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Department of Energy

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JAN 8 1997

DOE-0389-97

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Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

OPERABLE UNIT 4 VITRIFICATION PILOT PLANT PHASE I INTERIM TREATABILITY STUDY REPORT -- CAMPAIGN 2

The purpose of this letter is to transmit the *Operable Unit 4 Vitrification Pilot Plant Phase I (Campaign 2) Interim Treatability Study Report*. This transmittal satisfies the recently proposed amendment to the reporting requirements for Phase I. As previously discussed and documented in the September 26, 1996 letter titled *Operable Unit 4 Vitrification Pilot Plant, Phase I Treatability Study Reporting*, the Department of Energy, Fernald Environmental Management Project (DOE-FEMP) proposed the submittal of interim reports following the completion of each of the Phase I campaigns in lieu of bi-monthly reports. DOE-FEMP feels these reports along with the weekly status meetings currently being held will provide a better means for reporting status and facilitating decisions concerning the Vitrification Pilot Plant.

As you are aware, the objectives of campaign 2 were to perform acceptance testing of the melter, evaluate the feasibility of vitrifying residues from Silo's 1, 2, and 3 together, and gain experience with sulfates, phosphates, lead, and barium. The enclosed Report contains (1) a description of the work performed to meet these objectives; (2) pertinent data collected from the pilot plant operations, (3) results with technical discussion and interpretation of the data, and (4) lessons learned.

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Recycled and Recyclable

If you have any questions or concerns with this Report, please contact Nina Akgündüz at (513) 648-3110.

Sincerely,

Johnny Reising

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Johnny W. Reising
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OPERABLE UNIT 4
VITRIFICATION PILOT PLANT
PHASE I INTERIM TREATABILITY
STUDY REPORT

Campaign 2

40110-WP-0002
Revision 1

FLUOR DANIEL
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December 13, 1996
Fernald Environmental Management Project
Fernald, Ohio

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December 19, 1996

Fernald Environmental Management Project
Letter No. C:WMTSP(SP):96-0054

Ms. Nina Akgündüz
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Cincinnati, Ohio 45253-8705

Dear Ms. Akgündüz:

OPERABLE UNIT 4 VITRIFICATION PILOT PLANT PHASE I INTERIM TREATABILITY STUDY REPORT -- CAMPAIGN 2, REVISION 1

Enclosed is the Operable Unit 4 Vitrification Pilot Plant, Phase I, Interim Treatability Study Report for Campaign 2. All DOE-Fernald comments have been incorporated into this revision of the document.

If you have any questions or concerns on this matter, or require additional copies for transmittal to the agencies, please contact Rod F. Gimpel at (513) 648-4842 or Dennis A. Nixon at (513) 648-4800.

Sincerely,

Donald Paine
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OPERABLE UNIT 4
VITRIFICATION PILOT PLANT

PHASE I INTERIM TREATABILITY STUDY REPORT

40110-WP-0002 -- Campaign 2
Revision 1

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12/19/96
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LIST OF COMMON ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirements
AWWT	Advanced Wastewater Treatment
AWWTS	Advanced Wastewater Treatment System
Ba	Barium
BAT	Best Available Technology
BST	Building Sump Tank
°C	degrees Celsius or Centigrade
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci/yr	curies per year
cm^2	square centimeter
Cr	Chromium
DACS	Foxboro Data Acquisition and Control System
DCS	Distributed Control System
DOE	U.S. Department of Energy
EOG	emergency off-gas
EOGS	normal emergency off-gas system
EOS	Emergency Off-gas System
EPA	Environmental Protection Agency
°F	degrees Fahrenheit
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
ft	feet (foot)
ft^2	square feet
ft^3	cubic feet
FACTS	Fernald Analytical Computerized Tracking System
gal/hr	gallons per hour
gpm	gallons per minute
HEPA	high efficiency particulate air
HNT	High Nitrate Tank
HVAC	heating, ventilation and air conditioning
HWMU	Hazardous Waste Management Units
kg/m^3	kilogram per cubic meter
KVA	kilovolt-amp
LAN	local access network
lb/d	pound per day
lb/hr	pound per hour
m^3	cubic meter
MAWS	Minimum Additive Waste Stabilization
MEF	Material Evaluation Form
MEPA	medium efficiency particulate air
mg/kg	milligram per kilogram
mg/l	milligram per liter

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mrem/yr	millirem per year
MT	metric ton
MT/d	metric ton per day
NESHAP	National Emission Standards for Hazardous Air Pollutants
No.	number
NOG	Normal Off-gas
NO_x	nitrogen oxides
NPDES	National Pollution Discharge Elimination System
OAC	Ohio Administrative Codes
OATP	Ohio Air Toxics Policy
OGS	off-gas system
OU1	Operable Unit 1
OU4	Operable Unit 4
OU5	Operable Unit 5
Pb	lead
PbO	lead oxide
PPE	Personal Protective Equipment
PSP	Project Specific Plan
RCRA	Resource Conservation and Recovery Act
RH	relative humidity
ROD	Record of Decision
SCFM	standard cubic feet per minute
S/cm	Siemens/cm, units for conductivity, equivalent to one ampere per volt per cm.
Se	selenium
SOP	System Operating Procedure
SOT	System Operability Test
SO_x	sulfur oxides
TBC	to be considered
TC	toxicity characteristic
TCLP	toxicity characteristic leaching procedure (RCRA)
TDS	total dissolved solids
TSS	total suspended solids
V	volt
VitPP	Vitrification Pilot Plant
VSL	Vitreous State Laboratory of the Catholic University of America, Washington, D.C.
W.C.	water column
WMB	white metal boxes
wt%	weight percent

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1.0 EXECUTIVE SUMMARY WITH TEST OBJECTIVES

1.1 Background

The first 2 campaigns involving the Phase I testing and operation of the Operable Unit 4 (OU4) Vitrification Pilot Plant (VitPP) at the United Stages Department of Energy's (DOE) Fernald Environmental Management Project (FEMP) are complete. The first OU4 VitPP Interim Treatability Study Report for Campaign 1 was issued on October 14, 1996. Campaign 2 was recently completed on September 24, 1996. This document; the OU4 VitPP Interim Treatability Study Report for Campaign 2, summarizes development activities[1] pertinent to the glass formula for this campaign. Non-radioactive glass recipes, known as "Series D" glasses[2], were used to simulate the chemical composition of the silo residues. The remaining Phase I testing will be performed in the near future and will be reported in separate a report. A final integrated report, summarizing all the VitPP test Campaigns, will be issued following Phase I completion. A total of three campaigns are now planned for Phase I testing of the VitPP as follows:

Campaign 1 --	Startup and benign glass runs (completed and interim report issued)
Campaign 2 --	Glasses made from the blending of the silo residue surrogates (this interim report)
Campaign 3 --	No longer scheduled because of recommendation for deletion[3].
Campaign 4 --	Silos 1 and 2 surrogate glass recipes (commenced November 30, 1996 and is still in progress)

---

[1]Development activities prior to operation of the VitPP are documented in other reports. However, these results will be summarized in this report, and the future campaign reports, to help make the contents of these documents more meaningful.

[2]During glass formula development studies, the glasses made were grouped according to the silo wastes they contained (or simulated). This designation has continued. Series A glass formulations contain a blend of Silos 1 and 2 residues. Series B glass formulations are the same as Series A, except they also contain high concentrations of the bentonite cap in the Silos. Series C glass formulations contain only Silo 3 residues. Series D glass formulations contain a blend of all three silos.

[3]DOE letter, DOE-0041-97, "Deletion of Campaign 3 (Series C Glass Formula - Silo 3) From the Operable Unit 4 Vitrification Pilot Plant, Phase I Treatability Study Work Plan, Revision 2," J. W. Reising DOE Ohio Field Office to J. A. Saric U.S. EPA and T. Schneider Ohio EPA, date October 15, 1996.

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The VitPP has a high-temperature (1400°C design) joule-heated[4] ceramic Melt with a nominal production capacity rated at one (1) metric ton of glass per day (MT/d) from slurries. The Melter is of a unique three-chamber design to protect the electrodes from the corrosiveness of the silo wastes[5]. The electrodes are placed in two side chambers that also protects them the agitation and oxygenation that takes place in the center chamber. The glass pool surface area of the Melter's center chamber is 1 yd^2 (9 ft^2, 3 ft x 3 ft). By optimizing glass chemistry with the Melter's design, glass production rates of approximately three (3) MT/d were achieved during this campaign. Glass production was not limited by the Melter and glass chemistry, but by supporting systems (i.e., slurry feed and Off-gas systems).

The VitPP Campaign 2 testing officially started when the first batch of Series D type feed slurry was sent to the Melter on August 4, 1996, and was completed on September 24, 1996, when the last batch of Series D was processed.

The objectives of Campaign 2 were as follows:

1. Perform testing as acceptance of the Melter and Gem Making Machine from the vendor.

2. Determine if vitrification of OU4 waste residues (using surrogates) feasible via blending Silos 1 and 2 residues with Silo 3 residues.

3. Gain experience in handling and controlling sulfates and phosphates.

4. Gain experience in handling lead and barium in lower concentrations before attempting Silo 1 and Silo 2 (Series A and B) runs that contain higher lead and barium concentrations.

All of the Campaign 2 objectives were achieved. Further details are provided in the following text and Section 1.8, "Objectives."

---

[4]Heat produced from electrical current passing through a conductive material. In this case, molten glass.

[5]The silos wastes contain lead (Pb), sulfur (S), and phosphorous (P) that can be corrosive and present handling problems in conventional single-chamber melter design.

1.2 Test Description

During Campaign 2, eleven (11) batches were officially processed. The first batch was a transitional run to change the benign glass of Campaign 1 to the Series D glasses of Campaign 2. Batches 2 and 3 (which contained more lead, sulfur, and phosphorous than a typical Silo blend) were run to functionally test the Melter and Gem Making Machine to assure they met the minimum requirements stated in the vendor procurement specifications. This testing was known as the "Acceptance Test" (see Objective 1 above). The remaining batches were run using a representative blend of the silo wastes and optimized Series D glass formulation developed during the laboratory and minimelter studies.

Seven (7) additional batches were run after the official completion of Campaign 2 as defined in the Standard Operating Procedure (SOP) and Test Plan (TP) for Campaign 2. The first four (4) post-Campaign 2 batches were run to process slurries from previously aborted batches. These aborted batches had been transferred to temporary polytanks, so that needed repairs or system modifications to the VitPP could be performed without slurry in the feed system. The last three (3) batches were used to transition back to a benign glass formula so modifications could be made to the Off-gas System. This eliminated occupational exposure concerns associated with the higher concentrations of hazardous/RCRA type materials (e.g., Pb and Ba metals) entering the system from the Melter off gases while the melter was idling.

1.3 Glass Production

Tables 1-1 and 1-2 summarize the chemistry of the two Series D slurries and glasses made. Approximately 62,500 lbs of slurry were vitrified to produce approximately 24,000 lbs of glass. Of the 24,000 lbs of glass, 3500 lbs of glass were processed into glass gems; the balance was processed as monolithic pours into drums.

Each slurry batch, of approximately 5700 lbs, produced approximately 1820 lbs (0.83 metric ton) of glass (excluding frit addition). The slurries contained 16 to 45 wt% solids in content with an average content of 34 wt% solids. Batches containing 50 wt% solids were attempted, but because of feeding problems, a slurry with lower wt% solids was fed.

Glass frit, which was added to the side chambers to protect the electrodes from corrosion, eventually flowed to the center chamber as a result of erosion and cracks that formed in the side chamber walls. Once introduced in the center chamber melt

Acceptance Glass for Campaign 2
Table 1-1

Basis: 100 lbs Glass from Slurry

Melter Input -- Feed

Oxide	Oxide's Chemical Name	Glass	Mix dry, wt%	Moisture wt%	Batch
Al2O3	Aluminum oxide, Alumina	15.08	13.98	2.71	14.37
B2O3	Boron oxide	10.44			
H3BO3	Boric acid		1.92		1.92
BaO	Barium oxide	2.60			
BaCO3	Barium carbonate		1.02		1.02
BaSO4	Barium sulfate, X-ray milkshake		2.75	1.17	2.78
CaO	Calcium oxide, Lime	7.42	0.15		0.15
CaCO3	Calcium carbonate,Chalk		10.64	0.72	10.72
CaSO4	Calcium sulfate, Gypsum		3.19	20.73	4.03
Fe2O3	Iron (III) oxide, Rust	5.37	4.81		4.81
Fe2(SO4)3	Iron sulfate, III		0.79	1.98	0.81
K2O	Potassium oxide	1.06			
K2CO3	Potassium carbonate		0.75	6.56	0.81
KNO3	Potasium nitrate, Salt peter		1.06	2.19	1.08
Li2O	Lithium oxide	0.13			
Li2CO3	Lithium carbonate		0.32	0.96	0.32
MgO	Magnesium oxide	5.02	0.24		0.24
MgCO3	Magnesium carbonate		1.05		1.05
MgSO4	Epson salt		1.70	51.16	3.47
Mg3(PO4)2	Magnesium phosphate		7.11		7.11
MnO2	Manganese oxide	0.19	0.18		0.18
Na2O	Sodium oxide	6.76			
Na2B4O7	Borax		13.52	30.90	19.56
Na2SO4	Sodium sulfate		1.18		1.18
Na2CO3	Sodium carbonate, Washing soda		1.90	3.53	1.97
NaNO3	Sodium nitrate, Soda niter		2.01	0.71	2.03
NiO	Nickel oxide	0.14	0.14		0.14
P2O5	Phosphorous pentoxide	3.84			
PbO	Lead oxide, litharge	5.09	5.09		5.09
SiO2	Silica, sand, quartz	36.69	32.16		32.16
TiO2	Titanium oxide	0.02			
V2O5	Vanadium pentoxide	0.15	0.15		0.15
Bentonite	Bentonite clay		6.84	14.23	7.98
CO(NH2)2	Urea		3.89		3.89
Total Solids	na	100.00	118.54	na	129.03

Water for 28 wt% solids (solids ranged from 16 to 43 wt% during run):	331.79
Total	460.82

Melter Output

Glass	100.00
CO2 (to off-gas system)	6.46
SOx	5.12
NOx	1.78
Urea decomposition products	3.89
Water (H2O to off-gas system)	347.46
Subtotal	460.82

Frit Addition Impact

Glass from slurry	100.00
Side chamber leakage (or frit addition), lbs glass:	20.00
Total glass produced, lbs:	120.00

Optimum Series A Glass for Campaign 2
Table 1-2

Basis: 100 lbs Glass from Slurry

Melter Input – Feed Oxide	Glass wt%	Moisture wt%	Silo 1 Surrogate lbs	Silo 2 Surrogate lbs	Silo 3 Surrogate lbs	Surrogate Total lbs	Additives lbs	Batch lbs
Al_2O_3	14.03	2.71	0.84	0.96	1.26	3.05	10.72	13.78
B_2O_3	8.82							
H_3BO_3							6.00	6.00
BaO	2.80							
$BaCO_3$			1.15			1.15		1.15
$BaSO_4$		1.17	1.66	1.27		2.93		2.93
CaO	13.84			0.14		0.14		0.14
$CaCO_3$		0.72		0.93		0.93	21.41	22.34
$CaSO_4$		20.93		0.08	3.33	3.41		3.41
Fe_2O_3	4.45		0.78	1.68	1.58	4.04		4.04
$Fe_2(SO_4)_3$		1.98			0.68	0.68		0.68
K_2O	0.85							
K_2CO_3		6.56	0.33	0.29		0.63		0.63
KNO_3		2.19			0.91	0.91		0.91
Li_2O	1.15							
Li_2CO_3		0.96			0.27	0.27	2.60	2.88
MgO	3.40							
$MgCO_3$			0.95	1.39		2.33		2.33
$MgSO_4$		51.16			2.93	2.93		2.93
$Mg_3(PO_4)_2$			0.36	0.35	3.98	4.68		4.68
MnO_2	0.16				0.15	0.15		0.15
Na_2O	6.28							
$Na_2B_4O_7$		30.90					11.38	11.38
Na_2SO_4					1.00	1.00		1.00
Na_2CO_3		3.53	1.00	0.26	0.70	1.95	2.75	4.70
$NaNO_3$		0.71		0.27	1.48	1.75		1.75
NiO	0.12				0.12	0.12		0.12
P_2O_5	2.53							
PbO	5.46		3.75	1.71		5.46		5.46
SiO_2	35.47		15.63	14.04	3.23	32.90		32.90
TiO_2	0.01							
V_2O_5	0.13				0.13	0.13		0.13
Bentonite	–	14.23				4.53		4.53
$CO(NH_2)_2$	–						3.32	3.32
SO_3 in glass	0.50							
Total Solids	99.98	na	26.44	23.36	21.75	76.08	58.19	134.27

Water for average 34 wt% Solids	260.65
Total	394.92

Note:

The surrogates that were used for the silo residues is shown in the columns above. Another column shows the additives that were used for making the glass. Amounts are shown with moisture. Bentonite adds to the Al_2O_3, SiO_2, etc.

Later runs substituted:
- Chemicals for bentonite to help prevent blockage in the feed system.
- $CaSO_4$ substituted for $BaSO_4$ to determine different sulfate behavior.
- H_3BO_3 and Na_2CO_3 substitued for $Na_2B_4O_7$ to help prevent blockage in feed system.

Melter Output

Glass	100.00
CO_2 (to off-gas system)	14.41
SO_x	3.45
NO_x	1.58
Urea decomposition products	3.32
Water (H_2O to off-gas system)	272.16
Subtotal	394.92

Frit Addition Impact

Glass from slurry	100.00
Frit addition, lbs glass	20.00
Total glass produced, lbs	120.00

DOE-0041-97, of glass frit was added to the side chambers. This increased t amount of glass produced by 20 wt% to the 24,000 lb total. Leakage of the ... around and through the partition wall between the melter chambers was only expected to be approximately 5 wt% or 100 lbs per 2200 lbs. The density of the side chamber glass is approximately 2.4 g/cm^3 and the center chamber glass is approximately 2.7 g/cm^3. This provides a gradient that allows the center chamber glass to flow into the side chamber. A new denser side-chamber glass of 2.8 g/cm^3 will be used during Campaign 4. The purpose of this action is to reduce the gradient between the two glass pools and help reduce side chamber frit migration.

The average operating temperature during the Melter Acceptance Test was 1350°C, with a maximum temperature of 1400°C reached briefly during the second batch. The other batches during the campaign were run at approximately 1250°C.

Average glass production was 1.3 MT/d when the facility was operating (Melter being fed). The highest process rate of 2.91 MT/d of glass (at 1250°C and 40 wt% solids) produced 3740 lbs glass in 14.0 hours of run time. Campaign 2 batch slurries averaged between 16 and 45 weight percent solids as determined by laboratory personnel. Most batches were limited to approximately 34 wt% solids because of the slurry feed system problems. Campaign 2 testing provided evidence that production rates of 3 MT/d or greater are possible with Series D slurries a 1250°C. Higher production rates appear possible because the melter was not operated at full capacity, e.g., a large cold cap or sulfate layer that normally stops further production was not present. The limited capacity of: (1) the feed system to deliver feed and (2) the Off-gas System to handle higher flows, did not allow testing of the melter's operational limits during this campaign.

Glass production rates for the Melter were significantly limited by the Slurry Feed and Off-Gas Systems. The slurry feed system could only handle slurries with low weight percent solids (average 34 wt % solids for the campaign). Because of the lower wt% solids, the feed metering pump could not deliver solids at a high rate to make glass. Consequently, energy which would otherwise be used for making glass was spent on evaporating (or boiling away) water in the low-solids slurries. Also, the Off-gas System, as presently configured, cannot handle larger rates of steam production and off gassing without the emergency Off-gas System activating to make up for the shortfall of the main Off-gas System. Therefore, high production rates were discouraged to limit emergency off gas events. Modifications are presently being implemented to the slurry feed and Off-Gas Systems to enhance operations during Campaign 4, so these systems will not be a limiting factor in the performance of the VitPP.

Most of the solids in the slurry feed produced glass. However, some of the solid compounds in the slurry decomposed to produce carbon dioxide (CO_2) and water (H_2O); and, to a lesser extent, the acid gases: sulfurous oxides (SO_x) and nitrous oxides (NO_x). These gasses are lost to the Off-gas System. For example, calcium carbonate ($CaCO_3$, a glass additive) broke down to form calcium oxide (CaO, a solid), which becomes part of the glass, and carbon dioxide (CO_2, a gas). Thus, for Campaign 2, about 3.1 lbs of slurry produced 1 lb of glass[6].

The post-Campaign 2 benign glass batches (similar to the Campaign 1 slurry and glass chemistry) were significantly more sluggish than the Series D batches. The average production was approximately 0.8 MT/d at 1250°C, with an approximately 30 to 40 wt% solids content in the feed slurries. These slurries formed thick "barge-like" cold caps, and water often accumulated in a puddle on the top of the barge. The water eventually that fell onto the hot glass pool often (several times a day) forced momentary activation of the Emergency Off-gas System to maintain negative pressure in the Melter. In addition, the cold cap often "bridged" across the molten bath and attached itself to the walls making contact with the bath difficult during glass discharge. These problems were not observed with the Series D slurries. The cold cap with the Series D batches were thinner, broken, and more fluid (e.g., the cap deformed with the wake on the surface of the melt.) The operators reported that they could not always maintain a cold cap with the Series D batches. They preferred to operate with a cold cap because this (1) decreased splattering at the molten glass surface, (2) decreased the heat burden on the Quencher, and (3) decreased solids loading at the Film Cooler with resulting less frequent cleanouts necessary.

Sulfate events, described later in this summary, were initially a hindrance at higher production rates. The operators and engineers gained experience and learned how to lessen the effects by controlling the sulfate events during the campaign. Therefore, sulfate events became less of a limiting factor later in the campaign.

1.4 Melter Erosion

Slurry feed and glass samples were collected from each batch and analyzed for chemical and physical characteristics. Analytical results indicated that the levels of chromium (Cr) in the glass were low. Mass balance calculaations indicate that approximately 61 lbs of chromium oxide (Cr_2O_3) being leached from the refractories during Campaign 2. As expected, more was leached during Campaign 2 than Campaign 1 because of the increased erosiveness of the waste and glass

[6] 3.1 lbs slurry/lb glass = (5700 lbs slurry/batch)/(1820 lbs glass/batch)

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chemistry. Assuming uniform corrosion depths of the refractory surfaces an al corrosion rates of the Melter's two refractory types, approximately 3.0 millimeters (mm) of refractory in the Center Chamber, 0.37 mm in the East Chamber, and 0.72 mm in the West Chamber have eroded during Campaign 2. The inner wall refractories are 10.24 cm (4 in.) thick and the partition wall between the chamber is 7.62 cm (3 in.) thick. Therefore, under these test conditions, the Melter is expected to operate 1½ to 3 years before needing wall replacement.

The erosion rate for Campaign 2 was four times greater than Campaign 1. The application of more power through the E-wall partition walls could be a contributor. More power was used during Campaign 2 because of: (1) low-solids/high-water content slurries, (2) higher production rates and uptime, and (3) sulfate destruction. Most erosion is attributed to the increased fluxing agents added to the glass (mainly lithium oxide - Li_2O) and the fact that no zirconium oxide was used as a glass additive during Campaign 2.

Zirconium oxide was used in the formulation of the benign glass surrogate for Campaign 1. Zirconium oxide has been known to coat refractories and behave as an erosion inhibitor. However, the presence of lithium oxide (Li_2O) is considered a more important erosion factor in the Campaign 2 glass . The lithium oxide was two to three times what it should have been, based on the glass recipe of 1 wt%. The increase in lithium concentrations was due to inleakage of glass frit from the Melter's side chambers. Glass frit added to the side chambers contains10.1 lithium oxide. Glass frit usage during Campaign 4 will be recorded, and the amount of lithium in the frit will be subtracted from the next batch. This should provide a more accurate accounting of the amount of lithium and give a good comparison of the erosion rate seen in Campaign 4.

An encouraging result was the relatively low concentration of molybdenum (average 2000 ppm Mo) in the glass, since the amount of molybdenum in the glass is directly related to the Melter's electrode wear. The concentrations of Mo in the glass equated to 58 lbs of molybdenum contained in the glass produced during Campaign 2. Three pounds of molybdenum were found in the Off-gas streams. Overall, there are approximately 1500 lbs of molybdenum in the ten electrodes. This indicates that about 4% of the electrodes had eroded. After the power to the melter was secured, the electrodes were probed with a metal rod to determine if there was any noticable shortening or narrowing of the electrodes due to wear. No obvious wear was noticed except where a piece had fallen off the end of one electrode. A dimple was observed, in the fallen portion of the electrode, before it was inserted into the melter. The dimple could have been the reason the electrode end was effected.

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1.5 Sulfate Issues

From the analysis of power consumption during the VitPP runs, it was determined that the destruction of sulfates can take a significant amount of energy. It was not observed during laboratory testing that the destruction of sulfates was an endothermic reaction. The hardest sulfate to destroy is barium sulfate ($BaSO_4$). Barium sulfate is presumed to be in Silos 1 and 2. It can take between 122 to 146 kcal/gmole to destroy barium sulfate. In terms of Melter operation, it takes approximately 3000 kilowatt-hours (kwh) to destroy/distill 1 wt% SO_3 (as $BaSO_4$) from the Melter bath. Therefore, in effort to lower the power demand and still destroy sulfate, urea was added to the slurry feed to help reduce the amount of sulfate. Based upon observations, it appears that urea was an effective reductant because a molten sulfate layer was not observed by the operators.

Despite the addition of urea, the glass still has an affinity for sulfates. The glass will absorb up to approximately 1 wt% until it becomes saturated. This characteristic is greatly dependent on temperature and other factors. Transient temperature conditions in the melter can cause the glass to become supersaturated and release the sulfate from the molten glass in an uncontrolled manner. This happened as two different anomalies/events during Campaign 2.

1.5.1 Sulfate Effervescence Event

The first sulfate anomaly, known as a sulfate Effervescence Event[7], happened during the Acceptance Test when $BaSO_4$ was used to simulate the sulfates in Silos 1 and 2. During this event, the bath became supersaturated and the sulfate suddenly started to decompose and effervesce SO_x gas bubbles. The excessive bubbling of bath (or foaming) started and then stopped. The destruction of sulfate and the subsequent effervescence of gas removed heat from the glass pool and dropped the temperature of the bath. Consequently, the operators applied more power to maintain constant temperature, but more foaming occurred. The height of the foaming rose sufficiently to momentarily flow from the center chamber into the side chambers before the power was reduced.

Two effervescence events occurred during the Acceptance Test at 1350°C operation. None happened thereafter at lower temperature. When the

[7]Effervescence is the correct term to use here because every cubic inch of the molten bath produced SO_x bubbles and caused the bath to swell as a whole. Colonies of bubbles that collect near the surface create a foam or cause foaming.

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second event occurred, it was decided to "burn" or distill the sulfate fr the bath until it stopped foaming. Between 300 to 400 kw were applie intermittently to the Melter for approximately four (4) hours with no additional feeding of slurry; however, water was fed for cooling. It was then observed that the bath stopped foaming (no longer saturated) and the Melter pool temperature immediately started to climb. The Melter pool temperature reached 1400°C before the temperature reversed.

1.5.2 Sulfate Layer Event

The second sulfate anomaly, is known as a Sulfate Layer Event. This event occurred during the Series D run when Silo 1 and Silo 2 residues were simulated using calcium sulfate. The VitPP operators thought that the thermocouples in the melter had failed because the interior of the melter appeared hotter than measured. No darkly colored puddles of sulfate were noticed, but this event is attributed to a sulfate layer forming near the surface because it fits the scenario. With this event, the sulfate separated from the melt and collected near the surface. Sulfates, being conductive, increased the conductivity of the bath towards the surface of the glass pool. Therefore, more and more heat was generated at the surface, and less heat was generated at the bottom where the controlling thermocouple to the Melter is located. Hence, the Melter pool appeared to be cooling, while power was applied by the operators.

While this event was being observed, the top temperature measured approximately 1350°C with an infrared pyrometer in appearance, and the bottom temperature was dropping below 1250°C. The E-Wall partitions were observed to be glowing white-hot when normally they are dark in appearance. Normally, the surface of the Melter pool is approximately 50 to 100°C cooler than the bottom. This phenomenon resulted from the power traveling across the top of the conductive bath also caused power to travel through the top portions of the E-wall partition. Up to 350 kw of power were applied during this event, when normal operation should have been below 200 kw.

With experience, the operators learned to avoid the above situations (i.e., reduce feed rate with a corresponding reduction in power to the Melter) when an event appears to be approaching. The major indicator of the onset of both events is the need for increasing power with no proportionate increase in temperature or a decrease in temperature. More permanent solutions, such as using more urea, could be used to correct the problem if the events persist. Production rates in a

continuous process may creep down, or be somewhat lower, than intermittent processing production rates because the sulfates have extra time to decompose during less productive periods. There were no foaming incidents in the center chamber or side chambers during the last three batches, which also had higher production rates. This is attributable both to experience gained by the operators and use of the urea.

1.6 Lessons Learned

1.6.1 Partition Wall Cracks

An operational hindrance developed shortly after the Acceptance Test. It is believed the sudden power fluctuations and temperature changes opened up cracks in the E-wall. These cracks allowed sulfate-rich center chamber glass to migrate into the side chambers. These sulfates then off-gassed and caused foaming in the side chambers. This was more noticeable during high power conditions. The West Side Chamber had most of the foaming events. Frit addition was increased to help reduce the foaming. To help control foaming, a denser frit will be tried during Campaign 4. The concept is that a denser side chamber glass will change the pressure gradient between chambers and stop or reverse the flow of glass between chambers.

1.6.2 Bottom Drain Occurrences

There were problems experienced with the bottom drains in the Melter. During one incident, a drain leaked cooling solution into the East Side Chamber and caused flaming at the glass pool surface, because glycol present in the melter drain cooling loop flashed when it broke the surface. New inserts were placed in all the drains. However, a different mastic was placed in the same East Side Chamber drain than in the others. This mastic did not conduct heat as well to the insert as the other mastics. It is postulated that the glass around this drain softened more than the others. Consequently, glass migrated down the plug and glowing was periodically observed at bottom Drain #3. The exact cause for the glowing has not yet been determined. Alternatives to fixing the glow are being evaluated. (Please note potential reasons given in this paragraph have not been proven.)

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1.6.3 Slurry Feed System

The primary cause of downtime experienced during Campaign 1 was a result of the Slurry Feed System, and to a lesser extent, the Off-gas System. This downtime continued into Campaign 2. A significant amount of time was spent on removing blockages from piping, repairing/replacing Slurry Tank Pumps, and repairing the Melter Feed Pump. The following is a list of the causes identified which led to problems with these systems:

- Sharp bends (elbows) in the piping restricts flow and provides sites for the solids to collect.
- The piping is too small for the long runs, thereby restricting the flow.
- Slurry pump design, seal design, and materials of construction selected were not compatible for the task of transferring the abrasive slurry. The slurry appears to excessively wear at the diaphragms, internal valves, seals, and shafts of the pumps.
- Clogging of pipes between the bag dump station (where dry chemicals are introduced to the slurry system) and the slurry tanks was caused by a combination of moisture in the system, chemical and physi characteristics of the materials used, and limited ability of the mechanical system. Operational steps were taken to address the problem which included adding the bags of material slowly and adjusting the order in which the materials were added.
- Poor agitation and/or clay-like cohesive material results in the slurry settling in the bottom and clinging to the sides of the slurry tanks.

Thickening of the slurry appeared to happen an hour or two after mixing in the high-shear-mixing tank and feed recycle loop. It was verified in the lab that high-shear mixing can cause (1) bentonite to thicken in the presence of calcium and magnesium ions and (2) borax, a glass additive, to thicken in solution upon cooling. Boric acid and sodium carbonate were used as substitutes to replace the borax, and this appeared to work. Techniques that deal with the bentonite are being developed. For example, sodium phosphate may be used to poison or hinder the bentonite thickening reaction long enough to process the waste. Laboratory studies show that the thickening reaction can be delayed 60 hours with the feed being agitated moderately.

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1.6.4 Off-gas Treatment System

Frequently, the (normal) Off-gas Treatment System had insufficient capacity to handle the pressures developed when the cold cap collapsed, clogs in the Melter feed pump line dislodged, or flush water was introduced into the Melter. The Emergency Off-gas System frequently tripped when either of these scenarios occurred. Normally, the Emergency Off-gas System activated for only two or for three minutes or the time it took Operations to respond and reset the automatic activation.

1.6.5 Gem Making Machine

Operation of the Gem Making Machine did not stop production because the molten glass was diverted into monolith pours. Continuous operation and production of the Gem Making Machine were not consistent. During early testing, it was observed that the benign glass was too viscous for successful gem making. The glass would either stick to, string around, or spatter off the Gob Cutter resulting in the production of irregularly shaped gems, gems with "tails", and/or fiberglass. Later, there were operational problems with the lubrication system. The lubrication nozzle(s) did not spray a uniform thin stream on the cutting wheel. This resulted in too much lubricant spray being placed in the wrong places. As testing proceeded, the lubrication methods were changed (i.e., smaller nozzles were used), but the problem persisted. Some attempts resulted in filling the receiving drum with the lubricating solution (graphite in water). Additionally, it was observed that the Gob Cutter was getting too hot, thereby, allowing the glass to stick and "gum-up" on the cutter. Redirecting air flow helped cool the cutters somewhat and allowed the production of a few tons of gems. However, more cooling power (i.e., water cooling) to the cutter is needed for long production runs. Also, greater cooling should reduce the need for lubrication. A water-cooled cutter is being installed for testing in Campaign 4.

1.7 Productivity

The percentage of time the VitPP was producing glass during Campaign 2, known as "uptime," increased from Campaign 1. Uptime is defined as the percentage of time that the Melter Feed Pump is feeding slurry to the Melter during the day. The average amount of uptime during Campaign 1 was 19%. The average amount of uptime during Campaign 2 was 27%. This is in agreement with the scheduled and budgeted uptime for Phase I activities of 30%. Figures 1-1 and 1-2 graphically show the percentage of uptime per day.

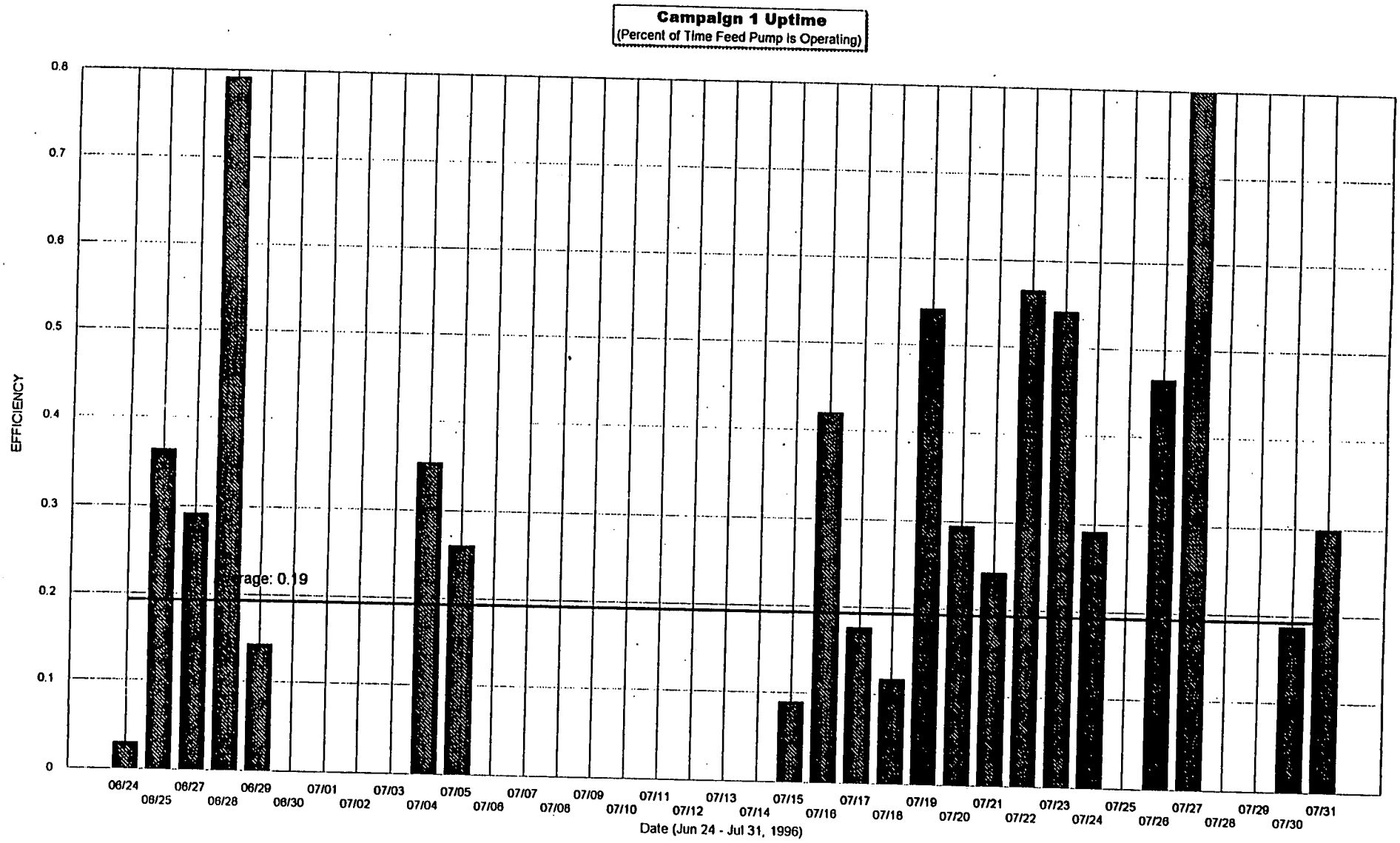

Figure 1-1

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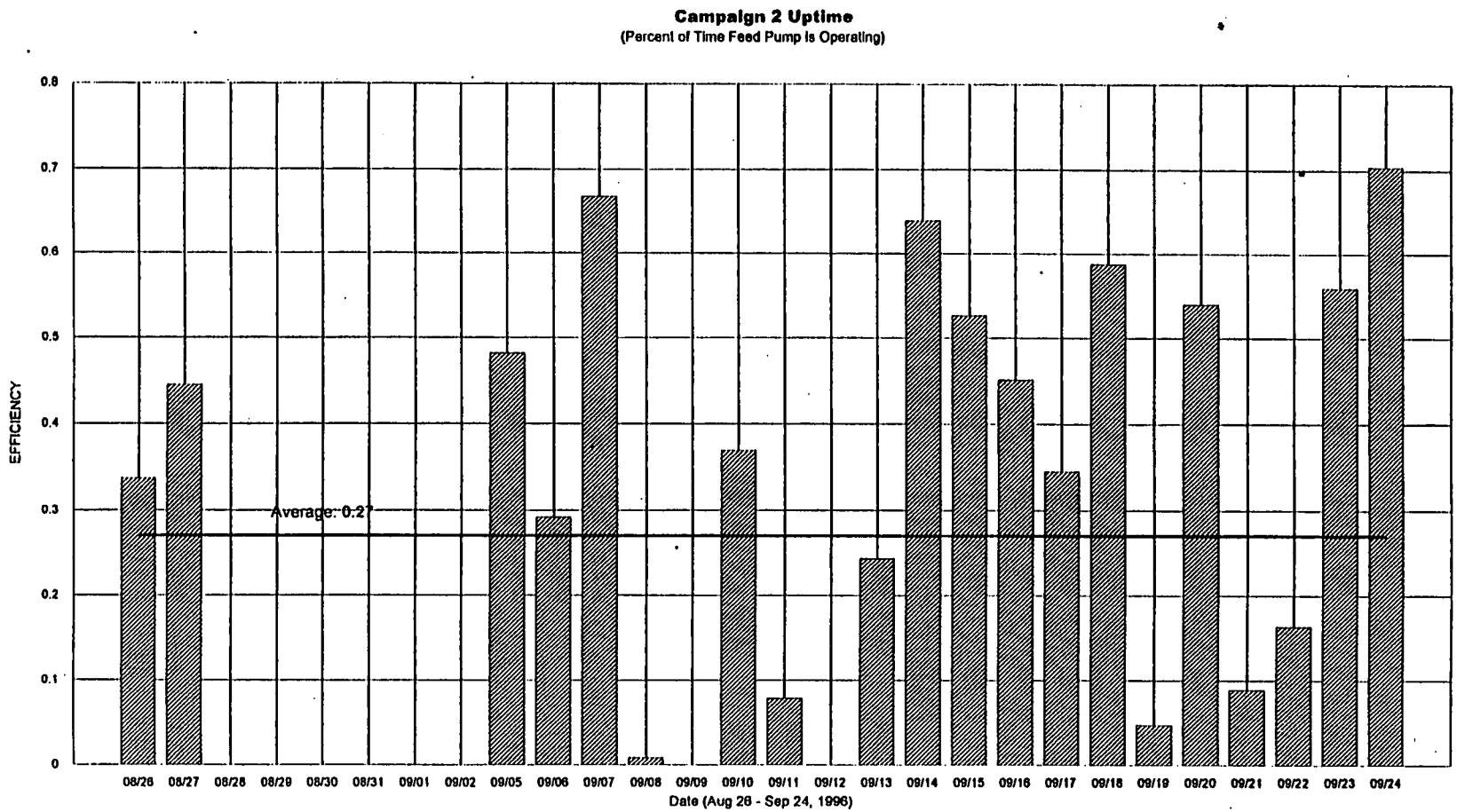

Figure 1-2

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1.8 Objectives

In accordance with the OU4 VitPP Phase I Test Plan (18-SU-0003, Rev. 2), four objectives were to be accomplished during Campaign 2. The following discussion presents the results of Campaign 2 relative to each objective:

Objective 1 Perform testing as acceptance of the Melter and Gem Making Machine from the vendor.

The Melter passed the acceptance testing with punch-list items. A number of warranty items; e.g., modifications and repairs to the Gem Making Machine need to be completed so the systems can work on a continuous basis.

Objective 2 Determine if vitrification of OU4 waste residues (using surrogates) is feasible via blending Silos 1 and 2 residues with Silo 3 residues.

This objective was achieved. Approximately 20,000 lbs of glass were made at 1350°C and 1250°C from 62,500 lbs of slurry containing 16 to 45 wt% solids. High sulfate events happened (as did in previ lab and bench-scale studies), but these were managed or avoide experience.

Most of the 11 batches were processed at rates over 1 MT/d (all rates are based on 100% availability, uptime). The Optimum Series D batches (the last four batches of Campaign 2) produced an average of 1.8 MT/d of glass produced at 1250°C. The most swiftest batch processed, produced glass at approximately 3 MT/d. Higher production rates appear possible with the Series D slurries because the Melter did not appear to be operating at full capacity, for example: (1) a large cold cap that could poison or stop glass production was not present, or (2) no significant foaming events of the center or side chambers occurred during the last Series D batches.

Reduced retention time during increased production rates (and uptimes) may result in foaming events that would reduce throughput. Unfortunately, this can only be accurately determined during long sustained runs. However, campaign results were encouraging because production rates were increasing with decreasing retention time. Uptime increased from Campaign 1 (19%) to Campaign 2 (27%). The

uptime of the last six Campaign 2 batches increased to 41%. The uptime for the last two batches was 57 and 71%. The limited abilities of (1) the feed system to deliver feed; and (2) the Off-gas System to handle higher flows, limited the production rate of the Melter.

Objective 3 Gain experience in handling sulfates and phosphates.

Sulfate off-gassing events and sulfate layer events that occurred during Campaign 2 were new experiences for VitPP operations personnel. With experience, the operators learned to manage and avoid the above situations (i.e., reduce feed rate and power when an event appears to be approaching). The major indicator of the onset of both events is the need for increasing power with no proportionate increase in temperature or a decrease in temperature. Significant amounts of the sulfate appear to be destroyed by the addition of urea because no sulfate layers have been observed by the operators. Samples taken from the molten glass surface do not show excessive amounts of sulfate.

Anticipated phosphate problems did not occur. Alumina added to the batches to control phosphates appeared to be effective. Devitrification as indicated by a milky appearance of the glass upon slow cooling, was observed in bench and lab-scale studies. However, this was not observed with the VitPP runs.

Objective 4 Gain experience in handling lead and barium in lower concentrations before attempting Silo 1 and Silo 2 (Series A and B) runs that contain high lead and barium concentrations.

The glasses processed for Campaign 2 passed the TCLP tests for RCRA metals, of greatest concern, lead (Pb) and barium (Ba). The barium TCLP limit is 100 ppm and the Campaign 2 glasses passed with values in the range of 2 to 4 ppm. The lead TCLP limit is 5 ppm and the Campaign 2 glasses passed with values in the range of 1 to 3 ppm. The Series D glass process during Campaign 2 contained about 5½ wt% Lead (55,000 ppm Pb) and 2½ wt % Barium (25,000 ppm Ba).

Three glass samples (from eleven Campaign 2 batches) initially failed with TCLP lead (Pb) results between 5 to 6.5 ppm even though other

samples taken for these batches passed with values between 2 ppm. Investigations showed that variation in the laboratory procedure protocol can account for this difference (see Section 5.1.7 for further details).

1.9 Future Phase I Campaigns, Testing, and Work

Upon completion of Campaign 2, the following testing is scheduled:

Campaign 4 -- Silo 1 and 2 glass recipes (Series A and B); and

Additionally, modifications may be necessary to the VitPP's facilities, and to the glass chemistry during execution of the campaigns, to improve performance. Key findings are that the present slurry feed and the Off-gas Systems need modifications to increase the reliability and availability of the VitPP Melter. Potential modifications are being evaluated and plans are being made to incorporate the selected modifications into the VitPP facilities between Campaigns 2 and 4.

A brief discussion of each of the remaining campaign is described below:

1.9.1 Campaign 4

Campaign 4 will be performed with Series A and Series B surrogate slurry formulation. These runs are planned to be performed at 1250°C. A third run may be performed at 1150°C depending on performance of the first two runs. The major concern is that the destruction of sulfates at 1150°C may not be possible. Specialized glass formulations may be required to facilitate running at 1150°C in an effort to maintain reasonable waste loading. However, if the sulfates are destroyed (or contained by the glass), then a low-temperature Melter may be considered in future design.

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2.0 GLASS FORMULA DETERMINATION

2.1 Silo Background and Contents

2.1.1 Silos Background

The silo wastes are residues remaining from processing of pitchblende ores. Silos 1 and 2, also designated as the "K-65" silos, contain the depleted ore residues, while Silo 3 contains calcined residue remnants from processing solutions. Silos 1 and 2 contain thorium and radium residues, known as "K-65" residue wastes. These silos are radon gas sources because of the high radium concentrations.

These wastes also contain high concentrations of natural lead (6 - 12 wt%) and radioactive lead, ^{210}Pb. Bentonite clay, which is high in alumina, was placed in the silo to form a cap over the wastes to capture the radon gas. Silo 3 contains metal oxide residues that contain high concentrations of sulfates (15 wt%), phosphates (9.3 wt%), nitrates (6.1 wt%), and thorium (0.31 wt%). Silos 1 and 2 contain significant quantities of glass formers (50 - 51 wt%) to make glass, whereas, Silo 3 (14 wt%) does not. The K-65 material (Silos 1 and 2) has a hazardous characteristic for lead according to the Toxicity Characteristic Leachate Procedure (TCLP), while Silo 3 material has a hazardous characteristic for arsenic, cadmium, chromium, and selenium.

2.1.2 Silo Contents

The estimated amounts of residues in the silos is given in Table 2-1. The average elemental compositions in the silos and bentonite are shown, as oxides, in Tables 2-2 and 2-3.

As a part of sampling for the Operable Unit 4 Remedial Investigation/Feasibility Study (RI/FS) approximately five years ago, small quantities of residues were withdrawn from the silos by a vibrating core drilling-instrument. The instrument withdrew samples from three different zones in each silo. Portions of the core-drilled samples were sent to PNL for characterization. The remaining portions of the sample were used in laboratory crucible melts with only small portions presently archived for future studies. Results of the analysis of these wastes are given in a

Table 2-1
Operable Unit 4 In Situ Waste Quantity Estimates

Material	Media	Volume yd3	Density Tons/yd3	Weight Tons	Comments
Silo 1					
Silo 1 Cap	Bentogrout	467	1.35	630	
Silo 1 Contents	Sludge	4,293	1.78	7,642	
Silo 1 Structure	Structure	667	2.00	1,334	
Subtotals		5,427		9,606	
Silo 2					
Silo 2 Cap	Bentogrout	411	1.35	555	
Silo 2 Contents	Sludge	3,719	1.78	6,620	
Silo 2 Structure	Structure	667	2.00	1,334	
Subtotals		4,797		8,509	
Silo 3					
Silo 3 Contents	Dry Waste	5,088	0.77	3,918	
Silo 3 Structure	Structure	667	2.00	1,334	
Subtotals		5,755		5,252	
Silo 4					
Silo 4 Contents	Water	64	0.84	54	Silo 4 standing water, treat on-site
Silo 4 Structure	Structure	667	2.00	1,334	
Subtotals		731		1,388	
Decant Sump System					
Decant Sump System Contents	Water	40	0.84	34	Decant sump system standing water; treat on-site
Decant Sump System Contents	Sludge	5	1.78	9	Decant sump sludge
Decant Sump System Structure	Structure	365	2.00	730	Decant sump tank, K-65 slurry pipe and pipe trench
Decant Sump System Structure	Concrete	29	2.00	58	Drum bldg. pad and sump lift station concrete
Subtotals		439		831	
OU4 General Area					
OU4 General Area - Berm Soil	Soil	10,537	1.69	17,808	
OU4 General Area - Surface Soil	Soil	4,444	1.35	5,999	
OU4 General Area - Subsurface Soil	Soil	14,646	1.35	19,772	
OU4 General Area - Water	Water	495	0.84	416	Excavation standing water, treat on-site
Subtotals		30,122		43,995	
OU4 In Situ Totals					
OU4 General Area	Bentogrout	878		1,185	
OU4 General Area	Concrete	29		58	
OU4 General Area	Dry Waste	5,088		3,918	
OU4 General Area	Sludge	8,017		14,271	
OU4 General Area	Soil	29,627		43,579	
OU4 General Area	Structure	3,033		6,066	
OU4 General Area	Water	599		504	
Totals (All Materials)		47,271		69,581	

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Silo Compositions According To PNL Analysis

Rank	SILO 1			SILO 2			SILO 3		
	Component	Measured	Normalized	Component	Measured	Normalized	Component	Measured	Normalized
1	SiO_2	50.00	58.06	SiO_2	51.00	60.23	SO_3	15.00	17.26
2	PbO	12.00	13.93	PbO	6.20	7.32	SiO_2	14.00	16.11
3	BaO	6.30	7.32	Fe_2O_3	6.10	7.20	MgO	10.00	11.51
4	CO_2	3.20	3.72	Al_2O_3	3.40	4.02	P_2O_5	9.30	10.70
5	Al_2O_3	2.60	3.02	CO_2	3.40	4.02	Fe_2O_3	8.00	9.21
6	Fe_2O_3	2.50	2.90	BaO	3.00	3.54	N_2O_5	6.10	7.02
7	Na_2O	1.80	2.09	CaO	2.50	2.95	Na_2O	5.90	6.79
8	SO_3	1.80	2.09	MgO	1.70	2.01	Al_2O_3	5.30	6.10
9	MgO	1.20	1.39	SO_3	1.70	2.01	CaO	4.70	5.41
10	K_2O	0.68	0.79	Na_2O	0.88	1.04	CO_2	1.90	2.19
11	P_2O_5	0.62	0.72	K_2O	0.68	0.80	K_2O	1.80	2.07
12	MoO_2	0.43	0.50	P_2O_5	0.68	0.80	MnO_2	0.67	0.77
13	La_2O_3	0.42	0.49	N_2O_5	0.62	0.73	NiO	0.52	0.60
14	NiO	0.42	0.49	UO_2	0.47	0.56	V_2O_3	0.50	0.58
15	Ce_2O_3	0.41	0.48	NiO	0.36	0.43	Li_2O	0.47	0.54
16	CaO	0.37	0.43	Ce_2O_3	0.33	0.39	CuO	0.41	0.47
17	N_2O_5	0.29	0.34	TiO_2	0.33	0.39	CoO	0.36	0.41
18	TiO_2	0.28	0.33	La_2O_3	0.29	0.34	UO_2	0.34	0.39
19	CoO	0.19	0.22	CoO	0.21	0.25	ThO_2	0.31	0.36
20	Nd_2O_3	0.19	0.22	Nd_2O_3	0.16	0.19	As_2O_3	0.29	0.33
21	SrO	0.08	0.10	ZrO_2	0.14	0.17	TiO_2	0.22	0.25
22	Cl	0.08	0.09	CuO	0.08	0.10	PbO	0.19	0.22
23	V_2O_3	0.06	0.07	Cr_2O_3	0.08	0.10	MoO_2	0.18	0.21
24	CuO	0.06	0.07	V_2O_3	0.08	0.10	Cr_2O_3	0.08	0.10
25	ZrO_2	0.05	0.06	MoO_2	0.08	0.09	F	0.07	0.08
26	SeO_2	0.05	0.05	SrO	0.06	0.07	ZnO	0.07	0.08
27	Cr_2O_3	0.02	0.02	As_2O_3	0.05	0.06	Y_2O_3	0.04	0.04
28	MnO_2	0.01	0.02	SeO_2	0.04	0.05	BaO	0.03	0.04
29	BeO	0.01	0.01	MnO_2	0.03	0.04	SeO_2	0.03	0.03
30	F	0.00	0.01	ZnO	0.01	0.01	SrO	0.03	0.03
31	As_2O_3			Cl	0.00	0.01	Ce_2O_3	0.02	0.02
32	CdO			F	0.00	0.01	ZrO_2	0.02	0.02
33	Li_2O			BeO			Cl	0.02	0.02
34	ThO_2			CdO			Nd_2O_3	0.01	0.01
35	UO_2			Li_2O			La_2O_3	0.01	0.01
36	Y_2O_5			ThO_2			BeO	0.01	0.01
37	ZnO			Y_2O_3			CdO	0.00	0.01
	Totals	86.12	100.00		84.68	100.00		86.89	100.00

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Table 2-3
Average Bentonite Composition

Rank	Bentonite		
	Component	Measured (wt%)	Normalized (wt%)
1	SiO_2	65.40	67.35
2	Al_2O_3	15.80	16.27
3	MgO	6.30	6.49
4	Fe_2O_3	3.60	3.71
5	Na_2O	3.40	3.50
6	CaO	1.80	1.85
7	K_2O	0.80	0.82
	Total	97.10	100.00

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treatability report prepared by PNL[8].

A second set of analyses of the silo wastes is available in the final OU4 RI/FS documents[9]. Unfortunately, the chemical analysis data of the composition of the silo wastes does not match the PNL data. Some of the RI/FS data is shown in Table 2-4. Concentrations in the RI/FS data are given as elemental concentrations, but they were converted into oxide concentrations for Table 2-4 to allow easy comparison to the PNL data. The table also shows percent differences between the PNL and RI/FS data. The instruments used in the RI/FS analyses were calibrated for these minor analyses. Consequently, bulk constituents (normally of little concern in this type of investigation since they are usually nontoxic) are overlooked. However, many of the minor constituents between the two sources do not match and leaves doubt. Therefore, some archived samples are being analyzed by the FERMCO labs[10] to verify which of the data sets is more correct. The capability of the FERMCO labs has increased since the first analyses were done and can now give good results. Development activities, thus far, and the data presented in this document are based on the PNL data. Exceptions are noted.

2.2 Silo Surrogates

The silo residues were analyzed for elemental makeup. However, the fashion, in which, these elements are combined into compounds is not known. Generally, this information is not needed in determining the glass composition, because the identity of the compounds are lost once the glass is made. Surrogates were formulated for each of the Silos in accordance with the elemental analysis. The elements were simulated as follows:

Metals (Na, Si, etc.) as oxides (Na_2O, SiO_2, etc.)
Sulfur (S) as sulfates (SO_4)
Phosphorus (P) as phosphates (PO_4)
Nitrogen (N) as nitrates (NO_3)
Carbon (C) as carbonates (CO_3)

It is not known which metals of the silo residues are attached with sulfates, phosphates, etc. However, the surrogates were made to ensure the ratios of the

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[8] R. A. Merrill and D. S. Janke, Battelle-Pacific Northwest Laboratory, "Results of the Vitrification Treatability Study for OU-4 Residues," dated February 1993.

[9] OU4 Final Remedial Investigation Report, November 3, 1993, Tables 4, 1 through 22.

[10] There are procurement contracts being placed with VSL and the University of Cincinnati that will also analyze the Silo wastes. These will also help verify the data.

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Table 2-4

Sllo 1 PNL and RI Charaterizations

Rod F. Gimpel 03/06/96

Analyte As Oxide	Analyte mol. wt.	As Oxide mol. wt.	PNL average	PNL normalized	RI average	RI normalized	RI low (l)	RI high (h)	RI Variance 100%*(h-l)/l	PNL-RI 100%*(PNL-RI)/RI
Al2O3	26.98	101.96	2.60	3.02	0.20	0.85	0.09	0.46	447	1211
As2O3	74.92	197.84			0.00	0.01	0.00	0.01	2,106	na
B2O3	10.81	69.62			0.01	0.06	0.01	0.02	159	na
BaO	137.34	153.34	6.30	7.32	1.30	5.52	0.22	2.47	1,022	386
BeO	9.01	25.01	0.01	0.01	0.00	0.00	0.00	0.00	375	2062
CO2	12.01	44.01	3.20	3.72	7.04	29.99	1.89	12.75	574	-55
CaO	40.08	56.08	0.37	0.43	0.41	1.77	0.11	0.80	613	-11
CdO	112.40	128.40			0.00	0.00	0.00	0.00	1,329	na
Ce2O3	140.12	328.24	0.41	0.48						na
CoO	58.93	74.93	0.19	0.22	0.12	0.51	0.04	0.24	436	60
Cr2O3	52.00	151.99	0.02	0.02	0.01	0.03	0.00	0.02	738	210
CuO	63.55	79.54	0.06	0.07	0.04	0.15	0.02	0.06	289	60
Fe2O3	55.85	159.69	2.50	2.90	2.10	8.96	0.61	10.74	1,655	19
K2O	39.10	94.20	0.68	0.79	0.05	0.22	0.02	0.09	353	1216
La2O3	138.91	325.82	0.42	0.49						na
Li2O	6.94	29.88								na
MgO	24.31	40.31	1.20	1.39	0.48	2.04	0.25	1.00	301	151
MnO2	54.94	86.94	0.01	0.02	0.01	0.05	0.00	0.04	904	19
MoO2	95.94	127.94	0.43	0.50	0.65	2.76	0.13	1.15	788	-34
N2O5	14.01	108.01	0.29	0.34	0.26	1.09	0.19	0.41	115	14
Na2O	22.99	61.98	1.80	2.09	1.17	4.98	0.05	2.25	4,539	54
Nd2O3	144.24	336.48	0.19	0.22						na
NiO	58.71	74.71	0.42	0.49	0.23	0.97	0.08	0.43	437	84
P2O5	30.97	141.94	0.62	0.72	0.26	1.10	0.00	0.75	822,400	139
PbO	207.19	223.19	12.00	13.93	8.80	37.52	1.87	14.33	664	36
SO3	32.06	80.06	1.80	2.09	0.11	0.46	0.04	0.29	677	1562
SeO2	78.96	110.96	0.05	0.05	0.04	0.17	0.01	0.39	4,703	17
SiO2	28.09	60.08	50.00	58.06	0.15	0.66	0.08	0.28	259	32229
SrO	87.62	103.62	0.08	0.10						na
ThO2	232.04	264.04								
TiO2	47.90	79.90	0.28	0.33						na
UO2	238.03	270.03								
V2O3	50.94	149.88	0.06	0.07	0.02	0.09	0.01	0.04	364	205
Y2O3	88.91	225.81								
ZnO	65.37	81.37			0.00	0.01	0.00	0.03	2,653	na
ZrO2	91.22	123.22	0.05	0.06						na
Cl	35.45	35.45	0.08	0.09	0.01	0.03	0.00	0.01	404	1115
	19.00	19.00	0.00	0.01		0.00	0.00	0.04	2,527	4700
Total	n/a	n/a	86.12	100.00	[illegible]	100.00	5.73	49.10	768	73
Gases			5.29	8.14	7.40	31.54	2.12	13.45	534	40

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elements and sulfates, phosphates, etc. were consistent with the PNL analysis of the Silo residues.

Tables 2-5 through 2-7 show (1) the method used to arrange the compounds in the surrogates and the (2) the resulting surrogates used in Phase I. Table 2-8 shows how a spreadsheet was used to determine the glass chemistry for the Series D glass. This was the glass used in the Campaign 2 Series D glass. Notice that the Silo wastes and bentonite are blended in proportion to their total amounts in the silos. Then the additives are added to the blend to make a close approximation of the target glass shown toward the right in the spreadsheet. The amounts shown in the spreadsheet or those necessary to make 100 grams of glass. It takes more grams of silo wastes and additives to make 100 grams of glass because some of the components are lost, as gases, to the off gas system. Notice that the spreadsheet does calculations with oxides in accordance with the glass convention.

Table 2-9 shows the same calculations as Table 2-8, except the oxides have been replaced with the silo surrogates and additives are also shown in their compound form. Most of the additives are carbonates for ease in handling and cost. Sodium oxide (Na_2O), for example, is a very corrosive, toxic substance that reacts violently with water to form sodium hydroxide (NaOH) commonly known as lye (also a corrosive substance). Therefore, sodium carbonate (Na_2CO_3) is used.

Table 2-10 shows the similar information as Table 2-9, except the quantities shown are those needed make a batch of surrogate slurry for the Melter. A batch normally makes 2200 lbs or 1 metric ton of glass.

It is unfortunate that the exact compound makeup of the silos is not known. Because the rates and ease of forming that glass may be dependent on the compounds used to make that glass. More is being understood about which compounds may be in the Silos. For example, process knowledge indicates that the sulfates in Silo 1 and 2 may be barium sulfate ($BaSO_4$) because barium was used to strip radium from the refining process as radium sulfate ($RaSO_4$). Recent analyses done by FD Fernald, with a Leco sulfur analyzer purchased for the Silos project, indicate that sulfate content in Silos 1 and 2 is between 3 and 3½ dry wt% (per a single sample measured for each silo) instead of the 1¾ and 2% measured by PNL. These concentrations more closely match the measured barium concentrations stoichiometrically. A more complete listing of these analyses for Silos 1, 2, and 3 are given in Tables 2-11 through Table 2-13.

Table 2-5
Silo 1 Surrogate

Silo 1 Surrogate Compound	mo. wt.	Silo wt%	Silo, n wt%	mols X100	Metal	Nonmetal	Surrogate Compound	Oxide	CO2	N2O5	P2O5	SO3	as metal Oxide	Compound Mols%	Rod F. Gimpel V2.0 Compound wt%	Compound wt%, n	05/25/95 Compound wt%, c
Al2O3	101.96	2.60	3.14	3.08	3.08		Al2O3	3.08					3.08	3.08	3.14	3.15	3.02
B2O3	69.62																
H3BO3	61.83																
BaO	153.34	6.30	7.62	4.97	4.97												
BaCO3	197.35						BaCO3		2.25				2.25	2.25	4.44	4.44	4.27
BaSO4	233.40						BaSO4					2.72	2.72	2.72	6.35	6.35	6.10
CO2	44.01	3.20	3.87	8.79		8.79											
CaO	56.08																
CaCO3	100.09																
CaSO4	136.14																
Ca3(PO4)2	310.18																
Fe2O3	159.69	2.50	3.02	1.89	1.89		Fe2O3	1.89					1.89	1.89	3.02	3.02	2.90
K2O	94.20	0.68	0.82	0.87	0.87												
K2CO3	138.21						K2CO3		0.87				0.87	0.87	1.21	1.21	1.16
KNO3	101.11																
Li2O	29.88																
Li2CO3	73.89																
MgO	40.31	1.20	1.45	3.60	3.60												
MgCO3	84.32						MgCO3		2.02				2.02	2.02	1.70	1.70	1.63
MgSO4	120.37																
Mg3(PO4)2	262.88						Mg3(PO4)2				0.53		1.58	0.53	1.39	1.39	1.33
MnO2	70.94																
N2O5	108.01																
Na2O	61.98	1.80	2.18	3.51	3.51												
Na2B4O7	201.22																
Na2SO4	142.04																
Na2CO3	105.99						Na2CO3		3.51				3.51	3.51	3.72	3.72	3.58
NaNO3	84.99						NaNO3										
NiO	74.71																
P2O5	141.94	0.62	0.75	0.53		0.53											
PbO	223.19	12.00	14.51	6.50	6.50		PbO	6.50					6.50	6.50	14.51	14.52	13.94
SO3	80.06	1.80	2.18	2.72		2.72											
SiO2	60.08	50.00	60.46	100.63	100.63		SiO2	100.63					100.63	100.63	60.46	60.50	58.09
TiO2	79.90																
Al2O3	149.88																
Other																	3.97
Bentonite	na																
		82.70	100.00	137.10	125.06	12.04		112.11	8.65		0.53	2.72	125.06	124.01	99.94	100.00	100.00
							Difference:		-0.14								

Note: n = data normalized to 100 wt%
c = Corrected. The actual wastes contain other compounds that are less than 0.5 wt%, but total to the amount labeled "other" in this table. Therefore, the compound concentrations are adjusted for the mass the "others" occupy in the real waste.

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Table 2-6
Silo 2 Surrogate

Silo 2 Surrogate

Compound	mol. wt.	Silo wt %	Silo, n wt %	mols x100	Metal	Nometal
Al2O3	101.96	3.40	4.15	4.07	4.07	
B2O3	69.62					
H3BO3	61.83					
BaO	153.34	3.00	3.66	2.39	2.39	
BaCO3	197.35					
BaSO4	233.40					
CO2	44.01	3.40	4.15	9.44		9.44
CaO	56.08	2.50	3.05	5.45	5.45	
CaCO3	100.09					
CaSO4	136.14					
Ca3(PO4)2	310.18					
Fe2O3	159.69	6.10	7.45	4.67	4.67	
K2O	94.20	0.68	0.83	0.88	0.88	
K2CO3	138.21					
KNO3	101.11					
Li2O	29.88					
Li2CO3	73.89					
MgO	40.31	1.70	2.08	5.15	5.15	
MgCO3	84.32					
MgSO4	120.37					
Mg3(PO4)2	262.88					
MnO2	70.94					
N2O5	108.01	0.62	0.76	0.70		0.70
Na2O	61.98	0.88	1.08	1.73	1.73	
Na2B4O7	201.22					
Na2SO4	142.04					
Na2CO3	105.99					
NaNO3	84.99					
NiO	74.71					
P2O5	141.94	0.68	0.83	0.59		0.59
PbO	223.19	6.20	7.57	3.39	3.39	
SO3	80.06	1.70	2.08	2.59		2.59
SiO2	60.08	51.00	62.30	103.70	103.70	
TiO2	79.90					
V2O3	149.88					
Other						
Bentonite	na					
		81.86	100.00	144.75	131.43	13.32

Surrogate Compound	Oxide	CO2	N2O5	P2O5	SO3	as metal Oxide	Compound mols	Rod F. Gimpel V2.0 Compound wt%	Compound wt%, n	05/25/95 Compound wt%, c
Al2O3	4.07					4.07	4.07	4.15	4.15	4.02
BaSO4					2.39	2.39	2.39	5.58	5.58	5.39
CaO	1.12					1.12	1.12	0.63	0.63	0.61
CaCO3		4.12				4.12	4.12	4.13	4.13	3.99
CaSO4					0.20	0.20	0.20	0.28	0.28	0.27
Fe2O3	4.67					4.67	4.67	7.45	7.45	7.20
K2CO3		0.88				0.88	0.88	1.22	1.22	1.18
MgCO3		3.40				3.40	3.40	2.86	2.86	2.77
Mg3(PO4)2				0.59		1.76	0.59	1.54	1.54	1.49
Na2CO3		1.03				1.03	1.03	1.10	1.10	1.06
NaNO3			0.70			0.70	1.40	1.19	1.19	1.15
PbO	3.39					3.39	3.39	7.57	7.57	7.32
SiO2	103.70					103.70	103.70	62.30	62.30	60.23
										3.33
	116.95	9.43	0.70	0.59	2.59	131.43	130.97	100.00	100.00	100.00
Difference:		-0.00				-0.00				

Note: n = data normalized to 100 wt%
c = Corrected. The actual wastes contain other compounds that are less than 0.5 wt%, but total to the amount labeled "other" in this table. Therefore, the compound concentrations are adjusted for the mass the "others" occupy in the real waste.

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Table 2-7
Silo 3 Surrogate

Silo 3 Surrogate

Compound	mol. wt.	Silo wt %	Silo wt %, n	mols x100	Metal	Nonmetal
Al2O3	101.96	5.30	6.30	6.18	6.18	
B2O3	69.62					
H3BO3	61.83					
BaO	153.34					
BaCO3	197.35					
BaSO4	233.40					
CO2	44.01	1.90	2.26	5.13		5.13
CaO	56.08	4.70	5.58	9.96	9.96	
CaCO3	100.09					
CaSO4	136.14					
Ca3(PO4)2	310.18					
Fe2O3	159.69	8.00	9.51	5.95	5.95	
Fe2(SO4)3	399.87					
K2O	94.20	1.80	2.14	2.27	2.27	
K2CO3	138.21					
KNO3	101.11					
Li2O	29.88	0.47	0.56	1.87	1.87	
Li2CO3	73.89					
MgO	40.31	10.00	11.88	29.48	29.48	
MgCO3	84.32					
MgSO4	120.37					
Mg3(PO4)2	262.88					
MnO2	70.94	0.67	0.80	1.12	1.12	
N2O5	108.01	6.10	7.25	6.71		6.71
Na2O	61.98	5.90	7.01	11.31	11.31	
Na2B4O7	201.22					
Na2SO4	142.04					
Na2CO3	105.99					
NaNO3	84.99					
NiO	74.71	0.52	0.62	0.83	0.83	
P2O5	141.94	9.30	11.05	7.79		7.79
PbO	223.19					
SO3	80.06	15.00	17.82	22.26		22.26
SiO2	60.08	14.00	16.63	27.69	27.69	
TiO2	79.90					
V2O3	149.88	0.50	0.59	0.40	0.40	
Other						
Bentonite	na					
		84.16	100.00	138.94	97.05	41.89

Surrogate Compound	Oxide	CO2	N2O5	P2O5	SO3	as metal Oxide	Compound mols%	Rod F. Gimpel V2.0 Compound wt%	Compound wt%, n	05/25/95 Compound wt%, c
Al2O3	6.18					6.18	6.18	6.30	6.30	6.06
CaSO4					9.96	9.96	9.96	13.56	13.56	13.05
Fe2O3	5.09					5.09	5.09	8.14	8.14	7.83
Fe2(SO4)3					2.57	0.86	0.86	3.43	3.43	3.30
KNO3			2.27			2.27	4.54	4.59	4.59	4.42
Li2CO3		1.87				1.87	1.87	1.38	1.38	1.33
MgSO4					6.12	6.12	6.12	7.37	7.37	7.09
Mg3(PO4)2				7.79		23.36	7.79	20.47	20.47	19.70
MnO2	1.12					1.12	1.12	0.80	0.80	0.77
Na2SO4					3.61	3.61	3.61	5.13	5.13	4.94
Na2CO3		3.26				3.26	3.26	3.46	3.46	3.33
NaNO3			4.44			4.44	8.88	7.55	7.55	7.27
NiO	0.83					0.83	0.83	0.62	0.62	0.59
SiO2	27.69					27.69	27.69	16.63	16.63	16.01
V2O3	0.40					0.40	0.40	0.59	0.59	0.57
										3.73
	83.19	5.13	6.71	7.79	22.26	97.05	88.19	100.00	100.00	100.00
Difference:						-0.00				

Note: n = data normalized to 100 wt%
c = Corrected. The actual wastes contain other compounds that are less than 0.5 wt%, but total to the amount labeled "other" in this table. Therefore, the compound concentrations are adjusted for the mass the "others" occupy in the real waste.

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Table 2-8

Formula Description: **Series D per C4D-01** **Glass Formula Development Spreadsheet** Rod F. Gimpel V2.7 09/08/96

Component	mol. wt.	Silo 1	Silo 1n	Silo 2	Silo 2n	Silo 3	Silo 3n	Bento-grout	Bento-grout n	Portions norm.	Portions in glass	Additives as oxides	Glass Result	Target C4D-01	Delta	Additives mol%	Glass mol%
Al2O3	101.96	2.60	3.02	3.40	4.02	5.30	6.10	13.60	13.74	4.81	3.45	10.00	13.45	13.98	-0.53	6.86	9.23
As2O3	197.84			0.05	0.06	0.29	0.33			0.11	0.08		0.08		0.08		0.03
B2O3	69.62											10.00	10.00	10.04	-0.04	10.05	10.05
BaO	153.34	6.30	7.32	3.00	3.54	0.03	0.04			3.74	2.69		2.69	2.66	0.03		1.22
BeO	25.01	0.01	0.01			0.01	0.01			0.00	0.00		0.00		0.00		0.01
CO2	44.01	3.20	3.72	3.40	4.02	1.90	2.19			3.17	2.28		2.28	released	-		3.62
CaO	56.08	0.37	0.43	2.50	2.95	4.70	5.41	1.53	1.55	2.62	1.88	11.50	13.38	13.88	-0.50	14.34	16.69
CdO	128.40					0.00	0.01			0.00	0.00		0.00		0.00		0.00
Ce2O3	328.24	0.41	0.48	0.33	0.39	0.02	0.02			0.30	0.21		0.21		0.21		0.05
CoO	74.93	0.19	0.22	0.21	0.25	0.36	0.41			0.27	0.19		0.19		0.19		0.18
Cr2O3	151.99	0.02	0.02	0.08	0.10	0.08	0.10			0.06	0.05		0.05		0.05		0.02
CuO	79.54	0.06	0.07	0.08	0.10	0.41	0.47			0.18	0.13		0.13		0.13		0.11
Fe2O3	159.69	2.50	2.90	6.10	7.20	8.00	9.21	3.07	3.10	5.95	4.28		4.28	4.33	-0.05		1.87
K2O	94.20	0.68	0.79	0.68	0.80	1.80	2.07	0.66	0.67	1.13	0.81		0.81	0.79	0.02		0.60
La2O3	325.82	0.42	0.49	0.29	0.34	0.01	0.01			0.28	0.20		0.20		0.20		0.04
Li2O	29.88					0.47	0.54			0.15	0.10	1.00	1.10	1.08	0.02	2.34	2.59
MgO	40.31	1.20	1.39	1.70	2.01	10.00	11.51	5.40	5.46	4.56	3.27		3.27	2.76	0.51		5.68
MnO2	86.94	0.01	0.02	0.03	0.04	0.67	0.77	0.05	0.05	0.23	0.16		0.16		0.16		0.13
MoO2	127.94	0.43	0.50	0.08	0.09	0.18	0.21			0.26	0.19		0.19		0.19		0.10
N2O5	108.01	0.29	0.34	0.62	0.73	6.10	7.02			2.24	1.61		1.61	released	-		1.04
Na2O	61.98	1.80	2.09	0.88	1.04	5.90	6.79	2.92	2.95	3.08	2.21	4.50	6.71	7.09	-0.38	5.08	7.58
Nd2O3	336.48	0.19	0.22	0.16	0.19	0.01	0.01			0.14	0.10		0.10		0.10		0.02
NiO	74.71	0.42	0.49	0.36	0.43	0.52	0.60			0.47	0.34		0.34	0.10	0.24		0.32
P2O5	141.94	0.62	0.72	0.68	0.80	9.30	10.70	1.22	1.23	3.47	2.49		2.49	2.46	0.03		1.23
PbO	223.19	12.00	13.93	6.20	7.32	0.19	0.22			7.34	5.27		5.27	5.22	0.05		1.65
SO3	80.06	1.80	2.09	1.70	2.01	15.00	17.26			6.03	4.33		3.83	released	-		3.35
SeO2	110.96	0.05	0.05	0.04	0.05	0.03	0.03			0.04	0.03		0.03		0.03		0.02
SiO2	60.08	50.00	58.06	51.00	60.23	14.00	16.11	56.20	56.80	47.35	34.01		34.01	33.66	0.35		39.59
SrO	103.62	0.08	0.10	0.06	0.07	0.03	0.03			0.07	0.05		0.05		0.05		0.03
ThO2	264.04					0.31	0.36			0.10	0.07		0.07		0.07		0.02
TiO2	79.90	0.28	0.33	0.33	0.39	0.22	0.25	0.22	0.22	0.32	0.23		0.23		0.23		0.20
UO2	270.03			0.47	0.56	0.34	0.39			0.28	0.20		0.20		0.20		0.05
V2O3	149.88	0.06	0.07	0.08	0.10	0.50	0.58			0.21	0.15		0.15		0.15		0.07
Y2O3	225.81					0.04	0.04			0.01	0.01		0.01		0.01		0.00
ZnO	81.37			0.01	0.01	0.07	0.08			0.02	0.02		0.02		0.02		0.02
ZrO2	123.22	0.05	0.06	0.14	0.17	0.02	0.02			0.08	0.06		0.06		0.06		0.03
Cl	35.45	0.08	0.09	0.00	0.01	0.02	0.02			0.04	0.03		0.03		0.03		0.06
F	19.00	0.00	0.01	0.00	0.01	0.08	0.09			0.03	0.02		0.02		0.02		0.07
Ignition loss								14.08	14.23	0.86	0.62		0.62	released	-		
SO3 in glass	80.06												0.50	0.50			0.44
Other A	1.00																
Other B	1.00																
Total	n/a	86.12	100.00	84.68	100.00	86.90	100.00	98.95	100.00	87.70	63.00	37.00	100.50	98.55	1.95	38.66	100.00
Gases		5.29	6.14	5.72	6.75	23.00	26.47	14.08	14.23	12.30	8.84		8.34				8.01

Ratios (dry wt.)	Silo 1	Silo 2	Silo 3	Bentonite	All Wastes	Additives	Total In	Glass	Gases	Total Out
Mass balance:	25.79	22.34	19.37	4.34	71.84	37.00	108.84	100.50	8.34	108.84
Silo mix Ratio	35.90	31.10	26.96	6.04	100.00	–	–	–	–	–

Note: Data are gram component per 100 grams of glass product
n = Data normalized for 100 wt%.

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Surrogate Glass For:

Table 2-9

Series D per C4D-01

Compound	Mol. Wt.	%Moisture	Silo 1 Su. wt%	Silo 2 Su. wt%	Silo 3 Su. wt%	Bentonite Makeup	Silo 1 Surrogate	Silo 2 Surrogate	Silo 3 Surrogate	Silo 1 S. w/H2O	Silo 2 S. w/H2O	Silo 3 S. w/H2O	Tot. Silos S. w/H2O	Additives Mix Tank	Add. & Sur.-H2O	Add & Sur. as oxides	Rod F. Gimpel V2.7 Glass Result	Glass Result, adj.	09/08/96 Glass Mol%
Al2O3	101.96		3.02	4.02	6.05	13.74	0.78	0.90	1.17	0.78	0.90	1.17	2.85	10.00	13.44	13.44	13.44	13.71	9.37
B2O3	69.62															10.00	10.00	10.19	10.20
H3BO3	61.83																		
BaO	153.34																		
BaCO3	197.35		4.27				1.10			1.10			1.10		1.10	0.85	2.68	2.73	1.24
BaSO4	233.40		6.10	5.39			1.57	1.20		1.57	1.20		2.78		2.78	1.82			
CO2	44.01															12.79	released		
CaO	56.08			0.61		1.55		0.14			0.14		0.14		0.20	0.20	13.27	13.53	16.81
CaCO3	100.09			3.99				0.89			0.89		0.89	20.52	21.42	12.00			
CaSO4	136.14	6.20		0.27	13.04			0.06	2.53		0.06	2.69	2.76		2.59	1.07			
Fe2O3	159.69		2.90	7.20	7.83	3.10	0.75	1.61	1.52	0.76	1.61	1.52	3.88		4.01	4.01	4.27	4.35	1.90
Fe2(SO4)3	399.87				3.30				0.64			0.64	0.64		0.64	0.26			
K2O	94.20					0.67									0.03	0.03	0.81	0.83	0.61
K2CO3	138.21		1.16	1.18			0.30	0.26		0.30	0.26		0.56		0.56	0.38			
KNO3	101.11				4.42				0.86			0.86	0.86		0.86	0.40			
Li2O	29.88																1.10	1.13	2.63
Li2CO3	73.89				1.33				0.26			0.26	0.26	2.47	2.73	1.10			
MgO	40.31					5.46									0.24	0.24	3.26	3.32	5.74
MgCO3	84.32		1.63	2.77			0.42	0.62		0.42	0.62		1.04		1.04	0.50			
MgSO4	120.37				7.08				1.37			1.37	1.37		1.37	0.46			
Mg3(PO4)2	262.88		1.33	1.49	19.69		0.34	0.33	3.81	0.34	0.33	3.81	4.49		4.49	2.07			
MnO2	86.94				0.77	0.05			0.15			0.15	0.15		0.15	0.15	0.15	0.15	0.12
N2O5	108.01															1.51	released		
Na2O	61.98					2.95									0.13	0.13	6.71	6.84	7.69
Na2B4O7	201.22	30.90												20.91	14.45	4.45			
Na2SO4	142.04				4.94				0.96			0.96	0.96		0.96	0.42			
Na2CO3	105.99		3.58	1.06	3.33		0.92	0.24	0.64	0.92	0.24	0.64	1.80	0.08	1.89	1.10			
NaNO3	84.99			1.15	7.28			0.26	1.41		0.26	1.41	1.66		1.66	0.61			
NiO	74.71				0.59				0.12			0.12	0.12		0.12	0.12	0.12	0.12	0.11
P2O5	141.94					1.23									0.05	2.42	2.42	2.47	1.21
PbO	223.19		13.94	7.32			3.60	1.64		3.60	1.64		5.23		5.23	5.23	5.23	5.33	1.67
SO3	80.06															3.81	released		
SiO2	60.08		58.09	60.23	16.00	56.80	14.98	13.46	3.10	14.98	13.46	3.10	31.54		34.00	34.00	34.00	34.66	40.21
TiO2	79.90					0.22									0.01	0.01	0.01	0.01	0.01
V2O5	181.88				0.63				0.12			0.12	0.12		0.12	0.12	0.12	0.13	0.05
Minors	na		3.97	3.33	3.73		1.02	0.74	0.72	1.02	0.74	0.72	2.49		2.49	2.49	2.49	--	
Bentonite	na	14.23											4.34		--	--	--	--	
F	19.00																		
SO3 in glass	80.06															0.50	0.50	0.51	0.44
CO(NH2)2	60.06													3.18	3.18	released			
Other A	1.00																		
Other B	1.00																		
			100.00	100.00	100.00	85.77	25.79	22.34	19.37	25.79	22.35	19.53	72.01	57.18	121.93	118.70	100.58	100.00	100.00
													Total In:	129.18	Gases released:		18.12	18.01	
															Urea products:		3.18	3.16	
															Steam:		10.49	10.43	
															Total Out:		129.18	131.60	

Ratios (dry wt.)	Silo 1	Silo 2	Silo 3	Bentonite	All Wastes	Additives	Total In	Glass	Gases	Total Out
Mass balance:	25.79	22.34	19.37	4.34	71.84	57.18	129.01	100.50	28.51	129.01
Silo mix Ratio	35.90	31.10	26.96	6.04	100.00	--	--	--	--	--
Urea, Stoichiometric %:		50.00								

(Includes water of hydration in additives)

Note: Data are gram component per 100 grams of glass product
n = Data normalized for 100 wt%.

Table 2-10

Batch Quantities for: Series D per C4D-01

Rod F. Gimpel V2.7 09/08/96

Compound	Common Name	%Moisture	Silo 1 Surrogate	Silo 2 Surrogate	Silo 3 Surrogate	Surrogate Total	Additives Mix Tank	Batch Total	As Oxides	Glass Makeup	Glass Makeup, %	Off Gas Makeup	Sub Bentonite	Sulfate on Calcium	New Batch Total
Al2O3	Alumina		17	20	26	64	224	288	302	302	13.71		13.37		302
B2O3	Boron oxide								224	224	10.19				
H3BO3	Boric acid														
BaO	Barium oxide									60	2.73				
BaCO3	Barium carbonate		25			25		25	19					53	77
BaSO4	X-ray milkshake		35	27		62		62	41					(62)	
CO2	Carbon dioxide											287			
CaO	Lime			3		3		3	5	298	13.53				3
CaCO3	Chalk, calcite			20		20	460	480	269				2.69	(27)	456
CaSO4	Gypsum	6.20		1	60	62		62	24					36	98
Fe2O3	Rust		17	36	34	87		87	90	96	4.35		3.02		90
Fe2(SO4)3	Iron sulfate, III				14	14		14	6						14
K2O	Potassium oxide								1	18	0.83				
K2CO3	Potassium carbonate		7	6		13		13	9				0.96		14
KNO3	Salt peter				19	19		19	9						19
Li2O	Lithium oxide									25	1.13				
Li2CO3	Lithium carbonate				6	6	55	61	25						61
MgO	Magnesium oxide								5	73	3.32				
MgCO3	Magnesium carbonate		9	14		23		23	11				11.11		34
MgSO4	Epson salt				31	31		31	10						31
Mg3(PO4)2	Magnesium phosphate		8	7	86	101		101	46						101
MnO2	Mangenese oxide				3	3		3	3	3	0.15				3
N2O5	Nitrogen pentoxide											34			
Na2O	Sodium oxide								3	150	6.84				
Na2B4O7	Borax	30.90					469	469	100						469
Na2SO4	Sodium sulfate				21	21		21	9						21
Na2CO3	Washing soda		21	5	14	40	2	42	25				4.91		47
NaNO3	Soda niter			6	32	37		37	14						37
NiO	Nickel oxide				3	3		3	3	3	0.12				3
P2O5	Phosphorous pentoxide								54	54	2.47				
PbO	Lead oxide		81	37		117		117	117	117	5.33				117
SO3	Sulfur trioxide											85			
SiO2	Silica, sand, quartz		336	302	70	707		707	763	763	34.66		55.27		763
TiO2	Titanium oxide								0	0	0.01				
V2O5	Vanadium pentoxide				3	3		3	3	3	0.13				3
Bentonite	Bentonite	14.23				97		97	--	--	--	--	(97.31)		
CO(NH2)2	Urea						71	71				71			71
SO3 in glass	Sulfate								11	11	0.51				
Other A															
Other B															
H20	Water							--	--			235			
			555	484	422	1,559	1,282	2,841	2,200	2,200	100.00	713	(5.98)	0	2,835
												Water for x% solids:		45%	3,466
Batch, lbs glass:		2,200													6,301

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Table 2-11
Silo 1 Residue Composition
as Measured by FD Fernald 11/22/96

a Element as oxide	b Analyzed wt%	c Normalized wt%	d Stoichio. mol. %	e PNL Anal. wt%	f c - e wt%
Al2O3	2.63	2.91	2.04	3.02	-0.11
B2O3	0.36	0.40	0.41	0.00	0.40
BaO	5.81	6.44	3.00	7.32	-0.88
CO2	3.36	***3.72***	6.05	3.72	0.00
CaO	0.24	0.27	0.34	0.43	-0.16
Fe2O3	2.10	2.33	1.04	2.90	-0.57
K2O	0.12	0.13	0.10	0.79	-0.66
Li2O	0.19	0.21	0.50	0.00	0.21
MgO	0.29	0.32	0.57	1.39	-1.07
MnO2	0.01	0.01	0.01	0.01	0.00
N2O5	0.31	***0.34***	0.23	0.34	0.00
Na2O	1.73	1.92	2.21	2.09	-0.17
NiO	0.44	0.49	0.47	0.49	-0.00
P2O5	0.65	***0.72***	0.36	0.72	0.00
PbO	12.69	14.06	4.51	13.93	0.13
SO3	3.40	3.77	3.37	2.09	1.68
SiO2	53.49	59.26	70.56	58.06	1.20
V2O5	0.08	0.09	0.03	0.07	0.02
Others	2.37	***2.63***	4.20	2.63	-0.00
	90.27	100.00	100.00	100.00	-0.00

Sample No.: 200222611

Numbers in bold were not analyzed by FD Fernald. They are taken from the PNL Analysis.
The "others" are other elements in the residue that are less than 0.5 wt% each, but total collectively to the amount shown.

Table 2-12
Silo 2 Residue Composition
as Measured by FD Fernald 11/22/96

a Element as oxide	b Analyzed wt%	c Normalized wt%	d Stoichio. mol. %	e PNL Anal. wt%	f c - e wt%
Al2O3	3.01	3.47	2.37	4.02	-0.55
B2O3	0.00	0.00	0.00	0.00	0.00
BaO	4.47	5.15	2.34	3.54	1.61
CO2	3.49	***4.02***	6.36	4.02	0.00
CaO	2.81	3.24	4.02	2.95	0.29
Fe2O3	4.82	5.56	2.42	7.20	-1.64
K2O	0.25	0.29	0.21	0.80	-0.51
Li2O	0.00	0.00	0.00	0.00	0.00
MgO	0.39	0.45	0.78	2.01	-1.56
MnO2	0.00	0.00	0.00	0.04	-0.04
N2O5	0.63	***0.73***	0.47	0.73	-0.00
Na2O	0.74	0.85	0.96	1.04	-0.19
NiO	0.38	0.44	0.41	0.43	0.01
P2O5	0.69	***0.80***	0.39	0.80	-0.00
PbO	7.59	8.75	2.73	7.32	1.43
SO3	3.50	4.03	3.51	2.01	2.02
SiO2	51.58	59.46	68.85	60.23	-0.77
V2O5	0.01	0.01	0.00	0.10	-0.09
Others	2.39	***2.76***	4.20	2.76	-0.00
	86.75	100.00	100.00	100.00	0.00

Sample No.: 200222612

Numbers in bold were not analyzed by FD Fernald. They are taken from the PNL Analysis.
The "others" are other elements in the residue that are less than 0.5 wt% each, but total collectively to the amount shown.

Table 2-13
Silo 3 Residue Composition
as Measured by FD Fernald 11/22/96

a Element as oxide	b Analyzed wt%	c Normalized wt%	d Stoichio. mol. %	e PNL Anal. wt%	f c - e wt%
Al2O3	5.20	6.60	4.53	6.10	0.50
B2O3	0.14	0.18	0.18	0.00	0.18
BaO	0.05	0.06	0.03	0.04	0.02
CO2	1.73	***2.19***	3.48	2.19	-0.00
CaO	4.94	6.27	7.82	5.41	0.86
Fe2O3	7.20	9.14	4.00	9.21	-0.07
K2O	0.79	1.00	0.74	2.07	-1.07
Li2O	0.40	0.51	1.19	0.54	-0.03
MgO	11.55	14.66	25.43	11.51	3.15
MnO2	0.59	0.75	0.60	0.77	-0.02
N2O5	5.54	***7.02***	4.55	7.02	0.00
Na2O	1.73	2.20	2.48	6.79	-4.59
NiO	0.60	0.76	0.71	0.60	0.16
P2O5	8.43	***10.70***	5.27	10.70	-0.00
PbO	0.19	0.24	0.08	0.22	0.02
SO3	15.10	19.16	16.74	17.26	1.90
SiO2	12.10	15.36	17.87	16.11	-0.75
V2O5	0.26	0.33	0.13	0.58	-0.25
Others	2.27	***2.88***	4.20	2.88	0.00
	78.80	100.00	100.00	100.00	0.00

Sample No.: 20027134

Numbers in bold were not analyzed by FD Fernald. They are taken from the PNL Analysis.
The "others" are other elements in the residue that are less than 0.5 wt% each, but total collectively to the amount shown.

Also, the sulfate in Silo 3 is most likely, magnesium sulfate ($MgSO_4$), because (1) magnesium is stoichiometrically the predominate component in the silos, and (2) a study done by with the Leco sulfur analyzer indicates this. The Leco produced the following information:

Table 2-14
Destruction Temperature of Actual Silo 3 wastes

15.1 wt% sulfate destroyed at 1450°C with catalyst V_2O_5
14.3 wt% sulfate destroyed at 1250°C with catalyst V_2O_5
13.0 wt% sulfate destroyed at 1250°C without a catalyst

Table 2-15 shows the destruction temperatures and behaviors of various sulfates. The Silo 3 wastes were, supposedly, calcined at 600°C before being sent to Silo 3. So the destruction temperature for the main Silo 3 sulfate is between 600°C and 1250°C. This leaves magnesium sulfate which destructs at 1125°C. Silos 1 and 2 required the catalyst, V_2O_5, to destroy the sulfates at 1450°C.

2.3 Glass Chemistry

The development of the glass formulas and the Melter design are dependent upon each other. Both are significantly influenced by the waste materials in Silos 1, 2, and 3. Characteristics of the glass that are key formula and Melter design parameters include the concentration of sulfate, phosphate, and other waste components in the slurry feed and the viscosity, liquidus, redox state, foaming, and conductivity of the resultant glass. The design of the Melter and the slurry formulas address challenges of transforming the silo waste into acceptable glass without generating unacceptable waste streams (such as waste water and off gas) and reactions (such as foaming and devitrification).

During glass formula development studies, the glasses made were grouped according to the silo wastes they contained (simulated). This designation has continued. Series A contains a blend of Silos 1 and 2. Series B is the same as Series A except it also contains a high concentration of bentonite. Series C is contains only Silo 3. Series D contain a blend of all three silos.

2.3.1 Viscosity vs. Temperature

Viscosity is probably the most important parameter to characterize for a prescribed glass. If the glass melt becomes too thick, the waste dissolution (glass production)

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Table 2-15
Decomposition Temperatures of Sulfates

Compound	Melting Point, °C	Decomposition Temperature, °C	Behavior
$Al_2(SO_4)_3$	–	770	Low temperature decomposition.
$BaSO_4$	1580	>1580	Melts without decomposition.
$CaSO_4$	1450	Graduated	Some decomposition before melting, but slow.
$Fe_2(SO_4)_3$	–	480	Low temperature decomposition.
Li_2SO_4	860	860	Decomposition is not far above melting temperature.
$MgSO_4$	–	<1124	Decomposes before melting.
Na_2SO_4	884	Graduated	Volatilization and decomposition both take place, however, both are slow at lower molten glass temperatures. Increases with temperature.
$PbSO_4$	1170	< 1170	Decomposes noticeably below the melting point.

Information from:

The Chemical Rubber Company (CRC) Handbook of Chemistry and Physics, 51st Edition, and

High Temperature Properties and Decomposition of Inorganic Salts, "Part 1. Sulfates," October 1, 1966, K. H. Stern and E. L. Weise, Institute for Basic Standards, National Bureau of Standards, Washington, D.C.

rates will decrease and may result in possible stoppage and/or blockage of the Melter discharge chamber. If the glass melt is too thin, glass can leak through joints and result in problems causing premature corrosion and erosion of the equipment. Additionally, final waste form production (e.g., gem production) is sensitive to glass viscosity.

The desired viscosity of the molten glass in the Melter is between 10 and 80 poise. Due to temperature loss during Melter discharge and glass forming production, the viscosity of the glass may increase. For gem production, it is expected that the viscosity of the glass "gob" should not be below 200 poise when it reaches the conveyor. This allows the gob of glass to flow and have enough time to "pull" itself together, much like water "beads" on the surface of freshly a waxed car. If the glass is too thick, the glass does not have enough time to form a gem before it freezes.

2.3.2 Conductivity vs. Temperature

Like viscosity, characterization of the glass conductivity is necessary for joule-heated melter operation. The VitPP has a joule-heated melter where electrical resistance of the glass produces the heat for melting. A low conductive glass requires electrical transformer taps that produce power at a higher voltage and lower amperage, compared to a high conductive glass that requires electrical transformer taps that produce power at a lower voltage and higher amperage.

In the VitPP, if a glass is too conductive, excessive heat is generated in the Melter electrode chambers and/or the electrically semi-transparent walls, resulting in less heat transfer to the glass melt. This could cause melter failure or premature deterioration of key melter components. Increasing resistivity of the glass melt requires increasing voltage in order to put in the same amount of power. A glass that is too resistive may exceed the voltage capability of the Melter.

With the three-chamber melter design, the conductivity of the side chamber (electrode chamber) glass is also very important. Originally, it was felt that the side-chamber glass should be of much higher conductance (five times higher) than the waste glass in the main chamber so that the side chamber glass generates less heat (this allows most of the heat to be generated in the main chamber glass). However, recent minimelter runs and calculations show the side chamber should remain cool even with more resistive glasses. Current design values for glass conductivity (resistivity) have been approximated at 1.0 Siemens/cm (S/cm, 1.0 ohm·cm) for the side chamber glass and 0.15 to 0.33 S/cm (3.0 to 6.7 ohm·cm) for the main chamber.

2.3.3 Liquidus Temperature Range

Liquidus temperature range is a temperature band below (and often near) the melting point of glass where crystallization, precipitation, and/or phase separation occurs within the glass melt given enough time. Different glass compositions have different liquidus temperature range profiles. The best liquidus temperature profile is one that is narrow, allows a low melting point of the glass, and has minor sensitivity to compositional changes. A wide profile, or one that approaches the melt temperature, can make pouring and forming glass difficult because the glass can crystallize or separate (decompose) as it cools before it has a chance to solidify. Likewise, a liquidus temperature profile that approaches the operating temperature can result in high viscosity and blockage(s) where the temperature can drop (e.g., the discharge chamber). A liquidus temperature profile that is sensitive to compositional changes can result in blockage of a melter if the melter feed composition inadvertently drifts.

For operation of the VitPP, the glass will automatically pass a liquidus temperature evaluation if visible crystals, phase separation, or other defects are not detected at a temperature 200°C below the glass's operating conditions in the Melter. Minor crystallization (precipitation) may be acceptable if the glass melt appears it can keep the crystals suspended without bunching together since such a condition may not cause blockage within the Melter.

2.3.4 Redox[11] Control

Redox control in the VitPP Melter is a significant concern when processing actual waste since it has the potential for adverse effects on the electrodes. For actual waste materials and surrogates, adverse redox conditions in the VitPP Melter are mitigated because the electrodes are protected in the side chambers. Oxygen feed to the melt bath with the agitation air provides sufficient oxygen to prevent the "soft" metals, such as lead (Pb), from precipitating. Precipitation would put elemental metal(s) in the glass melt and possibly produce a short across the electrodes.

In the main chamber molten glass, high temperatures and/or running idle with low agitation may result in some reduction in the redox state. Urea may be used, as a reductant, to destroy/control sulfate at the molten glass surface. However, it should not significantly affect the redox of the molten glass in the main chamber.

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[11] Redox is a term used to describe the amount of oxygen in a system. It is short for Reduction oxygen potential.

2.3.5 Foaming

Foaming is a release of gases within the molten glass which causes the whole glass mass to swell (or foam). It becomes less likely for foaming to happen if the reactions occurs closer to the surface and the gases can be easily released. Thin (less viscous) glasses are less likely to foam because the bubbles that trap the gases "pop" at the surface and do not have the chance to collect and build up a "head." Foaming of the molten glass was shown to be a potential problem in the Battelle Pacific Northwest Laboratory (PNL) crucible melts and several of the Fernald laboratory melts.

Conditions that cause foaming can be a change in redox or temperature. It was found in minimelter Vitreous State Laboratory (VSL)[12] runs that the latter appears to be the case with the silo wastes. Foaming was observed in the minimelter runs when the glass was discharged, feed to the melter ceased, or the temperature of the melter was ramped up too quickly. The minimelter is not temperature controlled, but rather, power controlled. Therefore, when the glass was discharged or the feed to the melter ceased, the same amount of power went into the smaller volume of glass. The net increase of power per unit mass of glass resulted in the temperature climbing. Since gas solubility decreases with increasing temperature, the saturated molten glass released dissolved SO_4 as a gas. Under certain conditions where the glass is viscous enough and the temperature increase is rapid enough, foaming occurs.

Foaming events were controlled in the minimelter by decreasing the viscosity of the glass through glass chemistry, increasing power into the molten glass slowly, and destroying sulfates with urea. Decreasing the feed rate with a corresponding decrease in power to the melter also can help control foaming events. Foaming events were noticed in the minimelter with Silos 1, 2, and 3 surrogate glasses.

2.3.6 Devitrification

Devitrification (opacity, crystal formation, precipitation formation) upon cooling of the final product is permissible as long as it does not cause the final product to fail the EPA TCLP or impair the glass forming or handling properties of the glass (e.g., create excessive breakage in gems). Glasses prepared from Silo 3 material are more prone to devitrification because the glass is more "basic" (which generally implies less glass formers) in nature than the Silos 1 and 2 glasses. The silo

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[12] VSL is part of the Catholic University of America located in Washington, D.C.

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glasses devitrify and form crystals at their liquidus temperatures much like igr "ultra basic" mineral/rock counterparts. Below is the general characterization o glasses (and igneous rocks):

Acid	Mostly made of glass formers. Over 65 wt% silica.
Basic	Contains 45 wt% to 55 wt% silica. Generally rich in ferro-magnesium type minerals.
Ultra Basic	Contains less than 45 wt% silica. Contains significant amounts of alkali and alkaline metal oxide, etc. Prone to form crystals like spinels, etc.

The study of igneous rocks and minerals gives additional insight of how the silo glasses may behave and what precipitates and crystals may form within the glasses, provided conditions are right.

2.3.7 Additives

Additives are necessary to impart the desired properties necessary to make glass in the Melter. The following paragraphs list and summarize additives used durin development program. A brief summary is provided to discuss the effect of th additives.

Fluxes: these lower the melting point of the glass formers.

- Sodium oxide (added as soda ash, Na_2CO_3)
- Calcium oxide (added as chalk, $CaCO_3$)
- Lithium oxide (added as lithium carbonate, Li_2CO_3)
- Boron oxide (added as boric acid or borax pentahydrate)
- Fluoride (metal fluorides)

All fluxes lowered the viscosity of the molten glasses and all, except fluoride, could be used as fluxes in the final glass formulas. Lithium (Li) is the most effective flux (produces the highest waste loading), but is also the most expensive. Boron (B) is the next most expensive. Studies may be necessary to determine if the extra material costs are warranted.

Modifiers: impart some desired property to glass.

- Aluminum oxide -- used to help the dissolution of phosphates

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into the molten glass and improve durability of the glass (added as alumina).

- Boron oxide -- used to make the molten glass more vitreous and help prevent devitrification of the glass upon cooling (added as boric acid or borax pentahydrate).

- Calcium oxide -- used to stabilize the molten glass and possibly aid in the handling and destruction of sulfates in the glass (added as chalk, $CaCO_3$).

- Urea -- used as a reductant. It is used successfully to destroy sulfates without reducing lead from the molten glass.

2.3.8 Phosphate - Treatment and Resulting Glass Devitrification

Studies conducted by Fluor Daniel and VSL provide evidence that phosphates in glass can be dissolved and/or suspended in the molten glass with the addition of alumina (igneous rock also supports this fact). Originally, the major problem with adding alumina was that it would raise the melting temperature of the molten glass. This did not appear to be a significant problem, with fluxes such as sodium and lithium working well with aluminum to mitigate this effect. Alumina is soluble in both silicate and phosphate glass, and therefore can act as a mechanism to increase the solubility of phosphates in the predominantly silica-based silo waste glasses. Laboratory studies and minimelter runs demonstrate this finding to be true.

Glass formulas have been developed that contain the phosphates in the waste glasses. Glass formulas have been developed that contain high phosphate concentrations in the melter, and have good liquidus temperature. However, these glasses tend to turn milky opaque colors upon cooling because the glass slightly devitrifies with phosphates precipitating before the glass solidifies. The color can go through a series of colors or deepening of color, with the color depending on average size of the phosphate microscopic particle generated in the glass. "Deepening the color means changing it from yellow to orange, red, purple, violet, blue, and finally to green. In those cases where the absorption is very intense, the substance may even have a metallic lustre."[13] The most common color is green in the Fernald waste

[13] W. E. S. Turner, Author of "Coloured Glass," 1960 (title page of book with publishing date missing, but believed to be around 1960), page 4, quoting, W. Biltz,

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glasses, which is full color deepening or saturation. Some pieces of gla can have all colors as described above.

2.3.9 Sulfate - Treatment

2.3.9.1 Selection of Sulfate Compounds

Originally during early investigations, it was assumed that a "sulfate compound is a sulfate compound" and the compounds used in the slurry to make the glass surrogates were of little importance since most chemical constituents thermally break down in the molten glass pool. Most of the sulfate surrogates used in the tests conducted by PNL, Fluor Daniel Fernald and VSL were calcium sulfate, which resulted in sulfate layers. The tests Fluor Daniel Fernald conducted with barium sulfate for Silo 1 and Silo 2 simulations did not form a sulfate layer.

After reviewing the results from the different studies and test, it was concluded that magnesium sulfate is a more representative sulfate compound to use for Silo 3 surrogate and barium sulfate is a mor representative sulfate compound to use for Silo 1 and Silo 2 surrogate. The following sections discuss the results of the tests and studies that support this conclusion.

2.3.9.2 Sulfate Compounds Investigations and Results

Several alternatives have been used to investigate different methods to treat sulfates. It was empirically determined in the Fernald labs (and verified at the VSL) that about ½ to 1½ wt% of sulfate as SO_3 dissolves into the molten glass, depending on the glass's composition, temperature, and residence time in the melter. Sulfate above this level, if not destroyed, will separate from the molten glass and float to the surface. Experiments were performed at the Fernald labs to investigate the following effects on sulfate treatment. These alternatives are listed below. It was determined that urea performed the best.

1876, Chapter 9, page 522 or 1888, Chapter 21, page 321.

1. Calcium: calcium oxide was added to the melt to hold the sulfate in the glass long enough until it was destroyed by the heat. Results indicated that this treatment worked for lower concentrations sulfates, but not higher concentrations.

2. Carbon: carbon was added to the melt mix (feed) to reduce the sulfates to SO_x. Results indicated that this does destroy the sulfates, however, balancing the reactions between destroying the sulfates and reducing lead to metallic lead was difficult to control. Reduced metallic lead was not observed, however, lead sulfide, which looks like metal, was observed. Lead sulfide is similar to metallic lead because it is molten, precipitates to the bottom, and is conductive.

3. Water addition: water converted the sulfate to sulfuric acid at the molten sulfate layer's surface. The water addition was accomplished by dropping metered water through the furnace onto the molten sulfate layer. A couple of times this method produced a frothy foam on top of the molten glass, however, it worked effectively on the sulfate layer. This method could be used if a sulfate layer formed on the molten glass surface.

4. Sugar-water addition: this method used a combination of carbon addition and water addition. The goal was to limit carbon reduction to the sulfate layer (and not the entire glass melt). Results indicated this method had similar problems as when carbon was mixed with the feed. This method seemed to work faster than just water addition to the reduce the sulfate layer.

5. Urea addition: this method of treatment reduced the sulfate layer into gases with no residue falling into the glass melt. This method appeared to be the most effective of the alternatives.

6. Catalytic destruction: some chemicals do not form sulfates well at higher temperature because the oxides act as catalysts to destroy the sulfates that form. Vanadium or tungsten form such oxides. Vanadium pentoxide was used to prevent a sulfate layer formation. The results indicate the catalyst did not work at a low concentration when mixed with the melt mix (feed). However, it quickly destroyed the sulfate layer when sprinkled on a formed sulfate layer. Cost should be considered when

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using this alternative.

7. Temperature and time: Most of the sulfate originates from Silo 3 material, which contains more magnesium than calcium. Most of the laboratory studies were performed with calcium or barium sulfate. Recent studies performed at Fernald show that magnesium sulfate is easily destroyed at approximately 1100°C, whereas calcium sulfate is destroyed at temperatures exceeding 1400°C. Most of the melts performed at PNL with Silo 3 wastes did not produce the amount of sulfate layer as expected. This could be because the sulfate existed as magnesium sulfate, and that the heat in the melter destroyed much of the sulfate at the lower temperatures before reacting with the other constituents to form glass. Future studies are to be performed to determine the sulfate form and to determine how easily and quickly the sulfate can be destroyed.

2.4 The VitPP Lab Crucible Melts - Series D glass formulas

During Campaign 2, Series D formula surrogate slurry was processed in the VitP A significant amount of development was performed by personnel at the VitPP at the FEMP. VitPP Lab personnel performed a series of crucible melts and associated tests on various Series D glass formulas. They adjusted different components of the batch to determine the workable range of the glass.

The primary components of the Series D Glass include compounds of Aluminum, boron, barium, calcium, iron, potassium, lithium magnesium, manganese, sodium, nickel, phosphorous, lead, silica, and vanadium. The components adjusted in the series of batches include the compounds of aluminum, boron, calcium, lithium, sodium, phosphorous, silica, and vanadium. As indicated in the results on Table 2-16, the Series D glass is very robust and forgiving.

The aluminum compound was decreased by 5 wt% and then 10 wt% from the control formula with a minimal increase of viscosity of 1250 °C. Similarly, the Boron concentration was decreased by 5 wt% and then 10 wt% from the control formula with more significant results. With a 5 wt% decrease, the viscosity increased from 57 poise to 70 poise and visual evaluation indicated that a 10 wt% reduction was even more dramatic. Decreasing sodium in smaller portions (2.5 wt% and 5 wt%) had comparable results. In contrast, when the calcium compound was decreased by 5 wt% and 10 wt% the viscosity decreased strikingly. The measured viscosity dropped to 34 poise at 1250 °C. A similar reaction occurred

Table 2-16

Robustness of Series D Glass AG-10/C4D-01

Rick Frost & Rod Gimpel R2 4/24/96

Changed Component	Original AG-10/C4D-01 g/100g glass	Silo 3 Portions g/100g glass	Changed Amount g/100g glass	Change in Silo 3 wt%	Density g/cc	Visual Viscosity 1 thru 10 *a	Viscosity at 1250^C	Good Glass at 1250^C	Melt No.	Appearance
Control - no change					2.87	3	57	yes	AG-10a-25	Transparent, dark-amber glass, no bubbles
Al2O3	14.21	1.18	-5.00	425	2.54	3	66	yes	AG-11-26	Same as control w/slight glaze -- disappears w/> time or temp.
	"	"	-10.00	849	2.76	3		yes	AG-19a-31	looks better than control -- melts good at 1150^C (AG-19b-57)
B2O3	10.24	0.00	-5.00	na	2 87	3	70	yes	AG-12-26	Same as control but a little less fluid.
	"	"	-10.24	na	2.82	7		yes	AG-20-31	Transluscent, dark-amber glass w/small air bubbles
BaO	2.69	0.01	nd	nd						
CaO	14.06	1.04	-5.00	479	2.79	3	34	yes	AG-13-26	Same as control w/small bubbles -- disappear w/> time or temp.
	"	"	-10.00	958	2.71	4			AG-21-32	Same as control w/small bubbles -- disappear w/> time or temp.
Fe2O3	4.28	1.78	nd	nd						
K2O	0.81	0.40	nd	nd						
Li2O	1.13	0.10	-1.13	1084	2.78	4		yes	AG-26-34	Same as control w/small bubbles -- disappear w/> time or temp.
MgO	3.27	2.22	nd	nd						
MnO2	0.15	0.14	nd	nd						
Na2O	7.08	1.31	-2.50	191	2.87	3	63	yes	AG-14-27	Same as control w/small bubbles -- disappear w/> time or temp.
	"	"	-5.00	382	2.83	5		yes	AG-22-32	Transparent, very dark-amber glass, w/small air bubbles
NiO	0.12	0.12	nd	nd						
P2O5	2.43	2.06	5.00	242		3		yes-b	AG-30-35	Bottom 1 mm same as contol; rest opaque greenish-gray (PO4)
PbO	5.25	0.04	nd	nd						
SiO2	34.14	3.11	5.00	161	2.78	3	47	yes	AG-16-28	Same as control w/small bubbles -- disappear w/> time or temp.
V2O5	0.12	0.11	1.00	893		4			AG-32-37	Same as control w/small bubbles -- disappear w/> time or temp.
	100.00	13.62								
Special Cases:										
-5% Al2O3 + =mole% SiO2					2.86	3		yes	AG-15-27	Same as control w/small bubbles -- disappear w/> time or temp.
-10% Al2O3 + =mole% SiO2					2.79	3		yes	AG-23-32	Same as control w/small bubbles -- disappear w/> time or temp.
-2 5% NaO2 + 3 75%CaO					2.80	3		yes	AG-24-33	Same as control w/small bubbles -- disappear w/> time or temp.
SO3 Saturated			Saturated	na	2.74	3	26	yes	AG-17-28	Same as control w/small bubbles -- disappear w/> time or temp.
-25% Additives					2.79	4		yes	AG-28-35	Same as control w/small bubbles -- disappear w/> time or temp.
+25% Additives					2.78	4		yes	AG-29-35	Best looking glass in series

● Visual Viscosity was determined by looking at a glass while it was poured and giving it a number between 1 and 10.
1 appears to pour like water. 10 it is solid like and cannot be racked out of the crucible. The startup glass was given a 3 as a standard.

*b This glass appears that it would be a good glass in the melter, but upon cooling it degrades.

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when silica was increased.

As demonstrated in the VitPP Lab crucible melts, the Series D glass formula is very robust. This proved to be very helpful during the performance of Campaign 2 at the VitPP.

2.5 The Vitreous State Laboratory (VSL) Minimelter Runs

A minimelter was used at the Vitreous State Laboratory at the Catholic University of America in Washington D.C. (VSL) to develop and simulate Fernald glass formulas with the correct viscosities and electrical conductances for operation and testing in the Fernald VitPP. The minimelter is of similar type construction as the VitPP Melter and proved very helpful in providing data for scale-up to the large pilot facility.

The VSL runs were performed in the following order:

1. Series D, Glass melt C4D-04 or Run D_1
2. Series A, Glass melt C4A-03 or Run A
3. Series C, Glass melt C4C-03 or Run C_1
4. Series C, Glass melt C4C-08 or Run C_2
5. Series D, Glass melt C4D-15 or Run D_2
6. Series D, Glass melt C4D-01 or Run D_3

However, the results will be reported in alphabetical order for better clarity. The recipes for these minimelter runs with key parameter information is given in Tables 2-17, 2-18 and 2-19. Melt C4D-15 is known as the "Acceptance Glass" during the VitPP runs. Melt C4D-01 is known as the "Series D Glass" during the VitPP runs. Collectively, they are called "Series D" glasses during the VitPP runs. Viscosity and conductivity curves are shown, in Figures 2-1 through 2-4, for the Series D glasses used in the VitPP. Commentary on these melts is noted in the following Subsections.

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Table 2-17
Minimelter Melter Glass Formulas

Series - Run	A		C-1		C-2	
Melt Number	C4A-03		C4C-03		C4C-08	
Comp. (Wt%)	Calc.	Analy.	Calc.	Analy.	Calc.	Analy.
Al_2O_3	5.89	6.08	12.35	11.98	14.43	13.75
B_2O_3	12.89	11.84	12.23	11.77	6.00	5.79
BaO	4.47	4.11	0.03	0.04	0.03	0.04
CaO	5.08	5.49	9.43	9.08	8.61	8.09
Fe_2O_3	3.98	3.60	5.72	5.47	7.70	7.02
K_2O	0.61	0.55	1.35	1.38	1.74	1.63
La_2O_3	0.34	0.02	-	-	-	-
Li_2O	1.52	1.44	2.13	1.97	1.88	1.82
MgO	1.32	1.20	7.18	6.74	9.63	9.07
MnO_2	-	-	0.48	0.53	0.64	0.64
Na_2O	5.68	4.66	7.86	6.91	5.27	4.88
NiO	0.38	0.33	0.37	0.35	0.50	0.43
P_2O_5	0.63	0.65	6.73	6.67	8.95	6.41
PbO	8.63	7.87	0.20	0.24	0.20	0.25
SO_3	1.62	1.44	0.00	na	0.00	na
SiO_2	46.90	40.70	33.56	33.68	33.93	33.33
V2O5	-	-	0.36	na	0.48	na
ZrO_2	0.09	0.11	-	na	na	na
Total	100.00	90.81	100.00	96.81	100.00	93.36
Appearance upon cooling	Dark brown glass		Opaque on top black on bottom		Dark brown	
Liquidus	<1100°C		<1000°C		about 1050°C	
Density, g/cm^3	2.76		2.49		2.7	
Temp., °C						
1150	234.0	0.06-0.08	40.07	0.11	53.47	0.055
1200	123.1	--	25.21	0.15	34.96	0.084
1250	76.2	0.07-0.09	16.96	0.21	23.51	0.125
1300	52.6		12.03	0.28	16.21	0.180
1350	39.1	--	8.91	0.38	11.44	0.255
1400		--	--	--	--	--
TCLP, ppm						
Pb	2.6		0.05		0.07	
Ba	2.06		0.24		0.88	
Ni	0.10		0.47		0.71	
Waste Loading:						
g dry waste/g glass	79.08 %		68.00 %		81.60 %	
as oxides in glass (100% - additives)	74.00% (74.50% w/SO_3)		50.00% (~52% w/SO_3)		60.00% (~62.00% w/SO_3)	

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Table 2-18
Minimelter Melter Glass Formulas

Series, Run	D-1		D-2		D-3	
Glass Number	C4D-04		C4D-15		C4D-01	
Comp. (Wt%)	Calc.	Anal.	Calc.	Anal.	Calc.	Anal.
Al_2O_3	9.63	9.34	15.13	12.69	13.98	13.37
B_2O_3	14.96	13.98	10.06	7.87	10.04	9.60
BaO	2.46	2.11	2.45	2.30	2.66	2.32
CaO	6.97	6.78	7.70	6.91	13.88	13.18
Fe_2O_3	5.33	5.01	5.58	5.01	4.33	4.15
K_2O	1.13	1.04	1.10	1.06	0.79	0.67
La_2O_3	-	-	-	-	-	-
Li_2O	0.2	0.25	0.18	0.24	1.08	1.22
MgO	4.51	3.64	5.03	4.28	2.76	2.41
MnO	-	-	-	-	-	-
Na_2O	6.66	5.93	7.01	5.92	7.09	6.12
NiO	0.41	0.40	0.40	0.36	0.10	0.10
P_2O_5	3.48	3.20	3.87	3.42	2.46	2.33
PbO	5.53	5.02	4.85	4.61	5.22	5.41
SO_3	2.05	na	-	-	1.97	1.56
SiO_2	36.58	34.38	36.56	33.59	33.66	34.27
ZrO_2	0.10	0.11	0.06	0.07	0.00	0.00
Total	100.00	91.33	100.00	88.33	100.00	96.71
Appearance upon cooling	bottom black; top opaque blue/green		black glass		dark brown homogeneous	
Liquidus	<1100°C		<1050°C		<1050°C	
Density, g/cm³	2.71		na		2.79	
Temp., °C						
1100	205.15	0.017	314.1*	0.02	87.45	0.046
1150	114.92	0.026	161.3	0.032	53.16	0.067
1200	69.73	0.038	92.6	0.051	34.52	0.095
1250	45.13	0.055	57.9	0.078	23.64	0.133
1300	30.79	0.077	38.8	0.116	16.92	0.181
1350	21.94	0.106	27.4	0.169	12.57*	0.243
1400	–	–	*extrapolated	–	*extrapolated	–
TCLP, ppm						
Pb		2.43		1.4		3.15
Ba		1.56		1.2		1.88
Ni		0.32		0.12		0.10
Waste Loading:						
g dry waste/g glass		79.82%		78.68%		71.84%
as oxides in glass (100% - additives)	70.00% (70.50% w/SO_3)		69.00% (69.5% w/SO_3)		63.00% (63.5% w/SO_3)	

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Table 2-19
Modified Series A Glass Formula

Series - Run	Ax	
Melt Number	S12-04 (C4A-03 mod.)	
Comp. (Wt%)	Calc.	Analy.
Al_2O_3	6.15	na
B_2O_3	10.51	na
BaO	4.09	na
CaO	13.31	na
Fe_2O_3	3.60	na
K_2O	0.58	na
Li_2O	1.28	na
MgO	1.23	na
Na_2O	7.33	na
NiO	0.56	na
P_2O_5	0.56	na
PbO	7.98	na
SiO_2	43.38	na
Total	100.00	na
Appearance upon cooling	brown clear transparent glass	
Liquidus	<na°C	
Density, g/cm^3	na	
Temp., °C		
1100	258	na
1150	140	na
1200	84	na
1250	53	na
1300	35	na
1350	23	na
1400	17	na
TCLP, ppm		
Pb		na
Ba		na
Ni		na
Waste Loading:		
g dry waste/g glass		71.60 %
as oxides in glass (100% - additives)		0.67

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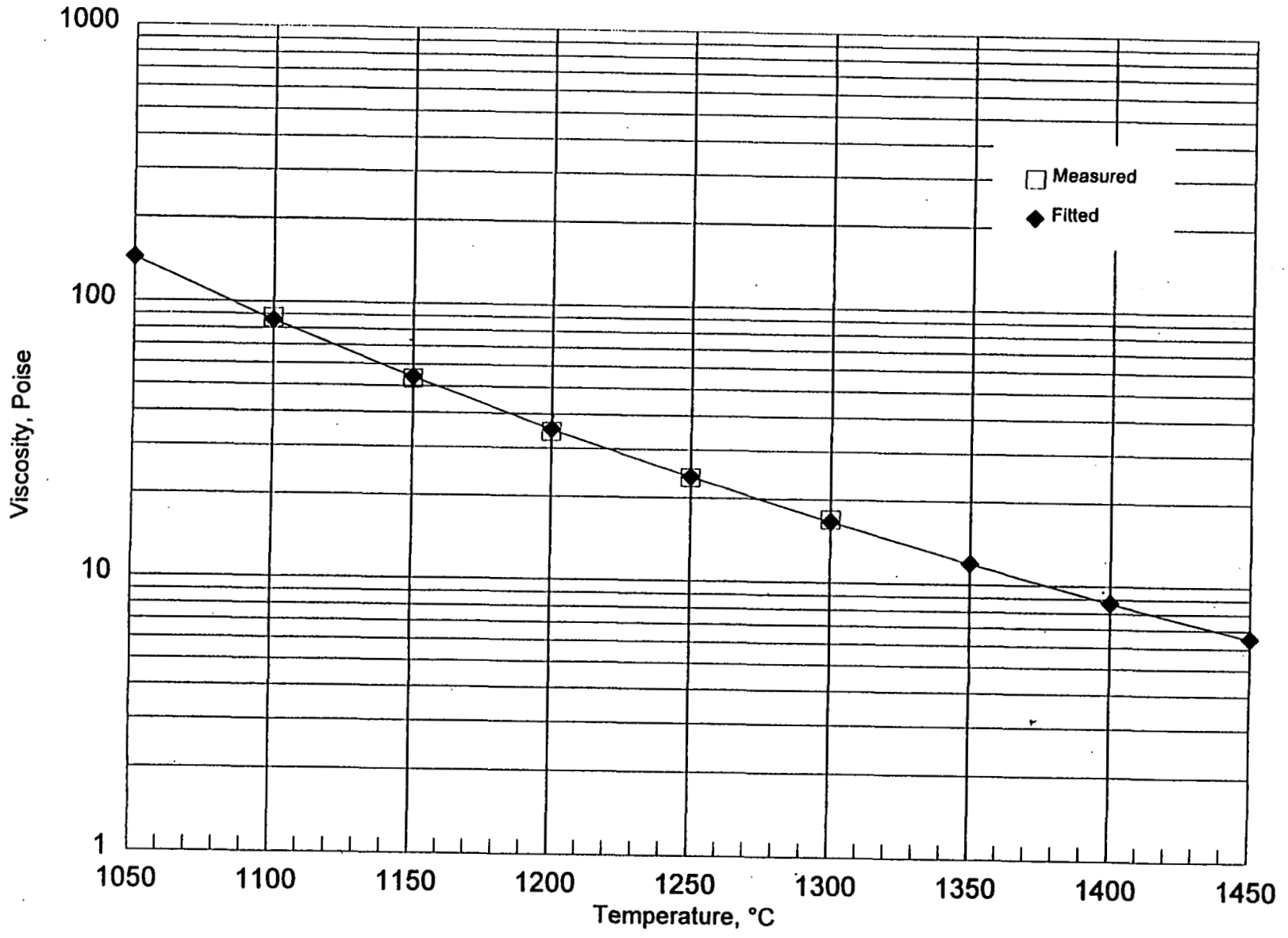

C4D-01 Viscosity c... e "Series D Glass"
Figure 2-1

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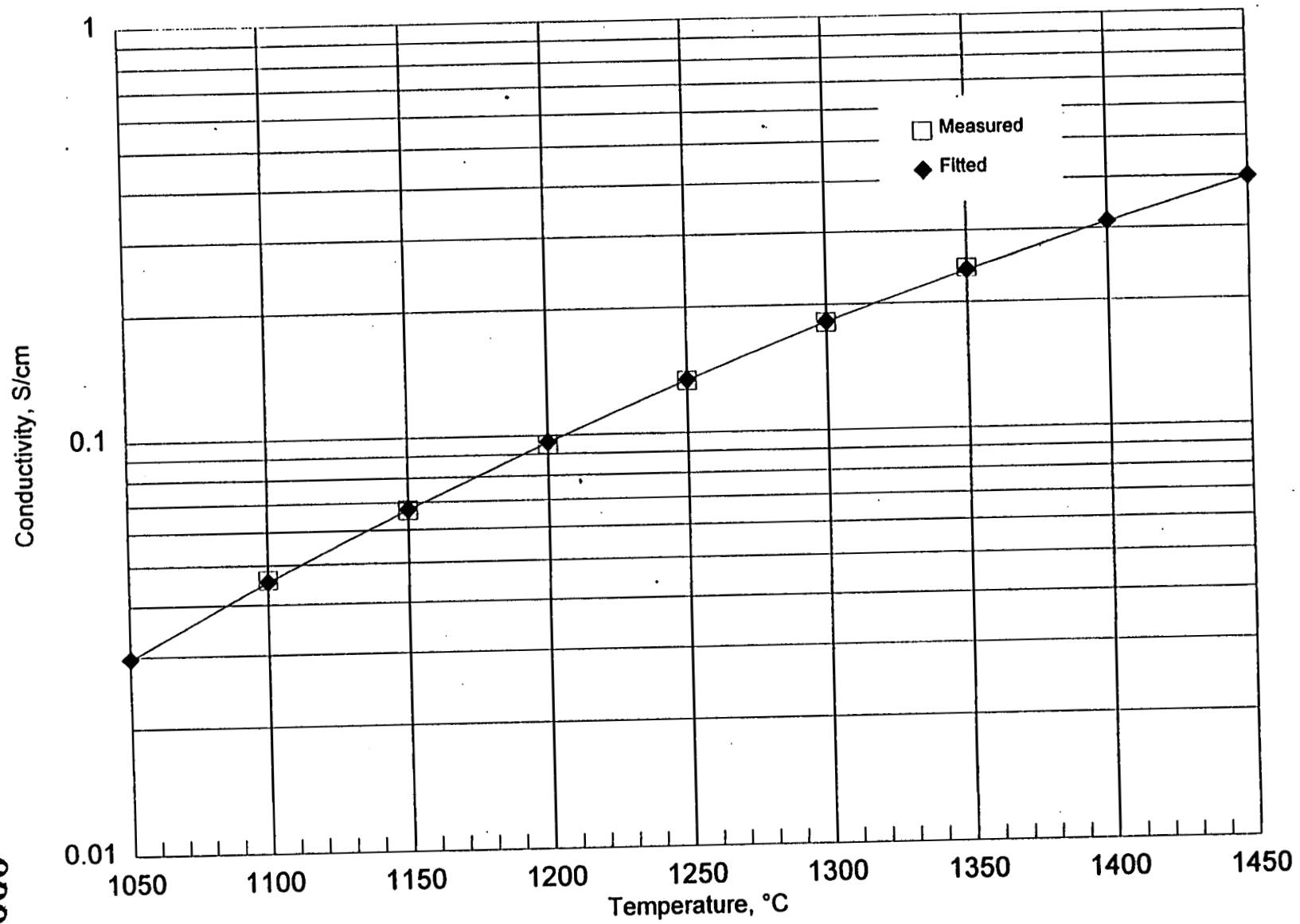

C4D-11 Conductivity Curve "Series D Glass"
Figure 2-2

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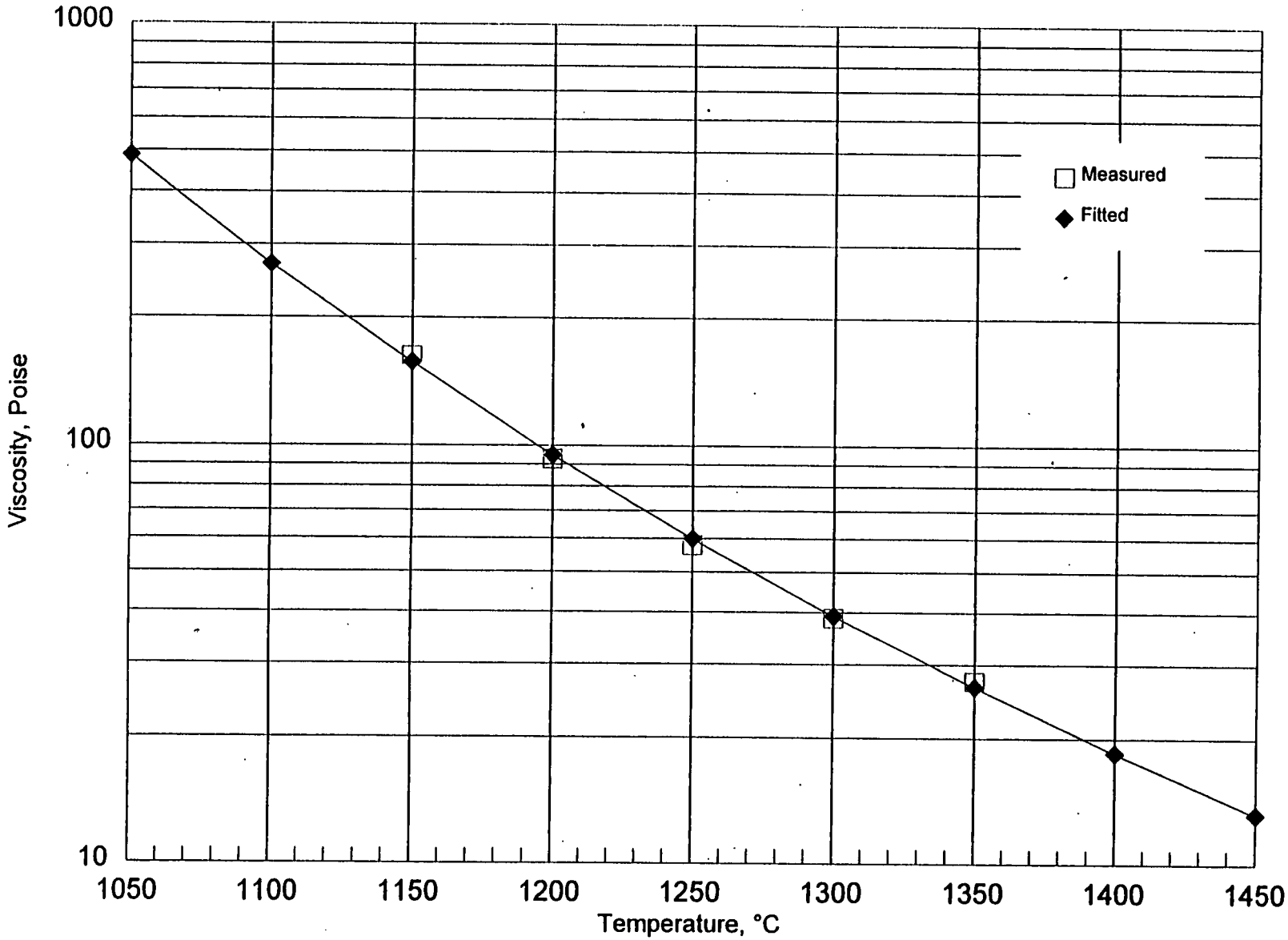
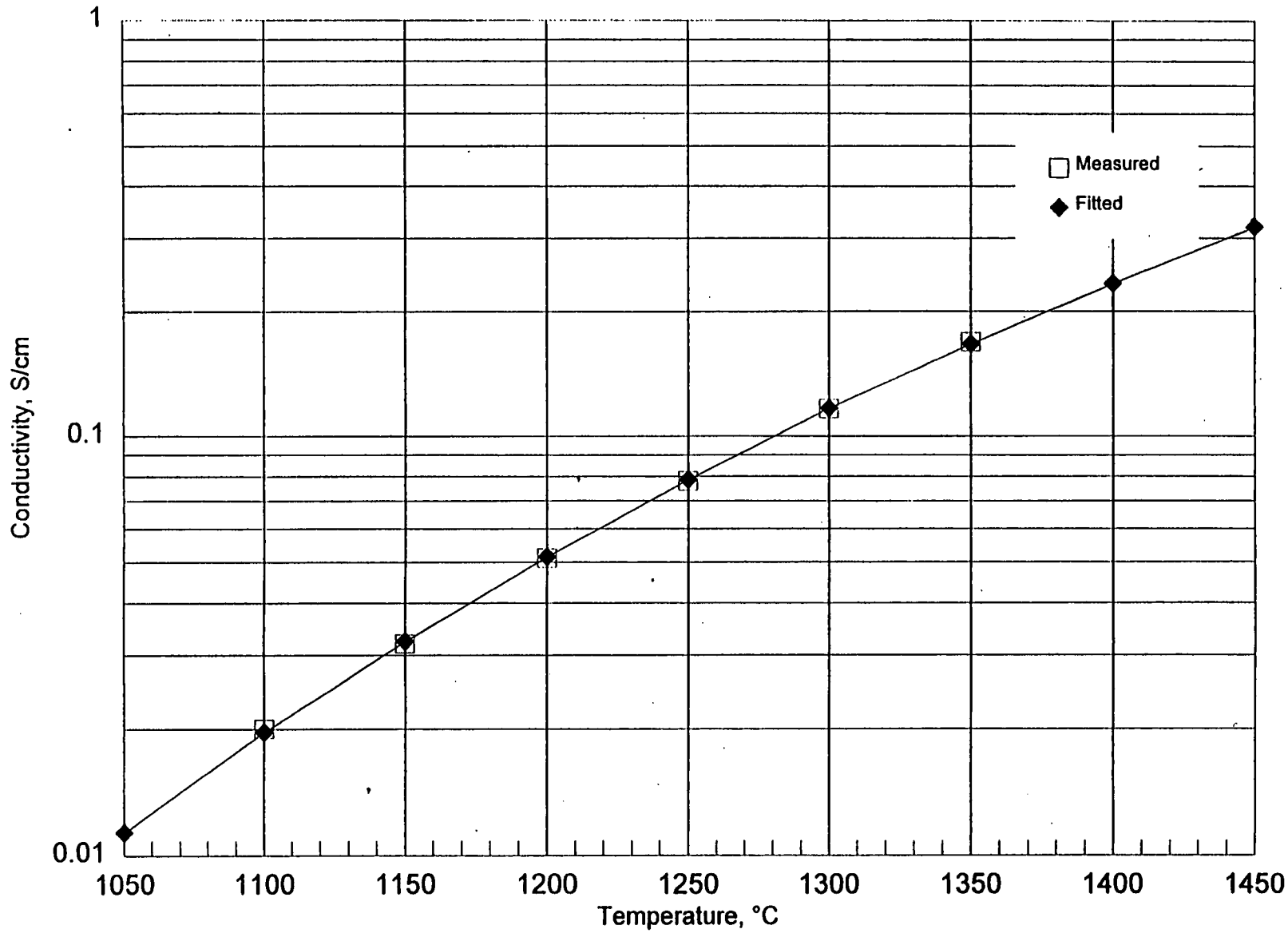


C4D-15 Viscosity Cur .cceptance Glass"
Figure 2-3



C4D-15 Conductivity Curve "Acceptance Glass"
Figure 2-4

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2.5.1 Series A Minimelter Run -- Silo 1 and Silo 2 Blend

Minimelter Run A demonstrated that a select Series A formulation could process simulated wastes into glass between 1130°C and 1310°C. A total of 63.2 kg of glass was produced from 104 liters feed covering a 27-hour period. Using a nominal processing rate of 19 kg/day for a series glass as a basis for comparison, results show that the surrogate Series A glass could be processed at about 0.8 nominal at 1130°C, 3 times at 1250°C, and 5 times at 1310°C. The processing rates appeared to be cold cap limited. Foaming occurred sometimes when the temperature of the bath increased. The nominal throughput was achievable around 1150°C, despite the fact the melt viscosity for the 1130°C test was over 230 poise (which is considerably higher than optimal). Conductance of this glass was low.

The measured viscosity and conductance values were outside the range of other runs that were performed, and outside the previously accepted ranges for the Melter (and gem making machine). The glass formulation was therefore required to be modified in order to lower its viscosity and increase its conductance to within the limits previously mentioned in the document. Changing these parameters will give the Series A glass a more desirable compositional and operating envelope for the melter.

A modification to the Series A glass recipe is shown in Table 2-19. This melt was recently made in the FERMCO lab and visibly appeared to have a good characteristics and good viscosity. If the VitPP melter is running sluggishly during Campaign 2 with the above recipe, this recipe will be tried.

2.5.2 Series B Minimelter Run -- Silo 1 and Silo 2 Blend with Bentonite

A minimelter run was not performed for Silos 1 and 2 Series B glass because bentonite is known to be less of a problem than originally thought (with the latest glass recipes). Since alumina had been used as an additive in the glass recipes, and since fluxes had already been added to adjust for its impact, the higher alumina concentration in the bentonite had less of an impact than originally expected. As a matter of fact, at low-to-moderate blends of bentonite, less alumina will need to be added as an additive. However, if the alumina concentration gets excessive, fluxes will need to be added to reduce the viscosity of the glass.

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2.5.3 Series C Minimelter Runs – Silo 3

Processable, leach resistant glass recipes were identified for the Series C, Silo 3 glasses. Two of these recipes, C4C-03 and C4C-08, were selected for minimelter runs C_1 and C_2. The original recipe had a waste loading of approximately 50 wt% as waste oxides in the glass. However, FERMCO suggested a glass (formulated in the FERMCO laboratory) with a 60 wt% be tested in the minimelter. Also, FERMCO requested that reductants be used to reduce the sulfates and foaming problems expected during this melter run.

The C_1 and C_2 minimelter runs demonstrated that both of the formulations could be processed in sustained test runs in the temperature range of about 1220°C to 1320°C. For the C4C-08 formulation (C_2), three different reductants were examined to mitigate foaming events associated with the 12.4 wt% SO_3 in the feed. Of the three reductants examined (urea, starch, and polyethylene glycol 7500, or PEG 7500), the most effective reductant in reducing the foaming events and increasing SO_2 emissions was urea. Using ½ the stoichiometric amount of urea required to reduce all the nitrates and sulfates in the waste, reduced the foaming and nearly 100% of the sulfate fed in the melter was reduced to SO_2 (a gas that leaves the melter). This enabled the feed rate to be increased from 2.9 liters/hour to 4.6 liters/hour, thus increasing the glass production rate from 37 kg/day to 58 kg/day (the nominal production rate for this minimelter is 19.4 kg/day).

2.5.4 Series D Runs – Blend Of All The Silos

Run D_1

Run D_1 was the first of the minimelter runs performed. It was also the worst performing of all the runs because melter control had not yet been perfected and reductants were not used. A glass of the formulation given in melt C4D-01, which produced a brown homogeneous glass, was recommended to VSL for the run. However, VSL felt the high calcium concentration could lead to calcium phosphate precipitate problems (killer scum) even though they were not noticed. VSL made almost 20 melts by the time the D Series minimelter runs were completed. Approximately, eight melts were completed at the time of the D_1 run. The melt selected for the D_1 run was C4D-04. In addition to containing less calcium, it contained no lithium additive to reduce viscosity. To lower the viscosity, less

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alumina and higher boron concentrations were used. However, t was against the grain noticed at FERMCO. FERMCO noticed that:

1. Higher alumina concentrations reduced or eliminated phosphate precipitation.

2. High boron concentration also encourage A green precipitation (presumed phosphate again) in the glass.

3. The less viscous glass (e.g., higher lithium and calcium) glass were less prone to the "green" precipitation.

The primary limitation on feed rates for this surrogate waste blend was found to be foaming of the melt. For operating temperatures of about 1300-1350°C, operating protocols allowed the foaming events to be manageable in order to achieve production rates of about 20 kg/day. A slightly higher production rate was possible when the sulfate content was reduced. Foaming events were triggered during glass pours most likely due to temperature increases during pouring operations. Since melter power is held constant during pouring, the smaller inventory of glass in the melter increases in temperature quickly. On this basis, a procedure was developed and implemer which successfully alleviated such foaming events by reducing currents shortly before pouring glass.

Run D_2

Run D_2 was performed after the Series C runs. VSL felt that higher phosphate concentrations in the Series C run helped to mitigate foaming events observed in the D_1 Run. This was the reason some melts were performed with higher phosphate concentrations. The main obstacle in producing a Series D formulations with higher phosphate concentrations was the tendency of these glasses to phase-separate into phosphate and silicate phases, even at temperature as high as 1050°C (liquidus temperature). Several glass melts were attempted with no success, however, the acceptance glass formulation did not exhibit phase separation at 1050°C. For this, and other reasons, this glass formulation (Run D_2) was selected for the second Series D minimelter run.

Tests conducted on the high-temperature three-chamber melter

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demonstrated that the acceptance glass formulation could be processed at 1250°C using ¾ stoichiometric urea and ½ stoichiometric urea. When using ½ stoichiometric urea in the acceptance formulation feed, a processing rate of 3.3 times the nominal rate was achieved, with forming events ultimately limiting the production rate. By increasing the urea content to ¾ stoichiometric, the acceptance glass formulation was processed at 3.6 times the nominal rate. The acceptance glass formulation was processed at about 1150°C at 1.3 times the nominal glass production rate. The feed processed easily at this rate with little cold-cap and well controlled, very slight foaming. The maximum achievable feed rate is therefore higher than this under these conditions.

The acceptance glass formulation was investigated without sulfur to study the effect of sulfur on processing rates. At a processing temperature of 1250°C, the maximum feed rate achievable for the feed without sulfur was 2.9 times the nominal rate, which was less than the sulfur feed with reductants! This feed rate was limited by cold-cap formation. The sulfur-containing feed with ¾ stoichiometric urea was foaming limited, rather than cold-cap limited.

Run D_3

The goal of the D_3 run was to demonstrate that the Series D glass could be processed without foaming at temperatures down to 1150°C. A lower melt viscosity was felt to be beneficial because it generally takes a viscous liquid to contain bubbles long enough to cause foaming (unless there is tremendous gas generation in the liquid that quickly replaces the "popping bubbles.") Glass formulations and melts were performed in attempts to lower the viscosity of the glass, with glass melt C4D-01 being the best overall performer in areas other than just reduced viscosity. Therefore, C4D-01 was used for Run D_3.

In contrast to previous runs, foaming events were not observed during this run. At 1150°C the melter was cold-cap limited at the nominal production rate, while at 1250°C the feed could easily be processed at three times nominal. An even higher production rate was probably possible at this temperature. Stalactites and stalagmites formed at 1150°C and glass discharge was difficult due to high glass viscosity. However, these would be less apparent in a larger melter since the melting materials would be less likely to touch, and stick, to cool walls

in a large melter. Also, it is difficult to maintain a high temperatu the minimelter's discharge chamber, thus hindering low-temperature pours. Run D_3 was the only melt run at 1150°C where the melter had a sufficiently long time for the melter to come to equilibrium (steady-state).

2.5.5 Pouring Gems

All the glasses where tested in abilities for product forming in a make-shift gem making machine. All the series glasses were able to form gems, except the Series A glass. This glass became too viscous too early in the gem forming process for gob cutting and forming gems. The glass may even be too thick for monolithic pours. It may not "puddle" in A container before it freezes; thus, only partially filling the container.

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3.0 VitPP SYSTEMS

Little has changed with this Section since the Campaign 1 VitPP Phase I Interim Treatability Study Report, Revision 0, dated December 16, 1996. Therefore, this Section has been moved to Appendix A of this document.

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4.0 DATA ACQUISITION AND PROCESS CONTROL

Little has changed with this Section since the Campaign 1 VitPP Phase I Interim Treatability Study Report, Revision 0, dated December 16, 1996. Therefore, this Section has been moved to Appendix B of this document.

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5.0 CAMPAIGN 2 RESULTS

The VitPP Phase I, Campaign 2 objectives were as follows:

1. Perform testing as acceptance of the Melter and Gem Making Machine from the vendor.

2. Determine if vitrification of OU4 waste residues (using surrogates) is feasible via blending Silos 1 and 2 residues with Silo 3 residues.

3. Gain experience in handling and controlling sulfates and phosphates.

4. Gain experience in handling lead and barium in lower concentrations before attempting Silo 1 and Silo 2 (Series A and B) runs that contain higher lead and barium concentrations.

5.1 Campaign 2 Runs

During Campaign 2, 11 batches were officially processed. Table 5-1 lists the batches and gives the dates they were run. The first batch was a transitional batch to change the benign glass of Campaign 1 to the Series D glasses of Campaign 2. Batches 2 and 3 were fed to provide testing to accept the Melter and Gem Making Machine from the vendor. The remaining batches were for transition from the acceptance glass to running a more realistic and optimized Series D glass formulation developed during the laboratory and minimelter studies.

Additional batches were processed after the official completion of Campaign 2 as defined in the Test Plan (TP) for Campaign 2. These batches were documented by two Operations Work Instructions (OWI) documents. The first 4 post batches were run to process slurries of previously aborted batches. The aborted batches were transferred to temporary polytanks so that the needed repairs and modifications to the feed preparation system could be made without slurry containing lead (Pb) and barium (Ba). The last batches were used to transition back to a benign glass so modifications could be made to the Off-Gas System. This eliminated concerns associated with the presence of high concentrations of hazardous/RCRA type materials (e.g., Ba, Pb) from entering in the system from the Melter off-gassing.

These runs are documented in this report, but not to the detail as with the official

Table 5-1
GLASS PRODUCTION SUMMARY CAMPAIGN 2

Date	Slurry Batch Type	Batch No.	Solids Weight %	Melter Feeder Run Time Hours	Total Glass Produced Lbs	Glass Production Rate MT/Day
8-26/27-96	Transition Glass	C2B01	33.8	18.8	2373	1.38
9-4/5-96	Acceptance Glass	C2B02	43.0	19.5	1465 Monolith	0.82
9-5/6-96	Acceptance Glass	C2B03	16.0	10.8	150 Gems 601 Monolith	0.76
9-7/8-96	Acceptance Glass	C2B04	26.0	17.0	6 Gems 1809 Monolith	1.16
Average Acceptance Glass production rate						0.91
9-10/11-96	Series D Transition Glass	C2B05	45.2	20.1	1134 Gems 1016 Monolith	1.17
9-13/14-96	Series D Transition Glass	C2B06	34.0	21.0	262 Gems 2070 Monolith	1.21
9-15/17-96	Series D Transition Glass	C2B07	27.0	28.9	1994 Monolith	0.75
Average Series D Glass production rate						1.04
9-17/18-96	Series D Glass	C2B08	37.5	19.0	608 Gems 2086 Monolith	1.55
9-19/21-96	Series D Glass	C2B09	40.0	14.0	1310 Gems 2430 Monolith	2.91
9-21/23-96	Series D Glass	C2B10	37.7	18.5	2938 Monolith	1.73
9-23/24-96	Series D Glass	CSB11	33.0	19.3	31 Gems 1682 Monolith	0.97
Average Series D Transition Glass production rate						1.79
Totals Campaign 2 8-27-96 thru 9-24-96	Glass produced includes 5000 Lbs frit charged to main and electrode chambers and 144 Lbs magnesium phosphate charged to main chamber (yield ~ 115 Lbs as glass)			206.9	3501 Gems 20543 Monolith 24044 Total	1.27

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batches required per the SOP and TP. Uptime of the vitrification facility increased from 19% in Campaign 1 to 27% in Campaign 2. Figure 1-2 graphically shows the uptime during Campaign 2. The projected uptime for Scheduling and Cost Estimating purposes for Campaign 2 was 30%, which is close to that realized during Campaign 2. Table 5-1 summarizes the amounts of slurries processed and quantities of glass produced. Each batch produced approximately 1 MT of glass. Specific details, for each of the runs, are described in greater detail in the following sections. Tables 5-2 and 5-3 summarize the batch recipes and the expected glasses for the Acceptance Test and the Series D runs. The batch recipes shown are formulated for 50 wt% solids. However, no batches were run at 50 wt% solids. They were run with lower wt% solids (as low as 16%) to address slurry thickening and pumping problems encountered during this campaign. Barium Sulfate was used to simulate sulfates in Silos 1 and Silo 2 for the first transition batch and the first 36-hr Acceptance.Test batch. Because of "foaming" or effervescence, the problems encountered during the latter part of this batch, calcium sulfate was used instead of barium sulfate after the Acceptance Test.

Table 5-4 summarizes elemental analytical results of glasses sampled from each batch. Table 5-5 summarizes the same data, but the percentages have been normalized so totals add up to 100%. The most significant differences between the actual and calculated (and expected results) values in Tables 5-2 through Table 5-4 are the lithium and phosphate concentrations. Probable reasons for these differences are explained in Section 5.3.4, "Side Chamber Frit Usage and Foaming," for lithium and Section 5.1.8, "Devitrification and Phosphorous."

5.1.1 Transition to the Melter Acceptance Test in Campaign 2

Phase I, Campaign 1 finished with benign glass in the Melter. Campaign 2 runs involved making Series D surrogates, which simulate blends involving residues from all three Silos. The first run during Campaign 2 was the 36-hr Acceptance Test specified in the Melter procurement specification. The test was run with a Series D recipe formulated with higher than expected lead (Pb), sulfur (S), and phosphorous (P) to test the Melter functionally. This recipe is known as the Acceptance Glass or Acceptance Glass Surrogate. The 36-hr test did not start until the benign glass in the Melter was replaced with the Acceptance Glass. The original plan was to flush the Melter by feeding the Acceptance Glass Surrogate until the Acceptance glass replaces the benign. However, this could not be easily achieved since the Melter behaves more like a well-mixed vessel and the feed mixes with the molten bath as

Table 5-2
Acceptance Glass Recipe

Batch Quantities for: Acceptance Glass: C4D-15 or RG-01 Rod F. Gimpel V2.6 08/19/96

Compound	Common Name	%Moisture	Silo 1 Surrogate	Silo 2 Surrogate	Silo 3 Surrogate	Accept. G. Adjust.	Surrogate Total	Additives Mix Tank	Batch Total	As Oxides	Glass Makeup	Glass Makeup, %	Off Gas Makeup
Al2O3	Alumina	2.71	16	19	25		60	273	333	336	336	15.29	
B2O3										226	226	10.34	
H3BO3	Boric acid												
BaO											55	2.50	
BaCO3	Barium carbonate		23				23		23	18			
BaSO4	X-ray milkshake	1.17	33	25			58		58	37			
CO2													145
CaO	Lime			3			3		3		163	7.39	
CaCO3	Chalk, calcite	0.72		18			18	213	231	129			
CaSO4	Gypsum	20.93		2	66	29	96		96	34			
Fe2O3	Rust		15	33	31	34	113		113	116	121	5.52	
Fe2(SO4)3	Iron sulfate, III	1.98			13		13		13	5			
K2O										1	24	1.09	
K2CO3	Potassium carbonate	6.56	7	6			12	6	18	11			
KNO3	Salt peter	2.19			18	8	26		26	12			
Li2O											2	0.10	
Li2CO3	Lithium carbonate	0.96			5		5		5	2			
MgO						17	17		17	21	108	4.89	
MgCO3	Magnesium carbonate		9	13			21		21	10			
MgSO4	Epson salt	51.16			58		58		58	9			
Mg3(PO4)2	Magnesium phosphate		7	7	78	52	144		144	66			
MnO2					3		3		3	3	3	0.14	
N2O5													35
Na2O										3	153	6.94	
Na2B4O7	Borax	30.90						476	476	101			
Na2SO4	Sodium sulfate				20		20		20	9			
Na2CO3	Washing soda	3.53	20	5	14		38	11	49	28			
NaNO3	Soda niter	0.71		5	29		34		34	12			
NiO	Nickel oxide				2		2	6	9	9	9	0.40	
P2O5										78	78	3.55	
PbO	Lead oxide		74	34			107		107	107	107	4.88	
SO3													106
SiO2	Silica, sand, quartz		307	276	64	113	760		760	811	811	36.85	
TiO2										0	0	0.01	
V2O5	Vanadium pentoxide				3		3		3	3	3	0.11	
Bentonite		14.23					89		89	–	–	–	–
CO(NH2)2	Urea							76	76				76
SO3 in glass	Sulfate									0	0	0.00	
Other A													
Other B													
H20	Water								–	–			223
			510	445	42	253	1,725	1,060	2,785	2,200	2,200	10(	585

Batch, lbs 2,200

** K2CO3 and NIO adjusted per VSL's request in the Additives Column

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Table 5-3
Series D Glass Recipe

Batch Quantities for: Series D per C4D-01 — Rod F. Gimpel V2.7 — 09/08/96

Compound	Common Name	%Moisture	Silo 1 Surrogate	Silo 2 Surrogate	Silo 3 Surrogate	Surrogate Total	Additives Mix Tank	Batch Total	As Oxides	Glass Makeup	Glass Makeup, %	Off Gas Makeup	Sub Bentonite	Sulfate on Calcium	New Batch Total
Al2O3	Alumina		17	20	26	64	224	288	302	302	13.71		13.37		302
B2O3									224	224	10.19				
H3BO3	Boric acid									60	2.73				
BaO															
BaCO3	Barium carbonate		25			25		25	19					53	77
BaSO4	X-ray milkshake		35	27		62		62	41					(62)	
CO2												287			
CaO	Lime			3		3		3	5	298	13.53				3
CaCO3	Chalk, calcite			20		20	460	480	269				2.69	(27)	456
CaSO4	Gypsum	6.20		1	60	62		62	24					38	98
Fe2O3	Rust		17	36	34	87		87	90	96	4.35		3.02		90
Fe2(SO4)3	Iron sulfate, III				14	14		14	6						14
K2O									1	18	0.83				
K2CO3	Potassium carbonate		7	6		13		13	9				0.96		14
KNO3	Salt peter				19	19		19	9						19
Li2O										25	1.13				
Li2CO3	Lithium carbonate				6	6	55	61	25						61
MgO									5	73	3.32				
MgCO3	Magnesium carbonate		9	14		23		23	11				11.11		34
MgSO4	Epson salt				31	31		31	10						31
Mg3(PO4)2	Magnesium phosphate		8	7	86	101		101	46						101
MnO2					3	3		3	3	3	0.15				3
N2O5												34			
Na2O									3	150	6.84				
Na2B4O7	Borax	30.90					469	469	100						469
Na2SO4	Sodium sulfate				21	21		21	9						21
Na2CO3	Washing soda		21	5	14	40	2	42	25				4.91		47
NaNO3	Soda niter			6	32	37		37	14						37
NiO	Nickel oxide				3	3		3	3	3	0.12				3
P2O5									54	54	2.47				
PbO	Lead oxide		81	37		117		117	117	117	5.33				117
SO3												85			
SiO2	Silica, sand, quartz		336	302	70	707		707	763	763	34.66		55.27		763
TiO2									0	0	0.01				
V2O5	Vanadium pentoxide				3	3		3	3	3	0.13				3
Bentonite		14.23				97		97	–	–	–	–	(97.31)		
CO(NH2)2	Urea						71	71				71			71
SO3 in glass	Sulfate								11	11	0.51				
Other A															
Other B															
H20	Water								–	–		235			
			555	484	422	1,559	1,282	2,841	2,200	2,200	100.00	713	(5.98)	0	2,835
												Water for x% solids:		45%	3,466
Batch, lbs glass:		2,200													6,301

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Table 5-4
Analytical Results for Batch Glass: Averages of Campaign 2

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Batch 6	Batch 7	Batch 8	Batch 9	Batch 10	Batch 11	Average
SiO_2	35.93	28.93	42.23	41.82	30.41	29.43	30.19	37.63	31.90	38.00	41.30	35.25
B_2O_3	6.20	6.90	9.76	9.56	7.74	6.98	6.02	7.62	8.00	9.56	9.38	8.07
Li_2O	2.07	2.50	2.47	2.66	1.66	2.25	2.19	2.28	3.62	3.74	2.83	2.56
Al_2O_3	13.60	13.00	14.37	14.47	12.95	13.11	12.74	13.04	11.91	12.85	12.90	13.18
BaO	1.40	1.60	1.80	1.75	1.79	1.41	1.45	1.71	1.56	1.74	1.93	1.65
CaO	7.13	5.80	6.22	6.20	9.97	9.39	9.87	10.29	9.06	9.66	11.02	8.60
Cr_2O_3	0.18	0.18	0.23	0.29	0.20	0.21	0.20	0.23	0.26	0.42	0.32	0.25
Fe_2O_3	4.00	3.70	4.18	4.01	4.06	3.64	3.56	3.38	2.58	2.94	3.34	3.60
PbO	3.45	2.83	3.38	3.40	3.78	3.74	3.41	3.58	1.96	2.43	3.18	3.20
MgO	3.79	3.57	3.62	3.21	3.03	3.02	2.93	3.07	2.53	2.59	2.93	3.12
Mn_3O_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NiO	0.25	0.27	0.29	0.27	0.32	0.31	0.25	0.16	0.09	0.12	0.12	0.22
K_2O	0.94	0.18	0.46	0.11	0.62	1.18	0.45	0.18	0.79	0.95	0.76	0.60
V_2O_5	0.00	0.00	0.00	0.00	0.07	0.06	0.00	0.02	0.00	0.00	0.00	0.02
Na_2O	7.44	7.11	7.23	7.27	7.32	6.59	6.55	7.36	7.68	7.91	7.56	7.27
wt% SO_3	0.77	0.63	0.79	0.63	1.02	1.19	1.34	1.31	1.12	1.06	1.36	1.06
wt% PO_4												
Molybdenum (ppm)	0	1000	1050	900	1300	1925	1900	5420	3720	3367	2400	2089
Total Percent	89.154	76.40	97.05	95.75	85.14	82.73	81.15	91.86	83.10	93.99	96.93	
Glass Prod. (lbs.)	2373	1465	751	1815	2150	2332	1994	2694	3740	2938	1792	Totals 24044
Total Cr_2O_3 (lbs.)	4.271	2.637	1.727	5.264	4.300	4.897	3.988	6.196	9.724	12.340	5.734	61.079
Total Molybdenum	0.000	1.465	0.789	1.634	2.795	4.489	3.789	14.601	13.913	9.692	4.301	57.667
TCLP (mg/L)												
Barium	1.11	1.48			2.65	2.27	2.02	2.14	2.01	4.21		
Chromium	0.02	0.05			0.08	0.08	0.07	0.06	0.07	0.23		
Lead	2.77	2.98			6.46	5.56	5.02	3.30	1.65	3.36		
Viscosity (Poise)												
@ 1250 C	44.66		41.12	37.64	32.37	26.03	26.49	22.59				
@ 1350 C	19.12		17.22	15.95	14.04	12.31	13.72	12.36				
Density (g/cc)	2.72	2.70	2.75	2.73	2.73	2.79	2.74	2.69	2.68	2.68		

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Table 5-5
Analytical Results for Batch Glass: Normalized Averages of Campaign 2

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Batch 6	Batch 7	Batch 8	Batch 9	Batch 10	Batch 11	Average
SiO_2	40.30	37.87	43.51	43.68	35.72	35.67	37.20	40.96	38.39	40.43	41.75	39.58
B_2O_3	9.20	7.72	10.08	9.98	9.09	8.44	7.42	8.30	9.63	10.17	9.48	9.05
Li_2O	2.32	3.27	2.55	2.67	2.18	2.72	2.70	2.48	4.36	3.98	2.66	2.92
Al_2O_3	15.25	17.02	14.81	15.11	15.21	15.65	15.70	14.20	14.33	13.67	13.04	14.93
BaO	1.57	2.09	1.65	1.63	2.10	1.70	1.79	1.86	1.68	1.85	1.95	1.86
CaO	6.00	7.59	6.41	6.46	11.71	11.35	12.16	11.20	10.93	10.28	11.14	9.75
Cr_2O_3	0.20	0.24	0.24	0.30	0.23	0.25	0.25	0.25	0.31	0.45	0.32	0.28
Fe_2O_3	4.49	4.84	4.31	4.19	4.77	4.64	4.39	3.68	3.10	3.13	3.38	4.08
PbO	3.87	3.70	3.48	3.55	4.44	4.52	4.20	3.90	2.38	2.59	3.21	3.62
MgO	4.25	4.87	3.73	3.35	3.66	3.65	3.61	3.34	3.04	2.76	2.96	3.54
Mn_3O_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NiO	0.28	0.35	0.30	0.28	0.38	0.37	0.31	0.17	0.11	0.13	0.12	0.25
K_2O	1.05	0.24	0.47	0.11	0.73	1.43	0.55	0.20	0.95	1.01	0.77	0.68
V_2O_5	0.00	0.00	0.00	0.00	0.06	0.10	0.00	0.02	0.00	0.00	0.00	0.02
Na_2O	8.35	9.31	7.45	7.59	8.60	7.97	8.07	8.01	9.24	8.42	7.64	8.24
wt% SO_3	0.87	1.09	0.81	0.87	1.20	1.44	1.65	1.43	1.35	1.15	1.37	1.20
wt% PO_4												
Molybdenum (ppm)	0	1000	1050	900	1300	1925	1900	5420	3720	3367	2400	2089
Total Percent	100	100	100	100	100	100	100	100	100	100	100	
Glass Prod. (lbs.)	2373	1465	751	1815	2150	2332	1994	2694	3740	2938	1792	Totals 24044
Total Cr_2O_3 (lbs.)	4.791	3.451	1.760	5.497	5.051	5.919	4.914	6.745	11.702	13.129	5.796	68.776
Total Molybdenum	0.000	1.465	0.789	1.634	2.795	4.489	3.789	14.601	13.913	9.892	4.301	57.667
TCLP (mg/L)												
Barium	1.11	1.48			2.85	2.27	2.02	2.14	2.01	4.21		
Chromium	0.02	0.05			0.06	0.06	0.07	0.06	0.07	0.23		
Lead	2.77	2.98			6.46	5.56	5.02	3.30	1.85	3.36		
Viscosity (Poise)												
@ 1250 C												
@ 1350 C												
Density (g/cc)	2.72	2.70	2.75	2.73	2.73	2.79	2.74	2.69	2.68	2.68		

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glass leaves the Melter. Concentrations in a well-mixed vessel will change according to the following expression:

$$C_b = C_f e^{-1/rb} + C_0(1 - e^{-1/rb}) \qquad \text{(Equation 5-1)}$$

where:

C_b	Concentration at batch b
C_f	Concentration of feed
r	Retention time in the Melter
b	Number of batch equivalents
C_0	Concentration initially in the Melter

The retention time in the Melter is approximately 2 batches because the Melter holds 4000 lbs glass and each batch normally produces 2200 lbs (1 MT) of glass:

b = (x lbs glass made)/(2200 lbs/batch) (Equation 5-2)

r = (4000 lbs/Melter volume)/(2200 lbs/batch) (Equation 5-3)

r = 1.82 batches/Melter volume

This expression shows that it would take 10 batches to replace 90% of the old glass with the new glass. Fortunately, a new technique, called "pulling," was developed. The same effect, as described above, can be accomplished in one batch (or two batches) which is know as "transition batch(es)". The transition batch is not of the new glass's recipe. Rather, it contains higher concentrations than normal for those components that are high in the new glass recipe and lower than normal concentrations for those components that are low in the new glass recipe. This large concentration difference blends (or pulls) the concentrations in the Melter bath so the desired blend is achieved after one or two batches.

