more difficult to remove. As a result, the estimated time to change out a melter at West Valley is around 6 months. The estimated time to replace the DWPF melter assembly is 1-1/2 months.

b. Design Life

This is included as a consideration, based on photographs of West Valley equipment that were shown during the August meeting. One of these showed a thermowell that was about an inch in diameter. The DWPF thermowells are finished to a three inch diameter to improve life through added corrosion allowance. With the current glass formulation, the expected corrosion life for the Inconel 690 components is in the range of 5 to 10 years.

c. Tolerances

One of the contributing factors that influenced DWPF melter fabrication costs was the requirement for close tolerances to insure interchangeability. This applied to the melter frame, frame nozzles, top head nozzles, and top head components. The West Valley approach was different, as the intent was to run with only one melter. The nozzles on their melter were not located to the precision required for DWPF, since the jumpers can be made to fit the as-built condition. This may create some difficulty in the future, since West Valley has indicated they will build a second melter and install it prior to hot operation.

d. Design Approach

Two problems have surfaced on the West Valley melter that are of interest, since they were a result of a different approach to design.

The first problem is that refractory from the roof is flaking off and falling into the glass melt. This is due to the combination of a flat roof construction, coupled with the use of castable materials for the refractory. Both of these approaches were deliberately avoided on DWPF. Our refractory consultant, F. W. Thompson, made strong recommendations for using an arched roof construction, and equally strong recommendations against using castable refractory due to its inherent instability. This approach has been proven by the excellent refractory condition shown in the Scale Melter after more than two years of operation.

The second problem involves warping of the flanges on the top head of the melter. This was avoided on DWPF by water cooling the exterior, and using thick sections and gussets to stabilize these elements. In addition, the DWPF melter has two independent water cooling circuits to provide redundancy.

The short operating life, and the fact that interchangeable melter assemblies are not required, probably influenced the overall design approach at West Valley to reduce equipment costs.

2. Capacity

The DWPF melter is sized for a larger (about 3X) capacity than West Valley. This can have a significant effect on cost, since a larger melt pool requires a larger vessel, more refractory and more instrumentation. A comparison of cost vs. capacity may be estimated using the "six tenths" exponential factor as a rule of thumb. This is a standard approach to approximate the cost of a piece of equipment when the cost of a similar unit of different capacity is known. The formula is:

$$\text{Cost}_2 = \text{Cost}_1 \times \left(\frac{\text{Capacity 2}}{\text{Capacity 1}} \right)^{0.6}$$

The exponent is not a constant, but a reasonable approximation can be made by assuming it is constant over a limited range of sizes, usually 1/2 to 2X base size.

For comparison of DWPF vs. West Valley, assuming the DWPF capacity is 3X that of West Valley:

$$\text{DWPF Cost} = \text{West Valley Cost} \left(\frac{\text{DWPF Capacity}}{\text{West Valley Capacity}} \right)^{0.6}$$

$$\begin{aligned} &= \text{West Valley Cost (3.0)}^{0.6} \\ &= \text{West Valley Cost (1.93)} \end{aligned}$$

or by capacity alone, the DWPF melter would be expected to cost about 2X the West Valley unit. The LWPF cost should be the equivalent cost, after allowances have been made for differences in quantity and types of components.

A set of curves for different values of the exponent is shown in Table 6. As shown, a capacity ratio of 3.0 for DWPF vs West Valley translates to an approximate 2X increase in cost using the rule of thumb 0.6 exponent.

Over the total exponent range of 0.3 to 0.9, the DWPF melter cost would be expected to range from 1.5 to 2.8 times the West Valley melter cost.

C. Melter Equipment Cost Comparisons

The advertised cost of the West Valley melter is around \$2.0 million. The equivalent equipment cost of Melter #1 is \$1.6 million, using the following basis for comparison:

1. Melter #1 vs. Melter #3

Comparisons between West Valley and DWPF melters should be based on Melter #1 costs only, since the materials and equipment for this melter and West Valley were purchased in the same time period. As shown in Table 1, the total equipment cost for Melter #1 is \$6,076,460, while the estimated cost of Melter #3 is \$8,246,280. The #3 melter cost is based on budget prices from CBI for the vessel and frame, and escalating all other #1 melter costs to 2Q88. The project level estimate for #3 melter is further increased by \$1,597,820 to bring final cost up to the future scheduled delivery dates (CAB page 1, line 16).

2. Quantity of Components

If component costs are compared, this should be done on an item by item basis. This is particularly true for the top head components. We believe the DWPF melter has more redundancy than West Valley in feed tubes, thermowells, etc.

3. Equipment Unique to DWPF

The \$2,000,000 cost of the West Valley melter does not include a frame assembly, drain valve, dome heaters, or top head components. These items are unique to the DWPF melter.

4. Cost Comparison - Melter #1 Vs. West Valley

The equivalent cost of Melter #1 relative to West Valley can be calculated using the known differences between the two configurations. In the table below, the total equipment cost of Melter #1 is first reduced by subtracting the cost of components that are not included in the \$2.0 million West Valley melter cost. This reduces the equivalent cost from \$6.1 to 3.3 million. An additional cost factor is applied to account for the 3X difference in capacity. This results in a final equivalent equipment cost of \$1.6 million.

Not included in this table are allowances for component quantities or factors for differences in replacement time or design life. All of these would tend to further reduce the equivalent cost of Melter #1.

<u>ITEM</u>	<u>COST</u>	<u>SOURCE</u>
Melter #1 Equipment Total	6,076,460	Table 1
Frame Assembly	-1,467,000	Table 1
Top Head Components	- 706,170	Table 1
Dome Heaters	- 151,600	Table 2
Drain Valve	- 475,500	Table 2
<hr/>		
Net Equipment Total Cost	3,276,190	
Less 3X Capacity Factor	- 1,638,095	Table 6
<hr/>		

Equivalent Cost of DWPF Melter 1,638,095

CONCLUSION

The West Valley and DWPF melter designs were based on two different criteria. For West Valley, the major factors influencing design were:

- o Convert all waste in six months
- o Only one melter required

The short operating time, and the fact that interchangeable melter assemblies are not required, probably influenced the overall design approach to reduce equipment costs.

In contrast, DWPF has a minimum two year operating life, and must use interchangeable melter assemblies to process the waste over a period of some 20 years. Under these conditions, the design approach was to attain maximum life and integrity through a high quality design, fabrication and assembly program.

Although the equipment cost for Melter #1 totals \$6.1 million, the cost relative to West Valley is considerably lower. When the cost of equipment unique to DWPF is subtracted out, the total becomes \$3.3 million. Applying a factor to account for differences in capacity makes the comparative DWPF equipment cost approximately \$1.6 million. Further reductions can be considered by including additional factors for redundancy and design life. When viewed in this perspective, the cost of the DWPF melter compares favorably with the West Valley melter.

ATOMIC ENERGY DIVISION

J. D. Gutmann, Jr.
Project Engineer

JDG/RDC:plc
JDG/D
Atchs.

ATOMIC ENERGY DIVISION

R. D. Crecco
Senior Investment Engineer

TABLE 1

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - SUMMARY BY PRIMARY GROUP

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

MELTER PRIMARY EQUIPMENT GROUP	MELTER #1 COST IN \$	MELTER #3 COST IN \$
VESSEL & RELATED COMPONENTS	1,081,500	2,274,280
REFRACTORY LINING	1,089,900	1,321,450
TOP HEAD COMPONENTS	706,170	796,410
SHELL COMPONENTS	1,223,740	1,429,730
INCONEL 690 MATERIAL & WELD WIRE	508,150	377,500
MELTER FRAME, COMPONENTS, & ASSY	1,467,000	2,046,910
TOTAL MELTER EQUIPMENT COST	6,076,460	8,246,280

This is a cost breakdown by primary equipment group, in which component costs are totaled and grouped by location in the vessel top head and shell.

A cost breakdown by component assembly is shown in Table 2.

A further breakdown of each component assembly into its individual items is shown in Table 3.

GENERAL NOTES

1. Melter 1 equipment costs are as-built, based on time of delivery.
2. Melter 3 costs are based on the following:
 - Melter vessel and frame costs are budget prices from CBI
 - Superstructure refractory was underbid on Melter #1. An additional allowance was included in the estimate to cover this.
 - Inconel 690 costs include use of remaining material from P 1780
 - All other costs are escalated from the Melter #1 order date to 2Q88.
3. In the CAB, items are grouped by purchase order: thermocouples, bellows, ceramic isolators, etc. In Tables 1 through 4, these items and their costs have been grouped with their respective vessel and component assemblies. The CAB page and line numbers for each item have been included in Tables 3 through 5 to permit a cross reference with the CAB details. Table 3 also includes the engineering number.
4. Field costs, allowances, and Inconel 690 material for Melter 4 are not included in Tables 1 through 3. These are shown in Tables 4 and 5, and in the CAB.
5. The cost of the West Valley melter must be compared, at a detailed level, with the costs for Melter #1, since both were ordered during the same time period.

TABLE 2
MELTER #3 vs MELTER #1 EQUIPMENT COSTS - SUMMARY BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

MELTER SUB ASSEMBLY	MELTER #1 COST IN \$	MELTER #3 COST IN \$
VESSEL & RELATED COMPONENTS	1,081,500	2,274,280
REFRACTORY LINING	1,089,900	1,321,450
ANCHOR FLANGES	31,600	37,130
FEED TUBE (NOZZLE B1)	74,650	87,845
FEED TUBE (NOZZLE B2)	74,650	87,845
FILM COOLER (NOZZLE A)	20,000	22,470
FILM COOLER (NOZZLE T)	14,400	16,160
MELT LEVEL DIP TUBE	26,300	30,920
THERMOWELL - MELT (NOZZLE C4)	72,440	80,700
THERMOWELL - MELT (NOZZLE E)	71,240	79,310
THERMOWELL - VAPOR/CONDUCT. PROBE	41,910	47,930
THERMOWELL - T/C FITTINGS	4,000	4,280
T.V. CAMERA ASSEMBLY (NOZZLE D1)	137,490	150,910
T.V. CAMERA ASSEMBLY (NOZZLE D)	137,490	150,910
DOMES HEATERS	151,600	173,050
DRAIN VALVE	475,500	557,430
ELECTRODES	84,840	98,370
POUR SPOUT BELLOWS	264,300	312,440
RISER HEATER	247,500	288,440
INCONEL 690 MATERIAL & WELD WIRE	508,150	377,500
MELTER FRAME, COMPONENTS, & ASSY	1,467,000	2,046,910
TOTAL MELTER EQUIPMENT COST	6,076,460	8,246,280

See notes 1 through 5, Table 1.

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPf GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
VESSEL & RELATED COMPONENTS					
S999-351-10-00	VESSEL SHELL & HEAD	1,040,000	2,225,600	13	3
S999-351-10-02	EXTERNAL ISOLATORS	20,000	23,540	12	19
S999-351-10-05	SS O RINGS - VESSEL SHELL/HEAD FLANGE	10,400	12,200	13	11
S999-351-10-06	BORE INCONEL 690 FOR A & T NOZZLES	1,100	1,280	13	8
S999-351-10-10	SS O RINGS - A & T NOZZLES - HYDROTEST	1,100	1,280	13	14
S999-351-10-12	SHELL COMPONENTS - MISC	8,600	10,060	11	40
S999-351-2964-TE-A	TYPE K THERMOCOUPLE - REFRACTORY BACKFACE	150	160	18	1
S999-351-2964-TE-B	TYPE K THERMOCOUPLE - REFRACTORY BACKFACE	150	160	18	3
	TOTAL COST - VESSEL & RELATED COMPONENTS	1,081,500	2,274,280		
REFRACTORY LINING					
S999-351-10-00	REFRACTORY DRY OUT	16,000	17,120	13	6
S999-351-12-00	REFRACTORY INSTALLATION	143,400	167,240	13	22
S999-351-12-10	K-3 REFRACTORY	476,500	560,680	13	35
S999-351-12-12	K-3 GRINDING & DRILLING	92,500	108,820	13	36
S999-351-12-13	K-3 WIRE CUTTING & GRINDING	9,700	11,340	13	37
S999-351-12-20	ZIRMUL REFRACTORY	131,300	154,080	14	43
S999-351-12-22	ZIRMUL GRINDING	8,400	9,840	14	8
S999-351-12-30	SUPERSTRUCTURE REFRACTORY	100,000	160,500	13	42
S999-351-12-40	FIBERFRAX T-30 INSULATION (VESSEL HEADS, RISER)	110,500	130,010	13	30
S999-351-12-45	FIBERFRAX - MISC BULK PAPER, DSM	1,600	1,820	13	20
	TOTAL COST - REFRACTORY LINING	1,089,900	1,321,450		
MELTER FRAME					
S999-351	VENDOR ASSEMBLY	1,150,000	1,209,100	14	21
S999-351	DOVE HEATER TRANSFORMER BUS BAR GAGE		5,350	14	36
S999-351	HANFORD ELECTRICAL LOWER HOLDERS	22,000	23,540	14	39
S999-351	ELECTRICAL CABLE	2,000	2,140	14	42
S999-351	HANFORD PROCESS CONNECTORS	2,000	2,140	15	1
S999-351-161-00	ELECTRODE BUS BARS	31,000	44,940	14	33
S999-351-290-01	CANISTER POSITIONING ARM	2,000	2,140	14	28
S999-351-41-00	DOVE HEATER TRANSFORMERS	18,000	19,260	14	30
S999-351-46-00	MELTER FRAME	240,000	738,300	14	25
	TOTAL COST - MELTER FRAME	1,467,000	2,046,910		
MATERIAL - I 690					
S999-351-10-01	EXCESS 690 MATERIAL FROM S1780 (1 MELTER ASSY)		157,500	12	30
S999-351-10-02	INCONEL 690 MATERIAL-NEW MAT'L (1 MELTER ASSY)	463,050	120,000	12	34
S999-351-10-04	TYPE 690 WELD WIRE (1 MELTER ASSY)	45,100	100,000	12	27
	TOTAL COST - MATERIAL - I 690	508,150	377,500		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
	ANCHOR FLANGES				
S999-351-10-03	ANCHOR FLANGES	31,600	37,130	12	1
	TOTAL COST - ANCHOR FLANGES	31,600	37,130		
	FEED TUBE (NOZZLE B1)				
S999-351-13-00	FEED TUBE - NOZZLE B1	74,250	87,365	11	25
S999-351-13-01	FIBERFRAX - MILLED	400	480	11	19
	TOTAL COST - FEED TUBE (NOZZLE B1)	74,650	87,845		
	FEED TUBE (NOZZLE B2)				
S999-351-13-00	FEED TUBE - NOZZLE B2	74,250	87,365	11	25
S999-351-13-01	FIBERFRAX - MILLED	400	480	11	19
	TOTAL COST - FEED TUBE (NOZZLE B2)	74,650	87,845		
	FILM COOLER (NOZZLE A)				
S999-351-15-40	FILM COOLER - OFF GAS NOZZLE A	20,000	22,470	12	3
	TOTAL COST - FILM COOLER (NOZZLE A)	20,000	22,470		
	FILM COOLER (NOZZLE T)				
S999-351-15-50	FILM COOLER - BACK UP OFF GAS NOZZLE T	14,400	16,160	12	5
	TOTAL COST - FILM COOLER (NOZZLE T)	14,400	16,160		
	MELT LEVEL DIP TUBE				
S999-351-15-20	MELT LEVEL DIP TUBE	26,300	30,920	11	34
	TOTAL COST - MELT LEVEL DIP TUBE	26,300	30,920		
	THERMOWELL - MELT (NOZZLE C4)				
S999-351-15-05	MELT THERMOWELL - NOZZLE C-4	30,200	35,520	11	29
S999-351-3272-TE-A	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	15	42
S999-351-3272-TE-B	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	16	1
S999-351-3274-TE-A	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	7
S999-351-3274-TE-B	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	9
S999-351-3276-TE-A	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	15
S999-351-3276-TE-B	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	17
	TOTAL COST - THERMOWELL - MELT (NOZZLE C4)	72,440	80,700		
	THERMOWELL - MELT (NOZZLE E)				
S999-351-15-00	MELT THERMOWELL - NOZZLE E	29,000	34,130	11	27
S999-351-3271-TE-A	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	15	38
S999-351-3271-TE-B	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	15	40
S999-351-3273-TE-A	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	3
S999-351-3273-TE-B	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	5
S999-351-3275-TE-A	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	11
S999-351-3275-TE-B	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	13
	TOTAL COST - THERMOWELL - MELT (NOZZLE E)	71,240	79,310		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
THERMOWELL - T/C FITTINGS					
S999-351-TF	CONAX FITTINGS (ITEMS 351-TF-1 THRU 6)	4,000	4,280	18	6
	TOTAL COST - THERMOWELL - T/C FITTINGS	4,000	4,280		
THERMOWELL - VAPOR/COND. PROBE					
S999-351-15-10	VAPOR THERMOWELL / CONDUCTIVITY PROBE	29,700	34,880	11	31
S999-351-4085-TE-A	TYPE B THERMOCOUPLE - VAPOR SPACE	4,070	4,350	16	19
S999-351-4085-TE-B	TYPE B THERMOCOUPLE - VAPOR SPACE	4,070	4,350	16	21
S999-351-4085-TE-C	TYPE B THERMOCOUPLE - VAPOR SPACE	4,070	4,350	16	23
	TOTAL COST - THERMOWELL - VAPOR/COND. PROBE	41,910	47,930		
T.V. CAMERA ASSEMBLY (NOZZLE D1)					
S999-351-BB-02	BELLOWS - BORESCOPE	2,000	2,140	18	20
S999-351-CR-02	S.S. C RING	40	40	18	24
S999-351-MB-02	BORESCOPE	12,000	12,840	18	16
S999-351-15-30	T.V. CAMERA CARRIER FRAME	35,450	41,730	11	36
S999-351-672-02	T.V. CAMERA/HOUSING ASSEMBLY	88,000	94,160	15	5
	TOTAL COST - T.V. CAMERA ASSEMBLY (NOZZLE D1)	137,490	150,910		
T.V. CAMERA ASSEMBLY (NOZZLE D)					
S999-351-BB-01	BELLOWS - BORESCOPE	2,000	2,140	18	18
S999-351-CR-01	S.S. C RING	40	40	18	22
S999-351-MB-01	BORESCOPE	12,000	12,840	18	14
S999-351-15-30	T.V. CAMERA CARRIER FRAME	35,450	41,730	11	36
S999-351-672-01	T.V. CAMERA/HOUSING ASSEMBLY	88,000	94,160	15	3
	TOTAL COST - T.V. CAMERA ASSEMBLY (NOZZLE D)	137,490	150,910		
DOME HEATERS					
S999-351-12-00	FIBERFRAX ROPE - DOME HEATER SEAL	500	540	13	24
S999-351-16-00	DOME HEATERS (4 ASSYS)	86,300	101,540	11	23
S999-351-16-01	ISOLATORS - DOME HEATERS	16,800	19,690	12	15
S999-351-2960-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	7
S999-351-2961-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	9
S999-351-2962-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	11
S999-351-2963-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	13
S999-351-2968-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	15
S999-351-2969-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	17
S999-351-2970-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	19
S999-351-2971-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	21
S999-351-2972-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	23
S999-351-2973-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	25
S999-351-2974-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	27

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
S999-351-2975-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	29
S999-351-3800-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	31
S999-351-3801-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	33
S999-351-3802-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	35
S999-351-3803-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	37
	TOTAL COST - DOME HEATERS	151,600	173,050		
DRAIN VALVE					
S999-351-19-00	DRAIN VALVE	191,300	225,130	11	42
S999-351-19-01	CANISTER BELLOWS ASSEMBLY - DRAIN VALVE	46,000	54,140	10	23
S999-351-19-02	ISOLATORS - DRAIN VALVE	142,000	167,130	12	11
S999-351-19-03	ZIRCAR INSULATION - DRAIN VALVE	7,200	8,450	11	17
S999-351-19-04	ADAPTER BELLOWS ASSEMBLY - DRAIN VALVE	13,400	15,730	10	26
S999-351-19-05	PLUG BELLOWS ASSEMBLY - DRAIN VALVE	18,000	21,190	10	29
S999-351-19-06	UPPER PROBE BELLOWS ASSY - DRAIN VALVE	11,600	13,590	10	32
S999-351-19-07	LOWER PROBE BELLOWS ASSY - DRAIN VALVE	11,600	13,590	10	35
S999-351-19-08	DRAIN VALVE BELLOWS - ENGR & SETUP CHARGES	16,000	18,830	10	38
S999-351-2940-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 1	3,260	3,480	15	25
S999-351-2941-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 1	3,260	3,480	15	27
S999-351-2942-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 2	1,460	1,560	16	33
S999-351-2943-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 2	1,460	1,560	16	35
S999-351-2944-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 3	1,400	1,500	16	37
S999-351-2947-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 4	1,620	1,730	16	41
S999-351-2948-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 3	1,400	1,500	16	39
S999-351-2949-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 4	1,400	1,500	17	1
S999-351-2955-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 5	1,570	1,670	17	3
S999-351-2956-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 5	1,570	1,670	17	5
	TOTAL COST - DRAIN VALVE	475,500	557,430		
ELECTRODES					
S999-351-14-00	ELECTRODES (2 UPPER, 2 LOWER)	63,300	74,470	11	21
S999-351-14-01	ISOLATORS - ELECTRODES	8,500	9,950	12	13
S999-351-18-05	GASKETS - FIBERFRAX	400	430	11	15
S999-351-2920-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	25
S999-351-2921-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	27
S999-351-2930-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	29
S999-351-2931-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	31
	TOTAL COST - ELECTRODES	84,840	98,370		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
POUR SPOUT BELLOWS					
S999-351-20-00	POUR SPOUT BELLOWS ASSY	224,200	266,220	11	9
S999-351-20-01	ACTUATOR BELLOWS - POUR SPOUT BELLOWS	10,200	11,770	10	41
S999-351-20-02	LOWER ADAPTER BELLOWS- POUR SPOUT BELLOWS	13,300	15,300	11	1
S999-351-20-03	UPPER ADAPTER BELLOWS	16,600	19,150	11	4
	TOTAL COST - POUR SPOUT BELLOWS	264,300	312,440		
RISER HEATER					
S999-351-18-00	RISER/POUR SPOUT HEATER	103,200	121,450	11	38
S999-351-18-02	ISOLATORS - RISER HEATER	98,400	115,770	12	17
S999-351-18-06	ZIRCAR INSULATION - RISER/PS HEATER	10,100	11,980	11	11
S999-351-18-08	ZIRCAR INSULATION - RISER END	8,600	10,170	11	13
S999-351-2753-TE	TYPE B THERMOCOUPLE - RISER HEATER, TOP UPPER	5,350	5,720	15	21
S999-351-2754-TE	TYPE B THERMOCOUPLE - RISER HEATER, TOP LOWER	6,280	6,720	15	23
S999-351-2951-TE	TYPE B THERMOCOUPLE - RISER HEATER, BOTTOM	4,140	4,420	15	29
S999-351-2952-TE	TYPE B THERMOCOUPLE - RISER HEATER, BOTTOM	4,140	4,420	15	31
S999-351-2953-TE	TYPE B THERMOCOUPLE - POUR SPOUT HEATER, UPPER	3,370	3,600	15	33
S999-351-2954-TE	TYPE B THERMOCOUPLE - POUR SPOUT HEATER, LOWER	3,920	4,190	15	35
	TOTAL COST - RISER HEATER	247,500	288,440		
	TOTAL COST -	6,076,460	8,246,280		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

TABLE 4

MELTER #3 COST SUMMARY - WILMINGTON EQUIPMENT TO DESIGN AREA NET TOTAL

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

DESCRIPTION	MELTER #3 COST IN \$	CAB LOCATION	
		PAGE	LINE
VESSEL & RELATED COMPONENTS	2,274,280	10-19	
REFRACTORY LINING	1,321,450	13-14	
TOP HEAD COMPONENTS	796,410	11-18	
SHELL COMPONENTS	1,429,730	11	
INCONEL 690 MATERIAL & WELD WIRE	377,500	12	
MELTER FRAME, COMPONENTS, & ASSY	2,046,910	14	
TOTAL MELTER WILMINGTON EQUIPMENT COST*	8,246,280		
Following are field costs and allowances for melter #3:			
FIELD LABOR & MATERIALS FOR ASSY IN 717-F MOCK UP SHOP	68,000	18	34-41
" " "	136,000	19	1-13
" " "	10,000	15	7
ALLOWANCE FOR SHIPPING REFRACTORY FIXTURES	30,000	14	10
ALLOWANCE FOR NICKLE MATERIAL COST INCREASES	150,000	12	38
INCONEL 690 MATERIAL & WELD WIRE FOR MELTER #4	377,500	12	27-34
PROJECT ENGINEERING ALLOWANCE	1,352,700	19	18
EXTRA MACHINERY - MELTER #3 - DESIGN AREA NET TOTAL	10,370,480	19	30

This is a summary of the Melter #3 project cost showing how the \$8,246,280 equipment cost is escalated to the \$10,370,480 Design Area Net Total. This net total appears on CAB page 19 line 30, and is carried over to CAB page 9 line 3. See Table 6 for grossing to the \$19,000,000 grand total project level.

* The \$8.2 million equipment cost does not appear as a line item in the CAB since the cumulative total on each page includes the field costs and allowances. Equipment costs include the following values for thermocouples:

- Vessel & related components: \$320 (Type K)
- Top Head Components: \$107,690 (Type B, platinum sheath)
- Shell Components: \$113,520 (Type B, platinum sheath)

See Tables 1 through 3 for additional equipment cost details.

TABLE 5
MELTER #3 COST SUMMARY - DESIGN AREA NET TOTAL TO PROJECT GRAND TOTAL
PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

DESCRIPTION	MELTER #3 COST IN \$	CAB LOCATION	
		PAGE	LINE
EXTRA MACHINERY - MELTER #3 - DESIGN AREA NET TOTAL	10,370,480	19	30
(Design area net total carried over to CAB page 9 line 3)	10,370,480	9	3
CONSTRUCTION TICE, CF, TE	139,000	9	9
QUALITY ASSURANCE - CONSTRUCTION	10,900	9	10
TURNOVER & TRAINING	2,200	9	11
STORES MATERIAL	6,600	9	12
M & M DISTRIBUTION	13,100	9	13
FREIGHT ALLOWANCE	100,900	9	14
DIRECT MANUFACTURING FACILITIES EQUIPMENT	10,643,180	9	17
(Dir.mfg.facs.equipment carried over to CAB page 1 line 8)	10,643,180	1	8
PROVISIONS FOR ADVANCING WAGES AND MATERIALS	1,597,820	1	16
PREMIUM TIME - ABNORMAL REQUIREMENTS ONLY	25,000	1	17
DIRECT TOTAL	12,266,000	1	19
FIELD INDIRECTS	34,000	1	21
FIELD COST	12,300,000	1	23
OWNER'S PROJECT ADMINISTRATION (DuPONT)	700,000	1	25
ENGINEERING CONTRACTOR (BECHTEL)	5,700,000	1	26
AED LIAISON ALLOWANCE	300,000	1	27
GRAND TOTAL AT PROJECT LEVEL	19,000,000	1	29

This summary is taken directly from the CAB showing how the \$10,370,480 design area net total grosses to the \$19,000,000 project level cost. Refer to the CAB for the breakdown of these total costs into labor, field material, and Wilmington material.

Included in this estimate is a total cost of \$3.2 million for quality assurance related items - inspections, additional costs for SRQA, etc.

