EnVitCo, Inc.
A COGEMA Group Company
3400 Executive Parkway
P. O. Box 2451
Toledo, OH 43606

2291

FLUOR DANIEL FERNALD PROOF–OF–PRINCIPLE TEST OF JOULE-HEATED VITRIFICATION

FINAL REPORT

Envitco Project #98703

May 4, 1999

Contract No. 98WO002240

EnVitCo, Inc.
A COGEMA Group Company
3400 Executive Parkway
P. O. Box 2451
Toledo, OH 43606

E 2291

FLUOR DANIEL FERNALD PROOF–OF–PRINCIPLE TEST OF JOULE-HEATED VITRIFICATION

FINAL REPORT

Envitco Project #98703

May 4, 1999

Contract No. 98WO002240

2

[✓] A - Conforms to the Subcontract Requirements
[ ] B - Minor Comment - Incorporate and Resubmit
[ ] C - Revise and Resubmit
Sig: Date: 6/4/99

EnVitCo, Inc.
A COGEMA Group Company

2291

TABLE OF CONTENTS

TABLE OF CONTENTS I

APPENDICES AND ADDITIONAL SUBMITTALS IV

TABLES AND FIGURES V

ACRONYMS VIII

1.0 EXECUTIVE SUMMARY 1

1.1 VITRIFICATION RECIPE DEVELOPMENT 2
1.2 RECIPE DEVELOPMENT FOR TCLP AND UTS COMPLIANT GLASSES 3
1.3 POPT DEMONSTRATION 4
1.3.1 Facilities and Equipment 4
1.3.2 Process Establishment and Optimization 6
1.3.3 Processing Rate 7
1.4 DEMONSTRATION PROCESSING 7
1.4.1 Demonstration Results 7
1.4.2 Conclusions (Full-scale Design Considerations) 15

2.0 PROOF-OF-PRINCIPLE TEST OVERVIEW 19

2.1 LABORATORY-SCALE TESTING 20
2.1.1 Test Objectives 20
2.1.2 Glass Recipe Formulation Rationale 23
2.1.3 Laboratory-scale Test Description 23
2.2 PILOT-SCALE DEMONSTRATION TESTING 25
2.2.1 Test Requirements and Objectives 25
2.2.2 Facility and Equipment Descriptions 27
2.2.3 Test Process Operations 30
2.3 PRE-CONCEPTUAL FULL-SCALE DESIGN 30
2.4 POPT QUALITY ASSURANCE 31
2.4.1 Laboratory-Scale QA Implementation 33
2.4.2 Demonstration-scale QA Implementation 35
2.4.3 Pre-conceptual Full-scale Design QA Implementation 40

3.0 PRE-PERFORMANCE ACTIVITIES 41

3.1 RAW MATERIAL PROCUREMENT AND VALIDATION 41
3.1.1 LOD / LOI 41
3.1.2 Maximum Particle Size 41
3.2 30% MOISTURE SURROGATE MIX VALIDATION 42
3.2.1 Demonstration Surrogate (S0) Validation at 30% Moisture 42
3.3 GLASS MELTING TECHNIQUE DEVELOPMENT 47
3.3.1 Crucibles Used in Glass Melting Experiments 47
3.3.2 Glass Foaming Tendency 48
3.3.3 Glass Production Volume/Use of Wetted Batch 49
3.3.4 Process Temperature Evaluation and Calibration 49
3.3.5 Surrogate Batch Blending and Melting Protocols 50
3.4 PREPARATION OF TCLP LEACHING SAMPLES 51
3.4.1 Sizing of Glass Samples for TCLP Analysis 51

3.4.2 *TCLP Leaching and Particle Size Distributions* ... 58

4.0 GLASS RECIPE DEVELOPMENT ... **60**

4.1 TARGETS FOR GLASS RECIPE DEVELOPMENT ... 60
4.1.1 *Glass Viscosity Target* ... 60
4.1.2 *Glass Leachability Targets* ... 60
4.1.3 *Glass Redox Targets* ... 61
4.2 TREATMENT RECIPE DEVELOPMENT – S0 – TCLP-COMPLIANT GLASS ... 61
4.2.1 *First Glass Series – S0-D1* ... 61
4.2.2 *Effects of Lead and Lead Sulfide on Molybdenum Electrodes* ... 65
4.2.3 *Second Glass Series – S0-D2* ... 65
4.2.4 *Third Glass Series – S0-D3* ... 68
4.2.5 *Fourth Glass Series S0-D4* ... 69
4.2.6 *S0-D5 Glass Series* ... 71
4.2.7 *The S0-D5B Glass Sub-Series – Verification of Demonstration Recipe* ... 75
4.3 S1/S2 TCLP-COMPLIANT GLASSES ... 76
4.3.1 *Basis for Glass Formulation Development* ... 76
4.3.2 *Conversion of S0 Demonstration Glass to S1 and S2 Surrogates* ... 77
4.4 TREATMENT RECIPE DEVELOPMENT – UTS-COMPLIANT GLASSES ... 77
4.4.1 *First UTS Glass Series – U1 Series (S0-U1, S1-U1 and S2-U1) - Variation in Waste Loading* ... 77
4.4.2 *Second UTS-Compliant Glass Series - S1-U2 - Variation of Composition* ... 79
4.4.3 *Summary - UTS-Compliant Glasses For S0, S1, and S2 Surrogates* ... 82

5.0 PROOF-OF-PRINCIPLE DEMONSTRATION ... **83**

5.1 DEMONSTRATION DESCRIPTION ... 83
5.1.1 *POPT Demonstration Objectives* ... 83
5.1.2 *Facility Description* ... 85
5.1.3 *Equipment Description* ... 85
5.1.4 *Demonstration Process Description* ... 86
5.1.5 *Demonstration Melter Operation* ... 94
5.2 SURROGATE COMPOSITION ... 97
5.3 MATERIAL AND ENERGY BALANCE ... 99
5.3.1 *Material Balance* ... 101
5.3.2 *Lead and Molybdenum Interaction* ... 106
5.3.3 *Waste Loading and Bulking Factor* ... 108
5.4 PRODUCT AND SECONDARY WASTE PERFORMANCE ... 110
5.4.1 *POPT Treated Wasteform – Demonstration Glass S0-D5B-2* ... 110
5.4.2 *POPT Secondary Wastes* ... 115
5.5 72-HOUR DEMONSTRATION DATA ... 122
5.6 MELTER PERFORMANCE ... 131
5.6.1 *Refractory Performance* ... 131
5.6.2 *Electrode Performance* ... 131
5.7 SECONDARY WASTE DISPOSAL ... 132

6.0 PRE-CONCEPTUAL FULL-SCALE DESIGN DATA ... **133**

6.1 PROCESS DESIGN BASIS ... 133
6.1.1 *FDF Contract Requirements* ... 134
6.1.2 *Envitco Design Assumptions and Basis* ... 138
6.1.3 *Technology Experience* ... 141
6.2 SCALE-UP – LESSONS LEARNED ... 143
6.2.1 *Vitrification Melter* ... 143
6.2.2 *Melter Auxiliary Systems* ... 151
6.2.3 *Melter Feed Preparation* ... 151

6.2.4 *Melter Feeding* ... 152
6.2.5 *Offgas Treatment* ... 154
6.2.6 *Secondary Waste* ... 155
6.2.7 *Glass Handling* ... 156
6.3 PFD, ENERGY & MATERIAL BALANCE ... 156
6.3.1 *Process Flow Diagrams (PFD)* ... 156
6.3.2 *Material Balance* ... 157
6.3.3 *Utilities Summary – Energy Balance* ... 160
6.4 FACILITY ARRANGEMENT DRAWINGS ... 166
6.4.1 *Facility Zoning* ... 166
6.4.2 *Dose Rates and Area Access* ... 167
6.5 SYSTEM DESIGN DESCRIPTIONS ... 171
6.5.1 *System Numbers and Descriptions* ... 171
6.5.2 *Primary Process Characteristics* ... 172
6.5.3 *Basic Equipment Data* ... 179
6.5.4 *Process Descriptions* ... 182
6.5.5 *Monitoring and Control* ... 202
6.6 EQUIPMENT DATA SHEETS AND EQUIPMENT LIST ... 207
6.7 PROCESS ISSUES ... 217
6.7.1 *Safety* ... 217
6.7.2 *Reliability* ... 220
6.7.3 *Waste Minimization Summary* ... 223
6.7.4 *Treatment Recipe Impacts* ... 224

7.0 CONCLUSIONS ... 226

7.1 RESULTS SUMMARY ... 226
7.2 JOULE-HEATED VITRIFICATION POPT CONCLUSIONS ... 228

8.0 REFERENCES ... 230

APPENDICES AND ADDITIONAL SUBMITTALS

Reserved ..... Section 9

Appendix B ..... Section 10

Reserved ..... Section 11

Laboratory Log Book ..... Section 12

Weekly Teleconference Call Reports ..... Section 13

Chain of Custody Forms ..... Section 14

Sample Log Book ..... Section 15

Toxicity Characteristic Leaching Procedure Results (Compuchem) ..... Section 16

Quantitative Chemical Analysis Results (CELS) ..... Section 17

Envitco POPT Batch Sheets ..... Section 18

R.O.M. Project Costing and Schedule Data ..... Section 19

Process Flow Diagrams – Full-scale ..... Section 20

Material Balance – Full-scale ..... Section 21

Facility Layouts – Full-scale ..... Section 22

Equipment Data Sheets ..... Section 23

Offgas Sampling Results (Trigon) ..... Separate Bound Attachment

Electrostatic Precipitator Report (McGill AirClean) ..... Separate Bound Attachment

TABLES AND FIGURES

Table 1.2-1: Summary of TCLP-Compliant Glass Performance....4
Table 1.2-2: Summary of UTS-Compliant Glass Performance....4
Table 1.4.1.3-1: POPT Demonstration Operating Conditions....9
Table 1.4.1.5-1 POPT Material Balance....11
Figure 1.4.1.5-2 POPT Summary Mass Balance....12
Figure 1.4.2-1 Pre-conceptual Full-scale Material Balance....18
Table 2.1.1-1: FDF-Provided Surrogate Compositions....20
Table 2.1.1-2: Glass Formulation Designations....21
Table 2.1.1-3: RCRA TCLP and UTS Treatment Standards....22
Table 2.1.1-4: Envitco-established Requirements for Glass Formulation....22
Table 2.2.5-1: Quality Assurance Procedures....32
Table 2.2.5-2: Quality Assurance Instructions....32
Table 2.4.2.5-1: Calibrated Instrumentation....38
Table 3.2.1.1-1 Moisture Levels at Plasticity Limit....43
Table 3.2.1.5-1: Lead Leachability Validation Results....45
Table 3.2.1.5-2: TCLP Results Based on Variable $Mg_3(PO_4)_2$ Content....46
Table 3.2.1.6-1: Demonstration Surrogate Elemental Analysis....47
Table 3.4.1-1 – Size Distribution of Crushed Glass Particles....54
Table 3.4.2-1: TCLP Leaching (Pb) Based on Particle Size Split....59
Table 4.2.1.3-1 Effect of Oxidant/Reductant Additions on Molten Salt Formation....62
Table 4.2.1.5-1 Variation of Glass Redox....63
Table 4.2.1.8-1 Composition and TCLP Lead Release for S0-D1 Series Glasses....64
Table 4.2.3.3-1 Results from Glass Series S0-D2....67
Table 4.2.3.4-1 Effect of Carbon Addition with Glass S0-D2-8....67
Table 4.2.4.1-1 TCLP Results from S0-D3 Series....69
Table 4.2.5.2-1 Summary of Results for S0-D4 Series....71
Table 4.2.6.5-1 Measured/Predicted Glass Composition of S0-D5B-2....73
Table 4.2.6.5-2 S0-D5B-2 Glass Crucible Melt Batch Sheet....74
Table 4.2.6.5-3 Effect of Reductant on Demonstration Glass S0-D5-2....75
Table 4.2.7-1 Effect of Batch Reductant Changes in S0-D5B-2 Glasses....76

Table 4.3.2-1 Experimental Verification of S1/S2 TCLP Glass Recipes....77
Table 4.4.1.2-1 UTS Glass Leaching Results....79
Table 4.4.2.7-1 – UTS-compliant S1-U2 Glasses....81
Figure 5.1.4-1 POPT Process Flow....87
Table 5.1.4.1-1 Demonstration Surrogate Target Recipe....88
Table 5.1.5.1-1 Demonstration Target Operating Parameters....95
Table 5.2-1 Demonstration Surrogate Formulation....98
Table 5.2-2 POPT Surrogate Slurry Analyzed Compositions....99
Figure 5.3-1 POPT Melter System Including Offgas Treatment....100
Table 5.3.1-1 Analytical Results of POPT Feed Samples....102
Table 5.3.1-2 Analytical Results of Glass Samples....103
Table 5.3.1-3 Demonstration Glass - Theoretical vs. Measured....104
Table 5.3.1-4 POPT Material Balance....105
Table 5.4.1-1 – Demonstration Glass Samples....111
Table 5.4.1-2 - Demonstration Glass TCLP Results....112
Table 5.4.1-4 Statistical Variability of Demonstration Glass TCLP Results....114
Table 5.4.2.1-1 Offgas Solids TCLP Results....117
Table 5.4.2.1-2 Offgas Solids versus Current Regulatory TCLP Criteria....118
Table 5.4.2.2-1 TCLP Results of Salts Collected Within the 7800-kg Processing Window....120
Table 5.4.2.2-2 Collected Salts versus Current Regulatory TCLP Criteria....121
Table 5.5-1 Demonstration Operating Parameters....122
Figure 5.5-2 Melter Temperatures....125
Figure 5.5-3 Melter Set-points....126
Figure 5.5-4 Melter Throughput....127
Figure 5.5-5 Furnace Pressure....128
Figure 5.5-6 Redox Ratio....129
Figure 5.5-7 Glass Level....130
Figure 6.1.1.8-1 Envitco – FDF Interface Diagram....138
Table 6.2.1.6-1 Molybdenum vs. Tin Electrodes....149
Table 6.3.1-1 Equipment Codes....157
Table 6.3.2-1 Major Radionuclides in the K-65 Residues....158
Table 6.3.3-1 Utilities Summary....160
Table 6.3.3-2 Power Requirement Summary....162

2291

Table 6.3.3-3 HVAC Heat Loads....166
Table 6.5.1-1 Facility Room Zoning List....168
Table 6.5.1-1 System Identification Numbers....172
Table 6.5.2.5-1 Secondary Waste Estimates....177
Table 6.5.3.2-1 System Throughput and Design Capacity....180
Table 6.5.3.3-1 Estimated Equipment Life....181
Table 6.6-1 Equipment List....208

ACRONYMS

ACFM	-	actual cubic feet per minute
ALARA	-	As Low As Reasonably Achievable
ANS	-	American Nuclear Society
ASTM	-	American Society of Testing and Materials
AWR	-	Advanced Waste Retrieval
AWWT	-	Advanced Waste Water Treatment
BAT	-	Best Available Technology
CEM	-	Continuous Emissions Monitor
CETL	-	Clemson Environmental Technologies Laboratory
CFR	-	Code of Federal Regulations
COA	-	Certificate of Analysis
DOE	-	Department of Energy
DOT	-	Department of Transportation
DWPF	-	Defense Waste Processing Facility
EOG	-	Emergency Offgas
EPA	-	Environmental Protection Agency
ESP	-	Electrostatic Precipitator
FDF	-	Fluor Daniel Fernald
FEMP	-	Fernald Environmental Management Project
g	-	grams
kg	-	kilograms
HEPA	-	High Efficiency Particulate Air
LLMW	-	Low-level Mixed Waste
LLW	-	Low-level Waste
LMES	-	Lockheed Martin Energy Systems
LOD	-	Loss On Drying
LOI	-	Loss On Ignition
lpm	-	Liters Per Minute
m	-	meter
ml	-	milliliter
mm	-	millimeters
µm	-	micrometers
MT	-	Metric Ton
MTPD	-	Metric Tons Per Day
Nm^2	-	Normal Meter Squared
NTS	-	Nevada Test Site
OSDF	-	On-Site Disposal Facility
PFD	-	Process Flow Diagram
POPT	-	Proof of Principle Test
PPE	-	Personnel Protective Equipment
ppm	-	parts per million

ACRONYMS (continued)

psi	-	pounds per square inch
QA	-	Quality Assurance
RCRA	-	Resource Conservation and Recovery Act
RCS	-	Radon Control System
RSW	-	Radioactive Solid Waste
S0	-	Demonstration Surrogate Designation
S1	-	Silo 1 Surrogate Designation
S2	-	Silo 2 Surrogate Designation
SCFM	-	Standard Cubic Feet per Minute
SEG	-	Scientific Ecology Group
SLS	-	Soda-Lime-Silica
S0-D5B	-	Demonstration Surrogate Treatment Recipe Formulation
SRS	-	Savannah River Site
TCLP	-	Toxicity Characteristic Leaching Procedure
TECO	-	Toledo Engineering Company
TVS	-	Transportable Vitrification System
UTS	-	Universal Treatment Standards
WAC	-	Waste Acceptance Criteria
WETF	-	West End Treatment Facility
WHC	-	Westinghouse Hanford Company
WSRC	-	Westinghouse Savannah River Company
WVDP	-	West Valley Defense Processing
wt%	-	weight percent

1.0 EXECUTIVE SUMMARY

A Proof-of-Principle Test (POPT) program was performed by Envitco, Inc., in support of the Fernald Environmental Management Project (FEMP) OU-4 Silos Project. The objective of the POPT program was to perform rigorous testing of proven and commercially available remediation technologies to evaluate their potential use for treatment of Silos 1 and 2 residue. Silos 1 and 2 contain approximately 6100 m^3 of wet, gray, silty clay residue with an average moisture content of 30 wt%. The significant metals of concern are lead, barium, and arsenic. The radionuclides of concern include Ra-226, Pb-210, and Th-230 (Fluor Daniel Fernald Contract No. 98WO002240).

The testing was performed using non-radioactive surrogates which simulated selected chemical and physical characteristics of the Silos 1 and 2 residue. The results of the testing provide Fluor Daniel Fernald (FDF) with technology-specific information on safety, reliability, implementability, cost and schedule to treat the residue.

The Proof-of-Principle testing was intended to provide data confirming that the vitrification process could produce a stable material that meets established performance requirements. The stated performance requirements included:

A) Appearance: Treated surrogate shall appear uniform and homogeneous to non-magnified vision.

B) Compressive Strength: Compressive strength of at least 50 psi per American Society of Testing and Materials (ASTM) Method C39.

C) No Liquids: No free standing liquids per American Nuclear Society (ANS) Method 55.1.

D) Toxicity Characteristic Leaching Procedure (TCLP): Leachate concentrations for Resource Conservation and Recovery Act (RCRA) metals shall be no more than 50% of the RCRA limit.

E) Dusting/Particulate. Disposal package contains no more than 1 wt% less than 10 micron diameter particles, or 15 wt% of less than 200 micron diameter particles.

The POPT contract requirements called for Envitco to develop vitrification treatment recipes for three (3) different surrogates representing Silo 1, Silo 2 and a composite material referred to as Demonstration Surrogate (hereafter referred to as S0 surrogate). Two independent treatment recipes were developed for each surrogate formulation, the first to meet 50% of the RCRA TCLP leaching

standards, and the second to meet the Universal Treatment Standards (UTS) requirements. Surrogate and glass additive mixes were melted on a crucible scale to determine the maximum waste loading that could be achieved while not impacting the continuous melting operation.

The vitrification recipe selected for the Demonstration Surrogate was to be processed in an existing melter system for 72 hours with less than 5% total unplanned downtime. The 72-hour demonstration was to provide data to support pre-conceptual design of the full-scale vitrification process capable of treating the waste inventory in three years. This included minimum data requirements of residue flow rates and concentrations, sampling and analysis, technology-specific treatment parameters, container/packaging characterization and waste loading/bulking factors.

1.1 Vitrification Recipe Development

As required of the contract, Envitco generated Demonstration Surrogate samples for validation by FDF. The validations confirmed the physical characteristics of the surrogate (plasticity, in-situ density and moisture content). Adjustments were made to the magnesium phosphate content at the request of FDF in an effort to attain the lead leaching characteristics. Following these adjustments, the surrogate was accepted and Envitco was authorized to proceed with the glass formulation development.

Envitco developed a performance basis for the demonstration glass formulation based on the wasteform performance criteria established by the Contract, and glass processing characteristics that were required for the melter design basis. The following parameters were established as guidelines for the glass processing:

a) Temperature: A target glass processing temperature of 1300°C.

b) Viscosity: A log 2 viscosity (100 poise) at less than 1350°C.

c) Salt Generation: Processing at full-scale without secondary salt draining.

d) Resistivity: 1.0-6.0 ohm-inches

e) Redox Control: $Fe^{+2}/\sum Fe$ between 0.1 and 0.2 (based on observed metal precipitation limits).

1.2 Recipe Development for TCLP and UTS Compliant Glasses

Initial glasses were developed through a number of iterations including variations in alkali ratio, alkaline earth substitution, former/modifier adjustments, and reductant additions (reductant type and concentrations). These formulations focussed on development of a Demonstration Surrogate glass recipe to comply with the 50% TCLP limit imposed by the contract. The crucible scale development program resulted in a glass recipe that did not exhibit atypical foaming characteristics, metal precipitation, or secondary salt phase formation, while meeting the wasteform performance requirements.

The Demonstration Surrogate recipe development resulted in a 50% TCLP compliant glass with 83% waste loading. The lead leachate concentration for the Demonstration Surrogate recipe was 2.0 ppm. This was approximately 80% of the contract maximum leachate concentration, and 40% of the Nevada Test Site (NTS) Waste Acceptance Criteria (WAC) requirements.

During the glass formulation work for the TCLP compliant Demonstration Surrogate recipe, over 75 glasses were developed, with typical waste loadings of 75-80%. Of these glasses, 58 samples were submitted for TCLP, representing 42 independent glass formulations. Out of the 58 TCLP samples, only one sample failed to meet the NTS WAC, and five samples failed to meet the Contract limit of 50% of the TCLP limit.

Initial tests on Silo 1 (S1) and Silo 2 (S2) surrogate glass recipes were based on extrapolations of the glass recipes applied to the Demonstration Surrogate. This was done in an effort to produce glasses that mimicked the composition and performance of the Demonstration Surrogate recipes. This approach also sought to further demonstrate the robustness of the baseline Demonstration Surrogate glass recipe. The resultant glasses performed as expected, with lead leaching limited to 2.14 ppm Pb at 82.3% waste loading for Surrogate S1, and 1.49 ppm Pb at 83.4% waste loading for Surrogate S2. No additional refinement was made to these formulations. It is anticipated that higher waste loadings could be achieved with the Surrogate S2 based on its low leachate concentration (60% of the contract maximum requirements, and 30% of the maximum required of the NTS WAC). Performance of the TCLP-compliant glasses is summarized in Table 1.2-1.

Table 1.2-1: Summary of TCLP-Compliant Glass Performance

Surrogate	Waste Loading	NTS WAC Requirement for Lead	Meets NTS WAC Requirement	50% TCLP Limit for Lead	50% TCLP Performance for Lead	Meets Contract Requirement
S0	83%	5.0 ppm	Yes	2.5 ppm	2.0 ppm	Yes
S1	82.3%	5.0 ppm	Yes	2.5 ppm	2.14 ppm	Yes
S2	83.4%	5.0 ppm	Yes	2.5 ppm	1.49 ppm	Yes

Development of UTS-compliant glasses again focussed on utilization of the baseline formulation. Experimental design varied waste loading along with secondary variations in glass modifier ratios, metal oxides, and reductants that had been demonstrated to suppress salt formation. The results of these tests are presented in Table 1.2-2.

Table 1.2-2: Summary of UTS-Compliant Glass Performance

Surrogate	Waste Loading	NTS WAC Requirement for Lead	Meets NTS WAC Requirement	UTS Requirement for Lead	UTS Performance for Lead	Meets Contract Requirement
S0	50%[1]	5.0 ppm	Yes	0.75 ppm	<0.75 ppm	Yes
S1	50%	5.0 ppm	Yes	0.75 ppm	0.60 ppm	Yes
S2	50%[1]	5.0 ppm	Yes	0.75 ppm	<0.75 ppm	Yes

Note 1. Due to schedule constraints, the 50% waste loading presented for S0 and S2 is a projection based on experimental data generated during the S1 recipe development. Adjustments in the reductant ratios resulted in an increased durability in S1 glasses, improving demonstrated waste loading from 30% to 50%. Based on the comparable performance of TCLP compliant S0, S1 and S2 recipes, a similar tendency would be expected in the UTS-compliant glasses. Actual S0 and S2 data prior to the S1 development indicated waste loadings of approximately 40%.

1.3 POPT Demonstration

1.3.1 Facilities and Equipment

The POPT demonstration was conducted per the contract requirements. Envitco utilized their EV-101 melter which is designed for a nominal of two (2) TPD of dry soda-lime-silica (SLS) glass batch. Per the Contract, an existing melter system

was utilized. Due to the presence of the water in the slurry feed, Envitco recognized that the capacity would be downrated, though the actual impact on throughput could not be determined without actual testing. Based on prior testing, the water content of the slurry offsets the glass production approximately 1-to-1. In terms of the POPT, a processing capacity of 1818 kg (2 tons) of dry SLS batch which produces 1534 kg of glass is comparable to a Demonstration Surrogate processing capacity of 1818 kg at 36% solids feed producing 486 kg of glass. This further equates to 1515 kg of 30% solids surrogate.

The Envitco WASTE-VIT® EV-101 was installed at the Clemson Environmental Technologies Laboratory in Anderson, SC. The facility is designed with technology demonstration and development laboratories capable of receiving and installing a melter such as the EV-101.

The EV-101 is a three-chamber melter typical of the Envitco WASTE-VIT® design. The three (3) chambers include the main melt chamber, glass drain bay, and salt drain bay. The primary heating mode is Joule-heating (via molybdenum electrodes) through the glass, with resistance heating elements in the bays, and a propane-air torch in the main tank. The torch provides startup heat to establish the molten glass path necessary for the Joule-heating circuit. Once Joule-heating is established, the burner can be used as necessary to provide supplemental heat to the plenum of the main tank. (NOTE: The burner system utilized in the POPT has been replaced with resistance heating elements in the full-scale design in an effort to minimize the offgas generation term. This change is not considered to be a significant technical change due to Envitco's experience in resistance heating systems, which are applied in both the WASTE-VIT® line and through Toledo Engineering's commercial glass melters and equipment.)

The melter construction was typical of that applied to prior WASTE-VIT® and commercial applications. The melter was lined with alumino-silicate refractory, with five (5) coupons of chrome based and zirconia based refractories. The coupons were installed to provide a reference for estimating the refractory life, and a comparison of performance of various refractories exposed to the melt process. The refractory is encased in a water cooled shell, which cools the outside skin and effectively freezes any glass that may begin to penetrate the refractory over time due to wear or damage. The water cooled shell also removes heat from the refractory and reduces the wear rate, providing an additional level of safety while extending the usable life of the melter.

The main tank of the melter was equipped with a bottom drain to allow for evacuation of metals and precipitates that might deposit in the main melt chamber. This is a feature of all large-scale Envitco melters.

The glass drain bay isolates the melt area from the drain area, and ensures that unreacted material does not leave the melter. The drain bay also permits conditioning of the glass to the desired pouring temperature prior to exiting the melter. The salt drain bay is a system of weirs that separates the low viscosity, low density salts from the melt surface, and allows them to be drained from the melter periodically or continuously as required.

Peripheral equipment was installed as required, including five 500-gallon holding tanks for the prepared surrogate, a 600 gallon mix tank, and a 500-gallon feed tank. The offgas was treated by a McGill Model 4-24 dry electrostatic precipitator (ESP). A manual control system, complete with alarms and interlocks, was installed for process control. This included independent power control for all melter zones, feed rate control, glass level monitoring and control, temperature/burner output control, and video monitoring of the melt process.

The molten glass was poured into 30-gallon carbon steel drums, installed inside of a 55-gallon drum. The 55-gallon drum was used as an overpack to ensure no glass leakage would occur, and to provide operator safety while the drums were cooling on the conveyor. The glass collection approach was based on the desire to produce a monolithic wasteform, rather than a frit or gem. The use of the monolith reduces the available surface area for leaching, and provided higher packing density in the final disposal container.

1.3.2 Process Establishment and Optimization

Following completion of the melter installation, the melter was started using a soda-lime-silica (SLS) cullet. Once stabilized, a blended feed based on the Demonstration Surrogate treatment recipe (S0-D5B) was fed to the melter. Three (3) volumes of material were processed to establish steady-state conditions.

During the optimization period, several changes to the system were required to improve the reliability of these supporting systems.

(NOTE: The feed system and several peripheral systems were designed for a short-term demonstration and, as such, did not include the redundancy or reliability features that would be anticipated of the full-scale treatment facility. Design changes and redundant services installation were required to ensure that the demonstration could be conducted at less than 5% downtime as dictated by the Contract. These changes were all related to the blended feed mixing/storage and transfer systems. Specific modifications were made to include a redundant feed recirculation loop, redundant recirculation pumps, and redundant feed nozzles. No changes were made to the melter system, offgas treatment system, glass handling system, or control system.)

Process optimization was based on variables that could be adjusted without additional modifications to the glass formulation. This included power, temperature, feed rate and distribution. No changes were made to the glass formulation.

1.3.3 Processing Rate

The process optimization period yielded a steady-state feed rate of 54 kg/hour of blended feed, which produced 14.4 kg/hour of glass. The feed had a solids content of 36%, and an oxide content of 28%, based on loss on drying (LOD) and loss on ignition (LOI) values of 64% and 72% respectively. This was below the target processing rate of 108 kg/hr. The rate was discussed with FDF Project Management personnel. FDF reviewed the process, with understanding that the throughput rate was limited by the size of the melter available for the demonstration and not by any technical constraint of the vitrification process.

Envitco was granted approval to proceed with the demonstration under the requirement that the entire inventory of 7800 kg of surrogate would be processed under the oversight of FDF Project Management personnel. The start date of January 15, 1999 was established.

1.4 Demonstration Processing

The test was initiated on January 15, 1999. This served as the start point for the processing of the 7800 kg surrogate inventory.

On January 18, 1999, the official 72-hour process period was initiated. This period was considered to be the formal demonstration period upon which the downtime (less than 5% [3.6 hours] unplanned downtime in 72 hours) would be assessed.

1.4.1 Demonstration Results

1.4.1.1 Process Uptime

The 72-hour demonstration was conducted with only four (4) minutes of total downtime. This occurred during the last seven minutes of the 72-hour period, and was attributed to the failure of a back pressure valve in the slurry feed recirculation line. This resulted in a stoppage of the feed system only and did not require a stoppage of the glass drain. This equates to an availability of 99.9% during the official demonstration.

The 7800 kgs of surrogate were processed over an eight (8) day period. The process was run continuously. Approximately one (1) hour was lost due to unplanned downtime. This equates to an availability of 99.5% over the eight (8) days of witnessed demonstration time.

1.4.1.2 Process Throughput

Steady-state conditions were established at an average slurry feed rate of 0.72 liters per minute (lpm). This rate was based on the desire to operate in a steady, stable mode with minimal or no operator intervention in the process. Higher rates had been utilized during the process optimization period, but were not used due to the desire to demonstrate as stable an operation as possible. (NOTE: An increase in throughput was demonstrated to the FDF observer for two days following the 72-hour demonstration period, as presented later in this summary.)

Glass production averaged 14.4 kg/hr continuous over the 72 hours. There were no interruptions in the glass drain during the 72 hours. A total of 1036 kg of glass was produced during this same period.

The eight-day witnessed processing of the 7800 kg of surrogate resulted in the production of 2952 kg of glass. Glass flow was stopped for only one (1) hour over the entire eight (8) day/7800 kg inventory.

1.4.1.3 Operating Conditions

Prior to the demonstration, the operating conditions were established based on the results of the optimization period. The target operating conditions, as well as the range that occurred during the 72-hour demonstration, are presented below in Table 1.4.1.3-1.

Table 1.4.1.3-1: POPT Demonstration Operating Conditions

Parameter	Target	Test Average
Main Tank Glass Temperature (°C)	1150 to 1200	1165
Main Tank Plenum Temperature (°C)	800	818
Slurry Feed Rate (kg/hr)	52	54
Glass Drain Rate (kg/hr)	15	14
Plenum Pressure (inches water column)	-0.05 to -0.1	-0.06
Glass Redox Ratio (Fe^{+2}/Fe^{total})	0.1 to 0.2	0.15

1.4.1.4 Glass Product Performance

The glass performed as expected based on the crucible tests. Lead leachate concentrations for the samples taken during the POPT averaged 1.90 ppm lead, versus a Contract maximum of 2.5 ppm.

The calculated waste loading, based on the contract-defined waste loading equation, was 83.46%. The waste loading presented on an oxide basis (as typically used to describe glass systems) was 79.86%.

The bulking factor, based on the contract-defined bulking factor equation was 43.7%. This corresponds to a volume reduction of approximately 60% from dry silo residue to the glass wasteform.

1.4.1.5 Material Balance

The material balance was based on analysis of the blended feed, glass, and offgas as sampled by Environmental Protection Agency (EPA) Method 5 (particulate matter), Method 29 (metals), Method 8 (sulfuric acid/SO_2), and continuous emissions monitoring (CEM) of O_2, CO_2, SO_2, and NO_x.

Overall, closure of the material balance was 98.9%. Approximately 43% of the SO_3 reported to the glass, resulting in 1.2 wt% SO_3 in the glass. This is over twice the typical sulfate solubility of most commercial and waste glasses. The total closure on the sulfate was only 53%, leaving 47% unaccounted. It is assumed to have reported to the offgas, though offgas sampling does not account for the balance. Deposition in the offgas duct is not considered to be a

major contributor to the error, since the sampling ports were approximately 2 meters from the melter. The deposits between the melter and sampling point were minimal (less than 1 kg).

Approximately 92% of the lead (as PbO) was retained in the glass, at 95% closure. Entrainment accounted for approximately 0.4%, while 0.0002% was accounted for with the volatiles.

The process demonstrated very low entrainment, accounting for 0.1% of the oxide equivalent (glass equivalent) fed to the melter. Entrainment accounted for approximately 26% of the total offgas emissions, at a rate if 0.0155 kg/hr. Volatiles accounted for the remainder of the offgas emissions, contributing 0.043 kg/hr, or 74% of the total offgas emissions. In both cases, sulfate was a major constituent, comprising 11% of the total entrainment, and 88% of the volatile fraction. Lead and phosphate were also major contributors to the entrainment term at 44% and 21% respectively.

The material balance summary for the POPT demonstration is presented below in Table 1.4.1.5-1 and Figure 1.4.1.5-2.

Table 1.4.1.5-1 POPT Material Balance

	Input (1)	Output (1, 2)				Melter		
Oxide	Feed kg/hr	Glass kg/hr	Entrainment kg/hr	Volatility kg/hr	Total Offgas kg/hr	Accumulation kg/hr	% Closure	Melter DF
R2O (3)	1.1210	1.3065	1.91E-03	2.46E-04	2.16E-03		116.74	519.10
As2O3	0.0154	0.0171	2.62E-05	4.02E-07	2.66E-05		111.17	579.17
BaO	0.6307	0.5493	2.65E-04	6.89E-07	2.66E-04		87.15	2374.90
Cr2O3	0.0165	0.0170	6.28E-05	1.47E-06	6.43E-05		103.21	256.80
Fe2O3	0.3456	0.3253	2.10E-04	1.46E-05	2.25E-04		94.20	1537.94
MgO	0.1222	0.1098	5.96E-05	6.68E-06	6.63E-05		89.90	1842.65
MoO3	0.0000	0.0287	1.61E-04	4.57E-07	1.61E-04		N/A	N/A
NiO	0.0498	0.0449	2.29E-05	6.46E-07	2.35E-05		90.20	2120.28
P2O5	0.1371	0.1065	3.23E-03	1.95E-05	3.25E-03		80.09	42.14
PbO	1.4981	1.3852	6.89E-03	2.61E-06	6.89E-03	3.18E-02	95.05	217.36
SO3	0.3945	0.1706	1.74E-03	3.77E-02	3.95E-02		53.24	10.00
SeO2	0.0051	0.0000	2.47E-04	4.70E-03	4.94E-03		97.00	1.03
SiO2	7.8344	7.9706	0.00E+00	2.22E-04	2.22E-04		101.74	35255.39
V2O5	0.0102	0.0090	1.81E-06	5.44E-07	2.35E-06		88.43	4355.22
Additives (4)	2.4693	2.3522	6.97E-04	5.26E-05	7.49E-04		95.29	3295.66
TOTAL	14.6499	14.3929	0.0155	0.0430	0.0585	3.18E-02	98.86	250.36

1. Feed and Glass Terms Normalized on the Average of 72-hour Samples Only (Minus Sample #454).
2. Entrainment, Volatility and Total Offgas Values are the averages provided by Trigon.
3. R2O represents the combined contributions of K2O, Li2O, and Na2O.
4. Additives represent the combined contributions of Al2O3, CaO, and ZnO.

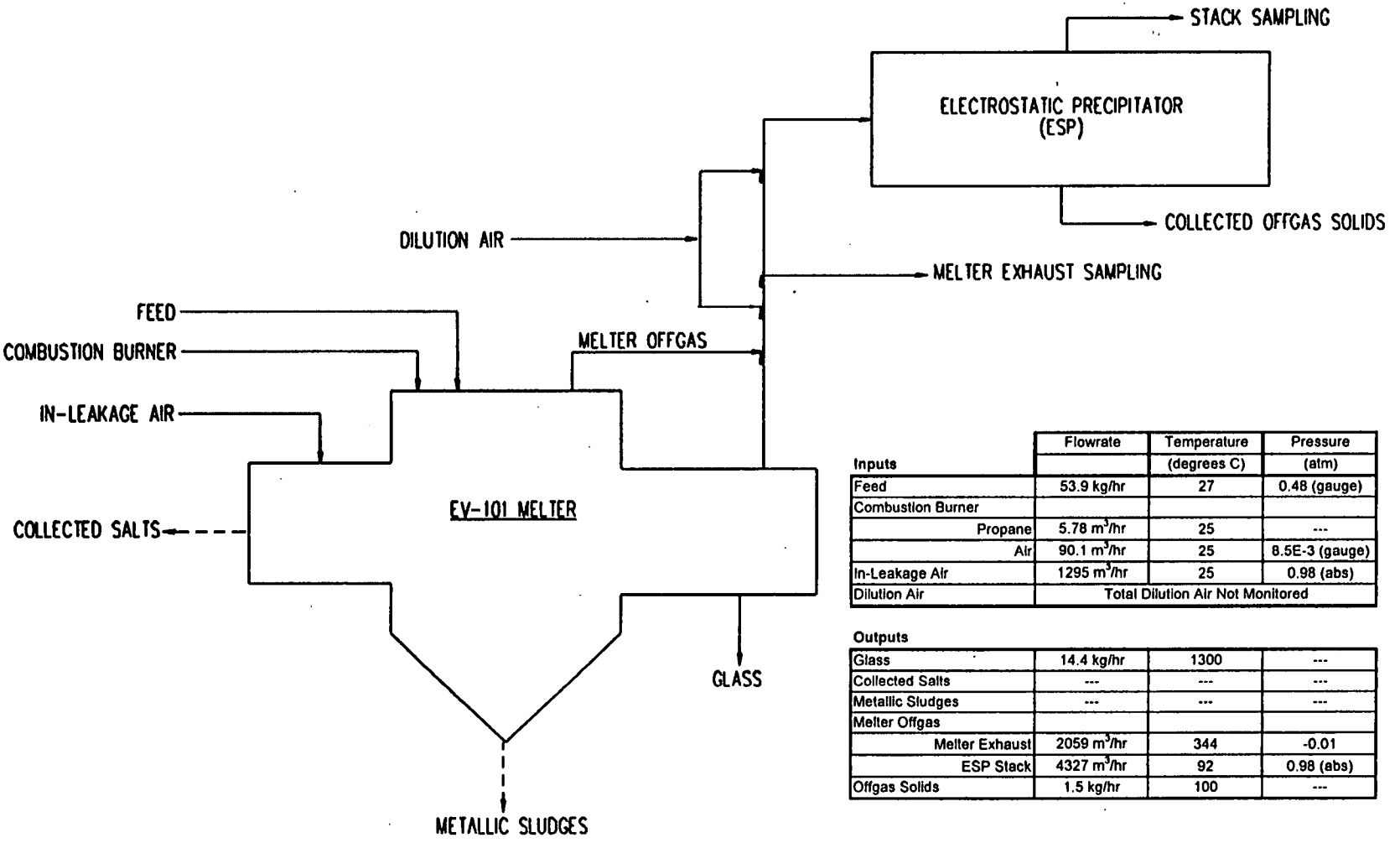
Where:

$$\%Closure = \frac{\sum(Total\,Outputs)}{\sum(Total\ Inputs)} \times 100$$

$$Melter\ DF = \frac{(Feed\ Rate)_x}{(Total\ Offgas\ Rate)_x}$$

EnVitCo, Inc.
A COGEMA Group Company

Figure 1.4.1.5-2 POPT Summary Mass Balance



Inputs	Flowrate	Temperature (degrees C)	Pressure (atm)
Feed	53.9 kg/hr	27	0.48 (gauge)
Combustion Burner			
Propane	5.78 m^3/hr	25	---
Air	90.1 m^3/hr	25	8.5E-3 (gauge)
In-Leakage Air	1295 m^3/hr	25	0.98 (abs)
Dilution Air	Total Dilution Air Not Monitored		

Outputs			
Glass	14.4 kg/hr	1300	---
Collected Salts	---	---	---
Metallic Sludges	---	---	---
Melter Offgas			
Melter Exhaust	2059 m^3/hr	344	-0.01
ESP Stack	4327 m^3/hr	92	0.98 (abs)
Offgas Solids	1.5 kg/hr	100	---

1.4.1.6 Melter Operating Observations

Melt Process

The melter was operated with a partial cold-cap which covered approximately 50% of the working surface of the melter. The location of the feed presentation was changed periodically between three points on the melt surface to ensure that the cold-cap did not excessively build-up in any one location.