Also, to help pull the Melter bath more quickly, the transition batch is added in increments called "lifts". The transition was done in six lifts. Each lift started by discharging 400 pounds of glass from the Melter and then adding 1/6 of the batch to the Melter. Computer spreadsheets were used to calculate the expected incremental concentration changes with each lift. Tables 5-6 a & b show the additives being used and their expected impacts on the Melter concentrations. Table 5-7 shows the batch makeup used for the transition. The 36-hour test was not started until the analytical results (as shown in Table 5-3) of the glass were completed. The results show that the technique of pulling the glass worked well and approval was given to proceed with the Acceptance Test.

Table 5-6a
Additive Effects on Melter Concentration - First Lift

08/19/96

First Lift Component	mol. wt.	Intial Glass	Intial Glass normalized	Portions norm.	Portions in glass	Additives as oxides	Glass Result	Target C4D-15	Delta	Additives mol%	Glass mol%
Al2O3	101.96	10.92	10.92	10.92	9.83	1.94	11.77	15.13	-3.36	1.26	7.65
As2O3	197.84										
B2O3	69.62	10.58	10.58	10.58	9.52	0.92	10.44	10.06	0.38	0.88	9.94
BaO	153.34					0.49	0.49	2.45	-1.96	0.21	0.21
BeO	25.01										
CO2	44.01							released	-		
CaO	56.08	14.56	14.56	14.56	13.10		13.10	7.70	5.40		15.49
CdO	128.40										
Ce2O3	328.24										
CoO	74.93										
Cr2O3	151.99										
CuO	79.54										
Fe2O3	159.69					1.15	1.15	5.58	-4.43	0.48	0.48
K2O	94.20					0.23	0.23	1.10	-0.87	0.16	0.16
La2O3	325.82										
Li2O	29.88					0.03	0.03	0.18	-0.15	0.07	0.07
MgO	40.31					1.04	1.04	5.03	-3.99	1.71	1.71
MnO2	86.94										
MoO2	127.94										
N2O5	108.01							released	-		
Na2O	61.98	14.53	14.53	14.53	13.08		13.08	7.01	6.07		13.98
Nd2O3	336.48										
NiO	74.71					0.07	0.07	0.40	-0.33	0.06	0.06
P2O5	141.94					0.79	0.79	3.87	-3.08	0.37	0.37
PbO	223.19					1.02	1.02	4.85	-3.83	0.30	0.30
SO3	80.06								-		
SeO2	110.96										
SiO2	60.08	45.41	45.41	45.41	40.87	2.31	43.18	36.56	6.62	2.54	47.63
SrO	103.62										
ThO2	264.04										
TiO2	79.90										
UO2	270.03										
V2O3	149.88										
Y2O3	225.81										
ZnO	81.37										
ZrO2	123.22	4.00	4.00	4.00	3.60		3.60	0.06	3.54		1.94
Cl	35.45										
F	19.00										
Ignition loss								released	-		
SO3 in glass	80.06										
Other A	1.00										
Other B	1.00										
Total	n/a	100.00	100.00	100.00	90.00	10.00	100.00	99.98	0.02	8.05	100.00

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Table 5-6b
Additive Effects on Melter Concentration - Sixth Lift

08/19/96
Rod F. Gimpel V2.6

Sixth Lift Component	mol. wt.	Last lift	Last lift, n	Portions norm.	Portions in glass	Additives as oxides	Glass Result	Target C4D-15	Delta	Additives mol%	Glass mol%	Additives Ratio
Al2O3	101.96	14.41	14.41	14.41	12.97	1.94	14.91	15.13	-0.22	1.26	9.69	5.90
As2O3	197.84											
B2O3	69.62	10.03	10.03	10.03	9.02	0.92	9.95	10.06	-0.11	0.88	9.47	2.80
BaO	153.34	2.02	2.02	2.02	1.82	0.49	2.32	2.45	-0.13	0.21	1.00	1.50
BeO	25.01											
CO2	44.01							released	-			
CaO	56.08	8.60	8.60	8.60	7.74		7.74	7.70	0.04		9.15	
CdO	128.40											
Ce2O3	328.24											
CoO	74.93											
Cr2O3	151.99											
CuO	79.54											
Fe2O3	159.69	4.72	4.72	4.72	4.25	1.15	5.40	5.58	-0.18	0.48	2.24	3.50
K2O	94.20	0.94	0.94	0.94	0.85	0.23	1.08	1.10	-0.02	0.16	0.76	0.70
La2O3	325.82											
Li2O	29.88	0.13	0.13	0.13	0.12	0.03	0.15	0.18	-0.03	0.07	0.34	0.10
MgO	40.31	4.25	4.25	4.25	3.83	1.04	4.86	5.03	-0.17	1.71	8.00	3.15
MnO2	86.94											
MoO2	127.94											
N2O5	108.01							released	-			
Na2O	61.98	8.58	8.58	8.58	7.72		7.72	7.01	0.71		8.26	
Nd2O3	336.48											
NiO	74.71	0.27	0.27	0.27	0.24	0.07	0.31	0.40	-0.09	0.06	0.27	0.20
P2O5	141.94	3.24	3.24	3.24	2.91	0.79	3.71	3.87	-0.16	0.37	1.73	2.40
PbO	223.19	4.18	4.18	4.18	3.76	1.02	4.79	4.85	-0.06	0.30	1.42	3.10
SO3	80.06								-			
SeO2	110.96											
SiO2	60.08	36.26	36.26	36.26	32.63	2.31	34.94	36.56	-1.62	2.54	38.55	7.00
SrO	103.62											
ThO2	264.04											
TiO2	79.90											
UO2	270.03											
V2O3	149.88											
Y2O3	225.81											
ZnO	81.37											
ZrO2	123.22	2.36	2.36	2.36	2.13		2.13	0.06	2.07		1.14	
Cl	35.45											
F	19.00											
Ignition loss								released	-			
SO3 in glass	80.06											
Other A	1.00											
Other B	1.00											
Total	n/a	100.00	100.00	100.00	90.00	40.00	100.00	99.98	0.02	8.05	92.02	30.36

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Table 5-7
Batch Makeup for Transition Glass

08/19/96

Compound	Mol. Wt.	Common Name	%Moisture	Add. Ratio as oxides	Batch as oxides	Batch dry weight	Batch mix, lbs
Al2O3	101.96	Alumina	2.71	1.94	470	470	483
B2O3	69.62			0.92	223		
H3BO3	61.83	Boric acid				396	396
BaO	153.34			0.49	119		
BaCO3 **	197.35	Barium carbonate				76	76
BaSO4 **	233.4	X-ray milkshake	1.17			90	91
CO2	44.01						
CaO	56.08	Lime				–	
CaCO3	100.09	Chalk, calcite	0.72				
CaSO4	136.14	Gypsum	20.93				
Fe2O3	159.69	Rust		1.15	279	279	279
Fe2(SO4)3	399.87	Iron sulfate, III	1.98				
K2O	94.2			0.23	56		
K2CO3	138.21	Potassium carbonate	6.56				
KNO3	101.11	Salt peter	2.19			120	122
Li2O	29.88			0.03	7	–	
Li2CO3	73.89	Lithium carbonate	0.96				
MgO	40.31			1.04	252	89	89
MgCO3	84.32	Magnesium carbonate					
MgSO4	120.37	Epson salt	51.16				
Mg3(PO4)2	262.88	Magnesium phosphate				354	354
MnO2	86.94						
N2O5	108.01						
Na2O	61.98						
Na2B4O7	201.22	Borax	30.9				
Na2SO4	142.04	Sodium sulfate					
Na2CO3	105.99	Washing soda	3.53				
NaNO3	84.99	Soda niter	0.71				
NiO	74.71	Nickel oxide		0.07	17	17	17
P2O5	141.94			0.79	191		
PbO	223.19	Lead oxide		1.02	247	247	247
SO3	80.06						
SiO2	60.08	Silica, sand, quartz		2.32	562	562	562
TiO2	79.9						
V2O5	181.88	Vanadium pentoxide					
Bentonite	na						
CO(NH2)2	na	Urea	14.23				
SO3 in glass	18.998	Sulfate					
Other A	80.06						
Other B	60.06						
H20	18	Water					
				10.00	2,422	2,700	2,717

Lbs oxides/lift, /batch:	404	2,422.34	Water, 50wt%:	2,717
Melter contents and SO3 amount at 0.75 wt%:	4,037	60.56	Batch Total:	5,434
Approx. Lbs transition glass made:		2,482.90		

Directions for transition from startup glass to acceptance glass in six lifts:

1. Mix complete batch in tank – some foaming may occur because chemicals are a mix of acids and bases.
2. Discharge 10%. of the melter's bath for the addition of a lift.
   Note: Draining bath can increase temperature under constant power control and could cause foaming from SO3 effervescence during last lifts.
3. Sent 1/3 of the batch to melter (this is called a lift).
4. Repeat steps 2 and 3 until batch is gone.
5. Use separate batch formulation for acceptance glass run.

The Melter performed smoothly during transition with the transition glass. Transition was accomplished done at an average of 1250°C. The average production rate was 1.38 MT/d of glass. The material cap on the molten glass surface was thin (~1 inch thick), segmented, evenly spread across the melt surface, and semi-molten having characteristics of a material cap close to the molten glass temperature.

5.1.2 Running the Melter Acceptance Test

The Melter Acceptance Test started September 4, 1996 and was completed September 8, 1996. The Melter functioned as expected, processing 11 batches of slurry. Four batches were run at 1350°C and were formulated representative of the most challenging waste loading per the design criteria. Seven batches were formulated as the Series D composition and were run at 1250°C. The Melter was accepted with some punch-list items that require resolution. The punch-list items are listed on pages 4 and 5 in Appendix A.

The Acceptance Test required that the Melter run at 1350°C for 36 hours and produce glass at approximately 1 metric ton per day from the Acceptance Glass formula. Production rate was hampered during the last part of the test because low solids contents (16 and 26 wt%) in the feed. The Melter produced 0.91 glass during the Acceptance Test.

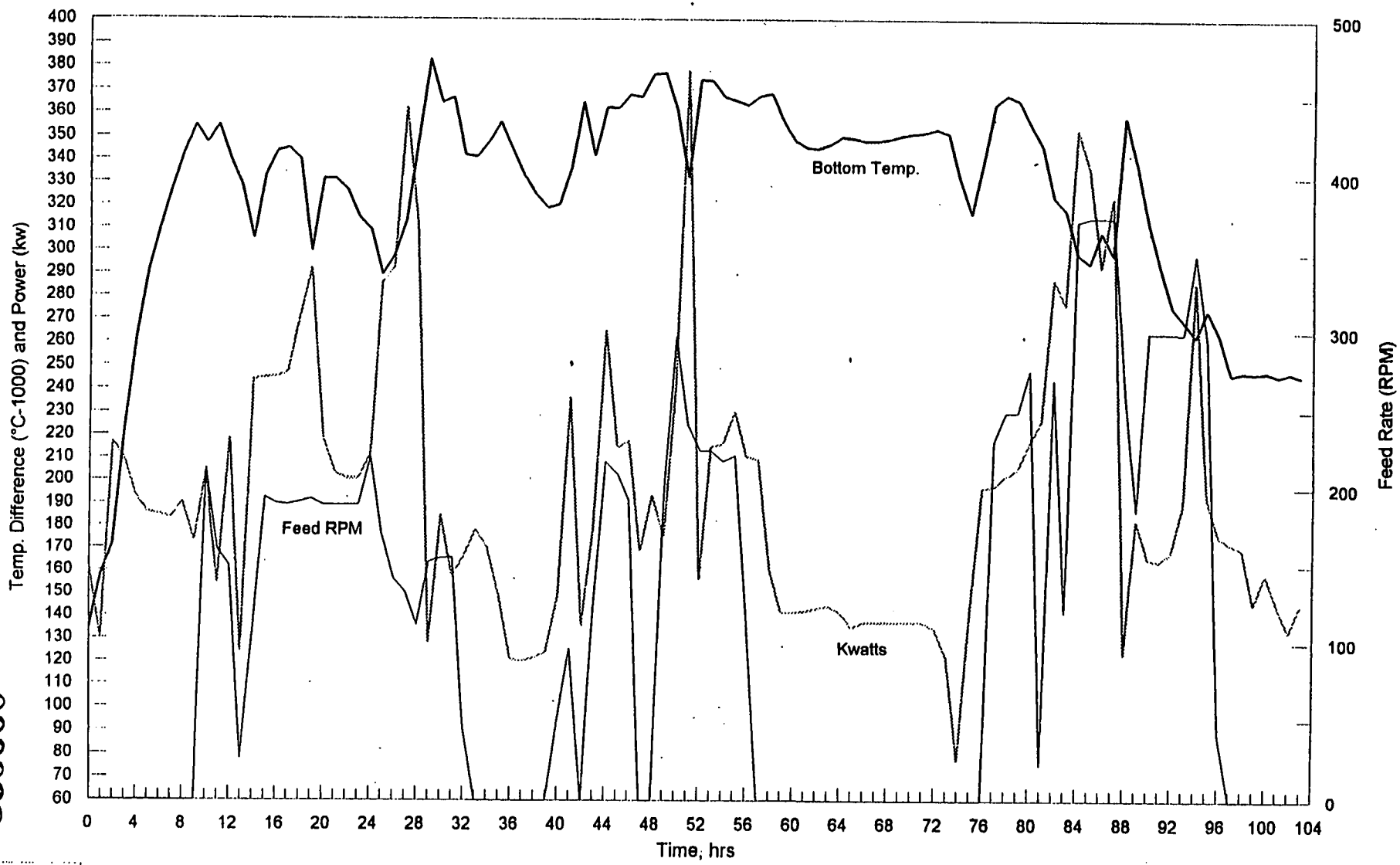
The melter procurement specification required the Acceptance Test to be run at 1350°C. Figure 5-1 shows the temperature maintained in the melter during this. However, during the course of the test the melter started to effervesce SO_x gas. This gives the melter a foaming like appearance at the molten glass surface. This anomaly is referred to as a "Sulfate Effervescence Event." During the Effervescence Event the temperature dropped which made it difficult to maintain the temperature at the required 1350°C without delivering more power to the melter. A detailed description of this anomaly is given in Section 5.3, entitled, "Sulfate Effervescence Events."

The capabilities of the Melter were tested during the acceptance test. Figure 5-1 shows that the Melter can be operated around 1350°C for an extended period of time. The Melter reached a maximum temperature of 1400°C for short durations of time. Up to 400 kilowatts of power were delivered by the Melter to the glass melt for extended periods of time. Operation of gem make and product forming are discussed in Section 5.3.8, "Gem Making and Melter Discharge". Increased leakage of the side chambers was a shortcoming of the Melter, discovered shortly after the Acceptance Test. This is discussed separately in Section 5.3.4, "Side

Figure 5-1

Melter Power and Feed Rate vs. Control Temperature, 9/4/96

36-hr Acceptance Test



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Chamber Frit Usage and Foaming".

5.1.3 Transition from the Acceptance Test to the Series D Runs

Several batches were run using the Series D slurry to acquire time and experience running the Melter with sulfates and phosphates. "Pulling" the glass recipe from the Acceptance Glass to the Series D glass was not performed because the glasses were similar and there was insufficient time to process several batches. The transition batches were processed at 1250°C. The first three batches are considered transition glasses and the runs thereafter Series D glass. However, the Melter behaved the same during the transition and Series D batches. Discussion of the glass chemistry and Melter behavior for both are discussed in Section 5.1.4 "Series D Runs".

5.1.4 Series D Runs

The last batches of Campaign 2 were of the Series D formulation. They were processed at 1250°C. The goal was to process and to maintain Series D glass production at approximately 1 MT/d. The average production rate was approximately 1.8 MT/d with slurries containing approximately 30 wt% solids (based on batches labeled as Series D glass in Table 5-1) and the highest prod. d batch was 2.91 MT/d. Little or no cold cap formed during these batches. The cold cap was generally broken into pieces with an average thickness 1 inch that partially covered the molten glass surface. Most of the cold cap was semi-molten (or fluid) because its contour flowed with the wave action on the surface of the Melter pool. The flowing type cold-cap is sometimes called a "hot cap" since the materials are at or near the temperature of the molten glass underneath. However, the materials have not yet completely reacted and dissolved into the glass. Therefore, it appears the Melter was not limited by the cold cap and could have operated at higher capacity.

5.1.5 Post Campaign 2 Runs

Additional batches were run after the official closing of Campaign 2 as defined in the Standard Operating Procedure (SOP) and Test Plan (TP) for Campaign 2. The first 4 post Campaign 2 batches were run to process slurries of previously aborted batches. The aborted batches were originally transferred to temporary polytanks so that needed repairs and modifications to the Feed Preparation system could be made without slurry containing Pb and Ba containing slurry in the feed system. For

post Campaign 2, these aborted batches were transferred back to the VitPP feed tanks and analyzed for elemental makeup and solids content. Based on the analytical results, chemical adjustments were made to the batches to purge Ba and Pb from the molten glass. These glass batches were processed at 1250°C.

Modifications to the Off-gas System were made after the completion of Campaign 2 before starting Campaign 4. For safety reasons, the glass in the melter was transitioned to a benign glass containing low concentrations of lead and barium concentrations. This transition provided an opportunity to test a benign glass formula (designated as Wet-12) that was being considered to determine the maximum production of the melter, if the opportunity became available in a future campaign. Wet-12 glass was formulated for low glass conductivity. This glass would allow the melter to put more power in melter for glass production with less amperage. The first transition glass fed to the melter was Wet-12. Even though the Wet-12 glass had the right conductance for a high production rate, its performance in the melter was sluggish because it formed a very thick rigid cold cap. Therefore, it is no longer considered for use as a high production test glass. Because the Wet-12 glass slurry was sluggish, the remainder of the transition was done with Wet-16, which was the benign glass used in Campaign 1. Its performance was better in the Wet-12, but its performance was still more sluggish than the Series D slurry run during Campaign 2.

The compositions of Wet-12 and Wet-16 glasses are summarized in Table 5-8. The Wet-12 glass contains significantly less sodium to reduce the conductivity of the glass melt and significantly more calcium to maintain the lower viscosity.

The operators and engineers at the VitPP have both commented that the Campaign 2 recipes appeared to process significantly quicker and easier than the benign glass batches. The benign transition batches were processed at 1250°C with 40 wt% solids in the slurry feed. The goal was to process and maintain production at approximately 1 MT/d. However, only 0.8 MT/d was achievable because of large cold-cap formation. The cold cap was very buoyant. The cold cap did not appear to make good contact with the molten glass because the agitation air collected underneath and rocked the cold cap. The cold cap was normally two to three inches thick and sometimes as thick as seven to eight inches. Water would sometimes collect on top of the cold cap and fall onto the molten glass. This resulted in a small steam excursion that momentarily caused activation of the emergency Off-Gas system.

Table 5-8
Wet 12 and Wet 16 Glasses

Oxides	Wet W12	Wet W16
Al_2O_3	11.00	10.92
B_2O_3	10.50	10.58
CaO	28.00	14.56
Fe_2O_3	0.00	0.00
K_2O	0.00	0.00
Na_2O	5.00	14.53
SiO_2	45.50	45.41
ZrO_2	4.00	4.00
TiO_2		
Sum	100.00	100.00
Viscosity		
1250 °C	19.24	35.41
1200 °C	36.32	51.21
1150 °C	71.69	79..
1100 °C	148.7	134.73
1050 °C	crystal.	258.49
1000 °C		588.19
950 °C		
Conductivity		
1250 °C	0.07	0.28
1200 °C	0.05	0.23
1150 °C	0.03	0.18
1100 °C	0.02	0.15
1050 °C		0.11
1000 °C		0.09
950 °C		
Liquidus	>1050	<850

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5.1.6 Mass Balance for Ba, Pb, S, P, Cr, & Mo

A mass balance of the elements Barium, Lead, Sulfur, Phosphorous, and elemental accumulation calculations were performed on the VitPP Melter, Off-gas, and Water systems. The sample points included in the balance were the slurry feed tank, product glass, quench tower, desiccant tower, recycle and building sump tank waters, and normal and emergency off-gas filters. For the molybdenum and chromium accumulation calculations, the following conditions were applied to determine the total accumulated weights of each analyte. In the scrubber system, the highest concentration was used for each interval between system flushings. If the system was flushed on August 27 and again on September 3, then the highest concentration (ug/L) from a sample taken during that time interval was multiplied by the volume of water in the system (386 L) to determine the total weight accumulated for that specific time interval. For filter samples, it was assumed that the filter material weighed five kilograms.

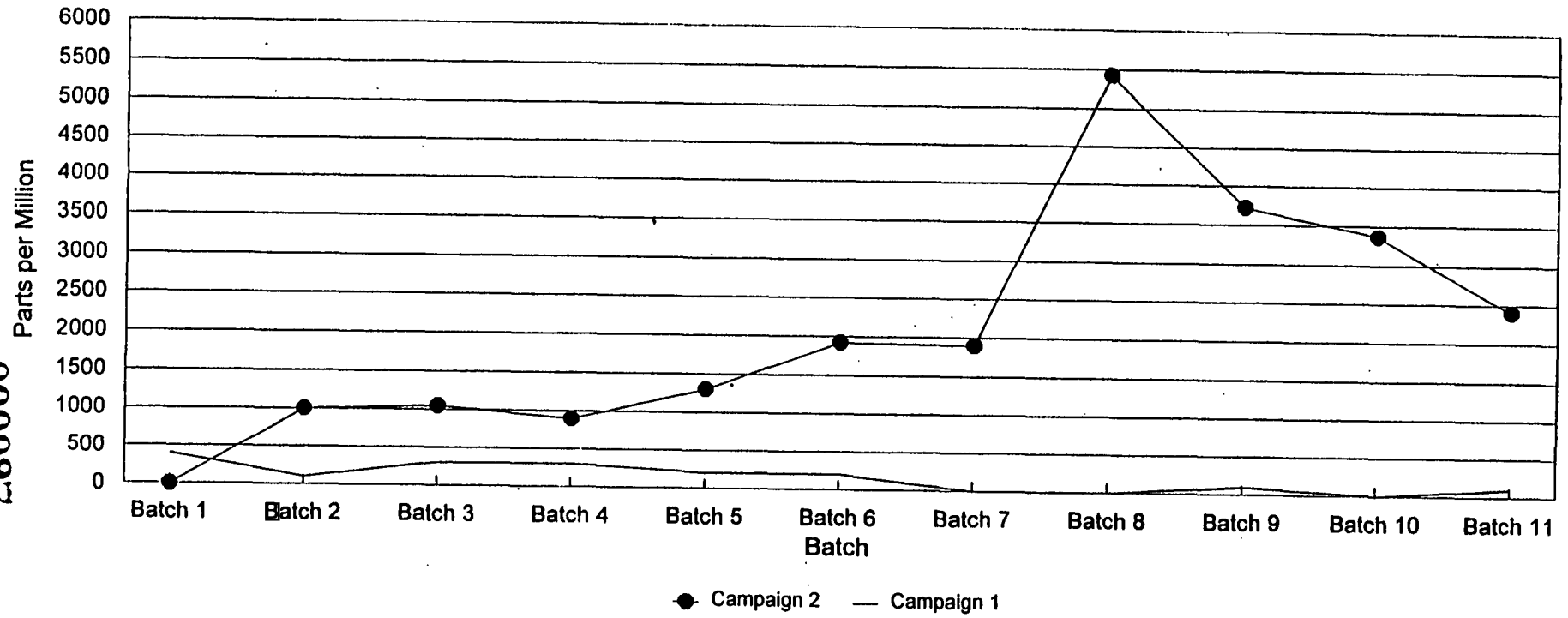
Mass balances for lead, barium and sulfates are presented for Batches 4 and 6 in the respective sections for an approximate indication of where these analytes concentrate. The necessary data was not available to perform an accurate account of these elements.

5.1.6.1 Molybdenum

It was expected that the molybdenum eroding from the melter electrodes would be captured in the product glass, but it was discovered that molybdenum was volatilizing and appearing in the off-gas streams. In its highest oxidation state, molybdenum is gaseous and escapes to the Off-gas System. Although present in the off-gas waste streams, most of the molybdenum was detected in the glass.

The amount of molybdenum present in the glass has increased from less than 500 ppm for every batch sample in Campaign 1 to 5500 ppm in Campaign 2 (Figure 5-2) with an average of 2000 ppm (see Table 5-4). This increase is attributed to contamination of the benign side chamber glass by center chamber glass. The partition wall E-brick developed a crack and the differential density between the side chamber and center chamber glass allowed migration of the center chamber glass into the side chamber. Second, the center chamber glass foamed enough to run over the partition wall. Samples analyzed have shown that the west chamber

Figure 5-2
Weight Percent molybdenum in Glass



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glass is virtually identical to the center chamber glass. For future campaigns, the calcium oxide constituent of the side chamber glass will be replaced by barium oxide to raise the density above that of the center chamber glass density to direct any migration of glass from the side chamber to the center chamber. During Campaign 2, the density of the side chamber glass was approximately 2.5 g/cc and the density of the center chamber glass was approximately 2.7 g/cc. In Campaign 1, the center chamber glass was benign and did not have an adverse effect on the electrodes. However, the Series D glass of Campaign 2 is more corrosive and has had a harsher effect on the electrodes.

The amount of molybdenum traced in the Off-gas System is not significant when compared to the amount recovered in the product glass. Approximately 58 lbs of molybdenum were captured in glass, and approximately three lbs of molybdenum have been lost to the Off-gas System during Campaign 2.

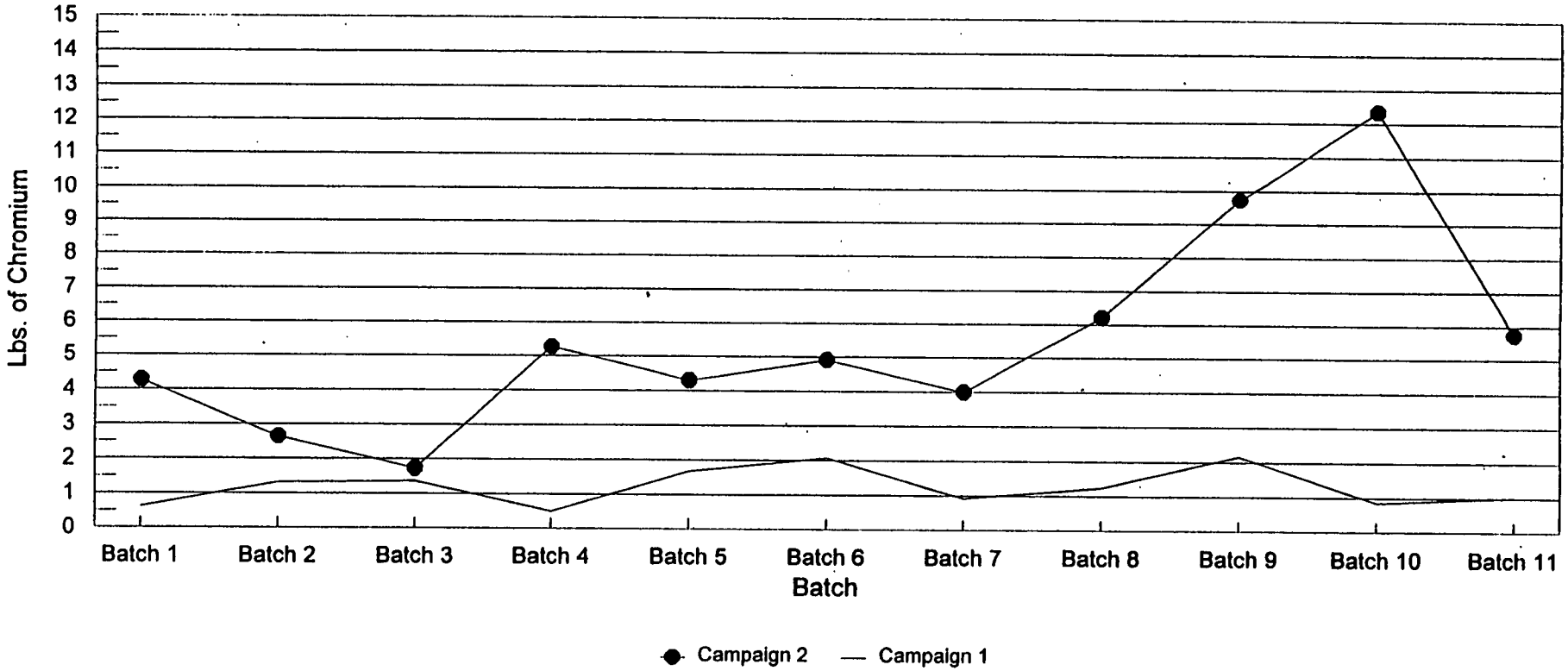
5.1.6.2 Chromium Oxide

The melter walls are comprised of two types of refractory. The Partition wall is constructed of Monofrax Type E Fused Cast Refractory, consisting of 77.7% Cr_2O_3. The remaining melter walls are constructed of Monofrax Type K-3 Fused Cast Refractory, consisting of 27.1% Cr_2O_3.

The chromium oxide mass balance performed determined the amount of refractory wall corrosion. No Cr_2O_3 was introduced into the system through slurry feed or glass frit addition, therefore all Cr_2O_3 present in the system and product glass was attributed to corrosion of the refractory brick. It was expected that the amount of Cr_2O_3 in the system would be higher in Campaign 2 do to the more corrosive nature of the series D glass. During Campaign 1, the total weight of Cr_2O_3 detected was 16 lbs. Calculations show that 61 lbs of Cr_2O_3 were accounted for in Campaign 2 glass (see Table 5-4 and Figure 5-3). The amount of chromium that accumulated in the rest of the system was less than a pound.

Assuming uniform corrosion depths and equal corrosion rates of the two types of refractory, approximately 3.56 millimeters of refractory in the Center Chamber, 0.397 mm in the East Chamber and 1.83 in the West Chamber have eroded in Campaigns 1 and 2.

Figure 5-3
Pounds of Cr2O3 per Batch



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5.1.6.3 Lead

During Campaign 2, the concentration of lead in the quench tower recycle water loop was expected to gradually accumulate since the system recycled 25,000 gallons and was not flushed out. A slug of lead, determined by an isolated instance of a sample with a high concentration taken at sample point S06 would not be unexpected during the feeding of a batch since the sample point is just beyond the release of recycle water from the quench tower . However, a spike at the same moment and of the same magnitude at sample point S14, which is after the water passes through the thickener tank, is not likely. Figure 5-4 shows the concentrations of lead during Campaign 2 for sample points S06 and S14 to spike at the same times. If the recycle water runs through the thickener tank and does not get mixed, a lag would still be expected before the spike at sample point S06 showed in sample point 14.

Another problem arises with the analysis of lead at concentrations in the range of samples taken from sample point S14 when, out of necessity, the laboratory dilutes samples by a factor of 100. This lowers the concentration of a sample at 3000 ug/L to a concentration of 30 ug/L which is at the lower instrument detection limit of 32 ug/L. Sample results at these concentrations are not reliable. Samples from the scrubber system were on the order of ten times the concentrations of the Quench Tower and Recycle Water Loop, therefore, the results are more reliable. Filters from sample point 48 were not all analyzed for lead, so the average was taken for all the filters that were analyzed for lead and that value was applied to the number of filters used during a given batch to determine the total amount of lead that was discharged to the filters during a batch. Sample point S17 was not analyzed frequently enough to make any determination on the amount of lead released to the Building Sump Tank during any one batch. A lead mass balance for Batches 4 and 6 are shown below in Table 5-9.

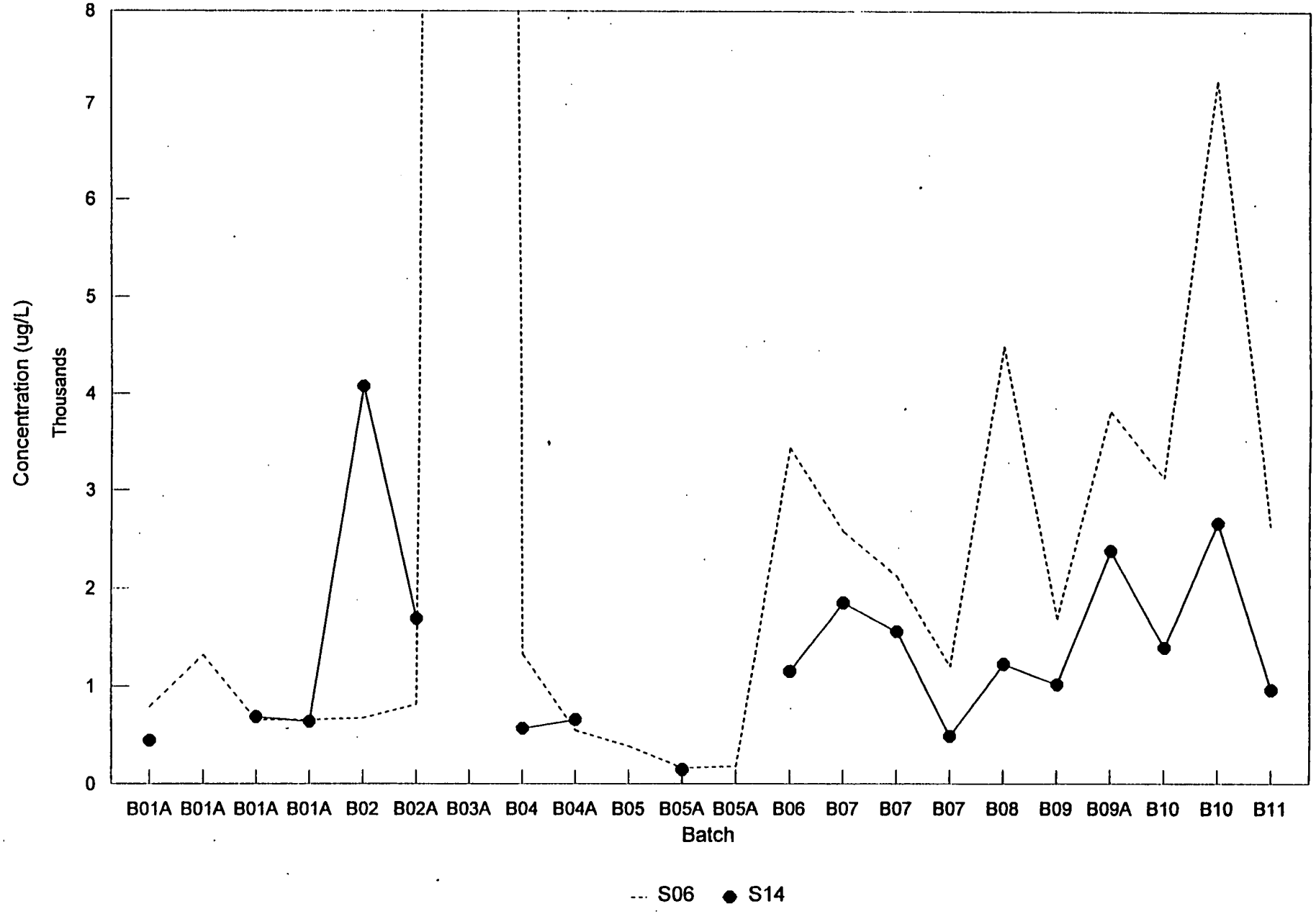
Concentration (ug/L)
Thousands
0
1
2
3
4
5
6
7
8
B01A B01A B01A B01A B02 B02A B03A B04 B04A B05 B05A B05A B06 B07 B07 B07 B08 B09 B09A B10 B10 B11
Batch
S06
S14

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Table 5-9
Lead Mass Balance for Batches 4 and 6

Batch	4	6
Pounds of slurry fed:	6448	6448
Slurry wt% solids:	26.0	34.0
Wt% Lead in slurry solids:	3.64	4.31
Total Lead introduced (Lbs):	**61.0**	**94.5**
Amount of Lead in glass (Lbs):	54.8	77.5
Amount of Lead in Scrubber system (Lbs):	0.042	0.042
Amount of Lead in Recycle water Loop (Lbs):	Not determined	Not determined
Amount of Lead collected on filters (Lbs):	1.6	0.4

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5.1.6.4 Barium

The levels of barium in the quench tower and recycle water loop remained below the detection limit for the majority of Campaign 2. Occasional traces of barium detected in S14 samples indicated that even the highest concentration of barium was less than 1 ppm which would account for less than one tenth of a pound of barium total in the recycle loop. In the Scrubber System and Building Sump Tank during Batches 4 and 6, the highest concentration of barium was 0.6 ppm indicating negligible amounts of barium in the scrubber loop. Accumulation of barium on the filters totaled four tenths of a pound for Batch 4 and one tenth of a pound for Batch 6. As expected, most of the barium was retained in the glass product (Table 5-10).

Table 5-10
Barium Mass Balance for Batches 4 and 6

Batch	**4**	**6**
Pounds of slurry fed:	6448	6448
Slurry wt% solids:	26.0	34.0
Wt% Barium in slurry solids:	2.20	0.47
Total Barium introduced (Lbs):	**33.03**	**NA**
Amount of Barium in glass (Lbs):	28.44	29.45
Amount of Barium in Scrubber system (Lbs):	Negligible	Negligible
Amount of Barium in Recycle water Loop (Lbs):	Negligible	Negligible
Amount of Barium collected on filters (Lbs):	~0.5	~0.1

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5.1.6.5 Sulfates

Results from sample points S06 and S14 are very erratic and difficult to track. The calculated amount of sulfate in the recycle loop for Batches 4 and 6 exceeded the calculated amount of sulfates that were added to the system. Examination of sample point S07 showed small amounts when compared to that which accumulated in the Recycle Water Loop, approximately 7.0 and 0.6 lbs respectively for Batches 4 and 6 (Table 5-11). It appears that the majority of the sulfate constituent escapes to the Off-gas System and gets removed by the Scrubber. Approximately twenty five to forty percent of the sulfates added to the system are recovered in the glass product.

Table 5-11
Sulfate Mass Balance for Batches 4 and 6

Batch	4	6
Pounds of slurry fed:	6448	6448
Slurry wt% solids:	26.0	34.0
Wt% Sulfates in slurry solids:	3.2	2.83
Total Sulfate introduced (Lbs):	**53.65**	**62.04**
Amount of Sulfate in glass (Lbs):	13.98	27.75
Amount of Sulfate in Scrubber system (Lbs):	Undetermined	Undetermined
Amount of Sulfate in Recycle water Loop (Lbs):	7.16	0.64
Amount of Sulfate collected on filters (Lbs):	Not Reported	Not reported

In order to perform an accurate mass balance in Campaign 4, it is will be necessary to take additional samples from the system. All filter samples will need to be analyzed for total metals and the Building Sump Tank will need to be sampled at the beginning and end of each batch and before it is discharged. Full metals and sulfate analysis is necessary for each slurry fed to the tank. These issues will be addressed before Campaign 4.

5.1.7 TCLP

Regulations mandate that the vitrified glass product be subject to the Toxicity Characteristic Leaching Procedure (TCLP). The TCLP test determines the ability of the glass product to withstand leaching of barium, chromium and lead when extracted by the appropriate extraction fluid for a period of eighteen hours. The TCLP requirements for the VitPP glass are that the concentrations of barium, chromium and lead in the leachate remain below 100 mg/L for barium and 5 mg/L for chromium and lead in order to be non-hazardous waste.

TCLP tests were performed on glass samples representative of each batch in Campaign 2. The results are presented in Table 5-12. Samples from Batches 5, 6 and 7 contained the least amount of lithium and were expected to better resist leaching than other batch glasses. The results for batches 5,6 and 7 originally failed but upon re-analysis were well below the regulatory limit. Results of the original and subsequent analysis are shown in Table 5-13. The inconsistencies in the original analysis (described below) dictated that the samples be re-tested.

Physical observation showed the glass samples in Batches 5, 6, and 7 had a powder residue at the bottom of the sample container. The powder was generated when the glass was ball milled for total metals analysis and therefore is not representative of the original sample. Part of the ball mill residue was analyzed with the glass sample. The TCLP procedure specifies that the sample particles pass through a 9 mm sieve but need not be reduced to a powder.. With the presence of the residue, the sample portion analyzed was not representative of the glass produced in that sample population. The sample was rinsed and re-analyzed, and the results of the re-analysis versus the original results are shown in Table 5-13. For each re-analysis, the TCLP result unexpectedly increased.

To determine if there was any error in analysis, the internal laboratory control samples (LCS), sample duplicates, spikes and sample blanks were checked for both the original batch and for the re-analysis batch. All the internal LCS were within the required limits. However, it was determined that the glass samples from batches 5, 6 and 7 were left in the extraction fluid for 48 hours after the initial 18 hour tumbling process.

To ensure that the glass chemistry did not cause the initial failure the chemical makeup of the glass samples submitted for TCLP was plotted against all the results of the TCLP analysis. The TCLP results were ordered from the lowest concentration of lead to highest concentration on the X-axis (Figures 5-5 and 5-6). If the samples from batches 5, 6, and 7 failed due to glass chemistry, a positive or negative slope would be the expected trend. Neither trend was evident. The same

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plot was created to determine if the mole percent of total glass formers, alanines or alkalis affected the TCLP results (Table 5-14 and Figures 5-7 and 5-8). This analysis also failed to exhibit a trend.

Table 5-13 shows the results of all three runs for the samples from batches 5, 6 and 7 as well as the result of a TCLP test performed on glass pieces that were not broken up prior to analysis to determine the effect that surface area had on TCLP results. All three constituents for all three samples followed the same trend (Figures 5-9, 5-10 and 5-11) indicating that the inconsistent results are likely due to a variance in the TCLP procedure. Table 5-13 and Figures 5-9, 5-10 and 5-11 also show the results from a re-analysis of the leachate for runs 2 and 3 to insure there was no instrumental error. Tests are currently being run to determine the reason for the inconsistent results. Corrective actions will be determined and implemented for following campaigns.

Table 5-12
TCLP Results - Campaign 2 Glass

Batch Number	Results (mg/L)			Pass	Fail
	Barium	Chromium	Lead		
1	1.11	0.02	2.77	X	
2	1.48	0.05	2.98	X	
3	1.35	0.02	2.24	X	
4	1.39	0.03	2.58	X	
5	2.85	0.08	6.46	X*	
6	2.27	0.08	5.56	X*	
7	2.02	0.07	5.02	X*	
8	2.14	0.06	3.30	X	
9	2.01	0.07	1.85	X	
10	4.21	0.23	3.36	X	
11	2.75	0.04	2.94	X	

* Samples from Batches 5, 6 and 7 passed the TCLP test upon re-analysis. Results of the re-analysis are shown in Table 5-13

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Table 5-13
TCLP Runs for VitPP Glass Product

	Run 1	Run 1 result	Run 2	Run 2 result	Run 3	Run 3 result	As is	Re-Run of Run 2	Re-Run of Run 3
Batch 5 200252881									
Barium (ppm)	2.85	Pass	2.92	Pass	1.04	Pass	0.50	3.26	0.86
Chromium (ppm)	0.08	Pass	0.10	Pass	0.04	Pass	0.01	0.11	0.02
Lead (ppm)	6.46	Fail	6.76	Fail	1.86	Pass	0.92	7.61	1.97
Batch 6 200252881									
Barium (ppm)	2.30	Pass	3.12	Pass	0.89	Pass	0.40	3.10	0.75
Chromium (ppm)	0.08	Pass	0.11	Pass	0.02	Pass	0.01	0.11	0.01
Lead (ppm)	5.56	Fail	8.08	Fail	1.22	Pass	0.91	8.62	1.24
Batch 7 200258199									
Barium (ppm)	2.02	Pass	2.97	Pass	2.26	Pass	NR		
Chromium (ppm)	0.07	Pass	0.11	Pass	0.04	Pass	NR		
Lead (ppm)	5.02	Fail	7.76	Fail	2.58	Pass	NR		

Figure 5-5
Glass Chemistry vs TCLP Results

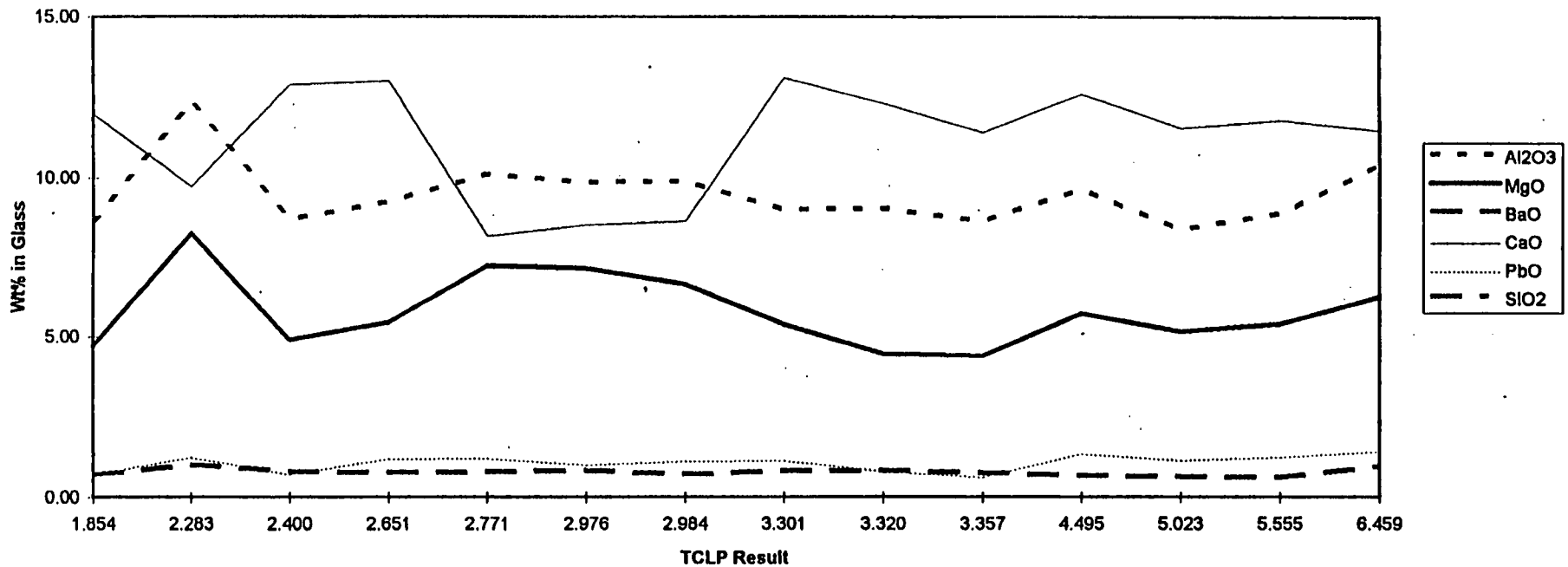

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Figure 5-6
Glass Chemistry vs TCLP Results: SiO_2

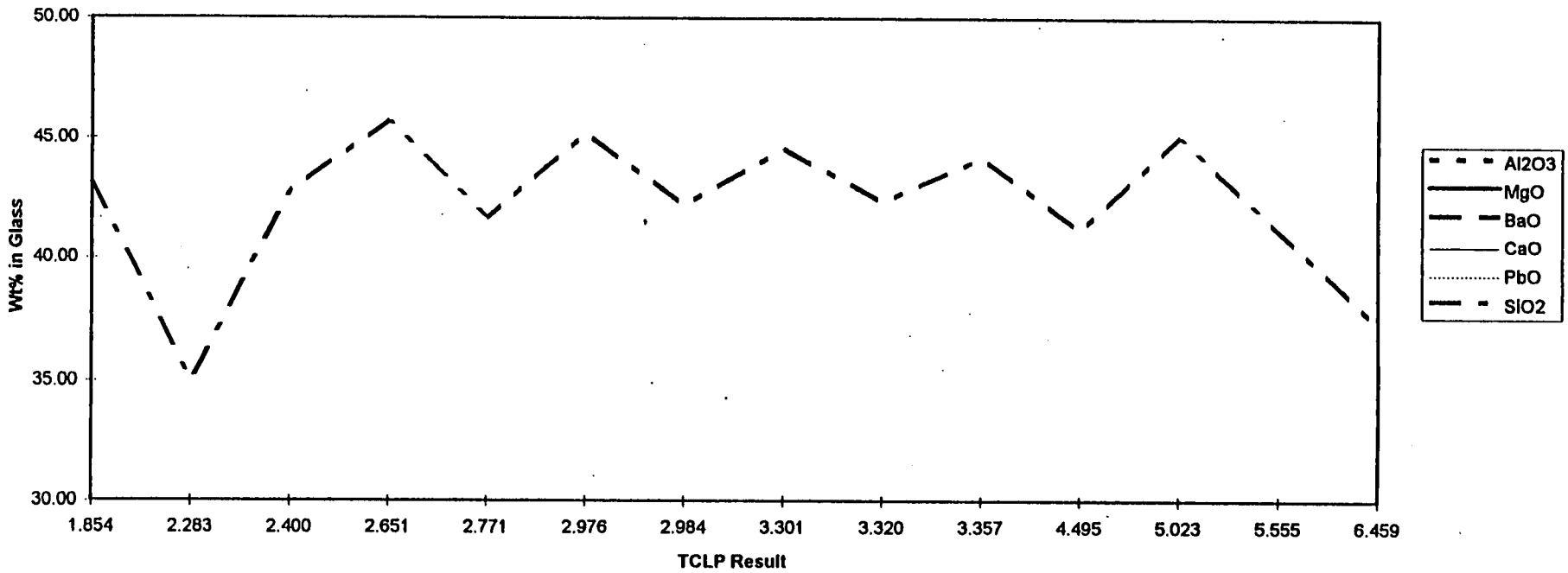

Table 5-14
Mole Percent vs TCLP Results

Lead	Glass Formers	Alkaline	Alkali	B_2O_3	PbO
1.854	51.70	17.40	19.90	8.90	0.70
2.283	47.32	18.98	17.21	6.98	1.22
2.400	51.50	18.60	18.40	8.30	0.70
2.651	54.96	19.23	14.08	7.82	1.17
2.771	51.79	16.18	14.24	8.44	1.18
2.976	55.04	16.50	15.46	7.07	0.98
2.984	52.09	16.02	15.02	8.47	1.10
3.301	53.57	19.30	13.95	7.65	1.11
3.320	51.39	17.59	17.69	9.22	0.79
3.357	52.81	16.56	19.16	9.42	0.62
4.495	50.81	19.00	14.36	7.93	1.31
5.023	53.49	17.39	15.55	7.92	1.11
5.555	50.05	17.83	16.00	7.96	1.21
6.459	47.73	18.69	15.11	8.06	1.40

Figure 5-7
Mole Percent vs TCLP Result

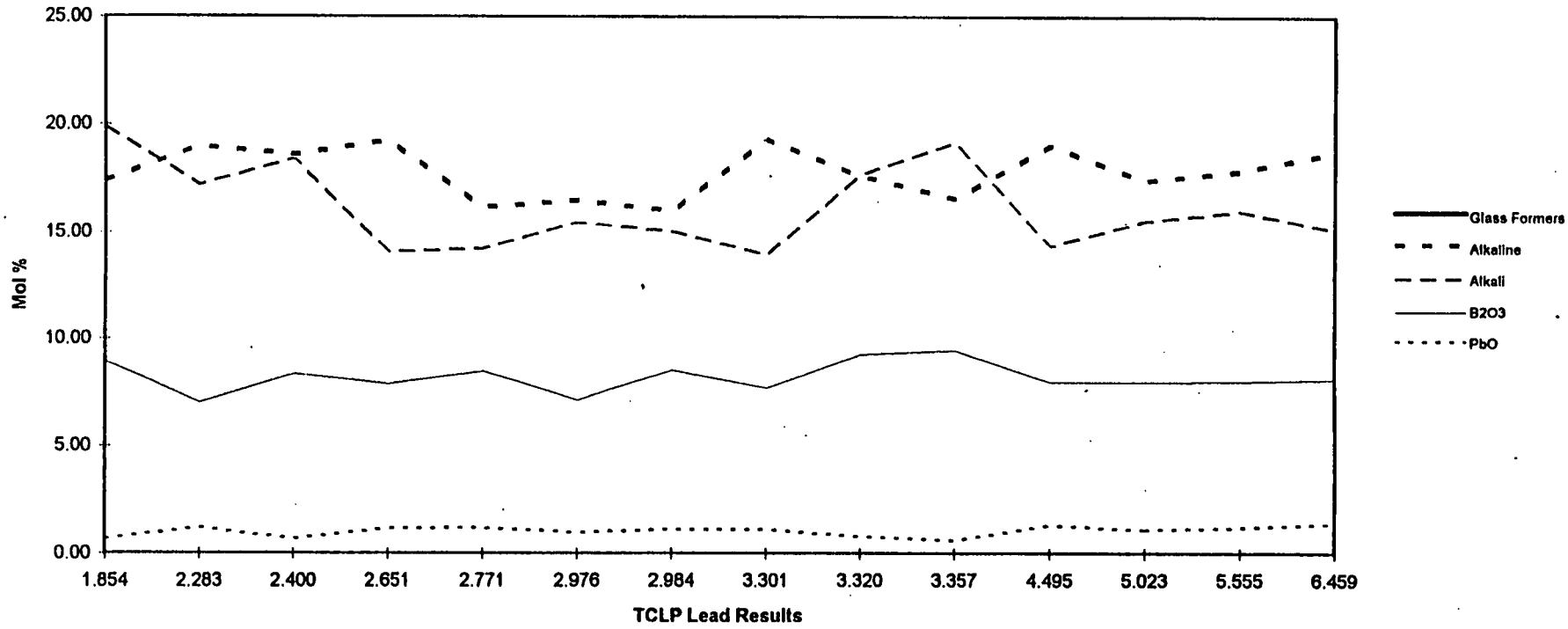

Figure 5-8
Mole Percent vs TCLP Result: Glass Formers

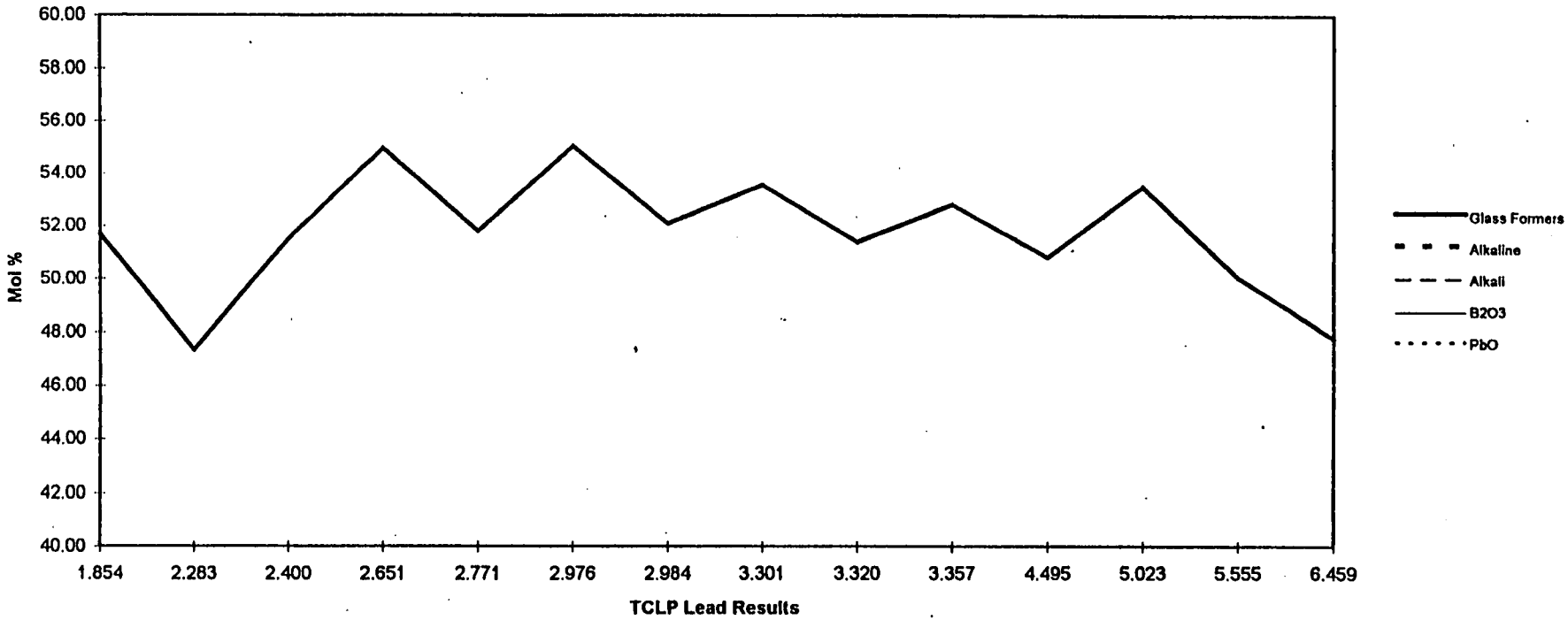

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Figure 5-9
TCLP Pb Results: Batches 5, 6 & 7 - Runs 1, 2 & 3

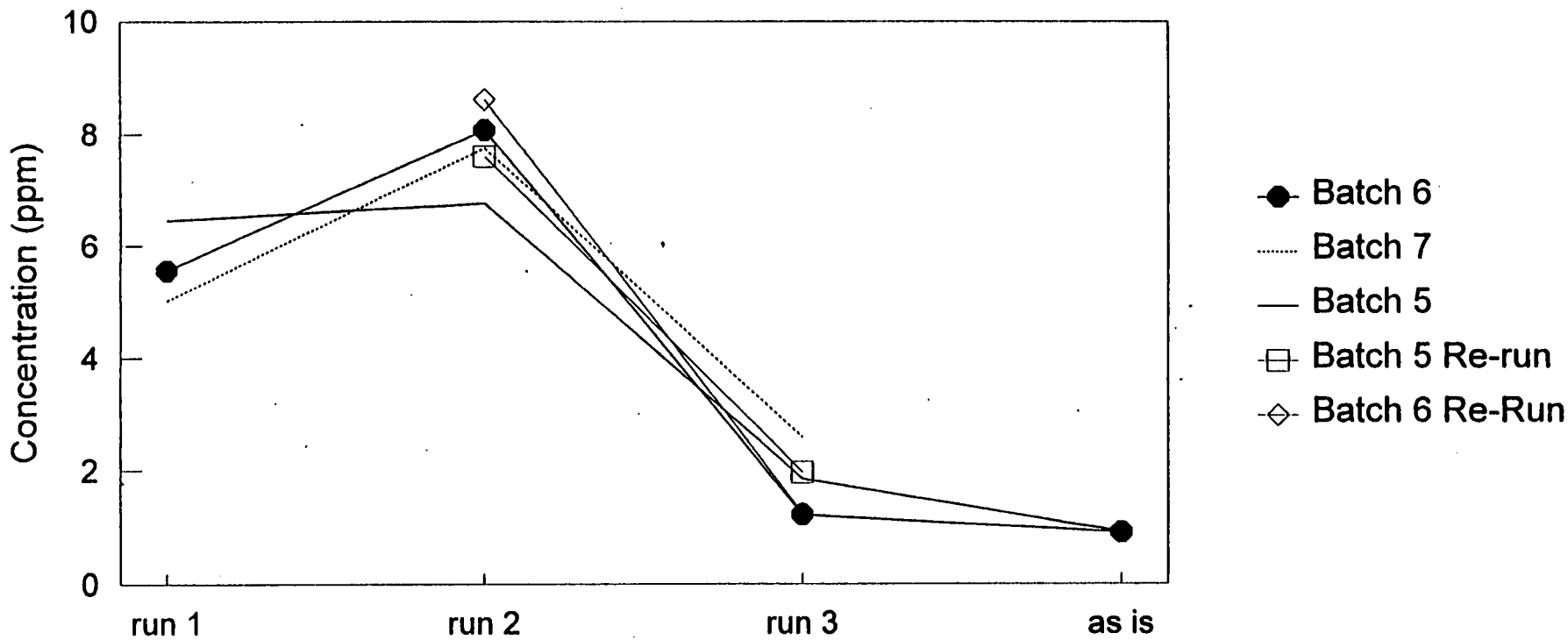

Figure 5-10
TCLP Ba Results: Batches 5, 6 & 7 - Runs 1, 2 & 3

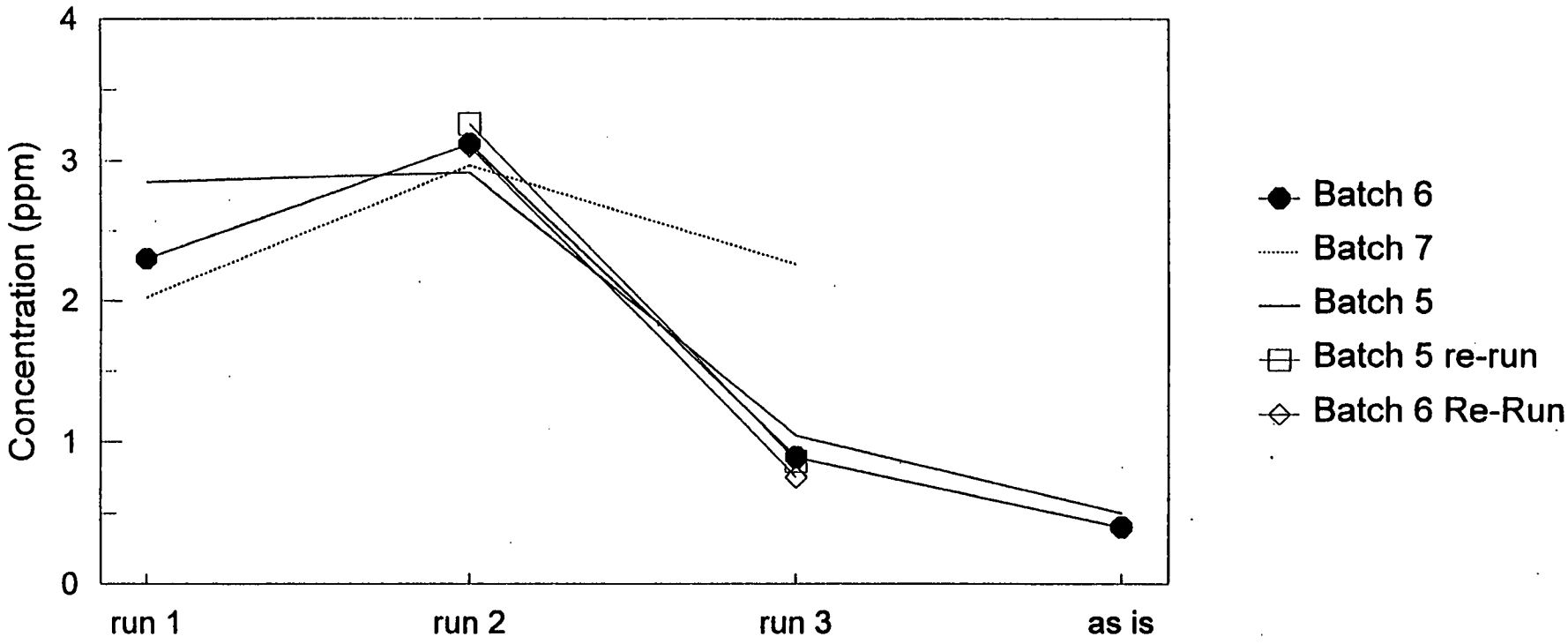

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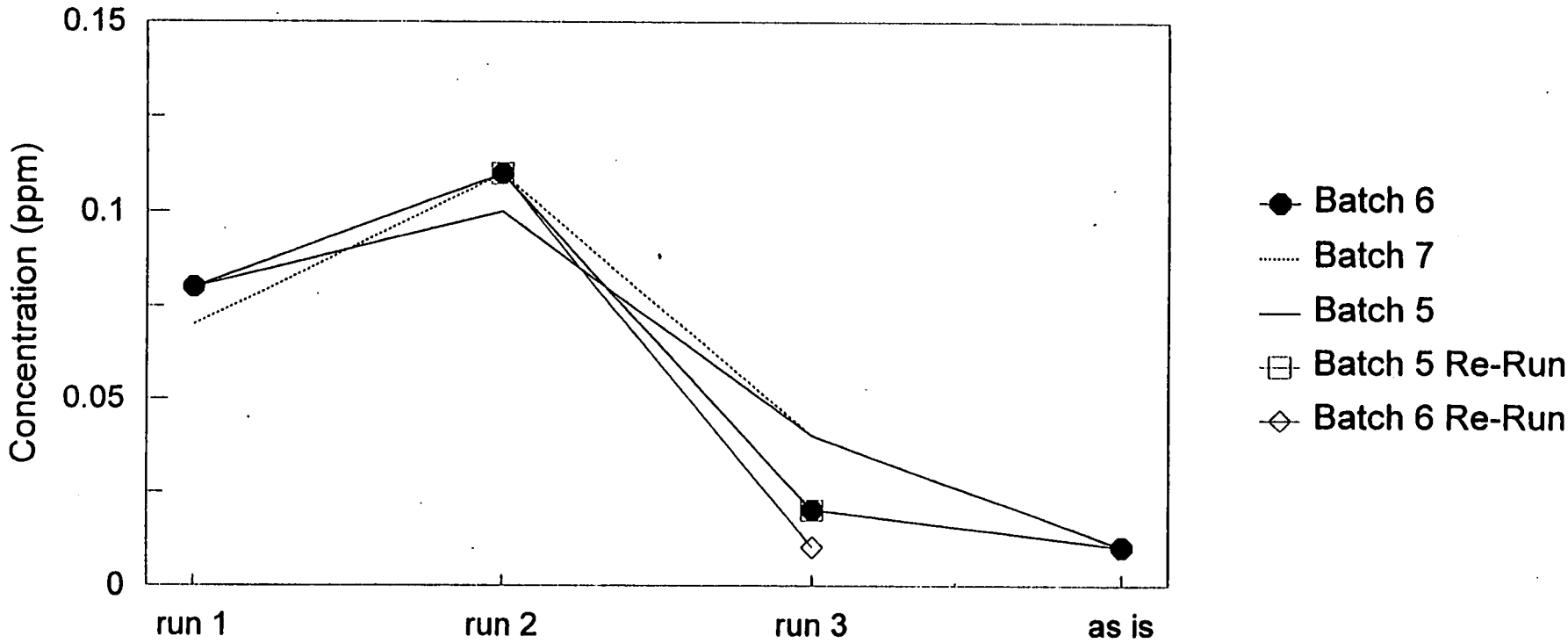
Figure 5-11
TCLP Cr Results: Batches 5, 6 & 7 - Runs 1, 2 & 3



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5.1.8 Devitrification and Phosphorous

As mentioned in Section 2.2.8 of this report, phosphates caused devitrification of the glass in the Series C and D glasses especially when poured in larger masses that cooled slowly. Aluminum was used to help reduce this tendency. However, the glasses normally took on a milk appearance, usually with a green color as the first sign of devitrification. However, none of the Campaign 2 glass showed signs of devitrification. This could possibly be due to the higher flux content in the Campaign 2 glasses. As described in greater detail in this document, the side chamber glass leaks to the center chamber and increases the lithium oxide (a flux) content in the center chamber glass. Extra flux lowers the melting temperature of the glass and was noticed to reduce tendencies towards devitrication in the lab.

It is good news to know that phosphorous did not present operational problems. Sodium phosphate may be used to "mitigate" the thickening problem seen in the feed slurries with bentonite. See Section 5.2 for more details on this topic.

5.2 Feed Preparation and Feed System

5.2.1 Blockage in the Bag Dump Station and Dry Transfer

Eleven batches of slurry were prepared during Campaign 2. Throughout the campaign there were a variety of problems with the operation of the Bag Dump Station and the Dry Additive Transfer System as follows: (1) dry materials clumping, (2) dry materials clogging the elbow immediately downstream of the Bag Dump Station, (3) dry materials collecting in the Filter/Additive Receiver, and (4) dry materials clogging the Filter/Additive Receiver Diverter and the downstream pipe to the slurry tanks.

Magnesium Phosphate and Lead Oxide were the two primary materials that exhibited clumping tendencies. Magnesium Phosphate would clump upon introduction to water in the slurry tank and cause clogging of the slurry recirculation pipes. Operations personnel resolved this problem by adding Magnesium Phosphate directly to the center chamber of the Melter during slurry feeding. The dry material was added in four lifts throughout the duration of the batch. Lead Oxide clumping was limited. The Lead Oxide shipped in 100 pound bags was found to be clumpy upon opening. Fortunately, some Lead Oxide had been received in cardboard carboys and double wrapped in plastic. This material was clump free and was acceptable for use in the Dry Additive Transfer System.

Despite the efforts of VitPP operators to select materials that appeared to be clump-free, the pipes downstream of the Bag Dump Station were significantly clogged three times during Campaign 2. On these three occasions, it required at least 30 minutes for VitPP personnel to unclog the pipes. Inspection of the material that created the clogs revealed that the finer meshed and denser dry chemicals were the primary causes.

To avoid clogging the pipes, the sequence in which the dry materials were added was changed. The finer meshed and heavier dry materials were alternated with dry materials known to be "non-cloggers," like silica. In combination with slowing the addition rate for each 50-pound bag of dry material, the altered addition sequence of materials significantly improved the operation time and reliability of the Bag Dump Station as the Campaign progressed.

In addition to the Bag Dump Station, dry material accumulation was also found to be a problem within the Filter/Additive Receiver, the Filter/Additive Receiver Diverter, and the pipes downstream of the Diverter. Four times, the accumulation on the Filter/Additive Receiver prevented the dry materials from transferring to the selection slurry tank. On one occasion, approximately 1200 pounds of materials were caught in the Filter/Additive Receiver. Twice, there was significant accumulation found in the Filter/Additive Receiver Diverter and the eight-inch pipe joining the Diverter to the selected slurry tank.

Solutions to these clogs were a combination of maintenance and operations activities and preventative measures. In one instance, the problem was addressed by repairing a broken chain drive on the rotary air lock. VitPP personnel solved the problem with a combination of installing a temporary air vibrator, manually knocking on the outside of the unit, and closely monitoring the increase in weight of the slurry tank during dry material addition. It also was found that exercising the diverter and rodding the eight-inch pipe successfully encouraged the transfer of dry materials to the appropriate slurry tank.

The vacuum blower package (5-BL-66) used in Campaign 2 was replaced with a higher capacity Roots-Dresser® blower and DOP testable filter unit. This blower has 3 times the pressure capability at the same flow rate as the original vacuum blower package.

5.2.2 Thickening of the Slurry Feed

Series D formula slurry challenged the slurry recirculation and transfer system. The slurry chemical and physical characteristics created significant challenges to VitPP

personnel. The slurry would thicken, forming a dense clay-like substance that readily clogged the pipes and built-up on the slurry tank walls.

During Campaign 2, the slurry pumps failed six times and the pipes were repeatedly manually cleared by auguring and rodding. Due to the physical layout of the pipes, some clogged sections were abandoned and flexible hoses were installed. The cohesiveness and clay-like behavior of the slurry not only resulted in clogged pipes, but also caused buildup on the slurry tank walls. It was found that after all the slurry possible was transferred to the Melter, hundreds of pounds of slurry remained on the walls of the slurry tanks. Adding water and agitating the material in the tank had some impact. To remove all of the slurry, VitPP personnel determined that manually shoveling the residue from the tanks was the only available solution.

As Campaign 2 progressed, VitPP personnel developed some preventive measures. When the slurry pumps began to hesitate or low flow indications were received from Flow Indicator FI170 on the long loop of the slurry transfer line, VitPP personnel would flush the lines with recycle water back to the slurry tanks to remove the accumulation of slurry in the pipes. In addition, if feed to the Melter was interrupted, VitPP personnel would return to the short recirculation loop and flush the long loop to avoid settling of the slurry in the pipes.

The reasons for the behavior of the slurry can be contributed to the presence of magnesium phosphate (in the early batches), the chemical reaction of Bentonite with calcium and magnesium cations, and the precipitation of supersaturated borax feed. As mentioned earlier in the text, the problem caused by the presence of magnesium phosphate was resolved by adding the material directly to the center chamber of the Melter. The other two primary components of the problem were addressed by the deletion of BentoGrout[R] from the batch and addition of alumina and other chemicals to the batch. While these solutions were available and somewhat successful, other solutions (such as tank design, piping layout, and pump selection) must be developed for the preparation of the actual silo material.

5.2.3 Piping and Equipment Blockages

The current slurry feed system was not capable of operating with slurry batches greater than 45% weight solids and with thick, viscous, properties. The slurry system will be upgraded by replacing piping and installing hose in key locations. The flexible hose will allow sections of pipe to be replaced in the event of pipe plugging and permit maintenance to be performed on the pipe. Also, the Marathon® slurry pumps will be replaced with a higher pumping capacity Sandpiper pumps.

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These Sandpiper pumps are more resistant to abrasive slurries.

The Melter Feed Pump and associated piping presented a series of challenges to VitPP personnel. The pump plugged nine times, the flow to the center chamber was directed to the side chambers two times, and the feed pipe to the Melter was clogged two times. Flushing with recycle water resolved the problems more than half of the times, but on four occasions, the feed pipe was opened a rodded clean. VitPP personnel learned to flush the Melter Feed Pump and feed pipe whenever the slurry feed was stopped or interrupted.

In addition to the challenges presented by the nature of the slurry, the Melter Feed Pump had mechanical problems too. On at least 10 occasions, the pump was removed due to excessive packing leakage. Each time, the pump was repacked. At the end of Campaign 2, mechanical seals were installed in the Melter Feed Pump, which resulted in significantly improved performance of the pump. It passed a 36-Hour Performance Test conducted during Batches C2B10 and C2B11.

5.2.4 Slurry Thickening Chemistry

The VitPP has experienced problems with the gelling and thickening of the bentonite cap material used in the silos as it intermixes with the silo surrogate material. This has resulted in the clogging of pumps and lines and their subsequent replacement, hence increased downtime and expense. This problem was not seen in the original laboratory studies. This is probably because high-shear mixing was not necessary to mix and deliver the slurry feed to the melter. However, studies are now being conducted by the laboratory to attempt to solve this problem.

Thickening occurred more often during Campaign 2 than in Campaign 1. This is probably because of different batch chemistry. High shear mixing seems to physically break down the crystals in the slurry and produce more surface area, which in turn, produces more sites of hydration or ionic adhesion. It was shown in a laboratory high-shear blender that dissolved calcium or magnesium ions react with bentonite, causing expansion of the particles. This, in turn, causes the slurry to become gelatinous.

Techniques are being investigated that bind the calcium and magnesium ions, and to a lesser extent iron and aluminum ions, and prevent them from reacting with the bentonite. Such chemicals, as sodium phosphate, seem to help. These techniques may not prevent the thickening reaction from eventually happening, but should slow the reaction time sufficiently for processing the silo residues. Lab studies show that up to 60 hours operating time is possible using 2 wt% sodium

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phosphate with moderate mixing. The sodium phosphate does three things to hinder thickening:

1. The phosphate chemically scavenges the calcium and magnesium ions and prevents them from reacting with the bentonite.

2. It neutralizes the charge on the bentonite edges

3. It floods the sites on bentonite with sodium.

Bentonite was not the only substance used in Campaign 2 that caused thickening. Borax, which was an additive in making glass, also caused thickening. The problem noticed with borax is that was very soluble at the warm temperatures, but it was not nearly as soluble at low temperatures. The heat of hydration, while the chemicals mixed, caused the feed slurry to warm and large amounts of borax dissolved. An hour or two later, the slurry cooled and thickened because the borax came out of solution. The crystals that formed lent themselves to thickening, like the bentonite, under high shear.

Later batches replaced borax with a blend of boric acid and sodium carbonate. This blend did not appear to thicken. The boric acid and sodium carbonate were added in the appropriate stoichiometric amounts to apportion the same amounts of boron oxide and sodium oxide in the glass as the borax. Therefore, there use has no impact on the glass chemistry

5.3 Melter Operation and Glass Chemistry

The Melter generally performed well during Campaign 2. Some anomalies happened during the runs in Campaign 2. Nevertheless, techniques were developed and experience helped handling or preventing recurrence of the anomalies. These anomalies and general Melter and glass chemistry performances are described in detail in this section (Section 5.3).

5.3.1 Sulfate Effervescence Events

A Sulfate Effervescence Event appears to be characterized by rapid SO_x effervescence (gas generation, bubbling, or foaming) in the molten glass bath and a need to increase power to maintain a dropping temperature of the bath. The effervescence event is not a surface event, but rather, it involves the whole bath. When this happened, the bath instantaneously changes appearance. The bath

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surface changes from a smooth, translucent soupy appearance to a milky, fro rippled appearance. Then the surface rises. Each cubic centimeter of the bath contributes to production of SO_x, which collectively, causes the whole bath to swell. Figure 5-12 shows measured Melter parameters that happened during the effervescence events. A description of what happened is highlighted on the figure. A more detailed description follows and coincides with the events labeled on the figure.

1. Just before these Effervescence events happened, the Melter was processing slurry and maintaining a Melter bath temperature around 1350°C. Then the Melter bath temperature started to drop for no apparent reason.

2. More power was applied and the temperature would again drop and the Melter started to effervesce. Even more power was applied to increase the bath temperature to the required Acceptance Test operating temperature of 1350°C. The first effervescence event started to happen. At about 7:00 p.m., the temperature started to drop.

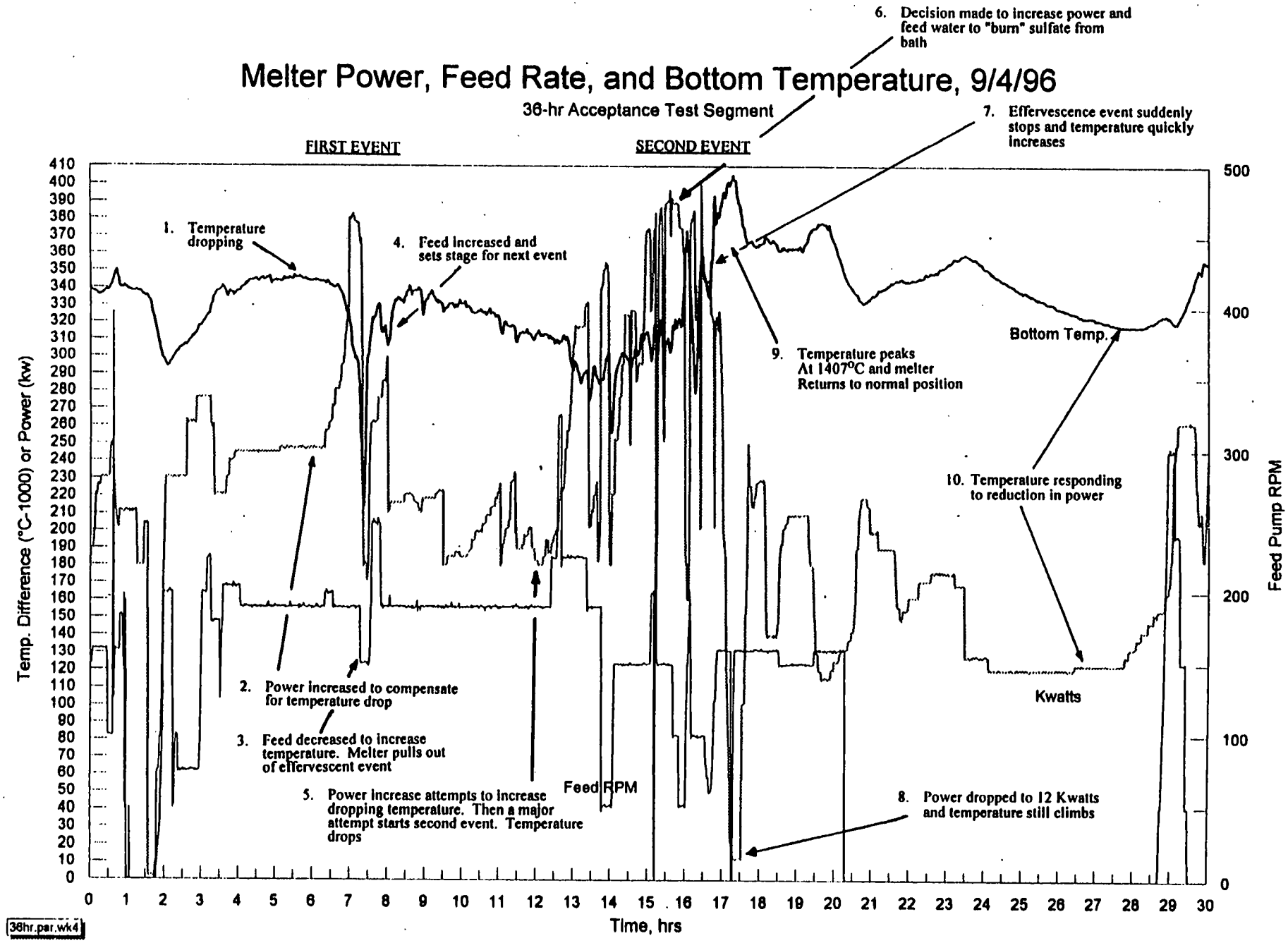
3. More power was applied and the feed rate decreased to compensa but the temperature dropped even further. The foaming in the ba was observed. However, the foaming was short lived and the Me stabilized.

4. Then the feed rate was increased to a high rate to make up for lost processing time. Unfortunately, this set the scene for the next effervescence event.

5. The temperature slowly starts to drop again. Several attempts were made to increase the temperature by increasing power, but the temperature still continued to slowly drop. Then the power was quickly increased approximately 150 kilowatts in an attempt to increase the temperature. The second effervescence event immediately started and the temperature dropped even further.

6. During the second effervescence event, it was postulated that something (probably SO_x) was being distilled from the bath and taking the heat with it. Therefore, it was decided to stop feeding and try distilling (or burning) the material from the bath before proceeding. Water was fed to help (1) cool the bath, (2) prevent the feed nozzle from plugging, and (3) destroy sulfates (even though one was not

Figure 5-12



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visible). More than 350 kw was applied intermittently for approximately 5 hours between midnight and 5:00 a.m. the next day (September 5). Power input sometimes approached 400 kw.

7. Then suddenly the effervescence stopped and the temperature started to rise quickly. This is because the sulfate concentration in the glass dropped below its saturation point.

8. The power was quickly ramped down to 12 kilowatts to compensate for the quickly climbing temperature, but the temperature continued to climb.

9. The temperature peaked at 1407°C 15 to 20 minutes later before the temperature started to fall.

10. Then normal operation of the Melter again resumed when the temperature came to 1350°C. The temperature again responded to power changes as expected.

Research and mathematical modeling paid off in developing a plausible explanation for this event. This power requirement is explained by the fact that the destruction of sulfates is an endothermic reaction. The following equations show the exp reactions. The values for Heat of Formation (h) come from the 51st CRC Handbook of Chemistry and Physics:

$$RSO_4 \rightarrow RO + SO_3\uparrow \quad \text{or} \quad RSO_4 \rightarrow RO + SO_2\uparrow + \tfrac{1}{2}O_2\uparrow \qquad \text{(Equation 5-4)}$$

For the decomposition of barium sulfate ($BaSO_4$):

$$\Delta h = -133.4 - 94.45 - (-350.2), \text{ or}$$

$$= -133.4 - 70.96 + 0 - (-350.2) \qquad \text{(Equation 5-5)}$$

$$\Delta h = 122 \text{ or } 146 \text{ kcal/gmole}$$

Compare this to the burning of charcoal, which is and exothermic reaction:

$$C + O_2 \rightarrow CO_2 \qquad \text{(Equation 5-6)}$$

$$\Delta h = -94.5 - (0 + 0) \qquad \text{(Equation 5-7)}$$

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Δh = -94.5 kcal/gmole

By comparison, one can see that energy to decompose sulfates is significant. A summary of other sulfates is presented in Table 5-15. This reaction appears to be dominant only when the glass becomes saturated with sulfate and the temperature or power is increased. Then the event appears to continue until one of the following happens:

1. Melter pool temperature is reduced;
2. Power is reduced; or
3. Enough sulfate effervesces (burns out of the glass) to drop the sulfate concentration below saturation.

Table 5-15
Energy Required to Reduce Sulfates to SO_2 Gas

Compound	Energy Kcal/gmole	Power (kwh) to destroy 1 wt% SO_3 in bath
$MgSO_4$	67	1420
$CaSO_4$	96	2040
$BaSO_4$	145	3080
Na_2SO_4	126	2670

The sulfate concentration in the Melter bath may need to drop only a fraction of percent to stop the effervescence. Therefore, the power required to accomplish this is less than the 3080 kwh shown in Table 5-15, but is still a significant amount of power as observed during the effervescence. This effervescence appears to require approximately 500 to 1000 kwh to burn out the sulfate.

Heat stored in the E-bricks of the partition walls can explain why the temperature of the bath rose immediately after the bath stopped effervescing. Figure 5-13 is a computer spreadsheet that models the effervescence event and it shows that the E-bricks rose to approximately 1430°C. The mass of the E-bricks is approximately 1300 lbs which is a significant fraction of the interior mass of the Melter.

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Therefore, the heat stored in the bricks could flow into the cooler glass and momentarily raise the temperature of the glass to 1400°C. Figure 5-14 gives a pictorial snapshot of the Melter conditions during peak power and shortly before the sulfate was "burned" from the glass melt and the temperature increased to 1400°C.

The second effervescence event caught the operators off guard. Foam momentarily rose to the height of E-wall partitions and overflowed into the side chambers before it was observed and the operator responded by lowering power to the Melter. Foaming to the side chamber was controlled after this event. There were effervescence events in the side chambers. These are discussed in Section 5.3.4, "Side Chamber Frit Usage and Foaming".

The only significant effervescence events noticed in the center chamber were during the first Acceptance batch. During this batch, barium sulfate was used to simulate the sulfates in Silos 1 and 2. The other batches of Campaign 2 used calcium sulfate to simulate the sulfates in Silos 1 and 2.

5.3.2 Sulfate Layer Events

A second type of anomaly, which happened during Campaign 2, was when m sulfate layer collected on the surface of the molten glass. This could cause increased current to flow at the surface of the molten glass bath. It has been termed a sulfate-layer event when this happens. This is what is believed to have happened on September 20-22, 1996. The symptoms were as follows:

1. The Melter bottom (controlling) temperature dropped so more power was applied.

2. No Melter temperature (per the bottom temperature) increase is noticed which implied more power was needed. Therefore, more power was applied.

This cycle continued for approximately 2 days when operators observed that the interior of the Melter appeared to be glowing brighter (hotter) than normal. For example, the E-brick partitions appeared "transparent" and glowing white when they normally appear dark. Table 5-16 gives an approximate indication of temperature per color and brightness. The operators describe the event more toward the last two entries in Table 5-16. In addition, the surface of the bath was very fluid flowing or "violent" which could have been due to the sulfate on the surface and the fluidness of the bath surface at high temperature.

Figure 5-13

Melter Heat & Power Profile

Rod F. Gimpel 09/09/00

E-AC04x.WK4

Scenario: **Acceptance Test- Sulfate Effervescence**

Waste Glass: **C4D-15** Electrode Glass: **C4EG-10**

S, watts/cm3:	0.4963
k, watts-cm/cm2-^C:	0.0577
A, cm2:	7,431
Te, ^C:	1,343
Tb, ^C:	1,385

Inputs:		Calculated:		Qout/Qin:
Bath temp., ^C	1,385	W. chamber temp, ^C:	1,343	1.00
Bath level, cm	81.3	Glass, tonnes/day	0.00	
S.Chamber depth, cm	4.50			
Feed rate, L/hr	25.00	Inputs:		
kg glass/L feed	0.00	Air inleakage, scfm	30	
% Moisture	100.00	Bubbler, scfm	2	
Feed density, g/cm3	1.00	Radiant heat sink, ^C:	1300	

Needed Power	Amount kg/hr	Amount each	q' watts/unit	Q watts
Moisture	25.00		1,031	25,775
Gas generation	0.00		195	0
Inleakage & bubbler	66.67		195	13,000
Radiant losses	–		60,259	60,259
Cooling - Electrodes		10	635	6,345
Cooling - Ports		5	3,337	16,687
Cooling - Drains		4	3,969	15,876
Vitrification, glass	0.00		452	0
Sulfate Effervescence		1	264,058	264,058
Lid heater banks		2	(1,000)	(2,000)
	91.67	19	na	400,000

Power Calc.	Conduct. S/cm	Resist. ohm-cm	Resist. ohm	Power watts	Voltage Drop, v	%
West cham.	0.584	1.71	0.0010	7,803	2.84	1.95
L. partition	0.274	3.65	0.0037	28,104	10.24	7.03
Main	0.280	3.57	0.0439	330,788	120.55	82.70
R. partition	0.274	3.65	0.0037	28,104	10.24	7.03
East cham.	0.876	1.14	0.0007	5,202	1.90	1.30
Total	na	na	0.0531	400,000	145.77	100.00
				Amps:	2,744.09	

Ac	Qg	Qx	Qe	Qd	Qs	Qw
19	7,803	16,415	(3,173)	(2,000)	(948)	(18,078)

Part. depth X, cm	Temp. C	Conduction Only, ^C	Generation Only, ^C	Q(x) watts
0.00	1,343	1,343	1,343	16,415
0.25	1,352	1,344	1,351	15,493
0.50	1,361	1,346	1,358	14,571
0.75	1,369	1,347	1,365	13,649
1.00	1,377	1,349	1,371	12,727
1.25	1,384	1,350	1,377	11,805
1.50	1,391	1,351	1,382	10,883
1.75	1,397	1,353	1,387	9,961
2.00	1,402	1,354	1,391	9,039
2.25	1,407	1,355	1,395	8,117
2.50	1,412	1,357	1,398	7,195
2.75	1,416	1,358	1,401	6,273
3.00	1,419	1,360	1,403	5,351
3.25	1,422	1,361	1,404	4,429
3.50	1,424	1,362	1,405	3,507
3.75	1,426	1,364	1,405	2,585
4.00	1,427	1,365	1,405	1,662
4.25	1,428	1,366	1,405	740
4.50	1,428	1,368	1,403	(182)
4.75	1,428	1,369	1,402	(1,104)
5.00	1,427	1,371	1,399	(2,026)
5.25	1,425	1,372	1,397	(2,948)
5.50	1,423	1,373	1,393	(3,870)
5.75	1,421	1,375	1,389	(4,792)
6.00	1,418	1,376	1,385	(5,714)
6.25	1,414	1,377	1,380	(6,636)
6.50	1,410	1,379	1,374	(7,558)
6.75	1,405	1,380	1,368	(8,480)
7.00	1,400	1,382	1,362	(9,402)
7.25	1,394	1,383	1,355	(10,324)
7.50	1,388	1,384	1,347	(11,246)
7.62	1,385	1,385	1,343	(11,689)

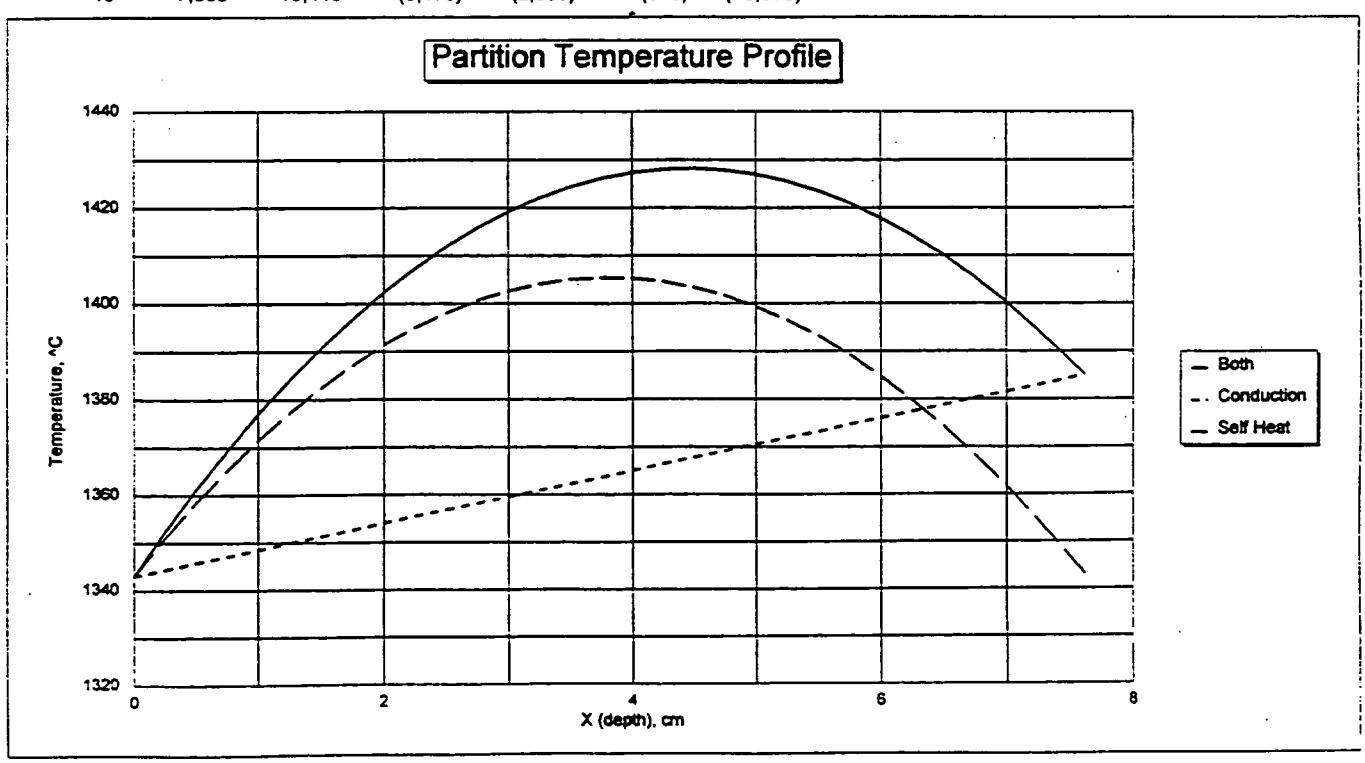

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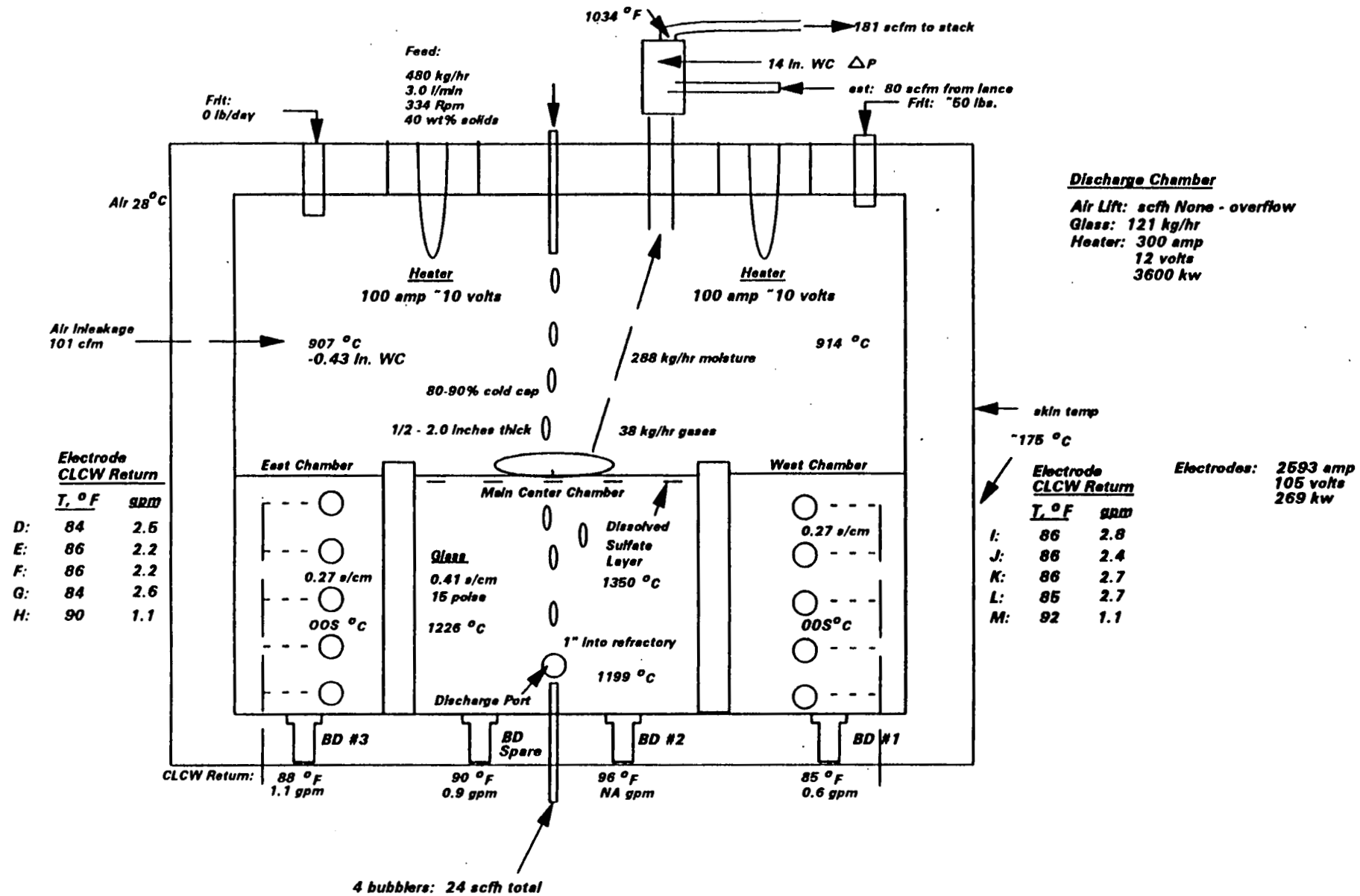
Figure 5-14



Snapshot of Melter Operation

Se r 20, 1996, 11:00 p.m.
Se. Glass, Sulfate Layer

Legend: BD: Bottom Drain
OOS: Out of Service
CLCW: Closed Loop Cooling Water
NA; Not Available

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Table 5-16
Color and Brightness vs. Temperature[14]

Color and Brightness	°F	°C
Dark blood red, black red	990	530
Dark red, blood red, low red	1050	565
Dark cherry red	1175	635
Medium cherry red	1250	675
Cherry, full red	1375	750
Light cherry, light red	1550	850
Orange	1650	900
Light orange	1725	950
Yellow	1825	1000
Light yellow	1975	1080
White	2200	1200
Bright white	2400	1315
Dazzling white	2800	1540

[14] From "Marks" Mechanical Engineers' Handbook

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Most interesting during this event is the fact that the refractory temper momentarily became hotter than the bottom controlling temperature as shown in Figure 5-15. Figure 5-16 presents additional supporting parameters measured at the same time. Figure 5-17 is a compilation of Figures 5-15 and 5-16 to present more directly the relationship of the parameters. Figure 5-15 shows the chronology of happenings during this sulfate layer event. The major happenings that took place are described here. A corresponding number is placed on Figure 5-15 indicating when each event took place:

1. The Bottom Temperature and the Conductance of the glass are tracking together as they should. For example, when the Melter temperature increases, the glass temperature increases with a resulting increase in conductance of the glass. The Bottom Temperature and Conductance peak and valleys appear to be in sync at this time.

2. The Refractory Temperature is lagging behind the Bottom Temperature. This indicates the Bottom Temperature is dominant and is driving the Refractory Temperature.

3. The Bottom Temperature is dropping and is responded with increa[illegible] power to maintain temperature. This could be the preliminary on[illegible] a sulfate layer event.

4. The Conductance of the Melter increases, but this increase is not reflected in a rise in the Bottom Temperature as expected. This suggests the onset of a sulfate layer or sulfate pockets collecting near the surface. Sulfates are salts that are much more conductive than molten glass. Therefore, their presence will divert power away from the whole of the melt and channel it toward the surface. The higher temperature can force more sulfate to come out of the glass and again make the surface more conductive.

   Since the surface of the glass melt is now more conductive, more power will travel through the top portions of the E-wall and causing them to heat. This explains why the E-walls appeared so hot and transparent looking. The operators observed foaming in the Center Chamber periodically during this time, but managed to keep it under control.

5. The Refractory temperature is rising and appears to reflect the Conductance Curve. The Refractory temperature is located mid-height

in the Melter. Therefore, the heating surface appears to have more of a dominating influence on the Refractory Temperature than the Bottom Temperature.

6. The Bottom Temperature appears to be lagging behind the Conductance and the Refractory Temperature. This suggests that the Bottom Temperature is responding to the heating surface. This is when operations decided the Melter was getting hot. An infrared pyrometer was used to measure the surface temperature because the bath top thermocouple was out of service. The surface measured 1343°C.. Normally, the top temperature of the Melter has been approximately 50 to 100°C lower than the bottom temperature (see the Campaign 1 Test Report) and approximately the same as the Refractory Temperature. This implies that the surface may have been 100 to 200°C hotter than observed before.

7. Operators respond and decrease power to Melter. The original response to this event was that the thermocouples in the Melter were malfunctioning. However, they probably were functioning correctly and responding the scenario described here.

8. Control is regained and the measured parameters go back to more typical readings.

5.3.3 Handling of Sulfates

Both the Sulfate Layer and the Effervescence Events can take the operators by surprise. In both events the Melter bottom temperature appears to drop with increasing power. This is because the destruction of sulfates is an endothermic reaction and heat (or power) is needed to destroy the sulfates wherever they are located. For example, the sulfates are located in the bath (in the case of the Effervescence Event) or at the surface (in the case of the Sulfate Layer Event). What this implies is that the sulfates that the reductants do not destroy and the glass can absorb must be destroyed by the absorption heat from the Melter or pass through the Melter with the glass discharge. The sulfate discharge has been observed when glass was made at lower temperatures. The sulfate appears as minor amounts (gram quantities) of yellow flakes or nodules on the surface of some drums of glass poured. Once, it was noticed to have collected on the discharge chute. Table 5-17 summarizes the elemental make-up of some sulfate collected. It is high in sodium and is rather water soluble. Therefore, it needs to be brushed off the surface and collected because its presence in a glass TCLP sample could cause

Figure 5-15

Melter Conductance vs. Control Temperature, 9/18/9

Campaign 2 Anomaly

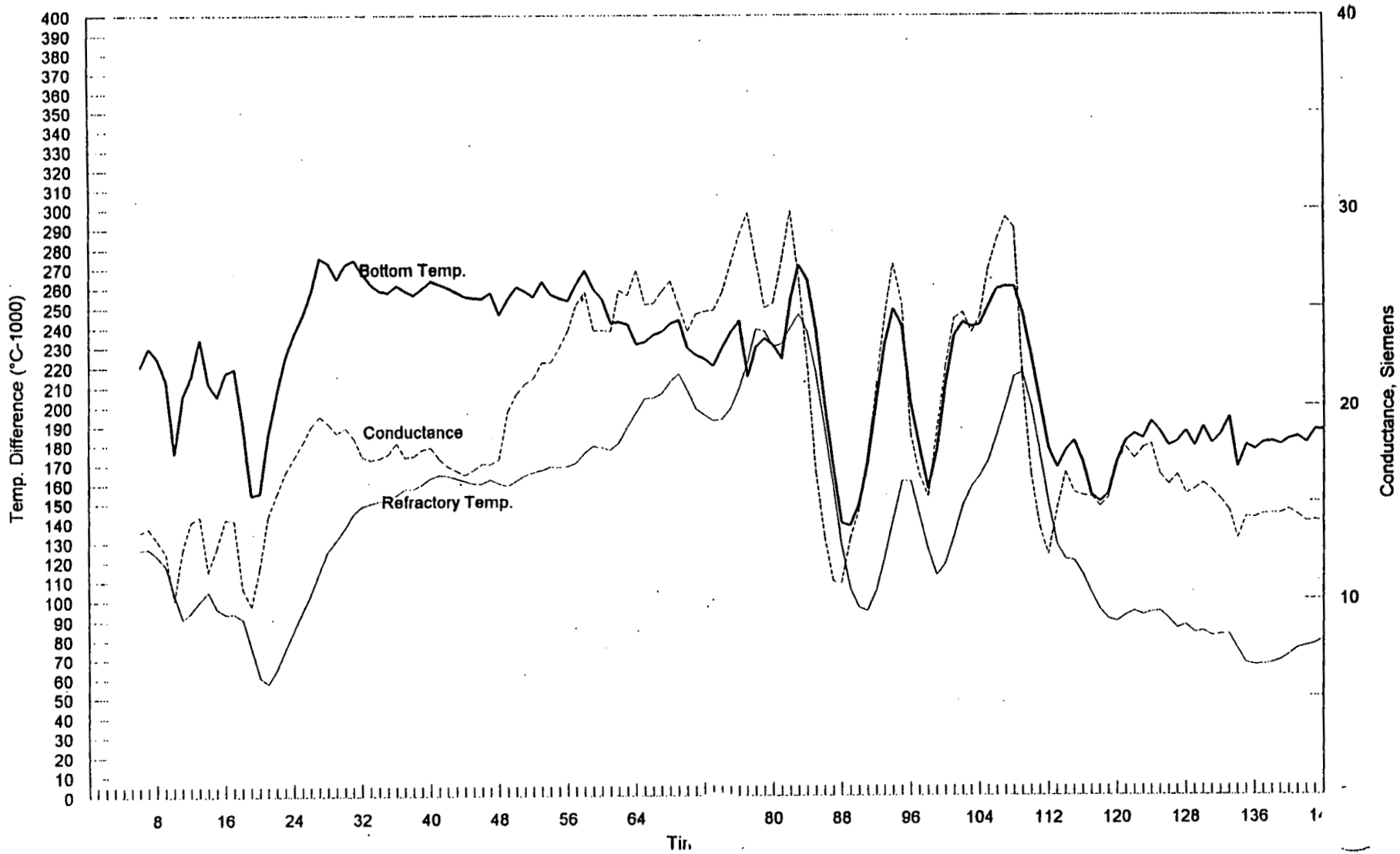

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Figure 5-16

Melter Power and Feed Rate vs. Control Temperature, 9/18/9

Campaign 2 Anomaly

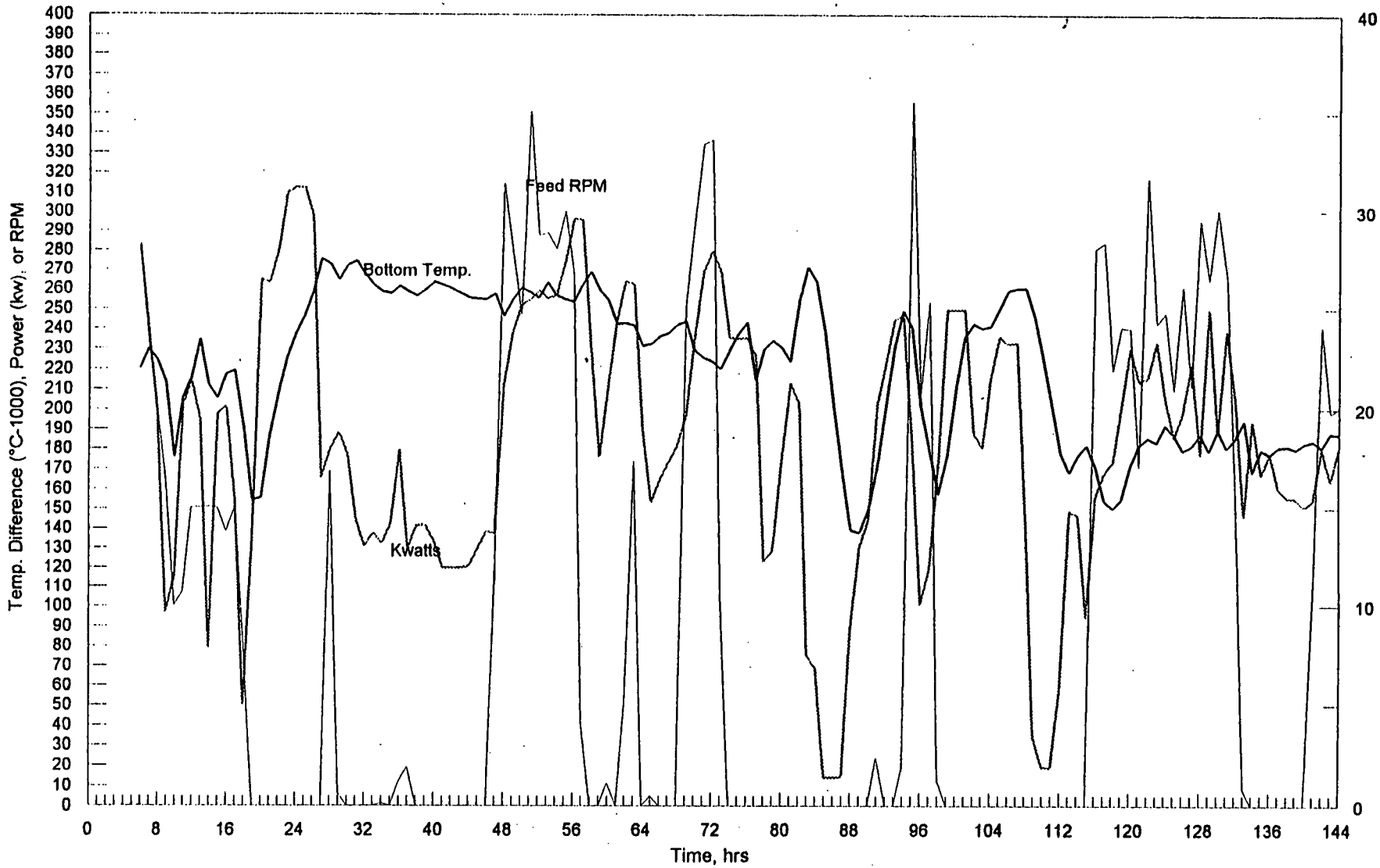

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Figure 5-17

Combined Parameters 9/18/9

Campaign 2 Anomaly

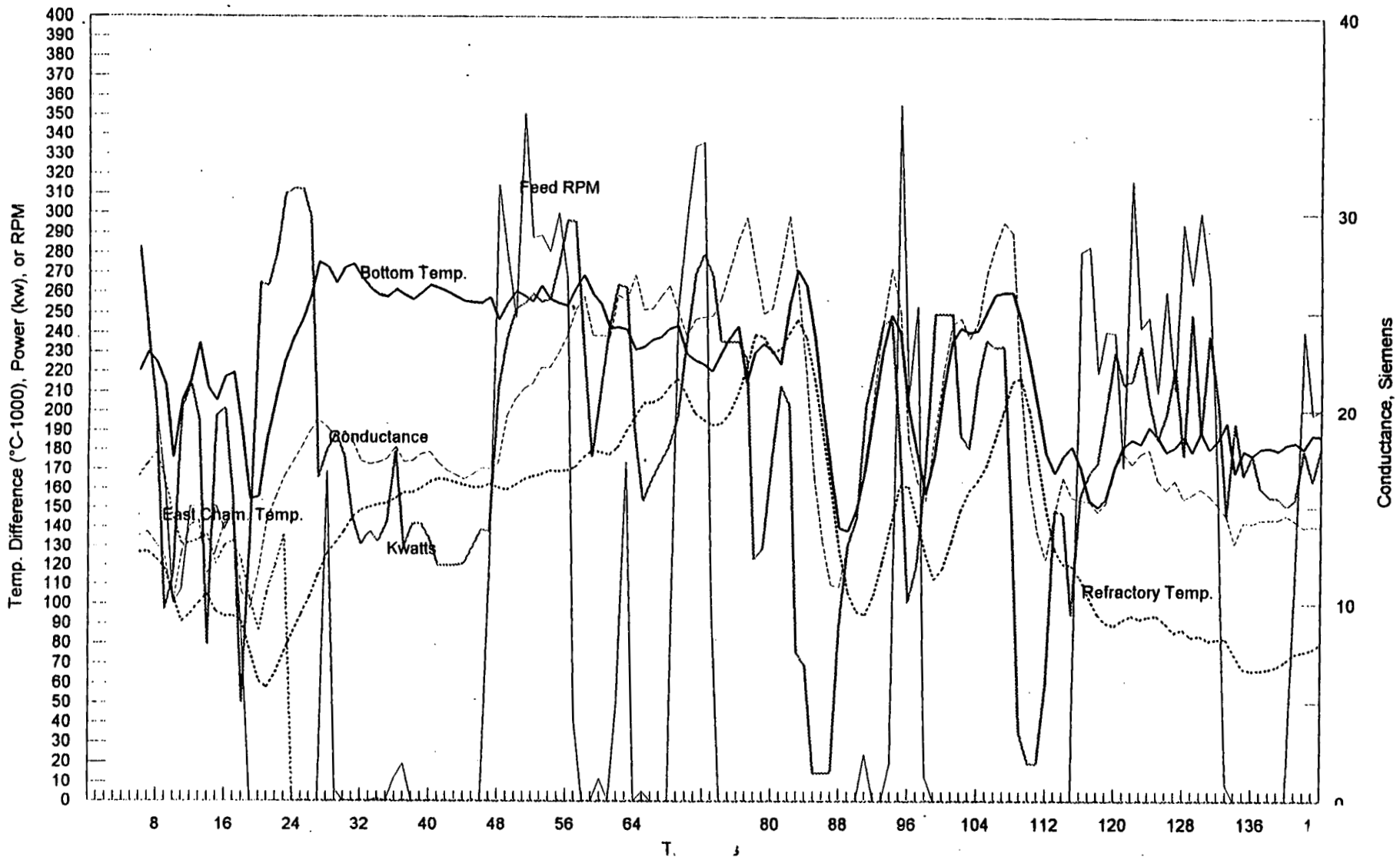

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Table 5-17

Analysis of Sulfate Discharge with Glass

Shown as Oxide		Shown as Sulfate	
Oxide	wt%	Sulfate	wt%
B_2O_3	0.64	B_2O_3	0.64
BaO	2.18	$BaSO_4$	3.31
CaO	9.07	$CaSO_4$	22.01
Cr_2O_3	0.26	$Cr_2(SO_4)_3$	0.34
K_2O	3.06	K_2SO_4	2.83
Li_2O	6.37	Li_2SO_4	11.72
MoO_2	0.81	$Mo(SO_4)_2$	0.81
Na_2O*	38.34	Na_2SO_4*	55.02
NiO	0.13	$NiSO_4$	0.26
PbO	2.24	$PbSO_4$	3.04
SO_3	36.90	–	–
	100.00		100.00

Sodium calculated by difference, not analyzed.

Density of sulfate was 2.72 g/cm3

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a false high reading that would not be representative of the whole batch of g produced. Another approach to remedy the situation is to place a small amount of chemical powder (i.e., a phosphate) on the surface of the glass in the drum that would neutralize or reduce lead sulfate leaching.

The density of the sulfate discharged measured 2.6 to 2.7 g/cm^3 for three samples taken. It appears the sulfate was caught in the bath's agitation and carried down the Melter discharge because its density was close to the density of the glass (~2.7 g/cm^3) in the Melter.

The power needs to destroy sulfates were not observed in the laboratory studies or the minimelter runs. The discovery of the sulfate presence has accompanying impacts. For example, the full-scale Melter may need to be sized for larger retention times and/or more power input, than previously thought, to allow for the destruction of the sulfates. Campaign 4 testing will involve lesser sulfate concentrations. However, it is not clear at this time in the Phase I testing, if Campaign 4 will avoid these events because Silos 1 and 2 still contain more sulfates than is soluble in glass.

5.3.4 Side Chamber Frit Usage and Foaming

Shortly after the Acceptance Test, foaming was noticed in the West Side Chamber. It was presumed that sulfates were getting into the side chamber. It was known that the Side Chamber E-wall Partitions contained cracks during Campaign 1 as reported in the Campaign 1 Test Report. The side chambers, along with the center chamber, were sampled on September 17 and 18, 1996. The results of the analytical analysis are given in Table 5-18. The results showed the West Side Chemistry to be closer to the Center Chamber's Chemistry. The East Side Chamber's Chemistry was less affected. The results imply that the flow through the partition was in both directions. Therefore, the frequency of frit addition was increased in an attempt to reverse the flow of glass into the side chamber. Less foaming has been seen in the side chambers since this extra addition was started. The bubbling was often seen along the partition wall. It was assumed this happens because the redox chemistry in the side chamber is reduced. The side chambers were purposely maintained deprived of oxygen (a slightly reduced Redox state) to protect the molybdenum electrodes. Also, prolonged heat tends to reduce the glass chemistry by driving off oxygen in the glass and its compounds. For example, iron (III) oxide can be reduced to iron (II) oxide:

$$2Fe_2O_3 \rightarrow 4FeO + O_2\uparrow \qquad \text{(Equation 5-8)}$$

Side Chamber Glass Analysis

Analyte	CUSTOMER I.D. S10C-960917-1415 Result (wt %-abs)	CUSTOMER I.D. S10C-960917-1415 Result (wt %-norm.)	CUSTOMER I.D. S10W-960918-1000 Result (wt %-abs)	CUSTOMER I.D. S10W-960918-1000 Result (wt %-norm.)	CUSTOMER I.D. S10W-960917-1400 Result (wt %-abs)	CUSTOMER I.D. S10W-960917-1400 Result (wt %-norm.)	CUSTOMER I.D. S10E-9609171415 Result (wt %-abs)	CUSTOMER I.D. S10E-9609171415 Result (wt %-norm.)
SiO2	26.88	37.86	25.78	34.65	32.51	39.77	44.64	53.12
B2O3	5.10	7.18	5.64	7.58	5.70	6.97	1.89	2.25
Li2O	2.26	3.18	1.82	2.45	3.01	3.68	7.25	8.63
Al2O3	10.92	15.38	12.51	16.81	12.16	14.88	12.09	14.39
BaO	1.38	1.94	1.62	2.18	1.52	1.86	0.96	1.14
CaO	9.02	12.70	10.00	13.44	9.37	11.46	6.31	7.51
Cr2O3	0.20	0.29	0.20	0.27	0.27	0.33	0.27	0.32
Fe2O3	2.83	3.99	3.24	4.35	2.99	3.66	0.95	1.13
PbO	2.72	3.83	3.20	4.30	4.09	5.00	0.44	0.52
MgO	2.67	3.76	2.86	3.84	2.99	3.66	3.52	4.19
Mn3O4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NiO	0.16	0.23	0.15	0.20	0.60	0.73	0.00	0.00
K2O	0.25	0.35	0.53	0.71	0.00	0.00	0.00	0.00
V2O5	0.00	0.00	0.10	0.13	0.00	0.00	0.00	0.00
Na2O	6.61	9.31	6.75	9.07	6.54	8.00	5.72	6.81
ZrO2	NR	0.00	NR	0.00	NR	0.00	NR	0.00
Molybdenum (ppm)	3100	NA	6800	NA	16300	NA	4200	NA
	sum (wt%) 71.00	norm sum (wt%) 100.00	sum (wt%) 74.40	norm sum (wt%) 100.00	sum (wt%) 81.75	norm sum (wt%) 100.00	sum (wt%) 84.04	norm sum (wt%) 100.00
	multiplier	1.41	multiplier	1.34	multiplier	1.22	multiplier	1.19

TCLP Results

ANALYTE	(ug/L)		(ug/L)				(ug/L)	
BARIUM								
LEAD								
CHROMIUM								

Density

	S10W-960918-1000							
DENSITY (g/cc)	2.47							

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Reduced compounds in the side chamber glass can break down sulfates to ge oxygen. For example:

$$2FeO + CaSO_4 \rightarrow Fe_2O_3 + CaO + SO_2\uparrow \qquad \text{(Equation 5-9)}$$

However, if the glass becomes too reduced, the lead oxide in the waste glass that leaks into the center chamber glass could also become reduced to elemental lead or lead sulfide (because of the sulfate presence in the glass). Both, of which, are denser glass and will settle on the bottom of the chamber. For example:

$$2FeO + PbO \rightarrow Fe_2O_3 + Pb\downarrow \qquad \text{(Equation 5-10)}$$

Glass samples were recently collected from the side chambers and sent to VSL for Redox analysis. Analysis showed that 50% of the iron (total iron II and iron III) was reduced (iron II) in the East Chamber and 74% in the West Chamber. A redox of 74% reduced iron is approaching the realm where lead oxide can be reduced to elemental lead or lead sulfide. If lead is being reduced, lead could be an underlying cause of the glow noticed in the East Side-Chamber as described in Section 5.3.6, "Drain Replacement and Glow in Side Chamber Drain." However, the glowing condition has subsided at the time this report was prepared. This a good indication that it is not caused by reduced lead, because the continual production of reduced lead should worsen the problem.

The center chamber glass is denser (at approximately 2.7 g/cm^3) than the side chamber glass (at approximately 2.6 g/cm^3). The higher density produces a pressure differential in the bath that can drive the center chamber to the side chamber. Originally, it was hypothesized that periodically adding new frit to the side chamber would supply enough of a driving force so glass flow would only be from the side chamber to the center chamber. However, this may not be the case. A new, denser side chamber glass will be tested during Campaign 4. Table 5-19 shows the chemical makeup of the original side chamber glass with a density of 2.6 g/cm^3. Some lab analyses have shown side chamber glass density as low as 2.47 g/cm^3 with VitPP side-chamber glass samples. To make a denser glass, the calcium oxide in the side chamber glass was replaced, in stoichiometrical amounts, with barium oxide. The new side chamber glass formula is shown in Table 5-19. The glass was made in the lab and has become known as the Barium Electrode Glass. It has a density of about 2.8 g/cm^3. It is hypothesized that using this glass should help reduce the inflow of center chamber glass to the side chamber and reduce the frequency of side chamber frit additions as shown in Campaign 2. Although barium is a RCRA hazardous waste component in the Silo 1 and Silo 2 residues, its addition in the electrode glass formula should not adversely affect the TCLP of the waste glasses. The waste glasses have had low TCLP leachate

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Table 5-19
Making Denser Electrode Glass by Replace CaO with BaO

Component	Mol. wt.	Light Glass wt%	Replace. Wt%	Dense Glass wt%
Al2O3	101.96	12.70	12.70	11.43
BaO	153.34		17.50	15.75
CaO	56.08	6.40		
Li2O	29.88	10.10	10.10	9.09
MgO	40.31	4.10	4.10	3.69
Na2O	61.98	5.30	5.30	4.77
SiO2	60.08	55.30	55.30	49.78
ZrO2	123.22	6.10	6.10	5.49
Total		100.00	111.10	100.00

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concentrations for barium. Therefore, it is anticipated that the additional bari coming from the side-chamber frit will not be a problem.

The barium electrode glass has similar electrical conductance as the former side-chamber glass because it contains the same stoichiometrical amount of flux. Other properties are similar, for example the liquidus temperature for the new glass is 1000°C, which is good.

5.3.5 Side Chamber Glass Impacts on the Waste Glass

The side chamber glass leaking into the center chamber impacts the glass chemistry of the center chamber glass. Its major noticeable impact is on the lithium concentration. The formulated VitPP recipes for the Acceptance Glass and the Series D glass were 0.18 and 1.08 wt% Li_2O respectively. However, the analysis of the glass produced by the VitPP shows concentrations much higher as shown in Table 5-20. Too much lithium in the glass can:

1. Force the Melter to operate at high amperage and low voltage. This, in turn, can force the Melter to exceed its amperage limits, especially at higher production limits.

2. Reduce the viscosity of the glass to the extent that it creeps deep into the liner of the Melter before the coolness of the Melter shell stops its migration. This can result in the following: (1) more heat loss and a increased power demand by the Melter because the hot glass, is in effect, closer to the outer shell; and (2) increased unwanted grounding potential between energized and grounded parts of the Melter.

3. Increase potential for the glass to fail the TCLP test. Generally, leachability of a glass increases with increased concentration of alkali fluxes (such as Lithium).

The chemistry of the batch would have been adjusted if the analysis of the glass was known earlier during the campaign. However, during Campaign 4, the frit added during each previous batch will be noted and adjustment made in the next batch. Likewise, when the Melter has sat idle for sometime, the glass in the Melter will be analyzed and the feed recipe adjusted appropriately.

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Table 5-20
Lithium Oxide (Li_2O) in the VitPP Glasses

Batch No.	Measured Average wt%	Formulated Recipe wt%	Difference Δ	Difference Δ%
C2B01	2.34	0.18	2.16	1200
C2B02	3.30	0.18	3.12	1730
C2B03	2.56	0.18	2.38	1320
C2B04	2.70	1.08	1.62	150
C2B05	2.28	1.08	1.20	111
C2B06	2.75	1.08	1.67	155
C2B07	2.74	1.08	1.66	154
C2B08	2.52	1.08	1.44	133
C2B09	4.43	1.08	3.35	310
C2B10	4.02	1.08	2.94	272
C2B11	2.90	1.08	1.82	169
Total Average	2.95	0.83	2.12	254
Average w/o Acceptance Glass	3.04	1.08	1.96	182

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5.3.6 Drain Replacement and Glow in Side Chamber Drain

5.3.6.1 Introduction

On September 24, 1996, a glow was discovered emanating from the outer shell penetration for Bottom Drain #3. In the next month, several measurements, inspections, experiments and component extractions were conducted. Changes in component operating temperatures were also performed. Over the month, the glow appeared on several occasions. It always emanated from the Bottom Drain #3 penetration. The exact source of light producing the glow could not be seen and was randomly changing. The intensity also changed randomly from a dull barely visible orange to a bright white. From "Marks Mechanical Handbook", steel at 500°C, produces a dull red glow, at 900°C the glow is a light orange and at approximately 1000°C, a bright yellow is seen.

5.3.6.2 Theories on the Source of the Glow and Actions Taken

The first theory is based on the proximity of the glow to Bottom Drain #3 and the direct relationship to the output of SCR #1 and the glow. VitP' personnel believed the Bottom Drain #3 was electrically shorting the Ea. Side Chamber glass bath to the inner shell.

This theory was soon dismissed based on the fact that the electrical readings on the bottom drain showed no indication of a short between the bottom drain and the side chamber. Readings taken prior to the appearance of the glow and readings taken after the glow showed little differences.

The second theory is that glass migration through the floor of the Melter side chambers is completing an electrical circuit between the electrodes through the inner shell. This would cause some of the SCR #1 current to bypass the glass bath and flow between electrodes through the inner shell. The inner shell would then be joule heated. The glow is produced due to the temperature of the inner shell near the Bottom Drain #3 opening.

The Melter Electrode system is a single phase ungrounded electrical circuit. This simply means that current flows back and forth from electrode bank to electrode bank. Grounding or shorting one electrode bank to ground does not produce a flow of current. However, if both banks are shorted to ground, or any other highly conductive path, current will flow between the

electrodes through the ground loop or other conductive path. The theory on the glow is that glass from each of the side chambers has migrated to the inner shell and is providing an alternate path for current to flow from one electrode bank through the migrated glass, through the inner shell, again finally through migrated glass to the other electrode bank.

To find out if each electrode chamber had leaked glass to the inner shell, thermal imaging of the outer shell was performed. The thermal imaging of the Melter outer shell did show two distinct hot zones. One on the south side of the Melter near the penetration of the thermowell for the west chamber emanating toward the east thermowell. And, one on the bottom of the Melter just northeast of Bottom Drain #3. In these areas, temperatures of the outer shell ranged from 150 to 200°C the remaining outer shell temperatures show 70 to 90°C.

Based on this information, operations decided to remove both the east and west side chamber thermowells. During removal of the west side chamber thermowell, workers found molten, taffy like consistency glass present on the inner shell. They also noted the glass had actually flowed through the thermowell and down in between the inner and outer shell. After removal, thermal imaging was reperformed. No noticeable changes were seen. Next, the SCR was shut down and external water cooling of the outer shell was performed. Again, no sustained noticeable changes in Melter shell temperatures were noted.

The inner and outer shell are separated by 1-3/4 inches of Fiberfrax^R. Vendor data sheets indicate thermal conductivities of Fiberfrax^R are low enough, 0.1 - 0.2 W/m C to support this theory. It can be shown that when the inner shell temperature is 1000°C, the corresponding outer shell temperature is 150 to 200°C.

Further analysis of the on-line Melter parameters and the electrical data indicates that the hotter the Melter gets, the worse the problem. As Melter temperatures approach the 1300°C mark, the frequency of the glow increases and the resistance between the electrodes and the inner shell decreases. When the Melter SCR is left off for several hours, then restarted, the glow disappears for awhile and the resistance between the bus and ground increases.

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5.3.6.3 Conclusion

Bottom Drain #3 is not shorting the east electrode chamber to ground and causing the glow. The glow seems to be produced from the heating of the inner shell near Bottom Drain #3. The heat is caused by current which is flowing through glass that has migrated from the electrode chambers to the inner shell. The amount of flow is proportional to the relative resistance of the migrated glass and the Melter bath. The only corrective action is the removal of the inner shell. On future designs, deletion of this inner glass containment shell should be considered.

5.3.7 Melter Power Demand Appears to be Increased

It may be a simple matter of not being able to accurately measure, but it appears that the Melter now uses more power to idle than it did when it was placed in service. Table 5-21 summarizes the approximate values for idling for both Campaigns 1 and 2 as follows:

Table 5-21
Approximate Melter Idling Power at Different Times

When	Temperature °C	Power kw
Start of Campaign 1 -- Right after electrode insertion	1250	105 -120
End of Campaign 1	1250	130 -150
End of Campaign 2	1175	140 - 160

The power usage will be further evaluated during Campaign 4 to see if there really is a change. If there is indeed an increase, the following scenarios are postulated as possible reasons:

1. Glass is permeating toward the Melter outer shell. This would draw the Melter's heat closer to the Melter's shell and increase temperature at the surface and increase heat loss. The glasses are thinner (less viscous) and may have allowed deeper penetration into the Melter walls.

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2. Electrical power may be conducting through the refractories and placing heat closer to the surface of the Melter, and thereby increase heat loss. Two major paths are possible:

   a. From electrode to electrode. Preliminary calculations show that only 1 to 2 percent of the power is possible by this method because the path the electricity must follow through the Melter refractories is long.

   b. From an electrode to the shell of the Melter. This is a shorter path than described in Item a above. Also, this in combination with Item 1 will produce an even more conductive path.

3. Unexplained — do not know at this time.

Another possibility to consider is that the above items happened as part of a natural curing process and little or no further progression will take place.

5.3.8 Gem Making and Melter Discharge

5.3.8.1 Diverters

Glass from the discharge orifice was not completely captured by the diverter chute while in the "startup" position. Glass from the far west side of the discharge chamber would stream by and pour directly on the cutter wheel. When flow was diverted, the molten glass had a tendency to accumulate on or adhere to the discharge chute and the east inside wall of the gem machine housing prior to falling into the startup drum. The gem machine lower side panels were removed to access the solidified glass and break it loose. Since the glass streams from the discharge chamber orifice inconsistently flowed from the west and center sections of the orifice, all glass discharge would be directed on the emergency diverter chute.

In the "emergency" position, molten glass had a tendency to adhere to the discharge chute and the west inside surface of the gem machine housing also. Over a period of time, molten glass would accumulate rather than fall into the emergency drum. The area between the diverter chute and the emergency drum was cleared of glass on two occasions. One accumulation amounted to a 55 gallon drum full of solidified discharged glass.

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The pneumatic actuation of the diverter positioning was not smooth. The pneumatic cylinders were physically coaxed to be positioned properly. The kinematics of the design allowed the cylinder to catch periodically as it was actuated.

5.3.8.2 Lube spray System

The cutter/roller assembly had to be continuously monitored to adjust lube spray flow during gem production. A continuous flow of lubricant was necessary to eliminate the glass sticking problems and keep the cutter/roller assembly cool at the point pour stream contact.

There was an accumulation of lubricant in both the startup and emergency drums due to the heavy (required) lubricant usage. The lube reclamation aspect of the system was in-effective. If a better reclamation system of the lube is installed there would significant increase in the gem machine performance.

5.3.8.3 Discharge Chamber

The chamber pour spout did not condone to pouring a consistent single stream. The spout has a large hole (3 inches diameter) at the bottom and the glass can pour off any point (or points) around this hole. However, the multiple pour stream effect supported easier control of the stream during the manufacturing gems and while adjusting (increasing) air lift flow to control stream diameter. When air lift control was increased the consequential glass flow increased proportionally to each stream. This proportioning provided a continuous and smooth gem making process. If a single glass stream was pouring, a small air lift adjustment [($\leq$ 0.5 scfh) with a constant Trickle Air Flow setting of 2.0 scfh] would have a significant impact on the pour stream size.

The pour spout developed a stress heat crack, but this did not directly hamper pouring capability. Indirectly, however, glass sometimes slowly leaked between the crack if the pour spout was running whole. Its buildup disrupted pouring. Therefor, the glass buildup was periodically removed.

Over a period of time ($\leq$ 20 minutes), semi-solidified ribbons of glass would form. The ribbons would start at the discharge orifice and gradually grow downward toward the cutter to the point that it would influence and

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eventually eliminate the pour stream. Either the startup or emergency diverter would have to be cycled into position to break the ribbon at the point of origin, or at some other point above the cutter/roller. Once the ribbon was broken, the diverter would be actuated to the "gem" position to continue gem making.

Glass continued to flow from the annulus around the discharge chamber orifice. This flow was slow and generated a gradual buildup in the orifice to the point of completely clogging the opening to the gem machine housing. Prior to feeding the melter, the clogs required a welder to burn out the clog with an acetylene touch. The timing of the burning out process was essential. If the orifice was unclogged too early and glass flow was not established in a few hours, the orifice would clog again.

5.3.8.4 Summary and Recommendations

Clearly the gem machine requires constant supervision to: (1) adjust air lift flow, (2) actuate the diverters, (3) adjust lube spray flow, and (4) flush the lube spray nozzles. Gem cutter lubrication adjustment is a constant battle to reduce graphite lube accumulation in the startup and emergency drums.

The air lift adjustment required two people due to the sensitivity; one to adjust air lift flow at the Utility Rack and one to provide feed back as to the impact of the adjustment on the glass streams.

It is believed that the problems associated with molten glass adhering to the diverters, adhering to the inside wall of the gem machine, and developing semi-solid ribbons are due to less than desired gem housing temperatures. Gem housing temperatures were typically running in the range of 160°F to 210°F with the melter pressure slightly more negative (-0.75" WC) in relation with the gem machine housing (-0.70" WC). Only when the gem housing vacuum was increased to approximately 0.85" WC was heat drawn from the melter (via the discharge chamber) into the gem machine housing. With the vacuum increased, the gem machine housing increased in temperature to approximately 325°F. Increasing the gem housing temperature aided in exacerbating the above described problems. However, the practice is not judged to be acceptable due to melter atmosphere being driven into the building HVAC system and not the normal Off-Gas System.

Information was obtained to help gem production. A lard based lubricant was recommended by a major supplier of shear lubricants. The commercial

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glass industry is presently using this type. In fact, a graphite lubricant not recommended for the VitPP application. The same vendor suggested that the cutting surface be maintained below 200°F to reduce glass sticking. A water cooled cutter would be responsive to this recommendation.

In areas of glass build up or glass sticking, the discharge chamber and the inside vertical walls of the gem machine housing, graphite lining would reduce or eliminate the problem. A smoother and more consistent pour stream (location and size) would be easier to obtain and maintain.

5.3.9 Chlorides in Melter Cooling Water

A dedicated, closed cooling water loop is used to cool the Melter electrodes, bottom drains, side drain, IR detectors, feed tubes, the Gem Machine conveyor, and the Gem Machine diverters. For freeze protection, the coolant was a 50:50 volume mix of deionized water and commercially available inhibited propylene glycol. At the end of Campaign 1, intermittent flames were observed at the molten glass surface of the east side electrode chamber of the Melter. When coolant flow was reduced to the east chamber bottom drain, the flames subsided. It was obvious that the flames were caused by burning antifreeze (propylene glycol) from a coolant leak into the east electrode chamber.

The coolant was analyzed and found to contain 150 ppm chloride which was traced to the commercial glycol antifreeze. The bottom drain consisted of a 304L stainless steel pipe with a welded-on cap made of Inconel™ 690. The chlorides may have attacked this assembly, producing the leak. However, the welding of dissimilar metals could also be the major cause for the cracking. This is currently being investigated. As a temporary corrective action, the east chamber bottom drain was disconnected from the closed loop system and put on its own water-only cooling loop consisting of a 55-gal drum and a small pump. The glycol solution was replaced with deionized water only, and the bottom drains were slated for replacement prior to Campaign 4.

5.4 Off-gas System

The Off-gas System consists of the Film Cooler, Quench Tower, Scrubber, Desiccant Tower, HEPA Filter, Off-gas Blower, Stack, and the interconnecting off-gas lines. Generally, the Off-gas System suffered from continual plugging problems that required a lot of maintenance activity to keep it available for handling Melter off-gas.

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5.4.1 Film Cooler

An air lance, which injected air at the point where the Melter off gas left the Melter plenum, was installed into the Film Cooler during Campaign 1 as an engineered, temporary fix to reduce plugging in the Film Cooler. Plugging in the Off-gas Film Cooler and the line downstream of the Film Cooler was a serious problem until the installation of the air lance. The air lance was a pipe inserted through the center of the Film Cooler which provided for injection of compressed air at the point where off-gas leaves the Melter plenum. The original Film Cooler left a gap of about 10" before off-gas leaving the plenum was contacted with compressed air. It also appeared that the method which the original Film Cooler initially introduced compressed air (through four 3/4" diameter holes) was inadequate in that these holes plugged up. The air lance, along with operating the Melter with a cold cap, substantially solved these problems such that Film Cooler and off-gas line plugging were no longer a significant operating impediment. Frequent removal of the air lance would not be acceptable for melter application with radioactive materials. A complete redesign of the melter off-gas nozzle and film cooler would be required.

The added ingredients used in the surrogate feed for Campaign 2 caused the plugging problems to return. Periodic removal of the air lance and manual cleaning of the Film Cooler was required up to several times a day while feeding the Melter. The need for cleaning was based on the pressure drop through the Film Cooler. Pressure drops ranged from 5" WC (when clean and with no feed to the Melter) to 40" WC (when dirty and with feed to the Melter). On two occasions, the tip of the air lance was found to have burned off. Plans were made to fabricate future air lances out of Inconel® to better resist oxidation.

Compressed air flow to the air lance was fairly constant at about 40 SCFM as read on a rather crude rotameter. Compressed air flow to the Film Cooler housing was generally 20 to 40 SCFM until September 12, 1996, when it was (for the most part) discontinued in favor of adding air only through the air lance. During high temperature (1350°C) Melter operation, the off-gas temperature exiting the Film Cooler ranged from 800°F to 1030°F depending on the extent of the cold cap in the Melter. A larger cold cap produced cooler Melter plenum temperatures and cooler off-gas. During low temperature (1250°C) Melter operation, the off-gas temperature exiting the Film Cooler ranged from 600°F to 900°F, again depending on the cold cap (some abnormally high Film Cooler exit temperatures in excess of 1000°F were caused by the air lance tip failures mentioned above). Because of the crude nature of the flow measurements, no material or energy balance was possible around the Film Cooler.

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5.4.2 Transition Line

The transition line is the 4" diameter stainless steel pipe that carries off-gas from the Film Cooler to the Quench Tower. This line experienced partial plugging a few times at the Film Cooler end. The pressure drop through this line was about 5" WC when clean and with no feed to the Melter. The pressure drop would rise to about 10" WC when feeding the Melter, and twice exceeded 20" WC just prior to being cleaned at the Film Cooler end.

Over several days starting around September 13, 1996, it was not possible to control the Melter pressure at -0.75" WC while feeding it. A plug was found on September 17, 1996, in the transition line near where it enters the Quench Tower. Apparently, the thermowell there acted to collect solids and slowly plugged the line. The thermowell was pulled and the buildup of solids was rodded into the Quench Tower. The solids were not sampled, but they are presumed to be similar to those found elsewhere in the Off-gas System. Pluggage at this thermowell did not recur in Campaign 2.

5.4.3 Quench Tower

The Quench Tower operated satisfactorily, as it did during Campaign 1. Recy water flow through the spray nozzles was close to 15 gpm throughout the campaign. During high temperature (1350°C) Melter operation, the Quench Tower typically cooled the off-gas from an inlet temperature of 700°F to an outlet temperature of 150°F. During low temperature (1250°C) Melter operation, the Quench Tower typically cooled the off-gas from an inlet temperature of 550°F to an outlet temperature of 130°F.

On two occasions a small amount of caustic (NaOH) was added directly to the Quench Tower when the pH in the recycle water dropped below 7.0. The pH in the recycle water was generally kept above 8.0 to prevent corrosion of the carbon steel equipment and piping. The Quench Tower did no significant removal of acid gases from the off-gas.

5.4.4 Scrubber

During Campaign 2 caustic was added to the Scrubber to neutralize sulfur oxides in the off-gas from the Melter. Caustic was added as 50 wt% NaOH from a drum as necessary to maintain a pH of 11.0 to 12.5 in the scrubbing solution. To prevent the buildup of dissolved solids (sodium carbonate, sulfate, and sulfite), the Scrubber

was drained and refilled about every other day while the Melter was being fed. Despite this, by 9/19/96 solids were observed in the rotameter going to the packed tower section of the Scrubber package. Then on 9/24/96 the idle Scrubber recirculating "B" pump was found to be plugged with a white salt-like solid. Testing confirmed that a large fraction of the precipitate was sodium carbonate. Sodium sulfate and/or sulfite might also have contributed. To help prevent carbonate precipitation in the future, the scrubbing solution should be kept between pH 9.0 and 10.0. Also, more frequent draining and refilling of the Scrubber will probably be required.

The amount of caustic used appears to be commensurate with the amount of sulfates fed to the Melter. The first 11 batches of Campaign 2 would have produced about 920 lb SO_X (SO_3 basis) in the off-gas, based on an average of 3.9 wt% SO_3 in the slurry feed (dry basis) and 0.7 wt% SO_3 solubility in the glass. This amount of SO_3 would have required 920 lb NaOH to neutralize it. During this time the pilot plant used about 3 drums of 50 wt% caustic which provided 1030 lb NaOH to the process. The extra caustic was used to neutralize some of the carbon dioxide also present in the off-gas from the Melter. Essentially all of the caustic was added to the Scrubber.

5.4.5 Filters and Particulate Carryover

That significant amounts of particulate were getting through the Scrubber was seen in the frequency that the HEPA prefilters were changed. Between September 2, 1996 and September 22, 1996, the two HEPA prefilters were changed a total of 9 times. Also, on September 21, 1996, the differential pressure in the Carbon Bed bypass line shot up from a normal range of 2" - 6" WC to a range of 10" - 20" WC. On September 22, 1996, it was discovered that this was caused by particulate build-up at the bypass block valve. Analysis of the material collected in the prefilters indicated that it was similar to what was being fed to the Melter. Clearly, significant amounts of particulate were getting through the Scrubber.

In general, an ejector-venturi/packed tower scrubber like the one used in the Pilot Plant loses efficiency quickly for particles less than 5μm in diameter. Apparently, the Melter produces significant quantities of these small particles. While prefilter plugging was most problematic while the Melter was being fed, it was observed that prefilter pressure drop would continue to rise (albeit more slowly) even with no feed.

Another problem with the HEPA housings was water condensation. After the Desiccant Tower was allowed to become ineffective, the off-gas line between the

Desiccant Tower and the HEPA Filters (i.e., the Carbon Bed bypass line) was traced and insulated in order to superheat the off-gas and prevent condensation. Unfortunately, the outside walls of the HEPA housings cooled enough that condensation did occur, filling a housing to a 1" - 2" depth with liquid water. It is not believed that this condensation significantly hurt filter performance, but since the water collection is a concern in general, and a housekeeping and environmental concern in particular, future plans include heat tracing and insulating the HEPA housings. (Note that heating the lines and HEPA housings is not acceptable when processing K-65 residues. The high temperature and moisture content would render the carbon beds ineffective for radon removal.)

5.4.6 Off-gas Systems Upgrades and Maintenance

The Off-gas System problems with particulates down-stream of the Scrubber has resulted in system upgrades using spray nozzles up-stream of the Quench Tower to flush particles into the Quench Tower and spray nozzles on top of the Scrubber Tower to clean the mist eliminator in case of obstructions. The Off-gas piping from the Scrubber to the HEPA housings will be straightened.

Upgrades to decrease the amount of vapor condensate in the system include h- -+ tracings and insulating the piping down-stream of the Scrubber and the HEPA housings.

Other modifications to the VitPP are as follows:

1) Drain and abandon the Thickener Tank. Thickener will not be used in Campaign 4.
2) Drain and abandon the Cooling Tower. Apply a nitrogen blanket to the Heat Exchanger.
3) Drain and abandon the Desiccant Tower. The Desiccant Tower will not be needed with the Off-gas System upgrades.

5.5 Other Systems - Recycle Water System

Operation of the recycle water loop (Recycle Water Tank to Recycle Water Pump to Quench Tower to Heat Exchanger to Thickener and back to Recycle Water Tank) was unchanged from the operation reported in the Campaign 1 report. The flow through the loop remained stable at about 15 gpm during all of Campaign 2, indicating no more scaling occurred in the lines. During periods of Melter feeding, the Heat Exchanger routinely cooled the water exiting the Quench Tower from

130-150°F down to less than 80°F using 60-70°F cooling water. This indicated good heat transfer and minimal fouling in the Heat Exchanger.

5.6 Process Control

5.6.1 Melter Control

Control focuses on maintaining the main chamber glass at an optimal temperature. When the temperature of the glass drops, more heat is imparted to the glass (joule heating of the glass from current flow between the electrodes) until the temperature is again reached. Heat to the main chamber glass is controlled by a 60 hertz, single phase, SCR 1. SCR 1 may be operated using voltage, temperature, current, or power set points. All Campaign 2 operations have been performed using operator selected power set points to maintain the main chamber glass at various operating temperatures.

There are four basic parameters or characteristics of the glass melt that affect the operation of the Melter, but are not readily measurable. These are (1) viscosity, (2) electrical conductivity, (3) liquidus temperature, and (4) redox. The relation of these parameters with the Melter feed are described in Section 2.1.

5.6.2 Batch Operation and Analytical Process Control

Melter runs were performed with slurry feed batches prepared in accordance with Batch Sheets to provide slurries for the Transition Glass, Acceptance Glass, and Series D Glass. The slurry constituents were determined to meet the chemistry requirements and solids content for each glass type.

Samples were taken for each slurry batch during slurry mixing/preparation (Sample points S-04A/04B) and as a batch was being fed to the Melter (Sample points S-05/05A). The samples were tested by the laboratory for physical and chemical properties following the analysis procedures specified in the Project Specific Plan for Phase I process sampling (document 2504-SU-0011). Appendix C includes the laboratory results reported for each batch.

5.6.3 Process Sample Analytical Problems

Problems with process sample procedures, sample identification, analysis tracking,

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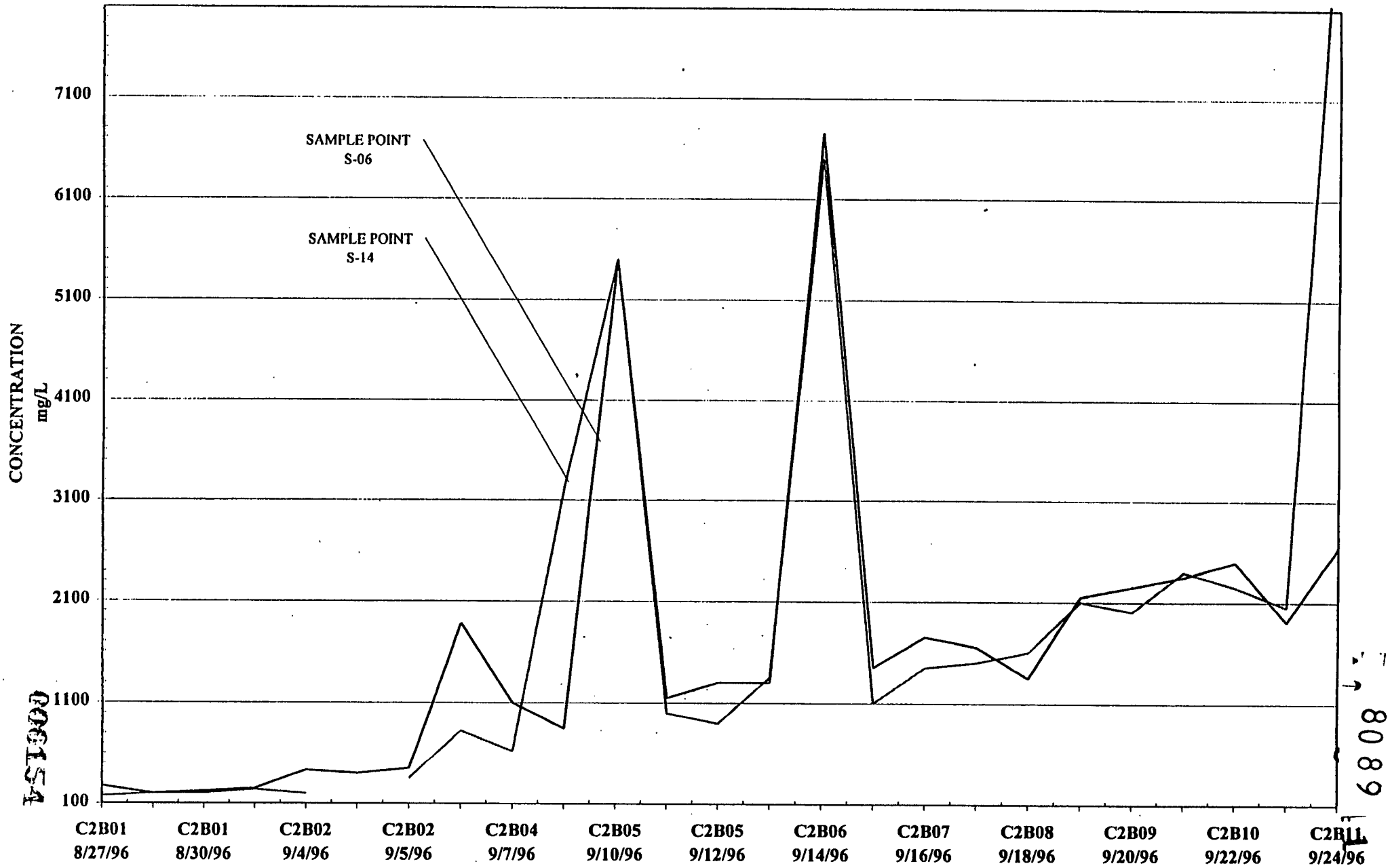
and analytical turnaround timeliness experienced during Campaign 1 continued during Campaign 2. For Campaign 2, steps were taken as a result of lessons learned to improve sampling procedures and provide additional training. As the revised sampling and identification steps were implemented, sample tracking problems and the availability of analytical results improved. The revision steps continued as an ongoing process during Campaign 2.

Slurry preparation and vitrification of the Acceptance Glass and the Series D Glass focused on laboratory analytical data. The data were required to confirm slurry composition, TCLP results, glass composition, recycle water, and material balance of RCRA materials used in the glass formulations. The material balance data included sampling the recycle water system for the Quench Tower, Scrubber, and the Building Sump Tank and filter components of the Normal Off-gas, building HVAC, and Emergency Off-gas Systems. The number of analyses provided comparison of individual results and related sample points within a system. The sampling of the recycle water loop between the Quench Tower, Heat Exchanger, Thickener Tank, and return to the Quench Tower consists of two water samples. One sample at the discharge from the Quench Tower (sample point S-06) and one as the water returns from the Thickener Tank to the Quench Tower (sample point S-14).

Data results for sulfate, chromium, molybdenum, barium, and lead from water samples for the Quench Tower system have shown irregular results. Figure 5-1 presents a graph of the sulfate concentration for sample points S-06 and S-14 versus a common time line for Campaign 2. Most of the data show a reasonable increasing concentration trend from batch C2B01 through batch C2B11. However, the concentration spikes for samples from both sample points illustrate possible analysis problems. The close time coupling of the concentration spikes for both sample points indicates that there may have been a systematic problem with the analyses. Similar irregular data have occurred for the other analytes. The cause and steps to understand and correct these occurrences will be evaluated for future campaigns.