TABLE 6

CAPACITY COST FACTOR vs CAPACITY RATIO

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

$$COST_2 = COST_1 \left[\frac{CAPACITY\ 2}{CAPACITY\ 1} \right]^n \quad \text{where } n = \text{exponential factor (usually 0.6)}$$

This graph is used by the industry to estimate costs of similar pieces of equipment having different capacities. The "rule of thumb" is to use the curve for the 0.6 exponent. Assuming that the DWPF melter has a 3X capacity compared to the West Valley unit, $C_2/C_1 = 3$, and the capacity cost factor is almost 2 at the 0.6 exponential curve, i.e. the DWPF melter would be expected to cost approximately 2X more for the capacity increase alone. This comparison should be based on the adjusted cost of the DWPF melter equipment, after subtracting the costs of items not included in the West Valley design (See letter DP 0002621 for details).

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

DESCRIPTION		FROM:	D O L L A R S				
		SHEET:	U. S.				
		NO.	LABOR	FIELD MATERIAL	WILM. MATERIAL	LS/UP CONTRACT	TOTAL
1:	LAND		0	0	0	0	0
2:	PRECIOUS METALS		0	0	0	0	0
3:	ABANDONED FIELD COST		0	0	0	0	0
4:	MAINTAINING PRODUCTION		0	0	0	0	0
5:	DISMANTLING AND REARRANGING		0	0	0	0	0
6:	PROPERTY DAMAGES & PUBLIC LIABILITY LOSSES		0	0	0	0	0
7:	DIRECT MANUFACTURING FACILITIES		0	0	0	0	0
8:	-BUILDINGS		0	0	0	0	0
9:	TECHNICAL ACTIVITIES FACILITIES	9	312700	139700	10190780	0	10643180
10:	-EQUIPMENT		0	0	0	0	0
11:	POWER, GENERAL AND SERVICE FACILITIES		0	0	0	0	0
12:	-BUILDINGS		0	0	0	0	0
13:	-EQUIPMENT AND MISC.		0	0	0	0	0
14:			312700	139700	10190780	0	10643180
15:							
16:	PROVISIONS FOR ADVANCING WAGES AND MATERIALS		61500	30700	1505620	0	1597820
17:	PREMIUM TIME - ABNORMAL REQUIREMENTS ONLY		25000	0	0	0	25000
18:							
19:	DIRECT TOTAL		399200	170400	11696400	0	12266000
20:							
21:	FIELD INDIRECTS		34000	0	0	0	34000
22:							
23:	FIELD COST		433200	170400	11696400	0	12300000
24:							
25:	OWNERS PROJECT ADMINISTRATION		700000	0	0	0	700000
26:	ENGINEERING CONTRACTOR		5700000	0	0	0	5700000
27:	AED LIAISON ALLOWANCE		0	0	0	300000	300000
28:							
29:	GRAND TOTAL		6833200	170400	11696400	300000	19000000

CAB UPDATE 10/88

RECOMMEND DOE INCLUDE
10% ADDITIONAL FUNDS
FOR CONTINGENCY.

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

PROJECT OBJECTIVE

THE OBJECTIVE OF P-3420 (AND THIS CAB ESTIMATE) IS TO
PROVIDE NO. 3 MELTER ASSEMBLY AND SUFFICIENT INCONEL
690 MATERIAL, INCLUDING TYPE 690 WELD WIRE FOR BOTH
MELTER 3 & 4.
AN OPTION TO PROCURE MELTER NO. 4 WILL BE INCLUDED IN
THE BID PACKAGE FOR NO. 3, BUT THIS PROJECT (AND ESTIMATE)
WILL NOT FUND PROCUREMENT OF NO. 4.

PROJECT SCOPE

ESTIMATE IS BASED ON DESIGN BY DUPONT LOUVIERS AED AND
PROCUREMENT BY BECHTEL BRDO SAVANNAH RIVER PLANT. BECHTEL
WILL OVERSEE THE MELTER FABRICATION, ASSEMBLY & CONSTRUCTION
(FIELD ASSEMBLY).

DUPONT MECHANICAL & INSTRUMENT SCOPES

1. ONE MELTER VESSEL
2. REFRACTORY LINING MATLS, INSTALLATION OF THESE IN THE
VESSEL SHELL & HEAD, AND DRYOUT OF THE REFRACTORY
3. INCONEL 690 MATL FOR TWO MELTER ASSEMBLIES
4. ONE SET OF MELTER COMPONENTS CONSISTING OF (4)
ELECTRODES, (8) DOME HEATERS, (1) RISER/POUR SPOUT
HEATER, (1) POUR SPOUT BELLOWS, (1) DRAIN VALVE,
(2) FEED TUBES, (2) MELT THERMOWELLS, (2) TV CARRIER
FRAMES, (1) VAPOR THERMOWELL/CONDUCTIVITY PROBE, (1)
MELT LEVEL DIP TUBE, AND (2) FILM COOLERS
5. ONE SET OF ALUMINA ISOLATORS
6. ONE SET OF BELLOWS FOR THE POUR SPOUT AND DRAIN VALVE
7. THERMOCOUPLES FOR RISER/POUR SPOUT HEATER, DRAIN
VALVE, DOME HEATERS, AND REFRACTORY BACK FACE
8. TWO BORESCOPES FOR THE TV CAMERA CARRIER FRAMES

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPFG GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

.BECHTEL EQUIPMENT LIST

1. ONE MELTER FRAME
2. MELTER ASSEMBLY (PARTIAL) AT VENDOR'S SHOP
3. ELECTRICAL ITEMS- BUS BARS, DOME HEATER TRANSFORMERS,
LOWER HOLDERS AND CABLE
4. PROCESS CONNECTORS
5. TWO TV CAMERA ASSEMBLIES
6. CANISTER POSITIONING ARM

.CONSTRUCTION SCOPE

1. INSTALLATION OF ALL MELTER COMPONENTS
2. COMPLETION OF ASSEMBLY WORK, INCLUDING ELECTRICAL,
PIPING, HYDROTESTS AND FLOW TESTS

THE FOLLOWING ITEMS ARE NOT INCLUDED IN THIS PROJECT SCOPE

1. JUMPERS FROM CANYON WALL TO MELTER FRAME AND TOP
HEAD COMPONENTS
2. OFF-GAS PIPING
3. SEAL POT
4. PHYSICAL MOCKUP OF JUMPERS WITH THE FRAME AND TOP
HEAD COMPONENTS
5. SPARE COMPONENTS AND EXTRA MACHINERY
6. PROVISIONS FOR ADDITIONAL STORAGE FOR MELTER
ASSEMBLIES, ETC.
7. REFRACTORY AND INSULATION FIXTURES
8. INSTALLATION OF THE MELTER INTO THE VIT BUILDING

PROJ 9S3420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25

DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

SCOPES OF WORK

FUNCTION -----	DATE ----	AUTHOR -----	REMARKS -----
PROCESS	02/29/88	WE GUENTHNER	
PROCESS	04/06/88	WE GUENTHNER	
MECHANICAL	04/04/88	JD GUTMANN	
MECHANICAL	03/23/88	JE MEUNIER-BECHTEL	EQUIP LIST ONLY
ELECTRICAL	02/22/88	AQ HAIDERI	
INSTRUMENTS	02/24/88	RW FOSTER	
DUPONT QAMME	03/14/88	LJ MCANALLEN	
CONSTRUCTION	03/31/88	JN ODUM	

ESTIMATE REVIEW COMMENTS

PROCESS	04/28/88	WE GUENTHNER	
MECHANICAL	04/28/88	JD GUTMANN	
MECHANICAL	04/26/88	JE MEUNIER	
ELECTRICAL		NONE	
INSTRUMENTS		NONE	
CONSTRUCTION	04/26/88	JN ODUM	
PD AED	04/25/88	JR GLASSCOCK	

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ESTIMATE REVIEW UPDATE

CAB ESTIMATE UPDATE WAS HELD ON 10/13/88 AT SAVANNAH RIVER
CONSTRUCTION. THE FOLLOWING ATTENDED THE MEETING:

D.C. WITT	PD AED
D.T. TESCHNER	BECHTEL
W.R. FRAZER	BECHTEL
D.L. KINNSCH	BECHTEL
P.T. MC CUE	BECHTEL
D.W. STROHMAN	BECHTEL
R.J. HEALY	BECHTEL
J.M. MC KIBBEN	DU PONT
J.D. GUTMANN JR.	DU PONT
C.G. MULLINS	DU PONT
R.J. TUURI	DU PONT
R.D. CRECCO	DU PONT
T.F. HARRINGTON	DU PONT

BASIS OF ESTIMATE

1. THE MAJOR COST OF THIS PROJECT WILL BE THE DESIGN AND
PROCUREMENT OF NO.3 MELTER AND IT'S COMPONENTS. CONSTRUCTION
WILL INSTALL PART OF THE COMPONENTS AND COMPLETE THE ASSEMBLY IN
THE 717F MOCKUP BUILDING. FOLLOWING IS THE BASIS FOR PRICING:

.DUPONT DESIGN (FUNCTIONS 2.3,13E AND 13I) WROTE SCOPES OF
WORK WHICH INCLUDED A PRICED EQUIPMENT LIST OF THE MAJORITY
OF NO.3 MELTER COMPONENTS.

.BECHTEL ENGINEERING FURNISHED A PRICED EQUIPMENT LIST FOR
THE REMAINING PIECES, INCLUDING MELTER FRAME, VENDOR SHOP
ERECTION COST AND ELECTRICAL COMPONENTS.

.PRICING FOR (1)ONE MELTER VESSEL, (2)ONE FRAME & (3)ONE
VENDOR'S ASSEMBLY IS BASED ON A \$3.9MM VERBAL QUOTE FROM
CB&I CORPORATION. CB&I'S \$3.9MM QUOTE IS RANGED +10,-10%
AND IS BASED ON ORDER RELEASE 3/89 AND DELIVERY 4Q91.

.INCONEL 690 MATERIAL PRICING IS BASED ON THE FOLLOWING:

1. APPROXIMATELY 45000 LBS. OF EXCESS INCONEL 690 FROM
P-1780 DWPF AXC 6844W PURCHASED AT ABOUT \$7.00/LB WHICH
IS TO BE TRANSFERRED FOR USE ON THIS PROJECT 3420
2. PROCURING APPROXIMATELY 16000 LBS OF ADDITIONAL INCONEL
690 AT ABOUT \$14.00/LB WITH A 7% SROA ALLOWANCE ADDED.

DEPARTMENT - PETROCHEMICALS AED

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TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

.ALL OTHER EQUIPMENT PRICES ARE BASED ON NO.1&2 MELTER
PURCHASE ORDERS AND INDEXED TO CURRENT TIME. MELTER 3
COMPONENTS ARE IDENTICAL IN DESIGN TO NO.1 & 2.
.A \$150,000 PRICE ADJUSTMENT FOR NICKEL MATERIAL IS
INCLUDED IN THE ESTIMATE. THIS IS BASED ON PROCURING
APPROXIMATELY 40,000 LBS. OF NICKEL AT A PRICE OF \$6.00 PER
POUND FOR THIS PROJECT VERSUS APPROXIMATELY \$2.30 PER POUND
WHEN MELTERS 1 & 2 WERE PROCURED.
.CONSTRUCTION FURNISHED THE FIELD ASSEMBLY ESTIMATE
BASED ON THEIR EXPERIENCE ASSEMBLING NO.1 MELTER.
.DOLLARS FOR SAVANNAH RIVER QUALITY ASSURANCE (SRQA) ARE
INCLUDED IN THE ESTIMATE DETAIL BASED ON DESIGN'S AND
CONSTRUCTION'S ASSESSMENT OF THE THREE COMPONENTS BELOW:
A.DUPONT OWNERS PROJECT ADMINISTRATION (OPA) AND
BECHTEL HOME OFFICE ESTIMATES FOR ADDITIONAL
MANMONTHS OF DESIGN TIME DUE TO SRQA REQNTS.
B.WILMINGTON MATERIAL (MELTER & COMPONENTS)-
ANTICIPATED ADDITIONAL COST AS A PERCENT
OF WILM MATL - ESTIMATED APPROX 7% OF WM
C.CONSTRUCTION'S ESTIMATE OF ADDITIONAL LABOR
FOR ASSEMBLY WORK

.DUPONT OPA & BECHTEL ENGINEERING & PROCUREMENT
ESTIMATES ARE BASED ON TASK ANALYSES MADE BY
BOTH ORGANIZATIONS AS FOLLOWS:

\$M

TOTAL BUDGET

A.DUPONT OWNERS PROJ ADM

700

B.BECHTEL (ENGG CONTRACTOR) HOME OFFICE

5700

2.PROJECT SCHEDULE (PRELIMINARY)

.DESIGN START	4087 (UPDATE MELTERS 1&2 DRAWINGS FOR MELTER 3 PROJECT)
.AUTHORIZATION	1089
.INITIAL ORDER RELEASE	1089
.LAST ORDER RELEASE	3090
.MELTER DELIVERY TO SRP	4091
.START FIELD ASSEMBLY	4091
.MECHANICAL COMPLETION	1092
.PHYSICAL COMPLETION	2092

DEPARTMENT - PETROCHEMICALS AED

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SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

3. INDEXES AND ESCALATION RATES

.M&E INDEX AT TIME OF ESTIMATE 166 2088

.M&E INDEX AT MIDPOINT OF PROCUREMENT 181 3090

.CCI INDEX AT TIME OF ESTIMATE 182 2088

.DOE ESCALATION RATES(%), L.S. BABB'S LETTER 8/15/88

1988 1989 1990 1991 1992

LABOR 2 4 5 6 6

MATERIAL 3 4 4 5 5

E&PA 5 4 4 5 5

4. MAJOR ALLOWANCES

SUMMARY (FRONT) SHEET ALLOWANCES

.SRQA COSTS

DOLLARS INCLUDED IN
ESTIMATE DETAIL
(SEE BASIS OF ESTIMATE)

.AED LIAISON ALLOWANCE

\$300,000

.CONTINGENCY (DOE)

\$0 IN THIS ESTIMATE,
RECOMMEND DOE INCLUDE
+10% OF TOTAL PROJECT

SUBSUMMARY ALLOWS & SITE FACTORS

.M&M DISTRIBUTION

6% OF LABOR

.STORES MATERIAL

3% OF LABOR

.TURNOVER & TRAINING

1% OF LABOR

.QUALITY ASSURANCE - CONSTR.

5% OF LABOR

.FREIGHT ALLOWANCE

1% OF WILM MATL'

.QUALITY ASSURANCE MATERIALS MGT.

INCL IN BECHTEL H.O. COST

DESIGN AREA ALLOWANCES

.NICKEL MATERIAL ADJUSTMENT

\$150,000

.PROJECT ENGG ALLOWANCE

15% OF DESIGN AREA TOTALS

5. CONSTRUCTION OVERHEADS

.FIELD INDIRECTS

TWC 0209 10% OF NET LABOR

.CONSTR TICF,CF,TE-LABOR

TWC 0401 20% OF NET LABOR

.CONSTR TICF,CF,TE-FLD MATL

TWC 0401 21% OF NET LABOR

TOTAL 51%

PROJ 9S3420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

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TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

JOURNEYMEN WAGE RATES

EFFECTIVE DATE		EXPIRATION DATE	JOURNEYMAN WAGE RATE
04/01/88	CARPENTER	03/31/89	17.78
05/01/87	ELECTRICIAN	04/30/88	19.75
06/01/87	POWER EQUIP. OPERATOR	05/31/88	18.96
08/01/87	INSULATOR	07/31/88	18.33
06/01/87	IRONWORKER-STRUCTURAL	05/31/88	18.52
07/01/87	LABORER	06/30/88	9.82
08/01/87	MILLWRIGHT	07/31/88	18.42
05/01/87	PAINTER	04/30/88	17.67
05/01/87	PIPE FITTER	04/30/88	18.71
05/01/87	SHEET METAL WORKER	04/30/88	19.70
04/04/88	WEIGHTED SITE AVERAGE-JOURNEYMEN ONLY		17.87

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
SUB-SUMMARY

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

DESIGN :	DESCRIPTION :	FROM :	\$\$\$\$\$\$\$\$\$\$\$ U.	S.	D	O	L	L	A	R	S	\$\$\$\$\$\$\$\$\$\$\$
AREA :		SHEET :		FIELD								
OR TWC :		NO. :	LABOR	MATERIAL		WILM.				LS/UP	CONTRACT	TOTAL
1:	DIR. MFG. FACS. EQUIPMENT	:										
2:		:										
3:	5999 EXTRA MACHINERY-MELTER NO.3	10 :	218500	62100		10089880						10370480
4												
5												
6		SUB TOTAL	218500	62100		10089880						10370480
7												
8												
9	0401 CONSTR TICF,CF,TE		68000	71000								139000
10	9500 QUALITY ASSURANCE-CONSTR		10900									10900
11	9500 TURNOVER & TRAINING		2200									2200
12	9500 STORES MATERIAL			6600								6600
13	9500 M&M DISTRIBUTION		13100									13100
14	9500 FREIGHT ALLOW					100900						100900
15												
16												
17	DIR. MFG. FACS. EQUIPMENT	NET TOTAL	312700	139700		10190780						10643180
18												
19												
20												
21												
22												
23												
24												
25												
26												
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PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

: ENGINEERING NUMBER : TWC F: D E S C R I P T I O N : QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$\$\$\$\$									
: DESIGN : U: R: FIELD WILM.									
: AREA UNIT ITEM ELM : N: : AMT UM: C: LABOR MATERIAL MATERIAL TOTAL									

1:	S999								
2:									
3:	S999								
4:									
5:									
6:									
7:									
8:									
9:									
10:									
11:									
12:									
13:									
14:									
15:	S999								
16:									
17:									
18:									
19:									
20:									
21:	S999								
22:									
23:	S999	351	19	1: 1300	3: CANISTER BELLOWS ASSEMBLY -	1 EA: I:		54140	54140
24:	S999	351	19	1: 1300	3: DRAIN VALVE				
25:									
26:	S999	351	19	4: 1300	3: ADAPTER BELLOWS ASSEMBLY -	1 EA: I:		15730	15730
27:	S999	351	19	4: 1300	3: DRAIN VALVE				
28:									
29:	S999	351	19	5: 1300	3: PLUG BELLOWS ASSEMBLY - DRAIN:	2 EA: I:		21190	21190
30:	S999	351	19	5: 1300	3: VALVE				
31:									
32:	S999	351	19	6: 1300	3: UPPER PROBE BELLOWS ASSY -	1 EA: I:		13590	13590
33:	S999	351	19	6: 1300	3: DRAIN VALVE				
34:									
35:	S999	351	19	7: 1300	3: LOWER PROBE BELLOWS ASSY -	1 EA: I:		13590	13590
36:	S999	351	19	7: 1300	3: DRAIN VALVE				
37:									
38:	S999	351	19	8: 1300	3: DR VALVE BELLOWS ENGG & SETUP:	1 LS: I:		18830	18830
39:	S999	351	19	8: 1300	3: CHARGES				
40:									
41:	S999	351	20	1: 1300	3: ACTUATOR BELLOWS-POUR SPOUT	1 EA: I:		11770	11770
42:	S999	351	20	1: 1300	3: BELLOWS				
43:									
44:									
45:									
PAGE 10					PAGE TOTALS		0	0	148840 148840

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC		DESCRIPTION				QUANTITY		S: \$\$\$\$\$\$\$\$\$\$ U. S.		D O L L A R S \$\$\$\$\$\$\$\$\$\$	
DESIGN				U:				R:				FIELD		WILM.	
AREA	UNIT	ITEM	ELM		N:			AMT	UM:	C:	LABOR	MATERIAL	MATERIAL	TOTAL	
1:	S999	351	20	2:	1300	3:	LOWER ADAPTER BELLOWS-POUR	1	EA:	I:			15300	15300	
2:	S999	351	20	2:	1300	3:	SPOUT BELLOWS								
3:															
4:	S999	351	20	3:	1300	3:	UPPER ADAPTER BELLOWS	1	EA:	I:			19150	19150	
5:															
6:															
7:	S999						COMPONENTS								
8:															
9:	S999	351	20		1300	3:	POUR SPOUT BELLOWS ASSY	1	EA:	I:			266220	266220	
10:															
11:	S999	351	18	6:	1300	3:	ZIRCAR INSULATION-RISER HTR.	1	LS:	I:			11980	11980	
12:															
13:	S999	351	18	8:	1300	3:	ZIRCAR INSULATION	1	LS:	I:			10170	10170	
14:															
15:	S999	351	18	5:	1300	3:	GASKETS-FIBERFRAX	1	LS:	I:			430	430	
16:															
17:	S999	351	19	3:	1300	3:	ZIRCAR INSUL.-DRAIN VALVE	1	LS:	I:			8450	8450	
18:															
19:	S999	351	13	1:	1300	3:	FIBERFRAX-MILLED	1	LS:	I:			960	960	
20:															
21:	S999	351	14		1300	3:	ELECTRODES(2 UPPER,2 LOWER)	4	EA:	I:			74470	74470	
22:															
23:	S999	351	16		1300	3:	DOME HEATERS (4 ASSYS)	4	EA:	I:			101540	101540	
24:															
25:	S999	351	13		1300	3:	FEED TUBES (2)	2	EA:	I:			174730	174730	
26:															
27:	S999	351	15		1300	3:	MELT THERMOWELL-NOZZLE E	1	EA:	I:			34130	34130	
28:															
29:	S999	351	15	5:	1300	3:	MELT THERMOWELL-NOZZLE C-4	1	EA:	I:			35520	35520	
30:															
31:	S999	351	15	10:	1300	3:	VAPOR THERMOWELL/CONDUCTIVITY	1	EA:	I:			34880	34880	
32:	S999	351	15	10:	1300	3:	PROBE								
33:															
34:	S999	351	15	20:	1300	3:	MELT LEVEL DIP TUBE	1	EA:	I:			30920	30920	
35:															
36:	S999	351	15	30:	1300	3:	T.V. CAMERA FRAMES (2)	2	EA:	I:			83460	83460	
37:															
38:	S999	351	18		1300	3:	RISER HEATER	1	EA:	I:			121450	121450	
39:															
40:	S999	351	10	12:	1300	3:	SHELL COMPONENTS-MISC	1	LS:	I:			10060	10060	
41:															
42:	S999	351	19		1300	3:	DRAIN VALVE	1	EA:	I:			225130	225130	
43:															
44:															
45:															
				PAGE 11		PAGE TOTALS		0		0		1258950		1258950	

PROJ 9S3420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25

DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC		F	DESCRIPTION		QUANTITY		S	D O L L A R S		TOTAL	
DESIGN	AREA	UNIT	ITEM	ELM	U	N			AMT	UM	C	LABOR	FIELD MATERIAL	WILM. MATERIAL	
1:	S999	351	10	3:	1300	3:	ANCHOR FLANGES		1	LS	I			37130	37130
2:															
3:	S999	351	15	40:	1300	3:	FILM COOLER-OFF GAS NOZZLE A		1	EA	I			22470	22470
4:															
5:	S999	351	15	50:	1300	3:	FILM COOLER-BACK UP OFF GAS		1	EA	I			16160	16160
6:	S999	351	15	50:	1300	3:	NOZZLE T								
7:															
8:															
9:	S999						ISOLATORS								
10:															
11:	S999	351	19	2:	1300	3:	ISOLATORS-DRAIN VALVE		1	LS	I			167130	167130
12:															
13:	S999	351	14	1:	1300	3:	ISOLATORS-ELECTRODES		1	LS	I			9950	9950
14:															
15:	S999	351	16	1:	1300	3:	ISOLATORS-DOME HEATERS		1	LS	I			19690	19690
16:															
17:	S999	351	18	2:	1300	3:	ISOLATORS-RISER HEATER		1	LS	I			115770	115770
18:															
19:	S999	351	10	2:	1300	3:	EXTERNAL ISOLATORS		1	LS	I			23540	23540
20:															
21:															
22:	S999						INCONEL 690 MATERIAL								
23:															
24:							NOTE: INCLUDES 690 MATERIAL								
25:							FOR MELTER 3& FUTURE MELTER 4:								
26:															
27:	S999	351	10	4:	1300	3:	TYPE 690 WELD WIRE (2 MELTER		1	LS	I			200000	200000
28:	S999	351	10	4:	1300	3:	ASSYS)								
29:															
30:	S999	351	10	1:	1300	3:	INCONEL 690 MATERIAL (P-1780		45M	LB	I			315000	315000
31:	S999	351	10	1:	1300	3:	AXC 6844W EXCESS MATERIAL -								
32:	S999	351	10	1:	1300	3:	TO BE TRANSFERRED TO P-3420)								
33:															
34:	S999	351	10	2:	1300	3:	INCONEL 690 MATERIAL		16M	LB	V			240000	240000
35:	S999	351	10	2:	1300	3:	(ADDITIONAL NEW MATERIAL TO								
36:	S999	351	10	2:	1300	3:	BE PROCURED)								
37:															
38:	S999	351			1300	3:	ADJUSTMENT FOR UNUSUAL NICKEL		1	LS	D			150000	150000
39:	S999	351			1300	3:	MATERIAL PRICE FLUCTUATIONS								
40:															
41:															
42:															
43:															
44:															
45:															
				PAGE		12		PAGE TOTALS		0		0		1316840	1316840

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC F		DESCRIPTION		QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S.		D O L L A R S \$\$\$\$\$\$\$\$\$\$			
DESIGN				U				R					
AREA	UNIT	ITEM	ELM		N			AMT	UM	C	TOTAL		
1:	S999					MELTER VESSEL							
2:													
3:	S999	351	10		1300	3:	MELTER VESSEL-PART OF	1	EA	V	2225600		
4:	S999	351	10		1300	3:	CB&I VERBAL QUOTE				2225600		
5:													
6:	S999	351	10		1300	3:	REFRACTORY DRY OUT	1	LS	I	17120		
7:											17120		
8:	S999	351	10	6:	1300	3:	BORE INCONEL 690 FOR	1	LS	I	1280		
9:	S999	351	10	6:	1300	3:	A & T NOZZLES				1280		
10:													
11:	S999	351	10	5:	1300	3:	SS O RINGS-VESSEL SHELL/HEAD	1	LS	I	12200		
12:	S999	351	10	5:	1300	3:	FLANGE				12200		
13:													
14:	S999	351	10	10:	1300	3:	SS O RINGS-A&T NOZZLES -	1	LS	I	1280		
15:	S999	351	10	10:	1300	3:	HYDROTEST				1280		
16:													
17:													
18:	S999					REFRACTORY INSTALLATION							
19:													
20:	S999	351	12	45:	1300	3:	FIBERFRAX-MISC BULK PAPER,DSM	1	LS	I	1820		
21:											1820		
22:	S999	351	12		1300	3:	REFRACTORY INSTALLATION	1	LS	I	167240		
23:											167240		
24:	S999	351	12		1300	3:	FIBERFRAX ROPE-DOME	1	LS	I	540		
25:	S999	351	12		1300	3:	HEATER SEAL				540		
26:													
27:													
28:	S999					FIBERFRAX LINERS							
29:													
30:	S999	351	12	40:	1300	3:	FIBERFRAX INSULATION	1	LS	I	130010		
31:											130010		
32:													
33:	S999					REFRACTORY K-3							
34:													
35:	S999	351	12	10:	1300	3:	K-3 REFRACTORY	1	LS	I	560680		
36:	S999	351	12	12:	1300	3:	K-3 GRINDING & DRILLING	1	LS	I	108820		
37:	S999	351	12	13:	1300	3:	K-3 WIRE CUTTING & GRINDING	1	LS	I	11340		
38:											11340		
39:													
40:	S999					REFRACTORY-SUPERSTRUCTURE							
41:													
42:	S999	351	12	30:	1300	3:	SUPERSTRUCTURE REFRACTORY	1	LS	I	160500		
43:											160500		
44:													
45:													
				PAGE	13	PAGE TOTALS				0	0	3398430	3398430