Glass processing temperatures were slightly lower than predicted during the crucible level glass formulation work. Glasses produced at a crucible level were melted at 1300°C, versus melter temperatures approximately 150°C lower. This is due, in part, to limitations imposed by Envitco in the establishment of steady-state conditions, whereby the operation at the lower temperatures was deemed more stable than initial tests at the 1300 °C target. The change in temperatures did not impact the effectiveness of the Envitco melter, since the glass temperature could be adjusted during the conditioning step in the glass drain bay.

Melt Rate

At the request of FDF, the feed rate was increased following the 72-hour demonstration period. This was requested to observe the sensitivity of the process to changes, and the potential for increased throughput. The feed rate was increased from the nominal 0.7 lpm to 1.0 lpm. Some changes were observed in the activity of the cold-cap but, otherwise, there were no significant impacts. This rate was used for the remainder of the 7800 kg processing period without upset.

The feed rate of 1.0 lpm confirmed that the process was robust with respect to processing rates, and that a higher throughput basis could be applied to the full-scale design.

Salt Formation/Salt Drainage

One of the primary objectives of the recipe development program was to produce a glass that maximized the solubility of the sulfate, while avoiding the accumulation of a secondary salt phase in the melter. This was accomplished with the S0-D5B treatment recipe as developed. No salt was drained during the 72-hour demonstration. This was due to the high solubility attained (1.2 wt% SO_3), and the volatilization of any remaining sulfate. Sulfate salts were present in the melter, intermixed with the slurry feed being presented to the melt surface. The volatilization rate was balanced with amount of excess sulfate that was not solubilized in the glass.

At the request of FDF, Envitco operated the salt drain following the 72-hour demonstration. There was no significant accumulation of excess salt during the test so the demonstration resulted in no salt being drained from the melter.

Enhanced salt solubility may be possible through refinement of the reductant addition. Other reductants (urea, carbon, etc.) may prove to be more effective in salt volatilization.

Precipitated Metals/Metal Drain

The EV-101 melter is equipped with a bottom metals drain in the main tank for the evacuation of metal precipitates that may occur. The drain is of the same design as that employed in the glass drain bay. Minor differences exist in the geometry and temperatures characteristics of the installations, though the two devices are effectively the same.

Following the 72-hour demonstration, FDF requested that Envitco operate the metals drain. Efforts were made to perform a drain but were not successful due to the temperature of the drain orifice. The orifice, which controls the flow from the drain, could not be heated to the temperature sufficient to initiate draining.

After investigation of the problem, it was determined that the geometry difference was the primary factor in limiting the temperature. This problem can be remedied by adjusting the relationship between the drain orifice and the bulk glass. Other adjustments were noted that might provide additional ease in startup and shutdown of the bottom drain.

Following the demonstration (after processing all wastes and residues), a post-mortem analysis was conducted on the melter. An accumulation of approximately 15-20 kg of metallic material was identified in the bottom of the tank. The material had accumulated in the metals drain as expected.

A review was conducted of the oxidation/reduction reactions that result in the precipitation of lead in glass systems. From this, it was determined that approximately 11 kg of the lead were due to lead/molybdenum oxidation reactions. The balance of the lead was probably due to an excess addition of lead during the cleanup activities immediately before the melter shutdown. This data indicates that an estimated lead precipitation rate equivalent to 0.0014 kg-Pb/kg-glass may occur in the full-scale design.

Refractory and Electrode Wear

The EV-101 melter was fitted with five coupons of chrome and zirconia based refractories. These coupons were installed in a manner that exposed them to the plenum atmosphere, melt line/reaction zone, and the bulk glass environments in

the main melt chamber. All coupons were installed in a manner to ensure uniform environments/exposure. The nominal refractory wear over the entire demonstration process (estimated at 30 days at heat) was 1.5 mm (0.060 inches). This equates to 50 μm/day (0.002 inches/day).

Assuming a constant wear rate, this projects to approximately 55 mm (2.16 inches) over the three-year, full-scale treatment campaign. This is considered satisfactory. Increases in processing temperatures, if applied, will increase the wear rate logarithmically. This may account for a 100-200% increase in wear over the campaign. Wear of 100-150mm is still considered acceptable based on commercial experience.

The electrode wear observed during the demonstration was approximately 0.0193 kg/hr for molybdenum (Mo) to the glass and to the offgas. This equates to 0.0013 kg-Mo/kg-glass produced.

Based on the post-mortem analysis, the top electrodes in the main tank accounted for approximately 75% of the electrode wear. This was attributed to sulfate reactions with the molybdenum. Further improvements can be made by changing the relationship of the electrodes with the melt surface and improving the sulfate reduction/volatilization process.

1.4.2 Full-scale Design Considerations

From the data and observations collected during the treatment recipe development and the POPT demonstration, the full-scale design was based on the following data and design considerations:

a) Melter: A design basis throughput of 14 metric tons per day (MTPD) was used at 70% availability. A surface area relationship of 1 MTPD/m^2 was applied. No salt draining will be required, though a salt drain was provided for flexibility to recover from upsets and process changes. A metals drain was provided to permit evacuation of metals that may occur. The metals drain must have the capacity to remove metals accumulating at a rate equivalent to at least 0.0014 kg Pb/kg glass produced.

b) Salt Drain: The presence of molten salts indicates that conditions may exist where salt accumulation exceeds the evaporation rate. The availability of a molten salt drain was included in the full-scale design basis to ensure process flexibility in dealing with the molten salts. NOTE: The process design was based on the philosophy that molten salt drainage is not an acceptable mode of operation, and that salt solubilization or evaporation is the preferred operating method.

c) Metals Drain: The presence of precipitated metals indicates that conditions exist where metals may precipitate in the melter and require periodic removal. Actual precipitation was lower than expected based on theoretical oxidation/reduction estimates (re. Section 5.3.2). The POPT successfully demonstrated the controlled accumulation of the metals in an area isolated from the main melting region. Refinements will be required on the drain orifice heating method to confirm the reliable operation of the drain. This is not considered a significant technical issue, based on the successful operation of the glass drain valve. Refinements are primarily related to improvement in the temperature profile in the area of the orifice. Other methods are under consideration to mitigate metal precipitation, and will be studies as a supplement to the metals drain.

d) Offgas Treatment: The solids entrainment in the offgas was low (0.1% of total feed solids). Volatilization of the sulfate, as SO_x, was the primary fraction of the volatiles reporting to the offgas. These conditions, coupled with prior experience with high-temperature filtration on high-level waste vitrification processes in France (SGN), confirms the suitability of the selected approach for treatment of the offgas. Envitco has, therefore, based the pre-conceptual design on dry filtration followed by wet scrubbing. This permitted Envitco to maximize the non-volatile oxide content in the glass and reduce the amount of secondary waste solids for disposal. Further studies (engineering trade studies, optimization studies) will be required prior to the final design which may verify that other approaches are technically equivalent, while providing other cost or maintenance benefits.

e) Plenum Heating: The use of a propane-fired burner in the melter plenum proved to be effective for the POPT demonstration, with no indications of significant impact on the solids entrainment in the offgas. The use of resistance heaters in the glass and salt drain bay also proved to be very effective. Interface requirements established by FDF identify a preference for lower offgas volumes from the vitrification process so as to meet existing radon control system capacity requirements (<500 scfm). Based on this preference, and Envitco's confidence with the application of resistance heating systems, the propane system demonstrated in the POPT was replaced with a resistance heating system in the full-scale design. This permitted Envitco to meet the 500 scfm requirement established for the Radon Control System (RCS). Secondary benefits are anticipated including simplified safety analysis, lower entrainment, and more uniform heat distribution in the plenum.

f) Refractory Wear: Refractory wear was well within acceptable ranges, based on an estimated 55 mm of wear over a three-year campaign. High chrome refractory provided the best wear, with minimal difference between

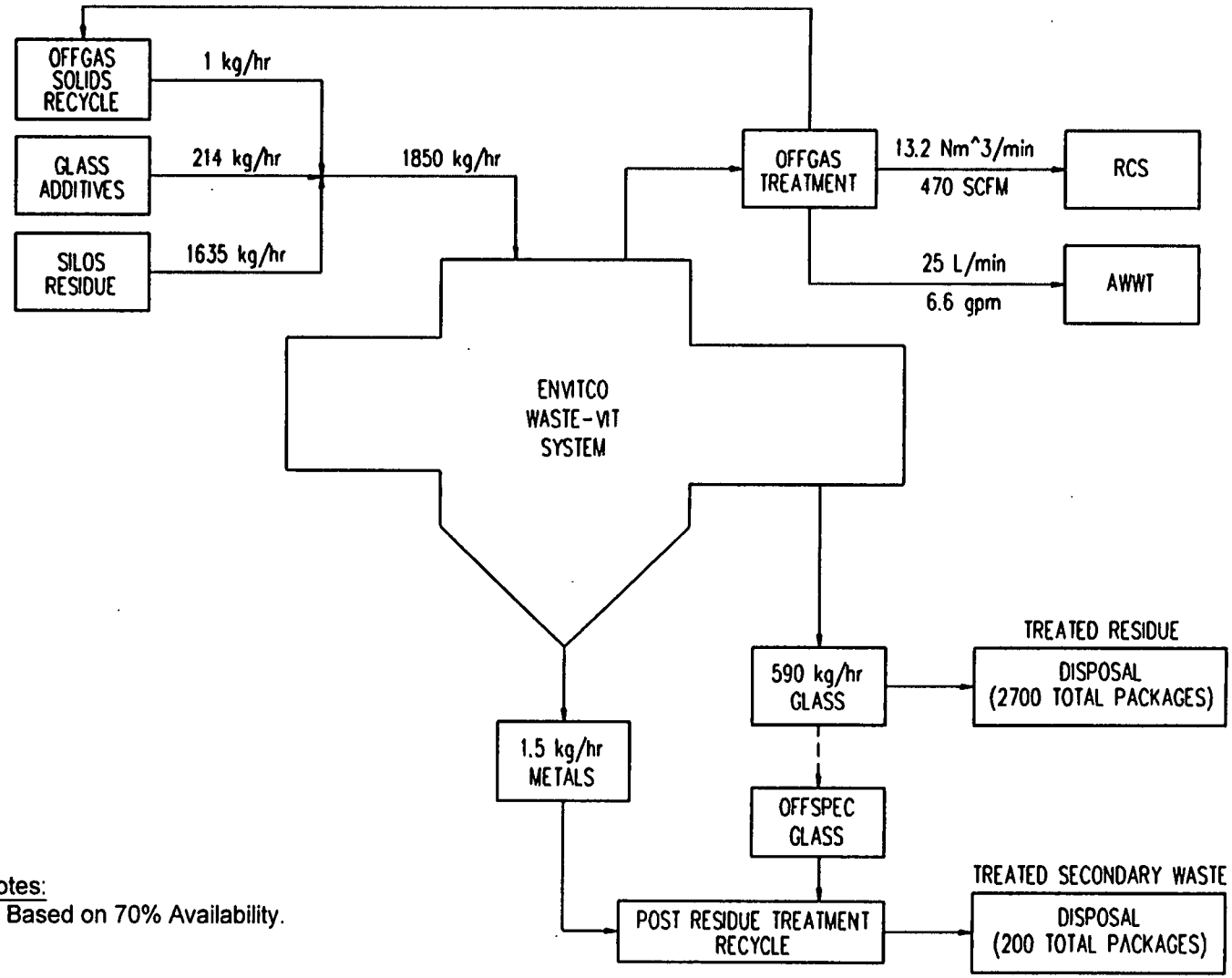
manufacturers. Possible increases in the processing temperatures will increase the wear, though a 100-200% increase is considered acceptable, and has been accounted for in the pre-conceptual, full-scale design.

g) Electrode Wear: Electrode wear was acceptable. Refinements were made in the full-scale design to reduce the current density, and move the electrodes further from the melt reaction area. Other power conditioning techniques offer opportunity for further improvements. Existing electrode holder designs have been applied and extensively proven in commercial applications, and permit periodic advancement of the electrodes to compensate for regular wear.

A material balance for the pre-conceptual full-scale design is presented in Figure 1.4.2-1.

EnVitCo, Inc.
A COGEMA Group Company

Figure 1.4.2-1 Pre-conceptual Full-scale Material Balance



Notes:
1) Based on 70% Availability.

2.0 PROOF-OF-PRINCIPLE TEST OVERVIEW

The purpose of the Proof-of-Principle Testing for the Silos Project was to perform rigorous testing of proven and commercially available remediation technologies to evaluate their potential for use for treatment of Silos1 and 2 residue. As the selected vendor for the Joule-heated technology family, Envitco performed testing of its Joule-heated vitrification technology to assess the technology's ability to meet the regulatory, processing, storage, transportation, and disposal requirements of the Silos 1 and 2 residue.

The results of the POPT presented in this report provide FDF specific information on the safety, reliability, implementability, cost, and schedule for treatment of the Silos 1 and 2 residue by Joule-heated vitrification. The information provided in this section was the framework developed by FDF, and enhanced by Envitco, to ensure relevant and appropriate results were obtained from the POPT.

The POPT project was divided into two (2) overall parts: Pre-Performance Activities and Performance Activities. The Pre-Performance Activities included completion of the following:

- An FDF-approved Project Work Plan,
- An FDF-Approved Project QA Plan, and
- Procurement and approval by FDF of the compounds required for surrogate manufacturing.

The POPT Performance Activities were divided into three activity areas:

- Treatment recipe formulation of six (6) glasses to meet the Contract requirements for each of three (3) surrogates that meet two (2) different sets of leaching criteria at the laboratory scale.
- Pilot-scale, continuous processing of the Demonstration Surrogate to prove the technology's treatment capability and the collection of data to support a material balance.
- Develop a pre-conceptual full-scale treatment process design package based on the pilot-scale demonstration results and lessons learned.

2.1 Laboratory-scale Testing

2.1.1 Test Objectives

The primary objective of the laboratory-scale testing was to develop a treatment recipe glass formulation that conformed to the Contract specifications for wasteform performance. FDF Contract No. 98WO002240 called for the development of six glass formulations addressing three FDF-provided surrogate compositions. The FDF-provided surrogate compositions simulated the physical and chemical characteristics of the Silo 1 residue, the Silo 2 residue, and a combination of the Silos 1 and 2 residue (Table C3-1 of the Contract).

Table 2.1.1-1: FDF-Provided Surrogate Compositions

Composition Name	Composition Description
Demonstration Surrogate	Simulation of Silo 1 residue spiked with the concentrations of heavy metals present in Silo 2 residue
Silo 1 Surrogate	Simulation of Silo 1 Residue
Silo 2 Surrogate	Simulation of Silo 2 Residue

The treated surrogate performance requirements for the bench-scale testing were stipulated in the Contract, Sections C.4.1, C.4.2.1 and C.4.2.3.1. The FDF-imposed treated surrogate requirements were:

A. Appearance: The treated surrogate residue shall appear uniform and homogeneous to non-magnified vision.

B. Compressive Strength: Compressive strengths of at least 50 psi per ASTM C39. (Requirement retracted for glass wasteforms by FDF letter: February 5, 1999 – M. Morse)

C. No liquids: Contain no free-standing liquids per ANS 55.1. (Envitco's FDF-approved Work Plan excluded testing by ANS 55.1. A monolithic vitrified product contains no free-standing liquids.)

D. TCLP: Perform the TCLP for the metals listed in Table C4-2. TCLP analysis shall be performed on samples of treated surrogate that have been aged for 28 days. Passing concentrations shall be less than 50% of the RCRA limit. Current applicable and anticipated regulatory limits for the analytical results of the United States Environmental Protection Agency (U.S. EPA) TCLP are

provided in Table C4-2 of the Contract and as presented in Table 2.1.1-3 of this report.

In addition to the current TCLP metals, testing shall also be performed for the additional metals listed in Table 2.1.1-3. There are no current standards for these additional metals but the additional data will provide a basis for comparison of treating Silos 1 and 2 residue to meet the TCLP and UTS standards. (Envitco's FDF-approved Work Plan excluded the aging of vitrified samples for 28 days.)

E. Dusting / Particulate: Fine particulate surrogate shall be immobilized so that the treated surrogate disposal package contains no more than 1 wt% of less-than-10 micrometer-diameter particles, or 15 wt% of less-than-200 micrometer-diameter particles. Residues that are known to be in a fine particulate form or in a form that could be mechanically or chemically transformed to a particulate during handling and interim storage shall be immobilized.

F. RCRA Characteristics: The treated wasteform shall not exhibit a characteristic of a hazardous waste as defined by 40 Code of Federal Regulations (CFR) 261 Subpart C – Characteristics of Hazardous Waste (261.20 through 261.24). Nor shall treated waste be listed as hazardous waste. (Envitco's FDF-approved Work Plan excluded testing for CFR 261.20 through 261.23. A vitrified product does not exhibit the Resource Conservation and Recover Act (RCRA) characteristics defined in CFR 261.20 through 261.23.)

The required treatment recipes were designated by FDF as:

Table 2.1.1-2: Glass Formulation Designations

Surrogate Name	Treatment Recipe Name	
	50% of Present TCLP Limits	Proposed UTS Limits
Demonstration Surrogate	S0-D	S0-U
Silo 1 Surrogate	S1-T	S1-U
Silo 2 Surrogate	S2-T	S2-U

The requirements of the TCLP and UTS standards were based on the revised treatment standards as promulgated in 1998 (Environmental Protection Agency, 1998), and presented in the Contract as Table C4-2: RCRA Treatment Standards. These standards are summarized in the following table:

Table 2.1.1-3: RCRA TCLP and UTS Treatment Standards

Constituent	Current Regulatory Limit (PPM)	Performance Limit 50% of TCLP (PPM)	UTS Regulatory Limits (PPM)
Arsenic (As)	5.0	2.5	5.0
Barium (Ba)	100.0	50.0	21
Cadmium (Cd)	1.0	0.5	0.11
Chromium (Cr)	5.0	2.5	0.60
Lead (Pb)	5.0	2.5	0.75
Mercury (Hg)	0.20	0.10	0.025
Selenium (Se)	1.0	0.5	5.7
Silver (Ag)	5.0	2.5	0.14
Antimony (Sb)	-	-	1.15
Beryllium (Be)	-	-	1.22
Nickel (Ni)	-	-	11
Thallium (Tl)	-	-	0.20
Vanadium (V)	-	-	1.6
Zinc (Zn)	-	-	4.3

A secondary objective was to ensure that the glass formulation met the processing requirements of the Envitco melter system. In addition to the Contractual requirements, Envitco established processing requirements (Table 2.1.1-4) for the treated surrogate wasteform.

Table 2.1.1-4: Envitco-established Requirements for Glass Formulation

Characteristic	Requirement	Notes
log 2 viscosity	less than 1350°C	Envitco design basis
waste loading	Maximized	Envitco processing requirement
resistivity	1.0-6.0 ohm-inches	Envitco design basis
redox ratio	0.1-0.2 $Fe^{+2}/\Sigma Fe$	Envitco design basis
salt/salt accumulation	no secondary salt generation	Envitco objective: solubilize or volatilize all salts; no accumulation in process

2.1.2 *Glass Recipe Formulation Rationale*

The rationale behind the glass formulation was based on work conducted previously on the K-65 waste, as well as data from other similar waste streams and commercial processes (Bowan 1995; Feng 1996; Fu 1996; Jantzen 1998, Perez 1994; Scholes 1975; Tooley 1984; U.S. Department of Energy 1997; Vogel 1985; Volf 1984; Weyl 1951; WSRC 1998).

The development of the glass matrix incorporated changes to increase the durability through glass former/modifier adjustments (SiO_2, Al_2O_3, and $CaCO_3$), as well as mixed alkali affects. These variables were also controlled with respect to increases in sulfate solubility in the glass.

Salt solubility and formulation robustness were key considerations in the development of the demonstration glass formulation. Due to time constraints, the full impact of each of these variables could not be fully qualified. A screening system was applied to determine if the variables had a significant positive impact on durability or sulfate control, and what secondary impacts may occur (e.g. viscosity, corrosivity, phase separation, etc.). This is discussed in more detail in Section 4. The impacts of process requirements on the full-scale design are also discussed in Section 6.2 (Scale Up-Lessons Learned) and Section 6.5 (Systems Design Descriptions).

2.1.3 *Laboratory-scale Test Description*

The glass formulation effort was conducted in two phases based on the time constraints of the demonstration. The main emphasis was placed on development of a glass formulation to meet the requirements of the demonstration scale testing. This required development of a glass with TCLP leachate concentrations less than 50% of the current TCLP regulatory limit.

Bench-scale testing was conducted at the Clemson Environmental Technology Laboratory (CETL) in Anderson, SC. CETL is equipped with the necessary tools to manufacture the surrogate materials and produce the glass samples required for TCLP testing.

The bench-scale testing proceeded in two phases: surrogate validation and glass formulation.

2.1.3.1 Surrogate Validation

The surrogate validation required that the surrogate be manufactured per the composition requirements presented in the Contract , Table C1 - Demonstration

Surrogate. All constituents used to manufacture the surrogate were procured according to the specifications described in Table C4: Compound Specifications of the Contract. Copies of the Certificates of Analysis (COAs) were provided to FDF and approved prior to manufacturing the surrogate as a confirmation of quality. All constituents were tested for Loss on Drying (LOD), and their batch weight adjusted accordingly.

The blended surrogate was tested against the physical characteristics presented in the Contract, Appendix C.

Once the surrogate formulation was approved by FDF for conformance to the Appendix C requirements, Envitco proceeded with the glass composition development.

Details of the surrogate formulation and manufacturing procedure are presented in Section 3 of this report.

2.1.3.2 Glass Formulation

A system of glasses was identified with potential for meeting the glass performance and processing requirements as previously shown in Tables 2.1.1-3 and 2.1.1-4. The study focused on the soda-lime-silica system, with variation in alkali content, alkaline earth content, glass network modifiers, durability-enhancing additives, waste loading and reductant additions.
Tests were conducted in two phases. The first stage provided screening information that determined which variables proved to have a significant impact on the glass or process performance. Preliminary screening reduced the focus of the glass formulation work to the alkali content, network modifiers, and reductant additions. Subsequent glass formulations (stage 2) emphasized the variation of these constituents with emphasis on salt control and durability.

To produce the glasses, the surrogates were manufactured by weighing the necessary dry additives in a fume hood in accordance with the batch sheet. The dry additives were then transferred to a V-blender to be properly homogenized with the organics. This blend was then transferred to a finger mixer where it was blended with water. The finger mixer further homogenized and distributed the water throughout the blend to allow further handling without segregation.

Additives were blended with the surrogate using a Hobart mixer. The blend (surrogate and additives) was melted in fused silica crucibles utilizing a Deltech bottom-loading furnace. The glasses were examined periodically before completion of the melting process to observe any salt reactions (formation, segregation, and volatilization) that may have occurred. Once fully melted, the glasses were poured onto a chilled plate, cooled, and examined for

homogeneity/secondary phase, salt residues, metallic precipitates and other undesirable conditions.

Details of the glass recipe development work are presented in Section 4 of this report.

2.2 Pilot-scale Demonstration Testing

2.2.1 Test Requirements and Objectives

The Contract required the POPT to demonstrate that the treatment technology can produce a treated wasteform that consistently meets the performance criteria stated in the Contract, Section C.4.2.3. This was to be accomplished by achieving the following objectives:

1. Duration: The treatment process must be performed on the surrogate material over a continuous 72-hour period. Surrogate slurry preparation, in accordance with the formula provided in Table C1 of the Contract, shall be completed prior to initiation of the 72-hour demonstration period. The demonstration must be conducted with unplanned downtime not exceeding 3.5 hours over the entire 72-hour demonstration period.

2. Quantity: The demonstration shall target a processing rate of 2600 kg of 30% solids surrogate slurry per 24-hour period.

3. Batches: The POPT shall be performed in a minimum of 5 batches (or defined populations in a continuous process) to obtain sufficient data to assure reliability of the process.

4. Samples: Collect samples in accordance with the Project Work Plan's Sampling, Data Collection and Analysis Plan. Samples will be collected for analysis, FDF testing, and archive.

5. Analysis: Representative samples shall be analyzed by FDF-approved laboratories per the Project Work Plan in order to provide data to support the achievement of the treated wasteform performance criteria.

6. Process: Performance of the POPT shall be conducted either in batches or continuously, based on the type of process to be used in the full-scale design.

7. Equipment: The POPT shall be performed using equipment that is representative of the equipment that would be used in the full-scale design.

The Contract required the technology provider to use existing equipment for the POPT demonstration. The largest melter immediately available for use on the POPT was the EV-101 melter. The EV-101 was designed to process dry soda-lime-silica glass batches at a rate of two tons per day. Therefore, Envitco anticipated that the EV-101 would process the 30% solids surrogate at approximately 2600 kg per day based on previous experience with processing slurries. See Section 5.1.5 of this report for more detailed discussion of the melter processing rate.

Early observations of the process revealed that the EV-101 was not large enough to achieve the processing rate of 2600 kg/day. FDF was immediately informed of this situation, and apprised of Envitco's efforts and successes maintaining a steady-state process. FDF agreed that Envitco would operate the melter under steady-state conditions, at the rate established by Envitco, for the 72-hour period. FDF emphasized that steady operating conditions were more critical than the operating rate and directed Envitco to develop their process to ensure steady conditions. Prior to initiation of the demonstration, agreement was reached in accordance with the Contract, Section C4.2.2 - Statement of Work which defined the performance requirements as follows:

- There would be an official 72-hour run, during which the 3.5 hour limit of down time would be in effect;
- FDF would witness Envitco processing 7800 kg of 70% water demonstration surrogate;
- Envitco would process the slurry at an optimal feed rate maintaining a balanced, steady-state condition; and
- Samples collected outside of the 72-hour run would be limited to slurry and glass.

During the performance of the Demonstration Run, Envitco established steady-state optimized conditions with a process rate of 0.34 metric tons per day. FDF witnessed the processing of the total 7800 kg of demonstration surrogate between January 15 and January 23, 1999. The 72-hour run occurred between January 18 and January 21, 1999.

2.2.2 *Facility and Equipment Descriptions*

2.2.2.1 Test Facility

The pilot-scale POPT was conducted at CETL. The test was conducted on the Envitco WASTE-VIT® EV-101 melter. The melter was installed in one of the Technology Demonstration and Development bay areas of the CETL facility.

CETL is permitted to conduct hazardous waste testing through treatability study exemptions. The Demonstration Surrogate material prior to treatment was handled as a feedstock, and was not designated as a waste material. Debris generated during the demonstration that was in contact with the surrogate (gloves, coveralls, clean-up wastes, etc.) was designated as hazardous waste and processed in accordance with RCRA hazardous waste regulations.

Prior to any testing, CETL notified the South Carolina Department of Health and Environmental Control to advise them of the treatability study being conducted. All handling and testing of hazardous wastes were conducted in accordance with the terms of 40 CFR 261.4 (Exclusions).

2.2.2.2 POPT Demonstration Melter

The POPT demonstration was conducted utilizing the Envitco WASTE-VIT® EV-101 melter. The three-chamber EV-101 melter was designed for a nominal throughput of 2 tons per day on a dry soda-lime-silica batch formulation.

The EV-101 melter was typical of the Envitco WASTE-VIT® design, and included all of the features that were anticipated in the full-scale melter system. The melter was refractory-lined, with an external water-cooled shell. The shell provided operator protection by reducing the glass contact refractory outside skin temperature to less than 50°C. This approach provided additional safety and melter life by maintaining a cold skin that would freeze any glass that may penetrate the refractory due to wear or joints in the refractory construction. The system utilized molybdenum electrodes during the POPT.

The three-chamber design included a main melt chamber, a glass drain bay and a salt drain bay. The slurried feed was presented to the main melt chamber where a cold cap was formed. Secondary heat in the plenum of the EV-101 melter was provided by a propane-air burner system. The burner assisted in evaporation of the water from the slurry and provided heat to the offgas to avoid condensation of water vapor or salts in the offgas ductwork.

The majority of the melter inventory resided in the main melt chamber. This ensured that the feed presented to the melter was fully reacted and homogenized before it was drained. This allowed for higher waste loading and the production of more robust glass formulations using higher durability glass additives which typically require additional time to dissolved in the glass.

The molten glass exited the melt chamber through a submerged throat. This approach minimized the possibility for unreacted material to leave the melt chamber. The glass traveled through the throat into the glass drain bay where it was temperature-adjusted to match the desired drain temperature. The glass exited the melter continuously through a bottom drain valve. This valve was controlled to allow the drain rate to match the feed rate. The glass level was monitored to ensure that the feed rate was properly matched to the glass drain rate.

On the opposing end of the main melt chamber was the salt drain bay. This bay was provided to allow for continuous draining of salts, if required, or to accommodate conditions where it is beneficial to remove the salt layer as an alternative to evaporation. The salt drain bay was not operated during the formal 72-hour testing program as the salts were either solubilized in the glass or volatilized at a steady rate.

At the request of FDF, the salt drain was successfully demonstrated following completion of the 72-hour demonstration. Regardless of the necessity of the drain during the POPT, the availability of a salt drain is beneficial for handling upset or excess salt conditions. The drain can be operated as a contingency measure to handle non-typical conditions in which the salt concentration exceeds the solubility or volatilization rate. This provides an option for removal of the salt and avoidance of interruption to the melter operation. Additional salt drain discussion can be found in Sections 5 and 6 of this report.

The melter was also provided with a bottom metals drain. The metals drain was available to evacuate metallic precipitates (lead, lead sulfide, spinels) that may form in the process. The melter was configured to accumulate these secondary phases and permit them to be removed periodically.

The metals drain was not operated during the POPT due to insufficient heating. The metals drain was of the same design as the glass drain, which was proven to perform reliably and controllably throughout the demonstration. The difference in the metals drain was related to the temperature distribution at the bottom of the melter tank. This is easily resolved through changes in the drain heating system.

2.2.2.3 Offgas Treatment System

The offgas from the melter were treated for the Proof-of-Principle Testing through a McGill electrostatic precipitator. McGill provided their Model 4-24 Mobile ESP which is a transportable testing and demonstration system suitable for treating particulate emissions and testing the efficacy of the process.

The Model 4-24 is a single-chamber, four-zone ESP designed to operate at 3500-7800 actual cubic feet per minute (acfm) at velocities of 2.5-5.5 feet per second. The Envitco melter produced velocities through the unit of approximately 1-1.5 feet per second.

2.2.2.4 Blending and Feed System

The feed system consisted of a primary mix tank, five holding tanks and a feed tank. All tanks were piped to permit transfer between the mix tank, feed tank and the holding tanks. Diaphragm pumps transferred and recirculated the feed to the melter feed metering pumps.

The mix tank was a 650-gallon stainless steel vessel with dome top and bottom. The tank was fitted with internal steam coils which were not used for this test. The mixer was fitted with two impellers mounted at approximately 10% and 50% of the depth of the tank.

The feed tank was a 500-gallon polypropylene tank with a 5 degree sloped bottom. The tank was fitted with two Lightnin mixers positioned to maintain a circular flow pattern of the bulk fluid and some high-shear mixing locally around the impeller.

The holding tanks were 500-gallon polyethylene tanks with closed tops and 45 degree conical bottoms. The surrogates were continuously mixed in the holding tanks by Pulsair™ mixers.

Surrogate and feed transfers between the tanks were achieved with a double diaphragm pump, valved to allow for transfer between any tankage system. The feed was recirculcated from the feed tank to the melter feed metering pump skid through the use of double-diaphragm Sandpiper pumps. The feed recirculation system drew feed from the bottom of the feed tank through the recirculation pump to the metering pump skid and back to the feed tank. The feed was metered to the melter through two Moyno progressive cavity pumps.

2.2.2.5 Other Supporting Systems

The interface between the melter and the cooling water and nitrogen source was through the Services Pallet. The Services Pallet monitors and distributes the water and nitrogen, and was linked to the main control to provide alarms for low pressure or low flow conditions.

Cooling water for the melter shells was provided through the use of the CETL facility cooling tower. Nitrogen was also supplied through the CETL facility gas distribution system.

Compressed air was used for the Pulse-Air mixers, viewport purges, camera purges, and the film cooler. The CETL facility compressor was not capable of providing enough air for these services, and was supplemented with a portable air compressor and accumulator. Air usage for the process varied from approximately 30-100 standard cubic feet per minute (scfm), depending on the needs of the mixers and the film cooler.

2.2.3 Test Process Operations

Testing was conducted in accordance with the Envitco Test Plan (98703 PR DMB LTR 19981210 1351 0 Q) which defined the operating conditions, data collection requirements, sample collection requirements, and standard operating procedures by which the test would be conducted.

2.3 Pre-conceptual Full-scale Design

A pre-conceptual full-scale design package was developed according to Table F2 of the Contract. Section 6 of this report presents the full-scale design which includes the following information:

- Process Scale-up and Lessons Learned (based on POPT demonstration),
- Process Flow Diagrams (PFD),
- Equipment List and Data Sheets,
- Equipment and facility layouts,
- Material Balance, and
- System Design Descriptions.

2.4 POPT Quality Assurance

Project Quality Assurance was driven by the Project-Specific QA Plan (98703 QA DMB QAD 19980918 1100 0 Q). The QA Plan established the QA Level for the demonstration based on its potential impact to safety, health, environment, performance, schedule and cost. The project was determined to be an Impact Level C. This established the basis for application of the quality system at a level commensurate with testing and development work. This work had minimal risk to Health and Personnel Safety, zero Nuclear Hazards, minimal risk to System Performance/Secondary Systems, minor affect on Schedule, and a potentially major impact on Project Cost.

The Project Cost Impact is related to the demonstration performance requirements. A failure to meet any of the criteria established in the Contract would require a second demonstration program, which would have an immediate cost impact.

The longer term cost impact is related to the pre-conceptual full-scale design and life cycle cost estimates by FDF. Errors in the data affecting melter scale-up and operating requirements could result in erroneous life cycle cost determinations, impacting the cost and technical evaluation from that point forward. Therefore, it was imperative that the data be sufficiently accurate as to not impact the overall process scale-up factors.

The Project-Specific Quality Assurance Plan identified the training requirements necessary to complete the work, as well as the specific Quality Assurance (QA) tasks (inspections, calibrations, data collection, documentation, and analysis) required by the application of Impact Level C.

The applicable QA Requirements, as presented in Section 2.1 of the QA Plan, are presented below:

Table 2.2.5-1: Quality Assurance Procedures

Procedure	Title
QAP 4.2.2	Graded Quality Assurance Application
QAP 4.3.1	Contract Review
QAP 4.4.1	Design Control
QAP 4.5.1	Document Preparation, Approval and Control
QAP 4.6.1	Purchasing
QAP 4.10.1	Test Performance and Control
QAP 4.11.1	Control of Measuring and Testing Equipment
QAP 4.12.1	Inspection, Test and Verification of Operating Status
QAP 4.13.1	Control of Non-Conformances
QAP 4.14.1	Corrective and Preventative Action Requests
QAP 4.14.2	Stop Work Notices
QAP 4.18.1	Training

Table 2.2.5-2: Quality Assurance Instructions

Instruction	Title
QAI 4.5.001	Document Identification System
QAI 4.5.002	Filing and Storage of Quality Records
QAI 4.5.005	Maintenance of Long Term Document Index
QAI 4.5.006	Maintenance of Long Term Controlled Document Index
QAI 4.6.001	Approved Supplier List
QAI 4.18.001	Job Descriptions
QAI 4.18.002	Envitco Training Matrix
QAI 4.18.003	Employee Training Matrix

The QA Plan further defined the necessity of procedures, in addition to those identified above, that would be integrated into the Test Plan. Task-specific procedures were developed and applied to ensure consistent conduct of testing during the demonstration; applicable procedures were included in the test plan.

2.4.1 Laboratory-Scale QA Implementation

2.4.1.1 Surrogate Material Procurement

Surrogate Raw Materials were all received with Certificates of Analysis (COA) or similar Quality Certifications to confirm their adherence with the quality specifications defined in the purchase order. The results of the review of the COAs indicated that the samples were chemically within specifications. The particle size of the raw material was not generally qualified in the COAs, and required Envitco to perform sieve analysis on all of the insoluble raw materials. The soluble species were accepted without sieve analysis, since they would dissolve in the slurry. This is presented in further detail in Section 3.1.

2.4.1.2 Analytical Services Procurement

Data to be reported by FDF was contracted to FDF- approved laboratories or CELS-Corning Laboratory Services. Leachability Analyses (TCLP) were conducted by Texidyne (Central, SC) and Compuchem (Cary, NC). Texidyne was used only for rapid screening analysis of the glass formulations, and did not provide reportable leaching data. All reportable TCLP data for glasses, residues, and surrogates were generated by Compuchem. The use of Compuchem was driven by the requirement that Envitco use an FDF-approved laboratory. Envitco reviewed the quality assurance program of Compuchem, who was then accepted as an Envitco Approved Vendor.

Glass analysis was performed by CELS-Corning Laboratory Services. CELS is an Envitco Approved Vendor based on previous experience and a satisfactory review of CELS methods, QA program and manuals. Based on the recommendations of Envitco and other technology providers, CELS was reviewed by FDF and judged to be the only laboratory capable of conducting proper surrogate and glass analyses. FDF then requested that all surrogate and glass analyses be conducted by CELS.

2.4.1.3 Laboratory-Scale Hold Points

Three hold-points were defined for the laboratory-scale work as follows:

- Hold Point-Surrogate Validation: FDF participated in a review of Envitco's surrogate manufacturing procedure at CETL. FDF witnessed all operations, record keeping, laboratory operations, glass formulation test plan, and surrogate raw material certifications. Discrepancies were identified in the particle size of the NiO and $PbCO_3$, as well as several of

the soluble components of the surrogate formulation. FDF authorized Envitco to proceed with the glass formulation work as noted in Section 3 of this report.

- Hold Point-Batch Sheet Verification: FDF reviewed the batch sheet as developed by Envitco. This included FDF's review of the loss on drying determinations for the raw material, and the correction method applied to the batch sheet.

- Hold Point-Recipe Performance Verification: Samples of the 30 wt% water surrogate were provided to FDF for performance approval. Discrepancies in leaching were identified. Envitco supplied variations on the surrogate formulation at the request of FDF. FDF ultimately approved a revised surrogate formulation for both physical and leaching characteristics (Section 3.0).

2.4.1.4 Non-conformance Reports (NCR)

NCRs were written for those items not conforming to the specifications as required by the Contract or procurement guidelines. NCRs regarding the following items were written and closed according to the Envitco QA program:

- $PbCO_3$ and NiO did not meet the particle size requirements of the Contract. FDF approved the use of the compounds as noted in Section 3 of this report.

- Material Safety Data Sheets (MSDS) were not received nor shipped with some of the surrogate compounds. They were collected from other sources and posted as required at CETL and placed in the Project File.

- COAs were not received with all surrogate compound shipments. COAs were faxed by the vendors to Envitco and subsequently submitted to FDF for approval.

2.4.1.5 Instrumentation

Thermocouples, scales, and other instrumentation used for the laboratory scale recipe development were calibrated or were verified for calibration under CETL's on-going calibration program.

2.4.2 *Demonstration-scale QA Implementation*

2.4.2.1 Surrogate Material Procurement

Specifications were provided by the vendor in accordance with the specifications in the POPT Contract. Quality was confirmed through Certificates of Analysis review and approval by FDF.

2.4.2.2 Analytical Services Procurement

The analytical services procured in the laboratory-scale work included analyses of the demonstration-scale samples. Therefore, the vendors chosen for chemical analyses (CELS) and leaching analyses (Compuchem) for the laboratory-scale work were also used for the demonstration samples.