FIGURE 5-18
CAMPAIGN 2 SULFATE ANALYSES



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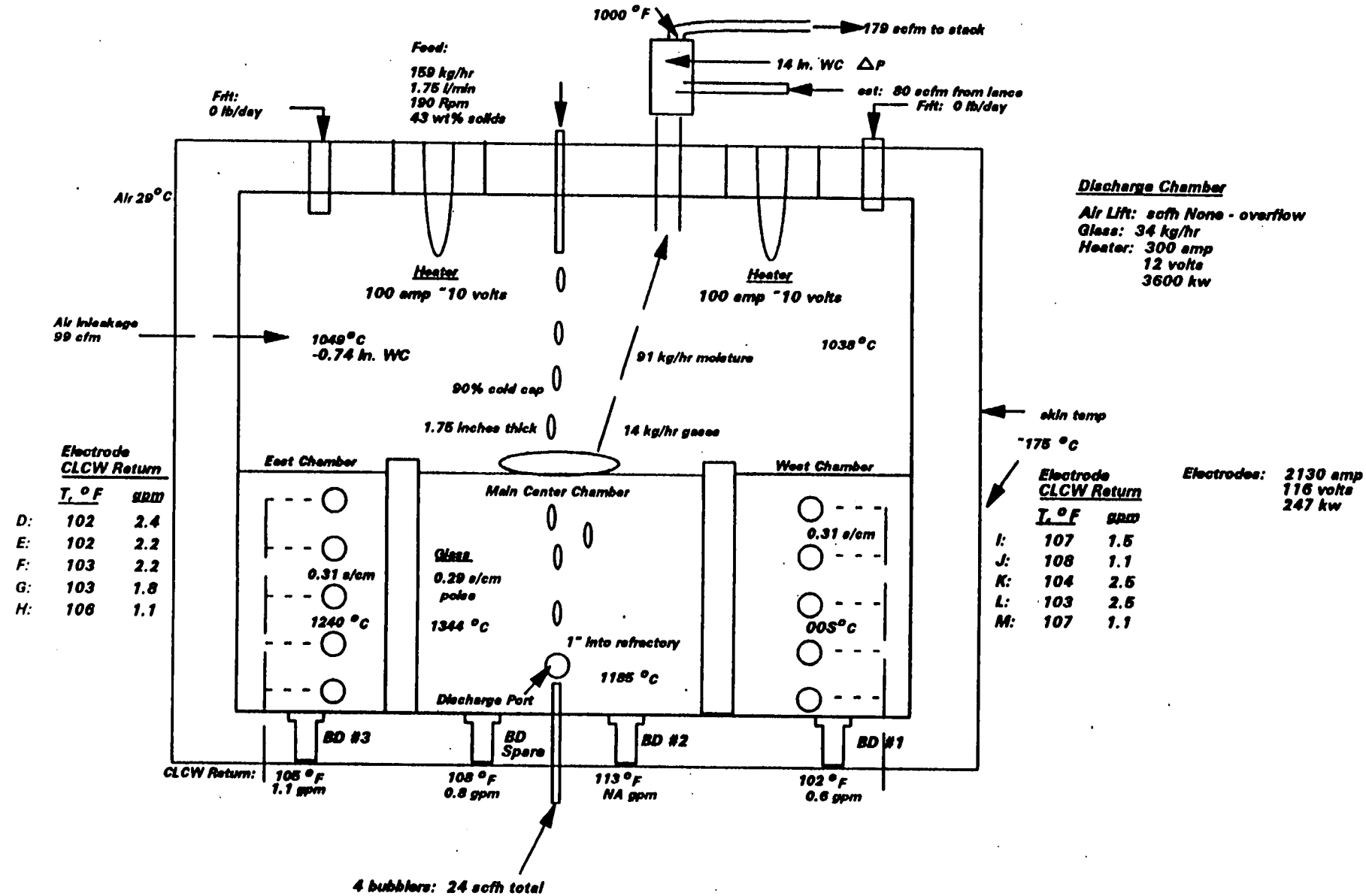
5.7 Snapshot

Three run series were performed during Campaign 2; 36-Hour Acceptance Glass Runs, Transition Glass runs to transition the melter glass from the Acceptance Glass formula to the Series D Glass formula, and Series D Glass runs. Data tabulations and plots for these run series are in Appendix D to this report. Appendix D is organized as D1, 36-Hour Acceptance Glass; D2, Transition Glass; and D3, Series D Glass. Within each appendix, the data are organized by VitPP systems: Feed Preparation System, Furnace System, and Furnace Off-gas System.

The 36-Hour Acceptance Glass run is described in section 5.1.2. The conditions of the Melter components, glass and internal conditions, off gas and the Discharge Chamber at a representative time during this run are shown on Figure 5-19.

As described in section 5.3.1, a peak, melter power condition occurred during the 36-Hour Acceptance Glass run. The Melter conditions for this occurrence are shown on Figure 5-14 .

Melter snapshot data for typical conditions during the Series D Glass run, described in Section 5.1.4 are shown on Figure 5-20. The occurrence of the sulfate layer during the Series D Glass run is described in Section 5.3.2. Snapshot data that are representative of the Melter conditions during the sulfate layer occurrence are shown on Figure 5-21.

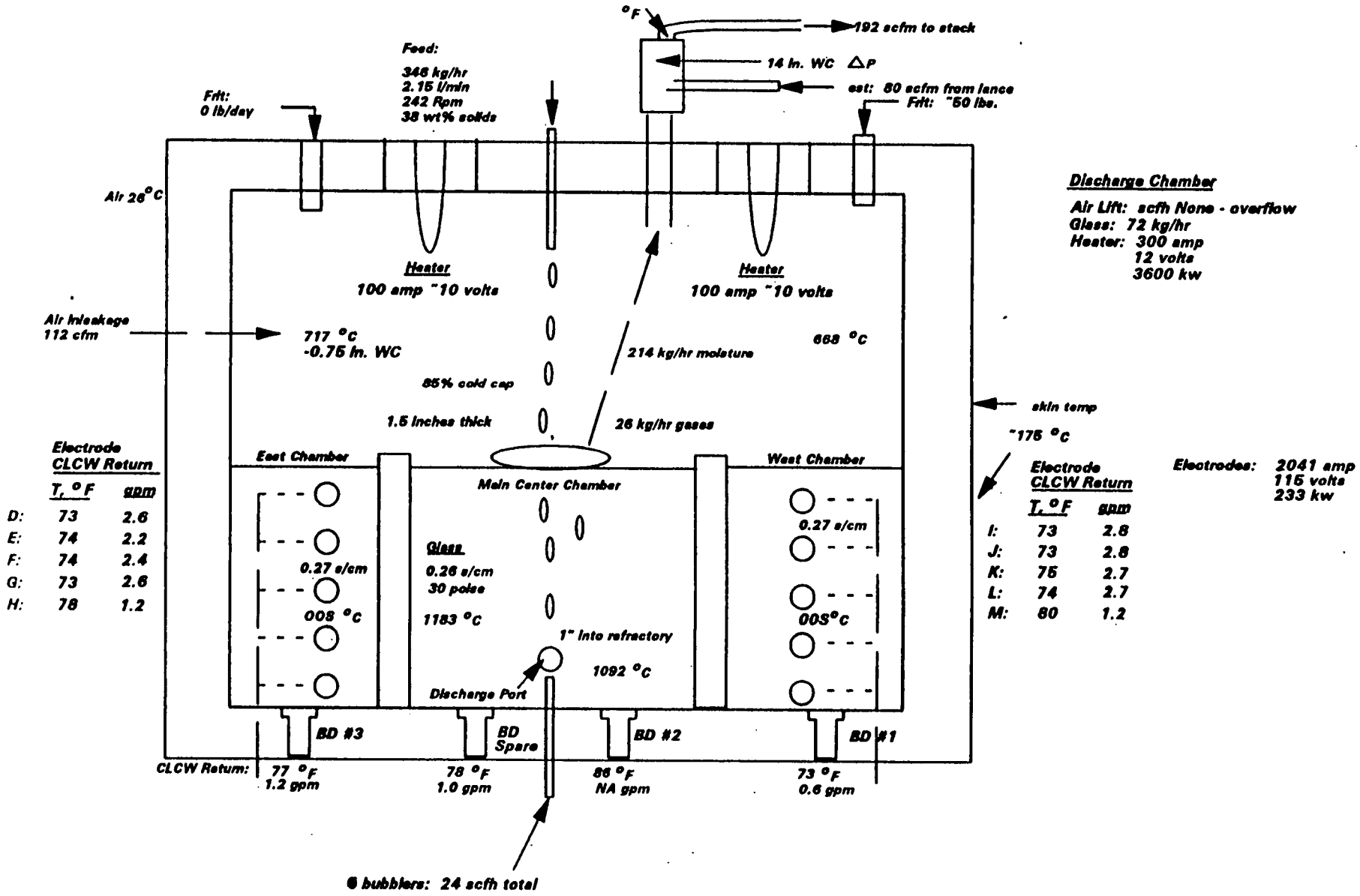


Snapshot of Melter Operation

September 4, 1996, 5:00 p.m.
36-Hour Acceptance Run, Typical

Legend: BD: Bottom Drain
OOS: Out of Service
CLCW: Closed Loop Cooling Water
NA: Not Available

Figure 5-20
Series D Glass, Typical



Snapshot of Melter Operation

Sunday 23, 1996, 3:00 a.m.
Series D Glass, Typical

Legend: BD: Bottom Drain
OOS: Out of Service
CLCW: Closed Loop Cooling Water
NA: Not Available

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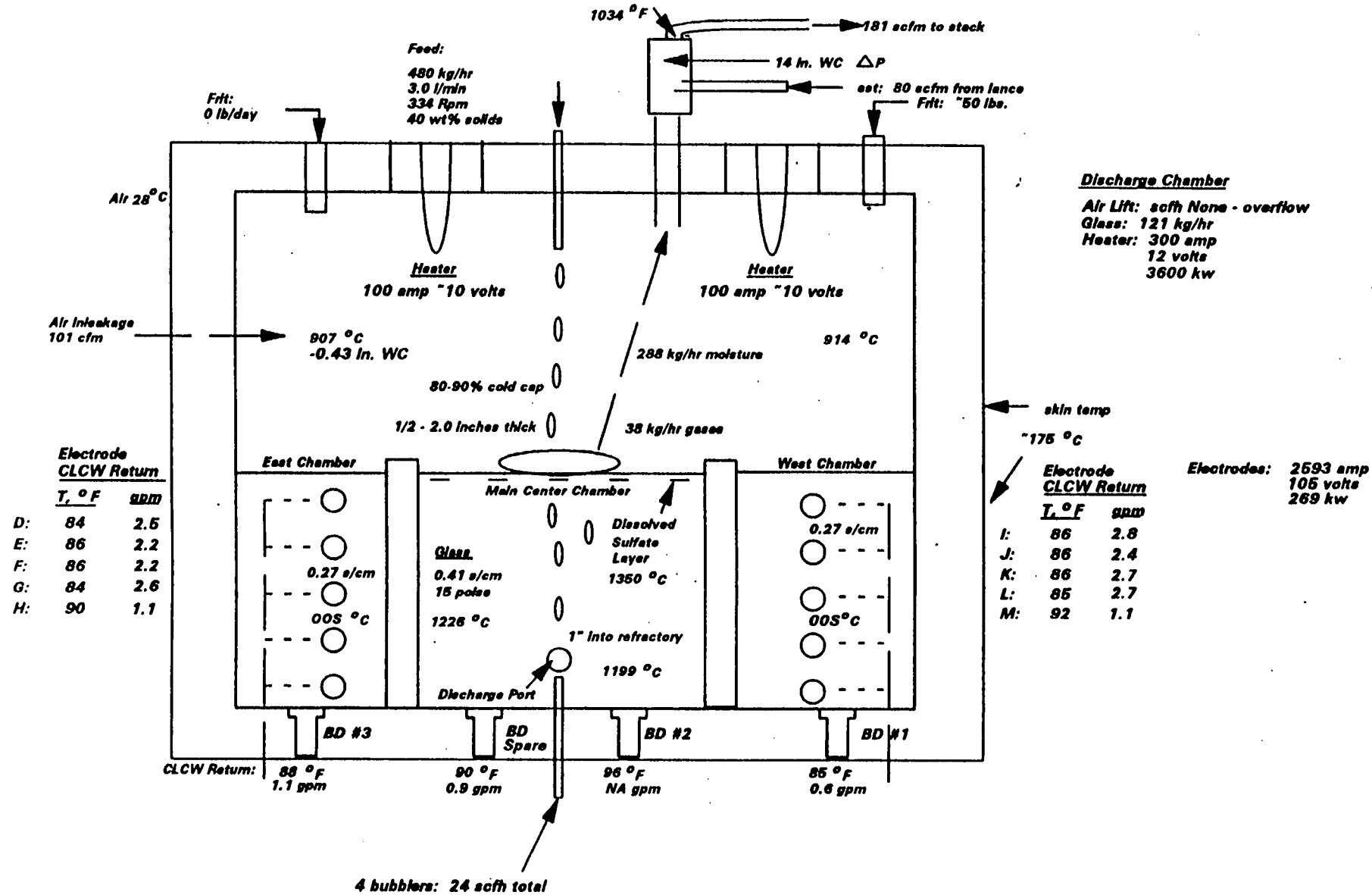

Snapshot of Melter Operation

September 20, 1996, 11:00 p.m.
Series D Glass, Sulfate Layer

Legend: BD: Bottom Drain
OOS: Out of Service
CLCW: Closed Loop Cooling Water
NA: Not Available

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6.0 CAMPAIGN 2 MAINTENANCE ACTIONS, EQUIPMENT WEAR AND EXPECTED LONGEVITY

6.1 Chromium Oxide Balance

See Section 5.1.6 ,Mass Balance for Ba, Pb, S, Cr, & Mo, for the chromium oxide balance.

6.2 Molybdenum Balance

See Section 5.1.6 ,Mass Balance for Ba, Pb, S, Cr, & Mo, for the molybdenum balance.

6.3 Film Cooler

See Section 5.4.1, Film Cooler, for a description of the air lance and the Melter Off gas Film Cooler.

6.4 Chlorides in Melter Cooling Water

See Section 5.3.9, Chlorides in Melter Cooling Water, for a description of the closed cooling water loop chloride problem.

6.5 Feed Preparation System Upgrades and Maintenance

See Section 5.2.1, Blockage in the Bag Dump Station and Dry Transfer, and Section 5.2.3, Piping and Equipment blockages, for descriptions of upgrades and maintenance for the dry material transfer and the slurry feed systems.

6.6 Off-gas System Upgrades and Maintenance

See Section 5.4.6, Off-gas System Upgrades and Maintenance, for description of the system upgrades and maintenance.

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7.0 ENVIRONMENTAL

The environmental objective for the VitPP treatability testing is to ensure off-site protection of human health and the environment during the various vitrification campaigns. The degree to which the design and operation of the plant has met the environmental objective is determined by evaluation of compliance with the environmental regulatory requirements, as well as the application of environmental ALARA concepts and waste minimization practices during operation of the plant.

Phase I Campaign 2 involved the use of glass additives and chemicals to make up a surrogate to simulate a blend of Silo 1, 2, and 3 residues. During Campaign 2, lead and barium compounds were added to the surrogate. These metals were tracked and a mass balance accounting conducted to determine the degree of partitioning of the metals into the glass, and to ensure that the metals were controlled and not released to the environment at levels which exceed regulatory limits.

7.1 Release Pathways and Monitoring Points

Potential environmental release pathways for contaminants from the VitPP include the following:

- Air - Stack emissions
- Water - Wastewater and stormwater
- Soil - Includes spills or other releases
- Waste - Hazardous or toxic waste managed off-site

Potential sources of discharge, and associated monitoring points for these release pathways are listed in Table 7-1. The environmental sampling locations are shown on the flow diagram in Figure 7-1. Note that there are no designated monitoring points for releases to soil; monitoring of spills or releases off the plant pad is on a case by case basis.

Although Campaign 2 has a beginning and end date, environmental data from the Campaign 2 time period in many cases cannot be directly correlated with a specific run or activity. This is due to waste being generated in between Campaigns, and sampling of waste streams (wastewater, air filters) on a batch basis that may take place long after the activity has ceased. To ensure the majority of environmental data are included in this report, data from sampling events both prior to, and following Campaign 2 were evaluated for this report.

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Table 7-1
Summary of Environmental Data from Campaign 2

PATH	SOURCE	SAMPLING[1]	DATA	MANAGEMENT
AIR	VitPP Stack	Normal Off-Gas HEPA Prefilter S-48 (37 samples of which 31 were for TCLP)	TCLP[2] results: Ba up to 4.9 mg/l Cr up to 528.4 mg/l Pb up to 112.4 mg/l Se 0.09 - 0.1 mg/l	HEPA filters meet BAT for particulate. Filters that fail TCLP are managed as Hazardous Waste.
		Emergency Off-Gas HEPA Prefilter S-37 (2 samples, both for TCLP)	TCLP results: Ba up to 0.2 mg/l Cr 6.2 to 43.8 mg/l Pb 0.1 to 11.2 mg/l Se 0.2 (single sample)	HEPA filters meet BAT for particulate. Filters that fail TCLP are managed as Hazardous Waste.
		Building HVAC HEPA Prefilter S-85	No sampling during Campaign 2. Data will be reported for Campaign 4.	NA[3]
		S-12[4]	None. (See footnote 4)	BAT for stack met by HEPA filters
	Bag Dump Station	HEPA Prefilter	Filter was not changed; no samples taken	BAT for air source include fabric filter and HEPA filte Filters characterized for management.
WATER	WWTR Filters	S-1[5]	NA[3]	Wastewater from filters to Building Sump Tank[6]
	Bldg Sump	S-17 (7 samples, all for TCLP)	TCLP results: Ba - up to 2.9 mg/l Cr - 0.5 to 0.9 mg/l Pb - 0.5 to 16.1 mg/l TDS 15400-52500 mg/l TSS up to 53.2 mg/l	Wastewater sent to AWWT for further treatment
SOIL	Spills	Case by Case	No spills reported	NA[3]
WASTE	Glass	S-10 (44 samples, of which 23 were for TCLP)	TCLP results: Ba - 1.1 to 4.2 mg/l Cr - 0.02 to 0.23 mg/l Pb - 1.9 to 6.5 mg/l[7]	Glass that passes TCLP staged for disposal as solid waste. Drums of glass that fail TCLP are stored for reprocessing.
	Misc. Waste	Characterization per procedure	MEF generated or referenced	Disposal per site procedures

[1] Sampling points are described and their locations indicated in the Project Specific Plan (PSP) for Operable Unit 4 Vitrification Pilot Plant, Phase I, Process Sampling, 2504-SU-0011, Rev. 1, May 1996. The "S" numbered sampling points are established locations where samples are routinely taken during operation. Other waste streams are sampled on a case by case basis. Since Campaign 1, the PSP has been revised to include designated sampling for Emergency Off-Gas filters (S-37) and Building HVAC filters (S-85)

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[2] Toxicity Characteristic Leaching Procedure (TCLP) for testing for RCRA characteristic waste (40 CFR Part 261 Appendix II, Method 1311). Regulatory TCLP-based limits for barium, chromium, and lead are as follows:

Barium	100.0 mg/l
Chromium	5.0 mg/l
Lead	5.0 mg/l

[3] Not applicable. No sampling conducted.

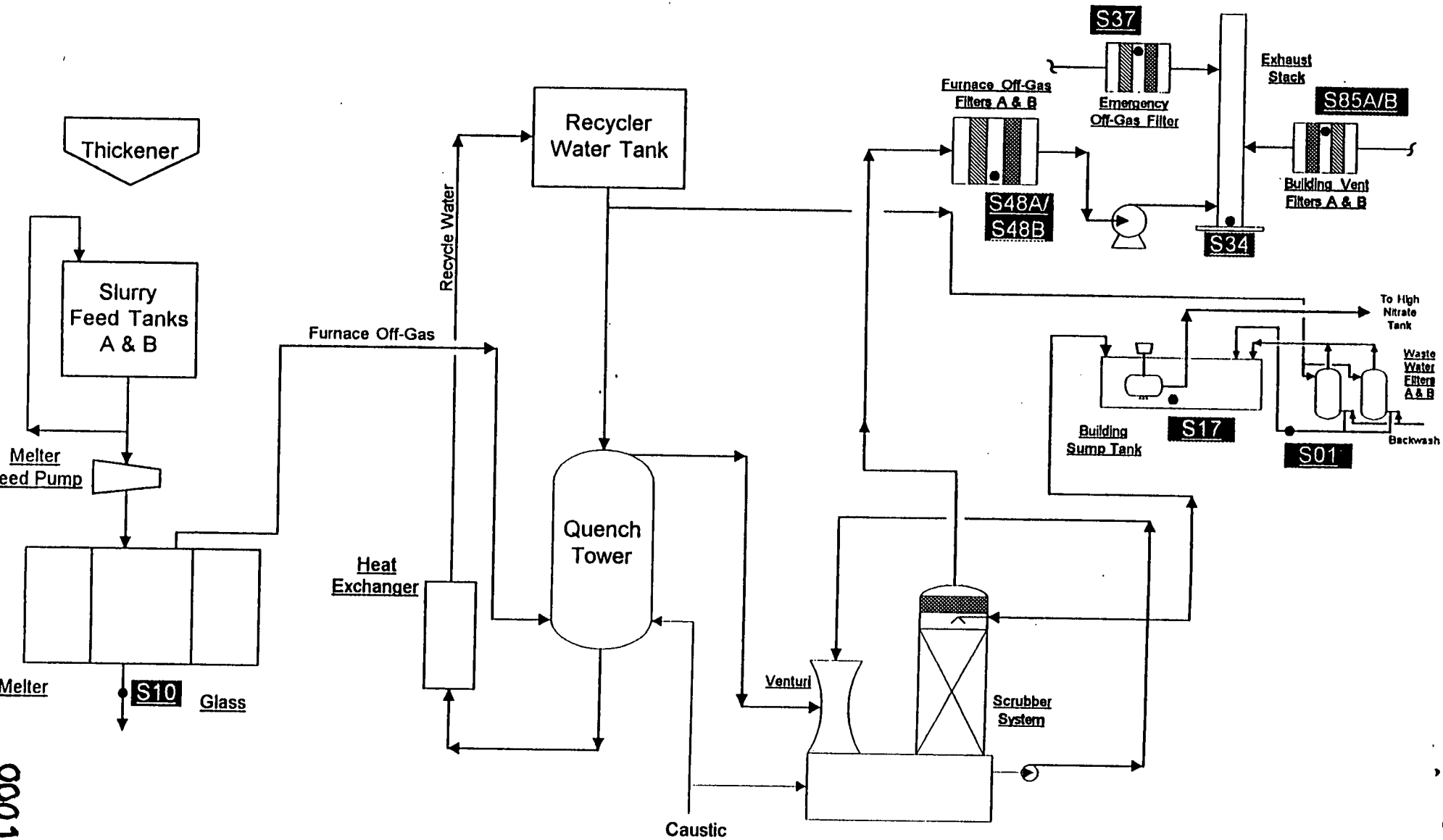
[4] Sampling point S-12 will be used to collect stack data only during Campaign 4. This sampling may include grab or continuous sampling, but most likely will not include isokinetic sampling.

[5] Testing of the thickener and the wastewater filters has been deleted from the test plan for Campaign 4. No filter effluent samples were taken during Campaign 2.

[6] Normal management of VitPP wastewater and stormwater is by collection in the Building Sump Tank (BST) and discharge to the Advanced Waste Water Treatment (AWWT) plant via the High Nitrate Tank.

[7] Several samples of glass from Batches 5, 6, and 7 failed the TCLP for lead. Retesting the three batches produced data that were below the TCLP regulatory limits, listed in footnote 2. This is discussed in more detail in Section 5.0 of the report.

Figure 7-1
VitPP Environmental Sampling Locations
Campaign 2



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7.2 Environmental Evaluation of Phase I Campaign 2

The Phase I Campaign 2 testing met all environmental regulatory requirements identified as applicable or relevant and appropriate requirements (ARARs) or environmental "to be considered" (TBC) criteria in the VitPP Phase I Work Plan, in accordance with the signed OU4 Record of Decision (ROD).

Environmental data taken during Campaign 2 included sampling of the air, water, and solid waste release pathways. A summary of environmental data for Campaign 2 is presented in Table 7-1. These data include the source of environmental contaminant, sample point, sample results, and how the contamination was managed. There were no spills or releases to soil during Campaign 2.

7.3 Air

Air sampling during Campaign 2 consisted of samples from HEPA filters and medium efficiency particulate air (MEPA) prefilters. Since there were no radionuclides present in the surrogate or feed additives, isokinetic monitoring of the stack at S-12 was not conducted. In addition, no stack performance testing was conducted. HEPAs used for VitPP building ventilation (new sample point S-85) were not sampled during Campaign 2.

A summary of the sampling data for the air pathway is included in Table 7-1.

Normal Off-gas HEPA Filters and Prefilters (S-48)

Samples from HEPA filters and prefilters used during Campaign 2 were taken and analyzed for RCRA metals. Several of the normal Off-gas System (OGS) filters failed (exceeded) the Toxicity Characteristic Leaching Procedure (TCLP) limit for chromium (5.0 mg/l limit for Cr) and lead (5.0 mg/l limit for Pb). The source of the lead is the feed additives. The source of the chromium is believed to be erosion of the high chromium refractory lining the Melter. Since chromium is observed at consistent concentration, the release rate from the refractory appears to be steady.

High humidity was present in the off-gas during Campaign 2. On occasion, free liquids condensed and collected in the HEPA filter housing. Samples of this liquid were analyzed and found to exceed the TCLP limits for chromium and lead. Excess filter liquid was disposed in the Building Sump Tank (BST). Filters that failed the TCLP were staged in two white metal boxes (WMBs) in Building 80 for disposal as hazardous waste.

Emergency Off-gas System (EOS) Filters and Prefilters (S-37)

The EOS consists of two possible off-gas pathways to the atmosphere. The "normal" EOS path is designed to prevent negative pressures in the melter from going positive. It consists of an 8-inch line through a pressure activated flow control valve, a knockout pot, and a 6-inch line to a high temperature HEPA filter and prefilter to remove particulate prior to discharge to the atmosphere. A continuously operating exhaust fan is situated downstream of the HEPA train. The pressure valve is set to open at -0.2 inches W.G. pressure in the melter.

The "true emergency" EOS path is designed to handle dangerous positive over pressurization in the melter. It consists of the same 8-inch line to the knockout pot, but bypasses the pressure controlled valve through a parallel rupture disk set to burst at a nominal 3 psi. From the knockout pot, a 10-inch line exhausts the gas unfiltered to the atmosphere through a pressure relief valve that opens at +10 inches W.G. This EOS flow path has not been activated during any of the Phase I testing.

All EOS filters were characterized for waste management. As indicated in Table 7-1, analysis of EOS filters from Campaign 2 indicated the filters occasionally f the TCLP for lead and chromium. As before, these filters that failed the TCLP were managed as hazardous waste.

The "normal" EOS was triggered on various occasions during Campaign 2. The "normal" EOS was placed in manual operation during maintenance on the off-gas system or melter. Maintenance activities included clean out of the NOG system, replacing the film cooler air lance, and replacement of the melter view ports. The EOS was also triggered during the various runs, mainly due to brief "pressure" surges caused by Melter cold cap upset, or the inability of the NOG system to maintain sufficient vacuum in the Melter. Feeding of the melter, or flushing of the feed lines into the melter was a frequent cause of EOS activation. Since the HEPA filtration on the EOS met Best Available Technology (BAT) for the surrogate constituents in Campaign 2, use of the EOS did not violate any environmental regulatory requirements. For the acid gases, the maximum SO_x potential release levels during Campaign 2 operation were close to the Ohio Air Toxics Policy (OATP) regulatory limit for releases of these pollutants to the off-site environment. However, the use of the acid gas scrubber during Campaign 2 met BAT for this class of pollutant.

During Campaign 2, the "normal" EOS activated a total of 38 times. Total duration of "normal" EOS usage during Campaign 2 was 24.3 hours. The longest

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continuous period of use was 4.9 hours, for maintenance on the NOG system and Melter. Average length of time the EOS was in use was 38 minutes; however, most EOS events were either very short (3 minutes typical), or very long durations.

Feed Additives

To ensure effluent from the feed additives station meets the OATP off-site limits, the hood fan exhaust is prefiltered through a fabric filter, then passed through a Medium Efficiency Particulate Air (MEPA) filter before reaching the atmosphere. Since the MEPA filter was changed prior to Campaign 2, no change or sampling of the filter was conducted during Campaign 2. Since lead and barium were added during Campaign 2, characterization sampling of this filter will be conducted prior to replacement to determine proper management.

There is a second feed additives filter assembly on top of the dry additives feed bin filter/receiver. This "Invincible" prefilter was not replaced during Campaign 2. Again, characterization sampling will be conducted prior to filter replacement.

7.4 Water and Wastewater (S-17)

Wastewater generated during Campaign 2 included scrubber blowdown, building sink drains, pad washdown, rainwater, and slurry tank flush water. These wastewaters are routed to the Building Sump Tank (BST), where they are subsequently transferred by one of two sump pumps controlled by automatic level switch. This wastewater is mixed with other FEMP wastewaters in the High Nitrate Tank (HNT), where it is continuously fed to the AWWT for additional treatment prior to discharge under the site NPDES permit.

Samples of wastewater were routinely taken at sampling point S-17 and analyzed for the RCRA metals barium, chromium, and lead. In addition, analyses for nitrate, total dissolved solids (TDS), and total suspended solids (TSS) were also conducted on Campaign 2 wastewater. Analytical data from S-17 indicate the RCRA metals concentrations in the BST exceeded the TCLP limits for lead in two samples (8.8 mg/l and 16.1 mg/l) during Campaign 2, and one sample (9.7 mg/l) following Campaign 2. A summary of the analytical data on the wastewater are presented in Table 7-1.

Off-specification batches of slurry were containerized and staged for refeed to the melter. Heel and slurry tank washout water that could not be refed to the melter was discharged as wastewater via the BST.

7.5 Soil and Spills

There were no reported off-pad spills of hazardous substances to soil during Campaign 2. However, there were various instances of leaks, pump seal failures, etc., which occurred on the VitPP containment pad. Leaks and spills on the pad were containerized for reprocessing to the extent practicable; residues remaining on the pad were washed down to the BST.

7.6 Glass and Other Waste

Waste produced during Campaign 2 included glass product, used air filters, empty feed additive bags, and personnel protective equipment (PPE). Each drum of glass has been characterized for metals in accordance with the TCLP. Preliminary analytical data from glass sampling (sample point S-10) indicated that glass samples from three drums of Campaign 2 glass (from batches 5, 6, and 7) exceeded the TCLP limit for lead. These batches were later re-analyzed using the TCLP and passed for the RCRA metals. The reasons for the discrepancy are being investigated. All glass from Campaign 2 that passes the TCLP will be managed as solid waste.

During Campaign 2, several pumps, valves, and sections of pipe were either rebuilt or replaced. Material contained in the pipe sections was removed and refed to the melter. Pipes, hoses, and other equipment that could not be reused and that contained Campaign 2 slurry, or lead and barium, were staged for waste characterization. Material that exhibited a RCRA characteristic was managed in accordance with the RCRA regulations.

Management of filters was discussed in the previous section. Empty bags and PPE that were not reused were disposed in dumpsters as solid waste. Miscellaneous waste was characterized by process knowledge, or by sampling on a case by case basis, as required, to determine proper management.

7.7 Mass Balance for Lead and Barium

Due to problems in obtaining data (see discussion below), a definitive environmental mass balance determination for lead and barium in Campaign 2 was not possible.

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7.8 Problems and Concerns

There are several opportunities for improvement in the area of environmental protection for future operation of the VitPP. These are discussed below.

7.8.1 General Regulatory

7.8.1.1 Lead and Barium Mass Balance

A mass balance determination to track lead and barium is needed for Phase I, Campaigns 2 and 4. There were both technical and procedural difficulties with providing a reliable mass balance determinations for lead and barium in Campaign 2, as follows:

1) There is no continuous stack monitoring in place to show concentration and total amount of metals released to the atmosphere. The iso-kinetic sampler was not installed during Campaign 2. Technical issues associated with installation include the need to weatherproof and heat the unit to ensure moisture in the off-gas does not condense or freeze in the sampler lines and bias the data. Another issue is the buildup of condensed liquids in the lower portion of the stack that could submerge the entry point of the sampler return line. It is recommended that the sampler be calibrated, and installed prior to Campaign 4.

2) Changing of HEPA filters and prefilters on the normal and emergency Off-gas System is keyed to pressure differential across the filter, and not to the beginning or end of a campaign or specific batch. This does not allow correlation of analytical data on the filter with off-gas concentration or metals loading for a specific glass formulation.

3) No specific procedure or protocol exists to conduct a mass balance determination. The current method of recordkeeping cannot quantify where lead and barium went in the system after it was added.

4) There was no way to track actual wastewater volumes discharged to the HNT during Campaign 2. The BST Sump Pump B was not connected to the VitPP database, VPPS, during Campaign 2 to record run times on the motor. Now connected, these data will be picked up by the database for Campaign 4.

5) Samples from the BST are taken on a fixed schedule, and are not keyed to wastewater generation or discharge rate, volume of wastewater, field activities, or processing of batches. Discharge from the BST is automatic. This means that the same wastewater could remain in the tank and be sampled twice, or the contents of the tank turn over several times between sample events. Therefore, no correlation can be drawn between S-17 data and actual mass of lead or barium leaving the system via the wastewater discharge.

7.8.1.2 Housekeeping and Waste Management

During Campaign 2, there were numerous spills and leaks on the pad, and modification of lines and equipment. Much of the equipment was left on the pad for extended periods of time before characterization and containerization. There needs to be a more systematic approach to management of residual material that is to be recycled or disposed.

7.8.2 Off-gas System

Ongoing problems associated with the desiccant system, high particulates in the normal Off-gas System, and use of the building HVAC filtration system were discussed in detail in the Campaign 1 Interim Report.

7.8.2.1 Moisture Control

Inability of the Desiccant Tower to remove excess moisture from the off-gas resulted in removal of the unit from the off-gas treatment train in Campaign 2. The high moisture content and relatively high particulate loading in the off-gas resulted in frequent plugging of the HEPA filters and prefilters during operation, requiring frequent changeout and replacement.

7.8.2.2 Emergency Off-gas System

As in Campaign 1, Campaign 2 also experienced significant use of the emergency Off-gas System. Although the emergency off-gas was HEPA filtered and the EOS met BAT for Campaign 2 runs, this is a concern for future plant operation. Limitations in design and operation contribute to the

frequent use of the EOS. Due to excessive inleakage, and pressure (head) losses in the off-gas line, the NOG system is unable to maintain target negative pressures in the Melter, causing the valve opening set points in the EOS line to be exceeded. Variation in the feed rate, cold cap disturbance, and flushing the feed line during operation also caused frequent activation of the EOS. Maintenance of the Melter or off-gas line (such as Film Cooler cleaning) also contributed to EOS usage. Use of the EOS during times of Melter feeding is of particular concern since there is the increased risk of overwhelming the filters with water vapor, entraining fine particulate from the feed directly into the off-gas, and exceeding the SO_x and NO_x environmental regulatory limits.

Use of the EOS on a routine basis negates the purpose of the EOS. Routine use of an Emergency Off-gas System would normally require the same controls as a normal Off-Gas System. For campaigns which could exceed regulatory limits for air pollutants, bypassing normal required control systems is not allowed under the OEPA Ohio Administrative Code (OAC). The corrective action alternative is to redesign the normal Off-gas System to improve control of the Melter to bring utilization of the emergency off-gas system back to only true emergency use. Since the EOS does not include treatment of the off-gas, feed to the Melter should cease whenever the EOS is being utilized.

7.8.3 Wastewater

The existing wastewater filter design will not be tested during Phase I (removed from scope of Campaign 4). This issue is important only if the filter will not be upgraded or the design changed prior to Phase II operation. Other issues associated with the wastewater system were included in the discussion on the lead and barium mass balance under 7.8.1.1 above.

7.8.4 Sampling and Data Management

Since Campaign 2 was initiated prior to preparation of the Campaign 1 report, problems identified with management of analytical data, cross referencing of analytical data with sample source, and timely access to data and information were not resolved in Campaign 2. These issues were discussed in detail in the Campaign 1 Interim Report. Corrective measures implemented during Campaign 2 are discussed in Section 5.6.3.

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7.8.5 Environmental ALARA

Ongoing problems with large volumes of slurry tank heel and rinseout waters, and control of contamination due to equipment leaks and failures during operations were discussed in detail in the Campaign 1 Interim Report.

7.8.6 Miscellaneous

Ongoing problems with unreviewed field changes, lack of regulatory review of SOPs and SOT procedures, and VitPP test log entries were discussed in detail in the Campaign 1 Interim Report.

7.8.6.1 Shift Manager's Turnover Checklist (Turnover Logs)

The Shift Reports frequently contain errors and inconsistencies. For example, dates of the night shift log are sometimes from the evening the shift started, other times from the morning the shift ended. Weights and volumes of material, and designation of tanks or lines are occasionally inconsistent or contradictory. Attention to detail, and updated training staff is recommended.

8.0 VitPP DESIGN DATA NEEDS FOR PHASE II

Data needs and test requirements were identified by the project for development of the VitPP for Phase II testing using silo waste and for design and cost information for a future higher throughput waste vitrification facility. These data needs were planned to be accomplished from the Phase I and Phase II VitPP operating campaigns.

The major VitPP systems operation and the test data obtained from Campaign 1 and Campaign 2 were reviewed from the perspective of providing the identified data needs. Table 8-1 summarizes the status of data requirements identified for the design of the FRVP; a higher throughput waste vitrification facility.

8.1 Feed Preparation System

The Feed Preparation System must be able to mix and homogenize the process slurry and to reliably pump the slurry through both horizontal and vertical piping containing valves and fittings. During Campaign 1 and Campaign 2 operations, variations were observed in the slurry solids loading during gradual pumped withdrawals from the two slurry tanks (5-TK-29A & B). This nonhomogeniety is believed to be caused by insufficient slurry mixing and solids suspension by the existing slurry tank agitators (5-AG-05A & B).

The supplier of the existing slurry tank agitators (Mixmor) indicates that the following data are needed to assess the agitator design:

- Dimensions of process tank and range of operating levels
- Specific gravity of slurry
- Solids content of slurry (percent by weight)
- Particle size distribution
- Density of individual particles (as opposed to the apparent density of a layer of settled solids)
- Slurry viscosity
- Determination of force to overcome settled slurry conditions

When pumping the slurry, the lack of in-line pressure instrumentation in the slurry piping has precluded calculation of slurry friction losses and apparent viscosity under actual flow conditions. Providing instrumentation for pump suction and discharge pressures would provide information for adjusting the diaphragm pump motive air supply and discharge pressures to improve operations and reduce wear. Data needed on the flow characteristics and rheology of the slurries were not

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obtained during Campaign 1 and Campaign 2.

Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
		SILO RESIDUAL MATERIAL RETRIEVAL		
11-1	Water flow to silo residue removal	Validate pilot plant material balance for Phase II operation	None	Planned from future Phase II pilot plant operation
11-2	Retrieved residue slurry composition, density, suspended solids content, size and density of largest particles	Material balance and rheology of residue feed slurry	None	Planned from future Phase II pilot plant operation
11-3	Retrieved residue slurry flow rate	Validate pilot plant material balance for Phase II operation, rheology of residue slurry, and hydraulic characteristics	None	Planned from future Phase II pilot plant operation
		THICKENER PERFORMANCE		
12-1	Flocculant addition rate	Thickener performance	None	Thickener not used for Campaigns 1 and 2 Separate thickener test planned
12-2	Thickener bottom slurry density, % suspended solids, size and density of largest particles	Thickener performance	None	Thickener not used for Campaigns 1 and 2 Separate thickener test planned
12-3	Thickener overflow dissolved and suspended solids particle size and size distribution	Thickener performance, determine downstream treatment of overflow stream, and validate material balance	None	Thickener not used for Campaigns 1 and 2 Separate thickener test planned
12-4	Recycle water flow to Quench Tower	Thickener performance	None	Thickener not used for Campaigns 1 and 2 Separate thickener test planned
12-5	Thickener overflow stream flow rate	Thickener performance	None	Thickener not used for Campaigns 1 and 2 Separate thickener test planned
12-6	Thickener underflow stream flow rate	Thickener performance	None	Thickener not used for Campaigns 1 and 2 Separate thickener test planned
12-7	Residue Slurry Pump discharge pressure	Rheology of Thickener underflow stream	None	Thickener not used for Campaigns 1 and 2 Separate thickener test planned

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Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
		FEED PREPARATION SYSTEM		
12-8	Melter feed composition, slurry density, % solids, size and density of largest particles Feed slurry rheology data	Material balance, glass quality slurry chemistry-glass correlations Feed slurry rheology data	Feed slurry composition, density, and % solids for benign glass, acceptance glass, and Series D glass formulations None	Continue slurry sampling and analyses during Campaign 4 Feed slurry system instrumentation required for rheology data not installed for Campaigns 1, 2, and 4 Campaign 4 feed slurry system design retrofit does not incorporate instrumentation for rheology data
12-9	Slurry Tank Pump discharge pressure	Hydraulics of slurry feed preparation loop	None	Slurry Tank Pump and pressure instrumentation performance inadequate for Campaigns 1 and 2 Campaign 4 feed slurry system retrofit design to incorporate changed pumps, piping, and instrumentation
12-10	Melter slurry feed flow rate Melter feed loop hydraulics	Hydraulics of Melter slurry feed loop	Melter slurry feed flow data for benign glass, acceptance glass, and Series D glass formulations None	Continue slurry sampling and analyses during Campaign 4 Feed loop instrumentation inadequate for Campaigns 1 and 2 Campaign 4 Melter feed loop and feed pump retrofit design to incorporate instrumentation
		MELTER		
13-1	Electrode movement	Determine electrode corrosion rate	Molybdenum concentration analyses of molten glass samples from Melter chambers East chamber D electrode end piece broken off	No electrode movement occurred during Campaigns 1 and 2 Continue electrode movement recording during Campaign 4
13-2	Electrode power	Melter energy consumption	Continuous amperage, voltage, and power data recorded	Continue power recording during Campaign 4
13-3	Glass production rate	Melter effectiveness	Produced glass weight recorded	Continue data recording during Campaign 4
13-4	Glass properties	Determine required molten glass residence time Determine Melter component temperatures, etc.	None Mr[illegible]nponent temperatures, co[illegible] cooling temperatures and flow [illegible]s, glass agitation air flow rates, glass air lift flow rate, observations of	Insufficient stable, sustained, Melter feed and glass discharge operating conditions during Campaigns 1 and 2 Sustained Melter runs planned for Campaign 4 Continue glass sampling and analyses ar recording during Campaign 4

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Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
13-5	Glass temperatures	Melter effectiveness	Molten glass and plenum temperatures recorded	Continue data recording during Campaign 4
		MELTER OFFGAS		
14-1	Compressed air flow rate to Melter	Quantify Melter inleakage to validate offgas system dynamic simulation	Melter air agitator and airlift air flow rate recorded	Continue data recording during Campaign 4
14-2	Compressed air flow rate to film cooler	Quantify Melter inleakage to validate offgas system dynamic simulation	Film Cooler and Lance cooling air flow rate recorded	Continue data recording during Campaign 4
14-3	Quench Tower offgas cooling	Evaluate Quench Tower performance	Offgas and water temperature data in and out of the Quench Tower and Quench Tower internal temperature recorded	Continue data recording during Campaign 4
14-4	Quench Tower overhead offgas flow rate	Quantify Melter inleakage to validate offgas system dynamic simulation	None	Offgas flow instrumentation in Quench Tower overhead stream not installed for Campaigns 1, 2, and 4
14-5	Film Cooler outlet offgas temperature	Design data for Quench Tower Scrubber, and Melter Offgas system	Film Cooler offgas outlet temperature recorded	Continue data recording during Campaign 4
14-6	Film Cooler offgas pressure drop	Film Cooler design	Film Cooler offgas pressure drop recorded	Continue data recording during Campaign 4
14-7	Melter internal operating pressure	Develop Melter pressure control logic	Melter internal pressure recorded	Continue data recording during Campaign 4
14-8	Quench Tower overhead gas composition (NOx, SOx, CO2)	Design acid gas removal/abatement capabilities and verify material balance	None	Instrumentation for Quench Tower overhead offgas composition not installed for Campaigns 1, 2, and 4
14-9	Composition and pH of spent Quench Tower liquid discharge	Decontamination efficiency of Quench Tower and verify material balance	Quench Tower discharge liquid stream composition data recorded during Campaign 2	Continue data recording during Campaign 4
14-10	Composition and pH of Quench Tower recycle water supply, suspended solids content and size distribution, dissolved solids content and size distribution	Decontamination efficiency of Quench Tower, verify material balance, and evaluate Waste Water Filter performance	Quench Tower recycle water supply composition data recorded during Campaign 2	Continue data recording during Campaign 4
	Radon concentration during Phase II operation	Radon material balance	None	Planned from future Phase II pilot plant operation

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Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
14-11	Composition and pH of Scrubber recirculation liquid	Quantify acid gas removal by Scrubber	None	No Scrubber recirculation liquid sampling during Campaign 1 Insufficient sampling and analyses during Campaign 2 for material balance information Planned from Campaign 4
14-12	Temperature of Scrubber liquid	Quantify Scrubber offgas cooling	Scrubber sump temperature recorded during Campaigns 1 and 2	Continue data recording during Campaign 4
14-13	Scrubber liquid supply pressure	Calculate total Scrubber liquid supply flow	Scrubber liquid recirculation pressure recorded during Campaigns 1 and 2	Continue data recording during Campaign 4
14-14	Scrubber Packed Tower liquid flow	Evaluate packed tower performance	Scrubber Tower liquid flow recorded during Campaigns 1 and 2	Continue data recording during Campaign 4
14-15	Offgas temperature to Desiccant Tower	Evaluate Desiccant Tower performance	Offgas temperature at Desiccant Tower inlet recorded during campaigns 1 and 2	Continue data recording during Campaign 4
14-16	Offgas temperature out of Desiccant tower	Evaluate Desiccant Tower performance	Offgas temperature at Desiccant Tower outlet recorded during Campaigns 1 and 2	Continue data recording during Campaign 4
14-17	Offgas moisture content of Desiccant Tower outlet	Evaluate Desiccant Tower performance	Offgas moisture content at Desiccant Tower outlet recorded during Campaigns 1 and 2	Continue data recording during Campaign 4
14-18	Radon content of Offgas at inlet to Carbon Beds during Phase II operation	Quantify Radon removal by Carbon Beds	None	Planned from future Phase II pilot plant operation
14-19	Radon content of Offgas at outlet from carbon Beds	Quantify Radon removal by Carbon Beds	None	Planned from future Phase II pilot plant operation
14-20	Combined Melter Offgas and vessel vent non-condensibles flow rate	Evaluate Radon removal and Desiccant Tower performance	None	Planned from future Phase II pilot plant operation
14-21	Scrubber overhead Offgas composition	Measure NOx scrubbing performance	None	Instrumentation for Scrubber Tower overhead offgas composition not installed for Campaigns 1, 2 and 4
14-22	Desiccant Tower operating p[illegible]	Quantify volumetric Offgas flow through Desiccant tower and Carbon Beds	None	Insufficient data recorded during Campaign 1 Desiccant Tower internal pressure instrumentation out of service during Ca[illegible]/2 Campaign 4 Offgas system retrofit desig[illegible]isses Desiccant Tower

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Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
14-23	Carbon Bed pressure drop	Quantify volumetric Offgas flow through Carbon Bed	None	Carbon Beds bypassed during Campaigns 1, 2, and 4
14-24	Radon concentration at exhaust stack	Quantify total Radon emissions	None	Planned from future Phase II pilot plant operation
14-25	Gamma concentration at exhaust stack	Quantify total gamma emissions	None	Planned from future Phase II pilot plant operation
14-26	Exhaust stack discharge rate	Quantify total radionuclide emissions	None	Planned from future Phase II pilot plant operation
14-27	Offgas temperature at inlet to HEPA filters	Material balance and pressure profile through system	None	Instrumentation for HEPA filter inlet Offgas temperature data not installed for Campaigns 1, 2, and 4
14-28	Exhaust Stack discharge rate	Material balance and pressure profile through system	Exhaust Stack total Offgas flow recorded during Campaigns 1 and 2	Continue data recording during Campaign 4
14-29	NOx loading on Carbon Beds	Quantify NOx interaction with activated carbon	None	Planned from future Phase II pilot plant operation
14-30	Pressure drop across Offgas Film Cooler outlet line	Provide indication of solids deposition/fouling inside line	Offgas Film Cooler transition line pressure drop recorded during Campaigns 1 and 2	Continue data recording during Campaign 4
14-31	Temperature of Sparge Tank liquid	Evaluate Radon stripping efficiency	None	Planned from future Phase II pilot plant operation
14-32	Air flow rate to Sparge Tank	Evaluate Radon stripping efficiency	None	Planned from future Phase II pilot plant operation
14-33	Radon content of Sparge Tank liquid effluent	Evaluate Radon stripping efficiency	None	Planned from future Phase II pilot plant operation
14-34	Radon emission from Stack	Demonstrate compliance to Rn-222 negotiated site release limit	None	Planned from future Phase II pilot plant operation
14-35	Emissions from Stack during Phase I tests to support Pb, Ba and Cr material balance	Demonstrate compliance with 40 CFR 61 and DOE Orders	None	No Stack Offgas sampling or analyses during Campaigns 1 and 2 Insufficient sampling and analyses of other plant streams to perform material balance during Campaign 2 Campaign 4 Offgas isokinetic sampling planned
	Emissions from Stack during Phase II tests; radionuclides, TOC, NOx, SOx, HCL, fluorides, heavy metals, particulates		None	Planned from future Phase II pilot plant operation

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Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
14-36	1 time Stack performance test of emissions of radionuclide, visible particulates, heavy metals, TOC, NOx, SOx, HCL, and fluorides	Demonstrate compliance with OAC 3745-17-11 for particulate emissions	None	Planned from future Phase II pilot plant operation
15-1	Operating pressure of Thickener, Slurry Tanks, Recycle Water Tank, Building Sump Tank, and Sparge Tank	Monitor pressure profile through process vessel vent system, confirm negative gauge pressure in each tank, monitor effects of tank filling and pump out	None	Planned from future Phase II pilot pant operation
WASTE WATER TREATMENT				
20-1	Deleted; same data as item 14-10			
20-2	Waste Water Filter effluent, suspended solids content, and size distribution	Evaluate filter performance	Recycle Water Filter effluent samples analyzed during Campaign 2	Continue sampling and analysis during Campaign 4
20-3	Pressure drop across Waste Water Filter	Evaluate filter performance	Waste Water Filter pressure drop recorded during Campaigns 1 and 2	Continue recording Waste Water Filter pressure drop during Campaign 4
20-4	Flow rate through Waste Water Filter	Evaluate filter performance	Waste Water Filter flow recorded during Campaigns 1 and 2	Continue recording Waste Water Filter flow during Campaign 4
20-5	Cumulative flow through Waste Water Filter between backflushes	Evaluate filter performance	Waste Water Filter cumulative flow recorded during Campaigns 1 and 2	Continue recording Waste Water Filter cumulative flow during Campaign 4
20-6	Pilot Plant Building Sump Tank effluent	Pilot Plant Building waste water characterization during Phase I for Ba, Pb, and Cr Phase II for hazardous materials and radionuclides	Pilot plant Building Sump effluent sampling and analyses performed during Campaign 2	Continue pilot plant Building Sump Tank sampling an analyses during Campaign 4
GLASS PRODUCT HANDLING				
24-1	Gob cutter wheel and roller temperature as a function of time	Reliability/operability of the gem maker	None	Insufficient Gem Machine operating time and instrumentation during Campaigns 1 and 2 Run time data to be recorded during Campaign 4
24-2	C surface temperature of chine housing	Feasibility of locating equipment near Gem Machine conveyor housing	Gr chine housing interior and ex e joint temperatures recorded d mpaigns 1 and 2	Continue recording Gem Machine housin and expansion joint temperature during Campaign 4

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Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
24-4	Operation hours before failure for all equipment in this system	To estimate mean time to failure for all equipment	None	Insufficient operating time of Gem Machine during Campaigns 1 and 2 Run time data to be recorded during Campaign 4
		GLASS PRODUCT PACKAGING		
25-1	Gem temperature as a function of time after discharge into hopper	Required staging time before gems can be loaded into concrete boxes	None	Instrumented hoppers not provided during Campaigns 1 and 2; no data recorded Record drum temperature data during Campaign 4
25-2	Radiation field from glass (hopper) as a function of time after discharge from Melter	Design of shielding for material handling device and optimization of waste container	None	Planned from future Phase II pilot plant operation
25-3	Monolith temperature as a function of time after pouring	Required staging time before drums can be loaded into concrete boxes	None	Instrumented hoppers not provided during Campaigns 1 and 2; no data recorded Record drum temperature data during Campaign 4
25-4	Radiation field at the surface of the concrete waste container	Verify the optimization of the waste container design to minimize shielding and weight of container, maximize payload, and minimize disposal costs	None	Planned from future Phase II pilot plant operation
		RADIATION TECHNOLOGY SYSTEM		
62-1	Thickener Tank shield wall gamma dose rate survey	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-2	Furnace room shield wall gamma dose rate survey	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-3	Carbon Bed shield wall gamma dose rate survey	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-4	Slurry Tank shield wall gamma dose rate survey	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-5	Major component survey; Thickener	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-6	Major component survey; Recycle Water Tank	Modeling correlation	None	Planned from future Phase II pilot plant operation

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Table 8-1
FRVP DATA NEEDS SUMMARY ASSESSMENT

FRVP DATA ID#	DATA REQUIRED	FRVP DATA NEED	DATA ACQUISITION STATUS THROUGH PHASE I CAMPAIGN 2	REMARKS
62-7	Major component survey; Carbon Bed(s))	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-8	Major component survey; Melter Offgas HEPA Filter housing	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-9	Major component survey; Building Sump Tank	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-10	Major component survey; Silo material transfer piping	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-11	Major component survey; Gem Hopper (over time)	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-12	Major component survey; shipping container	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-13	Major component survey; Quench Tower	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-14	Major component survey; Desiccant Tower	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-15	Major component survey; Slurry Tank(s)	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-16	Deleted; same data as 62-10			
62-17	Silo 3 surge Bin	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-18	Silo 3 Filter/Receiver	Modeling correlation	None	Planned from future Phase II pilot plant operation
62-19	Thickener area Radon concentration	Radon release from Thickener	None	Planned from future Phase II pilot plant operation

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During Campaign 2 it was recognized that the continuing problems related to the operation of the slurry tanks, slurry pumps, valves in the slurry piping, and the layout of the slurry piping would be an unsatisfactory basis for design of an upgraded vitrification plant. The Feed Preparation System required significant retrofit to provide reliable operation to support the upcoming Campaign 4 vitrification operations.

The OU4 project determined to replace the Feed Preparation System as necessary to provide reliable slurry feed operation for Campaign 4. The basis for the retrofit design does not include the system being prototypical of a Feed Preparation System for a higher throughput vitrification facility.

Additional system operation testing of a prototypical Feed Preparation System will be necessary to provide data needed for a higher throughput facility capable of vitrifying radioactive material.

The Feed Preparation System deficiencies discussed in the Campaign 1 treatability report were unchanged throughout Campaign 2. The lessons learned from Campaigns 1 and 2 contributed to the design of the retrofit system for the Feed Preparation System for Campaign 4.

8.2 Glass Product Handling

Design data on the temperature and temperature decay with time of the glass product containers were not obtained during Campaign 2 operations. Glass container external surface temperature data as a function of time are being considered for Campaign 4.

8.3 Furnace Off-gas System

During Campaign 2, the Furnace Off-gas System performed in the same manner as in Campaign 1 after the system fan upgrade was completed and the Film Cooler air lance was incorporated. As with the Feed Preparation System, the project has determined to overhaul the Furnace Off-gas System to provide reliable operation for the upcoming Campaign 4 operation. The system revision, while satisfactory for Phase I nonradioactive operation, is not prototypical for a higher throughput vitrification facility for radioactive service. Additional system testing of a prototypical Furnace Off-gas System will be necessary to provide process and design data needed for a higher throughput vitrification facility for radioactive material.

8.4 Gem Machine System

Glass Discharge Diverters

During Campaign 2, glass from the Melter discharge orifice was not completely captured by the diverter chute while the diverter was in the "startup" position. Glass emerging from the far west side of the Discharge Chamber would stream by and pour directly on the Gob Cutter wheel. When the glass flow was diverted, the molten glass had a tendency to accumulate and adhere to the discharge chute and to the east inside wall of the Gem Machine housing prior to falling into the Startup Drum. The Gem Machine's lower side panels were removed to access the solidified glass and break it loose. Since the glass streams from the Discharge Chamber orifice inconsistently flowed from the west and center sections of the orifice, all glass discharge was directed onto the Emergency Diverter chute.

With the Discharge Diverter in the "emergency" position, molten glass had a tendency to adhere to the discharge chute and to the west inside surface of the Gem Machine housing. Over a period of time, the molten glass would accumulate rather than fall into the emergency drum. The area between the diverter chute and the emergency drum was cleared of glass on two occasions. One instance amounted to a 55-gallon drum full of solidified glass.

The pneumatic actuation for the diverter positioning was not smooth. The pneumatic cylinders required physical coaxing to be positioned properly. The kinematics of the design allowed the cylinder to catch periodically as it was actuated.

Lube Spray System

The Gob Cutter/Gob Roller assembly required continuous monitoring to adjust the lube spray flow during gem production. A continuous flow of lubricant was necessary to control glass sticking problems and keep the Gob Cutter/Gob Roller assembly cool at the pour stream contact point.

Lubricant accumulation in both the startup and the emergency drums was due to the required heavy lubricant usage. The lube reclamation aspect of the system was not effective. A better lube reclamation system would significantly improve the Gem Machine performance.

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Discharge Chamber

The Discharge Chamber geometry did not provide a consistent glass pour stream location or a consistent single pour stream. However, the multiple pour stream effect supported easier control of the streams during gem production and while adjusting the Melter glass discharge Air Lift flow. When the Air Lift flow was increased, the glass flow increased proportionally in each pour stream. This proportioning provided a continuous and smooth gem production rate. When a single glass stream was pouring, a small Air Lift flow adjustment (~0.5 scfh) with a constant trickle air flow setting of 2.0 scfh had a significant effect on the pour stream flow rate and stream diameter.

Over a period of time (~20 minutes), semi-solidified ribbons of glass would form.. The ribbons started at the discharge orifice and gradually grew downward toward the Gob Cutter. Eventually the ribbon formation eliminated the glass pour stream. Either the startup or the emergency diverter were cycled into position to break the ribbon at the point of origin or some other point above the Gob Cutter/Gob Roller. With the glass broken, the diverter could be actuated into the "gem" position to continue gem production.

Glass continued to flow from an annulus section around the discharge orifice. The flow was slow and gradually formed a glass buildup around the orifice to the point of fully blocking the orifice opening. It was necessary to burn out the glass clog using an acetylene torch. The burn out process required repeating often during runs, necessitating turn off of the Melter feed and interrupting the run continuity.

Glass Discharge Control

The Gem Machine operation required constant supervision to adjust the Air Lift flow, monitor the discharge glass stream flow and condition, actuate the diverters, adjust the Gob Cutter lube spray flow, and flush the lube spray nozzles. Adjustment of the Gob Cutter lubrication requires continuous monitoring to reduce the accumulation of excess graphite lubricant in the gem product, startup, and emergency drums. Two operators were required to monitor the discharge of molten glass from the Melter and the glass stream from the discharge orifice; one to adjust the Air Lift flow and one to observe and feed back information on the effect of an adjustment on the discharge orifice stream flow.

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Recommendations

Problems associated with the molten glass stream adhering to the diverters, the inside walls of the Gem Machine, and developing ribbons were observed to be effected by the gem housing temperature. Typically the gem housing temperature was in the range of 160°F to 210°F. Operating the gem housing at ~ 325°F aided in exacerbating the glass adherence problems.

A major supplier of shear lubricants recommended use of a lard-based lubricant in place of the graphite spray lube for the Gob Cutter. The commercial glass industry currently uses the lard-based lubricant.

The vendor also suggested that the Gob Cutter surface temperature should be maintained below 200°F to reduce glass sticking. For Campaign 4 operation, a water-cooled Gob Cutter retrofit is planned.

To control the glass adherence problems within the Gem Machine housing, installation of graphite lining is recommended.

8.5 Maintenance Log Keeping

VitPP maintenance activities during Campaign 1 and Campaign 2 were contained in the Supervisor's Shift Turnover Log prepared at the end of each shift. For maintenance work, a FEMP Work Request/Order is prepared (see FEMP Work Request/Order Procedure, MT-0003, 6/28/96) and executed. The work request as written is general and typically does not describe in detail the work or activities performed to complete the work request. Section F of the procedure, Work Process/Package Closeout, provides for recording comments/lessons learned from the activity, however, this may be general comments since no guidelines are provided. Completed FEMP Work Request/Order forms are archived and controlled at the document control center.

The present Maintenance Log keeping is not adequate for tracking equipment performance, failure modes, diagnostics, and corrective actions in enough detail to provide design data for a future vitrification facility. It is suggested that log keeping guidelines/procedures be provided for recording information on logs, log keeping responsible party, and archiving of the log. The Maintenance Log should serve as a record for defining equipment maintenance history for both plant and engineering personnel, and it should be recorded and stored in a retrievable manner.

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9.0 LESSONS LEARNED

The VitPP has and is undergoing extensive testing of all the operating systems. Design, construction, and operation of the VitPP has provided experiences that can be valuable to others.

These "lessons learned" are contained in Appendix E of this report. The information has been accumulated from "plan of the day" meetings, Total Quality Management (TQM) meetings, and daily operations/testing at the VitPP. Appendix E is sorted by system and area of the VitPP. These items will be reviewed by Fluor Daniel Fernald Engineering, Operations, Project Management, and Testing to ensure all activities are incorporated, documented, and implemented in design and procedures for operation for the VitPP, plant upgrades, and ultimately the final operating facility and program.

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Appendix A
VitPP SYSTEMS

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Appendix A
VitPP SYSTEMS

The operation of various systems in the VitPP during Campaign 2 is detailed in the following subsections. Figure A-1 is a process flow diagram which shows the movement of material through the VitPP.

A.1 Feed Preparation

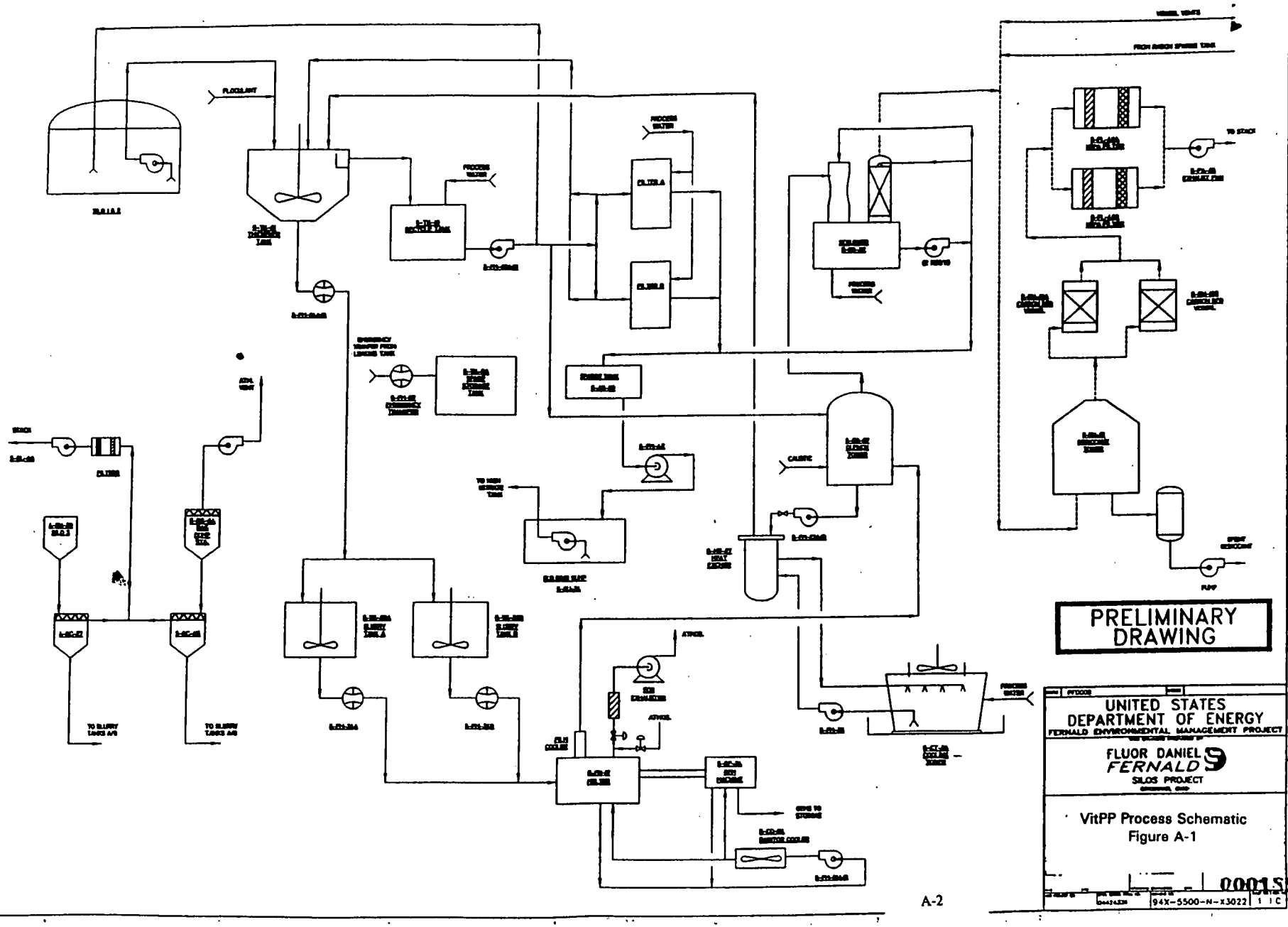
The equipment for introducing additives to the feed includes a standard industrial bag slitting and dumping station. The bag dump station has its own ventilation fan and includes filters to control fugitive dust during the dumping operation. The surrogate and additive materials, which are introduced as dry powders, are pneumatically conveyed to a filter/receiver unit. Exhaust from the filter/receiver is vented by a vacuum blower (that draws through a HEPA filter unit) prior to release through the VitPP exhaust stack.

Solids from the filter/receiver fall into one of two slurry tanks for mixing with water. Slurry is agitated with turbine agitators and recirculated with double-diaphragm slurry transfer pumps to maintain the slurry in suspension. The slurry transfer pumps recirculate the slurry through either (1) a short loop directly back to the slurry tank or (2) through a longer loop to the Melter Feed Pump and back to the slurry tank.

During Campaign 2[1], all of the slurry feed ingredients were added directly to one of the Slurry Tanks (A or B). The Thickener Tank was not used. Water was added to a Slurry Tank. Dry ingredients were pre-weighed and added to a Slurry Tank via the pneumatic transfer system. The slurry was mixed using the tank agitators and recirculated through the Melter feed loop for feed to the Melter or through the bypass loop if the slurry was being held in standby.

Throughout Campaigns 1 and 2, the feed preparation and slurry systems provided many operational challenges. The pipes of the pneumatic material transfer system and the slurry recirculation and Melter feed system frequently clogged. Clogging

[1]It must be noted that during this phase of testing, all materials are added through this system and therefore large quantities must be processed manually. During operations with slurry from the thickener, the quantities of additives will be reduced significantly as would be the case with actual remediation.


PRELIMINARY DRAWING
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FLUOR DANIEL FERNALD
SILOS PROJECT
VitPP Process Schematic
Figure A-1
94X-5500-N-X3022

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was a result of two primary issues: (1) poorly designed piping with too many 90 degree bends, horizontal sections, and dead sections with too few access ports for flushing and cleaning; and (2) the physical and chemical characteristics of the slurry. In combination with the clogging issues, components of the slurry transfer pumps and Melter Feed Pump wore down rapidly with constant exposure to the abrasive slurry. The diaphragms, balls, and seats, of the double-diaphragm Slurry Tank Pumps as well as the seals on the Melter Feed Pump were frequently replaced.

While the inherent problems of the system still exist, Operations and Maintenance personnel have developed techniques to lengthen the life of the components and quickly replace or rebuild the components when they do fail.

Operational experience gained during Campaigns 1 and 2 also provides evidence that the agitation system in the Slurry Tanks and the shape of the tanks are inadequate. The agitator is incapable of independently mixing the slurry and preventing solids from depositing on the bottom of the tank. This is a critical issue considering the frequency that the Slurry Transfer Pumps fail. Even with the combined mixing effort of the slurry pumps and the agitator, the slurry is not homogeneous throughout the batch. Operations personnel have learned to anticipate the changing percent solids of the slurry and the effects it has on the Melter.

Examination of the Slurry Tanks after a series of batches revealed that the current configuration of the tanks is inadequate for the slurry preparation and feeding process. Significant quantities of material are retained in the tank due to the various ledges and access ports in each tank. This design oversight was addressed with a combination of forgiving slurry formulas and occasional labor-intensive tank cleanings. Redesign of this system will be considered prior to Phase II testing.

A.2 Melter, Glass Forming, and Water Cooling

A.2.1 Vitrification and the VitPP Melter

Glass is normally an excellent electrical insulator. However, glass does become conductive when it melts at high temperatures. Once glass becomes soft, its ability to conduct electricity increases with temperature, although it always offers some electrical resistance to the electricity flowing through it. This resistance results in heat. "Joule" heat is the name given for heat that is generated from electricity passing through a material. The glass, itself, generates the heat in a

joule-heated melter.

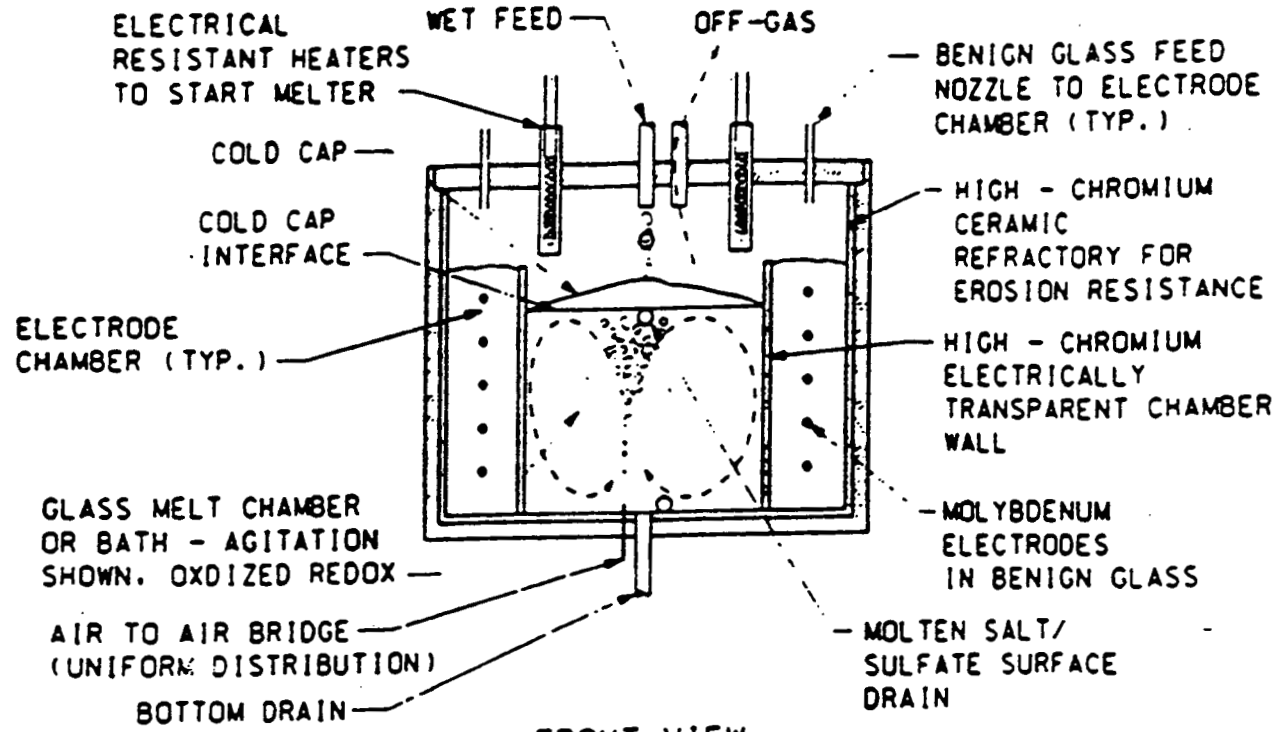
Electrical power, and thus heat, is added to the molten glass via the in-bed electrodes. A secondary heat source is required to initially melt glass before the electrodes are inserted into the molten glass and energized. The electrodes are not functional until the glass softens and becomes conductive. Electrical resistance heaters above the bath (molten glass in the Melter) provide the heat to melt the startup glass and initiate the joule-heating process.

Slurry feed enters the Melter from the top and collects on the surface of the bath. Typically, joule-heated melters operate with a "cold cap." The cold cap is defined as a mass of solid materials that collects on top of the molten glass after entering the melter. When the materials come to temperature, technically, they do not melt, but rather, dissolve into the molten glass like sugar into water. This is evident because most of the constituents in the glass have higher melting points than the glass itself (e.g., SiO_2 and $CaCO_3$ both melt above 1700°C).

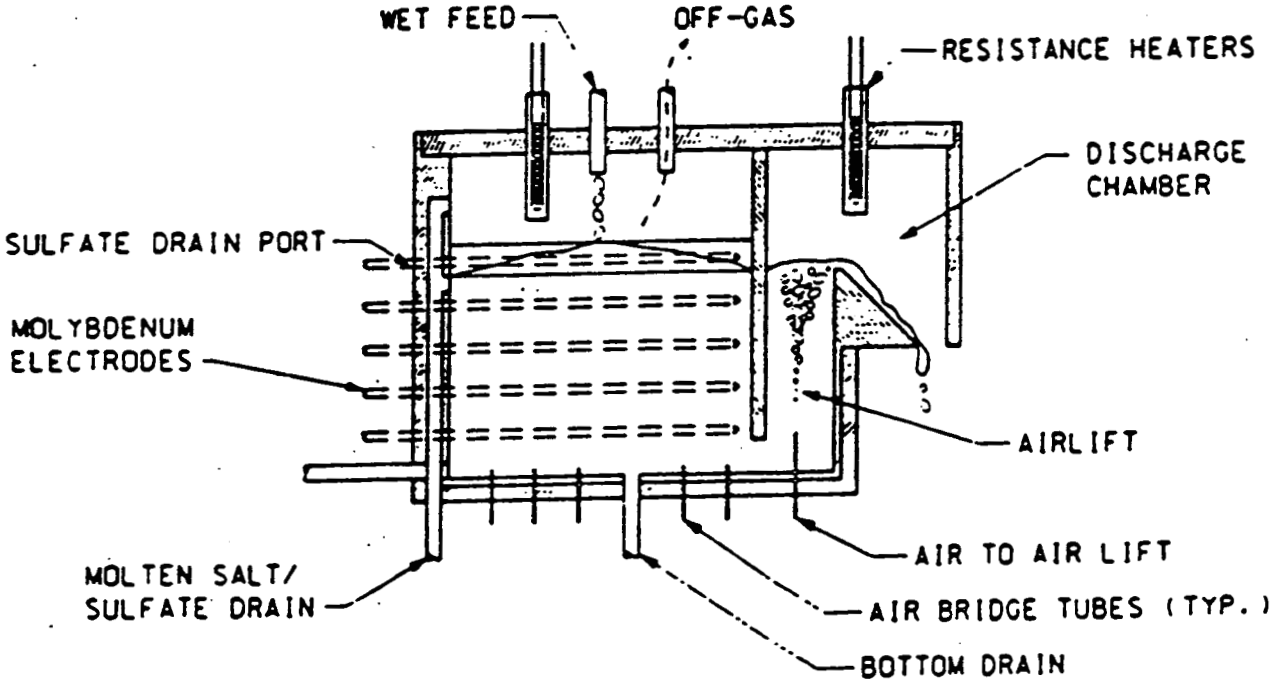
Melter production is largely dependent on the rate of the dissolution at the cold-cap/molten-glass interface. Increased agitation and temperature can increase the rate of production. However, constituents that do not readily dissolve in the melt can form layers at the interface or "wick" into the cold cap. These effects ca hinder (or even poison) dissolution, and thus, decrease the glass production ra. Conversely, these effects can increase the production rate if they help to conduct the heat into the cold cap without poisoning the dissolution.

A melter that is not operating with a cold cap is probably not working at full capacity, unless the Melter cannot deliver more power to the glass melt. The VitPP Melter appears to be no different. A change in glass chemistry can help match parameters with the Melter to increase power delivery.

The general arrangement of the Melter is shown in Figure A-2. The Melter was designed and manufactured by GTS Duratek. Some parts of this melter design are proprietary and/or patented by GTS Duratek. This melter was designed to produce 1 MT/d of glass without agitation and up to (and possibly over) 3 MT/d of glass with agitation. Its electrodes are made of molybdenum, but unlike a conventional melter the electrodes do not contact the waste materials. The erosiveness of the silo wastes would actively erode the electrodes in typical melters with in-bath electrodes. Therefore, the electrodes are housed in isolated chambers where they are immersed in a benign glass. The isolation walls are only to provide a physical barrier. The walls are electrically semi-transparent to allow current to travel between the electrodes and keep the glass molten. This melter concept and design are experimental and have not been demonstrated for this large a melter until



FRONT VIEW



SIDE VIEW

OU4 Melter Concept -- Simplified

Figure A-2: Melter Layout

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Because the walls do offer some resistance, the Melter design and glass chemistry are more complex than for a conventional melter.

A.2.1.1 Melter Agitation

Agitation increases glass production rate. Mechanical agitation is difficult (if not impossible) to construct because of material of construction and cooling problems at high temperature. Therefore, the VitPP uses an air bridge consisting of sparge tubes for agitation. The tubes are located in a row down the center of the Melter and bubble air through the bath. This action produces agitation much like boiling water does in a cooking pot. Agitation should assist dissolution of the cold cap, distribution of heat in the bath and reduce the potential of the settling of elemental metals and debris in the glass melt. The results of agitation will be discussed in detail in the campaign results.

A.2.1.2 Wet Feed

The wastes from Silos 1 and 2 will be removed from the silos as a wet slurry. Early designs for the VitPP included a dryer which sent dry feed to the Melter. However, this was eliminated when it was found that the Minimum Additive Waste Stabilization (MAWS) Project[2] melter ran with high rates with a wet slurry feed. Also, some of the steam flashing concerns about placing water atop molten glass were eliminated.

Glass is a poor conductor of heat. Therefore, glass cannot deliver heat fast enough to boil water fast enough to cause a steam excursion at the surface. Water actually puddles and/beads on the surface of molten glass and boils. Large quantities of water would have to be injected into the interior of the glass melt bath to cause a steam excursion.

It is possible for a melter to perform better with a wet or slurry feed. The agitation of the boiling water can enhance heat transfer and dissolution of

[2]The MAWS is a vitrification process installed in Plant 9 at Fernald. It also has a joule-heated melter, but it has only one chamber with Inconel 690™ plate electrodes. Its maximum operation temperature was 1150°C. Its capacity was 1/3 to 1 MT/d. The vitrification process was linked to other waste minimization processes to establish synergy in waste volume reduction and minimization of the need for addition additives, hence its name, the Minimum Additive Waste Stabilization Project.

the slurry constituents into the molten glass. There have been some melter studies that have started as dry feed systems, but their production rates were less than expected. The dry feed formed a stagnate interface with molten glass. However, when the same feeds were fed wet, the production rates increased, even though more heat was needed by the Melter to boil the water.

A.2.1.3 Melter Discharge

Molten glass can be discharged from the Melter in either a continuous or batch mode. The continuous mode is accomplished by the molten glass passing through the discharge chamber and out the discharge trough. The batch method is accomplished by using a unique air lift feature located in the bottom of the discharge chamber. The air lift injects air bubbles that lift molten glass into the discharge chamber over the edge of the trough. The rate of discharge can be controlled by the rate of air flow applied. The air lift gives flexibility in the control of glass flow through the Melter and to the Gem Making Machine. The ability of the Gem Making Machine (discussed later) appears to be largely dependent on the ability of the discharge orifice to deliver a consistent stream of molten glass.

A.2.1.4 Melter Cooling and Wall Design

The VitPP Melter's walls are designed for air cooling. This requires the melter to have thicker walls and insulation when compared to common water-cooled melters. Both air and water-cooled melters require a temperature drop across the thickness of the walls to prevent the seepage of molten glass past the refractory bricks. The VitPP Melter's walls are thick to keep the exterior temperature of the Melter within reasonable limits (≤100°C). Water-cooled melter walls are thin because cooling plates are placed on the walls to absorb the extra heat and drop the temperature to prevent the flow of glass through the wall. Also, water-cooled melters are prone to damage in the event of power failures and other unexpected shutdowns. The extra mass of the walls in an air-cooled melter stores heat and helps keep the melter warm. The VitPP Melter appears that it could hold enough heat for about 6 hours before the glass gets too cold (900 °C). The VitPP Melter also has an intermediate shell made of Inconel™, to stop the flow of glass should it start to advance.

Cooling of the molybdenum electrodes, where exposed to air, is essential

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because molybdenum will start to oxidize in air at 400°C and burn at h. temperatures. Therefore, the electrode holders are water-cooled to drop the temperature of the molybdenum electrodes below 400°C within 15 cm of the hot side of the Melter wall. Molten glass flows around the inner portion of the electrode and freezes to prevent oxidation. The electrode can wear down with use requiring more electrode material to be inserted. This is done by temporarily turning off the cooling water to the drain and letting the glass around the electrode soften until the electrode can be pushed in with a new section of molybdenum added.

The feed ports and drains are also water-cooled. Drains work by freezing glass above the drain pipe with cooling water. Then, when needed, the cooling water is turned off, the glass plug thaws and a mechanism is used to push the plug into the Melter before backing out the mechanism to allow the glass to flow out.

A.2.1.5 Melter Refractories and Operating Temperature

Most commercial melters are made of alumina or alumina/zirconium type refractories because they do not impart color to the glass and they ha fairly good erosion/corrosion resistance against normal glasses. Howev these refractories would not be effective against the erosiveness of the silo wastes. Also, a good portion of the waste is alumina which makes alumina refractories less desirable. Refractories high in chromium are commonly used for this application. The major drawbacks with chromium refractories are that they are expensive and they may need to be treated as Resource Conservation Recovery Act (RCRA) material when the melter is dismantled. In addition, the erosion of the refractory introduces chromium into the NOG system and glass.

The refractories in the Melter walls and the partition walls are expected to allow operating temperatures above 1400°C; however, the lives of these components and melter would be greatly reduced. Therefore, the stated melter design temperature is 1400°C with a maximum operating temperature of 1350°C. Direct temperature measurements of the bath, using thermocouples in thick platinum thermowells, are presently working well. However, this may not always be possible because the thermocouple wells may corrode/erode away. Correlations with other thermocouples in the Melter and other methods to determine the bath temperature are being developed and are presented in this report.

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A.2.2 Mass and Energy Balance Around the Melter

Large amounts of mass and energy pass through the Melter during the vitrification process. Most of the mass transfer takes place in the center chamber; however, some energy is also transferred to the side chamber. The amount of power that needs to be supplied to the Melter by the electrodes is the summation of all the heat losses throughout the Melter. Table A-1 contains calculated heat loss for the Melter producing 1 MT/d of startup glass (known as Wet 16 glass) from a 50 wt% slurry.

Notice, that the lid heater banks are shown as negative values because they are minimally energized to prolong their lives. However, some of these heaters did fail during Campaign 2. Spare heaters are available for replacement when necessary. The basis for the numbers is summarized in Table A-2.

Table A-1
Melter Heat Loss

Power Requirements	Amount kg/hr	Amount Each	q' watts/unit	Q watts
Feed Moisture -- evaporate	53.26	--	1,031	54,900
Gas Generation	11.52	--	195	2,200
In-leakage & bubbler	66.67	--	195	13,000
Radiant/convection shell loss	--	--	52,000	52,000
Cooling -- Electrodes	--	10	500	5,000
Cooling -- Ports	--	5	3,000	14,400
Cooling -- Drains	--	4	3,500	13,700
Vitrification, glass	41.76	--	408	17,000
Lid heater banks	--	2	-1,000	-2,000
Total	--	--	--	170,200

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Table A-2
Melter Heat Loss Calculation Basis

Power Requirements	Basis
Feed Moisture -- evaporate	Heat to boil and raise the temperature of water vapor to exhaust temperature, X°C.
Gas Generation	Heat to the temperature of air to exhaust temperature, X°C.
In-leakage & bubbler	Heat to the temperature of air to exhaust temperature, X°C. In-leakage is assumed 30 scfm and the bubbler 2 scfm for the calculations in the chamber. However, the in-leakage has been determined to be as high as 80 to 100 scfm. If so, this can increase the heat demand approximately 20 to 40 more kilowatts. Air in-leakage from the discharge chamber is already preheated to approximately 1250°C, and therefore, requires no additional heating.
Radiant/convection shell loss	The MAWS melter (located at the Fernald Site and of similar construction) lost approximately 16,600 watts at 1150°C and has a surface area of approximately 116 ft^2. The VitPP has approximately 338 ft^2 and is at 1250°C. Therefore: $q_p \approx$ 16,600 watts x (338 ft^2/116 ft^2) x (1250°C-20°)/(1150°C-20°C) $q_p \approx$ 52,000 watts
Cooling -- Electrodes	Calculated by the amount of heat that can pass along the axis of a 3-in molybdenum metal cylinder between the temperatures of approximately 1150°C and 400°C.
Cooling -- Ports	Reference
Cooling -- Drains	Reference
Sulfate destruction	See Campaign 2, Section 5.3.1,"Sulfate Effervescence Events." for discussion and values for sulfate destruction.
Vitrification, glass	Heat capacity, C_p, of the glass was experimentally determined in the lab by pouring molten glass into water and measuring the temperature rise of the water. The C_p = 0.33 watt-hours/kg°C. This equates to 17,000 watts/metric ton to heat the glass to 1250°C.
Lid heater banks	Measured in the field.

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A.2.3 Energy Balance Around the Side Electrode Chamber

The ability to put power into the Melter is best understood by doing an energy balance around a side electrode chamber. Calculations showed that the electrode chamber would normally run cooler than the center chamber and this was proven in the campaign runs. Figure A-3 shows the model used to perform the calculations.

The heat balance for the side chamber is mathematically as follows:

$$\text{Accumulation, } a_c = \sum \text{in} - \sum \text{out} \qquad \text{(Equation A-1)}$$

$$a_c = q_b + q_g + q_p - q_e - q_s - q_w - q_d \qquad \text{(Equation A-2)}$$

Each flux was individually broken down into equations and entered into fields in a spreadsheet so values could be calculated for different scenarios. Figure A-4 shows the spreadsheet calculating the results for producing startup glass at 1 MT/d at 1250°C from 50 wt% solids in the slurry. The basis for the temperature profile through the partition wall is given in the appendix. The temperature profile across the thickness of the partition wall is also shown in Figure A-4 with a Campaign 1 Startup glass. Notice that the partition wall can get hotter than the surrounding glass; however, this depends on the conductance of the center chamber glass conductivity, center bath temperature, and production rate of the Melter. Figure A-5 shows the Melter producing the same glass at 3 MT/d with Campaign 1 Startup glass. This glass rate puts undue hardship on the Melter because it requires high amperage.

The Melter can behave quite differently from one glass to the next. Compare Figure A-4 against Figure A-6 (showing a Series A Glass). Both are producing glass at 1 MT/d at 1250°C from 50 wt% solids in the slurry, but notice the difference in voltage, amperage, temperature profile of the partition wall, and the temperature in the side chamber. They are greatly different because of the differences in the conductivity of the glasses. This was evident when sodium carbonate was added directly to the Melter to reduce the viscosity of the glass during Campaign 1 (see Section 5.14). Increasing the temperature also changes the conductivity of the glass as shown in Figure A-7 (also showing a Campaign 1 Startup Glass). Notice that the conductivity of the side chamber glass and the partition wall also change. Together these show that the Melter is sensitive to the conductivity of the glass and vice versa. They become more sensitive at higher production rates and the operating envelope narrows. This is because at high power the conductivity of the glass needs to be just right so power can be put into the Melter at the proper volts to amps ratio. Figure A-8 shows how this envelope looks. This envelope is only preliminary and will be refined with data from future Melter runs.

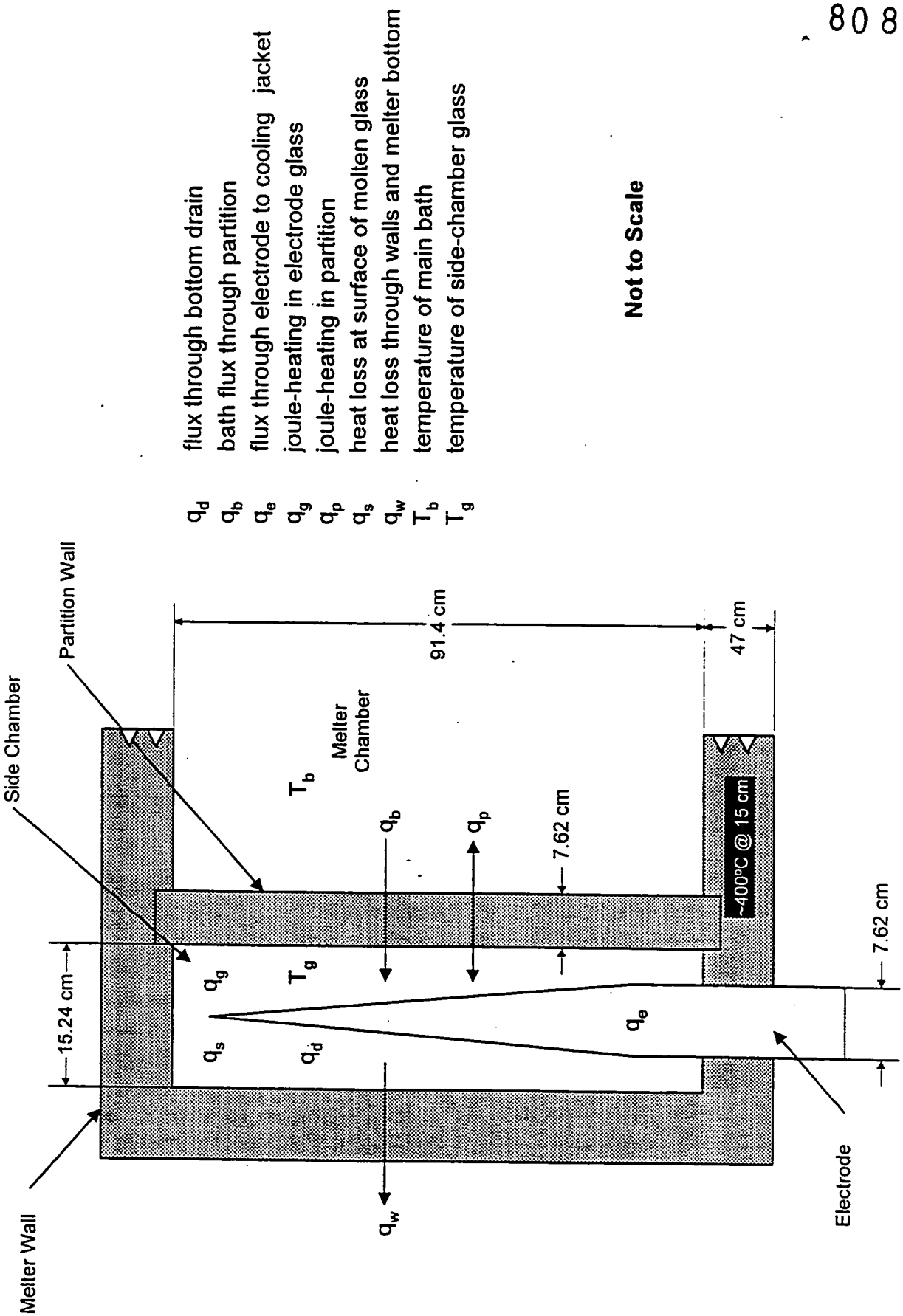


Figure 3-3
Melter Heat Balance

Melter Heat & Power Profile

Rod F. Gimpel 08/13/96

E-ST09x.WK4

Scenario: **Startup Glass (Wet16) -- 50 wt% Slurry, 1 tonnes/day glass**
Estimate

Waste Glass: **Startup** Electrode Glass: **C4EG-10**

Inputs:		Calculated:		Qout/Qin:
Bath temp., ^C	1,250	S. chamber temp, ^C:	1,138	1.00
Bath level, cm	81.3	Glass, tonnes/day	1.00	
S.Chamber depth, cm	4.50			
Feed rate, L/hr	72.00	Inputs:		
kg glass/L feed	0.58	Air Inleakage, scfm	30	
% Moisture	50.00	Bubbler, scfm	2	
Feed density, g/cm3	1.48	Radiant heat sink, ^C:	450	

Needed Power	Amount kg/hr	Amount each	q' watts/unit	Q watts
Moisture	53.28		1,031	54,932
Gas generation	11.52		195	2,246
Inleakage & bubbler	66.67		195	13,000
Radiant losses	--		52,000	52,000
Cooling - Electrodes		10	481	4,808
Cooling - Ports		5	2,880	14,400
Cooling - Drains		4	3,425	13,700
Vitrification, glass	41.76		408	17,038
Lid heater banks		2	(1,000)	(2,000)
	173.23	19	na	170,124

Power Calc.	Conduct. S/cm	Resist. ohm-cm	Resist. ohm	Power watts	Voltage Drop, v	%
Left cham.	0.333	3.00	0.0018	4,788	2.95	2.81
L. partition	0.096	10.38	0.0106	27,954	17.21	16.43
Main	0.310	3.23	0.0397	104,639	64.43	61.51
R. partition	0.096	10.38	0.0106	27,954	17.21	16.43
Right cham.	0.333	3.00	0.0018	4,788	2.95	2.81
Total	na	na	0.0645	170,124	104.76	100.00
				Amps:	1,623.95	

Ac	Qg	Qx	Qe	Qd	Qs	Qw
44	4,788	20,279	(2,404)	(2,000)	(5,019)	(15,600)

S, watts/cm3:	0.4937
k, watts-cm/cm2-^C:	0.0577
A, cm2:	7,431
Te, ^C:	1,138
Tb, ^C:	1,250

Part. depth X, cm	Temp. C	Conduction Only, ^C	Generation Only, ^C	Q(x) watts
0.00	1,138	1,138	1,138	20,279
0.25	1,150	1,142	1,146	19,362
0.50	1,161	1,145	1,153	18,445
0.75	1,171	1,149	1,160	17,528
1.00	1,181	1,153	1,166	16,611
1.25	1,190	1,156	1,172	15,693
1.50	1,199	1,160	1,177	14,776
1.75	1,208	1,164	1,182	13,859
2.00	1,215	1,167	1,186	12,942
2.25	1,223	1,171	1,190	12,025
2.50	1,230	1,175	1,193	11,108
2.75	1,236	1,178	1,195	10,191
3.00	1,241	1,182	1,197	9,273
3.25	1,247	1,186	1,199	8,356
3.50	1,251	1,189	1,200	7,439
3.75	1,255	1,193	1,200	6,522
4.00	1,259	1,197	1,200	5,605
4.25	1,262	1,200	1,199	4,688
4.50	1,264	1,204	1,198	3,771
4.75	1,266	1,208	1,196	2,854
5.00	1,268	1,211	1,194	1,936
5.25	1,268	1,215	1,191	1,019
5.50	1,269	1,219	1,188	102
5.75	1,269	1,223	1,184	(815)
6.00	1,268	1,226	1,180	(1,732)
6.25	1,266	1,230	1,175	(2,649)
6.50	1,265	1,234	1,169	(3,566)
6.75	1,262	1,237	1,163	(4,484)
7.00	1,259	1,241	1,157	(5,401)
7.25	1,256	1,245	1,149	(6,318)
7.50	1,252	1,248	1,142	(7,235)
7.62	1,250	1,250	1,138	(7,675)

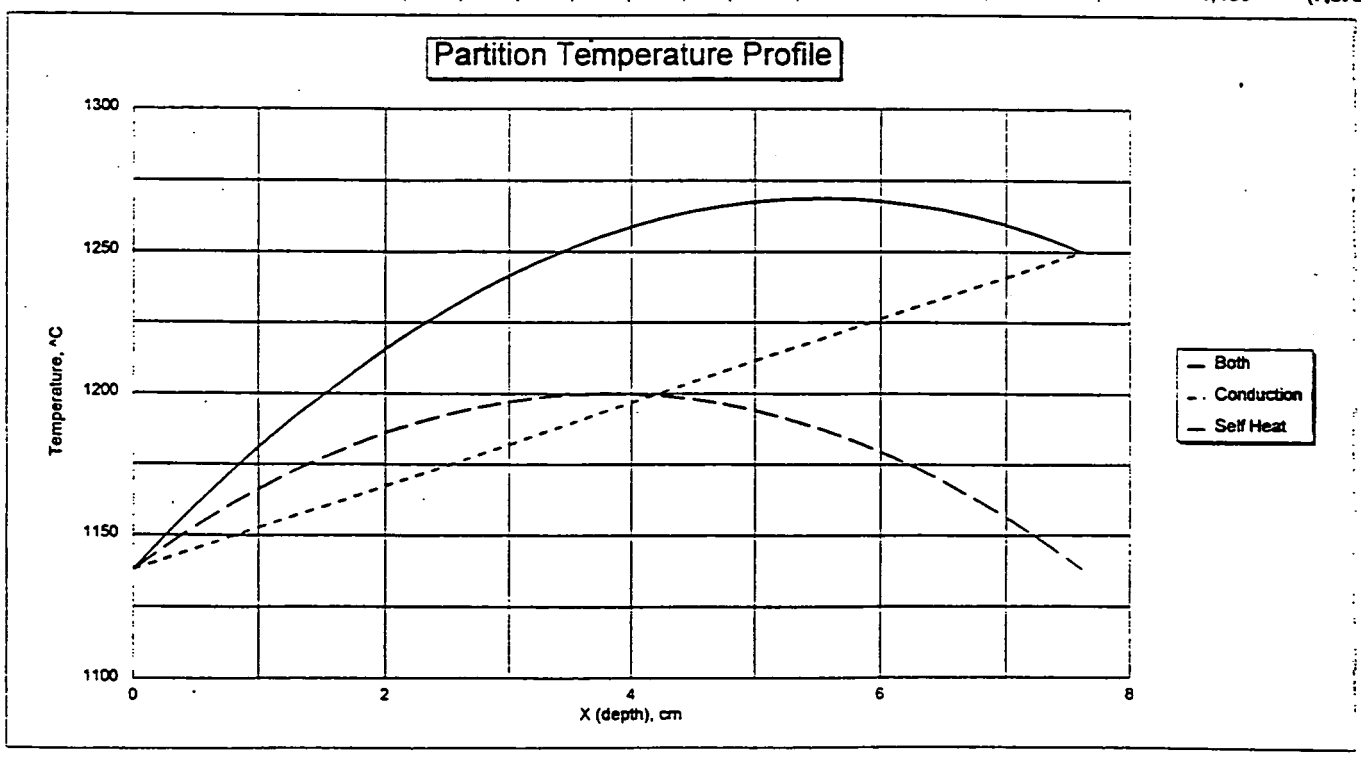


Figure A-4

Melter Heat & Power Profile

Rod F. Gimpel

Scenario: **Startup Glass (Wet16) -- 50 wt% Slurry, 3 tonnes/day glass**
Estimate

Waste Glass: Startup Electrode Glass: C4EG-10

Inputs:		Calculated:		Qout/Qin:
Bath temp., ^C	1,250	S. chamber temp, ^C:	1,242	1.00
Bath level, cm	81.3	Glass, tonnes/day	3.00	
S.Chamber depth, cm	4.50			
Feed rate, L/hr	215	Inputs:		
kg glass/L feed	0.58	Air Inleakage, scfm	30	
% Moisture	50.00	Bubbler, scfm	2	
Feed density, g/cm3	1.48	Radiant heat sink, ^C:	450	

Needed Power	Amount kg/hr	Amount each	q' watts/unit	Q watts
Moisture	159.31		1,031	164,246
Gas generation	34.44		195	6,717
Inleakage & bubbler	66.67		195	13,000
Radiant losses	--		52,000	52,000
Cooling - Electrodes		10	559	5,588
Cooling - Ports		5	2,880	14,400
Cooling - Drains		4	3,425	13,700
Vitrification, glass	124.86		408	50,944
Lid heater banks		2	(1,000)	(2,000)
	385.28	19	na	318,594

Power Calc.	Conduct. S/cm	Resist. ohm-cm	Resist. ohm	Power watts	Voltage Drop, v	%
Left cham.	0.657	1.52	0.0009	5,155	2.18	1.62
L. partition	0.133	7.54	0.0077	43,109	18.22	13.53
Main	0.310	3.23	0.0397	222,065	93.87	69.70
R. partition	0.133	7.54	0.0077	43,109	18.22	13.53
Right cham.	0.657	1.52	0.0009	5,155	2.18	1.62
Total	na	na	0.0569	318,594	134.67	100.00
				Amps:	2,365.74	

Ac	Qg	Qx	Qe	Qd	Qs	Qw
(27)	5,155	22,005	(2,794)	(2,000)	(6,793)	(15,600)

S, watts/cm3:	0.7613
k, watts-cm/cm2-^C:	0.0577
A, cm2:	7.431
Te, ^C:	1,242
Tb, ^C:	1,250

Part. depth X, cm	Temp. C	Conduction Only, ^C	Generation Only, ^C
0.00	1,242	1,242	1,242
0.25	1,254	1,242	1,254
0.50	1,266	1,243	1,265
0.75	1,277	1,243	1,276
1.00	1,287	1,243	1,286
1.25	1,296	1,243	1,295
1.50	1,304	1,244	1,303
1.75	1,312	1,244	1,310
2.00	1,318	1,244	1,316
2.25	1,324	1,244	1,322
2.50	1,329	1,245	1,326
2.75	1,333	1,245	1,330
3.00	1,337	1,245	1,333
3.25	1,339	1,245	1,336
3.50	1,341	1,246	1,337
3.75	1,342	1,246	1,338
4.00	1,342	1,246	1,338
4.25	1,341	1,246	1,336
4.50	1,339	1,247	1,335
4.75	1,337	1,247	1,332
5.00	1,334	1,247	1,328
5.25	1,330	1,248	1,324
5.50	1,325	1,248	1,319
5.75	1,319	1,248	1,313
6.00	1,312	1,248	
6.25	1,305	1,249	
6.50	1,297	1,249	
6.75	1,288	1,249	1,281
7.00	1,278	1,249	1,271
7.25	1,267	1,250	1,260
7.50	1,256	1,250	1,248
7.62	1,250	1,250	1,242

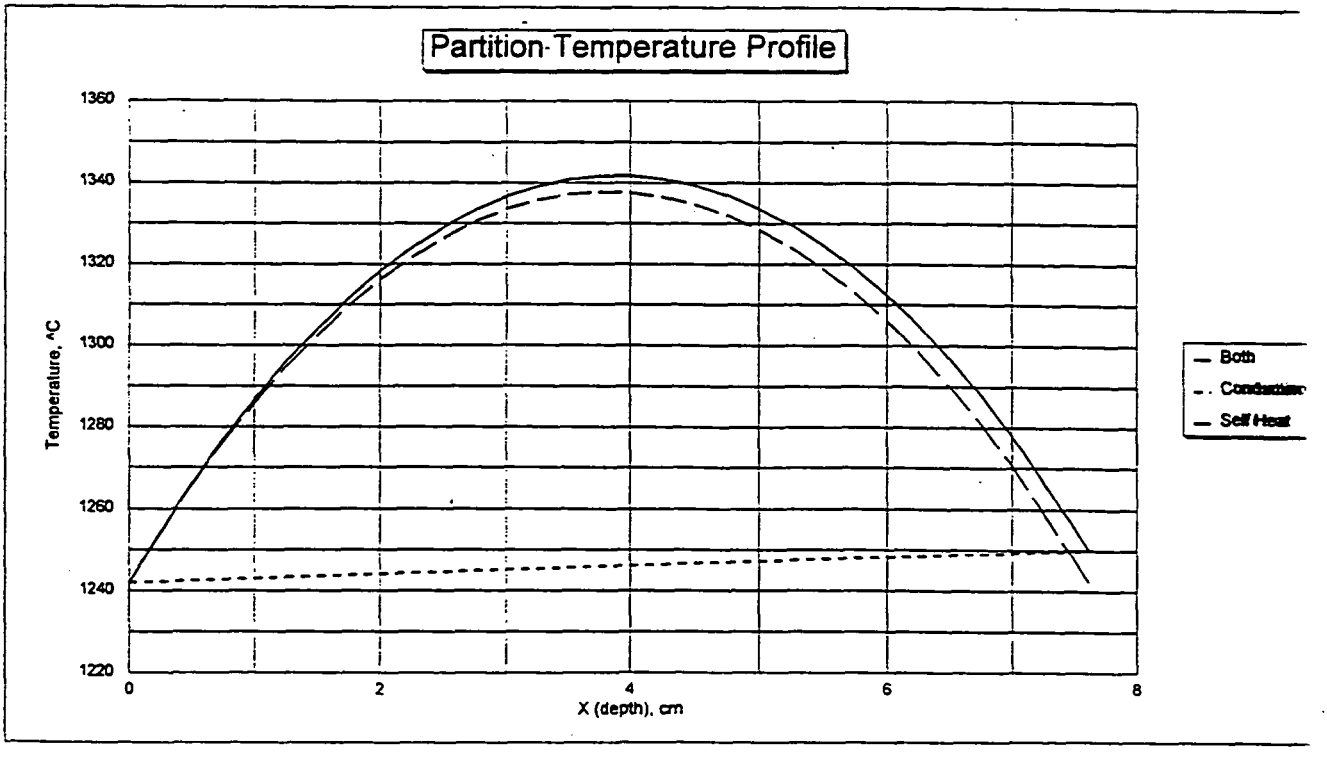


Figure A-5

Melter Heat & Power Profile

Rod F. Gimpel 08/08/96

E-A01x.WK4

Scenario: **Series A Glass at 1 tonne/day glass, 50 wt% slurry**

S, watts/cm3:	0.2331
k, watts-cm/cm2-^C:	0.0577
A, cm2:	7,431
Te, ^C:	1,025
Tb, ^C:	1,250

Waste Glass: **C4A-03** Electrode Glass: **C4EG-10**

Inputs:		Calculated:		Qout/Qin:
Bath temp., ^C	1,250	S. chamber temp, ^C:	1,025	1.00
Bath level, cm	81.3	Glass, tonnes/day	1.00	
S.Chamber depth, cm	4.50			
Feed rate, L/hr	72.00	Inputs:		
kg glass/L feed	0.58	Air Inleakage, scfm	30	
% Moisture	50.00	Bubbler, scfm	2	
Feed density, g/cm3	1.48	Radiant heat sink, ^C:	450	

Needed Power	Amount kg/hr	Amount each	q' watts/unit	Q watts
Moisture	53.28		1,031	54,932
Gas generation	11.52		195	2,246
Inleakage & bubbler	66.67		195	13,000
Radiant losses	–		52,000	52,000
Cooling - Electrodes		10	396	3,960
Cooling - Ports		5	2,880	14,400
Cooling - Drains		4	3,425	13,700
Vitrification, glass	41.76		408	17,038
Lid heater banks		2	(1,000)	(2,000)
	173.23	19	na	169,276

Power Calc.	Conduct. S/cm	Resist. ohm-cm	Resist. ohm	Power watts	Voltage Drop, v	%
Left cham.	0.141	7.10	0.0043	3,778	4.03	2.23
L. partition	0.068	14.68	0.0150	13,198	14.07	7.80
Main	0.080	12.50	0.1538	135,323	144.24	79.94
R. partition	0.068	14.68	0.0150	13,198	14.07	7.80
Right cham.	0.141	7.10	0.0043	3,778	4.03	2.23
Total	na	na	0.1923	169,276	180.43	100.00
				Amps:	938.16	

Ac	Qg	Qx	Qe	Qd	Qs	Qw
(31)	3,778	19,259	(1,980)	(2,000)	(3,489)	(15,600)

Part. depth X, cm	Temp. C	Conduction Only, ^C	Generation Only, ^C	Q(x) watts
0.00	1,025	1,025	1,025	19.259
0.25	1,036	1,032	1,029	18.826
0.50	1,047	1,040	1,032	18.393
0.75	1,058	1,047	1,035	17.960
1.00	1,068	1,055	1,038	17.527
1.25	1,078	1,062	1,041	17.094
1.50	1,088	1,069	1,044	16.661
1.75	1,097	1,077	1,046	16.228
2.00	1,107	1,084	1,048	15.795
2.25	1,116	1,091	1,049	15.362
2.50	1,125	1,099	1,051	14.929
2.75	1,133	1,106	1,052	14.496
3.00	1,142	1,114	1,053	14.063
3.25	1,150	1,121	1,054	13.630
3.50	1,157	1,128	1,054	13.197
3.75	1,165	1,136	1,054	12.764
4.00	1,172	1,143	1,054	12.331
4.25	1,179	1,150	1,054	11.898
4.50	1,186	1,158	1,053	11.465
4.75	1,193	1,165	1,053	11.032
5.00	1,199	1,173	1,051	10.599
5.25	1,205	1,180	1,050	10.166
5.50	1,211	1,187	1,049	9.733
5.75	1,217	1,195	1,047	9.300
6.00	1,222	1,202	1,045	8.867
6.25	1,227	1,210	1,042	8.434
6.50	1,232	1,217	1,040	8.001
6.75	1,236	1,224	1,037	7.568
7.00	1,240	1,232	1,034	7.135
7.25	1,244	1,239	1,030	6.702
7.50	1,248	1,246	1,027	6.269
7.62	1,250	1,250	1,025	6.061

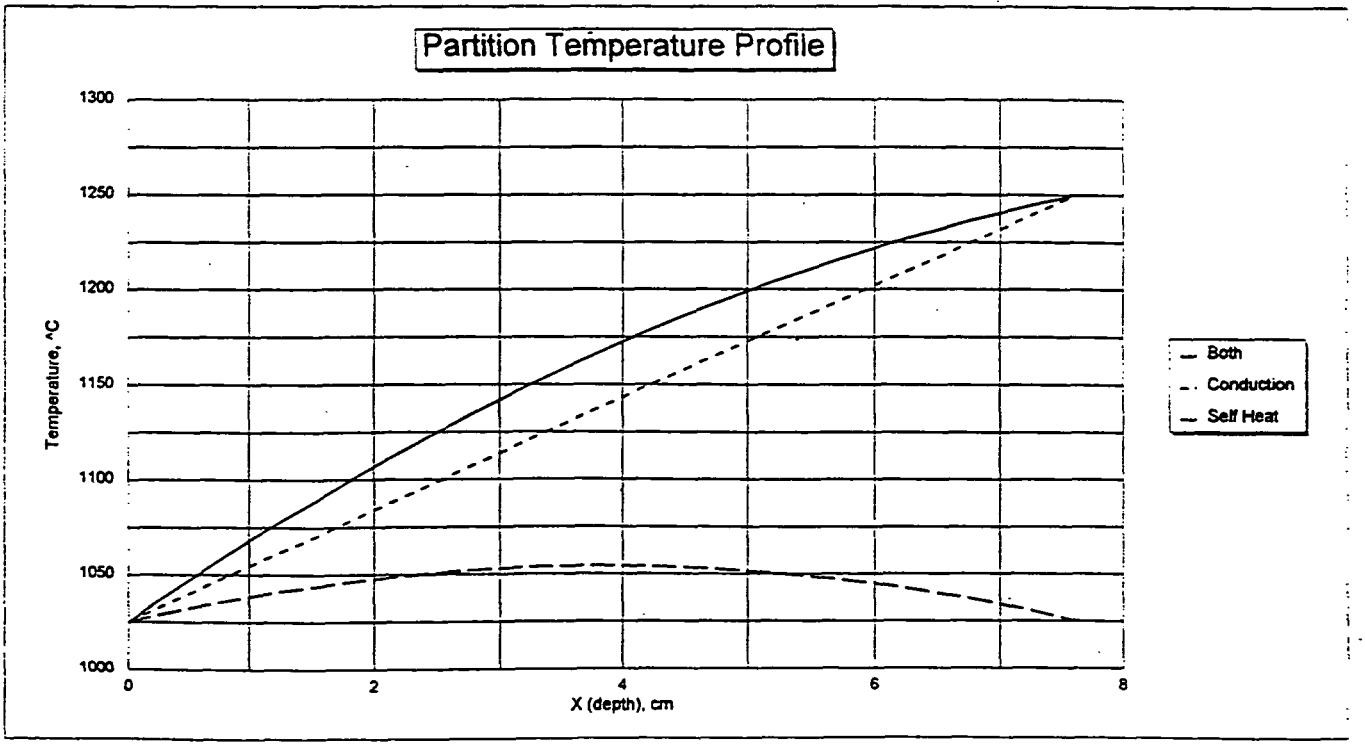


Figure A-6

Melter Heat & Power Profile

Rod F. Gimpel

Scenario: **Startup Glass (Wet16) -- 50 wt% Slurry, 1 tonnes/day glass**
Estimate

Waste Glass: **Startup** Electrode Glass: **C4EG-10**

Inputs:		Calculated:		Qout/Qin:
Bath temp., ^C	1,350	S. chamber temp, ^C:	1,204	1.00
Bath level, cm	81.3	Glass, tonnes/day	1.00	
S.Chamber depth, cm	4.50			
Feed rate, L/hr	72.00	Inputs:		
kg glass/L feed	0.58	Air inleakage, scfm	30	
% Moisture	50.00	Bubbler, scfm	2	
Feed density, g/cm3	1.48	Radiant heat sink, ^C:	450	

Needed Power	Amount kg/hr	Amount each	q' watts/unit	Q watts
Moisture	53.28		1,031	54,932
Gas generation	11.52		195	2,246
Inleakage & bubbler	66.67		195	13,000
Radiant losses	–		58,118	58,118
Cooling - Electrodes		10	530	5,303
Cooling - Ports		5	3,219	16,094
Cooling - Drains		4	3,828	15,312
Vitrification, glass	41.76		441	18,401
Lid heater banks		2	(1,000)	(2,000)
	173.23	19	na	181,405

Power Calc.	Conduct. S/cm	Resist. ohm-cm	Resist. ohm	Power watts	Voltage Drop, v	%
Left cham.	0.518	1.93	0.0012	5,377	2.51	2.96
L. partition	0.160	6.23	0.0064	29,334	13.67	16.17
Main	0.506	1.98	0.0243	111,984	52.17	61.73
R. partition	0.160	6.23	0.0064	29,334	13.67	16.17
Right cham.	0.518	1.93	0.0012	5,377	2.51	2.96
Total	na	na	0.0394	181,405	84.52	100.00
				Amps:	2,146.34	
Ac	Qg	Qx	Qe	Qd	Qs	Qw
72	5,377	22,882	(2,651)	(2,000)	(6,101)	(17,435)

S, watts/cm3:	0.5181
k, watts-cm/cm2-^C:	0.0577
A, cm2:	7,431
Te, ^C:	1,204
Tb, ^C:	1,350

Part. depth X, cm	Temp. C	Conduction Only, ^C	Generation Only, ^C
0.00	1,204	1,204	1,204
0.25	1,217	1,209	1,212
0.50	1,230	1,214	1,220
0.75	1,242	1,218	1,227
1.00	1,253	1,223	1,234
1.25	1,264	1,228	1,240
1.50	1,274	1,233	1,245
1.75	1,284	1,238	1,250
2.00	1,293	1,242	1,254
2.25	1,301	1,247	1,258
2.50	1,309	1,252	1,261
2.75	1,317	1,257	1,264
3.00	1,324	1,261	1,266
3.25	1,330	1,266	1,268
3.50	1,336	1,271	1,269
3.75	1,341	1,276	1,269
4.00	1,346	1,281	1,269
4.25	1,350	1,285	1,268
4.50	1,353	1,290	1,267
4.75	1,356	1,295	1,265
5.00	1,359	1,300	1,263
5.25	1,360	1,305	1,260
5.50	1,362	1,309	1,256
5.75	1,362	1,314	1,252
6.00	1,363	1,319	
6.25	1,362	1,324	
6.50	1,361	1,329	
6.75	1,360	1,333	1,230
7.00	1,358	1,338	1,223
7.25	1,355	1,343	1,216
7.50	1,352	1,348	1,208
7.62	1,350	1,350	1,204

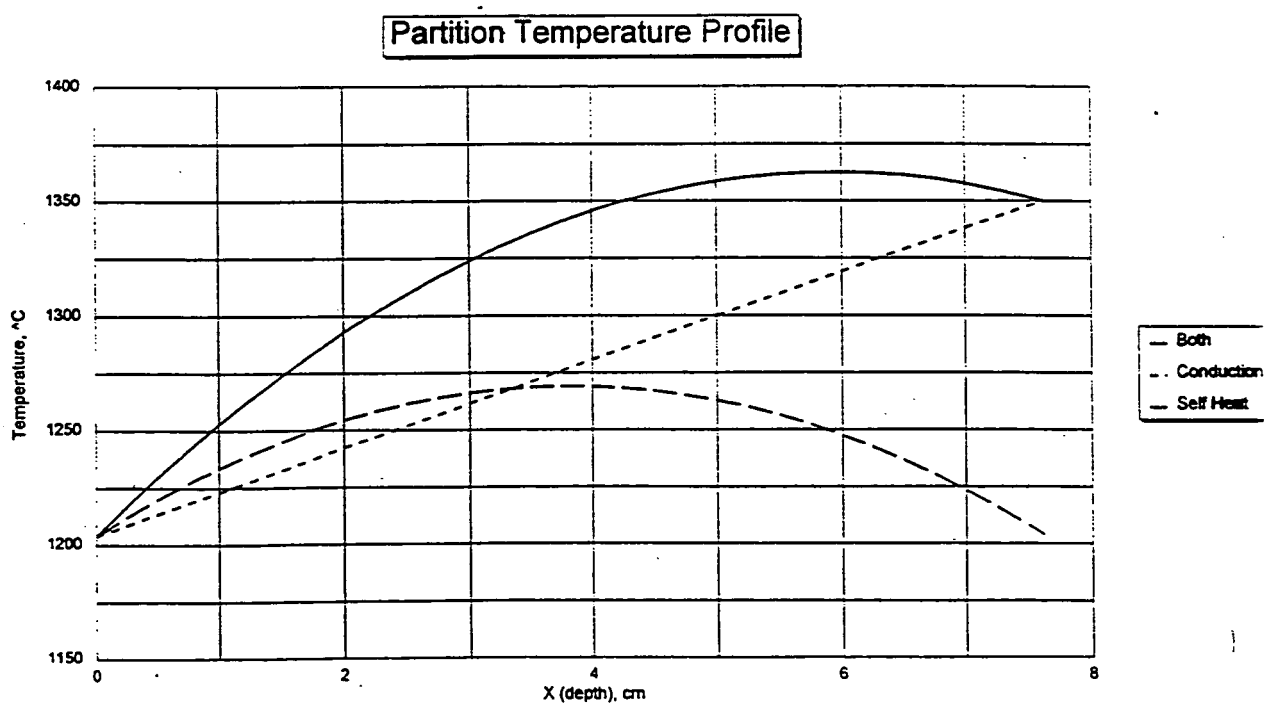


Figure A-7

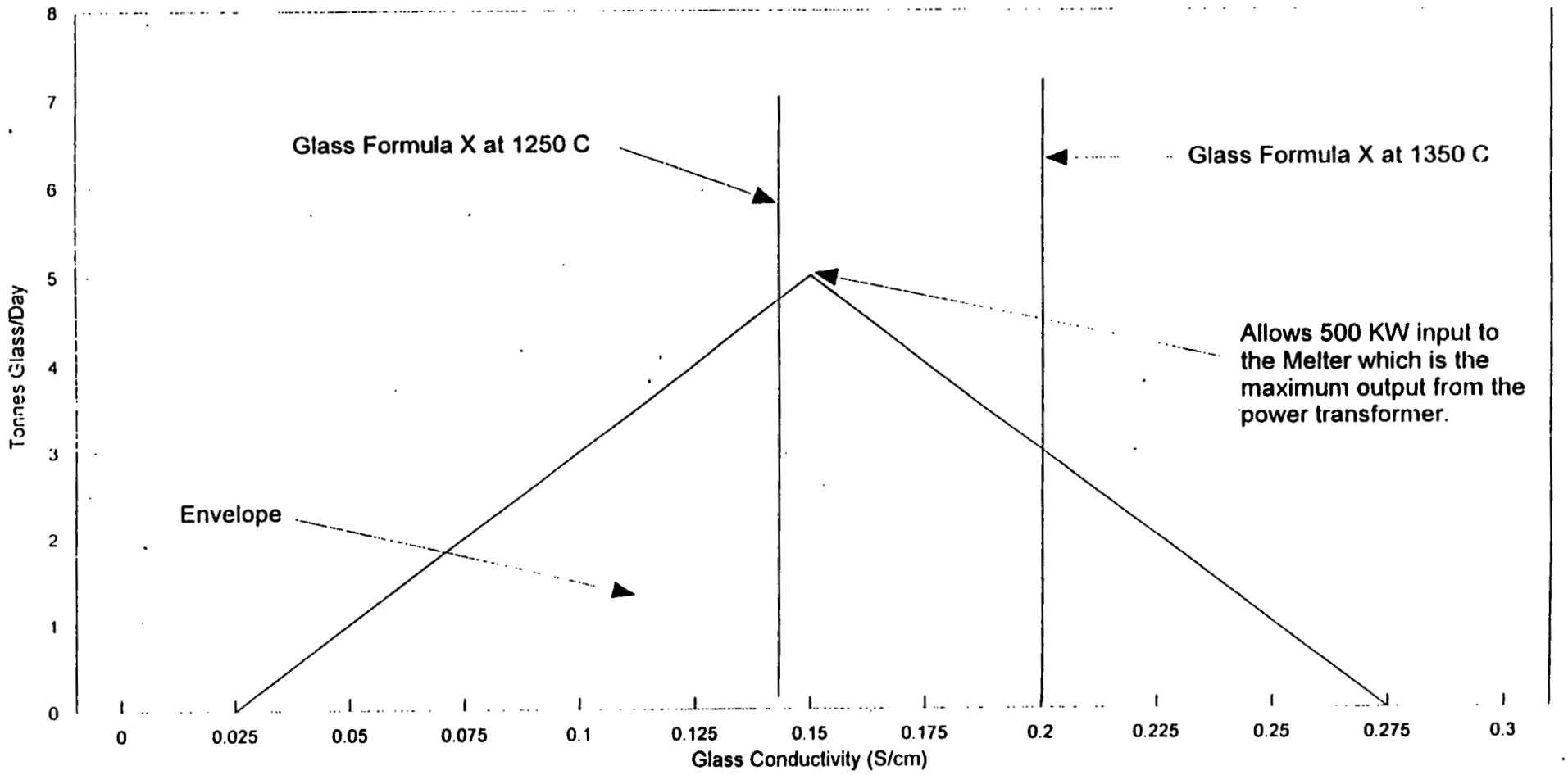


Figure 3-8: Melter and Glass Conductivity Envelope

A.2.4 Glass Form

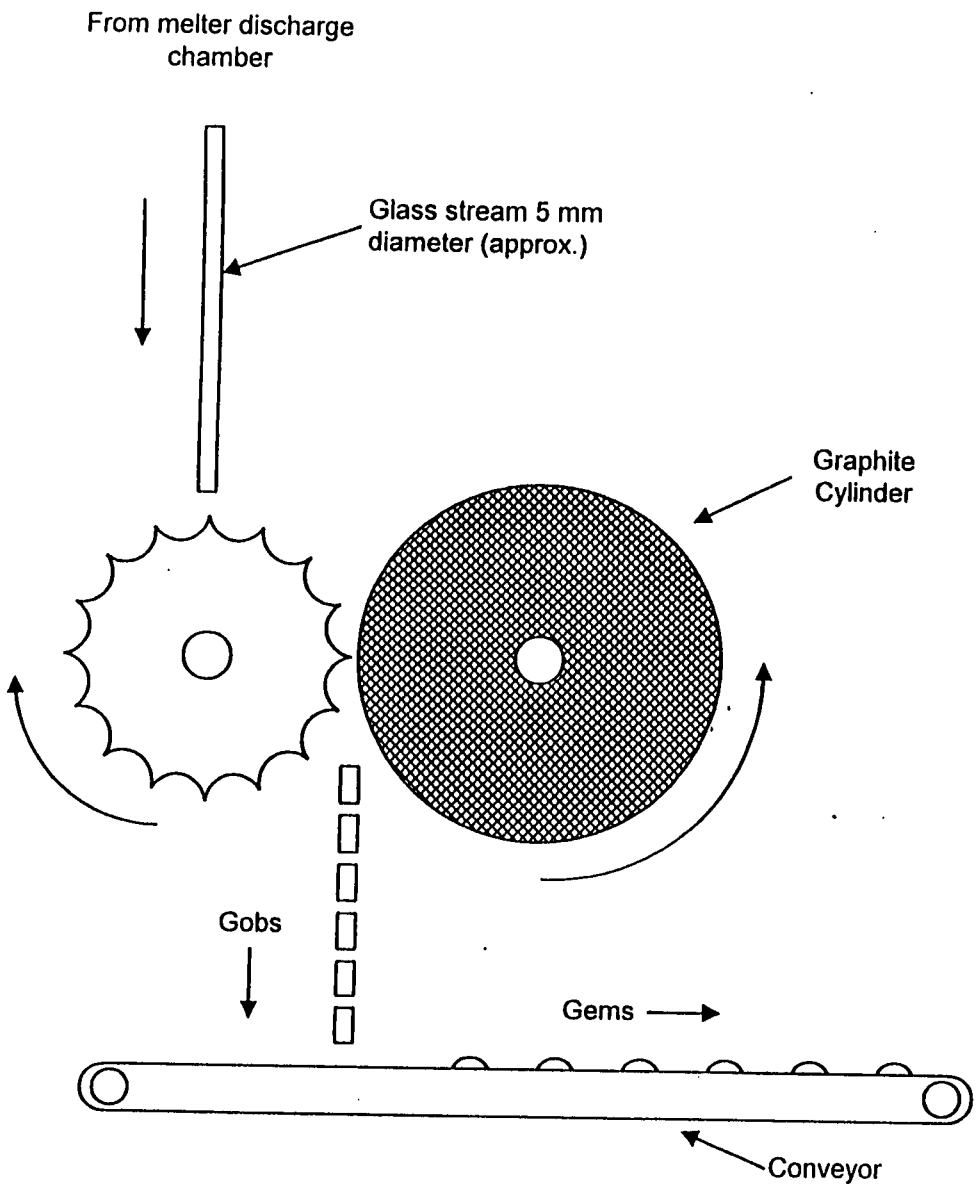
The VitPP is equipped to turn the molten glass into gems. Gems are hemispherical pieces of glass that look like "flattened marbles." The VitPP has a conveyor-type Gem Making Machine that is connected to the discharge chamber of the Melter. Gems are made by cutting the molten glass stream from the Melter into individual pieces, called gobs. The gob cutting mechanism, shown in Figure A-9, is composed of two rotating cylinders that turn into each other. One cylinder is made of steel and has hollowed grooves that capture the falling glass as it turns. The crest of the grooves then touch the opposing smooth cylinder made of graphite and momentarily pinches off the flow (or cuts) the glass. The glass gobs fall onto a conveyor where they are quickly cooled and solidified. However, before the glass solidifies, the gob has time to form a puddle on the plate and pull itself together as a gem because of surface tension.

The VitPP has produced gems and monolithic pours into drums but not enough of either have been made to effectively determine which is better for OU4. Some glasses (monolithic pours) will devitrify when poured into slowly cooling drums. Bench studies showed that devitrification did not happen for any of the silo glasses when made into gems. However, the Series C and D glasses did devitrify (t a milky color -- mostly green) when cooled slowly. Consequently, better vol may be gained by using gems to prevent devitrification. This is because the monolithic glass would have to be made with a much lower waste loading, with a resulting increase in volume, to prevent devitrification within the drum. Also, the drums may not be poured completely full because they will need to be moved with hot glass in them during full-operation. Series A glasses show promise that they may not devitrify even with slow cooling. This is probably because of higher silica and lower phosphate content in the Series A glasses.

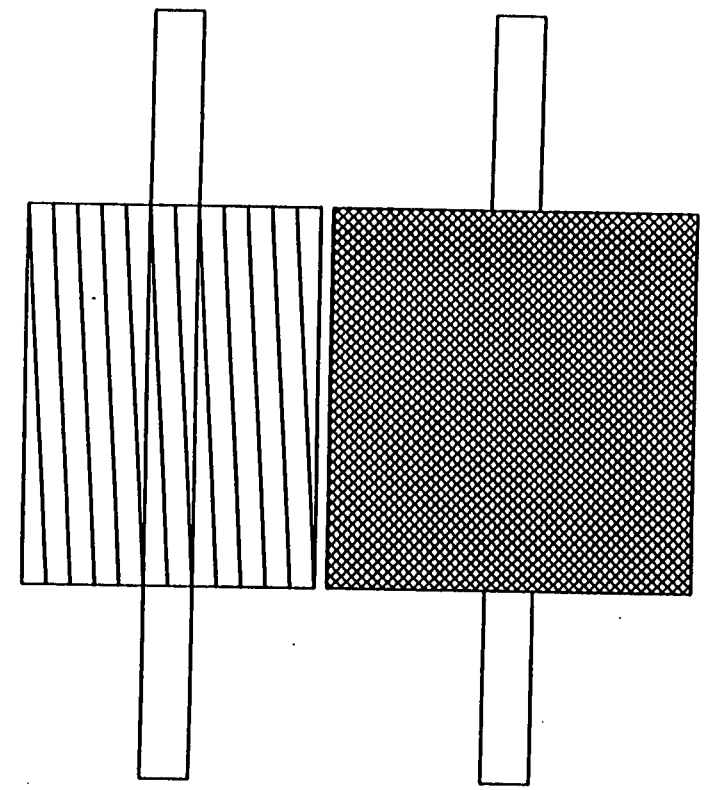
The void fraction for the gems will be measured once the production of gems is perfected in later runs. Gems typically have a void volume of approximately 20% to 30% which is better than marbles and significantly better than frit or cullet which is 50% void volume. The integrity of the container will be monitored during the monolithic pours. The outside surface of the drums poured thus far, at 1250°C, melter temperature, appear to have withstood the heat.

A.2.5 Water Cooling for the Melter and Gem Making Machine

The Melter and the Gem Machine have a separate devoted water cooling system. The water is fed to the electrode holders, ports, and parts of the Gem Making Machine to keep components from overheating and stop the advance of molt



Side View



Top View
Diameter Cutter = 15 cm (6")
Cutter Width = 45 cm (18")
Diameter Graphite Roller = 20 cm (8")

Figure A-9
Gob Cutter

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glass into the ports. The cooling water is recycled. Heat is removed from th cooling water by an air-cooled radiator. The temperature and flow rate of the water leaving each port, etc., are measured and recorded. High purity water is needed to limit high-temperature corrosion/erosion problems. The cooling water originally contained an antifreeze (50/50 mixture of water and glycol); however, it was later discovered the antifreeze contained a small concentration of chloride that may have lead to corrosion problems. It is questionable if the low amount of chloride could cause the corrosion problems in such a short time, but it was removed from the cooling system between Champaign 1 and 2 for assurance at this time (see Section 6.4). This is being investigated.

A.3 Offgas and Film Cooler

Sources of off-gas are the Melter and the VitPP tank vents. The offgas treatment system consists of a Film Cooler, Quench Tower, Scrubber, Desiccant Tower, radon absorption carbon beds, HEPA filters, blower and stack. The temperature of the hot Melter off-gas (800 °C) is reduced by the Film Cooler and direct heat loss through the pipe wall to the surrounding atmosphere. The Quench Tower then receives the Melter off-gas and cools it further using recycled water. The offgas from the Quench Tower flows into the Scrubber/Venturi system for removal sulfur oxides using caustic solution. Since no radon (Rn-222) producing mate will be processed during Phase I of the VitPP, the carbon beds are bypassed. HEPA filtration for final particulate removal is the last offgas treatment step prior to discharge through the exhaust fan and the stack.

During Campaign 2, the Scrubber was operated with caustic. The split in the Scrubber recirculation loops was 8 gpm to the packed tower and the rest to the ejector-venturi. The Desiccant Tower contained no desiccant and was not utilized to dehumidify. All the various tank vents were closed to the off-gas system. (The tank vents were closed early in Campaign 1 because of problems holding sufficient negative pressure in the Melter.)

A.4 Recycle Water

The recycle water loop starts with the Recycle Water Tank which holds a controlled inventory of recycle water. Recycle water is pumped from the Recycle Water Tank by one of two recycle water pumps to the Quench Tower for melter offgas cooling via direct, water-spray contact. Recycle water collects in the base of the Quench Tower and is pumped by one of two Quench Tower pumps to the Heat Exchanger where the recycle water is cooled against Cooling Tower Water. The recycle er

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then flows to the Thickener which runs full and overflows to the Recycle Water Tank to complete the loop. Additionally, recycle water is piped to various slurry lines for flushing purposes.

The recirculating flow (Recycle Water Tank to Quench Tower to Heat Exchanger to Thickener and back to Recycle Water Tank) continued to be about 15 gpm vs. a design flow of 40 gpm. This was due to scaling in the water line to the Quench Tower spray nozzles. It was determined that 15 gpm water flow to the Quench Tower was acceptable for Campaign 2 based on the fact that the off gas is maintained at less than 150°F while feeding the Melter.

A.5 Data Gathering

The Vitrification Pilot Plant System (VPPS) is an ORACLE-based system developed to provide data management support for the VitPP. ORACLE is a data base program by ORACLE Corporation that is leased and used at the Fernald site. The database contains specific tables, fields, and programs to support the VPPS. VPPS acts as a central repository for several types of data collected during the operation of the VitPP. The system consists of a central database and related data collection and reporting software as shown on the simplified Data Flow Diagram, Figure A-10 below.

A.5.1 System Overview

The core of VPPS is an ORACLE-based relational database running on one of the FEMP's VAX (trade name of computer) mainframe computers. Data from the various VitPP data streams are loaded into this data base.

The operation of the VitPP currently produces data streams from the following sources:

1. Process data is collected via the Foxboro Distributed Acquisition and Control System (DACS). The Foxboro system automatically records and temporarily stores the plant process data. The system has data storage capacity for approximately 24 hours. After this time period, the stored data is overwritten and replaced with current data. The Foxboro acquisition cycle is approximately 1 minute. Three programs perform the data transfer to ORACLE:

   IMMRUN, which is a computer program, sends the data for

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selected data tags to a port on the VitPP control Foxboro.

GETDATA.WAX is a computer program that creates data files from the IMMRUN output. Files are saved locally until picked up by the computer program VPPSLOAD.

VPPSLOAD computer program copies the waiting files to the FEMP network and loads the files onto ORACLE. All files are saved in the ARCHIVE program; rejected files are saved in a separate directory known as BAD.

2. Analytical data from on- and off-site labs as well as the VitPP lab will be available in the site FACTS (Fernald Analytical Computerized Tracking System).

3. Operations log book information such as the Test Coordinators' Log, Shift Turnover Log, and operator's comments may be manually keyed into the data base using the VPPS Data Entry Module. This module is accessed using the FACTS system in a manner similar to the analytical VPPS combines these data streams into a set of tables that can be accessed for reporting and analytical data. VPPS combines the: a streams into a set of tables that can be accessed for reporting a

4. Data from shift Roundsheets and other special data collection sheets may be entered into the ORACLE data base manually using the Data Entry Module. The Roundsheet data are collected by plant operators on a routine time cycle throughout an operating shift.

VPPS combines these data streams into a set of tables that can be accessed for reporting and analysis.

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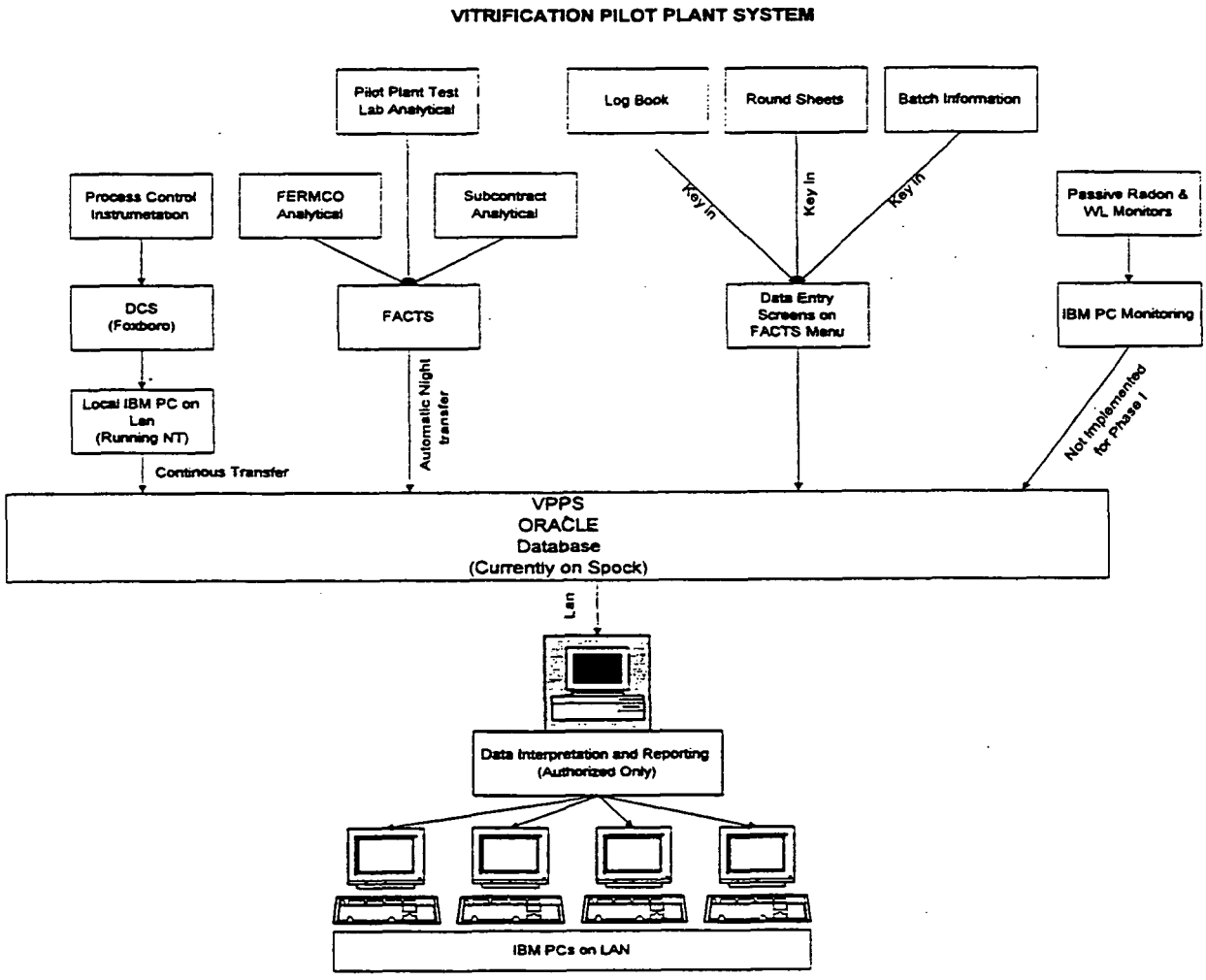
A.5.2 Reporting

The VPPS database is accessed through the VPPS Reporting Application available on the Local Access Network (LAN) to selected users. Individual data tags or groups of data tags as specified by the user may be accessed on an hourly averaged basis or a minute-by-minute basis. Reports may be printed or read to file.



Data Flow Diagram
Figure A-10

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Appendix B
Data Acquistion and Process Control

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Appendix B
DATA ACQUISITION AND PROCESS CONTROL

B.1 Data Acquisition

For Melter control, the process instrumentation system and Melter observation points provide the means to measure, observe, and respond to changes in the Melter vitrification process to maintain steady-state conditions. The following "real-time" parameters are measured or observation noted:

Melter Chamber

- Glass temperature - thermowells into the waste chamber glass
- Amperage, voltage, and power Silicon Control Rectifier (SCR) to resistance heaters - SCRs 3, and 4 to resistance heaters for the main chamber lid and the glass discharge chamber
- Agitation - air flow rate to bubblers
- Glass discharge - air pressure to the glass air lift between the main chamber and the discharge chamber
- Glass level in the main chamber - observation ports
- Glass surface of melt - observation ports
- % cold cap and appearance - observation ports and CCTV camera
- Foaming - observation ports and CCTV camera
- Response time to changed conditions - process instrumentation recorded on the Data Acquisition and Control System (DACS)
- Chamber glass - periodic sampling
- Feeder tubes - surface thermocouples, cooling water temperature, and water flow rate
- Main chamber drains - 2 bottom drains, surface thermocouples, cooling water temperature, and water flow rate
- Refractory wall - thermocouple behind refractory in main chamber

Electrode Chamber(s)

- Electrode amperage, volts, and power - SCR 1
- Temperature - thermowells into the glass and optical infrared glass surface measurement (IR detectors out of service during Campaign 2)
- Electrode holders - surface thermocouple, cooling water temperature, and water flow rate

- Chamber glass level - level probes molybdenum disilicide electrical co. .cs (level probes out of service during Campaign 2)
- Chamber glass - periodic sampling
- Drains - surface thermocouples, cooling water temperature, and water flow rate

Glass Discharge Chamber

- Glass temperature - thermowell into glass
- Amperage, voltage, and power to resistance heaters - SCR 2 to resistance heaters for the glass discharge chamber
- Glass transfer to discharge chamber - air lift flow rate and pressure
- Appearance and thickness of glass discharged - observation ports
- Plenum temperature - thermowell into plenum area

The following ancillary systems are provided with instrumentation and observation points to support the control and operation of the Melter.

Feed Preparation

- Dry materials addition - Bag dump station, vacuum pneumatic transfer system, filter/receivers, level instrumentation, rotary airlocks, diverter valves, and transfer lines
- Slurry preparation - Slurry tanks A and B, tank agitators, recirculation pumps A and B, recirculation and Melter feed piping, slurry flow metering
- Glass feed composition - batch formulation sheets
- Feed rate - Melter feed pump rpm and feed rate calibration, feed slurry tank weight
- Laboratory support - Slurry determination of percent solids, constituent concentration analyses, physical and chemical properties

Off-gas and Melter Plenums

- Melter pressure - differential pressure between room and Melter, emergency off-gas system and Melter, and furnace off-gas system and Melter
- Plenum temperature - thermowells into plenum area of each electrode chamber (east chamber thermocouples out of service during Series D Glass run and west chamber thermocouples out of service for Campaign 2)
- Film Cooler - air flow rates, temperature, and pressure drop

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- Film cooler air lance - cooling air flow rate
- Off-gas system - pressure, temperature, and flow in lines and at components
- Constituent gases - concentration and make up from sample points
- Volatilization and particulate carry over - sampling of pre-filters and HEPA filters, observation of lines and components
- Moisture content - moisture instrumentation

Gem Machine

- Enclosure pressure - differential pressure between room and enclosure
- Enclosure temperature - thermocouples at top, bottom, and expansion joint
- Conveyor - head and tail component temperatures, cooling water temperature and flow rate, speed
- Gem roller and cutter - component temperatures, cooling water temperatures, and cooling water flow rate, speed
- Glass diverters - cooling water temperature and flow rate, position indicators
- Material receivers - emergency, startup, and gem receivers

Closed-Loop Cooling Water

- System water - level indicators, flow rate, supply and return pressure and temperature
- Pumps - discharge pressure, operating mode
- Water to air cooler - fan speed, operating mode

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Appendix C
Closeout of Systems Operability Test
Glass Campaign 2

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FINAL TEST REPORT FOR

TEST PROCEDURE 2504-SU-0035

PILOT PLANT SYSTEMS OPERABILITY TEST PROCEDURES

MELTER GLASS CAMPAIGN 2

Revision 0

September 1996

Prepared by:

APPROVED BY:

VITPP Quality Assurance	Date
VITPP OS&H	Date
VITPP CRU4 Project Manager	Date
VITPP Operations Manager	Date
VITPP Regulatory Programs	Date
VITPP Start-Up and Turnover	Date

Fernald Environmental Restoration Management Corporation
Fernald, Ohio

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TEST DATA REPORT

Test Report Issue Date 9-30-96

Partial Test Report No. N/A

Supplement No. N/A

Final (All testing and identified retests are complete)

Test Procedure Number 2504-SU-0035 Test Procedure Revision 0

Test Title PILOT PLANT SYSTEMS OPERABILITY TEST PROCEDURES OPERATIONAL TESTING OF MELTER, GLASS CAMPAIGN 2

Date(s) of Test 8-22-96 through 9-24-96

Test Sections Covered by this Report All sections completed

Procedure Completion Form Issued 9-24-96 Date

Test Report Prepared By _____ 9/30/96
Test Coordinator Date

Test Report Approved By _____ 9/30/96
Project Manager Date
for D. Bone

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PROCEDURE COMPLETION FORM (PCF)

Test Number:2504-SU-0035 | Date:9-24-96

Test Title:Test Procedure 2504-SU-0035 Pilot Plant Systems Operability Test Procedures Operational Testing of Melter, Glass Campaign 2

Procedure Sections Completed All Sections completed.
(Current test period only)

All TP Sections Complete? ☒ YES ☐ NO | Previous PCFs Issued:NONE

Date(s):8-22-96 through 9-24-96

Description of System Tested
and Boundary:This testing will demonstrate continuous operations with Acceptance Glass and Series D surrogate under the conditions specified in the Melter and Gem Machine specification.

Testing Started: 8-22-96 | Testing Completed:5-05-96

Unresolved or open Plant Work Request/Orders or RCAs/CWOs which affect system maintenance are as follows:

NONE

Evaluation of Testing: Data obtained in test sections complete. Appears to be satisfactory:

[signature] 9/30/96
Test Coordinator Date

A. Disposition of Test Equipment

Remove the following at earliest convenience: N/A

Retain the following until notified otherwise: N/A

Justification for retaining: N/A

B. Plant Work Requests and System Tagouts:

Plant Work Requests and System Tagouts for performing this Test Procedure either have been cleared or are noted as exceptions in the Remarks section

N/A
Test Coordinator Date Facility Owner Date

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PROCEDURE COMPLETION FORM (PCF) (Continued)

C. **Jumpers and Disconnected Wires:**

Jumpers and Disconnected Wires used to conduct this Test Procedure have been cleared or are noted as exceptions in the Remarks section with explanations as to why they are in the system and under what conditions the system can be restored to normal. The F. accepts custody for all installed jumpers and disconnected wires.

Test Coordinator	Date	Facility Owner	Date
[signature]	9/30/96		

D. **Drawings Used for Testing:**

Indicated below (or attached) is a list of any drawings which were changed by Engineering Change Notice due to performance of the Test Procedure or the associated CG&A package.

N/A

Test Coordinator	Date

Drawings/Revision No./ECN No. NONE

E. **Operating Procedures Used for Testing:**

All required changes to Operating Procedures used during CG&A or Test Procedure have been identified and transmitted t Facility Owner

Test Coordinator	Date
[signature]	9/30/96

F. **REMARKS:**

NONE

The FO accepts responsibility for the system (or partial system) tested.

Facility Owner	Date

VITRIFICATION PILOT PLANT
PHASE I
CLOSEOUT OF
SYSTEM OPERABILITY TEST PROCEDURE 2504-SU-0035 REV.0
GLASS CAMPAIGN 2

The following report summarizes the Vitrification Pilot Plant (VITPP) Operability Test Procedure Melter Campaign 2, 2504-SU-0035, Revision 0 in accordance with the requirements of ENG-12-6003 Startup and System Operability Test Procedure.

SUMMARY

System operability testing in accordance with revision 0 of the SOT for the VITPP Melter and Gem Machine Systems commenced on August 22, 1996 and was completed September 24, 1996. During Campaign 2, a total of 11 slurry tank batches were fed to the melter. The Melter's main chamber temperature was maintained at approximately 1250° Celsius while transition glass was in the Center Chamber. While the Acceptance glass was in the melter, the melter was maintained at 1350° Celsius. The slurry batches contained Barium and Lead compounds.

Summary data for the 11 batches is provided in the attached "Test Performance Parameters for SOT Campaign 2 at the Vitrification Pilot Plant" data sheets. Some noted highlights from these sheets are as follows:

Average Melter Temperature:	1300 deg. C
Total Slurry Fed:	62,578 lbs
Total Glass Produced as Monolith:	20,474 lbs
Total Glass Produced as Gems:	3,570 lbs
Total West Side Chamber Frit:	3,200 lbs
Total East Side Chamber Frit:	875 lbs
Total Center Chamber Frit:	50 lbs

The following provides a correlation between the batch and the section of the SOT to which it corresponds:

Batch No.	SOT Section	Description
C2B01	7.1.1 - 7.1.29	Slurry to transition from Campaign 1 Center Chamber benign glass chemistry to Melter Acceptance Glass formula
C2B02	7.2.1 - 7.3.7	Slurry included Boric Acid to compensate for an insufficient concentration of Boron in the Center Chamber Glass. First Batch for 36-Hour Melter Performance Test Run
C2B03	7.2.6 - 7.3.7	Slurry to continue 36-Hour Melter Performance Test Run
C2B04	7.3.2 - 7.3.7	Slurry to continue 36-Hour Melter Performance Test Run
C2B05	7.5.1 - 7.5.4	Slurry to transition from Acceptance Glass to Series "D" Glass
C2B06	7.5.5a - 7.5.5d	Slurry to transition from Acceptance Glass to Series "D" Glass
C2B07	7.5.5e - 7.5.5h	Slurry to transition from Acceptance Glass to Series "D" Glass
C2B08	7.5.5i - 7.5.5l	Slurry to transition from Acceptance Glass to Series "D" Glass
C2B09	7.5.5m - 7.5.5p 7.4.1 - 7.4.4	Slurry to transition from Acceptance Glass to Series "D" Glass and 8-Hour Gem Machine Performance Test
C2B10	7.5.5q - 7.5.5t	Slurry to transition from Acceptance Glass to Series "D" Glass
C2B11	7.5.5u - 7.5.5x	Slurry to transition from Acceptance Glass to Series "D" Glass

Attached is a "Test Performance Parameter" data sheet for each batch ran during Campaign 2. Each batch data sheet compiles operational data, sampling data, slurry feed/glass production data, etc. that pertain to each batch.

PURPOSE

The purpose of this test was to document the Melter Campaign 2 and the testing of Acceptan Glass and Series D glass which is the surrogate for a vitrified product of waste (70% K-65 mater and 30% Silo 3 material) and requisite additives. This test covers:

- -The displacement of benign glass from the Melter
- -The 36 hour Acceptance Testing of the Melter for final acceptance by FERMCO
- -The 8 hour Gem Machine Performance Test
- -The preparation of Series D glass slurry
- -The operation of the Melter and the Gem Machine at 1 MT/D to satisfy the procureme specification
- -The adjustment of Melter temperature to correspond to Series D glass formulati

INTERIM CHANGE PROCEDURE

A total of 18 Interim Change Procedures (ICP's) were written during the performance of this tes The ICP system addresses changes to the SOT methodology and criteria.

ICP 1 was written to implement inventory sheets and slurry sample/flush sheets to track potem RCRA hazardous waste streams.

ICP 2 was written to delete addition of Magnesium Phosphate in batch C2B01 into the slurry tan This was done to avoid clogging in slurry lines and pumps. The Magnesium Phosphate was adde directly to the Melter 25 pounds lifts.

ICP 3 was written to revise text to recommence transition glass feeding and allow for continuou slurry feed and maintain the cold cap with Magnesium Phosphate additions.

ICP 4 was written to allow the Testing and Data Manager and Test Coordinator to specify the ord in which the chemicals should be added to the Bag Dump Station.

ICP 5 was written to implement 3 changes to the SOT. The first change was to change the ord of the chemicals added to the slurry tanks. The second change was to permit the ad n Magnesium Phosphate directly to the Melter and decrease the required amount of wa th slurry tanks for Acceptance Formula batches. The third change was to add Boric Acid to batc C2B02 to adjust the chemistry of the Acceptance formula.

ICP 6 was written to decrease the amount of certain chemicals to be added to slurry tank A. The amount of material in the heel of slurry tank A was estimated in which batch C2B03 will be mixed.

ICP 7 was written to increase the amount of water required to decrease the weight percent solids of slurry to 45% by weight. Batch C2B02 was too viscous for the slurry system to maintain continuous operations.

ICP 8 was written to adjust the chemistry and physical characteristics of batch C2B03. The adjusted batch was identified as batch C2B04.

ICP 9 was written to permit feeding the remainder of batch C2B04 at the completion of the 36 hour melter acceptance test.

ICP 10 was written to delete the addition of Bentonite Clay to the Bag Dump Station and replace this bulk chemical with the individual constituents (chemicals) that make up Bentonite Clay. This was done to avoid clogging the Bag Dump Station.

ICP 11 was cancelled due to the fact that a decision was made to run six batches of series D glass to transition the melter bath to series D glass.

ICP 12 was written to cancel ICP 11 and to edit text in the SOT to include making a slurry batch in one tank while recirculating the other tank in the melter feed bypass loop. This step will ensure that if a clog develops within one slurry tanks piping, the melter feed loop will be clear to receive slurry from the other slurry tank.

ICP 13 was written to replace the batch sheet with a revised batch sheet. The new batch sheet and order of chemicals to be added was implemented to avoid clogging in the slurry system.

ICP 14 was written to correct an erroneous reference to an attachment in the SOT.

CP 15 was written to replace an attachment with a revised attachment. The previous attachment did not specify the amount of Magnesium Phosphate required for each batch.

CP 16 was written to adjust the chemistry of the melter bath. Amounts of chemical to be added to the batch were changed to prevent foaming in the melter bath.

CP 17 was written to delete the GTS Duratek field representative concurrence to start the second attempt of the 8 hour Gem Machine Acceptance test and GTS Duratek completion and acceptance signature. The second attempt of the Gem Machine Acceptance test was performed without GTS Duratek technical support.

CP 18 was written to change the amounts of specific chemicals to be added to the slurry tanks for batch C2B11. This change was implemented to adjust the Melter bath chemistry.

TEST EXCEPTIONS

A total of 1 Test Exception (TE) was written against 2504-SU-0035 Revision O.

TE 1 was written to document the unsuccessful attempt of the Gem Machine 8 hour Accepta test. The unsuccessful attempt was due to the double glass stream flowing from the discha orifice. ICP 17 permitted the second attempt of the 8 hour test using a glass stream control de (Cone). The 8 hour Gem Machine Acceptance test was successfully completed and TE 1 resolved.

General Exceptions to the 36-hour Acceptance Test are noted in the test log pp. 89-90. Th items are minor in nature and do not hamper the ability of the melter to perform this SO test. following is a summary of items which needed repair, replacement, or redesign at the time completion of the 36-hour Acceptance Test. The open items (with the exceptions of Film Coo problems) have been turned over to Duratek for resolution.

- Film Cooler - Is not effective as designed as discussed in the n section.
- IR temperature detectors - Inadequate cooling designs allowed all to be destroyed fr excessive heat.
- Melter Feed Pump Seals - Seals experienced excessive failure rates and unsatisfact time to failure on rebuilt seals. This item was resol during subsequent testing (as discussed in the n section).
- Side Chamber Level Detectors Level detectors needed to be replaced. They were replac and performed satisfactorily during subsequent testing.
- Thermocouples- West Side Glass, East Side Glass, Main Chamber Top Glass, and Main Chamber Plenum have failed.
- Bottom Drains-1,2,3,and spare Water Cooling Jacket failed. Related issue- Breakdown electrical isolation of the Bottom Drains resulting in curre leakage. This issues is discussed in the next section.

•	East and West Side Chamber Frit Feeder	Design is inadequate. Hoppers can not be used as originally configured without clogging.
•	KW transducer for lid heaters	Device has never worked.
•	Discharge Level Probe	Design is inadequate. Probe will not reliably read the submerged/exposed states.
•	Discharge Chamber	Design is inadequate. Glass leaks through refractories and clogs the glass discharge openings.
•	Discharge Chamber	Stream control is inadequate.

PROBLEMS ENCOUNTERED AND SOLUTIONS IMPLEMENTED

Material Additive System

Problem: Magnesium phosphate was found to be clumping when mixed with water in the slurry tanks. The clumping slurry would clog the slurry re-circulation pipes.

Solution: Magnesium phosphate was added directly to the Melter. This additive is not required in Campaign 4.

Problem: Lead Oxide was found to be clumpy but only when packaged in 100 pound bags.

Solution: Lead Oxide which was packaged in double-wrapped plastic and contained in 100 pound cardboard carboys did not experience this problem.

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Problem: Dry chemicals are continuing to plug the long elbow immediately downstre of the Bag Dump Station. This occurred with significant down time (grea than 30 minutes) on three (3) occasions. It was noted that the plugs usua occurred during pumping of the finer meshed and heavier dry chemic (particularly, iron III oxide, lead monoxide).

Solution: The sequence of dry chemical additions were modified. Barium and le compounds which were added last in the event that if the batch was aborte these hazardous compounds were absent. Additionally, during bag dum operations, dry chemical additions were intersperse with compounds tr typically did not have problems with plugging (ie, silica). Operator experien with slow dry chemical additions and constant monitoring of the syste pressure indicators improved greatly over Campaign 1 bag dump operation

Problem: Dry chemicals were found to be accumulating within the Filter/Additi Receiver on four (4) occasions preventing dry chemicals from entering t Slurry Tanks. One of the occasions saw up to 1200 pounds and anot 10 pounds had accumulated within the Receiver.

Solution: Installing of a temporary air vibrator on the outside of the Filter/ Addit Receiver helped somewhat to prevent bridging of the Receiver outlet. One event was corrected by the repair of a broken chain drive on the Rotary Airloc The remaining events were corrected by manually knocking on the outside the Receiver. Additionally, closer attention and weight tracking was given the Slurry Tanks' weight during dry chemical additions.

Problem: Dry chemicals accumulated and clogged the Slurry Tank A/Slurry Tank Diverter located between the Filter/Additive Receiver and the Slurry Tanks c two (2) separate Batches. These clogs amounted to 200 pounds and 8 pounds.