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPFG GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC		DESCRIPTION		QUANTITY		U. S.		D O L L A R S		\$\$\$\$\$\$\$\$	
DESIGN	AREA	UNIT	ITEM ELM	U	N	AMT	UM	LABOR	FIELD MATERIAL	WILM. MATERIAL	TOTAL				
1:	S999														
REFRACTORY-ZIRMUL															
2:															
3:	S999	351	12	20:	1300	3:	ZIRMUL REFRACTORY	1 LS:	I:			154080		154080	
4:															
5:															
6:	S999						REFRACTORY - ZIRMUL GRINDING								
7:															
8:	S999	351	12	22:	1300	3:	ZIRMUL GRINDING	1 LS:	I:			9840		9840	
9:															
10:	S999	351			1300	3:	ALLOWANCE FOR SHIPPING	1 LS:	E:	5000	25000			30000	
11:	S999	351			1300	3:	REFRACTORY FIXTURES								
12:															
13:															
14:															
15:	S999						THE FOLLOWING EQUIPMENT WAS								
16:							PRICED BASED ON EQUIP LIST								
17:							FURNISHED BY JE MEUNIER								
18:							DATED 3/23/88:								
19:															
20:															
21:	S999	351			1300	3:	MELTER ASSEMBLY AT VENDOR'S	1 LS:	V:			1209100		1209100	
22:	S999	351			1300	3:	SHOP-PART OF CB&I VERBAL								
23:	S999	351			1300	3:	QUOTE								
24:															
25:	S999	351	46		1300	3:	MELTER FRAME-PART OF CB&I	1 LS:	V:			738300		738300	
26:	S999	351	46		1300	3:	VERBAL QUOTE								
27:															
28:	S999	351	290	1:	1300	3:	CANISTER POSITIONING ARM	1 EA:	I:			2140		2140	
29:															
30:	S999	351	41		1600	6:	DOMHEATER TRANSFORMERS	4 EA:	I:			19260		19260	
31:	S999	351	41		1600	6:	INCLS 351-41,42,43,44								
32:															
33:	S999	351	161		6200	3:	BUS BARS-FRAME TO ELECTRODES	4 EA:	I:			44940		44940	
34:	S999	351	161		6200	3:	INCLS 351-161,162,163,164								
35:															
36:	S999	351			6200	6:	BUS BAR GAUGE FOR DOME	1 EA:	I:			5350		5350	
37:	S999	351			6200	6:	HTR TRANSFS								
38:															
39:	S999	351			6200	6:	ELECTRICAL LOWER HOLDERS	22 EA:	I:			23540		23540	
40:	S999	351			6200	6:	(HANFORD)								
41:															
42:	S999	351			6200	6:	ELECTRICAL CABLE	4400 LF:	I:			2140		2140	
43:															
44:															
45:															
				PAGE	14	PAGE TOTALS					5000	25000	2208690	2238690	

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER		TWC	DESCRIPTION			QUANTITY		S: \$\$\$\$\$\$\$\$\$\$ U. S.		D O L L A R S \$\$\$\$\$\$\$\$\$\$		
DESIGN	AREA	UNIT	ITEM	ELM	U: N:	AMT	UM:	C:	LABOR	FIELD MATERIAL	WILM. MATERIAL	TOTAL

1:	S999	351			8400 3:	PROCESS CONNECTORS (HANFORD)	20	EA:	I:		2140	2140
2:												
3:	S999	351	672	1:	7500 7:	TV CAMERA ASSEMBLY	1	EA:	I:		94160	94160
4:												
5:	S999	351	672	2:	7500 7:	TV CAMERA ASSEMBLY	1	EA:	I:		94160	94160
6:												
7:	S999				7500 7:	TV INSTALLATION & MISC MATL	1	LS:	E:	7000	3000	10000
8:												
9:												
10:												
11:	S999					THE FOLLOWING INSTRUMENT						
12:						ITEMS ARE BASED ON SCOPE &						
13:						PRICE INFORMATION PER						
14:						RW FOSTER SCOPE 2/24/88:						
15:												
16:												
17:												
18:	S999					THERMOCOUPLES TYPE B						
19:						-----						
20:												
21:	S999	351	2753	TE:	7100 7:	RISER (TOP,UPPER)	1	EA:	I:		5720	5720
22:												
23:	S999	351	2754	TE:	7100 7:	RISER (TOP,LOWER)	1	EA:	I:		6720	6720
24:												
25:	S999	351	2940	TE:	7100 7:	DRAIN VALVE,ZONE 1	1	EA:	I:		3480	3480
26:												
27:	S999	351	2941	TE:	7100 7:	DRAIN VALVE,ZONE 1	1	EA:	I:		3480	3480
28:												
29:	S999	351	2951	TE:	7100 7:	RISER,BOTTOM	1	EA:	I:		4420	4420
30:												
31:	S999	351	2952	TE:	7100 7:	RISER,BOTTOM	1	EA:	I:		4420	4420
32:												
33:	S999	351	2953	TE:	7100 7:	POUR SPOUT,UPPER	1	EA:	I:		3600	3600
34:												
35:	S999	351	2954	TE:	7100 7:	POUR SPOUT,LOWER	1	EA:	I:		4190	4190
36:												
37:												
38:	S999	351	3271	TEA:	7100 7:	MELT POOL,UPPER	1	EA:	I:		6940	6940
39:												
40:	S999	351	3271	TEB:	7100 7:	MELT POOL,UPPER	1	EA:	I:		6940	6940
41:												
42:	S999	351	3272	TEA:	7100 7:	MELT POOL,UPPER	1	EA:	I:		6940	6940
43:												
44:												
45:												
		PAGE 15		PAGE TOTALS		7000		3000		247310		257310

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER : TWC F: DESCRIPTION							QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S.	D O L L A R S \$\$\$\$\$\$\$\$\$\$		
DESIGN							R:	FIELD		
AREA UNIT ITEM ELM :							WILM.	MATERIAL		
							AMT UM:C:	LABOR	MATERIAL	TOTAL
1:	S999	351	3272	TEB:	7100	7:	MELT POOL,UPPER	1 EA:I:		
2:									6940	6940
3:	S999	351	3273	TEA:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		
4:									7530	7530
5:	S999	351	3273	TEB:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		
6:									7530	7530
7:	S999	351	3274	TEA:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		
8:									7530	7530
9:	S999	351	3274	TEB:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		
10:									7530	7530
11:	S999	351	3275	TEA:	7100	7:	MELT POOL,LOWER	1 EA:I:		
12:									8120	8120
13:	S999	351	3275	TEB:	7100	7:	MELT POOL,LOWER	1 EA:I:		
14:									8120	8120
15:	S999	351	3276	TEA:	7100	7:	MELT POOL,LOWER	1 EA:I:		
16:									8120	8120
17:	S999	351	3276	TEB:	7100	7:	MELT POOL,LOWER	1 EA:I:		
18:									8120	8120
19:	S999	351	4085	TEA:	7100	7:	VAPOR SPACE	1 EA:I:		
20:									4350	4350
21:	S999	351	4085	TEB:	7100	7:	VAPOR SPACE	1 EA:I:		
22:									4350	4350
23:	S999	351	4085	TEC:	7100	7:	VAPOR SPACE	1 EA:I:		
24:									4350	4350
25:	S999	351	2920	TE:	7100	7:	ELECTRODE	1 EA:I:		
26:									3380	3380
27:	S999	351	2921	TE:	7100	7:	ELECTRODE	1 EA:I:		
28:									3380	3380
29:	S999	351	2930	TE:	7100	7:	ELECTRODE	1 EA:I:		
30:									3380	3380
31:	S999	351	2931	TE:	7100	7:	ELECTRODE	1 EA:I:		
32:									3380	3380
33:	S999	351	2942	TE:	7100	7:	DRAIN VALVE,ZONE 2	1 EA:I:		
34:									1560	1560
35:	S999	351	2943	TE:	7100	7:	DRAIN VALVE,ZONE 2	1 EA:I:		
36:									1560	1560
37:	S999	351	2944	TE:	7100	7:	DRAIN VALVE,ZONE 3	1 EA:I:		
38:									1500	1500
39:	S999	351	2948	TE:	7100	7:	DRAIN VALVE,ZONE 3	1 EA:I:		
40:									1500	1500
41:	S999	351	2947	TE:	7100	7:	DRAIN VALVE,ZONE 4	1 EA:I:		
42:									1730	1730
43:										
44:										
45:										
PAGE 16							PAGE TOTALS	0	0	103960
										103960

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

: ENGINEERING NUMBER : TWC F: D E S C R I P T I O N						: QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$\$\$\$\$				
: DESIGN : AREA UNIT ITEM ELM :						: R: FIELD WILM. : : : : :				
: : : : : : :						: AMT UM: C: LABOR MATERIAL MATERIAL TOTAL				
1:	S999	351	2949	TE: 7100	7: DRAIN VALVE, ZONE 4	1 EA: I:			1500	1500
2:										
3:	S999	351	2955	TE: 7100	7: DRAIN VALVE, ZONE 5	1 EA: I:			1670	1670
4:										
5:	S999	351	2956	TE: 7100	7: DRAIN VALVE, ZONE 5	1 EA: I:			1670	1670
6:										
7:	S999	351	2960	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
8:										
9:	S999	351	2961	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
10:										
11:	S999	351	2962	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
12:										
13:	S999	351	2963	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
14:										
15:	S999	351	2968	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
16:										
17:	S999	351	2969	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
18:										
19:	S999	351	2970	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
20:										
21:	S999	351	2971	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
22:										
23:	S999	351	2972	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
24:										
25:	S999	351	2973	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
26:										
27:	S999	351	2974	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
28:										
29:	S999	351	2975	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
30:										
31:	S999	351	3800	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
32:										
33:	S999	351	3801	TE: 7100	7: DOME HEATER	1 EA: I:			3090	3090
34:										
35:	S999	351	3802	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
36:										
37:	S999	351	3803	TE: 7100	7: DOME HEATER	1 EA: I:			3320	3320
38:										
39:										
40:	S999				THERMOCOUPLES TYPE K					
41:										
42:										
43:										
44:										
45:										

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC	F	DESCRIPTION	QUANTITY	S	U.	S.	D	O	L	A	R	S
DESIGN	AREA	UNIT	ITEM	ELM	U	N	AMT	UM	C	LABOR	FIELD MATERIAL	WILM. MATERIAL	TOTAL			
1:	S999	351	2964	TEA	7100	7: REFRACTORY	1	EA	I			160	160			
2:																
3:	S999	351	2964	TEB	7100	7: REFRACTORY	1	EA	I			160	160			
4:																
5:																
6:	S999	351	TF		7100	7: THERMOCOUPLE FITTINGS	1	LS	I			4280	4280			
7:	S999	351	TF		7100	7: INCLUDES ITEMS 351-TF-1										
8:	S999	351	TF		7100	7: THRU 6										
9:																
10:																
11:	S999					BORESCOPIES										
12:						-----										
13:																
14:	S999	351	MB	1:	7100	7: BORESCOPE	1	EA	I			12840	12840			
15:																
16:	S999	351	MB	2:	7100	7: BORESCOPE	1	EA	I			12840	12840			
17:																
18:	S999	351	BB	1:	7100	7: METAL BELLOWS	1	EA	I			2140	2140			
19:																
20:	S999	351	BB	2:	7100	7: METAL BELLOWS	1	EA	I			2140	2140			
21:																
22:	S999	351	CR	1:	7100	7: METAL C RING	1	EA	I			40	40			
23:																
24:	S999	351	CR	2:	7100	7: METAL C RING	1	EA	I			40	40			
25:																
26:																
27:																
28:	S999					THE FOLLOWING FIELD ASSEMBLY										
29:						FOR MELTER 3 IS PRICED BASED										
30:						ON JN ODUMS' SCOPE DATED										
31:						3/31/88:										
32:																
33:																
34:	S999					CRAFT BREAKDOWN										
35:						-----										
36:																
37:	S999	351			1300	3: BOILERMAKERS 1600 MANHOURS	1	LS	I	48000	6000		54000			
38:																
39:	S999	351			1300	3: LABORERS 800 MANHOURS	1	LS	I	10000			10000			
40:																
41:	S999	351			1300	3: CARPENTERS 200 MANHOURS	1	LS	I	4000			4000			
42:																
43:																
44:																
45:						PAGE 18				PAGE TOTALS	62000	6000	34640	102640		

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

[illegible]

PROJ 953420 PART 01

REPORT #81

DATE 10/25/88 TIME 15:14:25
GLOSSARY

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

A. SOURCE CODES (SRC)
(APPLICABLE TO THIS ESTIMATE)

CODE	MEANING
A	NON-ENGINEERED SCOPE
B	UNIT LIBRARY
C	CUBED OR SQUARE FOOT
D	ESTIMATED WITH DETAILED DESIGN
E	ESTIMATED WITHOUT DETAIL DESIGN
F	LINEAL FOOT
I	INDEXED INVESTMENT - COST RELATED
K	GBC
L	LINE COUNT PIPE ESTIMATING
M	DESIGN DEVELOPMENT
O	ORDER PLACED
P	ACTUAL COST
Q	ORDER QUOTE
R	FACTOR
S	INDEXED INVESTMENT - ESTIMATED
U	ESTIMATING ALLOWANCE
V	VERBAL QUOTE
Y	PRICE INCLUDED ELSEWHERE

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

B. TYPE WORK CATEGORIES (TWC)

TWC	DEFINITION
0600	ABANDONED FIELD COST
0700	MAINTAINING PRODUCTION
0800	DISMANTLING & REARRANGEMENT
1100	EQUIP FOUNDATIONS & SUPPORTS
1200	PROCESS EQUIPMENT
1300	MECHANICAL EQUIPMENT
1400	ARCHITECTURAL & CIVIL EQUIPMENT
1500	HEATING & VENTILATING AND POWER EQUIPMENT
1600	ELECTRICAL EQUIPMENT
1800	TANKS (\$25,000 OR GREATER)
1900	ELEVATORS AND DUMBWAITERS
2100	INSULATION-EQUIPMENT
2200	INSULATION-PIPING
2300	INSULATION-DUCT
3100	SITE DEVELOPMENT
3200	ROADS, SIDEWALKS, PARKING LOT
3300	RAILROADS
3400	FENCES GATES
3700	PRECIOUS METALS
3800	INVENTORY ACCOUNTS
3900	LAND
4000	BUILDINGS
5100	BUILDING & LABORATORY DUCTWORK
5200	MANUF. & PROCESS DUCTWORK
6100	BUILDING-ELECTRIC & LIGHTING
6200	ELECTRICAL-ALL OTHER (POWER WIRING, MOTOR CONTROL CENTERS, ETC)
7100	INSTRUMENTS & PANELS
7200	INSTRUMENT PIPING
7300	INSTRUMENT WIRING
7500	CONTROL SYSTEMS EQUIPMENT
8100	OUTSIDE LINE SUPPORTS
8200	OUTSIDE OVERHEAD PIPE LINES
8300	OUTSIDE UNDERGROUND PIPE LINES
8400	PROCESS & SERVICE PIPING(INSIDE)
8600	PLUMBING & BUILDING SERVICE PIPE
8700	SPRINKLER-BUILDING FIRE PROTECTION
9100	ABNORMAL PREMIUM TIME
9200	MINOR CHANGES
9300	NON-ENGINEERED SCOPE
9500	PROV. FOR ALLOW. (ESTIMATING, SALES TAX, WORK. COND., FRT.,ETC.)
9700	SPECIAL ADD/PROJECT ENGINEERING ALLOWANCE
9781	SPECIAL ADD/PROJECT ENGINEERING ALLOWANCE (CONTRACTS)
9800	LS/UP CONTRACT ALLOWANCE

3RD & 4TH DIGIT DEFINITIONS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

--81 FIELD CONTRACT (SHOWS AS *)

--82 WILM CONTRACT (SHOWS AS *)

--83 E-WORK ORDER (SHOWS AS *)

C. FUNCTION CODES (FUN)

CODE	DESIGN GROUP
2	PROCESS
3	MECHANICAL
4	ARCHITECTURAL & CIVIL
5	HEATING & VENTILATING AND POWER
6	ELECTRICAL
7	INSTRUMENTS
8	MECHANIZED SYSTEMS

D. QUANTITY DEFINITIONS

CODE	MEANING
1EA	ONE EACH
1LS	ONE LUMP SUM
1LF	LINEAL FEET
1CP	ESTIMATE ENTRY IS TOTAL (COMPUTER PRINTOUT) FROM PIPE, ELECTRICAL, OR INSTRUMENT ESTIMATE. DETAILS AVAILABLE FROM BM&I BY SPECIAL REQUEST.

E. ALLOWANCE DEFINITIONS

1. MINOR CHANGE ALLOWANCE IS TO ACHIEVE INTENDED QUALITY AND QUANTITY OF MANUFACTURED PRODUCT AT TIME OF PHYSICAL COMPLETION AND START-UP.
2. NON-ENGINEERED SCOPE ALLOWANCE - FUNCTIONS SPECIFIED BY DESIGN WHERE REQUIREMENTS OR SCOPE CANNOT BE SUFFICIENTLY DEVELOPED FOR PRICING. ALLOWANCES SHOULD BE JOINTLY DEVELOPED BY AED INVESTMENT ENGINEERING AND AED DESIGN.
3. PROJECT ENGINEERING ALLOWANCE - A PROVISION FOR THE UNFORE-SEEN COST ELEMENTS DUE TO ENGINEERING EVOLUTION, ESTIMATE ADJUSTMENTS, AND PRICING DIFFERENCES WITHIN THE DEFINED PROJECT SCOPE. THE AMOUNT OF FUNDS IS INTENDED TO PROVIDE THE ESTIMATE WITH AN EVEN CHANCE OF OVERRUN OR UNDERRUN.
4. CONTINGENCY - A FINANCIAL RISK ALLOWANCE INCLUDED IN CURRENT APPRAISAL FOR BUDGETS (CABS) TO COVER THE RANGE OF ACCURACY. THIS GIVES AN 85% PROBABILITY THAT A PROJECT'S ESTIMATE WOULD NOT BE EXCEEDED.

DD 0005743

CC: *W. R. Frazer, Bechtel, SRP, S-1
*R. Kesavan, Bechtel, SRP, S-2
*J. N. Meunier, Bechtel, SRP, S-2
*B. K. Parsons, Bechtel, SRP, S-2
*J. R. Glasscock, PD-AED, SRP, 704-11S
*D. C. Nichols, PD-AED, SRP, 704-S
L. M. Papouchado, PD-AED, SRP, 703-A
*A. F. Weisman, PD-AED, SRP, 704-11S
R. W. Baxter, PD-AED, SRP, 704-S
*C. R. Lund, M&L, L11W19
W. Campbell, Engrg-AED, SRC, S-1
J. C. Davis, Engrg-AED, SRC, S-1
D. J. Barnette, Engrg-AED, SRC, 717-F
*J. N. Odum, Engrg-AED, SRC, S-37
*C. R. Pair, Engrg-AED, SRC, S-1
*T. G. Powell, Engrg-AED, SRC, S-37
L. F. Shafranek, Engrg-AED, L3303
N. R. Levins, Engrg-AED, L2324
*D. G. Kasal, Engrg-AED, L3316
*G. E. Miller, Engrg-AED, L3311
R. A. Epperly, Engrg-AED, L3314
*J. S. Johnson, Engrg-AED, L3358
*R. T. Britt, Engrg-AED, L33E82
*B. J. Etienne, Engrg-AED, L33W39
*W. E. Guenther, Engrg-AED, L3375
*J. Scafaria, Engrg-AED, L3378
R. W. Foster, Engrg-AED, L3335
*J. E. Savoy, A/S, L33
IC 33 (2)

January 18, 1988

TO: *J. M. MC KIBBEN, ENGRG-AED, SRC, S-1

FROM: *J. D. GUTMANN, JR., ENGRG-AED, L3321 *JDG*

PROJECT 9S1780 - SAVANNAH RIVER PLANT
DEFENSE WASTE PROCESSING FACILITY
DA S350 - GLASS MELTER
MINUTES OF MELTER #3 PLANNING MEETING

This memo documents the discussion and agreements made during the January 7 planning meeting at Louviers. The objective of the meeting was to resolve program issues for melter #3 only. Future melter design/development was not a topic for this meeting.

A. SUMMARY

Following are the major points and decisions made at the planning meeting:

1. Project Items

- o This will be a capital project managed by Engineering Department. This responsibility will be transferred to the new SRP contractor after one is selected.

- o Work request funding is required for Engrg-AED and Bechtel participation.
- o A project objectives letter has been prepared.
- o The plant will prepare and submit basic data, which will go through a formal review and comment process.
- o The plant's desired completion date for melter #3, per the project objectives letter, is July, 1991. This timing is not compatible with the long lead time required to procure a melter vessel, typically 3 1/2 years after the order is placed.

2. Procurement

- o The bid package for melter #3 will include an option for melter #4.
- o Bechtel will be responsible for procurement of the melter and assembly with its components. This includes preparation of specifications and the bid package, and selection of the vendor for competitive bid orders. The existing Du Pont contract with Bechtel will have to be revised for added scope and timing. The orders will be executed by M&L Department.
- o In support of Bechtel procurement, AED - mechanical at Louviers will provide drawing packages for the melter vessel and bolt-on components (same equipment furnished by Louviers for melters 1 and 2).
- o Bechtel will be responsible for drawing packages for all other components related to the melter frame and assembly.
- o SRP should consider placing orders for additional borescopes as soon as possible. There is some risk of losing continuity of design details, since these are all coordinated by one consultant.

3. Task Team

- o A Task Team will be formed under J. M. McKibben to provide leadership and coordination for producing the bid packages, with follow-up through awarding the bids. After the orders are placed, the Task Team will be disbanded.
- o Bechtel will assign a lead coordinator for this effort. Additional support will be provided by Engineering Department, SRL and plant production/technical, Projects Department and QA. The plan is to have one member from each organization.

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4. Quality Assurance Aspects

- o The current assumption is that NQA-1 requirements will be imposed on the melter #3 project. SR/QA requirements that are in place will be included. Additional SR/QA requirements will be included as they are available.
- o In Bechtel's experience, the inclusion of NQA-1 can be more than double the time it normally takes to select a vendor and place an order.
- o Bechtel will prequalify vendors to satisfy NQA-1. The QA portion of each bid package will be reviewed and approved by Bechtel's QA group before the bid package is released as a request for quotes.

B. DISCUSSION

J. M. McKibben covered the objectives of the meeting, and presented the list of items requiring decisions, Figures 1 and 2.

1. Schedule

J. R. Glasscock stated that the required completion date for the melter #3 assembly is July, 1991. This objective is included in the project objectives letter, and is based on the following assumptions. (See Figure 7):

- o Melter #1 starts up early 4Q '89 and runs for 2 years.
- o Melter #3 is available to back up #2 when it is installed in 4Q 1991.

J. D. Gutmann presented a summary of procurement time durations for melter #1 components, Figure 3 through 5. These orders were placed by Louviers-Mechanical (Gutmann, Etienne, Scafaria). Procurement timing figures are based on the actual release dates, ie, order time is the interval between release of the price request to solicit bids and the date the order was placed. This includes the time to prepare and review bids, assemble the bid package, obtain DOE approval where necessary and release the order through M&L. Fabrication timing is the interval from order placement to the date of shipment. For the melter vessel, the "ship" date is the date the vessel was completed and ready for refractory installation.

This data was entered into the Macintosh OverVUE database program, the order and fabrication times were added to obtain the total in weeks and months, the total time column was sorted from longest to shortest and like times for a given order were grouped together.

Following are comments on this data:

- o Time required for the order phase ranged from 24 to 44 weeks when DOE approval was required. This timing was typical in 1984 and early 1985, when the DOE approval cycle was usually 4 to 8 weeks. Today, this cycle is longer, and new QA requirements are expected to increase the time even more. The order for Inconel 690 material (Figure 4) was placed within 14 weeks via letter of intent. DOE agreed to permit this order to be placed prior to approval of the bid package due to the critical effect of this material delivery on the schedule. In general, orders that required less than 14 weeks to place did not require DOE approval.
- o Some of the refractory fabrication times are longer than normal by several months because the vendor had to wait for the fixture to be completed at CBI. The same fixtures will be used for melter #3, so there will not be any delays delivering the fixtures to the vendors.
- o As before, the critical path item is the melter vessel itself. Fabrication of melter #1 took 150 weeks to reach the point where refractory could be installed.
- o Following the melter vessel order, the next most critical item for timing is Inconel 690 material. This must be ordered early to have material available in time to fabricate the melter components. As shown in Figure 4, the Inconel for melter #1 took 38 weeks to fabricate after the order was placed.

The overall schedule for melter #1 is shown in bar chart form in Figure 6. Starting from the time the order request was released in 2Q 1984, it will be end of the first quarter of 1988 before the assembly and mock up activities are complete, a total of nearly four years. Figure 7 shows the influence of this schedule on the start up of melter #2, assuming that the total hot running time of #1 is limited to two years. This is the basis for establishing the July 1991 completion date for melter #3 in the project objectives letter.

Melter #1 procurement data was combined with other broad assumptions to produce a preliminary comparison schedule for melter #3, Figure 8, to illustrate the difficulty of meeting the July 1991 completion date. This indicates that the melter assembly cannot be completed until late 1992, assuming that the order can be placed in 3Q '88. As shown, there are schedule requirements that are in bold face with question marks to flag out the areas of

greatest uncertainty. The largest of these is the effect of the QA requirements, which were not clear when this comparison schedule was developed. During the discussion of this schedule, the following comments were made:

- o There are no foreseeable short cuts that can be applied to vessel fabrication on future orders. The vessel is relatively small, and this limits the number of welders that can be working on it at a given time. Realistically, we must assume that the fabrication phase will take the same time - 150 weeks. Time can be potentially reduced up front by taking steps to place the order early. One possibility is to get DOE concurrence to place an order via letter of intent, prior to DOE approval of the bid package, releasing the vendor to order material and prepare drawings for approval.
- o The assembly plan for melter #3 and future units will not include a physical mock-up of the jumpers in 717-F. The intent is to measure and verify that the jumper connection points are at the correct x, y and z coordinates. This should reduce the time required in 717-F by approximately two months.
- o In Bechtel's experience, the addition of NQA-1 requirements will more than double the time it normally takes to get an order placed, since these QA requirements must also be met by all of the primary vendor's subcontractors. The impact of this makes the schedule in Figure 8 look optimistic.
- o In view of the long procurement time required to purchase and build a melter, it was recommended that the contract for melter #3 include an option for melter #4.

2. Procurement

J. D. Gutmann described the procurement history of melter #1, Figures 9 through 15. As shown in Figure 9, there were a total of 39 individual Engineering Department orders for the vessel and its components.

A. Fixtures

Included in the above orders are a number of fixtures that will be used for melter #3 and beyond, Figure 10. SRP will have to arrange for indoor storage of these, and initiate procedures to control their location and disposition for future orders. It may be possible to have the sole source vendors accept the responsibility for storing their respective

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fixtures locally, which would avoid the expense of shipping these back and forth to SRP. Other fixtures are used for competitive bids, and would have to be stored at SRP. At present, there is no permanent storage facility available at the plant for these items.