An additional requirement of the POPT demonstration was to sample and analyze offgas samples from the ductwork above the melter. Offgas sampling and analysis was conducted by Trigon Engineering and Oxford Laboratories. Trigon is an Envitco Approved Vendor, and has been used in the past by Envitco for DOE-related testing. Oxford Laboratories was selected for the analysis of the offgas samples based on an independent review of their quality program by Envitco and approval by FDF.

2.4.2.3 Demonstration Hold Points

The following hold-points were identified for the demonstration:

- POPT Demonstration Run Readiness Confirmation: FDF inspected Envitco's readiness to conduct the POPT demonstration. Envitco had chosen to delay the demonstration due to concerns with the reliability of the feed system. To confirm the state of the project, FDF representatives visited the CETL facility on December 12, 1998 and confirmed that the melter and other supporting systems were ready, but additional work on the feed system was required.

A second review was conducted prior to the rescheduled demonstration. This review included inspection of all processes, documentation, log books, etc. FDF arrived on site January 15, 1999 and approved the facility as ready. The demonstration was then initiated on January 15, 1999.

- Established Steady-State Operation Prior to Testing: FDF confirmed steady-state operations on January 15, 1999 based on observations of the demonstration and review of processing records.

- Verifications of Calibrations Prior to Testing: An internal audit was conducted by Envitco confirming the devices intended for calibration and the actual calibration status. The selected devices and their respective calibrations were verified.

2.4.2.4 NCRs and Corrective and Preventive Action Reports (CPAR)

NCRs were written for those items not conforming to the specifications as required by the Contract or procurement guidelines. NCRs regarding the following items were written and closed according to the Envitco QA program:

- Diaphragm Pumps: The primary feed recirculation system was designed to mimic the principal of the full-scale slurry feed system, but was constructed of materials and equipment that were felt to be suitable for a short-term demonstration (2-3 weeks). The diaphragm pumps used for the demonstration were not suited to the abrasiveness of the feed and, therefore, had a short life span (1-7 days). No equipment changes were made, though redundancy was added to permit continuous operation during pump rebuild. This type of pump (double-diaphragm) does not appear in the full-scale conceptual design, and has been replaced by a vaneless centrifugal design.

- Pulsair™ Mixers: Pulse-Air® mixers were used to maintain the suspension of the surrogate prior to conversion to feed. A mixer periodically malfunctioned due to blockage in the air injection pipe, and damaged a polyethylene holding tank. Following discussions with the manufacturer, a new injection pipe that incorporated a wear plate was installed. To remedy the blockage, the cycle rate and pressures were also increased. This was communicated to the lead engineers and implemented.

CPARs were written and closed regarding the following processes or procedures:

- Air/Water System Interface: The compressed air system at CETL included an air-over-water unit that serviced a system independent of the Envitco melter. A failure of the main facility compressor system allowed water to enter the Envitco air system as the water pressure exceeded the air pressure. No damage was done, though some downtime was required to flush the air system and remove excess water. The problem was corrected by the isolation of the air-over-water system through the installation of a manual isolation valve and a redundant check valve.

- Metals Drain: The metals drain did not operate during the demonstration. This was due to a lack of available heat in the drain orifice. See Sections 5.1 and 6.2 for further information. This feature will be addressed in the full-scale design.

2.4.2.5 Instrumentation

Instruments used for the POPT program were identified in the Test Plan by location, type of data collection, control (manual/automatic), data acquisition requirements, and function in the control of the melter or process. Instruments that impacted the control of the melter or provided data that was directly related to the melter scale-up considerations were calibrated or certified prior to the demonstration. This approach was also applied to the offgas sampling process and equipment.

Items considered to be process control or design related were primarily limited to thermocouples, scales, flow meters and pressure transducers. A list of the calibrated instruments is presented in Table 2.4.2.5-1.

Table 2.4.2.5-1: Calibrated Instrumentation

Item	DESCRIPTION	CAL. DATE	LOCATION	FUNCTION
1	Type B thermocouple	09/24/98	drain bay	bay temperature monitoring
2	Type B thermocouple	09/24/98	drain bay	drain temperature monitoring
3	Type R thermocouple	10/05/98	salt bay	salt bay atmosphere temp.
4	Type R thermocouple	10/05/98	melt chamber	melt chamber atmos. temp.
5	Type B thermocouple	10/05/98	melt chamber	glass temperature
6	Pressure Transducer Model 3051CD1A53A1AB4Q4	12/02/98	melt chamber	melt chamber plenum pressure
7	Panther/Lynx scale/readout 5035869-5W2	11/16/98	mix tank	mix tank materials weight
8	Panther/Lynx scale/readout 5035871-5W2	01/07/99	glass conveyor	glass production weight
9	Panther/Lynx scale/readout 5035868-5W2	01/07/99	feed tank	feed tank weight
10	Type R Thermocouple	10/05/98	drain bay	drain bay atmosphere
11	Flow Meter 8710A0242A1	12/01/98	pump skid	slurry feed flow rate

2.4.2.6 Inspections and Testing

Inspection and testing were carried out in accordance with the requirements established in Section 3.9.2.3 of the QA Plan. The following inspection and testing activities were conducted:

- Surrogate compounds: Surrogate compounds were procured with Certificates of Analysis (COAs) or Quality Certifications. Copies of the COAs and Certifications were provided to FDF for review if the source of the compounds was different than that used during the laboratory-scale work.

- Refractories: Refractories were inspected by Envitco prior to shipment from the manufacturer. A protocol was established and documented to guide the inspection in accordance with the procurement specifications. Selected blocks were measured and checked against the design drawings. The

assembled refractory set was inspected for fit and finish, including verification of gaps, stackups, etc. The vendor supplied Quality Certification on the refractory materials. The inspection report is on file at Envitco.

- Control/power upgrades: The power supplies were inspected by Envitco's subcontractor, Toledo Engineering, prior to shipment from the manufacturer. The performance of various functions was audited. A second inspection was required at Clemson due to problems that arose during shipping and installation of the transformers. This required factory assistance, who determined that a metal shaving had contributed to a short circuit in one of the control boards. This was remedied by the service technician. An additional check of the field-installed wiring also identified a control wire termination problem. This was also remedied by the technician prior to approval of the power supply.

- CETL Facility Upgrades: Envitco placed technical support personnel at CETL for project management and inspection activities during the melter erection and facility preparations. This work was documented through weekly reports from CETL, and monitored through daily communications meetings.

- TECO Design Activities: TECO's design activities related to the modifications to the EV-101 were monitored weekly through Design Review Meetings. Other reviews were conducted as necessary to confirm calculations, design assumptions, and design approaches. The results of these meetings were documented through meeting minutes or summary reports of the independent reviews.

Specifications were developed for non-commercial items that were designed or purchased for the melter or testing program. Other procedures or operations were developed and implemented based on manufacturers' recommendations or instructions for typical applications. Due to unknown characteristics of the surrogate, feed, glass, offgas, and other streams, processes or services, not all specifications or instructions were sufficient to achieve the desired performance. These items are identified as follows:

- Progressive Cavity Pump Seals: Original specifications of the progressive cavity pumps called for single mechanical seals. This type of seal was not suited to the duty requirements of the surrogate/feed. Based on discussions with the manufacturer of the pump, as well as discussions with several seal manufacturers and FDF, a pressure-flushed double mechanical seal was chosen to replace the original single mechanical design. There were no indications of leakage following the demonstration.

- Rupture Discs: Rupture discs were installed on the slurry feed system to ensure that the hoses and piping were not overpressurized due to feed nozzle blockage or similar malfunctions. Flush valve operations, as well as some nozzle blockages early in the pre-demonstration, led to the replacement of the rupture discs with relief valves. Procedures were also modified to minimize the potential for future nozzle blockages, and the sequencing of valve operation to avoid dead-heading of the pumps. Operators were trained on procedural changes. Procedural changes were posted.

2.4.3 Pre-conceptual Full-scale Design QA Implementation

The full-scale design was developed by Envitco and SGN. SGN worked under their own QA plan and performed reviews and checks accordingly. Envitco also conducted reviews and calculation checks as required by Envitco's QA System.

3.0 PRE-PERFORMANCE ACTIVITIES

3.1 Raw Material Procurement and Validation

Raw material validation was required for the materials purchased and obtained for the preparation of the surrogate waste streams. For chemical composition and purity, the manufacturers' COAs were submitted to FDF for review and approval. The chemicals were approved by FDF.

3.1.1 LOD / LOI

Loss on Drying (LOD) and Loss on Ignition (LOI) were performed on the raw materials. LOD was performed on the inorganic raw materials per American Society for Testing and Materials (ASTM) Method D 2216. The LOD data was used in batch calculations for the 30% moisture content surrogate batches made up for surrogate validation. The LOI measurements were used for glass batch composition calculations. LOI measurements were made by heating a sample in 50 ml covered alumina crucible per ASTM C 146, Section 28. LOI values for lithium carbonate, sodium carbonate and sodium nitrate were determined theoretically since the R_2O alkali calcines would react with the alumina crucibles and would have absorbed significant amounts of moisture after cooling, preventing an accurate dry weighing.

3.1.2 Maximum Particle Size

An additional compound specification validation was conducted to demonstrate that the insoluble materials (with exception of the silicas and the BentoGrout™) had a maximum particle size of 100 microns (passing a 140 mesh screen). Initial attempts at dry manual screening were not successful. Exceptions to the standard screening procedures were required in order to confirm the particle size of some of the more difficult materials.

3.1.2.1 Exceptions to Particle Size Requirements

Several adjustments were made to the particle size validation requirements by FDF. For the insoluble materials used to manufacture the surrogate, FDF agreed that it was suitable to perform maximum particle size verification via wet screening. In order to assist in breaking up agglomerates of the dry materials, the individual dry materials were dispersed in water prior to screening. The

amount of water used was equivalent to the water that would be present in the 30% moisture surrogate mix. A mixture of the raw material and water was stirred for at least 30 minutes, then passed through a 140 mesh screen. Additional water was used to assist in working the fine solids through the screen. Residual coatings of a soft powder or "sludge" that passed through the screen with a light rubbing of the screen and without an abrasive feel were considered to pass the screen.

Two of the surrogate materials did not pass this screening test. Lead carbonate ($PbCo_3$) showed over 45% retained on the coarser 100 mesh screen, even with the wet screening technique. To maintain schedule, the 30% moisture demonstration surrogate was produced using this lead carbonate material. The sample was validated by FDF for use in the bench scale development program (D. Bennert 1998). A correctly-sized material was procured for the demonstration run and was used in subsequent testings.

Nickel oxide (NiO) showed a retention of roughly 5% after wet screening. This supply of NiO was approved for use by FDF due to the low amount of NiO in the surrogate.

FDF also approved the use of larger particle size raw materials (> 100 microns) for water-soluble additives. Materials thus exempted from the particle size requirements included sodium arsenate, sodium chromate, sodium nitrate, sodium selenite, and vanadium pentoxide.

The impact of the particle size and the validation approach were considered to be negligible in terms of the bench-scale development and POPT performance. The low contribution of NiO to the surrogate batch (0.47% composite dry weight) was not felt to be significant in the surrogate rheology. The $PbCO_3$ was corrected prior to the actual POPT process and, therefore, did not impact any of the POPT work. There were no indications of inclusions or unreacted raw materials in the bench-scale samples, indicating complete dissolution of both the NiO and $PbCO_3$. The soluble materials were in a dissolved form in the surrogate, thereby making their initial physical form irrelevant.

3.2 30% Moisture Surrogate Mix Validation

3.2.1 Demonstration Surrogate (S0) Validation at 30% Moisture

Validation of the S0 surrogate was conducted over a period of several days. The tests that were conducted were Plastic Limit, Moisture Content, pH, and In-Situ Density. Samples were sent to FDF for validation of the Pb leaching characteristics and elemental analysis of the mixed surrogate.

3.2.1.1 Plastic Limit

The Plastic Limit testing was conducted in accordance with ASTM Method D4318. Initial tests were conducted using surrogate manufactured per the recipe defined in the Contract. Surrogate S0-D0 was tested.

Initial determinations of the plastic limit were gathered by performing a variation of the standard procedure, in which the sample was produced by rolling the material between the hands rather than on a ground glass plate. The results of these tests indicated that the S0-D0 formulation had a plasticity limit of approximately 34.7 wt% water. Initial results did not meet the Contract requirements of 45 - 55 wt%.

Discussions were held with FDF to determine the path forward to correct the plasticity. FDF provided additional information on the affect of fume silca on the plasticity (Morse 1998). Extrapolation of this data indicated that an increase in the sum of fume silica and diatomaceous earth (maintaining a constant, total SiO_2) to 15% (2% DE and 13% fume silica) would increase the plasticity to the target 50 wt% moisture. New batches of surrogate were produced at fumed silica concentrations of 12, 13, 14 and 15%, representing 20, 30, 40 and 50% increases respectively in the amount of fume silica. (Increases in fume silica were offset by reductions in coarse silica to maintain a constant, SiO_2 concentration.) The impact of the increase in fume silica on the Plasticity Limit are presented below in Table 3.2.1.1-1.

Table 3.2.1.1-1 Moisture Levels at Plasticity Limit

Sample	Test 1	Test 2	Average
12% fume SiO_2	43.42 wt%	43.58 wt%	43.50 wt%
13% fume SiO_2	42.99 wt%	43.26 wt%	43.13 wt%
14% fume SiO_2	43.86 wt%	44.17 wt%	44.02 wt%

There were no clear correlations between the silica ratios and plasticity at the levels tested. Discussions with FDF indicated that similar results were being observed by other POPT contractors. FDF directed Envitco to proceed with the lower fume silica levels (12% fume silica). A large batch of material was subsequently manufactured and supplied to FDF for validation (re. sample SURR-S0-T-0019).

3.2.1.2 Moisture Content

The S0-D0 surrogate blend was tested for moisture in accordance with ASTM Method D 2216. The average moisture content was within the contractual requirements at 30.14 wt%.

3.2.1.3 pH

The surrogate pH was tested in accordance with the first steps of EPA Method 1311, TCLP. The actual pH testing was conducted per Section 7.1.4 of the above method.

The pH was measured using a Corning Check-Mate 90. The device was calibrated to the degree possible and any repeating error noted. Problems were encountered with the calibration, resulting in a repeating of +0.10 at pH 7.0. This was noted and considered in the analysis.

The results of the test ranged from pH 9.80 to 9.86, with an average of about pH 9.83. The positive error on the meter at pH 7.0 indicated that the readings might be slightly higher than actual (approximate average of pH 9.7 considering bias correction). The pH was considered acceptable based on the range of pH required by the Contract: pH 9 - 10.

3.2.1.4 In-Situ Density

In-Situ Density was conducted in accordance with the guidance provided in Contract Modification No. 04.

The test was initiated by obtaining the tare weight of a 50 ml graduated cylinder, then adding approximately 10 -15 g of SURR-D0-T-0022 to the cylinder. This material was weighed, then compacted using a ½" wooden dowel. Hand compaction was carried out until no further compaction could be attained. The level and weight were measured and recorded. The process was then repeated. Sequential additions to the cylinder were in approximate 10 gm increments, followed by compaction and measurements until approximately 85 gm of surrogate had been added to the cylinder.

The density was determined by a simple mass/volume calculation. The results at each increment were calculated, and the data set plotted.

The data showed a trend of continued compaction of prior additions of surrogate. The resulting densities ranged from 1.68 grams per milliliter (g/ml) for the first compaction sample to 1.78 g/ml at the end of the test. The density stabilized at

1.78 g/ml. The density of 1.78 g/ml satisfied the Contract requirement of an in-situ density at 1.78 g/ml +/-0.1 g/ml.

3.2.1.5 TCLP

Initial samples submitted to FDF for validation did not meet the target lead leachate concentration of 650-850 ppm. The sample leachate concentrations were much lower than the target. The results of the initial analyses are presented in Table 3.2.1.5-1.

NOTE: Several analyses were conducted by FDF in an effort to determine if the holding time of the sample prior to leaching had any affect on the lead leaching characterizations. The various time based analyses are presented.

Table 3.2.1.5-1: Lead Leachability Validation Results

		Analysis Time	1430	1430	1430	1330	1300	1300	1300
		Analysis Date	10/3	10/03	10/03	10/04	10/05	10/06	10/07
FDF Sample ID	Envitco Sample ID	pH	Pb TCLP Leachate Concentration (ppm)						
341378	-0019	10.07	226	211	221	253	301	265.4	251.5

The test resulted in an average leachate concentration of approximately 247 ppm lead.

After several attempts by FDF to identify the cause of the low leachate concentrations, the quantity and chemical moisture content of magnesium phosphate $Mg_3(PO_4)_2$ in the surrogate was identified as the lead leaching modifier. A series of surrogate samples with $Mg_3(PO_4)_2$ levels varied between zero and 100% of the Contract formulation was generated by Envitco and submitted to FDF for testing. TCLP testing was conducted on all of the samples for the heavy metals plus iron, magnesium and calcium. The data was analyzed for lead leaching response as a function of magnesium phosphate content. The results of these tests are presented below in Table 3.2.1.5-2.

Table 3.2.1.5-2: TCLP Results Based on Variable $Mg_3(PO_4)_2$ Content

FDF Sample ID	Envitco Sample ID	Variable $Mg_3(PO_4)_2$ (% of target $Mg_3(PO_4)_2$)	pH	TCLP (Pb) (ppm)	TCLP (Mg) (ppm)
343055	-0172	0%	9.61	1780	0.57
343056	-0173	20%	9.67	1490	47.1
343057	-0174	40%	9.64	1100	88.9
343058	-0175	60%	9.65	902	135
343059	-0176	80%	9.72	601	156
343060	-0177	100%	9.73	382	213

The magnesium (Mg) leaching was determined to provide a reference for the solubilization of the $Mg_3(PO_4)_2$, and its concentration in the leachate. Magnesium is not considered a hazardous material in terms of RCRA requirements.

Based on the FDF study, it was determined that, for the Envitco surrogate, a 25 - 35% reduction in the $Mg_3(PO_4)_2$ content would result in a leachate concentration near the 650 - 850 ppm target.

FDF formalized this change in Contract Modification No. 06. The modification changed the $Mg_3(PO_4)_2$ concentration from 1.92 wt% (surrogate mix), to 1.46 wt%, or a reduction of about 24% versus the initial concentration.

3.2.1.6 Elemental Analysis of the S0 Demonstration Surrogate

Validation of the elemental analysis of the Demonstration Surrogate was conducted on the initial samples submitted to FDF. These samples were generated prior to Contract Modification No. 06, and do not reflect the reduced $Mg_3(PO_4)_2$ content. The results of the analysis is provided in Table 3.2.1.6-1 below.

Table 3.2.1.6-1: Demonstration Surrogate Elemental Analysis

Analyte	Elemental Concentration (mg/kg dry)	Oxide Concentration (mg/kg dry)	Oxide Concentration (wt%)	Target Concentration (wt%)
Ba	44100	49392	4.93	4.14
Cu	270	338	0.03	N/A
Fe	18700	26741	2.67	2.91
Mg	8170	13562	1.36	2.21
Na	15500	20925	2.09	2.34
Ni	2660	3378	0.34	0.33
Pb	114000	123120	12.31	10.12
V	640	1145	0.11	0.07
Zn	170	210	0.02	0.01
Si	261000	558540	55.85	65.94
As	591	632	0.06	0.07
Se	365	512	0.05	0.05

N/A: Not Applicable

Based on the sample analysis provided above, the surrogate and batch sheet were approved by FDF. This permitted Envitco to proceed with the glass formulation development.

3.3 Glass Melting Technique Development

3.3.1 Crucibles Used in Glass Melting Experiments

For the preliminary portion of the treatment recipe development, 75%-fused silica grain/kaolinite ceramic crucibles were utilized. This type of crucible was selected for its resistance to thermal shock damage, allowing direct insertion of the crucible into the 'at temperature' furnace. This characteristic also allowed for periodic removal/reinsertion into the furnace for in-process inspections.

During the treatment recipe development, minor wear was observed on the crucible, primarily in the area of the glass/atmosphere interface. This visible interface "cut-line" proved to be quite useful in the experimental recipe development since the most aggressive attack of the crucible was associated with molten salt (sodium sulfate) attack. The cut line was typically greatest on formulations with excessive salt which accumulated on the molten glass surface. Successful volatilization of the salt was indicated by the lack of residual salts and minimal wear (i.e. absence of a cut line on the crucible) at the glass/atmosphere interface.

3.3.2 Glass Foaming Tendency

With the high levels of sulfate in the surrogate, a possibility of foaming tendency during the melting process was anticipated. The tendency for the Silo surrogate to foam was described during the Fernald pilot plant operating experience (Fu 1996).

In anticipation of the formation of foam during the melting process, initial tests were carried out by gradually heating the glass batch up to the melting/processing temperature. Initial batches were produced from dry additives, with the intent of enhancing the melt rate and minimizing release of decomposition gases. The use of dry additives and slow heatup allowed decomposition of the raw materials before the melt surface would fuse and hamper gas evolution. Initial experiments consisted of inserting crucibles into the furnace at 600°C, and subsequently heating to the melt temperature of 1300°C at a rate of 480°C/hr. These melts did not show an increase in glass level above the initial batch fill line (no foaming).

In order to verify that foaming was not an issue in the crucible melts, subsequent batches were inserted into the furnace at 1100°C, again increasing temperature at 480°C/hr to the melt temperature of 1300°C. While the batch surface in the crucible was liquid at 1100°C, the gases of decomposition from underlying components were able to escape without foaming. This process was then repeated, placing the batches directly into the furnace at 1300°C. Again, there was no indication of foaming, confirming that full crucibles could be processed directly into the furnace at melt temperature.

Subsequent glass melts were produced using heavily wetted batches to increase the amount of glass produced. The wetted batch also had no impact on foaming. This made it feasible to fill the large "I" crucibles to within 1 cm of the top with the wetted batches and to insert these full crucibles directly into the furnace at the final melting temperature.

3.3.3 *Glass Production Volume/Use of Wetted Batch*

Due to the low bulk density of the dry batch (0.4 gm/cubic centimeter), the amount of glass produced per melt was unacceptably low. Mixing the dry-blended batch (surrogate plus additives) with water greatly increased the bulk density of the batch, delivering a greater quantity of glass per crucible.

Various quantities of water addition were tested. At approximately 30% water, the material formed agglomerates, with a slight increase in bulk density to 0.6 g/cc. By increasing the moisture content to approximately 35 – 40 wt%, the batch took on a paste-like consistency with a bulk density of approximately 1.8 - 2.0 g/cc. This allowed melting of approximately 400 gm of glass in a single crucible and casting of a bulk sample of approximately 350 grams.

3.3.4 *Process Temperature Evaluation and Calibration*

3.3.4.1 LOI Oven Temperature

The temperature of the laboratory furnace used to perform LOIs on the raw materials was verified against a calibrated (4 point) Type B thermocouple that had been purchased specifically for verification/calibration functions. The reference thermocouple was inserted parallel to (within 1") and at the same length of insertion as the furnace control thermocouple. The control thermocouple was approximately 4 – 5°C lower than the reference (calibrated) thermocouple. This was judged to be suitable for the purpose of LOI.

3.3.4.2 Deltech Furnace Temperature

In the Deltech furnace, the reference thermocouple was used to determine the temperature in the melt zone rather than to verify the accuracy of the control thermocouple reading. The control thermocouple of the Deltech furnace is positioned against the sidewall of the furnace and outside the circle of the molybdenum disilicide elements, approximately 7" from the center (working area) of the furnace. This creates a discrepancy between the control temperature and the temperature in the working area.

To determine the actual working temperature, the reference thermocouple was dropped vertically into the furnace (centered) with the bead contained inside a short ceramic cup, thereby shading the junction from the direct radiation of the heating elements. A correction factor (at steady state) was determined to correct the control temperature to the working area temperature. The working area temperature read by the reference thermocouple was approximately 15°C lower

than the control reading at both the 1300°C and the 1350°C setpoints. A 15°C bias correction was applied to the setpoint; thus, the setpoint was programmed to 1315°C in order to achieve a working area temperature of 1300°C.

3.3.5 *Surrogate Batch Blending and Melting Protocols*

To prepare a surrogate 'batch', the dry additives were weighed and accumulated in a V-blender. In a separate vessel, the liquid organic components (kerosene and tri-butyl phosphate) were added to a mixture of the coarse silica and feldspar that were held out from the dry mixture. The silica/feldspar/organic blend was mixed sufficiently to ensure that the liquid additives were uniformly distributed. The silica/feldspar/organic blend was then added to the other dry additives in the V-blender and homogenized for approximately 15 minutes. The high-speed impellers were operated during the blending cycle to break up any agglomerates that might be present.

The dry blended surrogate was then added to a counter-current high-shear "finger" blender. Approximately 30% water was added to convert the blend to a heavy wet paste consistency. The specific water addition was recorded for correction of subsequent batches. The wetted batch was placed in sealed storage bags and used, as necessary, for each glass melt.

In order to convert the wetted surrogate to a glass batch, a sample (typically about 400 g) of the wetted surrogate was removed from the plastic storage bag and weighed. The sample was manually mixed with the required glass additives in proportion to the sample size. Water was added, as necessary, so that the final batch was a fully homogeneous paste (typically 35 - 40% water).

To avoid diffusion of alkali-rich water from the wet batch into the porous crucibles, the empty crucibles were maintained at 120°C. The wetted mixed batch was added directly into the crucibles, and the crucibles were placed directly into the furnace.

Fused silica crucibles were used for all surrogate glass development. Two crucibles were placed in the furnace for each melt cycle. A single crucible was placed in the furnace, and the second crucible was added 10 minutes later. The 10 minute offset was done to allow the furnace to re-equilibrate prior to introduction of the second crucible. The glasses were melted for 75 minutes each. For melt periods of 75 minutes, it is estimated that the average time for these glasses at setpoint was 65 minutes.

3.4 Preparation of TCLP Leaching Samples

3.4.1 Sizing of Glass Samples for TCLP Analysis

Glasses were poured into a graphite mold that formed a glass sample of approximately 100 mm diameter. The depth of glass was dependent on the amount of glass produced. The glass discs were then placed in a simple hammer/crusher and size reduced to the minimum extent necessary to reduce the sample to less than 9.5 mm. The reduced sample was then sieved with a 9.5 mm screen and any remaining material was further size-reduced. This process was continued until at least 100 g, of the less than 9.5 mm sample, was available.

To ensure consistency, Envitco evaluated submitting TCLP without the fine fractions. The goal was to reduce the impact of the fine particle fractions which had a strong influence on the surface area/volume ratio in the TCLP test. Elimination of the fine fraction would assure less sample-to-sample variability.

A number of subsequent samples were submitted in "duplicate", i.e., a single glass sample crushed, split, and sieved. One of the duplicates was screened between 9.5 mm and 50 mesh, rejecting the fines below 50 mesh. The second sample was screened to include the < 50 mesh fines.

Table 3.4.1-1, Size Distribution of Crushed Glass Particles, shows the relationship between the mesh size of the split fractions and the percentage of surface area of the sample represented by that fraction. These calculations show that between 40 and 50% of the total surface area available for leaching on the crushed TCLP samples was in the fraction that is finer than 50 mesh. All of the later TCLP samples were submitted per specification (i.e., crushed to pass 9.5 mm) and all fines retained in the sample.

VitCo, Inc.
EMA Group Company

This page intentionally left blank.

Table 3.4.1-1 – Size Distribution of Crushed Glass Particles

Sample	Screen Size		Size in Cm		Median	Weight	Weight %	Cumulative weight %	Surface Area	Number of Particles	Surface Area	Cumulative Surface Area
	Minus	Plus	Minus	Plus	Cm	Grams			cm^2/ particle	this size	Total Cm^2	Area Fraction
S0-D1-10		9.5 mm		0.95		0	0.00%	0.00%				
	9.5 mm	4 mesh	0.95	0.475	0.7125	104.13	50.08%	50.08%	1.59	203.64	324.77	0.13
	4 mesh	6 mesh	0.475	0.335	0.405	34.35	16.52%	66.60%	0.52	365.76	188.48	0.20
	6 mesh	10 mesh	0.335	0.2	0.2675	29.78	14.32%	80.93%	0.22	1100.50	247.39	0.30
	10 mesh	14 mesh	0.2	0.141	0.1705	12.39	5.96%	86.88%	0.09	1768.21	161.49	0.36
	14 mesh	35 mesh	0.141	0.05	0.0955	17.25	8.30%	95.18%	0.03	14009.27	401.40	0.52
	35 mesh	50 mesh	0.05	0.03	0.04	3	1.44%	96.62%	0.01	33157.20	166.67	0.59
	50 mesh	PAN	0.03		0.015	7.02	3.38%	100.00%	0.001	1471295.59	1040.00	1.00
	Total					207.92					2530.19	
	Initial					211.08						

Table 3.4.1-1 – Size Distribution of Crushed Glass Particles (continued)

Sample	Screen Size		Size in Cm		Median	Weight	Weight %	Cumulative weight %	Surface Area	Number of Particles	Surface Area	Cumulative Surface Area
	Minus	Plus	Minus	Plus	Cm	Grams			Cm^2/ particle	this size	Total Cm^2	Area Fraction
S0-D3-1		9.5 mm		0.95		0	0.00%	0.00%				
	9.5 mm	4 mesh	0.95	0.475	0.7125	134.02	52.57%	52.57%	1.59	262.09	418.00	0.15
	4 mesh	6 mesh	0.475	0.335	0.405	37.91	14.87%	67.43%	0.52	403.67	208.01	0.23
	6 mesh	10 mesh	0.335	0.2	0.2675	31.91	12.52%	79.95%	0.22	1179.21	265.09	0.32
	10 mesh	14 mesh	0.2	0.141	0.1705	15.07	5.91%	85.86%	0.09	2150.68	196.42	0.39
	14 mesh	35 mesh	0.141	0.05	0.0955	25.49	10.00%	95.86%	0.03	20701.24	593.14	0.61
	35 mesh	50 mesh	0.05	0.03	0.04	5.28	2.07%	97.93%	0.01	58356.68	293.33	0.72
	50 mesh	PAN	0.03		0.015	5.28	2.07%	100.00%	0.00	1106615.49	782.22	1.00
	Total					254.96					2756.20	
	Initial					261.29						

Table 3.4.1-1 – Size Distribution of Crushed Glass Particles (continued)

Sample	Screen Size		Size in Cm		Median	Weight	Weight %	Cumulative weight %	Surface Area	Number of Particles	Surface Area	Cumulative Surface Area
	Minus	Plus	Minus	Plus	Cm	Grams			Cm^2/ particle	this size	Total Cm^2	Area Fraction
S0-D3-7		9.5 mm		0.95		0	0.00%	0.00%				
	9.5 mm	4 mesh	0.95	0.475	0.7125	109.91	45.55%	45.55%	1.59	214.94	342.80	0.10
	4 mesh	6 mesh	0.475	0.335	0.405	41.17	17.06%	62.62%	0.52	438.38	225.90	0.17
	6 mesh	10 mesh	0.335	0.2	0.2675	34.21	14.18%	76.79%	0.221	1264.21	284.20	0.25
	10 mesh	14 mesh	0.2	0.141	0.1705	14.34	5.94%	82.74%	0.09	2046.50	186.90	0.30
	14 mesh	35 mesh	0.141	0.05	0.0955	26.22	10.87%	93.60%	0.029	21294.09	610.12	0.48
	35 mesh	50 mesh	0.05	0.03	0.04	5.29	2.19%	95.80%	0.01	58467.20	293.89	0.56
	50 mesh	PAN	0.03		0.015	10.14	4.20%	100.00%	0.00	2125204.74	1502.22	1.00
	Total					241.28					3446.03	
	Initial					242.8						

Table 3.4.1-1 – Size Distribution of Crushed Glass Particles (continued)

Sample	Screen Size		Size in Cm		Median	Weight	Weight %	Cumulative weight %	Surface Area	Number of Particles	Surface Area	Cumulative Surface Area
	Minus	Plus	Minus	Plus	Cm	Grams			Cm^2/ particle	this size	Total Cm^2	Area Fraction
S0-D3-8		9.5 mm		0.95		0	0.00%	0.00%				
	9.5 mm	4 mesh	0.95	0.475	0.7125	96.43	42.09%	42.09%	1.59	188.58	300.76	0.09
	4 mesh	6 mesh	0.475	0.335	0.405	39.96	17.44%	59.54%	0.52	425.50	219.26	0.15
	6 mesh	10 mesh	0.335	0.2	0.2675	33.08	14.44%	73.98%	0.22	1222.45	274.81	0.23
	10 mesh	14 mesh	0.2	0.141	0.1705	15.81	6.90%	80.88%	0.09	2256.29	206.06	0.29
	14 mesh	35 mesh	0.141	0.05	0.0955	28.3	12.35%	93.23%	0.029	22983.33	658.52	0.48
	35 mesh	50 mesh	0.05	0.03	0.04	5.71	2.49%	95.72%	0.01	63109.21	317.22	0.57
	50 mesh	PAN	0.03		0.015	9.8	4.28%	100.00%	0.00	2053945.41	1451.85	1.00
	Total					229.09					3428.48	
	Initial											

3.4.2 TCLP Leaching and Particle Size Distributions

TCLP protocol requires that solid materials must be 9.5 mm or less. Glass samples generated from the crucible testing required size reduction to meet this standard.

Sample crushing methods are subjective, and the distribution of particle sizes greatly influences the surface area of the sample, as presented in Table 3.4.1-1 above. To determine if this would have a significant impact on the TCLP results, several samples were processed with and without the fine fraction. These data are presented in Table 3.4.2-1 below.

NOTE: These samples were selected at random from the initial glasses manufactured. Several of the samples included precipitated lead present in the samples submitted for TCLP. It is believed that the lead stayed with the course fraction of the sample. This is based on the malleability of the lead, and the improbability that a significant fraction of the lead was sufficiently friable/fracturable to produce particles of less than 0.03 cm. The samples that had observed metal precipitation are noted.

Based on this data, the fine fraction increases the lead concentration in the leachate (on average) between 9% (for all data) and 16% (for all data less samples with precipitated metals). This is based on 'typical' size reduction methods, without attempting to over-reduce the material.

All TCLP data reported to FDF was based on testing using the complete, unsieved sample. Though the data presented does not change the testing protocol or outcome of the glass formulation development, it emphasizes that the size reduction methodology, and resulting particle size distribution, have a direct impact on the results of the TCLP test. It also emphasizes that the size reduction used in the test should be representative of the actual wasteform within the limitations of the TCLP protocol. Excessive size reduction will skew the results, and should be controlled to avoid variations between tests and technologies.

Table 3.4.2-1: TCLP Leaching (Pb) Based on Particle Size Split

	TCLP for Pb (ppm)			
Sample	**without fine fraction**	**with fine fraction**	**Leachate concentration change increase (decrease)**	**Precipitated Metals (?)**
S0-D1-10*	1.5	1.9	27%	No
S0-D3-1*	2.1	2.5	19%	No
S0-D3-2	1.8	2.4	33%	No
S0-D3-3	2.0	2.2	10%	No
S0-D3-4	1.7	2.0	18%	No
*S0-D3-7**	*2.1*	*1.8*	*(14%)*	*No*
S0-D3-8*	1.7	2.2	29%	No
S0-D2-5	*2.1*	*1.6*	*(23%)*	*Yes*
S0-D2-8	*2.7*	*2.3*	*(15%)*	*Yes*
S0-D3-5	*2.0*	*2.0*	*0*	*No*
S0-D3-6	1.6	1.9	19%	no

* Indicates those samples for which seive analysis was conducted, as presented in Table 3.5.1-1.

Note: Italicized samples indicate a departure from expected response (i.e. a decrease in leaching with increased fine material)

4.0 GLASS RECIPE DEVELOPMENT

4.1 Targets for Glass Recipe Development

4.1.1 Glass Viscosity Target

Envitco targeted a glass viscosity for the demonstration glass formulation of approximately 100 poise (log of viscosity=2) at 1300°C. By design, Envitco can operate at a higher or lower viscosity, though this was used as a baseline for the formulation development.

Glass viscosity on a bench-scale was estimated visually during the sample manufacturing process. This served as a screening process to eliminate glasses that were either too fluid or too viscous at the testing temperatures. The glasses were examined while being poured from the crucibles and the viscosity evaluated. This yielded both an estimated viscosity and a subjective assessment of the viscosity relative to other glasses produced. Glycerin viscometer standards of 56, 133, and 333 poise at 20°C were used as a reference for estimating the viscosity and for 'eye calibration'. The viscosity standards would be poured between containers to provide a quantitative visual reference for estimating glass viscosity when the glass melts were poured from the crucibles.

4.1.2 Glass Leachability Targets

The Contract specified the leachability requirements of the wasteform based on TCLP performance. Glasses for each surrogate (i.e. S0, S1, and S2) were developed to meet two different standards:

- 50% of the allowable leaching levels under current RCRA regulations for TCLP; and
- 100 % of the allowable leaching levels under current UTS standards.

These limits were presented in Table 2.1.1-3 in Section 2.1.1 of this report.

4.1.3 *Glass Redox Targets*

Process control has been identified as a critical aspect of the vitrification process due to the presence of sulfates and reducible metals, as well as melter construction materials that are sensitive to the oxygen fugacity in the glass (DOE 1997). The glass redox state as measured by the ratio of Fe^{+2} to the total iron present in the glass ($Fe^{+2}/\sum Fe$) provides an indicator of the oxidation state of the transition metals and reducible species present.

Redox measurements on initial melts indicated reductant additives would likely be required for redox control. The initial target range for redox was $0.1<Fe^{+2}/\sum Fe<0.4$. Observations of metallic Pb separation in the crucible glass melts indicated that a tighter target range for redox of $0.1<Fe^{+2}/\sum Fe<0.2$ was necessary to avoid metal precipitation.

4.2 Treatment Recipe Development – S0 – TCLP-Compliant Glass

Based on literature review and prior experience with the Transportable Vitrification System (TVS) operations, the lithia-soda-lime-silicate glass system was selected for initial recipe development efforts. (Bechtel Jacobs 1998; Jantzen 1998). Several crucible melt series were performed with the S0 surrogate with the objective of developing an optimum recipe for the POPT demonstration meeting the 50% of TCLP leaching requirement.

4.2.1 *First Glass Series – S0-D1*

The primary objectives of this initial series of 10 glass melts were to determine the correct alkali addition to achieve a melt viscosity of 50 to 100 poise at 1300°C, and to determine the impact of oxidant/reductant additions to the batch. A third objective was to observe the effect of alkali content on TCLP leaching. These glasses use a mixture of additives for fluxing. (Volf 1984; Vogel 1985). The glasses in the S0-D1 series were produced as a screening to provide a baseline for subsequent glass formulations.

4.2.1.1 Alkali Variation (Glasses S0-D1-1 through S0-D1-5)

Glasses S0-D1-1 through S0-D1-5 decreased the glass alkali content from ~ 28.7 to 16.8 mol% (20.8 – 11.8 wt%) in five steps of ~ 3 mol% each. Glass S0-D1-4 was shown to be within the viscosity target, and the slightly more viscous S0-D1-5 was also usable. Only S0-D1-5 achieved the 50% of the TCLP limit for lead.

2291

4.2.1.2 Impact of Oxidant/Reductant (S0-D1-6 through S0-D1-9)

Glasses S0-D1-6 through S0-D1-9 were variations on S0-D1-4, and tested the effect of oxidant and reductant additions. Glasses S0-D1-6 and S0-D1-7 modified the additives for a greater oxidation. Glasses S0-D1-8 and S0-D1-9 had 0.1 wt% and 0.2 wt% equivalent carbon addition of a reductant based on glass oxide weight.

4.2.1.3 Presence of Molten Salt

All of the S0-D1 series glasses exhibited a significant amount of molten salt separated on the glass surface during melting. At 1300°C, this molten salt volatilized slowly, resulting in visible fuming of the salt. These glasses were cooled in the crucible, retaining the molten salt layer on the surface. After cooling, the crystallized salt layer was chipped off and weighed. The weights of the collected salts are presented in Table 4.2.1.3-1, "Effect of Oxidant/Reductant Additions on Molten Salt Formation."

Table 4.2.1.3-1 Effect of Oxidant/Reductant Additions on Molten Salt Formation

Glass	Variable	Sample No.	Collected Salt Weight	Salt Generation
S0-D1-4	No Oxidant/Reductant	XGLS-S0-T-0011	9.12 gm	3.6 wt%
S0-D1-7	14.3% Na_2NO_3 Substitution	XGLS-S0-T-0012	8.45 gm	2.1 wt%
S0-D1-6	6.4% Na_2NO_3 Substitution	XGLS-S0-T-0013	8.90 gm	2.3 wt%
S0-D1-9	0.2% C Equivalent Addition	XGLS-S0-T-0014	7.58 gm	2.0 wt%

Analyses of the salt samples show primarily Na_2SO_4 with lesser amounts of other alkalis, potassium, barium, calcium, and phosphate components. The chromium also appears to have preferentially segregated to the salt phase.