Solution: Exercising the Diverter allowed for the clogs to work loose.

Problem: Dry chemicals accumulated and clogged the 8" pipeline from the Filter/Addit Diverter and the Slurry Tank.

Solution: Piping system was breached and rodded where the pipe joins the tank, to allo the dry chemicals to fall into the Slurry Tank.

Slurry Tank Pump Operations and Piping

Problem: Slurry Batches greater than 45% weight solids were generally found to tax the Slurry Tank Pump operations. Slurries were found to be very viscous and with eventual setting up in pipelines. Additionally, the slurry pumps were found to be 'hesitating' or missing a stroke as air was delivered to the pump diaphragm.

Solution: Batch Sheets were modified to allow the solids content to be held below 45% weight solids. However, if the Slurry Tank Pump was found to be hesitating during Slurry Tank recirculation or Melter feeding, a controlled amount of water was added directly to the Slurry Tank or flushed in specific pipe sections. Subsequently, Slurry Tank Pump hesitation would be eliminated. This occurred in no less than eight (8) occasions.

A precursor to Slurry Tank Pump 'hesitating' while in the Melter Feed Loop, was the low flow alarm on FI-170 coming in at a low flow setpoint of 30 gpm. Typically, the Slurry Tank Pumps deliver greater than 40 gpm flowrate within the Loop. With operational experience, it was known that the slurry was becoming too viscous as soon as the low flow alarm came in. The corrective action was to add addition water to the Slurry Tank supplying the Melter Feed Loop slurry. Note, while the Slurry Tank Pumps are recirculating in their 'Short Loops' back into their respective Slurry Tanks, no such low flow alarm is available.

Additionally, whenever Melter feeding was suspended, the Melter Feed Loop was flushed and the recirculation of slurry was transferred back to the 'Short Loop.' This practice was adopted when the Melter Feed Loop plugged one (1) occasion. In this way, the Melter Feed Loop remains open with no chance of clogging when Melter feeding can resume.

Problem: Slurry piping plugged when using bentonite clay as a chemical additive (as occurred in C2B03). Slurry later determined to be building up on the Slurry Tank internal walls.

Solution: BentoGrout® was eliminated from the remaining batches and substitute chemicals were used. Up to 300 pounds of dense clay solids were found to have deposited in the tank manway (an area not within the tank mixing zone). The ability to handle BentoGrout® is still an open issue requiring resolution for future batches.

Problem: Sections of Slurry recirculation piping that plugged could not be flushed cl with water. This occurred in at least four (4) occasions.

Solution: Piping was breached and rodded/augured out. Sections of piping that w significantly difficult to physically cleared were abandoned-in-placed a replaced with flexible hoses. Line plugging is still an open issue requir resolution.

Problem: Solids build-up on Slurry Tank walls.

Solution: This was determined during the pumping slurry within the Melter Feed Loo Several hundreds of pounds of slurry remained within the Tank after the Slu Tank Pump could no longer pump. The problem was corrected by adding wa into the Slurry Tank to the level of the Tank agitator. The solids would tend knock off the walls during agitation. The resulting contents then constitut the Tank Heel used for the next batch make-up. This problem still requi resolution.

Problem: Slurry Tank Pump failure on six (6) occasions.

Solution: Slurry Tank Pumps were pulled and repaired. Two (2) failures were the res of air diaphragm ruptures. One (1) Spare pump failure was due to worn sea on ball check valve. In all cases, pumps were repaired and placed back service. The reliability of the slurry pumps is still an open issue requir resolution.

Melter Feed Pump Operations

Problem: Melter Feed Pump piping plugged nine (9) times. On one (1) occasion, t obstruction directed slurry feed directly into the West Side Chamber. On o (1) occasion, the obstruction directed slurry feed directly into the East Si Chamber. On two (2) occasions the feed piping at the Melter was pluggec

Solution: Corrective action to the above four (4) occasions was to breach the Feed Pun piping and rod out the piping. The remaining five (5) occasions of feed pi plugging could be flushed with recycle water or rodded out.

Problem: Melter Feed Pump was pulled due to excessive packing leakage on at least te (10) occasions.

Solution: Feed Pump was repacked. Eventually, mechanical seals, with improved fac design were installed and performed satisfactorily during C2B10 and C2B1

Melter Operations

Problem: Flashing and bubbling was noticed in the West Side Chamber. Problem was initially determined to be cooling water leakage from Bottom Drain #1. A separate temporary cooling system was installed (8/28/96). Bubbling continued after installation. New Bottom Drain Sleeve was installed for Bottom Drain #1. Bubbles continued to be observed in West Side Chamber. West Side Chamber Glass experienced heavy foaming beginning with the slurry feeding of C2B05. Glass chemistry determined that the West Side Chamber glass and Center Chamber Glass were the same prior to beginning C2B06. This strongly reinforced the belief that holes exist (or cracks visually seen) between the glass pool partition E-brick is providing an unrestricted flow path. The result was that sulfates introduced into the Center Chamber Glass through slurry feeding were eventually accumulating in the West Side Chamber Glass. Foaming would then result in the Side Chamber Glass. Unchecked foaming events resulted in foam rising from the West Side Chamber and spilling over the E-brick into the Center Chamber.

Solution: A regimen of West Side Chamber frit additions was developed (50 pounds/hour) to change its glass chemistry and reduce foaming while slurry feeding. If necessary, SCR#1 was reduced to at least 100 kilowatts which would also result in reduction and lowering of foam into original glass levels. This consequently would result in the lowering of Melter temperatures.

Problem: Side Chamber Glass low level indicators are unreliable. On several occasions, the electrodes could be seen from the top view ports prior to any low level alarm coming in.

Solution: Frequency of visual checks of side chamber glass levels was increased. The appearance of either east or west top electrodes through the glass signaled the addition of side chamber frit.

Problem: Melter pressure went positive during west side chamber viewport maintenance one (1) occasion. No feeding to melter had been occurring. Melter discharged off-gas into the Melter room and initiated fire detection system exhaust duct smoke detector.

Solution: Long Term Order Number 21-96 was implemented to administratively minimize the possibility of duplicating this event. Additionally, future process improvements should minimize the possibility of attaining an above atmospheric pressure.

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Melter Glass Camper
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Melter Discharge Chamber Orifice/Gem Machine Diverter and Glass Stream Control

Problem: Bulbous glass formations noticed building below the orifice. Eventual orif plugging occurred on seven (7) occurrences.

Solution: On three (3) occasions plugging was the result of SCR#1 being locked out Bottom Drain Sleeve installation. Melter glass temperatures reached as low 1100°C and would auto-discharge as the Melter came up to idling temperatur (1250°C). Of the seven (7) total plugging occurrences, three (3) had to burned out using a welder.

Problem: Glass discharge stream freezing as it leaves the orifice area due to low Ge Housing temperatures. This along with the bulbous glass formations hinder even glass discharge stream onto the gem cutter. It was also frequen experienced the splitting of the glass stream into two streams prior to hitti the cutter. This was the result of frozen glass hanging as 'stalactites' from t discharge orifice downwards between the diverters to the cutter. If all ed continue, the buildup of frozen glass from the orifice hindered the rep nir of the diverters through the Start-up, Gem, or Emergency positions.

Solution: Installation of a 'divining' glass rod and also a glass stream guide funnel belo the Discharge Orifice were initially implemented. However, the glass dischar stream was not significantly enhanced. Final corrective action was for o person to constantly monitor the glass stream at the Gem Machine and adj diverters as necessary. Additionally, a minimum Gem Housing Expansion Joi temperature 250°F was determine to deter the formation of 'stalactites However, to obtain this temperature, the Gem Machine Housing Vacuum ha to be adjusted to be slightly more negative than the Melter. The result wa pulling heat from the Discharge Chamber through the Discharge Orifice and o the Building HVAC system. This problem still requires resolution.

Problem: Glass being diverted into the Emergency or Start-up drums experienced glas freezing and sticking to the diverters. Glass also tended to build-up on the Ge Machine north wall between the diverter and the drum. Glass would slow build-up from the wall preventing the Emergency or Start-up gate from closing There were two (2) occurrences where build-up was great enough to plug th drum chute.

Solution: Air-lifts at greater flow rates were used. However, this would occasional result in glass spilling over the diverter and onto the Cutter/Roller. T alh the drum chutes were visually monitored. Periodically, the drums h t lowered and removed to physically break out frozen glass from within the drum chute. This problem still requires resolution.

000230

Melter Bottom Drains Replacement

Problem: Flashing and bubbling was observed in the east side chamber. Problem was determined to be cooling water system leakage from bottom drain #3. A temporary cooling system was installed (8-2-96). Flashing subsided with the elimination of glycol; however, some bubbling continued.

Solution: A sleeve was installed in the internals of bottom drain #3. Subsequent in-leakage was identified in the west side chamber. Corrective action was taken by installing sleeves in the remaining bottom drains.

Gem Machine Lube Spray and Gob Cutter Operations

Problem: Lube spray used to lubricate the roller/cutter continues to collect in the Emergency or Start-up drums.

Solution: Implemented several vendor prescribed design changes which yielded some improvement. Operationally, one person must constantly monitor the glass stream to adjust diverters or lube spray application. This problem still requires resolution.

Problem: Glass discharge at minimum or greater rates causes the glass cutter wheel to heat to a point where glass will adhere to the cutter wheel. Excessive amounts of lube spray/water must be used to mitigate this situation.

Solution: A redesigned cutter roller assembly which utilizes water cooling jackets was fabricated. However, this unit has not yet been operationally tested due to failure of the water sealing mechanism to pass hydrostatic leak tests. Installation of water tight seals in the unit would allow further testing and positive results are anticipated.

Gem Machine Operation

Problem: Emergency drum and Start-up drum drift from under the Gem Machine periodically. The result is the gradual loss of Gem Machine vacuum if their respective slide gates are opened.

Solution: Corrective action was to periodically ensure the drums were snugged up against the Gem Machine.

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Normal Off-Gas System and Air Lance

Problem: Off-gas piping that by-passes the carbon beds was found to be full of water one (1) occasion. Water was from Quench Tower carry-over or condens water vapor collecting in this section of piping which is at the Off-gas pipi low-point. This same section of Off-gas piping also experienced plugging w dry, fine material, on two (2) separate occasions. Dry material was similar the material found on the HEPA pre-filters.

Solution: Valve flange was opened allowing the liquid to be drained in the one occasion. On the other two (2) occasions, HEPA vacuuming was employe Note, that all three (3) incidents with this section of Off-gas piping we determined to be clogged by first noticing the degradation of Off-gas flow (FI-250) and degradation of Off-gas vacuum (particularly when PDIC-250 is High Memory Alarm). Secondly, PDI-172 and the on-line HEPA filter tra would be inspected for high differential pressure along with visible inspecti for clogging at the Air Lance. Through the process of elimination of or O gas piping sections and pressure indicators, the carbon bed by-p ipi would be determined to be plugged.

Problem: Transition line was found to have significant particulate build-up on (occasions.

Solution: Pipeline was cleaned out with HEPA vacuum.

Problem: Off-gas piping just prior to Quench Tower was found to be clogged at temperature element (TE-71) on one (1) occasion.

Solution: Element was removed and clogged released.

Problem: Air lance and film cooler were nearly clogged at least twenty-six (26) times

Solution: Off-gas piping at the air lance was rodded out and air lance brushed cleane

Problem: The filters in the Normal Off-gas HEPA filter trains loaded up frequently. Filt trains were switch over at least twelve (12) times.

Solution: Filter trains swapped over as frequently as necessary.

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Problem: Caustic needed to be added continuously to maintain the necessary pH in the Scrubber Tank during slurry feeding at approximately 1 MT/D rate. Indications are that the caustic addition pump will not support significantly increased feed rates.

Solution: Upgrading the caustic addition pump may be required for the Normal Off-gas system to support increased production rates of waste-loaded slurry.

Emergency Off-Gas System Initiations

A total of fifty-two (52) initiations of the Emergency Off-gas System occurred during Campaign 2. Twelve (12) of the initiations were intentional during such instances as film cooler cleaning and removal of particulate build-up or liquid accumulation within the Normal Off-gas Pipeline.

Spills with Hazardous Materials

Approximately 3 gallons of slurry containing lead and barium compounds were lost when the slurry pump diaphragm failed. Slurry exited through the pump exhaust port. All slurry was contained within the secondary containment surrounding the Slurry Tank Pump Area. Resulting rinse water was held in the Thickener Sump prior to transfer into Slurry Tank A.

Approximately 3 gallons of slurry were spilled during a slurry transfer from Slurry Tank B through a debris-strainer drum to Slurry Tank A. The spill was caused by overflowing the debris-strainer drum. The straining operation was necessary to remove debris entering Slurry Tank A from a previous spill contained in the Thickener Sump. All spilled slurry and rinse water was contained and placed in Slurry Tank B.

Approximately 20 gallons of slurry were spilled during a slurry transfer from Slurry Tank A to portable poly-tanks. Discharge hosing had worked from the poly-tank before transfer pump was shut-off. All slurry was contained within secondary containment. Resulting slurry and rinsed water was wet-vacuumed and placed into drums for later processing through the Melter.

APPLICABLE DOCUMENTS

The following drawings plus Constructor redline drawings were used to develop and perform th test.

94X-5900-F-851	Furnace and Gem Machine
94X-5900-F-278	Flow Diagram
94X-5900-F-279	Flow Diagram
94X-5900-F-280	Flow Diagram
94X-5900-N-272	Furnace and Gem Machine
94X-5900-N-315	Off-gas air
94X-5900-N-820	Emergency Off-gas system
94X-5900-N-891	Melter Water Cooling system
94X-5900-E-0935	Bottom Drain Electrical Drawing
CRU4-X-I-002	Melter PID
CRU4-X-I-003	Melter PID
CRU4-X-I-004	Utility Air PID
CRU4-X-I-005	Cooling Water PID
CRU4-X-E-002 SHTS 1-10	Melter Electrical Drawings
CRU4-X-EW-01	Utility Rack Wiring Diagram
CRU4-X-EW-02	Gem Machine Wiring Diagram
CRU4-ES-13	Gem Panel Annunciator Drawing
CRU4-M-M-26	Melter 1000 HT Drain Valve Assembly

A review of the Design Change Notices (DCN's) posted against VITPP was performed. Th following DCN's were identified to have potential impact to the test boundaries. All DCN's listed below were satisfactorily implemented in the field and bounded by this test package.

DCN's 21, 29, 33, 37, 39, 55, 56, 95, 97, 117, 157, 200, 210, 243

Other DCN's initiated subsequent to this test package should be evaluated for impact to system performance and re-test requirements.

PROCEDURE ACCEPTANCE

System performance is found to acceptable according to the criteria specified b SOT 2504-SU-0035, Rev. 0, including regard to the satisfactory resolution to the test exceptio discussed above. The test exception is closed and the SOT is complete.

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Appendix D
Snapshot Data

Appendix D1 36 Hour Acceptance Run

Appendix D2 Transition Glass

Appendix D3 Series D Glass

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Appendix D1
36 Hour Acceptance Run

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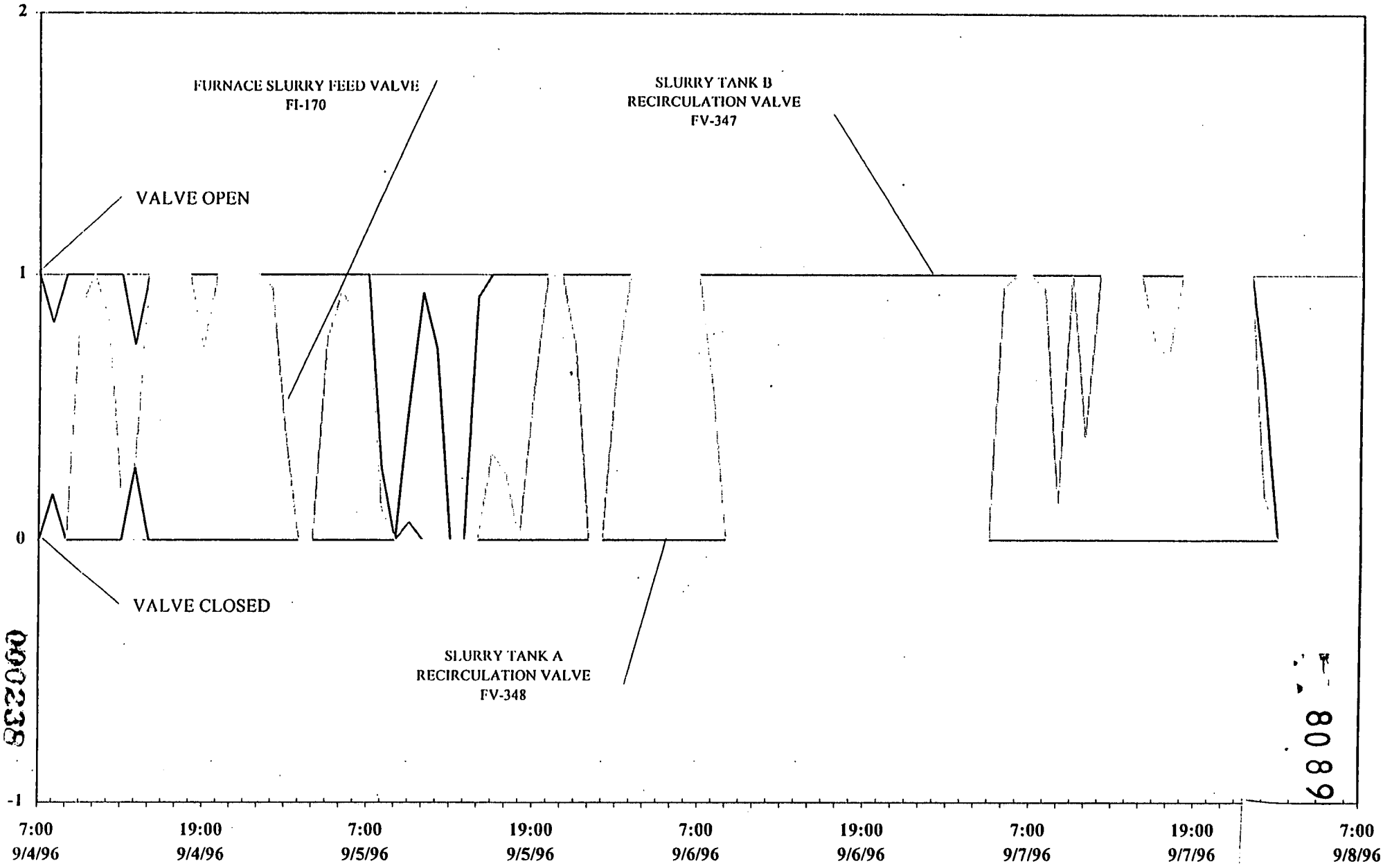
FEED PREPARATION SYSTEM

CAMPAIGN 2
36 HOUR RUN
FEED PREPARATION SYSTEM



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C2FDPRP.XLS Chart 14

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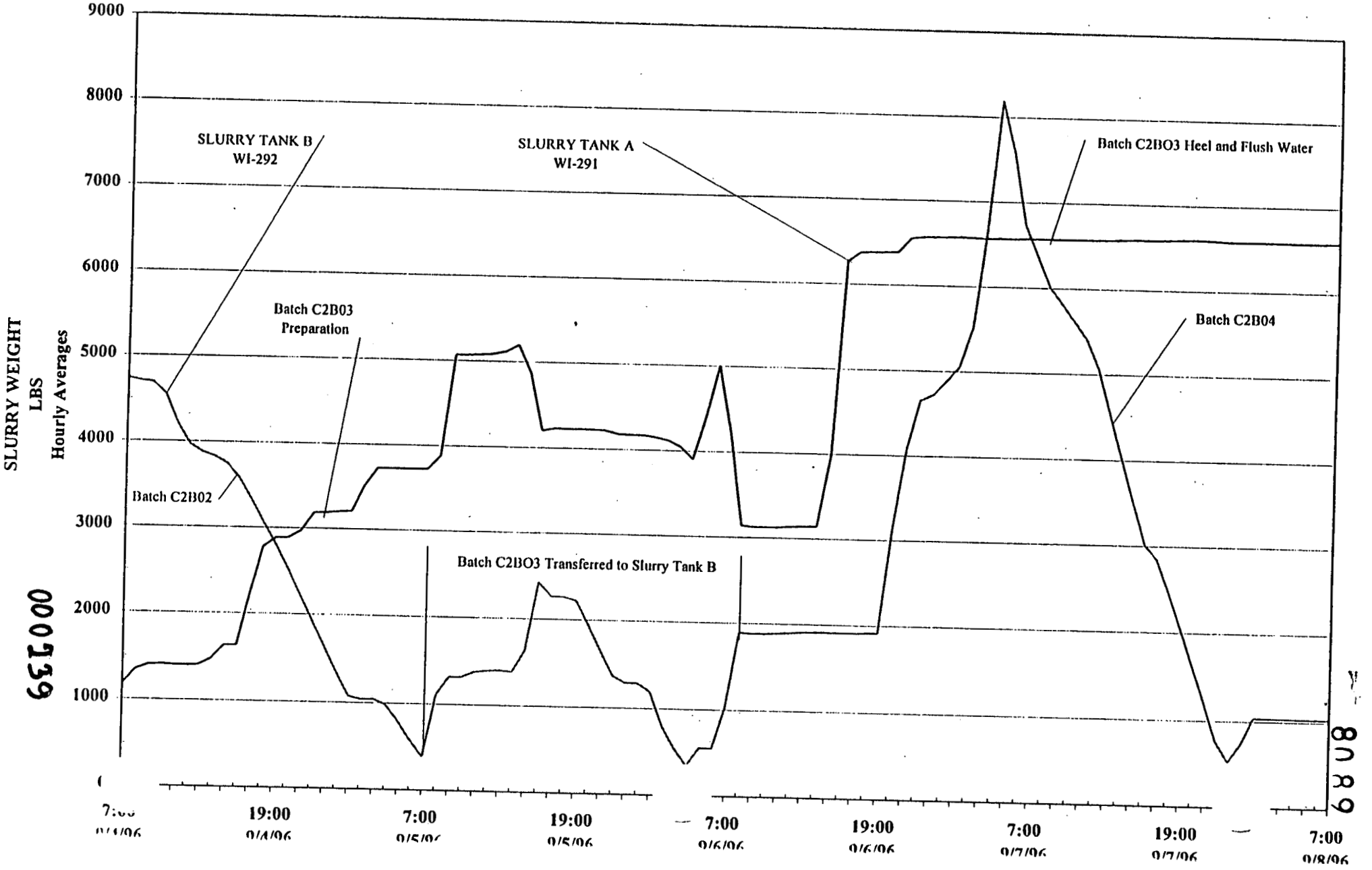
CAMPAIGN 2
36 HOUR RUN
FEED PREPARATION SYSTEM



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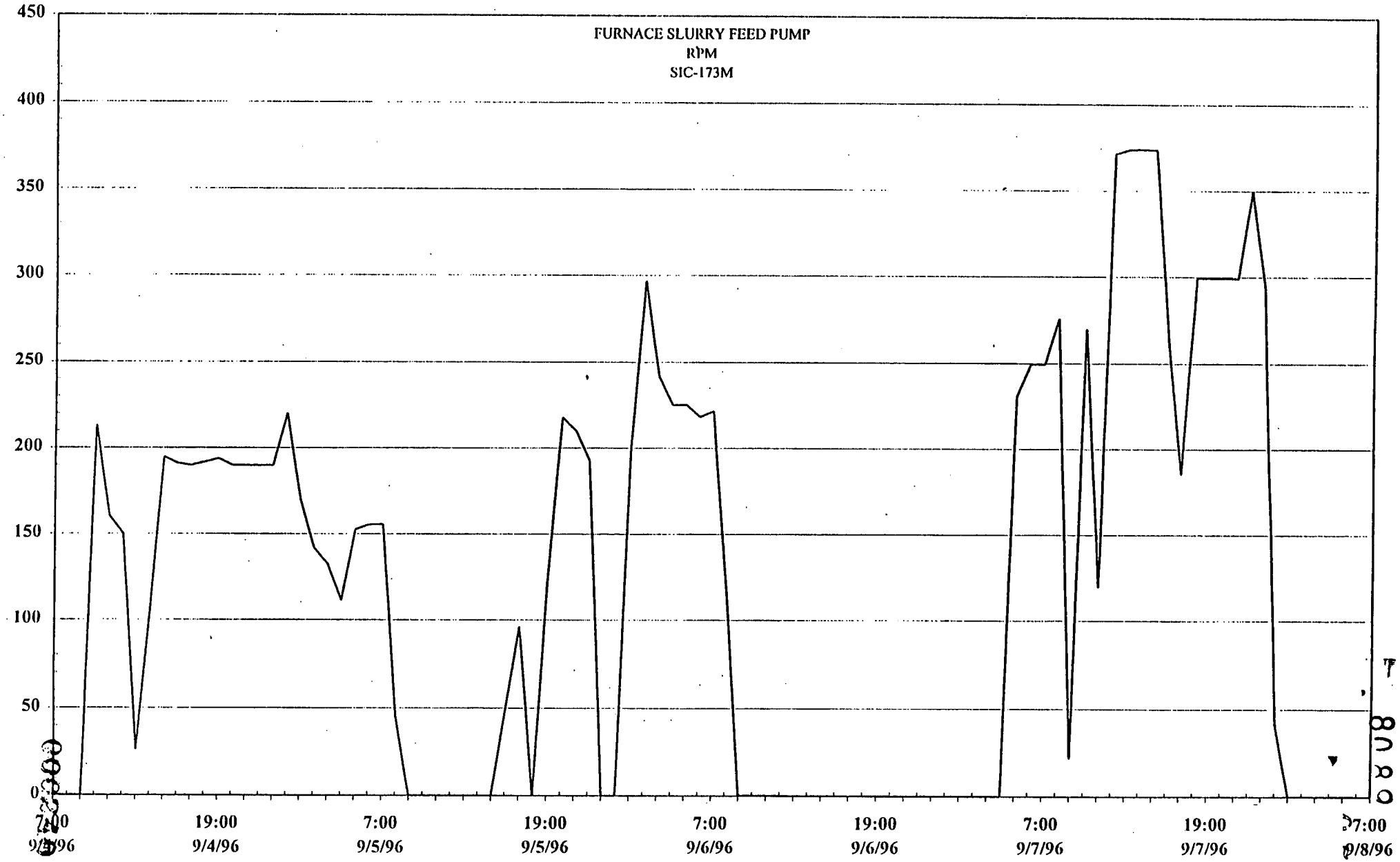
CAMPAIGN 2
36 HOUR RUN
FEED PREPARATION SYSTEM



CAMP2.XLS Chart 15

VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM

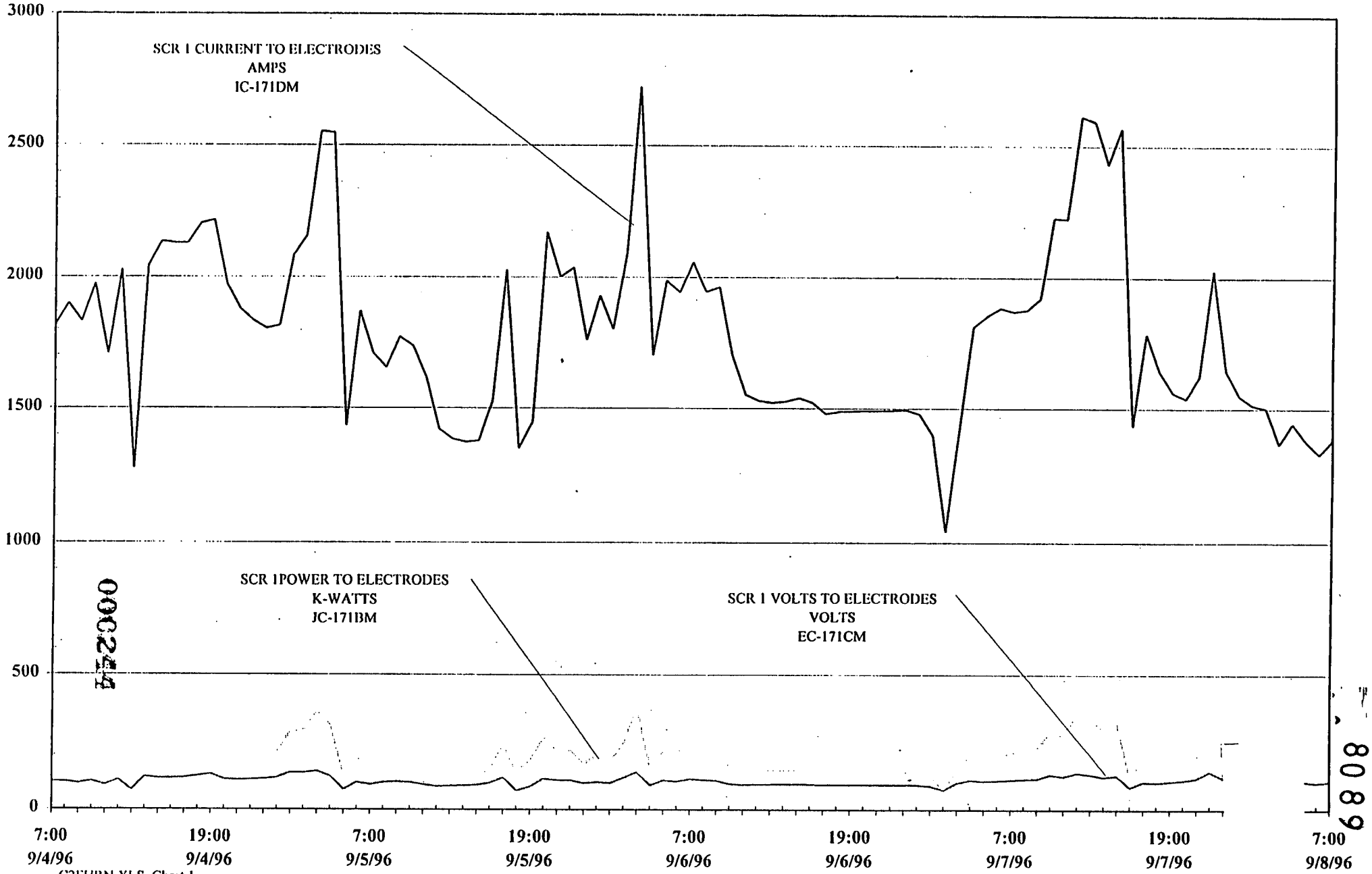
CAMPAIGN 2 36 HOUR RUN

		HOURLY AVERAGES						
READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY RECIRC VALVE	WEIGHT	SLURRY RECIRC VALVE	RECIRC FLOW	SLURRY FEED VALVE	SLURRY FEED PUMP RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/4/96	7:00	1180.13	0.0	4735.42	1.0	38.24	0.0	0.09
9/4/96	8:00	1345.50	0.2	4706.21	0.8	26.78	0.0	0.09
9/4/96	9:00	1401.44	0.0	4687.71	1.0	26.75	0.0	0.08
9/4/96	10:00	1408.42	0.0	4551.92	1.0	35.65	0.9	213.26
9/4/96	11:00	1401.38	0.0	4213.33	1.0	33.58	1.0	160.25
9/4/96	12:00	1398.14	0.0	3968.01	1.0	29.32	0.8	149.96
9/4/96	13:00	1407.20	0.0	3879.79	1.0	29.07	0.2	26.19
9/4/96	14:00	1478.58	0.3	3828.13	0.7	26.09	0.3	106.72
9/4/96	15:00	1633.81	0.0	3746.53	1.0	37.56	1.0	194.76
9/4/96	16:00	1635.33	0.0	3576.42	1.0	35.67	1.0	191.06
9/4/96	17:00	2220.79	0.0	3331.25	1.0	35.35	1.0	190.05
9/4/96	18:00	2774.42	0.0	3058.96	1.0	32.86	1.0	191.78
9/4/96	19:00	2885.79	0.0	2813.42	1.0	31.86	0.7	193.85
9/4/96	20:00	2888.38	0.0	2536.67	1.0	35.57	1.0	189.94
9/4/96	21:00	2966.17	0.0	2232.71	1.0	36.50	1.0	189.87
9/4/96	22:00	3183.46	0.0	1931.38	1.0	37.27	1.0	189.82
9/4/96	23:00	3188.79	0.0	1633.04	1.0	38.08	1.0	189.87
9/5/96	0:00	3201.38	0.0	1343.67	1.0	39.18	1.0	220.11
9/5/96	1:00	3208.04	0.0	1073.63	1.0	39.34	0.4	170.15
9/5/96	2:00	3515.54	0.0	1042.13	1.0	38.47	0.0	141.80
9/5/96	3:00	3722.38	0.0	1044.21	1.0	39.39	0.0	132.44
9/5/96	4:00	3721.38	0.0	984.67	1.0	40.08	0.8	111.14
9/5/96	5:00	3721.29	0.0	798.96	1.0	39.73	0.9	152.45
9/5/96	6:00	3722.50	0.0	585.33	1.0	37.41	0.9	155.26
9/5/96	7:00	3724.25	0.0	390.88	1.0	31.74	0.9	155.48
9/5/96	8:00	3880.25	0.0	1101.79	0.3	3.08	0.1	45.48
9/5/96	9:00	5071.57	0.0	1312.59	0.0	0.00	0.0	0.08
9/5/96	10:00	5073.92	0.5	1316.46	0.1	0.00	0.0	0.08
9/5/96	11:00	5077.50	0.9	1375.88	0.0	0.00	0.0	0.08
9/5/96	12:00	5088.92	0.7	1393.88	0.0	0.00	0.0	0.07
9/5/96	13:00	5118.67	0.0	1401.79	0.0	0.00	0.0	0.07
9/5/96	14:00	5197.83	0.0	1384.96	0.0	0.00	0.0	0.08
9/5/96	15:00	4872.21	0.0	1631.96	0.9	41.27	0.0	0.08
9/5/96	16:00	4205.75	0.0	2430.42	1.0	48.41	0.3	49.18
9/5/96	17:00	4234.38	0.0	2266.17	1.0	51.00	0.3	96.24
9/5/96	18:00	4229.17	0.0	2259.96	1.0	51.00	0.0	0.07
9/5/96	19:00	4230.34	0.0	2220.55	1.0	51.00	0.5	122.39
9/5/96	20:00	4227.96	0.0	1941.88	1.0	50.97	1.0	217.72
9/5/96	21:00	4222.58	0.0	1650.50	1.0	46.45	1.0	209.82
9/5/96	22:00	4184.17	0.0	1369.04	1.0	46.79	0.7	192.52
9/5/96	23:00	4179.33	0.0	1287.13	1.0	46.14	0.0	0.07
9/6/96	0:00	4176.08	0.0	1284.29	1.0	45.48	0.0	0.08
9/6/96	1:00	4156.38	0.0	1191.38	1.0	48.12	0.6	199.76
9/6/96	2:00	4119.83	0.0	801.25	1.0	48.09	1.0	296.80
9/6/96	3:00	4047.25	0.0	548.88	1.0	47.98	1.0	241.60
9/6/96	4:00	3900.54	0.0	353.13	1.0	45.60	1.0	224.99
9/6/96	5:00	4405.81	0.0	558.60	1.0	46.08	1.0	225.02
9/6/96	6:00	5001.58	0.0	556.33	1.0	47.66	1.0	218.14
9/6/96	7:00	4221.75	0.0	1046.50	1.0	46.86	1.0	221.50
9/6/96	8:00	3136.21	0.0	1895.13	1.0	47.20	0.6	120.77
9/6/96	9:00	3123.63	0.0	1886.04	1.0	47.84	0.0	0.26
9/6/96	10:00	3120.29	0.0	1885.08	1.0	47.95	0.0	0.20
9/6/96	11:00	3121.54	0.0	1893.58	1.0	48.09	0.0	0.22
9/6/96	12:00	3131.58	0.0	1900.50	1.0	48.20	0.0	0.11
9/6/96	13:00	3137.46	0.0	1909.71	1.0	48.27	0.0	0.07
9/6/96	14:00	3141.63	0.0	1913.88	1.0	48.33	0.0	0.07
9/6/96	15:00	3987.50	0.0	1912.75	1.0	48.39	0.0	0.08
9/6/96	16:00	6273.42	0.0	1911.50	1.0	48.46	0.0	0.08
9/6/96	17:00	6379.79	0.0	1910.88	1.0	48.52	0.0	0.06
9/6/96	18:00	6384.83	0.0	1914.46	1.0	48.64	0.0	0.08
9/6/96	19:00	6386.79	0.0	1915.96	1.0	48.69	0.0	0.08
9/6/96	20:00	6391.17	0.0	3122.88	1.0	49.24	0.0	0.07
9/6/96	21:00	6554.92	0.0	4088.54	1.0	48.16	0.0	0.07
9/6/96	22:00	6570.71	0.0	4653.33	1.0	44.66	0.0	0.10
9/6/96	23:00	6573.29	0.0	4721.13	1.0	44.16	0.0	0.08
9/7/96	0:00	6576.08	0.0	4879.71	1.0	43.94	0.0	0.07

VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM								
CAMPAIGN 2 36 HOUR RUN								
		HOURLY AVERAGES						
READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY	WEIGHT	SLURRY	RECIRC	SLURRY	SLURRY
			RECIRC		RECIRC	FLOW	FEED VALVE	FEED PUMP
			VALVE		VALVE			RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/7/96	1:00	6579.15	0.0	5051.44	1.0	43.55	0.0	0.09
9/7/96	2:00	6573.67	0.0	5519.79	1.0	44.84	0.0	0.09
9/7/96	3:00	6567.58	0.0	6663.54	1.0	38.68	0.0	0.08
9/7/96	4:00	6571.63	0.0	8186.46	1.0	29.92	0.0	0.08
9/7/96	5:00	6567.50	0.0	7596.42	1.0	29.99	1.0	230.65
9/7/96	6:00	6572.96	0.0	6730.42	1.0	39.54	1.0	249.41
9/7/96	7:00	6574.50	0.0	6379.21	1.0	43.84	1.0	249.39
9/7/96	8:00	6573.96	0.0	6011.08	1.0	44.07	1.0	275.94
9/7/96	9:00	6570.88	0.0	5816.71	1.0	44.34	0.1	22.15
9/7/96	10:00	6571.86	0.0	5617.80	1.0	46.87	1.0	269.84
9/7/96	11:00	6572.42	0.0	5413.04	1.0	48.45	0.4	119.29
9/7/96	12:00	6575.51	0.0	5061.86	1.0	47.93	1.0	371.68
9/7/96	13:00	6578.08	0.0	4541.58	1.0	47.93	1.0	373.99
9/7/96	14:00	6583.42	0.0	4018.21	1.0	48.28	1.0	374.25
9/7/96	15:00	6587.17	0.0	3498.04	1.0	47.72	1.0	374.05
9/7/96	16:00	6585.29	0.0	3011.46	1.0	46.95	0.8	263.74
9/7/96	17:00	6586.83	0.0	2840.75	1.0	47.32	0.7	185.54
9/7/96	18:00	6592.25	0.0	2458.46	1.0	47.62	1.0	299.34
9/7/96	19:00	6598.58	0.0	2044.54	1.0	47.97	1.0	299.34
9/7/96	20:00	6598.58	0.0	1626.58	1.0	48.88	1.0	299.29
9/7/96	21:00	6592.29	0.0	1207.08	1.0	48.87	1.0	299.00
9/7/96	22:00	6585.75	0.0	768.71	1.0	45.80	1.0	349.33
9/7/96	23:00	6583.75	0.0	529.33	1.0	38.88	1.0	293.76
9/8/96	0:00	6584.08	0.0	730.79	0.6	19.55	0.2	41.91
9/8/96	1:00	6584.33	0.0	1037.75	0.0	0.00	0.0	0.07
9/8/96	2:00	6583.17	0.0	1035.42	0.0	0.00	0.0	0.08
9/8/96	3:00	6582.96	0.0	1034.38	0.0	0.00	0.0	0.08
9/8/96	4:00	6581.67	0.0	1033.63	0.0	0.00	0.0	0.08
9/8/96	5:00	6580.33	0.0	1029.42	0.0	0.00	0.0	0.09
9/8/96	6:00	6583.75	0.0	1030.63	0.0	0.00	0.0	0.07
9/8/96	7:00	6583.54	0.0	1028.46	0.0	0.00	0.0	0.08

FURNACE SYSTEM

CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM



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C2FURN.XLS Chart 1

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

		HOURLY AVERAGES					
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IC-171DM	IC-171DSP	EC-171CM	EC-171SP	JC-171BM	JC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/4/96	7:00	1815.48	246.00	101.56	454.80	183.34	183.20
9/4/96	8:00	1897.40	246.00	101.04	454.80	190.09	189.88
9/4/96	9:00	1829.57	246.00	95.26	454.80	173.11	173.00
9/4/96	10:00	1974.60	246.00	103.24	454.80	203.28	203.64
9/4/96	11:00	1704.55	246.00	89.58	454.80	154.49	154.60
9/4/96	12:00	2026.68	246.00	108.44	454.80	218.98	219.13
9/4/96	13:00	1277.34	246.00	71.50	454.80	124.36	124.19
9/4/96	14:00	2041.45	246.00	119.41	454.80	243.45	243.60
9/4/96	15:00	2136.59	246.00	114.60	454.80	244.65	244.56
9/4/96	16:00	2130.63	246.00	115.02	454.80	244.84	244.80
9/4/96	17:00	2130.35	246.00	116.21	454.80	246.88	246.92
9/4/96	18:00	2205.33	246.00	122.73	454.80	270.81	271.00
9/4/96	19:00	2217.60	246.00	129.56	454.80	291.81	295.84
9/4/96	20:00	1971.20	246.00	111.02	454.80	218.20	218.12
9/4/96	21:00	1878.08	246.00	107.98	454.80	202.76	202.88
9/4/96	22:00	1832.55	246.00	109.49	454.80	200.46	200.44
9/4/96	23:00	1802.78	246.00	111.39	454.80	200.55	200.16
9/5/96	0:00	1813.95	246.00	115.99	454.80	211.35	211.48
9/5/96	1:00	2082.95	246.00	135.32	454.80	285.88	296.52
9/5/96	2:00	2159.28	246.00	134.45	454.80	291.88	291.44
9/5/96	3:00	2551.88	246.00	140.55	454.80	362.14	360.84
9/5/96	4:00	2546.73	246.00	121.87	454.80	312.15	312.72
9/5/96	5:00	1433.55	246.00	73.44	454.80	127.91	127.64
9/5/96	6:00	1868.65	246.00	98.91	454.80	184.55	184.40
9/5/96	7:00	1706.90	246.00	91.57	454.80	157.17	156.48
9/5/96	8:00	1653.05	246.00	99.37	454.80	165.76	165.64
9/5/96	9:00	1770.10	246.00	101.27	454.80	178.12	178.01
9/5/96	10:00	1735.13	246.00	98.80	454.80	170.19	170.00
9/5/96	11:00	1618.30	246.00	91.73	454.80	148.49	148.48
9/5/96	12:00	1420.60	246.00	85.60	454.80	120.77	120.84
9/5/96	13:00	1385.03	246.00	87.09	454.80	119.83	120.00
9/5/96	14:00	1373.50	246.00	88.77	454.80	121.36	121.44
9/5/96	15:00	1378.70	246.00	90.35	454.80	124.17	124.24
9/5/96	16:00	1525.73	246.00	97.71	454.80	148.21	148.36
9/5/96	17:00	2026.68	246.00	116.21	454.80	235.99	235.56
9/5/96	18:00	1350.93	246.00	70.83	454.80	135.73	134.88
9/5/96	19:00	1447.20	246.00	84.78	454.80	179.82	183.25
9/5/96	20:00	2171.28	246.00	112.65	454.80	264.75	265.20
9/5/96	21:00	2001.43	246.00	107.57	454.80	214.37	214.68
9/5/96	22:00	2035.05	246.00	107.05	454.80	217.04	216.88
9/5/96	23:00	1759.35	246.00	96.34	454.80	168.21	168.24
9/6/96	0:00	1928.10	246.00	101.14	454.80	193.35	193.56
9/6/96	1:00	1799.70	246.00	97.17	454.80	175.09	174.96
9/6/96	2:00	2084.90	246.00	116.10	454.80	242.70	242.76
9/6/96	3:00	2720.55	246.00	136.85	454.80	378.06	380.12

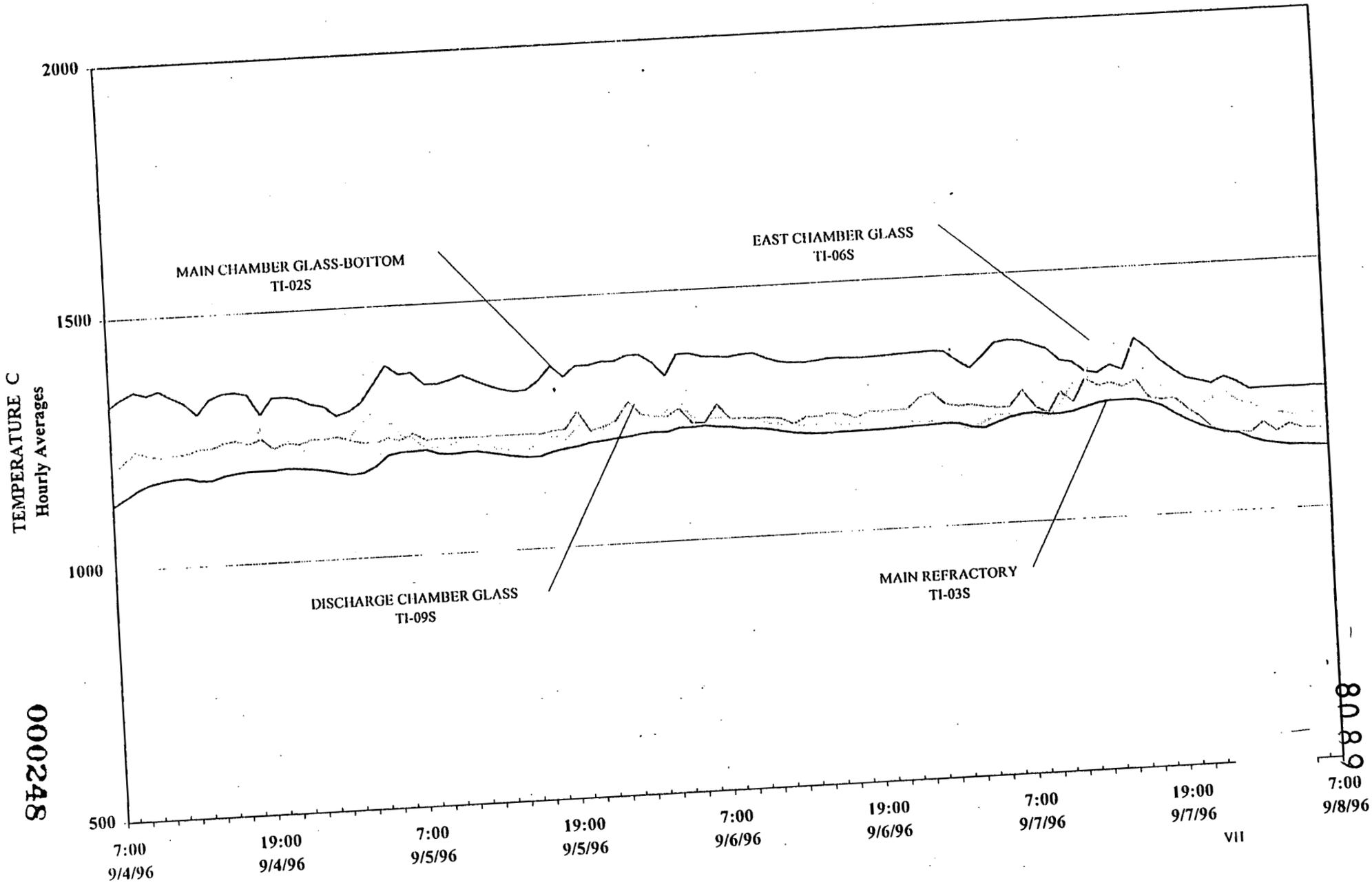
VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

		HOURLY AVERAGES					
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IC-171DM	IC-171DSP	EC-171CM	EC-171SP	JC-171BM	JC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/6/96	4:00	1699.83	246.00	89.34	454.80	155.84	155.72
9/6/96	5:00	1986.79	246.00	107.09	454.80	214.87	215.43
9/6/96	6:00	1942.15	246.00	103.24	454.80	215.78	216.12
9/6/96	7:00	2057.73	246.00	111.97	454.80	230.12	230.04
9/6/96	8:00	1943.08	246.00	108.72	454.80	210.38	210.44
9/6/96	9:00	1962.63	246.00	106.67	454.80	209.12	209.12
9/6/96	10:00	1700.70	246.00	94.99	454.80	160.14	160.12
9/6/96	11:00	1552.10	246.00	91.76	454.80	141.41	141.60
9/6/96	12:00	1529.68	246.00	93.06	454.80	141.59	141.80
9/6/96	13:00	1522.05	246.00	93.55	454.80	141.70	141.96
9/6/96	14:00	1526.93	246.00	94.09	454.80	143.07	143.16
9/6/96	15:00	1539.93	246.00	94.27	454.80	144.14	144.00
9/6/96	16:00	1523.13	246.00	93.32	454.80	141.42	141.20
9/6/96	17:00	1479.60	246.00	91.74	454.80	134.88	135.04
9/6/96	18:00	1488.00	246.00	92.63	454.80	136.93	136.80
9/6/96	19:00	1489.73	246.00	92.63	454.80	136.97	136.80
9/6/96	20:00	1490.68	246.00	92.54	454.80	136.89	136[illegible]
9/6/96	21:00	1491.35	246.00	92.45	454.80	136.87	13[illegible]
9/6/96	22:00	1492.80	246.00	92.40	454.80	136.90	136.[illegible]
9/6/96	23:00	1493.90	246.00	92.38	454.80	137.02	136.80
9/7/96	0:00	1478.05	246.00	91.61	454.80	134.18	134.16
9/7/96	1:00	1397.16	246.00	87.79	454.80	121.90	121.95
9/7/96	2:00	1043.00	246.00	73.82	454.80	77.03	77.00
9/7/96	3:00	1423.83	246.00	98.84	454.80	141.27	141.24
9/7/96	4:00	1810.80	246.00	109.26	454.80	196.30	196.44
9/7/96	5:00	1852.43	246.00	105.62	454.80	197.06	197.24
9/7/96	6:00	1882.90	246.00	107.37	454.80	201.34	201.08
9/7/96	7:00	1869.13	246.00	110.03	454.80	204.79	204.92
9/7/96	8:00	1875.50	246.00	112.67	454.80	215.97	217.76
9/7/96	9:00	1918.95	246.00	114.28	454.80	225.81	229.16
9/7/96	10:00	2227.55	246.00	128.40	454.80	287.19	287.23
9/7/96	11:00	2225.35	246.00	121.89	454.80	275.75	275.72
9/7/96	12:00	2611.53	246.00	134.88	454.80	352.99	353.25
9/7/96	13:00	2593.53	246.00	129.47	454.80	335.65	335.52
9/7/96	14:00	2432.58	246.00	120.88	454.80	292.28	292.96
9/7/96	15:00	2567.35	246.00	125.70	454.80	323.02	322.96
9/7/96	16:00	1433.40	246.00	83.94	454.80	122.93	122.76
9/7/96	17:00	1783.45	246.00	102.53	454.80	182.11	182.12
9/7/96	18:00	1641.55	246.00	101.17	454.80	165.01	165.24
9/7/96	19:00	1561.58	246.00	105.16	454.80	163.88	164.[illegible]
9/7/96	20:00	1538.55	246.00	108.95	454.80	167.90	167[illegible]
9/7/96	21:00	1621.38	246.00	116.26	454.80	189.17	189.[illegible]
9/7/96	22:00	2026.70	246.00	140.50	454.80	285.46	285.72
9/7/96	23:00	1643.30	246.00	116.54	454.80	192.43	192.40
9/8/96	0:00	1549.20	246.00	112.68	454.80	174.88	174.88

VITRIFICATION PILOT PLANT FURNACE SYSTEM							
CAMPAIGN 2 36 HOUR RUN							
		HOURLY AVERAGES					
READINGS		ELECTRODE	CURRENT	ELECTRODE	VOLTAGE	ELECTRODE	POWER
		CURRENT	CONTROLLER	VOLTAGE	CONTROLLER	POWER	CONTROLLER
			SET POINT		SET POINT		SET POINT
		IC-171DM	IC-171DSP	EC-171CM	EC-171SP	JC-171BM	JC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/8/96	1:00	1514.33	246.00	113.21	454.80	171.56	171.88
9/8/96	2:00	1501.63	246.00	112.62	454.80	169.40	169.32
9/8/96	3:00	1368.38	246.00	105.63	454.80	144.51	144.44
9/8/96	4:00	1443.25	246.00	109.61	454.80	158.08	158.08
9/8/96	5:00	1379.55	246.00	105.27	454.80	144.04	144.00
9/8/96	6:00	1330.00	246.00	100.36	454.80	132.86	132.80
9/8/96	7:00	1384.20	246.00	104.94	454.80	144.98	145.24

CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM



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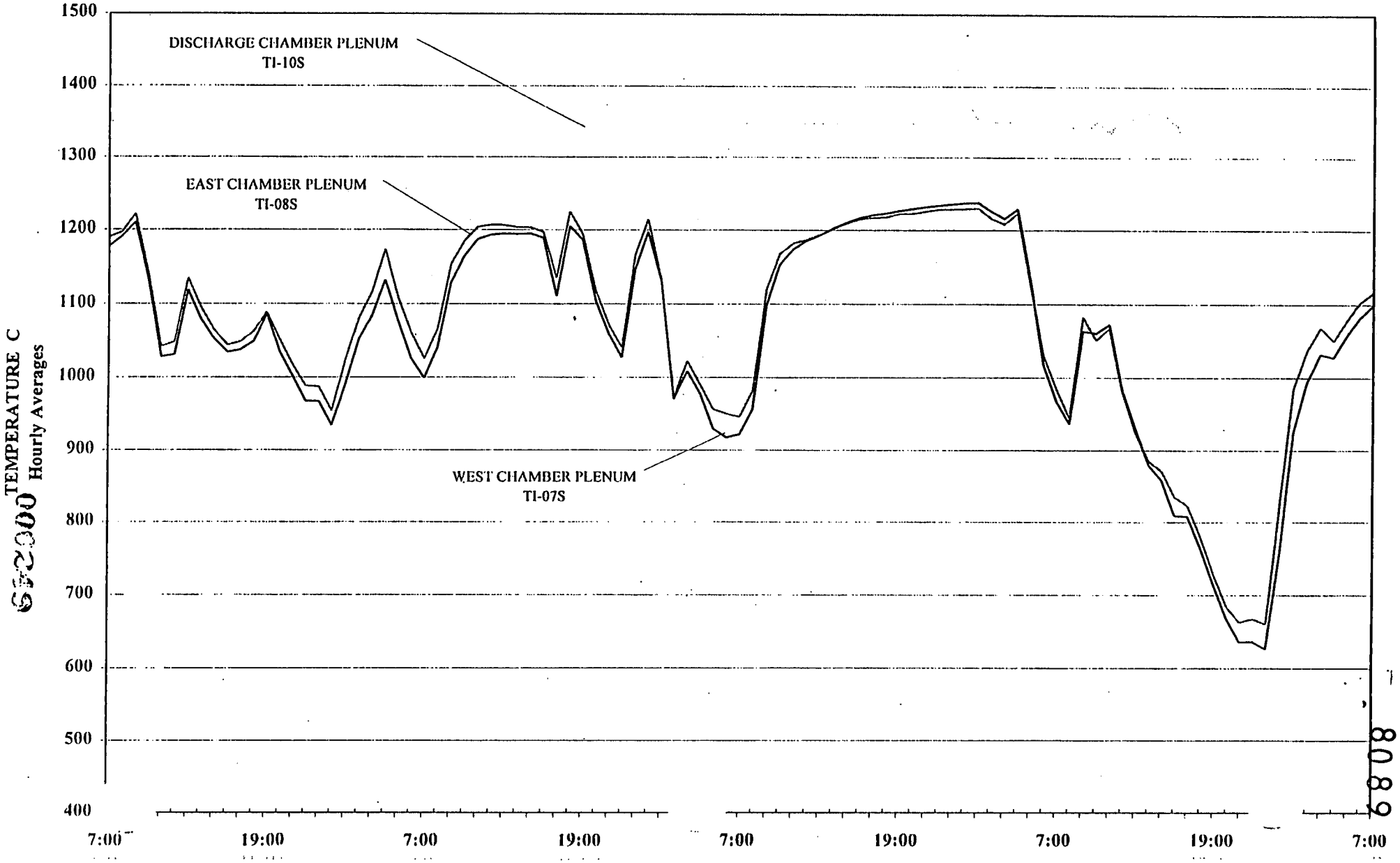
CAMP2.XLS Chart 2

CAMPAIAGN 2
36 HOUR RUN
FURNACE SYSTEM



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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

HOURLY AVERAGES

READINGS		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/4/96	7:00	OUT OF SERVICE	1326.73	OUT OF SERVICE	OUT OF SERVICE	1227.76	OUT OF SERVICE	1193.88	1177.80	1190.25	1327.94	1129.05
9/4/96	8:00		1342.46			1231.88		1216.30	1191.69	1197.12	1347.18	1143.44
9/4/96	9:00		1354.34			1234.24		1237.27	1210.29	1221.71	1347.66	1158.79
9/4/96	10:00		1346.78			1233.96		1226.40	1133.08	1142.66	1348.07	1169.90
9/4/96	11:00		1354.31			1228.51		1223.89	1028.05	1042.05	1347.75	1175.29
9/4/96	12:00		1339.68			1218.22		1226.25	1030.94	1048.28	1347.73	1179.01
9/4/96	13:00		1328.00			1218.21		1227.87	1118.93	1135.59	1347.72	1179.88
9/4/96	14:00		1304.83			1205.00		1235.55	1079.52	1095.34	1347.52	1174.12
9/4/96	15:00		1332.68			1225.93		1236.83	1052.40	1064.71	1347.44	1173.30
9/4/96	16:00		1343.19			1233.42		1246.34	1034.23	1043.95	1347.37	1180.97
9/4/96	17:00		1344.63			1240.12		1249.74	1037.60	1048.52	1347.33	1184.82
9/4/96	18:00		1339.53			1247.26		1241.67	1048.81	1063.22	1347.10	1187.53
9/4/96	19:00		1299.32			1271.47		1250.74	1086.65	1088.86	1347.07	1187.29
9/4/96	20:00		1331.22			1262.98		1230.46	1034.15	1051.11	1347.04	1187.31
9/4/96	21:00		1331.08			1246.91		1241.39	1001.15	1016.67	1347.13	1189.51
9/4/96	22:00		1326.25			1227.86		1236.30	967.35	988.10	1347.05	1188.01
9/4/96	23:00		1314.39			1218.90		1245.03	966.97	986.98	1347.01	1185.10
9/5/96	0:00		1308.96			1211.67		1244.25	934.21	954.07	1347.08	1181.26
9/5/96	1:00		1289.18			1226.19		1247.25	989.30	1023.74	1347.20	1176.06
9/5/96	2:00		1297.17			1245.45		1239.60	1051.72	1080.23	1347.09	1170.55
9/5/96	3:00		1312.97			1274.95		1232.23	1083.55	1116.12	1347.12	1172.87
9/5/96	4:00		1348.10			1293.36		1231.37	1132.56	1173.49	1347.13	1184.90
9/5/96	5:00		1382.28			1276.22		1239.45	1076.17	1107.85	1347.23	1205.16
9/5/96	6:00		1364.19			1244.86		1233.91	1025.70	1061.23	1347.14	1209.93
9/5/96	7:00		1366.40			1236.06		1246.19	998.79	1025.38	1347.17	1210.48
9/5/96	8:00		1341.91			1214.14		1231.37	1040.35	1065.58	1347.24	1211.75
9/5/96	9:00		1341.00			1217.69		1232.61	1128.95	1153.89	1347.42	1203.01
9/5/96	10:00		1347.23			1220.64		1232.73	1164.36	1184.95	1347.45	1201.17
9/5/96	11:00		1355.77			1224.17		1232.58	1187.41	1203.74	1347.43	1203.02
9/5/96	12:00		1343.94			1219.15		1232.41	1193.27	1206.70	1347.37	1203.42
9/5/96	13:00		1332.80			1211.20		1232.37	1194.87	1206.36	1347.30	1199.03
9/5/96	14:00		1324.27			1204.58		1232.37	1194.03	1203.34	1347.24	1194.14
9/5/96	15:00		1318.55			1200.58		1232.35	1194.76	1203.17	1347.15	1189.69
9/5/96	16:00		1319.94			1200.37		1231.97	1189.12	1197.18	1347.23	1186.36
9/5/96	17:00		1335.97			1212.50		1230.83	1110.67	1135.37	1347.00	1186.35
9/5/96	18:00		1364.17			1226.63		1236.27	1204.83	1224.54	1347.21	1194.92
9/5/96	19:00		1341.52			1217.78		1238.35	1186.13	1193.60	1346.98	1199.02
9/5/96	20:00		1362.16			1243.02		1272.30	1103.48	1117.60	1346.93	1202.58
9/5/96	21:00		1361.83			1237.84		1231.45	1059.38	1072.01	1346.81	1208.78
9/5/96	22:00		1367.83			1235.12		1238.76	1027.22	1040.87	1346.82	1210.71
9/5/96	23:00		1366.71			1233.85		1249.84	1146.64	1165.83	1346.67	1214.37
9/6/96	0:00		1376.45			1235.84		1285.78	1197.16	1214.38	1346.75	1215.74
9/6/96	1:00		1377.05			1238.70		1259.33	1132.46	1132.77	1346.71	1220.63
9/6/96	2:00		1361.09			1234.74		1253.89	970.42	972.22	1346.94	1222.03
9/6/96	3:00		1332.07			1265.12		1252.35	1008.14	1022.07	1347.03	1221.13
9/6/96	4:00		1374.10			1283.03		1266.76	977.25	989.66	1347.05	1227.88
9/6/96	5:00		1373.91			1247.22		1237.45	929.48	956.53	1347.13	1227.99
9/6/96	6:00		1366.93			1245.68		1236.32	917.85	950.31	1347.33	1229.55
9/6/96	7:00		1365.24			1243.18		1271.42	921.42	945.63	1347.41	1226.42
9/6/96	8:00		1363.20			1241.80		1240.90	956.03	981.41	1347.00	1224.33
9/6/96	9:00		1367.16			1241.95		1241.00	1098.26	1119.69	1346.94	1220.37
9/6/96	10:00		1368.39			1238.93		1238.58	1153.37	1167.52	1347.15	1219.03
9/6/96	11:00		1356.82			1229.00		1239.07	1173.72	1181.91	1347.21	1215.79
9/6/96	12:00		1348.28			1224.75		1236.64	1185.32	1186.73	1347.09	1210.58
9/6/96	13:00		1345.28			1221.03		1223.15	1193.14	1193.38	1347.02	1206.06
9/6/96	14:00		1344.60			1219.15		1235.98	1201.97	1202.67	1347.12	1203.17
9/6/96	15:00		1346.45			1219.04		1235.20	1209.66	1208.69	1347.03	1201.71
9/6/96	16:00		1349.89			1218.74		1241.68	1216.37	1214.18	1344.67	1201.83
9/6/96	17:00		1349.23			1217.61		1237.05	1220.52	1216.63	1349.34	1202.60

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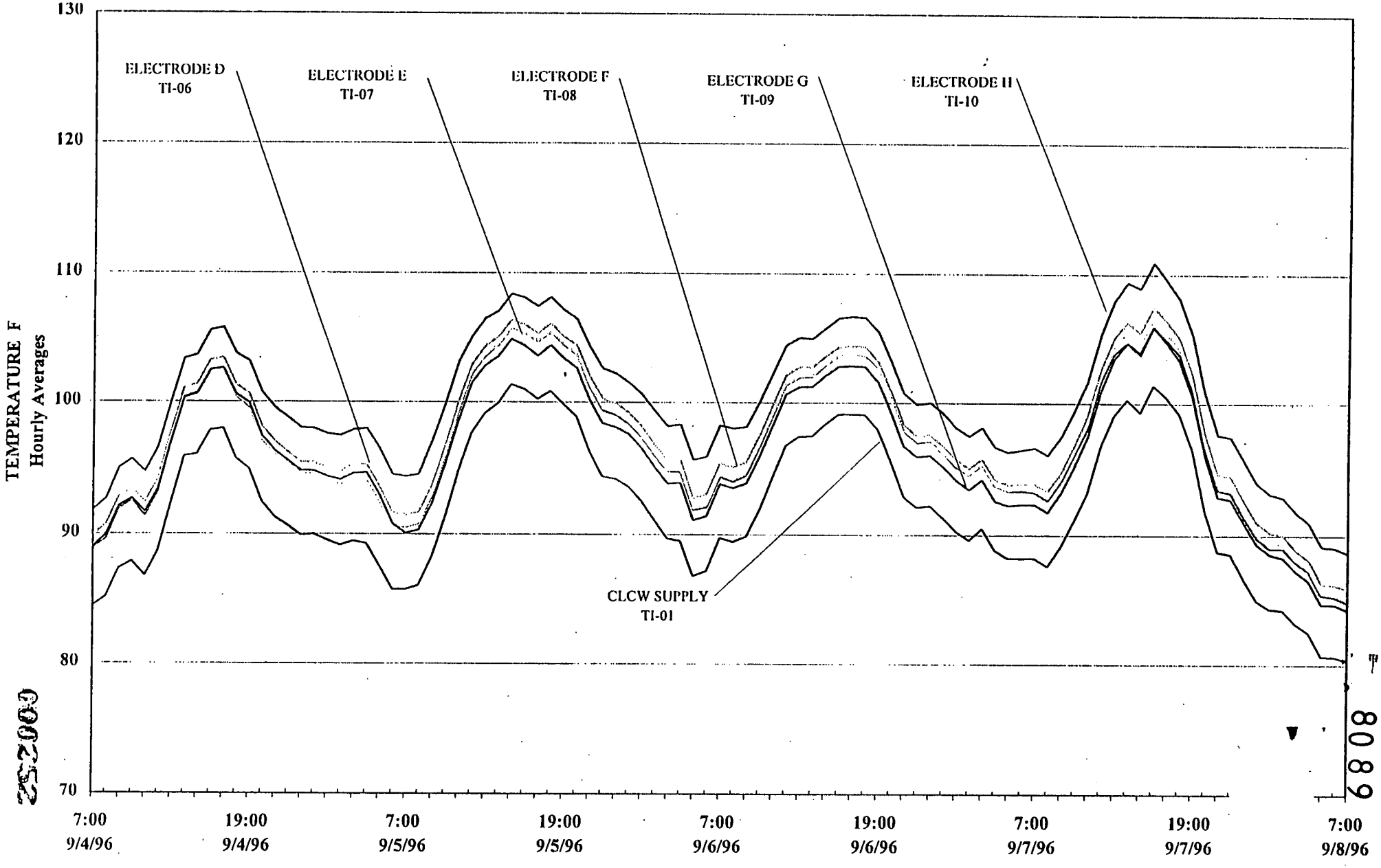
VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

HOURLY AVERAGES

READINGS		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/6/96	18:00		1348.06			1216.94		1230.32	1223.03	1217.42	1349.81	1202.41
9/6/96	19:00		1348.11			1216.87		1240.78	1226.25	1222.20	1350.99	1202.32
9/6/96	20:00		1349.00			1216.73		1238.68	1229.34	1222.42	1349.25	1203.03
9/6/96	21:00		1350.20			1216.56		1241.18	1231.78	1225.43	1350.21	1203.96
9/6/96	22:00		1351.21			1215.69		1241.81	1233.97	1228.38	1348.33	1204.94
9/6/96	23:00		1351.74			1214.42		1264.66	1235.59	1228.51	1378.77	1206.32
9/7/96	0:00		1353.16			1214.55		1270.61	1237.36	1228.76	1384.24	1207.29
9/7/96	1:00		1351.25			1213.62		1246.94	1237.43	1229.85	1353.19	1208.29
9/7/96	2:00		1331.46			1203.59		1241.90	1225.68	1215.89	1349.61	1206.31
9/7/96	3:00		1315.98			1194.16		1243.28	1216.00	1208.21	1352.60	1198.55
9/7/96	4:00		1338.62			1207.72		1238.13	1229.32	1222.79	1344.70	1195.47
9/7/96	5:00		1363.45			1220.54		1234.75	1131.70	1125.66	1345.67	1204.57
9/7/96	6:00		1367.59			1218.47		1235.15	1016.51	1029.56	1348.10	1213.86
9/7/96	7:00		1365.19			1211.97		1267.41	967.49	983.96	1347.72	1218.85
9/7/96	8:00		1355.23			1212.32		1232.65	936.32	944.44	1344.04	1220.37
9/7/96	9:00		1346.05			1213.97		1218.40	1063.24	1082.71	1334.05	1215.73
9/7/96	10:00		1323.08			1237.37		1260.35	1060.66	1051.04	1351.25	1215.82
9/7/96	11:00		1317.64			1275.42		1237.28	1072.74	1067.18	1334.74	1219.23
9/7/96	12:00		1298.36			1294.77		1284.19	982.90	981.04	1364.03	1226.90
9/7/96	13:00		1294.20			1332.70		1268.19	929.97	924.45	1350.43	1233.43
9/7/96	14:00		1307.91			1341.03		1272.98	879.62	885.35	1363.38	1236.80
9/7/96	15:00		1297.68			1355.42		1263.57	858.10	871.26	1361.30	1236.79
9/7/96	16:00		1358.09			1328.78		1277.23	808.94	835.01	1347.25	1235.74
9/7/96	17:00		1338.17			1276.24		1239.28	808.21	823.41	1301.26	1229.95
9/7/96	18:00		1311.59			1261.78		1234.19	764.62	780.44	1327.97	1220.58
9/7/96	19:00		1292.20			1234.44		1235.60	713.46	728.74	1334.02	1204.05
9/7/96	20:00		1275.04			1227.89		1212.75	667.86	684.42	1301.91	1189.81
9/7/96	21:00		1268.46			1217.15		1195.35	635.89	662.42	1277.46	1177.46
9/7/96	22:00		1261.85			1231.50		1171.23	636.56	667.13	1277.51	1168.41
9/7/96	23:00		1273.80			1243.39		1157.72	626.23	660.05	1286.88	1162.00
9/8/96	0:00		1262.34			1224.63		1161.25	760.53	827.25	1297.35	1157.49
9/8/96	1:00		1245.87			1217.21		1159.10	926.19	985.83	1297.43	1146.21
9/8/96	2:00		1247.04			1204.05		1178.16	993.60	1037.09	1297.55	1137.95
9/8/96	3:00		1246.68			1198.81		1158.07	1032.08	1068.11	1297.55	1133.55
9/8/96	4:00		1247.12			1190.53		1171.73	1027.82	1050.22	1297.58	1129.37
9/8/96	5:00		1245.38			1193.37		1162.85	1057.97	1078.61	1297.69	1128.43
9/8/96	6:00		1246.78			1191.21		1161.81	1082.27	1103.10	1297.70	1126.62
9/8/96	7:00		1244.98			1185.54		1160.30	1099.35	1116.43	1297.81	1125.21

CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
EAST ELECTRODE CLCW RETURN



CAMP2.XLS Chart 4

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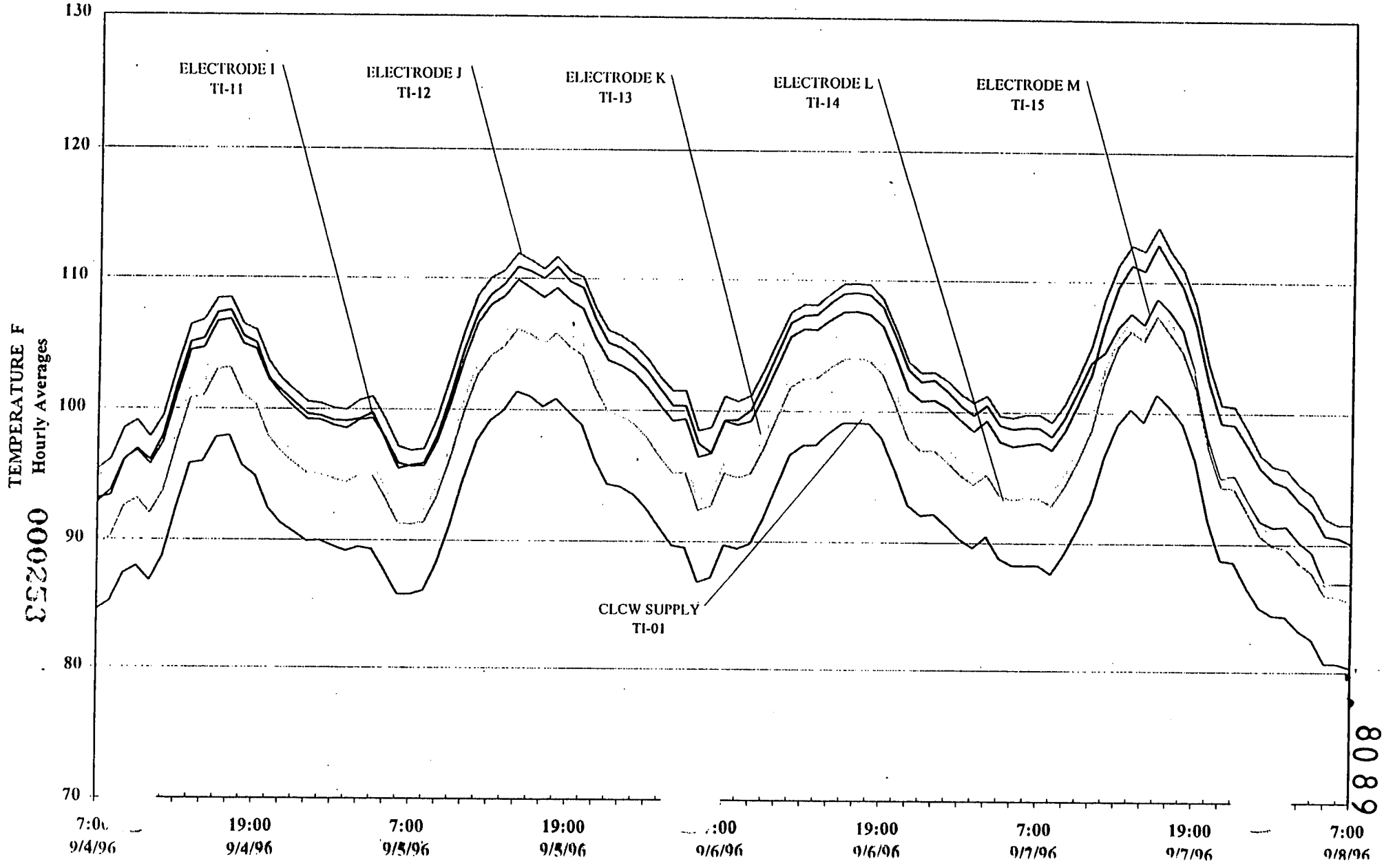
CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
WEST ELECTRODE CLCW RETURN



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6808

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

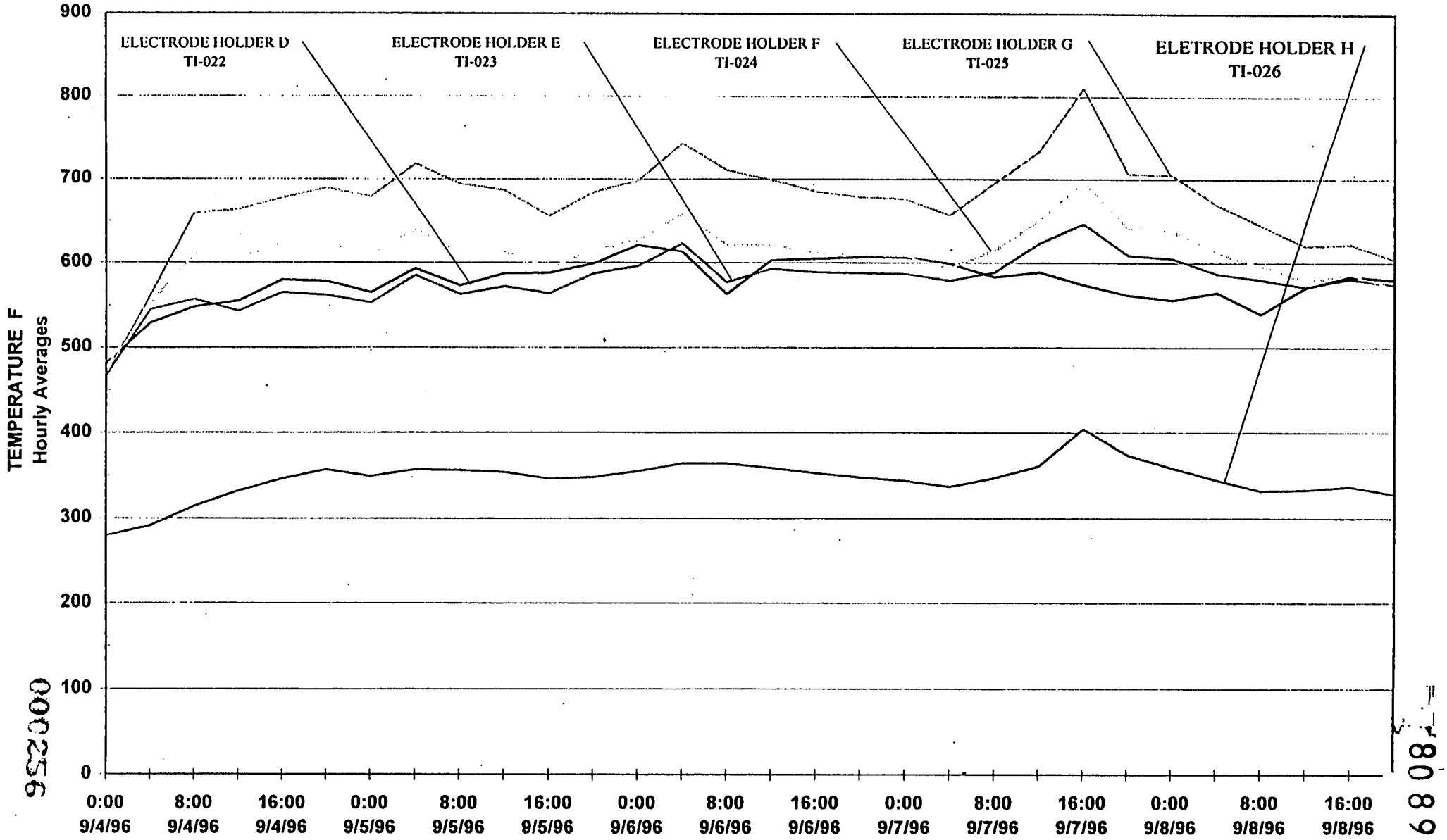
		HOURLY AVERAGES										
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM										
		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/4/96	7:00	84.47	88.93	89.14	89.95	89.01	91.84	93.17	95.43	90.44	89.51	92.88
9/4/96	8:00	85.16	89.63	89.93	90.70	89.93	92.66	93.40	96.19	91.15	90.24	93.80
9/4/96	9:00	87.39	91.95	92.09	92.90	92.13	95.01	96.12	98.53	93.49	92.56	96.17
9/4/96	10:00	87.93	92.54	92.68	93.46	92.69	95.64	96.96	99.10	93.98	93.19	96.85
9/4/96	11:00	86.78	91.38	91.55	92.41	91.64	94.69	96.12	97.87	92.84	92.05	95.82
9/4/96	12:00	88.68	93.23	93.42	94.19	93.41	96.50	97.95	99.47	94.65	93.74	97.49
9/4/96	13:00	92.41	96.93	97.09	97.79	97.06	100.06	101.70	103.12	98.29	97.42	101.08
9/4/96	14:00	95.88	100.33	100.42	101.13	100.34	103.33	105.03	106.39	101.68	100.78	104.41
9/4/96	15:00	96.03	100.61	100.69	101.40	100.67	103.64	105.32	106.78	101.92	100.98	104.62
9/4/96	16:00	97.85	102.34	102.35	103.24	102.46	105.58	107.31	108.40	103.84	102.99	106.64
9/4/96	17:00	97.99	102.49	102.47	103.42	102.62	105.78	107.49	108.47	104.01	103.14	106.82
9/4/96	18:00	95.71	100.42	100.45	101.34	100.59	103.74	105.51	106.45	101.87	101.02	104.90
9/4/96	19:00	94.94	99.63	99.71	100.65	99.92	103.15	104.99	105.95	101.28	100.40	104.50
9/4/96	20:00	92.45	97.14	97.16	98.14	97.43	100.73	102.29	103.59	98.81	97.94	102.18
9/4/96	21:00	91.29	96.12	96.12	97.00	96.28	99.56	101.34	102.24	97.64	96.75	100.99
9/4/96	22:00	90.63	95.30	95.28	96.17	95.54	98.81	100.49	101.38	96.74	95.91	100.06
9/4/96	23:00	89.92	94.56	94.53	95.43	94.80	98.02	99.63	100.56	96.00	95.15	99.23
9/5/96	0:00	89.99	94.48	94.48	95.41	94.76	97.98	99.52	100.45	95.98	95.10	99.19
9/5/96	1:00	89.54	94.12	94.12	95.02	94.35	97.58	99.17	100.08	95.57	94.74	98.78
9/5/96	2:00	89.15	93.80	93.83	94.73	94.11	97.44	99.10	99.96	95.36	94.49	98.56
9/5/96	3:00	89.47	94.24	94.22	95.25	94.57	97.88	99.29	100.68	95.79	94.97	99.17
9/5/96	4:00	89.29	94.22	94.27	95.30	94.64	98.00	99.73	100.94	95.83	95.02	99.32
9/5/96	5:00	87.60	92.57	92.61	93.62	93.00	96.47	97.68	99.25	94.13	93.29	97.81
9/5/96	6:00	85.75	90.65	90.66	91.63	90.79	94.51	95.52	97.20	92.11	91.32	95.95
9/5/96	7:00	85.76	90.54	90.59	91.47	90.07	94.36	95.77	96.92	92.08	91.26	95.68
9/5/96	8:00	86.05	90.79	90.82	91.64	90.31	94.51	95.94	97.04	92.30	91.40	95.74
9/5/96	9:00	88.25	92.84	93.03	93.68	92.33	96.99	97.99	99.38	94.21	93.40	97.62
9/5/96	10:00	91.23	95.88	96.00	96.64	95.21	99.85	101.06	102.55	97.25	96.39	100.45
9/5/96	11:00	94.70	99.27	99.41	100.04	98.56	103.10	104.53	105.92	100.68	99.80	103.81
9/5/96	12:00	97.62	102.18	102.27	102.88	101.48	105.07	107.35	108.72	103.57	102.58	106.58
9/5/96	13:00	99.16	103.58	103.61	104.35	102.82	106.48	108.78	110.06	104.99	104.08	108.01
9/5/96	14:00	99.92	104.41	104.46	105.07	103.52	107.07	109.58	110.62	105.80	104.78	108.63
9/5/96	15:00	101.36	105.80	105.83	106.39	104.88	108.42	110.89	111.98	107.10	106.15	109.89
9/5/96	16:00	100.99	105.41	105.42	106.03	104.36	108.09	110.54	111.39	106.72	105.73	109.25
9/5/96	17:00	100.24	104.71	104.76	105.33	103.58	107.44	110.02	110.74	106.10	105.04	108.56
9/5/96	18:00	100.83	105.41	105.44	106.12	104.40	108.15	110.91	111.71	106.79	105.83	109.31
9/5/96	19:00	99.82	104.44	104.47	105.09	103.37	107.16	109.78	110.60	105.73	104.78	108.35
9/5/96	20:00	98.91	103.67	103.70	104.40	102.63	106.47	109.32	110.11	105.08	104.12	107.71
9/5/96	21:00	96.27	101.17	101.29	102.02	100.17	104.30	106.91	107.75	102.60	101.68	105.45
9/5/96	22:00	94.38	99.37	99.54	100.28	98.40	102.61	105.08	106.05	100.83	99.87	103.77
9/5/96	23:00	94.20	99.03	99.20	99.93	98.09	102.23	104.72	105.64	100.51	99.57	103.38
9/6/96	0:00	93.62	98.35	98.48	99.23	97.57	101.53	103.97	104.96	99.86	98.98	102.78
9/6/96	1:00	92.54	97.36	97.42	98.20	96.49	100.62	102.98	103.95	98.80	97.94	101.71
9/6/96	2:00	91.07	95.96	96.05	96.78	95.09	99.36	101.65	102.54	97.37	96.51	100.40
9/6/96	3:00	89.69	94.77	94.85	95.61	93.85	98.18	100.39	101.49	96.18	95.31	99.23
9/6/96	4:00	89.50	94.72	94.87	95.65	93.88	98.31	100.37	101.51	96.12	95.32	99.37
9/6/96	5:00	86.82	91.86	92.00	92.74	91.09	95.63	97.53	98.49	93.27	92.43	96.50
9/6/96	6:00	87.18	92.07	92.19	93.08	91.40	95.88	96.84	98.76	93.65	92.76	96.81
9/6/96	7:00	89.74	94.35	94.52	95.37	93.82	98.25	99.26	101.08	96.08	95.29	99.20
9/6/96	8:00	89.45	93.99	94.18	95.10	93.52	98.03	99.33	100.70	95.77	94.95	98.94
9/6/96	9:00	89.84	94.45	94.73	95.48	93.85	98.13	100.07	101.15	96.10	95.29	99.23
9/6/96	10:00	91.83	96.56	96.73	97.44	95.83	100.02	102.09	103.11	98.12	97.21	101.19
9/6/96	11:00	94.33	98.95	99.10	99.79	98.21	102.22	104.42	105.36	100.40	99.57	103.42
9/6/96	12:00	96.71	101.36	101.42	102.08	100.61	104.43	106.71	107.52	102.73	101.80	105.66

VITRIFICATION PILOT PLANT FURNACE SYSTEM

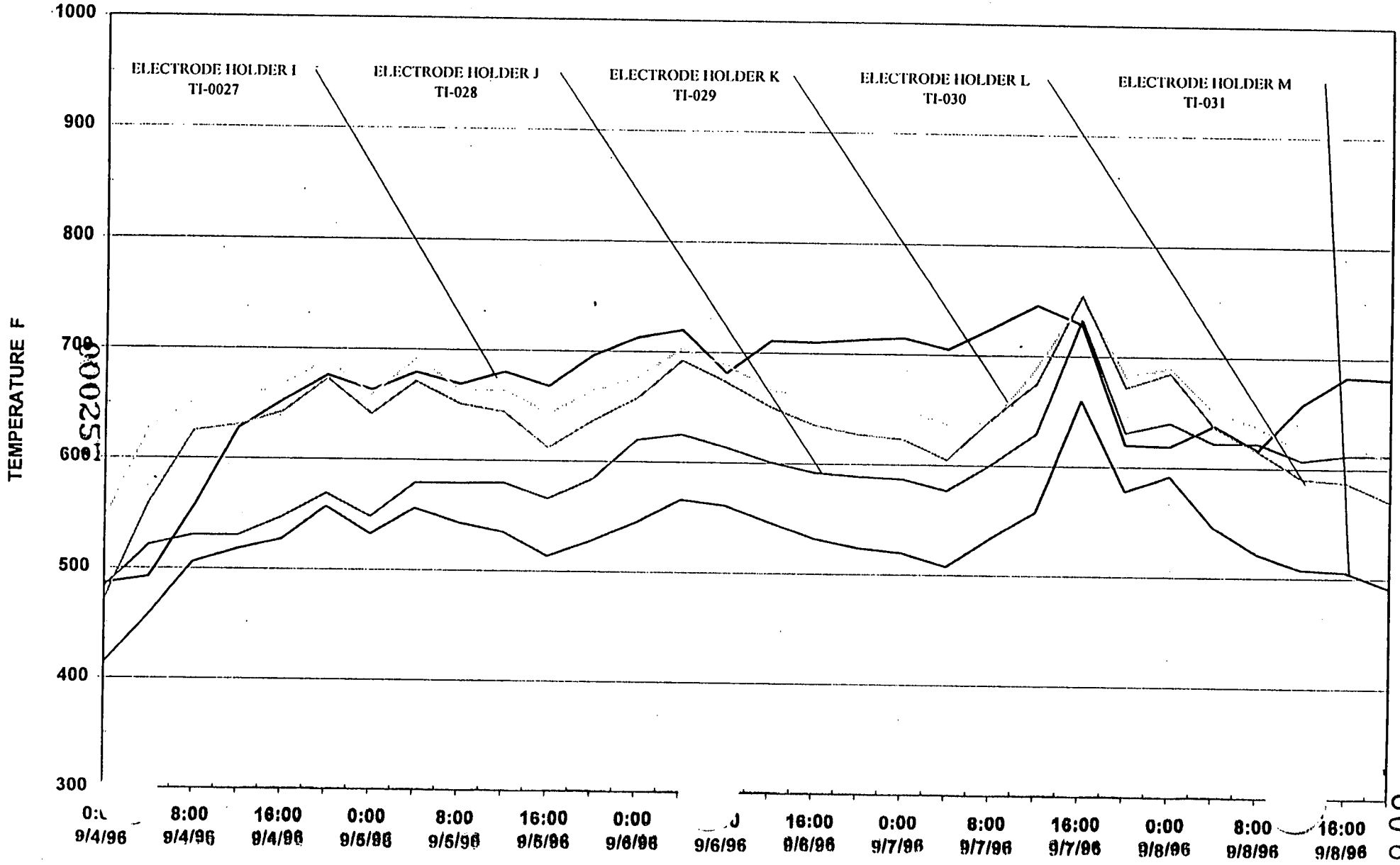
CAMPAIGN 2 36 HOUR RUN

		HOURLY AVERAGES										
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM										
		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/6/96	13:00	97.42	101.95	102.02	102.75	101.22	105.04	107.30	108.15	103.35	102.44	106.26
9/6/96	14:00	97.46	102.01	102.08	102.75	101.24	104.97	107.36	108.12	103.36	102.49	106.22
9/6/96	15:00	98.39	102.92	102.95	103.57	102.10	105.79	108.27	108.98	104.21	103.29	106.95
9/6/96	16:00	99.12	103.63	103.62	104.33	102.79	106.57	108.99	109.72	104.95	103.93	107.57
9/6/96	17:00	99.14	103.71	103.71	104.38	102.85	106.69	109.07	109.76	105.01	104.09	107.63
9/6/96	18:00	99.09	103.56	103.53	104.37	102.78	106.64	108.90	109.70	104.93	103.86	107.40
9/6/96	19:00	97.94	102.60	102.58	103.19	101.62	105.56	107.96	108.60	103.85	102.84	106.50
9/6/96	20:00	95.56	100.32	100.29	100.91	99.28	103.25	105.69	106.29	101.50	100.52	104.17
9/6/96	21:00	92.89	97.82	97.71	98.36	96.70	100.75	103.17	103.79	98.86	97.91	101.61
9/6/96	22:00	92.09	96.90	96.82	97.48	95.90	99.86	102.25	102.94	98.04	97.05	100.79
9/6/96	23:00	92.20	97.02	96.95	97.58	96.00	100.01	102.38	102.99	98.09	97.10	100.85
9/7/96	0:00	91.28	96.19	96.24	96.71	95.15	99.22	101.54	102.34	97.22	96.24	100.31
9/7/96	1:00	90.28	95.13	95.25	95.73	94.14	98.11	100.50	101.35	96.23	95.23	99.40
9/7/96	2:00	89.61	94.53	94.55	95.02	93.41	97.48	99.75	100.68	95.49	94.51	98.55
9/7/96	3:00	90.49	95.32	95.35	95.73	94.16	98.12	100.50	101.22	96.28	95.26	99.35
9/7/96	4:00	88.81	93.73	93.77	94.18	92.58	96.61	99.00	99.72	94.68	93.67	97.78
9/7/96	5:00	88.27	93.33	93.40	93.82	92.24	96.24	98.73	99.58	94.26	93.32	97.42
9/7/96	6:00	88.25	93.32	93.47	93.88	92.32	96.39	98.86	99.82	94.44	93.48	97.57
9/7/96	7:00	88.26	93.22	93.45	93.87	92.32	96.56	98.82	99.82	94.42	93.47	97.69
9/7/96	8:00	87.60	92.60	92.77	93.31	91.73	96.03	98.16	99.26	93.85	92.89	97.17
9/7/96	9:00	89.16	94.03	94.28	94.73	93.20	97.42	99.62	100.64	95.30	94.43	98.59
9/7/96	10:00	91.10	96.07	96.29	96.76	95.18	99.41	101.67	102.71	97.31	96.39	1.66
9/7/96	11:00	93.19	98.05	98.42	99.03	97.40	101.63	103.82	105.02	99.52	98.64	2.86
9/7/96	12:00	96.71	101.61	102.04	102.57	100.87	105.29	104.56	108.73	103.20	102.39	106.67
9/7/96	13:00	99.09	103.83	104.40	105.10	103.44	107.95	106.48	111.29	105.78	104.99	109.58
9/7/96	14:00	100.27	104.68	105.55	106.32	104.68	109.40	107.59	112.84	107.05	106.27	111.27
9/7/96	15:00	99.32	103.71	104.68	105.50	103.89	108.95	106.75	112.42	106.35	105.49	110.83
9/7/96	16:00	101.39	105.98	106.53	107.50	105.94	110.92	108.74	114.23	108.20	107.39	112.91
9/7/96	17:00	100.43	104.87	105.50	106.43	104.72	109.57	107.74	112.41	106.97	106.08	111.22
9/7/96	18:00	99.18	103.75	104.20	105.09	103.32	108.15	106.31	110.95	105.60	104.65	109.56
9/7/96	19:00	96.39	100.95	101.45	102.29	100.56	105.39	102.77	108.27	102.85	101.93	106.77
9/7/96	20:00	91.86	96.45	96.85	97.70	95.98	100.79	98.13	103.75	98.32	97.42	102.37
9/7/96	21:00	88.73	93.43	93.76	94.61	92.91	97.61	95.12	100.62	95.22	94.39	99.24
9/7/96	22:00	88.59	93.22	93.55	94.45	92.73	97.42	95.27	100.50	95.10	94.29	99.12
9/7/96	23:00	86.66	91.34	91.72	92.63	90.98	95.67	93.37	98.80	93.31	92.51	97.58
9/8/96	0:00	84.99	89.81	90.13	90.97	89.34	93.95	91.80	96.88	91.46	90.68	95.88
9/8/96	1:00	84.35	89.02	89.47	90.24	88.58	93.14	91.31	96.02	90.70	89.88	94.87
9/8/96	2:00	84.27	89.02	89.29	90.05	88.33	92.87	91.39	95.78	90.52	89.68	94.49
9/8/96	3:00	83.21	87.96	88.14	88.88	87.25	91.77	90.20	94.58	89.42	88.56	93.32
9/8/96	4:00	82.53	87.26	87.41	88.19	86.52	90.96	89.35	93.83	88.64	87.78	92.47
9/8/96	5:00	80.67	85.44	85.58	86.32	84.72	89.19	86.84	92.05	86.88	85.97	90.67
9/8/96	6:00	80.64	85.27	85.54	86.20	84.70	89.08	86.95	91.55	86.81	85.85	90.54
9/8/96	7:00	80.33	84.86	85.29	85.91	84.27	88.67	86.91	91.56	86.41	85.45	90.09

CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
EAST ELECTRODE HOLDER TEMPERATURES



CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
WEST ELECTRODE HOLDER TEMPERATURES



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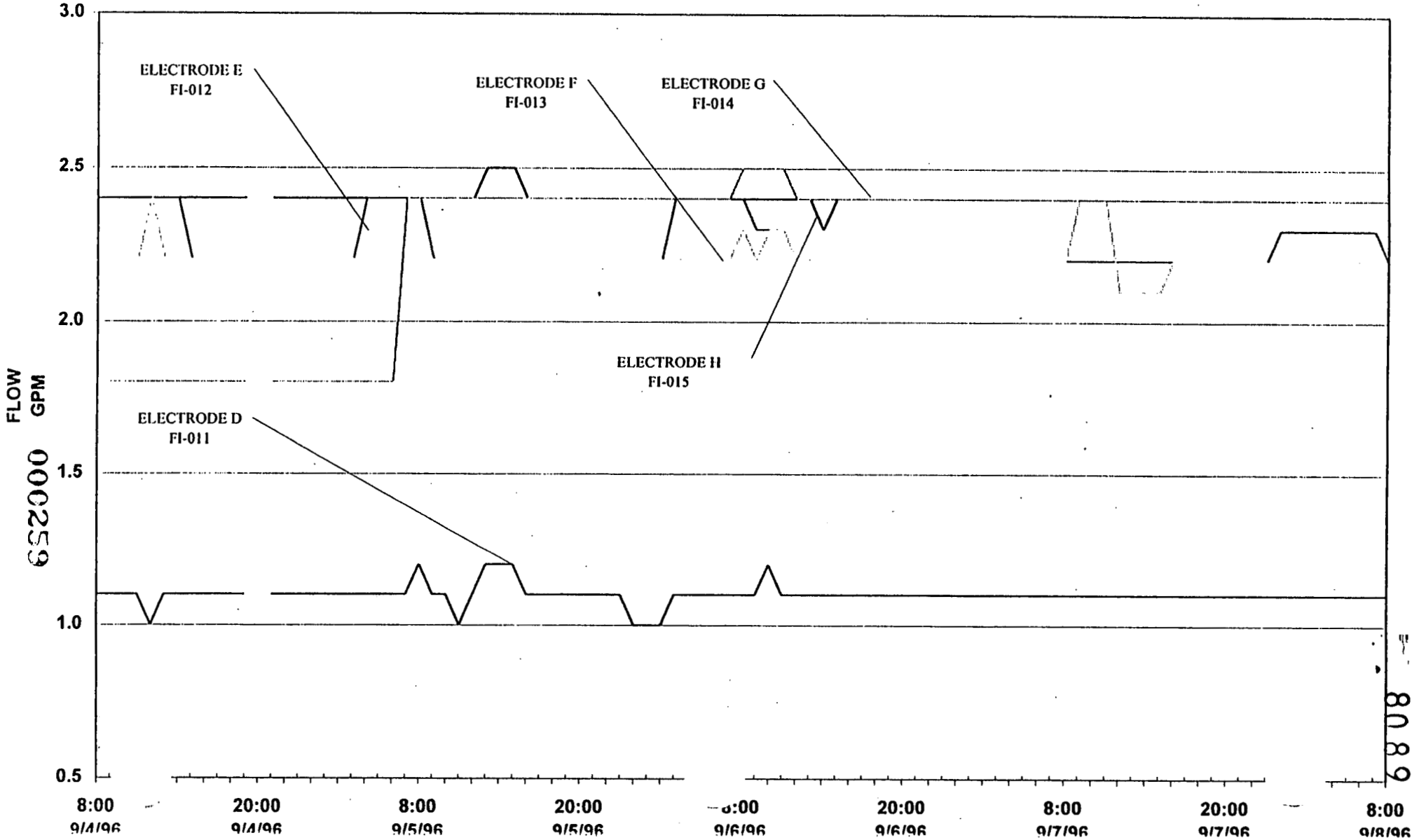
VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

		HOURLY READINGS ROUNDSHEETS									
READINGS		ELECTRODE HOLDER TEMPERATURES									
		D	E	F	G	H	I	J	K	L	M
		TI-022	TI-023	TI-024	TI-025	TI-026	TI-027	TI-028	TI-029	TI-030	TI-031
DATE	HOUR	F	F	F	F	F	F	F	F	F	F
9/4/96	0:00	481	467	477	468	279	486	483	544	471	414
9/4/96	4:00	529	545	553	562	291	492	521	629	560	457
9/4/96	8:00	548	557	610	659	314	555	530	652	625	506
9/4/96	12:00	555	543	605	663	332	628	530	653	631	518
9/4/96	16:00	580	565	622	677	346	653	547	669	643	527
9/4/96	20:00	578	562	624	689	357	676	569	689	673	557
9/5/96	0:00	565	553	611	678	349	663	548	659	641	532
9/5/96	4:00	593	585	638	718	357	679	579	692	671	556
9/5/96	8:00	573	563	613	694	356	669	579	664	651	543
9/5/96	12:00	587	572	613	686	354	680	580	663	644	535
9/5/96	16:00	588	564	594	655	346	668	566	643	612	514
9/5/96	20:00	599	587	615	684	348	696	584	664	637	528
9/6/96	0:00	621	596	627	698	355	713	620	677	658	545
9/6/96	4:00	613	623	657	743	364	720	625	703	692	566
9/6/96	8:00	563	577	622	711	364	681	614	688	673	561
9/6/96	12:00	603	593	621	699	359	711	601	667	651	546
9/6/96	16:00	605	589	612	685	353	710	592	657	635	532
9/6/96	20:00	607	588	609	678	348	713	589	653	627	524
9/7/96	0:00	607	587	608	676	344	715	587	650	623	520
9/7/96	4:00	599	579	594	656	337	705	577	637	605	508
9/7/96	8:00	583	589	615	695	347	725	601	639	642	534
9/7/96	12:00	589	623	650	733	361	746	629	690	675	558
9/7/96	16:00	574	646	696	810	404	729	733	752	755	660
9/8/96	20:00	562	609	641	707	374	620	631	682	672	578
9/8/96	0:00	556	605	638	705	359	619	640	690	685	592
9/8/96	4:00	565	587	612	669	345	638	622	650	637	546
9/8/96	8:00	540	580	596	644	332	616	622	637	615	522
9/8/96	12:00	571	572	579	620	333	658	607	617	591	508
9/8/96	16:00	584	581	586	622	337	683	612	620	588	506
9/8/96	20:00	580	574	572	604	328	681	612	609	570	491

CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
EAST ELECTRODE CLCW FLOW



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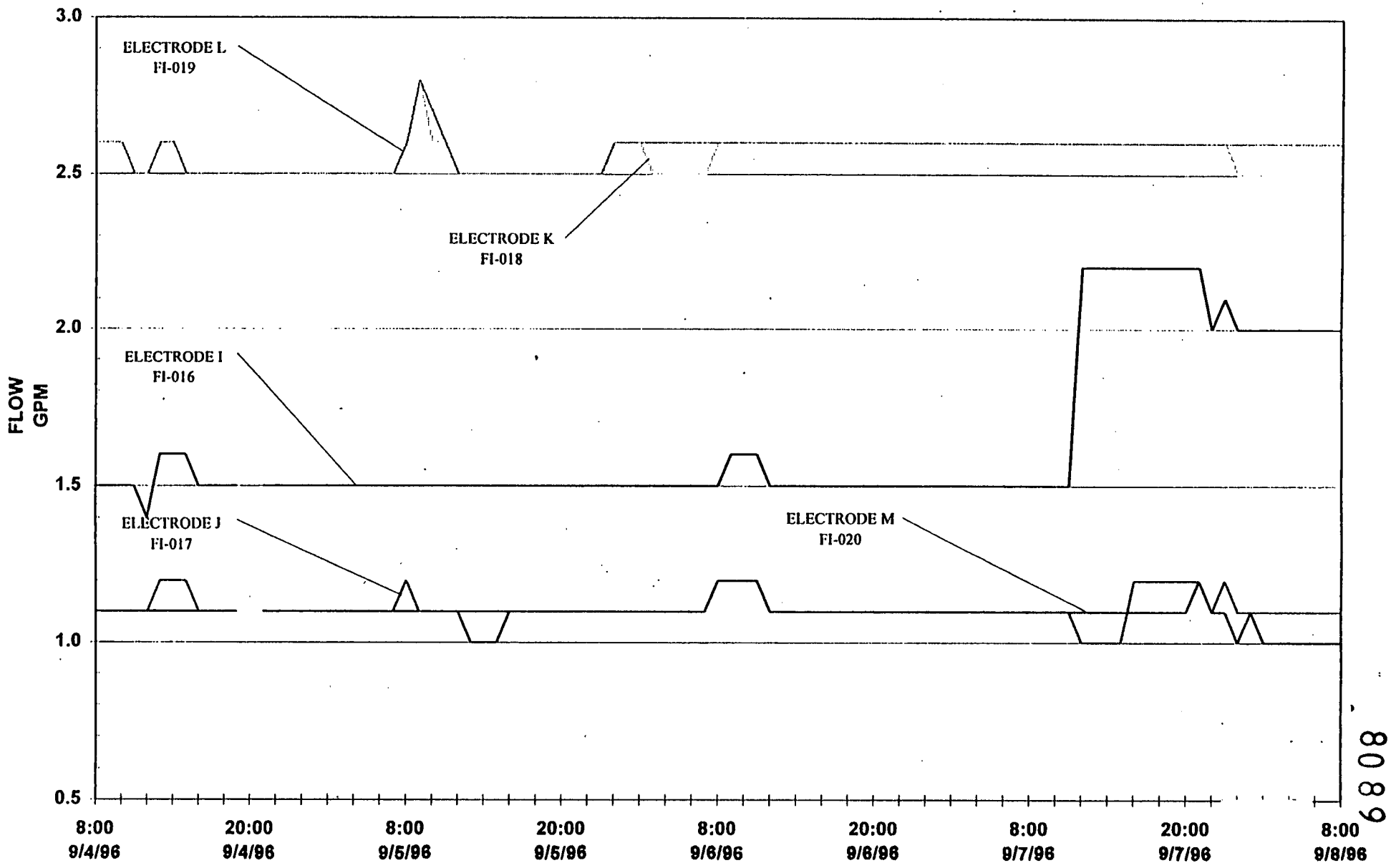
CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
WEST ELECTRODE CLCW FLOW



C2FURN.XLS Chart 15

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

		HOURLY READINGS ROUNDSHEETS									
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/4/96	8:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.6	2.6	1.1
9/4/96	9:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.6	2.6	1.1
9/4/96	10:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.6	2.6	1.1
9/4/96	11:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/4/96	12:00	2.4	2.4	2.4	1.8	1.0	1.4	1.1	2.5	2.5	1.1
9/4/96	13:00	2.4	2.4	2.2	1.8	1.1	1.6	1.2	2.6	2.6	1.1
9/4/96	14:00	2.4	2.4	2.2	1.8	1.1	1.6	1.2	2.6	2.6	1.1
9/4/96	15:00	2.4	2.2	2.2	1.8	1.1	1.6	1.2	2.5	2.5	1.1
9/4/96	16:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/4/96	17:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/4/96	18:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/4/96	19:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/4/96	20:00										
9/4/96	21:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/4/96	22:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/4/96	23:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	0:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	1:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	2:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	3:00	2.4	2.2	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	4:00	2.4	2.4	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	5:00	2.4	2.4	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	6:00	2.4	2.4	2.2	1.8	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	7:00	2.4	2.4	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	8:00	2.4	2.4	2.2	2.4	1.2	1.5	1.2	2.6	2.6	1.1
9/5/96	9:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.8	2.8	1.1
9/5/96	10:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.7	1.1
9/5/96	11:00	2.4	2.2	2.2	2.4	1.0	1.5	1.1	2.6	2.6	1.1
9/5/96	12:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	13:00	2.5	2.2	2.2	2.4	1.2	1.5	1.1	2.5	2.5	1.0
9/5/96	14:00	2.5	2.2	2.2	2.4	1.2	1.5	1.1	2.5	2.5	1.0
9/5/96	15:00	2.5	2.2	2.2	2.4	1.2	1.5	1.1	2.5	2.5	1.0
9/5/96	16:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	17:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	18:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	19:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	20:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	21:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	22:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/5/96	23:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.5	2.5	1.1
9/6/96	0:00	2.4	2.2	2.2	2.4	1.0	1.5	1.1	2.6	2.6	1.1
9/6/96	1:00	2.4	2.2	2.2	2.4	1.0	1.5	1.1	2.6	2.6	1.1
9/6/96	2:00	2.4	2.2	2.2	2.4	1.0	1.5	1.1	2.6	2.6	1.1
9/6/96	3:00	2.4	2.4	2.2	2.4	1.1	1.5	1.1	2.5	2.6	1.1
9/6/96	4:00	2.4	2.4	2.2	2.4	1.1	[illegible]	1.1	2.5	2.6	1.1

VITRIFICATION PILOT PLANT FURNACE SYSTEM

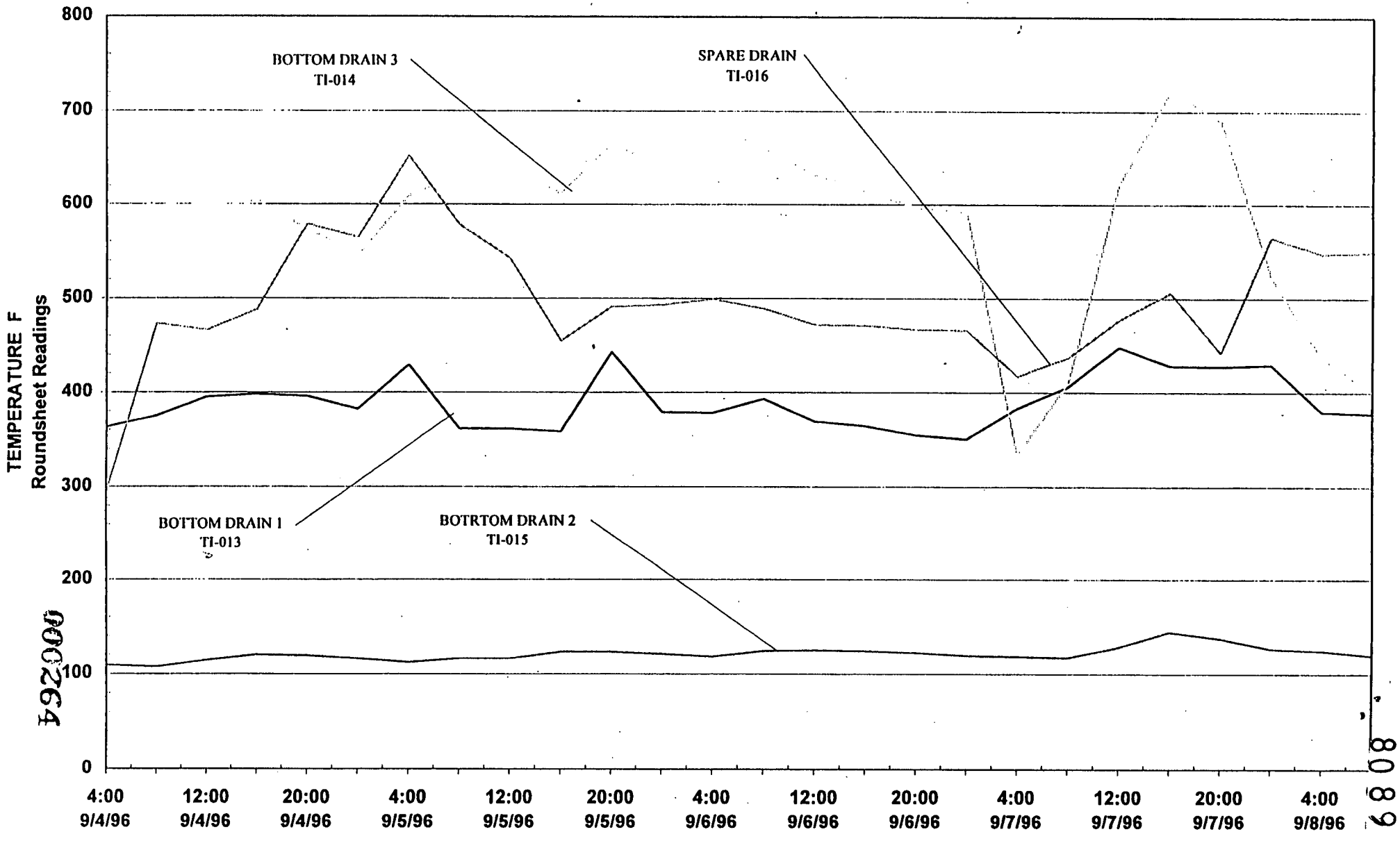
CAMPAIGN 2 36 HOUR RUN

HOURLY READINGS ROUNDSHEETS

READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/6/96	5:00	2.4	2.4	2.2	2.4	1.1	1.5	1.1	2.5	2.6	1.1
9/6/96	6:00	2.4	2.4	2.2	2.4	1.1	1.5	1.1	2.5	2.6	1.1
9/6/96	7:00	2.4	2.4	2.2	2.4	1.1	1.5	1.1	2.5	2.6	1.1
9/6/96	8:00	2.4	2.4	2.3	2.5	1.1	1.5	1.2	2.6	2.6	1.2
9/6/96	9:00	2.4	2.3	2.2	2.5	1.1	1.6	1.2	2.6	2.6	1.2
9/6/96	10:00	2.4	2.3	2.3	2.5	1.2	1.6	1.2	2.6	2.6	1.2
9/6/96	11:00	2.4	2.3	2.3	2.5	1.1	1.6	1.2	2.6	2.6	1.2
9/6/96	12:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	13:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	14:00	2.3	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	15:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	16:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	17:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	18:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	19:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	20:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	21:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	22:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/6/96	23:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	0:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	1:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	2:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	3:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	4:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	5:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	6:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	7:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	8:00	2.4	2.2	2.2	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	9:00	2.4	2.2	2.4	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	10:00	2.4	2.2	2.4	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	11:00	2.4	2.2	2.4	2.4	1.1	1.5	1.1	2.6	2.6	1.1
9/7/96	12:00	2.4	2.2	2.1	2.4	1.1	2.2	1.0	2.6	2.6	1.1
9/7/96	13:00	2.4	2.2	2.1	2.4	1.1	2.2	1.0	2.6	2.6	1.1
9/7/96	14:00	2.4	2.2	2.1	2.4	1.1	2.2	1.0	2.6	2.6	1.1
9/7/96	15:00	2.4	2.2	2.1	2.4	1.1	2.2	1.0	2.6	2.6	1.1
9/7/96	16:00	2.4	2.2	2.2	2.4	1.1	2.2	1.2	2.6	2.6	1.1
9/7/96	17:00	2.4	2.2	2.2	2.4	1.1	2.2	1.2	2.6	2.6	1.1
9/7/96	18:00	2.4	2.2	2.2	2.4	1.1	2.2	1.2	2.6	2.6	1.1
9/7/96	19:00	2.4	2.2	2.2	2.4	1.1	2.2	1.2	2.6	2.6	1.1
9/7/96	20:00	2.4	2.2	2.2	2.4	1.1	2.2	1.2	2.6	2.6	1.1
9/7/96	21:00	2.4	2.2	2.2	2.4	1.1	2.2	1.2	2.6	2.6	1.2
9/7/96	22:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/7/96	23:00	2.4	2.2	2.2	2.4	1.1	2.1	1.2	2.6	2.6	1.1
9/8/96	0:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0
9/8/96	1:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.1

VITRIFICATION PILOT PLANT FURNACE SYSTEM											
CAMPAIGN 2 36 HOUR RUN											
		HOURLY READINGS ROUNDSHEETS									
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/8/96	2:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0
9/8/96	3:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0
9/8/96	4:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0
9/8/96	5:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0
9/8/96	6:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0
9/8/96	7:00	2.4	2.3	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0
9/8/96	8:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.5	2.6	1.0

CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
BOTTOM DRAIN TEMPERATURES



C2FURN.XLS Chart 17

VHP 11/6/96

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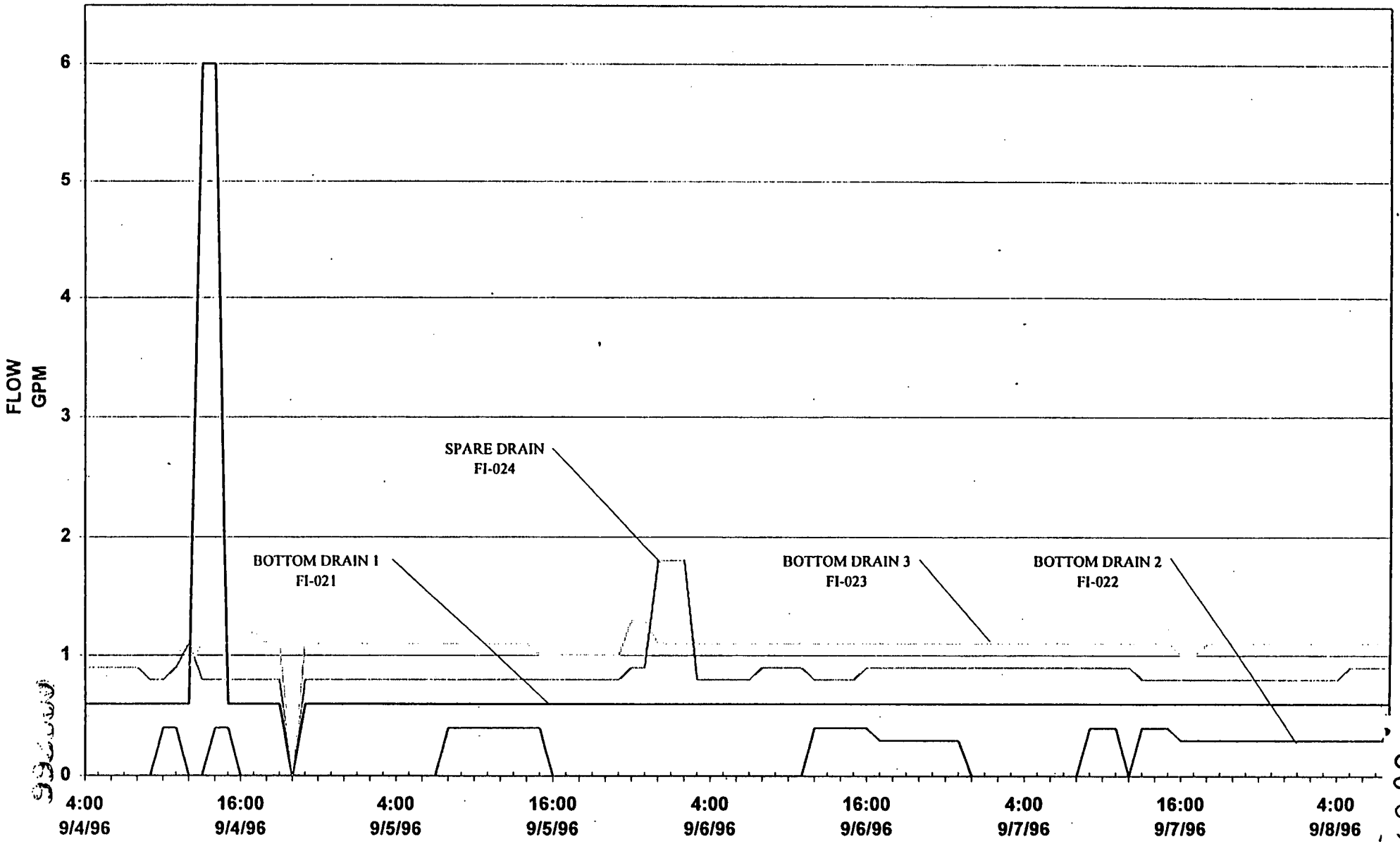
VITRIFICATION PILOT PLANT FURNACE SYSTEM					
CAMPAIGN 2 36 HOUR RUN					
MELTER BOTTOM DRAINS					
READINGS		ROUNDSHEET READINGS			
		SURFACE TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		TI-013	TI-15	TI-014	TI-016
DATE	HOUR	F	F	F	F
9/4/96	4:00	363	109	575	295
9/4/96	8:00	375	107	605	473
9/4/96	12:00	395	114	599	466
9/4/96	16:00	398	120	604	488
9/4/96	20:00	396	119	573	579
9/5/96	0:00	382	116	545	564
9/5/96	4:00	429	112	609	652
9/5/96	8:00	361	116	634	578
9/5/96	12:00	361	116	634	542
9/5/96	16:00	358	123	612	455
9/5/96	20:00	443	123	665	491
9/6/96	0:00	379	121	643	493
9/6/96	4:00	378	118	664	499
9/6/96	8:00	393	124	661	489
9/6/96	12:00	369	125	632	472
9/6/96	16:00	364	124	614	471
9/6/96	20:00	354	122	597	467
9/7/96	0:00	350	119	590	466
9/7/96	4:00	383	118	333	417
9/7/96	8:00	406	117	410	437
9/7/96	12:00	448	128	622	477
9/7/96	16:00	428	144	722	506
9/7/96	20:00	427	137	690	442
9/8/96	0:00	429	126	522	564
9/8/96	4:00	379	124	437	547
9/8/96	8:00	377	119	400	549

CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
BOTTOM DRAIN CLCW FLOW



C2FURN.XLS Chart 18

VHP 11/6/96

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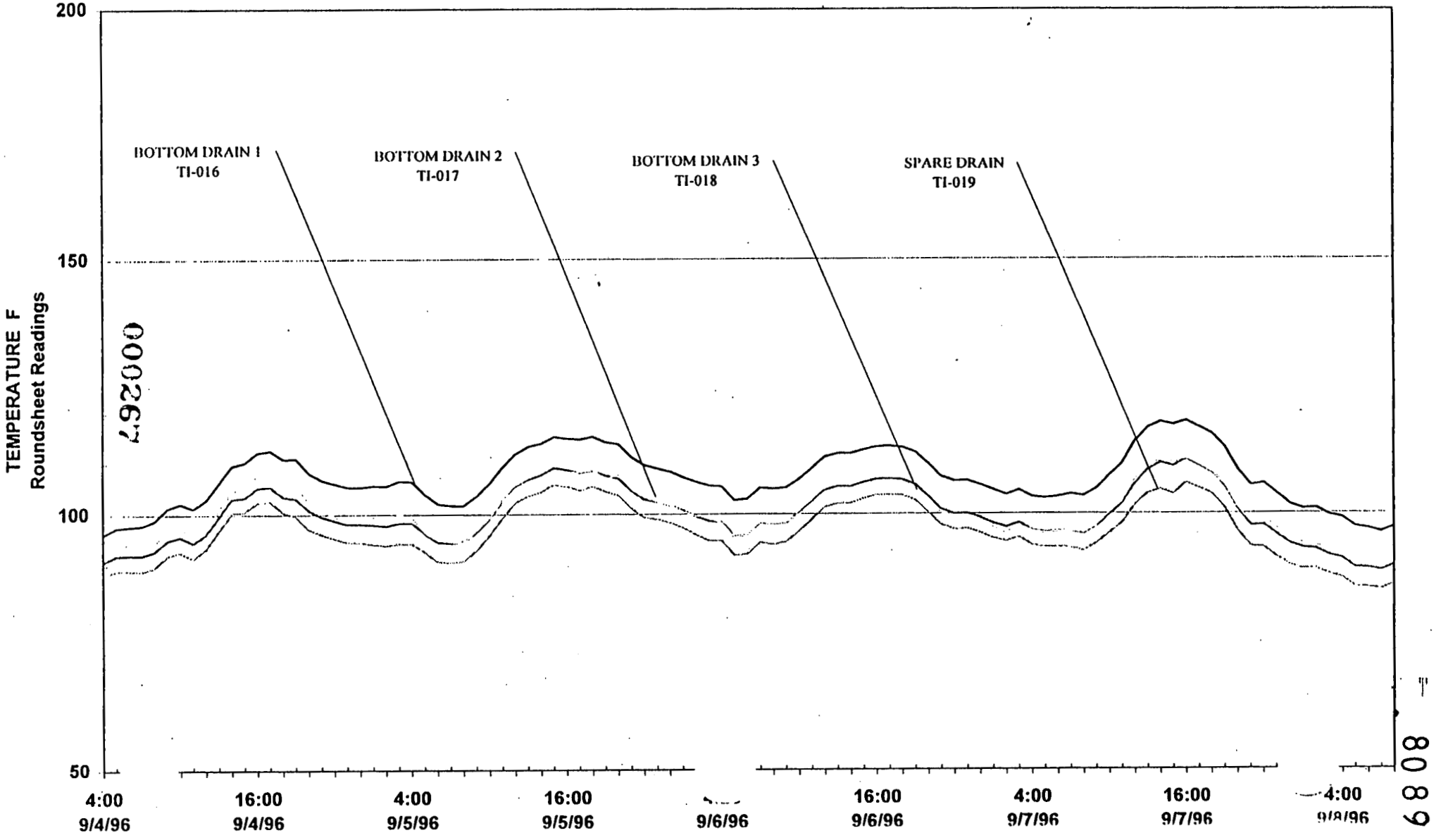
CAMPAIGN 2
36 HOUR RUN
FURNACE SYSTEM
BOTTOM DRAIN CLCW RETURN



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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 36 HOUR RUN

		MELTER BOTTOM DRAINS							
READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/4/96	4:00	0.6	0.0	1.1	0.9	96.12	90.70	93.64	87.93
9/4/96	5:00	0.6	0.0	1.1	0.9	97.48	91.89	94.24	88.98
9/4/96	6:00	0.6	0.0	1.1	0.9	97.72	92.03	93.94	88.98
9/4/96	7:00	0.6	0.0	1.1	0.9	97.94	92.00	93.75	88.93
9/4/96	8:00	0.6	0.0	1.1	0.9	98.92	92.76	94.52	89.63
9/4/96	9:00	0.6	0.0	1.1	0.8	101.24	94.96	96.49	91.95
9/4/96	10:00	0.6	0.4	1.1	0.8	102.10	95.69	97.24	92.54
9/4/96	11:00	0.6	0.4	1.1	0.9	101.17	94.43	95.92	91.38
9/4/96	12:00	0.6	0.0	0.9	1.1	102.81	96.14	97.92	93.23
9/4/96	13:00	6.0	0.0	1.1	0.8	106.22	99.66	100.80	96.93
9/4/96	14:00	6.0	0.4	1.1	0.8	109.62	103.01	104.69	100.33
9/4/96	15:00	0.6	0.4	1.1	0.8	110.20	103.31	105.57	100.61
9/4/96	16:00	0.6	0.0	1.1	0.8	112.16	105.21	107.44	102.34
9/4/96	17:00	0.6	0.0	1.2	0.8	112.59	105.42	107.65	102.49
9/4/96	18:00	0.6	0.0	1.1	0.8	110.87	103.43	105.88	100.42
9/4/96	19:00	0.6	0.0	1.1	0.8	110.99	103.06	105.66	99.63
9/4/96	20:00	0.0	0.0	0.0	0.0	108.16	100.80	102.42	97.14
9/4/96	21:00	0.6	0.0	1.1	0.8	106.78	99.56	100.74	96.12
9/4/96	22:00	0.6	0.0	1.1	0.8	106.07	98.84	99.76	95.30
9/4/96	23:00	0.6	0.0	1.1	0.8	105.36	98.14	99.00	94.56
9/5/96	0:00	0.6	0.0	1.1	0.8	105.31	98.17	98.99	94.48
9/5/96	1:00	0.6	0.0	1.1	0.8	105.63	98.01	99.30	94.12
9/5/96	2:00	0.6	0.0	1.1	0.8	105.51	97.76	99.16	93.80
9/5/96	3:00	0.6	0.0	1.1	0.8	106.52	98.35	99.92	94.24
9/5/96	4:00	0.6	0.0	1.1	0.8	106.46	98.37	99.63	94.22
9/5/96	5:00	0.6	0.0	1.1	0.8	103.91	96.28	96.39	92.57
9/5/96	6:00	0.6	0.0	1.1	0.8	102.03	94.47	94.96	90.65
9/5/96	7:00	0.6	0.0	1.1	0.8	101.70	94.35	94.51	90.54
9/5/96	8:00	0.6	0.4	1.1	0.8	101.66	94.60	94.50	90.79
9/5/96	9:00	0.6	0.4	1.1	0.8	103.51	96.53	96.77	92.84
9/5/96	10:00	0.6	0.4	1.1	0.8	106.07	99.27	99.40	95.88
9/5/96	11:00	0.6	0.4	1.1	0.8	109.24	102.53	102.62	99.27
9/5/96	12:00	0.6	0.4	1.1	0.8	111.82	105.31	105.10	102.18
9/5/96	13:00	0.6	0.4	1.1	0.8	113.27	106.77	106.48	103.58
9/5/96	14:00	0.6	0.4	1.1	0.8	113.92	107.72	107.26	104.41
9/5/96	15:00	0.6	0.4	1.0	0.8	115.23	109.10	108.56	105.80
9/5/96	16:00	0.6	0.0	1.0	0.8	114.95	108.73	108.37	105.41
9/5/96	17:00	0.6	0.0	1.0	0.8	114.75	108.20	108.27	104.71
9/5/96	18:00	0.6	0.0	1.0	0.8	115.30	108.59	108.69	105.41
9/5/96	19:00	0.6	0.0	1.0	0.8	114.18	107.56	106.85	104.44
9/5/96	20:00	0.6	0.0	1.0	0.8	113.76	107.03	107.74	103.67
9/5/96	21:00	0.6	0.0	1.0	0.8	111.20	104.60	104.99	101.17
9/5/96	22:00	0.6	0.0	1.3	0.9	109.62	102.82	103.30	99.37
9/5/96	23:00	0.6	0.0	1.3	0.9	108.99	102.35	102.43	99.03
9/6/96	0:00	0.6	0.0	1.1	1.8	108.36	101.71	101.73	98.35
9/6/96	1:00	0.6	0.0	1.1	1.8	107.24	100.71	100.51	97.36
9/6/96	2:00	0.6	0.0	1.1	1.8	106.35	99.63	99.72	95.96
9/6/96	3:00	0.6	0.0	1.1	0.8	105.62	98.68	99.35	94.77
9/6/96	4:00	0.6	0.0	1.1	0.8	105.39	98.44	98.33	94.72
9/6/96	5:00	0.6	0.0	1.1	0.8	102.62	95.57	95.49	91.86
9/6/96	6:00	0.6	0.0	1.1	0.8	102.89	95.89	95.89	92.07
9/6/96	7:00	0.6	0.0	1.1	0.8	105.10	98.32	98.44	94.35
9/6/96	8:00	0.6	0.0	1.1	0.9	104.88	98.10	98.15	93.99
9/6/96	9:00	0.6	0.0	1.1	0.9	105.11	98.32	98.43	94.45
9/6/96	10:00	0.6	0.0	1.1	0.9	106.80	100.14	99.98	96.56
9/6/96	11:00	0.6	0.0	1.1	0.9	108.96	102.33	102.01	98.95
9/6/96	12:00	0.6	0.4	1.1	0.8	111.20	104.63	104.28	101.36
9/6/96	13:00	0.6	0.4	1.1	0.8	111.83	105.33	104.89	101.95
9/6/96	14:00	0.6	0.4	1.1	0.8	111.81	105.32	104.92	102.01
9/6/96	15:00	0.6	0.4	1.1	0.8	112.52	106.15	105.63	102.92
9/6/96	16:00	0.6	0.4	1.1	0.9	113.15	106.76	106.30	103.63
9/6/96	17:00	0.6	0.3	1.1	0.9	113.29	106.84	106.35	103.71
9/6/96	18:00	0.6	0.3	1.1	0.9	113.02	106.67	106.13	103.56
9/6/96	19:00	0.6	0.3	1.1	0.9	112.08	105.70	105.17	102.60
9/6/96	20:00	0.6	0.3	1.1	0.9	109.81	103.35	102.86	100.32
9/6/96	21:00	0.6	0.3	1.1	0.9	107.23	100.85	100.23	97.82
9/6/96	22:00	0.6	0.3	1.1	0.9	106.39	99.92	99.39	96.90
9/6/96	23:00	0.6	0.3	1.1	0.9	106.48	100.07	99.45	97.02
9/7/96	0:00	0.6	0.0	1.1	0.9	105.63	99.23	98.61	96.19
9/7/96	1:00	0.6	0.0	1.1	0.9	104.64	98.10	97.49	95.13
9/7/96	2:00	0.6	0.0	1.1	0.9	103.67	97.32	96.22	94.53
9/7/96	3:00	0.6	0.0	1.1	0.9	104.59	98.19	97.57	95.32
9/7/96	4:00	0.6	0.0	1.1	0.9	103.22	96.65	96.58	93.73
9/7/96	5:00	0.6	0.0	1.1	0.9	102.95	96.29	96.20	93.33
9/7/96	6:00	0.6	0.0	1.1	0.9	103.26	96.45	96.43	93.32
9/7/96	7:00	0.6	0.0	1.1	0.9	103.74	96.56	96.57	93.22
9/7/96	8:00	0.6	0.0	1.1	0.9	103.39	96.02	96.14	92.60
9/7/96	9:00	0.6	0.4	1.1	0.9	104.82	97.50	97.62	94.03
9/7/96	10:00	0.6	0.4	1.1	0.9	107.42	99.72	100.18	96.07
9/7/96	11:00	0.6	0.4	1.1	0.9	109.69	101.89	102.30	98.05
9/7/96	12:00	0.6	0.0	1.1	0.9	114.08	105.74	106.57	101.61

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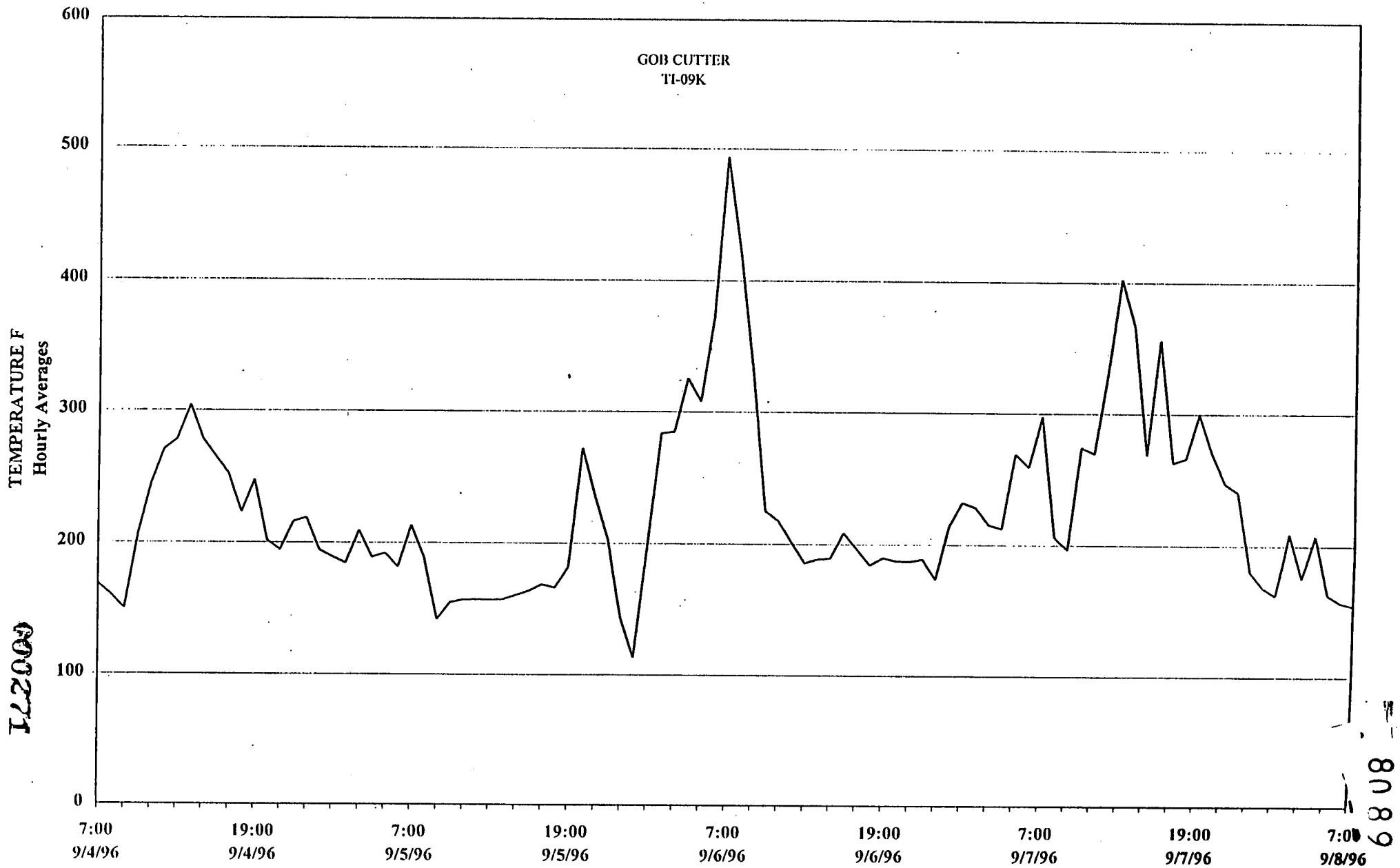
VITRIFICATION PILOT PLANT FURNACE SYSTEM									
CAMPAIGN 2 36 HOUR RUN									
		MELTER BOTTOM DRAINS							
READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/7/96	13:00	0.6	0.4	1.1	0.8	116.82	108.51	109.17	103.83
9/7/96	14:00	0.6	0.4	1.1	0.8	117.93	109.85	110.32	104.68
9/7/96	15:00	0.6	0.4	1.1	0.8	117.41	109.18	110.09	103.71
9/7/96	16:00	0.6	0.3	1.0	0.8	118.17	110.64	110.77	105.98
9/7/96	17:00	0.6	0.3	1.0	0.8	116.88	109.28	109.49	104.87
9/7/96	18:00	0.6	0.3	1.1	0.8	115.64	107.95	108.07	103.75
9/7/96	19:00	0.6	0.3	1.1	0.8	112.91	105.26	105.41	100.95
9/7/96	20:00	0.6	0.3	1.1	0.8	108.51	100.80	101.04	96.45
9/7/96	21:00	0.6	0.3	1.1	0.8	105.49	97.54	98.15	93.43
9/7/96	22:00	0.6	0.3	1.1	0.8	105.84	97.65	98.75	93.22
9/7/96	23:00	0.6	0.3	1.1	0.8	103.76	95.78	96.95	91.34
9/8/96	0:00	0.6	0.3	1.1	0.8	101.71	93.94	94.89	89.81
9/8/96	1:00	0.6	0.3	1.1	0.8	100.88	93.09	93.98	89.02
9/8/96	2:00	0.6	0.3	1.1	0.8	100.98	92.85	93.78	89.02
9/8/96	3:00	0.6	0.3	1.1	0.8	99.66	91.69	92.32	87.96
9/8/96	4:00	0.6	0.3	1.1	0.8	99.08	91.03	91.68	87.26
9/8/96	5:00	0.6	0.3	1.1	0.9	97.37	89.23	89.74	85.44
9/8/96	6:00	0.6	0.3	1.1	0.9	96.91	89.13	89.47	85.27
9/8/96	7:00	0.6	0.3	1.1	0.9	96.21	88.66	89.00	84.86
9/8/96	8:00	0.6	0.3	1.1	0.9	97.22	89.65	90.14	85.97

GEM MACHINE SYSTEM

CAMPAIGN 2
36 HOUR RUN
GEM MACHINE SYSTEM



CAMP2.XLS Chart 6

VHP 10/25/96

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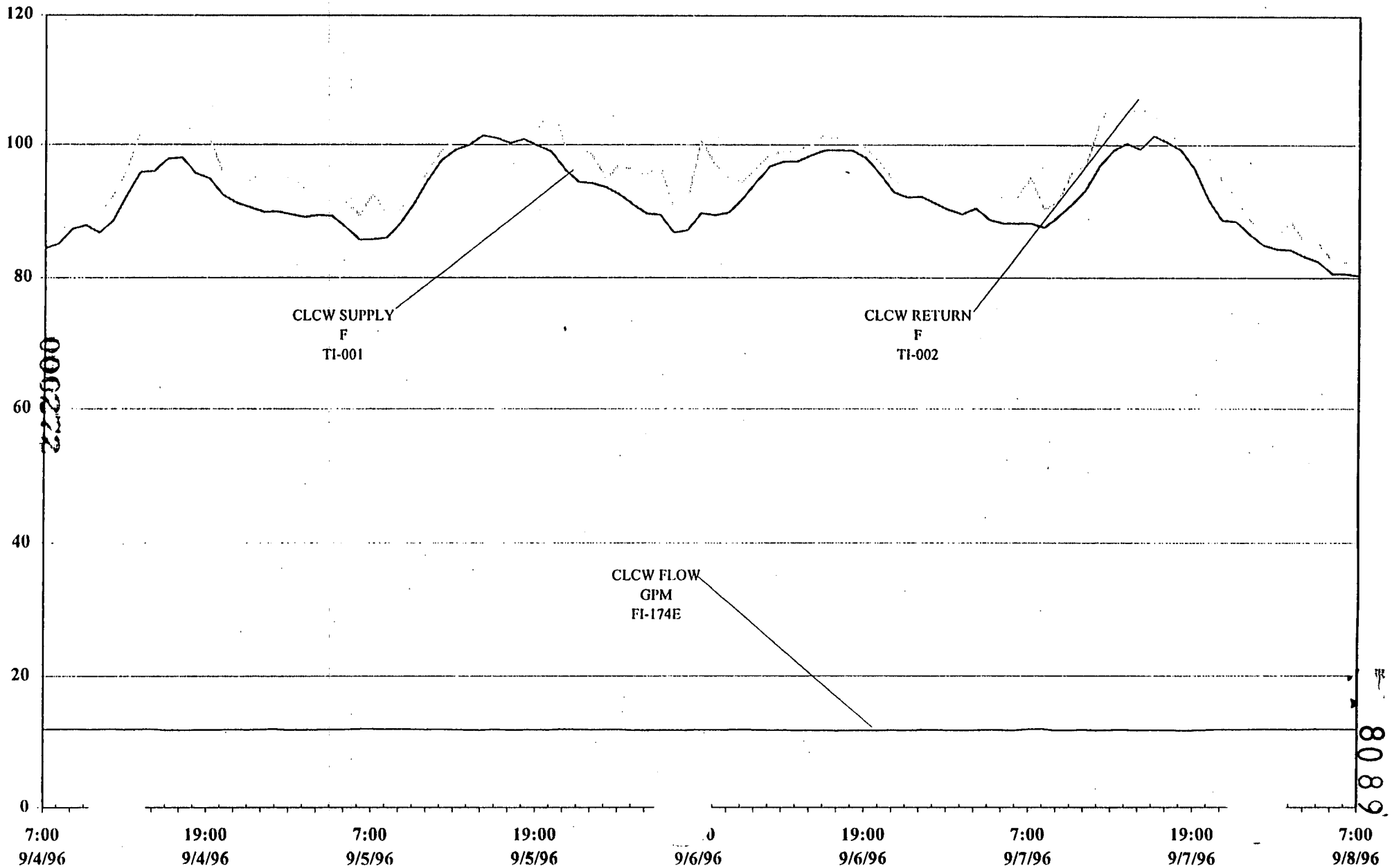
CAMPAIGN 2
36 HOUR RUN
GEM MACHINE SYSTEM



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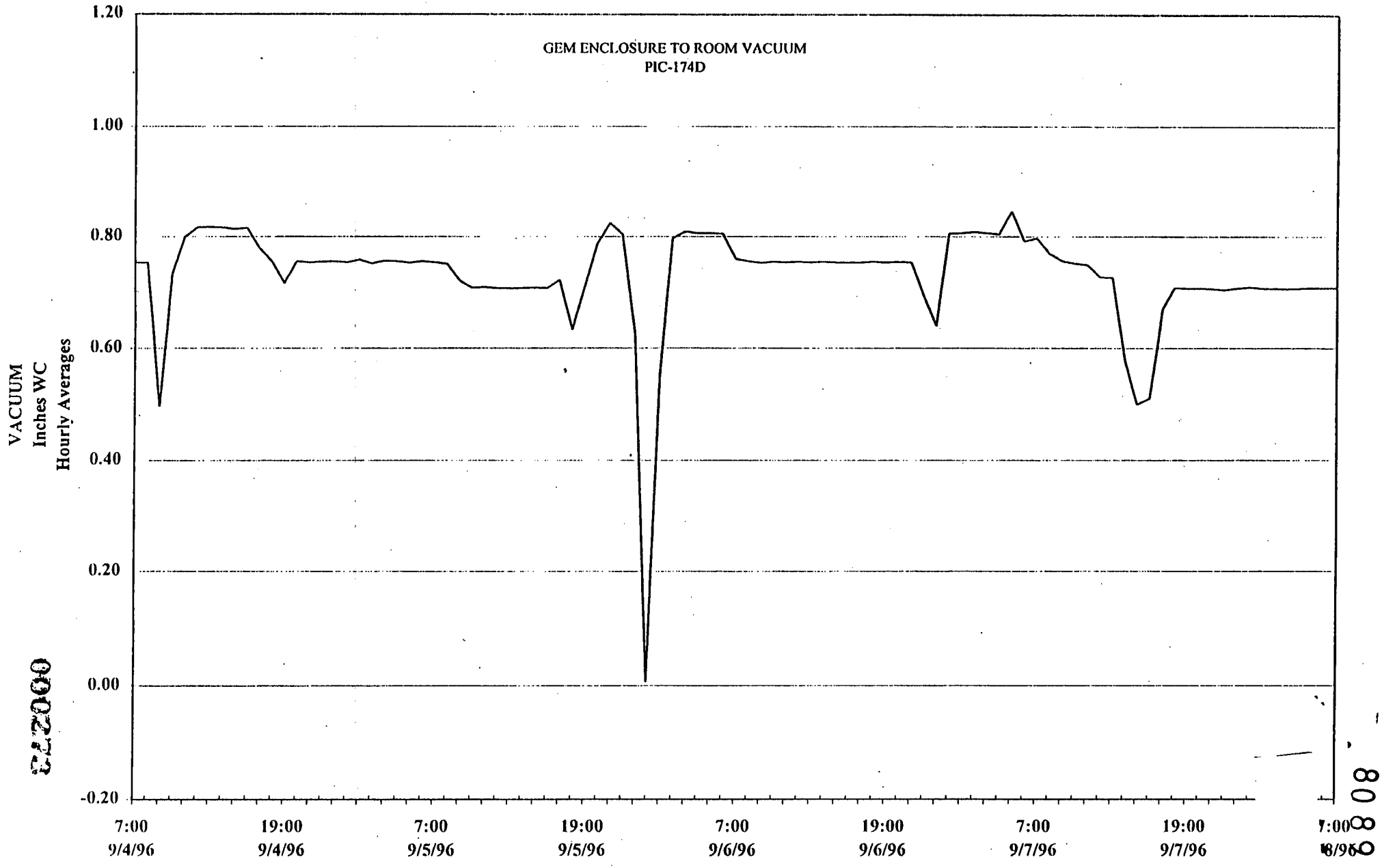
CAMPAIGN 2
36 HOUR RUN
GEM MACHINE SYSTEM



VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 36 HOUR RUN

		HOURLY AVERAGES									
READINGS		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	C. DIVERTERS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/4/96	7:00	73.17	168.90		17.05	16.98	32.10	0.75	11.92	84.47	86.16
9/4/96	8:00	72.90	160.38		17.02	16.98	32.12	0.75	11.92	85.16	86.98
9/4/96	9:00	76.85	150.11		3.00	3.06	32.11	0.50	11.94	87.39	88.79
9/4/96	10:00	78.70	205.60		16.77	16.69	32.09	0.73	11.90	87.93	90.08
9/4/96	11:00	79.48	244.13		17.04	17.11	32.13	0.80	11.89	86.78	89.76
9/4/96	12:00	80.58	270.57		17.00	17.07	32.12	0.82	11.93	88.68	92.37
9/4/96	13:00	82.13	277.89		16.94	17.07	32.13	0.82	11.87	92.41	96.18
9/4/96	14:00	84.72	304.08		17.03	16.74	32.13	0.82	11.92	95.88	101.93
9/4/96	15:00	83.60	278.50		17.13	17.07	32.04	0.81	11.94	96.03	100.95
9/4/96	16:00	86.66	265.08		16.99	17.08	32.12	0.82	11.79	97.85	104.38
9/4/96	17:00	89.00	252.10		17.10	17.04	32.11	0.78	11.80	97.99	104.97
9/4/96	18:00	82.09	222.92		17.13	17.05	32.13	0.75	11.79	95.71	100.37
9/4/96	19:00	85.00	247.43		17.02	17.04	32.08	0.72	11.83	94.94	101.13
9/4/96	20:00	80.28	201.48		17.03	17.06	32.06	0.76	11.82	92.45	95.71
9/4/96	21:00	84.08	194.64		17.10	17.05	32.14	0.75	11.87	91.29	95.90
9/4/96	22:00	89.74	215.77		17.09	17.05	32.13	0.75	11.82	90.63	94.59
9/4/96	23:00	80.20	218.81		17.11	17.05	32.06	0.76	11.87	89.92	95.71
9/5/96	0:00	80.24	194.63		17.07	17.05	32.05	0.75	11.92	89.99	94.75
9/5/96	1:00	83.10	189.28		17.13	17.05	32.16	0.76	11.80	89.54	95.40
9/5/96	2:00	82.50	184.94		17.07	17.06	32.12	0.75	11.83	89.15	93.14
9/5/96	3:00	78.39	209.13		17.11	17.05	32.14	0.76	11.81	89.47	93.10
9/5/96	4:00	77.51	189.23		17.06	17.06	32.08	0.76	11.87	89.29	92.20
9/5/96	5:00	79.81	192.28		17.06	17.05	32.09	0.75	11.85	87.60	91.52
9/5/96	6:00	82.60	182.28		17.09	17.05	32.14	0.76	11.94	85.75	89.47
9/5/96	7:00	91.12	213.29		17.10	17.04	32.13	0.75	11.95	85.76	92.64
9/5/96	8:00	86.00	188.66		17.12	17.06	32.09	0.75	11.90	86.05	89.47
9/5/96	9:00	82.65	142.15		17.04	17.06	32.11	0.72	11.91	88.25	90
9/5/96	10:00	82.19	155.15		17.03	17.06	32.09	0.71	11.90	91.23	9
9/5/96	11:00	82.52	157.09		17.04	17.06	32.13	0.71	11.87	94.70	9
9/5/96	12:00	83.20	157.48		17.05	17.06	32.13	0.71	11.89	97.62	99.05
9/5/96	13:00	83.81	157.05		17.06	17.06	32.10	0.71	11.81	99.16	100.69
9/5/96	14:00	84.20	157.45		17.04	17.07	32.09	0.71	11.81	99.92	101.41
9/5/96	15:00	84.69	160.73		17.04	17.05	32.11	0.71	11.75	101.36	102.85
9/5/96	16:00	85.13	163.97		17.10	17.05	32.11	0.71	11.87	100.99	102.65
9/5/96	17:00	87.04	168.83		17.08	17.06	32.11	0.72	11.80	100.24	102.18
9/5/96	18:00	84.83	166.43		16.79	17.05	32.14	0.63	11.81	100.83	102.26
9/5/96	19:00	84.93	182.38		17.10	17.06	32.02	0.71	11.82	99.82	101.90
9/5/96	20:00	135.78	271.79		15.41	15.28	32.13	0.79	11.80	98.91	107.00
9/5/96	21:00	110.82	235.22		10.05	10.07	32.09	0.82	11.91	96.27	99.79
9/5/96	22:00	102.74	202.44		9.92	10.08	32.11	0.80	11.86	94.38	99.83
9/5/96	23:00	96.49	143.94		5.01	5.01	32.11	0.63	11.82	94.20	98.32
9/6/96	0:00	91.61	113.64		0.16	0.21	32.07	0.01	11.83	93.62	95.01
9/6/96	1:00	99.04	196.43		12.34	12.51	32.13	0.55	11.87	92.54	96.88
9/6/96	2:00	143.45	283.31		11.33	11.39	32.09	0.80	11.76	91.07	96.20
9/6/96	3:00	111.33	284.69		10.05	10.05	32.13	0.81	11.73	89.69	95.59
9/6/96	4:00	136.10	325.22		10.01	10.11	32.15	0.81	11.75	89.50	96.62
9/6/96	5:00	104.68	308.03		10.24	10.09	32.12	0.81	11.77	86.82	90.52
9/6/96	6:00	100.92	370.85		10.33	10.23	32.11	0.81	11.74	87.18	91.92
9/6/96	7:00	99.97	493.65		6.22	10.76	32.11	0.76	11.78	89.74	100.54
9/6/96	8:00	95.27	422.20		0.16	15.11	32.12	0.76	11.78	89.45	96.99
9/6/96	9:00	91.72	331.60		1.99	15.05	32.10	0.75	11.79	89.84	94.87
9/6/96	10:00	87.93	224.93		10.73	15.06	32.11	0.75	11.81	91.83	94.30
9/6/96	11:00	87.01	217.53		14.34	15.05	32.14	0.75	11.78	94.33	96.57
9/6/96	12:00	85.05	201.45		14.33	15.05	32.14	0.75	11.74	96.71	98.51
9/6/96	13:00	84.42	186.03		14.27	15.06	32.10	0.75	11.75	97.42	98.98
9/6/96	14:00	83.84	188.90		14.34	15.06	32.11	0.75	11.68	97.46	99.04
9/6/96	15:00	83.45	189.61		14.31	15.06	32.10	0.75	11.72	98.39	99.89
9/6/96	16:00	83.50	208.39		14.28	15.06	32.10	0.75	11.71	99.12	101.43
9/6/96	17:00	83.22	196.37		14.19	15.05	32.13	0.75	11.67	99.14	100.86
9/6/96	18:00	82.88	184.77		14.40	15.06	32.12	0.75	11.68	99.09	100.
9/6/96	19:00	82.37	190.05		14.31	15.06	32.09	0.75	11.71	97.94	99
9/6/96	20:00	81.66	187.79		14.37	15.04	32.12	0.75	11.70	95.56	97
9/6/96	21:00	80.89	187.42		14.30	15.07	32.12	0.75	11.76	92.89	94.
9/6/96	22:00	80.12	189.21		12.65	13.31	32.13	0.69	11.70	92.09	93.92
9/6/96	23:00	80.08	173.93		10.73	11.47	32.09	0.64	11.77	92.20	93.93
9/7/96	0:00	81.01	213.77		14.24	15.06	32.10	0.81	11.80	91.28	93.82
9/7/96	1:00	82.79	231.63		14.26	15.06	32.12	0.81	11.73	90.28	93.12

VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM											
CAMPAIGN 2 36 HOUR RUN											
		HOURLY AVERAGES									
READINGS		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/7/96	2:00	81.57	228.08		14.37	15.06	32.13	0.81	11.74	89.61	92.66
9/7/96	3:00	81.79	215.21		14.37	15.05	32.12	0.81	11.72	90.49	93.37
9/7/96	4:00	81.77	212.31		14.26	15.07	32.08	0.80	11.79	88.81	91.64
9/7/96	5:00	81.85	268.92		14.31	15.07	32.12	0.85	11.76	88.27	92.39
9/7/96	6:00	82.01	258.98		14.17	15.05	32.14	0.79	11.72	88.25	92.21
9/7/96	7:00	83.53	297.36		14.03	15.24	31.67	0.80	11.86	88.26	95.08
9/7/96	8:00	79.78	205.88		14.48	15.08	32.09	0.77	11.92	87.60	90.37
9/7/96	9:00	79.36	196.67		14.45	15.05	32.10	0.76	11.69	89.16	91.43
9/7/96	10:00	81.59	274.05		14.32	15.05	32.08	0.75	11.73	91.10	95.92
9/7/96	11:00	83.76	269.73		14.38	15.06	32.14	0.75	11.80	93.19	96.72
9/7/96	12:00	84.60	330.53		14.07	15.05	32.19	0.73	11.70	96.71	103.23
9/7/96	13:00	85.57	402.62		8.89	15.08	32.08	0.73	11.77	99.09	106.97
9/7/96	14:00	85.94	366.54		3.05	15.05	32.15	0.58	11.78	100.27	107.12
9/7/96	15:00	88.10	268.59		6.26	15.10	32.11	0.50	11.69	99.32	103.64
9/7/96	16:00	100.87	355.94		5.27	15.10	32.15	0.51	11.75	101.39	108.68
9/7/96	17:00	97.18	262.73		9.06	15.07	32.05	0.67	11.72	100.43	105.16
9/7/96	18:00	195.95	266.08		14.62	15.07	32.11	0.71	11.70	99.18	103.71
9/7/96	19:00	93.54	299.24		13.47	15.06	32.12	0.71	11.68	96.39	102.36
9/7/96	20:00	88.44	269.87		15.13	15.07	32.12	0.71	11.77	91.86	98.18
9/7/96	21:00	86.02	246.88		15.07	15.05	32.11	0.71	11.83	88.73	94.78
9/7/96	22:00	85.15	240.53		15.01	15.06	32.11	0.70	11.82	88.59	92.06
9/7/96	23:00	84.52	180.36		15.07	15.06	32.13	0.71	11.82	86.66	88.91
9/8/96	0:00	83.10	168.54		15.02	15.05	32.13	0.71	11.88	84.99	86.92
9/8/96	1:00	81.81	162.45		15.06	15.06	32.10	0.71	11.87	84.35	86.11
9/8/96	2:00	81.02	209.03		15.18	15.06	32.11	0.71	11.84	84.27	88.59
9/8/96	3:00	80.76	175.46		15.11	15.07	32.06	0.71	11.82	83.21	85.36
9/8/96	4:00	80.19	207.32		15.08	15.05	32.13	0.71	11.88	82.53	85.34
9/8/96	5:00	79.43	163.07		15.00	15.07	32.12	0.71	11.89	80.67	82.73
9/8/96	6:00	77.91	157.15		15.12	15.05	32.12	0.71	11.87	80.64	82.37
9/8/96	7:00	77.10	154.78	-	15.05	15.03	32.13	0.71	11.85	80.33	82.07