B. Borescope

The borescope vendor, Stenning Instruments Co., is an individual that contracts work to a machine shop for the fabricated items, and has the optics furnished from another source. Since these details are all known and handled by one person, there is a greater risk of losing the continuity required for future orders. It is recommended that the plant place orders for additional borescope assemblies as soon as possible to avoid having to re-invent this assembly.

C. Proposed Procurement Plan

Because of different design completion dates and schedule requirements, separate orders were placed for the #1 melter vessel, frame, and assembly package. Figure 11 shows the recommended grouping of these items into one order, and the recommendation to do the final assembly of the melter components at SRP, as we are doing for melters 1 and 2. It was agreed that this approach would be used for melter #3.

In the same manner, the number of component orders can be reduced by grouping like items and making these the responsibility of a primary vendor. Since the component designs for melter #1 could not be completed simultaneously, a priority system was established for design completion to meet the melter assembly schedule requirements. As a result, 30 separate mechanical orders were placed as the design was completed for each major subassembly, Figure 12. For melter #3 procurement, these can be reduced to 12 orders by grouping as shown in Figure 13. The complexity and unusual nature of the melter assembly does not lend itself to reducing everything down to one or a few vendors at this time.

Figure 14 is a summary of single source orders required for melter #3. Virtually all of these are due to proprietary materials that are not available from other vendors. The proposed major competitive bid orders are listed in Figure 15. Under current rules, DOE approval is required for single source orders at or exceeding \$100,000, (six orders in Figure 14) and competitive bids at or exceeding \$250,000 (two orders in Figure 15).

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The use of existing vendor drawings for procurement was discussed. After reviewing the legal aspects of the DWPF contracts, legal consultants have determined that vendor drawings can be used for competitive bids for future orders, if the vendor logo and other identification is removed from the drawing.

3. Design Basis for Melter #3

For the past several months, the Engineering Department has been preparing a drawing package for the #3 melter vessel. The design basis assumed for this work is shown in Figure 16. Design revisions have been restricted to minor changes that will make fabrication easier, and reduce the difficulty of meeting close tolerances. We have assumed that the basic configurations used on melters 1 and 2 will also be used on #3. If basic data requires configuration changes, the design scope and time will increase.

Materials will be the same, except sealing gasket material will be Graphoil instead of asbestos. In addition to eliminating asbestos from the design, the switch to Graphoil will reduce the bolt torque required to seal the joint.

Lead was used on melters 1 and 2 for shielding the TV camera and counterweighting the camera carrier frames and feed tubes. The question about current policy on lead use was raised. In general, it is desirable to use substitutes for lead where feasible. It was pointed out that if lead cannot be used for counterweighting melter #3 top head components, this could result in a major design change, since the space envelope around these components is very restricted.

4. Scope of Work

Figures 17 and 18 show the proposed division of work between the Engineering Department and others for the #3 melter project. All drawings furnished by the Engineering Department for the melter vessel and its components will be reproduced on new mylars, assigned new numbers, and start with revision 0. This will preserve drawings showing the as-built configuration of melters 1 and 2. In addition to providing this drawing package, a melter design manual will be furnished that covers the history and design of the DWPF melter configuration, as well as details of procurement procedures and recommendations.

5. Decisions on Scope and Responsibility

After discussing the above information, the following decisions on project scope and responsibilities were reached:

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- o Melter #3 will be a capital project managed by the Engineering Department. This responsibility will be transferred to the new SRP contractor after one is selected.
- o Basic data will be submitted by SRP and go through a formal review and approval procedure.
- o Bechtel will be responsible for writing the specifications, preparing the bid packages, selecting vendors, and procuring all items required for the melter assembly. The current Du Pont contract with Bechtel will have to be revised to include this new scope and timing. Purchase orders will be executed by M&L Department. The bid package for melter #3 will include an option for melter #4.
- o AED-Mechanical at Louviers will prepare drawing packages, per paragraph 4, for the melter vessel and its bolt-on components. These will be used by Bechtel for procurement of these items. Bechtel will have responsibility for providing drawings of all other components related to the melter assembly.
- o J. Gutmann will coordinate the effort to prepare a manual on DWPF melter history, design basis, and procurement requirements. This will be used as a guide for future procurement of melters and form a basis for evaluating future suggestions for design modifications.
- o Bechtel was requested to start initial work to prepare a program for the melter #3 effort.

6. Program Task Team

J. M. McKibben recommended that a task team be formed under his direction to assist with the preparation of the bid packages, and continue through placement of the order. It was agreed that Bechtel will assign a lead coordinator for this effort. Additional support will be provided by Engineering Department, SRL, and SRP production/technical, Projects Department and QA. The intent is to have one member from each organization on the task team.

The task team charter will be as follows:

- o Review the basic data report.
- o Produce the design and bid packages for melter #3 with options for melter #4. This will include material release for #4.
- o Review and approve the bidder's lists.

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- o Participate in discussions with the vendors.
- o Follow up reviews with DOE.
- o Provide design liaison and follow-up through award of the orders.
- o Review the melter design manual.

7. Quality Assurance

There have been a number of questions regarding QA requirements for melter #3. This issue was addressed by Dan Kasal, and is summarized below:

The QA requirements address design verification, inspection and testing. Each order must include the critical requirements, with plus and minus acceptance limits for these requirements. The intent is to be able to verify that the as-built equipment meets the specification.

Melter #3 will be purchased under NQA-1 requirements. SR/QA requirements will be added in as they are available and training is completed. The primary vendor must audit subcontractors and verify that their procedures conform to NQA-1 requirements.

Bechtel QA will prequalify vendors for melter #3 components, and will review the QA portion of the bid package before it is released for quotes.

Verification is required for design changes. If the design has been used before, this is suitable verification. Since we have a history of melter tests verifying the configuration, we should not have a problem with this item. Additional details of the DWPF melter design basis will be covered in the manual that will be issued at a later date.

The question of code stamping requirements was raised. Melters 1 and 2 were built to the ASME code, but not stamped. At this time, it is not clear if melter #3 will require a code stamp. If a stamp is necessary, additional QA documentation will be required.

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8. Other Items

- o Drawings - Bechtel will consider converting the Engineering Department drawings to the CAD format. J. Gutmann recommended that the drawings for melter #3 procurement be used as is, and make the conversion to CAD a longer term project for future melters. Since the drawing package for the vessel and components exceeds 450 drawings, it will take a considerable amount of time to redraw and check these. A set of preliminary vessel prints for information will be sent to J. Muenier the week of January 18.
- o Inconel 690 Material - Keller Technology will be requested to submit an inventory of the remaining Inconel material. J. Gutmann will prepare a list of additional Inconel that must be ordered the melter #3 components on our drawings. Bechtel will combine these with any additional material needed for related frame/assembly orders.
- o J. D. Gutmann requested that SRP assign someone with a materials background to participate in the remaining final inspections for the #2 melter refractory. This will provide continuity for the refractory procurement for #3 and future melters.

AGENDA
MELTER #3 PROJECT KICKOFF
L-2309

MEETING CHAIRMAN: J. M. MC KIBBEN

SECRETARY: J. D. GUTMANN

INTRODUCTION - OUTLINE OF EFFORT	MC KIBBEN
- KEY DECISIONS	
OVERVIEW OF SCHEDULE	GLASSCOCK/GUTMANN
SCOPE - EQUIPMENT LIST	GUTMANN
- VENDORS	
DECISIONS ON SCOPE EXECUTION	ALL
1. TEAM TO PRODUCE BID PACKAGE	
2. BRDO TO PROCURE?	
3. ED-AED TO MANAGE?	
4. ASSEMBLY BY SRC?	
QUALITY ASSURANCE ISSUES	KASAL/ALL
- DESIGN BASIS DOCUMENTATION	
- ADHERE TO HOW DETAILS - VGA, FORMAL RESPONSE TO BASIC DATA, SCOPE, ETC.	
- VENDOR PRE-APPROVAL	
SCHEDULE DETAILS	ALL
<u>MISCELLANEOUS</u>	ALL
INCONEL STOCK	
HANDLING OF FIXTURES & TEMPLATES	
TECHNOLOGY TRANSFER - TRAINING	
COMPATIBILITY OF DU PONT VS. BECHTEL SYSTEMS	
ETC.	
<u>CONTRACT ISSUES</u>	LUND/ALL
<u>WRAP-UP</u>	ALL

KEY DECISIONS

- 1) LEAD ENGINEER (LOUVIERS VS. BECHTEL)
- 2) CLIENT (SRP PROJECT VS. LOUVIERS)
- 3) SCHEDULE CONSTRAINTS
 - A) EFFECT OF QA
 - B) BIDS VS. SOLE SOURCE
 - C) DESIGN IMPROVEMENTS
- 4) PERSONNEL TRANSITION PLANS

PROCUREMENT TIMING HISTORY FOR DWPF MELTER COMPONENTS

ORDER NO (AXC)	EN NUMBER	DESCRIPTION	RELEASE DATE			PROCUREMENT TIMING			
			PRICE REQUEST	ORDER REQUEST	SHIP EQUIPMENT	ORDER (WKS)	FAB (WKS)	TOTAL (WKS)	TOTAL (MOS)
6247W	S350-185-11-00	MELTER VESSEL	05/29/84	11/19/84	04/27/87	25	125	150	34 *
6846W	S350-185-12-10	K-3 REFRACTORY	09/21/84	03/17/85	04/23/87	25	109	134	30
6847W	S350-185-12-30	SUPERSTRUCTURE REFRACTORY	10/08/84	02/25/85	11/26/86	20	96	116	26
6853W	S350-185-10-12	SHELL COMPONENTS - MISC	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-13-00	FEED TUBES	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-00	MELT THERMOWELL - NOZZLE E	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-05	MELT THERMOWELL - NOZZLE C-4	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-10	VAPOR THERMOWELL/COND PROBE	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-20	MELT LEVEL DIP TUBE	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-18-00	RISER HEATER	08/05/85	01/23/86	09/09/87	24	85	109	25
8901W	S350-185-20-00	POUR SPOUT BELLOW ASSY	06/17/85	09/13/85	06/11/87	12	91	103	23
6853W	S350-185-14-00	ELECTRODES	08/05/85	01/23/86	06/05/87	24	71	95	21
6853W	S350-185-16-00	DOME HEATERS	08/05/85	01/23/86	06/05/87	24	71	95	21
6850W	S350-185-19-00	DRAIN VALVE	09/09/85	02/11/86	08/04/87	17	77	94	21
6849W	S350-185-12-12	K-3 GRINDING & DRILLING	02/07/85	06/26/85	09/30/86	20	66	86	19
6848W	S350-185-12-20	ZIRMUL REFRACTORY	10/18/84	04/10/85	06/06/86	25	60	85	19
6851W	S350-185-12-40	FIBERFRAX INSULATION	11/28/84	06/04/85	07/17/86	27	58	85	19
613W	S350-185-19-01	CANISTER BELLOW ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
613W	S350-185-19-04	ADAPTER BELLOW ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
613W	S350-185-19-05	PLUG BELLOW ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
613W	S350-185-19-06	UPPER PROBE BELLOW ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19

*Time to complete vessel. Refractory installation, assembly & mock up takes an additional 11 months.

SORTED BY TOTAL PROCUREMENT TIME - LONGEST TO SHORTEST

J. D. GUTMANN, JR.

Figure 3

PROCUREMENT TIMING HISTORY FOR DWPF MELTER COMPONENTS

ORDER NO (AXC)	EN NUMBER	DESCRIPTION	RELEASE DATE			PROCUREMENT TIMING			
			PRICE REQUEST	ORDER REQUEST	SHIP EQUIPMENT	ORDER (WKS)	FAB (WKS)	TOTAL (WKS)	TOTAL (MOS)
613W	S350-185-19-07	LOWER PROBE BELLOWS ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
6960W	S350-185-10-04	TYPE 690 WELD WIRE	08/22/84	12/03/84	01/21/86	14	59	73	16
725W	S350-185-10-03	ANCHOR FLANGES	03/17/86	05/02/86	05/15/87	7	54	61	14
6853W	S350-185-15-30	T.V. CAMERA FRAMES	08/05/85	01/23/86	10/01/86	24	36	60	13
6844W	S350-185-10-01	INCONEL 690 MATERIAL	11/01/84	02/07/85	10/30/85	14	38	52	12
6854W	S350-185-12-00	REFRACTORY INSTALLATION	07/11/85	05/14/86	05/29/87	44	5	49	11
482W	S350-185-12-45	FIBERFRAX - MISC BULK PAPER, DSM	10/10/85	03/31/86	10/01/86	24	22	46	10
1992W	S999-350-20-01	ACTUATOR BELLOWS ASSY	02/06/87	05/18/87	11/15/87	14	26	40	9
1992W	S999-350-20-02	UPPER ADAPTER BELLOWS ASSY	02/06/87	05/18/87	11/15/87	14	26	40	9
1992W	S999-350-20-03	LOWER ADAPTER BELLOWS ASSY	02/06/87	05/18/87	11/15/87	14	26	40	9
6852W	S350-185-14-01	ISOLATORS - ELECTRODES	09/30/85	11/26/85	06/30/86	8	31	39	9
6852W	S350-185-16-01	ISOLATORS - DOME HEATERS	09/30/85	11/26/85	06/30/86	8	31	39	9
8417W	S350-185-18-02	ISOLATORS - RISER HEATER	09/30/85	11/26/85	06/30/86	8	31	39	9
8823W	S350-185-19-02	ISOLATORS - DRAIN VALVE	06/19/85	09/16/85	03/20/86	13	26	39	9
341W	S350-185-18-06	ZIRCAR INSULATION - RISER HEATER	06/19/85	10/23/85	01/13/86	24	12	36	8
1489W	S350-185-10-02	EXTERNAL ISOLATORS	08/04/86	09/10/86	04/16/87	5	31	36	8
1716W	S350-185-18-08	ZIRCAR INSULATION - RISER HEATER	08/04/86	10/23/85	01/13/86	24	12	36	8
8941W	S350-185-10-05	SS O RINGS	09/18/85	01/03/86	05/16/86	15	19	34	7

*

*Order placed via letter of intent.

SORTED BY TOTAL PROCUREMENT TIME - LONGEST TO SHORTEST

J. D. GUTMANN, JR.

PROCUREMENT TIMING HISTORY FOR DWPF MELTER COMPONENTS

ORDER NO (AXC)	EN NUMBER	DESCRIPTION	RELEASE DATE			PROCUREMENT TIMING			
			PRICE REQUEST	ORDER REQUEST	SHIP EQUIPMENT	ORDER (WKS)	FAB (WKS)	TOTAL (WKS)	TOTAL (MOS)
755W	S350-185-13-01	FIBERFRAX - MILLED	10/15/85	01/23/86	04/03/86	14	10	24	5
2183W	S350-185-15-40	FILM COOLER-OFF GAS LINE NOZZLE A	04/06/87	05/11/87	09/09/87	5	17	22	5
2183W	S350-185-15-50	FILM COOLER-OFF GAS LINE NOZZLE T	04/06/87	05/11/87	09/09/87	5	17	22	5
154W	S350-185-10-06	BORE A & T NOZZLES	08/01/85	09/06/85	09/12/85	5	12	17	3
618W	S350-185-19-03	ZIRCAR INSULATION - DRAIN VALVE	11/11/85	02/22/86	04/04/86	10	6	16	3
392W	S350-185-18-05	GASKETS - FIBERFRAX	10/11/85	12/06/85	01/13/86	8	5	13	3
6854W	S350-185-19-00	FIBERFRAX ROPE - DOME HEATER SEAL				1	12	13	3
8976W	S350-185-12-13	K-3 WIRE CUTTING & GRINDING	08/05/85	09/19/85	11/25/86	7	4	11	2
8976W	S350-185-12-22	ZIRMUL GRINDING	08/05/85	09/19/85	04/08/87	7	4	11	2
8941W	S350-185-10-10	SS O RINGS - HYDROTEST	06/30/86	07/09/86	07/28/86	2	3	5	1

*Actual fabrication time shown. Vendors had to wait for refractory to be completed before they could start machining.

SORTED BY TOTAL PROCUREMENT TIME - LONGEST TO SHORTEST

J. D. GUTMANN, JR.

Figure 5

SCHEDULE FOR MELTER #1

Figure

SCHEDULE FOR MELTERS 1 & 2

Figure 7

MELTER SCHEDULE - TIMING FOR #3

PROCUREMENT HISTORY - MELTER #1

TOTAL OF 39 ENGINEERING DEPT ORDERS FOR THE MELTER

(5) INSTRUMENT ORDERS

BORESCOPES
TYPE B T/C'S - VENDOR
TYPE B T/C'S - FIELD
TYPE K T/C'S
T/C FITTINGS

(34) MECHANICAL ORDERS

3 - VESSEL
2 - MATERIAL
2 - BELLOWS
10 - COMPONENTS
9 - REFRACTORY
4 - ISOLATOR
4 - FIXTURES

gdf

Figure 9

MELTER FIXTURES

REFRACTORY

K-3 GAGING & FIT UP
ZIRMUL FIT UP & GRINDING
TOP HEAD FIT UP
K-3 RISER BLOCK WIRE CUT
K-3 THROAT BLOCK WIRE CUT
K-3 BLOCK GRINDING SET UP
K-3 RISER BLOCK - DUMMY HEATER

FIELD INSTALLATION

TOP HEAD ROTATOR
ANCHOR FLANGE ALIGNMENT

INSULATION

FIBERFRAX TOP HEAD LINER
FIBERFRAX BOTTOM HEAD LINER
FIBERFRAX BOTTOM CORNER LINER

FABRICATION

TOP HEAD COMPONENT ALIGN

SHIPPING

RISER / POUR SPOUT HEATER FRAME
DRAIN VALVE FRAME

MELTER VESSEL ORDER GROUP

COMBINE VESSEL, FRAME, & VENDOR ASSEMBLY INTO ONE ORDER

FINAL ASSEMBLY AT SRP MOCK UP SHOP, SAME AS MELTERS 1 & 2

Figure 11

JD

COMPONENT ORDERS FOR DWPF MELTER #1
30 INDIVIDUAL ORDERS (Does not include fixtures or instruments)

REFRACTORY (9)

REFRACTORY INSTALLATION
K-3 REFRACTORY
ZIRMUL REFRACTORY
SUPERSTRUCTURE REFRACTORY
K-3 DRILL & GRIND
K-3 WIRE CUTTING
FIBERFRAX FORMED LINERS
FIBERFRAX - MISC PAPER, DSM
REFRACTORY DRY OUT

COMPONENTS (10)

ANCHOR FLANGES
DRAIN VALVE
POUR SPOUT BELLOWS
ELECTRODES, ETC.
FILM COOLER
ZIRCAR INSULATION (2)
MILLED FIBERFRAX
FIBERFRAX ROPE
FIBERFRAX GASKETS

VESSEL (3)

MELTER VESSEL
S. S. O RINGS
A & T NOZZLES

ISOLATORS (4)

DRAIN VALVE
RISER / P S HEATER
VESSEL EXTERIOR
ELECTRODES & DOME HEATERS

BELLOWS (2)

DRAIN VALVE
POUR SPOUT BELLOWS

ALLOY MAT'L (2)

INCONEL 690
TYPE 690 WELD WIRE

PROPOSED COMPONENT ORDER GROUPS FOR DWPF MELTER #3
12 INDIVIDUAL ORDERS (Does not include 5 instrument orders)

REFRACTORY (6)

K-3 REFRACTORY
K-3 DRILL & GRIND
K-3 WIRE CUTTING

REFRACTORY INSTALLATION
FIBERFRAX - MISC PAPER, DSM

ZIRMUL REFRACTORY
SUPERSTRUCTURE REFRACTORY
FIBERFRAX FORMED LINERS
REFRACTORY DRY OUT

COMPONENTS (1)

ANCHOR FLANGES
DRAIN VALVE
POUR SPOUT BELLOWS
ELECTRODES, ETC.
FILM COOLER
ZIRCAR INSULATION (2)
MILLED FIBERFRAX
FIBERFRAX ROPE
FIBERFRAX GASKETS

VESSEL (1)

MELTER VESSEL
S. S. O RINGS
A & T NOZZLES

ISOLATORS (1)

DRAIN VALVE
RISER / P S HEATER
VESSEL EXTERIOR
ELECTRODES & DOME HEATERS

BELLOWS (1)

DRAIN VALVE
POUR SPOUT BELLOWS

ALLOY MAT'L (2)

INCONEL 690
TYPE 690 WELD WIRE

Figure 13

gds

SINGLE SOURCE ORDERS

ITEM	VENDOR	COST*
K-3 REFRACTORY	SOHIO / CARBORUNDUM	\$600,000
INCONEL 690	INCO ALLOYS INTERNATIONAL	\$500,000
REFRACTORY INSTALL	TOLEDO ENGINEERING	\$150,000
ZIRMUL REFRACTORY	DIDIER TAYLOR	\$120,000
FIBERFRAX LINERS	METAULLICS	\$110,000
BELLOWS	METAL BELLOWS	\$110,000
TYPE 690 WELD WIRE	U. S. WELDING	\$50,000
REFRACTORY DRY OUT	HOTWORK, INC.	\$15,000
BOREScope (2)	STENNING INSTRUMENTS	\$24,000

* NOT FOR ESTIMATING - PRICES ARE ROUNDED VALUES OF MELTER #1 ORDERS FOR COMPARISON

gds

COMPETITIVE BID ORDERS

ITEM	COST*
MELTER, FRAME, & ASSEMBLY	\$2,300,000
MELTER COMPONENTS	\$1,100,000
SUPERSTRUCTURE REFRACTORY	\$50,000
ALUMINA ISOLATORS	\$50,000

* NOT FOR ESTIMATING - PRICES ARE ROUNDED VALUES OF MELTER #1 ORDERS FOR COMPARISON

Figure 15

JWS

DESIGN BASIS FOR MELTER #3

- MAINTAIN CURRENT CONFIGURATION FOR ALL COMPONENTS
- LIMIT CHANGES TO MINOR REVISIONS TO REDUCE FABRICATION COST & DIFFICULTY
- USE THE SAME MATERIALS *EXCEPT* REPLACE ASBESTOS GASKETS WITH GRAPHOIL
- IS LEAD STILL OK FOR COUNTERWEIGHTS & SHIELDING?

Section 10 - Project Data

This section includes cost , schedule, and technical data that was developed during the procurement and construction of Melters #1 and #2. Following is a list of this information:

1. Melter Cost

Letter to D. C. Nichols from J. D. Gutmann, Jr. and R. D. Crecco dated December 9, 1988 - *Melter 1 vs. 3 Cost Summary and Details* - Document Number DP 0002621.

2. Melter Schedule

Letter to J. M. Mc Kibben from J. D. Gutmann, Jr. dated January 18, 1988 - *Minutes of Melter #3 Planning Meeting* - Document Number DD 0005743.

3. Melter Fixtures

Letter to D. L. Kinnsch from J. D. Gutmann, Jr. dated November 7, 1988 - *Melter Fixtures - Identification, Description, and Location* - Document Number DB 0009949.

4. Melter Weight

Letter to Larry hall from J. D. Gutmann, Jr. dated June 4, 1986 - *Component Weights for Melter Assembly* - Document Number DV 0000485.

5. Inconel® 690 Material

Letter to D. L. Kinnsch from J. D. Gutmann, Jr. dated October 13, 1988 - *Inconel® 690 Material Takeoff for Melters 1 and 2* - Document Number DB 0009872.

6. Order List

Letter to J. E. Meunier from J. D. Gutmann, Jr. dated March 2, 1988 - *Melter #3 Program - Information on Engineering Department Orders for Melter #1* - Document Number DB 0009622.

7. Vendor List

Letter to D. L. Kinnsch from J. D. Gutmann, Jr. dated October 24, 1988 - *Vendor List for DWPF Melters 1 and 2* - Document Number 0009873.

E. I. DU PONT DE NEMOURS & COMPANY

INCORPORATED

P. O. Box 6090

NEWARK, DE 19714-6090

DP-0002621

ENGINEERING DEPARTMENT
LOUVIERS BUILDING

December 9, 1988

CC: W. R. Frazer-BRDO-SRC-S2
D. L. Ketcham-BRDO-SRC-S2
D. L. Kinnsch-BRDO-SRC-S2
D. T. Teschner-BRDO-SRC-S2
L. M. Papouchado-AED-PD-SRP-704S
J. B. Mellen-AED-PD-SRP-704S
J. C. Davis-AED-ED-SRC-S1
J. M. McKibben-AED-ED-SRC-S1
L. F. Shafranek-AED-L3303
N. R. Levins-AED-L2324
G. E. Miller-AED-L3311
P. A. Norman-AED-L3353
W. E. Guenther-AED-L3331
J. Scafaria-AED-L3320
R. T. Britt-AED-L33W74
J. E. Savoy-A/S-L33W51
IC 33 (2)

D. C. NICHOLS
PETROCHEMICALS DEPARTMENT
ATOMIC ENERGY DIVISION
SAVANNAH RIVER PLANT
BUILDING 704-S

PROJECT 9S3420 - SAVANNAH RIVER PLANT
DWPF GLASS MELTER #3
MELTER 1 VS 3 COST SUMMARY AND DETAILS

References:

- 1) Melter #3 CAB estimate transmittal, letter to J. L. Lear from L. F. Shafranek, "Current Appraisal for Capitol Equipment Budget", October 31, 1988.
- 2) DD 0005743, letter to J. M. McKibben from J. D. Gutmann, Jr., "Minutes of Melter #3 Planning Meeting", January 18, 1988.
- 3) DB 0009622, letter to J. E. Meunier from J. D. Gutmann, Jr., "Information on Engineering Department Orders for Melter #1", March 2, 1988.

Attachments:

- 1) Tables 1 through 6, Melter Cost Summaries
- 2) Project 9S3420, CAB estimate for Melter #3, October 25, 1988, Pages 1-22.

SUMMARY

The advertised cost of the West Valley melter is \$2 million, and this is apparently being compared to the \$19 million project cost of Melter #3. This is not a valid comparison for the following reasons:

- o The West Valley cost is based on yesterday's prices for labor and material. Melter #3 costs are indexed for inflation to future delivery dates.
- o The Melter #3 cost is at the project level that includes field costs and allowances that are not part of the West Valley cost picture.
- o DWPF melter equipment costs include items that are not included in the West Valley design - frame, drain valve, dome heaters, etc.
- o A comparison is being made between melters having different capacities. The DWPF melter has approximately 3X the capacity of the West Valley unit.
- o The DWPF melter is designed for a longer service life.
- o The DWPF process will require operation over a period of years using several melter assemblies. This requires high tolerances to insure interchangeability between components and jumpers with any melter assembly.

For the above reasons, a valid cost comparison between the DWPF and West Valley melters must be based on the following:

1. Compare West Valley equipment costs with those for Melter #1, since these melters were constructed during the same time period. (Melter #3 costs include allowances and indexing for future pricing).
2. Separate equipment costs from allowances (and other project level costs) and itemize these in detail.
3. Subtract costs for Melter #1 equipment that are not included in the West Valley assembly, including added redundancy in removable instruments.
4. Include an allowance to adjust for the difference in capacity between DWPF and West Valley melters.
5. Include allowances to adjust for differences due to design life requirements and tolerances.

When the comparison is made per the above criteria, the equivalent equipment cost of Melter #1 is reduced from \$6.1 to \$1.6 million. This compares favorably with the \$2.0 million cost for West Valley.

DISCUSSION

This letter follows up your request to provide the following melter cost information:

- o Melter #1 equipment costs by summary and details.