The decrease in salt generation under more oxidizing conditions was not anticipated. One possible explanation lies in the effect of added alkalis (even nitrate), promoting the destruction of a barium sulfate component in the collected salts.

Subsequent testing confirmed that reductants added to the batch were also effective in volatilizing the sulfate salts. In addition to a need to minimize salts, one of our target goals was to maintain a reduced glass in the redox range of $0.1<Fe^{+2}/\sum Fe<0.4$ for the protection of Mo electrodes. Therefore, the control of salts by use of reductants was emphasized.

4.2.1.4 Presence of Precipitated or Settled Metallic Phases

No separated phases, other than the salt phase, were observed.

4.2.1.5 Effect of Batch Redox on the Final Glass Redox

Samples collected from batches S0-D1-5 (baseline), S0-D1-7 (with increased oxidant), and S0-D1-9 (with increased reductant) were submitted for Redox analysis. The results are presented in Table 4.2.1.5-1, "Variation of Glass Redox." The increase in an oxidant in the S0-D1-7 glass appeared to have no effect on the oxidation state of the glass. The organics in the surrogate also appeared to have minimal impact, based on the low redox ratio of the S0-D1-5 baseline glass. As discussed later, it appears that these organics are volatile at early stages in the batch heating. The increase in a reductant as a batch additive in the S0-D1-9 glass did appear to effectively react with reducible batch components, increasing the glass $Fe^{+2}/\Sigma Fe$ redox ratio to 0.169.

Table 4.2.1.5-1 Variation of Glass Redox

Sample No.	Glass	Oxidant/Reductant	Fe+2/ΣFe
XGLS-S0-T-0006	S0-D1-5	None	0.032
XGLS-S0-T-0012	S0-D1-7	14.3% Substitution of $NaNO_3$	0.035
XGLS-S0-T-0014	S0-D1-9	0.2% Equivalent C	0.169

4.2.1.6 Effect of Batch Redox on Glass Quality

For the period of glass melting used (~50 minutes at 1300°C), the glass containing reductant was clearly the highest "quality" glass produced. The level of contained seeds and bubbles was very low, and homogeneity of the glass appeared noticeably better. These glasses were darker in color, indicative of higher levels of iron reduction as in amber glasses. The glasses using substitution of sodium nitrate did show a strong concentration of residual bubbles in the center of the crucible, indicative of poor refining. While refining is not a requirement of the wasteform, high seed levels are not desirable.

4.2.1.7 Glass with High Level of Additive Y (S0-D1-10)

The S0-D1-10 glass was formulated by substituting additional amounts of additive Y for surrogate in the S0-D1-4 glass to increase the concentration of Y from 3.9 to 10.1 wt%. The objective was to see if increasing this component

would significantly increase TCLP durability. This glass was later seen to be improved in durability (2.02 ppm Pb) over S0-D1-4 (2.61 ppm Pb) and within a workable viscosity range.

4.2.1.8 Effect on Glass Leaching (TCLP)

Samples of the S0-D1 series glasses were submitted to Texidyne, Inc. for TCLP testing. The samples submitted were sieved before testing, and represent only the coarse fraction of the size reduced sample (> 50 mesh). Removal of the fine fraction of the samples was shown to decrease surface area by at least 50% and will therefore decrease the overall leaching of the lead. Later TCLP samples submitted included all fines produced during the size-reduction process. These results, however, still provide a good basis for comparison of performance between samples. The TCLP results are presented in Table 4.2.1.8-1.

Table 4.2.1.8-1 Composition and TCLP Lead Release for S0-D1 Series Glasses

	Glass					
Property	**S0-D1-1**	**S0-D1-2**	**S0-D1-3**	**S0-D1-4**	**S0-D1-5**	**S0-D1-10**
Glass Sample	-0008	-0009	-0010	-0016	-0006	-0015
TCLP Sample	-0021	-0023	-0024	-0020	-0018	-0025
Waste Loading (wt%)	79.2	81.5	82.7	85.3	87.9	78.6
R_2O (wt%)	20.8	18.5	16.2	14.0	11.8	13.7
RO (wt%)	18.1	19.1	20.1	20.3	20.5	19.2
Component Y (wt%)	3.6	3.7	3.8	3.9	4.0	10.1
SiO_2 (wt%)	50.9	52.0	53.1	54.8	56.5	50.5
Pb Release (ppm)	6.08	4.41	3.53	2.61	2.07	2.02

The TCLP Pb release values ranged from a minimum of 2.07 ppm for the S0-D1-5 glass up to 6.08 ppm for the highest alkali content S0-D1-1 glass.

As anticipated, lead concentration in the leachate tracks downward with a reduction in the total alkali content in the glass. Subsequent glass formulations further decreased the alkali content while maintaining the target glass viscosity (less than 100 poise). Substitution of alkaline earths for the alkali in order to

maintain the proper viscosity characteristics was one approach used to accomplish this.

4.2.2 Effects of Lead and Lead Sulfide on Molybdenum Electrodes

Incorporation of the salt into the glass, as well as the presence of lead in the glass, poses a risk of lead metal or lead sulfide in contact with molybdenum components of the melter. A literature review was conducted to determine the possible risks associated with lead/lead sulfide and molybdenum interactions in the melter.

The Pb-Mo binary metal phase diagram shows no low-melting eutectics or intermetallic phases and only slight solubility of Mo in molten Pb. Other literature findings (Brewer 1980) indicated Mo solubility in Pb of only a few ppm at the glass melting temperature and less than 1 ppm at 1100°C.

4.2.2.1 Confirmation of Pb/Mo Interaction

Coupons of molybdenum metal were placed in small (75ml) high-alumina crucibles. A quantity of either lead metal shot or alternately, lead sulfide, was placed around the coupon, and the crucible filled with soda-lime glass cullet to provide an oxidation barrier above the Mo/Pb or Mo/PbS melts.

Initial experiments used Rosemont alumina crucibles (lower density) held at 1300°C for four (4) hours. Inspection revealed that both the Pb metal and the PbS had thoroughly wetted the molybdenum. There was no evidence of significant reaction or other damage to the molybdenum by the Pb metal. The coupons tested in the PbS indicated some level of corrosion in this short period.

A second set of experiments was performed using Coors metallurgical crucibles. The samples were again melted at 1300°C and held for 18 hours. Inspection revealed that the Mo sample in the molten Pb metal was well-wetted by the lead, but with no visible reaction (size reduction, surface reaction) observed. The Mo sample in the molten PbS could not be identified as a separate piece of material. It was completely incorporated into a reasonably uniform mass of material at the bottom of the crucible.

4.2.3 Second Glass Series – S0-D2

The path forward for the second glass series S0-D2 was based on the results from the S0-D1 Series. The objectives established for the second test series were:

1.) Decrease the level of lead leaching; and

2.) Enhance salt volatilization or salt incorporation in the glass.

Glasses produced during the S0-D1 Series were only slightly more durable than the 50% of TCLP Pb leaching requirement. This was not felt to be suitable. Glasses that performed with some margin of safety for TCLP leaching were required to ensure that glasses produced in the demonstration met all requirements.

The observed salt phase separation and accumulation on the glass melt was also determined to be unacceptable due to the potential for partitioning of heavy metals and radionuclides to the salt phase. This concern lead to the establishment of a process philosophy requiring that the salts be either volatilized or incorporated into the glass matrix.

4.2.3.1 Basis for Series S0-D2 (Increased Salt Solubility)

Several notations in the literature indicate that certain metal ions in the glass structure can combine with excess sulfur to form stable compounds under reducing conditions (Volf 1984; Weyl 1951). This metal oxide (X) was identified as a candidate additive to suppress the formation of a separate salt phase during melting. The addition of this oxide would be coupled with variable reductant additions as a possible method for reducing sulfate salt phase separation.

A third variable, decreased waste loading, was also incorporated into the S0-D2 series in an effort to lower the lead leaching characteristics as well as the amount of sulfate to be processed.

4.2.3.2 Glasses of the S0-D2 Series

Eight glass formulations were generated, but only the S0-D2-5 and S0-D2-8 formulations were melted. The S0-D2-8 glass was prepared using in turn zero, 0.25 wt%, and 0.5 wt% equivalent carbon addition.

4.2.3.3 S0-D2 Series Results Summary

The results relative to salts and metals separation and TCLP Pb releases are summarized below in Table 4.2.3.3-1, "Results from Glass Series S0-D."

Table 4.2.3.3-1 Results from Glass Series S0-D2

Glass	Additive X (wt%)	Reductant (wt%) Equivalent C	Reductant (form)	Salt Phase*	Metal Phase*	TCLP Pb Release
S0-D2-5	2.5	0.5	Powder	N	Y	1.6 ppm**
S0-D2-8	5.0	0.5	Powder	N	Y	2.3 ppm**
S0-D2-8	5.0	0.25	Powder	Y	Y	NA
S0-D2-8	5.0	0.0	Powder	Y	N	NA

* Y=yes, N= no **TCLP sample included fines.

4.2.3.4 Presence of Separated Salts

With the highest level of reductant addition, no separated salts were noted after casting. This is assumed to be associated with the chemical reduction of the sulfate to SO_2 in the early stages of melting. At lower levels of reductant added to the batch (0.25 and 0.0 wt%), excess salts were still present.

The S0-D2-8 melts were allowed to cool undisturbed in the crucibles after melting, and the separated salts on the surface chipped off and weighed. The precipitated metal was also collected and weighed. The weights of the salts and metals collected are given in Table 4.2.3.4-1.

Table 4.2.3.4-1 Effect of Carbon Addition with Glass S0-D2-8

% Reductant addition	Weight Salts	Weight Metals
0.5	0.0 gm	3.8 gm
0.25	1.61 gm	0.5 gm
0.0	3.90 gm	0.0 gm

The data indicates that reductant addition is effective in mitigating the formation of a separate salt phase. The proper reductant addition required to chemically reduce the sulfate without inducing metal precipitation remains to be determined. The metal phase seen in these two glasses was largely lead. Obviously, the goal would be to provide a glass/batch formulation where separation of a salt layer is prevented, but which does not give precipitated metals.

4.2.3.5 Effect of Metal Oxide Additive X on Sulfate Solubility

2291

The results from S0-D2 glasses were insufficient to provide conclusive data on the effect of the metal oxide X on salt solubility. Additional experiments would be required to separate this effect from the strong action of the direct reductant addition.

4.2.3.6 Effect of Metal Oxide Addition X on Glass Leaching

Samples of S0-D2-5 and S0-D2-8 melts were submitted for TCLP testing. The Pb releases were 1.6 ppm and 2.3 ppm respectively for these two glasses. Both of these glasses had exhibited precipitated metal. While an inverse relationship of metal oxide X with durability could be surmised from these results, it is believed that the TCLP leaching results for Pb are being driven by the presence of precipitated lead in the glass. The obvious pieces of precipitated lead were removed prior to submission in order to get a leaching value of the glass that would be produced by the melter. The melter will collect and drain metals separately from the glass. Inclusion of the lead would have given an uncharacteristically high lead leaching value not associated with the glass. The high values experienced in the test were probably due to small droplets present in the glass not easily visible to the naked eye. Therefore, the effect of metal oxide X on durability is not clearly demonstrated by these results.

4.2.4 Third Glass Series – S0-D3

4.2.4.1 Basis for Series S0-D3 (Increased Durability)

A primary objective of the S0-D3 series was durability improvement. Several component variables were tested in order to provide insight into this durability challenge. Table 4.2.4.1-1, "TCLP Results from S0-D3-Series," presents the Series S0-D3 glasses, glass type, and TCLP for Pb results.

Table 4.2.4.1-1 TCLP Results from S0-D3 Series

Sample No.	Glass	Glass Type	TCLP for Pb (ppm)
-0047	S0-D1-10	10% Additive Y	1.7/2.0 *
-0050	S0-D3-1	10% RO-1 / 1.2%RO-2	2.5
-0059	S0-D3-2	10% RO-1 / 3% RO-2	2.4
-0062	S0-D3-3	4.5% additive Z	2.2
-0065	S0-D3-4	9.0% additive Z	2.0
-0038	S0-D3-5	1% additive A	2.0
-0039	S0-D3-6	3% additive A	1.9
-0053	S0-D3-7	3:1 alkali mole ratio	1.8
-0056	S0-D3-8	1:3 alkali mole ratio	2.2

* Results from two separate batch preparations and melts.

4.2.4.2 Summary of S0-D3 Results

All of the glasses in this series used additive Y at the 10% level. This had already demonstrated a significant benefit in durability. The addition of additive A showed slight improvement in durability, although not what was expected. The use of higher levels of a specific alkali compound provided the most significant benefit in durability. Although the durability was not any greater than the

S0-D1-10 base glass, the 3:1 ratio showed a significant benefit over the 1:3 ratio. Future glass formulations considered the impact of this alkali mole ratio, with efforts placed on further optimizing the demonstrated benefits.

4.2.5 Fourth Glass Series S0-D4

The main objectives of the S0-D4 series were to explore additional variables to further improve durability, and to test alternatives to the reductant utilized as a batch additive in the S0-D2 Series.

4.2.5.1 Basis for S0-D4 Series (Improved Durability)

Three variables were screened in the S0-D4 series. The variables included:

- increased alkaline earth (RO) to substitute for the alkali content;
- additional substitution of additive A; and
- decreased waste loadings.

A borosilicate formulation and partial substitution of B_2O_3 for CaO were also screened in the S0-D4 series.

4.2.5.2 Summary of Results for the S0-D4 Glass Series

Results confirmed that a decrease in waste loading resulted in improved durability (Pb leaching). This approach does not favor low treatment costs and should be avoided if possible.

Use of a higher mole ratio of the alkali components, as discussed earlier, was confirmed as improving the durability of the glass. It was also seen to significantly decrease the tendency for salt phase separation.

From the leaching results, use of B_2O_3 appeared to be of some benefit. Based on the literature, B_2O_3 may decrease sulfur solubility, increase volatility and increase the tendency for glass phase separation (Volf 1984; Scholes 1975). Based on discussion in the literature, however, any durability benefits gained using borosilicate formulations may be over-shadowed by other issues. No further investigations of boron oxide additives were performed.

The use of additive X, along with a reductant and a shift in the alkali ratio, resulted in elimination of residual salts. The effect of the batch reductant and of the shift in alkali ratio was very strong in eliminating salts. However, the impact of the additive metal oxide X is unclear and should be investigated further.

Reductant additions of 0.125 wt% and 0.25 wt% equivalent carbon produced glasses with acceptable redox state ($Fe^{+2}/\Sigma Fe$) with neither separated salt nor precipitated metal phase.

Table 4.2.5.2-1 Summary of Results for S0-D4 Series

Glass	Alk. Mol Ratio	Add.Y Wt%	Add.X Wt%	Add.A Wt%	B_2O_3 Wt%	Waste Loading	% C Equiv.	Salts	Metal	Redox	TCLP Pb (ppm)
S0-D4-1	1	10	2	4	0	60	0.3	N	N	--	1.6
S0-D4-2	2	10	2	4	0	60	0.3	N	N	--	1.2
S0-D4-3	1	10	2	4	5	60	0.3	N	N	--	1.3
S0-D4-4	1	10	2	0	9	71	0.3	N	Y	--	1.8
S0-D4-5	1	10	2	0	5	72	0.3	N	Y	--	1.9
S0-D4-6	1	10	1.5	0	0	74	0.3	N	Y	--	2.3
S0-D4-7	1	10	0	0	0	70	0	Y	N	0.05	1.9,1.9
S0-D4-8	1	10	0	0	0	60	0	Y	N	0.04	1.6,1.6
S0-D4-11	2	10	1.5	0	0	70	0	Y	N	0.07	1.9
S0-D4-11	2	10	1.5	0	0	70	0.1	N	N	0.18	1.2
S0-D4-11	2	10	1.5	0	0	70	1.2	N	N	0.21	–
S0-D4-11	2	10	1.5	0	0	70	0.3	N	Y	0.25	–
S0-D4-11	2	10	1.5	0	0	70	0.4	N	Y	0.28	–

4.2.6 S0-D5 Glass Series

The objective of the S0-D5 series was to isolate a glass formulation based on the performance, trends and lessons learned from the prior four-glass series. The selected formulation would serve as the baseline glass formulation for the POPT melter demonstration.

4.2.6.1 Basis for Glass Series S0-D5

Within the range of prior glass testing, the following glass formulation parameters approach an optimized glass system:

- Approximately ~80 wt% waste loading;
- 15-16 mol% R_2O;
- 15-17 mol% RO; and
- 9 wt% additive Y

2291

Variables to be investigated to refine the formulation include:

- Ratio of R_2O compounds, maintaining an overall 15 mol% R_2O;
- Additions of additive X at 0.0 wt%, and 1.5 wt%; and
- Reductant additions of 0.1, 0.2, 0.3, and 0.4 wt% equivalent carbon

The S0-D5 series was structured to provide direct comparisons of all the three variables.

4.2.6.2 Impact of the Alkali Compound Ratio

As noticed in previous glasses, the higher alkali compound ratio has a significant impact on minimizing salt phase segregation. However, no relationship between durability and alkali compound ratio at moderate reductant levels appears to exist.

4.2.6.3 Impact of the Level of Additive X in the Glasses

The addition of additive X did not produce a clear effect on minimization of separated molten salts. Additive X did, however, produce a reduction in TCLP Pb release at higher reductant levels.

4.2.6.4 Comparison of Glasses at Different Redox Levels

Additions of a specific reductant in proportions between 0.3 - 0.4 wt% equivalent carbon were seen to totally avoid salt phase accumulation. Levels of 0.3 wt% may be appropriate, assuming there is sufficient melt time to permit all of the salts to volatilize. None of the glasses produced secondary phase metals. The S0-D5-2 glass recipe with an alternative reductant, equivalent to 0.4 wt% of the specific reductant previously discussed, resulted in the best overall performance of the S0-D5 series glasses.

4.2.6.5 S0 Demonstration Glass (S0-D5-2)

Glass S0-D5–2 was seen to be appropriate for use in the POPT demonstration trial. This glass had 83.9 wt% waste loading and demonstrated approximately the target viscosity range of 100 poises at 1300°C.

The glass analysis, both from the theoretical prediction and from actual analysis from the POPT trial samples, is shown on Table 4.2.6.5-1. Table 4.2.6.5-2 presents the laboratory batch formulation for this glass. Table 4.2.6.5-3 presents

additional information on the effect of reductant on salt and metals formation, redox ratio, and lead leaching.

Table 4.2.6.5-1 Measured/Predicted Glass Composition of S0-D5B-2

Oxide	Predicted *	Measured **	Method
(wt%)	(wt%)	(wt%)	
R_2O	9.49	9.08	ICP
As_2O_3	0.08	Not measured	
BaO	4.16	4.21	ICP
Cr_2O_3	0.10	Not measured	
Fe_2O_3	2.20	Not measured	
MgO	0.94	0.72	ICP
NiO	0.34	0.34	ICP
P_20_5	0.82	0.86	ICP
PbO	9.48	9.56	ICP
SO_3	2.70*	0.35	LECO
SeO_2	0.05	Not measured	
SiO_2	52.55	58.2	ICP
V_20_5	0.07	Not measured	
From other Additives	17.02		

* - does not compensate for volatility losses or losses due to reaction with reductant

** - from Sample XGLS-S0-T-0232 submitted to Corning December 6, 1998.

EnVitCo, Inc.
A COGEMA Group Company

2291

Table 4.2.6.5-2 S0-D5B-2 Glass Crucible Melt Batch Sheet

Batch Sheet for S0-D5B-2-S1, 2, 3, 4 Crucible Melts

83.9 wt% Waste Loading, Total Alkali 9.49 wt%, Oxide from Additives 17.02 wt%

Reductant added at 0.1 to 0.4% wt% C*

Date Batched: _____

Dry Surrogate Weight: 400 gm

At ___ %H_2O, weigh out _____ gm. of wetted surrogate

	Wt-100	Target			
Component	**Dry Sur**	**Wt**	**+ Wt**	**- Wt**	**Actual Wt**
Surrogate	110.44	400.00	404.00	396.00	
Additive 1	13.98	50.63	51.13	50.12	
Additive 2	6.21	22.50	22.73	22.28	
Additive 3	13.81	50.00	50.50	49.50	
Additive 4	6.83	24.75	25.00	24.50	
Additive 5	1.95	7.06	7.13	6.99	
Totals	153.22	554.94			
		Reductant	+ Wt	- Wt	
-S1 (0.1% C*)	0.31	1.11	1.12	1.10	
-S2 (0.2% C*)	0.61	2.22	2.24	2.20	
-S3 (0.3% C*)	0.92	3.33	3.36	3.30	
-S4 (0.4% C*)	1.23	4.44	4.49	4.40	

* - C equiv. based on oxide wt.

Table 4.2.6.5-3 Effect of Reductant on Demonstration Glass S0-D5-2

Glass	Waste Loading	Wt% C equiv.	Redox value	Salts	Metals	TCLP Pb ppm
S0-D5-2	83.9	0.1	0.115	Y-Mod	N	–
S0-D5-2	83.9	0.2	0.103	Y-Mod	N	1.9
S0-D5-2	83.9	0.3	0.130	N*	N	1.6
S0-D5-2	83.9	0.4	0.160	N **	N	1.2,1.8

*- Salts not present at time of casting

** - Salts not seen during melting

4.2.7 The S0-D5B Glass Sub-Series – Verification of Demonstration Recipe

Glasses of the S0-D5 Series were later determined to contain excess $NaNO_3$ (2.82% rather than 1.03%) due to a batch calculation error. The corrected surrogate was used in later samples. The corrected S0 surrogate batch (with 1.03 wt% $NaNO_3$) was prepared and identified as S0-D5B. The major effect of the higher $NaNO_3$ was an increase in the oxidation capacity of the surrogate, negatively biasing the effect of reductant additions. With the correct surrogate (as in S0-D5B Glasses), any particular level of reductant would yield a higher redox ratio (more reducing) and more salt reduction than seen in samples from the S0-D5 Series. This should be considered when evaluating the data.

Using the new surrogate, a second set of S0-D5 glasses were prepared and tested. Based on the results of the S0-D5B Glass Sub-Series, the S0-D5B-2 glass was selected for POPT demonstration processing, with the reductant quantity adjusted to attain a redox ratio ($Fe^{+2}/\Sigma Fe$) of approximately 0.15 to 0.20. These S0-D5B glasses showed neither salt generation nor metals precipitation at reductant additions of 0.2 or 0.3 wt% equivalent carbon. Addition of 0.4 wt% equivalent carbon to this batch, however, did result in metals precipitation. This is shown in tabular fashion on Table 4.2.7-1. Appendix, Section 10 provides more detail on this glass selected for the POPT demonstration.

Table 4.2.7-1 Effect of Batch Reductant Changes in S0-D5B-2 Glasses

Glass	Waste Loading	Wt% C equiv.	Redox value	Salts	Metals
S0-D5-2	83.9	0.1	0.135	N**	N
S0-D5-2	83.9	0.2	0.166	N**	N
S0-D5-2	83.9	0.3	0.188	N**	N
S0-D5-2	83.9	0.4	0.217	N**	Y

**- Salts not seen during melting

Confirmation of the redox state and effectiveness of the reductant in the continued cold-top melter would require verification once the POPT demonstration approached steady-state conditions. A lower level of reductant would be anticipated in a cold-top continuous melter to yield the same glass redox as in a crucible study. Therefore, it was decided that an equivalent carbon level of 0.1 or 0.2 wt% be used with careful monitoring of the glass redox level to keep this value below 0.20.

4.3 S1/S2 TCLP-COMPLIANT GLASSES

4.3.1 Basis for Glass Formulation Development

Glass formulation S0-D5B-2, which was utilized for the POPT demonstration, was used as the baseline for development of the S1 and S2 glasses. The essential features of the S0-D5B-2 recipe were:

- 83.9 wt% waste loading;
- molar ratio of two R_2O compounds = 2;
- total alkali of 9.50 wt%;
- 22.6 wt% RO including PbO;
- 9 wt% Additive Y; and
- 1.5 wt% Additive Z.

The glass system, as applied to the S1 and S2 surrogates, was modified slightly to accommodate differences in the waste composition. Reductant additions were adjusted in proportion to the oxidation capacity of the batch formulations.

All glasses were melted at 1300°C, in accordance with the original target processing conditions and glass sample production procedures. Batching,

charging and casting procedures applied to the previous glass formulation work were applied for the S1 and S2 testing.

4.3.2 Conversion of S0 Demonstration Glass to S1 and S2 Surrogates

Initial testing focused on formulation of S1 and S2 glasses to meet the TCLP requirements as stated in the Contract (re. 50% of TCLP). The approach to the glass formulation for S1/S2 surrogates was to fit the waste and additive package into the demonstrated glass formulation S0-D5B-2.

The glasses produced based on the S0-D5B baseline composition performed as expected, with leachate concentrations below the TCLP requirements. The results are presented in Table 4.3.2-1.

Table 4.3.2-1 Experimental Verification of S1/S2 TCLP Glass Recipes

Sample No.	Glass No.	Waste Loading	Pb Leaching Value (TCLP)
XGLS-S1-T-0685	S1-U1-1-S3	82.3 wt% -Contract Calc. 78.8 wt% - Oxide Basis	2.14
XGLS-S2-T-0702	S2-U1-1-S3	83.4 wt% - Contract Calc. 78.7 wt% - Oxide Basis	1.49

4.4 TREATMENT RECIPE DEVELOPMENT – UTS-COMPLIANT GLASSES

4.4.1 First UTS Glass Series – U1 Series (S0-U1, S1-U1 and S2-U1) - Variation in Waste Loading

4.4.1.1 Use and Supply of Surrogates

The S0-U1 series used the demonstration surrogate (S0) formulation as applied to all prior glass work. This is presented in Table B.1 of Section 10.

The Silo 1 (S1) and Silo 2 (S2) surrogates were premixed by FDF and supplied to Envitco in 10 kg lots. Data was provided by FDF on the dry basis weight (or wt%) and LOD of each additive in the surrogate. Calculated batches for the S1 and S2 surrogates, including the bentogrout additions, are provided in Tables B.5 and B.6 of Section 10.

The S1 and S2 surrogates supplied by FDF were noticeably different from the S0 demonstration surrogate material manufactured by Envitco and validated by FDF. These differences included a stickier consistency when mixed with water. Another difference was a coarse component from the "coarse silica" of the surrogate that was considerably more coarse than the corresponding material used by Envitco in the S0 surrogate.

This coarser sand resulted in two more observed differences. The first was more severe corrosion of the crucibles, even with the low-sulfate S2 surrogate. The greater corrosion was attributed to slower reaction between the sulfate and batch silica, increasing sulfate attack on the clay-bonded fused silica crucible. The second effect of the coarser silica was the presence of residual crystalline silica stones in the cast test melts when conducted at the time and temperature conditions that had been applied to prior melts with the S0 surrogate.

Some of the archive samples sent to FDF contained silica stones. These glasses were accepted due to the variation in surrogates described above (Bennert, April 5,1999). In order to prove that stone-free glasses could be manufactured, some of the samples were processed at temperatures of 1350°C (50°C increase) for 3 hours (twice as long). Stone-free glasses were indeed prepared and submitted to FDF. This provided assurance that the silica stones were not due to glass formulation but surrogate silica variations and process time/temperature considerations.

The differences observed in the surrogates would not pose a problem in the actual waste being processed in a full-scale melting operation. The cycle time through the melters would be many multiples of that in the crucible tests, yielding very long times available for full dissolution of any large silica particles.

4.4.1.2 Variation of Waste Loading (UTS-Compliant Glasses)

The initial approach to development of UTS-compliant glass formulations was the reduction of the waste loading while still maintaining the basic S0-D5B-2 glass system. Since performance of the glass was generally dictated by lead leachability, reduction in the total lead content through decreased waste loading would be expected to yield a reduction in the lead leachate concentration.

A series of six (6) glass recipes was formulated using each of the three surrogate types. Each recipe was based on a progressive reduction in waste loading while attempting to maintain the established fundamental glass system. The highest waste loading recipes in the S1-U1 and S2-U1 series (82.3 and 83.4 respectively) would not meet the UTS requirements. The lower waste loading glasses, with lower PbO content, were expected to be candidate recipes for the more stringent UTS release requirements.

This theory was validated by the analytical results, confirming that lead leaching decreases as waste loading decreases. Based on the TCLP data presented in Table 4.4.1.2-1, a UTS-compliant glass was produced with the S1 surrogate at both 30% and 40% waste loading. The S0 and S2 surrogate produced UTS-compliant glasses at 30% waste loading.

Table 4.4.1.2-1 UTS Glass Leaching Results

Glass Composition	Waste Loading*	TCLP Pb Leaching (ppm)
S0-U1	30%	0.40
S1-U1	30%	0.70
S1-U1	40%	0.53
S2-U1	30%	0.58

*higher waste loadings are possible – see Section 4.4.3

4.4.1.3 Prediction of Durability Improvements Based on Reductant Adjustment

A trend that has been observed throughout the glass formulation work is a strong decrease in lead leaching at higher reductant levels. Based on this trend, it is logical to anticipate improvement in the measured performance of 40% waste loading glasses S0-U1-5-S2 (0.2 wt% C) and S2-U1-5-S1 (0.1%C), which just barely failed the UTS limit. These glasses demonstrated leachate concentrations of 0.89 and 0.82 ppm, respectively. It is assumed that an increase in the reductant to 0.3 wt% equivalent carbon for S0 and S2 would decrease the leachate concentration to below 0.75 ppm at 40% waste loading and probably for 50% waste loading as well.

4.4.2 Second UTS-Compliant Glass Series - S1-U2 - Variation of Composition

4.4.2.1 Experimental Design

While the previous test series with decreased waste loading produced UTS-compliant glasses, the low waste loadings were not economically desirable. A second series of developmental glass melts was developed to determine if higher waste loadings could be attained.

The U2 series was a three-dimensional matrix of experimental melts designed to show the effect of five variables on durability and processability.

- Additive X – three levels, 2%, 4%, and 7%, with corresponding decreases in other RO components;
- Additive A – three levels, 0%, 3%, and 6%;
- Alkali Ratio- two levels, 2:1 and 3:1 while maintaining constant R_2O level;
- Additive Y – two levels, 9%, and 6%; and
- Reductant addition – two levels, 0.2%, and 0.3% equivalent carbon.

The first three variables were set up as a 3 x 3 x 2 matrix with 18 discrete experimental points. The fourth and fifth variables were imposed as composition alternatives to these experimental points, e.g. most of the matrix points at a particular combination of additive X, A, and Y were melted at several levels of reductant addition.

This series of glasses was performed using only the S1 surrogate as provided by FDF. The results and observations from the S1 surrogate glasses were then applied (empirically and/or theoretically) to the S0 and S2 surrogates.

4.4.2.2 Impact of Additive A

The effects of additive A in the glass were mixed. The improvement in durability was significant at high levels of additive X. The data indicates that additive A may suppress metal precipitation, though there was no indication of suppressed salt phase formation. The benefits justify the use of additive A in any subsequent S0 and S2 UTS glass tests.

4.4.2.3 Impact of Additive X

The effects of increased levels of additive X in the glass were also mixed. Four of the comparisons showed major improvements in durability, two showed minor decreases in leaching, and one showed no significant change. Overall, the data indicates that increased levels of additive X are beneficial.

4.4.2.4 Impact of Additive Y

The limited experiments comparing the effects of additive A at 6 or 9 wt% indicated no significant difference. This is a favorable outcome, since subsequent glasses can be manufactured with only 6 wt% of additive A. This

allows for increased levels of SiO_2 for increased resistance to leaching and reduces the overall cost of glass additives.

4.4.2.5 Impact of the Alkali Ratio

Increases in the alkali ratio used in the glasses showed mixed results, with little effect on the glass durability. The increased alkali ratio did, however, suppress the generation of excess molten salts. Increases in this ratio will be applied to improve processability by retarding salt phase separation.

4.4.2.6 Impact of Reductant Additions

Increases in the reductant levels produced the most marked effect of any of the variables investigated. Durability improvements were apparent in most glasses, including even some glasses with precipitated metals. The added reductant had a strong effect on suppressing the amount of residual excess molten salts, as clearly shown in previous tests.

Reductant additions to the glass recipes will be maintained at as high a level as is possible within the acceptable bounds of processing and metal precipitation limits.

4.4.2.7 Results of S1-U2 Series

Three of the glasses of the S1-U2 recipe development series passed the UTS durability standards. These glasses were all formulated with a 50 wt% S1 surrogate waste loading. These are presented in Table 4.4.2.7-1 as they were outlined in the experimental testing matrix.

Table 4.4.2.7-1 – UTS-compliant S1-U2 Glasses

Glass	Alkali ratio	R_2O wt%	RO wt%	Additive Y wt%	% C equivalent	Additive X wt%	Additive A wt%	TCLP Pb (ppm)
S1-U2-10	2	10.0	20.2	9	0.3	2	6	0.58/0.73
S1-U2-8	2	10.2	21.6	9	0.2	7	3	0.60
S1-U2-14	3	9.2	21.6	9	0.3	7	6	0.65

4.4.3 Summary - UTS-Compliant Glasses For S0, S1, and S2 Surrogates

The demonstration glass (S-D5B-2) was adapted to use of the S1 and S2 surrogates, holding the oxide components as close to the same as possible while maintaining similar properties. In addition, the waste loading for each of the surrogate glasses was then reduced from the roughly 80 wt% level stepwise down to 30%, again maintaining processibility of the glass. The UTS-compliant glasses were further developed by a matrix evaluation of the effect of 4 variables on the S1 glass at 50% waste loading.

The S0, S1 and S2 UTS-compliant glasses are in the following composition range:

- 50 wt% waste loading;
- 9.2-10 wt% R2O;
- Alkali Ratio of 2;
- 20.2-21.6 wt% RO;
- 0.2-0.3 wt% C equivalent batch reductant;
- 4 - 7 wt% additive metal oxide X; and
- 3 - 6 wt% additive metal oxide A.

NOTE: Several UTS-compliant glasses were prepared from the S1 surrogate at a 50% waste loading. The S1 surrogate was the most challenging with respect to leaching due to both high sulfate level and high lead content. Experimental results for S1 could then be reasonably applied to the S0 and S2 surrogates. The S0 surrogate has 30% less sulfate and only 2% higher lead content than the S1 surrogate. The S2 surrogate has both 34% lower sulfate and a 45% lower lead content than the S1 surrogate. Therefore, 50% waste loading glasses for S0 and S2 UTS-compliant glasses are feasible.

Earlier experimental work (U1 Series) also showed UTS-compliant glasses were developed by decreasing waste loading only. Evaluation of the data on reductant use confirmed that all three of the surrogates would yield UTS-compliant glasses at a minimum of 40% waste loading if the equivalent carbon batch additions were increased to 0.3 wt%. Further recipe development increased durability to the level where 50% waste loading is achievable with all of the surrogates.

5.0 PROOF-OF-PRINCIPLE DEMONSTRATION

5.1 Demonstration Description

The POPT melter demonstration was conducted in January, 1999. Surrogate slurry was manufactured and treated in the Envitco WASTE-VIT® EV-101 melter. The feed, melter and glass handling systems were operated in a manner similar to the proposed full-scale design. Samples were collected throughout the demonstration and analyzed in order to produce a material balance. Operations, analytical, and material balance data were used in the design of the full-scale vitrification system presented in Section 6.

5.1.1 POPT Demonstration Objectives

The following list presents the specific test objectives of the POPT demonstration, as presented in the Work Plan, and how each objective was met during the demonstration:

1) OBJECTIVE: Perform the demonstration continuously under steady-state conditions over a 72-hour period with no more than 3.5 hours of downtime.

   RESULT: Continuous 72-hour demonstration with only 4 minutes of downtime due to a slurry system valve failure.

2) OBJECTIVE: Prepare a minimum of 5 batches of demonstration surrogate slurry prior to initiation of the 72-hour test.

   RESULT: Five (5) batches of demonstration surrogate were prepared prior to initiation of the test.

3) OBJECTIVE: Maintain an average target processing rate equivalent to 2600 kilograms of surrogate slurry (30 wt% solids) per day.

   RESULT: Stable melter operation was achieved at 46.4 % (by weight) of the target rate. A total of 7800 kg of surrogate was processed at this rate. The lower processing rate was approved by FDF as discussed in Section 5.1.5.

4) OBJECTIVE: Operate under conditions that minimize the production of secondary wastes.

RESULT: Secondary waste was minimized during the demonstration as evidenced by no molten salt nor metal draining. Low offgas entrainment was demonstrated at <0.1 wt% of the feed.

5) OBJECTIVE: Evaluate the ability to recycle condensed offgas blowdown liquids and scrubbed offgas solids to the melter feed for purpose of secondary waste minimization.

   RESULT: The POPT used a dry treatment system that did not produce offgas blowdown. The full-scale design described in Section 6.0 of this Report includes the evaluation of recycling offgas solids.

6) OBJECTIVE: Collect samples prior to, during, and after the demonstration in accordance with Section 7.0 - Sampling, Data Collection, and Analysis Plan of the Work Plan.

   RESULT: Surrogate, melter feed, glass, offgas and secondary waste samples were collected in accordance with the Work Plan.

7) OBJECTIVE: Analyze representative samples of the treated surrogate in accordance with Section 7.0 - Sampling, Data Collection, and Analysis Plan of the Work Plan.

   RESULT: Samples collected during the demonstration were analyzed according to the Work Plan. The results of these analyses are presented in this Report.

8) OBJECTIVE: Demonstrate operability and processability.

   RESULT: The POPT demonstration system operated successfully throughout the demonstration. Operations were conducted by trained technicians under Envitco direction. Processability was demonstrated by successfully producing acceptable glass with no required molten salt draining.

9) OBJECTIVE: Conduct the POPT demonstration with process equipment similar to that proposed for the full-scale remediation facility.

   RESULT: The primary process equipment (feed mixing, melter, glass handling) was similar to the proposed full-scale design. They were also operated in a manner similar to the proposed full-scale design. Based on the evaluation performed as part of Objective No. 5, other technologies better suited to secondary waste recycle have been included in the full-scale design.

5.1.2 Facility Description

The POPT demonstration was performed at Clemson University's Clemson Environmental Technologies Laboratory (CETL) in Anderson, South Carolina. This facility has been used for numerous other vitrification demonstrations for both the Department of Energy, Envitco and Envitco's customers. The CETL facility includes laboratories for crucible melting, bench-scale operations areas, pilot-scale process demonstration areas suitable for the POPT melter operations, and office space for both CETL staff and visiting staff.

The demonstration was conducted in the High-Bay area of CETL. The High-Bay Extension was used to house the feed preparation system and spare parts. The combined floor space occupied by the POPT demonstration melter system was approximately 110 m^2 (1,200 ft^2) inside the building plus approximately 55 m^2 (600 ft^2) of outdoor area.

5.1.3 Equipment Description

The following equipment and materials were used during the POPT demonstration run:

- Envitco WASTE-VIT® EV-101 Melter;
- Air Pollution Control Equipment;
  - film cooler
  - Electrostatic Precipitator (ESP)
- Slurry Preparation Equipment;
  - surrogate holding tanks with mixers
  - mixing tank
  - feed tank with mixers
  - diaphragm recirculation pumps
  - progressive cavity feed metering pumps
- Glass / Product Handling Equipment;
  - roller conveyors
  - 30 and 55-gallon drums
  - forklift
- Sampling Equipment;
  - sampling plate
  - steel sample pans
  - plastic sample containers
- Demonstration Surrogate;
- Glass Making Additives; and
- Utilities (electricity, water, compressed air, nitrogen).