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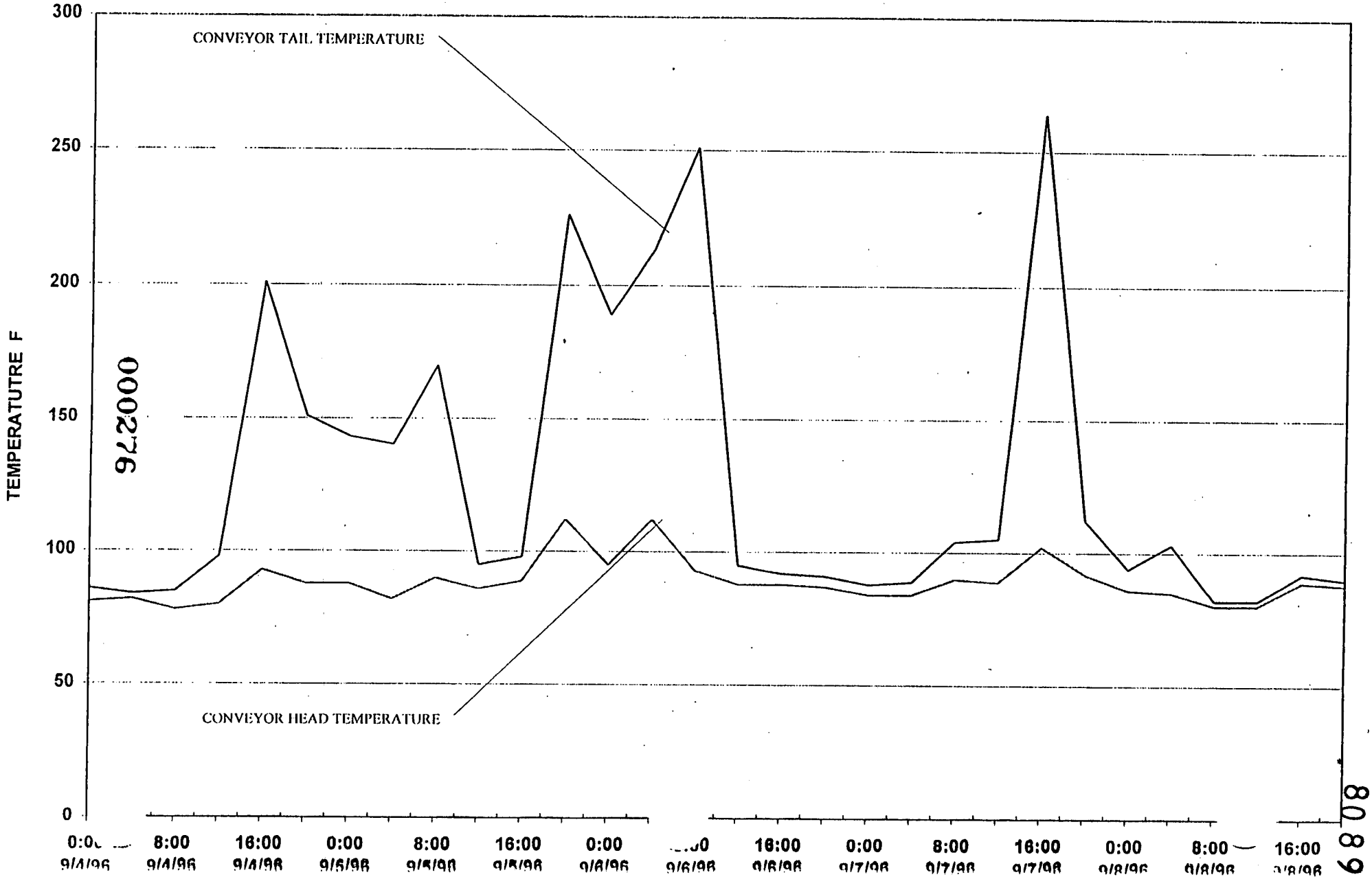
CAMPAIGN 2
36 HOUR RUN
GEM MACHINE SYSTEM



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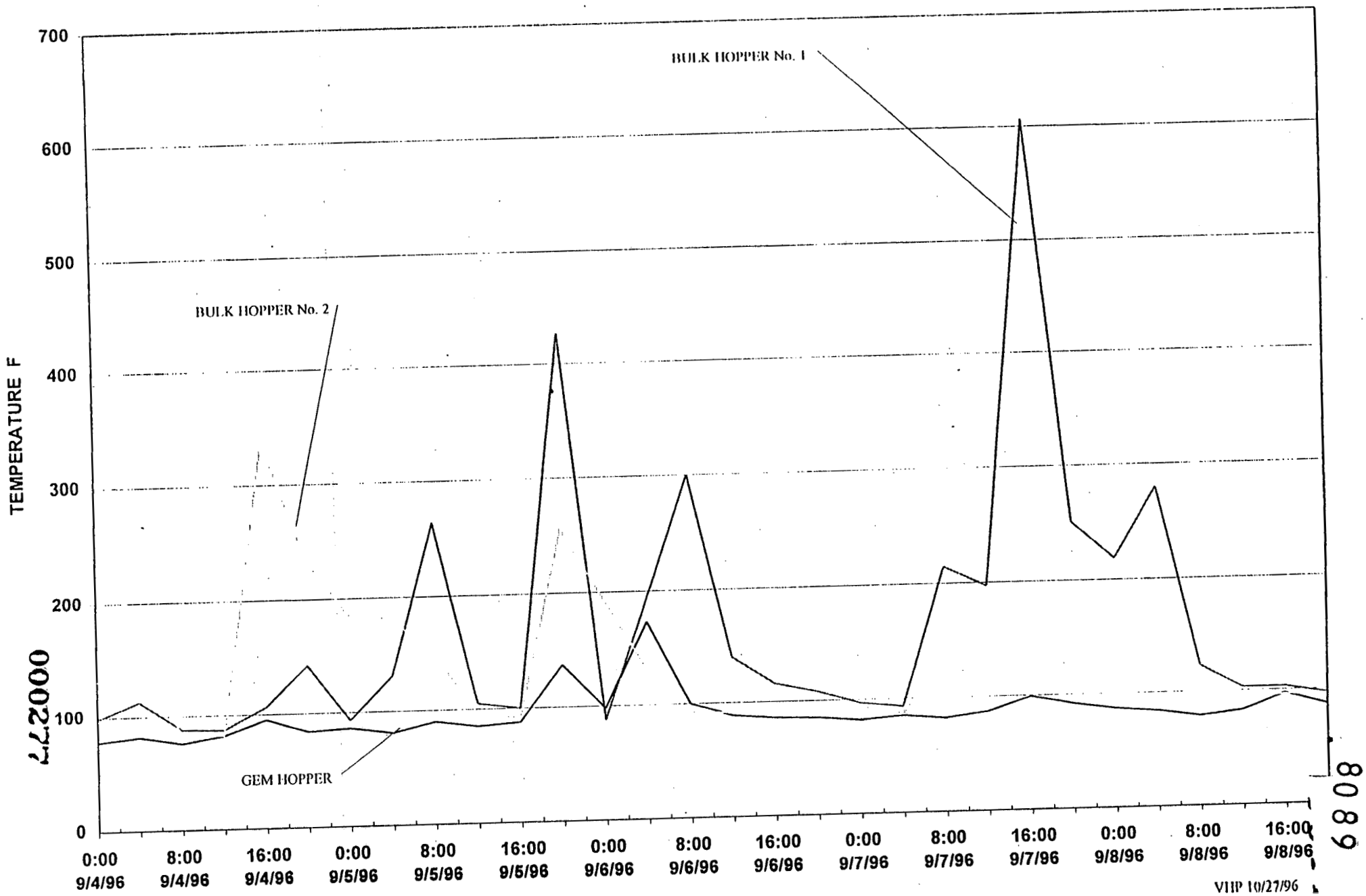
CAMPAIGN 2
36 HOUR RUN
GEM MACHINE SYSTEM



VHP 10/27/96

C2GEMMCH.XLS Chart 2

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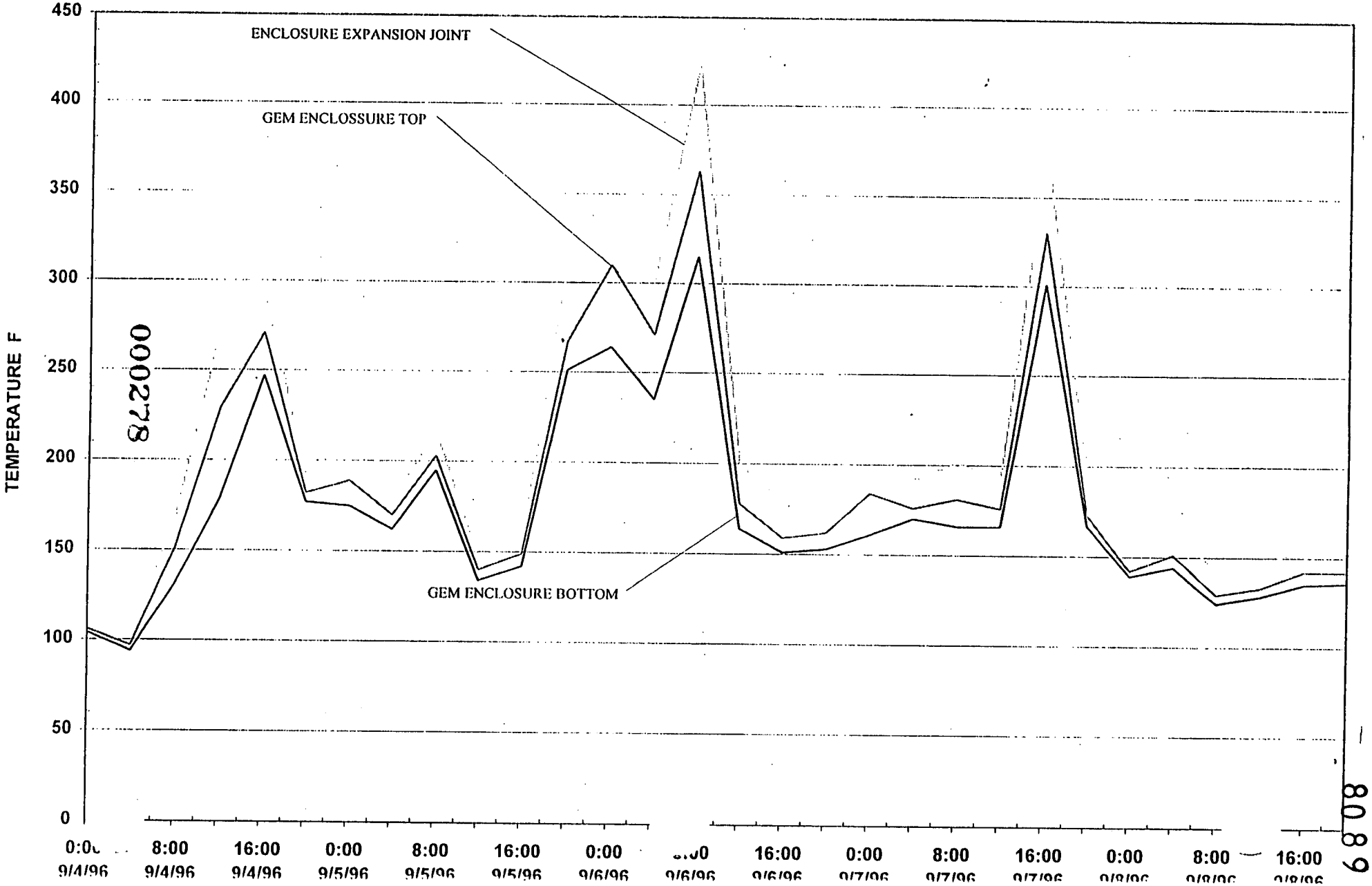
CAMPAIGN 2
36 HOUR RUN
GEM MACHINE SYSTEM



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VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

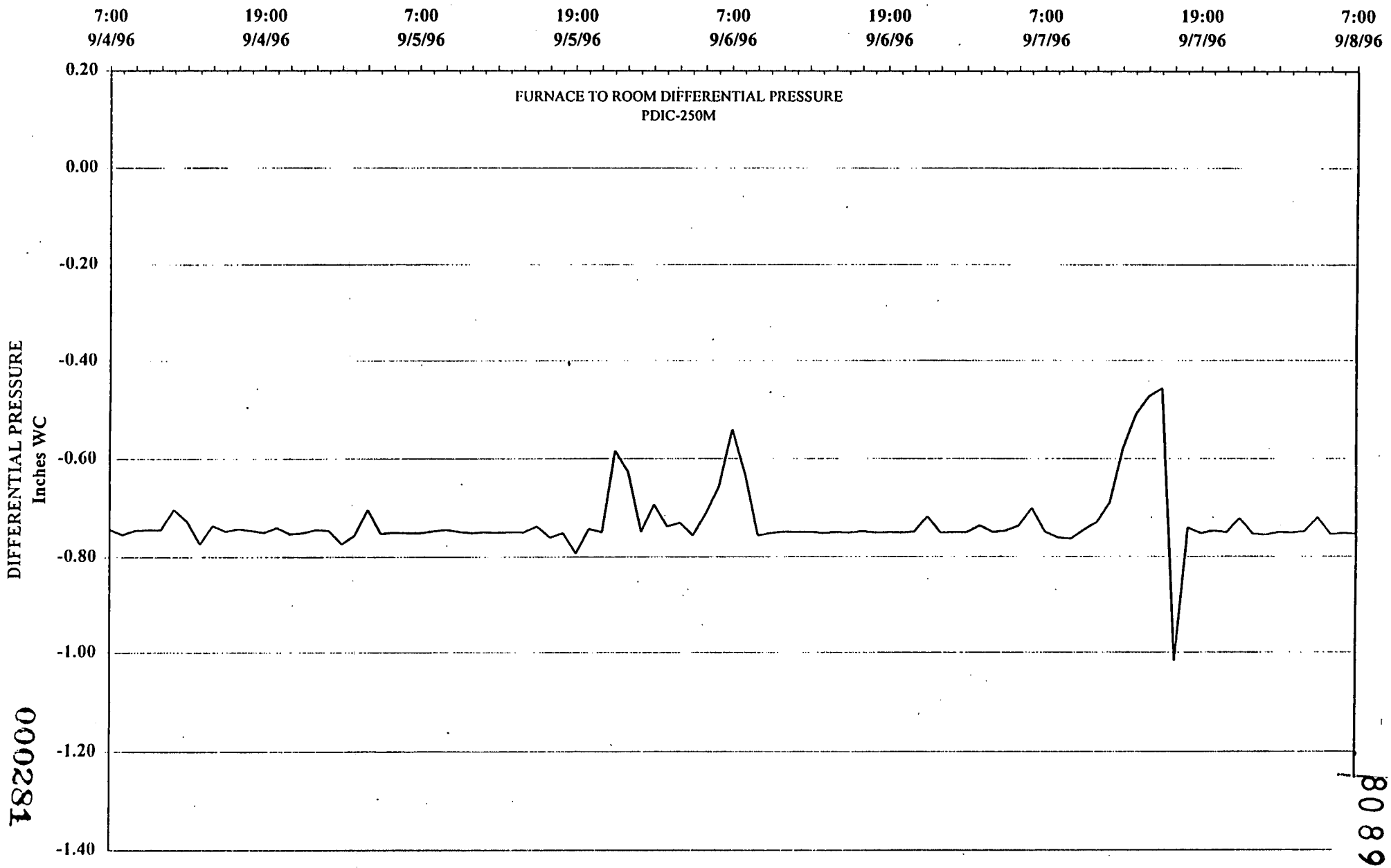
CAMPAIGN 2 36 HOUR RUN

HOURLY READINGS ROUNDSHEETS

READINGS		CONVEYOR TAIL TEMP	CONVEYOR HEAD TEMP	GEM HOPPER TEMP	BULK HOPPER #1 TEMP	BULK HOPPER #2 TEMP	GEM ENCLOSURE BOTTOM TEMP	GEM ENCLOSURE TOP TEMP	ENCLOSURE EXPANSION JOINT TEMP
DATE	HOUR	F	F	F	F	F	F	F	F
9/4/96	0:00	86	81	78	98	131	104	106	119
9/4/96	4:00	84	82	82	113	142	94	97	102
9/4/96	8:00	85	78	76	88	85	131	151	167
9/4/96	12:00	98	80	82	87	82	178	229	276
9/4/96	16:00	201	93	95	106	337	247	271	293
9/4/96	20:00	151	88	84	142	235	177	182	192
9/5/96	0:00	143	88	86	93	185	175	189	213
9/5/96	4:00	140	82	81	131	181	162	170	178
9/5/96	8:00	170	90	90	264	149	195	203	217
9/5/96	12:00	95	86	85	105	96	134	140	147
9/5/96	16:00	98	89	88	100	92	142	149	156
9/5/96	20:00	226	112	137	427	256	251	267	312
9/6/96	0:00	189	95	98	88	193	264	310	360
9/6/96	4:00	213	112	173	193	130	235	271	301
9/6/96	8:00	251	93	100	300	93	315	363	423
9/6/96	12:00	95	88	89	140	91	164	178	200
9/6/96	16:00	92	88	86	116	96	151	159	178
9/6/96	20:00	91	87	85	108	95	153	162	181
9/7/96	0:00	88	84	82	97	94	161	184	211
9/7/96	4:00	89	84	85	93	87	170	176	192
9/7/96	8:00	104	90	82	215	138	166	181	201
9/7/96	12:00	105	89	87	197	100	166	176	194
9/7/96	16:00	264	102	99	606	157	301	330	375
9/7/96	20:00	112	92	92	251	120	167	173	193
9/8/96	0:00	94	86	87	219	107	139	142	160
9/8/96	4:00	103	85	84	280	104	144	151	166
9/8/96	8:00	82	80	79	123	90	124	129	142
9/8/96	12:00	82	80	83	103	93	128	133	145
9/8/96	16:00	92	89	97	103	96	135	142	156
9/8/96	20:00	90	88	87	97	96	136	142	157

FURNACE OFFGAS SYSTEM

CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



CAMP2.XLS Chart 10

VHP 10/25/96

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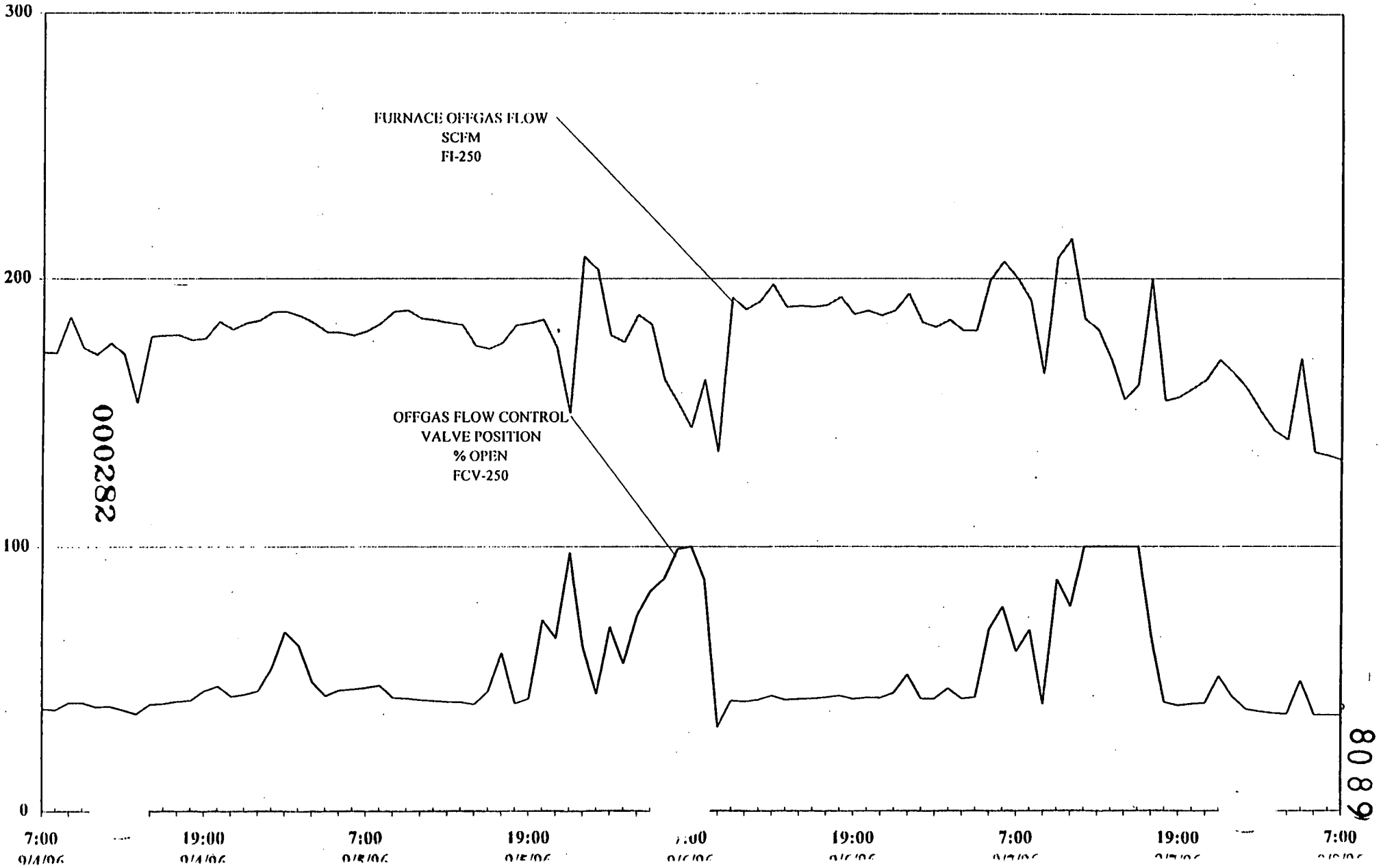
CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



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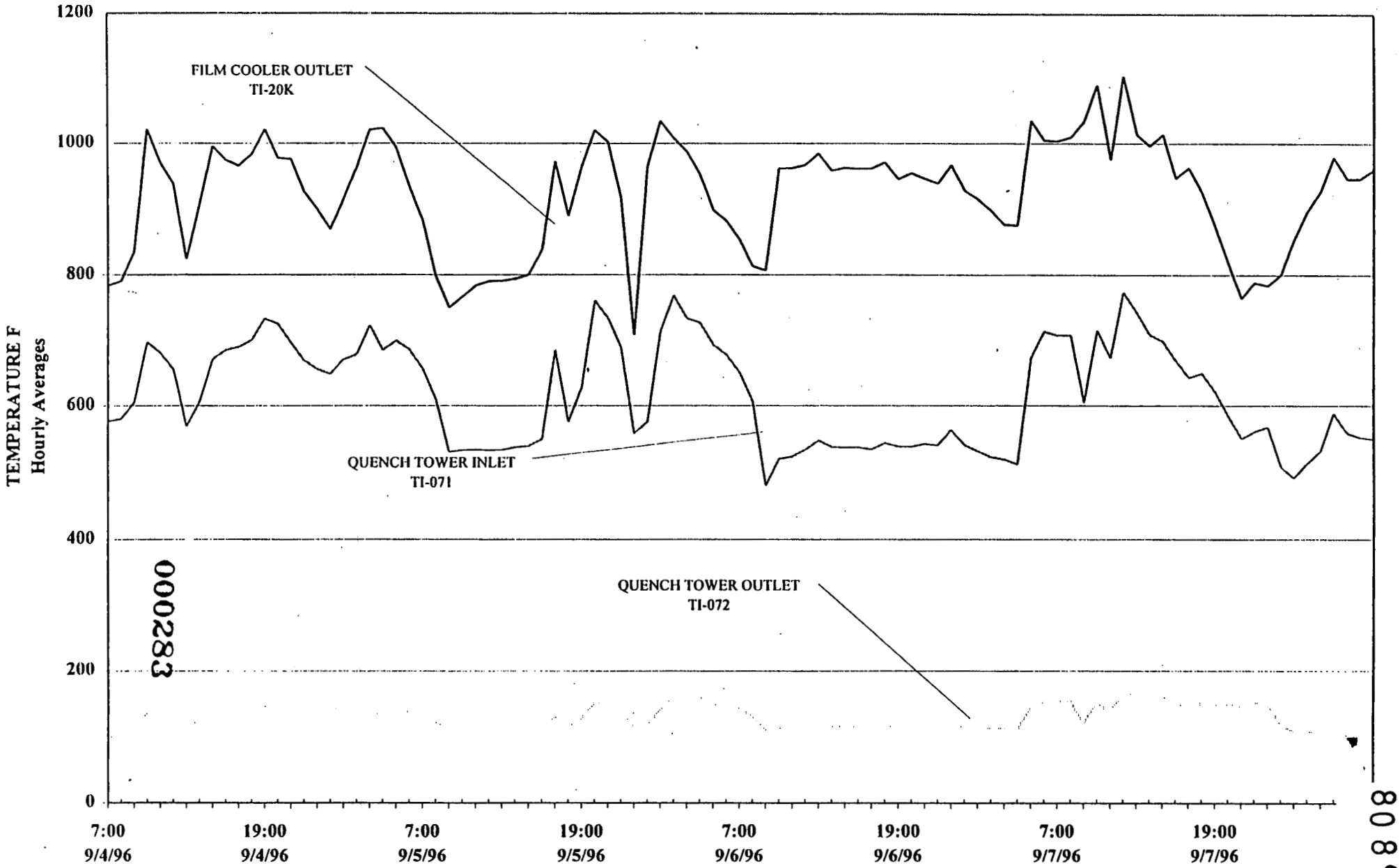
CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



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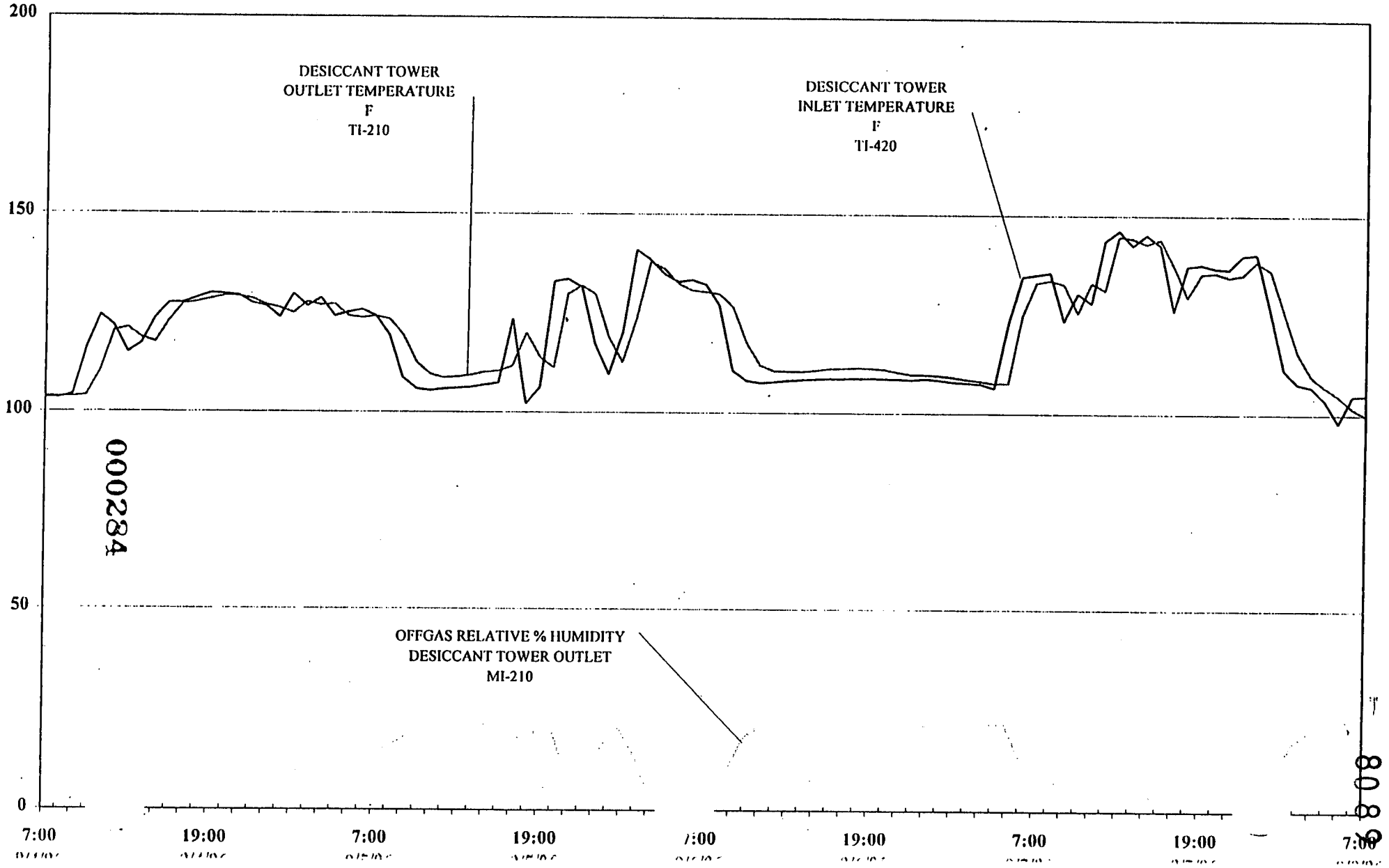
CAMP2.XLS Chart 12

VHP 11/8/96

CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 36 HOUR RUN

READINGS		HOURLY AVERAGES											
		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/4/96	7:00	-0.743	783.92	577.07	107.89	103.51	103.93	23.52	2.642	0.204	38.59	172.48	9456.83
9/4/96	8:00	-0.754	790.39	580.23	108.23	103.51	103.66	23.64	2.667	0.205	38.22	172.22	9435.50
9/4/96	9:00	-0.745	834.42	604.70	111.22	104.28	103.74	23.77	3.177	0.224	41.00	185.91	9445.85
9/4/96	10:00	-0.744	1020.86	696.21	134.79	115.98	104.06	23.58	3.471	0.215	40.84	174.14	9297.00
9/4/96	11:00	-0.744	970.42	679.71	134.01	124.20	110.12	21.31	3.087	0.213	39.26	171.56	9187.17
9/4/96	12:00	-0.702	937.31	654.76	131.04	121.36	120.24	16.62	3.061	0.222	39.53	175.93	9196.70
9/4/96	13:00	-0.727	823.84	568.81	113.04	114.72	120.98	16.29	2.586	0.216	38.11	171.83	9192.37
9/4/96	14:00	-0.773	905.91	605.10	124.94	117.05	118.45	16.92	2.636	0.197	36.64	153.52	8994.75
9/4/96	15:00	-0.736	995.11	670.05	135.97	123.51	117.29	18.33	3.444	0.224	40.21	178.33	8799.41
9/4/96	16:00	-0.747	974.09	684.25	138.72	127.17	122.70	15.56	3.415	0.228	40.54	178.86	8653.25
9/4/96	17:00	-0.742	965.54	688.96	138.87	127.23	126.85	13.34	3.440	0.230	41.40	179.00	8551.00
9/4/96	18:00	-0.746	982.95	699.62	140.09	128.38	127.40	13.05	3.494	0.231	41.72	177.00	8570.08
9/4/96	19:00	-0.750	1020.76	732.31	142.16	129.63	128.09	12.38	3.675	0.241	45.28	177.70	8546.25
9/4/96	20:00	-0.740	977.38	724.57	142.22	129.41	128.90	11.70	3.812	0.258	47.20	184.11	8688.00
9/4/96	21:00	-0.753	975.82	696.18	140.47	129.05	128.86	11.76	3.623	0.258	43.18	181.11	8822.50
9/4/96	22:00	-0.751	925.99	668.43	139.10	127.09	128.22	12.15	3.730	0.267	43.92	183.50	8758.42
9/4/96	23:00	-0.744	900.16	655.19	138.74	126.43	126.74	13.43	3.854	0.275	45.24	184.51	8750.33
9/5/96	0:00	-0.746	869.42	647.67	141.57	123.57	125.96	13.99	4.216	0.287	53.96	187.66	9020.75
9/5/96	1:00	-0.773	914.09	669.49	142.19	129.39	124.61	14.60	4.362	0.295	67.86	187.75	8849.92
9/5/96	2:00	-0.756	962.39	677.40	138.84	126.39	127.42	12.60	4.219	0.264	62.78	186.08	8894.83
9/5/96	3:00	-0.703	1020.13	721.71	141.13	128.38	126.61	13.39	4.140	0.221	48.86	183.68	8945.33
9/5/96	4:00	-0.752	1022.36	684.25	131.85	123.89	126.93	12.94	3.650	0.214	43.34	180.09	9024.83
9/5/96	5:00	-0.750	993.49	698.79	136.03	124.85	123.92	14.83	3.906	0.213	45.53	179.97	9077.33
9/5/96	6:00	-0.751	933.89	684.99	136.30	125.53	123.48	14.99	4.011	0.212	46.04	178.88	9030.83
9/5/96	7:00	-0.751	883.36	655.94	134.04	123.92	123.87	14.91	4.262	0.216	46.58	180.49	9027.67
9/5/96	8:00	-0.747	797.53	608.49	121.28	119.18	123.16	15.44	3.925	0.216	47.41	183.51	8626.33
9/5/96	9:00	-0.744	749.59	530.83	109.55	108.57	119.25	17.29	3.787	0.218	42.67	187.78	8738.48
9/5/96	10:00	-0.748	766.81	533.62	108.92	105.81	112.34	20.40	3.861	0.220	42.49	188.17	8737.33
9/5/96	11:00	-0.751	784.04	534.29	109.03	105.36	109.39	21.70	3.778	0.216	41.88	185.15	8637.29
9/5/96	12:00	-0.749	790.44	533.20	109.42	105.74	108.57	22.10	3.733	0.211	41.51	184.59	8507.33
9/5/96	13:00	-0.750	791.35	533.88	109.45	105.96	108.76	22.00	3.702	0.209	41.23	183.67	8459.58
9/5/96	14:00	-0.749	794.12	537.61	109.91	106.21	109.25	21.85	3.673	0.207	41.04	182.92	8493.50
9/5/96	15:00	-0.749	799.99	539.41	109.68	106.76	109.95	21.48	3.345	0.199	40.20	174.98	8428.83
9/5/96	16:00	-0.737	838.21	549.34	114.11	107.30	110.27	21.34	3.557	0.199	45.02	173.70	8393.25
9/5/96	17:00	-0.760	972.00	683.79	130.04	123.24	111.48	20.86	3.809	0.206	60.01	176.11	8425.67
9/5/96	18:00	-0.751	889.97	575.66	112.43	102.14	119.76	17.09	3.242	0.206	40.55	182.68	8419.25
9/5/96	19:00	-0.792	963.73	627.64	127.88	106.18	113.65	19.83	3.517	0.210	42.30	183.59	8393.90
9/5/96	20:00	-0.742	1019.54	760.65	150.73	132.76	111.15	20.97	4.522	0.228	72.30	184.85	8407.83
9/5/96	21:00	-0.749	1001.59	733.20	148.48	133.30	129.60	10.94	4.205	0.219	65.51	174.31	8357.25
9/5/96	22:00	-0.584	916.09	688.04	139.78	131.33	131.65	9.02	4.146	0.197	97.74	149.78	8321.00
9/5/96	23:00	-0.627	707.65	557.96	115.71	116.93	129.57	11.24	4.468	0.255	62.15	208.33	8393.00

VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 36 HOUR RUN

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/6/96	0:00	-0.748	963.47	575.57	116.61	109.45	118.65	17.78	3.806	0.243	44.24	203.45	8481.67
9/6/96	1:00	-0.692	1033.56	712.30	140.93	119.79	112.50	20.34	3.976	0.224	69.67	178.82	8434.25
9/6/96	2:00	-0.737	1007.81	768.13	159.69	140.76	123.34	14.76	4.187	0.229	55.92	176.25	8334.42
9/6/96	3:00	-0.730	986.97	732.70	153.86	138.19	137.74	6.21	4.263	0.249	73.94	186.50	8401.08
9/6/96	4:00	-0.756	952.49	726.13	150.30	134.65	135.95	7.18	4.339	0.243	83.39	183.08	8354.42
9/6/96	5:00	-0.710	899.05	692.60	147.94	132.75	132.26	8.79	4.024	0.217	87.96	162.19	8585.68
9/6/96	6:00	-0.656	882.32	677.21	145.46	133.19	130.58	9.68	3.882	0.206	99.07	153.45	8656.92
9/6/96	7:00	-0.542	854.32	650.04	142.11	132.13	130.21	9.61	3.712	0.199	100.00	144.20	8443.50
9/6/96	8:00	-0.631	813.36	606.27	130.45	126.85	129.67	10.21	3.805	0.216	87.76	162.16	8382.08
9/6/96	9:00	-0.756	807.18	479.86	110.50	110.53	126.50	10.79	1.874	0.170	31.65	135.16	8508.50
9/6/96	10:00	-0.751	961.54	520.25	111.66	108.04	117.41	18.13	3.096	0.235	41.63	192.94	8667.25
9/6/96	11:00	-0.748	962.09	523.37	112.05	107.50	111.89	20.63	3.124	0.234	41.22	188.56	8638.17
9/6/96	12:00	-0.748	966.53	533.80	113.27	107.74	110.47	21.23	3.359	0.238	41.85	191.34	8443.67
9/6/96	13:00	-0.748	984.11	547.51	115.26	108.05	110.34	21.33	3.692	0.247	43.47	197.77	8573.00
9/6/96	14:00	-0.751	958.14	538.12	114.40	108.27	110.31	21.22	3.505	0.238	41.91	189.47	8667.00
9/6/96	15:00	-0.749	962.37	537.21	114.48	108.44	110.61	21.09	3.612	0.239	42.23	189.92	8668.92
9/6/96	16:00	-0.750	961.02	537.22	114.75	108.55	111.04	20.91	3.703	0.240	42.39	189.59	8669.75
9/6/96	17:00	-0.747	961.39	534.19	114.72	108.56	111.15	20.84	3.733	0.242	42.80	190.13	8823.50
9/6/96	18:00	-0.750	970.63	543.77	115.74	108.66	111.28	20.80	3.902	0.247	43.49	193.12	8952.25
9/6/96	19:00	-0.749	945.12	538.68	114.75	108.66	111.16	20.77	3.682	0.238	42.19	186.79	8965.33
9/6/96	20:00	-0.750	953.85	538.37	114.67	108.56	110.85	20.85	3.885	0.242	42.74	188.10	8976.50
9/6/96	21:00	-0.748	945.92	542.47	114.56	108.53	110.26	21.02	4.413	0.242	42.60	186.34	9075.92
9/6/96	22:00	-0.717	938.48	540.29	114.28	108.36	109.66	21.18	4.569	0.247	44.55	188.25	9060.83
9/6/96	23:00	-0.750	966.37	563.51	117.09	108.61	109.62	21.29	4.905	0.259	51.58	194.40	9074.58
9/7/96	0:00	-0.749	927.81	540.99	114.14	108.28	109.40	21.22	4.509	0.244	42.32	183.92	9086.08
9/7/96	1:00	-0.749	915.20	531.58	113.15	107.83	109.09	21.26	4.567	0.242	42.25	181.97	9098.14
9/7/96	2:00	-0.736	898.01	522.59	112.72	107.63	108.51	21.43	4.801	0.247	46.19	184.81	9246.08
9/7/96	3:00	-0.749	876.35	519.76	112.12	107.39	108.12	21.52	4.540	0.241	42.27	180.73	9259.17
9/7/96	4:00	-0.746	875.29	511.96	110.33	106.33	107.57	21.78	4.643	0.242	42.81	180.68	9246.58
9/7/96	5:00	-0.736	1034.59	671.89	142.79	122.90	107.63	21.96	6.546	0.505	68.73	199.31	9244.33
9/7/96	6:00	-0.700	1004.69	712.75	152.34	134.27	124.53	14.14	6.118	0.558	77.32	206.45	9249.75
9/7/96	7:00	-0.748	1003.56	706.84	151.94	134.79	132.77	8.69	5.487	0.551	60.42	200.24	9096.67
9/7/96	8:00	-0.760	1009.37	706.91	154.88	135.34	133.42	8.34	5.406	0.540	68.59	191.95	9132.75
9/7/96	9:00	-0.762	1033.03	604.48	119.99	123.19	132.46	8.23	3.156	0.446	40.19	164.33	9104.50
9/7/96	10:00	-0.744	1088.79	714.22	150.42	130.11	125.19	13.71	5.811	0.588	87.72	207.84	8971.86
9/7/96	11:00	-0.729	975.51	672.10	139.13	127.64	132.77	9.14	5.507	0.603	77.45	214.92	8823.67
9/7/96	[illegible]	-0.688	1102.90	773.50	165.27	143.57	130.96	10.25	5.409	0.541	100.00	185.2[illegible]	[illegible].29
9/7/96		-0.581	1013.88	742.51	165.54	146.19	144.67	4.15	5.210	0.546	100.00	180.9	[illegible].33
9/7/96		-0.510	995.74	707.96	163.23	142.31	144.24	4.13	4.951	0.529	100.00	169.43	[illegible]62.50
9/7/96	15:00	-0.473	1013.48	697.81	162.13	145.16	142.79	4.50	4.638	0.503	100.00	154.74	8143.17
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 36 HOUR RUN

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/7/96	17:00	-1.018	962.47	642.44	139.76	125.75	137.15	6.87	4.804	0.645	66.46	199.78	8482.75
9/7/96	18:00	-0.740	924.70	648.56	150.52	137.05	129.26	10.33	3.387	0.497	40.92	154.20	8325.33
9/7/96	19:00	-0.751	874.02	619.58	149.04	137.52	135.12	7.19	3.366	0.510	39.62	155.64	8361.75
9/7/96	20:00	-0.746	818.42	583.49	147.39	136.61	135.40	6.97	3.512	0.530	40.19	158.83	8652.75
9/7/96	21:00	-0.749	763.95	550.13	146.53	136.36	134.31	7.55	3.618	0.549	40.55	162.08	8783.92
9/7/96	22:00	-0.721	788.30	560.50	152.33	139.79	134.87	7.48	4.092	0.594	50.93	169.62	8888.25
9/7/96	23:00	-0.752	783.77	567.65	149.89	140.15	138.18	6.09	3.717	0.580	43.02	164.77	9042.08
9/8/96	0:00	-0.754	800.21	507.64	119.18	125.83	136.04	6.67	2.796	0.540	38.33	158.85	9129.08
9/8/96	1:00	-0.749	852.75	491.11	107.36	111.09	125.63	11.88	2.455	0.506	37.47	150.53	9159.42
9/8/96	2:00	-0.750	895.86	512.91	106.50	107.67	115.32	17.48	2.252	0.476	36.80	143.26	9111.50
9/8/96	3:00	-0.747	926.84	530.77	106.27	106.84	109.44	20.10	2.141	0.462	36.52	139.75	9127.92
9/8/96	4:00	-0.719	978.45	587.88	107.69	103.50	106.83	21.66	3.187	0.574	49.19	170.05	9169.33
9/8/96	5:00	-0.753	945.60	558.31	103.10	97.91	104.59	22.02	1.955	0.443	36.14	134.94	9146.92
9/8/96	6:00	-0.751	945.95	551.84	102.05	104.62	101.55	23.03	1.917	0.440	36.14	133.73	9137.08
9/8/96	7:00	-0.752	959.39	549.22	103.77	104.82	99.79	23.70	1.889	0.436	36.10	132.14	9415.25

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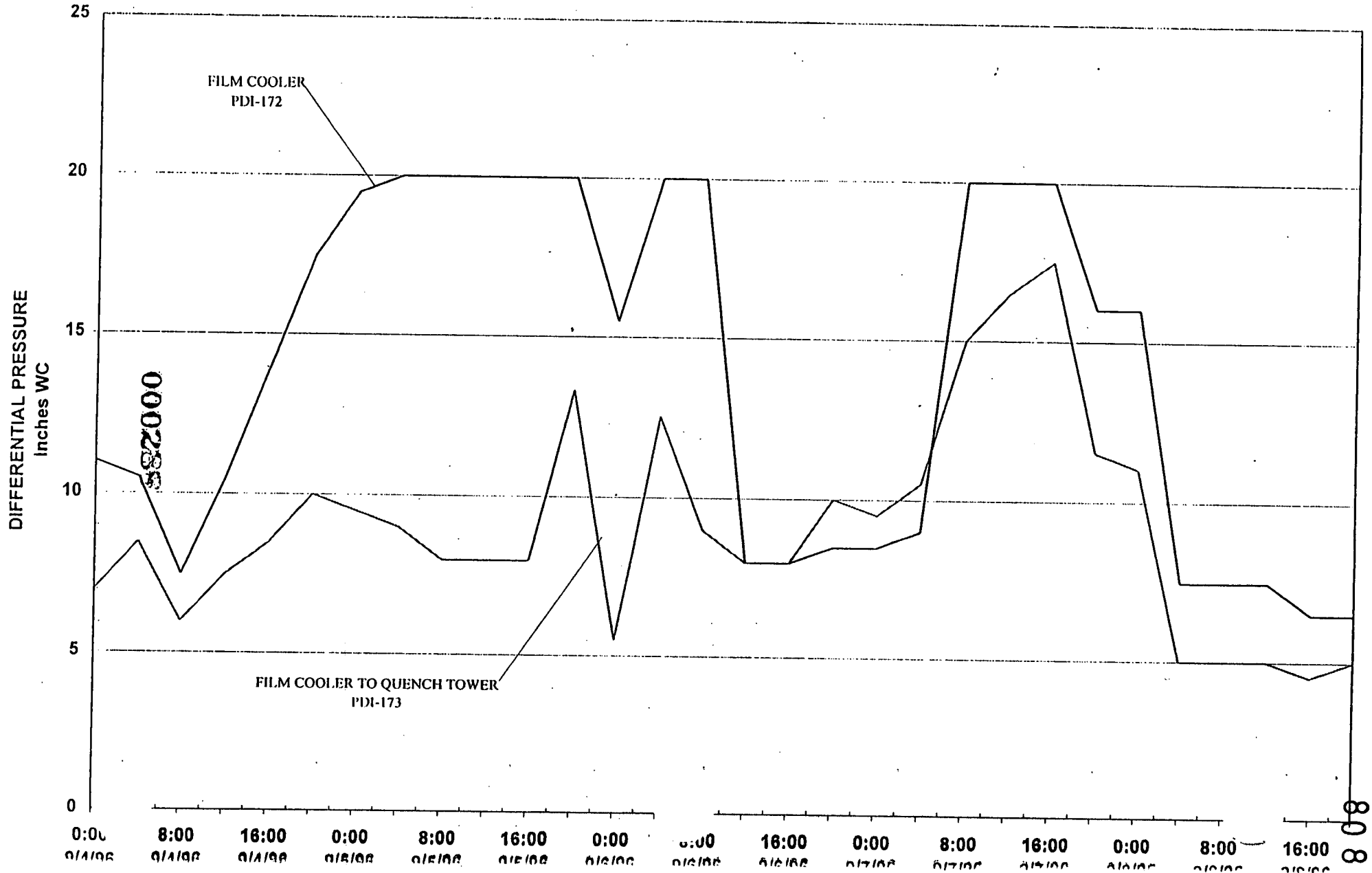
CAMP2 XLS Sheet 8

CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



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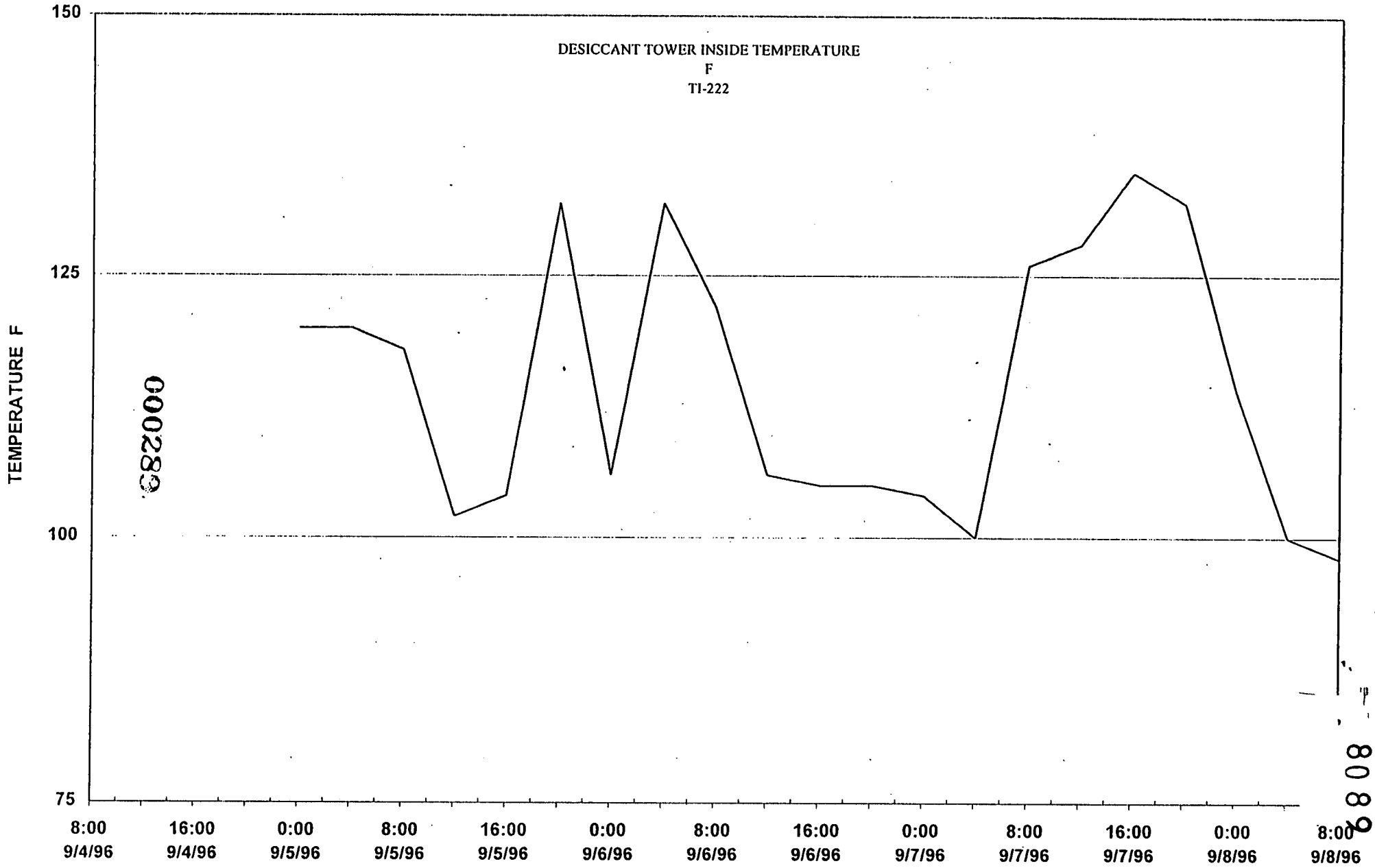
CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



C2OFFGAS.XLS Chart 5

VHP 10/26/96

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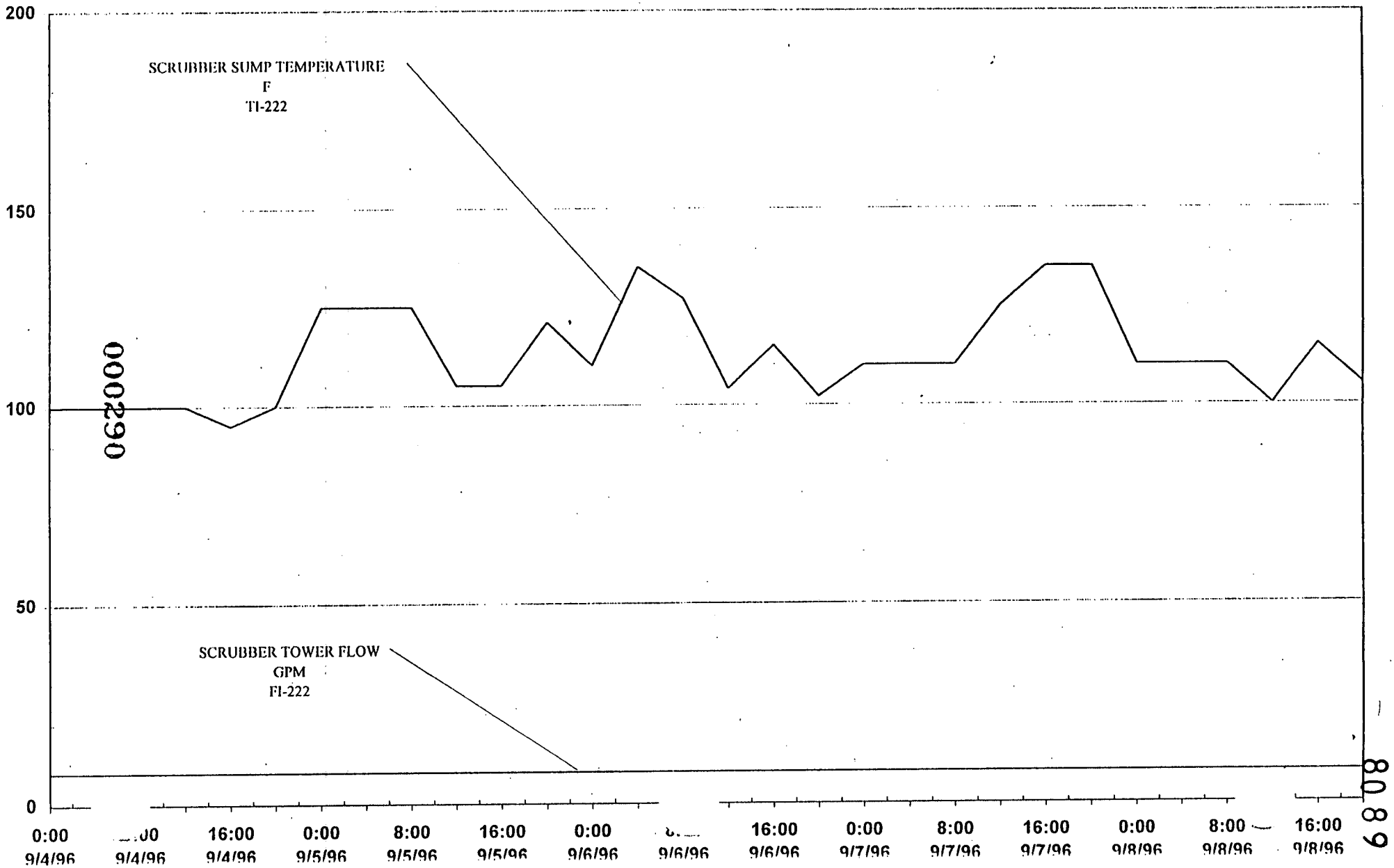
CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



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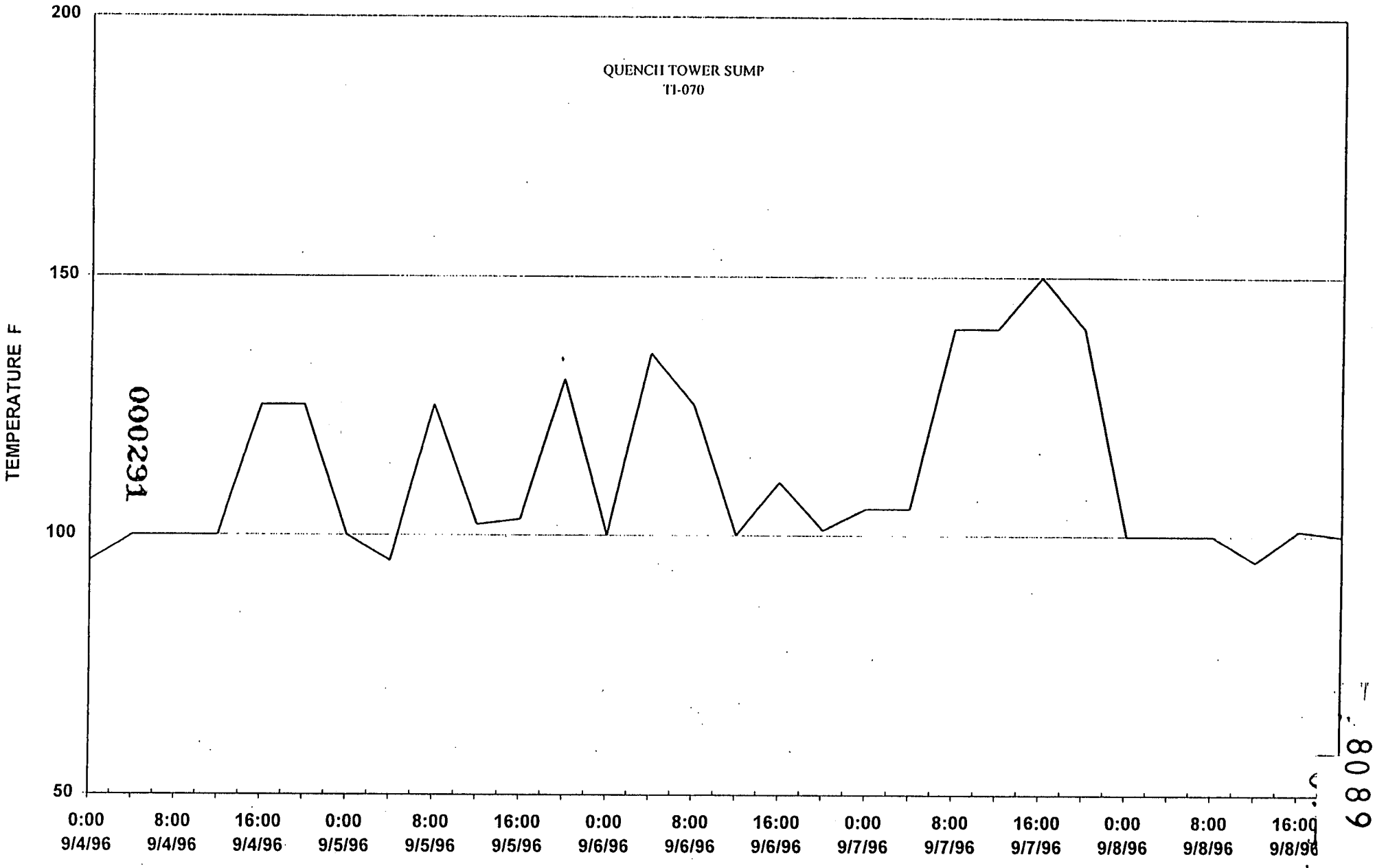
CAMPAIGN 2
36 HOUR RUN
FURNACE OFFGAS SYSTEM



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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 36 HOUR RUN

ROUNDSHEET DATA

READINGS		FILM COOLER DIFF PRESS	FILM COOLER TO QT DIFF PRESS	QUENCH TOWER SUMP TEMP	SCRUBBER TOWER VACUUM	SCRUBBER SUMP TEMP	SCRUBBER TOWER FLOW	DESICCANT TOWER INTERNAL TEMP	DESICCANT TOWER VACUUM
		PDI-172	PDI-173	TI-070	PI-222	TI-222	FI-222	TI-210	PI-210
DATE	HOUR	In WC	In WC	F	In WC	F	GPM	F	In WC
9/4/96	0:00	11.0	7.0	95	0.4	100	8		OUT OF SERVIC
9/4/96	4:00	10.5	8.5	100	0.4	100	8		
9/4/96	8:00	7.5	6.0	100	1.0	100	8		
9/4/96	12:00	10.5	7.5	100	2.0	100	8		
9/4/96	16:00	14.0	8.5	125	3.0	95	8		
9/4/96	20:00	17.5	10.0	125	2.5	100	8		
9/5/96	0:00	19.5	9.5	100	2.5	125	8	120	
9/5/96	4:00	20.0	9.0	95	2.5	125	8	120	
9/5/96	8:00	20.0	8.0	125	3.7	125	8	118	
9/5/96	12:00	20.0	8.0	102	3.8	105	8	102	
9/5/96	16:00	20.0	8.0	103	3.8	105	8	104	
9/5/96	20:00	20.0	13.3	130	4.5	121	8	132	
9/6/96	0:00	15.5	5.5	100	2.0	110	8	106	
9/6/96	4:00	20.0	12.5	135	4.0	135	8	132	
9/6/96	8:00	20.0	9.0	125	4.5	127	8	122	
9/6/96	12:00	8.0	8.0	100	2.0	104	8	106	
9/6/96	16:00	8.0	8.0	110	2.5	115	8	105	
9/6/96	20:00	8.5	10.0	101	2.5	102	8	105	
9/7/96	0:00	8.5	9.5	105	1.5	110	8	104	
9/7/96	4:00	9.0	10.5	105	1.5	110	8	100	
9/7/96	8:00	20.0	15.0	140	4.0	110	8	126	
9/7/96	12:00	20.0	16.5	140	4.0	125	8	128	
9/7/96	16:00	20.0	17.5	150	5.0	135	8	135	
9/8/96	20:00	16.0	11.5	140	2.5	135	8	132	
9/8/96	0:00	16.0	11.0	100	0.5	110	8	114	
9/8/96	4:00	7.5	5.0	100	0.5	110	8	100	
9/8/96	8:00	7.5	5.0	100	0.4	110	8	98	
9/8/96	12:00	7.5	5.0	95	2.0	100	8	100	
9/8/96	16:00	6.5	4.5	101	3.0	115	8	103	
9/8/96	20:00	6.5	5.0	100	3.0	105	8	100	

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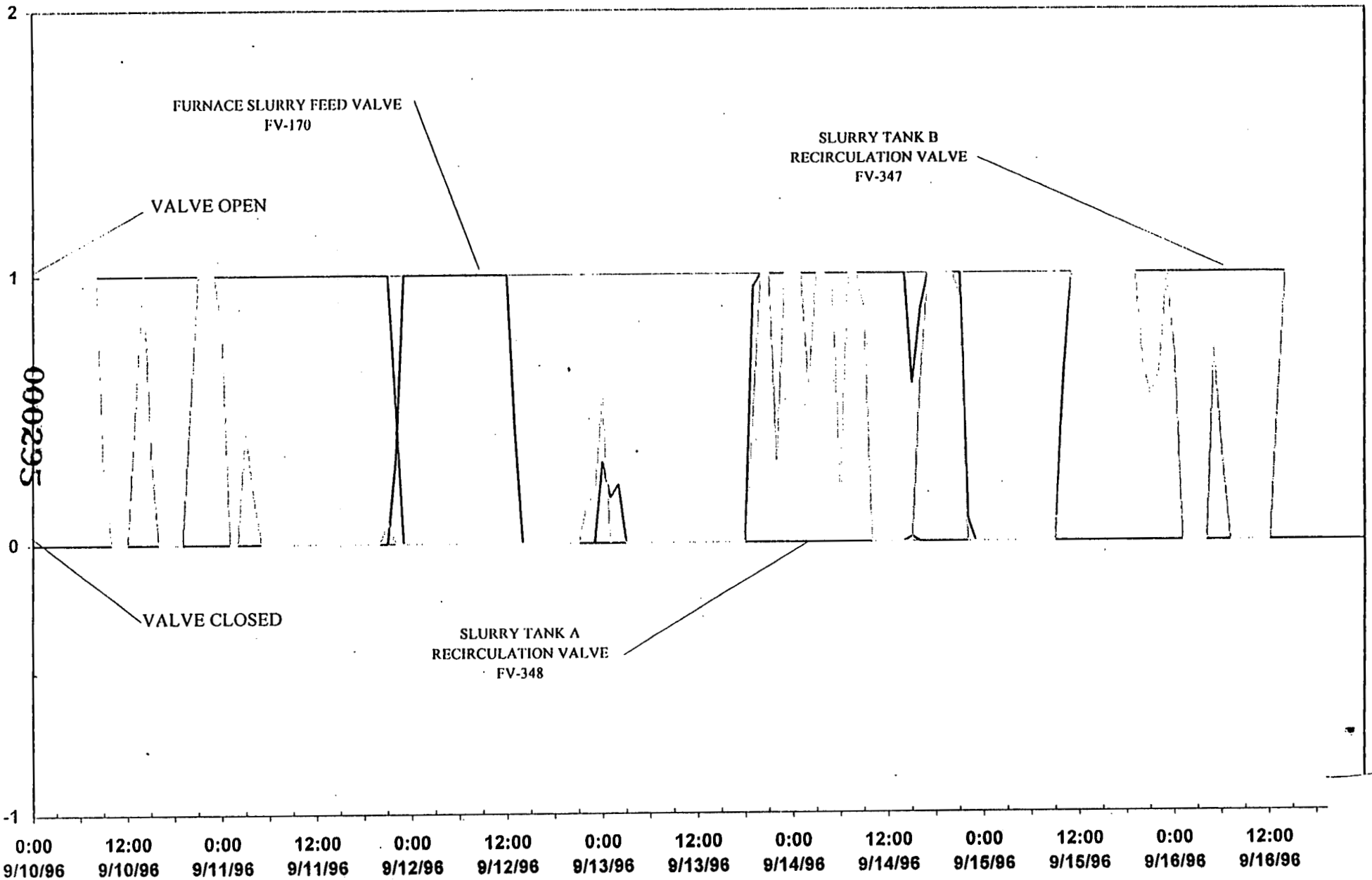
Appendix D2
Transition Glass

FEED PREPARATION SYSTEM

CAMPAIGN 2
TRANSITION GLASS
FEED PREPARATION SYSTEM



C2FDPRP.XLS Chart 1

VHP 10/28/96

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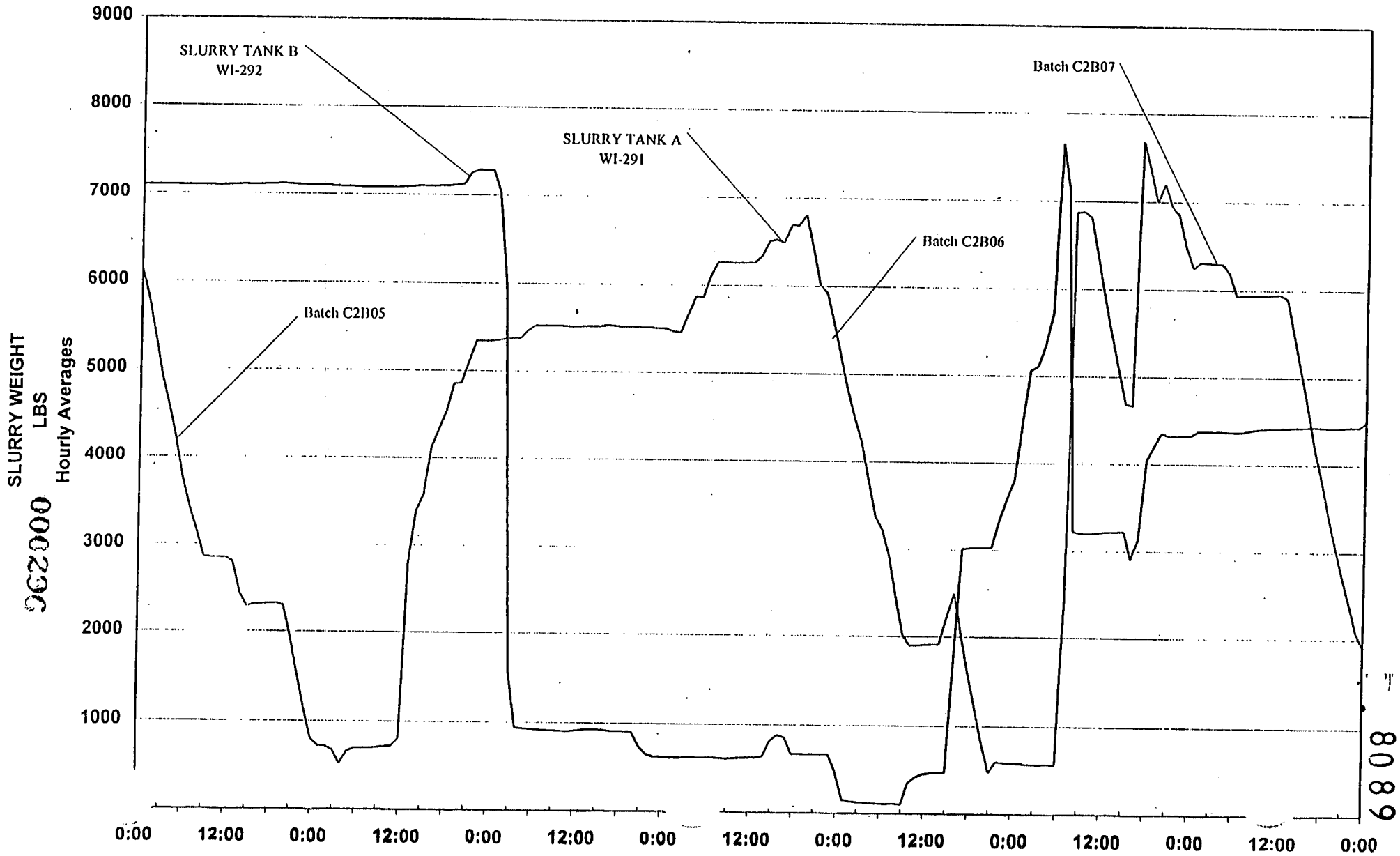
CAMPAIGN 2
TRANSITION GLASS
FEED PREPARATION SYSTION



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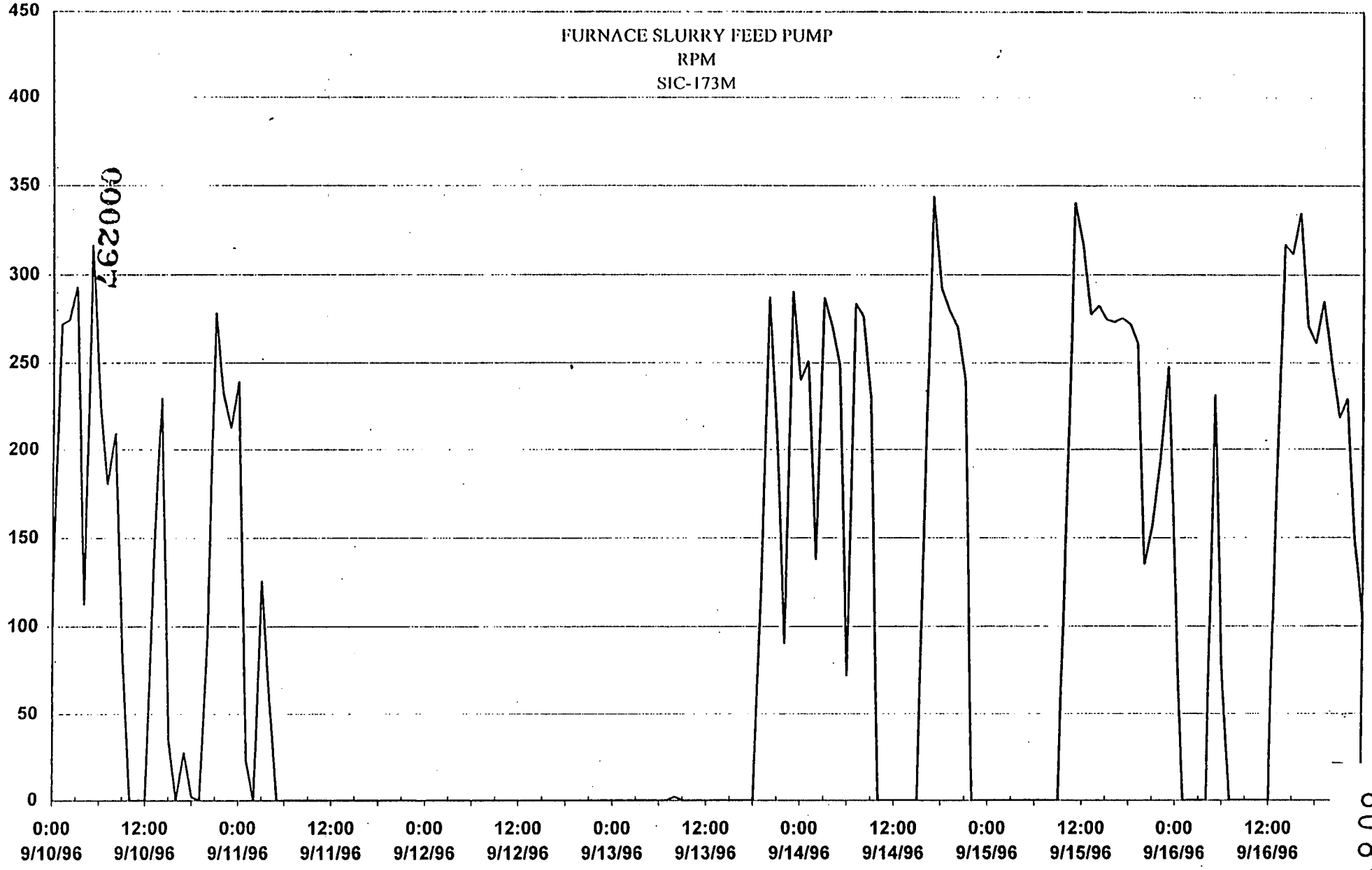
CAMPAIGN 2
TRANSITION GLASS
FEED PREPARATION SYSTEM



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C2FDPRP.XLS Chart 3

VHP 10/27/96

VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES						
READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY RECIRC VALVE	WEIGHT	SLURRY RECIRC VALVE	RECIRC FLOW	SLURRY FEED VALVE	SLURRY FEED PUMP RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/10/96	0:00	7099.96	0.0	6131.71	1.0	42.74	0.6	120.47
9/10/96	1:00	7100.00	0.0	5806.46	1.0	42.53	1.0	271.83
9/10/96	2:00	7100.00	0.0	5366.71	1.0	42.49	1.0	274.48
9/10/96	3:00	7100.89	0.0	4914.24	1.0	42.49	1.0	293.33
9/10/96	4:00	7100.30	0.0	4574.58	1.0	42.46	1.0	112.45
9/10/96	5:00	7099.70	0.0	4214.03	1.0	42.48	1.0	316.79
9/10/96	6:00	7099.03	0.0	3752.71	1.0	42.38	1.0	225.51
9/10/96	7:00	7098.88	0.0	3425.25	1.0	42.79	1.0	180.57
9/10/96	8:00	7099.13	0.0	3160.38	1.0	43.00	1.0	209.95
9/10/96	9:00	7099.46	0.0	2860.29	1.0	42.61	0.2	81.44
9/10/96	10:00	7096.21	0.0	2846.50	1.0	42.69	0.0	0.15
9/10/96	11:00	7095.67	0.0	2846.17	1.0	42.54	0.0	0.12
9/10/96	12:00	7100.04	0.0	2848.21	1.0	40.56	0.0	0.26
9/10/96	13:00	7102.46	0.0	2796.42	1.0	40.00	0.5	134.90
9/10/96	14:00	7107.50	0.0	2439.33	1.0	41.00	1.0	22[illegible]
9/10/96	15:00	7104.88	0.0	2287.08	1.0	41.92	0.3	3[illegible]
9/10/96	16:00	7106.00	0.0	2312.46	1.0	41.95	0.0	0.1[illegible]
9/10/96	17:00	7110.88	0.0	2316.21	1.0	42.16	0.0	27.87
9/10/96	18:00	7114.38	0.0	2321.33	1.0	41.88	0.0	1.87
9/10/96	19:00	7117.67	0.0	2323.58	1.0	41.78	0.0	0.08
9/10/96	20:00	7113.42	0.0	2298.33	1.0	41.68	0.5	93.43
9/10/96	21:00	7109.29	0.0	1937.42	1.0	42.23	1.0	278.37
9/10/96	22:00	7103.00	0.0	1526.17	1.0	41.85	1.0	231.83
9/10/96	23:00	7100.42	0.0	1143.50	1.0	41.70	1.0	212.49
9/11/96	0:00	7106.38	0.0	805.08	1.0	41.30	0.8	239.17
9/11/96	1:00	7105.13	0.0	724.00	1.0	42.67	0.0	23.54
9/11/96	2:00	7097.13	0.0	720.21	1.0	43.20	0.0	0.08
9/11/96	3:00	7092.88	0.0	681.75	1.0	42.43	0.4	125.74
9/11/96	4:00	7092.71	0.0	524.75	1.0	40.77	0.2	58.63
9/11/96	5:00	7089.32	0.0	664.70	1.0	44.73	0.0	0.06
9/11/96	6:00	7086.99	0.0	702.80	1.0	44.94	0.0	0.09
9/11/96	7:00	7087.04	0.0	703.00	1.0	46.36	0.0	0.08
9/11/96	8:00	7085.88	0.0	705.17	1.0	46.76	0.0	0.07
9/11/96	9:00	7086.71	0.0	711.04	1.0	47.99	0.0	0.08
9/11/96	10:00	7086.25	0.0	719.04	1.0	47.79	0.0	0.09
9/11/96	11:00	7086.46	0.0	721.92	1.0	46.93	0.0	0.09
9/11/96	12:00	7090.54	0.0	809.00	1.0	44.99	0.0	0.07
9/11/96	13:00	7097.29	0.0	2774.88	1.0	45.82	0.0	0.07
9/11/96	14:00	7102.46	0.0	3391.33	1.0	46.59	0.0	0
9/11/96	15:00	7100.88	0.0	3585.21	1.0	49.35	0.0	0.[illegible]
9/11/96	16:00	7100.42	0.0	4123.71	1.0	45.86	0.0	0.08
9/11/96	17:00	7108.46	0.0	4336.13	1.0	44.54	0.0	0.07
9/11/96	18:00	7107.82	0.0	4532.88	1.0	44.00	0.0	0.08

VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES						
READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY RECIRC VALVE	WEIGHT	SLURRY RECIRC VALVE	RECIRC FLOW	SLURRY FEED VALVE	SLURRY FEED PUMP RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/11/96	19:00	7115.63	0.0	4855.71	1.0	42.58	0.0	0.08
9/11/96	20:00	7129.53	0.0	4861.06	1.0	13.99	0.0	0.08
9/11/96	21:00	7257.71	0.0	5097.08	1.0	0.00	0.1	0.07
9/11/96	22:00	7290.50	0.3	5342.46	0.5	0.00	0.0	0.08
9/11/96	23:00	7285.79	1.0	5339.17	0.0	0.00	0.0	0.06
9/12/96	0:00	7285.63	1.0	5340.17	0.0	0.00	0.0	0.06
9/12/96	1:00	7036.21	1.0	5348.92	0.0	0.00	0.0	0.07
9/12/96	2:00	5996.17	1.0	5364.75	0.0	0.00	0.0	0.07
9/12/96	3:00	1571.85	1.0	5375.84	0.0	-0.01	0.0	0.04
9/12/96	4:00	942.71	1.0	5372.08	0.0	0.00	0.0	0.07
9/12/96	5:00	936.33	1.0	5457.88	0.0	0.00	0.0	0.10
9/12/96	6:00	928.35	1.0	5519.92	0.0	0.00	0.0	0.05
9/12/96	7:00	923.25	1.0	5520.92	0.0	0.00	0.0	0.07
9/12/96	8:00	917.63	1.0	5519.79	0.0	0.00	0.0	0.08
9/12/96	9:00	914.13	1.0	5521.83	0.0	0.00	0.0	0.07
9/12/96	10:00	910.46	1.0	5518.79	0.0	0.00	0.0	0.08
9/12/96	11:00	902.71	1.0	5511.19	0.0	0.00	0.0	0.07
9/12/96	12:00	913.00	1.0	5514.29	0.0	0.00	0.0	0.08
9/12/96	13:00	921.79	0.4	5517.67	0.0	0.00	0.0	0.08
9/12/96	14:00	927.71	0.0	5518.69	0.0	0.00	0.0	0.07
9/12/96	15:00	930.29	0.0	5515.75	0.0	0.00	0.0	0.08
9/12/96	16:00	926.50	0.0	5533.71	0.0	0.00	0.0	0.08
9/12/96	17:00	913.92	0.0	5523.42	0.0	0.00	0.0	0.09
9/12/96	18:00	911.79	0.0	5515.75	0.0	0.00	0.0	0.08
9/12/96	19:00	910.13	0.0	5516.46	0.0	0.00	0.0	0.08
9/12/96	20:00	907.46	0.0	5517.25	0.0	0.00	0.0	0.07
9/12/96	21:00	748.04	0.0	5511.08	0.0	0.00	0.0	0.08
9/12/96	22:00	656.95	0.0	5509.53	0.0	0.00	0.1	0.07
9/12/96	23:00	631.21	0.0	5502.08	0.0	0.00	0.2	0.08
9/13/96	0:00	627.63	0.0	5498.42	0.3	0.00	0.5	0.08
9/13/96	1:00	622.17	0.0	5466.58	0.2	0.00	0.0	0.07
9/13/96	2:00	620.92	0.0	5452.25	0.2	0.38	0.0	0.07
9/13/96	3:00	622.17	0.0	5668.58	0.0	0.00	0.0	0.08
9/13/96	4:00	628.88	0.0	5873.08	0.0	0.00	0.0	0.07
9/13/96	5:00	626.08	0.0	5865.04	0.0	0.00	0.0	0.08
9/13/96	6:00	625.71	0.0	6111.75	0.0	0.00	0.0	0.09
9/13/96	7:00	628.13	0.0	6263.83	0.0	0.00	0.0	0.08
9/13/96	8:00	621.29	0.0	6264.54	0.0	0.00	0.0	2.07
9/13/96	9:00	615.98	0.0	6259.96	0.0	0.00	0.0	0.08
9/13/96	10:00	617.71	0.0	6258.96	0.0	0.00	0.0	0.07
9/13/96	11:00	622.50	0.0	6260.38	0.0	0.00	0.0	0.09
9/13/96	12:00	627.83	0.0	6262.46	0.0	0.00	0.0	0.09
9/13/96	13:00	631.75	0.0	6339.92	0.0	0.00	0.0	0.08

VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM
CAMPAIGN 2 TRANSITION GLASS
HOURLY AVERAGES

READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY RECIRC VALVE	WEIGHT	SLURRY RECIRC VALVE	RECIRC FLOW	SLURRY FEED VALVE	SLURRY FEED PUMP RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/13/96	14:00	644.62	0.0	6509.45	0.0	0.00	0.0	0.08
9/13/96	15:00	818.18	0.0	6526.53	0.0	0.00	0.0	0.06
9/13/96	16:00	885.50	0.0	6495.79	0.0	0.00	0.0	0.08
9/13/96	17:00	861.00	0.0	6692.50	0.0	0.00	0.0	0.07
9/13/96	18:00	672.29	0.0	6688.17	0.0	0.00	0.0	0.09
9/13/96	19:00	674.29	0.0	6803.96	1.0	47.70	0.5	123.10
9/13/96	20:00	673.00	0.0	6436.00	1.0	51.00	1.0	287.28
9/13/96	21:00	673.43	0.0	6019.62	1.0	51.00	1.0	208.34
9/13/96	22:00	673.00	0.0	5918.50	1.0	51.00	0.3	90.15
9/13/96	23:00	674.70	0.0	5575.38	1.0	51.00	1.0	290.54
9/14/96	0:00	471.58	0.0	5185.17	1.0	51.00	1.0	240.12
9/14/96	1:00	154.50	0.0	4816.54	1.0	51.00	1.0	250.89
9/14/96	2:00	136.50	0.0	4486.92	1.0	50.97	0.6	137.64
9/14/96	3:00	128.81	0.0	4226.99	1.0	48.08	1.0	286.92
9/14/96	4:00	121.31	0.0	3791.99	1.0	46.38	1.0	271.[illegible]
9/14/96	5:00	115.72	0.0	3385.68	1.0	46.17	0.9	249
9/14/96	6:00	110.33	0.0	3221.38	1.0	45.88	0.2	71.55
9/14/96	7:00	109.67	0.0	2912.17	1.0	46.28	1.0	283.58
9/14/96	8:00	113.88	0.0	2462.42	1.0	46.11	1.0	276.30
9/14/96	9:00	101.54	0.0	2022.88	1.0	45.84	0.9	229.76
9/14/96	10:00	357.29	0.0	1898.05	1.0	45.46	0.0	0.06
9/14/96	11:00	428.08	0.0	1902.58	1.0	45.48	0.0	0.08
9/14/96	12:00	462.29	0.0	1908.88	1.0	45.53	0.0	0.08
9/14/96	13:00	471.54	0.0	1913.00	1.0	45.58	0.0	0.07
9/14/96	14:00	479.67	0.0	1915.29	1.0	45.62	0.0	0.08
9/14/96	15:00	480.46	0.0	2219.67	0.6	23.85	0.0	0.08
9/14/96	16:00	1735.42	0.0	2502.42	0.9	41.42	0.6	196.76
9/14/96	17:00	3014.29	0.0	2043.83	1.0	49.02	1.0	343.67
9/14/96	18:00	3022.50	0.0	1585.08	1.0	48.98	1.0	292.14
9/14/96	19:00	3027.29	0.0	1206.88	1.0	48.99	1.0	279.38
9/14/96	20:00	3030.04	0.0	805.96	1.0	48.66	1.0	270.08
9/14/96	21:00	3029.00	0.0	482.83	1.0	39.71	0.9	239.92
9/14/96	22:00	3344.67	0.0	603.38	0.1	1.24	0.0	0.07
9/14/96	23:00	3599.88	0.0	593.38	0.0	0.00	0.0	0.08
9/15/96	0:00	3805.92	0.0	588.96	0.0	0.00	0.0	0.07
9/15/96	1:00	4500.88	0.0	585.17	0.0	0.00	0.0	0.08
9/15/96	2:00	5056.50	0.0	577.46	0.0	0.00	0.0	0.07
9/15/96	3:00	5108.13	0.0	575.29	0.0	0.00	0.0	0.09
9/15/96	4:00	5352.63	0.0	575.09	0.0	0.00	0.0	0.0
9/15/96	5:00	5717.83	0.0	577.79	0.0	0.00	0.0	0.05
9/15/96	6:00	7660.00	0.0	571.04	0.0	0.00	0.0	0.07
9/15/96	7:00	7118.17	0.0	2353.29	0.0	0.00	0.0	0.08
9/15/96	8:00	3218.92	0.0	6867.38	0.0	0.00	0.0	0.06

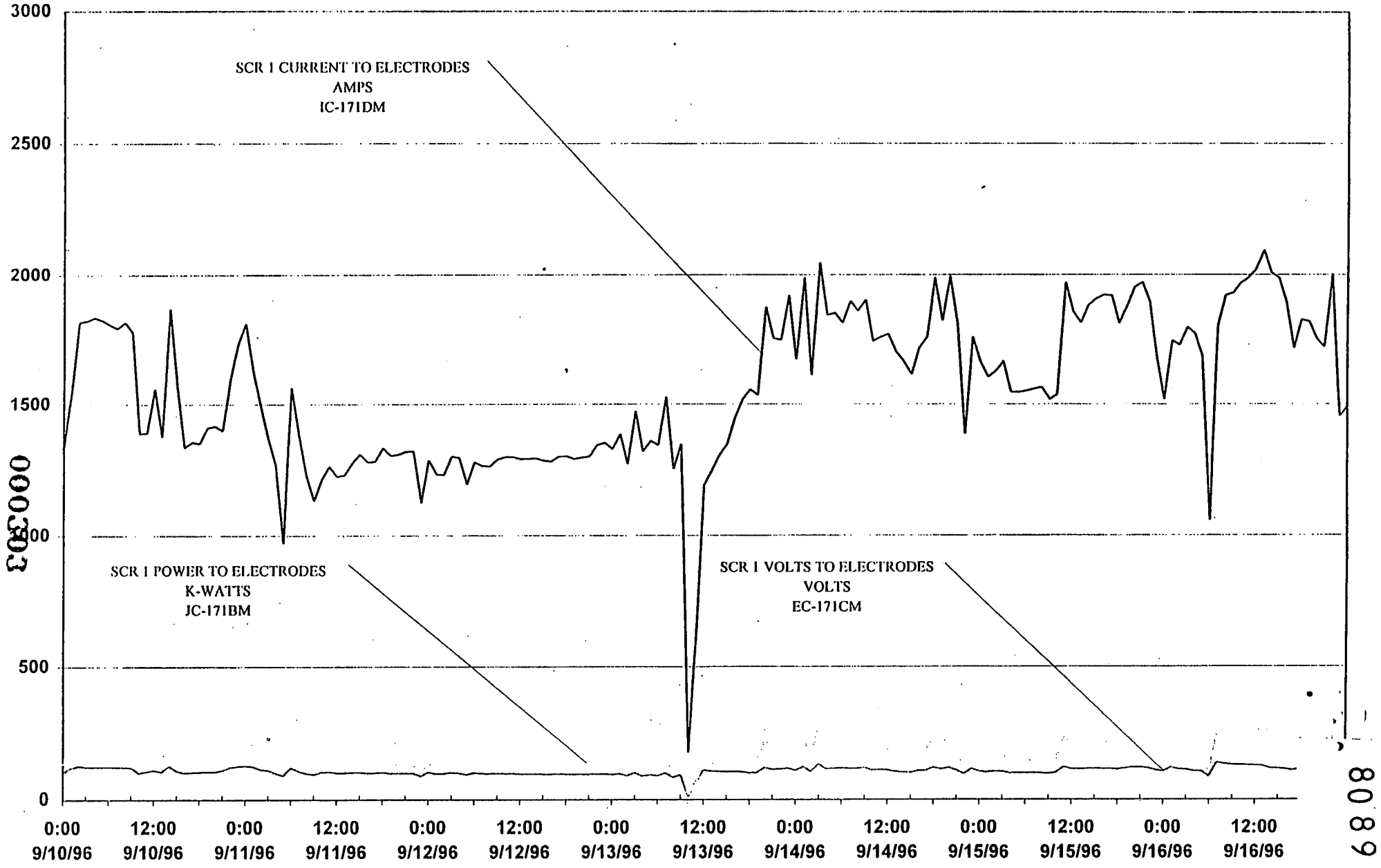
VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES						
READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY RECIRC VALVE	WEIGHT	SLURRY RECIRC VALVE	RECIRC FLOW	SLURRY FEED VALVE	SLURRY FEED PUMP RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/15/96	9:00	3205.38	0.0	6877.46	0.0	0.00	0.0	0.07
9/15/96	10:00	3198.83	0.0	6815.38	0.6	31.04	0.5	169.45
9/15/96	11:00	3203.09	0.0	6380.98	1.0	48.82	1.0	340.45
9/15/96	12:00	3213.62	0.0	5900.60	1.0	48.61	1.0	317.42
9/15/96	13:00	3219.79	0.0	5480.88	1.0	48.31	1.0	277.39
9/15/96	14:00	3222.63	0.0	5087.83	1.0	48.28	1.0	282.38
9/15/96	15:00	3226.04	0.0	4681.83	1.0	48.27	1.0	274.60
9/15/96	16:00	2906.42	0.0	4663.96	1.0	48.40	1.0	273.11
9/15/96	17:00	3132.83	0.0	7684.96	1.0	48.39	1.0	275.37
9/15/96	18:00	4036.17	0.0	7369.42	1.0	48.28	1.0	272.14
9/15/96	19:00	4210.38	0.0	6994.50	1.0	47.68	1.0	260.74
9/15/96	20:00	4356.29	0.0	7205.83	1.0	48.64	0.7	134.85
9/15/96	21:00	4323.17	0.0	6944.00	1.0	48.38	0.5	156.39
9/15/96	22:00	4324.75	0.0	6846.08	1.0	48.61	0.6	193.51
9/15/96	23:00	4324.92	0.0	6485.96	1.0	48.71	1.0	247.99
9/16/96	0:00	4329.67	0.0	6247.33	1.0	48.46	0.7	124.22
9/16/96	1:00	4377.33	0.0	6309.29	1.0	47.81	0.0	0.08
9/16/96	2:00	4378.83	0.0	6305.96	1.0	46.71	0.0	0.08
9/16/96	3:00	4377.42	0.0	6299.21	1.0	46.73	0.0	0.07
9/16/96	4:00	4378.79	0.0	6297.46	1.0	46.78	0.0	0.07
9/16/96	5:00	4374.66	0.0	6187.63	1.0	47.06	0.7	231.49
9/16/96	6:00	4370.71	0.0	5934.13	1.0	46.79	0.3	78.19
9/16/96	7:00	4374.46	0.0	5939.92	1.0	46.68	0.0	0.07
9/16/96	8:00	4389.58	0.0	5937.96	1.0	46.68	0.0	0.07
9/16/96	9:00	4402.04	0.0	5942.50	1.0	46.65	0.0	0.08
9/16/96	10:00	4406.21	0.0	5942.63	1.0	46.60	0.0	0.08
9/16/96	11:00	4410.67	0.0	5946.46	1.0	46.68	0.0	0.08
9/16/96	12:00	4413.35	0.0	5951.95	1.0	46.72	0.0	0.08
9/16/96	13:00	4418.69	0.0	5902.03	1.0	46.75	0.5	178.48
9/16/96	14:00	4425.21	0.0	5487.25	1.0	46.87	1.0	316.93
9/16/96	15:00	4426.33	0.0	5065.38	1.0	46.68	1.0	311.57
9/16/96	16:00	4429.17	0.0	4626.50	1.0	46.51	1.0	334.78
9/16/96	17:00	4433.08	0.0	4185.08	1.0	46.33	1.0	270.37
9/16/96	18:00	4427.63	0.0	3829.88	1.0	46.42	1.0	260.89
9/16/96	19:00	4418.04	0.0	3426.67	1.0	46.40	1.0	285.01
9/16/96	20:00	4418.83	0.0	3049.21	1.0	46.26	1.0	251.01
9/16/96	21:00	4425.79	0.0	2706.88	1.0	46.32	1.0	218.15
9/16/96	22:00	4433.42	0.0	2401.38	1.0	46.32	1.0	229.26
9/16/96	23:00	4432.25	0.0	2079.92	1.0	46.26	1.0	148.30
9/17/96	0:00	4495.88	0.0	1909.71	1.0	46.31	1.0	105.61

FURNACE SYSTEM

CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM



VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES					
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/10/96	0:00	1327.53	246.00	100.79	454.80	132.36	132.32
9/10/96	1:00	1547.03	246.00	118.24	454.80	182.50	182.92
9/10/96	2:00	1817.45	246.00	126.84	454.80	228.42	228.20
9/10/96	3:00	1823.03	246.00	123.64	454.80	223.27	223.20
9/10/96	4:00	1835.54	246.00	122.68	454.80	223.22	223.20
9/10/96	5:00	1824.51	246.00	123.35	454.80	223.09	223.20
9/10/96	6:00	1807.12	246.00	123.32	454.80	221.35	221.25
9/10/96	7:00	1793.00	246.00	123.07	454.80	220.66	220.60
9/10/96	8:00	1817.05	246.00	121.71	454.80	221.46	221.24
9/10/96	9:00	1777.68	246.00	119.93	454.80	213.44	213.52
9/10/96	10:00	1387.05	246.00	98.56	454.80	137.85	137.84
9/10/96	11:00	1389.35	246.00	104.44	454.80	145.80	153.32
9/10/96	12:00	1559.13	246.00	109.03	454.80	179.17	178.76
9/10/96	13:00	1374.05	246.00	102.43	454.80	148.85	148.96
9/10/96	14:00	1868.08	246.00	127.02	454.80	238.30	238.28
9/10/96	15:00	1558.03	246.00	105.92	454.80	170.37	170.20
9/10/96	16:00	1333.00	246.00	99.36	454.80	132.71	[illegible]
9/10/96	17:00	1354.08	246.00	100.66	454.80	136.82	[illegible]
9/10/96	18:00	1348.03	246.00	101.63	454.80	137.43	[illegible]
9/10/96	19:00	1410.00	246.00	102.83	454.80	145.49	145.24
9/10/96	20:00	1414.88	246.00	102.85	454.80	147.08	147.00
9/10/96	21:00	1398.50	246.00	108.25	454.80	155.54	155.64
9/10/96	22:00	1596.60	246.00	120.59	454.80	196.58	196.60
9/10/96	23:00	1734.23	246.00	124.86	454.80	220.75	220.76
9/11/96	0:00	1811.23	246.00	128.00	454.80	234.50	234.16
9/11/96	1:00	1621.40	246.00	124.68	454.80	201.05	201.04
9/11/96	2:00	1489.75	246.00	112.24	454.80	164.61	164.52
9/11/96	3:00	1364.40	246.00	108.54	454.80	147.06	147.12
9/11/96	4:00	1264.00	246.00	96.79	454.80	152.54	150.92
9/11/96	5:00	971.24	246.00	88.31	454.80	121.69	122.40
9/11/96	6:00	1564.55	246.00	119.01	454.80	184.40	184.31
9/11/96	7:00	1384.00	246.00	105.43	454.80	142.12	142.28
9/11/96	8:00	1228.88	246.00	96.86	454.80	116.36	115.88
9/11/96	9:00	1132.25	246.00	92.53	454.80	107.31	107.36
9/11/96	10:00	1211.53	246.00	100.47	454.80	122.89	124.48
9/11/96	11:00	1261.33	246.00	102.87	454.80	130.32	130.12
9/11/96	12:00	1224.43	246.00	98.62	454.80	124.24	124.08
9/11/96	13:00	1229.05	246.00	98.44	454.80	124.48	124.32
9/11/96	14:00	1272.65	246.00	100.15	454.80	130.75	130.68
9/11/96	15:00	1307.05	246.00	100.75	454.80	135.07	135.08
9/11/96	16:00	1277.95	246.00	97.20	454.80	127.55	[illegible]
9/11/96	17:00	1279.10	246.00	98.47	454.80	129.35	[illegible]
9/11/96	18:00	1330.91	246.00	100.31	454.80	136.89	136.80
9/11/96	19:00	1301.90	246.00	96.68	454.80	129.14	129.20
9/11/96	20:00	1306.04	246.00	97.27	454.80	130.51	130.50

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES					
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/11/96	21:00	1317.20	246.00	97.55	454.80	131.93	132.00
9/11/96	22:00	1318.43	246.00	97.44	454.80	131.86	132.00
9/11/96	23:00	1125.53	246.00	85.28	454.80	100.88	100.84
9/12/96	0:00	1284.33	246.00	100.79	454.80	132.86	133.08
9/12/96	1:00	1231.88	246.00	95.02	454.80	120.32	120.40
9/12/96	2:00	1230.20	246.00	95.46	454.80	120.37	120.52
9/12/96	3:00	1298.15	246.00	99.39	454.80	132.04	132.00
9/12/96	4:00	1294.03	246.00	97.31	454.80	128.96	128.96
9/12/96	5:00	1195.03	246.00	91.96	454.80	112.97	112.92
9/12/96	6:00	1277.31	246.00	97.96	454.80	127.96	128.10
9/12/96	7:00	1263.30	246.00	95.98	454.80	124.27	124.24
9/12/96	8:00	1261.00	246.00	95.92	454.80	123.95	123.92
9/12/96	9:00	1286.83	246.00	96.61	454.80	127.24	127.20
9/12/96	10:00	1296.60	246.00	96.00	454.80	127.28	127.20
9/12/96	11:00	1297.30	246.00	95.38	454.80	126.80	126.67
9/12/96	12:00	1288.33	246.00	94.45	454.80	125.05	124.80
9/12/96	13:00	1289.43	246.00	94.33	454.80	125.03	124.80
9/12/96	14:00	1290.94	246.00	94.19	454.80	125.03	124.80
9/12/96	15:00	1282.83	246.00	92.93	454.80	122.10	122.04
9/12/96	16:00	1279.35	246.00	93.16	454.80	122.05	122.04
9/12/96	17:00	1298.08	246.00	94.20	454.80	125.16	125.12
9/12/96	18:00	1299.50	246.00	93.46	454.80	124.39	124.24
9/12/96	19:00	1288.88	246.00	92.82	454.80	122.40	122.40
9/12/96	20:00	1294.60	246.00	93.25	454.80	123.57	123.60
9/12/96	21:00	1298.70	246.00	93.24	454.80	123.72	123.80
9/12/96	22:00	1341.38	246.00	94.28	454.80	129.12	128.99
9/12/96	23:00	1350.38	246.00	94.18	454.80	129.86	129.96
9/13/96	0:00	1325.83	246.00	91.64	454.80	124.11	124.04
9/13/96	1:00	1383.83	246.00	94.92	454.80	133.91	133.76
9/13/96	2:00	1269.13	246.00	86.98	454.80	112.94	113.00
9/13/96	3:00	1471.60	246.00	97.92	454.80	147.18	147.16
9/13/96	4:00	1316.63	246.00	85.96	454.80	115.81	115.76
9/13/96	5:00	1357.35	246.00	90.36	454.80	125.51	125.60
9/13/96	6:00	1341.08	246.00	87.57	454.80	121.66	121.36
9/13/96	7:00	1528.05	246.00	97.59	454.80	153.90	154.20
9/13/96	8:00	1250.80	246.00	81.57	454.80	104.85	104.76
9/13/96	9:00	1345.30	246.00	89.78	454.80	123.82	123.58
9/13/96	10:00	175.60	246.00	11.34	454.80	16.99	14.56
9/13/96	11:00	619.45	246.00	64.89	454.80	60.92	61.36
9/13/96	12:00	1190.38	246.00	108.57	454.80	132.22	132.00
9/13/96	13:00	1243.68	246.00	104.13	454.80	132.43	132.16
9/13/96	14:00	1302.10	246.00	103.13	454.80	137.05	136.80
9/13/96	15:00	1343.64	246.00	101.82	454.80	139.52	139.44
9/13/96	16:00	1443.50	246.00	103.56	454.80	151.17	151.20
9/13/96	17:00	1517.83	246.00	101.66	454.80	156.56	156.56

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

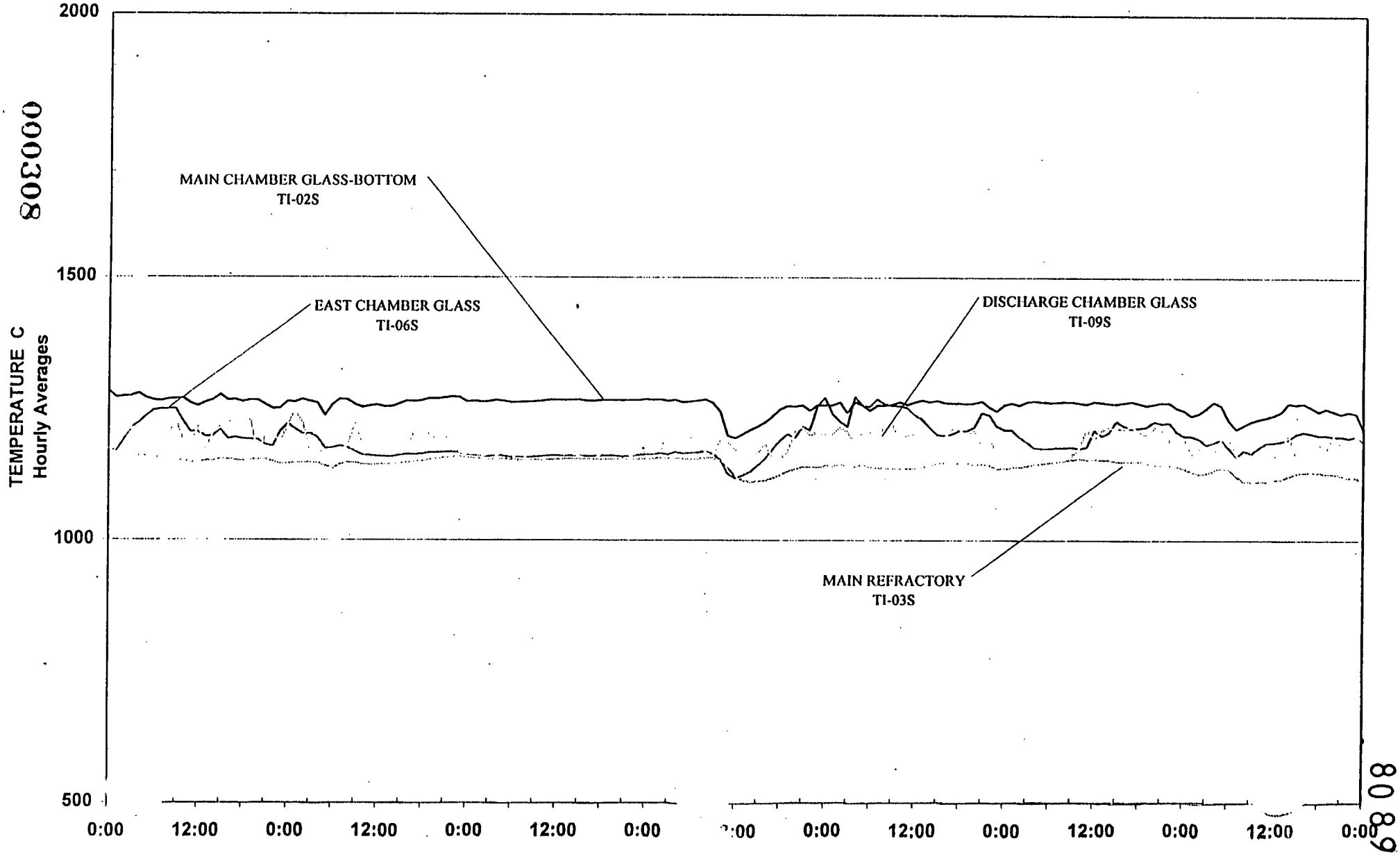
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLEI SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/13/96	18:00	1555.58	246.00	97.59	454.80	154.37	154.08
9/13/96	19:00	1535.18	246.00	98.06	454.80	148.82	149.04
9/13/96	20:00	1874.15	246.00	118.05	454.80	217.54	217.56
9/13/96	21:00	1753.40	246.00	111.00	454.80	190.54	190.50
9/13/96	22:00	1747.15	246.00	112.32	454.80	192.53	192.48
9/13/96	23:00	1919.11	246.00	116.28	454.80	220.40	220.15
9/14/96	0:00	1671.08	246.00	106.63	454.80	174.05	174.36
9/14/96	1:00	1989.53	246.00	121.45	454.80	237.25	237.04
9/14/96	2:00	1611.63	246.00	102.53	454.80	162.52	162.20
9/14/96	3:00	2046.47	246.00	132.71	454.80	272.04	272.22
9/14/96	4:00	1844.95	246.00	113.30	454.80	208.80	207.99
9/14/96	5:00	1851.25	246.00	115.30	454.80	211.30	211.24
9/14/96	6:00	1813.00	246.00	116.63	454.80	209.75	210.36
9/14/96	7:00	1898.03	246.00	114.96	454.80	222.23	221.76
9/14/96	8:00	1860.08	246.00	115.32	454.80	210.43	210.92
9/14/96	9:00	1902.80	246.00	118.03	454.80	219.57	219.56
9/14/96	10:00	1742.14	246.00	108.59	454.80	184.25	[illegible]
9/14/96	11:00	1758.18	246.00	110.45	454.80	189.50	[illegible]
9/14/96	12:00	1770.23	246.00	108.18	454.80	186.86	186.88
9/14/96	13:00	1698.78	246.00	102.59	454.80	169.81	169.68
9/14/96	14:00	1663.20	246.00	100.30	454.80	161.92	161.96
9/14/96	15:00	1614.18	246.00	98.29	454.80	153.61	153.60
9/14/96	16:00	1716.35	246.00	105.62	454.80	179.76	179.88
9/14/96	17:00	1757.05	246.00	106.63	454.80	185.75	185.80
9/14/96	18:00	1988.30	246.00	119.26	454.80	233.83	234.28
9/14/96	19:00	1821.80	246.00	111.61	454.80	202.67	202.20
9/14/96	20:00	1993.35	246.00	118.35	454.80	231.76	231.84
9/14/96	21:00	1807.35	246.00	107.60	454.80	193.13	192.92
9/14/96	22:00	1383.28	246.00	92.85	454.80	125.23	125.56
9/14/96	23:00	1758.68	246.00	113.78	454.80	197.28	197.28
9/15/96	0:00	1662.33	246.00	103.00	454.80	167.78	168.64
9/15/96	1:00	1603.95	246.00	99.89	454.80	157.32	157.04
9/15/96	2:00	1625.53	246.00	103.25	454.80	164.07	164.32
9/15/96	3:00	1663.23	246.00	102.44	454.80	166.11	166.00
9/15/96	4:00	1547.01	246.00	96.74	454.80	145.30	145.55
9/15/96	5:00	1545.83	246.00	97.40	454.80	146.26	146.40
9/15/96	6:00	1551.00	246.00	97.36	454.80	146.66	146.40
9/15/96	7:00	1558.05	246.00	97.16	454.80	146.89	146.72
9/15/96	8:00	1564.15	246.00	96.69	454.80	146.73	146.48
9/15/96	9:00	1518.35	246.00	94.21	454.80	139.37	[illegible]
9/15/96	10:00	1536.58	246.00	97.94	454.80	147.56	[illegible]
9/15/96	11:00	1971.18	246.00	120.31	454.80	232.92	[illegible]
9/15/96	12:00	1858.19	246.00	112.31	454.80	204.60	204.75
9/15/96	13:00	1813.55	246.00	111.32	454.80	199.94	199.96
9/15/96	14:00	1882.43	246.00	113.44	454.80	212.24	212.28

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES					
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/15/96	15:00	1907.53	246.00	114.05	454.80	216.13	215.92
9/15/96	16:00	1923.23	246.00	113.19	454.80	216.26	216.00
9/15/96	17:00	1920.45	246.00	113.47	454.80	215.28	215.12
9/15/96	18:00	1811.68	246.00	110.65	454.80	196.09	196.08
9/15/96	19:00	1877.80	246.00	115.33	454.80	212.68	212.72
9/15/96	20:00	1951.53	246.00	118.89	454.80	227.55	227.64
9/15/96	21:00	1971.35	246.00	119.49	454.80	230.32	230.40
9/15/96	22:00	1895.30	246.00	115.61	454.80	215.26	215.20
9/15/96	23:00	1677.45	246.00	107.51	454.80	177.08	177.32
9/16/96	0:00	1517.90	246.00	103.73	454.80	155.05	155.04
9/16/96	1:00	1744.23	246.00	118.75	454.80	204.67	204.16
9/16/96	2:00	1727.30	246.00	111.90	454.80	189.73	189.84
9/16/96	3:00	1797.55	246.00	110.36	454.80	194.53	194.40
9/16/96	4:00	1770.78	246.00	104.53	454.80	180.96	180.96
9/16/96	5:00	1682.19	246.00	103.64	454.80	171.76	171.66
9/16/96	6:00	1057.50	246.00	83.62	454.80	102.27	102.64
9/16/96	7:00	1806.03	246.00	138.43	454.80	248.15	248.16
9/16/96	8:00	1920.93	246.00	133.55	454.80	254.73	254.88
9/16/96	9:00	1930.70	246.00	130.29	454.80	249.22	249.28
9/16/96	10:00	1969.38	246.00	129.55	454.80	252.99	253.12
9/16/96	11:00	1989.73	246.00	127.67	454.80	251.73	251.76
9/16/96	12:00	2023.42	246.00	127.18	454.80	255.11	254.93
9/16/96	13:00	2095.37	246.00	124.82	454.80	259.17	259.57
9/16/96	14:00	2008.43	246.00	115.42	454.80	229.79	229.24
9/16/96	15:00	1986.20	246.00	114.37	454.80	223.92	223.84
9/16/96	16:00	1894.10	246.00	111.90	454.80	209.58	209.56
9/16/96	17:00	1714.38	246.00	107.77	454.80	184.18	183.00
9/16/96	18:00	1826.20	246.00	114.67	454.80	207.27	207.12
9/16/96	19:00	1818.78	246.00	114.94	454.80	206.39	206.28
9/16/96	20:00	1751.55	246.00	115.23	454.80	199.20	199.56
9/16/96	21:00	1719.23	246.00	116.61	454.80	197.85	197.72
9/16/96	22:00	2003.40	246.00	128.06	454.80	254.05	253.60
9/16/96	23:00	1452.08	246.00	98.36	454.80	144.02	144.08
9/17/96	0:00	1489.33	246.00	116.15	454.80	179.02	179.16

CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM



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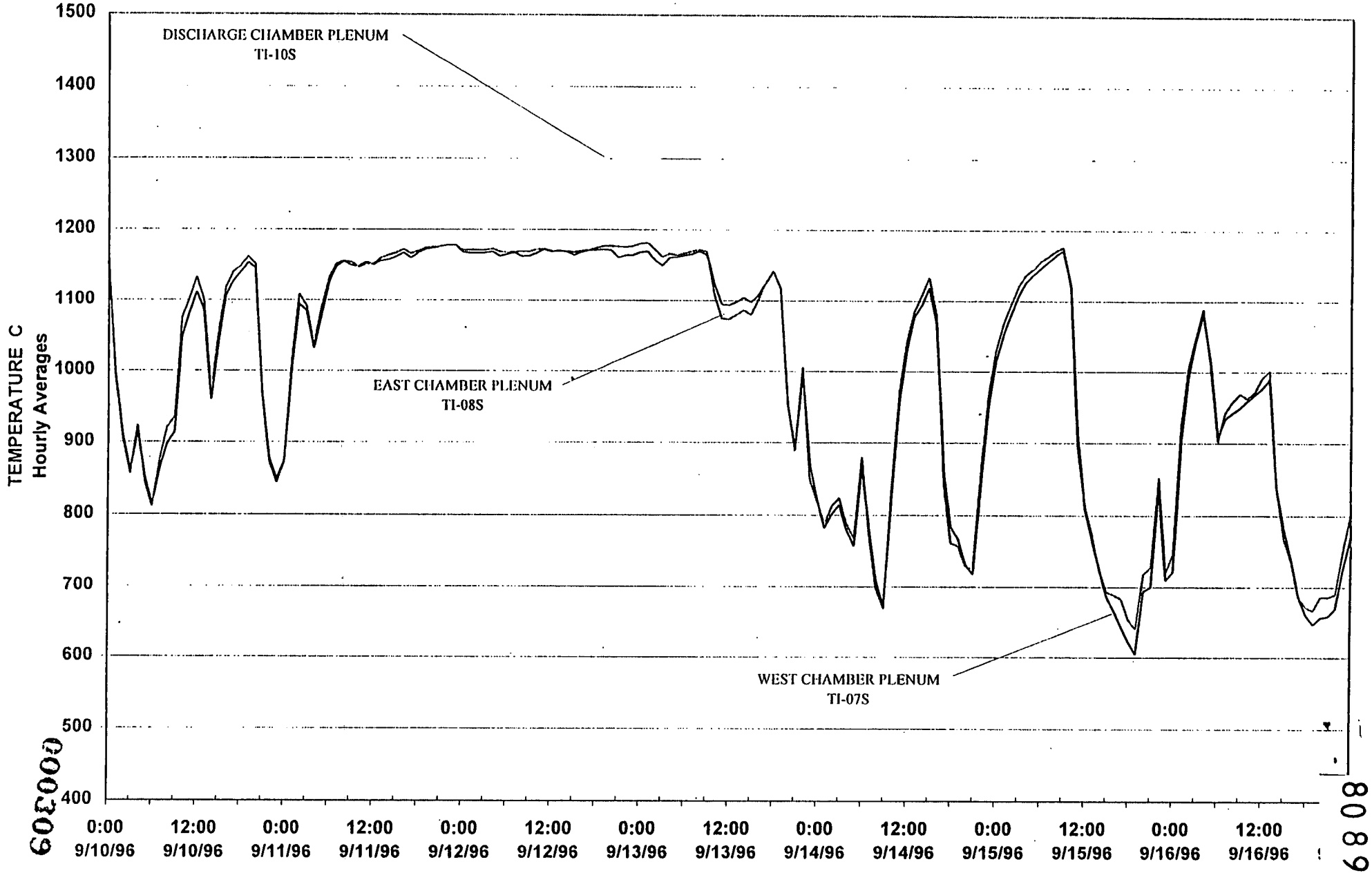
CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM



C2FURN.XLS Chart 4

VHP 10/27/96

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/10/96	0:00	OUT OF SERVICE	1282.56	OUT OF SERVICE	OUT OF SERVICE	1169.53	OUT OF SERVICE	1169.31	1153.02	1156.58	1298.19	1168.79
9/10/96	1:00		1270.09			1166.42		1206.55	993.26	990.44	1297.31	1164.33
9/10/96	2:00		1272.46			1187.59		1194.85	907.93	903.59	1297.35	1160.56
9/10/96	3:00		1273.10			1210.05		1209.68	860.10	856.24	1297.52	1159.52
9/10/96	4:00		1277.77			1220.94		1213.16	915.35	924.27	1297.31	1157.99
9/10/96	5:00		1269.23			1232.94		1200.55	852.10	844.16	1296.69	1157.38
9/10/96	6:00		1264.58			1244.43		1188.01	813.72	811.00	1297.20	1154.74
9/10/96	7:00		1262.91			1246.95		1189.22	863.04	875.75	1296.50	1151.07
9/10/96	8:00		1266.83			1247.55		1198.04	896.93	920.09	1298.30	1147.82
9/10/96	9:00		1267.75			1248.27		1224.63	913.29	935.23	1295.30	1147.24
9/10/96	10:00		1268.51			1223.29		1189.70	1047.36	1074.04	1297.74	1148.73
9/10/96	11:00		1258.56			1202.93		1176.71	1080.83	1101.69	1296.60	1145.79
9/10/96	12:00		1253.48			1203.69		1213.57	1111.51	1133.22	1298.74	1145.08
9/10/96	13:00		1259.93			1193.64		1169.78	1086.02	1099.81	1296.29	1148.35
9/10/96	14:00		1265.26			1195.15		1200.62	959.77	971.29	1296.73	1148.50
9/10/96	15:00		1275.26			1207.22		1215.15	1038.68	1053.99	1297.74	1152.36
9/10/96	16:00		1264.91			1189.79		1215.65	1106.74	1118.36	1295.72	1151.18
9/10/96	17:00		1265.73			1192.16		1237.03	1127.25	1140.26	1297.28	1149.06
9/10/96	18:00		1261.54			1189.67		1234.65	1139.58	1148.85	1296.45	1148.34
9/10/96	19:00		1264.84			1188.71		1224.91	1153.26	1162.79	1298.80	1149.27
9/10/96	20:00		1264.90			1188.50		1159.43	1145.54	1150.82	1296.01	1150.77
9/10/96	21:00		1255.81			1178.55		1194.98	966.33	965.09	1297.13	1151.04
9/10/96	22:00		1248.40			1175.79		1198.43	877.12	872.20	1297.27	1146.48
9/10/96	23:00		1248.75			1203.40		1183.98	849.28	843.88	1295.67	1142.83
9/11/96	0:00		1262.10			1218.51		1215.35	872.45	872.04	1298.58	1142.14
9/11/96	1:00		1260.41			1208.56		1244.60	1006.84	1015.74	1296.34	1145.15
9/11/96	2:00		1266.49			1199.20		1219.83	1093.93	1108.84	1295.79	1144.53
9/11/96	3:00		1262.18			1199.86		1166.33	1084.46	1091.06	1297.47	1145.06
9/11/96	4:00		1258.75			1192.35		1161.65	1031.95	1035.76	1296.39	1144.52
9/11/96	5:00		1234.50			1171.29		1165.33	1078.35	1091.03	1297.30	1138.44
9/11/96	6:00		1255.21			1172.86		1163.62	1125.17	1132.09	1296.87	1133.94
9/11/96	7:00		1266.74			1176.16		1168.56	1147.98	1152.28	1296.70	1140.92
9/11/96	8:00		1265.78			1173.66		1177.03	1154.57	1156.13	1296.83	1144.94
9/11/96	9:00		1255.74			1165.66		1220.29	1149.52	1153.91	1296.55	1144.43
9/11/96	10:00		1250.52			1159.07		1178.08	1148.49	1146.93	1298.41	1141.48
9/11/96	11:00		1253.23			1157.82		1174.15	1153.95	1150.98	1297.13	1140.26
9/11/96	12:00		1254.98			1156.55		1173.45	1150.52	1152.04	1297.03	1141.33
9/11/96	13:00		1251.52			1155.75		1178.57	1155.98	1160.85	1296.84	1141.55
9/11/96	14:00		1252.19			1155.66		1182.55	1157.68	1164.97	1297.47	1141.92
9/11/96	15:00		1257.72			1158.16		1195.50	1162.42	1167.72	1297.36	1142.62
9/11/96	16:00		1263.02			1160.47		1174.61	1167.54	1172.25	1297.25	1145.18
9/11/96	17:00		1261.79			1159.81		1203.10	1160.44	1166.71	1296.65	1147.24
9/11/96	18:00		1264.00			1160.81		1203.86	1167.48	1170.33	1296.46	1147.78
9/11/96	19:00		1268.03			1163.28		1199.61	1172.63	1175.03	1297.75	1150.36
9/11/96	20:00		1267.87			1163.53		1187.69	1174.42	1176.07	1295.97	1152.30
9/11/96	21:00		1269.64			1164.35		1195.97	1176.48	1176.38	1296.45	1153.69
9/11/96	22:00		1271.65			1164.57		1180.93	1178.51	1178.91	1297.53	1155.12
9/11/96	23:00		1270.83			1163.66		1164.65	1178.82	1177.72	1295.57	[illegible].68
9/12/96			1261.74			1157.78		1157.08	1168.66	1171.29	1297.03	[illegible]1
9/12/96			1263.25			1157.96		1155.86	1167.25	1171.98	1298.60	[illegible]4
9/12/96			1261.27			1156.57		1155.38	1167.75	1171.77	1298.46	[illegible].12
9/12/96	3:00		1262.45			1156.82		1162.37	1167.53	1171.56	1302.66	1151.15
9/12/96	4:00		1264.67			1158.55		1158.39	1169.06	1173.41	1299.21	1151.48

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/12/96	5:00		1262.67			1157.17		1163.83	1163.19	1169.60	1298.42	1151.72
9/12/96	6:00		1260.02			1154.71		1159.05	1165.91	1168.58	1298.81	1150.11
9/12/96	7:00		1261.08			1155.49		1142.86	1167.81	1169.91	1297.80	1149.86
9/12/96	8:00		1261.08			1155.41		1157.57	1162.90	1169.74	1300.27	1149.74
9/12/96	9:00		1261.76			1155.38		1160.05	1163.60	1169.52	1299.39	1149.66
9/12/96	10:00		1263.15			1156.69		1163.93	1167.46	1172.90	1299.45	1149.81
9/12/96	11:00		1265.26			1157.83		1162.92	1172.67	1173.67	1298.84	1150.23
9/12/96	12:00		1265.77			1158.11		1162.68	1169.40	1170.30	1298.87	1151.15
9/12/96	13:00		1265.13			1157.53		1160.25	1170.77	1169.90	1298.97	1151.69
9/12/96	14:00		1265.17			1157.89		1161.69	1169.33	1170.36	1299.05	1151.84
9/12/96	15:00		1266.07			1157.72		1157.54	1164.95	1168.89	1298.81	1152.09
9/12/96	16:00		1263.32			1156.95		1152.73	1168.84	1171.14	1299.19	1152.25
9/12/96	17:00		1263.06			1157.04		1149.53	1171.18	1171.52	1299.27	1151.64
9/12/96	18:00		1264.20			1157.47		1160.94	1171.54	1174.64	1299.56	1151.27
9/12/96	19:00		1264.80			1157.86		1162.19	1172.86	1177.47	1299.44	1151.56
9/12/96	20:00		1264.61			1157.39		1166.04	1171.49	1177.90	1298.22	1151.56
9/12/96	21:00		1264.36			1156.21		1163.84	1160.97	1176.86	1300.10	1151.85
9/12/96	22:00		1264.59			1157.51		1157.41	1164.59	1175.87	1299.14	1151.35
9/12/96	23:00		1264.71			1158.94		1162.77	1164.81	1177.42	1299.47	1151.57
9/13/96	0:00		1266.34			1160.71		1164.31	1168.92	1181.08	1299.34	1152.23
9/13/96	1:00		1265.67			1161.43		1163.20	1169.87	1181.95	1299.36	1152.44
9/13/96	2:00		1266.65			1162.74		1167.80	1156.78	1172.04	1299.27	1153.49
9/13/96	3:00		1263.12			1160.38		1190.03	1149.49	1162.79	1298.21	1152.90
9/13/96	4:00		1265.23			1164.83		1194.01	1161.23	1166.87	1298.30	1153.08
9/13/96	5:00		1260.07			1162.17		1183.31	1162.04	1164.74	1298.24	1152.60
9/13/96	6:00		1261.93			1163.35		1191.70	1164.63	1167.47	1298.34	1152.24
9/13/96	7:00		1263.48			1163.87		1185.62	1166.25	1170.41	1298.23	1152.25
9/13/96	8:00		1266.25			1166.31		1164.65	1170.24	1172.95	1298.52	1154.63
9/13/96	9:00		1259.27			1161.14		1155.98	1165.31	1169.84	1299.02	1152.84
9/13/96	10:00		1242.14			1150.51		1187.86	1123.78	1108.70	1299.91	1149.54
9/13/96	11:00		1195.74			1123.43		1184.02	1094.83	1074.51	1298.42	1135.45
9/13/96	12:00		1191.46			1115.12		1169.26	1093.44	1073.41	1299.45	1118.43
9/13/96	13:00		1198.51			1120.46		1163.31	1098.25	1079.53	1299.65	1110.36
9/13/96	14:00		1206.41			1127.12		1161.80	1104.11	1086.17	1299.38	1108.60
9/13/96	15:00		1213.44			1138.69		1160.98	1097.92	1079.84	1299.85	1109.15
9/13/96	16:00		1221.79			1152.14		1181.87	1107.72	1102.10	1299.47	1111.16
9/13/96	17:00		1232.92			1169.61		1155.34	1124.93	1125.16	1299.52	1115.12
9/13/96	18:00		1246.99			1186.92		1151.56	1141.86	1142.60	1299.51	1121.19
9/13/96	19:00		1253.28			1198.94		1166.52	1117.27	1115.90	1299.88	1128.53
9/13/96	20:00		1252.34			1191.82		1203.86	951.89	952.60	1299.83	1132.73
9/13/96	21:00		1254.67			1214.19		1212.78	891.21	888.43	1298.60	1137.18
9/13/96	22:00		1245.10			1206.27		1197.36	998.27	1006.34	1300.22	1137.14
9/13/96	23:00		1254.91			1253.75		1202.84	871.76	849.41	1299.09	1136.08
9/14/96	0:00		1255.09			1269.90		1198.35	821.35	819.87	1299.78	1139.67
9/14/96	1:00		1255.20			1238.14		1198.80	781.52	786.71	1299.80	1138.78
9/14/96	2:00		1260.53			1223.79		1212.07	801.59	812.69	1298.52	1142.19
9/14/96	3:00		1240.31			1213.66		1203.69	814.13	823.81	1299.24	1138.58
9/14/96	4:00		1260.37			1272.08		1182.23	778.59	787.02	1299.89	1138.19
9/14/96	5:00		1254.93			1254.11		1202.78	756.77	767.36	1299.82	1139.96
9/14/96	6:00		1244.80			1252.41		1201.31	868.50	879.80	1299.27	1137.40
9/14/96	7:00		1254.02			1267.22		1194.30	781.38	772.42	1299.32	1135.17
9/14/96	8:00		1254.08			1257.39		1211.59	707.86	697.32	1299.55	1134.96
9/14/96	9:00		1255.81			1253.87		1216.81	672.87	668.99	1299.16	1134.34

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		MAIN CHAMBER GLASS TOP TI-4S	MAIN CHAMBER GLASS BOTTOM TI-2S	WEST CHAMBER GLASS TI-5S	WEST CHAMBER IR GLASS TI-IRW	EAST CHAMBER GLASS TI-6S	EAST CHAMBER IR GLASS TI-IRE	DISCH CHAMBER GLASS TI-9S	WEST CHAMBER PLENUM TI-7S	EAST CHAMBER PLENUM TI-8S	DISCH CHAMBER PLENUM TI-10S	MAIN REFRACTORY TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/14/96	10:00		1261.41			1254.01		1189.56	825.98	836.35	1299.15	1134.28
9/14/96	11:00		1255.89			1250.12		1195.19	958.54	969.70	1299.48	1134.06
9/14/96	12:00		1260.39			1236.25		1198.00	1028.89	1041.98	1299.41	1134.00
9/14/96	13:00		1264.73			1228.16		1194.37	1076.64	1083.74	1299.71	1136.49
9/14/96	14:00		1261.46			1211.65		1196.41	1093.74	1108.46	1299.05	1139.97
9/14/96	15:00		1263.97			1198.04		1186.87	1118.47	1133.11	1299.48	1142.42
9/14/96	16:00		1259.83			1196.69		1191.85	1067.85	1078.82	1299.61	1144.52
9/14/96	17:00		1258.73			1199.50		1209.84	860.98	842.46	1299.22	1144.88
9/14/96	18:00		1259.02			1205.91		1209.15	783.20	761.22	1299.03	1143.73
9/14/96	19:00		1257.63			1205.70		1197.15	766.01	756.95	1299.12	1143.00
9/14/96	20:00		1259.05			1212.47		1206.10	731.41	729.22	1299.20	1142.00
9/14/96	21:00		1262.49			1240.21		1177.49	717.74	725.04	1298.00	1141.74
9/14/96	22:00		1251.33			1236.25		1193.45	841.39	861.39	1299.78	1140.17
9/14/96	23:00		1243.50			1214.56		1164.57	951.06	968.49	1299.03	1133.63
9/15/96	0:00		1255.66			1207.38		1157.45	1014.72	1029.82	1299.05	1133.24
9/15/96	1:00		1259.08			1207.45		1175.20	1053.11	1068.24	1299.48	1136.20
9/15/96	2:00		1254.73			1193.46		1153.53	1080.88	1095.48	1299.41	1137.10
9/15/96	3:00		1261.29			1184.20		1150.37	1108.43	1122.03	1299.40	1138.50
9/15/96	4:00		1263.09			1173.14		1149.91	1127.19	1137.49	1299.54	1141.55
9/15/96	5:00		1261.43			1172.28		1150.09	1137.82	1146.00	1299.48	1143.15
9/15/96	6:00		1260.58			1172.00		1153.72	1147.29	1156.66	1299.43	1144.62
9/15/96	7:00		1260.47			1173.33		1155.52	1156.27	1164.28	1299.45	1146.65
9/15/96	8:00		1261.90			1173.49		1156.89	1165.32	1171.64	1299.48	1148.77
9/15/96	9:00		1261.98			1174.23		1158.10	1171.82	1176.85	1299.45	1151.29
9/15/96	10:00		1259.46			1171.69		1172.30	1121.15	1117.69	1299.77	1152.62
9/15/96	11:00		1257.38			1174.37		1208.54	914.93	894.48	1299.40	1151.26
9/15/96	12:00		1262.27			1206.86		1190.10	809.94	813.69	1299.43	1151.60
9/15/96	13:00		1260.48			1196.08		1206.39	767.30	774.88	1298.11	1150.83
9/15/96	14:00		1258.28			1202.85		1211.16	726.09	724.03	1300.60	1149.74
9/15/96	15:00		1257.79			1224.33		1210.14	686.92	693.06	1299.36	1147.69
9/15/96	16:00		1260.08			1215.17		1209.66	666.32	688.39	1299.46	1146.78
9/15/96	17:00		1262.26			1209.25		1213.15	643.17	682.97	1299.37	1147.28
9/15/96	18:00		1258.63			1210.92		1205.14	622.40	653.55	1299.43	1146.58
9/15/96	19:00		1254.70			1213.33		1197.66	604.66	640.11	1299.19	1144.22
9/15/96	20:00		1257.21			1223.83		1211.15	693.21	717.84	1299.39	1141.87
9/15/96	21:00		1260.08			1220.02		1210.03	699.80	728.16	1298.68	1139.90
9/15/96	22:00		1259.78			1221.85		1187.53	838.33	852.14	1299.64	1139.92
9/15/96	23:00		1250.31			1204.36		1171.14	709.55	719.88	1299.01	1138.14
9/16/96	0:00		1245.19			1195.85		1192.46	720.60	745.35	1298.95	1134.09
9/16/96	1:00		1234.69			1195.35		1161.10	902.05	924.24	1299.13	1128.01
9/16/96	2:00		1239.53			1190.50		1172.24	991.10	1004.57	1299.44	1124.50
9/16/96	3:00		1249.50			1179.10		1152.61	1044.84	1048.66	1299.45	1125.16
9/16/96	4:00		1261.34			1183.26		1159.20	1082.09	1089.33	1299.57	1129.99
9/16/96	5:00		1254.44			1189.43		1190.90	1017.63	1011.55	1299.11	1135.90
9/16/96	6:00		1226.01			1172.29		1193.75	908.34	902.01	1299.41	1132.53
9/16/96	7:00		1209.18			1156.59		1158.35	933.89	943.07	1299.23	1119.31
9/16/96	8:00		1216.60			1167.84		1153.99	942.35	958.65	1299.14	1111.12
9/16/96	9:00		1224.25			1162.97		1156.41	949.64	969.19	1299.66	[illegible]09.41
9/16/96	[illegible]		1228.28			1173.72		1162.87	959.42	963.14	1298.85	[illegible]34
9/16/96			1231.81			1182.56		1149.33	967.75	971.40	1299.80	[illegible]2
9/16/96			1236.15			1183.85		1156.27	976.66	991.09	1299.68	[illegible].67
9/16/96	[illegible]		1242.92			1185.97		1176.36	989.65	1001.27	1299.65	1114.22
9/16/96	14:00		1238.80			1189.64		1195.69	835.79	835.47	1298.88	1119.99

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/16/96	15:00		1256.57			1199.84		1156.09	780.90	766.58	1299.34	1124.86
9/16/96	16:00		1258.51			1203.42		1176.91	738.53	735.77	1299.18	1126.90
9/16/96	17:00		1251.72			1201.09		1187.51	686.56	685.32	1298.99	1128.08
9/16/96	18:00		1243.44			1196.99		1178.74	660.37	671.21	1299.26	1126.60
9/16/96	19:00		1249.17			1197.54		1167.71	647.01	666.51	1298.80	1124.36
9/16/96	20:00		1244.01			1194.76		1195.28	656.45	685.92	1299.21	1123.99
9/16/96	21:00		1238.87			1195.15		1180.16	658.37	685.53	1298.84	1121.00
9/16/96	22:00		1242.92			1192.02		1180.02	669.10	689.21	1299.03	1117.87
9/16/96	23:00		1239.76			1195.44		1196.25	727.65	754.04	1297.58	1117.40
9/17/96	0:00		1207.66			1181.89		1178.50	769.78	801.46	1300.54	1108.99

000313

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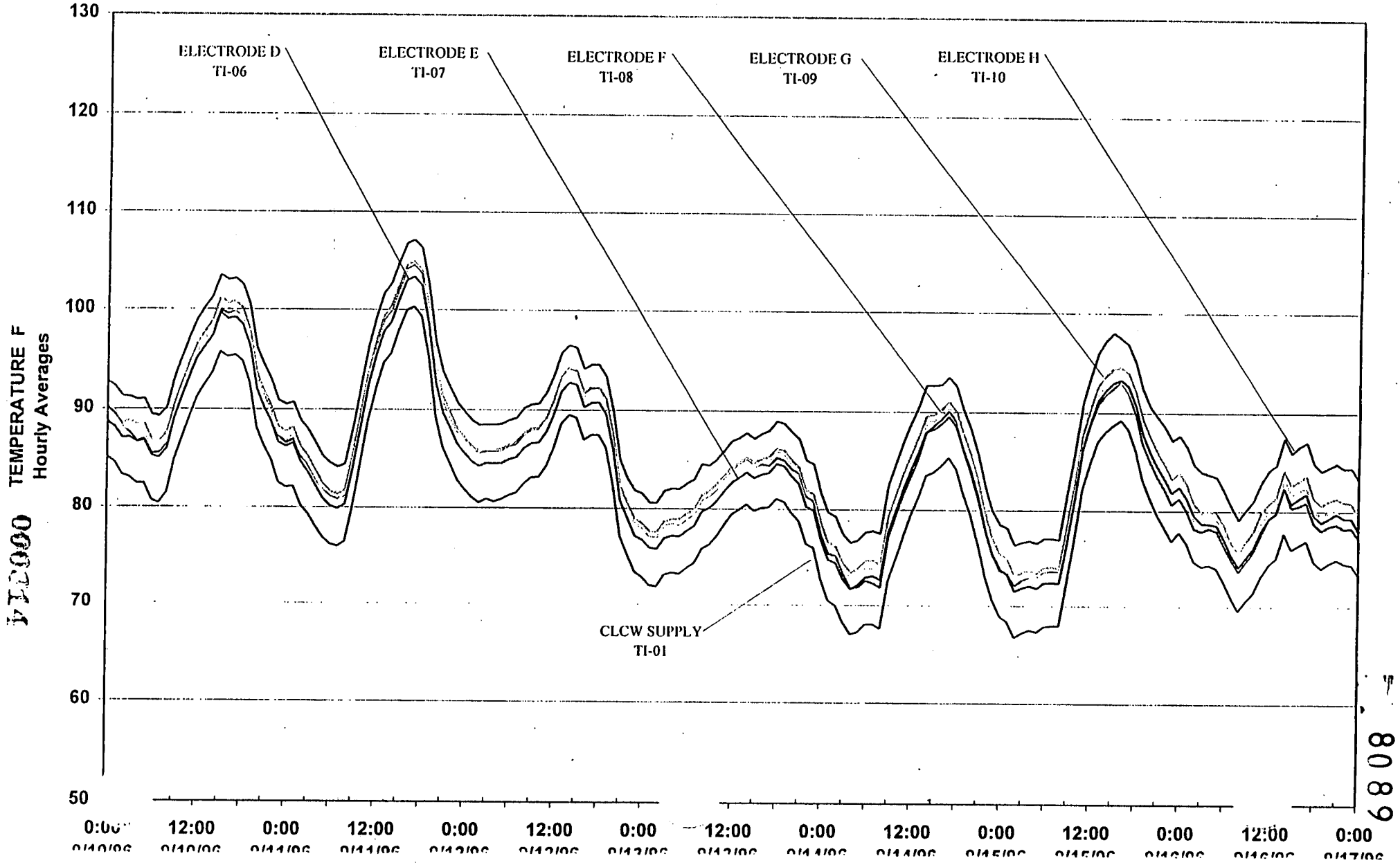
CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM



VI2000

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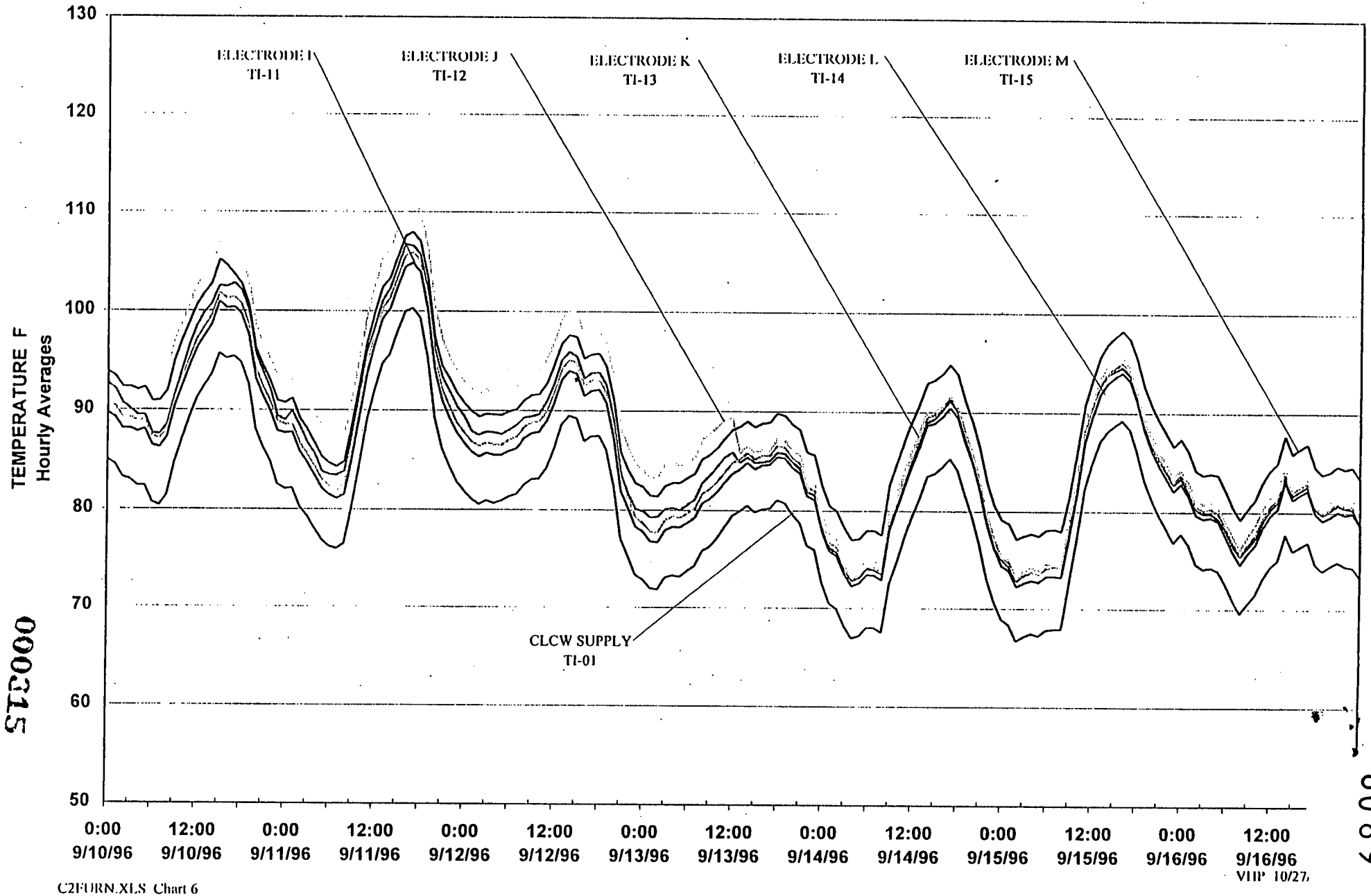
CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM



C2FURN.XLS Chart 6

VHP 10/27

000315

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES										
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM										
		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/10/96	0:00	85.06	90.11	89.74	90.33	88.67	92.72	92.71	96.29	90.85	89.72	93.92
9/10/96	1:00	84.57	89.51	89.22	89.84	88.17	92.28	92.13	95.80	90.36	89.24	93.41
9/10/96	2:00	83.29	88.23	88.10	88.61	87.03	91.28	90.71	94.61	89.27	88.12	92.35
9/10/96	3:00	83.07	87.55	87.89	88.87	87.09	91.20	90.13	95.03	89.26	88.14	92.35
9/10/96	4:00	82.41	86.68	87.43	88.47	86.60	90.92	89.51	94.99	88.91	87.84	92.05
9/10/96	5:00	82.44	86.91	87.63	88.54	86.76	91.01	89.49	94.94	89.03	88.07	92.30
9/10/96	6:00	80.70	85.46	85.95	86.83	85.23	89.44	87.67	93.41	87.43	86.48	90.91
9/10/96	7:00	80.41	85.51	85.72	86.66	85.02	89.27	87.58	93.21	87.14	86.29	90.96
9/10/96	8:00	81.49	86.46	86.64	87.59	85.94	90.15	88.51	94.08	88.11	87.27	91.91
9/10/96	9:00	84.74	89.58	89.70	90.48	89.10	93.07	91.53	96.91	91.14	90.33	94.96
9/10/96	10:00	86.99	91.77	91.87	92.63	91.23	95.19	94.03	98.83	93.30	92.46	97.06
9/10/96	11:00	89.24	93.91	94.01	94.75	93.30	97.28	96.57	100.69	95.32	94.48	98.89
9/10/96	12:00	91.21	95.85	95.87	96.61	95.17	99.03	98.52	102.55	97.22	96.25	100.64
9/10/96	13:00	92.50	97.13	97.13	97.83	96.32	100.25	99.88	103.72	98.44	97.53	101.79
9/10/96	14:00	93.60	98.10	98.15	98.88	97.32	101.27	100.72	104.75	99.55	98.62	102.78
9/10/96	15:00	95.72	99.91	100.48	101.21	99.68	103.46	102.56	106.98	101.81	100.92	105.12
9/10/96	16:00	95.23	99.58	99.77	100.61	99.04	103.00	102.43	106.54	101.23	100.32	104.59
9/10/96	17:00	95.42	99.91	99.96	100.79	99.20	103.11	102.77	105.98	101.36	100.38	103.68
9/10/96	18:00	94.78	99.34	99.36	100.10	98.49	102.49	102.09	104.97	100.73	99.71	102.72
9/10/96	19:00	92.64	97.28	97.25	97.99	96.37	100.48	100.15	102.96	98.63	97.62	100.60
9/10/96	20:00	88.11	92.94	92.86	93.60	91.97	96.14	95.71	98.59	94.14	93.19	96.21
9/10/96	21:00	86.29	91.23	91.12	91.83	90.22	94.41	93.88	96.70	92.38	91.41	94.47
9/10/96	22:00	84.84	89.63	89.56	90.31	88.68	92.92	92.08	95.08	90.84	89.87	[illegible]
9/10/96	23:00	82.57	87.31	87.45	88.18	86.59	90.88	89.42	93.41	88.90	87.90	
9/11/96	0:00	82.09	86.55	86.87	87.77	86.19	90.48	89.04	92.64	88.55	87.70	
9/11/96	1:00	82.18	86.95	87.31	88.12	86.53	90.71	89.91	93.06	88.57	87.78	[illegible]
9/11/96	2:00	80.23	85.22	85.44	86.20	84.63	88.88	88.37	91.38	86.67	85.84	89.17
9/11/96	3:00	79.34	84.33	84.48	85.24	83.58	87.95	86.80	90.39	85.67	84.78	88.10
9/11/96	4:00	78.04	82.95	83.05	83.80	82.24	86.62	85.68	89.77	84.39	83.43	86.70
9/11/96	5:00	76.90	81.76	81.75	82.48	80.93	85.24	83.85	88.37	83.05	82.12	85.35
9/11/96	6:00	76.20	81.16	81.02	81.70	80.13	84.55	83.52	87.70	82.33	81.48	84.68
9/11/96	7:00	75.99	80.81	80.70	81.41	79.89	84.12	83.46	87.45	82.03	81.12	84.35
9/11/96	8:00	76.49	81.24	81.42	81.79	80.31	84.41	83.85	87.73	82.45	81.51	84.83
9/11/96	9:00	80.31	84.97	85.14	85.46	84.04	87.99	87.51	91.21	86.13	85.14	88.51
9/11/96	10:00	84.55	89.10	89.28	89.57	88.12	92.10	91.66	95.27	90.30	89.31	92.61
9/11/96	11:00	89.05	93.46	93.63	93.83	92.44	96.32	96.02	99.59	94.69	93.70	96.87
9/11/96	12:00	92.07	96.44	96.57	96.80	95.40	99.22	98.51	102.66	97.69	96.65	99.83
9/11/96	13:00	94.67	98.99	99.11	99.34	97.83	101.65	101.02	105.26	100.30	99.22	102.38
9/11/96	14:00	95.64	100.02	100.17	100.45	98.80	102.68	102.27	106.28	101.30	100.20	103.32
9/11/96	15:00	97.96	102.12	102.31	102.43	100.99	104.83	104.50	108.37	103.49	102.42	105.43
9/11/96	16:00	99.96	104.20	104.32	104.54	102.99	106.74	106.68	110.42	105.53	104.48	107.50
9/11/96	17:00	100.28	104.57	104.72	104.90	103.31	107.09	106.52	110.80	105.92	104.81	107.87
9/11/96	18:00	99.33	103.69	103.85	104.00	102.44	106.25	105.67	109.92	105.01	103.92	106.95
9/11/96	19:00	95.39	99.80	99.99	100.21	98.59	102.57	101.97	106.25	101.16	100.08	103.29
9/11/96	20:00	89.28	93.92	94.09	94.29	92.69	96.85	96.26	100.34	95.21	94.09	97.40
9/11/96	21:00	86.19	90.95	91.07	91.35	89.72	93.84	93.36	97.25	92.09	91.00	94.44
9/11/96	22:00	84.47	89.24	89.27	89.70	88.09	92.16	91.95	95.51	90.40	89.24	93.23
9/11/96	23:00	82.87	87.80	87.84	88.07	86.46	90.70	90.43	93.98	88.75	87.76	91.76
9/12/96	0:00	81.93	86.85	86.81	87.16	85.57	89.81	89.41	92.92	87.76	86.78	90.74
9/12/96	1:00	81.09	85.91	85.90	86.27	84.71	88.92	87.89	92.19	86.88	85.86	89.92
9/12/96	2:00	80.55	85.45	85.39	85.72	84.24	88.42	87.53	91.75	86.48	85.39	89.39
9/12/96	3:00	80.93	85.80	85.59	85.88	84.57	88.48	87.84	92.11	86.79	85.76	89.66
9/12/96	4:00	80.67	85.71	85.60	85.88	84.50	88.48	87.79	91.48	86.62	85.54	
9/12/96	5:00	80.92	85.71	85.65	86.01	84.54	88.55	87.62	91.49	86.55	85.57	
9/12/96	6:00	81.33	86.17	86.08	86.39	84.93	88.94	88.04	92.16	87.05	85.93	[illegible]
9/12/96	7:00	81.60	86.46	86.25	86.72	85.16	89.18	88.52	92.47	87.32	86.22	90.13
9/12/96	8:00	82.52	87.31	87.21	87.59	86.07	90.17	89.31	93.34	88.31	87.20	91.02
9/12/96	9:00	83.12	87.85	87.79	88.08	86.55	90.56	89.43	93.83	88.80	87.72	91.54

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

ELECTRODE CLOSED LOOP COOLING WATER SYSTEM

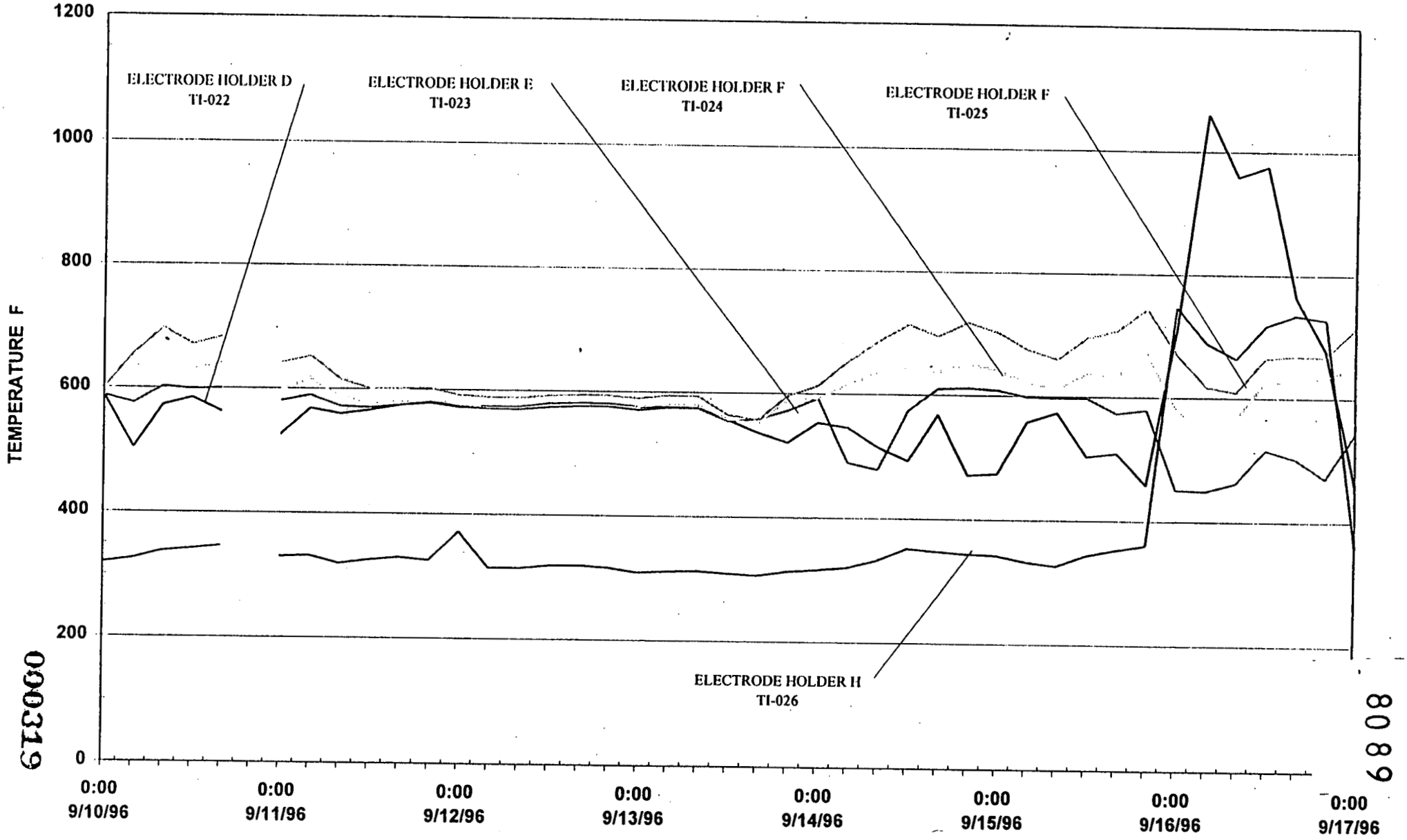
READINGS		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/12/96	10:00	83.16	87.95	87.85	88.17	86.65	90.64	89.64	93.95	88.88	87.82	91.64
9/12/96	11:00	84.28	89.10	89.01	89.22	87.72	91.67	90.94	95.09	89.95	88.95	92.71
9/12/96	12:00	86.19	90.89	90.81	91.08	89.63	93.49	92.68	96.90	91.81	90.77	94.57
9/12/96	13:00	88.62	93.21	93.12	93.38	91.86	95.73	95.06	99.21	94.21	93.13	96.75
9/12/96	14:00	89.50	94.06	93.95	94.25	92.72	96.50	95.93	100.13	95.11	93.99	97.64
9/12/96	15:00	89.23	93.84	93.71	94.03	92.55	96.25	95.49	99.83	94.86	93.74	97.45
9/12/96	16:00	86.93	91.58	91.45	91.81	90.30	94.13	93.27	97.62	92.60	91.44	95.22
9/12/96	17:00	87.43	92.09	91.97	92.30	90.70	94.50	93.80	98.05	93.05	91.99	95.69
9/12/96	18:00	87.47	92.15	92.05	92.32	90.78	94.53	93.87	98.02	93.08	92.12	95.77
9/12/96	19:00	86.14	90.83	90.74	91.07	89.53	93.36	92.62	96.79	91.80	90.76	94.47
9/12/96	20:00	82.42	87.32	87.21	87.58	86.03	89.94	89.04	93.46	88.24	87.18	91.05
9/12/96	21:00	77.12	82.12	82.05	82.39	80.80	84.94	83.74	88.21	83.00	81.93	85.89
9/12/96	22:00	75.25	80.33	80.19	80.54	79.03	83.09	81.60	86.35	81.17	80.10	84.04
9/12/96	23:00	73.38	78.51	78.52	78.95	77.18	81.88	80.14	84.80	79.30	78.28	82.73
9/13/96	0:00	72.87	78.07	78.12	78.52	76.78	81.58	79.88	84.10	78.69	77.79	82.35
9/13/96	1:00	71.97	77.15	77.23	77.66	75.93	80.62	79.26	83.18	77.80	76.79	81.45
9/13/96	2:00	71.86	77.11	77.13	77.60	75.82	80.60	79.33	83.32	77.72	76.71	81.41
9/13/96	3:00	73.10	78.35	78.37	78.69	76.93	81.83	80.14	84.68	79.02	77.95	82.46
9/13/96	4:00	73.33	78.57	78.60	78.97	77.23	82.11	80.24	84.85	79.35	78.28	82.76
9/13/96	5:00	73.19	78.39	78.41	78.94	77.14	82.05	80.02	84.54	79.23	78.24	82.78
9/13/96	6:00	73.83	78.97	79.03	79.50	77.71	82.60	80.56	84.90	79.69	78.76	83.29
9/13/96	7:00	74.31	79.49	79.53	79.94	78.22	83.02	81.12	85.37	80.18	79.21	83.69
9/13/96	8:00	75.84	80.97	81.03	81.46	79.72	84.57	82.80	87.14	81.73	80.74	85.23
9/13/96	9:00	76.28	81.34	81.42	81.87	80.09	84.41	83.50	87.74	82.20	81.15	85.62
9/13/96	10:00	77.18	82.09	82.10	82.60	80.83	85.02	84.45	88.42	82.94	81.90	86.33
9/13/96	11:00	78.32	82.97	82.93	83.42	81.80	85.89	85.38	89.19	83.87	82.84	87.21
9/13/96	12:00	79.46	83.92	83.87	84.30	82.72	86.90	85.88	89.29	84.84	83.75	88.10
9/13/96	13:00	79.94	84.43	84.39	84.71	83.18	87.22	84.88	85.88	85.26	84.19	88.44
9/13/96	14:00	80.50	84.99	84.94	85.30	83.72	87.73	85.44	86.58	85.82	84.84	88.99
9/13/96	15:00	79.82	84.35	84.33	84.72	83.16	87.13	84.86	85.87	85.26	84.21	88.39
9/13/96	16:00	80.15	84.58	84.75	85.11	83.52	87.64	84.92	86.16	85.60	84.59	88.77
9/13/96	17:00	80.22	84.43	85.00	85.31	83.72	87.98	85.07	86.12	85.62	84.65	88.90
9/13/96	18:00	81.06	85.23	85.85	86.16	84.61	88.94	85.90	87.24	86.59	85.46	89.83
9/13/96	19:00	80.75	84.97	85.61	85.97	84.38	88.69	85.78	87.09	86.40	85.35	89.60
9/13/96	20:00	79.65	84.08	84.44	85.04	83.36	87.85	84.97	86.19	85.41	84.40	88.72
9/13/96	21:00	78.77	83.67	83.83	84.25	82.59	87.14	84.28	85.61	84.80	83.80	88.15
9/13/96	22:00	76.43	81.33	81.60	81.99	80.28	84.99	81.96	83.22	82.45	81.51	85.91
9/13/96	23:00	76.02	80.81	81.22	81.63	79.92	84.60	81.60	82.73	82.05	81.10	85.65
9/14/96	0:00	72.71	77.39	78.26	78.67	76.87	81.67	78.31	79.61	78.92	77.97	82.62
9/14/96	1:00	70.49	75.42	76.12	76.60	74.75	79.68	76.23	77.57	76.69	75.90	80.52
9/14/96	2:00	69.94	75.21	75.66	76.18	74.41	79.23	75.75	77.11	76.36	75.41	79.96
9/14/96	3:00	68.19	73.30	73.82	74.42	72.70	77.47	74.01	75.15	74.44	73.57	78.25
9/14/96	4:00	66.96	71.77	72.79	73.43	71.70	76.57	72.87	73.82	73.10	72.30	77.03
9/14/96	5:00	67.16	71.87	73.13	73.85	72.13	76.82	73.18	74.06	73.46	72.60	77.13
9/14/96	6:00	67.99	72.56	73.90	74.66	72.93	77.64	74.10	75.01	74.28	73.47	78.00
9/14/96	7:00	68.00	72.29	73.91	74.73	73.08	77.79	74.01	74.91	74.19	73.40	78.00
9/14/96	8:00	67.53	71.86	73.40	74.23	72.67	77.51	73.59	74.46	73.75	72.92	77.51
9/14/96	9:00	72.54	77.00	78.41	79.22	77.62	82.47	78.58	79.63	78.93	78.03	82.57
9/14/96	10:00	74.80	79.39	80.65	81.45	79.81	84.67	80.66	81.74	81.12	80.30	84.89
9/14/96	11:00	77.26	81.66	82.82	83.76	82.17	86.94	82.96	84.04	83.35	82.50	87.04
9/14/96	12:00	79.48	83.43	84.53	85.56	84.06	88.85	84.88	86.14	85.47	84.66	89.06
9/14/96	13:00	81.35	85.34	86.75	87.49	85.93	90.65	86.98	88.04	87.45	86.51	90.86
9/14/96	14:00	83.53	87.85	88.89	89.55	87.99	92.67	88.99	90.14	89.53	88.66	92.97
9/14/96	15:00	83.86	88.56	89.10	89.74	88.20	92.66	89.34	90.19	89.81	88.87	93.26
9/14/96	16:00	84.51	89.23	89.54	90.27	88.76	92.70	90.27	90.57	90.43	89.52	93.87
9/14/96	17:00	85.34	90.12	90.34	91.05	89.52	93.48	91.23	91.53	91.35	90.46	94.77
9/14/96	18:00	84.19	88.94	89.31	90.05	88.46	92.57	90.13	90.64	90.42	89.54	93.89
9/14/96	19:00	81.67	85.97	86.64	87.74	86.09	90.16	87.58	88.14	87.96	87.05	91.25