- o Melter #3 equipment costs by summary and details, and how this escalates to the \$19,000,000 project level cost.

We understand that this information is needed by Don Fulmer, DOE, to provide a realistic basis for comparing DWPF vs. West Valley melter costs.

A. Cost Tables

To provide the requested cost information, it was necessary to group item costs for each melter component assembly. This was accomplished with J. D. Gutmann's MacIntosh OverVUE database program, used previously to prepare Melter #1 cost and timing information for Bechtel and Investment Engineering, References 2 and 3. In all cases, Melter #1 costs are as built, and Melter #3 costs are taken directly from the CAB. This data was sorted and grouped to provide the following:

- Table 1 - Summary of equipment costs, by primary equipment group, for Melters 1 and 3. As noted, prices for the Melter #3 vessel and frame are based on budget prices from CBI. Inconel 690 costs include use of remaining material from Project 9S1780, and all other costs are escalated from the Melter #1 order date to 4Q88.
- Table 2 - Provides a finer breakdown in which costs of the top head and shell component assemblies are shown individually.
- Table 3 - Provides a detailed breakdown of each assembly by item. This is at the same level of detail shown in the CAB. As noted on Table 1, the CAB groups items by purchase order: thermocouples, bellows, ceramic isolators, etc. In Tables 1 through 4, these items and their cost have been grouped with their respective vessel and component assemblies. The CAB page and line numbers and Engineering Numbers for each item are included to permit a cross reference with the CAB.
- Table 4 - Summary of equipment costs for Melter #3, showing the general breakdown of the \$8,246,280 equipment cost, and how this is increased by field costs and allowances to the \$10,370,480 design area net total. This net total number appears on page 19, line 30 of the CAB, and is carried over to page 9, line 3. (The \$8.2 million equipment cost does not appear in the CAB, since the cumulative total on each page includes other costs and allowances).
- Table 5 - Summary of the Melter #3 project costs, showing grossing from the \$10,370,480 design area net total to the \$19,000,000 grand total at project level. Included in this estimate is a total cost of \$3.2 million for quality assurance related items - inspections, SRQA, etc.
- Table 6 - Curves for cost vs. capacity using the exponential rule. (See paragraph B3 on page 7).

The information in these six tables will permit an accurate cost comparison with the West Valley melter, provided the West Valley costs are broken down to the same level of detail. Following are considerations for cost comparisons between the DWPF and West Valley melters.

B. Considerations For Cost Comparison - DWPF vs. West Valley Melters

1. Design Criteria and Approach

The DWPF and West Valley melter designs were based on different criteria and objectives. These have a major influence on equipment costs.

For West Valley, the limited amount of waste permits the use of one melter to convert all of the waste in six months.

For DWPF, the much larger amount of waste will require processing over a period of 20 years. Each melter assembly has a two year minimum operating life requirement, and the melter assemblies must be built to high tolerances to permit remote removal and installation.

This difference in objectives is reflected in the respective designs. Four examples follow:

a. Replacement Time

Since the intent at West Valley is to run hot with only one melter, the melter does not have an interchangeable cartridge design like the DWPF melter/frame assembly. Some of the West Valley equipment is hard piped and will be more difficult to remove. As a result, the estimated time to change out a melter at West Valley is around 6 months. The estimated time to replace the DWPF melter assembly is 1-1/2 months.

b. Design Life

This is included as a consideration, based on photographs of West Valley equipment that were shown during the August meeting. One of these showed a thermowell that was about an inch in diameter. The DWPF thermowells are finished to a three inch diameter to improve life through added corrosion allowance. With the current glass formulation, the expected corrosion life for the Inconel 690 components is in the range of 5 to 10 years.

c. Tolerances

One of the contributing factors that influenced DWPF melter fabrication costs was the requirement for close tolerances to insure interchangeability. This applied to the melter frame, frame nozzles, top head nozzles, and top head components. The West Valley approach was different, as the intent was to run with only one melter. The nozzles on their melter were not located to the precision required for DWPF, since the jumpers can be made to fit the as-built condition. This may create some difficulty in the future, since West Valley has indicated they will build a second melter and install it prior to hot operation.

d. Design Approach

Two problems have surfaced on the West Valley melter that are of interest, since they were a result of a different approach to design.

The first problem is that refractory from the roof is flaking off and falling into the glass melt. This is due to the combination of a flat roof construction, coupled with the use of castable materials for the refractory. Both of these approaches were deliberately avoided on DWPF. Our refractory consultant, F. W. Thompson, made strong recommendations for using an arched roof construction, and equally strong recommendations against using castable refractory due to its inherent instability. This approach has been proven by the excellent refractory condition shown in the Scale Melter after more than two years of operation.

The second problem involves warping of the flanges on the top head of the melter. This was avoided on DWPF by water cooling the exterior, and using thick sections and gussets to stabilize these elements. In addition, the DWPF melter has two independent water cooling circuits to provide redundancy.

The short operating life, and the fact that interchangeable melter assemblies are not required, probably influenced the overall design approach at West Valley to reduce equipment costs.

2. Capacity

The DWPF melter is sized for a larger (about 3X) capacity than West Valley. This can have a significant effect on cost, since a larger melt pool requires a larger vessel, more refractory and more instrumentation. A comparison of cost vs. capacity may be estimated using the "six tenths" exponential factor as a rule of thumb. This is a standard approach to approximate the cost of a piece of equipment when the cost of a similar unit of different capacity is known. The formula is:

$$\text{Cost}_2 = \text{Cost}_1 \times \left(\frac{\text{Capacity 2}}{\text{Capacity 1}} \right)^{0.6}$$

The exponent is not a constant, but a reasonable approximation can be made by assuming it is constant over a limited range of sizes, usually 1/2 to 2X base size.

For comparison of DWPF vs. West Valley, assuming the DWPF capacity is 3X that of West Valley:

$$\text{DWPF Cost} = \text{West Valley Cost} \left(\frac{\text{DWPF Capacity}}{\text{West Valley Capacity}} \right)^{0.6}$$

$$\begin{aligned} &= \text{West Valley Cost (3.0)}^{0.6} \\ &= \text{West Valley Cost (1.93)} \end{aligned}$$

or by capacity alone, the DWPF melter would be expected to cost about 2X the West Valley unit. The DWPF cost should be the equivalent cost, after allowances have been made for differences in quantity and types of components.

A set of curves for different values of the exponent is shown in Table 6. As shown, a capacity ratio of 3.0 for DWPF vs West Valley translates to an approximate 2X increase in cost using the rule of thumb 0.6 exponent.

Over the total exponent range of 0.3 to 0.9, the DWPF melter cost would be expected to range from 1.5 to 2.8 times the West Valley melter cost.

C. Melter Equipment Cost Comparisons

The advertised cost of the West Valley melter is around \$2.0 million. The equivalent equipment cost of Melter #1 is \$1.6 million, using the following basis for comparison:

1. Melter #1 vs. Melter #3

Comparisons between West Valley and DWPF melters should be based on Melter #1 costs only, since the materials and equipment for this melter and West Valley were purchased in the same time period. As shown in Table 1, the total equipment cost for Melter #1 is \$6,076,460, while the estimated cost of Melter #3 is \$8,246,280. The #3 melter cost is based on budget prices from CBI for the vessel and frame, and escalating all other #1 melter costs to 2Q88. The project level estimate for #3 melter is further increased by \$1,597,820 to bring final cost up to the future scheduled delivery dates (CAB page 1, line 16).

2. Quantity of Components

If component costs are compared, this should be done on an item by item basis. This is particularly true for the top head components. We believe the DWPF melter has more redundancy than West Valley in feed tubes, thermowells, etc.

3. Equipment Unique to DWPF

The \$2,000,000 cost of the West Valley melter does not include a frame assembly, drain valve, dome heaters, or top head components. These items are unique to the DWPF melter.

4. Cost Comparison - Melter #1 Vs. West Valley

The equivalent cost of Melter #1 relative to West Valley can be calculated using the known differences between the two configurations. In the table below, the total equipment cost of Melter #1 is first reduced by subtracting the cost of components that are not included in the \$2.0 million West Valley melter cost. This reduces the equivalent cost from \$6.1 to 3.3 million. An additional cost factor is applied to account for the 3X difference in capacity. This results in a final equivalent equipment cost of \$1.6 million.

Not included in this table are allowances for component quantities or factors for differences in replacement time or design life. All of these would tend to further reduce the equivalent cost of Melter #1.

<u>ITEM</u>	<u>COST</u>	<u>SOURCE</u>
Melter #1 Equipment Total	6,076,460	Table 1
Frame Assembly	-1,467,000	Table 1
Top Head Components	- 706,170	Table 1
Dome Heaters	- 151,600	Table 2
Drain Valve	- 475,500	Table 2
<hr/>		
Net Equipment Total Cost	3,276,190	
Less 3X Capacity Factor	- 1,638,095	Table 6
<hr/>		

Equivalent Cost of DWPF Melter 1,638,095

CONCLUSION

The West Valley and DWPF melter designs were based on two different criteria. For West Valley, the major factors influencing design were:

- o Convert all waste in six months
- o Only one melter required

The short operating time, and the fact that interchangeable melter assemblies are not required, probably influenced the overall design approach to reduce equipment costs.

In contrast, DWPF has a minimum two year operating life, and must use interchangeable melter assemblies to process the waste over a period of some 20 years. Under these conditions, the design approach was to attain maximum life and integrity through a high quality design, fabrication and assembly program.

Although the equipment cost for Melter #1 totals \$6.1 million, the cost relative to West Valley is considerably lower. When the cost of equipment unique to DWPF is subtracted out, the total becomes \$3.3 million. Applying a factor to account for differences in capacity makes the comparative DWPF equipment cost approximately \$1.6 million. Further reductions can be considered by including additional factors for redundancy and design life. When viewed in this perspective, the cost of the DWPF melter compares favorably with the West Valley melter.

ATOMIC ENERGY DIVISION

J. D. Gutmann, Jr.
Project Engineer

ATOMIC ENERGY DIVISION

R. D. Crecco
Senior Investment Engineer

JDG/RDC:plc
JDG/D
Atchs.

TABLE 1

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - SUMMARY BY PRIMARY GROUP

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

MELTER PRIMARY EQUIPMENT GROUP	MELTER #1 COST IN \$	MELTER #3 COST IN \$
VESSEL & RELATED COMPONENTS	1,081,500	2,274,280
REFRACTORY LINING	1,089,900	1,321,450
TOP HEAD COMPONENTS	706,170	796,410
SHELL COMPONENTS	1,223,740	1,429,730
INCONEL 690 MATERIAL & WELD WIRE	508,150	377,500
MELTER FRAME, COMPONENTS, & ASSY	1,467,000	2,046,910
TOTAL MELTER EQUIPMENT COST	6,076,460	8,246,280

This is a cost breakdown by primary equipment group, in which component costs are totaled and grouped by location in the vessel top head and shell.

A cost breakdown by component assembly is shown in Table 2.

A further breakdown of each component assembly into its individual items is shown in Table 3.

GENERAL NOTES

1. Melter 1 equipment costs are as-built, based on time of delivery.
2. Melter 3 costs are based on the following:
 - Melter vessel and frame costs are budget prices from CBI
 - Superstructure refractory was underbid on Melter #1. An additional allowance was included in the estimate to cover this.
 - Inconel 690 costs include use of remaining material from P 1780
 - All other costs are escalated from the Melter #1 order date to 2Q88.
3. In the CAB, items are grouped by purchase order: thermocouples, bellows, ceramic isolators, etc. In Tables 1 through 4, these items and their costs have been grouped with their respective vessel and component assemblies. The CAB page and line numbers for each item have been included in Tables 3 through 5 to permit a cross reference with the CAB details. Table 3 also includes the engineering number.
4. Field costs, allowances, and Inconel 690 material for Melter 4 are not included in Tables 1 through 3. These are shown in Tables 4 and 5, and in the CAB.
5. The cost of the West Valley melter must be compared, at a detailed level, with the costs for Melter #1, since both were ordered during the same time period.

TABLE 2
MELTER #3 vs MELTER #1 EQUIPMENT COSTS - SUMMARY BY COMPONENT ASSEMBLY
PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

	MELTER SUB ASSEMBLY	MELTER #1 COST IN \$	MELTER #3 COST IN \$
<div style="text-align: center;"> ↑ TOP HEAD COMPONENTS ↓ </div>	VESSEL & RELATED COMPONENTS	1,081,500	2,274,280
	REFRACTORY LINING	1,089,900	1,321,450
	ANCHOR FLANGES	31,600	37,130
	FEED TUBE (NOZZLE B1)	74,650	87,845
	FEED TUBE (NOZZLE B2)	74,650	87,845
	FILM COOLER (NOZZLE A)	20,000	22,470
	FILM COOLER (NOZZLE T)	14,400	16,160
	MELT LEVEL DIP TUBE	26,300	30,920
	THERMOWELL - MELT (NOZZLE C4)	72,440	80,700
	THERMOWELL - MELT (NOZZLE E)	71,240	79,310
	THERMOWELL - VAPOR/CONDUCT. PROBE	41,910	47,930
	THERMOWELL - T/C FITTINGS	4,000	4,280
	T.V. CAMERA ASSEMBLY (NOZZLE D1)	137,490	150,910
	T.V. CAMERA ASSEMBLY (NOZZLE D)	137,490	150,910
	DOME HEATERS	151,600	173,050
<div style="text-align: center;"> ↓ SHELL COMPONENTS ↓ </div>	DRAIN VALVE	475,500	557,430
	ELECTRODES	84,840	98,370
	POUR SPOUT BELLOWS	264,300	312,440
	RISER HEATER	247,500	288,440
	INCONEL 690 MATERIAL & WELD WIRE	508,150	377,500
	MELTER FRAME, COMPONENTS, & ASSY	1,467,000	2,046,910
	TOTAL MELTER EQUIPMENT COST	6,076,460	8,246,280

See notes 1 through 5, Table 1.

TABLE 3

PAGE 1

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
VESSEL & RELATED COMPONENTS					
S999-351-10-00	VESSEL SHELL & HEAD	1,040,000	2,225,600	13	3
S999-351-10-02	EXTERNAL ISOLATORS	20,000	23,540	12	19
S999-351-10-05	SS O RINGS - VESSEL SHELL/HEAD FLANGE	10,400	12,200	13	11
S999-351-10-06	BORE INCONEL 690 FOR A & T NOZZLES	1,100	1,280	13	8
S999-351-10-10	SS O RINGS - A & T NOZZLES - HYDROTEST	1,100	1,280	13	14
S999-351-10-12	SHELL COMPONENTS - MISC	8,600	10,060	11	40
S999-351-2964-TE-A	TYPE K THERMOCOUPLE - REFRACTORY BACKFACE	150	160	18	1
S999-351-2964-TE-B	TYPE K THERMOCOUPLE - REFRACTORY BACKFACE	150	160	18	3
TOTAL COST - VESSEL & RELATED COMPONENTS		1,081,500	2,274,280		
REFRACTORY LINING					
S999-351-10-00	REFRACTORY DRY OUT	16,000	17,120	13	6
S999-351-12-00	REFRACTORY INSTALLATION	143,400	167,240	13	22
S999-351-12-10	K-3 REFRACTORY	476,500	560,680	13	35
S999-351-12-12	K-3 GRINDING & DRILLING	92,500	108,820	13	36
S999-351-12-13	K-3 WIRE CUTTING & GRINDING	9,700	11,340	13	37
S999-351-12-20	ZIRMUL REFRACTORY	131,300	154,080	14	23
S999-351-12-22	ZIRMUL GRINDING	8,400	9,840	14	8
S999-351-12-30	SUPERSTRUCTURE REFRACTORY	100,000	160,500	13	42
S999-351-12-40	FIBERFRAX T-30 INSULATION (VESSEL HEADS, RISER)	110,500	130,010	13	30
S999-351-12-45	FIBERFRAX - MISC BULK PAPER, DSM	1,600	1,820	13	20
TOTAL COST - REFRACTORY LINING		1,089,900	1,321,450		
MELTER FRAME					
S999-351	VENDOR ASSEMBLY	1,150,000	1,209,100	14	21
S999-351	DOMHEATER TRANSFORMER BUS BAR GAGE		5,350	14	36
S999-351	HANFORD ELECTRICAL LOWER HOLDERS	22,000	23,540	14	39
S999-351	ELECTRICAL CABLE	2,000	2,140	14	42
S999-351	HANFORD PROCESS CONNECTORS	2,000	2,140	15	1
S999-351-161-00	ELECTRODE BUS BARS	31,000	44,940	14	33
S999-351-290-01	CANISTER POSITIONING ARM	2,000	2,140	14	28
S999-351-41-00	DOMHEATER TRANSFORMERS	18,000	19,260	14	30
S999-351-46-00	MELTER FRAME	240,000	738,300	14	25
TOTAL COST - MELTER FRAME		1,467,000	2,046,910		
MATERIAL - I 690					
S999-351-10-01	EXCESS 690 MATERIAL FROM S1780 (1 MELTER ASSY)		157,500	12	30
S999-351-10-02	INCONEL 690 MATERIAL-NEW MAT'L (1 MELTER ASSY)	463,050	120,000	12	34
S999-351-10-04	TYPE 690 WELD WIRE (1 MELTER ASSY)	45,100	100,000	12	27
TOTAL COST - MATERIAL - I 690		508,150	377,500		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

TABLE 3

PAGE 2

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
	ANCHOR FLANGES				
S999-351-10-03	ANCHOR FLANGES	31,600	37,130	12	1
	TOTAL COST - ANCHOR FLANGES	31,600	37,130		
	FEED TUBE (NOZZLE B1)				
S999-351-13-00	FEED TUBE - NOZZLE B1	74,250	87,365	11	25
S999-351-13-01	FIBERFRAX - MILLED	400	480	11	19
	TOTAL COST - FEED TUBE (NOZZLE B1)	74,650	87,845		
	FEED TUBE (NOZZLE B2)				
S999-351-13-00	FEED TUBE - NOZZLE B2	74,250	87,365	11	25
S999-351-13-01	FIBERFRAX - MILLED	400	480	11	19
	TOTAL COST - FEED TUBE (NOZZLE B2)	74,650	87,845		
	FILM COOLER (NOZZLE A)				
S999-351-15-40	FILM COOLER - OFF GAS NOZZLE A	20,000	22,470	12	3
	TOTAL COST - FILM COOLER (NOZZLE A)	20,000	22,470		
	FILM COOLER (NOZZLE T)				
S999-351-15-50	FILM COOLER - BACK UP OFF GAS NOZZLE T	14,400	16,160	12	5
	TOTAL COST - FILM COOLER (NOZZLE T)	14,400	16,160		
	MELT LEVEL DIP TUBE				
S999-351-15-20	MELT LEVEL DIP TUBE	26,300	30,920	11	34
	TOTAL COST - MELT LEVEL DIP TUBE	26,300	30,920		
	THERMOWELL - MELT (NOZZLE C4)				
S999-351-15-05	MELT THERMOWELL - NOZZLE C-4	30,200	35,520	11	29
S999-351-3272-TE-A	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	15	42
S999-351-3272-TE-B	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	16	1
S999-351-3274-TE-A	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	7
S999-351-3274-TE-B	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	9
S999-351-3276-TE-A	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	15
S999-351-3276-TE-B	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	17
	TOTAL COST - THERMOWELL - MELT (NOZZLE C4)	72,440	80,700		
	THERMOWELL - MELT (NOZZLE E)				
S999-351-15-00	MELT THERMOWELL - NOZZLE E	29,000	34,130	11	27
S999-351-3271-TE-A	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	15	38
S999-351-3271-TE-B	TYPE B THERMOCOUPLE - MELT POOL, UPPER	6,490	6,940	15	40
S999-351-3273-TE-A	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	3
S999-351-3273-TE-B	TYPE B THERMOCOUPLE - MELT POOL, MIDDLE	7,040	7,530	16	5
S999-351-3275-TE-A	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	11
S999-351-3275-TE-B	TYPE B THERMOCOUPLE - MELT POOL, LOWER	7,590	8,120	16	13
	TOTAL COST - THERMOWELL - MELT (NOZZLE E)	71,240	79,310		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
THERMOWELL - T/C FITTINGS					
S999-351-TF	CONAX FITTINGS (ITEMS 351-TF-1 THRU 6)	4,000	4,280	18	6
	TOTAL COST - THERMOWELL - T/C FITTINGS	4,000	4,280		
THERMOWELL - VAPOR/COND. PROBE					
S999-351-15-10	VAPOR THERMOWELL / CONDUCTIVITY PROBE	29,700	34,880	11	31
S999-351-4085-TE-A	TYPE B THERMOCOUPLE - VAPOR SPACE	4,070	4,350	16	19
S999-351-4085-TE-B	TYPE B THERMOCOUPLE - VAPOR SPACE	4,070	4,350	16	21
S999-351-4085-TE-C	TYPE B THERMOCOUPLE - VAPOR SPACE	4,070	4,350	16	23
	TOTAL COST - THERMOWELL - VAPOR/COND. PROBE	41,910	47,930		
T.V. CAMERA ASSEMBLY (NOZZLE D1)					
S999-351-BB-02	BELLOWS - BORESCOPE	2,000	2,140	18	20
S999-351-CR-02	S.S. C RING	40	40	18	24
S999-351-MB-02	BORESCOPE	12,000	12,840	18	16
S999-351-15-30	T.V. CAMERA CARRIER FRAME	35,450	41,730	11	36
S999-351-672-02	T.V. CAMERA/HOUSING ASSEMBLY	88,000	94,160	15	5
	TOTAL COST - T.V. CAMERA ASSEMBLY (NOZZLE D1)	137,490	150,910		
T.V. CAMERA ASSEMBLY (NOZZLE D)					
S999-351-BB-01	BELLOWS - BORESCOPE	2,000	2,140	18	18
S999-351-CR-01	S.S. C RING	40	40	18	22
S999-351-MB-01	BORESCOPE	12,000	12,840	18	14
S999-351-15-30	T.V. CAMERA CARRIER FRAME	35,450	41,730	11	36
S999-351-672-01	T.V. CAMERA/HOUSING ASSEMBLY	88,000	94,160	15	3
	TOTAL COST - T.V. CAMERA ASSEMBLY (NOZZLE D)	137,490	150,910		
DOME HEATERS					
S999-351-12-00	FIBERFRAX ROPE - DOME HEATER SEAL	500	540	13	24
S999-351-16-00	DOME HEATERS (4 ASSYS)	86,300	101,540	11	23
S999-351-16-01	ISOLATORS - DOME HEATERS	16,800	19,690	12	15
S999-351-2960-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	7
S999-351-2961-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	9
S999-351-2962-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	11
S999-351-2963-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	13
S999-351-2968-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	15
S999-351-2969-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	17
S999-351-2970-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	19
S999-351-2971-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	21
S999-351-2972-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	23
S999-351-2973-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	25
S999-351-2974-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	27

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	#3 CAB LINE
S999-351-2975-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	29
S999-351-3800-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	31
S999-351-3801-TE	TYPE B THERMOCOUPLE - DOME HEATER	2,890	3,090	17	33
S999-351-3802-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	35
S999-351-3803-TE	TYPE B THERMOCOUPLE - DOME HEATER	3,110	3,320	17	37
	TOTAL COST - DOME HEATERS	151,600	173,050		
	DRAIN VALVE				
S999-351-19-00	DRAIN VALVE	191,300	225,130	11	42
S999-351-19-01	CANISTER BELLOWS ASSEMBLY - DRAIN VALVE	46,000	54,140	10	23
S999-351-19-02	ISOLATORS - DRAIN VALVE	142,000	167,130	12	11
S999-351-19-03	ZIRCAR INSULATION - DRAIN VALVE	7,200	8,450	11	17
S999-351-19-04	ADAPTER BELLOWS ASSEMBLY - DRAIN VALVE	13,400	15,730	10	26
S999-351-19-05	PLUG BELLOWS ASSEMBLY - DRAIN VALVE	18,000	21,190	10	29
S999-351-19-06	UPPER PROBE BELLOWS ASSY - DRAIN VALVE	11,600	13,590	10	32
S999-351-19-07	LOWER PROBE BELLOWS ASSY - DRAIN VALVE	11,600	13,590	10	35
S999-351-19-08	DRAIN VALVE BELLOWS - ENGR & SETUP CHARGES	16,000	18,830	10	38
S999-351-2940-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 1	3,260	3,480	15	25
S999-351-2941-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 1	3,260	3,480	15	27
S999-351-2942-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 2	1,460	1,560	16	33
S999-351-2943-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 2	1,460	1,560	16	35
S999-351-2944-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 3	1,400	1,500	16	37
S999-351-2947-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 4	1,620	1,730	16	41
S999-351-2948-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 3	1,400	1,500	16	39
S999-351-2949-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 4	1,400	1,500	17	1
S999-351-2955-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 5	1,570	1,670	17	3
S999-351-2956-TE	TYPE B THERMOCOUPLE - DRAIN VALVE, ZONE 5	1,570	1,670	17	5
	TOTAL COST - DRAIN VALVE	475,500	557,430		
	ELECTRODES				
S999-351-14-00	ELECTRODES (2 UPPER, 2 LOWER)	63,300	74,470	11	21
S999-351-14-01	ISOLATORS - ELECTRODES	8,500	9,950	12	13
S999-351-18-05	GASKETS - FIBERFRAX	400	430	11	15
S999-351-2920-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	25
S999-351-2921-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	27
S999-351-2930-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	29
S999-351-2931-TE	TYPE B THERMOCOUPLE - ELECTRODE	3,160	3,380	16	31
	TOTAL COST - ELECTRODES	84,840	98,370		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

AIM

Association for Information and Image Management

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Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

6 of 6

TABLE 3

PAGE 5

MELTER #3 vs MELTER #1 EQUIPMENT COSTS - DETAILED BREAKDOWN BY COMPONENT ASSEMBLY

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

ENGINEERING NUMBER (MELTER #3)	DESCRIPTION	MELTER #1 COST IN \$	MELTER #3 COST IN \$	#3 CAB PAGE	LINE
	POUR SPOUT BELLOWS				
S999-351-20-00	POUR SPOUT BELLOWS ASSY	224,200	266,220	11	9
S999-351-20-01	ACTUATOR BELLOWS - POUR SPOUT BELLOWS	10,200	11,770	10	41
S999-351-20-02	LOWER ADAPTER BELLOWS- POUR SPOUT BELLOWS	13,300	15,300	11	1
S999-351-20-03	UPPER ADAPTER BELLOWS	16,600	19,150	11	4
	TOTAL COST - POUR SPOUT BELLOWS	264,300	312,440		
	RISER HEATER				
S999-351-18-00	RISER/POUR SPOUT HEATER	103,200	121,450	11	38
S999-351-18-02	ISOLATORS - RISER HEATER	98,400	115,770	12	17
S999-351-18-06	ZIRCAR INSULATION - RISER/PS HEATER	10,100	11,980	11	11
S999-351-18-08	ZIRCAR INSULATION - RISER END	8,600	10,170	11	13
S999-351-2753-TE	TYPE B THERMOCOUPLE - RISER HEATER, TOP UPPER	5,350	5,720	15	21
S999-351-2754-TE	TYPE B THERMOCOUPLE - RISER HEATER, TOP LOWER	6,280	6,720	15	23
S999-351-2951-TE	TYPE B THERMOCOUPLE - RISER HEATER, BOTTOM	4,140	4,420	15	29
S999-351-2952-TE	TYPE B THERMOCOUPLE - RISER HEATER, BOTTOM	4,140	4,420	15	31
S999-351-2953-TE	TYPE B THERMOCOUPLE - POUR SPOUT HEATER, UPPER	3,370	3,600	15	33
S999-351-2954-TE	TYPE B THERMOCOUPLE - POUR SPOUT HEATER, LOWER	3,920	4,190	15	35
	TOTAL COST - RISER HEATER	247,500	288,440		
	TOTAL COST -	6,076,460	8,246,280		

MELTER #1 COSTS ARE AS-BUILT DOLLARS.