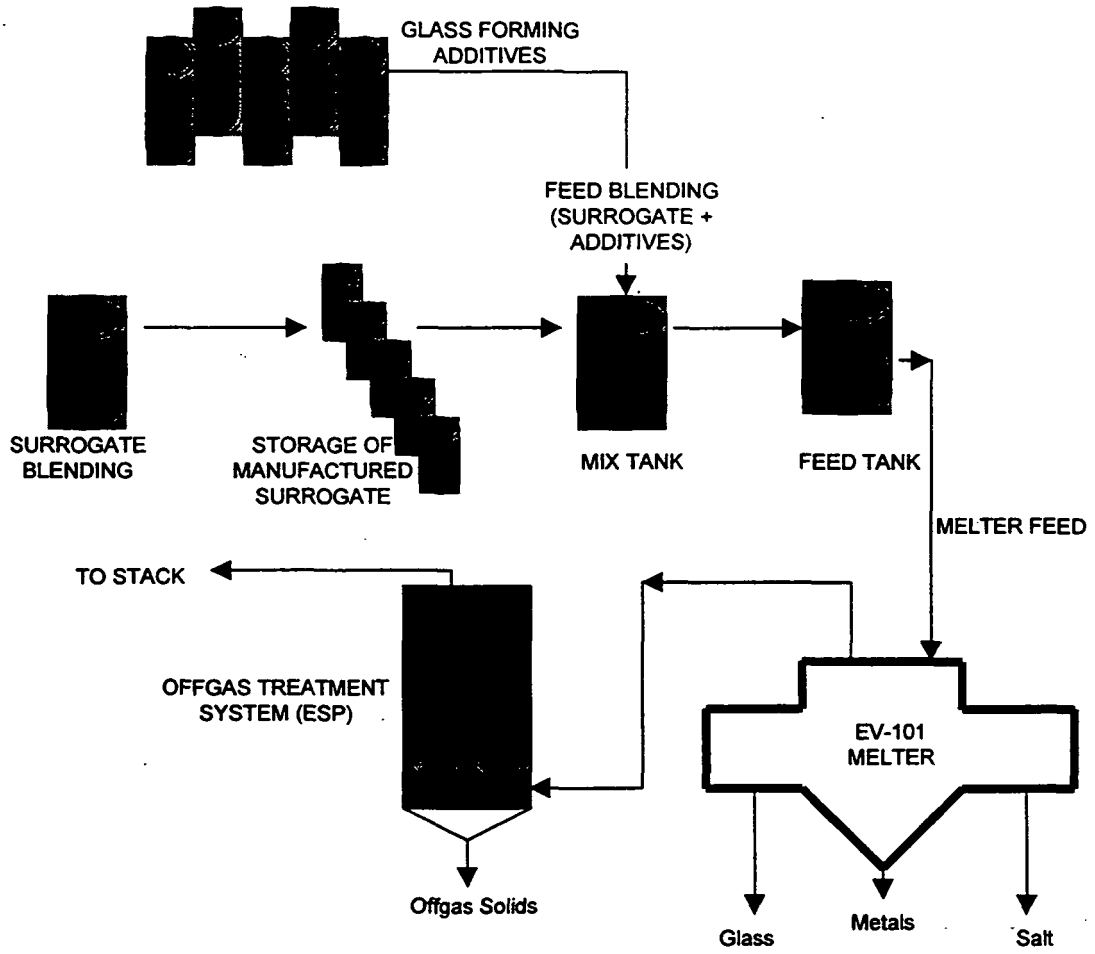
5.1.4 Demonstration Process Description

The POPT demonstration was conducted using a fully-integrated vitrification test unit at CETL. The system consists of the melter feed preparation, WASTE-VIT® EV-101 melter, auxiliary services (power, water, air, etc.), offgas treatment, and glass handling. The primary process steps were to:

- Manufacture the surrogate slurry;
- Convert surrogate into melter feed slurry by incorporating glass forming additives;
- Recirculate feed from the feed tank to the melter, and return to the feed tank;
- Meter a slip-stream of feed into the melter;
- Continuously melt and pour glass into 30-gallon steel drums; and
- Treat offgas with dry ESP.

Figure 5.1.4-1 shows a basic flow diagram of the POPT demonstration process. The same basic process flow for the full-scale design is described in Section 6 of this Report.

Figure 5.1.4-1 POPT Process Flow



5.1.4.1 Surrogate Preparation

The surrogate slurry was manufactured at least 24 hours prior to the initiation of the 72-hour test. Each batch of surrogate (30 wt% solids) was made according to Envitco-prepared batch sheets which served as a recipe log for surrogate manufacturing. These logs are included in this Report. The surrogate, as defined in Contract Modification No. 06, is presented in Table 5.1.4.1-1.

Table 5.1.4.1-1 Demonstration Surrogate Target Recipe
(Basis: g/100g dry solids)

Compound	Composite Dry	Surrogate Mix
Na_2HAsO_4	0.17	0.28
$BaSO_4$	8.18	8.18
Na_2CrO_4	0.27	0.39
Fe_2O_3	2.52	2.52
$Mg_3(PO_4)2$	1.46	1.46
$NaNO_3$	1.03	1.06
NiO	0.43	0.43
PbO	5.67	5.67
$PbCO_3$	6.60	6.60
$PbSO_4$	2.65	2.65
Na_2SeO_3	0.10	0.15
SiO_2 (see below)	48.83	48.83
V_2O5	0.09	0.09
ZnO	0.01	0.01
Tributyl Phosphate	0.92	0.92
Kerosene	0.92	0.92
Diatomaceous Earth	1.83	1.83
Feldspar	18.32	18.32
H_2O		

(SiO_2 mix = 20.81 Coarse, 18.90 Fine, 9.12 Fumed)

The surrogate mix takes into account the waters of hydration and adsorbed atmospheric water when manufacturing the surrogate. The surrogate was prepared as a 30 wt% solids slurry by the method defined in Contract Modification No. 01.

Surrogate Mixing Instructions

1. In accordance with the surrogate recipe and the batch sheet, add the desired amount of water into the mix tank.
2. Turn on the mix tank.
3. Add the bentonite while stirring/agitating.
4. Blend at high speed until the contents are well mixed.
5. Maintain the stirring for 24 hours to allow the bentonite to fully hydrate.
6. In a separate container, add the organics to the fine silica.
7. Allow the silica to absorb the organics.
8. Weigh the dry chemicals and add to the bentonite/water mixture with sufficient agitation to keep all chemicals suspended.
9. Add the organics/silica mixture and continue blending for 24 hours.

Note: The slurry may thicken over time.

The surrogate was prepared in a 600-gallon mix tank. After 4 to 6 hours of mixing, the slurry was then transferred into a storage tank and held for at least 24 hours. Each of the storage tanks was continuously mixed. Prior to melter feed manufacturing, the surrogate slurry was transferred back into the mix tank. Any remaining material at the bottom of the storage tank was flushed with a small amount of water into the mix tank.

5.1.4.2 Melter Feed Preparation

The melter feed preparation occurred simultaneously with melter operation. Each batch of surrogate slurry (30 wt% solids) was transferred back into the mix tank where the glass-forming additives were incorporated. The composition of the batch was controlled by using pre-determined batch sheets and weighing each glass additive individually. The mixed batch of melter feed was then transferred to the feed tank.

The volume of a complete melter feed batch, however, was larger than the space available to receive it in the feed tank. Only a portion of the mixed batch could be transferred immediately upon mixing. When the feed tank was about half-full, the remaining portion of the melter feed was transferred to the feed tank along with any rinse water.

Upon completion of the transfer of a melter feed batch to the feed tank, a new batch of surrogate slurry was transferred into the mix tank. This continued until 7800 kg of surrogate slurry were treated. Each transfer of surrogate slurry and melter feed was recorded in the test logs.

The melter feed system was inspected and tested during the Pre-POPT process optimization period. This testing resulted in the installation of a backup slurry recirculation line and pumps to mitigate the risk of possible downtime during the demonstration.

5.1.4.3 Melter Feeding

The melter feed slurry was recirculated continuously from the feed tank to the vicinity of the melter and back into the feed tank. A small slip-stream of melter feed was drawn from the recirculation line. Progressive cavity metering pumps were used to control the feed rate to the melter. One pump was in operation while the other was in standby. The feed rate was monitored by measuring the flow rate (liters per minute) to the metering pump. A magnetic, ceramic-lined, flow meter was used for the demonstration.

The metering pump was piped to a water-cooled nozzle that entered the top of the melter. The water-cooled nozzle was capable of being manually moved to three different locations in the plenum. The nozzle was moved approximately every 20 to 30 minutes. This prevented the built-up batch blanket from becoming excessively thick in any one location.

5.1.4.4 Melter Description

The Joule-heated melter technology was demonstrated by using Envitco's WASTE-VIT® EV-101. The melter is ceramic-lined, employs cold-top operation, and is slurry-fed. The melter has three (3) processing areas, each having an independent drain orifice. The main melt chamber was used to melt the feed and allow time for the glass to homogenize. The main melt chamber was equipped with a bottom drain for tapping metallic sludges. The other two chambers were for independent draining of molten salt and glass. The overall dimensions of the melter were 3.7m (l) x 2.5m (w) x 2.5 m (h).

Main Melt Chamber

Feed was introduced and melted into glass in the main melt chamber. Glass in the main melt chamber was heated by the Joule effect. Joule-heating is the result of passing current through glass. Heat is released by the resistance of the

glass to the electrical current. The resulting heat maintains the glass in a molten state.

The plenum above the glass was heated by a combustion burner located in the roof. The propane combustion system was used to start the melter and provide sufficient plenum heat to control the offgas exit temperature. The plenum pressure was maintained under vacuum by the offgas treatment equipment. Negative pressure operation prevents the release of gases into the work area surrounding the melter.

The temperature of the melter was monitored through the use of in-glass and plenum thermocouples. Power input to the melter was adjusted in order to maintain the glass temperature.

The POPT demonstration employed the cold-top approach in the main melt chamber. This approach minimizes power consumption (heat input) and reduces volatility. Under normal operation, feed covered greater than 50% of the glass surface. The slurry built up a layer of unmelted feed, commonly referred to as a cold-cap, that reduced heat losses and volatility. The unmelted feed layer acts as an insulating blanket over the glass. The cold-cap also reduces volatility by condensing the volatile species and returning them to the glass. The overall result was a very high retention of volatile elements, such as lead (>92%), in the final waste form.

Metals Drain

The Silo 1 and 2 residues contain high levels of lead which, under certain conditions, could be reduced to metallic sludge phases that will separate from the glass. If metallic species separate from the glass, the main melt chamber has a sloped bottom for the collection of reduced metal species. The bottom of the main melt chamber has a dedicated drain to purge any such collected material. The metals drain could not be opened during the demonstration due to unfavorable heat transfer conditions at the bottom of the main melt chamber.

Upon inspection of the melter after the POPT only, a very small accumulation of metallic material was found. The material was presumed to be because of a large quantity, short-duration input of lead (lead sulfate, lead carbonate) that was fed to the melter during the post-demonstration cleanup and shutdown period. This is confirmed by the material balance which does not indicate a significant accumulation term in the melter during the POPT. Therefore, the metals drain was not required.

Glass Drain

The main melt chamber is connected to a glass drain bay. The drain bay was used to condition the glass to the proper temperature for pouring into drums. Thermocouples in the drain bay allowed the operators to monitor the temperature and control the power input independent of the main melt chamber.

The glass was drained through an orifice at the bottom of the drain bay. The glass drain rate was controlled by managing the temperature of the glass which, in turn, controlled the viscosity and resulting flow rate through the orifice.

Salt Drain

When the solubility of salts (sulfates, phosphates, chlorides) is exceeded in the glass, they will separate as an independent phase and float on top of the glass surface. The molten salt will migrate to an open area of glass surface not covered by the cold-cap. The excess salt can then be "skimmed" from the melt surface into the salt drain bay. The molten salt is subsequently drained through an orifice.

The main melter chamber is connected to a salt drain bay. The salt drain bay allows for the collection and draining of molten salts during melter operation without disrupting the overall melter process. If the salt accumulates, it is drained through an orifice into steel collection containers.

The primary salt-forming concern with the Silo Residue is sulfur. The $PbSO_4$ and $BaSO_4$ in the surrogate will decompose in the melter resulting in PbO, BaO, and SO_3 / SO_4. The PbO and BaO will participate in the glass structure along with approximately 1 wt% of SO_3. However, if the sulfur solubility limit is exceeded, SO_3 will then combine with Ba, Ca or Na to form a separated phase containing $BaSO_4$, $CaSO_4$ and $NaSO_4$. Samples of salt from before and after the demonstration were analyzed and verified the predicted salt composition.

Based on the treatment recipe crucible results, salt formation was expected in the melter but accumulation was controlled through reductant addition to prevent the need for independent draining of molten salt. In order to minimize the formation of molten salts, increasing sulfate solubility was also a goal in the recipe development crucible work. Salt solubility was increased to 1.2 wt% (typical glass solubility = 0.5 wt%) through the use of solubility-enhancing glass additives. These actions avoided the formation of a secondary waste stream that would be highly radioactive in the full-scale treatment system.

5.1.4.5 Auxiliary Melter Services

The melter system also includes the power supply, services (utilities) and controls. These systems provided monitoring and control of the electrical energy input, cooling water, and protective gas.

The power supplies maintained constant power input to the melter. The operators adjusted the power to effect changes in the glass temperature. Key control parameters were displayed on the manual control panels and were recorded by the data acquisition system. All process variables and control parameters were logged on manual round sheets.

The services system provided cooling water and nitrogen protective gas distribution to the melter. The cooling water was used in the water-cooled shell surrounding the melter. The shell reduces refractory wear by lowering the operating temperature of the refractory. It also helps to mitigate glass leaks before they occur by freezing the glass before it can reach the exterior of the melter. Nitrogen was used to protect certain molybdenum parts from oxidation. Molybdenum parts that could be exposed to air above 500°C were purged with nitrogen. The cooling water and nitrogen were monitored for flow, temperature, and pressure, as required. High and low-level alarms were integrated into the control system to warn an operator of unacceptable conditions. These systems are only monitored for unacceptable conditions as they are important to safety, but are not key to maintaining steady-state operations.

5.1.4.6 Product Handling

The glass wasteform was cast directly into 30-gallon drums during the POPT demonstration. The 30-gallon drums were held inside a 55-gallon drum with a bed of sand holding the 30-gallon drum centered in the 55-gallon drum. This arrangement insured the integrity of the 30-gallon drum while pouring hot glass.

After pouring, the glass was cooled by natural convection. A lid was placed on the 55-gallon drum after the 30-gallon drum was full. The lid was installed as a safety measure.

The glass handling equipment was arranged with roller-conveyors to index the drums under the drain. Drums were continuously indexed under the drain without stopping the glass pour. Drums typically remained on the conveyor to cool for a period of hours prior to moving to an outdoor storage area. The conveyor was equipped with load cells to monitor the weight of the poured glass. This allowed the calculation of the glass drain rate and of the total amount of glass produced during the demonstration.

5.1.4.7 Offgas Treatment

Offgas generated during the demonstration was treated by the offgas treatment system. The system consisted of a film-cooler, offgas ductwork, ESP, induced draft fan, and a stack. Exhaust gases were drawn from the melter through the film-cooler and the ESP. The induced draft fan, located after the ESP and prior to the stack, was used to maintain a constant negative pressure within the melter and the offgas treatment system. The gases were then released to the atmosphere through the stack.

The film cooler was used to inject 10 – 20 cfm of dilution (cooling) air into the offgas so that the maximum operating temperature of the metal offgas ducts wasn't exceeded. The ESP removed particulate matter from the offgas stream. The ESP was operated at approximately 120°C to capture condensed volatile species but prevent water condensation within the equipment. The water vapor and non-condensable gases were exhausted out a stack to the atmosphere.

Sample points were provided at the entrance and exit of the offgas treatment system for the performance of EPA standard methods (Method 5, Method 29, etc.). Pressure monitors, pitot tubes and thermocouples mounted throughout the system provided flow characterization data. Figure 5.3.1-1 in Section 5.3.1 Material Balance shows the sample point locations in the offgas ductwork. The data was collected by EPA standard methods. This data and the physical and chemical characteristics of the offgas are integrated into the POPT demonstration material balance.

5.1.5 Demonstration Melter Operation

5.1.5.1 Pre-Demonstration Process Optimization

A period of process optimization with demonstration surrogate occurred prior to initiation of the POPT demonstration run. Four (4) tests and related objectives were accomplished: 1) inspection of melter and peripheral systems, 2) start and check the melter and peripheral systems, 3) establish the target operating parameters, and 4) process enough surrogate glass to reach a chemical steady-state.

The melter was started and all systems were checked for proper operation. The melter was brought to a chemical equilibrium by feeding demonstration surrogate during the process optimization period. A total of 1900 kg (dry basis) of demonstration surrogate was fed to the melter. The target operating parameters established for the demonstration are shown on Table 5.1.5.1-1.

Table 5.1.5.1-1 Demonstration Target Operating Parameters

Parameter	Target
Glass Temperature	1150 to 1200°C
Plenum Pressure	-0.05 to -0.1"
Cold-top Coverage	>50%
Feed Rate	0.7 l/min
Glass Pour Rate	15 kg/hr
Plenum Temperature	800°C
Glass Redox	0.1 – 0.2 $Fe^{+2}/\Sigma Fe$

The target feed rate of 0.7 l/min was 46% of the pre-operations target of 1.5 l/min. This was due to the use of an existing melter which was not specifically sized for the POPT, but that incorporated all of the standard melter design features of Envitco's other systems and the proposed full-scale melter. The reduced process rate was anticipated by Envitco during the proposal phase. Envitco took specific exception to FDF's 2600 kg/day specification in Section F of the Envitco Technical Proposal:

> "SOW Section C.4.2.2 – Demonstration of Process; Quantity: The target treatment rate of the process demonstration will be less than or equal to 2,600 kg of surrogate slurry at 30 wt.% solids during each 24-hour period. The melter proposed (Envitco's EV-101 melter) for the process demonstration was originally designed to produce two (2) tons per day of glass from a dry feed. The use of slurry feeding in this demonstration may reduce the overall melt rate causing the actual throughput of the demonstration to be less than 2,600 kg of surrogate slurry during each 24-hour period. Nevertheless, the use of the proposed melter with slurry feeding does not impact the appropriateness of scale-up of the chosen melter technology."
>
> The exception was subsequently incorporated in Contract #98WO002240.

The following discussion provides more detail as to the technical reason for the decrease in process rate:

The design melt rate of the EV-101 is 1.8 MTPD of glass production. This is based on a dry soda-lime-silica glass batch feed. The demonstration was run using a feed that contained 64 wt% water. The energy normally used to melt dry feed was being diverted to evaporating the water. The resulting amount of solids that would be equivalent to the normal dry glass batch was 36 wt% of the total feed rate of 1.45 MTPD or 0.52 MTPD of dry feed. The glass production rate

established during the POPT was 0.34 MTPD after taking into account decomposition losses from the surrogate chemical forms to the oxide glass forms.

5.1.5.2 POPT Demonstration Run Operations

The demonstration was conducted between January 15 and January 23, 1999. This longer time was required due to a change in the testing protocol.

The Contract required a target throughput of 2600 kg of surrogate slurry per day over a three (3) day period (7800 kg total). Stable melter operation, however, resulted in a process throughput of approximately 975 kg/day of demonstration surrogate slurry, or 1300 kg per day of melter feed. Therefore, FDF agreed to accept treatment of the 7800 kg over the time necessary for Envitco to operate under steady-state conditions.

The melter was run for approximately eight (8) days to process the entire 7800 kg of demonstration surrogate (2150 kg dry surrogate). The 72-hour demonstration was performed within those eight days from 10:00 a.m. January 18 to 10:00 a.m. January 21. Only four (4) minutes of downtime were recorded during the 72-hour demonstration. A total of approximately one (1) hour of unscheduled downtime was recorded during the eight day processing period. All eight days of processing were witnessed by FDF personnel.

5.1.5.3 Post-Demonstration Melter Operations

After the demonstration was completed, extra melter feed and other secondary wastes were treated in the melter. The remaining feed batch was fed to the melter at an increased feed rate of 1.15 l/min. This increased feed rate resulted in mixed results as identified in the pre-demonstration operations. The higher rate caused excess feed build-up on the surface of the melter due to capacity restraints as mentioned in 5.1.5.2. This caused infrequent, but periodic, stopping of the feed to allow excess batch to melt prior to additional feeding. This rate was demonstrated over a period of 30 hours but was not considered steady-state operation and was, therefore, not appropriate for the POPT demonstration run.

A total of 450 kg of dry demonstration surrogate (the final component of the 4500 kg project total), rinse and wash water, any collected surrogate due to spills and twenty-five to forty kilograms (25 – 40 kg) of lead compounds were directly added to the melter during the post-demonstration clean up. The surrogate-containing materials were added to the post-demonstration glass to prevent the disposal of hazardous wastes.

5.2 Surrogate Composition

Demonstration surrogate batches were manufactured in accordance with Contract Modification No. 06 - Table C1 (presented below).

Table C1: Demonstration Surrogate
(Basis: g/100 g dry solids)

a	b	c	d	e	f
		Composite	Composite	Chemical	Surrogate
Compound	MW	dry	insitu	% Moisture	Mix
Na2HAsO4	186.01	0.17	0.12	40.38	0.28
BaSO4	233.40	8.18	5.73		8.18
Na2CrO4	161.97	0.27	0.19	30.77	0.39
Fe2O3	159.60	2.52	1.76		2.52
Mg3(PO4)2	262.88	1.46	1.02		1.46
NaNO3	84.99	1.03	0.72	3.00	1.06
NiO	74.71	0.43	0.30		0.43
PbO	223.20	5.67	3.97		5.67
PbCO3	267.20	6.60	4.62		6.60
PbSO4	303.25	2.65	1.86		2.65
Na2SeO3	173.01	0.10	0.07	34.22	0.15
Coarse SiO2	60.08	20.81			
Fine SiO2	60.08	18.90	34.19		48.83
Fumed SiO2	60.08	9.12			
V2O5	181.88	0.09	0.06		0.09
ZnO	81.32	0.01	0.01		0.01
Kerosene		0.92	0.64		0.92
Tributyl Phosphate		0.92	0.64		0.92
Diatomaceous Earth		1.83	1.28		1.83
Feldspar		18.32	12.82		18.32
Surrogate Total		100.00	70.00		100.31

To ensure a chemically accurate surrogate formulation, the compounds used to manufacture the demonstration surrogate were adjusted for adsorbed or chemical moisture. For the Envitco POPT, the adjusted surrogate formulation is given in Table 5.2-1.

Table 5.2-1 Demonstration Surrogate Formulation

Component, Actual	Composite wt%	LOD wt%	Chemical % Moisture	Surrogate Mix
Na2HAsO4-7H2O	0.17	18.19	40.38	0.29
BaSO4	8.18	0.13		8.19
Na2CrO4	0.27	0.66		0.27
Fe2O3	2.52	0.01		2.52
Mg3(PO4)2-5H2O	1.46	1.65	25.50	1.96
NaNO3	1.03	0.00		1.03
NiO	0.43	0.02		0.43
PbO	5.67	0.12		5.68
PbCO3	6.60	1.18		6.68
PbSO4	2.65	0.04		2.65
Na2SeO3	0.10	0.06		0.10
Coarse SiO2	18.99	0.00		18.99
Fine SiO2	18.90	0.04		18.91
Fumed SiO2	10.94	1.85		11.15
V2O5	0.09	0.22		0.09
ZnO	0.01	0.08		0.01
Kerosene	0.92			0.92
Tributyl Phosphate	0.92			0.92
Diatomaceous Earth	1.83	4.70		1.92
Feldspar	18.32	0.07		18.33
Surrogate Total	100.00			101.03
BentoGrout (2.4 wt.%)	8.70	3.97		9.06
SubTotal	108.70			110.09
Water (70 wt. %)	253.62			252.23
Total Surrogate Slurry				362.32

In accordance with the Work Plan, three surrogate slurry samples were submitted to CELS for quantitative chemical analysis. The results of the analysis are presented on an oxide basis in Table 5.2-2 for surrogate slurry samples SURR-S0-T-0403, SURR-S0-T-0438, and SURR-S0-T-0446. The theoretical oxide composition for the demonstration surrogate is also presented in Table 5.2-2 based on the composite dry surrogate composition provided in Table C1 of the Contract.

Table 5.2-2 POPT Surrogate Slurry Analyzed Compositions

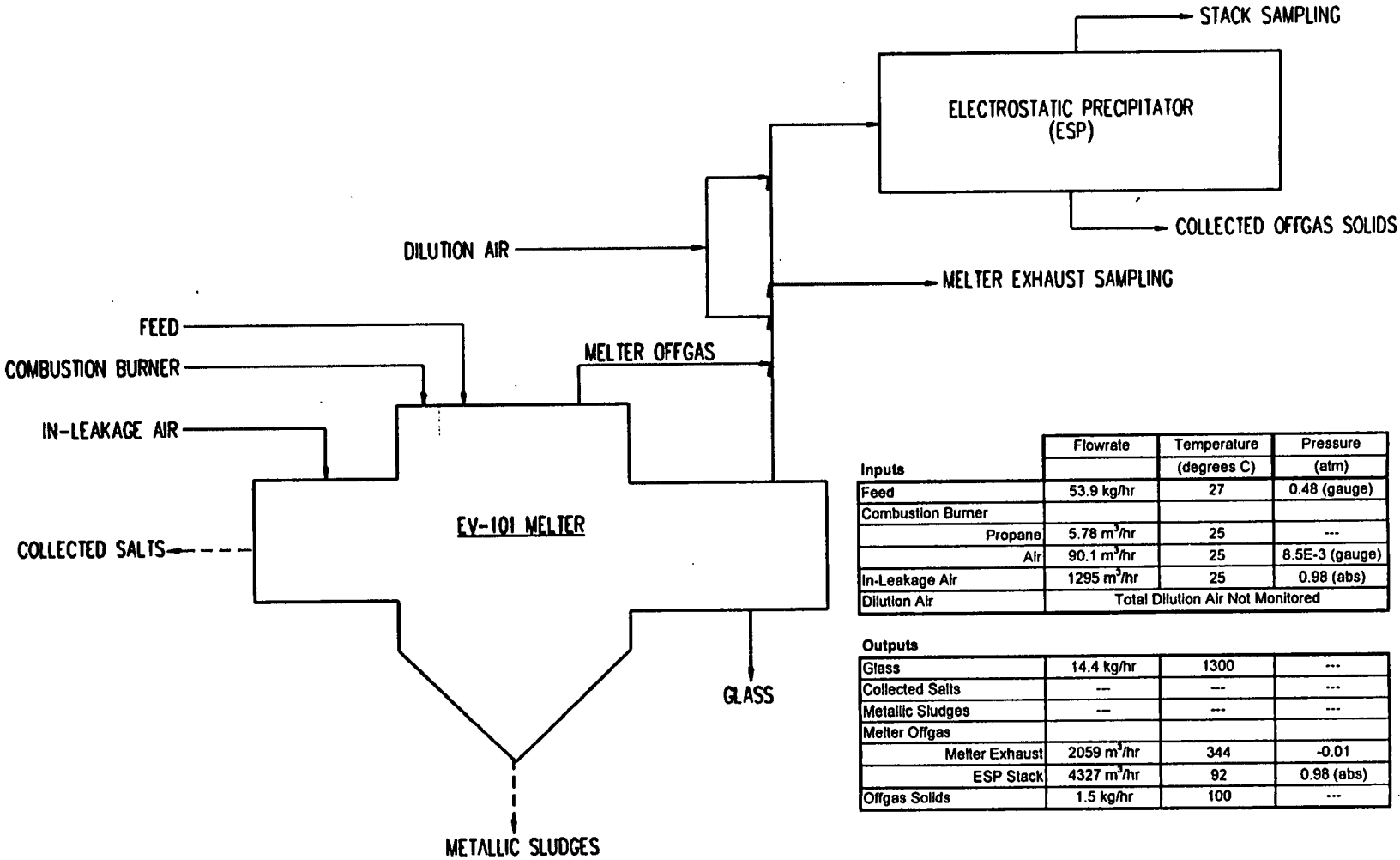
Oxide	Contract Mod. 6 wt. %	Analyzed 446 # 007	Analyzed 438 # 008A	Analyzed 403 # 008B	Analyzed Average wt. %
Al_2O_3	6.90	5.50	4.98	5.27	5.25
As_2O_3	0.07	0.18	0.11	0.19	0.16
BaO	4.14	6.20	4.79	6.89	5.96
CaO	0.68	0.45	0.50	0.47	0.47
Cr_2O_3	0.10	0.20	0.12	0.20	0.17
Fe_2O_3	2.91	3.95	2.97	4.68	3.87
K_2O	0.83	0.96	0.97	0.83	0.92
Li_2O	0.00	0.03	0.07	0.16	0.09
MgO	2.21	1.16	0.91	1.23	1.10
MoO_3	—	—	—	—	—
Na_2O	2.34	2.47	2.15	2.57	2.40
NiO	0.33	0.48	0.39	0.36	0.41
P_2O_5	0.62	1.66	1.25	1.83	1.58
PbO	10.12	12.93	12.52	12.28	12.58
SO_3	2.70	5.60	4.81	5.44	5.29
SeO_2	0.05	0.05	0.05	0.05	0.05
SiO_2	65.94	58.00	63.29	57.30	59.53
V_2O_5	0.07	0.12	0.09	0.15	0.12
ZnO	0.01	0.03	0.04	0.09	0.05
Total	100.00	100.00	100.00	100.00	100.00

The surrogate slurry analytical results varied widely between samples and diverged from the theoretical oxide composition. The 70 wt% moisture surrogate slurry exhibited a rapid settling velocity in the absence of mixing shear. Surrogate slurry samples were obtained by dipping the sample bottles into surrogate slurry storage tanks equipped with pulsed air mixers. Due to the surrogate slurry rheology, localized composition variations may have occurred within the storage tanks making uniform, representative sampling difficult. These variations are not seen in the slurry feed samples (discussed in Section 5.3) which were sampled directly from a uniformly-mixed, continuously-recirculating line.

5.3 Material and Energy Balance

The pictorial description of the POPT melter system (including offgas treatment) presented in Figure 5.3-1 identifies the major inputs and outputs for the material balance. Figure 5.3-1 also identifies the location of the offgas sampling ports for the melter exhaust and ESP stack.

Figure 5.3-1 POPT Melter System Including Offgas Treatment



Inputs	Flowrate	Temperature (degrees C)	Pressure (atm)
Feed	53.9 kg/hr	27	0.48 (gauge)
Combustion Burner			
Propane	5.78 m^3/hr	25	---
Air	90.1 m^3/hr	25	8.5E-3 (gauge)
In-Leakage Air	1295 m^3/hr	25	0.98 (abs)
Dilution Air	Total Dilution Air Not Monitored		

Outputs			
Glass	14.4 kg/hr	1300	---
Collected Salts	---	---	---
Metallic Sludges	---	---	---
Melter Offgas			
Melter Exhaust	2059 m^3/hr	344	-0.01
ESP Stack	4327 m^3/hr	92	0.98 (abs)
Offgas Solids	1.5 kg/hr	100	---

During the 72-hour Demonstration, the average melter feed rate was 53.94 kg feed (wet) per hour. Based on analytical results from CELS, the average Loss on Drying (LOD) and Loss on Ignition (LOI) for the demonstration feed was 64% and 72%, respectively. Conversion from feed to glass resulted in the production of 1036 kg of glass over the 72-hour Demonstration.

5.3.1 Material Balance

Quantitative chemical analysis (QCA) was performed by CELS – Corning Laboratory Services (CELS) on the demonstration surrogate slurry feed and resultant demonstration glass to determine the chemical constituents of each. The analytical results were coupled with the offgas sampling results to create a material balance [Input - Output = Accumulation] around the EV-101 melter.

Analytical results for the feed and glass samples taken during the 72-hour Demonstration are presented in Tables 5.3.1-1 and 5.3.1-2. The results are presented on an oxide basis. The alkali elements (potassium, lithium and sodium) have been summed and presented as R_2O. Similarly, the 'Additives' term represents the combined contribution of Al, Ca and Zn. An average feed composition and an average glass composition are also presented with the feed and glass results.

A comparison of the theoretical oxide composition, as calculated from the demonstration surrogate formulation presented in Section 5.2, and the average glass composition is presented in Table 5.3.1-3. Theoretical oxide compositions do not take into account the normal losses from offgas entrainment, volatility, and solubility limitations experienced during waste processing in a vitrification system. The comparison between theoretical and analyzed compositions is useful for evaluating the performance of the melter to treat the surrogate waste.

The results in Table 5.3.1-3 indicate excellent agreement between the theoretical oxide composition and the demonstration glass produced. With the exception of sulfur, the differences between the theoretical and analyzed glass compositions are the result of partitioning to the offgas either through entrainment or volatilization.

Sulfur has a limited solubility in glass. Typical sulfur solubilities in glass are limited to a maximum of ~0.5 wt % (as SO_3). The demonstration glass was specifically formulated to maximize the solubility of sulfur and achieved a 1.2 wt% sulfur loading (as SO_3). A reductant was added to the slurry feed to reduce a portion of the sulfates in the batch to sulfur dioxide, which was removed from the melter as part of the offgas stream.

Table 5.3.1-1 Analytical Results of POPT Feed Samples

		72-hour Demonstration						
	FEED-S0-T-	395	454	488	517	555	584	72-hour
	CELS Sample	#7	#8	#1	#2	#3	#4	AVG
R2O	wt% R2O	7.26	8.30	7.43	7.33	7.98	7.79	7.56
As	wt% As2O3	0.120	0.120	0.083	0.097	0.110	0.110	0.10
Ba	wt% BaO	4.45	4.88	4.25	4.31	4.17	4.08	4.25
Cr	wt% Cr2O3	0.062	0.072	0.059	0.052	0.069	0.071	0.06
Fe	wt% Fe2O3	2.42	2.61	2.29	2.38	2.31	2.25	2.33
Mg	wt% MgO	0.85	0.92	0.82	0.84	0.81	0.8	0.82
Mo	wt% MoO3							
Ni	wt% NiO	0.34	0.36	0.33	0.35	0.34	0.32	0.34
P	wt% P2O5	0.93	1.02	0.93	0.95	0.92	0.89	0.92
Pb	wt% PbO	10	10.9	10.00	10.1	10.2	10.2	10.10
Si	wt% SiO2	51.7	47	52.6	53	52.9	53.9	52.82
V	wt% V2O5	0.07	0.078	0.068	0.07	0.069	0.068	0.07
C	wt% C	3.50	3.50	3.10	3.20	3.30	3.20	3.26
S	wt% SO3	2.90	2.90	2.50	2.70	2.60	2.60	2.66
Se	wt% Se	0.01	0.013	0.012	0.013	0.016	0.015	0.01
Additives	wt%	17.30	18.97	16.38	16.78	16.34	16.44	16.65
Total		101.91	101.64	100.85	102.17	102.13	102.73	101.96

1. R2O represents the combined contribution of K2O, Li2O, and Na2O.
2. Additives represent the combined contribution of Al2O3, CaO, and ZnO.

Table 5.3.1-2 Analytical Results of Glass Samples

		72-hour Demonstration									
	DGLS-S0-T	392	417	443	471	491	514	543	568	592	72-hour
Test Performed	CELS Sample	#3	#4	#5	#6	#7	#8	#9	#10	#11	Average
R2O	wt% R2O	9.27	9.26	9.24	9.23	9.24	9.24	9.24	9.24	9.21	9.24
As	wt% As2O3	0.10	0.11	0.12	0.12	0.13	0.13	0.12	0.13	0.13	0.12
Ba	wt% BaO	3.88	3.83	3.8	3.91	3.89	3.87	3.92	3.93	3.94	3.89
Cr	wt% Cr2O3	0.14	0.12	0.12	0.12	0.11	0.12	0.12	0.11	0.12	0.12
Fe	wt% Fe2O3	2.27	2.28	2.29	2.33	2.29	2.32	2.32	2.3	2.31	2.30
Mg	wt% MgO	0.73	0.74	0.75	0.77	0.78	0.79	0.8	0.81	0.82	0.78
Mo	wt% MoO3	0.2	0.19	0.2	0.21	0.2	0.2	0.21	0.21	0.21	0.20
Ni	wt% NiO	0.32	0.32	0.32	0.31	0.31	0.32	0.32	0.32	0.32	0.32
P	wt% P2O5	0.62	0.68	0.68	0.7	0.8	0.81	0.79	0.85	0.85	0.75
Pb	wt% PbO	9.91	9.87	9.79	9.86	9.73	9.73	9.78	9.77	9.74	9.80
S	wt% SO3	1.17	1.22	1.22	1.24	1.23	1.23	1.18	1.22	1.15	1.21
Se	wt% SeO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Si	wt% SiO2	56	56.4	56.5	56	56.5	56.6	56.6	56.4	56.4	56.38
V	wt% V2O5	0.061	0.061	0.062	0.062	0.065	0.066	0.066	0.066	0.067	0.06
Additives	wt%	16.57	16.56	16.69	16.93	16.57	16.61	16.65	16.58	16.58	16.64
Total		101.242249	101.641964	101.782835	101.79289	101.845915	102.036793	102.116614	101.936538	101.847528	101.805

1. R2O represents the combined contributions of K2O, Li2O, and Na2O.
2. Additives represent the combined contributions of Al2O3, CaO, and ZnO.

Table 5.3.1-3 Demonstration Glass - Theoretical vs. Measured

	Predicted	Measured
Oxide	wt. %	wt. %
R2O	9.49	9.08
As2O3	0.08	0.12
BaO	4.16	3.82
Cr2O3	0.10	0.12
Fe2O3	2.20	2.26
MgO	0.94	0.76
MoO3	---	0.20
NiO	0.34	0.31
P2O5	0.82	0.74
PbO	9.48	9.62
SO3	2.70	1.19
SeO2	0.05	0.00
SiO2	52.55	55.38
V2O5	0.07	0.06
Additives	17.02	16.34
Total	100.00	100.00

The material balance, on an oxide basis, for the 72-hour Demonstration is presented in Table 5.3.1-4. The material balance is grouped into three terms: Inputs, Outputs and Accumulation. Inputs consists of the average feed rate during the 72-hour demonstration. Outputs consists of the average glass drain rate, the average entrainment (as determined by offgas sampling using EPA Methods 5 & 29), and the average volatility (as determined by offgas sampling using EPA Methods 5 & 29 and Method 8). Accumulation is the estimated quantity of material collected in the melter.

Overall closure for the POPT 72-hour Demonstration was 98.9%. Percent closure and the melter decontamination factor (DF) are presented for the major surrogate and glass additive elements in Table 5.3.1-4 as well. Contributions from gaseous species present in the demonstration surrogate, with the exception of sulfur oxides, were neglected.

Sulfur recovery was lower than expected. Since a molten salt phase did not accumulate during the 72-hour demonstration, any sulfur not retained in the glass was expected to have been reduced by the reductant and volatilized in the offgas. Offgas results do not coincide with the amount of sulfur expected in the gaseous phase. Explanations for the discrepancy are unknown at this time.

Table 5.3.1-4 POPT Material Balance

	Input (1)	Output (1, 2)				Melter		
Oxide	Feed kg/hr	Glass kg/hr	Entrainment kg/hr	Volatility kg/hr	Total Offgas kg/hr	Accumulation kg/hr	% Closure	Melter DF
R2O (3)	1.1210	1.3065	1.91E-03	2.46E-04	2.16E-03		116.74	519.10
As2O3	0.0154	0.0171	2.62E-05	4.02E-07	2.66E-05		111.17	579.17
BaO	0.6307	0.5493	2.65E-04	6.89E-07	2.66E-04		87.15	2374.90
Cr2O3	0.0165	0.0170	6.28E-05	1.47E-06	6.43E-05		103.21	256.80
Fe2O3	0.3456	0.3253	2.10E-04	1.46E-05	2.25E-04		94.20	1537.94
MgO	0.1222	0.1098	5.96E-05	6.68E-06	6.63E-05		89.90	1842.65
MoO3	0.0000	0.0287	1.61E-04	4.57E-07	1.61E-04		N/A	N/A
NiO	0.0498	0.0449	2.29E-05	6.46E-07	2.35E-05		90.20	2120.28
P2O5	0.1371	0.1065	3.23E-03	1.95E-05	3.25E-03		80.09	42.14
PbO	1.4981	1.3852	6.89E-03	2.61E-06	6.89E-03	3.18E-02	95.05	217.36
SO3	0.3945	0.1706	1.74E-03	3.77E-02	3.95E-02		53.24	10.00
SeO2	0.0051	0.0000	2.47E-04	4.70E-03	4.94E-03		97.00	1.03
SiO2	7.8344	7.9706	0.00E+00	2.22E-04	2.22E-04		101.74	35255.39
V2O5	0.0102	0.0090	1.81E-06	5.44E-07	2.35E-06		88.43	4355.22
Additives (4)	2.4693	2.3522	6.97E-04	5.26E-05	7.49E-04		95.29	3295.66
TOTAL	14.6499	14.3929	0.0155	0.0430	0.0585	3.18E-02	98.86	250.36

1. Feed and Glass Terms Normalized on the Average of 72-hour Samples Only (Minus Sample #454).
2. Entrainment, Volatility and Total Offgas Values are the averages provided by Trigon.
3. R2O represents the combined contributions of K2O, Li2O, and Na2O.
4. Additives represent the combined contributions of Al2O3, CaO, and ZnO.