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY AVERAGES										
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM										
		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/14/96	20:00	79.44	83.66	84.90	85.70	84.07	88.20	85.38	86.04	85.82	85.00	89.12
9/14/96	21:00	76.61	81.18	82.35	83.15	81.47	85.73	82.66	83.10	83.01	82.23	86.53
9/14/96	22:00	73.12	77.95	78.94	79.71	78.03	82.44	79.21	79.83	79.59	78.69	83.03
9/14/96	23:00	70.68	75.38	76.40	77.16	75.51	79.96	76.27	77.42	77.10	76.25	80.62
9/15/96	0:00	68.90	73.64	74.77	75.50	73.87	78.52	75.07	75.65	75.27	74.48	79.20
9/15/96	1:00	68.36	73.40	74.19	74.93	73.31	78.19	74.38	75.11	74.84	73.97	78.77
9/15/96	2:00	66.70	72.14	72.51	73.14	71.52	76.38	72.87	73.39	73.14	72.29	77.17
9/15/96	3:00	67.14	72.69	72.88	73.47	71.84	76.68	73.44	73.89	73.53	72.67	77.49
9/15/96	4:00	67.45	73.06	73.12	73.69	72.09	76.84	73.81	74.25	73.80	72.94	77.74
9/15/96	5:00	67.24	72.93	72.90	73.48	71.83	76.58	73.60	74.01	73.61	72.74	77.49
9/15/96	6:00	67.80	73.51	73.43	74.04	72.41	77.08	74.21	74.63	74.24	73.33	78.08
9/15/96	7:00	67.89	73.61	73.48	74.05	72.44	77.09	74.32	74.69	74.27	73.37	78.14
9/15/96	8:00	67.92	73.59	73.44	73.99	72.39	76.98	74.26	74.64	74.19	73.28	77.98
9/15/96	9:00	72.59	77.46	77.70	78.39	76.65	81.72	78.17	78.94	78.18	77.24	81.38
9/15/96	10:00	77.04	81.85	82.03	82.65	81.06	85.91	82.56	83.37	82.62	81.64	85.71
9/15/96	11:00	82.24	86.72	87.02	87.70	86.20	90.96	87.69	88.45	87.74	86.80	90.68
9/15/96	12:00	84.82	88.87	89.70	90.43	88.89	93.65	90.52	91.13	90.46	89.51	93.30
9/15/96	13:00	87.04	90.86	91.69	92.69	91.23	96.05	92.73	93.51	92.79	91.83	95.63
9/15/96	14:00	88.03	91.81	92.67	93.69	92.22	97.27	93.87	94.72	93.93	92.94	96.91
9/15/96	15:00	88.69	92.43	93.28	94.42	92.96	98.02	94.26	95.31	94.55	93.58	97.66
9/15/96	16:00	89.21	93.12	93.17	94.56	93.27	97.50	94.59	95.52	95.00	94.04	98.29
9/15/96	17:00	88.32	91.99	92.15	94.04	92.68	96.86	93.74	94.50	94.07	93.23	97.45
9/15/96	18:00	86.16	89.80	90.62	92.12	90.70	95.05	91.60	92.41	92.01	91.15	[illegible]
9/15/96	19:00	83.22	86.77	87.81	89.37	87.84	92.33	88.65	89.58	89.09	88.27	
9/15/96	20:00	81.28	85.00	85.85	87.55	85.97	90.58	86.87	87.70	87.10	86.29	
9/15/96	21:00	79.64	83.47	84.09	86.02	84.54	89.57	85.35	86.10	85.46	84.72	[illegible]
9/15/96	22:00	78.27	82.24	82.89	84.75	83.29	88.53	84.11	84.93	84.27	83.45	87.92
9/15/96	23:00	76.87	80.66	81.75	83.27	81.87	87.14	82.77	83.57	82.98	82.11	86.65
9/16/96	0:00	77.76	81.28	82.44	83.94	82.46	87.65	83.46	84.27	83.72	82.88	87.35
9/16/96	1:00	76.63	80.01	81.05	82.79	81.30	86.52	81.95	83.05	82.43	81.58	86.15
9/16/96	2:00	74.69	78.19	79.01	80.79	79.56	84.71	80.30	81.28	80.58	79.70	84.25
9/16/96	3:00	74.18	77.88	78.56	79.87	78.71	83.95	79.86	80.81	80.17	79.34	83.73
9/16/96	4:00	74.32	78.19	79.19	79.97	78.68	83.73	79.87	81.03	80.33	79.44	83.89
9/16/96	5:00	73.98	77.95	79.19	79.88	78.53	83.45	79.29	80.47	79.92	79.08	83.75
9/16/96	6:00	72.58	76.44	77.86	78.59	77.11	82.11	78.18	79.03	78.41	77.51	82.21
9/16/96	7:00	70.92	74.88	76.00	76.69	75.35	80.49	76.55	77.47	76.74	75.90	80.46
9/16/96	8:00	69.55	73.65	74.86	75.64	74.10	79.09	75.50	76.19	75.59	74.65	79.23
9/16/96	9:00	70.57	74.74	76.02	76.88	75.16	80.14	76.46	77.64	76.65	75.77	80.29
9/16/96	10:00	71.47	75.82	77.03	77.92	76.20	81.08	77.28	78.61	77.59	76.64	81.24
9/16/96	11:00	73.18	77.60	78.88	79.75	77.97	82.88	79.08	80.33	79.33	78.43	82.97
9/16/96	12:00	74.39	79.21	79.94	80.80	79.18	84.14	80.27	81.45	80.52	79.67	84.22
9/16/96	13:00	75.07	79.87	80.69	81.40	79.75	84.73	81.06	82.08	81.20	80.35	84.93
9/16/96	14:00	77.71	82.41	83.40	84.17	82.39	87.41	83.65	84.60	83.86	83.12	87.71
9/16/96	15:00	76.02	80.36	81.70	82.65	80.76	85.87	81.70	82.72	82.04	81.27	85.89
9/16/96	16:00	76.47	80.56	82.17	83.09	81.33	86.56	82.20	83.07	82.59	81.78	86.44
9/16/96	17:00	76.94	80.94	82.44	83.62	81.78	87.01	82.65	83.51	82.95	82.20	86.90
9/16/96	18:00	74.70	78.72	80.17	81.34	79.57	84.86	80.42	81.26	80.66	79.86	84.59
9/16/96	19:00	74.01	78.01	79.47	80.64	78.86	84.09	79.79	80.54	79.87	79.17	83.82
9/16/96	20:00	74.54	78.43	79.94	81.07	79.26	84.47	80.28	81.16	80.35	79.56	84.13
9/16/96	21:00	74.95	78.65	80.12	81.36	79.75	84.87	80.76	81.66	80.92	80.05	84.68
9/16/96	22:00	74.51	78.19	79.44	80.98	79.28	84.37	80.45	81.37	80.59	79.78	84.40
9/16/96	23:00	74.37	78.26	78.99	80.89	79.25	84.42	80.33	81.33	80.57	79.88	84.57
9/17/96	0:00	73.31	77.17	77.75	79.37	77.96	83.27	78.70	80.12	79.43	78.63	

CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM
EAST ELECTRODE HOLDER TEMPERATURES



C2FURN.XLS Chart 20

VHP 11/6/96

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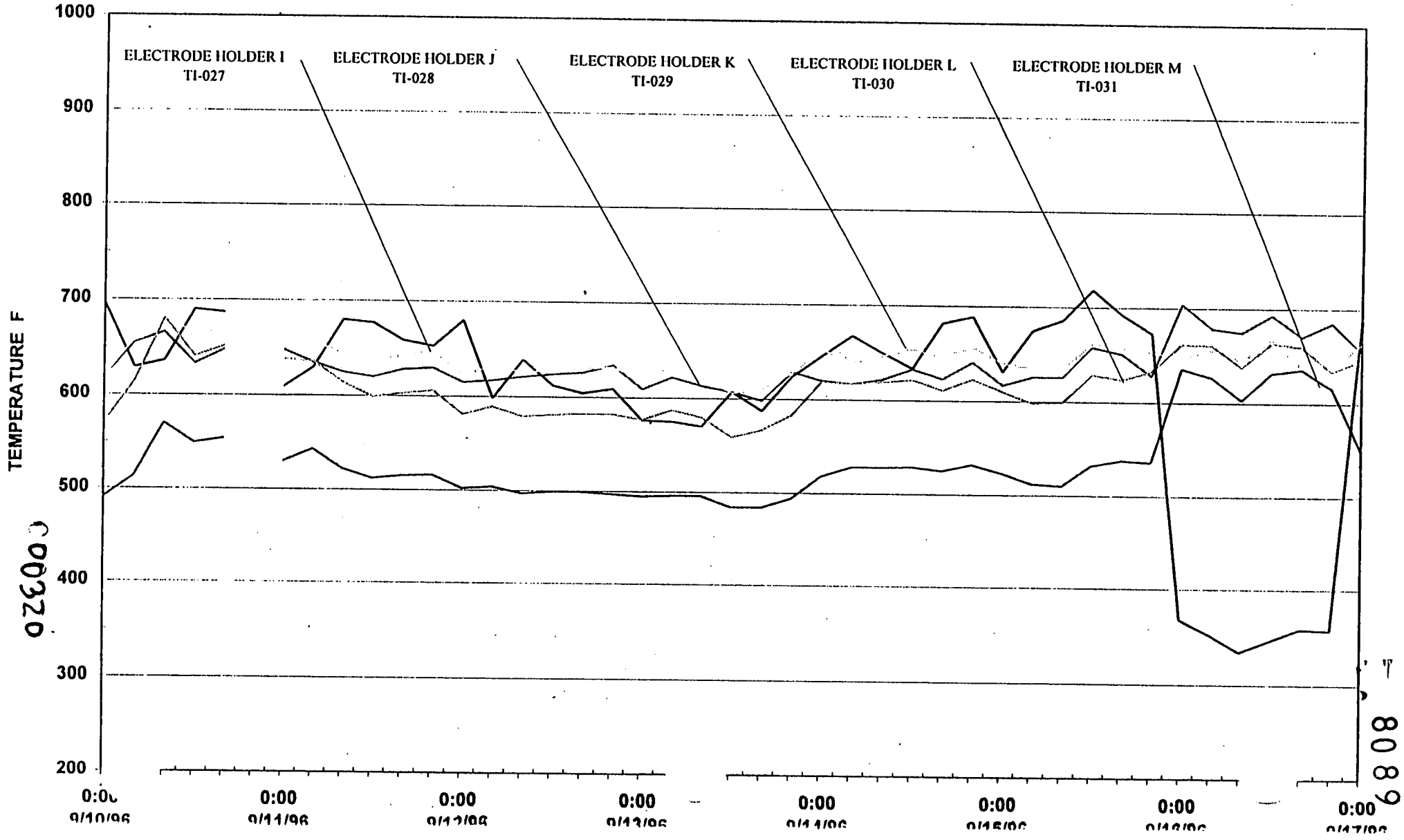
CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM
WEST ELECTRODE HOLDER TEMPERATURES



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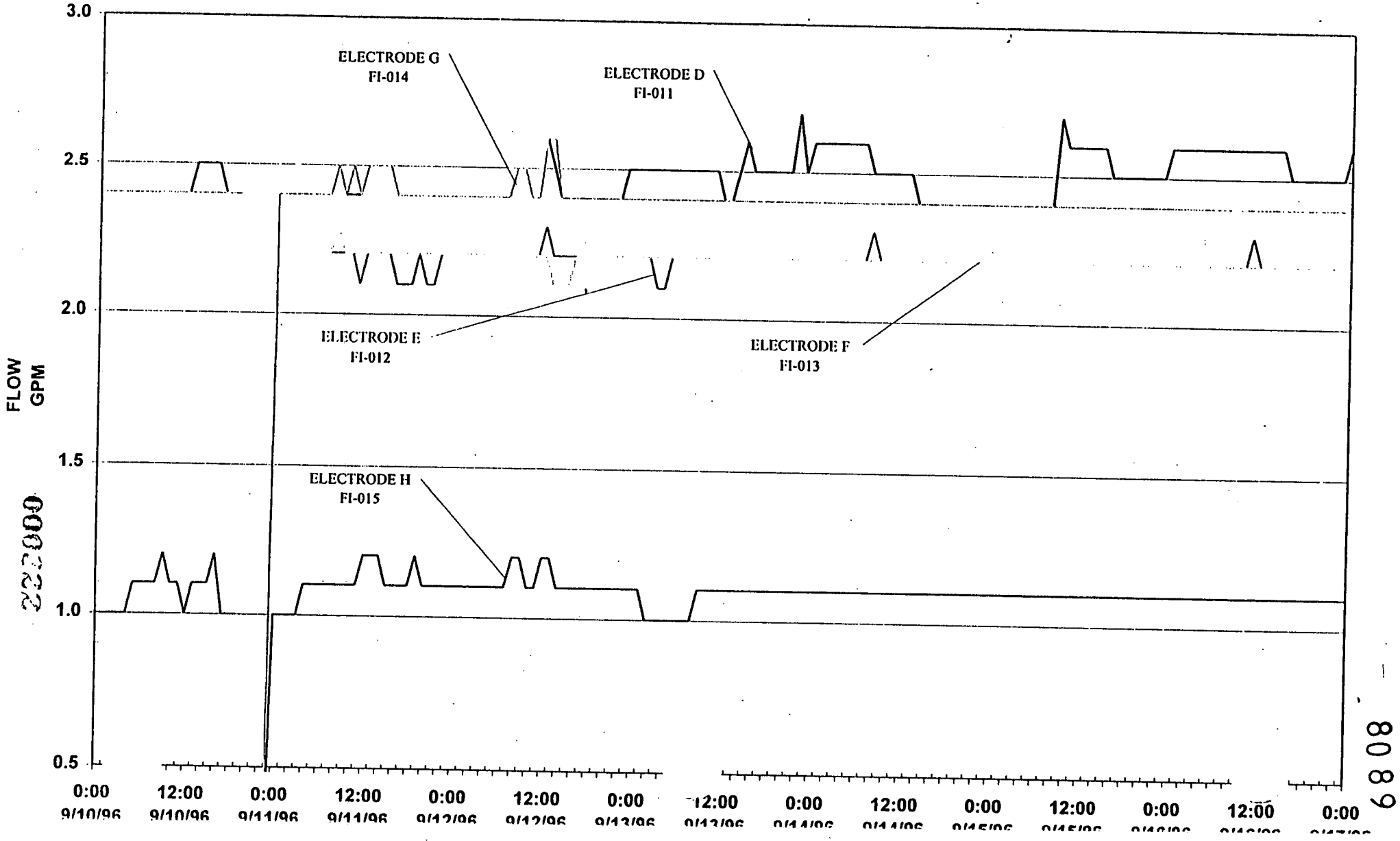
VITRIFICATION PILOT PLANT FURNACE SYSTEM
CAMPAIGN 2 TRANSITION GLASS

HOURLY READINGS ROUNDSHEETS

READINGS		ELECTRODE HOLDER TEMPERATURES									
		D	E	F	G	H	I	J	K	L	M
		TI-022	TI-023	TI-024	TI-025	TI-026	TI-027	TI-028	TI-029	TI-030	TI-031
DATE	HOUR	F	F	F	F	F	F	F	F	F	F
9/10/96	0:00	587	587	586	599	319	696	619	619	570	491
9/10/96	4:00	504	575	631	655	325	629	655	659	614	513
9/10/96	8:00	572	602	643	696	337	636	666	691	681	570
9/10/96	12:00	584	598	629	670	341	690	633	659	641	549
9/10/96	16:00	562	600	639	683	346	687	648	672	652	554
9/10/96	20:00										
9/11/96	0:00	526	580	598	641	329	609	648	663	638	530
9/11/96	4:00	568	589	615	652	331	630	635	657	636	543
9/11/96	8:00	560	572	587	615	319	680	625	644	614	522
9/11/96	12:00	566	570	578	601	325	677	620	635	599	512
9/11/96	16:00	574	574	580	601	329	659	628	643	603	515
9/11/96	20:00	579	578	583	602	325	653	630	647	606	516
9/12/96	0:00	573	571	575	591	371	680	615	623	581	502
9/12/96	4:00	573	570	572	588	314	598	617	632	589	504
9/12/96	8:00	573	569	572	587	314	639	621	626	579	497
9/12/96	12:00	579	573	577	592	318	612	624	628	581	499
9/12/96	16:00	580	575	579	593	319	604	626	630	582	499
9/12/96	20:00	580	575	578	593	316	609	634	632	582	497
9/13/96	0:00	575	570	575	589	309	576	609	619	577	495
9/13/96	4:00	575	574	580	594	311	575	622	633	587	496
9/13/96	8:00	574	574	579	593	312	570	613	622	580	496
9/13/96	12:00	556	554	557	564	309	607	607	606	559	484
9/13/96	16:00	536	558	552	557	306	587	598	611	567	484
9/13/96	20:00	521	572	590	596	313	624	629	628	583	494
9/14/96	0:00	553	592	592	613	316	646	620	653	619	518
9/14/96	4:00	546	489	615	652	320	668	617	639	617	528
9/14/96	8:00	515	478	635	685	332	650	622	647	619	528
9/14/96	12:00	493	574	643	713	351	634	633	654	622	529
9/14/96	16:00	568	610	637	695	347	682	623	647	611	525
9/14/96	20:00	471	612	651	718	344	689	641	657	623	532
9/15/96	0:00	474	609	640	702	342	631	617	640	610	523
9/15/96	4:00	558	598	621	675	332	675	626	635	598	512
9/15/96	8:00	573	597	613	660	326	686	626	635	599	510
9/15/96	12:00	503	597	636	695	343	718	658	662	629	532
9/15/96	16:00	509	573	633	707	352	692	651	658	624	538
9/15/96	20:00	458	579	671	743	360	673	628	653	633	536
9/16/96	0:00	708	451	581	670	746	368	704	649	662	636
9/16/96	4:00	1061	449	540	617	688	352	679	656	661	627
9/16/96	8:00	959	462	567	609	663	334	675	645	638	603
9/16/96	12:00	976	516	626	664	717	346	693	668	664	632
9/16/96	16:00	762	501	627	668	734	358	671	638	660	636
9/16/96	20:00	676	470	633	666	727	357	685	637	634	616
9/17/96	0:00	456	544	649	715	358	688	655	664	647	549

CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM
EAST ELECTRODE CLCW FLOW



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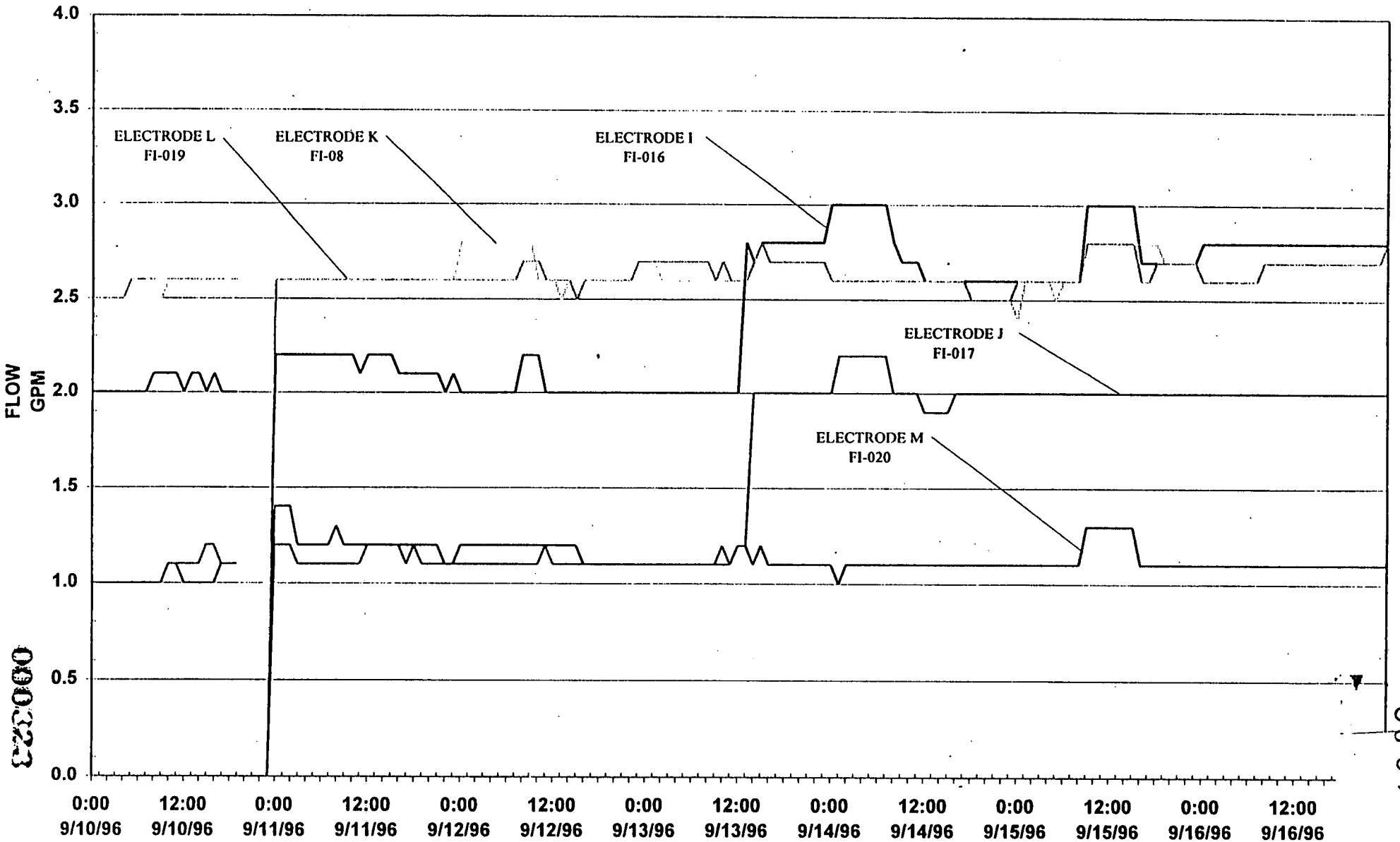
CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM
WEST ELECTRODE CLCW FLOW



C2FURN.XLS Chart 22

VHP 11/6/96

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		HOURLY READINGS ROUNDSHEETS									
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/10/96	0:00	2.4	2.2	2.2	2.4	1.0	2.0	1.0	2.5	2.5	1.0
9/10/96	1:00	2.4	2.2	2.2	2.4	1.0	2.0	1.0	2.5	2.5	1.0
9/10/96	2:00	2.4	2.2	2.2	2.4	1.0	2.0	1.0	2.5	2.5	1.0
9/10/96	3:00	2.4	2.2	2.2	2.4	1.0	2.0	1.0	2.5	2.5	1.0
9/10/96	4:00	2.4	2.2	2.2	2.4	1.0	2.0	1.0	2.5	2.5	1.0
9/10/96	5:00	2.4	2.2	2.2	2.4	1.1	2.0	1.0	2.5	2.6	1.0
9/10/96	6:00	2.4	2.2	2.2	2.4	1.1	2.0	1.0	2.5	2.6	1.0
9/10/96	7:00	2.4	2.2	2.2	2.4	1.1	2.0	1.0	2.5	2.6	1.0
9/10/96	8:00	2.4	2.2	2.2	2.4	1.1	2.1	1.0	2.5	2.6	1.0
9/10/96	9:00	2.4	2.2	2.2	2.4	1.2	2.1	1.0	2.5	2.6	1.0
9/10/96	10:00	2.4	2.2	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.1
9/10/96	11:00	2.4	2.2	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.1
9/10/96	12:00	2.4	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.6	1.0
9/10/96	13:00	2.5	2.2	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.0
9/10/96	14:00	2.5	2.2	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.0
9/10/96	15:00	2.5	2.2	2.2	2.4	1.1	2.0	1.2	2.6	2.6	1.0
9/10/96	16:00	2.5	2.2	2.2	2.4	1.2	2.1	1.2	2.6	2.6	1.0
9/10/96	17:00	2.4	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.6	1.1
9/10/96	18:00	2.4	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.6	1.1
9/10/96	19:00	2.4	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.6	1.1
9/10/96	20:00										
9/10/96	21:00	2.7	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.6	1.1
9/10/96	22:00	2.4	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.6	1.1
9/10/96	23:00	2.4	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.6	1.1
9/11/96	0:00	2.4	2.2	2.2	2.4	1.0	2.2	1.2	2.6	2.6	1.4
9/11/96	1:00	2.4	2.2	2.2	2.4	1.0	2.2	1.2	2.6	2.6	1.4
9/11/96	2:00	2.4	2.2	2.2	2.4	1.0	2.2	1.2	2.6	2.6	1.4
9/11/96	3:00	2.4	2.2	2.2	2.4	1.0	2.2	1.1	2.6	2.6	1.2
9/11/96	4:00	2.4	2.2	2.2	2.4	1.1	2.2	1.1	2.6	2.6	1.2
9/11/96	5:00	2.4	2.2	2.2	2.4	1.1	2.2	1.1	2.6	2.6	1.2
9/11/96	6:00	2.4	2.2	2.2	2.4	1.1	2.2	1.1	2.6	2.6	1.2
9/11/96	7:00	2.4	2.2	2.2	2.4	1.1	2.2	1.1	2.6	2.6	1.2
9/11/96	8:00	2.5	2.2	2.3	2.5	1.1	2.2	1.1	2.6	2.6	1.3
9/11/96	9:00	2.4	2.2	2.2	2.4	1.1	2.2	1.1	2.6	2.6	1.2
9/11/96	10:00	2.4	2.2	2.2	2.5	1.1	2.2	1.1	2.6	2.6	1.2
9/11/96	11:00	2.4	2.1	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.2
9/11/96	12:00	2.5	2.2	2.2	2.5	1.2	2.2	1.2	2.6	2.6	1.2
9/11/96	13:00	2.5	2.2	2.2	2.5	1.2	2.2	1.2	2.6	2.6	1.2
9/11/96	14:00	2.5	2.2	2.2	2.5	1.2	2.2	1.2	2.6	2.6	1.2
9/11/96	15:00	2.5	2.2	2.2	2.5	1.1	2.2	1.2	2.6	2.6	1.2
9/11/96	16:00	2.4	2.1	2.2	2.4	1.1	2.1	1.2	2.6	2.6	1.2
9/11/96	17:00	2.4	2.1	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.2
9/11/96	18:00	2.4	2.1	2.2	2.4	1.1	2.1	1.2	2.6	2.6	1.2
9/11/96	19:00	2.4	2.2	2.2	2.4	1.2	2.1	1.1	2.6	2.6	1.2
9/11/96	20:00	2.4	2.1	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.2

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY READINGS ROUNDSHEETS

READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/11/96	21:00	2.4	2.1	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.2
9/11/96	22:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/11/96	23:00	2.4	2.2	2.2	2.4	1.1	2.1	1.1	2.6	2.6	1.1
9/12/96	0:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	1:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	2:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	3:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	4:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	5:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	6:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	7:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.8	2.6	1.2
9/12/96	8:00	2.5	2.2	2.2	2.5	1.2	2.2	1.1	2.8	2.7	1.2
9/12/96	9:00	2.5	2.2	2.2	2.5	1.2	2.2	1.1	2.8	2.7	1.2
9/12/96	10:00	2.4	2.2	2.2	2.4	1.1	2.2	1.1	2.6	2.7	1.2
9/12/96	11:00	2.4	2.2	2.2	2.4	1.1	2.0	1.2	2.6	2.6	1.2
9/12/96	12:00	2.6	2.3	2.2	2.6	1.2	2.0	1.1	2.6	2.6	1.2
9/12/96	13:00	2.5	2.2	2.1	2.6	1.2	2.0	1.1	2.5	2.6	1.2
9/12/96	14:00	2.4	2.2	2.1	2.4	1.1	2.0	1.1	2.6	2.6	1.2
9/12/96	15:00	2.4	2.2	2.1	2.4	1.1	2.0	1.1	2.5	2.5	1.2
9/12/96	16:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/12/96	17:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/12/96	18:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/12/96	19:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/12/96	20:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/12/96	21:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/12/96	22:00	2.4	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/12/96	23:00	2.5	2.2	2.2	2.4	1.1	2.0	1.1	2.7	2.7	1.1
9/13/96	0:00	2.5	2.2	2.2	2.4	1.1	2.0	1.1	2.7	2.7	1.1
9/13/96	1:00	2.5	2.2	2.2	2.4	1.1	2.0	1.1	2.7	2.7	1.1
9/13/96	2:00	2.5	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.7	1.1
9/13/96	3:00	2.5	2.1	2.2	2.4	1.0	2.0	1.1	2.6	2.7	1.1
9/13/96	4:00	2.5	2.1	2.2	2.4	1.0	2.0	1.1	2.6	2.7	1.1
9/13/96	5:00	2.5	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.7	1.1
9/13/96	6:00	2.5	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.7	1.1
9/13/96	7:00	2.5	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.7	1.1
9/13/96	8:00	2.5	2.2	2.2	2.4	1.0	2.0	1.1	2.6	2.7	1.1
9/13/96	9:00	2.5	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/13/96	10:00	2.5	2.2	2.2	2.4	1.1	2.0	1.2	2.6	2.7	1.1
9/13/96	11:00	2.5	2.2	2.2	2.4	1.1	2.0	1.1	2.6	2.6	1.1
9/13/96	12:00	2.4	2.2	2.2	2.4	1.1	2.0	1.2	2.6	2.6	1.2
9/13/96	13:00	2.4	2.2	2.2	2.4	1.1	2.8	1.2	2.6	2.6	1.2
9/13/96	14:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/13/96	15:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.8	2.8	1.2
9/13/96	16:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/13/96	17:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY READINGS ROUNDSHEETS

READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/13/96	18:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/13/96	19:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/13/96	20:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/13/96	21:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/13/96	22:00	2.7	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/13/96	23:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/14/96	0:00	2.6	2.2	2.2	2.4	1.1	3.0	2.0	2.6	2.6	1.1
9/14/96	1:00	2.6	2.2	2.2	2.4	1.1	3.0	2.2	2.6	2.6	1.0
9/14/96	2:00	2.6	2.2	2.2	2.4	1.1	3.0	2.2	2.6	2.6	1.1
9/14/96	3:00	2.6	2.2	2.2	2.4	1.1	3.0	2.2	2.6	2.6	1.1
9/14/96	4:00	2.6	2.2	2.2	2.4	1.1	3.0	2.2	2.6	2.6	1.1
9/14/96	5:00	2.6	2.2	2.2	2.4	1.1	3.0	2.2	2.6	2.6	1.1
9/14/96	6:00	2.6	2.2	2.2	2.4	1.1	3.0	2.2	2.6	2.6	1.1
9/14/96	7:00	2.6	2.2	2.2	2.4	1.1	3.0	2.2	2.6	2.6	1.1
9/14/96	8:00	2.5	2.3	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/14/96	9:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.6	2.6	1.1
9/14/96	10:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.6	2.6	1.1
9/14/96	11:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.6	2.6	1.1
9/14/96	12:00	2.5	2.2	2.2	2.4	1.1	2.6	1.9	2.6	2.6	1.1
9/14/96	13:00	2.5	2.2	2.2	2.4	1.1	2.6	1.9	2.6	2.6	1.1
9/14/96	14:00	2.4	2.2	2.2	2.4	1.1	2.6	1.9	2.6	2.6	1.1
9/14/96	15:00	2.4	2.2	2.2	2.4	1.1	2.6	1.9	2.6	2.6	1.1
9/14/96	16:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/14/96	17:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/14/96	18:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.5	2.5	1.1
9/14/96	19:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.5	2.5	1.1
9/14/96	20:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.5	2.5	1.1
9/14/96	21:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.5	2.5	1.1
9/14/96	22:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.5	2.5	1.1
9/14/96	23:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.5	2.5	1.1
9/15/96	0:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.4	2.6	1.1
9/15/96	1:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/15/96	2:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/15/96	3:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/15/96	4:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/15/96	5:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.5	2.6	1.1
9/15/96	6:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/15/96	7:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/15/96	8:00	2.4	2.2	2.2	2.4	1.1	2.6	2.0	2.6	2.6	1.1
9/15/96	9:00	2.7	2.2	2.2	2.4	1.1	3.0	2.0	2.8	2.8	1.3
9/15/96	10:00	2.6	2.2	2.2	2.4	1.1	3.0	2.0	2.8	2.8	1.3
9/15/96	11:00	2.6	2.2	2.2	2.4	1.1	3.0	2.0	2.8	2.8	1.3
9/15/96	12:00	2.6	2.2	2.2	2.4	1.1	3.0	2.0	2.8	2.8	1.3
9/15/96	13:00	2.6	2.2	2.2	2.4	1.1	3.0	2.0	2.8	2.8	1.3
9/15/96	14:00	2.6	2.2	2.2	2.4	1.1	3.0	2.0	2.8	2.8	1.3

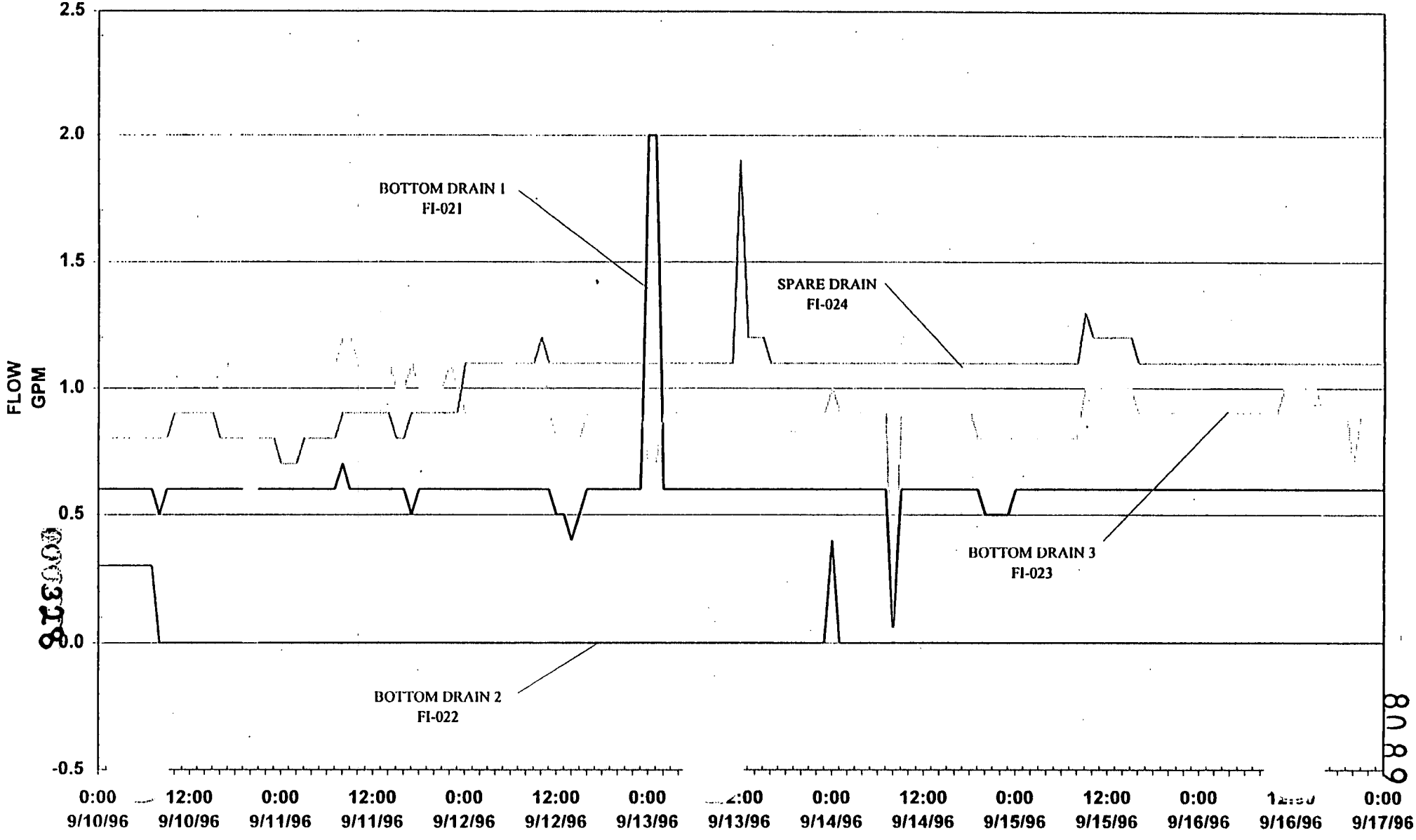
VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

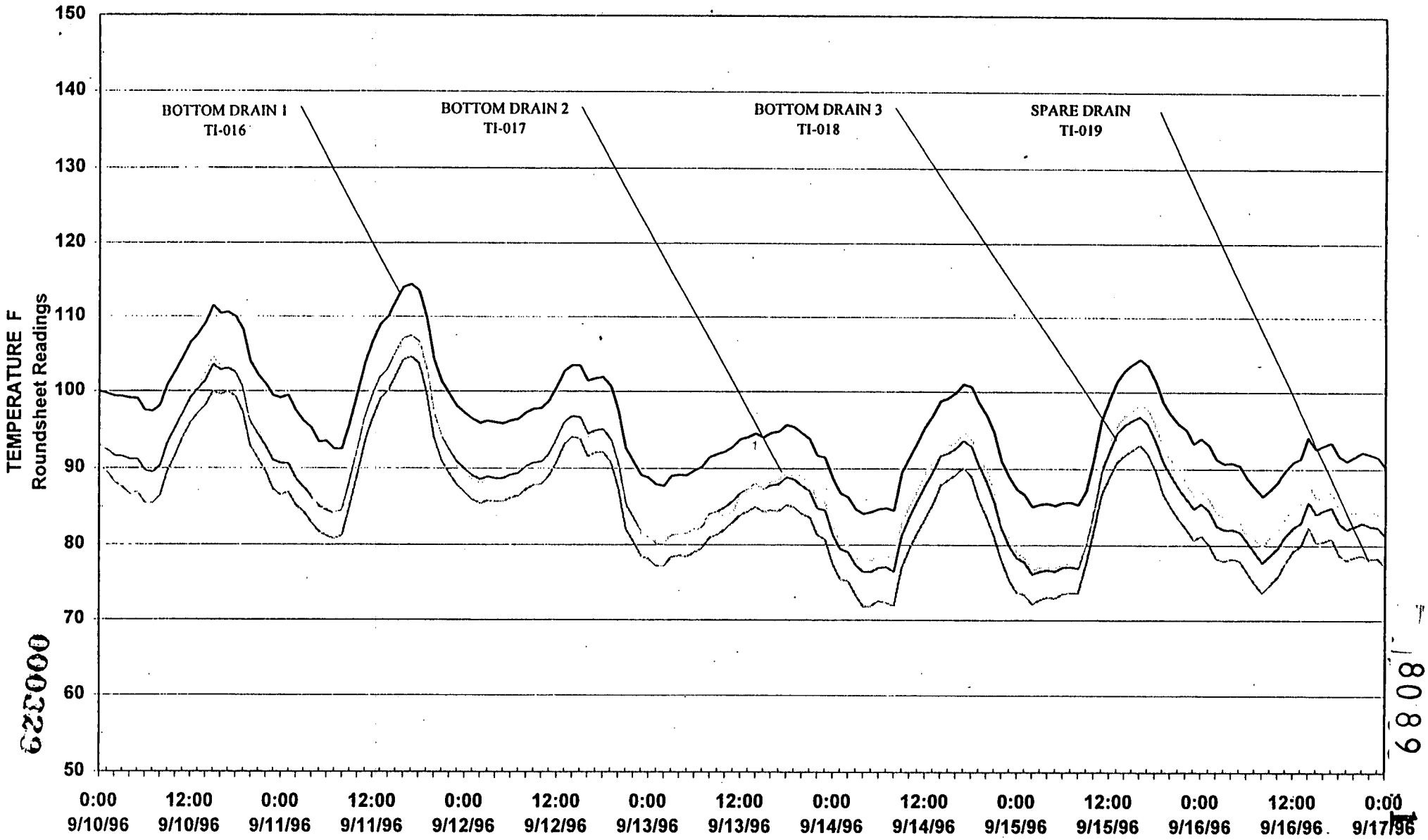
HOURLY READINGS ROUNDSHEETS

READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/15/96	15:00	2.6	2.2	2.2	2.4	1.1	3.0	2.0	2.8	2.8	1.3
9/15/96	16:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.8	2.6	1.1
9/15/96	17:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.8	2.6	1.1
9/15/96	18:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.8	2.7	1.1
9/15/96	19:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/15/96	20:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/15/96	21:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/15/96	22:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/15/96	23:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/16/96	0:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	1:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	2:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	3:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	4:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	5:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	6:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	7:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.6	2.6	1.1
9/16/96	8:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	9:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	10:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	11:00	2.6	2.3	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	12:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	13:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	14:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	15:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	16:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	17:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	18:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	19:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	20:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	21:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	22:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/16/96	23:00	2.5	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.7	1.1
9/17/96	0:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.8	1.1

CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM
BOTTOM DRAIN CLCW FLOW



CAMPAIGN 2
TRANSITION GLASS
FURNACE SYSTEM
BOTTOM DRAIN CLCW RETURN



C2FURN.XLS Chart 24

VHP 11/6/96

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

		MELTER BOTTOM DRAINS							
READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/10/96	0:00	0.6	0.3	1.1	0.8	99.96	92.99	92.75	90.11
9/10/96	1:00	0.6	0.3	1.1	0.8	99.70	92.47	92.69	89.51
9/10/96	2:00	0.6	0.3	1.1	0.8	99.34	91.63	92.24	88.23
9/10/96	3:00	0.6	0.3	1.1	0.8	99.30	91.56	92.38	87.55
9/10/96	4:00	0.6	0.3	1.1	0.8	99.11	91.18	92.09	86.68
9/10/96	5:00	0.6	0.3	1.1	0.8	99.05	91.22	92.16	86.91
9/10/96	6:00	0.6	0.3	1.1	0.8	97.54	89.72	90.58	85.46
9/10/96	7:00	0.6	0.3	1.1	0.8	97.40	89.46	90.43	85.51
9/10/96	8:00	0.5	0.0	1.1	0.8	98.13	90.32	91.36	86.46
9/10/96	9:00	0.6	0.0	1.1	0.8	100.90	93.32	94.23	89.58
9/10/96	10:00	0.6	0.0	1.1	0.9	102.64	95.23	95.73	91.77
9/10/96	11:00	0.6	0.0	1.1	0.9	104.41	97.16	97.55	93.91
9/10/96	12:00	0.6	0.0	1.1	0.9	106.47	99.09	99.81	95.85
9/10/96	13:00	0.6	0.0	1.1	0.9	107.56	100.31	100.51	97.13
9/10/96	14:00	0.6	0.0	1.1	0.9	109.09	101.38	102.42	98.10
9/10/96	15:00	0.6	0.0	1.1	0.9	111.45	103.52	104.58	99.91
9/10/96	16:00	0.6	0.0	1.0	0.8	110.38	102.83	103.30	99.58
9/10/96	17:00	0.6	0.0	1.1	0.8	110.56	103.05	103.51	99.91
9/10/96	18:00	0.6	0.0	1.1	0.8	109.98	102.50	102.81	99.34
9/10/96	19:00	0.6	0.0	1.1	0.8	108.15	100.52	100.86	97.
9/10/96	20:00					103.89	96.20	96.42	92.5
9/10/96	21:00	0.6	0.0	1.1	0.8	102.14	94.44	94.76	91.23
9/10/96	22:00	0.6	0.0	1.1	0.8	101.01	92.95	93.63	89.63
9/10/96	23:00	0.6	0.0	1.1	0.8	99.39	91.07	91.88	87.31
9/11/96	0:00	0.6	0.0	1.1	0.7	99.11	90.64	92.01	86.55
9/11/96	1:00	0.6	0.0	1.1	0.7	99.41	90.63	91.58	86.95
9/11/96	2:00	0.6	0.0	1.1	0.7	97.53	88.69	89.29	85.22
9/11/96	3:00	0.6	0.0	1.1	0.8	96.13	87.58	87.91	84.33
9/11/96	4:00	0.6	0.0	1.1	0.8	95.28	86.37	86.79	82.95
9/11/96	5:00	0.6	0.0	1.1	0.8	93,43	85.08	84.54	81.76
9/11/96	6:00	0.6	0.0	1.1	0.8	93.56	84.55	84.94	81.16
9/11/96	7:00	0.6	0.0	1.1	0.8	92.55	84.16	84.19	80.81
9/11/96	8:00	0.7	0.0	1.2	0.9	92.53	84.43	84.25	81.24
9/11/96	9:00	0.6	0.0	1.2	0.9	95.62	88.03	87.63	84.97
9/11/96	10:00	0.6	0.0	1.1	0.9	99.59	92.14	91.87	89.10
9/11/96	11:00	0.6	0.0	1.1	0.9	103.70	96.45	96.25	93.46
9/11/96	12:00	0.6	0.0	1.1	0.9	106.58	99.39	99.17	96.44
9/11/96	13:00	0.6	0.0	1.1	0.9	108.90	101.86	101.67	98.99
9/11/96	14:00	0.6	0.0	1.1	0.9	109.97	102.95	102.72	100.02
9/11/96	15:00	0.6	0.0	1.0	0.8	112.07	105.07	104.97	102.12
9/11/96	16:00	0.6	0.0	1.0	0.8	113.99	106.98	106.91	104.20
9/11/96	17:00	0.5	0.0	1.1	0.9	114.39	107.36	107.26	104.57
9/11/96	18:00	0.6	0.0	1.0	0.9	113.56	106.55	106.45	103.69
9/11/96	19:00	0.6	0.0	1.0	0.9	109.87	102.81	102.66	99.80
9/11/96	20:00	0.6	0.0	1.0	0.9	104.11	97.00	96.84	93.9
9/11/96	21:00	0.6	0.0	1.0	0.9	101.26	94.00	93.79	90.5
9/11/96	22:00	0.6	0.0	1.1	0.9	99.62	92.30	92.05	89.2
9/11/96	23:00	0.6	0.0	1.0	0.9	98.07	90.83	90.33	87.80
9/12/96	0:00	0.6	0.0	0.9	1.1	97.22	89.92	89.44	86.85
9/12/96	1:00	0.6	0.0	0.9	1.1	96.40	89.03	88.67	85.91

VITRIFICATION PILOT PLANT FURNACE SYSTEM
CAMPAIGN 2 TRANSITION GLASS
MELTER BOTTOM DRAINS

READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/12/96	2:00	0.6	0.0	0.9	1.1	95.87	88.54	88.16	85.45
9/12/96	3:00	0.6	0.0	0.9	1.1	96.14	88.90	88.39	85.80
9/12/96	4:00	0.6	0.0	0.9	1.1	95.97	88.68	88.42	85.71
9/12/96	5:00	0.6	0.0	0.9	1.1	95.82	88.71	88.35	85.71
9/12/96	6:00	0.6	0.0	0.9	1.1	96.17	89.14	88.78	86.17
9/12/96	7:00	0.6	0.0	0.9	1.1	96.38	89.36	89.05	86.46
9/12/96	8:00	0.6	0.0	0.9	1.1	97.25	90.27	90.04	87.31
9/12/96	9:00	0.6	0.0	0.9	1.1	97.71	90.75	90.47	87.85
9/12/96	10:00	0.6	0.0	0.9	1.2	97.82	90.86	90.60	87.95
9/12/96	11:00	0.6	0.0	0.9	1.1	98.81	91.91	91.59	89.10
9/12/96	12:00	0.5	0.0	0.8	1.1	100.60	93.74	93.45	90.89
9/12/96	13:00	0.5	0.0	0.8	1.1	102.72	95.97	95.72	93.21
9/12/96	14:00	0.4	0.0	0.8	1.1	103.47	96.77	96.51	94.06
9/12/96	15:00	0.5	0.0	0.8	1.1	103.40	96.63	96.31	93.84
9/12/96	16:00	0.6	0.0	0.9	1.1	101.39	94.45	94.09	91.58
9/12/96	17:00	0.6	0.0	0.9	1.1	101.74	94.91	94.53	92.09
9/12/96	18:00	0.6	0.0	0.9	1.1	101.88	95.08	94.69	92.15
9/12/96	19:00	0.6	0.0	0.9	1.1	100.69	93.76	93.45	90.83
9/12/96	20:00	0.6	0.0	0.9	1.1	97.46	90.38	90.03	87.32
9/12/96	21:00	0.6	0.0	0.9	1.1	92.64	85.26	84.88	82.12
9/12/96	22:00	0.6	0.0	0.9	1.1	90.88	83.46	83.17	80.33
9/12/96	23:00	0.6	0.0	0.9	1.1	89.13	81.64	81.61	78.51
9/13/96	0:00	2.0	0.0	0.7	1.1	88.77	81.16	81.21	78.07
9/13/96	1:00	2.0	0.0	0.7	1.1	87.94	80.29	80.38	77.15
9/13/96	2:00	0.6	0.0	0.9	1.1	87.73	80.13	80.10	77.11
9/13/96	3:00	0.6	0.0	0.9	1.1	88.98	81.39	81.46	78.35
9/13/96	4:00	0.6	0.0	0.9	1.1	89.15	81.58	81.59	78.57
9/13/96	5:00	0.6	0.0	0.9	1.1	89.08	81.45	81.41	78.39
9/13/96	6:00	0.6	0.0	0.9	1.1	89.70	82.01	81.96	78.97
9/13/96	7:00	0.6	0.0	0.9	1.1	90.21	82.49	82.59	79.49
9/13/96	8:00	0.6	0.0	0.9	1.1	91.49	83.97	83.84	80.97
9/13/96	9:00	0.6	0.0	0.9	1.1	91.88	84.35	84.26	81.34
9/13/96	10:00	0.6	0.0	0.9	1.1	92.18	84.93	83.85	82.09
9/13/96	11:00	0.6	0.0	0.9	1.1	92.81	85.73	84.28	82.97
9/13/96	12:00	0.6	0.0	0.9	1.9	93.79	86.77	86.58	83.92
9/13/96	13:00	0.6	0.0	0.9	1.2	94.02	87.24	87.21	84.43
9/13/96	14:00	0.6	0.0	0.9	1.2	94.51	87.97	87.96	84.99
9/13/96	15:00	0.6	0.0	0.9	1.2	94.02	87.39	87.42	84.35
9/13/96	16:00	0.6	0.0	0.9	1.1	94.57	87.81	88.25	84.58
9/13/96	17:00	0.6	0.0	0.9	1.1	94.75	87.96	88.49	84.43
9/13/96	18:00	0.6	0.0	0.9	1.1	95.63	88.84	89.43	85.23
9/13/96	19:00	0.6	0.0	0.9	1.1	95.38	88.58	89.09	84.97
9/13/96	20:00	0.6	0.0	0.9	1.1	94.60	87.79	88.94	84.08
9/13/96	21:00	0.6	0.0	0.9	1.1	93.84	87.09	88.23	83.67
9/13/96	22:00	0.6	0.0	0.9	1.1	91.70	84.79	85.80	81.33
9/13/96	23:00	0.6	0.0	0.9	1.1	91.48	84.61	85.72	80.81
9/14/96	0:00	0.6	0.4	1.0	1.1	88.72	81.40	82.38	77.39
9/14/96	1:00	0.6	0.0	0.9	1.1	86.86	79.43	80.55	75.42
9/14/96	2:00	0.6	0.0	0.9	1.1	86.31	79.05	79.88	75.21
9/14/96	3:00	0.6	0.0	0.9	1.1	84.70	77.26	78.53	73.30

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

MELTER BOTTOM DRAINS

READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/14/96	4:00	0.6	0.0	0.9	1.1	84.11	76.42	77.64	71.77
9/14/96	5:00	0.6	0.0	0.9	1.1	84.31	76.39	77.90	71.87
9/14/96	6:00	0.6	0.0	0.9	1.1	84.74	76.93	78.46	72.56
9/14/96	7:00	0.6	0.0	0.9	1.1	84.83	77.00	78.52	72.29
9/14/96	8:00	0.1	0.0	0.1	1.1	84.53	76.44	77.93	71.86
9/14/96	9:00	0.6	0.0	0.9	1.1	89.49	81.39	82.91	77.00
9/14/96	10:00	0.6	0.0	0.9	1.1	91.40	83.65	85.08	79.39
9/14/96	11:00	0.6	0.0	0.9	1.1	93.36	85.85	87.26	81.66
9/14/96	12:00	0.6	0.0	0.9	1.1	95.34	87.79	89.31	83.43
9/14/96	13:00	0.6	0.0	0.9	1.1	96.88	89.58	90.90	85.34
9/14/96	14:00	0.6	0.0	0.9	1.1	98.78	91.69	92.81	87.85
9/14/96	15:00	0.6	0.0	0.9	1.1	99.17	92.02	92.97	88.56
9/14/96	16:00	0.6	0.0	0.9	1.1	99.83	92.65	93.47	89.23
9/14/96	17:00	0.6	0.0	0.9	1.1	100.99	93.65	94.59	90.12
9/14/96	18:00	0.6	0.0	0.9	1.1	100.66	92.94	94.01	88.94
9/14/96	19:00	0.6	0.0	0.8	1.1	98.61	90.44	91.56	85.97
9/14/96	20:00	0.5	0.0	0.8	1.1	96.99	88.32	89.77	83.66
9/14/96	21:00	0.5	0.0	0.8	1.1	94.67	85.70	87.08	81.18
9/14/96	22:00	0.5	0.0	0.8	1.1	90.99	82.21	82.81	77.9[illegible]
9/14/96	23:00	0.5	0.0	0.8	1.1	88.88	79.88	80.83	75.[illegible]
9/15/96	0:00	0.6	0.0	0.8	1.1	87.33	78.26	79.05	73.[illegible]
9/15/96	1:00	0.6	0.0	0.8	1.1	86.64	77.70	78.38	73.40
9/15/96	2:00	0.6	0.0	0.8	1.1	85.04	76.13	76.64	72.14
9/15/96	3:00	0.6	0.0	0.8	1.1	85.34	76.46	76.98	72.69
9/15/96	4:00	0.6	0.0	0.8	1.1	85.47	76.68	77.05	73.06
9/15/96	5:00	0.6	0.0	0.8	1.1	85.20	76.48	76.80	72.93
9/15/96	6:00	0.6	0.0	0.8	1.1	85.60	76.99	77.33	73.51
9/15/96	7:00	0.6	0.0	0.8	1.1	85.64	77.06	77.43	73.61
9/15/96	8:00	0.6	0.0	0.8	1.1	85.28	76.87	77.15	73.59
9/15/96	9:00	0.6	0.0	1.0	1.3	87.18	80.28	80.48	77.46
9/15/96	10:00	0.6	0.0	1.0	1.2	91.18	84.54	84.82	81.85
9/15/96	11:00	0.6	0.0	1.0	1.2	96.29	89.69	90.46	86.72
9/15/96	12:00	0.6	0.0	1.0	1.2	99.00	92.22	93.14	88.87
9/15/96	13:00	0.6	0.0	1.0	1.2	101.36	94.55	95.53	90.86
9/15/96	14:00	0.6	0.0	1.0	1.2	102.85	95.70	96.89	91.81
9/15/96	15:00	0.6	0.0	1.0	1.2	103.68	96.27	97.57	92.43
9/15/96	16:00	0.6	0.0	0.9	1.1	104.33	96.75	98.63	93.12
9/15/96	17:00	0.6	0.0	0.9	1.1	103.48	95.83	97.91	91.99
9/15/96	18:00	0.6	0.0	0.9	1.1	101.42	93.66	95.67	89.80
9/15/96	19:00	0.6	0.0	0.9	1.1	98.76	91.04	92.94	86.77
9/15/96	20:00	0.6	0.0	0.9	1.1	97.12	89.14	91.22	85.00
9/15/96	21:00	0.6	0.0	0.9	1.1	95.90	87.54	89.76	83.47
9/15/96	22:00	0.6	0.0	0.9	1.1	95.12	86.18	88.35	82.24
9/15/96	23:00	0.6	0.0	0.9	1.1	93.32	84.81	86.45	80.66
9/16/96	0:00	0.6	0.0	0.9	1.1	93.93	85.46	87.00	81.2[illegible]
9/16/96	1:00	0.6	0.0	0.9	1.1	93.13	84.48	86.11	80.[illegible]
9/16/96	2:00	0.6	0.0	0.9	1.1	91.28	82.59	84.36	78.1[illegible]
9/16/96	3:00	0.6	0.0	0.9	1.1	90.71	82.09	83.74	77.88
9/16/96	4:00	0.6	0.0	0.9	1.1	90.81	82.11	83.58	78.19
9/16/96	5:00	0.6	0.0	0.9	1.1	90.46	81.85	83.14	77.95

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

MELTER BOTTOM DRAINS

READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/16/96	6:00	0.6	0.0	0.9	1.1	88.79	80.46	81.22	76.44
9/16/96	7:00	0.6	0.0	0.9	1.1	87.58	79.02	80.83	74.88
9/16/96	8:00	0.6	0.0	0.9	1.1	86.48	77.64	79.90	73.65
9/16/96	9:00	0.6	0.0	0.9	1.1	87.34	78.65	80.99	74.74
9/16/96	10:00	0.6	0.0	0.9	1.1	88.38	79.64	81.97	75.82
9/16/96	11:00	0.6	0.0	1.0	1.1	89.83	81.29	83.66	77.60
9/16/96	12:00	0.6	0.0	1.0	1.1	90.91	82.39	84.89	79.21
9/16/96	13:00	0.6	0.0	1.0	1.1	91.41	83.03	85.44	79.87
9/16/96	14:00	0.6	0.0	1.0	1.1	94.10	85.69	88.08	82.41
9/16/96	15:00	0.6	0.0	1.0	1.1	92.60	84.11	86.14	80.36
9/16/96	16:00	0.6	0.0	0.9	1.1	93.08	84.67	86.72	80.56
9/16/96	17:00	0.6	0.0	0.9	1.1	93.48	84.98	86.91	80.94
9/16/96	18:00	0.6	0.0	0.9	1.1	91.69	82.88	84.75	78.72
9/16/96	19:00	0.6	0.0	0.9	1.1	91.06	82.14	84.03	78.01
9/16/96	20:00	0.6	0.0	0.7	1.1	91.59	82.58	84.41	78.43
9/16/96	21:00	0.6	0.0	0.9	1.1	92.23	83.01	84.89	78.65
9/16/96	22:00	0.6	0.0	0.9	1.1	91.94	82.52	84.58	78.19
9/16/96	23:00	0.6	0.0	0.9	1.1	91.58	82.41	84.15	78.26
9/17/96	0:00	0.6	0.0	0.9	1.1	90.28	81.27	82.66	77.17

8089

GEM MACHINE SYSTEM

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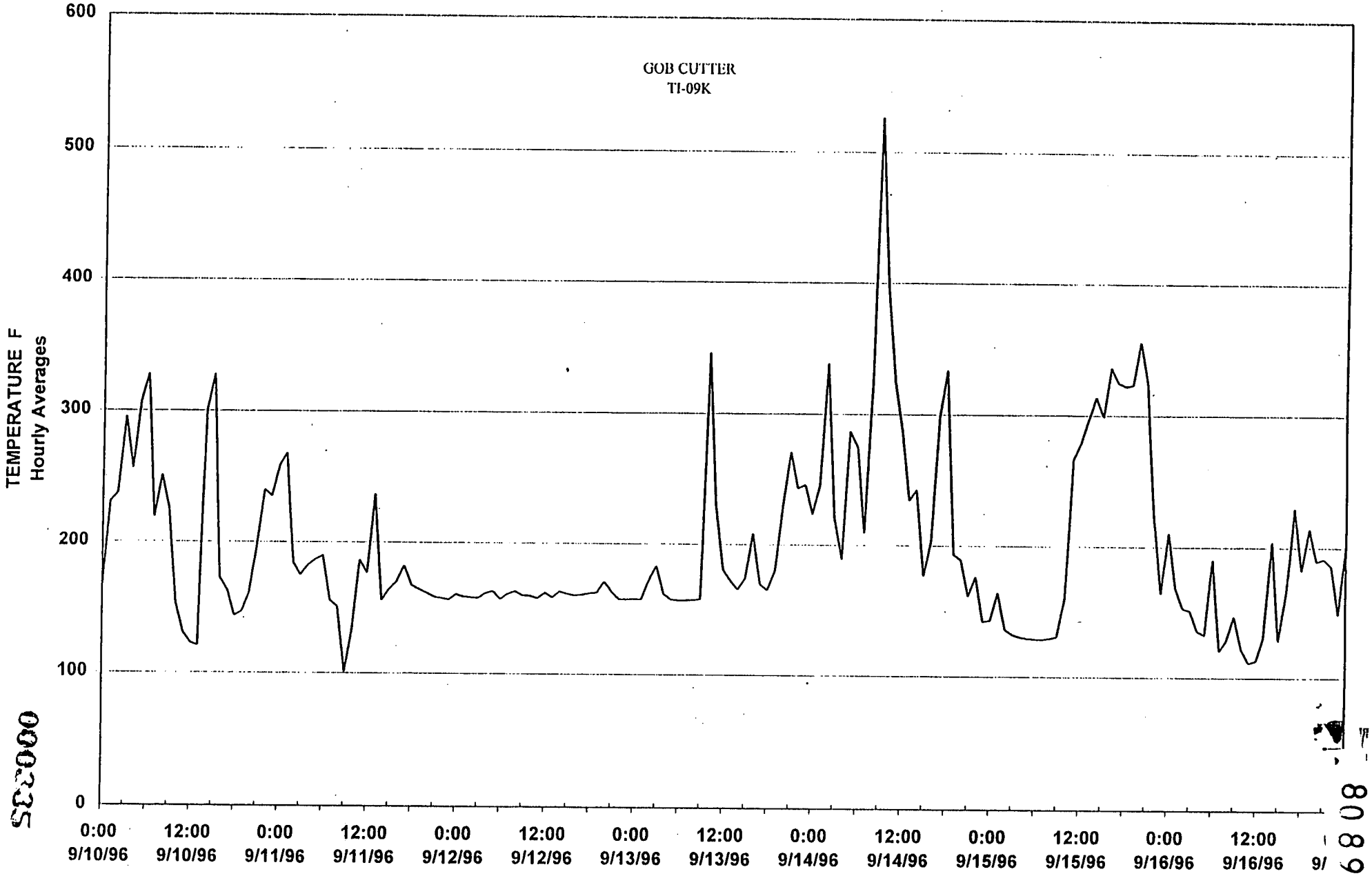
CAMPAIGN 2
TRANSITION GLASS
GEM MACHINE SYSTEM



C2GEMMCH.XLS Chart 4

VHP 10/28/96

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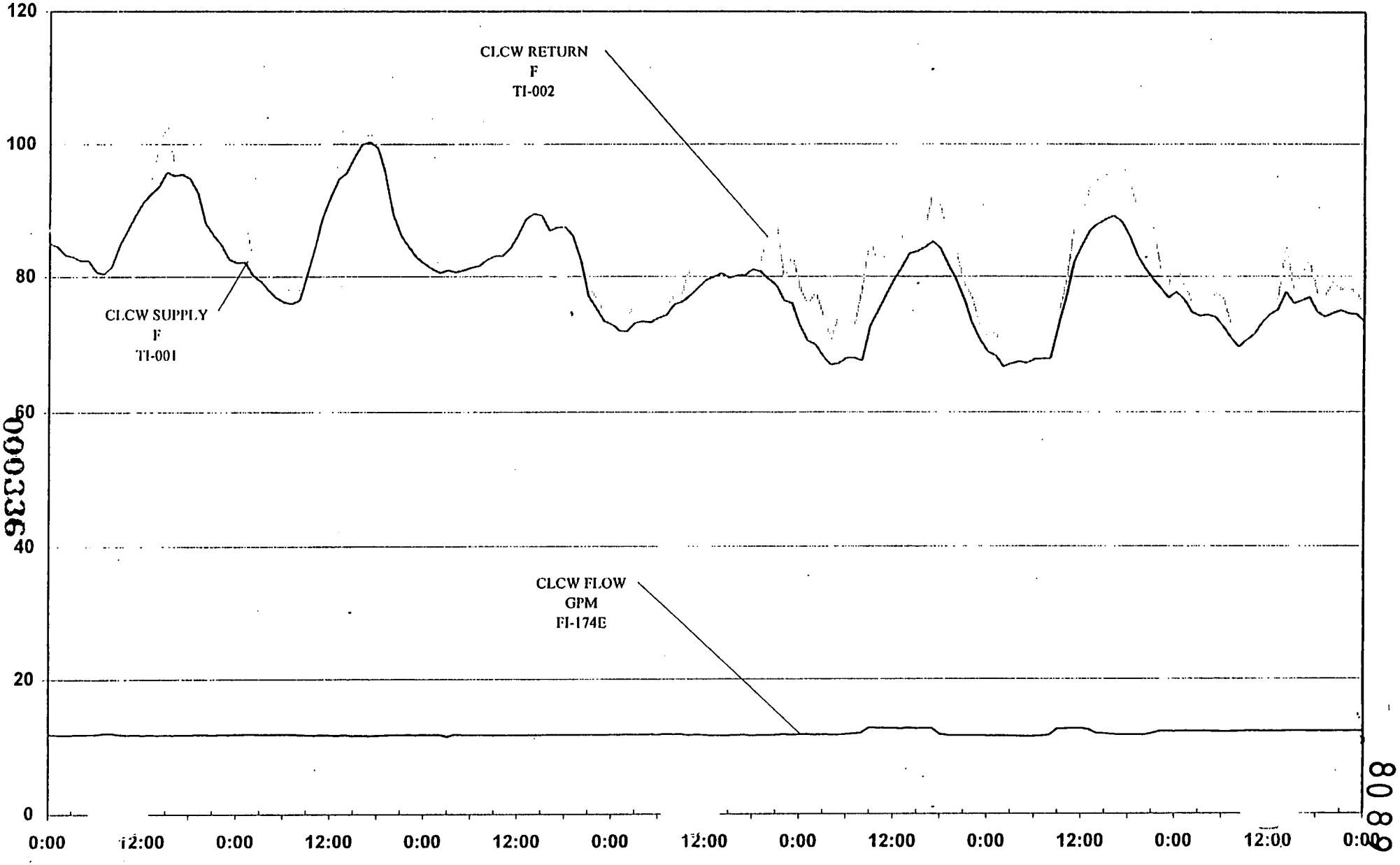
CAMPAIGN 2
TRANSITION GLASS
GEM MACHINE SYSTEM



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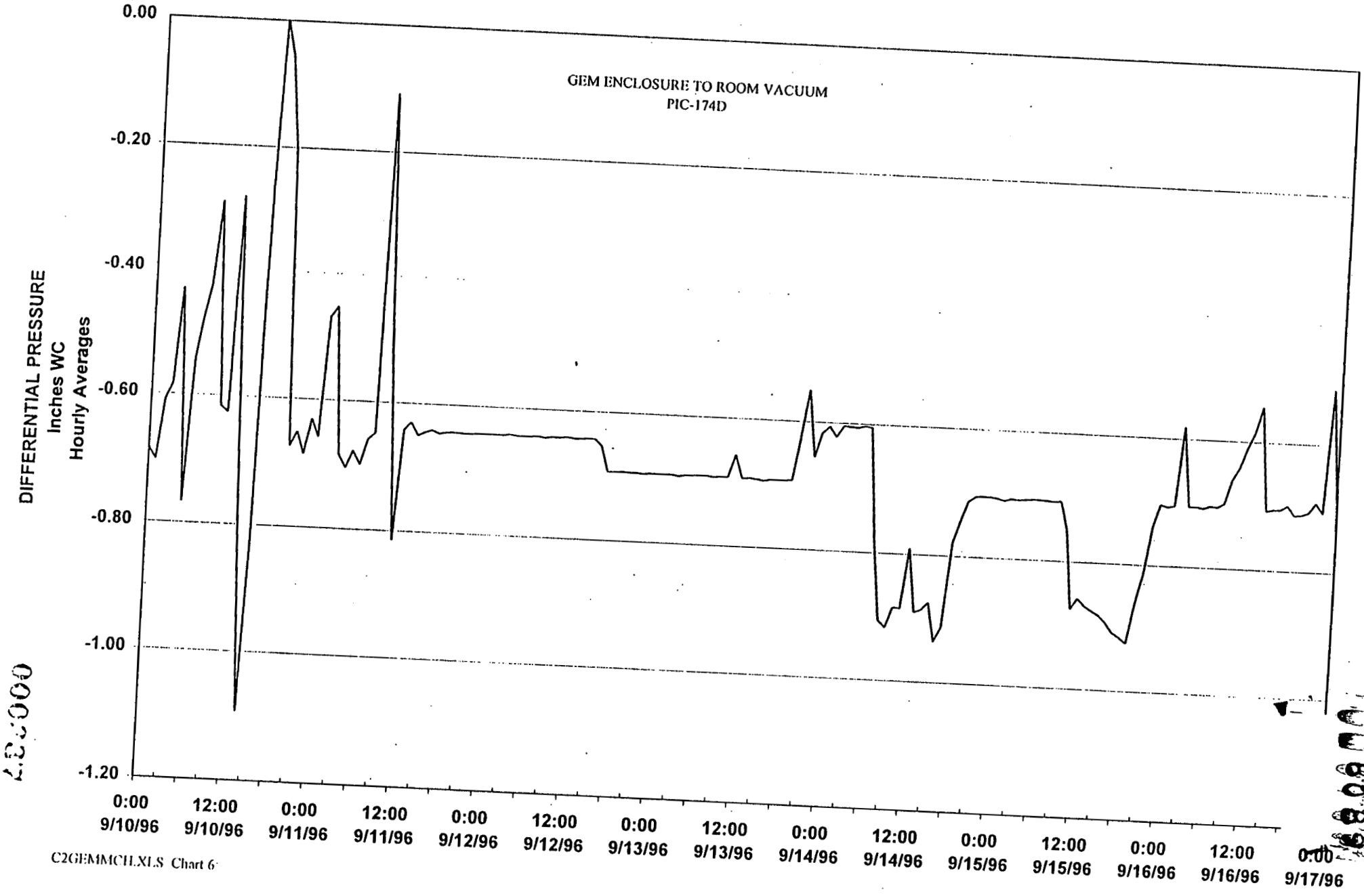
CAMPAIGN 2
TRANSITION GLASS
GEM MACHINE SYSTEM



C2GEMMCH.XLS Chart 6

VHP 10/28/96

VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/10/96	0:00	77.87	167.50		15.02	15.02	27.18	-0.69	11.95	85.06	86.81
9/10/96	1:00	92.12	231.16		14.03	14.82	27.13	-0.70	11.85	84.57	92.04
9/10/96	2:00	89.58	237.58		9.58	12.52	27.18	-0.61	11.81	83.29	89.23
9/10/96	3:00	90.06	295.15		1.74	3.21	27.18	-0.58	11.86	83.07	89.70
9/10/96	4:00	83.07	256.38		0.16	0.20	27.21	-0.43	11.90	82.41	87.39
9/10/96	5:00	80.73	307.05		0.79	4.84	27.23	-0.77	11.93	82.44	89.96
9/10/96	6:00	79.72	327.67		0.16	17.96	27.22	-0.54	11.93	80.70	86.97
9/10/96	7:00	79.13	219.19		0.84	15.59	29.94	-0.48	12.08	80.41	85.74
9/10/96	8:00	78.77	251.18		2.19	15.04	30.21	-0.43	12.09	81.49	88.16
9/10/96	9:00	79.02	226.22		3.38	12.31	30.22	-0.29	11.92	84.74	90.55
9/10/96	10:00	79.26	152.40		12.77	15.06	30.21	-0.62	11.83	86.99	89.09
9/10/96	11:00	79.55	130.34		17.66	15.06	30.22	-0.63	11.91	89.24	90.74
9/10/96	12:00	79.88	122.73		5.79	4.41	30.20	-0.28	11.79	91.21	92.53
9/10/96	13:00	80.41	120.47		15.45	11.28	30.23	-0.75	11.87	92.50	93.82
9/10/96	14:00	93.14	300.20		17.01	15.03	30.19	-1.09	11.80	93.60	100.00
9/10/96	15:00	88.47	327.44		2.79	15.03	30.24	-0.83	11.83	95.72	102.73
9/10/96	16:00	85.03	172.09		0.58	3.91	30.20	-0.27	11.80	95.23	97.18
9/10/96	17:00	84.94	162.55		0.15	0.21	30.21	0.00	11.86	95.42	96.49
9/10/96	18:00	83.74	143.06		0.15	0.24	30.21	-0.06	11.83	94.78	95.93
9/10/96	19:00	83.00	146.16		0.14	0.19	28.18	-0.19	11.89	92.64	93.96
9/10/96	20:00	83.56	160.71		-0.01	0.36	0.81	-0.67	11.90	88.11	89.91
9/10/96	21:00	82.36	197.02		0.01	0.13	0.09	-0.65	11.85	86.29	91.07
9/10/96	22:00	81.38	240.08		0.09	0.93	0.50	-0.69	11.89	84.84	90.78
9/10/96	23:00	79.65	235.40		0.14	0.20	0.10	-0.63	11.88	82.57	86.44
9/11/96	0:00	80.57	258.78		0.18	12.39	12.94	-0.66	11.92	82.09	88.89
9/11/96	1:00	80.07	268.11		0.19	15.09	15.25	-0.47	11.94	82.18	88.46
9/11/96	2:00	79.28	184.04		0.19	15.09	15.25	-0.45	11.96	80.23	8[illegible]
9/11/96	3:00	78.47	174.25		0.19	15.09	15.24	-0.68	11.89	79.34	[illegible]
9/11/96	4:00	77.22	182.33		0.19	15.09	15.23	-0.70	11.91	78.04	8[illegible]
9/11/96	5:00	74.92	186.87		0.19	15.08	15.18	-0.68	11.89	76.90	79.43
9/11/96	6:00	72.96	189.83		0.19	15.09	15.19	-0.70	11.93	76.20	78.67
9/11/96	7:00	72.09	154.85		0.19	15.09	15.17	-0.66	11.90	75.99	77.78
9/11/96	8:00	72.75	150.15		0.19	15.10	15.19	-0.65	11.88	76.49	78.10
9/11/96	9:00	72.86	101.05		0.14	2.42	2.35	-0.11	11.80	80.31	81.18
9/11/96	10:00	74.65	132.02		0.15	9.44	16.92	-0.53	11.78	84.55	85.36
9/11/96	11:00	78.18	186.55		0.15	12.34	26.92	-0.82	11.82	89.05	91.05
9/11/96	12:00	79.54	176.05		0.13	0.19	0.09	-0.64	11.78	92.07	93.39
9/11/96	13:00	80.22	236.97		0.13	0.20	0.08	-0.63	11.72	94.67	97.22
9/11/96	14:00	80.43	155.21		0.14	1.72	0.09	-0.65	11.79	95.64	96.58
9/11/96	15:00	81.07	163.70		0.14	0.20	0.09	-0.64	11.70	97.96	98.70
9/11/96	16:00	81.52	169.48		0.14	0.20	0.09	-0.64	11.74	99.96	100.82
9/11/96	17:00	82.06	182.02		0.15	0.20	0.09	-0.65	11.70	100.28	101.43
9/11/96	18:00	82.04	166.60		0.14	0.20	0.08	-0.64	11.73	99.33	100.20
9/11/96	19:00	81.49	163.73		0.13	0.20	0.10	-0.64	11.78	95.39	96.46
9/11/96	20:00	80.26	161.04		0.14	0.20	0.09	-0.64	11.84	89.28	90.53
9/11/96	21:00	78.95	158.08		0.14	0.20	0.09	-0.64	11.83	86.19	87.48
9/11/96	22:00	77.80	157.04		0.14	0.20	0.08	-0.64	11.88	84.47	85.73
9/11/96	23:00	77.05	155.87		0.14	0.20	0.09	-0.64	11.81	82.87	84.20
9/12/96	0:00	76.39	159.97		0.15	0.19	0.09	-0.64	11.87	81.93	83.34
9/12/96	1:00	75.80	158.34		0.15	0.20	0.09	-0.64	11.85	81.09	82.37
9/12/96	2:00	75.18	157.78		0.15	0.20	0.09	-0.64	11.87	80.55	81.86
9/12/96	3:00	74.76	157.25		0.14	0.19	0.10	-0.64	11.57	80.93	82.11
9/12/96	4:00	74.67	161.05		0.15	0.20	0.08	-0.64	11.86	80.67	82.12
9/12/96	5:00	74.56	162.54		0.14	0.20	0.09	-0.64	11.84	80.92	82.27
9/12/96	6:00	74.50	156.65		0.15	0.20	0.09	-0.64	11.83	81.33	82.56
9/12/96	7:00	74.51	160.40		0.15	0.20	0.09	-0.64	11.84	81.60	82.94
9/12/96	8:00	74.73	162.45		0.15	0.20	0.09	-0.64	11.79	82.52	83.88
9/12/96	9:00	74.96	159.52		0.14	0.20	0.09	-0.64	11.75	83.12	84.23
9/12/96	10:00	75.10	159.11		0.14	0.20	0.09	-0.64	11.79	83.16	84.40
9/12/96	11:00	75.29	157.44		0.14	0.20	0.08	-0.64	11.80	84.28	85.[illegible]
9/12/96	12:00	75.94	161.47		0.14	0.20	0.08	-0.64	11.77	86.19	8[illegible]
9/12/96	13:00	76.47	158.11		0.15	0.20	0.09	-0.64	11.77	88.62	8[illegible]
9/12/96	14:00	76.50	162.42		0.14	0.20	0.08	-0.64	11.80	89.50	90.[illegible]
9/12/96	15:00	76.45	160.82		0.15	0.20	0.10	-0.64	11.81	89.23	90.26
9/12/96	16:00	75.59	159.61		0.15	0.20	0.09	-0.65	11.82	86.93	87.99
9/12/96	17:00	74.71	160.05		0.14	0.20	0.08	-0.69	11.82	87.43	88.45
9/12/96	18:00	74.31	161.27		0.14	0.20	0.08	-0.69	11.84	87.47	88.47

VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/12/96	19:00	73.89	161.78		0.14	0.20	0.08	-0.69	11.80	86.14	87.24
9/12/96	20:00	73.24	170.28		0.14	0.20	0.09	-0.69	11.83	82.42	84.04
9/12/96	21:00	72.24	162.41		0.14	0.20	0.08	-0.69	11.85	77.12	78.62
9/12/96	22:00	71.24	157.15		0.14	0.19	0.08	-0.69	11.84	75.25	76.72
9/12/96	23:00	70.62	156.88		0.14	0.20	0.08	-0.69	11.81	73.38	74.82
9/13/96	0:00	70.93	157.26		0.14	0.20	0.08	-0.69	11.85	72.87	74.45
9/13/96	1:00	70.97	156.91		0.15	0.20	0.09	-0.69	11.84	71.97	73.57
9/13/96	2:00	71.01	171.42		0.15	0.20	0.08	-0.69	11.88	71.86	74.31
9/13/96	3:00	70.88	182.72		0.13	0.44	1.90	-0.69	11.88	73.10	75.65
9/13/96	4:00	71.14	161.15		0.14	0.20	0.08	-0.69	11.88	73.33	74.91
9/13/96	5:00	71.29	157.08		0.14	0.20	0.10	-0.69	11.90	73.19	74.77
9/13/96	6:00	71.30	156.37		0.14	0.20	0.09	-0.69	11.84	73.83	75.26
9/13/96	7:00	71.39	156.49		0.14	0.20	0.07	-0.69	11.92	74.31	75.73
9/13/96	8:00	71.63	156.74		0.14	0.20	0.08	-0.69	11.88	75.84	77.16
9/13/96	9:00	71.55	157.48		0.15	0.19	0.08	-0.69	11.89	76.28	77.67
9/13/96	10:00	70.87	345.94		0.14	0.20	0.08	-0.69	11.78	77.18	81.09
9/13/96	11:00	71.03	229.57		0.14	0.20	0.09	-0.66	11.86	78.32	81.17
9/13/96	12:00	71.17	180.28		0.14	0.20	0.08	-0.69	11.79	79.46	81.03
9/13/96	13:00	71.26	171.82		0.15	0.20	0.08	-0.69	11.69	79.94	81.38
9/13/96	14:00	71.18	164.79		0.14	0.20	0.08	-0.69	11.75	80.50	81.84
9/13/96	15:00	71.01	173.61		0.14	0.20	0.08	-0.70	11.74	79.82	81.41
9/13/96	16:00	71.22	208.54		0.15	0.97	0.68	-0.69	11.77	80.15	83.73
9/13/96	17:00	71.34	169.11		0.14	0.20	0.09	-0.69	11.83	80.22	81.62
9/13/96	18:00	71.26	164.56		0.14	0.20	0.09	-0.69	11.70	81.06	82.37
9/13/96	19:00	70.19	179.50		0.17	10.83	18.79	-0.69	11.77	80.75	82.41
9/13/96	20:00	141.18	228.94		0.17	16.26	26.98	-0.63	11.78	79.65	86.70
9/13/96	21:00	185.36	270.98		0.17	19.91	27.04	-0.55	11.80	78.77	88.57
9/13/96	22:00	127.86	243.53		0.18	20.07	27.00	-0.65	11.88	76.43	79.52
9/13/96	23:00	147.08	246.10		0.18	23.18	26.74	-0.62	11.84	76.02	83.24
9/14/96	0:00	113.86	223.78		0.17	23.64	26.97	-0.61	11.87	72.71	78.43
9/14/96	1:00	127.20	245.57		0.17	21.69	26.97	-0.62	11.91	70.49	75.78
9/14/96	2:00	115.73	338.48		0.18	21.58	26.96	-0.60	11.84	69.94	77.75
9/14/96	3:00	95.70	221.02		0.18	24.05	27.02	-0.61	11.85	68.19	74.20
9/14/96	4:00	85.63	189.43		0.18	24.99	27.01	-0.61	11.84	66.96	70.75
9/14/96	5:00	84.81	286.75		0.18	23.91	26.98	-0.60	11.81	67.16	74.15
9/14/96	6:00	81.90	275.08		0.17	24.99	26.99	-0.61	11.89	67.99	74.21
9/14/96	7:00	77.95	209.49		0.18	24.99	26.98	-0.79	11.96	68.00	72.59
9/14/96	8:00	112.22	328.21		0.18	25.02	27.00	-0.91	12.07	67.53	78.20
9/14/96	9:00	98.51	526.34		0.17	24.81	26.96	-0.92	12.90	72.54	85.98
9/14/96	10:00	81.16	394.72		0.18	25.02	26.99	-0.89	12.84	74.80	81.57
9/14/96	11:00	77.34	323.86		0.17	24.89	26.99	-0.89	12.82	77.26	83.33
9/14/96	12:00	76.03	286.65		0.18	21.17	26.97	-0.79	12.80	79.48	84.29
9/14/96	13:00	74.97	234.60		0.18	24.68	27.01	-0.89	12.70	81.35	86.09
9/14/96	14:00	75.89	242.85		0.18	24.43	26.97	-0.89	12.85	83.53	88.23
9/14/96	15:00	75.09	176.44		0.18	24.32	27.00	-0.88	12.73	83.86	85.92
9/14/96	16:00	74.75	203.10		0.18	24.36	26.97	-0.94	12.78	84.51	87.70
9/14/96	17:00	96.35	298.80		0.17	24.40	26.98	-0.91	12.81	85.34	92.81
9/14/96	18:00	87.81	333.38		0.18	24.64	26.95	-0.78	11.88	84.19	90.49
9/14/96	19:00	77.23	193.18		0.17	24.59	27.00	-0.74	11.73	81.67	85.51
9/14/96	20:00	74.81	189.26		0.17	24.76	26.99	-0.71	11.73	79.44	83.74
9/14/96	21:00	72.95	160.82		0.18	24.49	26.99	-0.71	11.73	76.61	78.93
9/14/96	22:00	73.06	175.91		0.17	24.14	26.97	-0.70	11.74	73.12	77.00
9/14/96	23:00	71.66	141.46		0.17	24.43	26.98	-0.70	11.69	70.68	72.79
9/15/96	0:00	68.15	142.27		0.18	24.10	26.98	-0.71	11.65	68.90	70.81
9/15/96	1:00	68.47	163.51		0.18	23.99	26.98	-0.71	11.64	68.36	71.95
9/15/96	2:00	68.50	135.36		0.18	23.94	27.00	-0.71	11.68	66.70	68.84
9/15/96	3:00	68.20	131.53		0.18	23.76	26.96	-0.71	11.62	67.14	69.09
9/15/96	4:00	67.78	129.70		0.18	23.56	26.98	-0.71	11.59	67.45	69.31
9/15/96	5:00	67.43	128.71		0.18	23.51	26.99	-0.71	11.58	67.24	69.10
9/15/96	6:00	67.06	128.26		0.18	23.61	26.98	-0.71	11.60	67.80	69.61
9/15/96	7:00	66.66	127.98		0.18	23.62	26.98	-0.71	11.64	67.89	69.66
9/15/96	8:00	66.62	128.63		0.18	23.76	27.03	-0.71	11.77	67.92	69.51
9/15/96	9:00	67.14	130.13		0.18	23.80	26.97	-0.71	12.70	72.59	73.93
9/15/96	10:00	67.58	159.29		0.18	24.03	26.96	-0.75	12.72	77.04	79.37
9/15/96	11:00	73.19	266.23		0.18	24.63	27.00	-0.88	12.78	82.24	87.73
9/15/96	12:00	75.29	278.98		0.18	24.95	26.98	-0.86	12.78	84.82	89.58
9/15/96	13:00	84.27	296.50		0.16	25.17	28.74	-0.87	12.62	87.04	93.81

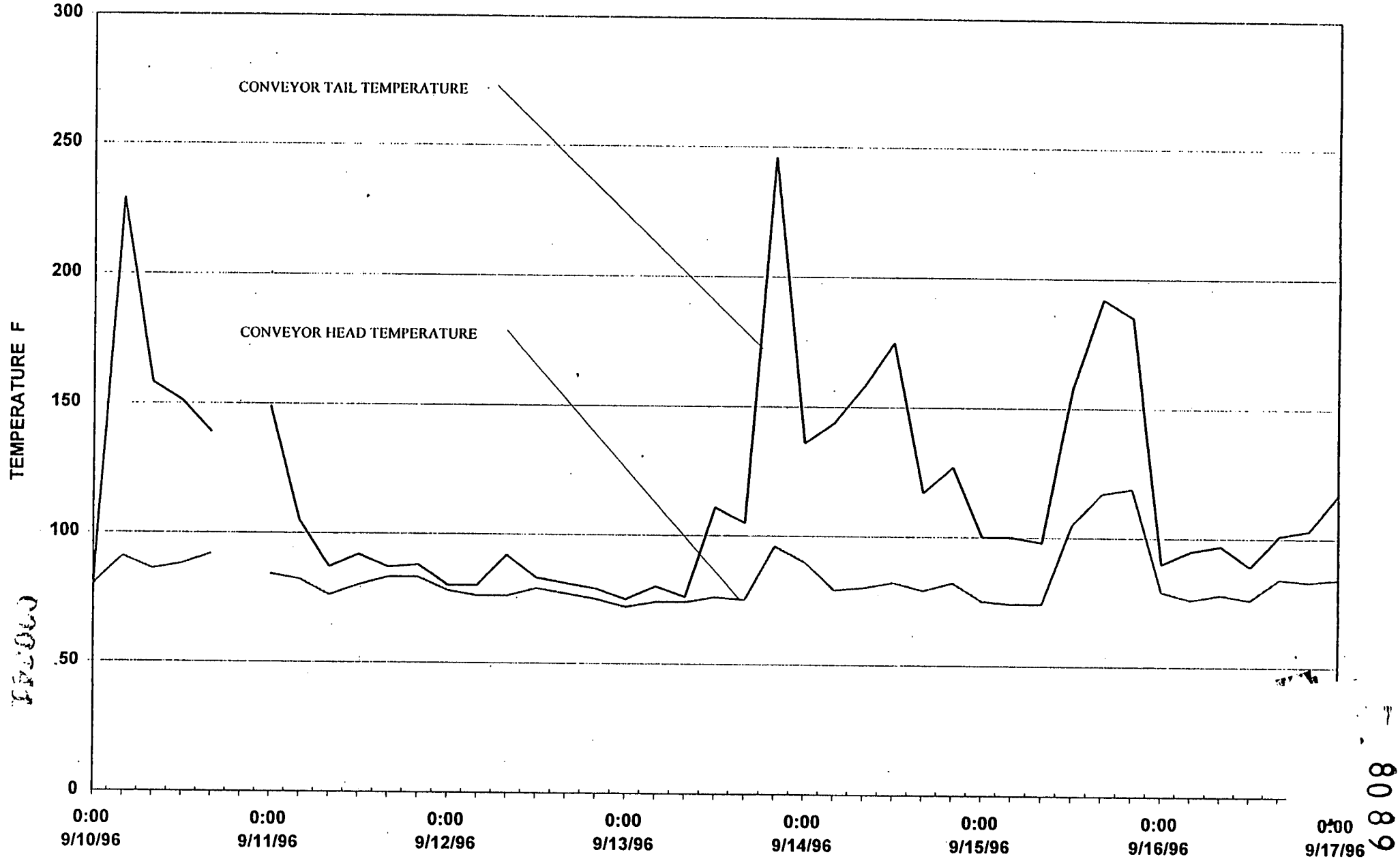
VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	DIV[illegible]RS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/15/96	14:00	78.11	313.75		0.16	24.99	28.95	-0.88	12.04	88.03	94.73
9/15/96	15:00	76.50	298.66		0.16	25.00	28.99	-0.88	12.01	88.69	95.32
9/15/96	16:00	76.39	335.97		0.16	24.98	28.99	-0.89	11.85	89.21	96.95
9/15/96	17:00	76.02	324.60		0.17	24.92	27.97	-0.91	11.81	88.32	97.07
9/15/96	18:00	75.57	322.14		0.18	24.84	26.99	-0.92	11.80	86.16	94.35
9/15/96	19:00	75.04	323.18		0.18	24.99	26.95	-0.93	11.79	83.22	90.36
9/15/96	20:00	74.77	355.89		0.18	25.09	27.01	-0.87	11.76	81.28	90.39
9/15/96	21:00	76.43	324.51		0.18	25.00	26.97	-0.82	11.98	79.64	87.54
9/15/96	22:00	75.49	223.35		0.18	24.93	26.99	-0.74	12.32	78.27	81.36
9/15/96	23:00	73.80	163.62		0.18	24.61	26.67	-0.70	12.33	76.87	78.89
9/16/96	0:00	72.91	210.72		0.18	24.38	27.00	-0.71	12.29	77.76	82.13
9/16/96	1:00	72.28	167.61		0.17	24.54	27.00	-0.71	12.33	76.63	78.73
9/16/96	2:00	71.37	152.38		0.18	18.72	26.97	-0.58	12.33	74.69	76.36
9/16/96	3:00	69.67	150.66		0.17	15.09	26.97	-0.71	12.34	74.18	75.74
9/16/96	4:00	69.59	134.97		0.17	15.08	26.94	-0.71	12.34	74.32	75.91
9/16/96	5:00	69.75	132.12		0.18	15.05	26.91	-0.71	12.32	73.98	77.48
9/16/96	6:00	74.23	190.23		0.18	15.12	27.03	-0.70	12.26	72.58	76.86
9/16/96	7:00	70.86	120.26		0.18	15.07	26.96	-0.70	12.27	70.92	72.92
9/16/96	8:00	69.99	127.96		0.17	15.10	27.01	-0.70	12.30	69.55	71.18
9/16/96	9:00	69.48	146.36		0.17	15.04	26.95	-0.66	12.34	70.57	73.09
9/16/96	10:00	69.38	121.51		0.18	15.08	26.98	-0.64	12.36	71.47	73.30
9/16/96	11:00	69.24	111.26		0.18	15.10	26.97	-0.61	12.35	73.18	74.47
9/16/96	12:00	69.25	113.02		0.17	15.11	27.04	-0.59	12.33	74.39	75.68
9/16/96	13:00	70.02	130.27		0.17	15.11	27.01	-0.55	12.33	75.07	76.94
9/16/96	14:00	87.64	204.12		0.17	15.13	27.00	-0.71	12.34	77.71	84.79
9/16/96	15:00	77.19	127.71		0.17	15.11	27.00	-0.70	12.39	76.02	78.07
9/16/96	16:00	80.53	164.13		0.17	15.08	26.99	-0.70	12.36	76.47	[illegible]
9/16/96	17:00	93.98	229.77		0.17	15.07	26.97	-0.70	12.35	76.94	[illegible]
9/16/96	18:00	73.58	181.90		0.17	15.08	26.99	-0.71	12.35	74.70	[illegible]
9/16/96	19:00	92.84	214.19		0.18	15.07	26.95	-0.71	12.34	74.01	7[illegible]
9/16/96	20:00	72.92	189.44		0.17	15.07	27.00	-0.71	12.32	74.54	79.17
9/16/96	21:00	72.30	191.27		0.17	15.09	26.99	-0.69	12.36	74.95	78.10
9/16/96	22:00	72.67	185.65		0.17	15.09	26.99	-0.71	12.32	74.51	78.49
9/16/96	23:00	71.52	147.95		0.18	15.06	26.97	-0.51	12.38	74.37	77.51
9/17/96	0:00	69.71	201.35		0.18	15.09	26.99	-0.69	12.31	73.31	75.64

CAMPAIGN 2
TRANSITION GLASS
GEM MACHINE SYSTEM



C2GEMMCH.XLS Chart 10

VHP 11/7/96

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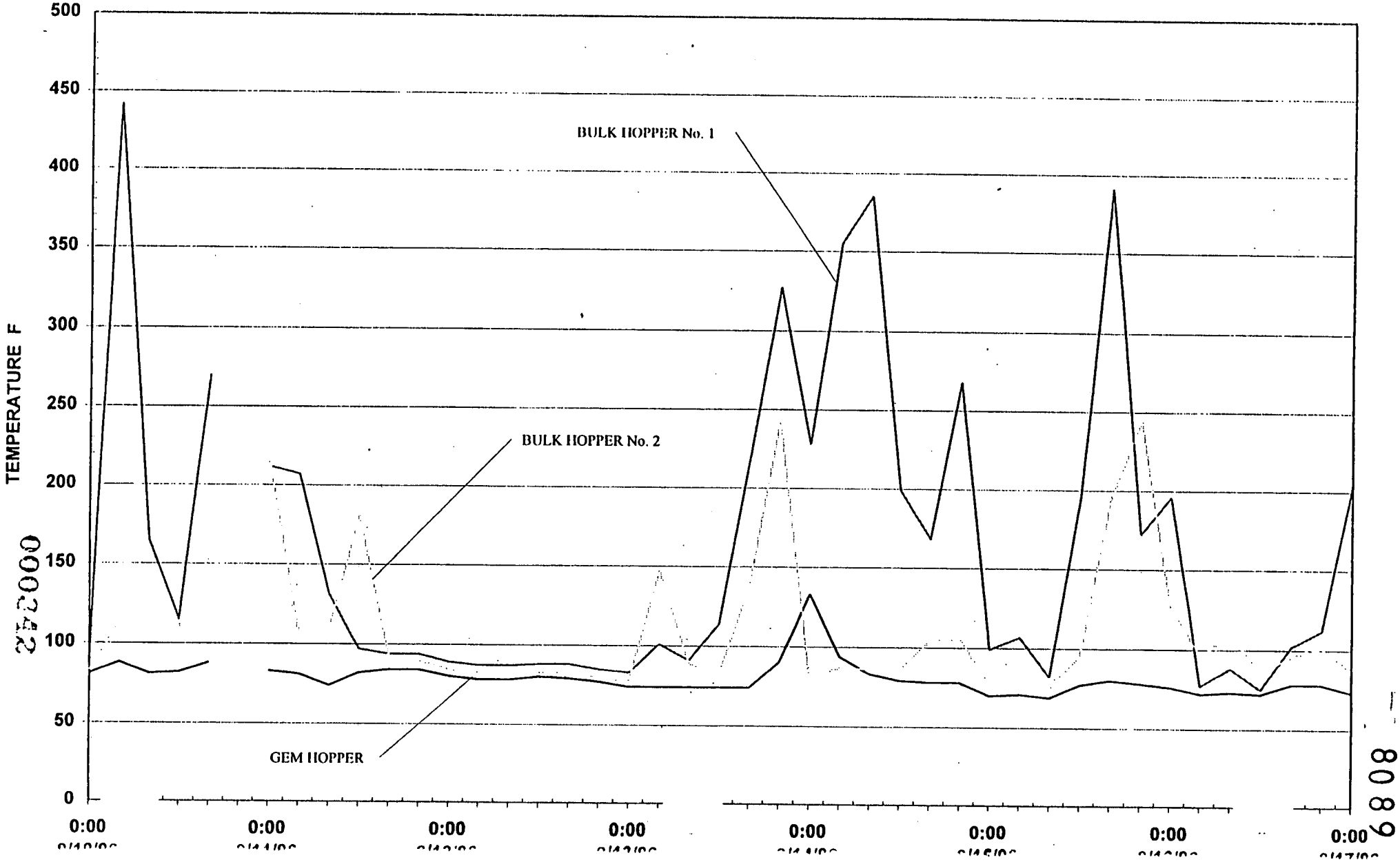
CAMPAIGN 2
TRANSITION GLASS
GEM MACHINE SYSTEM



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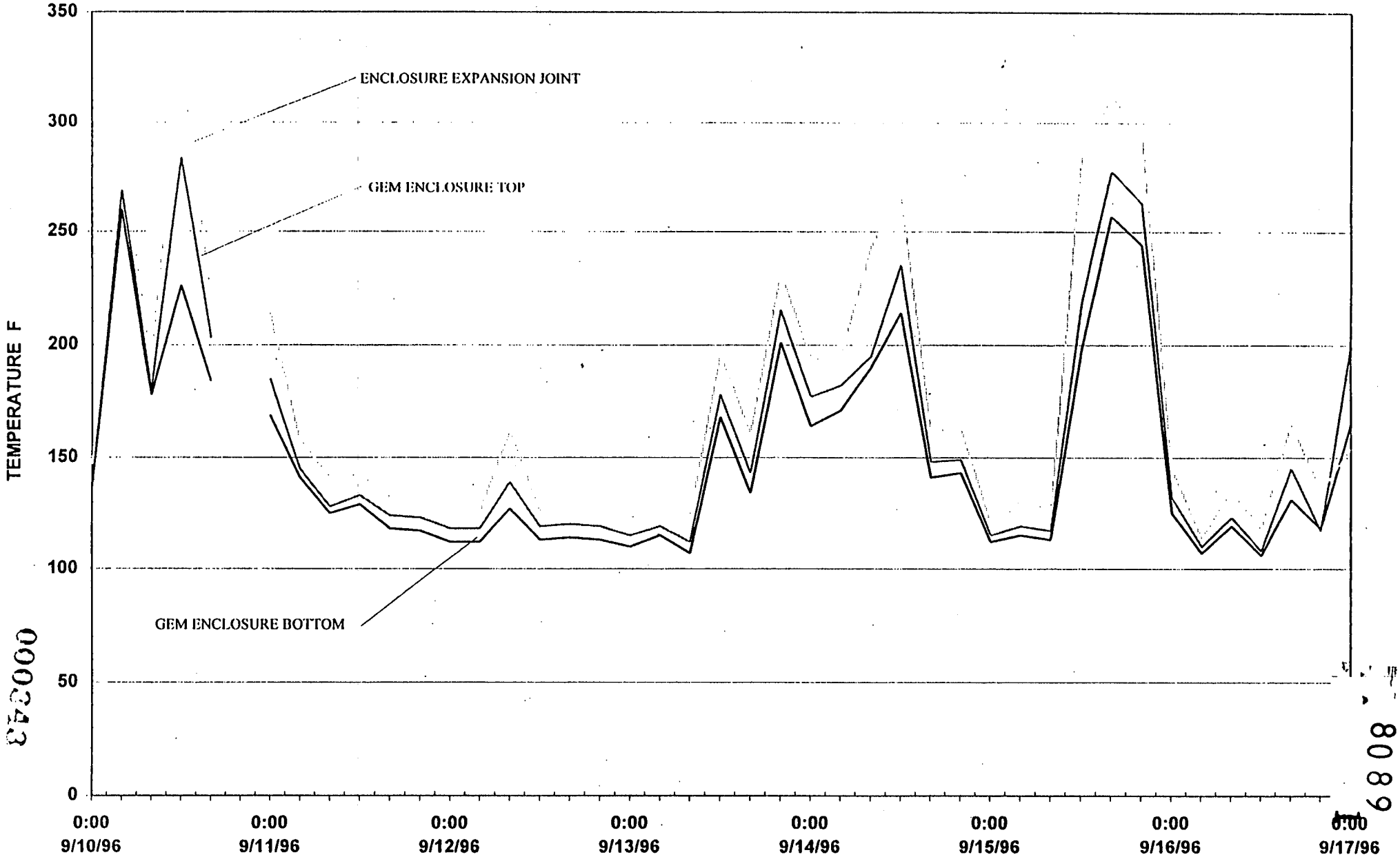
CAMPAIGN 2
TRANSITION GLASS
GEM MACHINE SYSTEM



C2GEMMCH.XLS Chart 12

VHP 11/7/96

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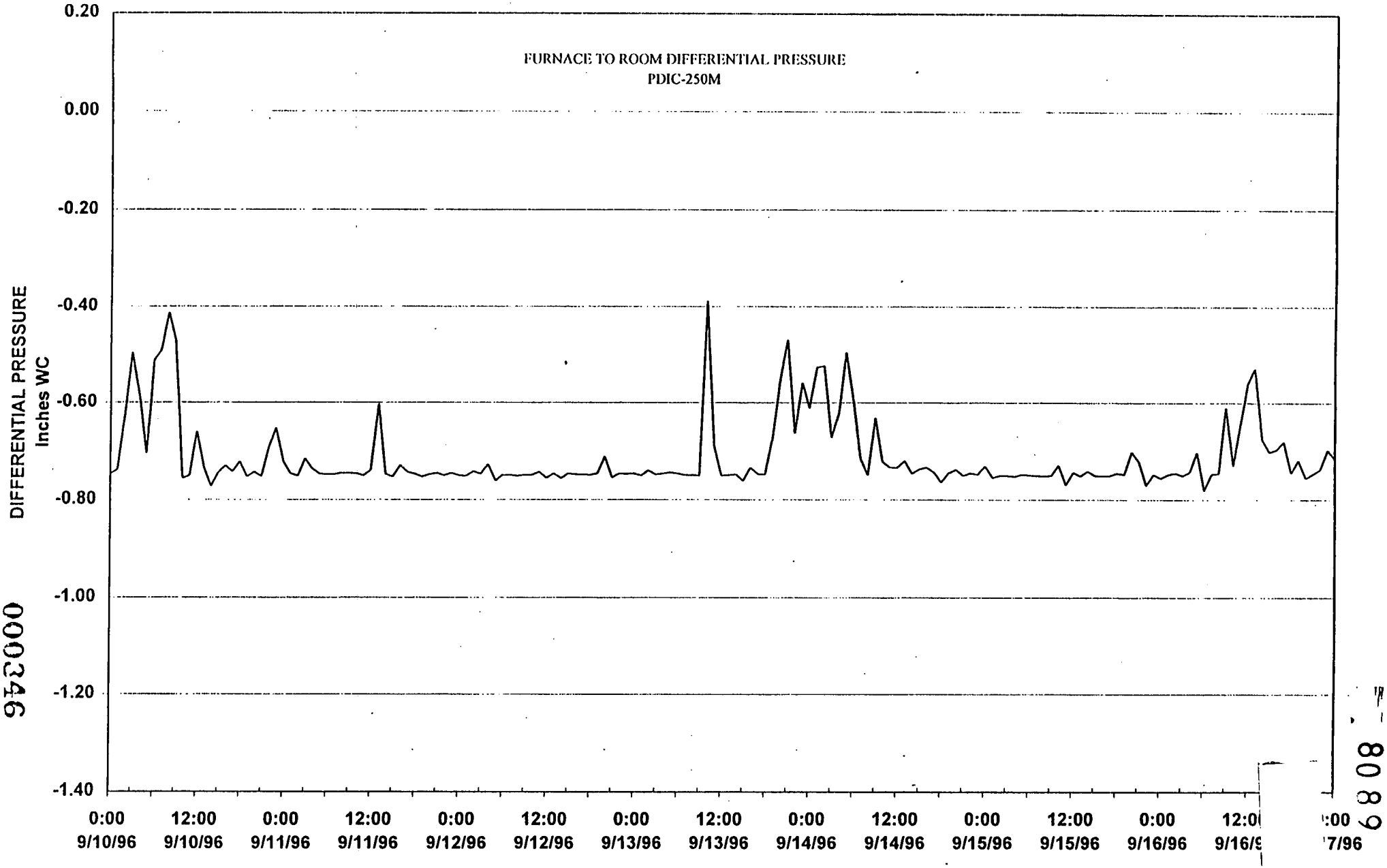
VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM
CAMPAIGN 2 TRANSITION GLASS
HOURLY READINGS ROUNDSHEETS

READINGS		CONVEYOR TAIL TEMP	CONVEYOR HEAD TEMP	GEM HOPPER TEMP	BULK HOPPER #1 TEMP	BULK HOPPER #2 TEMP	GEM ENCLOSURE BOTTOM TEMP	GEM ENCLOSURE TOP TEMP	ENCLOSURE EXPANSION JOINT TEMP
DATE	HOUR	F	F	F	F	F	F	F	F
9/10/96	0:00	81	80	81	93	83	137	138	147
9/10/96	4:00	229	91	88	442	113	260	269	281
9/10/96	8:00	158	86	81	165	127	178	180	193
9/10/96	12:00	151	88	82	115	110	226	284	327
9/10/96	16:00	139	92	88	270	155	184	203	221
9/10/96	20:00								
9/11/96	0:00	149	84	83	212	216	169	185	214
9/11/96	4:00	105	82	81	207	107	141	145	158
9/11/96	8:00	87	76	74	131	109	125	128	141
9/11/96	12:00	92	80	82	97	181	129	133	142
9/11/96	16:00	87	83	84	94	93	118	124	132
9/11/96	20:00	88	83	84	94	90	117	123	131
9/12/96	0:00	80	78	80	89	84	112	118	126
9/12/96	4:00	80	76	78	87	82	112	118	126
9/12/96	8:00	92	76	78	87	81	127	139	162
9/12/96	12:00	83	79	80	88	83	113	119	126
9/12/96	16:00	81	77	79	88	83	114	120	128
9/12/96	20:00	79	75	77	85	79	113	119	128
9/13/96	0:00	75	72	74	83	78	110	115	123
9/13/96	4:00	80	74	74	101	147	115	119	126
9/13/96	8:00	76	74	74	91	89	107	112	12
9/13/96	12:00	111	76	74	114	82	168	178	196
9/13/96	16:00	105	75	74	218	138	134	143	161
9/13/96	20:00	246	96	90	327	243	201	215	232
9/14/96	0:00	136	90	133	228	81	164	177	194
9/14/96	4:00	144	79	94	355	87	171	182	195
9/14/96	8:00	158	80	83	385	86	190	195	243
9/14/96	12:00	175	82	79	199	86	214	235	267
9/14/96	16:00	117	79	78	168	104	141	148	162
9/14/96	20:00	127	82	78	268	106	143	149	163
9/15/96	0:00	100	75	70	99	77	112	115	121
9/15/96	4:00	100	74	71	107	77	115	119	129
9/15/96	8:00	98	74	69	82	75	113	117	127
9/15/96	12:00	158	105	77	196	95	198	218	284
9/15/96	16:00	192	117	80	391	194	257	278	312
9/15/96	20:00	185	119	78	172	244	244	263	294
9/16/96	0:00	90	79	76	196	126	125	132	145
9/16/96	4:00	95	76	72	77	96	107	110	114
9/16/96	8:00	97	78	73	88	110	119	123	135
9/16/96	12:00	89	76	72	75	85	106	108	118
9/16/96	16:00	101	84	78	102	96	131	145	165
9/16/96	20:00	103	83	78	112	101	118	117	135
9/17/96	0:00	117	84	73	204	87	165	199	154

FURNACE OFFGAS SYSTEM

CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



C2OFFGAS.XLS Chart 3

VHP 10

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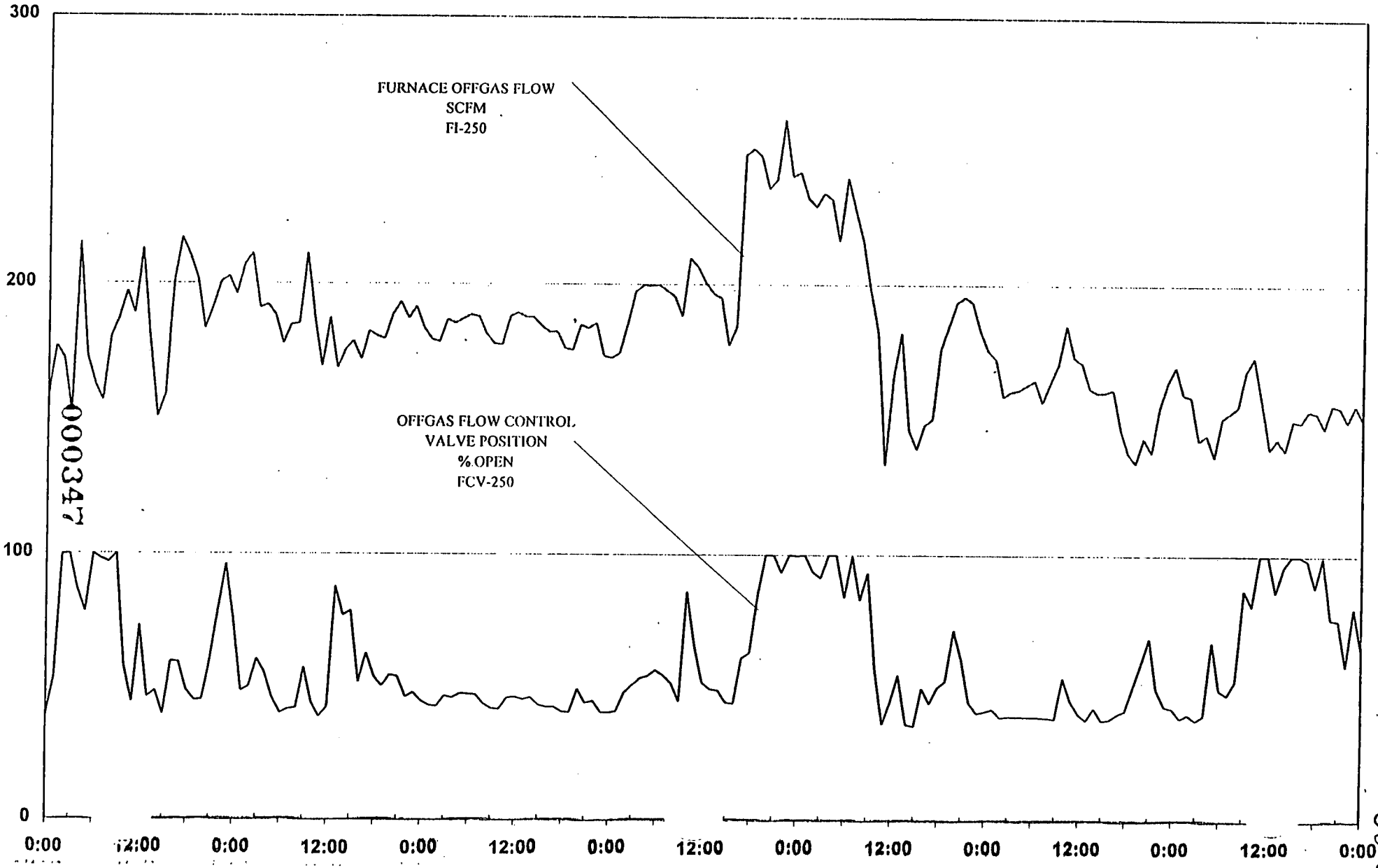
CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



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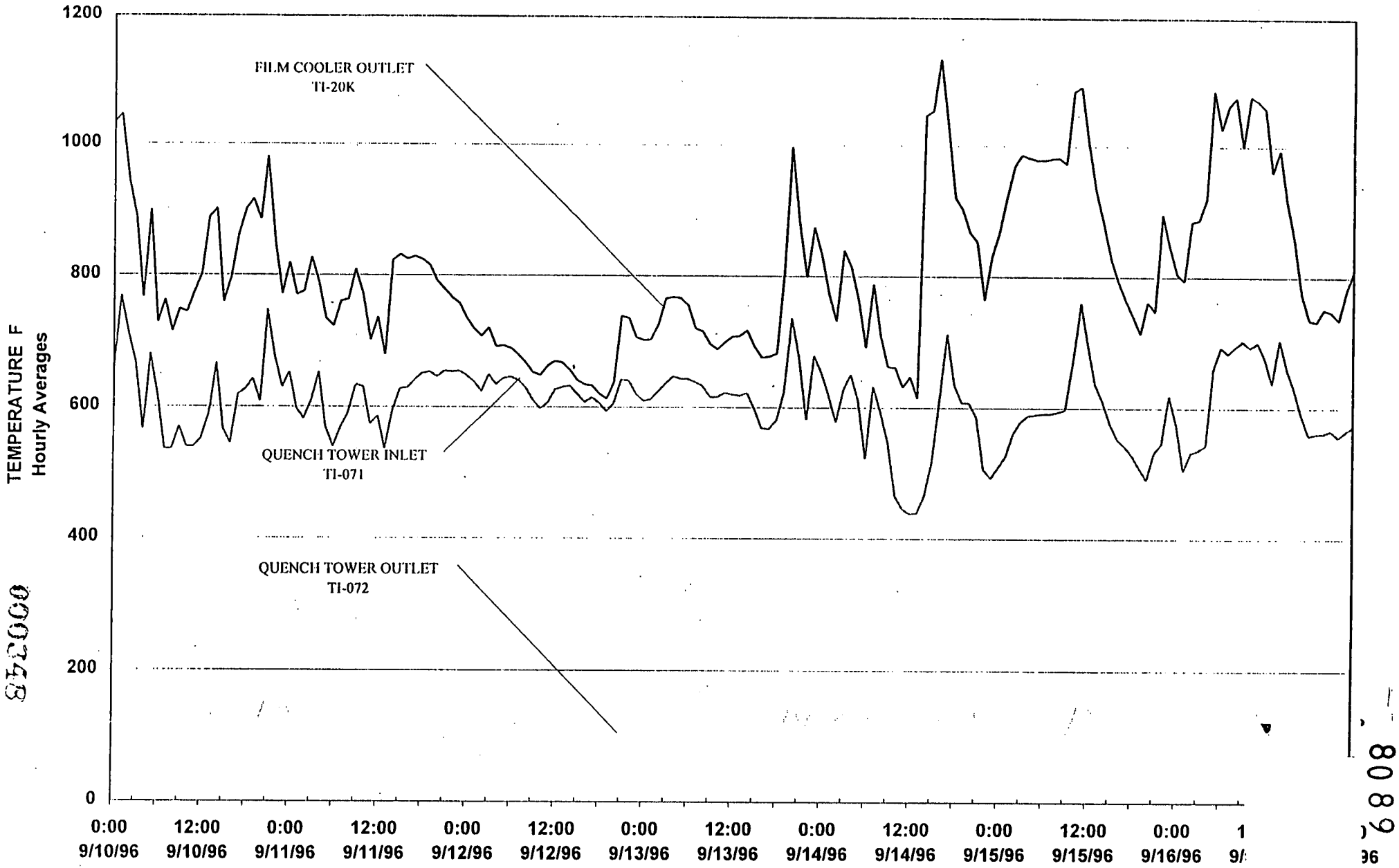
CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



C2OFFGAS.XLS Chart 7

VHP 10/28/96

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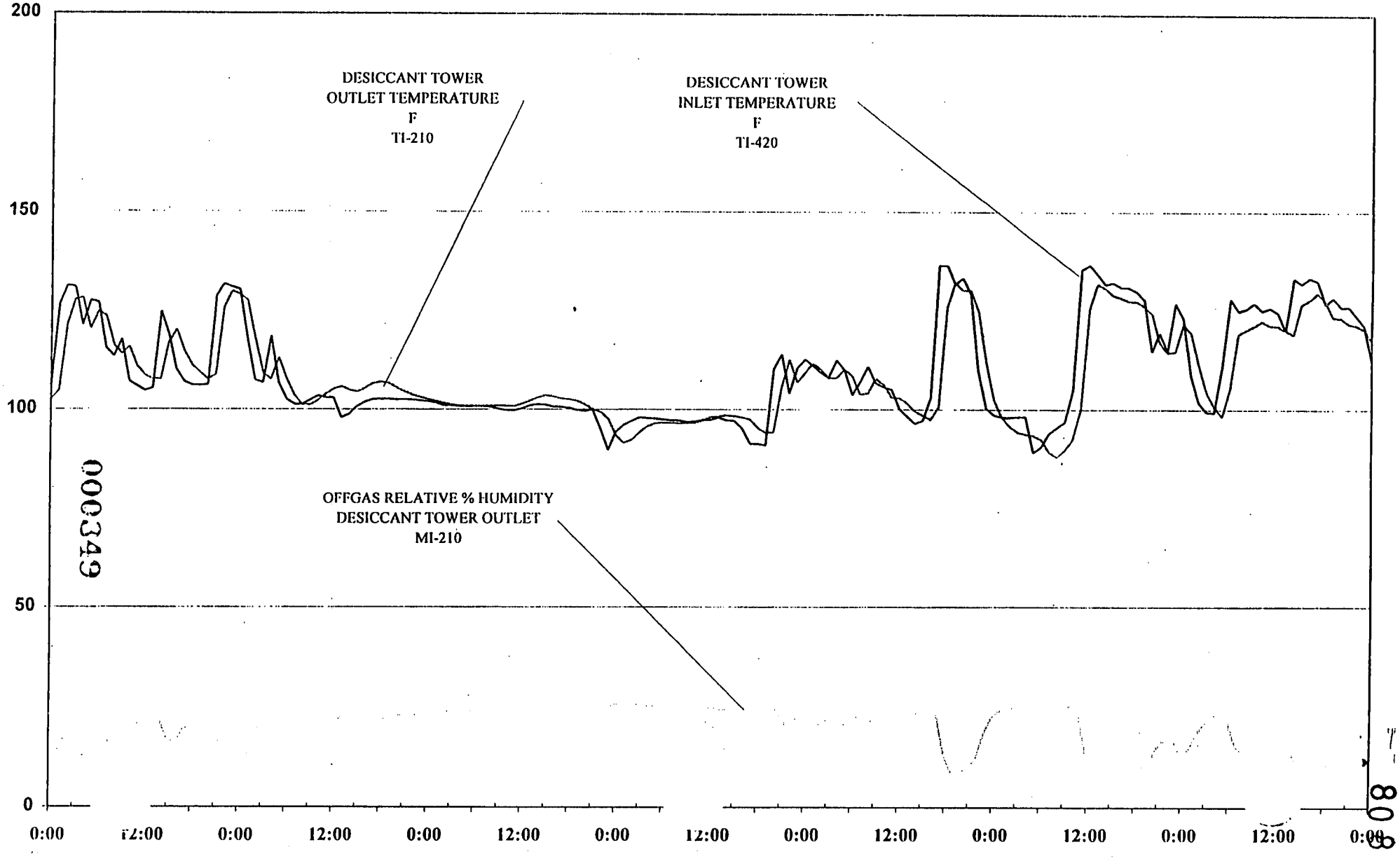
CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/10/96	0:00	-0.748	1034.38	660.07	117.18	106.09	102.48	23.34	3.144	0.173	38.97	158.54	9182.00
9/10/96	1:00	-0.739	1046.12	768.67	145.65	126.65	104.69	22.83	4.420	0.200	53.88	176.80	9121.75
9/10/96	2:00	-0.621	943.64	711.23	147.10	131.28	121.35	15.93	4.668	0.203	99.71	172.07	9047.58
9/10/96	3:00	-0.496	889.03	666.33	144.00	130.93	127.75	11.38	4.304	0.185	100.00	152.44	9003.56
9/10/96	4:00	-0.586	766.64	564.40	127.69	121.43	128.23	11.90	5.663	0.250	86.48	215.25	9113.31
9/10/96	5:00	-0.706	898.54	680.37	148.29	127.46	120.48	16.01	4.559	0.204	78.14	173.03	8861.70
9/10/96	6:00	-0.513	728.83	615.20	137.65	126.99	124.81	13.74	4.588	0.194	99.86	162.52	8930.42
9/10/96	7:00	-0.491	762.26	534.01	125.75	115.54	123.64	13.83	4.416	0.190	98.09	156.54	8968.33
9/10/96	8:00	-0.413	715.19	534.15	127.53	113.45	116.35	18.15	5.204	0.211	96.84	179.92	8845.33
9/10/96	9:00	-0.471	748.45	568.86	120.98	117.79	114.04	19.26	5.323	0.219	100.00	186.74	8781.83
9/10/96	10:00	-0.757	744.08	537.49	108.09	107.17	115.90	18.67	5.130	0.225	57.54	197.06	8832.17
9/10/96	11:00	-0.751	774.32	537.44	106.99	105.87	110.87	20.67	4.595	0.212	44.33	188.76	8858.50
9/10/96	12:00	-0.661	801.54	550.13	111.39	104.69	108.65	21.93	5.467	0.239	72.79	212.90	8834.75
9/10/96	13:00	-0.735	887.45	586.87	122.25	105.31	107.66	22.04	4.135	0.201	46.16	179.91	8723.50
9/10/96	14:00	-0.773	900.48	666.78	139.51	124.72	107.61	21.72	3.762	0.175	48.54	150.49	8548.75
9/10/96	15:00	-0.745	759.54	565.36	115.13	119.04	116.94	17.59	3.352	0.178	39.55	158.91	8647.33
9/10/96	16:00	-0.731	796.32	542.94	109.28	110.17	120.25	16.32	4.953	0.225	59.43	201.03	8592.83
9/10/96	17:00	-0.743	860.52	618.73	118.22	107.01	114.73	19.46	5.731	0.243	59.15	216.94	8429.83
9/10/96	18:00	-0.723	899.71	627.20	118.78	106.10	111.18	20.93	5.185	0.230	48.65	210.36	8889.50
9/10/96	19:00	-0.754	915.30	642.58	119.36	106.03	109.33	21.60	4.831	0.219	44.94	201.53	8771.00
9/10/96	20:00	-0.744	883.79	608.16	121.37	106.20	107.61	21.97	4.283	0.199	45.16	183.25	8942.25
9/10/96	21:00	-0.753	980.28	748.02	154.69	128.61	108.84	21.59	5.350	0.219	59.77	191.50	9005.17
9/10/96	22:00	-0.693	849.46	675.63	149.43	131.60	125.67	13.80	5.722	0.234	78.45	200.62	9012.25
9/10/96	23:00	-0.654	771.71	629.66	143.73	130.86	129.79	11.00	5.929	0.237	96.18	202.57	9065.67
9/11/96	0:00	-0.723	819.43	653.20	144.10	130.17	128.99	11.54	5.696	0.226	74.92	195.98	8989.00
9/11/96	1:00	-0.747	770.21	597.32	116.15	117.82	127.41	12.35	5.532	0.233	48.53	207.09	9003.50
9/11/96	2:00	-0.752	775.51	581.49	110.22	107.40	117.97	17.47	5.606	0.234	50.07	211.28	9154.83
9/11/96	3:00	-0.717	827.46	609.94	121.51	106.78	109.24	21.12	5.007	0.210	60.48	190.95	8979.92
9/11/96	4:00	-0.737	789.11	653.04	122.91	118.59	107.58	21.79	4.970	0.210	55.27	192.13	9187.08
9/11/96	5:00	-0.748	734.25	568.27	107.50	106.68	113.05	19.54	4.542	0.206	45.82	188.20	9329.24
9/11/96	6:00	-0.749	723.27	537.75	103.46	102.57	107.76	21.38	4.041	0.189	40.16	177.78	9446.53
9/11/96	7:00	-0.749	760.86	567.44	104.53	101.26	103.42	23.11	4.363	0.198	41.63	184.63	9542.42
9/11/96	8:00	-0.746	763.61	590.97	105.89	101.22	101.18	23.91	4.375	0.201	42.04	185.11	9582.58
9/11/96	9:00	-0.746	808.85	633.85	112.15	102.32	101.14	24.16	5.691	0.238	57.30	211.36	9435.83
9/11/96	10:00	-0.747	770.00	630.52	111.69	103.38	102.19	23.68	4.467	0.210	44.03	187.51	9365.33
9/11/96	11:00	-0.751	702.48	572.45	106.64	102.89	103.81	22.89	3.644	0.195	38.70	169.23	9145.67
9/11/96	12:00	-0.740	736.57	585.91	108.51	102.81	105.05	22.70	4.395	0.221	42.31	187.35	9189.83
9/11/96	13:00	-0.604	679.11	534.46	104.72	97.96	105.71	22.28	4.881	0.217	87.65	168.69	9032.00
9/11/96	14:00	-0.748	822.83	595.51	106.94	98.75	104.88	22.62	4.975	0.226	76.89	175.55	8879.51
9/11/96	15:00	-0.754	831.62	628.02	109.15	100.72	104.32	23.00	5.025	0.230	78.58	178.70	8905.7

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/11/96	16:00	-0.730	824.92	629.04	108.78	101.79	105.28	22.58	4.574	0.221	51.99	171.83	8794.08
9/11/96	17:00	-0.744	828.97	641.65	110.15	102.40	106.49	22.21	4.941	0.238	62.57	182.35	8668.00
9/11/96	18:00	-0.748	824.27	651.26	110.23	102.54	106.92	22.01	4.757	0.239	53.79	180.43	8836.82
9/11/96	19:00	-0.754	815.81	653.56	109.53	102.55	106.59	22.10	4.597	0.241	50.43	179.49	8971.25
9/11/96	20:00	-0.749	791.21	645.93	109.22	102.39	105.45	22.56	4.936	0.266	54.49	188.53	9173.48
9/11/96	21:00	-0.746	779.14	654.69	110.83	102.41	104.42	23.02	5.054	0.280	53.88	193.26	9251.50
9/11/96	22:00	-0.751	766.21	653.80	110.55	102.34	103.61	23.16	4.616	0.275	46.29	187.09	9246.92
9/11/96	23:00	-0.746	757.80	654.75	111.08	102.13	103.05	23.30	4.782	0.289	47.95	191.43	9220.67
9/12/96	0:00	-0.751	735.73	648.50	108.83	101.91	102.48	23.40	4.410	0.283	44.78	183.52	9251.75
9/12/96	1:00	-0.752	719.80	638.53	107.53	101.57	102.03	23.56	4.238	0.280	43.08	179.22	9505.42
9/12/96	2:00	-0.743	708.12	623.60	105.45	100.97	101.56	23.63	4.212	0.287	42.76	178.57	9522.67
9/12/96	3:00	-0.748	721.08	649.44	107.93	100.99	101.21	23.81	4.616	0.311	46.74	186.85	9516.74
9/12/96	4:00	-0.728	692.73	634.04	106.58	100.77	100.86	23.85	4.569	0.319	46.02	185.30	9531.42
9/12/96	5:00	-0.762	694.40	643.54	107.95	100.80	100.83	23.93	4.647	0.332	47.68	187.08	9537.25
9/12/96	6:00	-0.750	690.01	645.89	108.62	100.82	100.77	23.97	4.726	0.345	47.46	188.52	9547.80
9/12/96	7:00	-0.750	680.24	641.34	107.79	100.79	100.84	23.95	4.656	0.349	47.22	187.73	9532.33
9/12/96	8:00	-0.752	667.77	629.30	105.81	100.57	100.90	23.84	4.305	0.344	43.78	181.31	9518.17
9/12/96	9:00	-0.750	653.00	610.86	103.82	100.09	100.91	23.82	4.127	0.342	41.89	177.79	9498.08
9/12/96	10:00	-0.750	648.55	597.85	103.24	99.73	100.83	23.86	4.132	0.349	41.76	177.46	9491.50
9/12/96	11:00	-0.744	663.27	606.41	104.90	99.71	100.81	23.99	4.622	0.381	46.15	187.99	9513.05
9/12/96	12:00	-0.756	669.79	626.63	107.24	100.18	101.30	23.93	4.632	0.393	46.48	189.26	9305.92
9/12/96	13:00	-0.747	667.11	630.46	107.92	100.88	102.08	23.64	4.565	0.398	45.46	187.77	9376.08
9/12/96	14:00	-0.757	656.47	632.52	108.06	101.23	102.91	23.37	4.568	0.407	46.28	187.58	9242.88
9/12/96	15:00	-0.747	641.06	619.37	106.44	101.09	103.49	23.13	4.389	0.408	43.38	184.35	9314.00
9/12/96	16:00	-0.749	634.42	607.84	105.29	100.61	103.23	23.17	4.299	0.411	42.62	182.25	9666.50
9/12/96	17:00	-0.749	632.64	614.49	105.31	100.55	102.69	23.26	4.313	0.422	42.66	182.34	9663.58
9/12/96	18:00	-0.750	620.34	606.57	103.93	100.32	102.48	23.24	4.038	0.415	40.81	176.28	9697.00
9/12/96	19:00	-0.747	612.79	593.21	102.48	99.83	102.07	23.33	4.014	0.421	40.63	175.57	9666.08
9/12/96	20:00	-0.713	637.74	606.90	103.68	99.57	101.22	23.73	4.449	0.459	49.42	184.69	9692.17
9/12/96	21:00	-0.755	738.87	642.14	105.98	99.91	100.06	24.15	4.333	0.468	44.20	183.54	9717.88
9/12/96	22:00	-0.747	735.84	640.68	105.34	95.11	99.33	24.33	4.412	0.490	44.91	185.41	9765.17
9/12/96	23:00	-0.748	707.50	620.05	103.07	89.63	97.66	24.60	4.034	0.465	40.70	173.25	9723.25
9/13/96	0:00	-0.747	703.17	609.79	101.73	94.29	93.39	25.64	4.087	0.477	40.60	172.72	9743.00
9/13/96	1:00	-0.751	703.95	612.20	101.53	96.04	91.54	26.25	4.151	0.498	41.11	174.17	9758.33
9/13/96	2:00	-0.741	727.60	624.65	102.64	97.10	92.29	26.13	4.646	0.547	48.04	184.96	9758.75
9/13/96	3:00	-0.749	766.01	636.53	103.59	98.00	94.15	25.72	5.200	0.599	50.95	197.19	[illegible]46.83
9/13/96		-0.747	767.50	646.87	104.78	97.83	95.70	25.28	5.289	0.620	53.53	199.[illegible]	[illegible].50
9/13/96		-0.745	766.29	643.75	104.71	97.76	96.45	25.07	5.252	0.630	54.41	199.5[illegible]	[illegible].17
9/13/96	[illegible]	-0.747	755.07	643.25	104.22	97.50	96.68	25.01	5.275	0.641	56.57	199.77	9768.67
9/13/96	7:00	-0.750	721.01	638.48	104.02	97.31	96.60	25.03	5.146	0.644	54.65	197.77	9758.00

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/13/96	8:00	-0.750	716.54	632.89	103.37	97.25	96.52	25.01	4.990	0.646	51.89	195.47	9724.42
9/13/96	9:00	-0.751	697.31	615.94	101.74	96.83	96.49	24.98	4.659	0.365	44.90	188.10	9730.17
9/13/96	10:00	-0.388	689.00	615.84	104.27	96.97	96.56	25.08	5.834	0.226	85.98	209.93	9739.92
9/13/96	11:00	-0.690	700.03	622.32	105.40	97.38	97.22	24.93	5.680	0.223	65.54	206.51	9744.92
9/13/96	12:00	-0.751	708.41	619.79	103.99	97.42	98.06	24.67	5.326	0.218	52.07	200.64	9742.75
9/13/96	13:00	-0.750	709.45	618.05	103.33	97.95	98.27	24.58	5.083	0.212	49.47	196.47	9709.58
9/13/96	14:00	-0.749	718.34	622.47	103.02	97.34	98.61	24.46	5.021	0.210	49.10	195.05	9707.97
9/13/96	15:00	-0.762	693.56	598.25	100.75	97.12	98.35	24.35	4.179	0.188	44.52	177.37	9703.48
9/13/96	16:00	-0.735	676.42	568.05	97.87	95.20	98.02	24.40	4.457	0.196	44.15	184.25	9674.83
9/13/96	17:00	-0.748	677.85	566.05	97.27	91.31	97.54	25.07	6.843	0.263	61.13	248.38	9769.58
9/13/96	18:00	-0.749	682.56	580.14	97.62	91.27	95.30	25.77	6.939	0.266	63.08	250.57	9809.17
9/13/96	19:00	-0.671	806.11	623.65	111.84	90.91	94.08	26.13	7.003	0.265	84.36	248.07	9778.67
9/13/96	20:00	-0.552	997.30	736.41	140.10	110.18	94.13	26.08	6.745	0.255	100.00	235.92	9585.00
9/13/96	21:00	-0.469	881.47	677.33	134.44	113.91	105.55	22.74	7.397	0.263	99.99	239.23	9546.78
9/13/96	22:00	-0.664	799.21	581.35	112.76	103.93	112.61	20.07	7.571	0.285	93.35	261.24	9732.83
9/13/96	23:00	-0.559	873.84	678.82	138.39	110.51	106.80	21.97	6.914	0.263	100.00	240.45	9666.10
9/14/96	0:00	-0.611	832.79	654.10	135.22	112.62	109.27	21.27	7.101	0.267	99.74	241.99	9649.58
9/14/96	1:00	-0.526	772.80	618.55	133.12	111.08	111.60	20.24	6.976	0.254	100.00	232.46	9688.42
9/14/96	2:00	-0.523	732.34	577.62	122.07	109.30	110.14	20.71	6.942	0.246	93.74	229.23	9707.08
9/14/96	3:00	-0.673	839.41	627.69	134.44	108.10	107.98	21.59	7.132	0.251	91.40	234.24	9770.00
9/14/96	4:00	-0.623	814.30	651.16	137.24	112.42	108.02	21.67	7.374	0.250	100.00	232.17	9795.25
9/14/96	5:00	-0.495	764.11	610.57	133.06	110.03	110.09	20.71	6.975	0.235	100.00	216.42	9678.14
9/14/96	6:00	-0.598	692.49	520.41	109.15	103.60	108.53	21.33	7.330	0.251	83.98	239.85	9591.75
9/14/96	7:00	-0.716	788.04	632.32	137.03	106.85	103.80	22.92	6.984	0.242	99.60	228.06	9645.58
9/14/96	8:00	-0.750	711.00	594.16	135.63	110.86	103.99	22.92	6.569	0.229	83.14	216.72	9679.50
9/14/96	9:00	-0.632	662.75	546.83	130.43	106.65	107.82	21.25	5.966	0.216	93.32	198.01	9568.33
9/14/96	10:00	-0.723	661.23	465.24	97.81	105.62	106.25	21.44	4.804	0.193	57.20	182.42	9564.24
9/14/96	11:00	-0.734	631.43	445.57	94.09	105.05	103.02	21.53	2.816	0.142	36.50	133.29	9507.17
9/14/96	12:00	-0.735	647.32	437.60	95.38	100.11	102.91	22.30	3.820	0.177	44.80	166.00	9486.75
9/14/96	13:00	-0.721	614.78	438.65	96.03	98.33	101.57	22.80	4.573	0.198	55.01	182.03	9495.25
9/14/96	14:00	-0.747	1046.86	464.62	94.05	96.42	99.62	23.29	2.745	0.154	36.35	146.19	9352.75
9/14/96	15:00	-0.738	1054.57	514.90	93.97	97.23	98.51	23.42	2.490	0.148	35.70	139.08	9396.25
9/14/96	16:00	-0.734	1134.96	612.49	119.00	102.87	97.46	23.79	3.349	0.165	50.04	147.94	9438.83
9/14/96	17:00	-0.745	1035.94	713.01	148.39	136.51	100.69	22.81	3.683	0.172	44.33	150.23	9033.17
9/14/96	18:00	-0.765	920.51	634.87	146.45	136.52	125.76	12.86	4.582	0.208	50.26	176.15	9114.33
9/14/96	19:00	-0.746	901.68	608.14	142.03	131.64	132.03	8.17	4.861	0.220	52.84	184.84	9534.08
9/14/96	20:00	-0.739	867.52	607.74	144.44	133.27	130.14	9.55	5.339	0.228	71.77	193.51	969[illegible]
9/14/96	21:00	-0.751	852.99	585.82	138.28	129.17	130.05	9.71	5.369	0.226	60.98	195.49	974[illegible]
9/14/96	22:00	-0.746	765.40	504.95	103.44	109.86	124.84	12.48	4.622	0.210	44.83	193.49	9724
9/14/96	23:00	-0.749	831.47	491.41	97.02	100.32	111.97	18.64	4.047	0.194	40.69	182.77	990[illegible]

VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/15/96	0:00	-0.732	866.54	507.26	96.29	98.57	102.40	22.44	3.799	0.181	41.22	175.64	9807.17
9/15/96	1:00	-0.755	921.00	524.38	96.58	98.05	98.01	24.11	3.665	0.175	42.10	172.50	9782.75
9/15/96	2:00	-0.751	968.64	559.56	96.37	97.94	95.77	24.74	3.384	0.166	39.07	158.59	9799.75
9/15/96	3:00	-0.751	986.23	578.07	96.66	98.16	94.16	25.09	3.449	0.168	39.50	160.43	9756.08
9/15/96	4:00	-0.753	981.62	587.91	96.52	98.18	93.67	25.19	3.355	0.165	39.37	161.01	9716.61
9/15/96	5:00	-0.749	978.35	589.47	95.68	89.07	93.40	25.14	3.275	0.163	39.29	162.76	9738.00
9/15/96	6:00	-0.750	978.04	590.87	94.10	90.48	92.32	25.40	3.227	0.160	39.25	164.41	9841.67
9/15/96	7:00	-0.751	980.43	591.16	94.89	93.89	89.16	26.26	3.116	0.156	39.14	156.47	9935.92
9/15/96	8:00	-0.752	981.75	593.13	95.11	95.39	87.95	26.47	2.995	0.152	38.95	163.72	9828.17
9/15/96	9:00	-0.751	972.55	597.16	96.02	96.80	89.63	25.96	2.966	0.227	38.53	170.43	9771.33
9/15/96	10:00	-0.730	1085.37	672.05	118.02	104.91	92.40	25.18	3.648	0.323	53.99	184.88	9776.17
9/15/96	11:00	-0.770	1092.58	760.15	150.90	135.36	100.17	22.94	3.488	0.312	45.48	173.19	9511.78
9/15/96	12:00	-0.745	1001.80	695.54	147.59	136.61	125.33	11.97	3.474	0.282	40.53	170.95	9339.31
9/15/96	13:00	-0.752	930.78	637.30	139.04	134.17	131.67	7.04	3.137	0.252	38.10	161.57	9074.25
9/15/96	14:00	-0.742	882.42	610.88	137.57	131.68	130.66	7.43	3.512	0.273	42.58	160.03	9115.17
9/15/96	15:00	-0.751	828.87	576.34	135.61	132.05	128.88	8.01	3.014	0.254	37.96	160.25	9146.58
9/15/96	16:00	-0.751	793.25	552.15	133.11	130.91	128.30	8.25	3.106	0.259	38.38	161.24	9069.92
9/15/96	17:00	-0.751	764.52	540.78	133.82	130.83	127.43	8.82	3.416	0.267	40.31	146.83	9107.58
9/15/96	18:00	-0.746	740.45	526.77	132.50	129.81	127.33	9.06	3.512	0.269	41.56	137.87	9126.58
9/15/96	19:00	-0.749	714.52	507.01	130.84	127.77	126.11	9.87	3.753	0.272	50.43	134.17	9330.83
9/15/96	20:00	-0.703	761.42	489.29	117.22	114.79	124.18	11.77	4.153	0.297	58.82	143.25	9291.25
9/15/96	21:00	-0.723	747.31	529.98	121.15	119.45	117.08	15.16	4.020	0.280	68.86	138.12	9348.42
9/15/96	22:00	-0.771	894.72	544.52	121.33	114.78	114.39	17.20	3.854	0.286	49.64	154.69	9480.33
9/15/96	23:00	-0.749	845.16	618.94	136.03	126.81	114.67	17.29	4.223	0.303	43.32	163.93	9577.92
9/16/96	0:00	-0.756	804.33	574.35	123.95	123.14	121.52	13.88	4.384	0.314	42.48	169.68	9579.58
9/16/96	1:00	-0.749	794.35	503.11	98.45	108.67	119.52	14.35	3.682	0.290	38.78	159.46	9603.42
9/16/96	2:00	-0.746	883.35	530.66	97.27	101.67	111.22	18.38	3.790	0.285	40.26	158.53	9637.92
9/16/96	3:00	-0.751	886.13	534.05	95.71	99.44	104.36	21.09	3.213	0.259	38.04	142.48	9558.00
9/16/96	4:00	-0.744	918.82	542.25	96.26	99.24	100.62	22.60	3.371	0.264	39.88	144.49	9564.67
9/16/96	5:00	-0.704	1086.88	660.33	126.55	110.94	98.25	23.30	3.676	0.260	67.35	136.47	9398.98
9/16/96	6:00	-0.781	1026.53	692.87	133.30	127.88	105.16	21.39	4.120	0.284	49.48	150.63	9425.25
9/16/96	7:00	-0.748	1063.03	683.62	135.49	124.94	119.17	15.21	4.447	0.302	47.56	152.67	9506.50
9/16/96	8:00	-0.747	1076.20	694.16	137.45	125.54	120.25	14.23	4.707	0.308	52.97	154.97	9593.67
9/16/96	9:00	-0.610	999.47	703.53	139.54	126.90	121.21	13.71	5.475	0.335	86.99	167.86	9632.17
9/16/96	10:00	-0.731	1077.48	693.55	139.03	125.03	122.47	13.26	5.549	0.344	81.02	173.27	9623.42
9/16/96	11:00	-0.648	1070.63	700.98	138.54	125.65	121.39	13.39	5.221	0.321	100.00	157.36	9636.50
9/16/[illegible]	0	-0.560	1058.51	676.78	134.89	124.55	121.2[illegible]	13.04	4.746	0.285	100.00	139[illegible]	41.44
9/16/[illegible]	[illegible]	-0.528	960.27	637.98	128.60	120.03	120.1[illegible]	13.49	4.653	0.290	86.11	142[illegible]	26.95
9/16/96	[illegible]:00	-0.677	993.96	704.91	140.93	133.16	119.06	13.86	4.540	0.284	95.93	138.88	9041.17
9/16/96	15:00	-0.703	911.96	660.43	139.65	131.84	126.57	10.11	5.103	0.309	99.98	149.82	9345.75

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 TRANSITION GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/16/96	16:00	-0.698	854.30	629.84	141.26	133.30	127.69	9.17	5.280	0.312	99.97	149.17	9206.42
9/16/96	17:00	-0.682	773.37	589.90	137.02	132.52	129.44	8.38	4.863	0.325	98.43	153.58	9223.33
9/16/96	18:00	-0.746	735.18	556.96	131.95	126.70	127.35	9.57	4.750	0.325	87.96	152.65	9364.33
9/16/96	19:00	-0.720	732.91	560.25	133.27	128.21	123.44	11.96	4.618	0.315	99.40	147.02	9326.67
9/16/96	20:00	-0.756	751.08	560.73	129.89	125.89	123.21	12.49	4.786	0.330	76.08	155.71	9453.92
9/16/96	21:00	-0.748	747.25	564.92	129.57	126.02	121.87	13.16	4.761	0.332	75.67	154.75	9409.33
9/16/96	22:00	-0.739	734.98	554.45	128.59	123.65	121.37	13.42	4.496	0.323	58.42	149.29	9590.50
9/16/96	23:00	-0.699	778.10	563.88	122.54	121.33	120.45	14.14	4.846	0.344	80.21	155.60	9516.42
9/17/96	0:00	-0.717	808.72	570.95	115.59	112.29	117.39	15.59	4.778	0.332	64.61	149.97	9695.67

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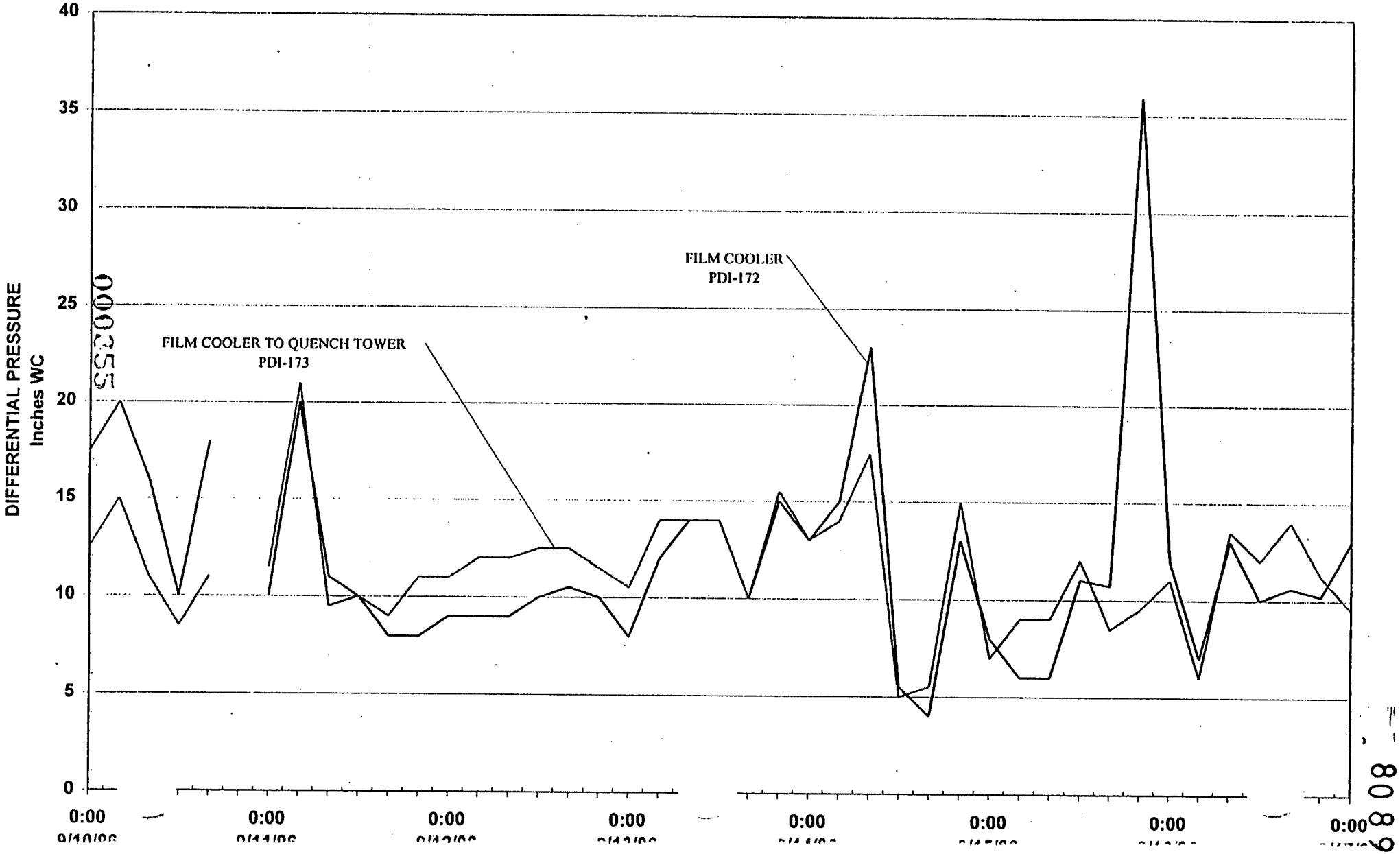
CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



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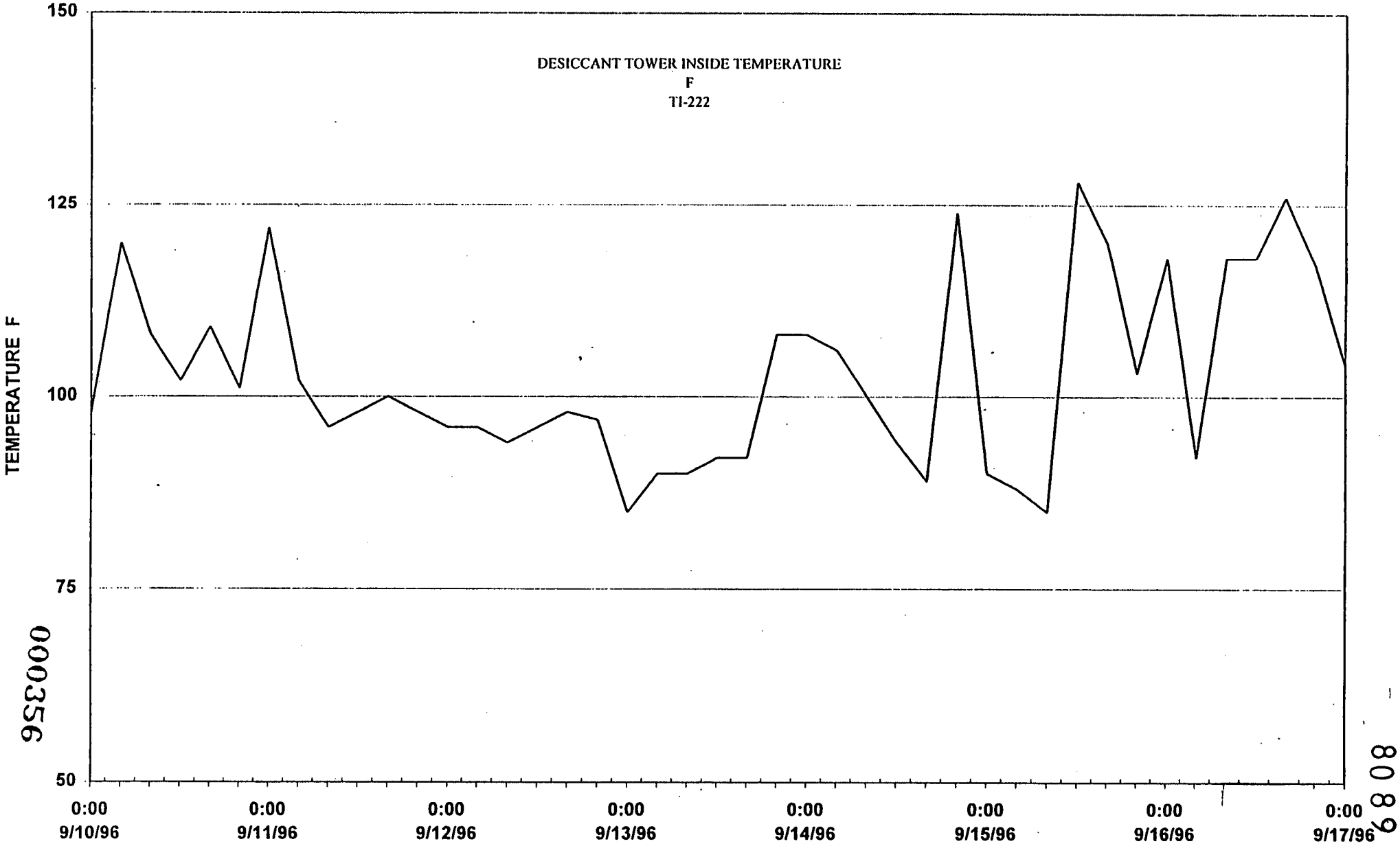
CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



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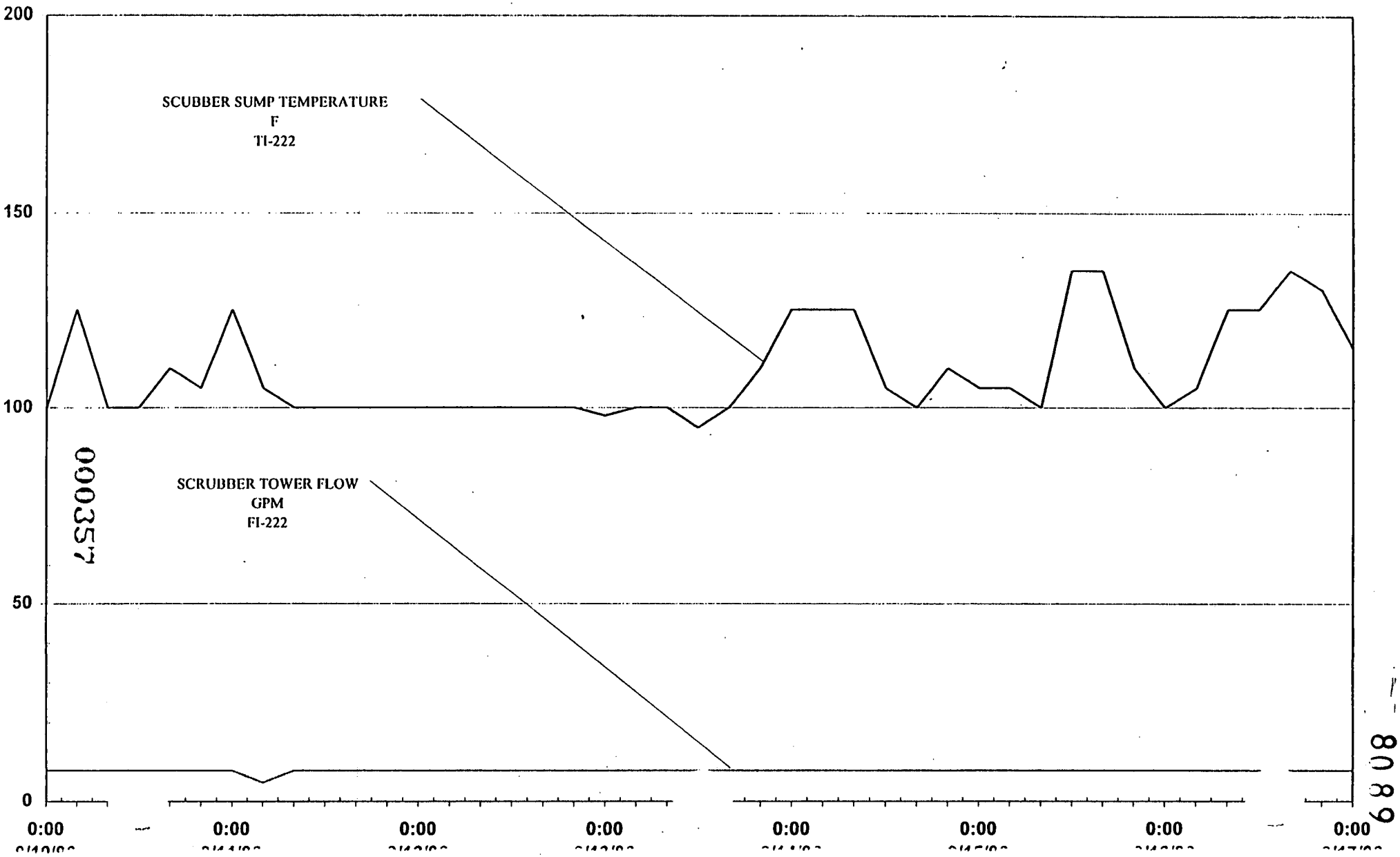
CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