MELTER #3 COSTS ARE BASED ON ESCALATING #1 COSTS FROM ORDER DATE TO 4Q88

TABLE 4
MELTER #3 COST SUMMARY - WILMINGTON EQUIPMENT TO DESIGN AREA NET TOTAL
PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

DESCRIPTION	MELTER #3 COST IN \$	CAB LOCATION	
		PAGE	LINE
VESSEL & RELATED COMPONENTS	2,274,280	10-19	
REFRACTORY LINING	1,321,450	13-14	
TOP HEAD COMPONENTS	796,410	11-18	
SHELL COMPONENTS	1,429,730	11	
INCONEL 690 MATERIAL & WELD WIRE	377,500	12	
MELTER FRAME, COMPONENTS, & ASSY	2,046,910	14	
TOTAL MELTER WILMINGTON EQUIPMENT COST*	8,246,280		
Following are field costs and allowances for melter #3:			
FIELD LABOR & MATERIALS FOR ASSY IN 717-F MOCK UP SHOP	68,000	18	34-41
" " "	136,000	19	1-13
" " "	10,000	15	7
ALLOWANCE FOR SHIPPING REFRACTORY FIXTURES	30,000	14	10
ALLOWANCE FOR NICKLE MATERIAL COST INCREASES	150,000	12	38
INCONEL 690 MATERIAL & WELD WIRE FOR MELTER #4	377,500	12	27-34
PROJECT ENGINEERING ALLOWANCE	1,352,700	19	18
EXTRA MACHINERY - MELTER #3 - DESIGN AREA NET TOTAL	10,370,480	19	30

This is a summary of the Melter #3 project cost showing how the \$8,246,280 equipment cost is escalated to the \$10,370,480 Design Area Net Total. This net total appears on CAB page 19 line 30, and is carried over to CAB page 9 line 3. See Table 6 for grossing to the \$19,000,000 grand total project level.

* The \$8.2 million equipment cost does not appear as a line item in the CAB since the cumulative total on each page includes the field costs and allowances. Equipment costs include the following values for thermocouples:

- Vessel & related components: \$320 (Type K)
- Top Head Components: \$107,690 (Type B, platinum sheath)
- Shell Components: \$113,520 (Type B, platinum sheath)

See Tables 1 through 3 for additional equipment cost details.

TABLE 5
MELTER #3 COST SUMMARY - DESIGN AREA NET TOTAL TO PROJECT GRAND TOTAL
PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

DESCRIPTION	MELTER #3 COST IN \$	CAB LOCATION	
		PAGE	LINE
EXTRA MACHINERY - MELTER #3 - DESIGN AREA NET TOTAL	10,370,480	19	30
(Design area net total carried over to CAB page 9 line 3)	10,370,480	9	3
CONSTRUCTION TICF, CF, TE	139,000	9	9
QUALITY ASSURANCE - CONSTRUCTION	10,900	9	10
TURNOVER & TRAINING	2,200	9	11
STORES MATERIAL	6,600	9	12
M & M DISTRIBUTION	13,100	9	13
FREIGHT ALLOWANCE	100,900	9	14
DIRECT MANUFACTURING FACILITIES EQUIPMENT	10,643,180	9	17
(Dir.mfg.facs.equipment carried over to CAB page 1 line 8)	10,643,180	1	8
PROVISIONS FOR ADVANCING WAGES AND MATERIALS	1,597,820	1	16
PREMIUM TIME - ABNORMAL REQUIREMENTS ONLY	25,000	1	17
DIRECT TOTAL	12,266,000	1	19
FIELD INDIRECTS	34,000	1	21
FIELD COST	12,300,000	1	23
OWNER'S PROJECT ADMINISTRATION (DuPONT)	700,000	1	25
ENGINEERING CONTRACTOR (BECHTEL)	5,700,000	1	26
AED LIAISON ALLOWANCE	300,000	1	27
GRAND TOTAL AT PROJECT LEVEL	19,000,000	1	29

This summary is taken directly from the CAB showing how the \$10,370,480 design area net total grosses to the \$19,000,000 project level cost. Refer to the CAB for the breakdown of these total costs into labor, field material, and Wilmington material.

Included in this estimate is a total cost of \$3.2 million for quality assurance related items - inspections, additional costs for SRQA, etc.

TABLE 6

CAPACITY COST FACTOR vs CAPACITY RATIO

PROJECT 9S 3420 - SAVANNAH RIVER PLANT - DWPF GLASS WASTE MELTER #3

$$COST_2 = COST_1 \left[\frac{CAPACITY\ 2}{CAPACITY\ 1} \right]^n \quad \text{where } n = \text{exponential factor (usually 0.6)}$$

This graph is used by the industry to estimate costs of similar pieces of equipment having different capacities. The "rule of thumb" is to use the curve for the 0.6 exponent. Assuming that the DWPF melter has a 3X capacity compared to the West Valley unit, $C_2/C_1 = 3$, and the capacity cost factor is almost 2 at the 0.6 exponential curve, i.e. the DWPF melter would be expected to cost approximately 2X more for the capacity increase alone. This comparison should be based on the adjusted cost of the DWPF melter equipment, after subtracting the costs of items not included in the West Valley design (See letter DP 0002621 for details).

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

ESTIMATED BY -CRECCO RD

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

: DESCRIPTION		FROM:	\$\$\$\$\$\$\$\$\$\$\$\$\$ U.	S.	D O L L A R S	\$\$\$\$\$\$\$\$\$\$\$\$\$	
:	:	SHEET	LABOR	FIELD MATERIAL	WILM. MATERIAL	LS/UP CONTRACT	TOTAL
:	:	NO.:					

1:	LAND	:	0	0	0	0	0
2:	PRECIOUS METALS	:	0	0	0	0	0
3:	ABANDONED FIELD COST	:	0	0	0	0	0
4:	MAINTAINING PRODUCTION	:	0	0	0	0	0
5:	DISMANTLING AND REARRANGING	:	0	0	0	0	0
6:	PROPERTY DAMAGES & PUBLIC LIABILITY LOSSES	:	0	0	0	0	0
7:	DIRECT MANUFACTURING FACILITIES	:	0	0	0	0	0
8:	-BUILDINGS	9 :	312700	139700	10190780	0	10643180
9:	TECHNICAL ACTIVITIES FACILITIES	:	0	0	0	0	0
10:	-EQUIPMENT	:	0	0	0	0	0
11:	POWER,GENERAL AND SERVICE FACILITIES	:	0	0	0	0	0
12:	-BUILDINGS	:	0	0	0	0	0
13:	-EQUIPMENT AND MISC.	:	0	0	0	0	0

13:		:	312700	139700	10190780	0	10643180
14:		:					
15:		:					
16:	PROVISIONS FOR ADVANCING WAGES AND MATERIALS	:	61500	30700	1505620	0	1597820
17:	PREMIUM TIME - ABNORMAL REQUIREMENTS ONLY	:	25000	0	0	0	25000

18:		:	399200	170400	11696400	0	12266000
19:	DIRECT TOTAL	:					
20:		:	34000	0	0	0	34000
21:	FIELD INDIRECTS	:					

22:		:	433200	170400	11696400	0	12300000
23:	FIELD COST	:					
24:		:					
25:	OWNERS PROJECT ADMINISTRATION	:	700000	0	0	0	700000
26:	ENGINEERING CONTRACTOR	:	5700000	0	0	0	5700000
27:	AED LIAISON ALLOWANCE	:	0	0	0	300000	300000

28:		:	6833200	170400	11696400	300000	19000000
29:	GRAND TOTAL	:					

CAB UPDATE 10/88

RECOMMEND DOE INCLUDE
10% ADDITIONAL FUNDS
FOR CONTINGENCY.

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

PROJECT OBJECTIVE

THE OBJECTIVE OF P-3420 (AND THIS CAB ESTIMATE) IS TO PROVIDE NO. 3 MELTER ASSEMBLY AND SUFFICIENT INCONEL 690 MATERIAL, INCLUDING TYPE 690 WELD WIRE FOR BOTH MELTER 3 & 4. AN OPTION TO PROCURE MELTER NO. 4 WILL BE INCLUDED IN THE BID PACKAGE FOR NO. 3, BUT THIS PROJECT (AND ESTIMATE) WILL NOT FUND PROCUREMENT OF NO. 4.

PROJECT SCOPE

ESTIMATE IS BASED ON DESIGN BY DUPONT LOUVIERS AED AND PROCUREMENT BY BECHTEL BRDO SAVANNAH RIVER PLANT. BECHTEL WILL OVERSEE THE MELTER FABRICATION, ASSEMBLY & CONSTRUCTION (FIELD ASSEMBLY).

DUPONT MECHANICAL & INSTRUMENT SCOPES

1. ONE MELTER VESSEL
2. REFRACTORY LINING MATLS. INSTALLATION OF THESE IN THE VESSEL SHELL & HEAD, AND DRYOUT OF THE REFRACTORY
3. INCONEL 690 MATL FOR TWO MELTER ASSEMBLIES
4. ONE SET OF MELTER COMPONENTS CONSISTING OF (4) ELECTRODES, (8) DOME HEATERS, (1) RISER/POUR SPOUT HEATER, (1) POUR SPOUT BELLOW, (1) DRAIN VALVE, (2) FEED TUBES, (2) MELT THERMOWELLS, (2) TV CARRIER FRAMES, (1) VAPOR THERMOWELL/CONDUCTIVITY PROBE, (1) MELT LEVEL DIP TUBE, AND (2) FILM COOLERS
5. ONE SET OF ALUMINA ISOLATORS
6. ONE SET OF BELLOWS FOR THE POUR SPOUT AND DRAIN VALVE
7. THERMOCOUPLES FOR RISER/POUR SPOUT HEATER, DRAIN VALVE, DOME HEATERS, AND REFRACTORY BACK FACE
8. TWO BORESCOPES FOR THE TV CAMERA CARRIER FRAMES

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

.BECHTEL EQUIPMENT LIST

1. ONE MELTER FRAME
2. MELTER ASSEMBLY (PARTIAL) AT VENDOR'S SHOP
3. ELECTRICAL ITEMS- BUS BARS, DOME HEATER TRANSFORMERS,
LOWER HOLDERS AND CABLE
4. PROCESS CONNECTORS
5. TWO TV CAMERA ASSEMBLIES
6. CANISTER POSITIONING ARM

.CONSTRUCTION SCOPE

1. INSTALLATION OF ALL MELTER COMPONENTS
2. COMPLETION OF ASSEMBLY WORK, INCLUDING ELECTRICAL,
PIPING, HYDROTESTS AND FLOW TESTS

THE FOLLOWING ITEMS ARE NOT INCLUDED IN THIS PROJECT SCOPE

1. JUMPERS FROM CANYON WALL TO MELTER FRAME AND TOP
HEAD COMPONENTS
2. OFF-GAS PIPING
3. SEAL POT
4. PHYSICAL MOCKUP OF JUMPERS WITH THE FRAME AND TOP
HEAD COMPONENTS
5. SPARE COMPONENTS AND EXTRA MACHINERY
6. PROVISIONS FOR ADDITIONAL STORAGE FOR MELTER
ASSEMBLIES, ETC.
7. REFRACTORY AND INSULATION FIXTURES
8. INSTALLATION OF THE MELTER INTO THE VIT BUILDING

PROJ 9S3420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

SCOPES OF WORK

FUNCTION -----	DATE ----	AUTHOR -----	REMARKS -----
PROCESS	02/29/88	WE GUENTHNER	
PROCESS	04/06/88	WE GUENTHNER	
MECHANICAL	04/04/88	JD GUTMANN	
MECHANICAL	03/23/88	JE MEUNIER-BECHTEL	EQUIP LIST ONLY
ELECTRICAL	02/22/88	AQ HAIDERI	
INSTRUMENTS	02/24/88	RW FOSTER	
DUPONT QAMME	03/14/88	LJ MCANALLEN	
CONSTRUCTION	03/31/88	JN ODUM	

ESTIMATE REVIEW COMMENTS

PROCESS	04/28/88	WE GUENTHNER	
MECHANICAL	04/28/88	JD GUTMANN	
MECHANICAL	04/26/88	JE MEUNIER	
ELECTRICAL		NONE	
INSTRUMENTS		NONE	
CONSTRUCTION	04/26/88	JN ODUM	
PD AED	04/25/88	JR GLASSCOCK	

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ESTIMATE REVIEW UPDATE

CAB ESTIMATE UPDATE WAS HELD ON 10/13/88 AT SAVANNAH RIVER
CONSTRUCTION. THE FOLLOWING ATTENDED THE MEETING:

D.C. WITT	PD AED
D.T. TESCHNER	BECHTEL
W.R. FRAZER	BECHTEL
D.L. KINNSCH	BECHTEL
P.T. MC CUE	BECHTEL
D.W. STROHMAN	BECHTEL
R.J. HEALY	BECHTEL
J.M. MC KIBBEN	DU PONT
J.D. GUTMANN JR.	DU PONT
C.G. MULLINS	DU PONT
R.J. TUURI	DU PONT
R.D. CRECCO	DU PONT
T.F. HARRINGTON	DU PONT

BASIS OF ESTIMATE

1. THE MAJOR COST OF THIS PROJECT WILL BE THE DESIGN AND
PROCUREMENT OF NO.3 MELTER AND IT'S COMPONENTS. CONSTRUCTION
WILL INSTALL PART OF THE COMPONENTS AND COMPLETE THE ASSEMBLY IN
THE 717F MOCKUP BUILDING. FOLLOWING IS THE BASIS FOR PRICING:

.DUPONT DESIGN (FUNCTIONS 2,3,13E AND 13I) WROTE SCOPES OF
WORK WHICH INCLUDED A PRICED EQUIPMENT LIST OF THE MAJORITY
OF NO.3 MELTER COMPONENTS.

.BECHTEL ENGINEERING FURNISHED A PRICED EQUIPMENT LIST FOR
THE REMAINING PIECES, INCLUDING MELTER FRAME, VENDOR SHOP
ERECTION COST AND ELECTRICAL COMPONENTS.

.PRICING FOR (1)ONE MELTER VESSEL, (2)ONE FRAME & (3)ONE
VENDOR'S ASSEMBLY IS BASED ON A \$3.9MM VERBAL QUOTE FROM
CB&I CORPORATION. CB&I'S \$3.9MM QUOTE IS RANGED +10,-10%
AND IS BASED ON ORDER RELEASE 3/89 AND DELIVERY 4Q91.

.INCONEL 690 MATERIAL PRICING IS BASED ON THE FOLLOWING:

1. APPROXIMATELY 45000 LBS. OF EXCESS INCONEL 690 FROM
P-1780 DWPF AXC 6844W PURCHASED AT ABOUT \$7.00/LB WHICH
IS TO BE TRANSFERRED FOR USE ON THIS PROJECT 3420
2. PROCURING APPROXIMATELY 16000 LBS OF ADDITIONAL INCONEL
690 AT ABOUT \$14.00/LB WITH A 7% SRQA ALLOWANCE ADDED.

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

ESTIMATED BY -CRECCO RD

TITLE - DWPFG GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

.ALL OTHER EQUIPMENT PRICES ARE BASED ON NO.1&2 MELTER
PURCHASE ORDERS AND INDEXED TO CURRENT TIME. MELTER 3
COMPONENTS ARE IDENTICAL IN DESIGN TO NO.1 & 2.
.A \$150,000 PRICE ADJUSTMENT FOR NICKEL MATERIAL IS
INCLUDED IN THE ESTIMATE. THIS IS BASED ON PROCURING
APPROXIMATELY 40,000 LBS. OF NICKEL AT A PRICE OF \$6.00 PER
POUND FOR THIS PROJECT VERSUS APPROXIMATELY \$2.30 PER POUND
WHEN MELTERS 1 & 2 WERE PROCURED.

.CONSTRUCTION FURNISHED THE FIELD ASSEMBLY ESTIMATE
BASED ON THEIR EXPERIENCE ASSEMBLING NO.1 MELTER.
.DOLLARS FOR SAVANNAH RIVER QUALITY ASSURANCE (SRQA) ARE
INCLUDED IN THE ESTIMATE DETAIL BASED ON DESIGN'S AND
CONSTRUCTION'S ASSESSMENT OF THE THREE COMPONENTS BELOW:

- A.DUPONT OWNERS PROJECT ADMINISTRATION (OPA) AND
BECHTEL HOME OFFICE ESTIMATES FOR ADDITIONAL
MONTHS OF DESIGN TIME DUE TO SRQA REQMTS.
- B.WILMINGTON MATERIAL (MELTER & COMPONENTS)-
ANTICIPATED ADDITIONAL COST AS A PERCENT
OF WILM MATL - ESTIMATED APPROX 7% OF WM
- C.CONSTRUCTION'S ESTIMATE OF ADDITIONAL LABOR
FOR ASSEMBLY WORK

.DUPONT OPA & BECHTEL ENGINEERING & PROCUREMENT
ESTIMATES ARE BASED ON TASK ANALYSES MADE BY
BOTH ORGANIZATIONS AS FOLLOWS:

\$M

TOTAL BUDGET

A.DUPONT OWNERS PROJ ADM

700

B.BECHTEL (ENGG CONTRACTOR) HOME OFFICE

5700

2.PROJECT SCHEDULE (PRELIMINARY)

.DESIGN START	4087 (UPDATE MELTERS 1&2 DRAWINGS FOR MELTER 3 PROJECT)
.AUTHORIZATION	1089
.INITIAL ORDER RELEASE	1089
.LAST ORDER RELEASE	3090
.MELTER DELIVERY TO SRP	4091
.START FIELD ASSEMBLY	4091
.MECHANICAL COMPLETION	1092
.PHYSICAL COMPLETION	2092

DEPARTMENT - PETROCHEMICALS AED

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ESTIMATED BY -CRECCO RD

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

3. INDEXES AND ESCALATION RATES

.M&E INDEX AT TIME OF ESTIMATE	166 2088
.M&E INDEX AT MIDPOINT OF PROCUREMENT	181 3090
.CCI INDEX AT TIME OF ESTIMATE	182 2088

.DOE ESCALATION RATES(%), L.S. BABB'S LETTER 8/15/88

	1988	1989	1990	1991	1992
LABOR	2	4	5	6	6
MATERIAL	9	4	4	5	5
EBPA	5	4	4	5	5

4. MAJOR ALLOWANCES

SUMMARY (FRONT) SHEET ALLOWANCES

.SRQA COSTS

DOLLARS INCLUDED IN
ESTIMATE DETAIL
(SEE BASIS OF ESTIMATE)

.AED LIAISON ALLOWANCE

\$300,000

.CONTINGENCY (DOE)

\$0 IN THIS ESTIMATE.
RECOMMEND DOE INCLUDE
+10% OF TOTAL PROJECT

SUBSUMMARY ALLOWS & SITE FACTORS

.M&M DISTRIBUTION	6% OF LABOR
.STORES MATERIAL	3% OF LABOR
.TURNOVER & TRAINING	1% OF LABOR
.QUALITY ASSURANCE - CONSTR.	5% OF LABOR
.FREIGHT ALLOWANCE	1% OF WILM MATL'
.QUALITY ASSURANCE MATERIALS MGT.	INCL IN BECHTEL H.O. COST

DESIGN AREA ALLOWANCES

.NICKEL MATERIAL ADJUSTMENT	\$150,000
.PROJECT ENGG ALLOWANCE	15% OF DESIGN AREA TOTALS

5. CONSTRUCTION OVERHEADS

.FIELD INDIRECTS	TWC 0209	10% OF NET LABOR
.CONSTR TICF,CF,TE-LABOR	TWC 0401	20% OF NET LABOR
.CONSTR TICF,CF,TE-FLD MATL	TWC 0401	21% OF NET LABOR

	TOTAL	51%

DATE 10/25/88 TIME 15:14:25
DETAILS

PROJ 9S3420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED
TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

ESTIMATED BY -CRECCO RD

JOURNEYMEN WAGE RATES		EXPIRATION	JOURNEYMAN
EFFECTIVE		DATE	WAGE RATE
DATE			
04/01/88	CARPENTER	03/31/89	17.78
05/01/87	ELECTRICIAN	04/30/88	19.75
06/01/87	POWER EQUIP. OPERATOR	05/31/88	18.96
08/01/87	INSULATOR	07/31/88	18.33
06/01/87	IRONWORKER-STRUCTURAL	05/31/88	18.52
07/01/87	LABORER	06/30/88	9.82
08/01/87	MILLWRIGHT	07/31/88	18.42
05/01/87	PAINTER	04/30/88	17.67
05/01/87	PIPE FITTER	04/30/88	18.71
05/01/87	SHEET METAL WORKER	04/30/88	19.70
04/04/88	WEIGHTED SITE AVERAGE-JOURNEYMEN ONLY		17.87

DATE 10/25/88 TIME 15:14:25
SUB-SUMMARY

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED SITE - SAVANNAH RIVER SITE NUMBER - 6180 ESTIMATED BY -CRECCO RD
TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

DESIGN	DESCRIPTION	FROM:	U.	S.	D	O	L	L	A	R	S	TOTAL
AREA		SHEET:	LABOR	FIELD	WILM.	CONTRACT						
OR TWC		NO.		MATERIAL	MATERIAL							
1:	DIR. MFG. FACS. EQUIPMENT											
2:												
3:	5999 EXTRA MACHINERY-MELTER NO.3	10	218500	62100	10089880							10370480
4												
5												
6		SUB TOTAL	218500	62100	10089880							10370480
7												
8												
9	0401 CONSTR TICF,CF,TE		68000	71000								139000
10	9500 QUALITY ASSURANCE-CONSTR		10900									10900
11	9500 TURNOVER & TRAINING		2200									2200
12	9500 STORES MATERIAL			6600								6600
13	9500 M&M DISTRIBUTION		13100									13100
14	9500 FREIGHT ALLOW					100900						100900
15												
16												
17	DIR. MFG. FACS. EQUIPMENT	NET TOTAL	312700	139700	10190780							10643180
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
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43												
44												
45												

DATE 10/25/88 TIME 15:14:25
DETAILS

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED
TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC	F	DESCRIPTION		QUANTITY		S: \$\$\$\$\$\$\$\$\$\$ U. S.		D O L L A R S \$\$\$\$\$\$\$\$\$\$	
DESIGN					U:			R:		FIELD		WILM.	
AREA UNIT ITEM ELM					N:			AMT UM:		C: LABOR		MATERIAL	
												TOTAL	
1:	S999				DMFEQU:	EXTRA MACHINERY-MELTER NO.3							
2:													
3:	S999					THIS DESIGN AREA INCLUDES THE							
4:						PROCUREMENT, ASSEMBLY (BOTH							
5:						VENDOR & CONSTRUCTION SITE							
6:						ASSLY) AND MOCKUP OF GLASS							
7:						WASTE MELTER NO 3. THE							
8:						VESSEL WILL BE USED IN THE							
9:						DWPf PROCESS TO REPLACE							
10:						MELTER NO 2 WHEN ITS USEFUL							
11:						LIFE HAS EXPIRED.							
12:													
13:													
14:													
15:	S999					THE FOLLOWING EQUIPMENT WAS							
16:						SCOPED AND PRICED BASED ON JD:							
17:						GUTMANNS' SCOPE DATED							
18:						4/04/88:							
19:													
20:													
21:	S999					BELLOWS							
22:													
23:	S999	351	19	1:	1300	3:	CANISTER BELLOWS ASSEMBLY -	1 EA:	I:			54140	54140
24:	S999	351	19	1:	1300	3:	DRAIN VALVE						
25:												15730	15730
26:	S999	351	19	4:	1300	3:	ADAPTER BELLOWS ASSEMBLY -	1 EA:	I:				
27:	S999	351	19	4:	1300	3:	DRAIN VALVE						
28:												21190	21190
29:	S999	351	19	5:	1300	3:	PLUG BELLOWS ASSEMBLY - DRAIN:	2 EA:	I:				
30:	S999	351	19	5:	1300	3:	VALVE						
31:												13590	13590
32:	S999	351	19	6:	1300	3:	UPPER PROBE BELLOWS ASSY -	1 EA:	I:				
33:	S999	351	19	6:	1300	3:	DRAIN VALVE						
34:												13590	13590
35:	S999	351	19	7:	1300	3:	LOWER PROBE BELLOWS ASSY -	1 EA:	I:				
36:	S999	351	19	7:	1300	3:	DRAIN VALVE						
37:												18830	18830
38:	S999	351	19	8:	1300	3:	DR VALVE BELLOWS ENGG & SETUP:	1 LS:	I:				
39:	S999	351	19	8:	1300	3:	CHARGES						
40:												11770	11770
41:	S999	351	20	1:	1300	3:	ACTUATOR BELLOWS-POUR SPOUT	1 EA:	I:				
42:	S999	351	20	1:	1300	3:	BELLOWS						
43:													
44:												148840	148840
45:													

DATE 10/25/88 TIME 15:14:25
DETAILS

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

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TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ENGINEERING NUMBER				TWC		F: DESCRIPTION		QUANTITY		S: \$\$\$\$\$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$\$\$\$\$			
DESIGN				U:		R:		AMT		UM:		C:	
AREA UNIT ITEM ELM				N:				LABOR		FIELD MATERIAL		WILM. MATERIAL	
												TOTAL	
1:	S999	351	20	2:	1300	3:	LOWER ADAPTER BELLOWS-POUR	1	EA:	I:		15300	15300
2:	S999	351	20	2:	1300	3:	SPOUT BELLOWS						
3:								1	EA:	I:		19150	19150
4:	S999	351	20	3:	1300	3:	UPPER ADAPTER BELLOWS						
5:													
6:													
7:	S999						COMPONENTS						
8:													
9:	S999	351	20		1300	3:	POUR SPOUT BELLOWS ASSY	1	EA:	I:		266220	266220
10:													
11:	S999	351	18	6:	1300	3:	ZIRCAR INSULATION-RISER HTR.	1	LS:	I:		11980	11980
12:													
13:	S999	351	18	8:	1300	3:	ZIRCAR INSULATION	1	LS:	I:		10170	10170
14:													
15:	S999	351	18	5:	1300	3:	GASKETS-FIBERFRAX	1	LS:	I:		430	430
16:													
17:	S999	351	19	3:	1300	3:	ZIRCAR INSUL.-DRAIN VALVE	1	LS:	I:		8450	8450
18:													
19:	S999	351	13	1:	1300	3:	FIBERFRAX-MILLED	1	LS:	I:		960	960
20:													
21:	S999	351	14		1300	3:	ELECTRODES(2 UPPER,2 LOWER)	4	EA:	I:		74470	74470
22:													
23:	S999	351	16		1300	3:	DOME HEATERS (4 ASSYS)	4	EA:	I:		101540	101540
24:													
25:	S999	351	13		1300	3:	FEED TUBES (2)	2	EA:	I:		174730	174730
26:													
27:	S999	351	15		1300	3:	MELT THERMOWELL-NOZZLE E	1	EA:	I:		34130	34130
28:													
29:	S999	351	15	5:	1300	3:	MELT THERMOWELL-NOZZLE C-4	1	EA:	I:		35520	35520
30:													
31:	S999	351	15	10:	1300	3:	VAPOR THERMOWELL/CONDUCTIVITY:	1	EA:	I:		34880	34880
32:	S999	351	15	10:	1300	3:	PROBE						
33:													
34:	S999	351	15	20:	1300	3:	MELT LEVEL DIP TUBE	1	EA:	I:		30920	30920
35:													
36:	S999	351	15	30:	1300	3:	T.V. CAMERA FRAMES (2)	2	EA:	I:		83460	83460
37:													
38:	S999	351	18		1300	3:	RISER HEATER	1	EA:	I:		121450	121450
39:													
40:	S999	351	10	12:	1300	3:	SHELL COMPONENTS-MISC	1	LS:	I:		10060	10060
41:													
42:	S999	351	19		1300	3:	DRAIN VALVE	1	EA:	I:		225130	225130
43:													
44:													
45:													