Where:

$$\%\,Closure = \frac{\sum(Total\,Outputs)}{\sum(Total\ Inputs)} \times 100 \qquad Melter\ DF = \frac{(Feed\ Rate)_x}{(Total\ Offgas\ Rate)_x}$$

115

2291

Melter Decontamination Factor

The melter decontamination factor provides an indication of the melter's ability to capture feed material within the glass matrix. The melter DF was calculated by dividing the feed rate of material to the melter by the total exhaust rate to the offgas treatment system. As calculated, a decontamination factor of one (1) indicates that any material introduced to the melter exited the melter in the offgas. DF values greater than one indicate the melter was successful in retaining feed material in the glass. A large decontamination factor equates to greater material retention in the glass.

In general, non-volatile elements such as silicon exhibit higher decontamination factors than volatile or semi-volatile elements. This generality holds true for the elements identified in Table 5.3.1-4. Non-volatile elements (i.e. silicon, vanadium, barium, iron, magnesium and additives) exhibited the highest decontamination factors. Semi-volatile elements, such as arsenic and lead, had moderate decontamination factors. The volatile elements selenium and sulfur had the lowest decontamination factor.

5.3.2 Lead and Molybdenum Interaction

The treatment recipe development phase established a glass redox range (0.1 – 0.2 $Fe^{+2}/\sum Fe$) that would not cause metal precipitation in the crucible. Metals precipitation due to the slightly reducing conditions was not expected in the POPT since the glass redox was controlled by the amount of reductant added to the feed. However, commercial experience and previous FDF experience suggested that metals precipitation due to a separate reduction-oxidation reaction between the molybdenum electrodes and the lead in the waste was possible.

Demonstration glass analyses presented in Table 5.3.1-2 reported an average molybdenum content of 0.20 wt% (as MoO_3) in the glass. Since molybdenum was not a component of the Demonstration Surrogate, the molybdenum found in the glass was assumed to be the result of corrosion of the molybdenum electrodes. Assuming all the molybdenum oxide present in the demonstration glass was from the electrodes, 1.4 kg of molybdenum (Mo) was drained from the melter during the 72-hour demonstration. (Calculation based on 1036 kg of glass drained in 72 hours.)

Molybdenum was also recovered in the offgas analyses. The partitioning of molybdenum to the offgas during the 72-hour demonstration occurred at a rate of 1.07E-4 kg per hour. Over the 72-hour demonstration, 7.7E-3 kg of molybdenum partitioned to the offgas treatment system.

The combined total molybdenum loss from the melter system (drained glass and offgas) was 1.4 kg during the 72-hour demonstration. Averaged over the 72-hour demonstration, the molybdenum corrosion rate was 0.019 kg Mo per hour.

When calculated over the entire surrogate processing period of the EV-101 (25 days, 6 hours and 23 minutes), the total expected molybdenum loss was 11.6 kg. The post-operation inspection of the molybdenum electrodes resulted in an estimated molybdenum loss of 10.6 kg for all electrodes (Section 5.6.2).

Electrode corrosion is a consequence of dissolution by the glass. In electric melting of any glass, the surface of the molybdenum electrode is oxidized to MoO_2. The MoO_2 surface layer slowly dissolves in the glass and is oxidized to MoO_3 (Volf 1984). A typical molybdenum corrosion in soda-lime-silica glasses was reported in the literature at up to 0.10 wt% as MoO_3 in the glass (Faught 1972). Assuming 0.10 wt% of the MoO_3 present in the demonstration glass was due to molybdenum oxidation and dissolution, additional molybdenum electrode corrosion mechanism(s) must have occurred.

The lead / molybdenum reduction-oxidation reaction presented in Equation 5.3.2-1 has often been assumed as the primary molybdenum corrosion mechanism in lead glasses. Equation 5.3.2-1 results in 6.48 g of precipitated lead metal for every 1 g of molybdenum metal reacted. If this reaction was responsible for the 0.20 wt% MoO_3 in the demonstration glass, 75.2 kg of lead would have precipitated in the melter (11.6 kg Mo times 6.48 kg Pb per kg Mo).

If Equation 5.3.2-1 is a supplementary molybdenum corrosion mechanism and is only responsible for 0.10 wt% of the MoO_3 content in the demonstration glass, then one-half of the above 75.2 kg, or 37.6 kg of lead would have precipitated in the melter. Both estimated quantities of lead precipitation are greater than the actual amount of metallic material found in the melter (less than 20 kg). Equation 5.3.2-1, therefore, was not the predominant mechanism for the Pb:Mo reduction-oxidation reaction.

Equation 5.3.2-1

$$Mo + 3PbO \rightarrow MoO_3 + 3Pb \downarrow$$
$$1\,g + 1.50\,g \rightarrow 1.50\,g + 6.48\,g$$

The mechanism presented in Equation 5.3.2-1 assumes intimate contact of PbO and molybdenum metal. As stated previously, molybdenum electrodes develop a mildly oxidized surface layer of MoO2. Since molybdenum metal is protected from Equation 5.3.2-1 by the oxidized surface layer, the lead precipitation reaction may occur with the MoO2. The reduction-oxidation reaction becomes:

Equation 5.3.2-2

$$MoO_2 + PbO \rightarrow MoO_3 + Pb \downarrow$$
$$0.89\,g + 1.55\,g \rightarrow 1\,g + 1.44\,g$$

Using Equation 5.3.2-2, only 1.44 g of lead would be precipitated for every 1 g of MoO_3 produced. Therefore, assuming 0.10 wt% MoO_3 is produced by corrosion of the MoO_2 surface layer and 0.10 wt% MoO_3 is produced by the Pb:Mo reaction in Equation 5.3.2-2, then 1.52 kg of lead would be predicted as being precipitated during the 72-hour demonstration (i.e. 0.1% times X kg glass times 1.44 kg Pb per kg MoO_3). Theoretically, the Pb/Mo reduction-oxidation reaction can occur whenever lead oxide is in contact with MoO_2. Therefore, the total predicted lead precipitation was calculated over the entire demonstration surrogate processing time, which includes process optimization, 7800-kg processing (72-hour demonstration inclusive), and the post-demonstration clean-up. Total lead precipitation over the entire demonstration surrogate processing window was then calculated as 11.5 kg of lead.

The previously-calculated 11.5 kg of precipitated lead were less than the total amount of metallic material found in the melter. An estimated 15 - 20 kg of metallic material were found upon visual inspection after the project was completed. This indicates that 3 - 8 kg of metallic material had accumulated by means other than the combination of the Pb/Mo reduction-oxidation reaction and the direct oxidation (corrosion) of the electrode surface. As noted in Section 5.1, a large quantity (25 - 40 kg) of lead compounds were added to the melter over a short period of time (hours) before the melter was shutdown. The limited time before melter shutdown is believed to have been insufficient to incorporate the high input of lead into the glass.

5.3.3 Waste Loading and Bulking Factor

The waste loading of the surrogate and associated bulking factor for the 72-hour demonstration were calculated using the equations presented in Contract Modification No. 01 (June 26, 1998).

5.3.3.1 Waste Loading

Waste loading is an important calculated factor for determining how much treated material will be produced from the Silo Residues. A waste loading of 'x' is defined, in simple terms, as: for every pound of Silo Residue treated, 'x' pounds of treated residues are produced. The Silo Residue content is always calculated on a dry weight basis because the water content varies throughout the silos and

would give a different result. This standardizes the calculation and allows comparison between treatment technologies.

$$Waste\ Loading = \frac{WDW}{WDW + Water + Additives + etc. - DG} \times 100\ wt.\%$$

where:

Waste Dry Weight (WDW) = Dry Surrogate + Dry Bentonite Weights = 107.73 g

Water = 251.37 g; Additives = 25.996 g

Decomposition Gases (DG) = 251.37 g + 4.645 g

$$Waste\ Loading = \frac{107.73\,g}{(107.73 + 251.37 + 25.996 - 256.015)\,g} \times 100\% = 83.46\%$$

Per Envitco's Demonstration Batch Sheets and the equation above, the waste loading for the demonstration glass (Demonstration Glass S0-D5B-2) was calculated to be 83.46%. When converted to an oxide basis, the equivalent waste loading is 79.86%.

5.3.3.2 Bulking Factor

Bulking factor is another important calculated factor for determining how much treated material will be produced from the Silo Residues. Whereas waste loading deals with weight, the bulking factor deals with volume. A bulking factor of 'x' is defined, in simple terms, as: for every cubic foot of Silo Residues treated, 'x' cubic feet of treated Silos Residue is produced. This standardizes the calculation and allows comparison between treatment technologies.

$$BF = \left(\frac{V_f}{V_i}\right) \times 100\% \qquad V_i = \frac{0.30 \times M_{si}}{\rho_i}$$

where:

BF = Bulking Factor

V_i = Specific volume of the 70 wt% solids surrogate slurry mixture.

V_f = Specific volume of treated surrogate

ρ_i = In-situ density (previously determined)

M_{si} = Mass of the 70 wt% water slurry before treatment

$$\rho_{dry} = \rho_i \times \%\, dry\ solids$$

$$\rho_{dry} = 1.78\frac{kg}{L} \times \frac{0.7\,kg}{1.0\,kg} = 1.246\frac{kg\ dry}{L}$$

$$M_{si} = 72\,hours \times 53.94\frac{kg\ feed}{hour} \times \frac{0.886\,kg\ surrogate}{1.0\,kg\ feed} = 3440.9\,kg\ surrogate$$

$$V_i = \frac{0.3 \times 3440.9\,kg\ surrogate}{1.246\frac{kg\ dry}{L} \times 3440.9\,kg\ surrogate} = 0.241\frac{L}{kg}$$

$$V_f = \frac{Volume\ Glass}{kg\ surrogate} = \frac{72\,hours \times 14.16\frac{kg}{hr} \times \frac{1.0\,L}{2.814\,kg}}{3440.9\,kg\ surrogate} = \frac{362.3\,L}{3440.9\,kg} = 0.1053\frac{L}{kg}$$

$$BF = \frac{V_f}{V_i} \times 100\% = \frac{0.1053\frac{L}{kg}}{0.241\frac{L}{kg}} = 43.7\%$$

Using the equations above, the bulking factor for the 72-hour demonstration was calculated to be 43.7%.

5.4 Product and Secondary Waste Performance

5.4.1 POPT Treated Wasteform – Demonstration Glass S0-D5B-2

Samples of the POPT Treated Wasteform, Demonstration Glass S0-D5B-2, were taken throughout the 72-hour demonstration test. Nine samples (Table 5.4.1-1 – Demonstration Glass Samples) were selected and submitted to the FDF-approved analytical laboratory, Compuchem, for analysis by the Toxicity Characteristic Leaching Procedure (TCLP). Two separate aliquots of each sample's leachate were taken and analyzed by Inductively Coupled Plasma Spectroscopy (ICP) for the eight RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag), as well as the six [6] additional metals (Sb, Be, Th, V, Ni and Zn) identified in the promulgated Universal Treatment Standards.

Table 5.4.1-1 – Demonstration Glass Samples

Sample ID	Duplicate Analysis ID
DGLS-S0-T-0394	DGLS-S0-T-0394D
DGLS-S0-T-0419	DGLS-S0-T-0419D
DGLS-S0-T-0440	DGLS-S0-T-0440D
DGLS-S0-T-0468	DGLS-S0-T-0468D
DGLS-S0-T-0492	DGLS-S0-T-0492D
DGLS-S0-T-0512	DGLS-S0-T-0512D
DGLS-S0-T-0544	DGLS-S0-T-0544D
DGLS-S0-T-0566	DGLS-S0-T-0566D
DGLS-S0-T-0590	DGLS-S0-T-0590D

TCLP results for each of the samples, including the duplicate leachate analyses, are presented in Table 5.4.1-2 – Demonstration Glass TCLP Results. A comparison of the analytical results against the Contract TCLP limits (50% of the RCRA TCLP limits) for the demonstration glass is presented in Table 5.4.1-3– Demonstration Glass versus Contract TCLP Criteria.

Table 5.4.1-2 - Demonstration Glass TCLP Results

		Samples from the 72-hour Demonstration										
	DGLS-S0-T	394	419	440	468	492	512	544	566	590	LEACHBLK	Regulatory
Analyte	Lab Sample ID	929128	929130	929132	929134	929136	929152	929138	929140	929142	929206	TCLP Limits
Arsenic	ppm	0.0114	0.0714	0.0122	0.0089	0.0100	0.0100	0.0095	0.0105	0.0092	0.0014	5
Antimony	ppm											
Barium	ppm	0.9350	0.8050	0.8900	0.9780	0.7630	1.1300	0.7660	0.7650	0.7740	0.0058	100
Beryllium	ppm	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	
Cadmium	ppm	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	1
Chromium	ppm	0.0137	0.0156	0.0215	0.0189	0.0357	0.0170	0.0224	0.0130	0.0174	0.0020	5
Lead	ppm	2.0700	1.9200	1.7600	2.1000	1.8500	2.1800	2.1700	1.7800	1.3000	0.0046	5
Mercury	ppm	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.2
Nickel	ppm	0.0551	0.0599	0.0571	0.0656	0.0732	0.0732	0.0711	0.0530	0.0573	0.0133	
Selenium	ppm	0.0216	0.7490	0.0204	0.0237	0.0224	0.0263	0.0240	0.0251	0.0178	0.0186	1
Silver	ppm	0.0004	0.0004	0.0004	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	5
Thallium	ppm	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	
Vanadium	ppm	0.0055	0.0055	0.0007	0.0070	0.0056	0.0061	0.0049	0.0049	0.0032	0.0005	
Zinc	ppm	0.3160	0.3700	0.3740	0.4010	2.6400	0.3490	0.3890	0.2970	0.3180	0.0189	

Duplicate Analyses	DGLS-S0-T	394D	419D	440D	468D	492D	512D	544D	566D	590D	LEACHBLK	Regulatory
Analyte	Lab Sample ID	929129	929131	929133	929135	929137	929153	929139	929141	929143	929206	TCLP Limits
Arsenic	ppm	0.0093	0.0754	0.0126	0.0082	0.0100	0.0133	0.0084	0.0107	0.0115	0.0014	5
Antimony	ppm											
Barium	ppm	0.9830	0.8470	0.8520	0.9170	0.7500	1.1900	0.7390	0.7830	0.7650	0.0058	100
Beryllium	ppm	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	
Cadmium	ppm	0.0002	0.0002	0.0003	0.0002	0.0002	0.0004	0.0002	0.0002	0.0002	0.0002	1
Chromium	ppm	0.0144	0.0168	0.0194	0.0175	0.0139	0.0180	0.0139	0.0131	0.0164	0.0020	5
Lead	ppm	2.1300	2.0100	1.6900	1.9700	1.8200	2.3100	2.1300	1.8200	1.2700	0.0046	5
Mercury	ppm	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.2
Nickel	ppm	0.0581	0.0620	0.0545	0.0610	0.0601	0.0787	0.0635	0.0547	0.0561	0.0133	
Selenium	ppm	0.0220	0.7860	0.0189	0.0195	0.0214	0.0263	0.0295	0.0292	0.0197	0.0186	1
Silver	ppm	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	5
Thallium	ppm	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	
Vanadium	ppm	0.0060	0.0066	0.0010	0.0064	0.0060	0.0062	0.0052	0.0055	0.0046	0.0005	
Zinc	ppm	0.3290	3.0000	0.3590	0.3740	0.3410	0.3700	0.3780	0.3030	0.3130	0.0189	

Table 5.4.1-3 Demonstration Glass versus Contract TCLP Criteria

		Samples from the 72-hour Demonstration										
	DGLS-S0-T	394	419	440	468	492	512	544	566	590	LEACHBLK	Contract
Analyte	Lab Sample ID	929128	929130	929132	929134	929136	929152	929138	929140	929142	929206	Values
Arsenic	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Antimony	ppm	---	---	---	---	---	---	---	---	---	---	
Barium	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	50
Beryllium	ppm	---	---	---	---	---	---	---	---	---	---	
Cadmium	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	0.5
Chromium	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Lead	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Mercury	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	0.1
Nickel	ppm	---	---	---	---	---	---	---	---	---	---	
Selenium	ppm	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	0.5
Silver	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Thallium	ppm	---	---	---	---	---	---	---	---	---	---	
Vanadium	ppm	---	---	---	---	---	---	---	---	---	---	
Zinc	ppm	---	---	---	---	---	---	---	---	---	---	

Duplicate Analyses	DGLS-S0-T	394D	419D	440D	468D	492D	512D	544D	566D	590D	LEACHBLK	Contract
Analyte	Lab Sample ID	929129	929131	929133	929135	929137	929153	929139	929141	929143	929206	Values
Arsenic	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Antimony	ppm	---	---	---	---	---	---	---	---	---	---	
Barium	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	50
Beryllium	ppm	---	---	---	---	---	---	---	---	---	---	
Cadmium	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	0.5
Chromium	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Lead	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Mercury	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	0.1
Nickel	ppm	---	---	---	---	---	---	---	---	---	---	
Selenium	ppm	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	0.5
Silver	ppm	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	2.5
Thallium	ppm	---	---	---	---	---	---	---	---	---	---	
Vanadium	ppm	---	---	---	---	---	---	---	---	---	---	
Zinc	ppm	---	---	---	---	---	---	---	---	---	---	

* Contract TCLP values are 50% of the present TCLP limits.

123

2629 I

The demonstration glass produced during the 72-hour demonstration exhibits excellent resistance to leaching. Eight of the nine demonstration glass samples passed all the Contract TCLP limits. Sample DGLS-S0-T-0419 resulted in a Se leaching value of 0.749 ppm (749 ppb) which exceeded the Se limit of 0.5 ppm (500 ppb). This sample passed the Contract TCLP limits for the other analytes. As shown below, the upper 95% confidence interval for the Se leaching was 158 ppb. The 749 ppb Se leaching for DGLS-S0-T-0419 is considered an anomaly since it is approximately 4 times the upper 95% confidence value for the data set.

A statistical analysis on the nine glass samples indicated all analytes were within the Contract TCLP limits. Table 5.4.1-4 presents the statistical variability of the TCLP analyses on the demonstration glass samples. The average and 95% confidence interval on each analyte was below the 50% TCLP limits as specified by the Contract.

Table 5.4.1-4 Statistical Variability of Demonstration Glass TCLP Results

Analyte	Sample Mean (ppb)	95% Confidence Interval (ppb)	Contract TCLP Limits (ppb)
Arsenic	17.0	3.7 to 30.3	2500
Barium	867.3	783.8 to 950.8	50000
Cadmium	0.2	0.19 to 0.21	500
Chromium	19.5	15.0 to 24.0	2500
Lead	1903.3	1721.9 to 2084.7	2500
Mercury	0.1	0.1	100
Selenium	103.4	0 to 261.6	500
Silver	0.4	0.38 to 0.42	2500

The demonstration glass successfully met the Contract requirements for the treated surrogate wasteform:

1. Appearance: Upon visual inspection, the demonstration glass appeared homogeneous and was free from inclusions, undissolved species, or precipitated metals.

2. Compressive Strength: As discussed in Section 2.0, the compressive strength requirement was retracted for vitrified wasteforms.

3. No liquids: The demonstration glass was free of liquids.

4. TCLP: TCLP results on the demonstration glass were at concentrations less than 50% of the RCRA limit.

5. Dusting/Particulate: The demonstration glass was poured into monoliths during the POPT. FDF agreed that monolithic vitrified wasteforms met the dusting/particulate requirement as defined in the Contract (February 25, 199 – M. Morse).

6. RCRA Characteristics: The demonstration glass did not exhibit a characteristic of a hazardous waste as defined by 40 Code of Federal Regulations (CFR) 261 Subpart C – Characteristics of Hazardous Waste (261.20 through 261.24). Nor was the treated surrogate listed as a hazardous waste.

5.4.2 POPT Secondary Wastes

Secondary wastes generated during the POPT included particulate matter (offgas solids) collected in the offgas treatment system. Molten salts and precipitated metallic species were not generated during the 72-hour demonstration.

5.4.2.1 Offgas Solids

Particulate matter present in the EV-101 offgas stream was removed in the McGill AirClean Electrostatic Precipitator and collected throughout the POPT. Samples were taken of the collected material every eight [8] hours during the 72-hour demonstration. Three offgas solids samples were selected and submitted to the FDF-approved analytical laboratory, Compuchem, for analysis by the TCLP. Two separate aliquots of each sample's leachate were taken and analyzed by ICP for the eight RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag), as well as the six [6] additional metals (Sb, Be, Th, Ni, V, and Zn) identified in the promulgated Universal Treatment Standards.

TCLP results for each of the samples, including the duplicate leachate and leachate blank analyses, are presented in Table 5.4.2.1-1 – Offgas Solids TCLP Results. A comparison of the analytical results against the Contract TCLP limits (50% of the RCRA TCLP limits) for the demonstration glass is presented in Table 5.4.2.1-2 – Offgas Solids versus Contract TCLP Criteria.

With the exception of arsenic, selenium, and lead, the analyzed offgas solids passed the Contract TCLP Criteria (50% of TCLP). All three offgas solids

samples failed the Contract TCLP Criteria for arsenic and selenium. Sample OGSO-S0-T-0497 also failed the Contract TCLP Criteria for lead.

5.4.2.2 Collected Salts

Although molten salts were not generated during the 72-hour demonstration, salt samples were collected before initiation and after the completion of the 7800-kg processing period. The salt samples (SALT-S0-T-0375 and SALT-S0-T-0673) were submitted to Compuchem for analysis by the TCLP. Two separate aliquots of each sample's leachate were taken and analyzed by ICP for the eight RCRA metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag), as well as the six [6] additional metals (Sb, Be, Tl, Ni, V, and Zn) identified in the promulgated Universal Treatment Standards.

Table 5.4.2.1-1 Offgas Solids TCLP Results

		Samples from the 72-hour Demonstration				
	OGSO-S0-T	360	497	587	LEACHBLK	Regulatory
Analyte	Lab Sample ID	929154	929156	929158	929206	TCLP Limits
Arsenic	ppm	52.6000	35.2000	35.0000	0.0014	5.0
Antimony	ppm					
Barium	ppm	1.9800	3.9100	2.6700	0.0058	100.0
Beryllium	ppm	0.0005	0.0005	0.0005	0.0005	
Cadmium	ppm	0.0040	0.0035	0.0030	0.0002	1.0
Chromium	ppm	0.0531	0.1040	0.1510	0.0020	5.0
Lead	ppm	1.7400	2.8100	1.8400	0.0046	5.0
Mercury	ppm	0.0001	0.0001	0.0001	0.0001	0.2
Nickel	ppm	1.5200	1.5200	1.1500	0.0133	
Selenium	ppm	503.0000	382.0000	248.0000	0.0186	1.0
Silver	ppm	0.0004	0.0004	0.0004	0.0004	5.0
Thallium	ppm	0.1170	0.0341	0.0449	0.0024	
Vanadium	ppm	0.0005	0.0005	0.0005	0.0005	
Zinc	ppm	25.7000	26.2000	15.8000	0.0189	

Duplicate Analyses	OGSO-S0-T	360D	497D	587D	LEACHBLK	Regulatory
Analyte	Lab Sample ID	929155	929157	929159	929206	TCLP Limits
Arsenic	ppm	52.6000	35.5000	35.6000	0.0014	5.0
Antimony	ppm					
Barium	ppm	1.9600	3.8100	2.7100	0.0058	100.0
Beryllium	ppm	0.0005	0.0005	0.0005	0.0005	
Cadmium	ppm	0.0039	0.0035	0.0030	0.0002	1.0
Chromium	ppm	0.0522	0.1010	0.1540	0.0020	5.0
Lead	ppm	1.7200	2.7800	1.8800	0.0046	5.0
Mercury	ppm	0.0001	0.0001	0.0001	0.0001	0.2
Nickel	ppm	1.5100	1.4700	1.1700	0.0133	
Selenium	ppm	501.00	384.00	252.00	0.0186	1.0
Silver	ppm	0.0004	0.0004	0.0004	0.0004	5.0
Thallium	ppm	0.1120	0.0300	0.0434	0.0024	
Vanadium	ppm	0.0005	0.0005	0.0005	0.0005	
Zinc	ppm	25.9000	26.2000	16.0000	0.0189	

Table 5.4.2.1-2 Offgas Solids versus Current Regulatory TCLP Criteria

		Samples from the 72-hour Demonstration				
	OGSO-S0-T	360	497	587	LEACHBLK	Regulatory
Analyte	Lab Sample ID	929154	929156	929158	929206	TCLP Limits
Arsenic	ppm	FAIL	FAIL	FAIL	PASS	5.0
Antimony	ppm	---	---	---	---	
Barium	ppm	PASS	PASS	PASS	PASS	100.0
Beryllium	ppm	---	---	---	---	
Cadmium	ppm	PASS	PASS	PASS	PASS	1.0
Chromium	ppm	PASS	PASS	PASS	PASS	5.0
Lead	ppm	PASS	PASS	PASS	PASS	5.0
Mercury	ppm	PASS	PASS	PASS	PASS	0.2
Nickel	ppm	---	---	---	---	
Selenium	ppm	FAIL	FAIL	FAIL	PASS	1.0
Silver	ppm	PASS	PASS	PASS	PASS	5.0
Thallium	ppm	---	---	---	---	
Vanadium	ppm	---	---	---	---	
Zinc	ppm	---	---	---	---	

Duplicate Analyses	OGSO-S0-T	360D	497D	587D	LEACHBLK	Regulatory
Analyte	Lab Sample ID	929155	929157	929159	929206	TCLP Limits
Arsenic	ppm	FAIL	FAIL	FAIL	PASS	5.0
Antimony	ppm	---	---	---	---	
Barium	ppm	PASS	PASS	PASS	PASS	100.0
Beryllium	ppm	---	---	---	---	
Cadmium	ppm	PASS	PASS	PASS	PASS	1.0
Chromium	ppm	PASS	PASS	PASS	PASS	5.0
Lead	ppm	PASS	PASS	PASS	PASS	5.0
Mercury	ppm	PASS	PASS	PASS	PASS	0.2
Nickel	ppm	---	---	---	---	
Selenium	ppm	FAIL	FAIL	FAIL	PASS	1.0
Silver	ppm	PASS	PASS	PASS	PASS	5.0
Thallium	ppm	---	---	---	---	
Vanadium	ppm	---	---	---	---	
Zinc	ppm	---	---	---	---	

TCLP results for each of the samples, including the duplicate leachate and leachate blank analyses, are presented in Table 5.4.2.2-1. A comparison of the analytical results against the current regulatory TCLP limits for the collected salts is presented in Table 5.4.2.2-2. With the exception of arsenic and selenium, the collected salts passed the current regulatory TCLP Criteria.

5.4.2.3 Precipitated Metal Species

Approximately 15 - 20 kg of metallic material were collected at the metals drain in the main tank. At least two factors contributed to the presence of metallic species: 1) the Pb:Mo reduction-oxidation reaction, and 2) the short-term addition of bulk quantities of lead compounds during the post-demonstration clean-up (See Section 5.3).

Table 5.4.2.2-1 TCLP Results of Salts Collected Within the 7800-kg Processing Window

	SALT-S0-T	375	375D	673	673D	LEACHBLK	Regulatory
Analyte	Lab Sample ID	930757	929130	930762	929134	930871	TCLP Limits
Arsenic	ppm	44.7000	44.3000	49.3000	44.4000	0.0078	5.0
Antimony	ppm	0.0100	0.0100	0.0100	0.0100	0.0014	
Barium	ppm	0.0662	0.0688	0.0361	0.0403	0.0034	100.0
Beryllium	ppm	0.0005	0.0005	0.0005	0.0005	0.0005	
Cadmium	ppm	0.0047	0.0048	0.0046	0.0050	0.0002	1.0
Chromium	ppm	0.5220	0.5580	0.0581	0.0644	0.0008	5.0
Lead	ppm	0.1610	0.1700	0.0589	0.0651	0.0027	5.0
Mercury	ppm	0.0001	0.0001	0.0001	0.0001	0.0001	0.2
Nickel	ppm	0.4740	0.5040	0.1130	0.1250	0.0008	
Selenium	ppm	1.4200	1.5200	1.2600	1.4100	0.0161	1.0
Silver	ppm	0.0016	0.0019	0.0012	0.0017	0.0004	5.0
Thallium	ppm	0.0024	0.0024	0.0024	0.0024	0.0024	
Vanadium	ppm	4.1900	4.5000	3.7500	4.1500	0.0005	
Zinc	ppm	2.7000	2.8900	1.6500	1.8300	0.0008	

EnVitCo, Inc.
A COGEMA Group Company

Table 5.4.2.2-2 Collected Salts versus Current Regulatory TCLP Criteria

	SALT-S0-T	375	375D	673	673D	LEACHBLK	Regulatory
Analyte	Lab Sample ID	930757	929130	930762	929134	930871	TCLP Limits
Arsenic	ppm	FAIL	FAIL	FAIL	FAIL	PASS	5.0
Antimony	ppm	---	---	---	---	---	
Barium	ppm	PASS	PASS	PASS	PASS	PASS	100.0
Beryllium	ppm	---	---	---	---	---	
Cadmium	ppm	PASS	PASS	PASS	PASS	PASS	1.0
Chromium	ppm	PASS	PASS	PASS	PASS	PASS	5.0
Lead	ppm	PASS	PASS	PASS	PASS	PASS	5.0
Mercury	ppm	PASS	PASS	PASS	PASS	PASS	0.2
Nickel	ppm	---	---	---	---	---	
Selenium	ppm	FAIL	FAIL	FAIL	FAIL	PASS	1.0
Silver	ppm	PASS	PASS	PASS	PASS	PASS	5.0
Thallium	ppm	---	---	---	---	---	
Vanadium	ppm	---	---	---	---	---	
Zinc	ppm	---	---	---	---	---	

131

2991

5.5 72-hour Demonstration Data

The 72-hour demonstration resulted in the collection of various data points in the melter process. The key control parameters identified in the Work Plan and again in Section 5.1.5 of this Report are presented.

The melter operated continuously for 72 hours. Four (4) minutes of downtime were logged as the result of a slurry valve failure in hour 72 of the test. Approximately 3900 kilograms of feed (30 wt% solids) were converted to 1000 kilograms of glass during the test. Melter operations were very stable during the test as shown in the following charts and figures.

The key parameters used to control the process were identified in Section 5.1.5 of this Report. Table 5.5-1 Demonstration Operating Parameters compares the following:

- Established targets from treatment recipe development and the pre-process optimization period; and
- Average and Range of the values logged during the demonstration.

The table shows that the 72-hour test was performed within the control parameters established during the pre-process optimization period.

Table 5.5-1 Demonstration Operating Parameters

Parameter	Pre-Test Target	Test Average	Test Range
Main Tank Glass Temperature (°C)	1150 – 1200	1165	1136 – 1177
Main Tank Plenum Temperature (°C)	800	818	704 – 896
Slurry Feed Rate (kg/hr)	52	54	50 – 60
Glass Level (inches)	-1 to +1	+ 0.1	-0.2 – 0.6
Glass Drain Rate (kg/hr)	15	14	9 – 20
Plenum Pressure (inches water column)	-0.05 to –0.1	-0.06	-0.13 to -0.01
Glass Redox Ratio (Fe^{+2} / ΣFe)	0.1 – 0.2	0.15	0.12 – 0.17

The following sections provide a description of each data plot figure. The figures are included after the discussions.

Figure 5.5-2 shows the temperature of the glass in the main tank and drain bay along with the main tank plenum temperature. Fluctuation in the glass temperature was expected during the operation of the melter. Convective flows due to heat gradients within the melter can cause fluctuations in the temperature of the glass passing a thermocouple at any point in time. No unusual changes in glass temperature were noted during the demonstration. The temperature of the glass in the drain bay was higher than the glass in the main tank to condition the viscosity of the glass for pouring.

Figure 5.5-3 shows the setpoints for the power input to the melter. These values range from 0 – 999 as an indicator of power applied to the in-glass electrodes. Data sets Main Tank 1 and Main Tank 2 were independently-controlled zones in the main melter tank. Data set Drain Bay is the set-point for the power applied to the glass drain bay. These setpoints were adjusted based on the glass temperatures in the main tank and drain bay. Changes in the setpoints were only made by Envitco engineers during the demonstration. The lack of fluctuation in the data shows that the process was very stable and required little change in the setpoints.

Figure 5.5-4 shows the processing rate of the melter. The data set Slurry Feed is the calculated slurry feed rate based on the magnetic flow meter used in the slurry feed metering system. The data set Glass Drain is the observed glass drain rate in kilograms per hour. A few one-hour gaps in the data are the result of data either not being recorded on the round sheet or an illegible entry.

The average volumetric feed rate was 0.72 liters per minute. At a slurry density of 1.23 kg/l, the resulting average mass feed rate was 54 kilograms per minute. The feed slurry contained an average 36 wt% dry solids and 28 wt% oxides that contributed to the glass. The resulting calculated glass production is, therefore, 54 x 28% = 15 kg/hr.

The glass drain rate values were based on the increase in weight of the glass pouring container over a period of 1 – 5 minutes. The values reported during the demonstration averaged 14 kg/hr. The difference between the calculated and observed is due to rounding error and variations in the solids content between batches.

The data shows that the feed and drain rate varied within acceptable ranges. The metering error induced due to the low feed flow and the human variability introduced with the timing of a change in weight for the glass collection container account for the minor variations in processing rate.

Figure 5.5-5 Furnace Pressure shows the main melter tank plenum pressure in inches of water column over the 72-hour test. A few one-hour gaps in the data are the result of data either not being recorded on the round sheet or an illegible

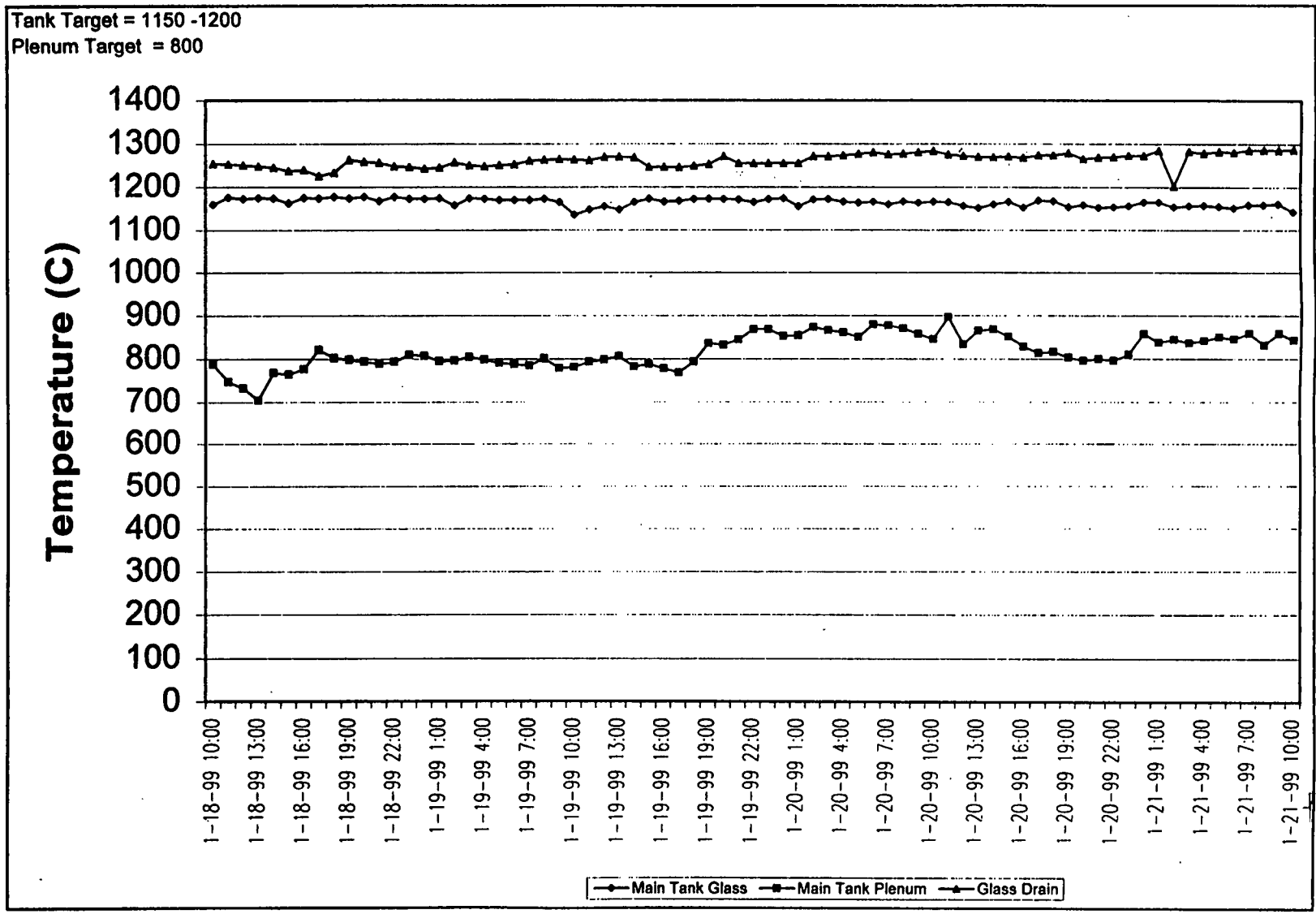
entry. The data shows that the furnace pressure changed significantly around 1700 hours on January 19th. Improved sealing in the ductwork between the melter and the ESP reduced inleakage and resulted in lowering the furnace pressure. The damper used to control the amount of air being withdrawn by the induced draft fan was adjusted to restore the furnace pressure to the previous range of operation as noted in Notebook JJ page 40 included with this report.

Figure 5.5-6 Redox Ratio shows the Fe^{+2} / ΣFe ratio of the glass over the course of the demonstration. The target range was 0.1 to 0.2 as established in the treatment recipe development phase to prevent elemental metal precipitation. The data shows that the redox was within the established operating range.

Figure 5.5-7 Glass Level shows the level of the glass in the drain bay relative to the zero-point established at the beginning of the test. The glass level was identified as a key melter control parameter in the Work Plan. The glass level must be maintained to prevent overfilling the melter or exposing the electrodes to oxidizing conditions which would damage them if the glass level dropped. The normal operating range of the glass level is between -1 and +1 inches from zero. The data shows that the glass level varied within the normal operating range.