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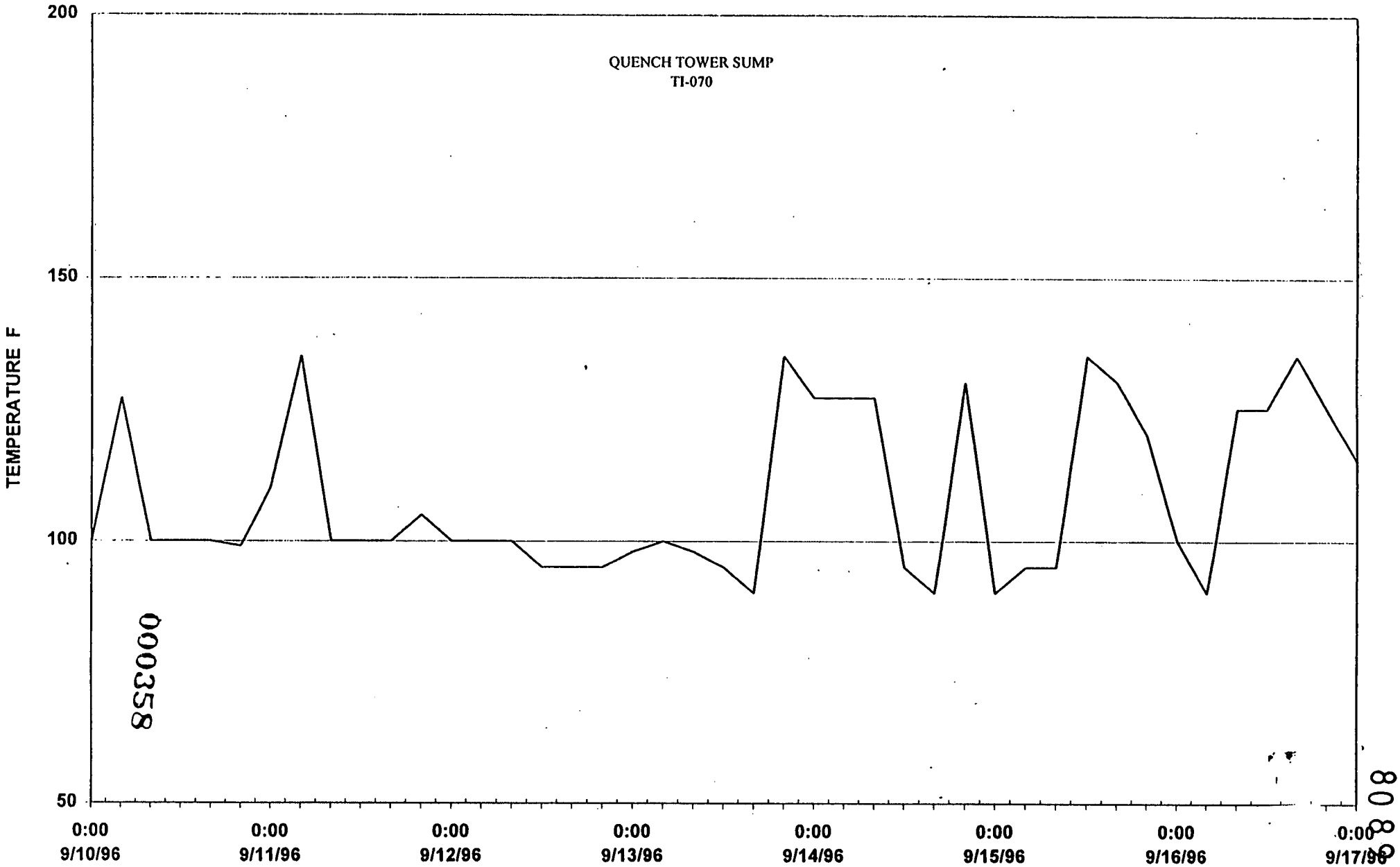
CAMPAIGN 2
TRANSITION GLASS
FURNACE OFFGAS SYSTEM



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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 TRANSITION GLASS

ROUNDSHEET DATA

READINGS		FILM COOLER DIFF PRESS	FILM COOLER TO QT DIFF PRESS	QUENCH TOWER SUMP TEMP	SCRUBBER TOWER VACUUM	SCRUBBER SUMP TEMP	SCRUBBER TOWER FLOW	DESICCANT TOWER INTERNAL TEMP	DESICCANT TOWER VACUUM
		PDI-172	PDI-173	TI-070	PI-222	TI-222	FI-222	TI-210	PI-210
DATE	HOUR	In WC	In WC	F	In WC	F	GPM	F	In WC
9/10/96	0:00	17.5	12.5	100	0.4	100	8	98	OUT OF SERVICE
9/10/96	4:00	20.0	15.0	127	0.4	125	8	120	
9/10/96	8:00	16.0	11.0	100	1.7	100	8	108	
9/10/96	12:00	10.0	8.5	100	3.0	100	8	102	
9/10/96	16:00	18.0	11.0	100	1.2	110	8	109	
9/10/96	20:00			99	1.0	105	8	101	
9/11/96	0:00	10.0	11.5	110	2.0	125	8	122	
9/11/96	4:00	20.0	21.0	135	3.5	105	5	102	
9/11/96	8:00	11.0	9.5	100	1.5	100	8	96	
9/11/96	12:00	10.0	10.0	100	3.0	100	8	98	
9/11/96	16:00	8.0	9.0	100	3.3	100	8	100	
9/11/96	20:00	8.0	11.0	105	2.5	100	8	98	
9/12/96	0:00	9.0	11.0	100	2.0	100	8	96	
9/12/96	4:00	9.0	12.0	100	2.0	100	8	96	
9/12/96	8:00	9.0	12.0	100	2.1	100	8	94	
9/12/96	12:00	10.0	12.5	95	3.1	100	8	96	
9/12/96	16:00	10.5	12.5	95	3.1	100	8	98	
9/12/96	20:00	10.0	11.5	95	2.4	100	8	97	
9/13/96	0:00	8.0	10.5	98	0.4	98	8	85	
9/13/96	4:00	12.0	14.0	100	0.4	100	8	90	
9/13/96	8:00	14.0	14.0	98	2.4	100	8	90	
9/13/96	12:00	14.0	14.0	95	3.2	95	8	92	
9/13/96	16:00	10.0	10.0	90	2.1	100	8	92	
9/13/96	20:00	15.0	15.5	135	2.9	110	8	108	
9/14/96	0:00	13.0	13.0	127	2.0	125	8	108	
9/14/96	4:00	15.0	14.0	127	2.0	125	8	106	
9/14/96	8:00	23.0	17.5	127	2.0	125	8	100	
9/14/96	12:00	5.5	5.0	95	2.5	105	8	94	
9/14/96	16:00	4.0	5.5	90	1.4	100	8	89	
9/14/96	20:00	13.0	15.0	130	1.5	110	8	124	
9/15/96	0:00	8.0	7.0	90	0.0	105	8	90	
9/15/96	4:00	6.0	9.0	95	0.0	105	8	88	
9/15/96	8:00	6.0	9.0	95	0.0	100	8	85	
9/15/96	12:00	11.0	12.0	135	3.0	135	8	128	
9/15/96	16:00	10.7	8.5	130	2.5	135	8	120	
9/15/96	20:00	35.9	9.5	120	3.0	110	8	103	
9/16/96	0:00	12.0	11.0	100	2.0	100	8	118	
9/16/96	4:00	7.0	6.0	90	0.5	105	8	92	
9/16/96	8:00	13.0	13.5	125	3.0	125	8	118	
9/16/96	12:00	10.0	12.0	125	3.2	125	8	118	
9/16/96	16:00	10.6	14.0	135	3.8	135	8	126	
9/16/96	20:00	10.2	11.2	125	3.5	130	8	117	
9/17/96	0:00	13.0	9.5	115	3.0	115	8	104	

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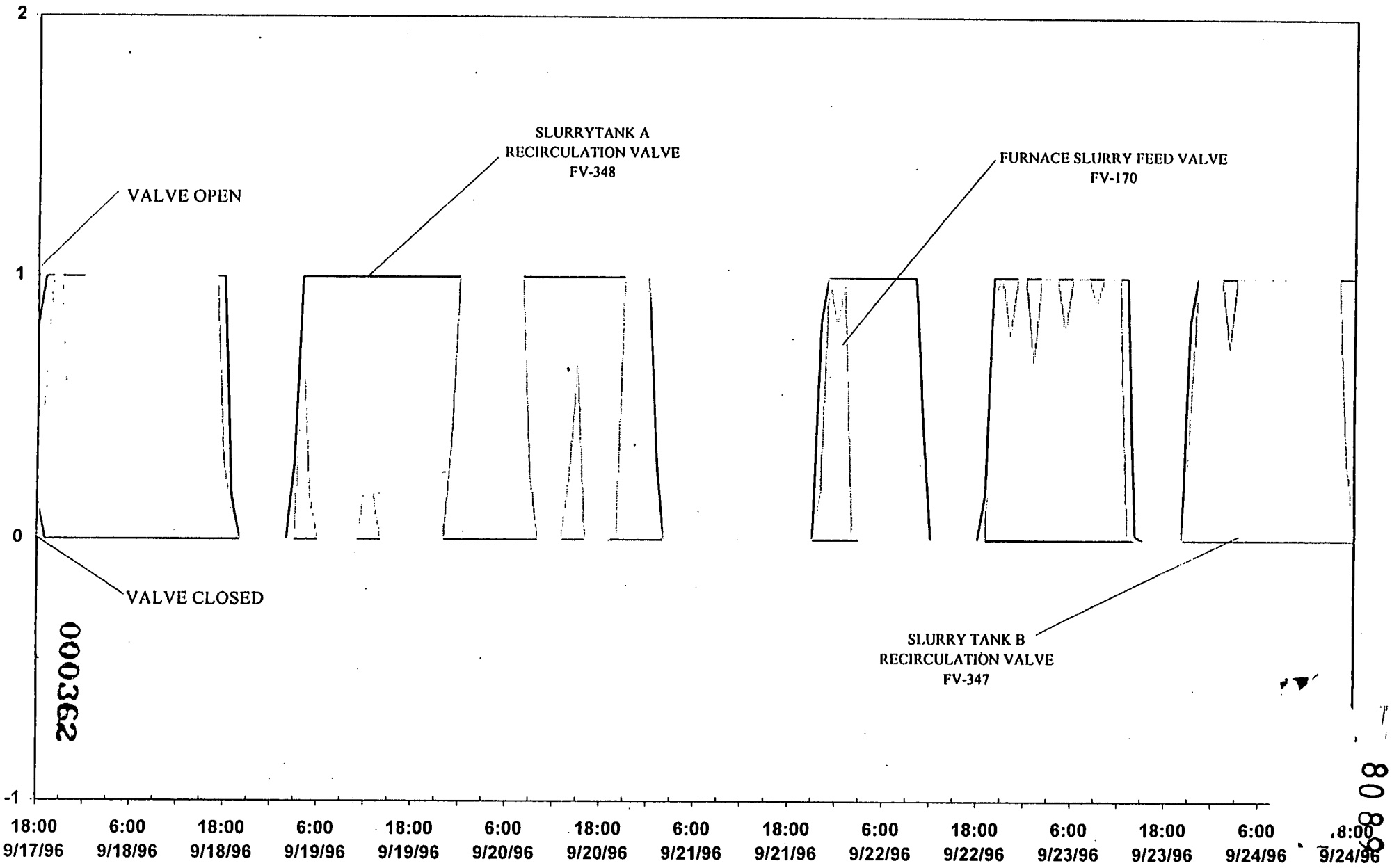
Appendix D3
Series D Glass

FEED PREPARATION SYSTEM

CAMPAIGN 2
SERIES D GLASS
FEED PREPARATION SYSTEM



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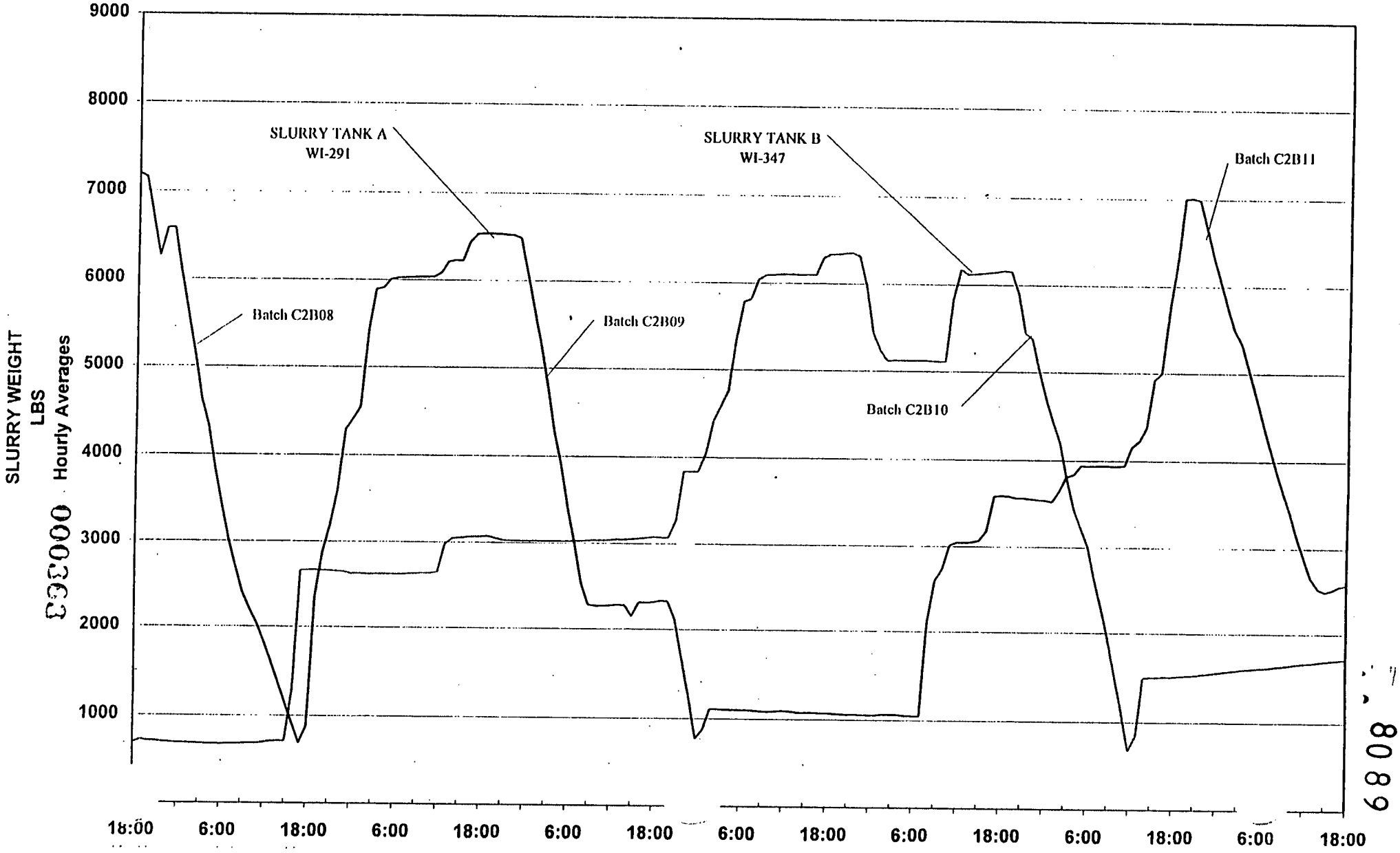
C2FDPRP.XLS Chart 4

VHP 10/28/96

CAMPAIGN 2
SERIES D GLASS
FEED PREPARATION SYSTEM



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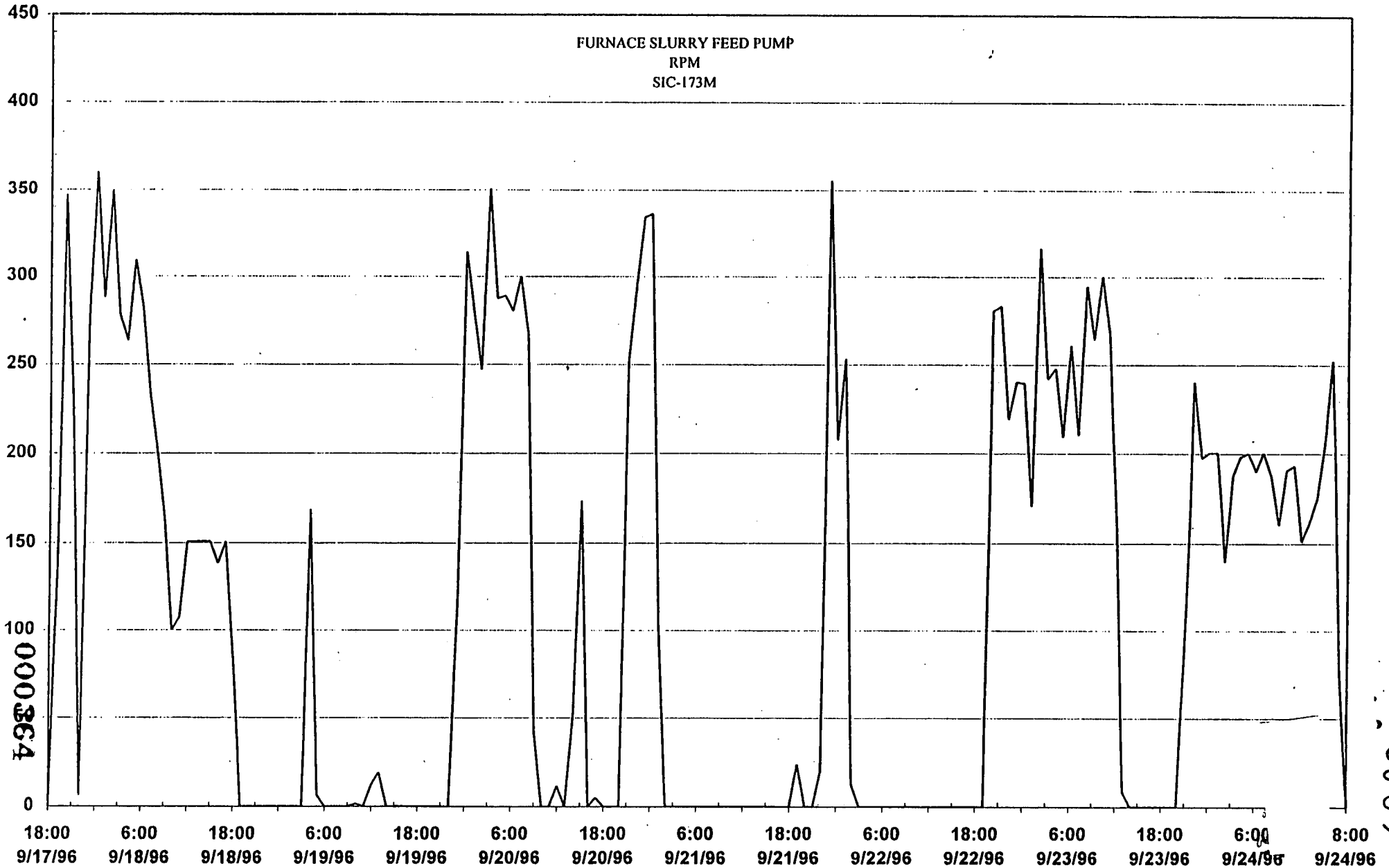
CAMPAIGN 2
SERIES D GLASS
FEED PREPARATION SYSTEM



C2FDPRP.XLS Chart 6

VHP 10/28/96

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VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM
CAMPAIGN 2 SERIES D GLASS

READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY RECIRC VALVE	WEIGHT	SLURRY RECIRC VALVE	RECIRC FLOW	SLURRY FEED VALVE	SLURRY FEED PUMP RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/17/96	18:00	7198.17	0.8	695.00	0.2	39.95	0.0	4.23
9/17/96	19:00	7158.96	1.0	725.17	0.0	46.53	0.6	134.67
9/17/96	20:00	6709.00	1.0	715.21	0.0	44.33	1.0	347.07
9/17/96	21:00	6266.21	1.0	711.79	0.0	44.36	1.0	224.00
9/17/96	22:00	6583.58	1.0	704.63	0.0	48.44	0.4	6.08
9/17/96	23:00	6586.29	1.0	699.79	0.0	50.24	0.8	275.81
9/18/96	0:00	6077.13	1.0	694.71	0.0	50.09	1.0	360.36
9/18/96	1:00	5613.22	1.0	692.54	0.0	50.00	1.0	288.02
9/18/96	2:00	5150.25	1.0	689.42	0.0	50.04	1.0	349.65
9/18/96	3:00	4624.08	1.0	686.58	0.0	49.62	1.0	278.06
9/18/96	4:00	4323.29	1.0	684.46	0.0	49.46	1.0	263.26
9/18/96	5:00	3841.88	1.0	683.83	0.0	49.38	1.0	309.28
9/18/96	6:00	3411.71	1.0	679.79	0.0	49.38	1.0	283.07
9/18/96	7:00	3015.04	1.0	684.08	0.0	49.34	1.0	234.65
9/18/96	8:00	2705.96	1.0	686.13	0.0	48.55	1.0	200.83
9/18/96	9:00	2405.71	1.0	688.04	0.0	47.03	1.0	164.02
9/18/96	10:00	2213.63	1.0	691.88	0.0	46.99	1.0	100.09
9/18/96	11:00	2047.83	1.0	692.25	0.0	47.43	1.0	107.33
9/18/96	12:00	1837.04	1.0	700.75	0.0	46.99	1.0	150.69
9/18/96	13:00	1611.13	1.0	712.88	0.0	45.82	1.0	150.88
9/18/96	14:00	1378.17	1.0	717.04	0.0	47.13	1.0	150.99
9/18/96	15:00	1139.21	1.0	715.33	0.0	47.60	1.0	150.66
9/18/96	16:00	916.83	1.0	1305.29	0.0	47.53	1.0	138.24
9/18/96	17:00	691.46	1.0	2660.83	0.0	46.18	1.0	150.67
9/18/96	18:00	876.00	1.0	2667.00	0.0	45.34	0.3	83.69
9/18/96	19:00	2337.25	0.2	2670.46	0.0	2.56	0.1	0.07
9/18/96	20:00	2873.42	0.0	2664.33	0.0	0.00	0.0	0.08
9/18/96	21:00	3194.29	0.0	2660.92	0.0	0.00	0.0	0.08
9/18/96	22:00	3600.17	0.0	2656.17	0.0	0.00	0.0	0.06
9/18/96	23:00	4288.50	0.0	2647.67	0.0	0.00	0.0	0.08
9/19/96	0:00	4407.58	0.0	2624.79	0.0	0.00	0.0	0.07
9/19/96	1:00	4541.00	0.0	2627.00	0.0	0.00	0.0	0.07
9/19/96	2:00	5420.33	0.0	2622.88	0.0	0.00	0.0	0.07
9/19/96	3:00	5893.18	0.3	2622.84	0.0	9.86	0.0	0.09
9/19/96	4:00	5909.00	1.0	2624.75	0.0	36.89	0.8	168.71
9/19/96	5:00	6010.92	1.0	2624.71	0.0	44.89	0.2	6.18
9/19/96	6:00	6027.00	1.0	2622.83	0.0	45.74	0.0	0.06
9/19/96	7:00	6031.54	1.0	2622.75	0.0	46.10	0.0	0.08
9/19/96	8:00	6035.21	1.0	2627.25	0.0	46.44	0.0	0.07
9/19/96	9:00	6037.75	1.0	2633.25	0.0	46.85	0.0	0.08
9/19/96	10:00	6037.96	1.0	2637.17	0.0	47.20	0.0	1.49
9/19/96	11:00	6041.21	1.0	2638.42	0.0	47.79	0.0	0.07
9/19/96	12:00	6086.83	1.0	2651.50	0.0	48.35	0.2	11.90
9/19/96	13:00	6214.00	1.0	2977.25	0.0	48.19	0.2	19.19
9/19/96	14:00	6230.88	1.0	3047.29	0.0	48.29	0.0	0.07
9/19/96	15:00	6226.04	1.0	3055.21	0.0	48.59	0.0	0.05
9/19/96	16:00	6440.29	1.0	3063.54	0.0	49.70	0.0	0.08
9/19/96	17:00	6530.29	1.0	3067.88	0.0	50.22	0.0	0.07
9/19/96	18:00	6535.33	1.0	3071.04	0.0	50.20	0.0	0.08
9/19/96	19:00	6538.04	1.0	3074.75	0.0	50.20	0.0	0.08
9/19/96	20:00	6532.71	1.0	3051.58	0.0	49.92	0.0	0.06
9/19/96	21:00	6526.67	1.0	3031.17	0.0	47.35	0.0	0.06
9/19/96	22:00	6521.54	1.0	3026.67	0.0	46.80	0.0	0.05
9/19/96	23:00	6491.08	1.0	3025.21	0.0	46.91	0.4	114.17
9/20/96	0:00	6101.88	1.0	3023.42	0.0	47.14	1.0	314.27
9/20/96	1:00	5669.83	1.0	3023.46	0.0	46.91	1.0	279.14
9/20/96	2:00	5278.67	1.0	3024.25	0.0	46.82	1.0	247.01
9/20/96	3:00	4789.92	1.0	3023.67	0.0	46.77	1.0	350.71
9/20/96	4:00	4287.13	1.0	3023.46	0.0	46.42	1.0	287.59
9/20/96	5:00	3895.04	1.0	3023.38	0.0	46.34	1.0	288.85
9/20/96	6:00	3405.25	1.0	3024.83	0.0	45.91	1.0	280.40
9/20/96	7:00	3002.04	1.0	3024.04	0.0	45.33	1.0	299.91
9/20/96	8:00	2532.75	1.0	3029.50	0.0	45.02	1.0	266.87
9/20/96	9:00	2284.92	1.0	3034.88	0.0	45.15	0.3	41.76
9/20/96	10:00	2274.21	1.0	3037.54	0.0	45.64	0.0	0.07
9/20/96	11:00	2272.83	1.0	3037.25	0.0	44.98	0.0	0.07

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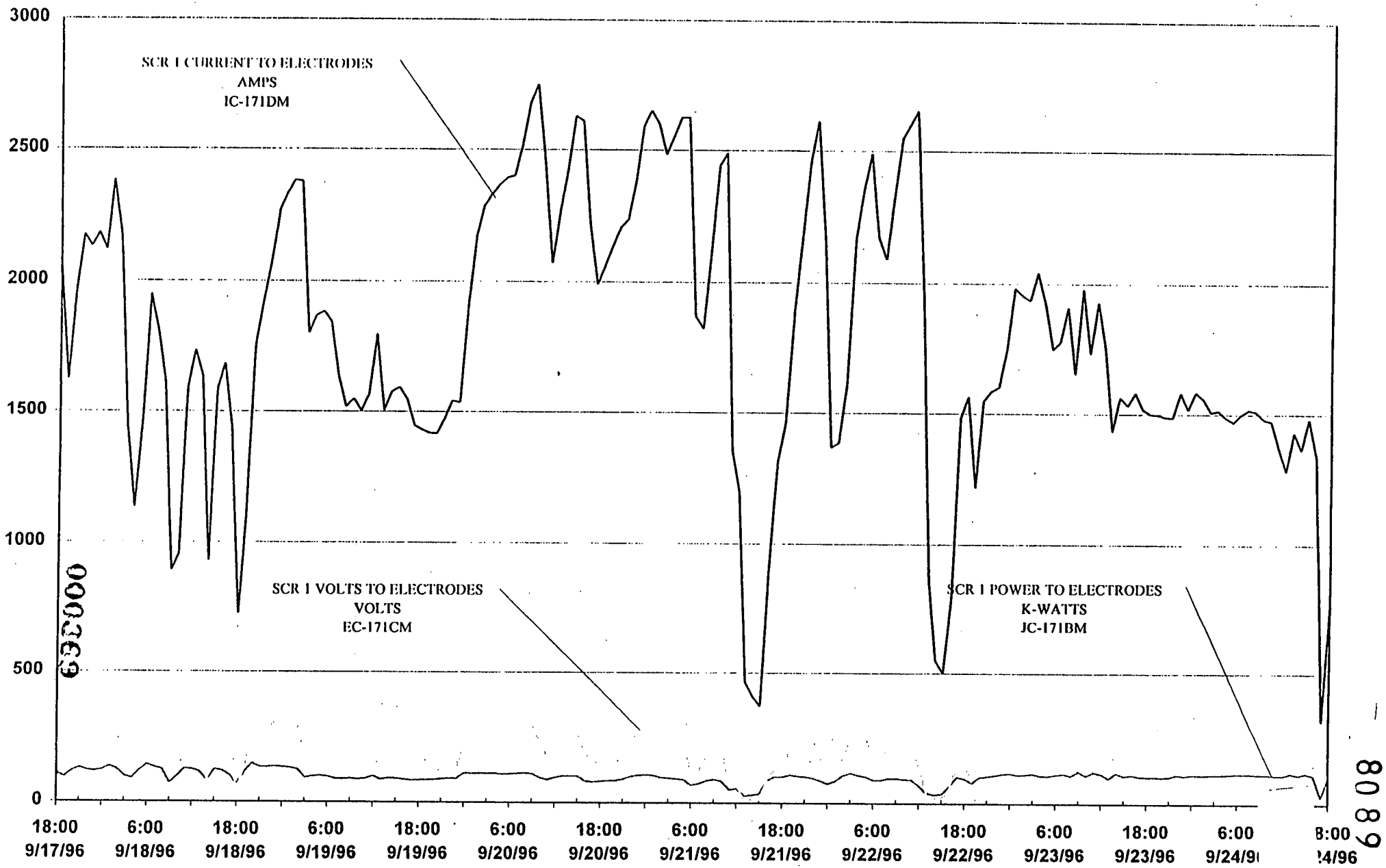
VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM
CAMPAIGN 2 SERIES D GLASS

READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY RECIRC VALVE	WEIGHT	SLURRY RECIRC VALVE	RECIRC FLOW	SLURRY FEED VALVE	SLURRY FEED PUMP RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/20/96	12:00	2276.83	1.0	3041.04	0.0	45.17	0.0	11.44
9/20/96	13:00	2286.50	1.0	3049.63	0.0	45.10	0.0	0.07
9/20/96	14:00	2281.83	1.0	3050.38	0.0	45.09	0.3	50.73
9/20/96	15:00	2153.04	1.0	3054.38	0.0	45.50	0.7	173.59
9/20/96	16:00	2318.17	1.0	3062.21	0.0	47.46	0.0	0.04
9/20/96	17:00	2313.79	1.0	3070.17	0.0	47.51	0.0	4.91
9/20/96	18:00	2319.63	1.0	3080.29	0.0	47.35	0.0	0.06
9/20/96	19:00	2338.21	1.0	3076.13	0.0	47.43	0.0	0.06
9/20/96	20:00	2330.96	1.0	3073.54	0.0	47.41	0.0	0.08
9/20/96	21:00	2119.79	1.0	3271.96	0.0	47.46	1.0	251.67
9/20/96	22:00	1679.25	1.0	3837.63	0.0	47.35	1.0	295.75
9/20/96	23:00	1254.21	1.0	3839.25	0.0	47.34	1.0	334.35
9/21/96	0:00	774.58	1.0	3838.88	0.0	43.09	1.0	336.21
9/21/96	1:00	876.92	0.4	4042.92	0.0	10.35	0.3	104.71
9/21/96	2:00	1108.92	0.0	4414.38	0.0	0.00	0.0	0.07
9/21/96	3:00	1106.67	0.0	4583.17	0.0	0.00	0.0	0.07
9/21/96	4:00	1101.27	0.0	4762.42	0.0	0.00	0.0	0.07
9/21/96	5:00	1101.29	0.0	5349.67	0.0	0.00	0.0	0.07
9/21/96	6:00	1098.00	0.0	5782.88	0.0	0.00	0.0	0.08
9/21/96	7:00	1098.00	0.0	5813.54	0.0	0.00	0.0	0.07
9/21/96	8:00	1094.63	0.0	6043.25	0.0	0.00	0.0	0.08
9/21/96	9:00	1085.54	0.0	6094.33	0.0	0.00	0.0	0.07
9/21/96	10:00	1084.75	0.0	6097.96	0.0	0.00	0.0	0.07
9/21/96	11:00	1090.13	0.0	6105.58	0.0	0.00	0.0	0.07
9/21/96	12:00	1092.88	0.0	6108.13	0.0	0.00	0.0	0.06
9/21/96	13:00	1088.00	0.0	6104.54	0.0	0.00	0.0	0.06
9/21/96	14:00	1079.00	0.0	6100.08	0.0	0.00	0.0	0.08
9/21/96	15:00	1076.00	0.0	6104.08	0.0	0.00	0.0	0.07
9/21/96	16:00	1077.79	0.0	6101.54	0.0	0.00	0.0	0.07
9/21/96	17:00	1072.59	0.0	6296.65	0.0	0.00	0.0	0.07
9/21/96	18:00	1073.71	0.0	6336.68	0.0	0.00	0.0	0.08
9/21/96	19:00	1067.75	0.0	6337.46	0.0	0.00	0.0	23.72
9/21/96	20:00	1063.47	0.0	6345.79	0.0	0.00	0.0	0.06
9/21/96	21:00	1059.58	0.0	6353.54	0.0	0.00	0.0	0.06
9/21/96	22:00	1060.25	0.0	6316.58	0.8	33.36	0.2	19.71
9/21/96	23:00	1055.25	0.0	5971.71	1.0	40.65	1.0	355.72
9/22/96	0:00	1053.96	0.0	5433.08	1.0	39.91	0.8	207.72
9/22/96	1:00	1055.67	0.0	5238.92	1.0	40.52	1.0	253.27
9/22/96	2:00	1064.33	0.0	5121.88	1.0	40.64	0.0	12.59
9/22/96	3:00	1064.54	0.0	5127.75	1.0	40.78	0.0	0.08
9/22/96	4:00	1060.04	0.0	5126.48	1.0	40.50	0.0	0.09
9/22/96	5:00	1050.29	0.0	5125.08	1.0	40.48	0.0	0.07
9/22/96	6:00	1047.88	0.0	5125.88	1.0	39.89	0.0	0.07
9/22/96	7:00	1048.33	0.0	5126.67	1.0	39.36	0.0	0.06
9/22/96	8:00	2120.71	0.0	5120.42	1.0	40.35	0.0	0.07
9/22/96	9:00	2597.97	0.0	5116.78	1.0	40.14	0.0	0.08
9/22/96	10:00	2735.71	0.0	5116.50	1.0	39.93	0.0	0.08
9/22/96	11:00	3013.67	0.0	5830.17	0.5	14.39	0.0	0.06
9/22/96	12:00	3050.00	0.0	6173.96	0.0	0.00	0.0	0.07
9/22/96	13:00	3046.83	0.0	6122.79	0.0	0.00	0.0	0.07
9/22/96	14:00	3053.13	0.0	6123.58	0.0	0.00	0.0	0.08
9/22/96	15:00	3069.33	0.0	6132.67	0.0	0.00	0.0	0.07
9/22/96	16:00	3180.25	0.0	6140.76	0.0	0.00	0.0	0.08
9/22/96	17:00	3581.92	0.0	6150.88	0.0	0.00	0.0	0.07
9/22/96	18:00	3588.71	0.0	6161.54	0.0	0.00	0.0	0.07
9/22/96	19:00	3582.21	0.0	6153.88	0.2	8.43	0.0	0.06
9/22/96	20:00	3565.50	0.0	5909.17	1.0	48.87	0.9	280.63
9/22/96	21:00	3562.50	0.0	5452.21	1.0	48.39	1.0	283.47
9/22/96	22:00	3552.67	0.0	5379.71	1.0	48.18	0.8	219.40
9/22/96	23:00	3544.58	0.0	5013.33	1.0	48.68	1.0	240.52
9/23/96	0:00	3537.17	0.0	4678.92	1.0	48.81	1.0	239.76
9/23/96	1:00	3522.63	0.0	4424.32	1.0	47.48	0.7	170.77
9/23/96	2:00	3656.08	0.0	4184.75	1.0	48.27	1.0	316.53
9/23/96	3:00	3810.34	0.0	3793.01	1.0	41.82	1.0	242.17
9/23/96	4:00	3837.00	0.0	3433.67	1.0	41.26	1.0	247.80
9/23/96	5:00	3941.13	0.0	3229.33	1.0	48.14	0.8	209.49

VITRIFICATION PILOT PLANT FEED PREPARATION SYSTEM								
CAMPAIGN 2 SERIES D GLASS								
READINGS		SLURRY TANK A		SLURRY TANK B		SLURRY	FURNACE	FURNACE
		WEIGHT	SLURRY	WEIGHT	SLURRY	RECIRC	SLURRY	SLURRY
			RECIRC		RECIRC	FLOW	FEED VALVE	FEED PUMP
			VALVE		VALVE			RATE
		WI-291	FV-348	WI-292	FV-347	FI-170	FV-170	SIC-173M
			OPENED = 1		OPENED = 1		OPENED = 1	
DATE	HOUR	LBS	CLOSED = 0	LBS	CLOSED = 0	GPM	CLOSED = 0	RPM
9/23/96	6:00	3937.29	0.0	3016.21	1.0	47.77	1.0	260.90
9/23/96	7:00	3938.86	0.0	2641.10	1.0	48.07	1.0	210.52
9/23/96	8:00	3941.83	0.0	2295.54	1.0	47.71	1.0	294.69
9/23/96	9:00	3938.79	0.0	1931.04	1.0	47.15	0.9	264.23
9/23/96	10:00	3936.50	0.0	1530.79	1.0	47.17	1.0	300.34
9/23/96	11:00	3944.96	0.0	1101.96	1.0	46.77	1.0	267.17
9/23/96	12:00	4157.42	0.0	677.45	1.0	46.62	1.0	160.51
9/23/96	13:00	4225.46	0.0	846.83	1.0	45.10	0.0	8.46
9/23/96	14:00	4375.92	0.0	1492.17	0.0	0.00	0.0	0.07
9/23/96	15:00	4924.07	0.0	1502.46	0.0	0.00	0.0	0.08
9/23/96	16:00	4997.42	0.0	1503.71	0.0	0.00	0.0	0.07
9/23/96	17:00	5745.79	0.0	1508.00	0.0	0.00	0.0	0.06
9/23/96	18:00	6305.21	0.0	1508.79	0.0	0.00	0.0	0.06
9/23/96	19:00	7002.67	0.0	1516.67	0.0	0.00	0.0	0.07
9/23/96	20:00	7007.13	0.0	1521.25	0.0	0.00	0.0	0.07
9/23/96	21:00	6988.58	0.8	1525.00	0.0	41.43	0.4	106.28
9/23/96	22:00	6660.92	1.0	1537.88	0.0	46.84	1.0	240.48
9/23/96	23:00	6342.08	1.0	1545.50	0.0	46.84	1.0	197.58
9/24/96	0:00	6050.38	1.0	1556.25	0.0	46.31	1.0	200.54
9/24/96	1:00	5752.46	1.0	1566.78	0.0	46.59	1.0	200.45
9/24/96	2:00	5498.71	1.0	1577.75	0.0	46.19	0.7	139.58
9/24/96	3:00	5340.75	1.0	1587.04	0.0	46.30	1.0	187.73
9/24/96	4:00	5060.29	1.0	1596.83	0.0	46.20	1.0	198.23
9/24/96	5:00	4760.00	1.0	1601.38	0.0	46.93	1.0	200.15
9/24/96	6:00	4466.08	1.0	1609.63	0.0	45.82	1.0	189.99
9/24/96	7:00	4171.67	1.0	1613.79	0.0	45.19	1.0	200.50
9/24/96	8:00	3900.50	1.0	1624.38	0.0	44.80	1.0	187.37
9/24/96	9:00	3633.04	1.0	1633.85	0.0	44.05	1.0	160.61
9/24/96	10:00	3389.92	1.0	1643.58	0.0	43.13	1.0	190.64
9/24/96	11:00	3117.58	1.0	1654.50	0.0	44.15	1.0	193.08
9/24/96	12:00	2875.13	1.0	1664.71	0.0	43.64	1.0	151.38
9/24/96	13:00	2651.29	1.0	1671.21	0.0	43.57	1.0	161.48
9/24/96	14:00	2527.25	1.0	1679.08	0.0	33.53	1.0	175.34
9/24/96	15:00	2490.73	1.0	1689.50	0.0	47.65	1.0	207.40
9/24/96	16:00	2515.17	1.0	1699.75	0.0	36.53	1.0	252.49
9/24/96	17:00	2553.71	1.0	1707.79	0.0	51.00	0.3	77.36
9/24/96	18:00	2571.63	1.0	1718.75	0.0	51.00	0.0	0.06

FURNACE SYSTEM

CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM



VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

		HOURLY AVERAGES					
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/17/96	18:00	2050.20	246.00	109.55	454.80	223.46	222.92
9/17/96	19:00	1625.50	246.00	94.26	454.80	152.29	152.36
9/17/96	20:00	1959.85	246.00	117.02	454.80	226.44	226.40
9/17/96	21:00	2177.18	246.00	130.38	454.80	283.41	283.40
9/17/96	22:00	2131.95	246.00	120.04	454.80	251.83	251.80
9/17/96	23:00	2184.80	246.00	117.05	454.80	250.81	251.40
9/18/96	0:00	2119.45	246.00	120.92	454.80	252.12	252.72
9/18/96	1:00	2384.16	246.00	135.87	454.80	319.70	319.61
9/18/96	2:00	2176.28	246.00	124.65	454.80	270.82	267.16
9/18/96	3:00	1435.83	246.00	97.49	454.80	139.73	139.56
9/18/96	4:00	1134.30	246.00	88.93	454.80	100.88	100.80
9/18/96	5:00	1468.15	246.00	118.90	454.80	177.19	177.48
9/18/96	6:00	1949.23	246.00	144.06	454.80	281.40	281.76
9/18/96	7:00	1807.43	246.00	131.78	454.80	239.77	240.08
9/18/96	8:00	1617.25	246.00	123.26	454.80	198.88	199.08
9/18/96	9:00	892.08	246.00	71.61	454.80	96.79	95.76
9/18/96	10:00	957.40	246.00	95.59	454.80	115.19	1[illegible]
9/18/96	11:00	1592.23	246.00	126.48	454.80	201.64	2[illegible]
9/18/96	12:00	1733.98	246.00	123.46	454.80	214.00	214.[illegible]
9/18/96	13:00	1636.23	246.00	114.06	454.80	194.60	192.48
9/18/96	14:00	930.08	246.00	80.87	454.80	79.10	79.84
9/18/96	15:00	1585.83	246.00	124.67	454.80	197.47	197.48
9/18/96	16:00	1683.35	246.00	118.64	454.80	201.55	201.60
9/18/96	17:00	1429.75	246.00	101.34	454.80	155.10	155.40
9/18/96	18:00	725.13	246.00	68.19	454.80	50.08	50.40
9/18/96	19:00	1120.83	246.00	115.12	454.80	137.15	137.52
9/18/96	20:00	1753.75	246.00	149.77	454.80	264.72	266.64
9/18/96	21:00	1928.73	246.00	134.65	454.80	262.99	262.80
9/18/96	22:00	2077.13	246.00	134.17	454.80	279.75	280.16
9/18/96	23:00	2270.58	246.00	136.88	454.80	309.43	309.28
9/19/96	0:00	2333.40	246.00	134.45	454.80	312.24	312.00
9/19/96	1:00	2383.93	246.00	131.53	454.80	311.80	311.60
9/19/96	2:00	2379.35	246.00	125.39	454.80	297.59	297.64
9/19/96	3:00	1800.66	246.00	92.27	454.80	165.57	165.64
9/19/96	4:00	1867.75	246.00	97.56	454.80	179.90	180.00
9/19/96	5:00	1883.23	246.00	101.02	454.80	187.91	188.04
9/19/96	6:00	1842.38	246.00	97.40	454.80	177.03	177.08
9/19/96	7:00	1637.03	246.00	89.12	454.80	143.69	143.92
9/19/96	8:00	1517.80	246.00	87.18	454.80	130.66	130.84
9/19/96	9:00	1549.28	246.00	89.81	454.80	137.40	137.[illegible]
9/19/96	10:00	1501.70	246.00	86.64	454.80	132.06	1[illegible]
9/19/96	11:00	1566.78	246.00	89.47	454.80	142.30	14[illegible]
9/19/96	12:00	1796.08	246.00	99.07	454.80	179.23	179.08
9/19/96	13:00	1505.63	246.00	86.61	454.80	129.10	129.40
9/19/96	14:00	1578.83	246.00	90.61	454.80	141.45	141.60

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

		HOURLY AVERAGES					
READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/19/96	15:00	1594.50	246.00	89.74	454.80	141.42	141.60
9/19/96	16:00	1548.35	246.00	86.67	454.80	133.13	133.24
9/19/96	17:00	1446.03	246.00	83.56	454.80	119.74	120.00
9/19/96	18:00	1428.60	246.00	84.37	454.80	119.76	120.00
9/19/96	19:00	1416.40	246.00	84.89	454.80	119.84	120.00
9/19/96	20:00	1414.78	246.00	85.86	454.80	120.72	120.84
9/19/96	21:00	1474.35	246.00	88.19	454.80	129.43	129.36
9/19/96	22:00	1541.33	246.00	90.45	454.80	138.29	138.36
9/19/96	23:00	1535.40	246.00	90.26	454.80	137.42	137.28
9/20/96	0:00	1907.73	246.00	110.50	454.80	212.01	212.28
9/20/96	1:00	2175.33	246.00	110.05	454.80	237.69	237.44
9/20/96	2:00	2287.85	246.00	110.88	454.80	251.93	251.80
9/20/96	3:00	2334.10	246.00	110.31	454.80	254.84	254.84
9/20/96	4:00	2367.78	246.00	110.56	454.80	259.24	259.20
9/20/96	5:00	2395.23	246.00	107.87	454.80	255.50	255.52
9/20/96	6:00	2402.38	246.00	108.16	454.80	256.80	256.96
9/20/96	7:00	2522.13	246.00	110.00	454.80	273.70	273.72
9/20/96	8:00	2676.65	246.00	112.30	454.80	296.17	296.12
9/20/96	9:00	2750.58	246.00	109.36	454.80	295.74	295.72
9/20/96	10:00	2458.40	246.00	95.34	454.80	231.80	231.40
9/20/96	11:00	2071.08	246.00	86.87	454.80	175.90	176.12
9/20/96	12:00	2264.43	246.00	94.96	454.80	211.33	211.20
9/20/96	13:00	2423.30	246.00	101.80	454.80	244.23	244.80
9/20/96	14:00	2629.33	246.00	101.66	454.80	263.83	263.72
9/20/96	15:00	2611.35	246.00	101.95	454.80	262.47	262.52
9/20/96	16:00	2211.20	246.00	82.23	454.80	189.36	189.08
9/20/96	17:00	1991.20	246.00	79.13	454.80	153.01	153.12
9/20/96	18:00	2061.58	246.00	81.78	454.80	164.55	164.48
9/20/96	19:00	2139.00	246.00	82.87	454.80	173.09	173.20
9/20/96	20:00	2208.05	246.00	83.82	454.80	181.04	180.88
9/20/96	21:00	2238.25	246.00	89.29	454.80	196.12	196.16
9/20/96	22:00	2381.13	246.00	100.10	454.80	235.21	235.24
9/20/96	23:00	2593.28	246.00	105.05	454.80	268.87	268.92
9/21/96	0:00	2651.18	246.00	106.86	454.80	279.39	279.48
9/21/96	1:00	2599.43	246.00	104.64	454.80	268.56	268.48
9/21/96	2:00	2483.85	246.00	96.57	454.80	235.46	235.20
9/21/96	3:00	2553.88	246.00	93.95	454.80	235.12	235.20
9/21/96	4:00	2626.22	246.00	91.68	454.80	235.13	235.20
9/21/96	5:00	2626.23	246.00	88.16	454.80	226.39	224.84
9/21/96	6:00	1868.23	246.00	68.16	454.80	122.74	124.48
9/21/96	7:00	1820.85	246.00	72.90	454.80	128.85	128.80
9/21/96	8:00	2118.58	246.00	83.97	454.80	173.97	173.88
9/21/96	9:00	2443.30	246.00	89.18	454.80	212.83	212.80
9/21/96	10:00	2490.08	246.00	83.38	454.80	202.69	202.44
9/21/96	11:00	1349.38	246.00	50.95	454.80	75.25	75.00

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/21/96	12:00	1197.43	246.00	54.27	454.80	68.49	69.72
9/21/96	13:00	464.63	246.00	28.12	454.80	14.15	14.40
9/21/96	14:00	410.30	246.00	31.11	454.80	14.19	14.40
9/21/96	15:00	373.95	246.00	34.14	454.80	14.25	14.40
9/21/96	16:00	919.38	246.00	84.70	454.80	88.65	89.48
9/21/96	17:00	1308.67	246.00	100.07	454.80	130.63	130.49
9/21/96	18:00	1460.32	246.00	100.10	454.80	144.18	145.69
9/21/96	19:00	1885.25	246.00	107.86	454.80	202.35	201.88
9/21/96	20:00	2177.74	246.00	103.70	454.80	222.99	223.29
9/21/96	21:00	2459.75	246.00	100.58	454.80	244.25	244.08
9/21/96	22:00	2613.48	246.00	96.13	454.80	247.16	246.96
9/21/96	23:00	2158.00	246.00	85.82	454.80	182.28	181.92
9/22/96	0:00	1366.20	246.00	73.84	454.80	100.81	99.60
9/22/96	1:00	1384.35	246.00	84.38	454.80	119.43	120.04
9/22/96	2:00	1610.20	246.00	105.16	454.80	173.88	174.60
9/22/96	3:00	2165.73	246.00	115.93	454.80	249.41	249.60
9/22/96	4:00	2353.32	246.00	107.39	454.80	249.49	[illegible]
9/22/96	5:00	2489.98	246.00	101.95	454.80	249.47	[illegible]
9/22/96	6:00	2174.90	246.00	87.89	454.80	187.56	187.60
9/22/96	7:00	2089.50	246.00	88.19	454.80	180.27	180.32
9/22/96	8:00	2320.48	246.00	94.74	454.80	215.64	215.48
9/22/96	9:00	2547.08	246.00	94.57	454.80	235.95	235.77
9/22/96	10:00	2599.33	246.00	91.51	454.80	232.26	232.24
9/22/96	11:00	2655.13	246.00	89.83	454.80	232.90	232.88
9/22/96	12:00	1943.20	246.00	66.98	454.80	141.24	140.64
9/22/96	13:00	860.88	246.00	40.20	454.80	34.67	34.84
9/22/96	14:00	550.23	246.00	33.51	454.80	19.32	19.20
9/22/96	15:00	499.80	246.00	36.51	454.80	19.02	19.20
9/22/96	16:00	785.47	246.00	63.96	454.80	57.42	57.80
9/22/96	17:00	1483.15	246.00	101.32	454.80	148.35	148.24
9/22/96	18:00	1566.30	246.00	94.71	454.80	146.61	146.32
9/22/96	19:00	1215.93	246.00	78.26	454.80	94.44	94.56
9/22/96	20:00	1549.73	246.00	100.97	454.80	155.53	155.76
9/22/96	21:00	1587.13	246.00	103.83	454.80	167.44	163.16
9/22/96	22:00	1602.63	246.00	108.50	454.80	173.19	173.64
9/22/96	23:00	1747.23	246.00	114.66	454.80	200.48	200.88
9/23/96	0:00	1981.23	246.00	116.44	454.80	229.83	229.76
9/23/96	1:00	1954.70	246.00	109.69	454.80	213.48	213.68
9/23/96	2:00	1935.13	246.00	112.25	454.80	215.86	215.84
9/23/96	3:00	2041.09	246.00	114.75	454.80	232.85	[illegible]
9/23/96	4:00	1927.18	246.00	107.19	454.80	205.32	[illegible]
9/23/96	5:00	1747.90	246.00	106.35	454.80	185.09	184.72
9/23/96	6:00	1775.13	246.00	111.66	454.80	198.10	198.00
9/23/96	7:00	1909.40	246.00	116.35	454.80	222.02	221.74
9/23/96	8:00	1653.08	246.00	107.13	454.80	176.96	176.72

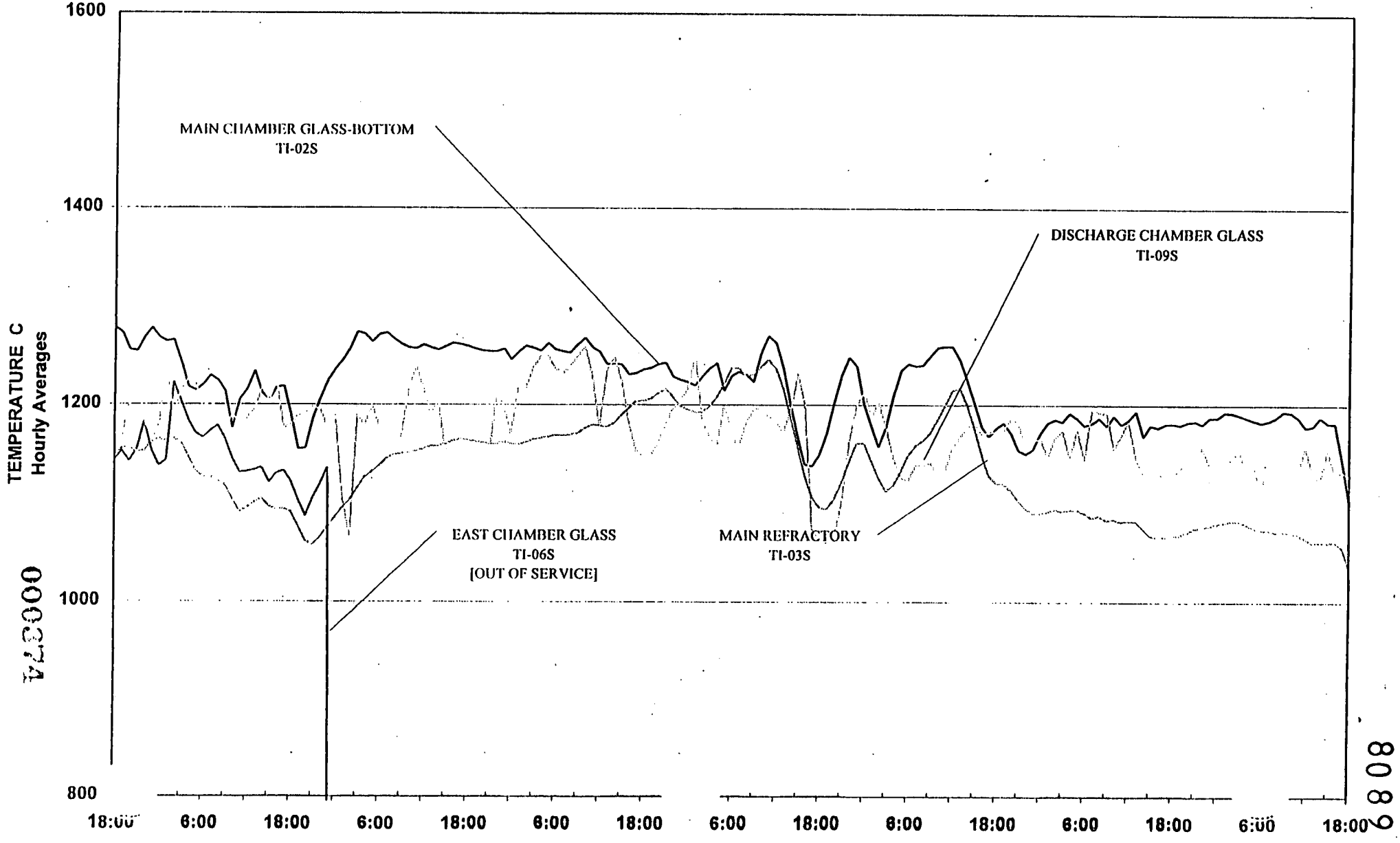
VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		ELECTRODE CURRENT	CURRENT CONTROLLER SET POINT	ELECTRODE VOLTAGE	VOLTAGE CONTROLLER SET POINT	ELECTRODE POWER	POWER CONTROLLER SET POINT
		IIC-171DM	IIC-171DSP	EIC-171CM	EIC-171SP	JIC-171BM	JIC-171BSP
DATE	HOUR	AMPS	AMPS	VOLTS	VOLTS	K-WATTS	K-WATTS
9/23/96	9:00	1978.70	246.00	126.24	454.80	249.30	249.36
9/23/96	10:00	1732.10	246.00	108.44	454.80	187.39	187.60
9/23/96	11:00	1927.98	246.00	123.53	454.80	238.42	238.32
9/23/96	12:00	1750.72	246.00	115.79	454.80	203.79	203.68
9/23/96	13:00	1431.83	246.00	98.45	454.80	146.12	146.08
9/23/96	14:00	1564.03	246.00	119.42	454.80	193.35	193.64
9/23/96	15:00	1531.96	246.00	107.84	454.80	166.60	166.54
9/23/96	16:00	1582.85	246.00	111.81	454.80	176.62	176.84
9/23/96	17:00	1516.88	246.00	105.74	454.80	159.44	159.28
9/23/96	18:00	1499.25	246.00	104.24	454.80	155.24	155.16
9/23/96	19:00	1496.68	246.00	104.06	454.80	154.77	154.84
9/23/96	20:00	1487.88	246.00	102.11	454.80	150.66	150.68
9/23/96	21:00	1486.38	246.00	104.10	454.80	153.82	153.80
9/23/96	22:00	1582.53	246.00	113.37	454.80	179.05	179.28
9/23/96	23:00	1516.78	246.00	108.16	454.80	163.21	163.28
9/24/96	0:00	1585.05	246.00	113.65	454.80	180.04	180.00
9/24/96	1:00	1559.09	246.00	112.07	454.80	174.55	174.51
9/24/96	2:00	1506.88	246.00	112.75	454.80	170.34	170.40
9/24/96	3:00	1512.93	246.00	113.18	454.80	171.22	171.20
9/24/96	4:00	1486.03	246.00	114.30	454.80	169.92	169.84
9/24/96	5:00	1468.35	246.00	116.29	454.80	170.82	170.92
9/24/96	6:00	1497.48	246.00	117.48	454.80	176.17	176.08
9/24/96	7:00	1515.98	246.00	117.78	454.80	179.00	178.76
9/24/96	8:00	1508.70	246.00	116.63	454.80	176.11	176.26
9/24/96	9:00	1479.68	246.00	115.12	454.80	170.39	170.52
9/24/96	10:00	1471.95	246.00	115.33	454.80	169.81	169.84
9/24/96	11:00	1364.10	246.00	111.35	454.80	151.49	151.64
9/24/96	12:00	1279.80	246.00	111.15	454.80	142.48	145.76
9/24/96	13:00	1427.63	246.00	120.85	454.80	172.77	172.72
9/24/96	14:00	1360.98	246.00	113.68	454.80	154.41	154.48
9/24/96	15:00	1479.11	246.00	120.40	454.80	180.65	180.66
9/24/96	16:00	1331.80	246.00	112.17	454.80	150.86	150.76
9/24/96	17:00	318.20	246.00	27.43	454.80	44.74	41.76
9/24/96	18:00	765.48	246.00	102.46	454.80	114.16	114.92

CAPAIGN 2
SERIES D GLASS
FURNACE SYSTEM



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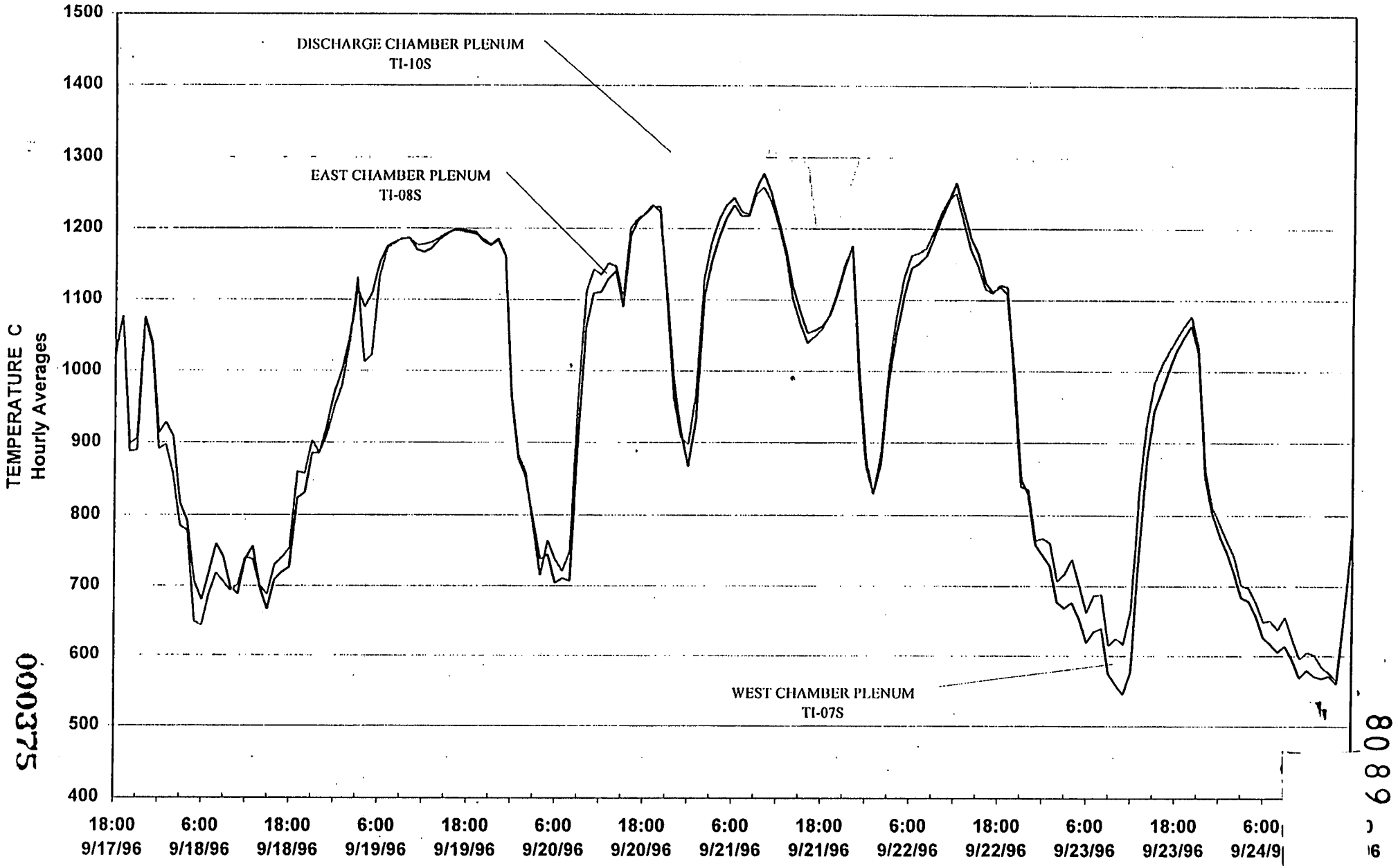
CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM



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C2FURN.XLS Chart 9

VHP 10/28/96

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/17/96	18:00	OUT OF SERVICE	1279.27	OUT OF SERVICE	OUT OF SERVICE	1144.00	OUT OF SERVICE	1170.03	1026.11	1021.82	1300.30	1145.65
9/17/96	19:00		1274.02			1152.26		1166.79	1076.79	1075.48	1298.70	1155.45
9/17/96	20:00		1256.06			1141.67		1203.17	898.30	887.47	1299.20	1155.82
9/17/96	21:00		1254.90			1154.53		1229.32	905.49	888.99	1299.36	1151.60
9/17/96	22:00		1268.88			1182.57		1183.04	1075.27	1072.15	1299.33	1152.28
9/17/96	23:00		1279.21			1153.18		1164.89	1040.33	1033.97	1299.56	1161.60
9/18/96	0:00		1269.10			1137.28		1176.83	913.58	890.59	1299.80	1165.25
9/18/96	1:00		1264.95			1142.56		1240.72	927.81	897.34	1299.07	1162.63
9/18/96	2:00		1266.58			1222.93		1191.90	908.55	856.66	1300.09	1164.80
9/18/96	3:00		1244.04			1203.52		1213.95	816.83	785.48	1298.85	1161.67
9/18/96	4:00		1218.12			1183.70		1227.25	791.27	777.90	1300.60	1147.17
9/18/96	5:00		1214.43			1170.76		1221.02	705.89	648.23	1299.69	1132.37
9/18/96	6:00		1220.07			1166.29		1195.44	679.64	642.49	1299.60	1126.48
9/18/96	7:00		1229.83			1172.71		1205.37	717.38	686.92	1299.58	1126.86
9/18/96	8:00		1224.45			1178.26		1188.91	759.57	718.43	1300.11	1123.11
9/18/96	9:00		1213.26			1164.98		1174.28	741.13	705.35	1299.39	1118.24
9/18/96	10:00		1175.81			1144.85		1189.90	697.35	693.20	1298.25	1103.51
9/18/96	11:00		1205.46			1130.69		1179.80	687.70	701.95	1301.02	1090.72
9/18/96	12:00		1215.30			1131.58		1185.36	738.11	740.49	1299.67	1094.81
9/18/96	13:00		1234.14			1133.16		1195.95	756.70	737.78	1299.69	1100.33
9/18/96	14:00		1211.87			1135.87		1217.32	697.94	700.44	1299.59	1104.85
9/18/96	15:00		1205.22			1120.73		1204.12	665.54	687.09	1299.36	1096.00
9/18/96	16:00		1217.20			1129.49		1223.66	708.32	729.78	1300.06	1093.49
9/18/96	17:00		1219.02			1132.73		1175.83	719.45	740.18	1298.50	1093.70
9/18/96	18:00		1190.55			1121.86		1179.23	726.17	753.19	1299.47	1090.76
9/18/96	19:00		1154.49			1102.41		1189.49	823.45	859.82	1299.53	1075.76
9/18/96	20:00		1155.47			1086.24		1190.96	830.59	857.91	1299.63	1060.87
9/18/96	21:00		1185.63			1105.31		1197.93	884.87	902.64	1297.66	1057.50
9/18/96	22:00		1206.80			1119.49		1194.42	884.87	885.59	1301.10	1065.03
9/18/96	23:00		1224.62			1135.62		1175.13	923.16	910.66	1299.58	1075.53
9/19/96	0:00		1236.78			OUT OF SERVICE		1188.94	970.29	950.45	1300.36	1085.31
9/19/96	1:00		1246.07					1105.56	1001.05	979.17	1300.26	1094.68
9/19/96	2:00		1257.81					1064.91	1045.38	1039.04	1300.01	1103.11
9/19/96	3:00		1275.26					1189.65	1115.42	1131.20	1299.51	1114.60
9/19/96	4:00		1272.71					1178.49	1089.49	1012.01	1296.47	1125.53
9/19/96	5:00		1264.50					1200.32	1108.56	1021.63	1299.88	1131.19
9/19/96	6:00		1272.24					1175.97	1151.22	1133.66	1299.65	1137.46
9/19/96	7:00		1274.14					1172.52	1174.49	1172.21	1299.57	1144.97
9/19/96	8:00		1267.40					1170.86	1180.18	1178.40	1299.61	1148.59
9/19/96	9:00		1261.92					1167.77	1184.89	1185.90	1299.59	1150.00
9/19/96	10:00		1258.58					1217.03	1186.46	1185.92	1298.26	1151.34
9/19/96	11:00		1257.65					1238.01	1169.81	1176.54	1302.73	1152.20
9/19/96	12:00		1261.41					1214.69	1166.68	1177.39	1297.62	1154.52
9/19/96	13:00		1258.58					1190.98	1171.94	1180.69	1300.48	1157.57
9/19/96	14:00		1256.35					1203.69	1183.84	1186.69	1299.53	1157.54
9/19/96	15:00		1259.73					1156.48	1191.24	1192.36	1299.62	1159.87
9/19/96	16:00		1263.41					1148.27	1197.69	1196.20	1299.68	1163.09
9/19/96	17:[illegible]		1261.98					1146.50	1198.13	1195.91	1299.75	[illegible]
9/19/96	[illegible]		1260.22					1144.44	1196.52	1193.51	1299.69	[illegible]
9/19/96	[illegible]		1257.77					1145.45	1194.09	1191.46	1299.71	[illegible]
9/19/96	20:[illegible]		1255.65					1150.85	1181.18	1184.68	1299.76	1161.57
9/19/96	21:00		1254.91					1142.69	1176.04	1177.30	1299.51	1160.26
9/19/96	22:00		1254.87					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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8089

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/19/96	23:00		1257.54					1198.66	1161.41	1161.85	1299.69	1162.11
9/20/96	0:00		1246.32					1170.74	963.79	965.61	1300.01	1160.37
9/20/96	1:00		1254.42					1219.58	876.34	881.90	1299.97	1158.97
9/20/96	2:00		1260.46					1217.83	853.26	858.29	1299.56	1161.57
9/20/96	3:00		1258.34					1238.55	790.43	784.51	1300.03	1164.65
9/20/96	4:00		1255.34					1250.51	738.34	715.03	1300.31	1165.90
9/20/96	5:00		1263.11					1249.84	745.17	764.02	1299.27	1167.09
9/20/96	6:00		1256.69					1236.78	703.99	738.19	1299.64	1168.86
9/20/96	7:00		1254.79					1232.04	710.75	721.31	1300.38	1168.67
9/20/96	8:00		1253.50					1240.17	707.04	749.02	1299.08	1169.20
9/20/96	9:00		1261.66					1250.24	903.61	960.84	1300.07	1170.81
9/20/96	10:00		1268.72					1259.61	1061.77	1111.43	1300.45	1175.73
9/20/96	11:00		1259.36					1229.92	1109.02	1143.01	1299.08	1179.33
9/20/96	12:00		1254.36					1177.89	1110.55	1134.89	1299.67	1178.53
9/20/96	13:00		1242.24					1234.19	1129.22	1151.26	1300.42	1177.35
9/20/96	14:00		1242.45					1249.21	1140.43	1147.44	1299.92	1181.11
9/20/96	15:00		1241.66					1224.05	1089.88	1103.01	1299.41	1189.24
9/20/96	16:00		1231.16					1182.62	1189.42	1200.51	1299.41	1196.62
9/20/96	17:00		1232.24					1153.63	1211.42	1214.11	1299.58	1203.92
9/20/96	18:00		1236.11					1148.14	1221.17	1220.73	1299.64	1204.21
9/20/96	19:00		1237.60					1147.15	1232.78	1231.11	1299.51	1206.57
9/20/96	20:00		1241.80					1161.30	1223.40	1230.33	1299.31	1212.12
9/20/96	21:00		1243.45					1179.08	1106.12	1097.82	1300.50	1216.30
9/20/96	22:00		1229.16					1196.00	986.51	962.54	1299.84	1207.96
9/20/96	23:00		1225.75					1205.84	913.96	907.33	1299.77	1198.69
9/21/96	0:00		1223.75					1215.80	866.91	897.11	1299.49	1195.40
9/21/96	1:00		1220.11					1250.54	930.15	966.51	1298.71	1192.72
9/21/96	2:00		1229.01					1184.46	1102.24	1130.41	1299.87	1193.02
9/21/96	3:00		1237.22					1167.14	1152.47	1180.32	1299.38	1198.53
9/21/96	4:00		1243.03					1155.91	1187.53	1212.84	1300.26	1208.65
9/21/96	5:00		1214.64					1199.77	1214.71	1233.13	1300.38	1221.96
9/21/96	6:00		1229.64					1170.63	1233.19	1242.99	1299.37	1238.73
9/21/96	7:00		1234.09					1155.18	1217.31	1223.99	1300.10	1237.70
9/21/96	8:00		1230.73					1182.49	1217.63	1219.89	1300.76	1229.58
9/21/96	9:00		1223.58					1194.43	1255.30	1247.72	1299.66	1231.41
9/21/96	10:00		1253.66					1198.03	1277.20	1258.23	1299.09	1239.70
9/21/96	11:00		1271.29					1188.73	1250.96	1238.61	1314.06	1246.58
9/21/96	12:00		1263.75					1183.29	1209.90	1204.15	1299.06	1237.22
9/21/96	13:00		1238.21					1170.62	1169.44	1163.28	1299.08	1216.18
9/21/96	14:00		1201.04					1192.95	1117.72	1100.05	1298.02	1188.38
9/21/96	15:00		1167.67					1232.36	1082.89	1066.16	1299.43	1158.19
9/21/96	16:00		1139.19					1200.07	1052.70	1038.93	1285.14	1127.96
9/21/96	17:00		1137.57					1075.53	1056.74	1048.11	1202.86	1105.62
9/21/96	18:00		1149.11					1061.83	1063.28	1059.44	1202.27	1095.98
9/21/96	19:00		1170.94					1060.11	1078.51	1079.94	1202.44	1094.34
9/21/96	20:00		1202.38					1061.94	1108.34	1111.92	1207.44	1104.10
9/21/96	21:00		1230.40					1099.31	1146.08	1149.84	1235.35	1121.02
9/21/96	22:00		1248.96					1160.40	1175.94	1173.57	1273.89	1140.88
9/21/96	23:00		1240.16					1198.60	1004.10	989.07	1300.86	1160.85
9/22/96	0:00		1201.22					1213.41	875.49	865.89	1298.05	1161.00
9/22/96	1:00		1178.78					1187.92	829.38	830.95	1300.24	1143.45
9/22/96	2:00		1157.18					1202.47	869.91	881.85	1300.28	1125.61
9/22/96	3:00		1176.37					1176.55	983.29	1000.61	1298.51	1112.46

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VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		MAIN CHAMBER GLASS TOP TI-4S	MAIN CHAMBER GLASS BOTTOM TI-2S	WEST CHAMBER GLASS TI-5S	WEST CHAMBER IR GLASS TI-IRW	EAST CHAMBER GLASS TI-6S	EAST CHAMBER IR GLASS TI-IRE	DISCH CHAMBER GLASS TI-9S	WEST CHAMBER PLENUM TI-7S	EAST CHAMBER PLENUM TI-8S	DISCH CHAMBER PLENUM TI-10S	MAIN REFRACTORY TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/22/96	4:00		1210.33					1145.59	1051.62	1076.22	1299.50	1118.32
9/22/96	5:00		1235.13					1126.74	1106.39	1132.11	1299.63	1132.16
9/22/96	6:00		1242.28					1122.78	1144.71	1162.48	1299.63	1148.13
9/22/96	7:00		1240.09					1138.16	1151.53	1166.23	1299.37	1158.34
9/22/96	8:00		1240.98					1137.92	1161.21	1172.71	1299.79	1163.39
9/22/96	9:00		1250.27					1141.61	1187.75	1196.00	1299.30	1171.26
9/22/96	10:00		1259.15					1130.86	1214.97	1222.65	1300.26	1184.63
9/22/96	11:00		1260.27					1131.91	1239.73	1241.56	1300.14	1199.46
9/22/96	12:00		1260.20					1155.36	1264.22	1249.54	1300.10	1214.74
9/22/96	13:00		1246.90					1166.49	1225.07	1210.53	1299.85	1216.81
9/22/96	14:00		1225.76					1176.72	1187.04	1170.42	1299.76	1200.41
9/22/96	15:00		1202.06					1179.29	1164.87	1147.38	1300.27	1175.36
9/22/96	16:00		1177.72					1170.63	1124.72	1115.69	1299.02	1149.59
9/22/96	17:00		1167.85					1171.27	1111.09	1109.39	1299.80	1128.16
9/22/96	18:00		1176.21					1173.46	1118.37	1121.07	1299.31	1120.72
9/22/96	19:00		1181.34					1173.83	1108.35	1118.55	1299.99	1119.92
9/22/96	20:00		1170.93					1186.74	995.75	985.22	1298.88	1113.08
9/22/96	21:00		1153.81					1180.13	850.35	839.84	1299.61	1103.14
9/22/96	22:00		1150.07					1160.45	829.80	835.58	1299.64	1094.72
9/22/96	23:00		1154.39					1162.83	759.25	765.15	1299.41	1090.31
9/23/96	0:00		1170.77					1165.91	744.49	767.83	1299.49	1088.93
9/23/96	1:00		1181.44					1146.75	728.98	761.34	1299.91	1091.75
9/23/96	2:00		1185.16					1166.95	676.93	706.73	1299.28	1093.94
9/23/96	3:00		1182.71					1174.09	668.12	717.16	1299.59	1092.08
9/23/96	4:00		1191.65					1145.94	676.24	738.85	1299.74	1093.47
9/23/96	5:00		1186.26					1174.99	653.14	701.21	1299.60	1093.86
9/23/96	6:00		1178.84					1144.00	618.80	661.57	1299.74	1090.27
9/23/96	7:00		1181.21					1195.56	634.27	686.22	1298.92	1085.31
9/23/96	8:00		1186.57					1193.05	639.15	687.93	1300.82	1087.00
9/23/96	9:00		1178.62					1191.43	573.61	614.70	1299.28	1083.03
9/23/96	10:00		1188.78					1155.56	558.00	624.66	1299.63	1083.90
9/23/96	11:00		1180.02					1167.89	544.26	616.43	1299.69	1081.39
9/23/96	12:00		1184.59					1183.12	575.97	664.93	1299.74	1081.89
9/23/96	13:00		1193.58					1145.69	748.19	833.79	1299.58	1082.17
9/23/96	14:00		1167.84					1130.65	874.76	928.28	1299.76	1074.57
9/23/96	15:00		1178.99					1127.59	944.70	983.44	1299.79	1067.20
9/23/96	16:00		1176.86					1133.28	971.78	1008.11	1299.66	1066.03
9/23/96	17:00		1180.34					1122.48	1002.31	1027.73	1299.78	1066.27
9/23/96	18:00		1180.89					1127.65	1028.42	1045.43	1299.86	1066.95
9/23/96	19:00		1179.50					1134.86	1047.25	1063.10	1299.83	1068.28
9/23/96	20:00		1182.48					1144.43	1063.88	1077.79	1299.54	1071.00
9/23/96	21:00		1183.37					1146.51	1026.68	1034.16	1299.39	1074.60
9/23/96	22:00		1180.19					1156.08	852.55	864.18	1299.44	1075.68
9/23/96	23:00		1187.12					1137.84	802.22	811.51	1299.56	1076.87
9/24/96	0:00		1186.84					1137.88	771.04	787.32	1299.34	1079.38
9/24/96	1:00		1192.57					1138.42	747.08	763.31	1299.57	1080.70
9/24/96	2:00		1192.01					1145.28	718.40	741.82	1299.17	1082.27
9/24/96	3:00		1189.79					1153.55	683.66	701.26	1299.59	[illegible]
9/24/96	[illegible]		1186.86					1131.61	678.85	697.23	1299.68	[illegible]
9/24/96	[illegible]		1184.11					1138.30	656.80	676.59	1299.46	[illegible]
9/24/96	[illegible]		1181.89					1112.90	626.06	648.45	1299.60	[illegible]
9/24/96	7:00		1183.80					1131.61	617.06	650.40	1299.54	1073.14
9/24/96	8:00		1189.71					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

6809

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

READINGS		HOURLY AVERAGES										
		MAIN CHAMBER	MAIN CHAMBER	WEST CHAMBER	WEST CHAMBER	EAST CHAMBER	EAST CHAMBER	DISCH CHAMBER	WEST CHAMBER	EAST CHAMBER	DISCH CHAMBER	MAIN
		GLASS TOP	GLASS BOTTOM	GLASS	IR GLASS	GLASS	IR GLASS	GLASS	PLENUM	PLENUM	PLENUM	REFRACTORY
		TI-4S	TI-2S	TI-5S	TI-IRW	TI-6S	TI-IRE	TI-9S	TI-7S	TI-8S	TI-10S	TI-3S
DATE	HOUR	C	C	C	C	C	C	C	C	C	C	C
9/24/96	9:00		1193.44					1137.77	614.17	655.60	1299.38	1071.81
9/24/96	10:00		1192.60					1139.74	593.30	623.34	1299.68	1070.41
9/24/96	11:00		1187.22					1133.37	567.89	595.45	1299.57	1068.69
9/24/96	12:00		1176.93					1155.77	579.16	604.87	1299.25	1064.77
9/24/96	13:00		1178.65					1130.90	570.42	600.86	1299.61	1060.72
9/24/96	14:00		1187.31					1123.88	567.09	583.87	1299.57	1061.44
9/24/96	15:00		1181.81					1153.70	570.48	575.17	1299.46	1061.01
9/24/96	16:00		1180.97					1131.38	559.23	564.23	1299.46	1061.72
9/24/96	17:00		1143.03					1132.24	664.72	664.54	1299.58	1055.59
9/24/96	18:00		1101.37					1127.91	778.13	784.11	1299.52	1034.58

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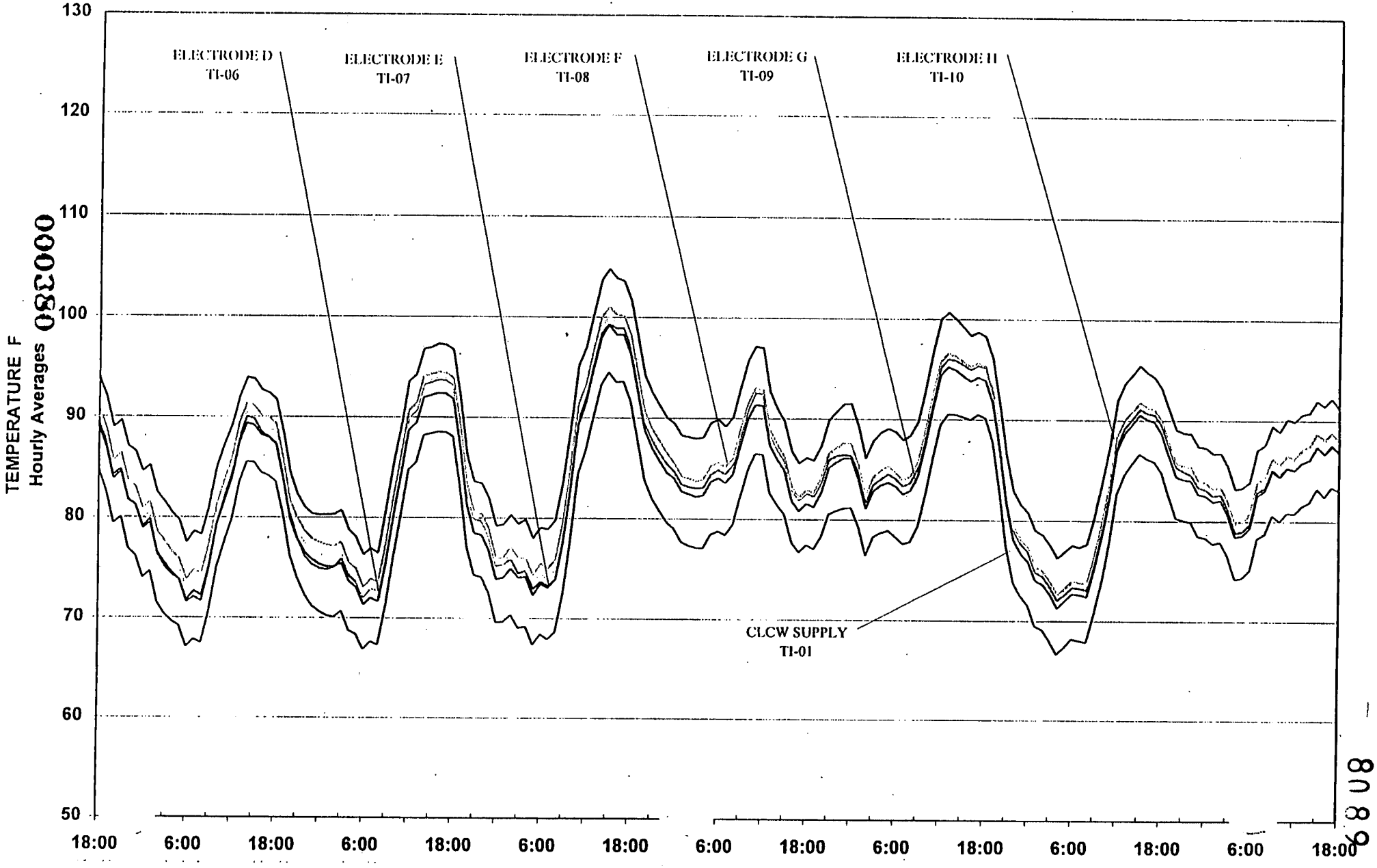
68089

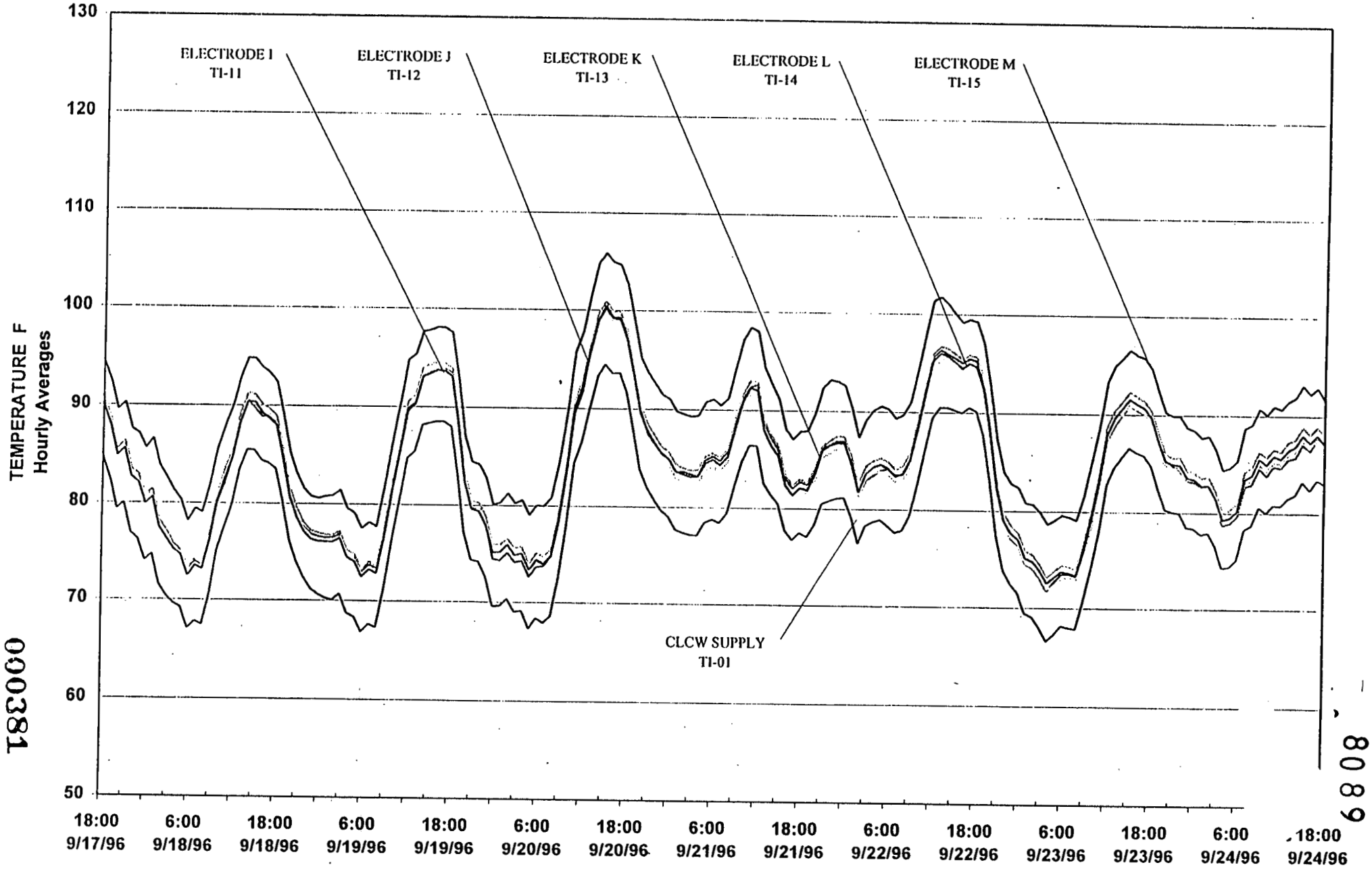
CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM



000380

8089

CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM



C2FURN.XLS Chart 11

VHP 10/28/96

000381

8089

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM										
		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/17/96	18:00	84.65	89.23	90.03	90.72	88.78	93.79	90.74	91.41	90.76	89.98	94.39
9/17/96	19:00	82.48	87.38	87.90	88.75	86.85	91.90	88.72	89.50	88.73	87.88	92.45
9/17/96	20:00	79.43	84.21	84.71	85.64	83.81	88.91	85.59	86.44	85.66	84.82	89.54
9/17/96	21:00	80.02	84.78	85.40	86.36	84.52	89.64	86.36	87.15	86.34	85.59	90.30
9/17/96	22:00	76.95	81.70	82.79	83.68	81.78	87.01	83.49	84.30	83.41	82.69	87.58
9/17/96	23:00	76.26	81.18	81.96	83.05	81.22	86.48	82.92	83.72	82.84	82.11	87.12
9/18/96	0:00	74.04	79.12	79.85	80.88	78.96	84.55	80.78	80.99	80.69	79.92	85.61
9/18/96	1:00	74.69	79.88	80.59	81.57	79.49	85.16	81.39	80.94	81.24	80.62	86.62
9/18/96	2:00	71.56	76.49	77.66	78.68	76.55	82.47	78.26	77.92	78.13	77.51	83.86
9/18/96	3:00	70.39	75.17	76.61	77.70	75.51	81.56	77.12	76.68	77.01	76.35	82.66
9/18/96	4:00	69.68	74.33	75.65	76.66	74.53	80.51	75.94	75.47	75.99	75.29	81.31
9/18/96	5:00	69.22	73.87	75.00	75.94	73.86	79.70	75.06	74.85	75.34	74.60	80.33
9/18/96	6:00	67.07	71.61	72.91	73.87	71.76	77.55	73.06	72.89	73.30	72.43	78.18
9/18/96	7:00	67.83	72.11	73.80	74.83	72.72	78.63	73.96	73.79	74.16	73.53	79.47
9/18/96	8:00	67.48	71.70	73.36	74.45	72.29	78.34	73.57	73.40	73.69	73.14	79.07
9/18/96	9:00	70.58	74.96	76.29	77.47	75.25	81.16	76.66	76.49	76.83	76.17	81.98
9/18/96	10:00	75.08	79.39	80.43	81.29	79.35	84.95	80.04	80.40	80.91	80.13	85.56
9/18/96	11:00	77.52	81.94	82.69	83.61	81.60	87.16	82.05	82.86	83.43	82.53	87.93
9/18/96	12:00	79.82	84.31	84.99	85.85	83.80	89.15	84.68	84.70	85.48	84.63	89.96
9/18/96	13:00	83.42	87.87	88.60	89.42	87.38	92.06	88.71	88.38	89.07	88.15	92.87
9/18/96	14:00	85.48	90.02	90.60	91.44	89.33	93.92	90.51	90.71	91.32	90.40	94.85
9/18/96	15:00	85.44	89.74	90.30	91.06	89.11	93.75	89.73	90.58	91.15	90.35	94.80
9/18/96	16:00	84.43	88.47	89.13	90.13	88.15	92.69	88.83	89.37	90.13	89.21	
9/18/96	17:00	84.13	87.95	88.96	89.96	87.89	92.39	88.92	89.04	89.70	88.72	
9/18/96	18:00	83.52	87.33	88.31	89.24	87.17	91.70	88.11	88.33	88.94	88.00	
9/18/96	19:00	80.33	84.30	84.95	85.83	83.87	88.52	84.61	85.08	85.65	84.75	89.13
9/18/96	20:00	76.22	80.37	80.82	81.64	79.80	84.48	80.60	81.21	81.70	80.77	85.22
9/18/96	21:00	73.99	77.95	78.76	79.93	77.91	82.32	78.99	79.10	79.65	78.67	83.14
9/18/96	22:00	72.34	76.23	77.54	78.69	76.61	81.03	77.59	77.52	78.09	77.15	81.54
9/18/96	23:00	71.21	75.37	76.96	77.94	75.91	80.39	76.90	76.72	77.28	76.36	80.79
9/19/96	0:00	70.66	74.99	76.48	77.61	75.40	80.27	76.65	76.34	77.02	76.16	80.61
9/19/96	1:00	70.24	74.88	76.28	77.36	75.17	80.29	76.53	76.18	76.83	76.10	80.77
9/19/96	2:00	70.07	75.10	76.16	77.21	75.18	80.32	76.56	76.11	76.78	76.10	80.86
9/19/96	3:00	70.69	75.94	76.51	77.60	75.52	80.72	76.88	76.68	77.23	76.46	81.43
9/19/96	4:00	68.76	74.26	74.63	75.57	73.69	78.83	74.49	74.72	75.21	74.45	79.59
9/19/96	5:00	68.37	73.60	73.84	74.95	73.12	78.08	74.36	74.27	74.85	74.04	79.06
9/19/96	6:00	66.85	72.10	72.23	73.11	71.35	76.39	72.99	72.69	73.24	72.46	77.53
9/19/96	7:00	67.62	73.02	73.12	73.93	72.03	76.97	73.75	73.48	74.06	73.24	78.16
9/19/96	8:00	67.32	72.79	72.84	73.61	71.65	76.53	73.38	73.07	73.59	72.81	77.71
9/19/96	9:00	71.25	76.63	76.70	77.45	75.47	80.79	77.21	76.92	77.45	76.61	81.84
9/19/96	10:00	76.04	81.22	81.33	82.02	80.08	85.28	81.85	81.55	82.05	81.21	86.33
9/19/96	11:00	80.39	85.54	85.62	86.30	84.31	89.19	85.70	85.81	86.35	85.44	90.51
9/19/96	12:00	84.76	89.93	90.03	90.68	88.69	93.57	89.50	89.97	90.58	89.81	94.82
9/19/96	13:00	85.46	90.67	90.83	91.47	89.43	94.26	90.30	90.63	91.30	90.41	95.39
9/19/96	14:00	88.16	93.27	93.42	94.10	92.01	96.82	93.06	93.43	94.09	93.15	97.71
9/19/96	15:00	88.36	93.48	93.64	94.28	92.21	96.98	93.44	93.69	94.32	93.39	97.84
9/19/96	16:00	88.52	93.74	93.85	94.50	92.41	97.33	93.88	93.86	94.56	93.74	98.13
9/19/96	17:00	88.49	93.71	93.80	94.42	92.35	97.23	93.88	93.82	94.47	93.67	98.10
9/19/96	18:00	88.02	93.18	93.34	93.96	91.85	96.72	93.45	93.34	94.01	93.16	97.61
9/19/96	19:00	83.09	88.34	88.48	89.15	87.05	92.05	88.64	88.48	89.16	88.23	92.85
9/19/96	20:00	77.13	82.54	82.70	83.33	81.27	86.24	82.75	82.68	83.30	82.35	87.07
9/19/96	21:00	74.35	79.89	80.03	80.60	78.49	83.58	79.75	79.93	80.49	79.62	
9/19/96	22:00	74.16	79.71	79.83	80.40	78.32	83.42	79.81	79.78	80.32	79.39	
9/19/96	23:00	72.56	78.21	78.31	78.97	76.79	81.97	78.25	78.32	78.88	77.96	
9/20/96	0:00	69.60	75.26	75.43	76.07	73.95	79.25	74.43	75.17	76.02	75.15	80.10
9/20/96	1:00	69.65	75.49	75.54	76.13	74.10	79.38	74.31	74.93	75.94	75.20	80.31
9/20/96	2:00	70.34	75.90	76.38	77.19	75.02	80.28	75.11	75.79	76.60	75.97	81.27
9/20/96	3:00	69.05	74.55	75.11	76.10	74.13	79.47	74.14	74.93	75.64	74.89	80.26

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM										
		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/20/96	4:00	69.17	74.82	74.96	76.08	74.17	79.86	74.29	75.04	75.75	75.05	80.58
9/20/96	5:00	67.35	72.96	73.56	74.38	72.33	78.04	72.61	73.13	73.96	73.36	79.06
9/20/96	6:00	68.40	73.68	74.53	75.47	73.47	79.10	73.66	74.31	75.08	74.40	80.03
9/20/96	7:00	67.93	73.31	73.92	75.05	73.11	78.94	73.77	73.98	74.76	73.98	79.99
9/20/96	8:00	68.62	73.89	74.89	75.89	73.86	79.80	74.78	74.82	75.47	74.80	80.87
9/20/96	9:00	72.45	78.12	78.64	79.63	77.54	83.51	78.26	78.42	79.04	78.37	84.40
9/20/96	10:00	77.93	83.69	84.15	85.08	82.98	88.95	83.55	83.66	84.34	83.62	89.48
9/20/96	11:00	84.40	89.96	90.38	91.41	89.34	95.23	89.59	90.01	90.74	90.11	95.75
9/20/96	12:00	86.70	92.15	92.62	93.44	91.57	97.08	91.85	92.15	93.02	92.32	97.90
9/20/96	13:00	90.06	95.51	96.04	96.88	94.92	100.46	95.89	95.75	96.60	95.89	101.46
9/20/96	14:00	93.27	98.43	99.19	100.04	98.04	103.68	99.03	98.83	99.70	99.02	104.74
9/20/96	15:00	94.52	99.33	100.11	101.02	99.23	104.81	100.48	100.08	100.90	100.20	105.79
9/20/96	16:00	93.60	98.90	99.42	100.29	98.30	103.93	99.31	99.03	99.94	99.25	104.89
9/20/96	17:00	93.64	98.92	99.32	100.17	98.27	103.63	99.31	99.02	99.83	99.10	104.59
9/20/96	18:00	91.68	97.03	97.43	98.25	96.35	101.71	97.48	97.04	97.91	97.09	102.68
9/20/96	19:00	87.74	93.26	93.66	94.43	92.59	98.02	93.72	93.30	94.13	93.36	99.01
9/20/96	20:00	83.80	89.45	89.74	90.59	88.72	94.22	89.91	89.52	90.34	89.52	95.27
9/20/96	21:00	81.98	87.72	88.05	88.87	86.93	92.51	87.50	87.70	88.47	87.75	93.69
9/20/96	22:00	80.78	86.53	86.79	87.66	85.70	91.27	86.45	86.58	87.36	86.57	92.64
9/20/96	23:00	79.67	85.39	85.70	86.46	84.53	90.02	85.53	85.50	86.18	85.45	91.53
9/21/96	0:00	79.05	84.66	85.08	85.53	83.99	89.49	84.89	84.47	85.70	84.93	91.10
9/21/96	1:00	77.73	83.40	83.77	84.24	82.73	88.23	83.60	83.03	84.37	83.64	89.81
9/21/96	2:00	77.41	83.16	83.58	83.99	82.45	88.07	83.64	82.70	84.08	83.37	89.53
9/21/96	3:00	77.19	83.02	83.37	83.72	82.16	87.93	83.37	82.48	83.82	83.11	89.31
9/21/96	4:00	77.14	83.07	83.38	83.86	82.31	88.03	83.18	82.47	83.88	83.17	89.40
9/21/96	5:00	78.48	84.37	84.82	85.25	83.67	89.53	84.86	83.81	85.25	84.51	90.83
9/21/96	6:00	78.81	84.81	85.14	85.55	84.01	89.87	85.27	84.17	85.57	84.91	91.11
9/21/96	7:00	78.46	84.40	84.71	85.10	83.55	89.18	84.81	83.73	85.12	84.37	90.45
9/21/96	8:00	79.44	85.35	85.61	85.98	84.41	90.09	85.71	84.69	85.98	85.21	91.20
9/21/96	9:00	82.18	88.17	88.53	88.89	87.22	93.00	88.70	87.58	88.84	88.03	94.13
9/21/96	10:00	84.82	90.91	91.25	91.56	89.98	95.82	91.18	90.36	91.62	90.86	97.21
9/21/96	11:00	86.43	92.54	92.83	93.05	91.38	97.21	92.38	91.73	93.02	92.29	98.42
9/21/96	12:00	86.37	92.44	92.68	92.94	91.28	97.05	92.64	91.66	92.96	92.05	98.05
9/21/96	13:00	82.57	88.48	88.62	88.84	87.26	92.71	88.80	87.76	88.98	87.98	94.40
9/21/96	14:00	81.37	86.89	87.05	87.37	85.86	90.96	87.17	86.30	87.47	86.38	92.70
9/21/96	15:00	80.49	85.78	85.93	86.22	84.81	89.73	85.99	85.28	86.40	85.34	91.24
9/21/96	16:00	77.75	82.95	83.07	83.24	81.80	86.72	83.08	82.36	83.38	82.38	88.12
9/21/96	17:00	76.76	81.90	82.00	82.19	80.82	85.53	82.04	81.31	82.34	81.35	87.07
9/21/96	18:00	77.53	82.59	82.70	82.93	81.55	86.08	82.73	82.01	83.05	82.12	87.91
9/21/96	19:00	77.10	82.25	82.46	82.66	81.21	85.81	82.47	81.62	82.68	81.88	87.94
9/21/96	20:00	78.35	83.64	84.00	84.12	82.66	87.26	83.89	82.91	84.03	83.46	89.75
9/21/96	21:00	80.54	85.87	86.43	86.54	85.07	89.84	86.22	85.29	86.37	85.96	92.42
9/21/96	22:00	80.85	86.29	86.97	87.08	85.64	90.72	86.54	85.73	86.95	86.51	93.19
9/21/96	23:00	81.11	86.38	87.51	87.60	86.07	91.51	86.94	86.17	87.48	86.76	93.05
9/22/96	0:00	81.17	86.29	87.24	87.53	86.07	91.56	86.95	86.17	87.44	86.72	92.66
9/22/96	1:00	79.28	84.54	85.16	85.36	83.95	89.21	84.25	84.13	85.40	84.66	90.34
9/22/96	2:00	76.49	81.63	82.20	82.36	81.06	86.04	81.33	81.30	82.55	81.77	87.37
9/22/96	3:00	78.34	83.48	84.08	84.25	82.86	87.81	82.96	83.14	84.42	83.66	89.16
9/22/96	4:00	78.75	83.98	84.77	84.88	83.41	88.60	83.42	83.68	85.00	84.33	90.15
9/22/96	5:00	78.96	84.49	85.03	85.23	83.70	89.03	84.01	83.91	85.27	84.61	90.58
9/22/96	6:00	78.35	84.06	84.52	84.68	83.29	88.71	84.15	83.55	84.94	84.23	90.28
9/22/96	7:00	77.66	83.33	83.80	83.95	82.54	87.91	83.56	82.81	84.10	83.39	89.32
9/22/96	8:00	77.87	83.66	84.07	84.29	82.91	88.33	83.54	83.08	84.44	83.66	89.67
9/22/96	9:00	79.38	85.13	85.50	85.72	84.32	89.71	84.94	84.50	85.85	85.12	91.01
9/22/96	10:00	82.49	88.28	88.72	88.91	87.48	92.95	88.49	87.62	89.07	88.32	94.34
9/22/96	11:00	86.18	91.96	92.42	92.61	91.17	96.78	92.35	91.32	92.81	92.09	98.09
9/22/96	12:00	89.46	95.19	95.67	95.84	94.42	100.03	95.66	94.55	95.99	95.31	101.36
9/22/96	13:00	90.53	96.07	96.56	96.66	95.27	100.69	96.39	95.49	96.80	96.06	101.72

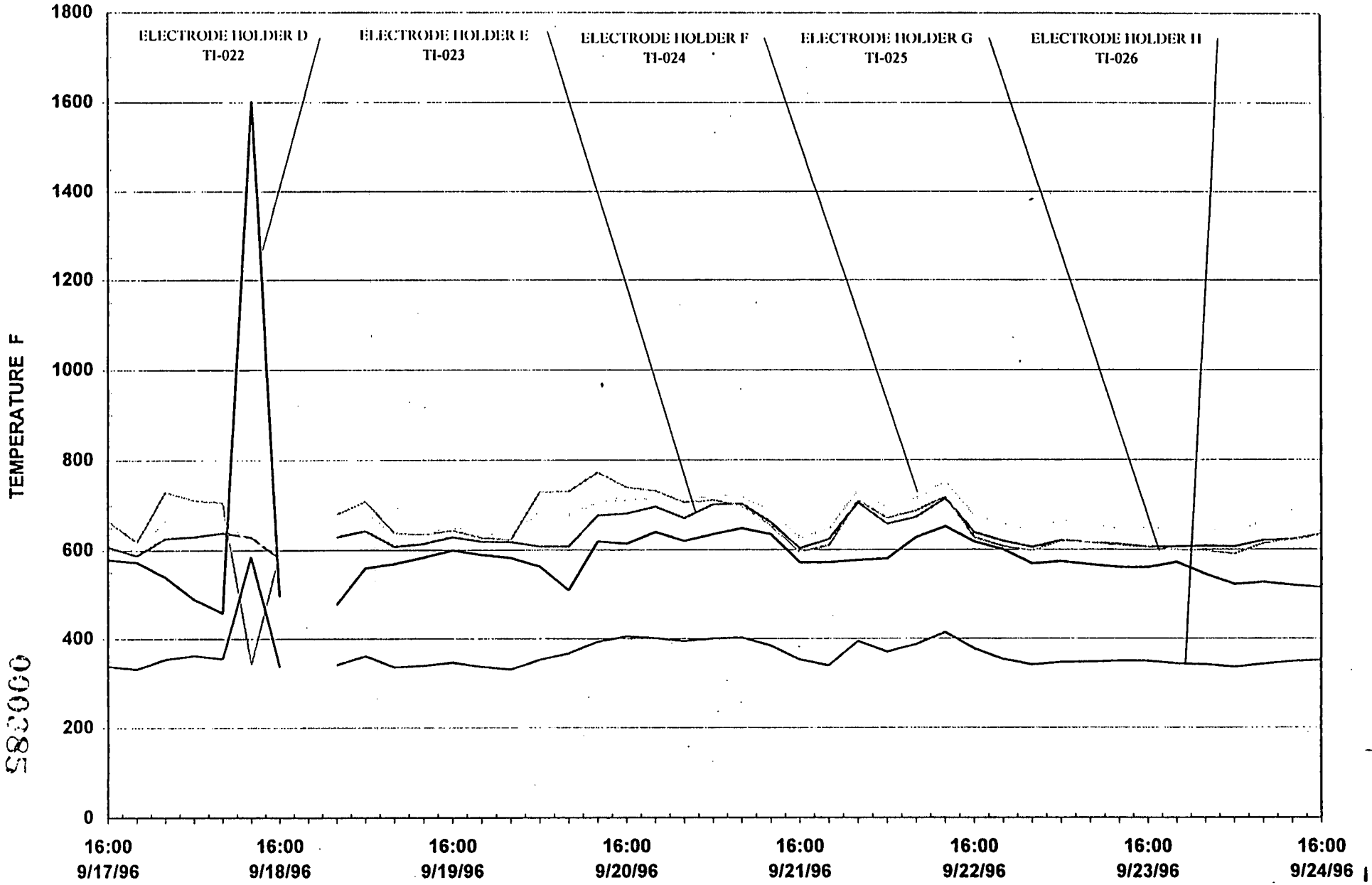
VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM										
		CLCW	D	E	F	G	H	I	J	K	L	M
		SUPPLY	COOLING WATER RETURN									
		TI-001	TI-006	TI-007	TI-008	TI-009	TI-010	TI-011	TI-012	TI-013	TI-014	TI-015
DATE	HOUR	F	F	F	F	F	F	F	F	F	F	F
9/22/96	14:00	90.52	95.91	96.27	96.39	94.95	100.03	95.98	95.31	96.54	95.75	101.00
9/22/96	15:00	90.26	95.49	95.72	95.81	94.38	99.22	95.54	94.82	96.02	95.17	100.02
9/22/96	16:00	89.98	94.97	95.18	95.26	93.83	98.39	95.10	94.32	95.48	94.49	99.21
9/22/96	17:00	90.51	95.42	95.56	95.66	94.25	98.72	95.53	94.83	95.94	95.04	99.50
9/22/96	18:00	90.14	95.22	95.31	95.36	93.92	98.32	95.29	94.45	95.71	94.67	99.27
9/22/96	19:00	87.73	92.82	93.02	93.09	91.66	96.21	92.68	92.23	93.38	92.46	97.12
9/22/96	20:00	82.93	88.11	88.30	88.39	86.94	91.55	87.74	87.43	88.62	87.71	92.50
9/22/96	21:00	77.41	82.71	82.93	83.01	81.62	86.36	82.51	82.12	83.31	82.41	87.38
9/22/96	22:00	73.82	79.12	79.40	79.47	78.14	82.90	78.74	78.60	79.81	78.99	83.96
9/22/96	23:00	72.46	77.72	78.00	78.11	76.73	81.56	77.19	77.26	78.57	77.77	82.81
9/23/96	0:00	71.53	76.90	77.27	77.40	75.96	80.77	76.50	76.55	77.82	77.06	82.41
9/23/96	1:00	69.49	74.90	75.29	75.46	74.06	79.07	74.60	74.62	75.97	75.17	80.83
9/23/96	2:00	69.10	74.50	74.90	75.05	73.66	78.60	74.08	74.25	75.52	74.84	80.67
9/23/96	3:00	68.02	73.43	73.91	74.05	72.69	77.65	73.09	73.26	74.56	73.88	79.93
9/23/96	4:00	66.64	72.07	72.52	72.67	71.28	76.33	71.76	71.87	73.16	72.55	78.70
9/23/96	5:00	67.29	72.59	73.10	73.23	71.96	76.89	72.60	72.37	73.77	73.13	79.09
9/23/96	6:00	68.18	73.38	73.79	73.99	72.69	77.55	73.48	73.09	74.40	73.74	79.61
9/23/96	7:00	68.01	73.29	73.73	73.87	72.60	77.39	73.49	73.04	74.31	73.61	79.42
9/23/96	8:00	67.86	73.10	73.54	73.80	72.40	77.66	73.24	72.84	74.02	73.32	79.10
9/23/96	9:00	70.71	75.64	76.27	76.47	75.22	80.32	75.49	75.56	76.79	76.04	81.66
9/23/96	10:00	73.91	78.93	79.48	79.68	78.38	83.52	78.64	78.76	80.02	79.34	85.04
9/23/96	11:00	77.86	82.70	83.27	83.53	82.17	87.22	82.69	82.60	83.87	83.16	88.67
9/23/96	12:00	82.73	87.45	88.02	88.35	86.99	92.02	87.32	87.36	88.67	87.84	[illegible]
9/23/96	13:00	84.55	89.22	89.79	90.05	88.65	93.66	88.81	89.10	90.43	89.66	[illegible]
9/23/96	14:00	85.59	90.09	90.65	90.88	89.56	94.50	89.97	90.04	91.34	90.61	[illegible]
9/23/96	15:00	86.59	91.12	91.64	91.83	90.56	95.46	90.99	90.96	92.32	91.59	96.59
9/23/96	16:00	86.12	90.72	91.22	91.37	90.08	94.79	90.48	90.57	91.86	91.10	96.04
9/23/96	17:00	85.80	90.55	90.91	91.06	89.82	94.30	90.07	90.17	91.44	90.68	95.77
9/23/96	18:00	84.78	89.48	89.99	90.06	88.65	93.20	89.30	89.15	90.43	89.70	94.68
9/23/96	19:00	82.41	87.34	87.65	87.73	86.38	91.09	87.34	86.83	88.14	87.36	92.35
9/23/96	20:00	80.30	85.31	85.61	85.69	84.38	89.08	85.37	84.84	86.05	85.28	90.25
9/23/96	21:00	80.06	84.88	85.34	85.45	84.11	88.73	84.80	84.53	85.64	84.95	89.90
9/23/96	22:00	79.94	84.55	85.27	85.35	84.01	88.63	84.36	84.50	85.67	84.86	89.88
9/23/96	23:00	78.51	83.34	83.93	84.05	82.66	87.35	83.19	83.11	84.30	83.57	88.70
9/24/96	0:00	78.40	83.10	83.80	83.83	82.48	87.27	83.14	82.90	84.13	83.38	88.41
9/24/96	1:00	77.78	82.50	83.18	83.23	81.88	86.66	82.68	82.26	83.53	82.75	87.66
9/24/96	2:00	77.94	82.62	83.33	83.40	82.04	86.70	82.81	82.40	83.64	82.79	87.82
9/24/96	3:00	76.58	81.19	81.99	81.98	80.68	85.38	81.09	81.10	82.27	81.47	86.46
9/24/96	4:00	74.27	78.89	79.72	79.78	78.48	83.18	78.77	78.93	80.09	79.30	84.35
9/24/96	5:00	74.41	79.01	79.85	79.95	78.61	83.30	78.97	79.11	80.30	79.51	84.63
9/24/96	6:00	75.16	79.69	80.60	80.69	79.32	83.89	79.67	79.92	80.99	80.20	85.37
9/24/96	7:00	78.33	82.85	83.70	83.83	82.49	87.05	82.70	83.09	84.25	83.42	88.64
9/24/96	8:00	78.77	83.29	84.18	84.31	83.04	87.51	82.93	83.39	84.68	83.86	89.05
9/24/96	9:00	80.59	85.05	86.01	86.18	84.90	89.42	84.53	84.97	86.30	85.56	90.73
9/24/96	10:00	80.03	84.49	85.40	85.53	84.36	88.87	83.78	84.29	85.73	84.97	90.08
9/24/96	11:00	80.83	85.28	86.26	86.47	85.21	90.12	84.78	85.18	86.60	85.88	90.97
9/24/96	12:00	80.76	85.06	86.11	86.23	85.02	89.91	84.62	85.02	86.32	85.58	90.67
9/24/96	13:00	81.51	85.80	86.88	87.06	85.76	90.65	85.51	85.93	87.29	86.46	91.48
9/24/96	14:00	81.89	86.04	87.24	87.43	86.07	90.81	85.72	86.22	87.58	86.85	91.89
9/24/96	15:00	83.23	87.36	88.62	88.70	87.38	92.02	87.08	87.38	88.80	87.98	93.10
9/24/96	16:00	82.39	86.61	87.83	88.06	86.69	91.49	86.44	86.76	88.04	87.25	92.24
9/24/96	17:00	83.39	87.39	88.66	88.78	87.53	92.26	87.71	87.61	88.84	88.01	[illegible]
9/24/96	18:00	83.03	86.82	87.82	87.97	86.84	91.28	86.96	86.86	87.99	87.15	[illegible]

CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM
EAST ELECTRODE HOLDER TEMPERATURES



C2FURN.XLS Chart 26

VHP 11/8/96

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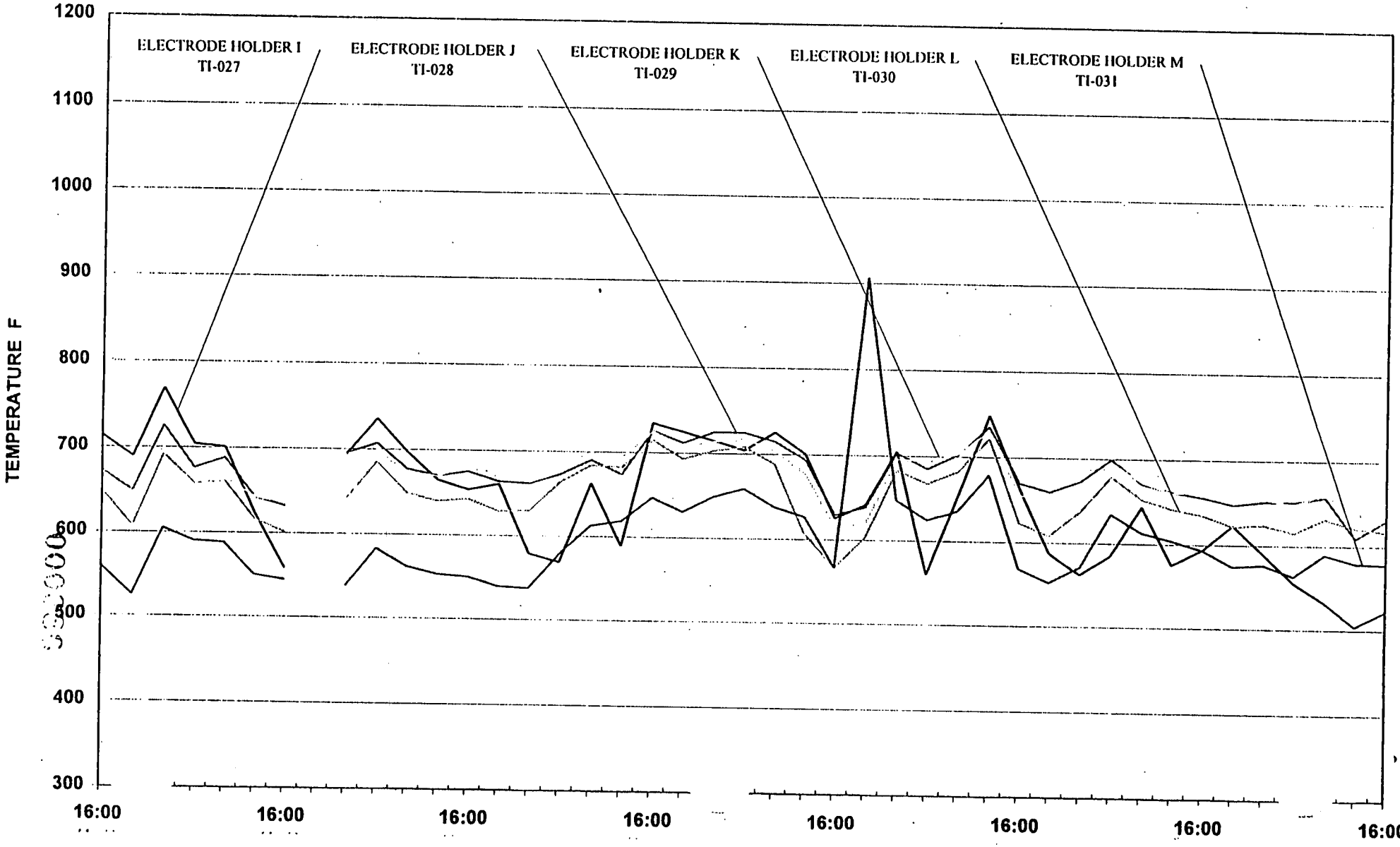
CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM
WEST ELECTRODE HOLDER TEMPERATURES



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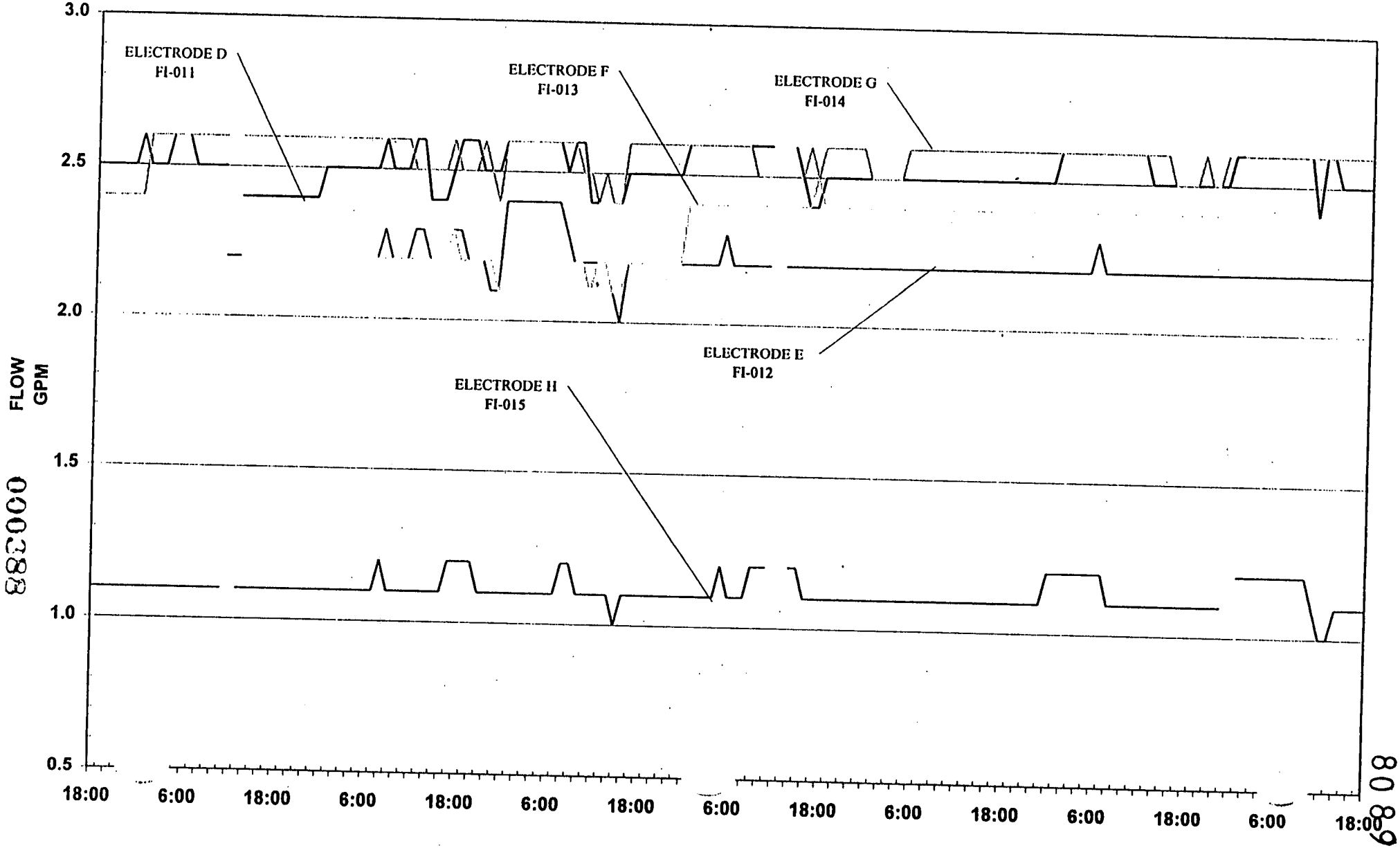
VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

		HOURLY READINGS ROUNDSHEETS									
ADINGS		ELECTRODE HOLDER TEMPERATURES									
		D	E	F	G	H	I	J	K	L	M
		TI-022	TI-023	TI-024	TI-025	TI-026	TI-027	TI-028	TI-029	TI-030	TI-031
DATE	HOUR	F	F	F	F	F	F	F	F	F	F
9/17/96	16:00	579	608	630	666	339	714	672	671	649	559
9/17/96	20:00	573	588	597	618	332	689	649	644	607	525
9/18/96	0:00	539	626	667	729	354	769	726	700	692	605
9/18/96	4:00	489	630	672	711	362	704	676	667	658	590
9/18/96	8:00	457	638	675	706	355	701	688	665	661	588
9/18/96	12:00	1603	629	612	343	585	623	642	642	616	550
9/18/96	16:00	496	582	612	591	336	558	632	636	601	544
9/18/96	20:00										
9/19/96	0:00	477	629	681	680	342	694	695	692	642	537
9/19/96	4:00	559	642	684	708	361	736	707	698	685	583
9/19/96	8:00	569	608	634	638	336	697	677	673	649	562
9/19/96	12:00	583	614	637	634	340	665	670	669	640	553
9/19/96	16:00	599	629	650	644	347	654	675	682	643	550
9/19/96	20:00	589	619	637	628	337	661	664	668	629	539
9/20/96	0:00	582	618	635	623	331	579	662	674	630	537
9/20/96	4:00	563	608	687	729	353	569	673	686	664	579
9/20/96	8:00	509	608	678	730	367	663	690	699	684	613
9/20/96	12:00	619	677	706	772	393	589	674	694	682	619
9/20/96	16:00	614	681	711	739	405	735	726	725	715	647
9/20/96	20:00	640	696	715	731	401	725	712	708	693	631
9/21/96	0:00	620	671	706	706	394	715	725	714	703	649
9/21/96	4:00	635	701	724	711	400	704	725	717	708	659
9/21/96	8:00	648	703	719	699	402	726	715	704	688	638
9/21/96	12:00	635	662	686	655	384	701	694	678	607	627
9/21/96	16:00	572	603	628	595	353	626	630	616	567	567
9/21/96	20:00	572	624	647	610	340	642	639	620	603	907
9/22/96	0:00	577	705	732	710	394	705	703	696	683	648
9/22/96	4:00	580	658	695	671	370	560	685	694	668	625
9/22/96	8:00	628	673	714	687	387	653	702	703	682	636
9/22/96	12:00	652	714	753	718	414	749	736	731	722	679
9/22/96	16:00	618	639	676	628	377	664	670	656	623	568
9/22/96	20:00	600	620	657	607	354	587	660	648	608	552
9/23/96	0:00	569	605	645	598	342	562	673	665	638	571
9/23/96	4:00	574	621	664	620	347	585	699	695	679	635
9/23/96	8:00	567	616	659	616	348	644	671	673	653	613
9/23/96	12:00	560	612	648	610	350	575	662	661	642	604
9/23/96	16:00	560	605	650	605	350	593	656	663	635	593
9/23/96	20:00	572	606	648	600	344	623	648	652	622	574
9/24/96	0:00	545	608	646	597	342	589	652	655	624	576
9/24/96	4:00	522	606	642	590	336	555	652	649	615	563
9/24/96	8:00	527	621	665	614	343	532	658	663	632	589
9/24/96	12:00	520	623	671	622	349	504	609	636	621	579
9/24/96	16:00	514	635	683	633	352	522	631	652	617	578

CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM
EAST ELECTRODE CLCW FLOW



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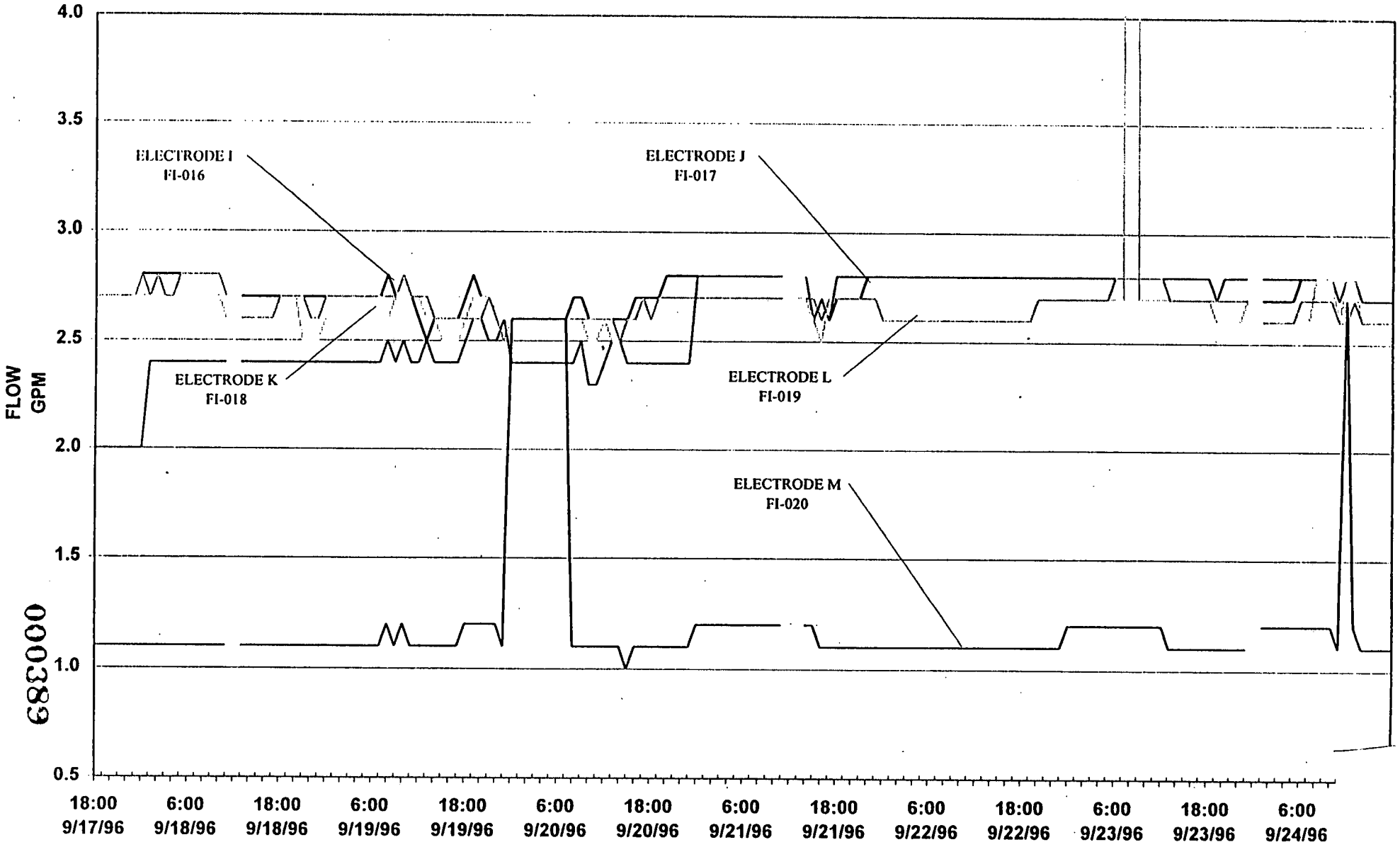
CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM
WEST ELECTRODE CLCW FLOW



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C2FURN.XLS Chart 29

VHP 11/8/96

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

		HOURLY READINGS									
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/17/96	18:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/17/96	19:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/17/96	20:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/17/96	21:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/17/96	22:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/17/96	23:00	2.5	2.2	2.2	2.4	1.1	2.7	2.0	2.7	2.7	1.1
9/18/96	0:00	2.6	2.2	2.2	2.4	1.1	2.8	2.0	2.7	2.8	1.1
9/18/96	1:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.7	1.1
9/18/96	2:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.8	1.1
9/18/96	3:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.7	1.1
9/18/96	4:00	2.6	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.7	1.1
9/18/96	5:00	2.6	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.8	1.1
9/18/96	6:00	2.6	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.8	1.1
9/18/96	7:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.8	1.1
9/18/96	8:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.8	1.1
9/18/96	9:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.8	1.1
9/18/96	10:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.8	1.1
9/18/96	11:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/18/96	12:00		2.2								
9/18/96	13:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.6	1.1
9/18/96	14:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.6	1.1
9/18/96	15:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.6	1.1
9/18/96	16:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.6	1.1
9/18/96	17:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.6	1.1
9/18/96	18:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.7	2.7	1.1
9/18/96	19:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.7	2.7	1.1
9/18/96	20:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.7	2.7	1.1
9/18/96	21:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.5	2.7	1.1
9/18/96	22:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.5	2.6	1.1
9/18/96	23:00	2.4	2.2	2.2	2.6	1.1	2.7	2.4	2.5	2.6	1.1
9/19/96	0:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	1:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	2:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	3:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	4:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	5:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	6:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	7:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.7	1.1
9/19/96	8:00	2.6	2.3	2.2	2.6	1.2	2.8	2.5	2.6	2.7	1.2
9/19/96	9:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.7	2.7	1.1
9/19/96	10:00	2.5	2.2	2.2	2.6	1.1	2.8	2.5	2.7	2.8	1.2
9/19/96	11:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.7	2.7	1.1
9/19/96	12:00	2.6	2.3	2.2	2.5	1.1	2.6	2.4	2.7	2.7	1.1
9/19/96	13:00	2.6	2.3	2.2	2.5	1.1	2.5	2.5	2.6	2.7	1.1
9/19/96	14:00	2.4	2.2	2.2	2.5	1.1	2.6	2.4	2.6	2.6	1.1

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

		HOURLY READINGS									
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/19/96	15:00	2.4	2.2	2.2	2.5	1.1	2.6	2.4	2.5	2.6	1.1
9/19/96	16:00	2.4	2.2	2.2	2.5	1.1	2.6	2.4	2.5	2.6	1.1
9/19/96	17:00	2.5	2.3	2.3	2.6	1.2	2.6	2.4	2.5	2.6	1.1
9/19/96	18:00	2.6	2.3	2.2	2.5	1.2	2.7	2.5	2.6	2.6	1.2
9/19/96	19:00	2.6	2.2	2.2	2.5	1.2	2.8	2.6	2.7	2.6	1.2
9/19/96	20:00	2.6	2.2	2.2	2.5	1.2	2.7	2.6	2.7	2.6	1.2
9/19/96	21:00	2.5	2.2	2.2	2.6	1.1	2.7	2.5	2.7	2.7	1.2
9/19/96	22:00	2.5	2.1	2.2	2.5	1.1	2.6	2.5	2.6	2.6	1.2
9/19/96	23:00	2.5	2.1	2.1	2.4	1.1	2.6	2.6	2.6	2.5	1.1
9/20/96	0:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	1:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	2:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	3:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	4:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	5:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	6:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	7:00	2.6	2.4	2.2	2.6	1.1	2.6	2.4	2.6	2.6	2.6
9/20/96	8:00	2.5	2.3	2.2	2.6	1.2	2.7	2.4	2.6	2.6	1.1
9/20/96	9:00	2.6	2.2	2.2	2.6	1.2	2.7	2.5	2.6	2.6	1.1
9/20/96	10:00	2.6	2.2	2.2	2.5	1.1	2.6	2.3	2.5	2.6	1.1
9/20/96	11:00	2.4	2.2	2.1	2.5	1.1	2.6	2.3	2.5	2.6	1.1
9/20/96	12:00	2.4	2.2	2.2	2.4	1.1	2.6	2.4	2.6	2.6	1.1
9/20/96	13:00	2.5	2.2	2.2	2.5	1.1	2.6	2.5	2.5	2.6	1.1
9/20/96	14:00	2.4	2.1	2.1	2.4	1.1	2.6	2.5	2.5	2.5	1.1
9/20/96	15:00	2.4	2.0	2.1	2.4	1.0	2.6	2.4	2.6	2.6	1.0
9/20/96	16:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.6	1.1
9/20/96	17:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.7	2.7	1.1
9/20/96	18:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.6	2.6	1.1
9/20/96	19:00	2.5	2.2	2.2	2.6	1.1	2.7	2.4	2.7	2.7	1.1
9/20/96	20:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.7	1.1
9/20/96	21:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.7	1.1
9/20/96	22:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.7	1.1
9/20/96	23:00	2.5	2.2	2.2	2.6	1.1	2.8	2.4	2.7	2.7	1.1
9/21/96	0:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	1:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	2:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	3:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	4:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	5:00	2.6	2.3	2.4	2.6	1.2	2.8	2.8	2.7	2.7	1.2
9/21/96	6:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	7:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	8:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.2
9/21/96	9:00	2.6	2.2	2.4	2.5	1.2	2.8	2.8	2.7	2.7	1.2
9/21/96	10:00	2.6	2.2	2.4	2.5	1.2	2.8	2.8	2.7	2.7	1.2
9/21/96	11:00	2.6	2.2	2.4	2.5	1.2	2.8	2.8	2.7	2.7	1.2

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

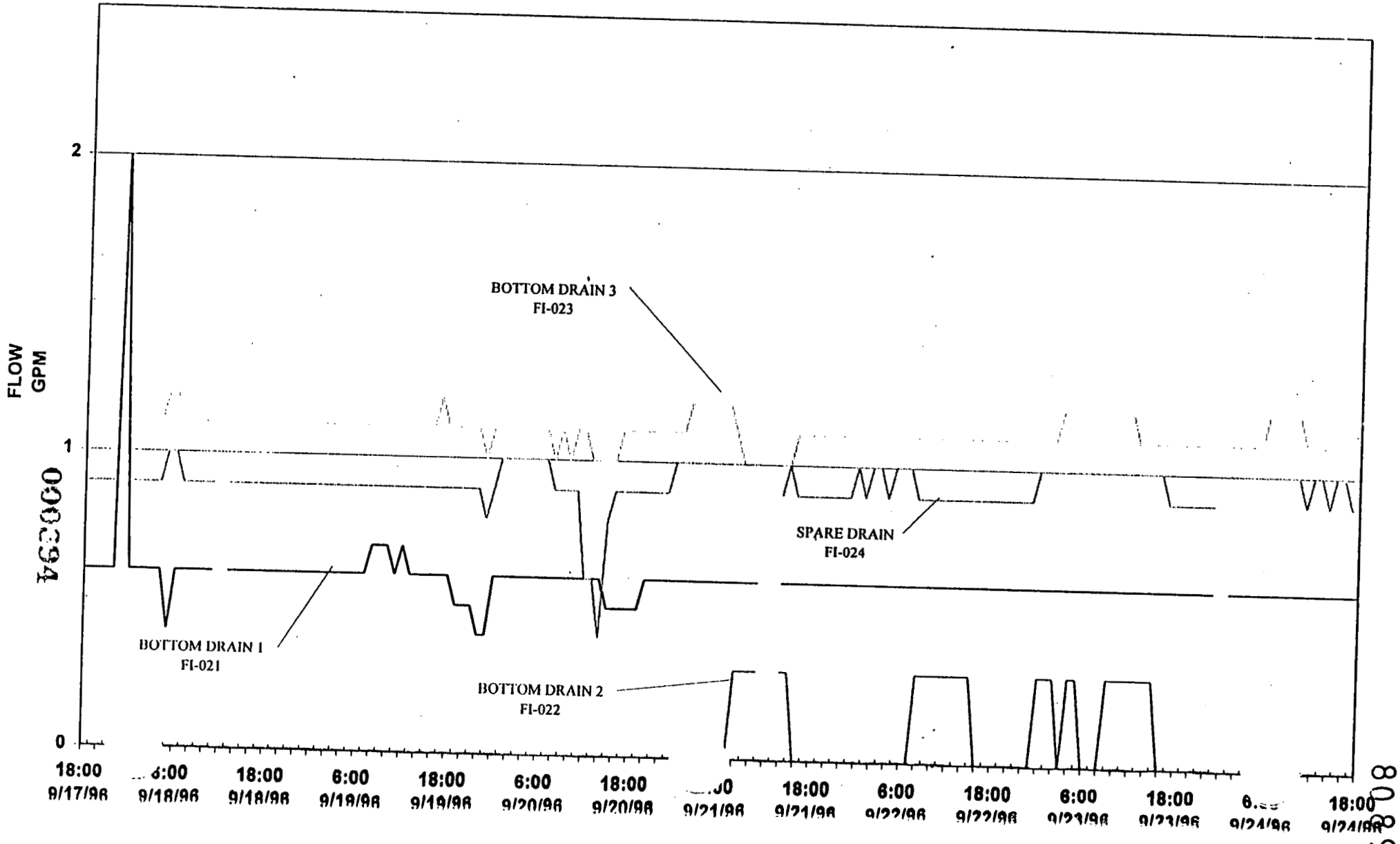
		HOURLY READINGS									
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/21/96	12:00										
9/21/96	13:00		2.2						2.7		
9/21/96	14:00	2.6	2.2	2.4	2.5	1.2	2.8	2.8	2.7	2.7	1.2
9/21/96	15:00	2.5	2.2	2.4	2.5	1.2	2.6	2.6	2.6	2.7	1.2
9/21/96	16:00	2.4	2.2	2.4	2.6	1.1	2.7	2.7	2.5	2.6	1.1
9/21/96	17:00	2.4	2.2	2.5	2.5	1.1	2.6	2.6	2.7	2.7	1.1
9/21/96	18:00	2.5	2.2	2.4	2.6	1.1	2.7	2.8	2.7	2.7	1.1
9/21/96	19:00	2.5	2.2	2.4	2.6	1.1	2.7	2.8	2.7	2.7	1.1
9/21/96	20:00	2.5	2.2	2.4	2.6	1.1	2.7	2.8	2.7	2.7	1.1
9/21/96	21:00	2.5	2.2	2.4	2.6	1.1	2.7	2.8	2.7	2.7	1.1
9/21/96	22:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/21/96	23:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/22/96	0:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	1:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	2:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	3:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	4:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	5:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	6:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	7:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	8:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	9:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	10:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	11:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	12:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	13:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	14:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	15:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	16:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	17:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	18:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	19:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.6	1.1
9/22/96	20:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/22/96	21:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/22/96	22:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/22/96	23:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/23/96	0:00	2.5	2.2	2.4	2.6	1.2	2.8	2.8	2.7	2.7	1.2
9/23/96	1:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.7	2.7	1.2
9/23/96	2:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.7	2.7	1.2
9/23/96	3:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.7	2.7	1.2
9/23/96	4:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.7	2.7	1.2
9/23/96	5:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.7	2.7	1.2
9/23/96	6:00	2.6	2.3	2.4	2.6	1.2	2.8	2.8	2.7	2.8	1.2
9/23/96	7:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.7	2.8	1.2
9/23/96	8:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	27.0	2.8	1.2

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

		HOURLY READINGS									
READINGS		ELECTRODE CLOSED LOOP COOLING WATER SYSTEM									
		D	E	F	G	H	I	J	K	L	M
		COOLING WATER SUPPLY									
		FI-011	FI-012	FI-013	FI-014	FI-015	FI-016	FI-017	FI-018	FI-019	FI-020
DATE	HOUR	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM	GPM
9/23/96	9:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.8	1.2
9/23/96	10:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.8	1.2
9/23/96	11:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.8	1.2
9/23/96	12:00	2.6	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.8	1.2
9/23/96	13:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/23/96	14:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/23/96	15:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/23/96	16:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.7	2.7	1.1
9/23/96	17:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.7	2.7	1.1
9/23/96	18:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.7	2.7	1.1
9/23/96	19:00	2.5	2.2	2.4	2.5	1.1	2.7	2.7	2.6	2.7	1.1
9/23/96	20:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.6	2.7	1.1
9/23/96	21:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.6	2.7	1.1
9/23/96	22:00	2.5	2.2	2.4	2.5	1.1	2.8	2.8	2.6	2.7	1.1
9/23/96	23:00	2.5	2.2	2.4	2.6	1.1	2.8	2.8	2.7	2.7	1.1
9/24/96	0:00	2.6	2.2								
9/24/96	1:00	2.6	2.2	2.4	2.6	1.2	2.7	2.8	2.6	2.6	1.2
9/24/96	2:00	2.6	2.2	2.4	2.6	1.2	2.7	2.8	2.6	2.6	1.2
9/24/96	3:00	2.6	2.2	2.4	2.6	1.2	2.7	2.8	2.6	2.6	1.2
9/24/96	4:00	2.6	2.2	2.4	2.6	1.2	2.7	2.8	2.6	2.6	1.2
9/24/96	5:00	2.6	2.2	2.4	2.6	1.2	2.7	2.8	2.6	2.6	1.2
9/24/96	6:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.6	2.7	1.2
9/24/96	7:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.6	2.7	1.2
9/24/96	8:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.8	2.7	1.2
9/24/96	9:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.8	2.7	1.2
9/24/96	10:00	2.6	2.2	2.4	2.6	1.2	2.8	2.8	2.8	2.7	1.2
9/24/96	11:00	2.4	2.2	2.4	2.6	1.1	2.7	2.7	2.6	2.6	1.1
9/24/96	12:00	2.6	2.2	2.4	2.6	1.0	2.8	2.8	2.8	2.6	2.7
9/24/96	13:00	2.6	2.2	2.4	2.6	1.0	2.8	2.8	2.8	2.7	1.2
9/24/96	14:00	2.5	2.2	2.4	2.6	1.1	2.7	2.7	2.6	2.6	1.1
9/24/96	15:00	2.5	2.2	2.4	2.6	1.1	2.7	2.7	2.6	2.6	1.1
9/24/96	16:00	2.5	2.2	2.4	2.6	1.1	2.7	2.7	2.6	2.6	1.1
9/24/96	17:00	2.5	2.2	2.4	2.6	1.1	2.7	2.7	2.6	2.6	1.1
9/24/96	18:00	2.5	2.2	2.4	2.6	1.1	2.7	2.7	2.6	2.6	1.1

CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM
BOTTOM DRAIN CLCW FLOW



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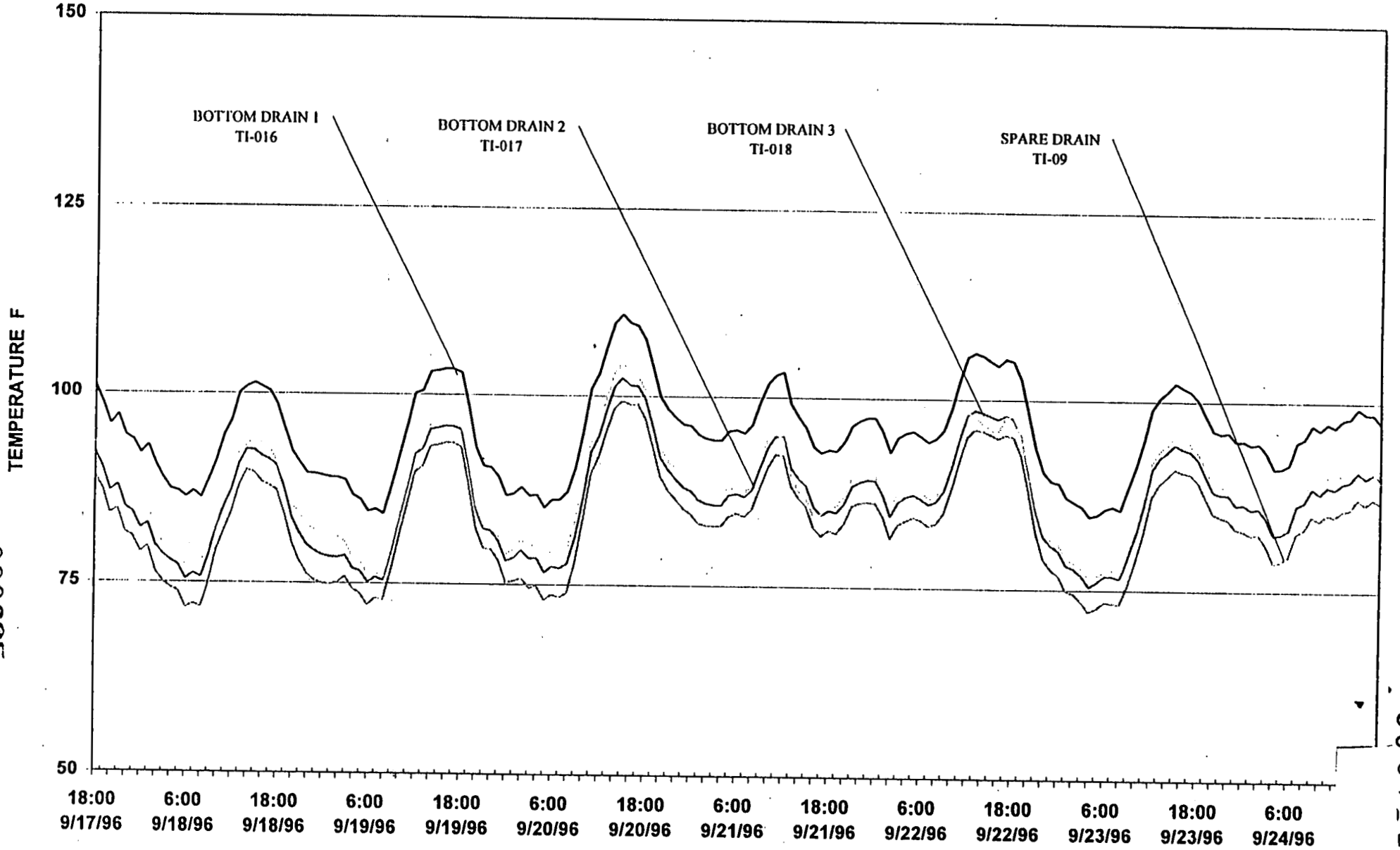
CAMPAIGN 2
SERIES D GLASS
FURNACE SYSTEM
BOTTOM DRAIN CLCW RETURN



C2FURN.XLS Chart 31

VHP 11/8/9

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

MELTER BOTTOM DRAINS

READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/17/96	18:00	0.6	0.0	1.1	0.9	100.93	92.25	93.68	89.23
9/17/96	19:00	0.6	0.0	1.1	0.9	98.59	90.18	91.04	87.38
9/17/96	20:00	0.6	0.0	1.1	0.9	95.92	87.16	88.42	84.21
9/17/96	21:00	0.6	0.0	1.1	0.9	97.19	87.96	89.72	84.78
9/17/96	22:00	0.6	0.0	1.1	0.9	94.48	85.04	86.96	81.70
9/17/96	23:00	2.0	0.0	1.1	0.9	93.90	84.41	86.20	81.18
9/18/96	0:00	0.6	0.0	1.1	0.9	92.16	82.29	84.13	79.12
9/18/96	1:00	0.6	0.0	1.1	0.9	93.24	82.93	85.06	79.88
9/18/96	2:00	0.6	0.0	1.1	0.9	90.78	80.01	82.13	76.49
9/18/96	3:00	0.6	0.0	1.1	0.9	88.93	78.82	80.30	75.17
9/18/96	4:00	0.6	0.0	1.1	0.9	87.46	77.94	78.81	74.33
9/18/96	5:00	0.4	0.0	1.2	1.0	87.17	77.35	78.56	73.87
9/18/96	6:00	0.6	0.0	1.2	1.0	86.41	75.44	77.35	71.61
9/18/96	7:00	0.6	0.0	1.1	0.9	87.17	76.24	78.37	72.11
9/18/96	8:00	0.6	0.0	1.1	0.9	86.34	75.70	77.52	71.70
9/18/96	9:00	0.6	0.0	1.1	0.9	88.63	78.59	79.77	74.96
9/18/96	10:00	0.6	0.0	1.1	0.9	91.23	82.46	82.75	79.39
9/18/96	11:00	0.6	0.0	1.1	0.9	94.54	85.15	86.68	81.94
9/18/96	12:00					96.48	87.27	88.97	84.[illegible]
9/18/96	13:00	0.6	0.0	1.1	0.9	100.09	90.87	92.67	8[illegible]
9/18/96	14:00	0.6	0.0	1.1	0.9	100.94	92.65	93.20	90.[illegible]
9/18/96	15:00	0.6	0.0	1.1	0.9	101.42	92.61	94.12	89.74
9/18/96	16:00	0.6	0.0	1.1	0.9	100.88	91.86	93.58	88.47
9/18/96	17:00	0.6	0.0	1.1	0.9	100.31	91.40	93.02	87.95
9/18/96	18:00	0.6	0.0	1.1	0.9	98.57	90.64	90.96	87.33
9/18/96	19:00	0.6	0.0	1.1	0.9	95.51	87.55	88.38	84.30
9/18/96	20:00	0.6	0.0	1.1	0.9	92.52	83.72	85.83	80.37
9/18/96	21:00	0.6	0.0	1.1	0.9	91.07	81.67	84.18	77.95
9/18/96	22:00	0.6	0.0	1.1	0.9	89.67	80.10	82.79	76.23
9/18/96	23:00	0.6	0.0	1.1	0.9	89.62	79.33	82.11	75.37
9/19/96	0:00	0.6	0.0	1.1	0.9	89.39	78.79	81.58	74.99
9/19/96	1:00	0.6	0.0	1.1	0.9	89.13	78.53	81.40	74.88
9/19/96	2:00	0.6	0.0	1.1	0.9	89.10	78.47	81.25	75.10
9/19/96	3:00	0.6	0.0	1.1	0.9	88.75	78.74	80.55	75.94
9/19/96	4:00	0.6	0.0	1.1	0.9	86.77	76.99	78.43	74.26
9/19/96	5:00	0.6	0.0	1.1	0.9	86.19	76.64	77.98	73.60
9/19/96	6:00	0.6	0.0	1.1	0.9	84.67	75.14	76.21	72.10
9/19/96	7:00	0.6	0.0	1.1	0.9	84.93	75.83	76.49	73.02
9/19/96	8:00	0.7	0.0	1.1	0.9	84.35	75.43	75.79	72.79
9/19/96	9:00	0.7	0.0	1.1	0.9	87.87	79.16	79.56	76.63
9/19/96	10:00	0.7	0.0	1.1	0.9	91.94	83.63	83.96	81.22
9/19/96	11:00	0.6	0.0	1.1	0.9	95.93	87.94	88.31	85.54
9/19/96	12:00	0.7	0.0	1.1	0.9	100.16	92.25	93.09	89.93
9/19/96	13:00	0.6	0.0	1.1	0.9	100.52	92.88	93.50	90.67
9/19/96	14:00	0.6	0.0	1.1	0.9	103.08	95.52	96.23	93.[illegible]
9/19/96	15:00	0.6	0.0	1.1	0.9	103.20	95.70	96.48	93[illegible]
9/19/96	16:00	0.6	0.0	1.1	0.9	103.46	95.94	96.63	93.[illegible]
9/19/96	17:00	0.6	0.0	1.2	0.9	103.40	95.86	96.51	93.71
9/19/96	18:00	0.6	0.0	1.1	0.9	102.94	95.49	96.02	93.18
9/19/96	19:00	0.5	0.0	1.1	0.9	98.53	90.82	91.32	88.34

VITRIFICATION PILOT PLANT FURNACE SYSTEM

CAMPAIGN 2 SERIES D GLASS

MELTER BOTTOM DRAINS

READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/19/96	20:00	0.5	0.0	1.1	0.9	93.14	85.12	85.53	82.54
9/19/96	21:00	0.5	0.0	1.1	0.9	90.76	82.41	82.91	79.89
9/19/96	22:00	0.4	0.0	1.1	0.9	90.58	82.21	82.77	79.71
9/19/96	23:00	0.4	0.0	1.0	0.8	89.35	80.83	81.42	78.21
9/20/96	0:00	0.6	0.0	1.1	0.9	86.86	78.17	79.18	75.26
9/20/96	1:00	0.6	0.0	1.1	1.0	87.08	78.57	79.84	75.49
9/20/96	2:00	0.6	0.0	1.1	1.0	87.97	79.59	80.97	75.90
9/20/96	3:00	0.6	0.0	1.1	1.0	86.86	78.51	79.98	74.55
9/20/96	4:00	0.6	0.0	1.1	1.0	86.97	78.60	80.48	74.82
9/20/96	5:00	0.6	0.0	1.1	1.0	85.29	76.63	78.39	72.96
9/20/96	6:00	0.6	0.0	1.1	1.0	86.33	77.45	79.42	73.68
9/20/96	7:00	0.6	0.0	1.1	1.0	86.34	77.23	79.18	73.31
9/20/96	8:00	0.6	0.0	1.0	0.9	87.36	77.86	79.97	73.89
9/20/96	9:00	0.6	0.0	1.1	0.9	90.63	81.40	83.44	78.12
9/20/96	10:00	0.6	0.0	1.0	0.9	95.29	86.52	88.38	83.69
9/20/96	11:00	0.6	0.0	1.1	0.9	100.94	92.66	94.07	89.96
9/20/96	12:00	0.6	WO*	1.1	0.6	103.00	94.79	96.32	92.15
9/20/96	13:00	0.6	WO	1.0	0.6	106.38	98.12	99.88	95.51
9/20/96	14:00	0.6	WO	1.0	0.4	109.66	101.26	103.22	98.43
9/20/96	15:00	0.5	WO	1.0	0.8	110.80	102.42	104.42	99.33
9/20/96	16:00	0.5	0.0	1.0	0.9	109.68	101.44	103.08	98.90
9/20/96	17:00	0.5	0.0	1.1	0.9	109.29	101.39	102.61	98.92
9/20/96	18:00	0.5	0.0	1.1	0.9	107.46	99.59	100.80	97.03
9/20/96	19:00	0.5	0.0	1.1	0.9	103.81	95.94	97.13	93.26
9/20/96	20:00	0.6	0.0	1.1	0.9	99.93	92.02	93.26	89.45
9/20/96	21:00	0.6	0.0	1.1	0.9	98.33	90.41	91.64	87.72
9/20/96	22:00	0.6	0.0	1.1	0.9	97.28	89.22	90.58	86.53
9/20/96	23:00	0.6	0.0	1.1	0.9	96.42	88.15	89.58	85.39
9/21/96	0:00	0.6	0.0	1.1	1.0	96.24	87.70	89.16	84.66
9/21/96	1:00	0.6	0.0	1.1	1.0	95.09	86.49	87.94	83.40
9/21/96	2:00	0.6	0.0	1.2	1.0	94.61	86.04	87.43	83.16
9/21/96	3:00	0.6	0.0	1.2	1.0	94.35	85.81	87.09	83.02
9/21/96	4:00	0.6	0.0	1.2	1.0	94.34	85.80	87.09	83.07
9/21/96	5:00	0.6	0.0	1.2	1.0	95.58	87.14	88.31	84.37
9/21/96	6:00	0.6	0.0	1.2	1.0	95.71	87.34	87.98	84.81
9/21/96	7:00	0.6	0.0	1.2	1.0	95.30	86.95	87.44	84.40
9/21/96	8:00	0.6	0.3	1.1	1.0	96.39	87.94	88.73	85.35
9/21/96	9:00	0.6	0.3	1.0	1.0	99.29	90.83	91.74	88.17
9/21/96	10:00	0.6	0.3	1.0	1.0	101.82	93.48	94.57	90.91
9/21/96	11:00	0.6	0.3	1.0	1.0	102.96	94.92	95.31	92.54
9/21/96	12:00					103.35	94.94	94.65	92.44
9/21/96	13:00					99.17	90.89	89.73	88.48
9/21/96	14:00	0.6	0.3	1.0	0.9	97.50	89.47	87.91	86.89
9/21/96	15:00	0.6	0.3	1.0	1.0	96.10	88.50	86.83	85.78
9/21/96	16:00	0.6	0.0	1.1	0.9	93.62	85.74	84.48	82.95
9/21/96	17:00	0.6	0.0	1.1	0.9	92.84	84.66	84.81	81.90
9/21/96	18:00	0.6	0.0	1.1	0.9	93.22	85.22	85.70	82.59
9/21/96	19:00	0.6	0.0	1.1	0.9	93.08	84.99	85.90	82.25
9/21/96	20:00	0.6	0.0	1.1	0.9	94.29	86.20	87.29	83.64
9/21/96	21:00	0.6	0.0	1.1	0.9	96.40	88.49	89.67	85.87