DATE 10/25/88 TIME 15:14:25
DETAILS

PROJ 9S3420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC		F		DESCRIPTION		QUANTITY		S: \$\$\$\$\$\$\$\$\$\$ U. S.		D O L L A R S \$\$\$\$\$\$\$\$\$\$	
DESIGN				U:		N:				R:		FIELD		WILM.	
AREA UNIT ITEM ELM										AMT UM:C		LABOR		MATERIAL	
1:	S999	351	10	3:	1300	3:		ANCHOR FLANGES		1 LS:I				37130	
2:															
3:	S999	351	15	40:	1300	3:		FILM COOLER-OFF GAS NOZZLE A		1 EA:I				22470	
4:															
5:	S999	351	15	50:	1300	3:		FILM COOLER-BACK UP OFF GAS		1 EA:I				16160	
6:	S999	351	15	50:	1300	3:		NOZZLE T							
7:															
8:															
9:	S999							ISOLATORS							
10:															
11:	S999	351	19	2:	1300	3:		ISOLATORS-DRAIN VALVE		1 LS:I				167130	
12:															
13:	S999	351	14	1:	1300	3:		ISOLATORS-ELECTRODES		1 LS:I				9950	
14:															
15:	S999	351	16	1:	1300	3:		ISOLATORS-DOME HEATERS		1 LS:I				19690	
16:															
17:	S999	351	18	2:	1300	3:		ISOLATORS-RISER HEATER		1 LS:I				115770	
18:															
19:	S999	351	10	2:	1300	3:		EXTERNAL ISOLATORS		1 LS:I				23540	
20:															
21:															
22:	S999							INCONEL 690 MATERIAL							
23:															
24:								NOTE: INCLUDES 690 MATERIAL							
25:								FOR MELTER 3& FUTURE MELTER 4							
26:															
27:	S999	351	10	4:	1300	3:		TYPE 690 WELD WIRE (2 MELTER		1 LS:I				200000	
28:	S999	351	10	4:	1300	3:		ASSYS)							
29:															
30:	S999	351	10	1:	1300	3:		INCONEL 690 MATERIAL(P-1780		45M LB:I				315000	
31:	S999	351	10	1:	1300	3:		AXC 6844W EXCESS MATERIAL -							
32:	S999	351	10	1:	1300	3:		TO BE TRANSFERRED TO P-3420)							
33:															
34:	S999	351	10	2:	1300	3:		INCONEL 690 MATERIAL		16M LB:V				240000	
35:	S999	351	10	2:	1300	3:		(ADDITIONAL NEW MATERIAL TO							
36:	S999	351	10	2:	1300	3:		BE PROCURED)							
37:															
38:	S999	351			1300	3:		ADJUSTMENT FOR UNUSUAL NICKEL		1 LS:D				150000	
39:	S999	351			1300	3:		MATERIAL PRICE FLUCTUATIONS							
40:															
41:															
42:															
43:															
44:															
45:															

DATE 10/25/88 TIME 15:14:25
DETAILS

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

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TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ENGINEERING NUMBER				TWC		F		DESCRIPTION		QUANTITY		S		U. S.		D O L L A R S		S	
DESIGN				U		R		FIELD		WILM.		TOTAL							
AREA UNIT ITEM ELM				N		C		LABOR		MATERIAL		MATERIAL							
1: S999								MELTER VESSEL											
2:										1 EA:V						2225600		2225600	
3: S999 351 10				1300		3:		MELTER VESSEL-PART OF											
4: S999 351 10				1300		3:		CB&I VERBAL QUOTE											
5:										1 LS:I						17120		17120	
6: S999 351 10				1300		3:		REFRACTORY DRY OUT											
7:										1 LS:I						1280		1280	
8: S999 351 10				6: 1300		3:		BORE INCONEL 690 FOR											
9: S999 351 10				6: 1300		3:		A & T NOZZLES											
10:										1 LS:I						12200		12200	
11: S999 351 10				5: 1300		3:		SS O RINGS-VESSEL SHELL/HEAD											
12: S999 351 10				5: 1300		3:		FLANGE											
13:										1 LS:I						1280		1280	
14: S999 351 10				10: 1300		3:		SS O RINGS-A&T NOZZLES -											
15: S999 351 10				10: 1300		3:		HYDROTEST											
16:																			
17:																			
18: S999								REFRACTORY INSTALLATION											
19:										1 LS:I						1820		1820	
20: S999 351 12				45: 1300		3:		FIBERFRAX-MISC BULK PAPER,DSM											
21:										1 LS:I						167240		167240	
22: S999 351 12				1300		3:		REFRACTORY INSTALLATION											
23:										1 LS:I						540		540	
24: S999 351 12				1300		3:		FIBERFRAX ROPE-DOME											
25: S999 351 12				1300		3:		HEATER SEAL											
26:																			
27:																			
28: S999								FIBERFRAX LINERS											
29:										1 LS:I						130010		130010	
30: S999 351 12				40: 1300		3:		FIBERFRAX INSULATION											
31:																			
32:																			
33: S999								REFRACTORY K-3											
34:										1 LS:I						560680		560680	
35: S999 351 12				10: 1300		3:		K-3 REFRACTORY								108820		108820	
36: S999 351 12				12: 1300		3:		K-3 GRINDING & DRILLING								11340		11340	
37: S999 351 12				13: 1300		3:		K-3 WIRE CUTTING & GRINDING											
38:																			
39:																			
40: S999								REFRACTORY-SUPERSTRUCTURE											
41:										1 LS:I						160500		160500	
42: S999 351 12				30: 1300		3:		SUPERSTRUCTURE REFRACTORY											
43:																			
44:																3398430		3398430	
45:																0		0	

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PAGE TOTALS

0

0

3398430

3398430

DATE 10/25/88 TIME 15:14:25
DETAILS

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC F: DESCRIPTION		QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$\$\$\$\$							
DESIGN	AREA	UNIT	ITEM ELM	U:	N:	AMT	UM:	C:	LABOR	FIELD MATERIAL	WILM. MATERIAL	TOTAL	

1:	S999												
REFRACTORY-ZIRMUL													
2:													
3:	S999	351	12	20:	1300	3:	ZIRMUL REFRACTORY	1	LS:I:		154080	154080	
4:													
5:													
6:	S999						REFRACTORY - ZIRMUL GRINDING						
7:													
8:	S999	351	12	22:	1300	3:	ZIRMUL GRINDING	1	LS:I:		9840	9840	
9:													
10:	S999	351			1300	3:	ALLOWANCE FOR SHIPPING	1	LS:E:	5000	25000	30000	
11:	S999	351			1300	3:	REFRACTORY FIXTURES						
12:													
13:													
14:													
15:	S999						THE FOLLOWING EQUIPMENT WAS						
16:							PRICED BASED ON EQUIP LIST						
17:							FURNISHED BY JE MEUNIER						
18:							DATED 3/23/88:						
19:													
20:													
21:	S999	351			1300	3:	MELTER ASSEMBLY AT VENDOR'S	1	LS:V:		1209100	1209100	
22:	S999	351			1300	3:	SHOP-PART OF CB&I VERBAL						
23:	S999	351			1300	3:	QUOTE						
24:													
25:	S999	351	46		1300	3:	MELTER FRAME-PART OF CB&I	1	LS:V:		738300	738300	
26:	S999	351	46		1300	3:	VERBAL QUOTE						
27:													
28:	S999	351	290	1:	1300	3:	CANISTER POSITIONING ARM	1	EA:I:		2140	2140	
29:													
30:	S999	351	41		1600	6:	DOME HEATER TRANSFORMERS	4	EA:I:		19260	19260	
31:	S999	351	41		1600	6:	INCLS 351-41,42,43,44						
32:													
33:	S999	351	161		6200	3:	BUS BARS-FRAME TO ELECTRODES	4	EA:I:		44940	44940	
34:	S999	351	161		6200	3:	INCLS 351-161,162,163,164						
35:													
36:	S999	351			6200	6:	BUS BAR GAUGE FOR DOME	1	EA:I:		5350	5350	
37:	S999	351			6200	6:	HTR TRANSFS						
38:													
39:	S999	351			6200	6:	ELECTRICAL LOWER HOLDERS	22	EA:I:		23540	23540	
40:	S999	351			6200	6:	(HANFORD)						
41:													
42:	S999	351			6200	6:	ELECTRICAL CABLE	4400	LF:I:		2140	2140	
43:													
44:													
45:													
PAGE 14									5000	25000	2208690	2238690	
PAGE TOTALS													

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DETAILS

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPFG GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER				TWC	F	DESCRIPTION	QUANTITY	S	U	S	D	O	L	L	A	R	S	TOTAL
DESIGN				U	N		AMT	UM	C	LABOR	FIELD	WILM.						
AREA UNIT ITEM ELM											MATERIAL	MATERIAL						
1:	S999	351		8400	3:	PROCESS CONNECTORS (HANFORD)	20	EA	I			2140						2140
2:																		
3:	S999	351	672	1:	7500	7: TV CAMERA ASSEMBLY	1	EA	I			94160						94160
4:																		
5:	S999	351	672	2:	7500	7: TV CAMERA ASSEMBLY	1	EA	I			94160						94160
6:																		
7:	S999			7500	7:	TV INSTALLATION & MISC MATL	1	LS	E	7000	3000							10000
8:																		
9:																		
10:																		
11:	S999					THE FOLLOWING INSTRUMENT												
12:						ITEMS ARE BASED ON SCOPE &												
13:						PRICE INFORMATION PER												
14:						RW FOSTER SCOPE 2/24/88:												
15:																		
16:																		
17:																		
18:	S999					THERMOCOUPLES TYPE B												
19:																		
20:												5720						5720
21:	S999	351	2753	TE:	7100	7: RISER (TOP,UPPER)	1	EA	I			6720						6720
22:																		
23:	S999	351	2754	TE:	7100	7: RISER (TOP,LOWER)	1	EA	I			3480						3480
24:																		
25:	S999	351	2940	TE:	7100	7: DRAIN VALVE,ZONE 1	1	EA	I			3480						3480
26:																		
27:	S999	351	2941	TE:	7100	7: DRAIN VALVE,ZONE 1	1	EA	I			4420						4420
28:																		
29:	S999	351	2951	TE:	7100	7: RISER,BOTTOM	1	EA	I			4420						4420
30:																		
31:	S999	351	2952	TE:	7100	7: RISER,BOTTOM	1	EA	I			3600						3600
32:																		
33:	S999	351	2953	TE:	7100	7: POUR SPOUT,UPPER	1	EA	I			4190						4190
34:																		
35:	S999	351	2954	TE:	7100	7: POUR SPOUT,LOWER	1	EA	I			6940						6940
36:																		
37:																		
38:	S999	351	3271	TEA:	7100	7: MELT POOL,UPPER	1	EA	I			6940						6940
39:																		
40:	S999	351	3271	TEB:	7100	7: MELT POOL,UPPER	1	EA	I			6940						6940
41:																		
42:	S999	351	3272	TEA:	7100	7: MELT POOL,UPPER	1	EA	I			6940						6940
43:																		
44:																		
45:																		

PROJ 953420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25
DETAILS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER : TWC F: D E S C R I P T I O N							QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$\$\$\$\$					
DESIGN		AREA UNIT ITEM ELM		U: N:		AMT UM: C:		LABOR	FIELD MATERIAL	WILM. MATERIAL	TOTAL	
1:	S999	351	3272	TEB:	7100	7:	MELT POOL,UPPER	1 EA:I:		6940	6940	
2:												
3:	S999	351	3273	TEA:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		7530	7530	
4:												
5:	S999	351	3273	TEB:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		7530	7530	
6:												
7:	S999	351	3274	TEA:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		7530	7530	
8:												
9:	S999	351	3274	TEB:	7100	7:	MELT POOL,MIDDLE	1 EA:I:		7530	7530	
10:												
11:	S999	351	3275	TEA:	7100	7:	MELT POOL,LOWER	1 EA:I:		8120	8120	
12:												
13:	S999	351	3275	TEB:	7100	7:	MELT POOL,LOWER	1 EA:I:		8120	8120	
14:												
15:	S999	351	3276	TEA:	7100	7:	MELT POOL,LOWER	1 EA:I:		8120	8120	
16:												
17:	S999	351	3276	TEB:	7100	7:	MELT POOL,LOWER	1 EA:I:		8120	8120	
18:												
19:	S999	351	4085	TEA:	7100	7:	VAPOR SPACE	1 EA:I:		4350	4350	
20:												
21:	S999	351	4085	TEB:	7100	7:	VAPOR SPACE	1 EA:I:		4350	4350	
22:												
23:	S999	351	4085	TEC:	7100	7:	VAPOR SPACE	1 EA:I:		4350	4350	
24:												
25:	S999	35	2920	TE:	7100	7:	ELECTRODE	1 EA:I:		3380	3380	
26:												
27:	S999	351	2921	TE:	7100	7:	ELECTRODE	1 EA:I:		3380	3380	
28:												
29:	S999	351	2930	TE:	7100	7:	ELECTRODE	1 EA:I:		3380	3380	
30:												
31:	S999	351	2931	TE:	7100	7:	ELECTRODE	1 EA:I:		3380	3380	
32:												
33:	S999	351	2942	TE:	7100	7:	DRAIN VALVE,ZONE 2	1 EA:I:		1560	1560	
34:												
35:	S999	351	2943	TE:	7100	7:	DRAIN VALVE,ZONE 2	1 EA:I:		1560	1560	
36:												
37:	S999	351	2944	TE:	7100	7:	DRAIN VALVE,ZONE 3	1 EA:I:		1500	1500	
38:												
39:	S999	351	2948	TE:	7100	7:	DRAIN VALVE,ZONE 3	1 EA:I:		1500	1500	
40:												
41:	S999	351	2947	TE:	7100	7:	DRAIN VALVE,ZONE 4	1 EA:I:		1730	1730	
42:												
43:												
44:												
45:												
PAGE 16							PAGE TOTALS		0	0	103960	103960

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DETAILS

PROJ 9S3420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

ESTIMATED BY -CRECCO RD

TITLE - DWPFG GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ENGINEERING NUMBER : TWC F: DESCRIPTION							QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$\$\$\$\$								
DESIGN				U:				R:		FIELD		WILM.		TOTAL	
AREA	UNIT	ITEM	ELM	N:		AMT	UM:	C:	LABOR	MATERIAL	MATERIAL				
1:	S999	351	2949	TE:	7100	7:	DRAIN VALVE, ZONE 4	1	EA:	I:		1500	1500		
2:															
3:	S999	351	2955	TE:	7100	7:	DRAIN VALVE, ZONE 5	1	EA:	I:		1670	1670		
4:															
5:	S999	351	2956	TE:	7100	7:	DRAIN VALVE, ZONE 5	1	EA:	I:		1670	1670		
6:															
7:	S999	351	2960	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
8:															
9:	S999	351	2961	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
10:															
11:	S999	351	2962	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
12:															
13:	S999	351	2963	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
14:															
15:	S999	351	2968	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
16:															
17:	S999	351	2969	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
18:															
19:	S999	351	2970	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
20:															
21:	S999	351	2971	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
22:															
23:	S999	351	2972	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
24:															
25:	S999	351	2973	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
26:															
27:	S999	351	2974	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
28:															
29:	S999	351	2975	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
30:															
31:	S999	351	3800	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
32:															
33:	S999	351	3801	TE:	7100	7:	DOME HEATER	1	EA:	I:		3090	3090		
34:															
35:	S999	351	3802	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
36:															
37:	S999	351	3803	TE:	7100	7:	DOME HEATER	1	EA:	I:		3320	3320		
38:															
39:															
40:	S999						THERMOCOUPLES TYPE K								
41:															
42:															
43:															
44:															
45:															
PAGE 17							PAGE TOTALS			0	0	56120	56120		

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DETAILS

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DMPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

ENGINEERING NUMBER : TWC F: DESCRIPTION							QUANTITY: S: \$\$\$\$\$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$\$\$\$\$				
DESIGN		AREA UNIT ITEM ELM		U: N:		AMT UM: C:		LABOR	FIELD MATERIAL	WILM. MATERIAL	TOTAL

1:	S999	351	2964	TEA	7100	7:	REFRACTORY	1 EA: I:		160	160
2:	S999	351	2964	TEB	7100	7:	REFRACTORY	1 EA: I:		160	160
3:	S999	351	TF		7100	7:	THERMOCOUPLE FITTINGS	1 LS: I:		4280	4280
4:	S999	351	TF		7100	7:	INCLUDES ITEMS 351-TF-1				
5:	S999	351	TF		7100	7:	THRU 6				
6:	S999	351	TF		7100	7:	THRU 6				
7:	S999	351	TF		7100	7:	THRU 6				
8:	S999	351	TF		7100	7:	THRU 6				
9:	S999	351	TF		7100	7:	THRU 6				
10:	S999	351	TF		7100	7:	THRU 6				
11:	S999	351	TF		7100	7:	THRU 6				
12:	S999	351	TF		7100	7:	THRU 6				
13:	S999	351	TF		7100	7:	THRU 6				
14:	S999	351	TF		7100	7:	THRU 6				
15:	S999	351	TF		7100	7:	THRU 6				
16:	S999	351	TF		7100	7:	THRU 6				
17:	S999	351	TF		7100	7:	THRU 6				
18:	S999	351	TF		7100	7:	THRU 6				
19:	S999	351	TF		7100	7:	THRU 6				
20:	S999	351	TF		7100	7:	THRU 6				
21:	S999	351	TF		7100	7:	THRU 6				
22:	S999	351	TF		7100	7:	THRU 6				
23:	S999	351	TF		7100	7:	THRU 6				
24:	S999	351	TF		7100	7:	THRU 6				
25:	S999	351	TF		7100	7:	THRU 6				
26:	S999	351	TF		7100	7:	THRU 6				
27:	S999	351	TF		7100	7:	THRU 6				
28:	S999	351	TF		7100	7:	THRU 6				
29:	S999	351	TF		7100	7:	THRU 6				
30:	S999	351	TF		7100	7:	THRU 6				
31:	S999	351	TF		7100	7:	THRU 6				
32:	S999	351	TF		7100	7:	THRU 6				
33:	S999	351	TF		7100	7:	THRU 6				
34:	S999	351	TF		7100	7:	THRU 6				
35:	S999	351	TF		7100	7:	THRU 6				
36:	S999	351	TF		7100	7:	THRU 6				
37:	S999	351	TF		7100	7:	THRU 6				
38:	S999	351	TF		7100	7:	THRU 6				
39:	S999	351	TF		7100	7:	THRU 6				
40:	S999	351	TF		7100	7:	THRU 6				
41:	S999	351	TF		7100	7:	THRU 6				
42:	S999	351	TF		7100	7:	THRU 6				
43:	S999	351	TF		7100	7:	THRU 6				
44:	S999	351	TF		7100	7:	THRU 6				
45:	S999	351	TF		7100	7:	THRU 6				

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DETAILS

PROJ 953420 PART 01

REPORT 881

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

ESTIMATED BY -CRECCO RD

TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

TITLE - DWA CLASS EAST RIVER										QUANTITY: \$\$\$\$\$\$ U. S. D O L L A R S \$\$\$\$\$\$													
ENGINEERING NUMBER				TWC		F: DESCRIPTION		QUANTITY: S: R:		FIELD		WILM.		TOTAL									
DESIGN				U:				AMT UM: C:		LABOR		MATERIAL											
AREA UNIT ITEM ELM				N:																			
1:	S999	351		1300	3:	INSULATORS	100	MANHOURS	1	LS:	I:		2000		2000								
2:																							
3:	S999	351		1300	3:	CONSTR LAYOUT	300	MANHOURS	1	LS:	I:		4000		4000								
4:																							
5:	S999	351		1300	3:	ELECTRICIANS	2200	MANHOURS	1	LS:	I:		60000	6000	66000								
6:																							
7:	S999	351		1300	3:	PIPEFITTERS	1800	MANHOURS	1	LS:	I:		45000	3000	48000								
8:																							
9:	S999	351		1300	3:	ALLOW FOR UNLOADING AND			1	LS:	E:		5000	1000	6000								
10:	S999	351		1300	3:	TRANSPORTING MELTER TO																	
11:	S999	351		1300	3:	717F BLDG.																	
12:																							
13:	S999	351		1300	3:	EXTRA EQUIPMENT RENTAL			1	LS:	I:			10000	10000								
14:																							
15:																							
16:																							
17:						DA SUB TOTAL (LESS CONTRACTS)							190000	54000	8773780	9017780							
18:				9700		PROJECT ENGINEERING ALLOW							28500	8100	1316100	1352700							
19:																							
20:																							
21:						DA NET TOTAL (LESS CONTRACTS)							218500	62100	10089880	10370480							
22:																							
23:																							
24:						CONTRACTS THIS DA							0	0	0	0							
25:																							
26:																							
27:						CONTRACTS NET TOTAL							0	0	0	0							
28:																							
29:																							
30:						EXTRA MACHINERY-MELTER NO.3																	
31:																							
32:																							
33:																							
34:																							
35:																							
36:																							
37:																							
38:																							
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42:																							
43:																							
44:																							
45:																							
PAGE 19										PAGE TOTALS										144500	28100	1316100	1488700

PROJ 9S3420 PART 01

REPORT 881

DATE 10/25/88 TIME 15:14:25

GLOSSARY

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

A. SOURCE CODES (SRC)
(APPLICABLE TO THIS ESTIMATE)

CODE	MEANING
A	NON-ENGINEERED SCOPE
B	UNIT LIBRARY
C	CUBED OR SQUARE FOOT
D	ESTIMATED WITH DETAILED DESIGN
E	ESTIMATED WITHOUT DETAIL DESIGN
F	LINEAL FOOT
I	INDEXED INVESTMENT - COST RELATED
K	GBC
L	LINE COUNT PIPE ESTIMATING
M	DESIGN DEVELOPMENT
O	ORDER PLACED
P	ACTUAL COST
Q	ORDER QUOTE
R	FACTOR
S	INDEXED INVESTMENT - ESTIMATED
U	ESTIMATING ALLOWANCE
V	VERBAL QUOTE
Y	PRICE INCLUDED ELSEWHERE

DEPARTMENT - PETROCHEMICALS AED SITE - SAVANNAH RIVER
TITLE - DWPF GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

SITE NUMBER - 6180

ESTIMATED BY -CRECCO RD

B. TYPE WORK CATEGORIES (TWC)

TWC	DEFINITION
0600	ABANDONED FIELD COST
0700	MAINTAINING PRODUCTION
0800	DISMANTLING & REARRANGEMENT
1100	EQUIP FOUNDATIONS & SUPPORTS
1200	PROCESS EQUIPMENT
1300	MECHANICAL EQUIPMENT
1400	ARCHITECTURAL & CIVIL EQUIPMENT
1500	HEATING & VENTILATING AND POWER EQUIPMENT
1600	ELECTRICAL EQUIPMENT
1800	TANKS (\$25,000 OR GREATER)
1900	ELEVATORS AND DUMBWAITERS
2100	INSULATION-EQUIPMENT
2200	INSULATION-PIPING
2300	INSULATION-DUCT
3100	SITE DEVELOPMENT
3200	ROADS, SIDEWALKS, PARKING LOT
3300	RAILROADS
3400	FENCES GATES
3700	PRECIOUS METALS
3800	INVENTORY ACCOUNTS
3900	LAND
4000	BUILDINGS
5100	BUILDING & LABORATORY DUCTWORK
5200	MANUF. & PROCESS DUCTWORK
6100	BUILDING-ELECTRIC & LIGHTING
6200	ELECTRICAL-ALL OTHER (POWER WIRING, MOTOR CONTROL CENTERS, ETC)
7100	INSTRUMENTS & PANELS
7200	INSTRUMENT PIPING
7300	INSTRUMENT WIRING
7500	CONTROL SYSTEMS EQUIPMENT
8100	OUTSIDE LINE SUPPORTS
8200	OUTSIDE OVERHEAD PIPE LINES
8300	OUTSIDE UNDERGROUND PIPE LINES
8400	PROCESS & SERVICE PIPING(INSIDE)
8600	PLUMBING & BUILDING SERVICE PIPE
8700	SPRINKLER-BUILDING FIRE PROTECTION
9100	ABNORMAL PREMIUM TIME
9200	MINOR CHANGES
9300	NON-ENGINEERED SCOPE
9500	PROV. FOR ALLOW. (ESTIMATING, SALES TAX, WORK. COND., FRT.,ETC.)
9700	SPECIAL ADD/PROJECT ENGINEERING ALLOWANCE
9781	SPECIAL ADD/PROJECT ENGINEERING ALLOWANCE (CONTRACTS)
9800	LS/UP CONTRACT ALLOWANCE

3RD & 4TH DIGIT DEFINITIONS

DEPARTMENT - PETROCHEMICALS AED

SITE - SAVANNAH RIVER

SITE NUMBER - 6180

TITLE - DWPf GLASS WASTE MELTER NO.3 & INCONEL FOR NO.4 (FY89 CAB)

ESTIMATED BY -CRECCO RD

--81 FIELD CONTRACT (SHOWS AS *)

--82 WILM CONTRACT (SHOWS AS *)

--83 E-WORK ORDER (SHOWS AS *)

C. FUNCTION CODES (FUN)

CODE	DESIGN GROUP
2	PROCESS
3	MECHANICAL
4	ARCHITECTURAL & CIVIL
5	HEATING & VENTILATING AND POWER
6	ELECTRICAL
7	INSTRUMENTS
8	MECHANIZED SYSTEMS

D. QUANTITY DEFINITIONS

CODE	MEANING
1EA	ONE EACH
1LS	ONE LUMP SUM
1LF	LINEAL FEET
1CP	ESTIMATE ENTRY IS TOTAL (COMPUTER PRINTOUT) FROM PIPE, ELECTRICAL, OR INSTRUMENT ESTIMATE. DETAILS AVAILABLE FROM BM&I BY SPECIAL REQUEST.

E. ALLOWANCE DEFINITIONS

1. MINOR CHANGE ALLOWANCE IS TO ACHIEVE INTENDED QUALITY AND QUANTITY OF MANUFACTURED PRODUCT AT TIME OF PHYSICAL COMPLETION AND START-UP.
2. NON-ENGINEERED SCOPE ALLOWANCE - FUNCTIONS SPECIFIED BY DESIGN WHERE REQUIREMENTS OR SCOPE CANNOT BE SUFFICIENTLY DEVELOPED FOR PRICING. ALLOWANCES SHOULD BE JOINTLY DEVELOPED BY AED INVESTMENT ENGINEERING AND AED DESIGN.
3. PROJECT ENGINEERING ALLOWANCE - A PROVISION FOR THE UNFORE-SEEN COST ELEMENTS DUE TO ENGINEERING EVOLUTION, ESTIMATE ADJUSTMENTS, AND PRICING DIFFERENCES WITHIN THE DEFINED PROJECT SCOPE. THE AMOUNT OF FUNDS IS INTENDED TO PROVIDE THE ESTIMATE WITH AN EVEN CHANCE OF OVERRUN OR UNDERRUN.
4. CONTINGENCY - A FINANCIAL RISK ALLOWANCE INCLUDED IN CURRENT APPRAISAL FOR BUDGETS (CABS) TO COVER THE RANGE OF ACCURACY. THIS GIVES AN 85% PROBABILITY THAT A PROJECT'S ESTIMATE WOULD NOT BE EXCEEDED.