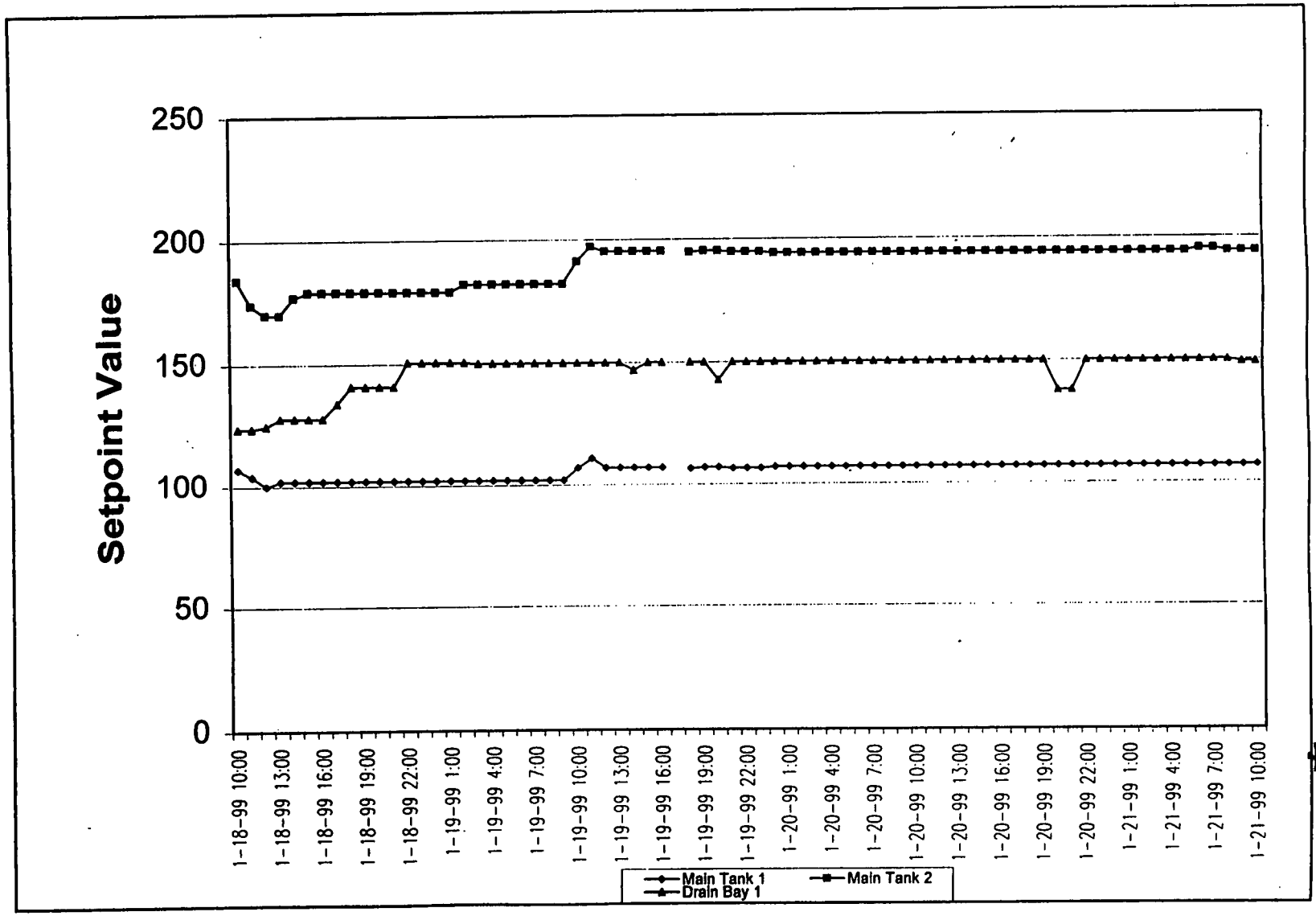
EnVitCo, Inc.
A COGEMA Group Company

Figure 5.5-2 Melter Temperatures



EnVitCo, Inc.
A COGEMA Group Company

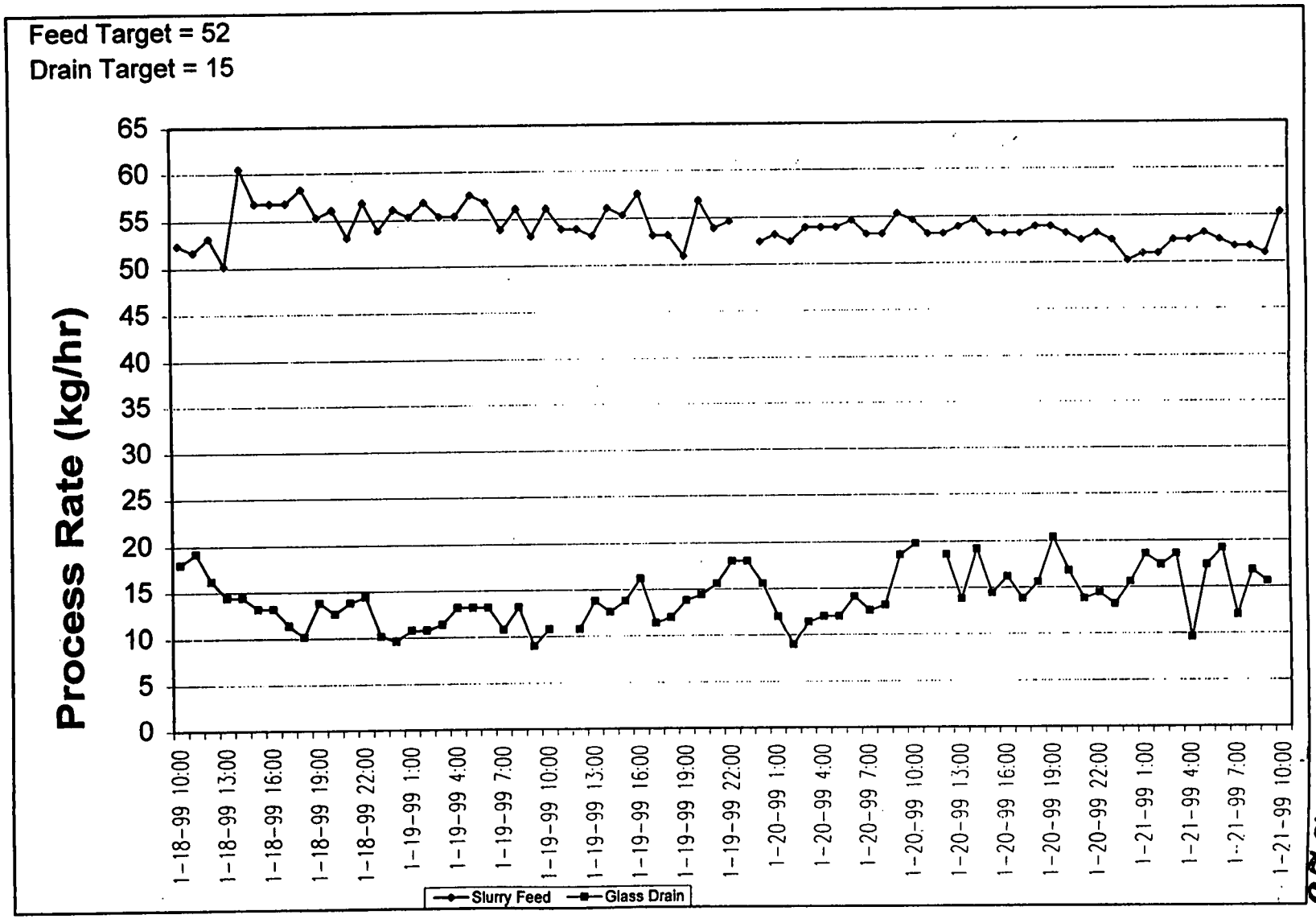
Figure 5.5-3 Melter Set-points



136

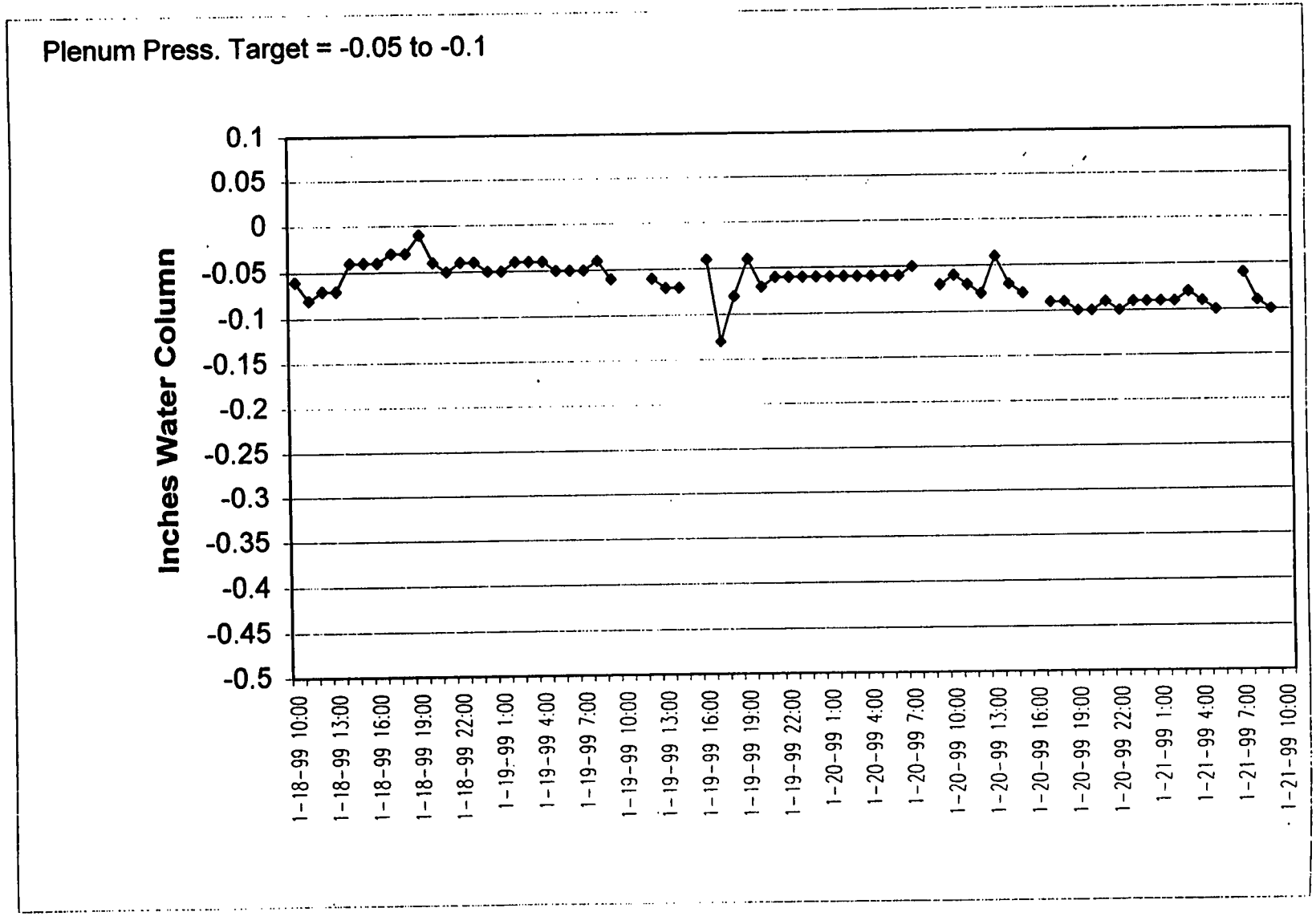
EnVitCo, Inc.
A COGEMA Group Company

Figure 5.5-4 Melter Throughput



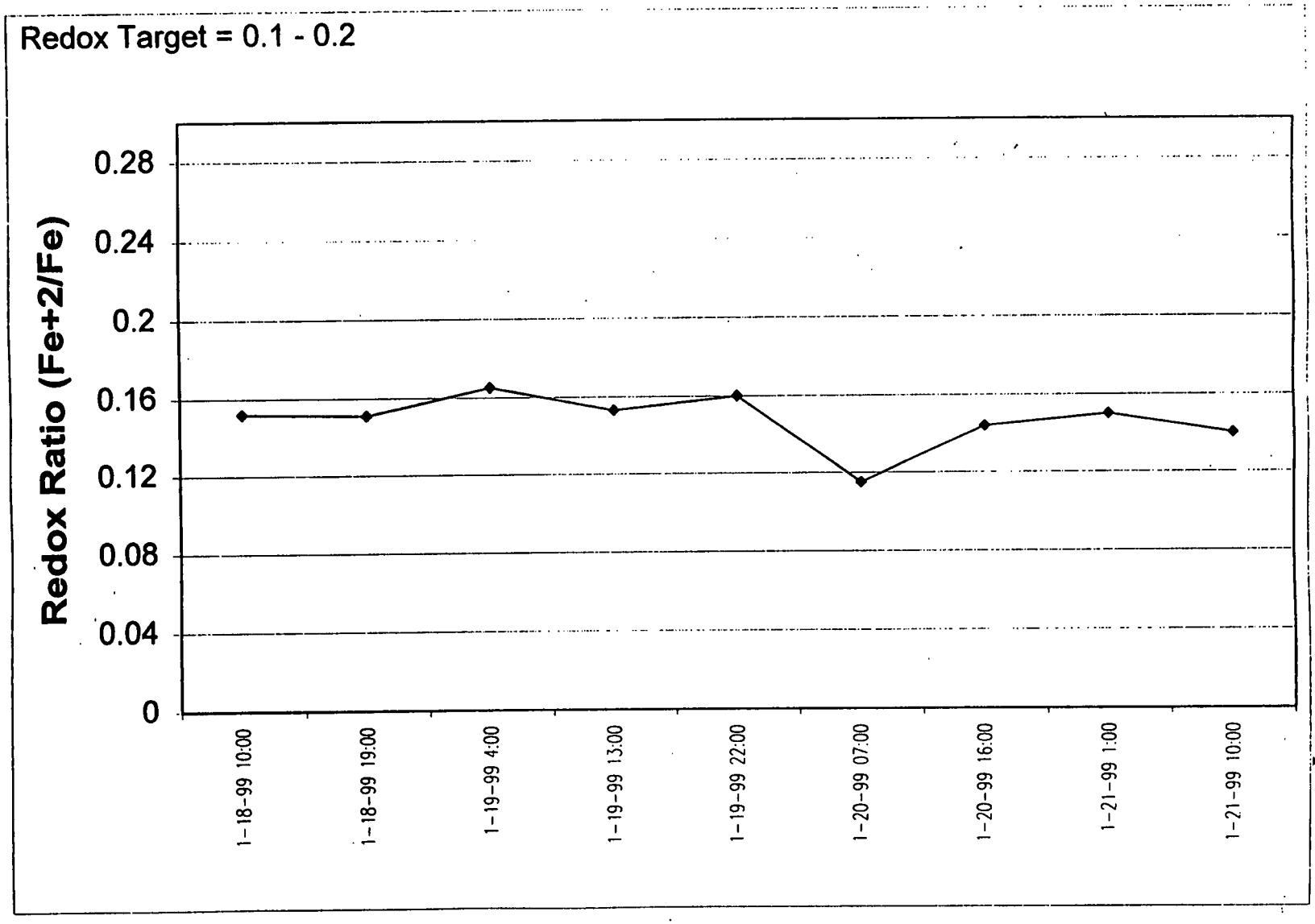
EnVitCo, Inc.
A COGEMA Group Company

Figure 5.5-5 Furnace Pressure



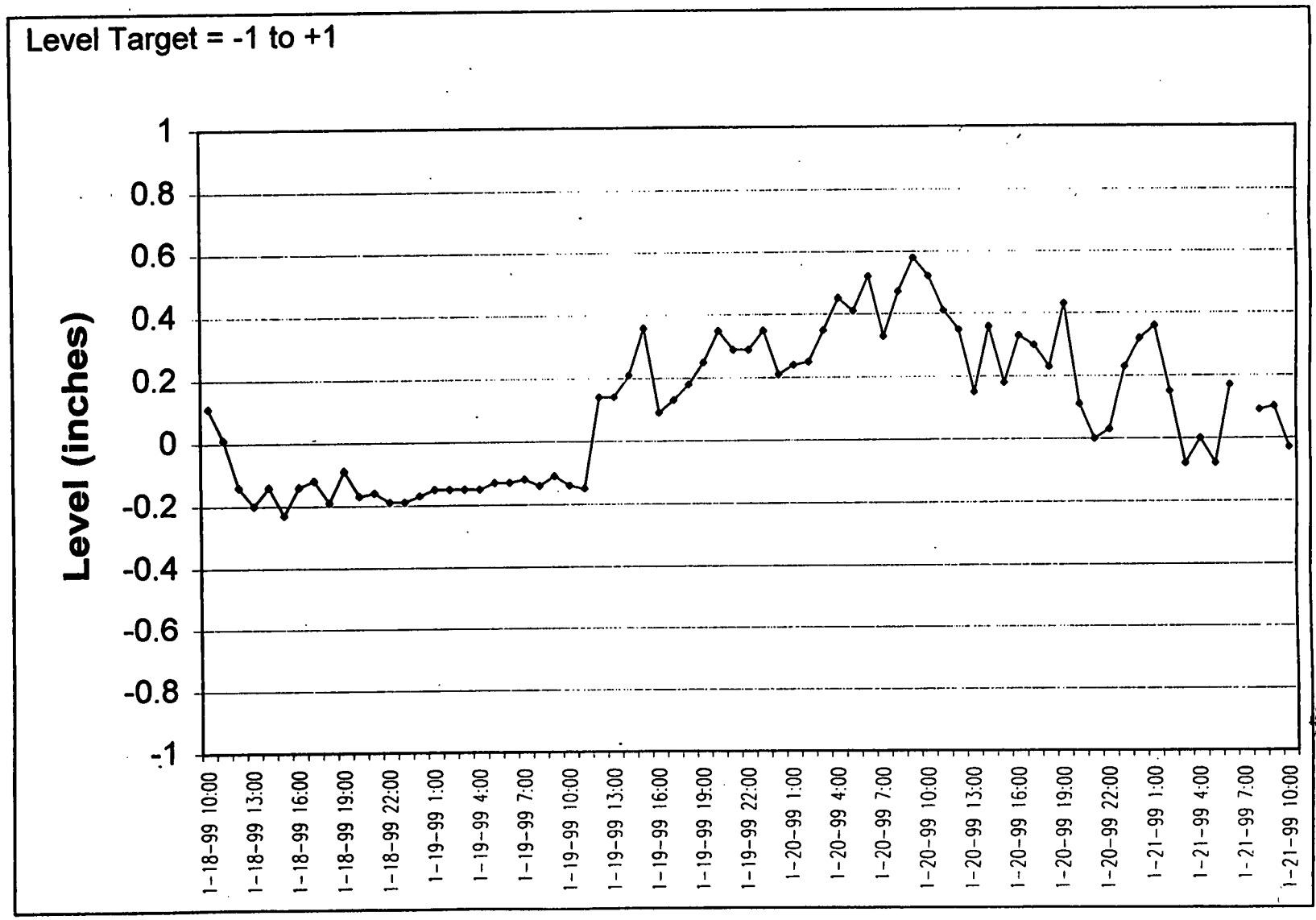
EnVitCo, Inc.
A COGEMA Group Company

Figure 5.5-6 Redox Ratio



EnVitCo, Inc.
A COGEMA Group Company

Figure 5.5-7 Glass Level



5.6 Melter Performance

A post-demonstration inspection was performed on the EV-101 melter upon shutdown. Shutdown of the EV-101 occurred after the post-demonstration cleanup activities were completed. The purpose of the post-demonstration inspection was to determine the refractory and electrode performance during the processing of the demonstration surrogate and observe any metal precipitation (as discussed in Section 5.3.2) in the melter.

5.6.1 Refractory Performance

The EV-101 melter incorporated six (6) different types of refractory for the purpose of evaluating Silo surrogate/refractory interaction. Three refractory types were used in the demonstration: mullite (aluminosilicate), alumina-zirconia-silica (AZS) and chrome-bearing. To test the refractory types, the melter was fitted with five refractory coupons prior to the demonstration to determine the typical wear responses expected for refractory in 1) the melt zone, 2) at the interface between the melt and plenum space, and 3) the plenum just above the melt interface.

The refractory wear was excellent for all refractories. None of the refractories were clearly better, though the dense chrome-bearing refractories exhibited slightly better durability. Variations in wear due to refractory location could not be accurately discerned though installation and exposure were theoretically similar. Average refractory wear was approximately 0.060" bulk. Assuming an operation time of 30 days, 0.060" bulk wear equates to 0.002" per day of wear.

5.6.2 Electrode Performance

Since molybdenum was not a component of the Demonstration Surrogate, a simple molybdenum mass balance was performed around the melter to estimate the average molybdenum consumption rate. The average molybdenum concentration in the demonstration glass was analyzed to be 0.20 wt% MoO_3 (oxide basis). At an average glass drain rate of 14.4 kg glass per hour, 0.0192 kg Mo was drained from the melter per hour. When coupled with the Mo partitioning rate to the offgas (1.08×10^{-4} kg Mo per hour), the total molybdenum loss from the melter was 0.019 kg Mo per hour. At this rate, 1.4 kg of molybdenum exited the melter during the 72-hour demonstration.

A post-demonstration inspection of the electrodes evaluated their overall wear. Physical dimensions of the electrodes were taken during the post-demonstration inspection and compared against the pre-demonstration measurements. The analysis indicated that 10.6 kg of molybdenum was consumed during the entire

operating period of the melter. Molybdenum wear was predominantly on the upper electrodes of the main tank and accounted for as much as 75% of the electrode wear. Additional process optimization is expected to mitigate the wear by 50% or more.

5.7 Secondary Waste Disposal

Excess demonstration feed, flush water, and residues from tanks, pumps, and feed lines generated during clean-up were processed through the EV-101 to minimize disposal of hazardous materials. Offgas solids and any collected salts were disposed in accordance with Clemson University's hazardous waste program. Debris generated during the demonstration that was in contact with the surrogate (gloves, coveralls, etc.) was designated as hazardous waste and processed in accordance with Clemson University's hazardous waste program.

6.0 PRE-CONCEPTUAL FULL-SCALE DESIGN DATA

The purpose of the proposed vitrification facility is to convert the Silos 1 and 2 residues into a durable, vitreous wasteform within 36 months. The wasteform will meet or exceed the Nevada Test Site (NTS) Waste Acceptance Criteria (WAC), as defined in the Contract.

The full-scale facility conceptual design is based on the demonstration surrogate composition as presented in Contract Modification No. 06 and the corresponding glass composition developed by Envitco to meet 50% of the TCLP limits.

The baseline technology for the full-scale facility is Joule-heated vitrification. The melter presented in this section incorporates the design features successfully employed during the POPT demonstration in the EV-101 WASTE-VIT® melter. The following is a list of common design features:

- Three process sections: main melting tank, glass drain bay, salt drain bay;
- Glass drain and salt drain orifices;
- Sloped bottom main melt tank with metals drain;
- Advanceable, renewable, molybdenum electrodes;
- Plenum heating for offgas temperature control;
- Refractory lining (chrome bearing);
- Water-cooled shell;
- Slurry feeding through water-cooled nozzle; and
- Variable setting power supplies to handle variations in resistivity.

6.1 Process Design Basis

The process design basis establishes certain parameters that form a reference for the facility design. The POPT Contract establishes some of these parameters in Section C.4.3. Additional parameters are also required for the design of the treatment equipment as outlined in the following sections.

6.1.1 FDF Contract Requirements

6.1.1.1 Facility Capacity

The vitrification facility must be able to accommodate treating the Silos Residue within 36 months. The total inventory of Silos Residue is 6780 m^3 equivalent to 9031 MT (9955 US tons) of residue on a dry basis (Fluor Daniel Fernald 1999). At 30 wt% solids, the Silos Residue inventory would be approximately 30,170 MT.

The treatment rate of the facility must be at least 27.6 MT of residue slurry per day, which equates to 8.3 MT per day on a dry basis, at 100% availability.

At a dry waste loading of 83.5% in the glass, the production rate of glass must be at least 9.9 MT per day of glass. The total amount of glass produced from the 9031 MT of dry Silos Residue is 10,800 MT.

The facility must maintain a minimum 70% availability factor. The melter is, therefore, rated at 14 MTPD.

6.1.1.2 Waste Recycle

Secondary wastes will be recycled to the greatest extent possible without being detrimental to waste loading or process reliability.

6.1.1.3 Final Product Specifications

The treated residue must comply with the Contract requirements. The requirements of FDF for the POPT, as applied to the design basis for the full-scale facility, were outlined in the POPT Contract, Section C.4.2.3.1. The requirements were as follows:

- Appearance – shall appear uniform and homogeneous to non-magnified vision;
- Compressive Strength – greater than 50 psi per ASTM C773;
- Liquids – no free liquids per ANS 55.1;
- TCLP – must meet RCRA TCLP characteristic waste specifications;

- Dusting/Particulate – the disposal package shall contain less than 1 wt% of less than 10 micrometer diameter particles and less than 15 wt% of less than 200 micrometer diameter particles; and

- RCRA Characteristics – the final wasteform must not exhibit a characteristic of hazardous waste defined in 40 CFR 261 Subpart C.

Note: The waste performance as required by NTS allows the full leachate concentration for lead, as defined by 40 CFR 261 for characteristic waste. The POPT demonstration required that the wasteform perform at better than 50% of the leachate concentration limits for lead. The design basis chosen by Envitco utilizes the glass formulation as tested during the POPT demonstration. It is assumed that application of the full, allowable TCLP range for lead will result in further improvements in waste loading, processing rate, testing/analytical costs, operations costs, and overall life cycle cost.

6.1.1.4 Air Emissions

Gaseous emissions from the treatment process must be treated and then released through the Radon Control System (RCS). The offgas treatment system must use Best Available Technology (BAT) including High Efficiency Particulate Air (HEPA) filters for particulate matter removal.

The constraints for sending emissions to the RCS were as follows:

- 500 SCFM maximum flow rate for existing RCS;

- maximum 0.022 pounds water per pound of dry air;

- maximum 32 degrees C (90 degrees F);

- maximum 20 ppm (by volume) SO_x;

- maximum 20 ppm (by volume) NO_x;

- maximum 10 vol% CO_2;

- maximum 40 ppm (by volume) total organics;

- HEPA filtered for particulate matter; and

- Air in contact with untreated waste must pass through the RCS.

6.1.1.5 Secondary Liquid Waste

Any secondary liquid waste must meet the following guidelines in order to be processed at the FEMP AWWT:

- 14,400 gallons per day maximum;
- 1000 ppm total suspended solids maximum;
- ALARA radon concentration; and
- Meet the discharge limits as described in the FDF POP Testing Interface Design Basis for metals and radionuclides.

6.1.1.6 Secondary Solid Waste

Secondary solid waste can be sent to either the On-Site Disposal Facility (OSDF) or the NTS. For the OSDF, the following criteria must be met.

- No visually observable Silos Residues, free liquids, used oils, scrap tires or lead;

Maximum size requirements are as follows:

Metal	10'L x 4'W x 1.5'H
Concrete	6'L x 4'W x 1.5'H
Other	8'L x 4'W x 1.5'H

Waste must be segregated and stored until turned over to FDF Waste Management.

If the NTS is to be used as the solid secondary waste disposal site, the following constraints must be met:

- Meet the NTS WAC;
- Packaged in 4'W x 4' or 2'H x 7'L boxes or 55, 85, or 110 gallon drums; and
- Packages must have the loading maximized in order to minimize void space.

6.1.1.7 Wasteform Final Container

The wasteform must be packaged into a container of the following specification:

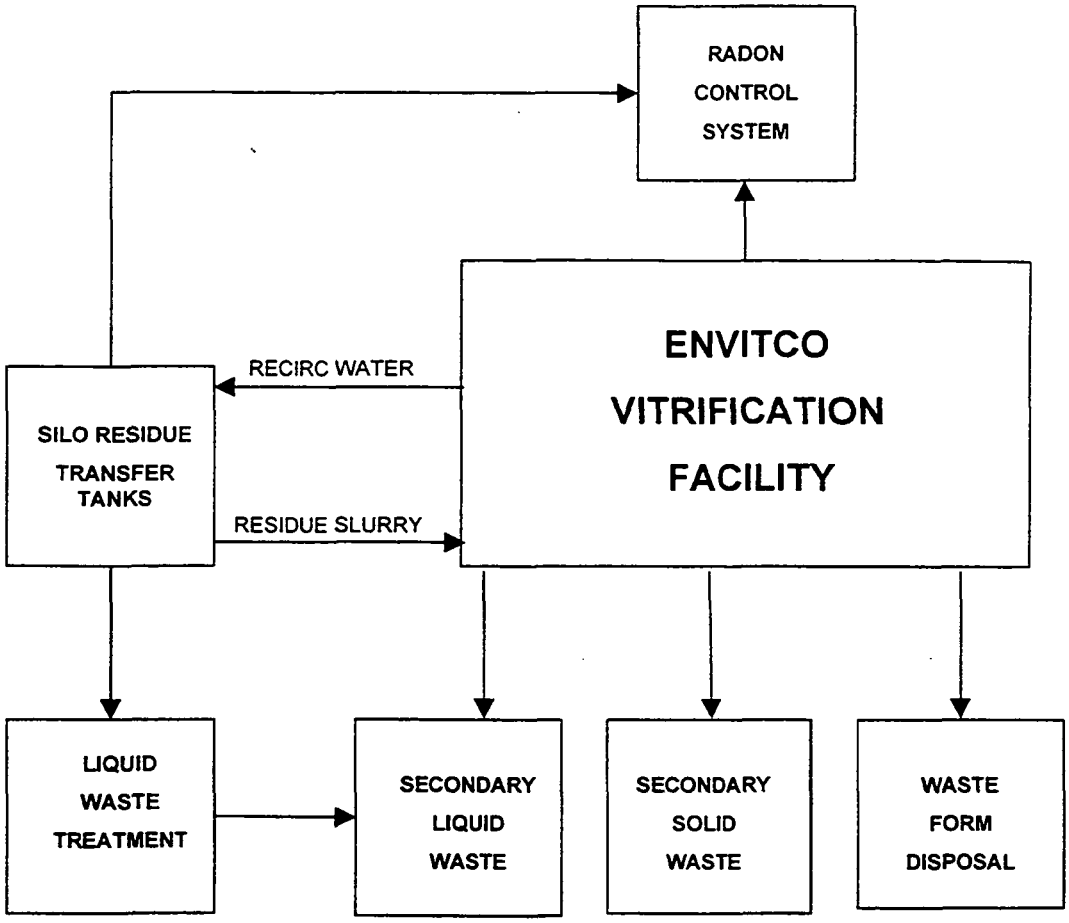
- DOT 7A, Type A container;
- Maximum 9545 kg (21,000 lbs) gross weight; and
- Less than 100 mrem/hr surface dose rate.

Envitco will use the Scientific Ecology Group (SEG)-designed concrete container as presented in the FDF Interface Design Basis as the final disposal container.

6.1.1.8 Interfaces

The interfaces are defined as shown in Figure 6.1.1.8-1. The final remediation contractor will be responsible for management and operation of the Accelerated Waste Retrieval (AWR) system, including transfer of the Silos Residue from the AWR. FDF (or their designated contractor) will be responsible for the installation, operation and maintenance of the RCS. FDF (or their designated contractor) will also treat the pretreated liquid waste (based on Advanced Wastewater Treatment facility (AWWT) requirements) from the vitrification facility in the AWWT. The final wasteform will be transferred to FDF in a ready-for-disposal state.

Figure 6.1.1.8-1 Envitco – FDF Interface Diagram



6.1.2 Envitco Design Assumptions and Basis

6.1.2.1 Facility Feed Streams

The vitrification facility will receive two feed streams: a) Silos Residue from the Accelerated Waste Retrieval system (AWR), and b) glass additives. The glass additives will be in the form of powders and liquids that will be delivered via bulk tanker truck. The Silos Residue will be transferred via pipeline at a solids content of 10 – 30 wt% with a maximum flow rate of 5900 lbs/hr on a dry basis.

6.1.2.2 Glass Formulation

The glass formulation used for the full-scale system is S0-D5B-2, which was used in the POPT demonstration, and is described in Section 4 of this document. The formulation is a soda-lime-silica glass with a high lead content. The Silos Residue composition is based on the demonstration surrogate as presented in the Contract Modification No. 06.

6.1.2.3 Waste Loading and Bulking Factor

The baseline full-scale waste loading of the treated Silos Residue is 83.5 wt%. A slightly higher waste loading may be possible based on crucible scale work presented in Section 4 of this report. However, the baseline waste loading of 83.5% is used in the remainder of the report since it was demonstrated during the POPT. The waste loading is calculated the same as in Section 5.3.2 of this report.

The estimated full-scale bulking factor is 43.7% based on the values calculated for the POPT demonstration and presented in Section 5.3.2 of this report.

6.1.2.4 Off-spec Product

Off-spec product will be treated by the vitrification system. Off-spec product will be stored until the end of the project and then recycled to the melter within the 36-month campaign. The estimated amount of off-spec product is 1% of the total glass produced. This is equal to an average of 40 MT per year or a total of 120 MT. This is equivalent to 30 disposal packages.

6.1.2.5 Equipment Maintenance Basis

The maintenance basis for most process equipment is contact maintenance. However, as with any radiological facility, As Low As Reasonably Achievable (ALARA) principles will be employed during the design phase and for the planning of maintenance activities when dealing with personnel exposure to radiation. Equipment will be maintained without the use of remote manipulators or tooling, unless remote services are justified based on ALARA analysis.

Specific equipment such as the tanks holding Silo Residue are located in shielded rooms away from the pumps and mixers to facilitate maintenance of "wear prone" equipment. For example, the mixers for the feed preparation tanks are shown on the floor level above the tanks. The mixers are, therefore, isolated from the tanks by the thick concrete floor. The shaft of the mixer then passes

through the floor and into the tank. The mixer motor can be serviced without direct radiation exposure to the residue. Access to the tanks is allowed only after the residue (radioactive source) has been removed. The tanks can then be contact-maintained by removing the floor slab located above the tanks as shown in the facility layout drawings.

This is discussed in further detail in Section 6.6.4.6.

6.1.2.6 Process Maintenance Philosophy

Equipment that fails during the course of plant operation will either require replacement or repair. Equipment that is prone to wear will be installed with redundancy in order to minimize downtime. This allows replacement or repair of the failed piece of equipment. Easily replaced, low-cost pieces of equipment (valves, latches, connectors, etc.) would be replaced and the failed equipment disposed. Larger, more complex equipment (pumps, drives, fans, etc.) would be repaired or rebuilt. Minor repairs would be handled by in-house maintenance personnel in the cold or warm maintenance areas of the facility. Major repairs or rebuilds would be contracted to an outside firm who would conduct the repairs on-site or at the vendors location as best suits each situation.

Specialty spare parts (melter components, filter elements, etc.), or parts that require long procurement times (melter parts, complex sensors, etc.) would be stored on-site. This would insure that if no redundancy is available, downtime is minimized. On-site storage also allows for rapid replacement of parts that fail and need to be replaced because the redundancy is only designed for a short duration of operation.

NOTE: A detailed Reliability, Accessability, Maintainability, Inspectability (RAMI) study, detailed radioactive source/dose information, and economic trade studies would be required to determine which equipment requires redundancy or required on-site spares. These evaluations are beyond the scope of the POPT. Therefore, only slurry pumps and certain offgas filters are shown with redundancy in the full-scale design based on previous experience.

6.1.2.7 Operations Basis

Most normal operations within the plant will be automated to the extent possible to minimize the exposure of personnel to radiation. For example, the indexing and movement of subcontainers under the glass drain will be performed remotely using automated conveying systems and remote manipulation through direct CCTV observation. The melter and feed preparation systems are also operated remotely.

This is discussed in further detail in Section 6.6.4.6.

6.1.3 *Technology Experience*

The basis for Envitco's confidence in treating low-level and mixed waste with a ceramic-lined, Joule-heated melter is based on Envitco's own experience and the experience of other DOE sites utilizing Joule-heated melters to treat radioactive waste. Specifically, Envitco and its related companies, Toledo Engineering, KTG Systems and SGN, have processed a number of slurried waste streams and commercial products with similar characteristics to the Silos Residue.

The Envitco WASTE-VIT® Joule-heated vitrification technology has been successfully used on a full-scale basis for treating mixed low-level waste from the DOE K-25 site in Oak Ridge, Tennessee. The system employed to perform this work was the five (5) ton per day (TPD) Transportable Vitrification System (TVS) that was designed and built by Envitco for the DOE in 1995.

The TVS treated over 15,000 pounds of low-level mixed waste from B&C Pond Sludge/CNF Sludge during an extended campaign in 1997. Prior to that, the TVS underwent extensive shakedown tests at two (2) sites over two (2) years. This work was conducted by Westinghouse Savannah River Company (WSRC) and Lockheed Martin Energy Systems (LMES) personnel with the technical and operating assistance of Envitco. The campaigns processed both non-radioactive surrogate and actual Oak Ridge mixed waste.

The B&C Pond Sludge/CNF sludge waste contained very finely divided particulate matter that was manufactured by a precipitation floculation/precipitation process. It contained variable amounts of residual carbon, Al, Ca, S, Fe, Si, as well as several reduceable/reactive metals.

In 1995, the two (2) TPD WASTE-VIT® EV-101 successfully completed the first vitrification demonstration program on West End Treatment Facility (WETF) sludge. This material was a low-level mixed waste that is currently generated and stored at the Oak Ridge K-25 site. The demonstration was conducted by Scientific Ecology Group (SEG) under the technical guidance of Envitco. This is the same melter that was used by Envitco for the POPT demonstration program.

The WETF material was a biodentrification precipitation residue which contained significant fractions of $CaCO_3$ and carbon, with the balance consisting of primarily Al, Fe, Mg, Na as nitrates, acetates, and carbonates. The precipitation process resulted in a material that was dilatent, and required special handling in mixing and pumping.

Envitco has a worldwide exclusive license to use the Joule-heated vitrification technology of TECO, its affiliated company. The Envitco Joule-heated vitrification technology is successful because this technology is mature and has been used in the glass industry for over thirty-five (35) years. In fact, Envitco's affiliated company, TECO, has designed and built over 250 Joule-heated melters worldwide for the commercial glass industry. These units have been designed and built for applications as large as 300 metric TPD. Due to this extensive commercial experience base, TECO was given a sole source order by Dupont Savannah River Company in the 1980's to assemble and install refractory in the current WSRC Defense Waste Processing Facility (DWPF). TECO, likewise, installed the refractory for the West Valley Vitrification Pilot Plant. Both facilities are currently treating high-level wastes.

The licensing arrangement allows Envitco to design their melters using commercially tested equipment, designs, and techniques to compliment their experience in the DOE and hazardous waste market. This includes the following devices:

Molybdenum electrode application: Over 90% of the Joule-heated melters designed and constructed by TECO utilize molybdenum electrodes. This accounts for 225 melter installations running a variety of glass compositions, including leaded glass. Variations on this approach have been applied in the commercial arena, including platinum electrodes, power conditioning, and Joule-heated boost systems. Joule-heated boost systems have been applied to over 500 fossil-fuel fired glass furnaces world wide.

Power Supply/Control Design: The success of any Joule-heated melter depends on proper specification of the power supply. The vitrification system must match the glass characteristics to specify the power supply requirements. Once this relationship is established, the design permits a significant amount of flexibility to handle waste variability, process changes and/or process optimization. The power supply/control package also requires that the system be designed to ensure proper monitoring, data acquisition and feedback to the controller or operator. The data requirements have been refined through the experience with large scale commercial Joule-heated and fuel-fired glass furnace design and operation. Over 700 Joule-heating transformers of this type have been installed by Envitco's affiliated companies.

Electrode Holders: Electrode holders designed by KTG Systems provide the most reliable, commercially-applied holder manufactured today. The design of these holders overcomes the weaknesses of traditional holders by eliminating the welds from the hot face of the holder. This design approach, combined with the use of specialized materials to resist wear, oxidation, and reaction with the glass provides a very reliable electrode holder system.

Refractory: Toledo Engineering is the largest single buyer of refractory in the U.S. This has provided them with direct access to both the manufacturer and the user, which has resulted in a strong understanding of refractory design, composition, wear, heat transfer, and proper design and application of the selected materials.

Computer Controls: TECO has developed standardized control systems and interfaces, including proprietary algorithms for process control on their glass melters. These control systems are applied by Envitco on systems where computer interfaces and controls are required. The full-scale vitrification process will be controlled and interfaced through this type of system.

In addition, Envitco has access to the 30-year nuclear waste treatment and nuclear fuel reprocessing experience of SGN. The SGN-designed, COGEMA-owned La Hague and Marcoule (France) nuclear fuel reprocessing facilities have over 20 years of vitrification technology experience treating nuclear waste for France and seven other countries of the world. Envitco, as a member of the COGEMA family, brings this successful design and operating expertise to bear on the full-scale design.

Joule-heated melter technology is also being used at other DOE sites for the full-scale treatment of radioactive waste. These plants are fully operational systems that mix slurried radioactive waste with glass-forming additives, vitrify the slurry in a refractory-lined melter, treat the offgas, and handle the glass product. Three such facilities are the DWPF at the Savannah River Site (SRS), the West Valley Demonstration Project (WVDP) in West Valley, N.Y., and the M-Area Project at SRS. The most direct example of the technology is the M-Area project where Low-Level Mixed Waste (LLMW) is being treated at approximately the same glass production rate as that specified in Envitco's full-scale design (Bowan 1995).

6.2 Scale-up – Lessons Learned

The POPT demonstration run resulted in a number of lessons learned, as well as process data input for the scale-up of the vitrification system. The following sections present those observations and lessons learned and their resulting impact on the scale-up of the melter, slurry preparation system, offgas conditioning system and secondary waste treatment.

6.2.1 Vitrification Melter

The EV-101 melter used for the POPT demonstration employs the basic Joule-heated technology that will be applied to the full-scale design. A number of

issues relating to the operation and maintenance of the melter were identified during the demonstration.

6.2.1.1 Melter Throughput

Melter throughput is primarily affected by temperature, feed chemistry, and surface area available for melting. The amount of surface area available for melting the feed is the main variable used in sizing a melter.

The demonstrated processing rate of the EV-101 during the POPT was 0.8 metric tons per day per meter squared (MTPD/m^2) for the 30 wt% solids slurry. A specific throughput of 1 MTPD/m^2 with the 30% solids slurry was investigated prior to the demonstration and achieved after the demonstration was completed. This increase was sustainable for approximately 12 hours. However, the process became too unstable to continue at this rate and maintain steady-state conditions. This lead to the operation of the melter at 0.8 MTPD/m^2. Previous tests processing the silos residue surrogate at the Fernald Vitrification Pilot Plant resulted in average specific throughputs of approximately 1 MTPD/m^2, with demonstrated processing rates as high as 3 MTPD/m^2 for very short durations (Fu 1996).

Based on this experience, as well as other improvements in feed chemistry and increased operating temperatures, Envitco believes that processing rates of 1 MTPD/m^2 are appropriate for the design basis of the full-scale, 14 MTPD WASTE-VIT® melter. Further improvements are under consideration and provide additional confidence in the design basis throughput.

In order to achieve the full-scale production throughput, the melter size must be increased proportionately from the 0.34 MTPD achieved by the EV-101 during the POPT demonstration. At 14 MTPD throughput (9.9 MTPD at 70% process availability), a scale-up of 40 times is required. Scale-up of this magnitude has been demonstrated commercially, with the manufacturing of Joule-heated glass furnaces up to 300 MTPD, or over 800 times the size of the POPT melter. Increases in the melter size are considered an improvement over the small-scale EV-101 demonstration melter. Increases in overall size allow sufficient room for installation of controls, feed nozzles, structural steel, and other devices that are typical of the integrated commercial melter system.