VITRIFICATION PILOT PLANT FURNACE SYSTEM
CAMPAIGN 2 SERIES D GLASS
MELTER BOTTOM DRAINS

READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
		CLCW FLOW				CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/21/96	22:00	0.6	0.0	1.1	0.9	97.07	89.04	90.31	86.29
9/21/96	23:00	0.6	0.0	1.1	0.9	97.46	89.37	90.41	86.38
9/22/96	0:00	0.6	0.0	1.1	1.0	97.47	89.30	89.88	86.29
9/22/96	1:00	0.6	0.0	1.1	0.9	95.68	87.38	88.06	84.54
9/22/96	2:00	0.6	0.0	1.1	1.0	92.95	84.58	85.35	81.63
9/22/96	3:00	0.6	0.0	1.1	1.0	94.96	86.42	87.81	83.48
9/22/96	4:00	0.6	0.0	1.1	0.9	95.53	87.11	88.52	83.98
9/22/96	5:00	0.6	0.0	1.1	1.0	95.74	87.44	88.74	84.49
9/22/96	6:00	0.6	0.0	1.1	1.0	95.12	86.88	87.90	84.06
9/22/96	7:00	0.6	0.0	1.1	1.0	94.32	86.16	86.93	83.33
9/22/96	8:00	0.6	0.3	1.1	0.9	94.89	86.57	87.33	83.66
9/22/96	9:00	0.6	0.3	1.1	0.9	95.95	87.97	88.98	85.13
9/22/96	10:00	0.6	0.3	1.1	0.9	98.74	91.09	92.00	88.28
9/22/96	11:00	0.6	0.3	1.1	0.9	102.47	94.80	95.64	91.96
9/22/96	12:00	0.6	0.3	1.1	0.9	105.57	97.93	98.38	95.19
9/22/96	13:00	0.6	0.3	1.1	0.9	106.12	98.56	97.75	96.07
9/22/96	14:00	0.6	0.3	1.1	0.9	105.78	98.31	96.81	95.91
9/22/96	15:00	0.6	0.3	1.1	0.9	105.07	97.84	96.16	95.49
9/22/96	16:00	0.6	0.0	1.1	0.9	104.49	97.44	95.79	94.[illegible]
9/22/96	17:00	0.6	0.0	1.1	0.9	105.39	97.92	97.72	95
9/22/96	18:00	0.6	0.0	1.1	0.9	105.08	97.57	97.84	95.[illegible]
9/22/96	19:00	0.6	0.0	1.1	0.9	102.74	95.34	95.19	92.82
9/22/96	20:00	0.6	0.0	1.1	0.9	98.22	90.69	90.98	88.11
9/22/96	21:00	0.6	0.0	1.1	0.9	93.69	85.57	86.05	82.71
9/22/96	22:00	0.6	0.0	1.1	0.9	90.61	82.15	82.65	79.12
9/22/96	23:00	0.6	0.0	1.1	0.9	89.43	80.89	81.57	77.72
9/23/96	0:00	0.6	0.3	1.1	1.0	89.18	80.18	81.18	76.90
9/23/96	1:00	0.6	0.3	1.1	1.0	87.28	78.29	79.24	74.90
9/23/96	2:00	0.6	0.3	1.1	1.0	86.67	77.83	78.75	74.50
9/23/96	3:00	0.6	0.0	1.2	1.0	86.10	76.93	77.93	73.43
9/23/96	4:00	0.6	0.3	1.2	1.0	84.77	75.45	76.40	72.07
9/23/96	5:00	0.6	0.3	1.2	1.0	85.03	76.07	76.84	72.59
9/23/96	6:00	0.6	0.0	1.2	1.0	85.79	76.91	77.59	73.38
9/23/96	7:00	0.6	0.0	1.2	1.0	86.12	76.89	77.60	73.29
9/23/96	8:00	0.6	0.0	1.2	1.0	85.65	76.58	77.17	73.10
9/23/96	9:00	0.6	0.3	1.2	1.0	88.64	79.33	80.15	75.64
9/23/96	10:00	0.6	0.3	1.2	1.0	91.40	82.37	83.21	78.93
9/23/96	11:00	0.6	0.3	1.2	1.0	94.81	86.19	87.15	82.70
9/23/96	12:00	0.6	0.3	1.2	1.0	98.86	90.94	91.88	87.45
9/23/96	13:00	0.6	0.3	1.1	1.0	100.41	92.55	93.46	89.22
9/23/96	14:00	0.6	0.3	1.1	1.0	101.29	93.38	94.35	90.09
9/23/96	15:00	0.6	0.3	1.1	1.0	102.41	94.32	95.54	91.12
9/23/96	16:00	0.6	0.0	1.1	1.0	101.80	93.81	95.06	90.72
9/23/96	17:00	0.6	0.0	1.1	0.9	101.29	93.45	94.42	90.55
9/23/96	18:00	0.6	0.0	1.1	0.9	100.12	92.38	93.37	89.[illegible]
9/23/96	19:00	0.6	0.0	1.1	0.9	98.12	90.24	91.16	87.[illegible]
9/23/96	20:00	0.6	0.0	1.1	0.9	96.22	88.20	89.12	85.3[illegible]
9/23/96	21:00	0.6	0.0	1.1	0.9	95.82	87.87	88.69	84.88
9/23/96	22:00	0.6	0.0	1.1	0.9	96.00	87.81	88.90	84.55
9/23/96	23:00	0.6	0.0	1.1	0.9	94.84	86.46	87.54	83.34

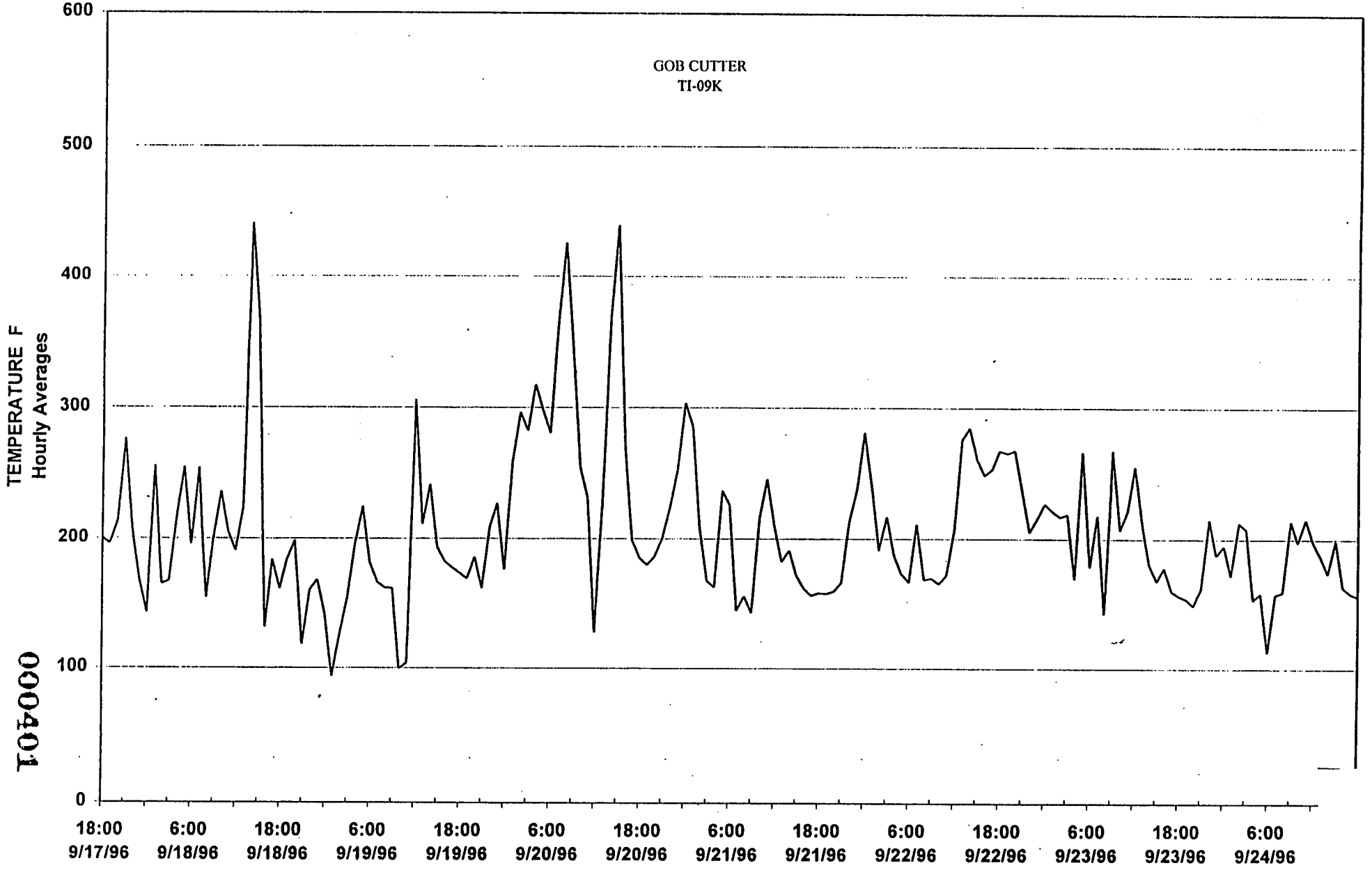
VITRIFICATION PILOT PLANT FURNACE SYSTEM									
CAMPAIGN 2 SERIES D GLASS									
		MELTER BOTTOM DRAINS							
READINGS		ROUNDSHEET READINGS				HOURLY AVERAGES			
	CLCW FLOW					CLCW RETURN TEMPERATURE			
		DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN	DRAIN #1	DRAIN #2	DRAIN #3	SPARE DRAIN
		FI-021	FI-022	FI-023	FI-024	TI-016	TI-017	TI-018	TI-019
DATE	HOUR	GPM	GPM	GPM	GPM	F	F	F	F
9/24/96	0:00					94.86	86.54	87.56	83.10
9/24/96	1:00	0.6	OOS	1.1	1.0	94.36	85.88	86.92	82.50
9/24/96	2:00	0.6	OOS	1.1	1.0	94.52	86.04	87.04	82.62
9/24/96	3:00	0.6	OOS	1.1	1.0	93.33	84.79	85.75	81.19
9/24/96	4:00	0.6	OOS	1.1	1.0	91.23	82.52	83.61	78.89
9/24/96	5:00	0.6	OOS	1.1	1.0	91.34	82.69	83.83	79.01
9/24/96	6:00	0.6	OOS	1.2	1.0	91.85	83.29	84.46	79.69
9/24/96	7:00	0.6	OOS	1.2	1.0	94.75	86.43	87.59	82.85
9/24/96	8:00	0.6	OOS	1.2	1.0	95.26	86.90	88.25	83.29
9/24/96	9:00	0.6	OOS	1.2	1.0	96.99	88.76	90.28	85.05
9/24/96	10:00	0.6	OOS	1.2	1.0	96.37	88.01	89.60	84.49
9/24/96	11:00	0.6	OOS	1.1	0.9	97.21	88.98	90.28	85.28
9/24/96	12:00	0.6	OOS	1.1	1.0	96.75	88.65	89.82	85.06
9/24/96	13:00	0.6	OOS	1.1	1.0	97.71	89.46	90.92	85.80
9/24/96	14:00	0.6	OOS	1.1	0.9	97.94	89.72	91.06	86.04
9/24/96	15:00	0.6	OOS	1.1	1.0	99.21	90.95	92.52	87.36
9/24/96	16:00	0.6	OOS	1.1	1.0	98.52	90.14	91.61	86.61
9/24/96	17:00	0.6	0.0	1.1	0.9	98.46	90.69	90.88	87.39
9/24/96	18:00	0.6	0.0	1.2	0.9	97.21	89.98	89.55	86.82

8089

GEM MACHINE SYSTEM

000400

CAMPAIGN 2
SERIES D GLASS
GEM MACHINE SYSTEM



C2GEMMCH.XLS Chart 7

VHP 10/28/9

000401

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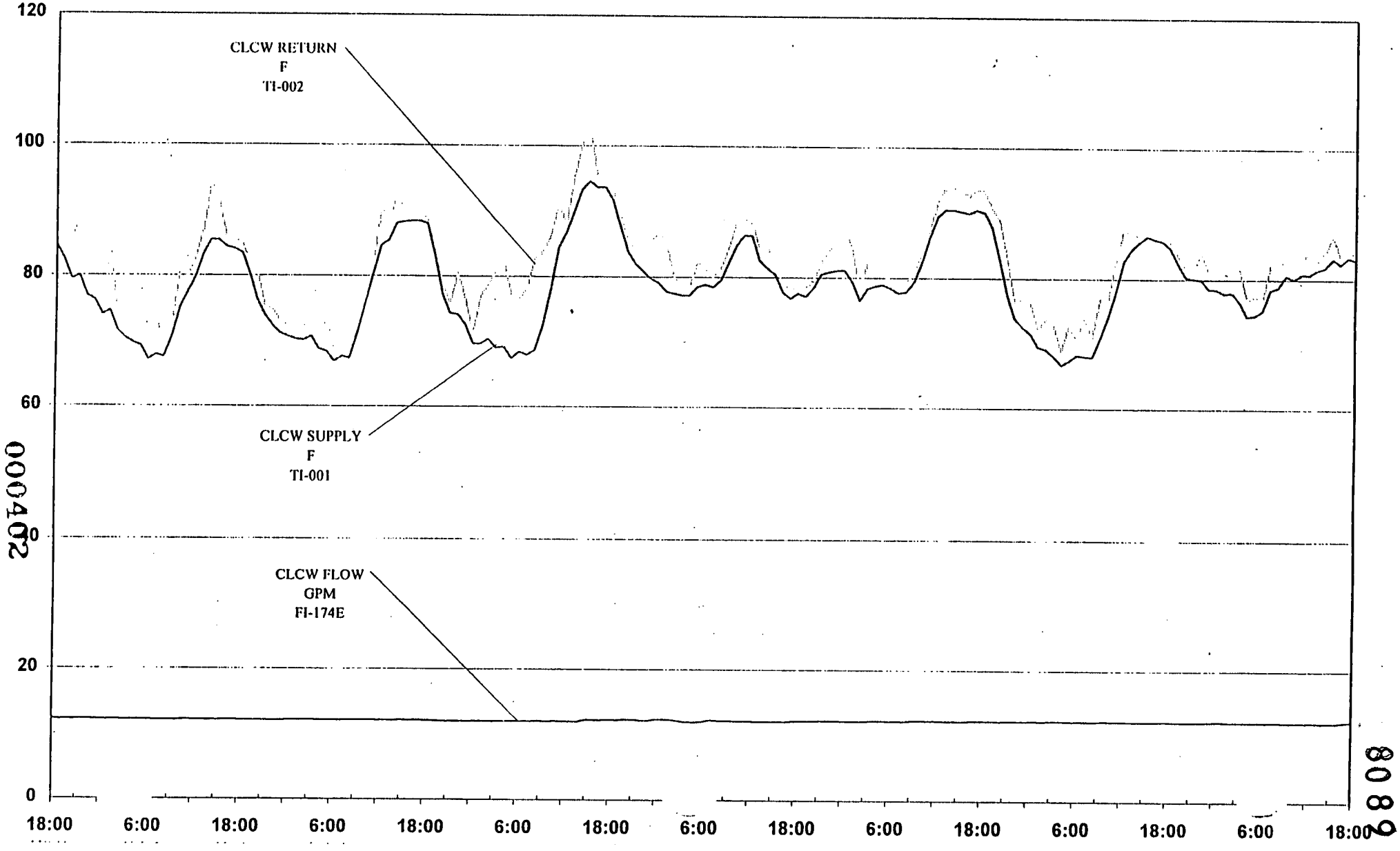
CMPAOGN 2
SERIES D GLASS
GEM MACHINE SYSTEM



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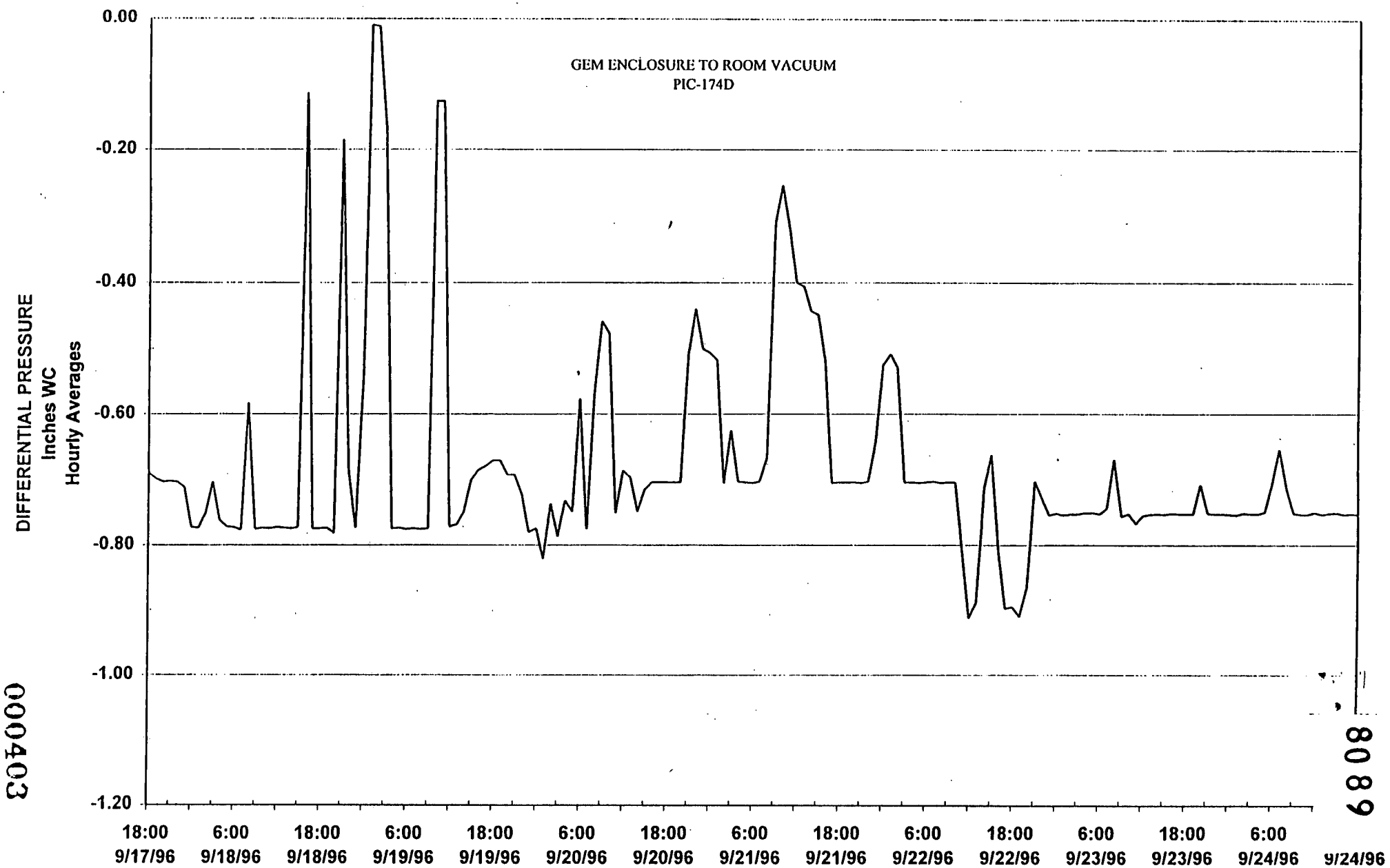
CAMPAIGN 2
SERIES D GLASS
GEM MACHINE SYSTEM



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C2GEMMCH.XLS Chart 9

VHP 10/28/96

VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	DIVERTERS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/17/96	18:00	95.92	199.99		0.17	15.07	27.01	-0.69	12.33	84.65	86.38
9/17/96	19:00	77.02	196.10		0.17	15.10	26.99	-0.70	12.28	82.48	84.29
9/17/96	20:00	101.47	213.29		0.17	19.95	26.97	-0.70	12.30	79.43	85.59
9/17/96	21:00	139.34	276.44		0.17	24.04	27.22	-0.70	12.28	80.02	88.96
9/17/96	22:00	96.95	206.73		0.17	20.11	27.00	-0.70	12.32	76.95	78.98
9/17/96	23:00	85.86	167.28		0.17	20.06	27.01	-0.71	12.32	76.26	77.91
9/18/96	0:00	81.16	142.34		0.17	19.96	26.99	-0.77	12.25	74.04	75.80
9/18/96	1:00	114.49	255.92		0.17	23.89	26.99	-0.77	12.22	74.69	84.00
9/18/96	2:00	98.91	164.40		0.18	25.09	26.99	-0.75	12.28	71.56	73.91
9/18/96	3:00	127.39	166.66		0.17	25.06	28.69	-0.70	12.24	70.39	75.65
9/18/96	4:00	185.86	217.30		0.16	25.04	37.21	-0.76	12.25	69.68	77.65
9/18/96	5:00	200.13	254.68		0.16	24.84	37.18	-0.77	12.28	69.22	78.26
9/18/96	6:00	130.13	195.56		0.16	25.29	37.21	-0.77	12.22	67.07	70.98
9/18/96	7:00	119.93	254.19		0.16	25.29	37.18	-0.78	12.20	67.83	73.51
9/18/96	8:00	80.12	153.84		0.16	16.88	37.24	-0.58	12.21	67.48	69.12
9/18/96	9:00	75.18	200.28		0.17	22.61	37.23	-0.78	12.18	70.58	72.38
9/18/96	10:00	115.49	235.97		0.16	25.08	36.43	-0.77	12.17	75.08	81.10
9/18/96	11:00	97.74	205.22		0.16	25.04	37.22	-0.78	12.25	77.52	79.91
9/18/96	12:00	88.73	190.45		0.16	24.99	37.25	-0.77	12.25	79.82	82.84
9/18/96	13:00	101.82	223.42		0.16	25.13	37.22	-0.77	12.21	83.42	87.20
9/18/96	14:00	102.90	440.59		0.16	25.49	37.23	-0.78	12.21	85.48	94.42
9/18/96	15:00	91.26	365.28		0.16	25.22	37.17	-0.77	12.22	85.44	91.50
9/18/96	16:00	86.66	131.09		0.14	0.19	13.72	-0.12	12.21	84.43	85.74
9/18/96	17:00	81.57	183.62		0.16	20.79	37.20	-0.78	12.22	84.13	85.78
9/18/96	18:00	80.23	160.82		0.16	25.60	37.21	-0.78	12.21	83.52	85.05
9/18/96	19:00	77.45	183.85		0.16	25.50	37.20	-0.77	12.18	80.33	82.09
9/18/96	20:00	99.39	198.18		0.16	21.43	37.22	-0.78	12.16	76.22	[illegible]
9/18/96	21:00	79.06	118.27		0.13	5.37	9.97	-0.19	12.17	73.99	[illegible]
9/18/96	22:00	73.34	159.69		0.15	9.02	19.85	-0.69	12.12	72.34	[illegible]
9/18/96	23:00	70.25	167.43		0.16	17.36	37.18	-0.77	12.13	71.21	73.18
9/19/96	0:00	70.19	141.14		0.16	17.46	37.28	-0.55	12.16	70.66	72.31
9/19/96	1:00	68.74	93.77		0.16	17.63	37.22	-0.01	12.19	70.24	71.80
9/19/96	2:00	68.99	125.44		0.14	10.65	22.36	-0.01	12.20	70.07	72.21
9/19/96	3:00	82.80	153.48		0.15	15.37	29.77	-0.17	12.22	70.69	73.94
9/19/96	4:00	66.42	195.78		0.15	17.44	37.17	-0.78	12.20	68.76	70.81
9/19/96	5:00	112.56	224.55		0.16	16.82	37.27	-0.77	12.16	68.37	73.65
9/19/96	6:00	97.22	180.85		0.16	17.05	37.18	-0.78	12.18	66.85	68.62
9/19/96	7:00	79.48	165.65		0.16	16.99	37.22	-0.78	12.18	67.62	68.99
9/19/96	8:00	71.62	161.36		0.16	16.93	37.20	-0.78	12.18	67.32	68.57
9/19/96	9:00	68.49	160.95		0.16	16.97	37.24	-0.78	12.21	71.25	72.32
9/19/96	10:00	67.95	99.48		0.14	2.99	6.27	-0.13	12.19	76.04	76.79
9/19/96	11:00	68.94	103.73		0.14	0.75	1.35	-0.13	12.22	80.39	81.70
9/19/96	12:00	71.33	306.06		0.16	16.90	37.19	-0.77	12.17	84.76	90.49
9/19/96	13:00	72.31	211.18		0.16	17.09	37.26	-0.77	12.21	85.46	88.28
9/19/96	14:00	73.47	241.47		0.16	17.19	37.22	-0.75	12.15	88.16	92.82
9/19/96	15:00	73.90	193.17		0.15	17.21	37.19	-0.70	12.23	88.36	89.86
9/19/96	16:00	74.24	182.10		0.16	17.17	37.19	-0.69	12.18	88.52	89.81
9/19/96	17:00	74.00	177.09		0.16	17.12	37.26	-0.68	12.21	88.49	89.58
9/19/96	18:00	73.50	172.70		0.16	17.07	37.25	-0.67	12.16	88.02	89.09
9/19/96	19:00	72.16	168.43		0.16	17.03	37.24	-0.67	12.13	83.09	84.37
9/19/96	20:00	70.96	185.54		0.16	16.96	37.21	-0.69	12.09	77.13	78.84
9/19/96	21:00	69.75	161.03		0.16	16.91	37.17	-0.69	12.04	74.35	75.83
9/19/96	22:00	186.65	208.82		0.16	19.55	37.20	-0.72	12.07	74.16	80.55
9/19/96	23:00	160.25	226.79		0.16	21.04	37.16	-0.78	12.07	72.56	76.48
9/20/96	0:00	109.19	175.81		0.16	21.02	37.19	-0.78	12.05	69.60	71.55
9/20/96	1:00	175.77	259.01		0.16	23.51	37.21	-0.82	12.10	69.65	77.00
9/20/96	2:00	169.92	296.44		0.16	32.32	37.21	-0.74	12.10	70.34	78.77
9/20/96	3:00	167.35	282.42		0.16	32.48	37.24	-0.79	12.05	69.05	80.87
9/20/96	4:00	216.67	317.42		0.16	33.29	35.36	-0.73	12.10	69.17	81.92
9/20/96	5:00	192.11	297.69		0.17	32.43	33.48	-0.75	12.08	67.35	[illegible]
9/20/96	6:00	183.06	280.97		0.16	20.33	37.18	-0.58	12.11	68.40	[illegible]
9/20/96	7:00	152.79	365.19		0.16	30.08	37.22	-0.78	12.10	67.93	[illegible]
9/20/96	8:00	195.19	425.81		0.15	30.07	37.19	-0.57	12.10	68.62	[illegible]
9/20/96	9:00	185.80	343.13		0.15	30.23	36.60	-0.46	12.12	72.45	83.83
9/20/96	10:00	169.52	254.95		0.16	30.34	37.23	-0.48	12.08	77.93	86.26
9/20/96	11:00	191.35	231.57		0.16	30.22	31.86	-0.75	12.13	84.40	91.21
9/20/96	12:00	99.91	127.20		0.16	30.08	32.10	-0.69	12.07	86.70	88.00

VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 SERIES D GLASS

READINGS		HOURLY AVERAGES									
		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/20/96	13:00	175.09	227.76		0.16	30.17	32.14	-0.70	12.06	90.06	95.46
9/20/96	14:00	163.28	368.20		0.16	30.21	31.98	-0.75	12.03	93.27	100.31
9/20/96	15:00	143.75	439.12		0.16	30.31	32.12	-0.72	12.35	94.52	102.20
9/20/96	16:00	108.79	268.49		0.16	30.44	32.14	-0.71	12.30	93.60	95.61
9/20/96	17:00	98.20	198.78		0.16	30.33	32.11	-0.71	12.31	93.64	94.84
9/20/96	18:00	90.99	184.67		0.15	30.23	32.13	-0.71	12.33	91.68	93.05
9/20/96	19:00	86.21	179.28		0.16	30.07	32.12	-0.71	12.30	87.74	89.25
9/20/96	20:00	82.14	185.98		0.16	25.99	32.09	-0.71	12.41	83.80	85.55
9/20/96	21:00	80.56	199.84		0.16	20.06	32.09	-0.51	12.41	81.98	84.13
9/20/96	22:00	85.99	223.82		0.16	20.02	31.32	-0.44	12.27	80.78	84.64
9/20/96	23:00	98.50	252.83		0.16	19.89	32.10	-0.50	12.25	79.67	85.61
9/21/96	0:00	124.43	303.39		0.16	20.05	32.13	-0.51	12.42	79.05	87.03
9/21/96	1:00	100.95	285.54		0.16	20.04	32.12	-0.52	12.45	77.73	84.80
9/21/96	2:00	87.79	208.33		0.15	20.05	32.10	-0.71	12.42	77.41	79.86
9/21/96	3:00	82.90	166.77		0.16	17.71	32.10	-0.63	12.20	77.19	78.84
9/21/96	4:00	78.90	162.04		0.16	20.05	32.12	-0.70	12.04	77.14	78.54
9/21/96	5:00	77.58	236.61		0.16	20.05	32.13	-0.71	12.00	78.48	82.32
9/21/96	6:00	78.40	226.06		0.16	20.05	32.13	-0.71	12.07	78.81	81.28
9/21/96	7:00	76.64	144.19		0.16	20.05	32.10	-0.70	12.34	78.46	80.00
9/21/96	8:00	75.56	155.13		0.15	20.05	32.13	-0.67	12.26	79.44	81.40
9/21/96	9:00	75.19	142.58		0.16	20.04	32.14	-0.31	12.22	82.18	84.46
9/21/96	10:00	75.50	215.66		0.16	20.05	32.08	-0.25	12.19	84.82	88.29
9/21/96	11:00	76.01	245.68		0.16	20.04	32.14	-0.32	12.16	86.43	88.87
9/21/96	12:00	77.64	209.42		0.16	20.04	32.14	-0.40	12.19	86.37	88.41
9/21/96	13:00	76.94	182.13		0.16	20.04	32.12	-0.41	12.10	82.57	84.20
9/21/96	14:00	83.66	190.79		0.16	20.04	32.17	-0.44	12.12	81.37	84.71
9/21/96	15:00	80.08	171.03		0.16	20.05	32.12	-0.45	12.14	80.49	81.94
9/21/96	16:00	76.28	160.95		0.16	20.05	32.10	-0.52	12.13	77.75	79.25
9/21/96	17:00	73.84	155.64		0.16	20.05	32.08	-0.71	12.13	76.76	78.15
9/21/96	18:00	72.90	157.74		0.16	20.03	32.07	-0.71	12.21	77.53	78.86
9/21/96	19:00	73.24	157.18		0.16	20.05	32.12	-0.71	12.22	77.10	78.49
9/21/96	20:00	71.60	158.84		0.16	20.06	32.12	-0.71	12.25	78.35	79.58
9/21/96	21:00	71.25	165.81		0.16	20.04	32.09	-0.71	12.27	80.54	82.32
9/21/96	22:00	69.18	212.43		0.15	20.04	32.12	-0.70	12.30	80.85	84.11
9/21/96	23:00	71.26	237.91		0.16	20.05	32.10	-0.64	12.29	81.11	86.10
9/22/96	0:00	73.12	281.30		0.16	20.05	32.14	-0.53	12.26	81.17	87.70
9/22/96	1:00	78.37	238.88		0.16	19.93	32.10	-0.51	12.24	79.28	84.30
9/22/96	2:00	71.67	191.14		0.16	20.05	32.10	-0.53	12.25	76.49	78.40
9/22/96	3:00	71.19	216.98		0.16	19.92	32.17	-0.71	12.25	78.34	82.23
9/22/96	4:00	71.39	187.52		0.16	20.06	32.08	-0.71	12.31	78.75	80.42
9/22/96	5:00	71.06	172.54		0.16	20.07	32.18	-0.71	12.31	78.96	80.34
9/22/96	6:00	70.52	165.89		0.16	20.05	32.12	-0.71	12.27	78.35	79.72
9/22/96	7:00	69.90	211.33		0.16	20.05	32.07	-0.70	12.25	77.66	79.64
9/22/96	8:00	72.11	167.98		0.16	20.07	32.12	-0.71	12.22	77.87	79.36
9/22/96	9:00	72.79	169.08		0.16	20.05	36.49	-0.71	12.32	79.38	80.79
9/22/96	10:00	74.01	164.89		0.16	20.04	37.24	-0.71	12.38	82.49	83.69
9/22/96	11:00	75.37	171.27		0.16	20.04	37.16	-0.81	12.35	86.18	87.38
9/22/96	12:00	77.00	206.18		0.16	20.05	37.24	-0.91	12.33	89.46	91.58
9/22/96	13:00	77.71	276.03		0.16	20.05	37.20	-0.89	12.31	90.53	93.71
9/22/96	14:00	77.30	284.71		0.16	20.05	37.20	-0.71	12.29	90.52	93.90
9/22/96	15:00	77.32	260.61		0.16	20.05	37.22	-0.66	12.27	90.26	93.48
9/22/96	16:00	79.01	248.79		0.16	20.05	37.22	-0.81	12.28	89.98	92.60
9/22/96	17:00	79.46	253.53		0.16	20.05	37.16	-0.90	12.33	90.51	93.50
9/22/96	18:00	79.23	267.37		0.16	20.05	37.21	-0.90	12.32	90.14	93.29
9/22/96	19:00	79.20	265.28		0.16	20.05	37.20	-0.91	12.34	87.73	90.86
9/22/96	20:00	79.40	267.48		0.16	19.99	37.27	-0.87	12.30	82.93	88.83
9/22/96	21:00	79.00	235.21		0.16	20.03	37.22	-0.70	12.31	77.41	82.92
9/22/96	22:00	78.03	205.21		0.16	20.06	37.20	-0.73	12.34	73.82	76.28
9/22/96	23:00	75.65	215.81		0.16	19.88	37.23	-0.76	12.29	72.46	77.10
9/23/96	0:00	76.92	227.02		0.16	19.89	37.20	-0.75	12.31	71.53	76.36
9/23/96	1:00	75.27	221.37		0.16	20.06	37.18	-0.76	12.33	69.49	72.19
9/23/96	2:00	84.60	217.17		0.16	19.48	37.18	-0.75	12.27	69.10	73.79
9/23/96	3:00	79.73	218.81		0.16	19.95	37.20	-0.75	12.32	68.02	72.80
9/23/96	4:00	76.09	168.86		0.16	19.72	37.23	-0.75	12.34	66.64	68.85
9/23/96	5:00	72.32	266.46		0.16	20.04	37.20	-0.75	12.32	67.29	72.78
9/23/96	6:00	70.86	178.17		0.16	19.76	37.20	-0.75	12.28	68.18	70.73
9/23/96	7:00	71.80	217.97		0.15	19.86	37.18	-0.75	12.28	68.01	73.70

VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 SERIES D GLASS

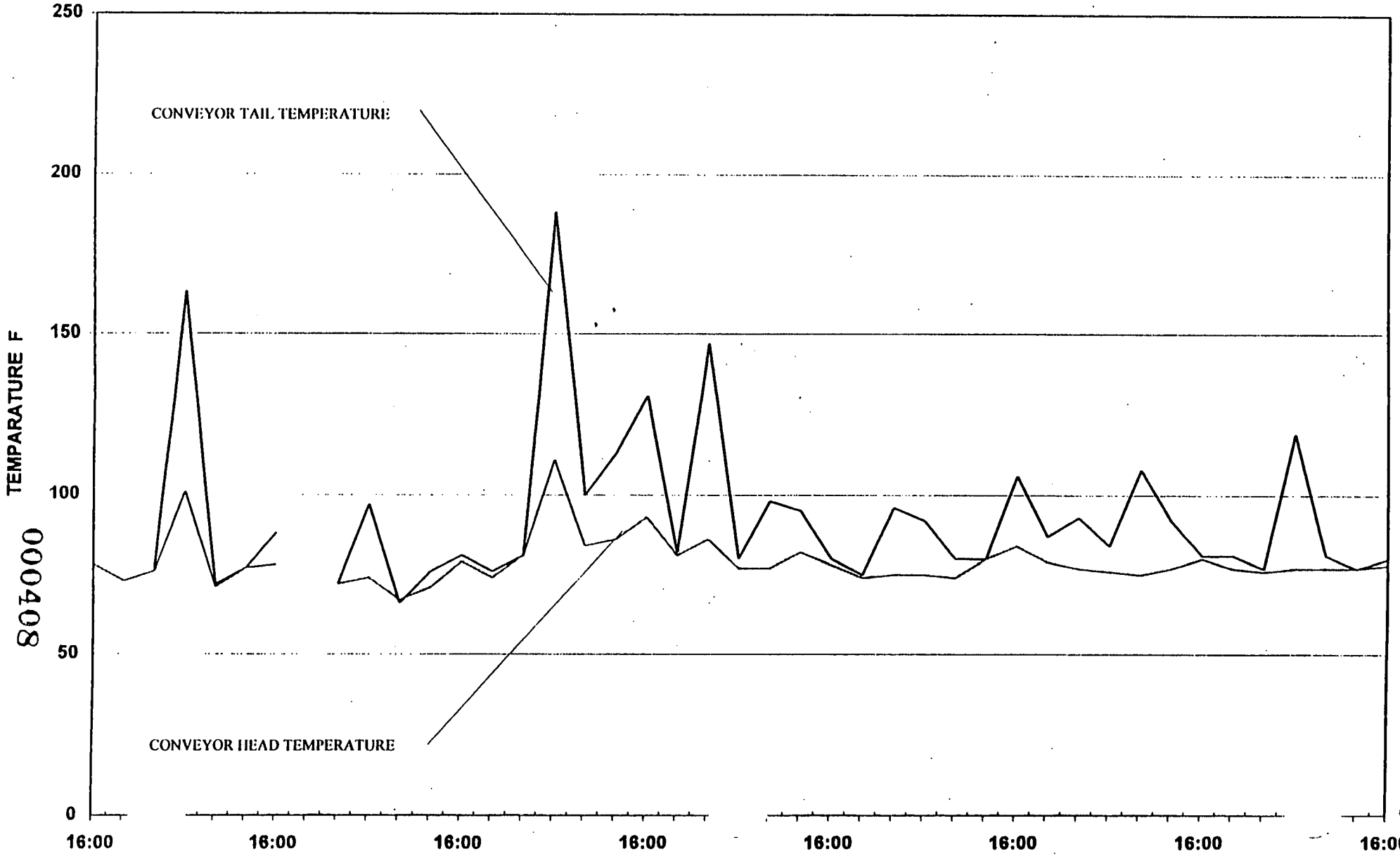
HOURLY AVERAGES

READINGS		GEM HOPPER	GOB CUTTER	GOB CUTTER TEMP	GOB CUTTER	GOB ROLLER	CONVEYOR SPEED	GEM ENCLOSURE TO ROOM VACUUM	CLCW DIVERTERS & CONVEYOR SUPPLY	CLCW DIVERTERS & CONVEYOR SUPPLY	DIVERTERS & CONVEYOR RETURN
		TI-3K	TI-9K	IR	SIC-174BM	SIC-174AM	SIC-174CM	PIC-174D	FI-174E	TI-001	TI-002
DATE	HOUR	F	F	F	RPM	RPM	RPM	In WC	GPM	F	F
9/23/96	8:00	70.36	142.22		0.16	20.04	37.22	-0.67	12.28	67.86	71.00
9/23/96	9:00	70.84	267.57		0.16	19.78	37.20	-0.76	12.26	70.71	76.91
9/23/96	10:00	71.27	206.85		0.16	5.82	37.18	-0.75	12.34	73.91	76.49
9/23/96	11:00	72.34	221.17		0.16	6.46	37.23	-0.77	12.26	77.86	82.65
9/23/96	12:00	74.12	255.02		0.15	12.86	37.19	-0.76	12.29	82.73	87.72
9/23/96	13:00	74.90	210.40		0.16	20.07	37.24	-0.75	12.25	84.55	86.53
9/23/96	14:00	74.92	179.84		0.16	6.83	37.22	-0.75	12.25	85.59	87.05
9/23/96	15:00	74.88	166.82		0.16	0.20	37.26	-0.75	12.26	86.59	87.89
9/23/96	16:00	74.86	177.25		0.16	0.21	37.15	-0.75	12.26	86.12	87.53
9/23/96	17:00	74.76	159.36		0.16	0.20	37.21	-0.75	12.26	85.80	86.92
9/23/96	18:00	74.68	155.82		0.16	0.21	37.18	-0.75	12.29	84.78	85.89
9/23/96	19:00	77.01	153.37		0.15	0.20	37.16	-0.75	12.23	82.41	83.71
9/23/96	20:00	74.23	148.37		0.15	0.20	37.18	-0.71	12.20	80.30	81.58
9/23/96	21:00	72.16	161.47		0.16	0.21	37.18	-0.75	12.19	80.06	81.38
9/23/96	22:00	79.86	215.05		0.16	7.13	37.24	-0.75	12.23	79.94	83.95
9/23/96	23:00	75.44	187.44		0.16	4.51	37.25	-0.75	12.24	78.51	81.28
9/24/96	0:00	73.95	194.50		0.15	2.52	37.19	-0.75	12.27	78.40	81.00
9/24/96	1:00	73.45	171.16		0.16	3.86	37.20	-0.76	12.29	77.78	80.67
9/24/96	2:00	100.74	212.31		0.16	3.84	37.22	-0.75	12.24	77.94	81.13
9/24/96	3:00	79.95	207.64		0.16	6.95	37.22	-0.75	12.24	76.58	81.72
9/24/96	4:00	75.16	152.82		0.16	2.08	37.22	-0.75	12.22	74.27	76.89
9/24/96	5:00	73.44	157.67		0.16	2.85	37.22	-0.75	12.22	74.41	77.52
9/24/96	6:00	71.90	112.68		0.15	0.20	37.23	-0.71	12.24	75.16	76.47
9/24/96	7:00	77.80	156.62		0.16	6.53	36.61	-0.66	12.21	78.33	82.39
9/24/96	8:00	78.94	158.66		0.16	2.86	36.02	-0.72	12.22	78.77	82.27
9/24/96	9:00	91.82	213.68		0.16	20.08	37.20	-0.75	12.21	80.59	83.28
9/24/96	10:00	82.48	197.18		0.16	20.07	37.22	-0.75	12.16	80.03	
9/24/96	11:00	79.95	215.20		0.16	20.07	37.23	-0.75	12.20	80.83	
9/24/96	12:00	76.31	198.03		0.16	20.08	37.15	-0.75	12.17	80.76	
9/24/96	13:00	75.42	186.63		0.16	20.06	37.20	-0.75	12.20	81.51	82.96
9/24/96	14:00	75.14	172.89		0.16	20.09	37.21	-0.75	12.14	81.89	84.10
9/24/96	15:00	75.81	198.74		0.16	20.15	37.01	-0.75	12.16	83.23	86.61
9/24/96	16:00	75.76	162.39		0.16	20.08	37.19	-0.75	12.17	82.39	83.64
9/24/96	17:00	75.52	157.66		0.16	20.07	37.22	-0.75	12.29	83.39	84.53
9/24/96	18:00	74.87	155.40		0.16	20.10	37.19	-0.75	12.39	83.03	84.05

VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM									
CAMPAIGN 2 SERIES D GLASS									
HOURLY READINGS ROUNDSHEETS									
READINGS		CONVEYOR	CONVEYOR	GEM	BULK	BULK	GEM	GEM	ENCLOSURE
		TAIL	HEAD	HOPPER	HOPPER #1	HOPPER #2	ENCLOSURE	ENCLOSURE	EXPANSION
		TEMP	TEMP	TEMP	TEMP	TEMP	BOTTOM	TOP	JOINT
							TEMP	TEMP	TEMP
DATE	HOUR	F	F	F	F	F	F	F	F

000407

CAMPAIGN 2
SERIES D GLASS
GEM MACHINE SYSTEM



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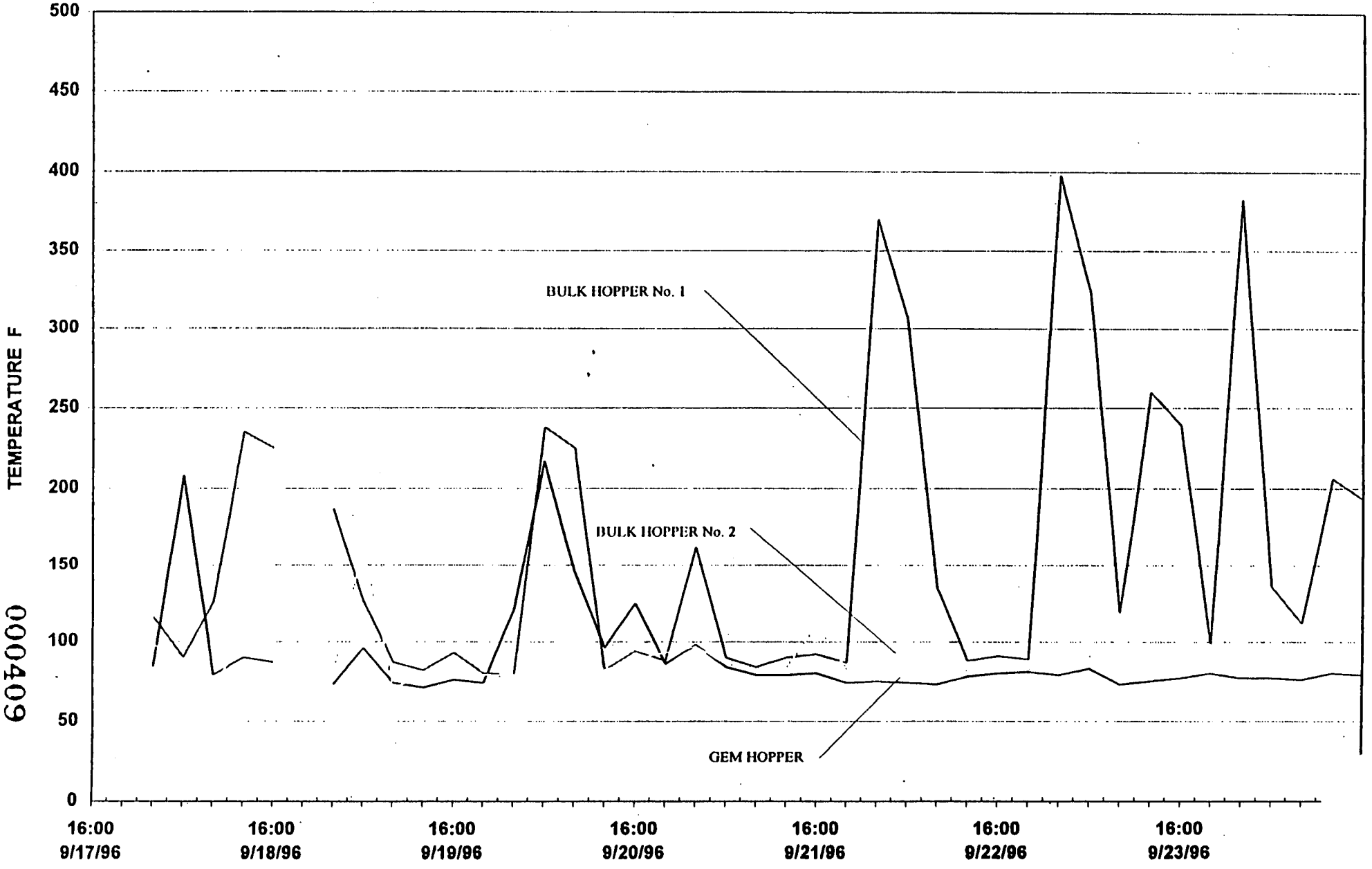
CAMPAIGN 2
SERIES D GLASS
GEM MACHINE SYSTEM



C2GEMMCH.XLS Chart 14

VHP 11/8/96

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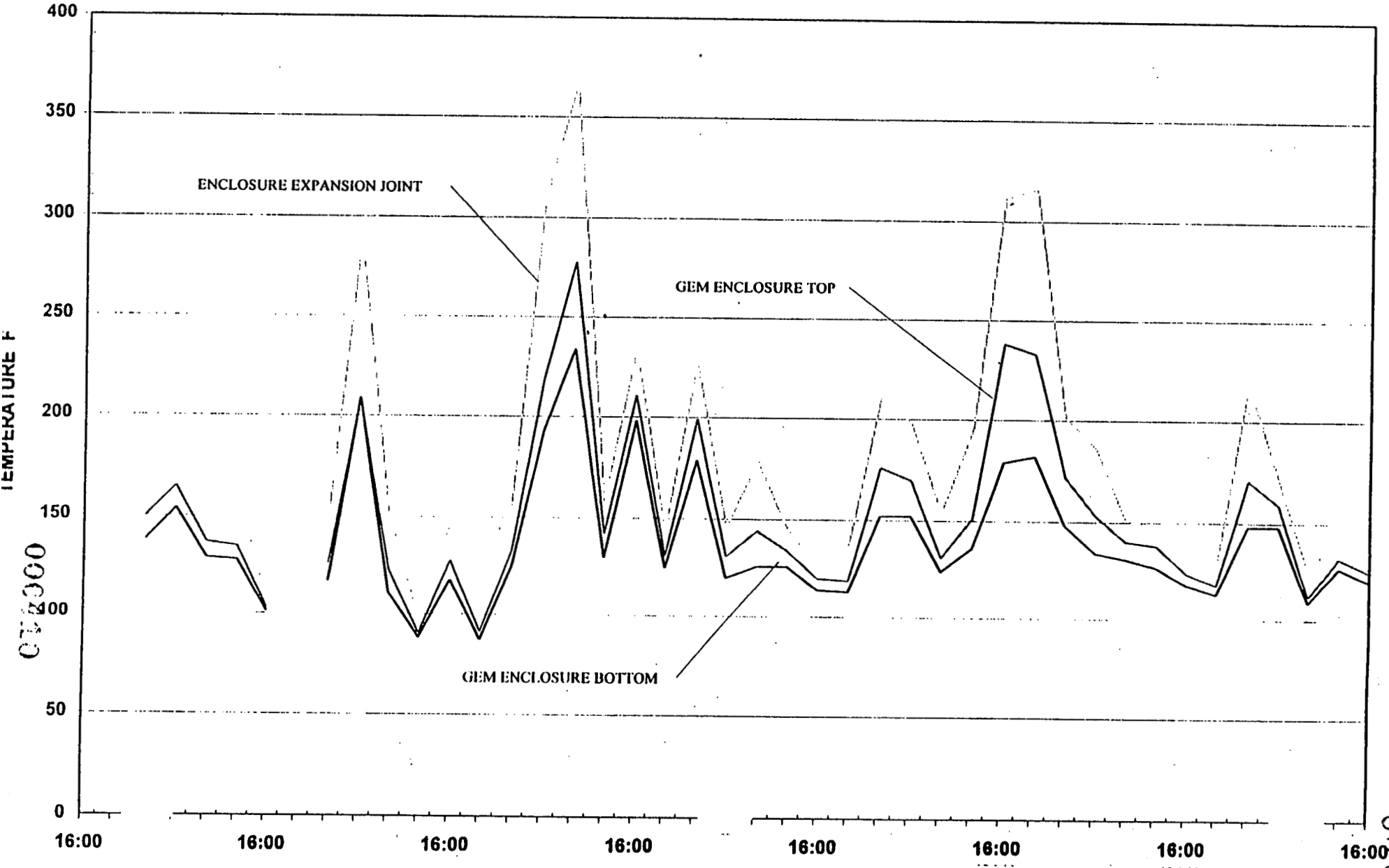
CAMPAIGN 2
SERIES D GLASS
GEM MACHINE SYSTEM



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VITRIFICATION PILOT PLANT GEM MACHINE SYSTEM

CAMPAIGN 2 SERIES D GLASS

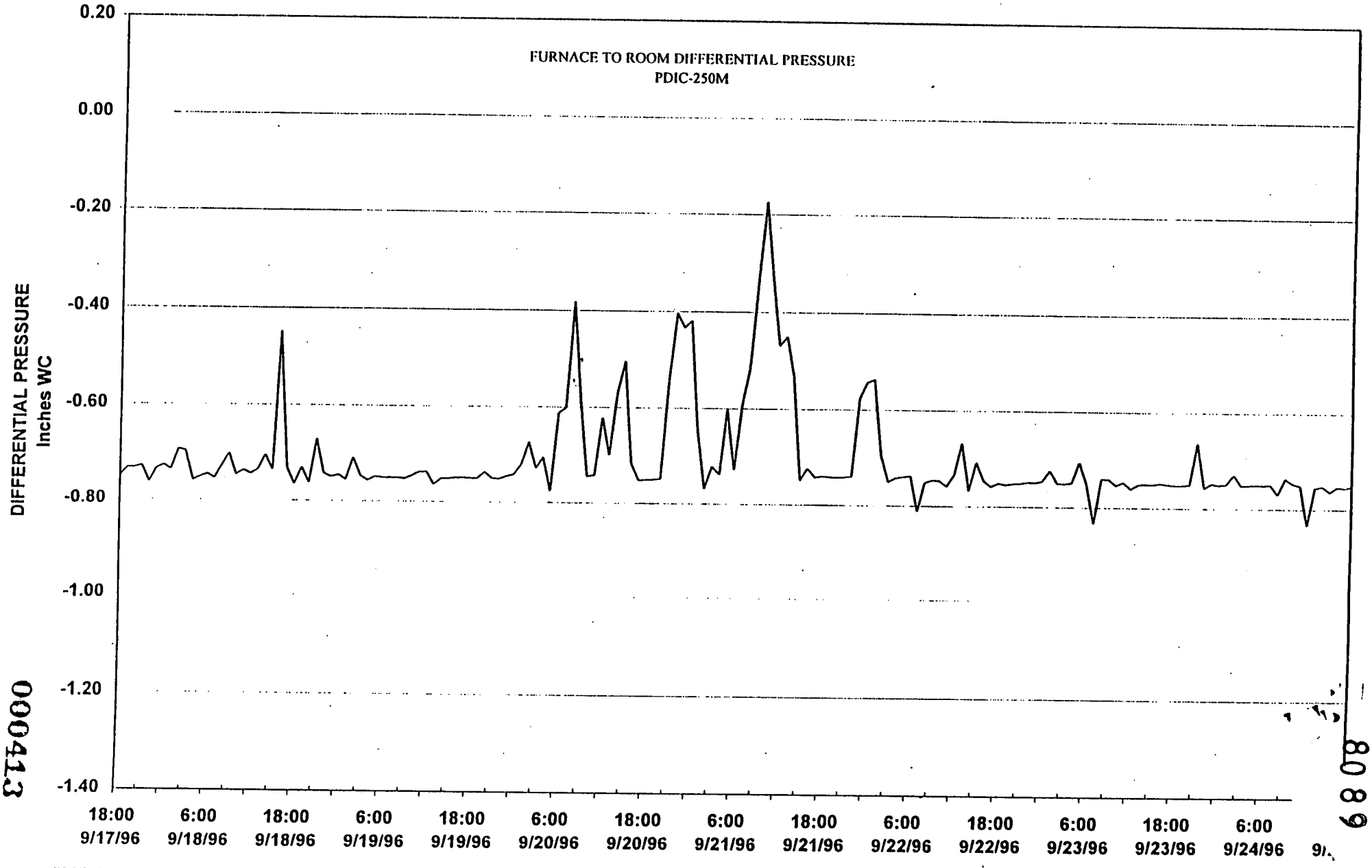
HOURLY READINGS ROUNDSHEETS

READINGS		CONVEYOR TAIL TEMP	CONVEYOR HEAD TEMP	GEM HOPPER TEMP	BULK HOPPER #1 TEMP	BULK HOPPER #2 TEMP	GEM ENCLOSURE BOTTOM TEMP	GEM ENCLOSURE TOP TEMP	ENCLOSURE EXPANSION JOINT TEMP
DATE	HOUR	F	F	F	F	F	F	F	F
9/17/96	16:00	80	78	80	104	92	126	132	150
9/17/96	20:00		73						
9/18/96	0:00	77	76	84	116	99	138	150	171
9/18/96	4:00	163	101	208	90	80	154	165	176
9/18/96	8:00	72	71	79	126	73	129	137	150
9/18/96	12:00	77	77	90	235	100	128	135	162
9/18/96	16:00	88	78	87	225	118	101	103	107
9/18/96	20:00								
9/19/96	0:00	72	72	73	187	81	117	126	149
9/19/96	4:00	97	74	96	127	161	209	208	289
9/19/96	8:00	66	67	74	87	71	111	123	152
9/19/96	12:00	76	71	71	82	78	88	90	98
9/19/96	16:00	81	79	76	93	83	118	128	147
9/19/96	20:00	76	74	74	80	79	87	91	125
9/20/96	0:00	81	81	121	79	79	125	133	157
9/20/96	4:00	188	111	217	238	96	193	219	311
9/20/96	8:00	100	84	146	225	88	234	278	367
9/20/96	12:00	113	86	96	82	82	130	142	158
9/20/96	16:00	131	93	125	94	89	198	211	234
9/20/96	20:00	82	81	86	88	93	125	131	145
9/21/96	0:00	147	86	98	162	97	179	199	227
9/21/96	4:00	80	77	84	90	86	120	131	146
9/21/96	8:00	98	77	79	84	83	126	144	179
9/21/96	12:00	95	82	79	90	84	126	134	145
9/21/96	16:00	80	78	80	92	110	114	120	127
9/21/96	20:00	75	74	74	-87	83	113	119	137
9/22/96	0:00	96	75	75	370	92	152	176	210
9/22/96	4:00	92	75	74	306	95	152	170	198
9/22/96	8:00	80	74	73	135	84	124	131	154
9/22/96	12:00	80	80	78	88	82	136	151	195
9/22/96	16:00	106	84	80	91	85	179	238	312
9/22/96	20:00	87	79	81	89	82	182	233	317
9/23/96	0:00	93	77	79	398	92	148	172	201
9/23/96	4:00	84	76	83	324	91	134	153	186
9/23/96	8:00	108	75	73	119	84	131	140	151
9/23/96	12:00	92	77	75	260	86	127	138	148
9/23/96	16:00	81	80	77	239	86	118	124	138
9/23/96	20:00	81	77	80	99	85	113	118	129
9/24/96	0:00	77	76	77	383	91	148	171	218
9/24/96	4:00	119	77	77	136	88	148	159	172
9/24/96	8:00	81	77	76	112	88	109	112	126
9/24/96	12:00	77	77	80	206	86	127	132	143
9/24/96	16:00	80	78	79	193	87	120	125	135

8089

FURNACE OFFGAS SYSTEM

CAMPAIGN 2
SERIES D GLASS
FURNACE OFFGAS SYSTEM



C2OFFGAS.XLS Chart 9

VHP 10/28/96

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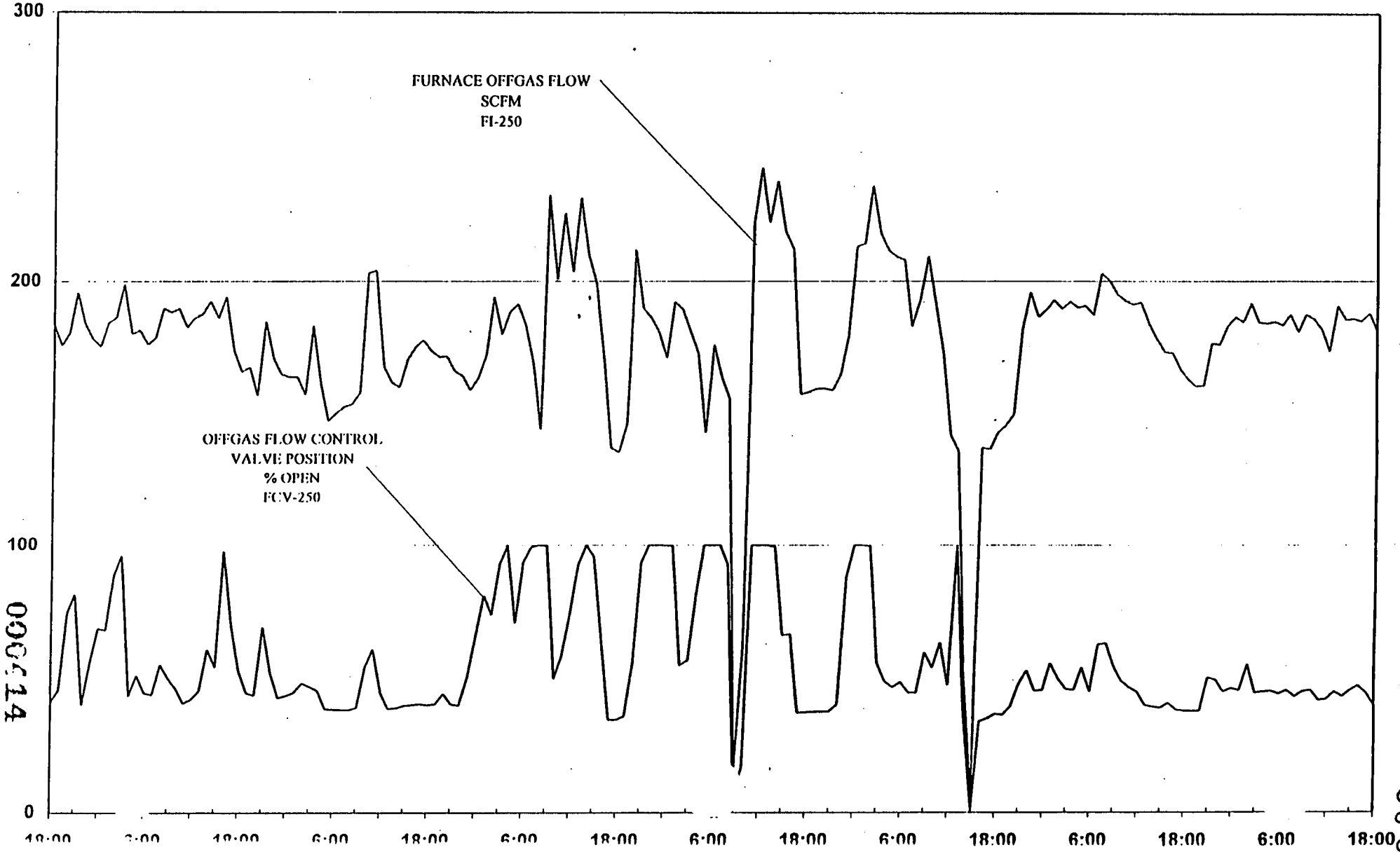
CAMPAIGN 2
SERIES D GLASS
FURNACE OFFGAS SYSTEM



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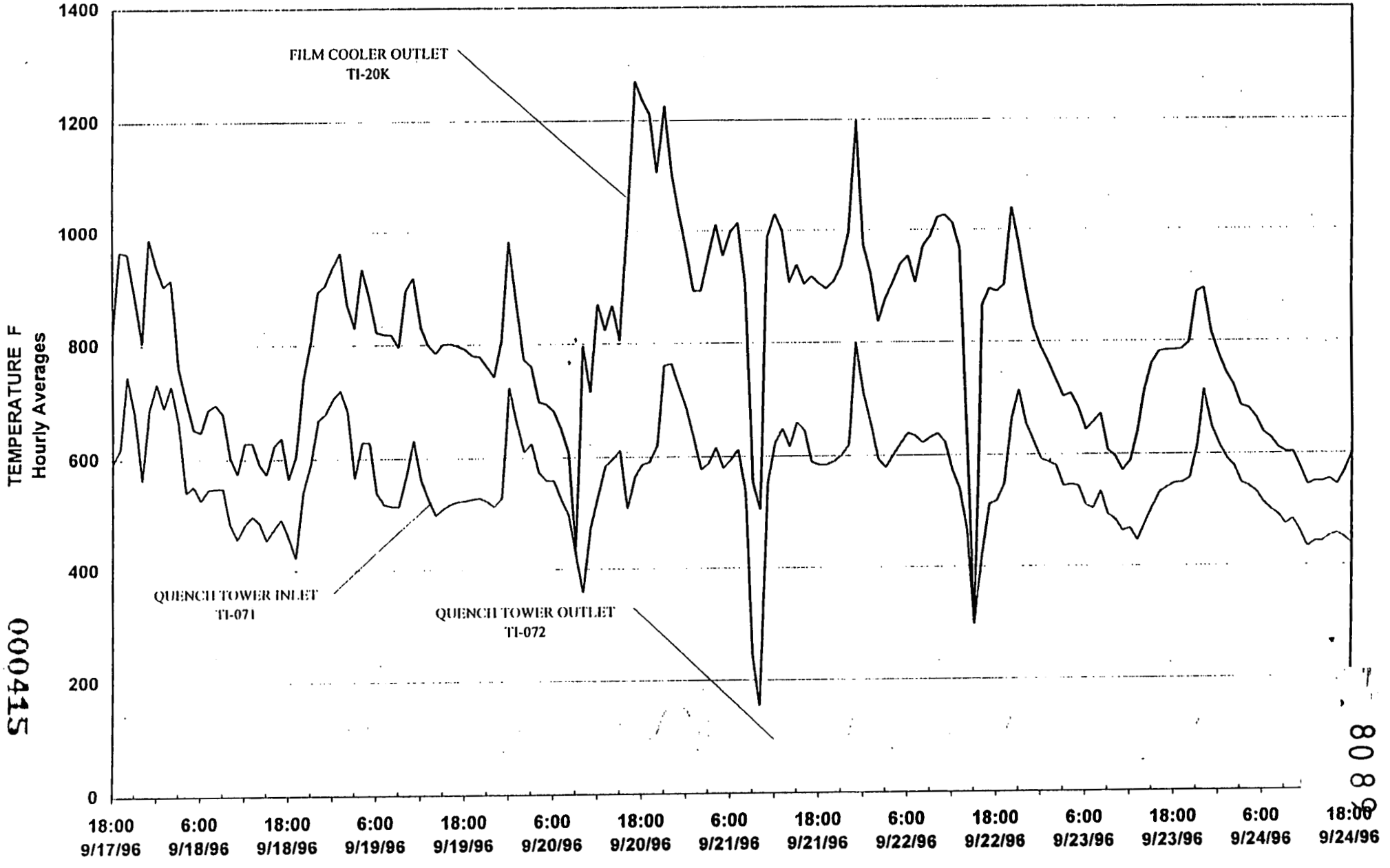
CAMPAIGN 2
SERIES D GLASS
FURNACE OFFGAS SYSTEM



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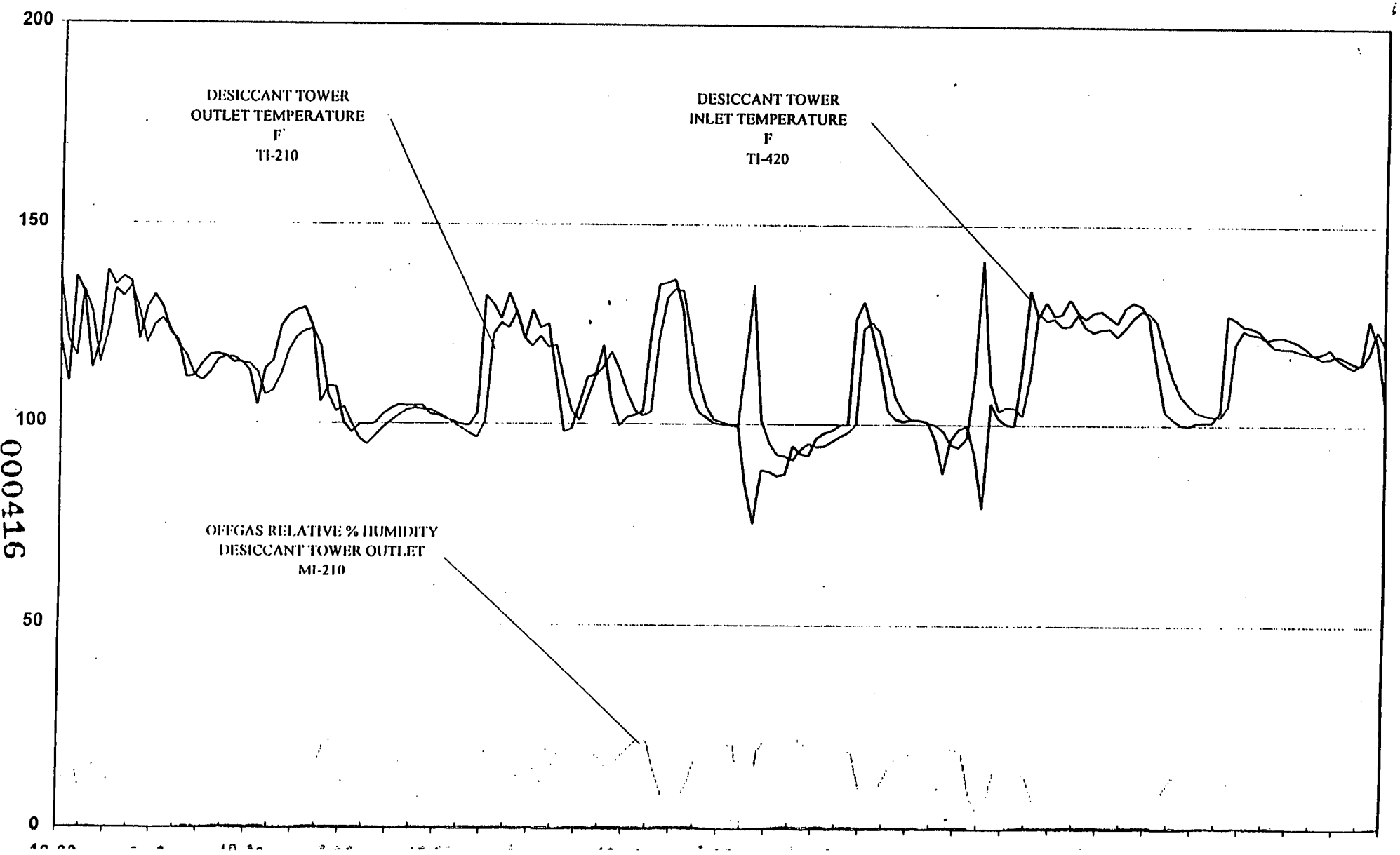
CAMPAIGN 2
SERIES D GLASS
FURNACE OFFGAS SYSTEM



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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
DATE	HOUR	PDIC-250M In WC	TI-20K F	TI-071 F	TI-072 F	TI-420 F	TI-210 F	MI-210 % RH	PDI-190 In WC	PDI-480 In WC	FCV-250 % OPEN	FI-250 SCFM	FI-251 SCFM
9/17/96	18:00	-0.750	820.80	592.53	110.34	120.55	136.07	7.57	3.261	0.417	41.08	183.61	9198.83
9/17/96	19:00	-0.732	966.35	617.86	117.48	109.89	120.51	14.95	2.986	0.390	45.58	176.01	9310.75
9/17/96	20:00	-0.732	963.32	746.76	153.79	136.20	116.29	17.74	3.393	0.416	73.94	180.82	9482.33
9/17/96	21:00	-0.728	889.77	680.23	143.88	132.26	132.99	9.23	4.061	0.464	80.97	195.80	9308.92
9/17/96	22:00	-0.762	804.65	563.17	105.37	113.29	127.24	11.53	3.155	0.409	40.34	184.08	9272.67
9/17/96	23:00	-0.734	988.94	687.29	136.14	119.92	114.76	17.91	3.155	0.411	55.45	178.42	9352.50
9/18/96	0:00	-0.726	938.81	733.42	153.81	137.83	122.36	14.87	3.295	0.424	68.23	175.61	9322.33
9/18/96	1:00	-0.736	904.36	690.51	145.33	134.01	133.05	8.52	3.529	0.447	67.60	184.49	9208.48
9/18/96	2:00	-0.693	915.47	729.19	151.82	136.05	131.15	9.46	3.693	0.470	88.29	186.63	9481.83
9/18/96	3:00	-0.696	763.86	665.19	146.05	134.83	133.83	8.23	4.391	0.513	95.88	198.86	9552.25
9/18/96	4:00	-0.758	704.80	540.51	126.87	120.53	127.57	11.20	3.436	0.443	43.45	180.37	9452.83
9/18/96	5:00	-0.751	652.90	551.81	138.10	128.19	119.56	15.76	3.620	0.444	50.91	181.73	9377.75
9/18/96	6:00	-0.745	647.84	526.63	137.91	131.55	124.17	13.70	3.418	0.437	44.46	176.34	9465.25
9/18/96	7:00	-0.754	687.01	546.24	133.62	128.43	125.68	12.61	3.486	0.448	43.82	178.85	9368.25
9/18/96	8:00	-0.727	695.79	547.55	127.10	122.12	122.97	14.00	3.878	0.476	54.85	189.83	9693.17
9/18/96	9:00	-0.701	679.49	548.20	124.87	119.99	118.92	16.12	3.675	0.456	49.82	188.46	9716.95
9/18/96	10:00	-0.746	602.80	482.93	113.00	110.98	116.53	17.19	3.649	0.447	46.14	189.69	9534.00
9/18/96	11:00	-0.737	573.95	455.82	112.53	111.28	111.45	19.42	3.351	0.421	40.70	182.79	9487.50
9/18/96	12:00	-0.744	627.54	481.85	118.42	114.39	110.17	20.13	3.458	0.431	42.11	186.27	9478.50
9/18/96	13:00	-0.735	627.87	498.09	119.74	116.64	112.20	19.19	3.553	0.443	45.22	187.82	9161.42
9/18/96	14:00	-0.704	590.84	486.33	120.08	116.84	115.32	17.89	4.053	0.477	60.42	192.34	8894.67
9/18/96	15:00	-0.735	572.63	454.01	118.38	116.38	116.11	17.43	3.921	0.470	53.98	186.27	8893.08
9/18/96	16:00	-0.448	623.12	474.24	118.29	114.78	116.08	17.61	4.342	0.498	97.52	194.04	9074.50
9/18/96	17:00	-0.732	636.72	492.11	117.99	114.86	114.80	17.89	3.748	0.454	69.65	173.98	9093.42
9/18/96	18:00	-0.765	564.46	459.02	107.43	112.60	114.43	17.82	3.279	0.420	52.66	166.05	9270.92
9/18/96	19:00	-0.730	604.07	421.60	101.42	104.37	112.47	18.64	3.290	0.418	44.44	167.86	9514.75
9/18/96	20:00	-0.762	740.48	541.87	117.78	113.17	106.76	20.98	3.013	0.392	43.64	157.06	9465.92
9/18/96	21:00	-0.670	806.59	589.87	119.60	115.22	107.98	20.81	4.051	0.460	68.71	184.92	9633.17
9/18/96	22:00	-0.742	893.55	668.48	135.78	123.89	111.89	19.29	3.548	0.433	51.89	171.06	9665.08
9/18/96	23:00	-0.749	904.81	678.27	135.56	126.53	117.82	16.41	3.315	0.428	42.66	165.02	9454.83
9/19/96	0:00	-0.745	937.20	704.82	137.38	127.93	121.30	14.48	3.192	0.440	43.43	164.14	9550.58
9/19/96	1:00	-0.755	963.34	720.11	137.96	128.49	122.64	13.70	3.200	0.453	44.53	164.00	9533.58
9/19/96	2:00	-0.709	870.53	684.21	124.02	123.55	123.36	13.15	2.870	0.437	48.03	157.54	9448.17
9/19/96	3:00	-0.747	829.41	565.75	100.83	105.20	119.01	15.61	3.687	0.502	46.66	183.30	9488.73
9/19/96	4:00	-0.756	933.69	628.37	115.35	108.99	106.81	20.95	3.005	0.434	45.18	161.36	9637.50
9/19/96	5:00	-0.748	884.30	628.13	106.31	108.75	103.00	22.24	2.502	0.381	38.64	147.75	9667.0
9/19/96	6:00	-0.750	822.25	538.61	95.06	100.06	103.97	21.90	2.487	0.390	38.45	150.64	9636.7
9/19/96	7:00	-0.750	818.59	518.85	93.32	97.71	99.88	23.24	2.358	0.393	38.36	152.90	9620.8
9/19/96	8:00	-0.750	817.83	515.04	92.93	99.73	96.16	24.32	2.288	0.394	38.30	153.89	9610.0
9/19/96	9:00	-0.752	795.91	514.75	93.44	99.64	94.76	24.75	2.499	0.424	39.06	158.02	9628.8

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/19/96	10:00	-0.746	896.40	567.67	100.96	100.06	96.86	24.56	4.026	0.579	54.04	203.15	9644.50
9/19/96	11:00	-0.738	917.63	630.78	108.29	102.30	99.01	24.04	4.167	0.612	60.47	204.05	9461.25
9/19/96	12:00	-0.737	829.99	561.07	102.92	103.67	100.63	23.10	2.816	0.495	44.39	167.85	8895.75
9/19/96	13:00	-0.764	798.83	527.81	99.06	104.56	102.01	22.57	2.606	0.480	38.66	162.05	8911.75
9/19/96	14:00	-0.751	784.88	498.37	95.90	104.35	103.30	22.13	2.715	0.470	38.96	160.23	8770.67
9/19/96	15:00	-0.751	800.66	509.64	96.87	104.32	103.73	22.06	2.882	0.482	39.77	170.53	8991.92
9/19/96	16:00	-0.749	801.28	518.34	97.74	104.36	103.48	22.16	2.941	0.487	40.12	175.25	9093.75
9/19/96	17:00	-0.749	797.52	522.99	98.37	102.39	103.32	22.24	3.006	0.491	40.37	177.94	9163.67
9/19/96	18:00	-0.750	791.74	524.06	98.82	102.02	102.51	22.44	2.948	0.487	40.10	173.97	9187.17
9/19/96	19:00	-0.750	780.18	526.91	99.10	101.20	101.42	22.75	3.016	0.485	40.42	171.66	9253.08
9/19/96	20:00	-0.737	778.38	529.06	98.97	100.48	100.08	23.16	3.131	0.484	44.14	171.87	9489.75
9/19/96	21:00	-0.750	760.33	522.92	97.44	99.91	98.80	23.46	2.902	0.461	40.27	166.25	9534.83
9/19/96	22:00	-0.751	743.01	514.03	96.59	99.58	97.67	23.72	2.800	0.448	39.86	164.55	9394.42
9/19/96	23:00	-0.745	807.12	528.19	105.95	102.71	96.53	23.92	2.801	0.396	49.97	159.05	9346.25
9/20/96	0:00	-0.742	982.28	723.99	138.56	131.72	100.82	22.85	3.317	0.198	65.04	163.61	9479.25
9/20/96	1:00	-0.720	873.59	661.21	135.76	129.48	121.98	14.77	3.964	0.218	80.47	172.43	9454.50
9/20/96	2:00	-0.673	773.03	609.94	132.16	125.84	124.88	12.76	4.709	0.241	73.24	194.03	9416.83
9/20/96	3:00	-0.728	761.11	624.48	140.98	132.26	123.69	13.49	4.615	0.229	92.65	180.21	9399.08
9/20/96	4:00	-0.705	697.61	573.17	136.40	127.32	127.75	11.21	5.029	0.239	99.58	188.54	9365.00
9/20/96	5:00	-0.775	694.11	559.33	133.48	120.91	121.08	14.75	4.908	0.233	70.39	191.43	9417.08
9/20/96	6:00	-0.612	681.33	559.60	134.87	128.15	119.12	16.05	4.839	0.226	93.21	183.80	9375.42
9/20/96	7:00	-0.601	650.94	527.62	130.88	123.65	121.58	14.71	4.343	0.211	99.17	169.81	9322.25
9/20/96	8:00	-0.381	608.24	498.10	126.25	124.64	118.81	15.54	3.403	0.184	100.00	144.54	9162.17
9/20/96	9:00	-0.587	438.89	427.77	105.03	111.83	119.39	15.87	7.754	0.284	99.76	232.42	9384.83
9/20/96	10:00	-0.744	796.33	358.49	92.90	98.04	110.27	19.67	5.363	0.233	49.62	200.96	9233.75
9/20/96	11:00	-0.742	715.20	471.69	99.93	98.80	103.22	22.56	6.553	0.269	57.93	225.72	8873.67
9/20/96	12:00	-0.621	868.79	530.60	117.87	105.12	100.97	23.23	5.614	0.251	73.96	203.68	8777.50
9/20/96	13:00	-0.698	823.17	584.19	112.65	111.42	106.32	21.54	6.969	0.285	92.47	231.37	8835.58
9/20/96	14:00	-0.567	866.43	596.60	121.57	112.07	111.78	19.09	5.989	0.265	100.00	209.64	8632.17
9/20/96	15:00	-0.504	806.16	611.13	126.34	119.25	113.86	17.66	5.469	0.254	95.53	199.45	8427.75
9/20/96	16:00	-0.716	1003.64	509.37	102.61	105.48	117.63	15.41	4.266	0.213	64.12	170.60	8554.75
9/20/96	17:00	-0.752	1269.92	564.18	97.21	99.63	113.28	16.31	2.222	0.163	34.76	137.37	8841.83
9/20/96	18:00	-0.751	1235.89	586.35	97.06	101.68	107.55	18.91	2.113	0.159	34.75	135.70	8953.58
9/20/96	19:00	-0.750	1210.54	591.20	97.48	102.32	103.42	20.63	2.468	0.167	35.92	146.42	9061.50
9/20/96	20:00	-0.748	1107.21	619.41	107.18	103.28	102.14	22.16	5.841	0.250	55.33	211.90	[illegible]87.67
9/20/96		-0.538	1225.06	760.55	143.33	122.35	103.08	21.61	5.627	0.234	93.14	189.83	50
9/20/96		-0.403	1109.72	763.57	151.12	134.47	120.69	14.19	5.636	0.240	100.00	186.26	33
9/20/96	23:00	-0.433	1034.34	723.47	151.98	134.98	131.22	8.04	5.479	0.239	99.96	180.65	[illegible]3.50
9/21/96	0:00	-0.418	965.95	683.86	148.80	135.79	133.32	7.08	5.477	0.228	99.90	171.26	9142.75

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/21/96	2:00	-0.768	892.38	577.23	105.19	107.75	122.47	10.83	6.596	0.239	54.64	189.42	9340.33
9/21/96	3:00	-0.721	950.79	587.38	103.89	102.96	110.64	16.88	5.805	0.222	56.53	181.00	9380.42
9/21/96	4:00	-0.738	1010.99	615.39	104.67	101.70	104.43	19.73	5.380	0.217	80.44	172.95	9346.53
9/21/96	5:00	-0.601	954.58	579.45	99.46	100.17	101.06	20.40	3.796	0.183	100.00	143.24	9274.25
9/21/96	6:00	-0.727	996.95	593.28	101.68	99.86	100.49	20.79	5.388	0.220	100.00	176.03	9326.58
9/21/96	7:00	-0.594	1014.14	611.95	102.60	99.94	99.70	20.86	5.318	0.204	100.00	163.57	9311.08
9/21/96	8:00	-0.517	905.32	538.59	100.02	99.63	99.30	20.65	4.868	0.195	92.64	155.72	9316.58
9/21/96	9:00	-0.342	553.48	245.21	94.50	85.01	115.41	6.05	0.491	0.026	7.23	16.70	9145.42
9/21/96	10:00	-0.174	505.32	154.85	100.37	75.81	134.35	4.02	2.634	0.079	17.16	61.12	9120.92
9/21/96	11:00	-0.332	988.07	552.42	101.11	88.87	100.86	19.20	13.451	0.575	99.88	222.06	7972.00
9/21/96	12:00	-0.469	1029.83	622.99	107.19	88.41	95.34	22.12	16.939	0.638	100.00	242.97	8110.33
9/21/96	13:00	-0.450	998.59	648.10	109.94	87.43	92.59	22.89	15.038	0.581	100.00	222.30	9402.92
9/21/96	14:00	-0.531	906.04	616.32	107.82	87.82	92.14	22.94	15.770	0.617	99.33	237.82	9528.75
9/21/96	15:00	-0.748	937.10	658.84	114.94	94.67	91.31	22.99	12.934	0.550	65.78	218.84	9344.17
9/21/96	16:00	-0.723	903.06	644.73	113.67	92.67	93.82	22.24	12.502	0.217	65.99	212.11	9372.08
9/21/96	17:00	-0.742	916.67	588.91	101.73	92.30	95.22	20.89	6.340	0.178	37.16	157.46	9268.06
9/21/96	18:00	-0.739	904.59	584.27	99.90	96.56	94.44	20.88	6.307	0.180	37.34	158.29	9465.85
9/21/96	19:00	-0.741	894.78	584.03	99.24	97.81	94.62	20.90	6.400	0.180	37.50	159.58	9461.08
9/21/96	20:00	-0.742	908.02	590.18	99.16	98.46	95.81	20.58	6.436	0.180	37.59	159.62	9441.37
9/21/96	21:00	-0.741	934.72	600.03	99.48	99.87	96.97	20.11	6.594	0.180	37.65	158.97	9392.92
9/21/96	22:00	-0.739	995.53	618.82	102.27	99.93	97.91	19.81	8.381	0.191	40.22	164.94	9168.17
9/21/96	23:00	-0.576	1198.18	798.85	147.07	126.03	100.00	18.98	10.291	0.222	87.40	179.55	9183.33
9/22/96	0:00	-0.543	972.15	709.65	141.25	130.28	123.57	10.50	9.297	0.278	99.97	213.23	9149.58
9/22/96	1:00	-0.537	919.51	656.03	137.05	122.86	125.15	8.01	7.485	0.278	99.90	214.41	9241.58
9/22/96	2:00	-0.695	835.35	593.66	117.24	115.07	122.87	8.77	8.999	0.303	99.66	236.12	9263.25
9/22/96	3:00	-0.750	876.72	577.96	108.01	103.55	114.38	12.37	7.408	0.269	55.68	218.37	9347.42
9/22/96	4:00	-0.742	906.79	600.32	108.09	101.29	106.60	16.29	6.883	0.466	48.59	211.88	9320.34
9/22/96	5:00	-0.739	938.54	620.25	108.93	100.80	102.89	18.09	6.658	0.561	46.47	209.34	9359.00
9/22/96	6:00	-0.737	952.74	639.11	110.01	101.25	101.18	18.91	6.861	0.569	48.24	208.26	9386.17
9/22/96	7:00	-0.811	905.07	634.37	109.57	101.14	101.19	18.06	6.644	0.504	44.53	183.07	9466.75
9/22/96	8:00	-0.751	969.14	621.96	106.83	100.68	100.46	18.44	7.818	0.524	44.39	192.65	9472.00
9/22/96	9:00	-0.746	988.14	631.07	106.80	96.23	99.88	19.17	10.383	0.578	59.36	209.53	9534.15
9/22/96	10:00	-0.747	1022.35	638.03	108.51	88.08	98.43	19.59	12.571	0.533	53.75	191.46	9170.25
9/22/96	11:00	-0.758	1026.57	623.78	106.90	96.27	95.01	20.28	19.803	0.476	62.81	172.79	8894.83
9/22/96	12:00	-0.734	1012.15	572.91	100.32	98.88	94.43	19.97	20.400	0.178	47.44	142.25	8792.42
9/22/96	13:00	-0.667	965.82	539.68	97.98	99.64	96.76	18.26	20.400	0.180	99.68	136.03	8703.33
9/22/96	14:00	-0.767	622.94	465.18	96.31	92.48	111.61	8.36	7.497	0.073	36.54	50.37	8914.75
9/22/96	15:00	-0.707	296.23	297.97	95.92	79.80	140.89	4.02	0.165	0.019	1.70	7.18	8940.33
9/22/96	16:00	-0.746	862.97	423.54	94.01	105.17	109.99	7.08	1.659	0.164	33.95	137.36	8970.68
9/22/96	17:00	-0.758	893.34	513.19	94.36	101.52	103.32	14.24	1.512	0.161	35.09	137.00	8972.92

000419

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/22/96	18:00	-0.751	888.46	518.52	94.89	100.04	104.37	14.11	1.689	0.169	36.70	143.10	9063.58
9/22/96	19:00	-0.754	900.47	548.56	96.60	99.81	104.08	14.22	1.646	0.171	36.45	145.83	9107.33
9/22/96	20:00	-0.752	1040.32	664.84	129.64	114.05	102.32	15.12	1.859	0.181	39.47	150.27	9123.58
9/22/96	21:00	-0.751	974.61	714.11	142.39	133.23	111.67	13.06	2.735	0.229	47.47	181.83	9124.92
9/22/96	22:00	-0.748	893.38	653.98	134.82	126.72	127.63	6.91	3.117	0.256	52.64	195.89	9187.08
9/22/96	23:00	-0.749	824.56	622.78	137.35	130.40	125.76	6.77	2.797	0.239	45.17	186.56	9395.67
9/23/96	0:00	-0.746	789.11	591.64	134.04	127.02	126.24	6.61	2.866	0.241	45.41	189.17	9354.58
9/23/96	1:00	-0.723	762.52	586.80	134.67	127.45	124.37	7.10	3.033	0.248	55.30	192.91	9438.64
9/23/96	2:00	-0.750	732.64	580.35	140.85	131.16	124.47	7.10	2.947	0.248	49.49	189.58	9502.83
9/23/96	3:00	-0.751	702.08	543.98	133.13	127.89	127.28	6.49	3.004	0.250	45.74	192.36	9552.12
9/23/96	4:00	-0.749	707.82	546.82	132.51	126.25	124.06	7.11	2.932	0.243	45.45	190.04	9565.50
9/23/96	5:00	-0.706	683.47	544.10	135.28	127.88	122.96	7.51	2.995	0.247	53.62	190.69	9453.83
9/23/96	6:00	-0.751	643.50	510.07	133.57	128.15	123.67	7.38	2.868	0.240	44.85	187.16	9441.25
9/23/96	7:00	-0.834	656.66	503.86	129.80	126.61	123.86	7.48	3.441	0.266	62.09	203.09	9267.29
9/23/96	8:00	-0.740	671.90	535.28	134.91	125.23	121.83	8.09	3.359	0.264	62.66	200.21	9391.02
9/23/96	9:00	-0.741	607.28	492.72	135.43	129.06	123.89	7.61	3.180	0.260	54.41	195.16	9436.42
9/23/96	10:00	-0.753	595.48	482.91	136.08	130.40	126.36	6.69	3.076	0.262	48.78	192.65	9423.33
9/23/96	11:00	-0.747	570.70	463.10	133.59	129.59	128.20	6.08	3.011	0.264	46.36	191.23	9348.92
9/23/96	12:00	-0.761	587.70	467.09	126.98	126.54	127.75	5.89	2.971	0.263	44.79	192.00	8987.47
9/23/96	13:00	-0.752	640.02	445.07	101.19	113.75	125.40	6.19	2.689	0.247	40.01	183.94	9049.92
9/23/96	14:00	-0.750	712.85	476.19	96.80	103.35	118.32	7.92	2.565	0.233	39.34	178.29	9088.00
9/23/96	15:00	-0.751	760.23	506.15	97.77	101.52	111.47	11.24	2.457	0.222	38.92	173.33	9008.22
9/23/96	16:00	-0.748	780.80	532.71	99.09	100.16	107.17	13.80	2.435	0.219	40.65	172.86	9003.75
9/23/96	17:00	-0.751	783.85	541.33	98.74	99.91	105.07	14.87	2.248	0.210	38.19	166.71	8889.92
9/23/96	18:00	-0.752	783.62	548.43	97.90	100.71	103.37	15.52	2.163	0.203	37.86	163.07	9039.83
9/23/96	19:00	-0.752	784.78	549.49	97.50	100.71	102.75	15.89	2.118	0.200	37.75	160.38	9332.67
9/23/96	20:00	-0.751	796.95	556.67	97.59	100.87	102.33	16.30	2.144	0.199	37.86	160.60	9433.33
9/23/96	21:00	-0.663	886.33	615.91	111.02	103.51	102.15	16.59	2.650	0.224	49.96	176.53	9487.42
9/23/96	22:00	-0.757	893.20	714.07	137.47	127.14	104.95	15.66	2.714	0.232	49.14	176.04	9390.83
9/23/96	23:00	-0.748	815.89	647.54	132.71	126.24	119.95	9.05	2.917	0.246	44.79	182.91	9334.92
9/24/96	0:00	-0.751	775.88	615.64	132.00	124.55	123.38	6.81	3.053	0.253	46.05	186.42	9280.25
9/24/96	1:00	-0.749	744.21	592.12	131.12	124.19	122.63	6.87	3.029	0.251	45.28	184.60	9312.97
9/24/96	2:00	-0.729	720.97	577.75	129.75	123.36	122.35	6.97	3.273	0.260	54.91	191.46	9221.08
9/24/96	3:00	-0.752	684.84	548.32	127.53	121.22	121.06	7.26	2.969	0.250	44.45	184.43	9252.58
9/24/96	4:00	-0.751	680.11	542.65	128.32	121.71	119.33	7.88	2.986	0.250	44.77	184.06	9315.83
9/24/96	5:[illegible]	-0.750	664.15	532.75	127.67	121.92	119.03	8.13	3.003	0.250	45.03	184.66	[illegible]58
9/24/96	[illegible]	-0.751	636.93	513.70	125.51	121.25	119.05	8.24	2.942	0.251	44.02	183.40	[illegible]0
9/24/96	[illegible]	-0.749	628.14	501.13	125.04	120.44	118.40	8.64	3.054	0.259	45.31	187.37	[illegible]00
9/24/96	8:00	-0.710	610.39	490.38	122.22	119.14	117.87	8.96	2.811	0.210	45.06	180.81	9402.54

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VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 SERIES D GLASS

HOURLY AVERAGES

READINGS		FURNACE TO ROOM DIFF PRESS	FILM COOLER OFFGAS OUTLET	QUENCH TOWER OFFGAS INLET	QUENCH TOWER OFFGAS OUTLET	DESICCANT TOWER OFFGAS INLET	DESICCANT TOWER OFFGAS OUTLET	DESICCANT TOWER RELATIVE HUMIDITY OFFGAS OUTLET	CARBON BEDS DIFF PRESS	HEPA FILTERS DIFF PRESS	OFFGAS FLOW CONTROL VALVE POSITION	FLOW TO STACK	TOTAL STACK FLOW
		PDIC-250M	TI-20K	TI-071	TI-072	TI-420	TI-210	MI-210	PDI-190	PDI-480	FCV-250	FI-250	FI-251
DATE	HOUR	In WC	F	F	F	F	F	% RH	In WC	In WC	% OPEN	SCFM	SCFM
9/24/96	10:00	-0.747	603.01	482.43	121.99	117.85	116.34	9.99	2.965	0.261	45.41	185.60	9410.08
9/24/96	11:00	-0.751	574.79	460.39	121.55	118.83	116.55	10.10	2.837	0.257	41.83	181.71	9262.17
9/24/96	12:00	-0.834	544.66	432.41	116.78	116.43	117.29	9.10	2.806	0.245	42.19	173.53	9403.42
9/24/96	13:00	-0.755	550.25	442.24	117.07	115.19	116.42	10.24	3.090	0.275	44.76	190.48	9309.83
9/24/96	14:00	-0.752	550.08	441.75	118.88	114.03	115.38	10.87	2.950	0.269	43.16	185.49	9354.08
9/24/96	15:00	-0.764	554.38	452.12	123.71	115.39	114.97	11.12	2.974	0.270	45.36	185.79	9311.65
9/24/96	16:00	-0.753	544.61	455.82	130.32	126.01	117.56	9.89	2.994	0.276	47.10	184.93	9106.00
9/24/96	17:00	-0.755	568.29	449.00	112.88	120.74	123.55	7.31	3.000	0.280	44.34	187.76	9094.42
9/24/96	18:00	-0.752	599.74	437.23	96.47	105.88	120.06	7.80	2.735	0.263	39.91	181.17	9170.50

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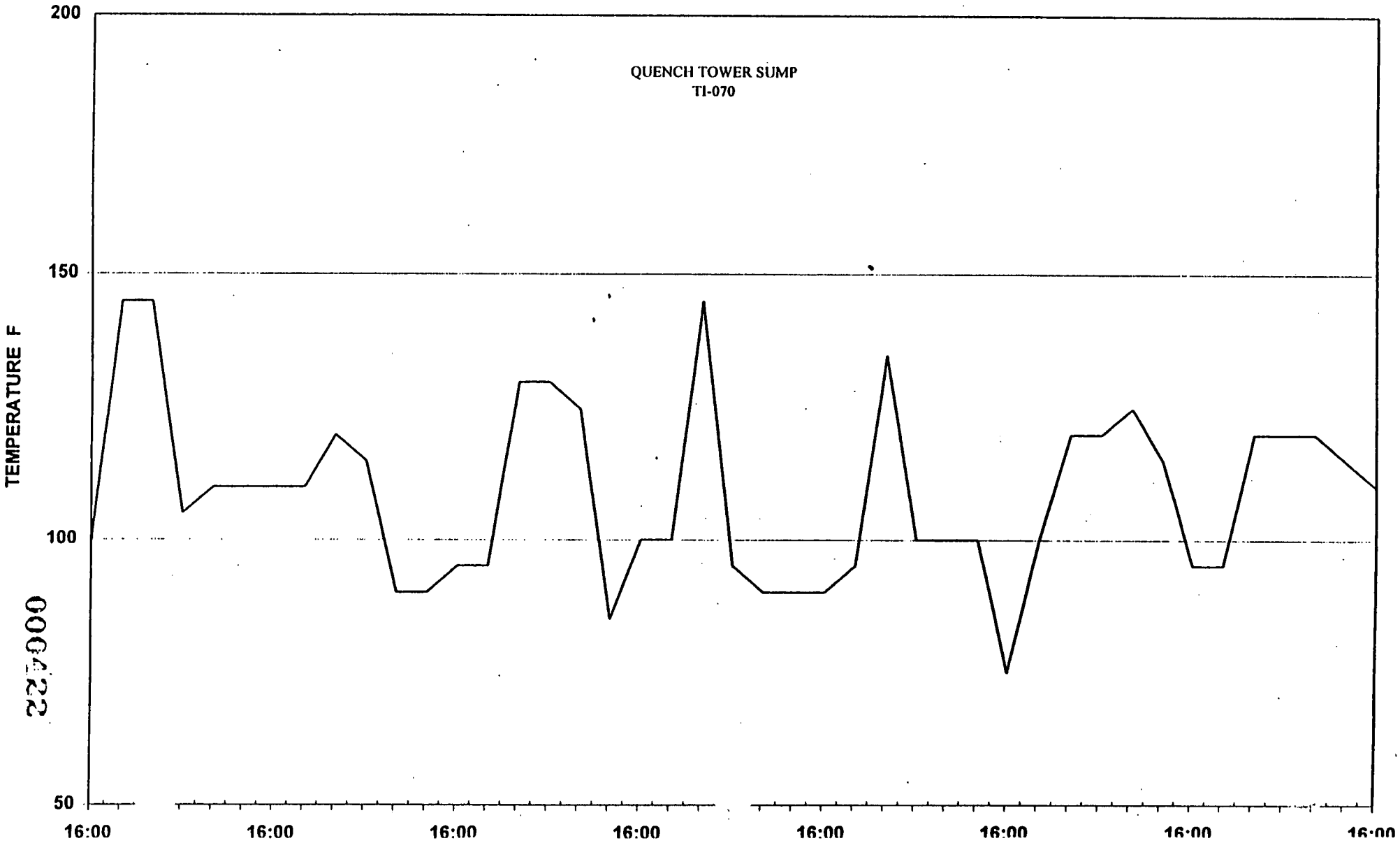
CAMPAIGN 2
SERIES D GLASS
FURNACE OFFGAS SYSTEM



004422

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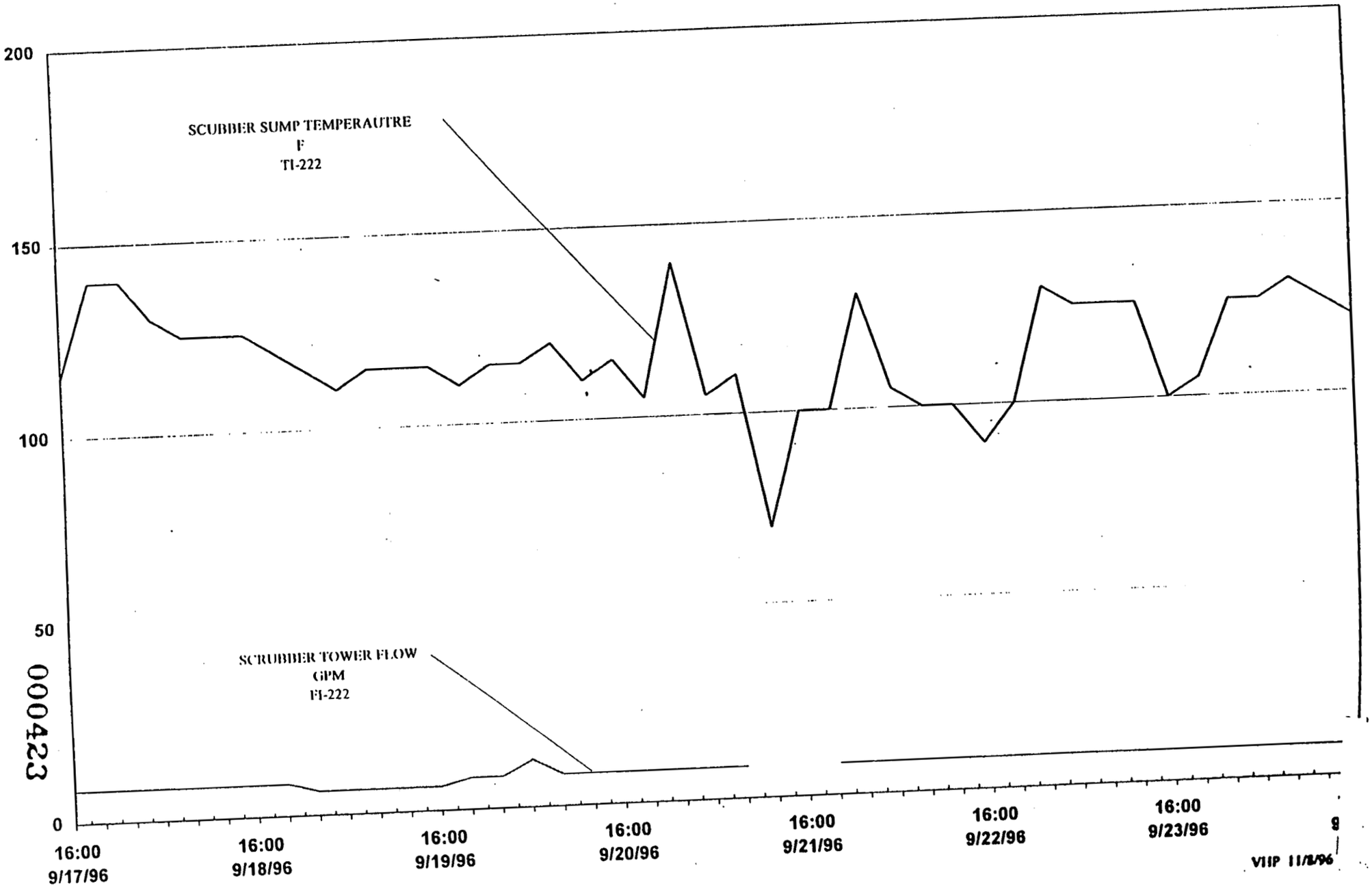
CAMPAIGN 2
SERIES D GLASS
FURNACE OFFGASSYSTEM



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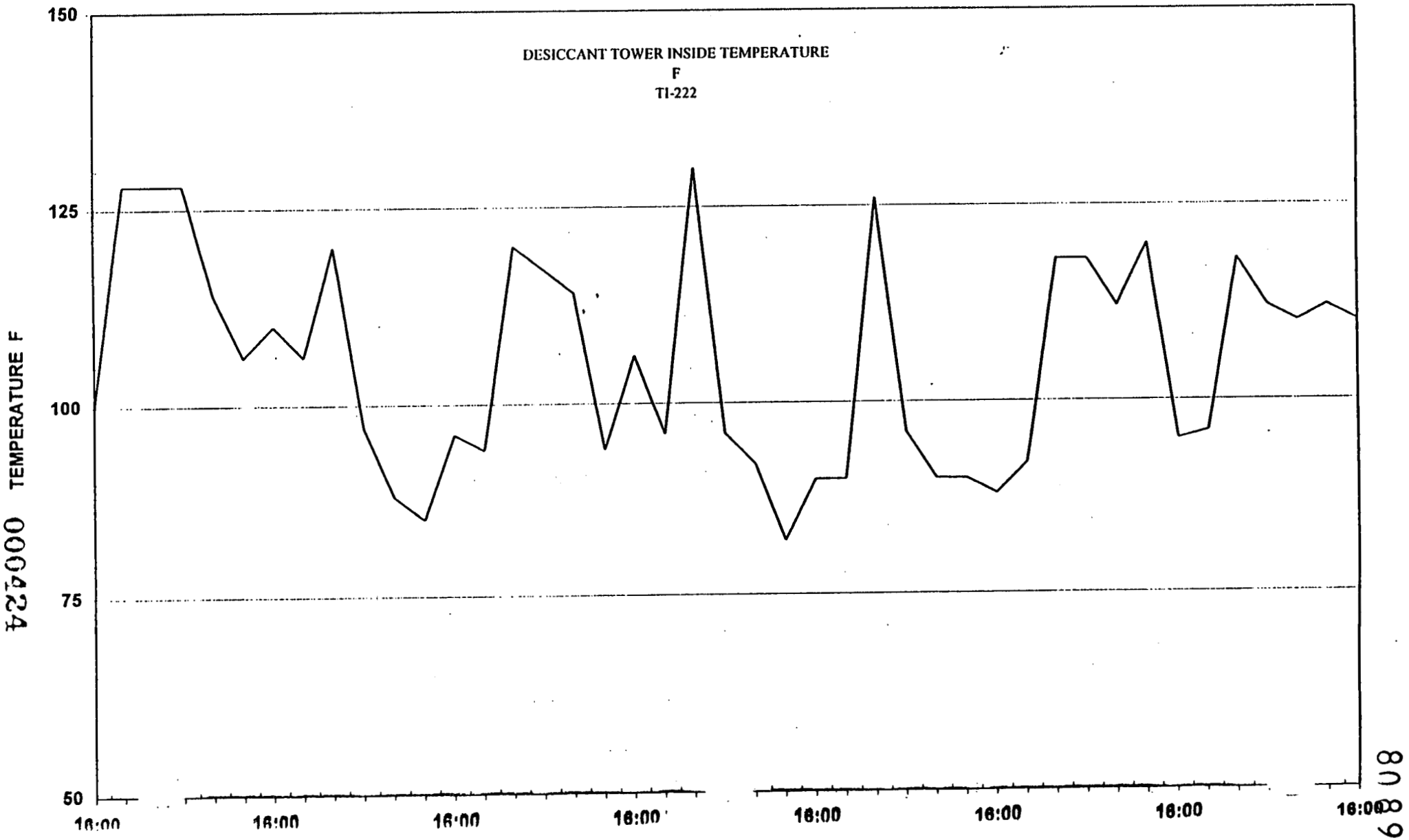
C2OFFGAS XLS Chart 19

CAMPAIGN 2
SERIES D GLASS
FURNACE OFFGAS SYSTEM



VITRIFICATION PILOT PLANT FURNACE OFFGAS SYSTEM

CAMPAIGN 2 SERIES D GLASS

ROUNDSHEET DATA

READINGS		FILM COOLER DIFF PRESS	FILM COOLER TO QT DIFF PRESS	QUENCH TOWER SUMP TEMP	SCRUBBER TOWER VACUUM	SCRUBBER SUMP TEMP	SCRUBBER TOWER FLOW	DESICCANT TOWER INTERNAL TEMP	DESICCANT TOWER VACUUM
		PDI-172	PDI-173	TI-070	PI-222	TI-222	FI-222	TI-210	PI-210
DATE	HOUR	In WC	In WC	F	In WC	F	GPM	F	In WC
9/17/96	16:00	20.0	23.5	100	1.1	115	8	100	OUT OF SERVICE
9/17/96	20:00			145	3.0	140	8	128	
9/18/96	0:00	1.0	2.0	145	2.5	140	8	128	
9/18/96	4:00	9.0	8.5	105	0.0	130	8	128	
9/18/96	8:00	11.0	12.0	110	0.0	125	8	114	
9/18/96	12:00			110	0.3	125	8	106	
9/18/96	16:00	38.5	11.0	110	4.0	125	8	110	
9/18/96	20:00			110	2.0	120	8	106	
9/19/96	0:00	17.0	14.5	120	1.9	115	6	120	
9/19/96	4:00	12.0	11.0	115	0.0	110	6	97	
9/19/96	8:00	7.0	7.0	90	0.0	115	6	88	
9/19/96	12:00	15.0	13.0	90	1.5	115	6	85	
9/19/96	16:00	8.0	8.0	95	2.0	115	6	96	
9/19/96	20:00	9.0	9.0	95	1.0	110	8	94	
9/20/96	0:00	27.0	23.0	130	2.5	115	8	120	
9/20/96	4:00	25.0	15.0	130	2.0	115	12	117	
9/20/96	8:00	12.0	10.5	125	3.0	120	8	114	
9/20/96	12:00	12.0	10.5	85	2.5	110	8	94	
9/20/96	16:00	17.0	18.0	100	3.5	115	8	106	
9/20/96	20:00	3.0	7.5	100	2.0	105	8	96	
9/21/96	0:00	28.0	17.0	145	3.0	140	8	130	
9/21/96	4:00	16.0	11.0	95	3.0	105	8	96	
9/21/96	8:00	6.0	8.0	90	3.0	110	8	92	
9/21/96	12:00	8.0	13.0	90	1.5	70		82	
9/21/96	16:00	9.0	15.0	90	2.0	100		90	
9/21/96	20:00	5.0	8.5	95	0.0	100	8	90	
9/22/96	0:00	15.0	18.5	135	3.0	130	8	126	
9/22/96	4:00	9.0	10.0	100	1.0	105	8	96	
9/22/96	8:00	8.0	9.5	100	1.0	100	8	90	
9/22/96	12:00	5.0	7.5	100	1.3	100	8	90	
9/22/96	16:00	8.0	11.0	75		90	8	88	
9/22/96	20:00	14.0	18.0	100	0.4	100	8	92	
9/23/96	0:00	12.0	13.0	120	0.1	130	8	118	
9/23/96	4:00	12.0	11.5	120	0.1	125	8	118	
9/23/96	8:00	12.0	14.0	125	1.4	125	8	112	
9/23/96	12:00	12.5	10.0	115	2.5	125	8	120	
9/23/96	16:00	9.0	6.5	95	1.5	100	8	95	
9/23/96	20:00	8.0	7.0	95	1.0	105	8	96	
9/24/96	0:00	13.5	12.5	120	2.0	125	8	118	
9/24/96	4:00	12.0	10.5	120	1.5	125	8	112	
9/24/96	8:00	10.2	10.0	120	1.5	130	8	110	
9/24/96	12:00	10.0	9.5	115	2.1	125	8	112	
9/24/96	16:00	22.5	19.0	110	2.1	120	8	110	

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Appendix E
Vitrification Pilot Plant (VitPP) - Lessons Learned

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

24	A/E Scope of Work	General

Description
FERMCO and A/E use same numbering system for DCNs.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	3/23/96

Disposition

Number	Area	Subarea
188	A/E Scope of Work	General

Description
Consider areas of uncertainty- Facility layout and Capacity and performance of ancillary systems

Source Reference	Functional Area	Responsible
NUMATEC	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
190	A/E Scope of Work	General

Description
Incorporate "lessons learned" in the VITPP Upgrade.

Source Reference	Functional Area	Responsible
NUMATEC	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

000427

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
195	A/E Scope of Work	General

Description
Some functions could be shared between VITPP and Production facility. Waste water treatment, laboratory, utilities, and gem cooling/handling

Source Reference	Functional Area	Responsible
NUMATEC	Engineering	Defining

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
197	A/E Scope of Work	General

Description
Have a clean separation between pilot plant and production plant operations

Source Reference	Functional Area	Responsible
NUMATEC	Management Systems	Nixon

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
199	A/E Scope of Work	General

Description
Upfront investments (safety, RAM) and planning will reduce long term costs

Source Reference	Functional Area	Responsible
NUMATEC	Management Systems	Defining

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

000428

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
12	Construction	General

Description
Fully define requirements for construction acceptance testing and turnover package contents in specifications (wiring checks, tests of motors, line flushing, hydrostatic testing, data sheets, submittals, QA checks, etc.). Include correction of deficiencies in subcontractor scope, estimate.

Source Reference	Functional Area	Responsible
TQM Meeting on 5/22/96	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	10/30/95	8/7/96

Disposition

Number	Area	Subarea
59	Construction	General

Description
Require redlines from subcontractor upon completion of work.

Source Reference	Functional Area	Responsible
	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	8/5/96

Disposition

Number	Area	Subarea
62	Construction	General

Description
Handle and stockpile soil, concrete, debris and other materials per EW-0006. Plan during design with Soil Remediation Project personnel.

Source Reference	Functional Area	Responsible
L. Lockerd	Engineering	Maurer

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	8/7/96

Disposition

000429

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
70	Construction	General

Description
Develop detailed, comprehensive inspection test plan during Title II. Involve Inspection Services personnel.

Source Reference	Functional Area	Responsible
L. Lockerd	Engineering	Gulldress

Implementation Reference	Date Entered	Date Last Modified
	11/13/95	8/19/96

Disposition

Number	Area	Subarea
120	Construction	General

Description
During construction, cover or plug open equipment nozzles, unconnected pipe and similar openings to prevent entry of rainwater or foreign materials.

Source Reference	Functional Area	Responsible
Woodroffe: M:CRUP:(CRU4/PP):95-0067	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	8/21/96

Disposition

Number	Area	Subarea
122	Construction	General

Description
Implement control of superseded and cancelled documents to ensure that only legible, properly marked current revisions of documents are used.

Source Reference	Functional Area	Responsible
McGuire: M:CONS(CCR4):96-0001	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	8/21/96

Disposition

000430

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
177	Design Criteria	Building

Description
Weather delays and equipment destroyed as a result of not having adequate protection from elements. No building around the water systems (pad). Temporary structure added. Additional cost of heating facility during winter, and heat tracing and insulating lines would more than justify a bilding and HVAC system.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition

Number	Area	Subarea
8	Design Criteria	Control Systems

Description
Use logic diagrams from pilot plant Foxboro to extent feasible.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	10/30/95	9/19/96

Disposition

Number	Area	Subarea
22	Design Criteria	Control Systems

Description
Involve fire protection personnel early in design to assure acceptable deployment and fire protection instrumentation.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	8/3/96

Disposition

000431

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
43	Design Criteria	Control Systems

Description
Define deliverables for documentation of control system software

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

Number	Area	Subarea
51	Design Criteria	Control Systems

Description
Include training simulator in plant control system.

Source Reference	Functional Area	Responsible
	Training	Bradburne

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

Number	Area	Subarea
66	Design Criteria	Control Systems

Description
Design for proper integration of thermocouples and other instrumentation into any local panels and DCS.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	9/19/96

Disposition

000432

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
83	Design Criteria	Control Systems

Description: Develop DCS/PLC architecture early.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	11/15/95	9/19/96

Disposition:

Number	Area	Subarea
84	Design Criteria	Control Systems

Description: Develop functional logic diagrams, for process programmers to work from for configuration control and for basis for program verification/validation later.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	11/15/95	9/19/96

Disposition:

Number	Area	Subarea
85	Design Criteria	Control Systems

Description: Develop an instrument list that can be used by project personnel through local network but with built-in security for changes.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	11/15/95	9/19/96

Disposition:

000433

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
88	Design Criteria	Control Systems

Description
Buy electronic/instruments that are magnetic/high frequency noise free, including instrument cabling. Route instrument cabling away from SCPS, VFDs, etc.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP x-x-x	11/15/95	9/19/96

Disposition

Number	Area	Subarea
91	Design Criteria	Control Systems

Description
Consider purchase of smart transmitters with any purchase of new control system (can check remotely).

Source Reference	Functional Area	Responsible
TQM Meeting on 6/18/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

Number	Area	Subarea
180	Design Criteria	Control Systems

Description
Need additional instrumentation for complete data for future design. DCN initiated.

Source Reference	Functional Area	Responsible
DCN No	Engineering	Solomon

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition

000434

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
5	Design Criteria	Electrical

Description
Define requirements for grounding of reifer other systems as early as is appropriate. (Title 1?)

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	10/30/95	9/19/96

Disposition

Number	Area	Subarea
55	Design Criteria	Electrical

Description
Settle on requirements for emergency power early, and size emergency generator generously.

Source Reference	Functional Area	Responsible
POD Meetings	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

Number	Area	Subarea
56	Design Criteria	Electrical

Description
Provide normal power bypass to UPS for maintenance work on UPS.

Source Reference	Functional Area	Responsible
Gbodenum / Williamson	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

000435

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
74	Design Criteria	Electrical

Description

Establish single line diagram early. Size power transformer with spare capacity. Use computerized calculation for load, short circuit, voltage drop and relay coordination. Establish tray and conduit routing envelope early, to avert layout interferences and signal interferences.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	11/15/95	9/19/96

Disposition

Number	Area	Subarea
75	Design Criteria	Electrical

Description

Generate standard design formats for drawings like layout, ladder diagram, connection wiring diagram, termination, cable conduit/tray routing, functional logic diagrams, grounding, lightning protection, etc.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	11/15/95	9/19/96

Disposition

000436

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
76	Design Criteria	Electrical

Description

Generate a electrical system description (SD) early. This SD and the design criteria will enable a smooth start in design with no guesswork.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP X.X.X	11/15/95	9/19/96

Disposition

Number	Area	Subarea
77	Design Criteria	Electrical

Description

Buy standard electrical equipment, do not custom build. Do not generate connection wiring diagrams, let the panel, switchgear or equipment vendor generate them based on ladder diagrams. Try to force vendors to match decided upon wiring format for ease of checking. Do not accept catalog cuts from vendors, to maintain configuration control of documents.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP X.X.X	11/15/95	9/19/96

000437

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
79	Design Criteria	Electrical

Description

Design grounding system properly for installation with your foundation and footing works. Make calculations and separate instrument grounding from power grounding. Define lightning protection requirements early. Placement these in design criteria.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smelts

Implementation Reference	Date Entered	Date Last Modified
DCP x.x.x	11/15/95	9/18/96

Disposition

Number	Area	Subarea
B1	Design Criteria	Electrical

Description

Try to get the electric substation as close to the facility being built as close as you can, even inside the [illegible] possible. Get load centers/MCC close to the loads. Cabling will be less and tray/conduit layout will be manageable.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
DCP x.x.x	11/15/95	9/18/96

Disposition

000438

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
192	Design Criteria	Equipment

Description
Specify removable insulation on pumps, valves and other equipment, as there are no insulators on FEMP maintenance staff.

Source Reference	Functional Area	Responsible
TQM Meeting on 3/26/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

Number	Area	Subarea
26	Design Criteria	Feed Preparation

Description
On any tanks on which load cells are used, isolate the tank physically from piping and instrumentation (flex connectors, etc.).

Source Reference	Functional Area	Responsible
TQM Meeting on 4/23/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
97	Design Criteria	Feed Preparation

Description
Route slurry lines as directly as possible; use large radius bends instead of elbows.

Source Reference	Functional Area	Responsible
TQM Meeting on 4/23/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

000439

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
145	Design Criteria	Feed Preparation

Description
Lines Plugging with slurry/ Line flushing has been improved however, lines are not designed for slurry transfer.

Source Reference	Functional Area	Responsible
Startup/SG Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/17/96

Disposition

Number	Area	Subarea
146	Design Criteria	Feed Preparation

Description
Erosion of ball valves/ replaced selected valves with pinch valves or better ball valves

Source Reference	Functional Area	Responsible
Startup/SG Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/17/96

Disposition

Number	Area	Subarea
147	Design Criteria	Feed Preparation

Description
Slurry tank agitation is poor. Material settling out in tank. Are doing off-site agitation testing to determine best agitation method.

Source Reference	Functional Area	Responsible
Startup/SG Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

000440

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
148	Design Criteria	Feed Preparation

Description

Dry additive system plugging. Heavy materials plug lines, moisture gets in and help causes plugging. Lines must be kept dry

Source Reference	Functional Area	Responsible
Startup/SQ Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
193	Design Criteria	Feed Preparation

Description

Use proven technology to handle slurry, use gravity- take conservative actions to declog and rinse piping. Locate the slurry pump in dedicated rooms. Install equipment that needs periodic maintaince in a lower RAD area.

Source Reference	Functional Area	Responsible
NUMATEC	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

000441

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
152	Design Criteria	Gem Maker

Description
Gem maker cutter needs to have water cooling - not just air cooling, need to improve seal on water cooled cutter system

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
153	Design Criteria	Gem Maker

Description
maker uses excessive lubrication/water spray. Fills drum with water solution

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
3	Design Criteria	General

Description
Use engineered controls to minimize likelihood of contamination and radiation exposure of plant and personnel

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP	10/30/95	9/19/96

Disposition

000442

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
4	Design Criteria	General

Description
Include high point vents and low point drains in all piping systems.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	10/30/95	9/19/96

Disposition

Number	Area	Subarea
15	Design Criteria	General

Description
Avoid putting flow meters in high points of piping systems.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxx	11/5/95	9/19/96

Disposition

Number	Area	Subarea
20	Design Criteria	General

Description
Specify valves to accept plant standard locks. Also, specify all process valves to avoid problems observed with VITPP manual valves (difficulty in operating valves).

Source Reference	Functional Area	Responsible
TQM on 4/23/98; other	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

000443

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
22	Design Criteria	General

Description
Do not vent tanks directly to atmosphere -- use vacuum breakers or other appropriate pressure protection.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
26	Design Criteria	General

Description
Allow adequate space within and adjacent to plot for emergency egress, maintenance, operation and other foot traffic and for possible future expansion.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
34	Design Criteria	General

Description
Follow plant labeling standard (ED-12-4016) and all other applicable plant procedures (engineering, RSO, safety and others).

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/95

Disposition

000444

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
38	Design Criteria	General

Description
Fix plant design capacity as early as possible to minimize later changes and rework.

Source Reference	Functional Area	Responsible
B. Tope cc:Mail, 10/30/95	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/6/95	6/3/96

Disposition

Number	Area	Subarea
39	Design Criteria	General

Description
Thoroughly define process and functional requirements, rest of design basis as early as possible (i.e., what facility must do) and obtain widespread agreement, then design the facility itself.

Source Reference	Functional Area	Responsible
Tope, 10/30/95	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
Functional Requirements	11/6/95	9/19/96

Disposition

Number	Area	Subarea
40	Design Criteria	General

Description
Include requirements for cold and hot operational testing in facility design criteria.

Source Reference	Functional Area	Responsible
Tope	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/6/95	9/19/96

Disposition

000445

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
42	Design Criteria	General

Description
Avoid ratcheting effects of midstream changes in internal procedures or other requirements.

Source Reference	Functional Area	Responsible
Tope	Engineering	Dehling

Implementation Reference	Date Entered	Date Last Modified
	11/6/95	6/3/96

Disposition

Number	Area	Subarea
54	Design Criteria	General

Description
Use double-valve isolation as appropriate for maintenance of equipment.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

Number	Area	Subarea
58	Design Criteria	General

Description
Provide adequate lighting for maintenance and operation (3 to 5 footcandles).

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

000

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
61	Design Criteria	General

Description
Design and construct systems for phased turnover and testing.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	6/3/96

Disposition

Number	Area	Subarea
67	Design Criteria	General

Description
Include provisions to facilitate maintenance of equipment, such as hoists, work platforms, etc. (note pilot plant gem maker maintenance).

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	9/19/96

Disposition

Number	Area	Subarea
72	Design Criteria	General

Description
Establish exact design criteria for calculation requirements, sizing equipment, type of equipment, tray/conduit loading, codes and standards, etc.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/15/95	9/19/96

Disposition

000447

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
78	Design Criteria	General

Description
Establish number of sets of documents needed from vendors and list of recipients at site.

Source Reference	Functional Area	Responsible
West Valley	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	11/15/95	9/19/96

Disposition

Number	Area	Subarea
80	Design Criteria	General

Description
Equipment specification has to be exacting, no open-ended statements. Try to buy standard equipment and off-the-shelf items (avoid custom designs) where feasible.

Source Reference	Functional Area	Responsible
West Valley, TQM 4/9/96	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	11/15/95	9/19/96

Disposition

Number	Area	Subarea
82	Design Criteria	General

Description
Develop P&IDs early. Agree on the format and detail of control/monitoring representation in the PIDs. There should only be one set of PIDs and one format. Tagging of equipment/instrument should be established early to avoid costs of retagging.

Source Reference	Functional Area	Responsible
West Valley	Engineering	Smiets

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	11/15/95	9/19/96

Disposition

000448

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
88	Design Criteria	General

Description
For sampling, use double valve arrangement, sampling cell or glovebox, or other improved system.

Source Reference	Functional Area	Responsible
TQM Meeting on 4/23/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/17/95	9/19/96

Disposition

Number	Area	Subarea
103	Design Criteria	General

Description
Obtain list of prohibited products, compounds, etc., from Industrial Hygiene, and require use of approved products for cements, solvents, cleaners and other construction uses.

Source Reference	Functional Area	Responsible
TQM Meeting on 3/26/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/7/96

Disposition

Number	Area	Subarea
119	Design Criteria	General

Description
For any outdoor equipment with containment curbs, provide means for pumping out rainwater and adequate anchoring to prevent floating.

Source Reference	Functional Area	Responsible
Woodroffe: M:CRUP:(CRU4/PP):95-0067	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	9/9/96

Disposition

000449

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
188	Design Criteria	General

Description
Contamination control- install SS drip trays under all pumps.
Paint all areas of possible contamination, to enable better clean-up

Source Reference	Functional Area	Responsible
NUMATEC	Operations	Bradburne

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
187	Design Criteria	General

Description
Control radiation similar to production plant
use shielding for sample taking and where operators are normally working.

Source Reference	Functional Area	Responsible
NUMATEC	Radiation Protection	Daniels

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
191	Design Criteria	General

Description
Use quick connectors for decoupling and refitting on key equipment

Source Reference	Functional Area	Responsible
NUMATEC	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

000450

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
192	Design Criteria	General

Description
Have redundancy on key process equipment

Source Reference	Functional Area	Responsible
NUMATEC	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
203	Design Criteria	General

Description
Provide CLEAN water supply to any mechanical seals for pumps...and proper method for supplying clean water to seals.

Source Reference	Functional Area	Responsible
POD Meetings	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/27/96	9/27/96

Disposition

Number	Area	Subarea
32	Design Criteria	HEPA Filters

Description
Include DOP testing ports on all HEPAs. Set up to FEMP plant standards for hookup of test equipment. Include provisions for access to HEPAs by test personnel and equipment. Involve plant HEPA filtration personnel early.

Source Reference	Functional Area	Responsible
J. Legge, M. RSO: (FP) 95-0270	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

000451

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
14	Design Criteria	HVAC

Description
Set up Silo 3 transfer system HEPA with DOP testing provisions, proper radiation shielding, appropriate prefilter etc.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	10/30/95	8/19/96

Disposition

Number	Area	Subarea
83	Design Criteria	HVAC

Description
Design for proper ventilation of rooms with UPS or other batteries.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	8/19/96

Disposition

Number	Area	Subarea
10	Design Criteria	Melter

Description
Provide current monitor on each electrode.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	10/30/95	8/19/96

Disposition

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
19	Design Criteria	Melter

Description
Avoid use of refractory ceramic fiber where feasible due to inhalation safety concerns.

Source Reference	Functional Area	Responsible
D. Jackson M.SH(CSH) 96-0112	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
33	Design Criteria	Melter

Description
Provide means for safely adding cold frit to melter (all chambers, if more than one) for testing and other purposes.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
53	Design Criteria	Melter

Description
Avoid the use of high maintenance items such as the electrode turning requirements on the pilot plant melter.

Source Reference	Functional Area	Responsible
	Engineering	Delining

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number: 108
Area: Design Criteria
Subarea: Melter

Description: Property size electrode cooling water lines.

Source Reference: TQM Meeting on 2/13/96
Functional Area: Engineering
Responsible: Smets

Implementation Reference:
Date Entered: 9/17/96
Date Last Modified: 9/19/96

Disposition:

Number: 150
Area: Design Criteria
Subarea: Melter

Description: Use of air supply for bubblers is crucial to operation. Add secondary/emergency air supplies for bubblers.

Source Reference: Startup/SO Testing
Functional Area: Engineering
Responsible: Smets

Implementation Reference:
Date Entered: 9/17/96
Date Last Modified: 9/17/96

Disposition:

Number: 151
Area: Design Criteria
Subarea: Melter

Description: Pour spout air inleakage/discharge plugging. Need redesign on pour spout to minimize inleakage.

Source Reference: Startup/SO Testing
Functional Area: Engineering
Responsible: Smets

Implementation Reference:
Date Entered: 9/17/96
Date Last Modified: 9/17/96

Disposition:

000454

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
154	Design Criteria	Melter

Description: Film cooler is plugging at entry point. Installed air lance is helpful...but, needs additional work.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition:

Number	Area	Subarea
156	Design Criteria	Melter

Description: All bottom drains failed. Started leaking water into melter and below on floor. Need better design

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition:

Number	Area	Subarea
157	Design Criteria	Melter

Description: Melter does an auto discharge of glass. This causes plugging of discharge outlet.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/17/96

Disposition:

000455

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
185	Design Criteria	Melter

Description
Premature failure of lid heaters

Source Reference	Functional Area	Responsible
Startup/SQ Testing	Engineering	Soloman

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
188	Design Criteria	Melter

Description
Level detector consumed in melt pool

Source Reference	Functional Area	Responsible
Startup/SQ Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
204	Design Criteria	Melter

Description
Ensure that any new design of melters are designed so that we do not have continious auto discharge such as we have experienced with our melter.

Source Reference	Functional Area	Responsible
POD Meetings	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/27/96	9/27/96

Disposition

000456

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
29	Design Criteria	Off-Gas System

Description
Auxiliary / emergency off-gas system needs to match primary in design and capabilities unless justified otherwise.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
30	Design Criteria	Off-Gas System

Description
Do not use deliquescent dryer as primary means of moisture removal from off-gas. If one is used for final moisture removal, provide means for charging desiccant as appropriate for usage rate.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
45	Design Criteria	Off-Gas System

Description
Design off-gas system for control of melter pressure, not system flow.

Source Reference	Functional Area	Responsible
	Engineering	Oehring

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

000457

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
46	Design Criteria	Off-Gas System

Description
Place quench tower a very few feet away from the melter. Include provisions for mechanical cleaning.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

Number	Area	Subarea
47	Design Criteria	Off-Gas System

Description
Avoid the use of a deliquescent dryer, especially as the only means of moisture removal. Consider the use of refrigeration or other means of moisture removal.

Source Reference	Functional Area	Responsible
POD Meetings	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

Number	Area	Subarea
49	Design Criteria	Off-Gas System

Description
Separate melter off-gas handling from vessel vents as appropriate. Also, use two blowers on off-gas system(s).

Source Reference	Functional Area	Responsible
POD Meetings	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

000458

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
92	Design Criteria	Off-Gas System

Description: Protect carbon beds from heating due to sunlight. Include roof, insulation, cooling or other.

Source Reference	Functional Area	Responsible
TQM Meeting on 6/5/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	6/7/96	9/19/96

Disposition:

Number	Area	Subarea
171	Design Criteria	Off-Gas System

Description: Rapid consumption of disiccant, possibly building up in lines. Wetting of HEPA's. Replacing of prefilters on almost daily basis. Heat tape not entirely sucessful. Need long term fix, chiller?

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition:

Number	Area	Subarea
172	Design Criteria	Off-Gas System

Description: Inability to DOP test filters while system on line. Need to add piping to add capability.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition:

000459

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
173	Design Criteria	Off-Gas System

Description
Inability of off-gas system to provide desired melter vacuum. Added additional blower, limited by duct/pipe size. Inleakage higher than anticipated.

Source Reference	Functional Area	Responsible
Startup/SC Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition

Number	Area	Subarea
174	Design Criteria	Off-Gas System

Description
scrubber pump failures because of seals (multiple)

Source Reference	Functional Area	Responsible
Startup/SC Testing	Maintenance	Bradburne

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition

Number	Area	Subarea
57	Design Criteria	Piping

Description
Design manually operated valves for easy access (location, chain or extension operators, etc.)

Source Reference	Functional Area	Responsible
Woodroffe, M:CRUP:(CRU4/PP):95-0067	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

000460

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
6	Design Criteria	Utilities

Description
Include utility drops / hose hookup stations at appropriate points in facility.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	10/30/95	9/19/96

Disposition

Number	Area	Subarea
7	Design Criteria	Utilities

Description
Pipe air directly to permanent usage points such as seal pots on pumps and others.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	10/30/95	9/19/96

Disposition

Number	Area	Subarea
16	Design Criteria	Utilities

Description
Make sure that utility supplies are adequate, with plenty of allowance for expansion. (Note problems with process water to VITPP.) Consider in-house supplies for air or others if plant systems will need to be taken out of service.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

000461

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
34	Design Criteria	Utilities

Description
Develop requirements for heat tracing early in project and implement consistently.

Source Reference	Functional Area	Responsible
L. Lockerd	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	9/19/96

Disposition

Number	Area	Subarea
121	Design Criteria	Utilities

Description
Include nitrogen purge for diesel fuel tanks or other means to prevent moisture accumulation, oxidation, and possible fuel contamination.

Source Reference	Functional Area	Responsible
Woodroffe: M:CRUP:(CRU4/PP):95-0067	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	9/19/96

Disposition

Number	Area	Subarea
31	Design Criteria	Vendor Packages

Description
Require vendors to number their equipment, valves, lines, instrumentation, etc., consistently with plant numbering standards. Provide blocks of numbers from project system for vendors to use.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

000462

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
107	Design Execution	Control Systems

Description
Systems Engineering or A/E select instrument set points and alarm points; implement in initial calibrations

Source Reference	Functional Area	Responsible
TQM Meeting on 1/30/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	8/19/96

Disposition

Number	Area	Subarea
181	Design Execution	Control Systems

Description
Grounding problems on DACS. Brought in additional outside contractor to help resolve problem. Need ensure that qualified personnell are availble to support data system installation and maintaince.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/18/96

Disposition

Number	Area	Subarea
207	Design Execution	Cooling Water Systems

Description
Cooling water originally contained antifreeze. This also contained small amounts of chlorides that could lead to corrosion problems. This was removed during Campaign 1.

Source Reference	Functional Area	Responsible
POD Meetings	Engineering	Solorman

Implementation Reference	Date Entered	Date Last Modified
	9/27/96	9/27/96

Disposition

000463

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
144	Design Execution	Field Preparation

Description
Damage to pump diaphragms due to material selection; other problems/ parts made of new materials have been installed; Little improvement in life.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Solomon

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
2	Design Execution	General

Description
Prepare standard specifications in advance for common items such as pumps, motors, valves, instruments, HEPA filters.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	10/20/95	9/19/96

Disposition

Number	Area	Subarea
9	Design Execution	General

Description
When design is frozen, set up in advance system for tracking and analyzing root causes of DCNs. Set up categories and system for tracking and controlling costs of each DCN.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP xxxx	10/30/95	9/19/96

Disposition

000464

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
80	Design Execution	General

Description

Before preparing Design Change Notices, concerned personnel in EERMCO engineering, construction and startup and A/E project management and design disciplines should discuss the problem and possible solutions (hold an alignment session) and spend time in the field as necessary to make sure that the solution is right.

Source Reference	Functional Area	Responsible
	Management Systems	Dehoog

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	9/19/96

Disposition

Number	Area	Subarea
85	Design Execution	General

Description

Define requirements for review and checking of vendor drawings, calculations and other media as part of procurement specifications.

Source Reference	Functional Area	Responsible
	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	9/19/96

Disposition

Number	Area	Subarea
95	Design Execution	General

Description

Have A/E redline drawings in the field, not the construction subcontractor.

Source Reference	Functional Area	Responsible
TQM Meeting on 4/9/96	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

000465

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
98	Design Execution	General

Description
Require A/E to provide lists with quality levels, inspection, other appropriate information - equipment, valves, instruments, lines, wall penetrations, other.

Source Reference	Functional Area	Responsible
TQM Meeting on 3/26/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	8/7/96

Disposition

Number	Area	Subarea
99	Design Execution	General

Description
Obtain block of CMMS numbers for valves, other items before issuing numbers in design, and use CMMS numbers from design through operation to eliminate renumbering.

Source Reference	Functional Area	Responsible
TQM Meeting on 3/26/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	8/7/96

Disposition

Number	Area	Subarea
100	Design Execution	General

Description
Show flanges, unions, other fittings on P&IDs.

Source Reference	Functional Area	Responsible
TQM Meeting on 3/26/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

000466

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
101	Design Execution	General

Description
Show pipe hangers on initial construction issue of piping drawings. Use typical details where appropriate.

Source Reference	Functional Area	Responsible
TQM Meeting on 4/23/95	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

Number	Area	Subarea
104	Design Execution	General

Description
As-build P&IDs, other drawings as appropriate, including equipment and other items actually installed.

Source Reference	Functional Area	Responsible
TQM Meeting on 3/26/95	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	8/7/96

Disposition

Number	Area	Subarea
106	Design Execution	General

Description
Fully integrate various disciplines' space requirements into three-dimensional model to eliminate interferences and space allocation conflicts.

Source Reference	Functional Area	Responsible
TQM Meeting on 3/12/95	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

000467

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
112	Design Execution	General

Description
Visit M-Area, other meilers as appropriate to obtain lessons learned and other information.

Source Reference	Functional Area	Responsible
TQM Meeting on 2/13/95	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	8/7/95	8/15/95

Disposition

Number	Area	Subarea
114	Design Execution	General

Description
Implement configuration management from the inception of the project.

Source Reference	Functional Area	Responsible
Skriba M:CRUP:(CRU4):95-0090	Configuration Management	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/12/96	8/12/95

Disposition

Number	Area	Subarea
115	Design Execution	General

Description
Carry out performance grading on all structures, systems and components during Title I, in conjunction with preparation of P&IDs, hazard analysis, and hazard categorization. Document grading rationale thoroughly and obtain Technical Review Board approval. Incorporate performance grades into specifications.

Source Reference	Functional Area	Responsible
Skriba M:CRUP:(CRU4):95-0090	Configuration Management	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/12/96	8/12/95

Disposition

000468

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
118	Design Execution	General

Description

Modify DCN forms and procedure to include performance grade, project engineering technical evaluation, and approval by Technical Review Board chair. Design engineer and project engineer should review in parallel, and DCN should be walked through the TRB during review cycle.

Source Reference	Functional Area	Responsible
Skrba M CRUP (CRUM) 95-0090	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	9/19/96

Disposition

Number	Area	Subarea
123	Design Execution	General

Description

Personnel reviewing plant operating data should hold frequent discussions with operations personnel for full understanding of operational changes, test results and other considerations.

Source Reference	Functional Area	Responsible
TQM Meeting on 8/13/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	8/21/96

Disposition

000469

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
179	Design Execution	General

Description

Access to some equipment and valves/instruments inadequate for operation and maintainance. Added stairs and platforms, relocated some equipment.

Source Reference	Functional Area	Responsible
Startup/SQ Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition

Number	Area	Subarea
111	Design Execution	Melter

Description

Schedule project so that preliminary melter design is provided in time for design of off-gas, utility and o[illegible] systems. Carefully define equipment interfaces and lines of communication between melter vendor, c[illegible] vendors, and rest of project.

Source Reference	Functional Area	Responsible
TQM Meeting on 2/13/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	6/7/96	8/21/96

Disposition

000470

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
158	Design Execution	Melter

Description
E. walls leak glass through them. Causes substantial increase in use of side chamber frit to maintain level and conductivity of side chambers.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
161	Design Execution	Melter

Description
Cooling wter lines to melter was to small. Changed to larger lines

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
162	Design Execution	Melter

Description
Side chamber frit feeder inoperable.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/17/96

Disposition

000471

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
163	Design Execution	Melter

Description
Side drain on melter, non operable. Also, A/E, Engineering forgot to install method for discharge of glass.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Dehning

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
164	Design Execution	Melter

Description
Failure of Thermowells on melter, need resolution.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Solomon

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
166	Design Execution	Melter

Description
Premature failure of I. R. detectors on side chambers.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

000472

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
189	Design Execution	Melter

Description
Air bubbler # 1 inoperable.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
110	Design Execution	Off-Gas System

Description
Involve melter vendor in design of off-gas system - design system, provide or review system basis and design requirements.

Source Reference	Functional Area	Responsible
TGM Meeting on 2/13/96	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

Number	Area	Subarea
175	Design Execution	Off-Gas System

Description
Quench tower has not been as effective as required. Plugging of spray nozzles. Replaced plugged spray nozzles.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Maintenance	Bradburne

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition

000473

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
178	Design/Execution	Off-Gas System

Description
Very lengthy and torturous off-gas routing. Increased potential for plugging. Needs to locate quench tower near the melter.

Source Reference	Functional Area	Responsible
Startup/SQ Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/19/96

Disposition

Number	Area	Subarea
155	Maintenance	Melter

Description
Monyo melter feed pumpcontinually fails. Seals do not hold up and pump is insufficient to supply melter feed at required rates.

Source Reference	Functional Area	Responsible
Startup/SQ Testing	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/19/96

Disposition

Number	Area	Subarea
180	Operation	Cooling Water Systems

Description
Water quality of cooling systems must be controlled to strick specifications

Source Reference	Functional Area	Responsible
	Operations	Bradburne

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/17/96

Disposition

000474

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
189	Operation	Feed Preparation

Description
Start ASAP the simulation tests of the whole retrieval system.

Source Reference	Functional Area	Responsible
NUMATEC	Operations	Nixon

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
202	Operation	Feed Preparation

Description
Slurry system has poor agitation. Agitator only reaches about two/thirds of the material in the slurry tanks. Pump recirculation is weak. However it is the only agitation when level is below the agitator. Need variable speed on agitation

Source Reference	Functional Area	Responsible
POD Meetings	Operations	Smiels

Implementation Reference	Date Entered	Date Last Modified
	9/23/96	9/23/96

Disposition

Number	Area	Subarea
105	Operation	General

Description
During SQ testing, startup and operation, involve Engineering and Maintenance in any consideration of changes to or replacement of equipment, valves or piping.

Source Reference	Functional Area	Responsible
TQM Meeting on 7/9/96	Operations	Bradburne

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	8/23/96

Disposition

000475

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
198	Operation	General

Description
Prove equipment with cold running. Go HOT only when you are ready. (It's expensive and time consuming when your not)

Source Reference	Functional Area	Responsible
NUMATEC	Operations	Nixon

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
149	Operation	Melter

Description
development of cold cap on glass melt reduces quantity of solids to the off-gas system.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Operations	Bradburne

Implementation Reference	Date Entered	Date Last Modified
	9/17/96	9/17/96

Disposition

Number	Area	Subarea
1	Procurement	General

Description
Require construction subcontractors to submit operation and maintenance manuals on equipment they purchase during construction.

Source Reference	Functional Area	Responsible
	Construction	Smets

Implementation Reference	Date Entered	Date Last Modified
DCP Sec. No.	10/20/95	10/23/96

Disposition

006176

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
11	Procurement	General

Description
Specify desired equipment and "or equal" salient features lightly enough to assure likelihood of getting desired item.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	10/30/95	9/19/96

Disposition

Number	Area	Subarea
68	Procurement	General

Description
Plan major procurements well in advance to phase design and construction properly and to provide vendor design for interface early in detailed design.

Source Reference	Functional Area	Responsible
	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	6/5/96

Disposition

Number	Area	Subarea
113	Procurement	General

Description
Engineer responsible for design of any system should review related procurement packages.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	8/12/96	8/12/96

Disposition

000477

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
183	Procurement	General

Description
Ensure that when a RFP goes out that acceptable Construction Acceptance Testing requirements are included and that Startup Turnover and Testing approves requirements.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/18/96

Disposition

Number	Area	Subarea
184	Procurement	General

Description
Define the specifications for pipe flushing in the SPECS.

Source Reference	Functional Area	Responsible
Startup/SO Testing	Engineering	Maurer

Implementation Reference	Date Entered	Date Last Modified
	9/18/96	9/18/96

Disposition

Number	Area	Subarea
13	Procurement	Melter

Description
Include significant weight for past performance on deliverables, etc. in technical evaluation of melter vendors.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	10/30/95	9/19/96

Disposition

000473

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
50	Procurement	Melter

Description
Require vendor of melter and other major equipment assemble equipment off-site as much as possible. Also, require vendors to provide critical spares with equipment, or at least as part of contract.

Source Reference	Functional Area	Responsible
Startup/SQ Testing	Construction	Maurer

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/19/96

Disposition

Number	Area	Subarea
17	Project Management	General

Description
Plan for adequate resources at FERMCO and at A/E for Title III.

Source Reference	Functional Area	Responsible
	Management Systems	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	6/3/96

Disposition

Number	Area	Subarea
18	Project Management	General

Description
Do plastic block model on general plant layout to allow for good review of layout, proximities, operability, etc.

Source Reference	Functional Area	Responsible
	Engineering	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

000479

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
25	Project Management	General

Description
Avoid the inclusion of used equipment in the design (for example, lab trailer, pumps, stack monitors, HEPA filte and associated problems during pilot plant construction and startup).

Source Reference	Functional Area	Responsible
	Engineering	Smiets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
35	Project Management	General

Description
Thoroughly spell out all vendor requirements in specifications - deliverables, documentation (O&M ma cut sheets), interfaces with A/E, with rest of plant and other vendors, compliance with site procedures, in st procedures by vendor, spares, supplies, chemicals. A/E integrate and check vendor packages.

Source Reference	Functional Area	Responsible
	Engineering	Smiets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	9/19/96

Disposition

Number	Area	Subarea
38	Project Management	General

Description
Make goals of project and facility clear from the outset to all personnel and organizations involved.

Source Reference	Functional Area	Responsible
	Management Systems	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/6/95	6/3/96

Disposition

000480

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
37	Project Management	General

Description
Carry out decisions and design in logical order to reduce unnecessary rework.

Source Reference	Functional Area	Responsible
	Management Systems	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/6/95	6/3/96

Disposition

Number	Area	Subarea
41	Project Management	General

Description
Involve appropriate groups and subject matter experts from definition of design requirements on, and allow time for thorough reviews on their part. Include construction, procurement, operations, maintenance, safety and others.

Source Reference	Functional Area	Responsible
Tope, TQM 3/26/96, other	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/6/95	9/19/96

Disposition

Number	Area	Subarea
52	Project Management	General

Description
Do not split up design work - have all design done by one agency.

Source Reference	Functional Area	Responsible
	Management Systems	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	6/3/96

Disposition

000481

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
89	Project Management	General

Description
Provide ample office trailer space as needed for various project personnel (construction, engineering, training, startup, etc.)

Source Reference	Functional Area	Responsible
	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	11/12/95	9/19/96

Disposition

Number	Area	Subarea
93	Project Management	General

Description
To the extent feasible, arrange for the same engineers to do systems engineering and design, write and perform systems operability tests, start up the facility, and operate the plant.

Source Reference	Functional Area	Responsible
TQM Meeting on 5/22/96	Management Systems	Dehring

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	8/7/96

Disposition

Number	Area	Subarea
94	Project Management	General

Description
Institute system for transfer of information from systems operability testing and other VITPP activities to future design work.

Source Reference	Functional Area	Responsible
TQM Meeting on 5/22/96	Engineering	Dehring

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	9/19/96

Disposition

000482

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
109	Project Management	General

Description
Design and construct plant with readiness review in mind. Functional area managers document how the plant and their activities meet specified requirements, company procedures.

Source Reference	Functional Area	Responsible
TQM Meeting on 2/13/96	Readiness	Dehring

Implementation Reference	Date Entered	Date Last Modified
	8/7/96	8/7/96

Disposition

Number	Area	Subarea
116	Project Management	General

Description
All project documents must be maintained in a single central project file, whether originated by FERMCO, A/E, vendor, construction subcontractor or other.

Source Reference	Functional Area	Responsible
Skriba M CRUP (CRU4) 95-0090	Engineering	Smiels

Implementation Reference	Date Entered	Date Last Modified
	8/12/96	8/12/96

Disposition

000483

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
124	Project Management	General

Description

The project manager should require all functional area managers to conduct readiness preparation in their areas. The project manager also needs to support training and other work by the functional area managers to learn wha is needed for RA or ORR and to prepare for it.

Source Reference	Functional Area	Responsible
TQM Meeting on 7/23/96	Readiness	Paine

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	8/21/96

Disposition

Number	Area	Subarea
125	Project Management	General

Description

The ORR plan of action should be prepared early in the project. The ORR plan of action should defin responsible for the various areas of readiness preparation (generally the functional area managers).

Source Reference	Functional Area	Responsible
TQM Meeting on 7/23/96	Readiness	Hiestand

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	8/21/96

Disposition

Number	Area	Subarea
126	Project Management	General

Description

The various functional areas should review other areas' preparations for ORR to avoid gaps and inconsistencies.

Source Reference	Functional Area	Responsible
TQM Meeting on 7/23/96	Readiness	Hiestand

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	9/19/96

Disposition

000184

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
127	Project Management	General

Description
The functional areas' preparation for readiness review should be built into the master schedule.

Source Reference	Functional Area	Responsible
TQM Meeting on 7/23/96	Readiness	Hiestand

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	9/19/96

Disposition

Number	Area	Subarea
128	Project Management	General

Description
Readiness reports from UNH, thorium overpack, other sites and VITPP RA should be reviewed as part of the planning and execution of future VITPP ORR.

Source Reference	Functional Area	Responsible
TQM Meeting on 7/23/96	Readiness	Hiestand

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	8/21/96

Disposition

Number	Area	Subarea
129	Project Management	General

Description
Self-assessments by FEMP personnel not on VITPP should be conducted to make sure that the systems put into place just before RA are functioning as intended and to otherwise prepare for VITPP ORR.

Source Reference	Functional Area	Responsible
Construction	Readiness	Hiestand

Implementation Reference	Date Entered	Date Last Modified
	8/21/96	9/19/96

Disposition

000485

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
198	Project Management	General

Description
Have good characterization of site residues

Source Reference	Functional Area	Responsible
NUMATEC	Environmental Restoration	Dolting

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
194	Safety	General

Description
Layout of facility should consider personnel path to avoid exposure, contamination, and risk

Source Reference	Functional Area	Responsible
NUMATEC	Occupational Safety	Daniels

Implementation Reference	Date Entered	Date Last Modified
	9/19/96	9/19/96

Disposition

Number	Area	Subarea
21	Startup	General

Description
Define during construction methods for documenting and resolving problems found by personnel from any functional area during startup and SO testing.

Source Reference	Functional Area	Responsible
	Startup	Smets

Implementation Reference	Date Entered	Date Last Modified
	11/5/95	8/23/96

Disposition

000486

LESSONS LEARNED
VITPP Input - All Records
Sorted by Subarea

Number	Area	Subarea
44	Startup	General

Description

Define need and responsibility (Maintenance vs. construction subcontractor) for instrument calibration during Title II. Make sure requirements for documentation of any calibration are clear to subcontractor.

Source Reference	Functional Area	Responsible
		Maurer

Implementation Reference	Date Entered	Date Last Modified
	11/8/95	9/9/96

Disposition

Number	Area	Subarea
208	Startup	Melter

Description

Ensure that during initial startup of any new melter, that you fully understand the thermal heat stresses to be encountered during initial heat up.

Source Reference	Functional Area	Responsible
DOE Lessons Learned West Valley	Operations	Nixon

Implementation Reference	Date Entered	Date Last Modified
	9/27/96	9/27/96

Disposition

000487

Appendix D
Melter Bottom Drain #3 "Glow" Condition

Attachment #1
Bottom Drain #3 Glow Highlights from Turn-over Checklist

9/24/96 Day Shift, Melter = 1200 C

Bottom Drain #3 glow discovered.

SCR #1 lock and tagged out. During ramp down a direct correlation between SCR #1 output and glow intensity is noted.

Bottom drain #3 cooling water flow meter increased to full open. Drain temperature as read on Melter panel is 685 F.

Installed compressed air line from utility rack to bottom drain #3. Blew air on drain to freeze any glass that may migrate from melter.

SCR #1 lock and tag out removed. SCR #1 ramped back up, no glow noted.

Night Shift,

Glow noted as intermittent.

Started a program to take Voltage readings on Melter. Voltages looked same as before glow.

9/25/96 Day Shift, Melter Temp = 1150

Connected Bottom drain #3 to temporary cooling system, 96-TA-053.

Glow noted as intermittent, appeared and reappeared 3 times so far. Light is emanating from different locations around bottom drain with each reoccurrence.

Night Shift,

Glow intermittent.

Experimented with the temporary Bottom drain #3 cooling system, 96-TA-053. Added ice, then dry ice to temporary cooling system. This provide a significant increase in cooling but had no apparent effect on glow.

Started a tracking sheet to monitor glow intensity and melter parameters.

9/26/96 Day Shift,

Lowered discharge chamber temperature while monitoring glow. Target temperature is 600 C on Discharge Chamber Plenum Thermocouple. Glow diminished as discharge temperature dropped. Seems to be related.

Measured individual electrode readings. Nothing unexpected noted.

Night Shift,

Discharge Chamber at 600 C, Glow is gone.

9/27/96 Day Shift,

Glow returned on melter with discharge chamber at 600 C. Still intermittent.

Performed Infrared Photo imaging of Melter Shell looking for hot spots. Highest spot found just east of the west side chamber thermowell.

Decision made to increase discharge char' - temperature to 1000 C.

Night Shift,

Discharge chamber temperature at 1000 C

Glow intermittent. Glow color ranges from dull orange to bright white.

Noted that glow always goes away when SCR #1 is ramped down but sometimes does not reappear immediately after ramping back up again.

9/30/96 Day Shift,

Bottom Drain #3 temporary drain system pump failed. Drain temperature reached 827 F.

Night Shift,

Performed flow testing on Bottom Drain #3 utility rack loop. Loop performed as designed with drain disconnected, flow meter capable of over 5 gpm.

10/2/96 Day Shift,

Checked for current through bottom drain #3 drain pins and motor mounting hardware. No current found.

Night Shift,

Dim glow on Bottom Drain #3 for the entire shift.

10/4/96 Day Shift,

Attempted to remove thermowell on West Side Chamber. Found it to be made of Kanthal Super Tube. Tube diameter is much smaller than the 1 1/4" hole through the refractory. Drilled out super tube from outer shell inward about 3 inches. Packed hole with castable. Workers noted taffy like glass found at inner shell. Looked like glass flow occurred past inner shell then down between inner and outer shell.

Cooled south side of melter shell with water.

Night Shift,

Glow still present. Intensity is brighter than previous night.

10/5/96 Day Shift,

Removed thermowell on East Side Chamber. Found it to be a 1" Stainless Steel Tube 10" long packed with frozen glass and the remains of the failed thermocouple.

Night Shift,

Noted glow intensity increases as melter temperature is ramped up in preparation for tommorrows feeding.

10/6/96 Day Shift,

Close visual inspection of Bottom Drain #3 seems to indicate glow is not emanating from the drain. Glow seems to be coming from inside melter somewhere around bottom drain #3.

Glow on Bottom Drain #3 brighter than usual.

10/7/96 Day Shift,

Duratek Electrical engineer Al Tamres arri on site to examine glow.

10/8/96 Day Shift,

Duratek and Fermco Electrical engineers measured resistances on several Melter Components. Information shows inner and outer shell are electrically connected with almost no resistance.

Boroscope analysis of Bottom Drain #3 confirms glow is emanating from inside melter and not from bottom drain.

10/9/96 Day Shift,

Thermal imaging video tape is made on all surfaces of the Melter. Temperatures are the same as in past measurements. Hottest area still in between side chamber thermowells. Hottest spot still just East of abandon West Side Chamber thermowell penetration.

10/10/96 Day Shift,

Discharge chamber dropped to 600 C.

Applied water to south wall of Melter in between thermowells.

Connected bottom drain #1 to temporary water system.

Night Shift,

Applied water to south, east and west wall of Melter. Monitored wall temperatures using thermal imaging camera. East and West walls cooled to 85 F. Resistance readings showed no change. Removed water and walls returned to 350 F.

10/11/96 Day Shift,

Ramped discharge chamber temperature to 1300 C.

10/15/96 Day Shift

Sampled East and West side chamber glass and sent to VSL for redox testing.

Sampled top and bottom of main chamber glass.

Samples sent to SPL for analysis to include sulfate.

10/16/96 Day Shift

Noted glow returned on bottom drain 3 for the first time in days. 30 minutes later it was gone.

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Optimum Series A Glass for Campaign 2
Table 1-2

Basis: 100 lbs Glass from Slurry

Melter Input – Feed Oxide	Glass wt%	Moisture wt%	Silo 1 Surrogate lbs	Silo 2 Surrogate lbs	Silo 3 Surrogate lbs	Surrogate Total lbs	Additives lbs	Batch lbs
Al2O3	14.03	2.71	0.84	0.96	1.26	3.05	10.72	13.78
B2O3	8.82							
H3BO3							6.00	6.00
BaO	2.80							
BaCO3			1.15			1.15		1.15
BaSO4		1.17	1.66	1.27		2.93		2.93
CaO	13.84			0.14		0.14		0.14
CaCO3		0.72		0.93		0.93	21.41	22.34
CaSO4		20.93		0.08	3.33	3.41		3.41
Fe2O3	4.45		0.78	1.68	1.58	4.04		4.04
Fe2(SO4)3		1.98			0.68	0.68		0.68
K2O	0.85							
K2CO3		6.56	0.33	0.29		0.63		0.63
KNO3		2.19			0.91	0.91		0.91
Li2O	1.15							
Li2CO3		0.96			0.27	0.27	2.60	2.88
MgO	3.40							
MgCO3			0.95	1.39		2.33		2.33
MgSO4		51.16			2.93	2.93		2.93
Mg3(PO4)2			0.36	0.35	3.98	4.68		4.68
MnO2	0.16				0.15	0.15		0.15
Na2O	6.28							
Na2B4O7		30.90					11.38	11.38
Na2SO4					1.00	1.00		1.00
Na2CO3		3.53	1.00	0.26	0.70	1.95	2.75	4.70
NaNO3		0.71		0.27	1.48	1.75		1.75
NiO	0.12				0.12	0.12		0.12
P2O5	2.53							
PbO	5.46		3.75	1.71		5.46		5.46
SiO2	35.47		15.63	14.04	3.23	32.90		32.90
TiO2	0.01							
V2O5	0.13				0.13	0.13		0.13
Bentonite	–	14.23				4.53		4.53
CO(NH2)2	–						3.32	3.32
SO3 in glass	0.50							
Total Solids	99.98	na	26.44	23.36	21.75	76.08	58.19	134.27

Water for average 34 wt% Solids	260.65
Total	394.92

Note:

The surrogates that were used for the silo residues is shown in the columns above. Another column shows the additives that were used for making the glass. Amounts are shown with moisture. Bentonite adds to the Al2O3, SiO2, etc.

Later runs substituted:
- Chemicals for bentonite to help prevent blockage in the feed system.
- CaSO4 substituted for BaSO4 to determine different sulfate behavior.
- H3BO3 and Na2CO3 substitued for Na2B4O7 to help prevent blockage in feed system.

Melter Output

Glass	100.00
CO2 (to off-gas system)	14.41
SOx	3.45
NOx	1.58
Urea decomposition products	3.32
Water (H2O to off-gas system)	272.16
Subtotal	394.92

Frit Addition Impact

Glass from slurry	100.00
Frit addition, lbs glass	25.00
Total glass produced, lbs	125.00