DD 0005743

CC: *W. R. Frazer, Bechtel, SRP, S-1
*R. Kesavan, Bechtel, SRP, S-2
*J. N. Meunier, Bechtel, SRP, S-2
*B. K. Parsons, Bechtel, SRP, S-2
*J. R. Glasscock, PD-AED, SRP, 704-11S
*D. C. Nichols, PD-AED, SRP, 704-S
L. M. Papouchado, PD-AED, SRP, 703-A
*A. F. Weisman, PD-AED, SRP, 704-11S
R. W. Baxter, PD-AED, SRP, 704-S
*C. R. Lund, M&L, L11W19
W. Campbell, Engrg-AED, SRC, S-1
J. C. Davis, Engrg-AED, SRC, S-1
D. J. Barnette, Engrg-AED, SRC, 717-F
*J. N. Odum, Engrg-AED, SRC, S-37
*C. R. Pair, Engrg-AED, SRC, S-1
*T. G. Powell, Engrg-AED, SRC, S-37
L. F. Shafranek, Engrg-AED, L3303
N. R. Levins, Engrg-AED, L2324
*D. G. Kasal, Engrg-AED, L3316
*G. E. Miller, Engrg-AED, L3311
R. A. Epperly, Engrg-AED, L3314
*J. S. Johnson, Engrg-AED, L3358
*R. T. Britt, Engrg-AED, L33E82
*B. J. Etienne, Engrg-AED, L33W39
*W. E. Guenther, Engrg-AED, L3375
*J. Scafaria, Engrg-AED, L3378
R. W. Foster, Engrg-AED, L3335
*J. E. Savoy, A/S, L33
IC 33 (2)

January 18, 1988

TO: *J. M. MC KIBBEN, ENGRG-AED, SRC, S-1

FROM: *J. D. GUTMANN, JR., ENGRG-AED, L3321 *JDG*

PROJECT 9S1780 - SAVANNAH RIVER PLANT
DEFENSE WASTE PROCESSING FACILITY
DA S350 - GLASS MELTER
MINUTES OF MELTER #3 PLANNING MEETING

This memo documents the discussion and agreements made during the January 7 planning meeting at Louviers. The objective of the meeting was to resolve program issues for melter #3 only. Future melter design/development was not a topic for this meeting.

A. SUMMARY

Following are the major points and decisions made at the planning meeting:

1. Project Items

- o This will be a capital project managed by Engineering Department. This responsibility will be transferred to the new SRP contractor after one is selected.

- o Work request funding is required for Engrg-AED and Bechtel participation.
- o A project objectives letter has been prepared.
- o The plant will prepare and submit basic data, which will go through a formal review and comment process.
- o The plant's desired completion date for melter #3, per the project objectives letter, is July, 1991. This timing is not compatible with the long lead time required to procure a melter vessel, typically 3 1/2 years after the order is placed.

2. Procurement

- o The bid package for melter #3 will include an option for melter #4.
- o Bechtel will be responsible for procurement of the melter and assembly with its components. This includes preparation of specifications and the bid package, and selection of the vendor for competitive bid orders. The existing Du Pont contract with Bechtel will have to be revised for added scope and timing. The orders will be executed by M&L Department.
- o In support of Bechtel procurement, AED - mechanical at Louviers will provide drawing packages for the melter vessel and bolt-on components (same equipment furnished by Louviers for melters 1 and 2).
- o Bechtel will be responsible for drawing packages for all other components related to the melter frame and assembly.
- o SRP should consider placing orders for additional borescopes as soon as possible. There is some risk of losing continuity of design details, since these are all coordinated by one consultant.

3. Task Team

- o A Task Team will be formed under J. M. McKibben to provide leadership and coordination for producing the bid packages, with follow-up through awarding the bids. After the orders are placed, the Task Team will be disbanded.
- o Bechtel will assign a lead coordinator for this effort. Additional support will be provided by Engineering Department, SRL and plant production/technical, Projects Department and QA. The plan is to have one member from each organization.

4. Quality Assurance Aspects

- o The current assumption is that NQA-1 requirements will be imposed on the melter #3 project. SR/QA requirements that are in place will be included. Additional SR/QA requirements will be included as they are available.
- o In Bechtel's experience, the inclusion of NQA-1 can be more than double the time it normally takes to select a vendor and place an order.
- o Bechtel will prequalify vendors to satisfy NQA-1. The QA portion of each bid package will be reviewed and approved by Bechtel's QA group before the bid package is released as a request for quotes.

B. DISCUSSION

J. M. McKibben covered the objectives of the meeting, and presented the list of items requiring decisions, Figures 1 and 2.

1. Schedule

J. R. Glasscock stated that the required completion date for the melter #3 assembly is July, 1991. This objective is included in the project objectives letter, and is based on the following assumptions. (See Figure 7):

- o Melter #1 starts up early 4Q '89 and runs for 2 years.
- o Melter #3 is available to back up #2 when it is installed in 4Q 1991.

J. D. Gutmann presented a summary of procurement time durations for melter #1 components, Figure 3 through 5. These orders were placed by Louviers-Mechanical (Gutmann, Etienne, Scafaria). Procurement timing figures are based on the actual release dates, ie, order time is the interval between release of the price request to solicit bids and the date the order was placed. This includes the time to prepare and review bids, assemble the bid package, obtain DOE approval where necessary and release the order through M&L. Fabrication timing is the interval from order placement to the date of shipment. For the melter vessel, the "ship" date is the date the vessel was completed and ready for refractory installation.

This data was entered into the Macintosh OverVUE database program, the order and fabrication times were added to obtain the total in weeks and months, the total time column was sorted from longest to shortest and like times for a given order were grouped together.

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Following are comments on this data:

- o Time required for the order phase ranged from 24 to 44 weeks when DOE approval was required. This timing was typical in 1984 and early 1985, when the DOE approval cycle was usually 4 to 8 weeks. Today, this cycle is longer, and new QA requirements are expected to increase the time even more. The order for Inconel 690 material (Figure 4) was placed within 14 weeks via letter of intent. DOE agreed to permit this order to be placed prior to approval of the bid package due to the critical effect of this material delivery on the schedule. In general, orders that required less than 14 weeks to place did not require DOE approval.
- o Some of the refractory fabrication times are longer than normal by several months because the vendor had to wait for the fixture to be completed at CBI. The same fixtures will be used for melter #3, so there will not be any delays delivering the fixtures to the vendors.
- o As before, the critical path item is the melter vessel itself. Fabrication of melter #1 took 150 weeks to reach the point where refractory could be installed.
- o Following the melter vessel order, the next most critical item for timing is Inconel 690 material. This must be ordered early to have material available in time to fabricate the melter components. As shown in Figure 4, the Inconel for melter #1 took 38 weeks to fabricate after the order was placed.

The overall schedule for melter #1 is shown in bar chart form in Figure 6. Starting from the time the order request was released in 2Q 1984, it will be end of the first quarter of 1988 before the assembly and mock up activities are complete, a total of nearly four years. Figure 7 shows the influence of this schedule on the start up of melter #2, assuming that the total hot running time of #1 is limited to two years. This is the basis for establishing the July 1991 completion date for melter #3 in the project objectives letter.

Melter #1 procurement data was combined with other broad assumptions to produce a preliminary comparison schedule for melter #3, Figure 8, to illustrate the difficulty of meeting the July 1991 completion date. This indicates that the melter assembly cannot be completed until late 1992, assuming that the order can be placed in 3Q '88. As shown, there are schedule requirements that are in bold face with question marks to flag out the areas of

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greatest uncertainty. The largest of these is the effect of the QA requirements, which were not clear when this comparison schedule was developed. During the discussion of this schedule, the following comments were made:

- o There are no foreseeable short cuts that can be applied to vessel fabrication on future orders. The vessel is relatively small, and this limits the number of welders that can be working on it at a given time. Realistically, we must assume that the fabrication phase will take the same time - 150 weeks. Time can be potentially reduced up front by taking steps to place the order early. One possibility is to get DOE concurrence to place an order via letter of intent, prior to DOE approval of the bid package, releasing the vendor to order material and prepare drawings for approval.
- o The assembly plan for melter #3 and future units will not include a physical mock-up of the jumpers in 717-F. The intent is to measure and verify that the jumper connection points are at the correct x, y and z coordinates. This should reduce the time required in 717-F by approximately two months.
- o In Bechtel's experience, the addition of NQA-1 requirements will more than double the time it normally takes to get an order placed, since these QA requirements must also be met by all of the primary vendor's subcontractors. The impact of this makes the schedule in Figure 8 look optimistic.
- o In view of the long procurement time required to purchase and build a melter, it was recommended that the contract for melter #3 include an option for melter #4.

2. Procurement

J. D. Gutmann described the procurement history of melter #1, Figures 9 through 15. As shown in Figure 9, there were a total of 39 individual Engineering Department orders for the vessel and its components.

A. Fixtures

Included in the above orders are a number of fixtures that will be used for melter #3 and beyond, Figure 10. SRP will have to arrange for indoor storage of these, and initiate procedures to control their location and disposition for future orders. It may be possible to have the sole source vendors accept the responsibility for storing their respective

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fixtures locally, which would avoid the expense of shipping these back and forth to SRP. Other fixtures are used for competitive bids, and would have to be stored at SRP. At present, there is no permanent storage facility available at the plant for these items.

B. Borescope

The borescope vendor, Stenning Instruments Co., is an individual that contracts work to a machine shop for the fabricated items, and has the optics furnished from another source. Since these details are all known and handled by one person, there is a greater risk of losing the continuity required for future orders. It is recommended that the plant place orders for additional borescope assemblies as soon as possible to avoid having to re-invent this assembly.

C. Proposed Procurement Plan

Because of different design completion dates and schedule requirements, separate orders were placed for the #1 melter vessel, frame, and assembly package. Figure 11 shows the recommended grouping of these items into one order, and the recommendation to do the final assembly of the melter components at SRP, as we are doing for melters 1 and 2. It was agreed that this approach would be used for melter #3.

In the same manner, the number of component orders can be reduced by grouping like items and making these the responsibility of a primary vendor. Since the component designs for melter #1 could not be completed simultaneously, a priority system was established for design completion to meet the melter assembly schedule requirements. As a result, 30 separate mechanical orders were placed as the design was completed for each major subassembly, Figure 12. For melter #3 procurement, these can be reduced to 12 orders by grouping as shown in Figure 13. The complexity and unusual nature of the melter assembly does not lend itself to reducing everything down to one or a few vendors at this time.

Figure 14 is a summary of single source orders required for melter #3. Virtually all of these are due to proprietary materials that are not available from other vendors. The proposed major competitive bid orders are listed in Figure 15. Under current rules, DOE approval is required for single source orders at or exceeding \$100,000, (six orders in Figure 14) and competitive bids at or exceeding \$250,000 (two orders in Figure 15).

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The use of existing vendor drawings for procurement was discussed. After reviewing the legal aspects of the DWPF contracts, legal consultants have determined that vendor drawings can be used for competitive bids for future orders, if the vendor logo and other identification is removed from the drawing.

3. Design Basis for Melter #3

For the past several months, the Engineering Department has been preparing a drawing package for the #3 melter vessel. The design basis assumed for this work is shown in Figure 16. Design revisions have been restricted to minor changes that will make fabrication easier, and reduce the difficulty of meeting close tolerances. We have assumed that the basic configurations used on melters 1 and 2 will also be used on #3. If basic data requires configuration changes, the design scope and time will increase.

Materials will be the same, except sealing gasket material will be Graphoil instead of asbestos. In addition to eliminating asbestos from the design, the switch to Graphoil will reduce the bolt torque required to seal the joint.

Lead was used on melters 1 and 2 for shielding the TV camera and counterweighting the camera carrier frames and feed tubes. The question about current policy on lead use was raised. In general, it is desirable to use substitutes for lead where feasible. It was pointed out that if lead cannot be used for counterweighting melter #3 top head components, this could result in a major design change, since the space envelope around these components is very restricted.

4. Scope of Work

Figures 17 and 18 show the proposed division of work between the Engineering Department and others for the #3 melter project. All drawings furnished by the Engineering Department for the melter vessel and its components will be reproduced on new mylars, assigned new numbers, and start with revision 0. This will preserve drawings showing the as-built configuration of melters 1 and 2. In addition to providing this drawing package, a melter design manual will be furnished that covers the history and design of the DWPF melter configuration, as well as details of procurement procedures and recommendations.

5. Decisions on Scope and Responsibility

After discussing the above information, the following decisions on project scope and responsibilities were reached:

- o Melter #3 will be a capital project managed by the Engineering Department. This responsibility will be transferred to the new SRP contractor after one is selected.
- o Basic data will be submitted by SRP and go through a formal review and approval procedure.
- o Bechtel will be responsible for writing the specifications, preparing the bid packages, selecting vendors, and procuring all items required for the melter assembly. The current Du Pont contract with Bechtel will have to be revised to include this new scope and timing. Purchase orders will be executed by M&L Department. The bid package for melter #3 will include an option for melter #4.
- o AED-Mechanical at Louviers will prepare drawing packages, per paragraph 4, for the melter vessel and its bolt-on components. These will be used by Bechtel for procurement of these items. Bechtel will have responsibility for providing drawings of all other components related to the melter assembly.
- o J. Gutmann will coordinate the effort to prepare a manual on DWPF melter history, design basis, and procurement requirements. This will be used as a guide for future procurement of melters and form a basis for evaluating future suggestions for design modifications.
- o Bechtel was requested to start initial work to prepare a program for the melter #3 effort.

6. Program Task Team

J. M. McKibben recommended that a task team be formed under his direction to assist with the preparation of the bid packages, and continue through placement of the order. It was agreed that Bechtel will assign a lead coordinator for this effort. Additional support will be provided by Engineering Department, SRL, and SRP production/technical, Projects Department and QA. The intent is to have one member from each organization on the task team.

The task team charter will be as follows:

- o Review the basic data report.
- o Produce the design and bid packages for melter #3 with options for melter #4. This will include material release for #4.
- o Review and approve the bidder's lists.

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- o Participate in discussions with the vendors.
- o Follow up reviews with DOE.
- o Provide design liaison and follow-up through award of the orders.
- o Review the melter design manual.

7. Quality Assurance

There have been a number of questions regarding QA requirements for melter #3. This issue was addressed by Dan Kasal, and is summarized below:

The QA requirements address design verification, inspection and testing. Each order must include the critical requirements, with plus and minus acceptance limits for these requirements. The intent is to be able to verify that the as-built equipment meets the specification.

Melter #3 will be purchased under NQA-1 requirements. SR/QA requirements will be added in as they are available and training is completed. The primary vendor must audit subcontractors and verify that their procedures conform to NQA-1 requirements.

Bechtel QA will prequalify vendors for melter #3 components, and will review the QA portion of the bid package before it is released for quotes.

Verification is required for design changes. If the design has been used before, this is suitable verification. Since we have a history of melter tests verifying the configuration, we should not have a problem with this item. Additional details of the DWPF melter design basis will be covered in the manual that will be issued at a later date.

The question of code stamping requirements was raised. Melters 1 and 2 were built to the ASME code, but not stamped. At this time, it is not clear if melter #3 will require a code stamp. If a stamp is necessary, additional QA documentation will be required.

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8. Other Items

- o Drawings - Bechtel will consider converting the Engineering Department drawings to the CAD format. J. Gutmann recommended that the drawings for melter #3 procurement be used as is, and make the conversion to CAD a longer term project for future melters. Since the drawing package for the vessel and components exceeds 450 drawings, it will take a considerable amount of time to redraw and check these. A set of preliminary vessel prints for information will be sent to J. Muenier the week of January 18.
- o Inconel 690 Material - Keller Technology will be requested to submit an inventory of the remaining Inconel material. J. Gutmann will prepare a list of additional Inconel that must be ordered the melter #3 components on our drawings. Bechtel will combine these with any additional material needed for related frame/assembly orders.
- o J. D. Gutmann requested that SRP assign someone with a materials background to participate in the remaining final inspections for the #2 melter refractory. This will provide continuity for the refractory procurement for #3 and future melters.

AGENDA
MELTER #3 PROJECT KICKOFF
L-2309

MEETING CHAIRMAN: J. M. MC KIBBEN

SECRETARY: J. D. GUTMANN

INTRODUCTION - OUTLINE OF EFFORT	MC KIBBEN
- KEY DECISIONS	
OVERVIEW OF SCHEDULE	GLASSCOCK/GUTMANN
SCOPE - EQUIPMENT LIST	GUTMANN
- VENDORS	
DECISIONS ON SCOPE EXECUTION	ALL
1. TEAM TO PRODUCE BID PACKAGE	
2. BRDO TO PROCURE?	
3. ED-AED TO MANAGE?	
4. ASSEMBLY BY SRC?	
QUALITY ASSURANCE ISSUES	KASAL/ALL
- DESIGN BASIS DOCUMENTATION	
- ADHERE TO HOW DETAILS - VGA, FORMAL RESPONSE TO BASIC DATA, SCOPE, ETC.	
- VENDOR PRE-APPROVAL	
SCHEDULE DETAILS	ALL
<u>MISCELLANEOUS</u>	ALL
INCONEL STOCK	
HANDLING OF FIXTURES & TEMPLATES	
TECHNOLOGY TRANSFER - TRAINING	
COMPATIBILITY OF DU PONT VS. BECHTEL SYSTEMS	
ETC.	
<u>CONTRACT ISSUES</u>	LUND/ALL
<u>WRAP-UP</u>	ALL

KEY DECISIONS

- 1) LEAD ENGINEER (LOUVIERS VS. BECHTEL)
- 2) CLIENT (SRP PROJECT VS. LOUVIERS)
- 3) SCHEDULE CONSTRAINTS
 - A) EFFECT OF QA
 - B) BIDS VS. SOLE SOURCE
 - C) DESIGN IMPROVEMENTS
- 4) PERSONNEL TRANSITION PLANS

PROCUREMENT TIMING HISTORY FOR DMPF MELTER COMPONENTS

ORDER NO (AXC)	EN NUMBER	DESCRIPTION	RELEASE DATE			PROCUREMENT TIMING			
			PRICE REQUEST	ORDER REQUEST	SHIP EQUIPMENT	ORDER (WKS)	FAB (WKS)	TOTAL (WKS)	TOTAL (MOS)
6247W	S350-185-10-00	MELTER VESSEL	05/29/84	11/19/84	04/27/87	25	125	150	34 *
6846W	S350-185-12-10	K-3 REFRACTORY	09/21/84	03/17/85	04/23/87	25	109	134	30
6847W	S350-185-12-30	SUPERSTRUCTURE REFRACTORY	10/08/84	02/25/85	11/26/86	20	96	116	26
6853W	S350-185-10-12	SHELL COMPONENTS - MISC	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-13-00	FEED TUBES	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-00	MELT THERMOWELL - NOZZLE E	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-05	MELT THERMOWELL - NOZZLE C-4	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-10	VAPOR THERMOWELL/COND PROBE	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-15-20	MELT LEVEL DIP TUBE	08/05/85	01/23/86	09/09/87	24	85	109	25
6853W	S350-185-18-00	RISER HEATER	08/05/85	01/23/86	09/09/87	24	85	109	25
8901W	S350-185-20-00	POUR SPOUT BELLOWS ASSY	06/17/85	09/13/85	06/11/87	12	91	103	23
6853W	S350-185-14-00	ELECTRODES	08/05/85	01/23/86	06/05/87	24	71	95	21
6853W	S350-185-16-00	DOMES HEATERS	08/05/85	01/23/86	06/05/87	24	71	95	21
6850W	S350-185-19-00	DRAIN VALVE	09/09/85	02/11/86	08/04/87	17	77	94	21
6849W	S350-185-12-12	K-3 GRINDING & DRILLING	02/07/85	06/26/85	09/30/86	20	66	86	19
6848W	S350-185-12-20	ZIRMUL REFRACTORY	10/18/84	04/10/85	06/06/86	25	60	85	19
6851W	S350-185-12-40	FIBERFRAX INSULATION	11/28/84	06/04/85	07/17/86	27	58	85	19
613W	S350-185-19-01	CANISTER BELLOWS ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
613W	S350-185-19-04	ADAPTER BELLOWS ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
613W	S350-185-19-05	PLUG BELLOWS ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
613W	S350-185-19-06	UPPER PROBE BELLOWS ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19

*Time to complete vessel. Refractory installation, assembly & mock up takes an additional 11 months.

SORTED BY TOTAL PROCUREMENT TIME - LONGEST TO SHORTEST

J. D. GUTMANN, JR.

Figure 3

PROCUREMENT TIMING HISTORY FOR DMPF MELTER COMPONENTS

ORDER NO (AXC)	EN NUMBER	DESCRIPTION	RELEASE DATE			PROCUREMENT TIMING			
			PRICE REQUEST	ORDER REQUEST	SHIP EQUIPMENT	ORDER (WKS)	FAB (WKS)	TOTAL (WKS)	TOTAL (MOS)
613W	S350-185-19-07	LOWER PROBE BELLWS ASSY	11/27/85	07/10/86	06/30/87	32	51	83	19
6960W	S350-185-10-04	TYPE 690 WELD WIRE	08/22/84	12/03/84	01/21/86	14	59	73	16
725W	S350-185-10-03	ANCHOR FLANGES	03/17/86	05/02/86	05/15/87	7	54	61	14
6853W	S350-185-15-30	T.V. CAMERA FRAMES	08/05/85	01/23/86	10/01/86	24	36	60	13
6844W	S350-185-10-01	INCONEL 690 MATERIAL	11/01/84	02/07/85	10/30/85	14	38	52	12
6854W	S350-185-12-00	REFRACTORY INSTALLATION	07/11/85	05/14/86	05/29/87	44	5	49	11
482W	S350-185-12-45	FIBERFRAX - MISC BULK PAPER, DSM	10/10/85	03/31/86	10/01/86	24	22	46	10
1992W	S999-350-20-01	ACTUATOR BELLWS ASSY	02/06/87	05/18/87	11/15/87	14	26	40	9
1992W	S999-350-20-02	UPPER ADAPTER BELLWS ASSY	02/06/87	05/18/87	11/15/87	14	26	40	9
1992W	S999-350-20-03	LOWER ADAPTER BELLWS ASSY	02/06/87	05/18/87	11/15/87	14	26	40	9
6852W	S350-185-14-01	ISOLATORS - ELECTRODES	09/30/85	11/26/85	06/30/86	8	31	39	9
6852W	S350-185-16-01	ISOLATORS - DOME HEATERS	09/30/85	11/26/85	06/30/86	8	31	39	9
8417W	S350-185-18-02	ISOLATORS - RISER HEATER	09/30/85	11/26/85	06/30/86	8	31	39	9
8823W	S350-185-19-02	ISOLATORS - DRAIN VALVE	06/19/85	09/16/85	03/20/86	13	26	39	9
341W	S350-185-18-06	ZIRCAR INSULATION - RISER HEATER	06/19/85	10/23/85	01/13/86	24	12	36	8
1489W	S350-185-10-02	EXTERNAL ISOLATORS	08/04/86	09/10/86	04/16/87	5	31	36	8
1716W	S350-185-18-08	ZIRCAR INSULATION - RISER HEATER	08/04/86	10/23/85	01/13/86	24	12	36	8
8941W	S350-185-10-05	SS O RINGS	09/18/85	01/03/86	05/16/86	15	19	34	7

*Order placed via letter of intent.

SORTED BY TOTAL PROCUREMENT TIME - LONGEST TO SHORTEST

J. D. GUTMANN, JR.

PROCUREMENT TIMING HISTORY FOR DWPF MELTER COMPONENTS

ORDER NO (AXC)	EN NUMBER	DESCRIPTION	RELEASE DATE			PROCUREMENT TIMING			
			PRICE REQUEST	ORDER REQUEST	SHIP EQUIPMENT	ORDER (WKS)	FAB (WKS)	TOTAL (WKS)	TOTAL (MOS)
755W	S350-185-13-01	FIBERFRAX - MILLED	10/15/85	01/23/86	04/03/86	14	10	24	5
2183W	S350-185-15-40	FILM COOLER-OFF GAS LINE NOZZLE A	04/06/87	05/11/87	09/09/87	5	17	22	5
2183W	S350-185-15-50	FILM COOLER-OFF GAS LINE NOZZLE T	04/06/87	05/11/87	09/09/87	5	17	22	5
154W	S350-185-10-06	BORE A & T NOZZLES	08/01/85	09/06/85	09/12/85	5	12	17	3
618W	S350-185-19-03	ZIRCAR INSULATION - DRAIN VALVE	11/11/85	02/22/86	04/04/86	10	6	16	3
392W	S350-185-18-05	GASKETS - FIBERFRAX	10/11/85	12/06/85	01/13/86	8	5	13	3
6854W	S350-185-19-00	FIBERFRAX ROPE - DOME HEATER SEAL				1	12	13	3
8976W	S350-185-12-13	K-3 WIRE CUTTING & GRINDING	08/05/85	09/19/85	11/25/86	7	4	11	2
8976W	S350-185-12-22	ZIRMUL GRINDING	08/05/85	09/19/85	04/08/87	7	4	11	2
8941W	S350-185-10-10	SS O RINGS - HYDROTEST	06/30/86	07/09/86	07/28/86	2	3	5	1

*Actual fabrication time shown. Vendors had to wait for refractory to be completed before they could start machining.

SORTED BY TOTAL PROCUREMENT TIME - LONGEST TO SHORTEST

J. D. GUTMANN, JR.

Figure 5

SCHEDULE FOR MELTER #1

Figure

SCHEDULE FOR MELTERS 1 & 2

Figure 7

MELTER SCHEDULE - TIMING FOR #3

PROCUREMENT HISTORY - MELTER #1

TOTAL OF 39 ENGINEERING DEPT ORDERS FOR THE MELTER

(5) INSTRUMENT ORDERS

BORESCOPES

TYPE B T/C'S - VENDOR

TYPE B T/C'S - FIELD

TYPE K T/C'S

T/C FITTINGS

(34) MECHANICAL ORDERS

3 - VESSEL

2 - MATERIAL

2 - BELLOWS

10 - COMPONENTS

9 - REFRACTORY

4 - ISOLATOR

4 - FIXTURES

JDF

Figure 9

MELTER FIXTURES

REFRACTORY

K-3 GAGING & FIT UP

ZIRMUL FIT UP & GRINDING

TOP HEAD FIT UP

K-3 RISER BLOCK WIRE CUT

K-3 THROAT BLOCK WIRE CUT

K-3 BLOCK GRINDING SET UP

K-3 RISER BLOCK - DUMMY HEATER

INSULATION

FIBERFRAX TOP HEAD LINER

FIBERFRAX BOTTOM HEAD LINER

FIBERFRAX BOTTOM CORNER LINER

FABRICATION

TOP HEAD COMPONENT ALIGN

FIELD INSTALLATION

TOP HEAD ROTATOR

ANCHOR FLANGE ALIGNMENT

SHIPPING

RISER / POUR SPOUT HEATER FRAME

DRAIN VALVE FRAME

DATE

FILMED

8 / 1 / 94

END