6.2.1.2 Glass Characteristics

Three primary glass characteristics required for the scale-up of the melter are resistance, viscosity and reduction potential (redox ratio). These characteristics

are a function of temperature, and must be defined as a basis for design and operation of the full-scale melter.

TEMPERATURE: The POPT demonstration was conducted with a main tank glass temperature of approximately 1180°C to facilitate steady-state operation. For the full-scale design, a higher operating temperature is desired to help increase the throughput (as noted in the previous section). The target glass temperature for the full-scale melter is 1250°C. This can be achieved through glass formulation and reductant choice refinement to result in steady-state operation at higher temperature.

VISCOSITY/RESISTIVITY: The viscosity and resistivity of the demonstration glass was 843 poises and 11.3 ohm-cm at 1,100°C. The full-scale melter will utilize these baseline viscosity and resistivity values corrected for the increased temperature of 1250°C, but will be able to accommodate variability within approximately +/- 20% of these values. This can be accommodated through the use of high-temperature materials (molybdenum, platinum), adjustable electrodes, and adjustable transformers that can operate at different voltages and current ranges. Techniques, such as electrode or transformer adjustments, have been applied in all Envitco melters and are characteristic of many of the commercial melters being designed and constructed by TECO. These features and controls have been driven by the commercial desire for better quality, lower energy consumption, and higher throughput through smaller melters.

REDOX: The redox potential of the glass is critical to the operation and design of the melter due to the use of molybdenum electrodes and the potential for metals precipitation in glasses with high metals content. If the redox potential tends toward oxidizing conditions (excess oxygen), the molybdenum electrodes will be susceptible to oxidation at the glass melting temperatures. If the glass is too reduced (oxygen deficient), metals can separate from the glass as elemental metal or reduced species such as a metal sulfide.

The addition of chemical reductants was proven to suppress the formation of secondary phase salts that would normally accumulate on the melt surface. Laboratory studies were performed using 0.1 wt% up to 0.4 wt% carbon (as sugar) in the batch. In crucible tests at carbon additions of 0.15-0.20 wt% carbon, salts were volatilized and no metal precipitation could be detected.

The POPT demonstration was performed with 0.1 wt% carbon. It was anticipated that the cold-top conditions under continuous operation would result in more carbon retention/efficiency than was demonstrated in the crucibles tests. The carbon proved appropriately effective in the melter and resulted in a glass redox ratio of 0.15 Fe^{+2} / Fe^{total}. This level of carbon addition resulted in the volatilization of the salt at a steady state proportional to the feed rate, thereby avoiding salt accumulation in the melter. This level of reductant also seemed to

be effective in avoiding metal precipitation due to excessive reducing conditions in the glass, though this must be confirmed with additional testing.

The target selected for the POPT demonstration was 0.1 wt% carbon equivalent in the batch. The full-scale batch formulation, as shown in the mass balance, only includes 0.05% carbon to ensure that metals precipitation is avoided, while still suppressing salt accumulation. Further investigation may be necessary to further optimize the reductant form (sugar, urea, etc.) and concentration.

6.2.1.3 Plenum Heating

The EV-101 melter used a propane/air burner to start the melter and maintain the plenum temperature during operation. The plenum temperature averaged 850°C during the demonstration with an offgas temperature in the ductwork above the melter of approximately 330°C. The temperature decrease in the offgas duct was accomplished through the use of a film cooler, dilution air and heat losses through uninsulated ductwork. These temperatures were required to keep volatile compounds from condensing and accumulating in the offgas ductwork, resulting in buildups or blockages. High offgas velocity also helped to prevent particulate matter from depositing in the pipes. Both of these strategies proved to be successful in avoiding accumulations of particulate and condensate in the offgas system.

Based on condensation temperature limitation, estimated heat losses, and historical data on resistance heater performance, it is feasible to replace the burner system used during the POPT with resistance heaters for the full-scale design. This type of resistance heating system has been installed in other Envitco melter systems, and the high-level waste melters at Savannah River and West Valley. Commercial applications also include kilns, lehrs, annealing ovens, and specialty glass melters. The use of resistance-heating elements will reduce the offgas volume from the vitrification process, while addressing safety issues associated with the use of propane.

Eliminating the offgas generated by the burner, dilution air for offgas cooling, and minimizing air inleakage will reduce the offgas volume. Based on this approach, it is estimated that the full-scale vitrification facility inclusive of the melter and vessel vent system will generate less than the 500 scfm limit for gasses entering the RCS.

6.2.1.4 Refractory Wear

The demonstration melter incorporated six (6) different types of refractory for the purpose of testing refractory durability in an operating system. The refractories

tested included several chrome-bearing refractories, mullite (aluminosilicate), and AZS (alumina-zirconia-silica). The wear was measured at the glass-refractory interface where corrosion is expected to be highest after the demonstration. Wear rates of 0.050 to 0.100 mm/day were observed, and are considered acceptable to support a three year melter campaign.

Commercial glass experience shows that the wear rate will decrease as the refractory wears. This is due to the mean temperature of the refractory being lower (hence, lower wear) nearer to the water-cooled shell. As the refractory becomes thinner, heat transfer to the water-cooled shell is increased resulting in a lower glass-refractory interface temperature. The water-cooled shell then acts to reduce the refractory wear.

The best refractory tested was a dense chrome-bearing material. Based on these results, the design of the full-scale melter will utilize chrome-bearing refractory for glass-contact areas. Thickness of the refractory will be adjusted to correspond with the wear rate and campaign duration. Higher wear areas will have thicker refractory than lower wear areas.

The mullite material used in the plenum of the demonstration melter displayed no measurable corrosion. The full-scale melter will utilize mullite where there isn't any direct glass contact.

6.2.1.5 Electrode Wear

Molybdenum electrodes were used in the EV-101 demonstration melter. The electrodes showed various wear patterns in the main melter tank, based on their location and function. Electrode wear was minor in the glass drain bay and on lower electrodes in the main melter tank, at less than 1% consumption per day.

Wear rate was greater on the top electrodes. This appeared to be due to increased convective flow, increased temperature, and increased quantities of exsolved molten sulfate salts near the batch/glass interface.

It is anticipated that the wear noted during the demonstration can be decreased by use of power conditioning methodologies. These methods have been applied in commercial lead glass melters utilizing molybdenum electrodes and have proven to be effective in decreasing electrode consumption due to oxidation and alloying. These power-conditioning methodologies were unavailable for the POPT due to schedule and budget constraints.

Electrode wear also increases as current density (amps/unit area of electrode) increases (Tooley 1984). The electrodes used in the main tank of the EV-101 were smaller than desired (3.2 cm dia.), and could not be increased without

significant melter redesign. Larger side-entry electrodes are the baseline for the full-scale melter design with the intent of lowering the current density, thereby reducing electrode wear. The exact size of the electrodes will be based on the current requirement of the detailed full-scale melter design. The current is dependent on the final glass formulation(s) chosen for remediation. Commercially-available electrodes are as large as 10 cm (4 in.) in diameter by 1 meter (3.3 feet) in length and will be installed in size and quantity to match the full-scale requirements.

Additional gains in reducing wear can be realized with top-entry vertical electrodes which have a number of technical advantages over side-entry electrodes. Please refer to Section 6.7.2.4 for more detailed information on the advantages of vertical electrodes in the full-scale design. Top-entry electrodes could not be incorporated into the POPT due to melter size and other design constraints.

6.2.1.6 Electrode Material Selection

The choice of electrode material for treatment of Silos Residue was evaluated prior to the demonstration. Initial investigation indicated that tin (Sn) electrodes would be suitable due to the high lead content of the glass. Tin electrodes are commercially used to melt lead crystal glass. Due to budget and time constraints imposed upon the POPT, a tin electrode melter was not possible. After careful consideration of the waste chemistry and commercial experience with molybdenum electrodes in lead glass, the existing electrode material and configuration were used in the POPT.

The results of using the molybdenum electrodes were very promising as noted in the previous section. The following table shows the evaluation of tin vs. molybdenum electrodes after the POPT experience:

Table 6.2.1.6-1 Molybdenum vs. Tin Electrodes

Features	Molybdenum	Tin
Overall Envitco & Affiliated Companies Experience Level	>700 installations in various glass types	<50 installations in lead glass furnaces only
Renewable / Advancable	Demonstrated in commercial, waste processing, and POPT	Not possible due to design features and brittleness
Thermal Shock Resistance	Very High	Very Low – can result in cracks that could lead to glass leak and failure of the electrode
Current Density (Tooley 1984)	1-3 A/cm^2	0.3 – 0.7 A/cm^2 (lower current density requires more electrode material than with moly)
Power Distribution Capability	Adjustable by insertion depth	Not Adjustable
Sulfur Interaction	Known – commercial confirmed in POPT	Unknown
Overall Wear Rate with Complex Waste Chemistry	Known – previous waste experience confirmed in POPT	Unknown
Lead Interaction	Oxidation reaction with Mo – can be mitigated by power conditioning	Little to no reaction based on commercial experience
Glass Oxidation State	Reducing = possible metal precipitation requires redox control	Oxidizing = better for no elemental metal precipitation

Based on the information presented in the table and the results of the POPT, molybdenum electrodes are renewable upon consumption, allow more flexibility, have known overall waste chemistry interactions, are based on more experience, and require less furnace space for the required current than tin electrodes.

6.2.1.7 Metals Drain

A small amount of metallic lead (15 – 20 kg) was found in the bottom of the melter after the demonstration. The sloped bottom of the melter was successful in accumulating these metals in a manner that they could then be drained from the system. The accumulation is believed to be due to the Pb:Mo electroreduction (Section 5.0) and a large quantity, short duration input of lead (lead sulfate, lead carbonate) that was fed to the melter during the post-demonstration cleanup and shutdown period. (It is estimated that 25 -40 kg of additional lead may have been fed to the melter in about a 12-hour period.) The presence of these residues, as well as lessons learned from FDF Vitrification Pilot Plant experience, confirms the necessity for a metals drain that can remove metals and secondary phases from the bottom of the full-scale melter.

The metals drain orifice installed in the demonstration melter failed to operate during the demonstration. This was due to the inability to provide enough heat to the drain orifice.

The bottom metal drain in the POPT melter is of similar design to the primary glass drain which operated flawlessly throughout the demonstration. The use of this drain valve in the bottom of the full-scale melter will require correction of the heat input/distribution to better mimic the primary glass drain installation. These issues are easily addressed in the full-scale design. The sloped bottom feature of the main melt tank is applied to the full-scale design in order to maintain the ability to collect the metals for draining. Refinement of the orifice can be accomplished by using existing testing and demonstration facilities prior to the detailed full-scale design phase.

6.2.1.8 Salt Drain

The salt drain was not used during the 72-hour demonstration, since salt evaporation and glass solubilization were maintained in balance with the melter feed rate, and excess salt accumulation did not occur. The salt drain was operated before the POPT program, as well as after the POPT demonstration, as requested and witnessed by FDF. The salt drain satisfactorily removed a small accumulation of salt (<10 kg) from the surface of the melter without interfering with normal steady-state melter operations.

The presence of a salt layer that could be drained indicates that conditions may occur in which it is beneficial to remove the salt layer and avoid interference with the primary vitrification process. The potential for upset conditions justify the necessity for a salt drain on the full-scale melter.

The full-scale melter conceptual design includes the salt drain as a safeguard for upset conditions or melter idling. The salt drain will not be required during normal operations.

6.2.1.9 Glass Level Control

Level control is important to maintain the proper glass inventory within the melter. The glass level in the EV-101 melter was controlled throughout the demonstration by a nuclear level indicator. This type of indicator has been used on many commercial melters and has been used in previous radioactive processing of DOE wastes in the TVS and the EV-101. This same type of level detector is used in the full-scale design.

6.2.2 Melter Auxiliary Systems

The associated systems that support the melter (compressed air, cooling water, protective gas) performed successfully during the demonstration. The primary variable that impacts the full-scale auxiliary systems is the melter size which, in turn, dictates the cooling water requirements. Compressed air and protective gas are not functions of melter size but rather the number of application points.

The cooling water/cooling panel system is a primary safety system, and will require proper sizing and redundancy to ensure proper functioning.

The EV-101 melter required approximately 230 lpm at an average temperature rise of 3.5°C (60 gpm at 6°F). Preliminary calculations for operation prior to the demonstration were 500 lpm at a temperature rise of 3°C which was 50% greater than the actual usage. This over-estimation is allowable and sometimes desirable because it is conservative with respect to safety.

In order to insure the proper sizing of the cooling water system for the full-scale design, heat transfer rates and conservative adjustments were applied to the full-scale melter. This insures that sufficient cooling water will be available during operations with enough reserve to support the melter at the end of the campaign, or under higher load conditions.

6.2.3 Melter Feed Preparation

The surrogate preparation and melter feed preparation systems were suitable for the demonstration, but were insufficient for the full-scale design. Problems identified with the surrogate settling characteristics will require special

considerations that were not understood prior to the demonstration. This was evidenced by problems in the surrogate storage tanks.

Surrogate storage mixing during the demonstration was accomplished using Pulsair™ mixers. These mixers inject a pulse of compressed air into the bottom of the tank. The pulse creates a bubble which sweeps the bottom of the tank, then rises to the top of the tank and creates an air-lift mixing action. These mixers are very efficient and transfer very little energy (heat) into the slurry, as compared to traditional mechanical mixers. However, the Pulsair™ mixer did not provide the shear or bulk flow necessary to keep all of the particles in suspension. Each of the tanks that stored surrogate experienced some settling in the bottom of the tank. This sludge appeared to be a mixture of silica and small (approximately 1 mm) agglomerates of the lead compounds. These deposits were flushed from the bottom of the tank at the end of each transfer.

The mix tank and the melter feed tank were both fitted with mechanical mixers. These mixers were used to incorporate the glass additives and then keep the melter feed slurry well mixed while it was pumped to the melter.

The initial sampling from the mix tank indicated that the surrogate was running at a lower solids content than was expected. After some investigation, it was determined that the mix tank could not maintain the suspension at low speed. Sampling at high speed confirmed that the solids could be re-suspended and maintained in a solution.

Similar observations were made in the feed tank. The original configuration of the melter feed tank had only one mixer, resulting in the settling of the small agglomerated lead particles. A second mixer was added to the melter feed tank in order to keep the solids suspended.

The full-scale waste characterization indicates that the Silos Residue has some larger particles than the surrogates used in the demonstration. Based on the POPT experience and the above-mentioned waste characterization, a larger particle size distribution than was used in the POPT will dictate the final design of the full-scale tanks, impellers and pumping systems. Additional evaluation of the Silo waste will be required during the AWR program to further characterize the waste to ensure that there is sufficient capacity in all systems to avoid settling and segregation of the waste and feed slurries.

6.2.4 *Melter Feeding*

The demonstration melter feed system included two types of pumps: diaphragm and positive displacement. The diaphragm pumps were used to recirculate the slurry from the feed tank to the melter and back. Diaphragm pumps were used

because they were readily available at the test facility. Pump life was typically 48 hours due to seal failure. This rate of wear was unexpected, and forced Envitco to take a number of steps to avoid lost time (double redundancy, non-optimized slurry system operation, etc.) The abrasive nature of the slurry was expected, though not to the degree observed.

Positive displacement pumps were used to meter the slurry into the melter. The pumps were originally equipped with single mechanical pump seals, which began leaking after less than 100 hours of operation. Double mechanical seals were installed with pressurized seal pots and water flush. The demonstration was completed using the double mechanical seals. One of the pumps indicated some seepage of slurry to the seal pot system, which may have been an indication of leakage or seal pot malfunction.

The diaphragm pumps used in the demonstration will be replaced with vaneless centrifugal pumps in the full-scale design. Envitco successfully used these pumps in the TVS. Wetted parts are made from abrasion resistant stainless steel; pump shafts use flushed double mechanical seals. The full-scale feed metering pumps are positive displacement with double mechanical seals based on the success of the POPT demonstration pumps. Both pumping systems will require special attention to materials of construction to ensure the longest life/highest reliability of the pump components in contact with the feed. All continuous duty pumps will require redundancy to minimize the production time lost during maintenance operations.

Feed was provided to the melter through four single-point feed nozzles which could be manually adjusted for insertion depth and pitch. Maintaining sufficient velocity in the feed tube and water-cooling the nozzle prevented any plugging of the nozzles during the demonstration. The full-scale design incorporates the features of the demonstration feed nozzle with mechanical positioning to allow remote control of the feed distribution. Multiple feed points are required in the larger full-scale melter to enhance batch coverage of the glass surface. This will allow improved control over the feed distribution, as well as minimization of maintenance activities on the melter in accordance with ALARA principles.

The rheology of the demonstration melter feed was not amenable to flowing and distributing over the entire melt surface. In order to take full advantage of the melting capability of the melter and to reduce volatility, it is important to cover most of the melter surface with feed. In addition to using multiple feed points, as mentioned above, additional testing is necessary to optimize the rheology and improve the flow characteristics of the feed. Changes in the glass additives will effect changes in the rheology of the feed slurry. Optimization can be conducted on existing equipment in advance of the full-scale system design.

6.2.5 *Offgas Treatment*

The demonstration employed an electrostatic precipitator (ESP) for removal of particulate matter. The ESP was operated dry at temperatures in excess of 100°C so that water in the offgas stream would not condense and accumulate in the ESP chambers.

The emission testing data from the demonstration confirmed that an ESP would be capable of removing particulate matter generated during vitrification, serving as a pre-filter prior to a final HEPA filtration step. The demonstration also confirmed that the particulate matter could be removed from the collector plates by standard rapping.

Offgas velocities averaged 1525 m/min (5,000 ft/min) in the ductwork between the melter and the ESP. This was equivalent to a volumetric flow rate of 28 m^3/min (980 cfm) during the demonstration. The velocity and the temperature control proved to be sufficient in preventing condensation and buildup of material in the ducts, elbows and transitions of the offgas system.

Based on the observations above, the full-scale offgas treatment system will incorporate dry, high temperature (>300°C) filtration for removal of the particulate matter. This type of ceramic filter technology is currently being employed in France for pilot melter offgas treatment. High-temperature filtration will allow for recycle of particulate matter captured on the filter, while passing volatile sulfur through the filter. Allowing the volatile sulfur to pass through the filter will prevent it from being recycled back to the melter where it has low solubility in the glass. The sulfates and other acid gases will be captured in a wet scrubbing process, thereby avoiding recycling of the low solubility sulfate compounds back to the melter. ESP technology is not recommended due to size, capital cost, and maintenance considerations.

Offgas ductwork will be sized to maintain velocities of 1000 to 1500 m/min in order to mitigate any particulate settling or buildup. Maintaining the velocity target is the basis for design of the offgas duct diameter. The volumetric flow estimated for the full-scale design is only 13.2 Nm^3/min (470 scfm) which will result in smaller duct diameters to maintain the desired velocity. The lower offgas volumetric flow is the result of using resistance heaters instead of the combustion burner, no dilution air for offgas temperature reduction and providing better sealing of the melter and offgas ductwork. The estimated contributions to the total offgas volume at standard temperature and pressure are as follows:

- Feed Decomp. Gases (no water) = 0.7 Nm^3/min (25 scfm);
- Melter (including inleakage) = 6.9 Nm^3/min (245 scfm); and
- Vessel Vent System = 5.6 Nm^3/min (200 scfm)

6.2.6 *Secondary Waste*

Several types of secondary waste were generated during the POPT demonstration. These included personal protective equipment (PPE); "wash water"; maintenance waste (spent equipment, valves, pump rebuild components); and, solids from the ESP. Each of these streams, including solids from the prefilter that will replace the ESP, will also be generated during full-scale operations, and are addressed in the full-scale design descriptions that follow in this report. Additional secondary wastes from the full-scale system will include metals drain material, salt drain material, offgas filter solids, scrubber water, and filter media. The treatment of these streams is addressed in Section 6.6.2.5.

A change in the type and amount of secondary waste for the full-scale offgas treatment system will be realized due to the high temperature filtration followed by wet scrubbing. The high-temperature pre-filter and high-efficiency metal filter (HEMF) will capture feed carryover and metals while allowing the volatile sulfur compounds to pass through the filter. The sulfur compounds, volatile Se, water vapor and other acid gases will be wet scrubbed from the offgas. Scrubber water from the offgas treatment system will be filtered by cross-flow filtration to remove the insoluble metals and Se. If necessary, the filtered waste water will be concentrated by reverse osmosis, with the high sulfur liquid fraction being sent to the AWWT. This will minimize the amount of secondary waste generated by recycling the pre-filter, HEMF, and cross-flow filter solids to the melter.

The primary concern with this approach is the removal of volatile metals that are not captured on the offgas filters but pass through to the scrubber water. Most all of the metals will be captured in the pre-filter and HEMF as insoluble species due to the high temperature decomposition of the most soluble forms (carbonates, nitrates, hydroxides). However, the demonstration material balance indicates that approximately 50% of the Se input to the melter will be condensed/scrubbed out in the offgas scrubbing stage. The scrubbing water will then require pretreatment for the removal of Se prior to transfer of the wastewater to the AWWT. The secondary waste treatment system in the full-scale design includes filtration of the Se after precipitation in the cross-flow filter feed adjustment tanks. Additional studies will be required to determine the optimum filtration/removal techniques for the Se.

A backup approach to Se filtration would be selective ion exchange. This step could replace precipitation/filtration but is not considered for the full-scale design. All available data indicates the current approach will be effective in meeting the AWWT requirements. Ion exchange would also result in a new secondary waste stream of spent resin which is contradictory to the objective of minimizing secondary waste production.

Another outstanding issue regarding offgas scrubber solution is the concentration of polonium (Po), for which little volatility data exists. Assuming that the Po is as volatile as Se, the Po will also condense in the scrubber water and require removal prior to transfer to AWWT. Volatility data is available for tellurium (Te), which is positioned between Se and Po, and is much less volatile than Se (Perez et al 1994). Based on this, it is reasonable to assume that the Po will be less volatile, which provides a basis for reducing the volatility estimate of Po and its concentration in the scrubber water. This approach has been applied in the material balance. Without data to the contrary, the full-scale design does not include any provisions for Po removal. Further testing on the volatility of Po will be required prior to final design of the full-scale treatment system.

6.2.7 Glass Handling

The glass drained from the EV-101 was collected in 30-gallon drums staged on a chain driven roller conveyor. The drums were indexed under the drain as each drum was filled without stopping the glass flow. This approach has also been used in previous EV-101 operations and the TVS.

The full-scale design incorporates continuous pouring with indexing of collection vessels under the drain. The collection vessel has been revised from 30-gallon drums to rectangular metallic subcontainers as described in Section 6.6.2.4. The subcontainers have been designed to allow higher packaging efficiency in the rectangular SEG designed concrete disposal container.

6.3 PFD, Energy & Material Balance

6.3.1 Process Flow Diagrams (PFD)

The PFDs presented in Section 20 show the flow of materials through the vitrification system. Each stream is identified by a line number that can be cross-referenced to the material balance. Each piece of equipment is identified by an equipment ID number. The ID number consists of the system number, type of equipment, and a sequential number within each system. For example, equipment number 15-TK-001 is in System 15, is a tank, and is number 001

within System 15. The equipment codes for all equipment numbers included on the PFDs and the General Arrangement drawings are as follows:

Table 6.3.1-1 Equipment Codes

Code	Equipment Name	Code	Equipment Name	Code	Equipment Name
AG	Agitator	CV	Conveyor	MX	Mixer, Agitator
AF	Air Filter	CT	Cooling Tower	PN	Pneumatic Conveyor
BH	Baghouse	CR	Crusher	PV	Pulverizer
B	Bin/Hopper	EC	Enclosure / Airlock	P	Pump
CA	Cart	FE	Feeder	RO	Reverse Osmosis
BL	Centrifugal Fan	F	Filter	TA	Table/Station
E	Heat Exchanger	GB	Glovebox	TK	Tank
E	Condenser	H	Heater, Electric	TP	Trap Door
E	Cooler	FH	HEPA Filter	TT	Transfer Trolley
CA	Compressor	M	Melter	V	Vessel/Container
CN	Crane	MI	Milling Machine	V	Scrubber
				WW	Scale

6.3.2 Material Balance

The material balance is presented in Section 21 on an elemental basis unless otherwise noted. The material balance presents the inputs, intermediate steps, and output of the vitrification facility.

For the purposes of the full-scale material balance, the following assumptions were made:

1. Since each silo has a different activity level for each radionuclide, a conservative approach was taken. The highest radionuclide activity was assumed to be applicable for the entire quantity of Silos residue. Using Table 6.3.2-1 Major Radionuclides in the K-65 Residues, the radionuclide activities used in the full-scale material balance are highlighted below (FDF Doc. #40430-RP-0001 Rev. D).

Table 6.3.2-1 Major Radionuclides in the K-65 Residues

Radionuclide	Silo 1 Activity Conc., *pCi/g	Silo 2 Activity Conc., *pCi/g	Total Activity, Ci
227Ac	5,960	5,100	70
210Pb	165,000	145,000	1,800
210Po	242,000	139,000	2,439
226Ra	391,000	195,000	3,700
228Th	422	645	6.6
230Th	60,000	48,400	685
232Th	424	402	600
* picocuries per gram (pCi/g)			

For reference, the values presented in Table 6.3.2-1 are the arithmetic mean values reported in the POPT Interface Design Basis, *Table A.6 – Summary of Radionuclide Analyses for the Silos Residue* (FDF Doc.#40720-DC-0001 Rev.0, July 31, 1998).

For completeness, the radionuclides listed in Table A.6, but not included in Table 6.3.2-1, (234U, 235/236U, and 238U) were included in the full-scale material balance at the greatest arithmetic mean value. The activities utilized for the uranium radionuclides are highlighted in Table A.6 (excerpted).

FDF Table A.6 (excerpt) Summary of Radionuclide Analyses in the Silos Residues

Radionuclide	Silo 1 Activity Conc., *pCi/g	Silo 2 Activity Conc., *pCi/g	Total Activity, Ci
^{234}U	800	961	70
$^{235/236}U$	38	73	1,800
^{238}U	642	912	2,439
* picocuries per gram (pCi/g)			

2. Application of the picocuries per gram (pCi/g) units was assumed to be picocuries per gram of dry residue. For example, the total dry residue mass (calculated) in Table 2.1 – Silo 1 and 2 Material Quantities was given as 9735 tons of dry residues or approximately 8831 metric tons of dry residues (FDF Doc. #40430-RP-0001 Rev. D). When multiplied by the activity of ^{227}Ac, (5,960 pCi/g multiplied by 8,831,000,000 g) the resulting total activity is 5.26E13 pCi or 52.6 Ci. The total activity presented in Table 6.3.2-1 (70 Ci for ^{227}Ac) could not be duplicated and the resulting values calculated were assumed sufficient for the POPT pre-conceptual process design.

3. Offgas estimations are based on the offgas sampling results from the 72-hour POPT. Average entrainment and volatility factors were calculated for each major cation (including sulfur) present in the Demonstration Surrogate and Slurry Feed. Exceptions to this statement include Se, Si (entrainment only), Ac, Po, Th, and U.

   - The selenium (Se) entrainment and volatility factors were calculated based on the theoretical feed rate of Se during the 72-hour POPT. Analytical results on the slurry feed suggested that total Se content in the slurry feed was not accounted. For the full-scale material balance, the theoretical selenium feed rate (based on the batch sheets and average feed rate during the 72-hour demonstration), in conjunction with the offgas sampling results, was used to calculate both the entrainment and volatility factors.

   - The silicon (Si) entrainment factor cannot be calculated from the standard offgas sampling methods (EPA Methods 5 & 29) due to interferences with the quartz filter. A General Entrainment Factor (GEF) was calculated from the total particulate matter collected on the quartz filter. The GEF was assumed to be sufficiently representative of the silicon entrainment and was utilized to calculate the contribution of entrained silicon in the melter offgas.

   - Physical and chemical simulants of the four radionuclides, Ac, Po, Th and U, were not present in the POPT demonstration surrogate. Consequently, the contribution of these radionuclides to the melter offgas was calculated using the General Entrainment Factor. The volatile contribution to the melter offgas was assumed to be negligible for these radionuclides.

4. The preliminary full-scale material balance is based on the Demonstration Surrogate formulation utilized during the 72-hour Demonstration Run (FDF Contract 98WO002240 - Contract Modification No. 6, November 25, 1998).

6.3.3 Utilities Summary – Energy Balance

The full-scale facility will require electrical service, potable water, cooling water, compressed air, steam and nitrogen gas. These services are used in various steps in the process. Some of the utilities will be produced in the plant and require no outside source. A summary of the maximum utilities usage is shown in the following table.

Table 6.3.3-1 Utilities Summary

Utility	Usage	In-Plant Production
13.2 kV Power	2 MW	No
460 V Power	1.2 MW	No
Backup Power (melter)	500 kW	Yes
Backup Power (460V)	500 kW	Yes
Cooling Water	1500-2000 lpm	Yes
Chilled Water	200 lpm	Yes
Make-up Water	3 lpm*	No
Compressed Air	1200 Nm^3/hr	Yes
Steam	10 Nm^3/hr	Yes
Nitrogen	40 Nm^3/hr	No

*Note: Does not include any general facility requirements for sanitary services, fire protection, potable water requirements, etc.

The electricity should be delivered to the vitrification facility as 3-phase, 60 Hz, 13.2 kV. Step-down transformers will be required to support the melter and peripheral systems. The distribution of the power will be provided by the power and motor control centers in the facility. A cooling tower supplied with the process equipment will provide cooling water. Chilled water will be used in the offgas treatment system and will be generated within the plant. Make-up water is required from the city services during normal operations of the cooling tower, chiller, and DI water systems included in the plant design.

Backup power services will be required to safeguard the facility and melter in the event of a primary power outage. This detail must be addressed with FDF to determine the availability of alternative supplies based on grid design.

Depending on the availability of backup power, an emergency water system may be required to provide process cooling water to the melter until the cooling water system is restored or the melter is sufficiently cooled so as not to require additional cooling water.

Steam and compressed air will be generated within the facility. Nitrogen will be supplied to the facility through bulk storage tanks and a liquid nitrogen/vaporizer system.

The following table breaks down the power requirements of the facility. The major pieces of equipment that will require power are included from the equipment list found in Section 6.6 of this report. The duty cycle noted in the table applies to those components that will be run periodically or at varying levels during normal operations. For example, the mixer for the Hold/Blend Tank will not operate at 100% output all of the time. Its power is reduced between mixing batches and will vary with the amount of slurry in the tank.

Table 6.3.3-2 Power Requirement Summary

Equipment Name	ID Number	PFD	Power	Duty
Manual Fill Dust Collector w/ Exhaust	44-BH-155	FDFP-01	5 hp	10%
Silo Discharge Rotary Vane Feeder	44-FE-103	FDFP-01	1.0 hp	50%
Silo Discharge Rotary Vane Feeder	44-FE-113	FDFP-01	1.0 hp	50%
Silo Discharge Rotary Vane Feeder	44-FE-123	FDFP-01	1.0 hp	50%
Silo Discharge Rotary Vane Feeder	44-FE-133	FDFP-01	1.0 hp	50%
Silo Discharge Rotary Vane Feeder	44-FE-143	FDFP-01	1.0 hp	50%
Manual Silo Fill Equipment	44-PN-150	FDFP-01	10 hp	10%
Screw Feeder to Blend Tank	15-CV-145	FDFP-03	3.0 hp	80%
Offgas Solids Screw Feeder	15-CV-615	FDFP-03	2 hp	80%
Rotary Vane Feeder	15-FE-140	FDFP-03	0.5 hp	80%
Rotary Vane Feeder	15-FE-610	FDFP-03	0.5 hp	80%
Rotary Vane Feeder	15-FE-630	FDFP-03	0.5 hp	80%
Rotary Vane Feeder	44-FE-515	FDFP-03	0.5 hp	80%
Liquid Additives Mixer	45-MX-115	FDFP-04	10 hp	100%
Liquid Additives Mixer	45-MX-125	FDFP-04	10 hp	100%
Liquid Additives Unload Pump	45-P-105	FDFP-04	3.0 hp	20%
Liquid Additives Unload Pump	45-P-106	FDFP-04	3.0 hp	20%
Liquid Additives Transfer Pump	45-P-130	FDFP-04	2.0 hp	80%
Liquid Additives Transfer Pump	45-P-140	FDFP-04	2.0 hp	80%
Receipt Tank Mixer	15-MX-515	FDFP-05	100 hp	100%
Residue Transfer Pump	15-P-520	FDFP-05	50 hp	100%
Residue Transfer Pump	15-P-521	FDFP-05	50 hp	100%
Underflow Transfer Pump	15-P-535	FDFP-05	50 hp	100%

Table 6.3.3-2 Power Requirement Summary (continued)

Underflow Transfer Pump	15-P-536	FDFP-05	50 hp	100%
Overflow Transfer Pump	15-P-565	FDFP-05	10 hp	100%
Overflow Transfer Pump	15-P-580	FDFP-05	10 hp	100%
Rotary Vane Feeder	15-FE-200A,B	FDFP-06	0.5 hp	80%
Rotary Vane Feeder	15-FE-300A,B	FDFP-06	0.5 hp	80%
Rotary Vane Feeder	15-FE-400A,B	FDFP-06	0.5 hp	80%
Hold & Blend Tank Mixer	15-MX-205	FDFP-06	100 hp	80%
Hold & Blend Tank Mixer	15-MX-305	FDFP-06	100 hp	80%
Hold & Blend Tank Mixer	15-MX-405	FDFP-06	100 hp	80%
Feed Tank Mixer	15-MX-605	FDFP-06	150 hp	100%
Feed Transfer Pump	15-P-225A/B	FDFP-06	50 hp	80%
Feed Transfer Pump	15-P-325A/B	FDFP-06	50 hp	80%
Feed Transfer Pump	15-P-425A/B	FDFP-06	50 hp	80%
Backup Recirculation Pump	15-P-620A	FDFP-06	100 hp	100%
Slurry Feed Recirculation Pump	15-P-620B	FDFP-06	100 hp	100%
Slurry Feeder Nozzle Drive	15-FE-335 A,B	FDFP-07	1.0 hp	100%
Slurry Metering Pump	15-P-330 A,B	FDFP-07	15.0 hp	100%
Vitrification Melter	17-M-101	FDFP-07	2 MW (4160 V)	100%
Pouring Conveyor Station	23-TA-001	FDFP-07	5 hp	50%
Cullet Recycle Feed System	26-FE-135	FDFP-07	2 hp	25%
Offgas Fan	18-BL-501	FDFP-08	100 hp	100%
Screw Conveyor	18-CV-110	FDFP-08	3 hp	80%
Scrubber Heat Exchanger	18-E-310	FDFP-08		100%
Cooler	18-E-401	FDFP-08		100%

Table 6.3.3-2 Power Requirement Summary (continued)

Rotary Feeder	18-FE-102	FDFP-08	0.5 hp	80%
Rotary Feeder	18-FE-103	FDFP-08	0.5 hp	80%
Electric Reheater	18-H-410	FDFP-08		100%
Scrubber Water Pump	18-P-320	FDFP-08	30 hp	100%
Scrubber Blowdown Pump	18-P-331	FDFP-08	10 hp	100%
NaOH Pump	18-P-341	FDFP-08	1 hp	50%
Emergency Water Pump	18-P-351	FDFP-08	30 hp	100%
Offgas Fan	18-BL-502	FDFP-09	100 hp	100%
EOG Fan	18-BL-701	FDFP-09	100 hp	100%
EOG Fan	18-BL-702	FDFP-09	100 hp	100%
EOG Heat Exchanger	18-E-620	FDFP-09	5 kW	100%
Electric Reheater	18-H-640	FDFP-09	5 kW	100%
EOG Quench Pump	18-P-612	FDFP-09	50 hp	100%
Screw Conveyor	26-CV-110	FDFP-10	3 hp	80%
Screw Conveyor	26-CV-135	FDFP-10	3 hp	80%
Rotary Valve Feeder	26-FE-130	FDFP-10	0.5 hp	80%
Glass Mill	26-MI-115	FDFP-10	30 hp	25%
Waste Accumulation Tank Agitator	19-AG-001	FDFP-11	1.5 hp	50%
Decontamination Waste Tank Agitator	19-AG-002	FDFP-11	1 hp	50%
Waste Return Pump	19-P-001	FDFP-11	4 hp	50%
Decontamination Waste Transfer Pump	19-P-002	FDFP-11	1 hp	50%
Filter Feed Adjustment Tank Agitator	19-AG-002	FDFP-12	10 hp	80%
Filter Feed Adjustment Tank Agitator	19-AG-003	FDFP-12	10 hp	80%
Filter Feed Transfer Pump	19-P-003	FDFP-12	0.5 hp	100%

Table 6.3.3-2 Power Requirement Summary (continued)

Filter Feed Transfer Pump	19-P-004	FDFP-12	0.5 hp	100%
Filter Feed Pump	19-P-005	FDFP-12	20 hp	100%
Feed Tank Cleanout Pump	19-P-006	FDFP-12	1 hp	50%
Reverse Osmosis Feed Pump	19-P-007	FDFP-12	10 hp	50%
Recycle Water Transfer Pump	19-P-008	FDFP-12	1 hp	50%
Recycle Water Transfer Pump	19-P-009	FDFP-12	1 hp	50%
Treated Waste Transfer Pump	19-P-010	FDFP-12	1 hp	80%
Treated Waste Transfer Pump	19-P-011	FDFP-12	1 hp	80%
Cooling Tower (pumps, fans)	17-CT-220	FDFP-13	300 hp	100%
Compressed Air	17-CA-205		100 hp	60%

Based on the power requirements presented in the table, less the melter, redundant pumps and services, the total 460V power requirement is 1200 kW. Adjustment for duty factors reduces the 460V load to approximately 950 kW.

Critical services dictating backup power requirements for the facility and process include offgas treatment, tank mixing and recirculation, and cooling water recirculation. A more detailed assessment will be necessary to determine other facility requirements. Based on this, the backup power requirement is approximately 500 kW, not including facility requirements for HVAC, lighting or other general facility requirements. A second 500 kW supply of backup power for the melter will be required. Backup power is considered to be included in the overall facility design.

The 460V power requirement is 2 MW, which is based on full operation of the melter at the end of the campaign when losses are maximized. Normal operation at the beginning and middle of the melter campaign will require less power.

The HVAC in the melter and subcontainer cooling room will receive the heat load of the melter superstructure and the subcontainer cooling. The estimated heat load and HVAC requirements are shown on the following table. The heat load in the subcontainer cooling area assumes that 50% of the energy from each subcontainer is released to the room atmosphere.

Table 6.3.3-3 HVAC Heat Loads

Facility Room	Heat Load
Melter	85,000 BTU/hr
Subcontainer Cooling	470,000 BTU/hr

6.4 Facility Arrangement Drawings

The drawings in Appendix Section 22 present the arrangement of the process equipment, as they would be assembled in the facility. The drawings contain plan and elevation views of the primary process facility and key pieces of equipment.

The facility layouts include the process equipment and directly associated support services such as electrical rooms, piping galleries, etc. The facility does not take into account a number of common radioactive facility areas that would be applicable to all of the technologies tested for the POPT. The following areas are not included in the facility layouts:

- Radiation worker changing areas;
- Offices for non-operations staff;
- Health Physics facilities;
- Maintenance shops (non-rad. and rad.);
- Sample storage;
- Document storage; and
- Canteen.

6.4.1 Facility Zoning

The facility is arranged in zones which identify the nature of personnel access based on the level of contamination or the dose rate expected. Areas of the facility that are contaminated have been separated from the rest of the facility by air-locks. Other areas are limited access due to proximity to the waste and the related dose rate. The facility is segregated according to 4 radiation zones that dictate maximum access time limits.

- Zone 1 is an area that can be inhabited continuously or 40 hours per week.
- Zone 2 is an area that personnel can access between 8 and 20 hours per week.
- Zone 3 is an area that personnel should access less than 8 hours per week.
- Zone 4 is an area that is off-limits to personnel access unless the radiation source has been removed from the area.

6.4.2 Dose Rates and Area Access

The formal study of the dose rates will be required during the definitive design phase. This will include dose rates and shielding calculations for all primary sources in the vitrification facility.

The zone designations and occupancy types are based on process knowledge and prior facility design experience.

The estimated type of occupancy is also considered in the facility design. The type of occupancy primarily refers the level of health physics (HP) intervention required prior to accessing a room in the facility. The types of occupancy are:

- Permanent (P) – no direct HP involvement required during normal operation; full-time habitation by operating staff (offices, control room);
- Circulation (C) – no direct HP involvement required during normal operation; circulation of personnel through hallways or stairwells;
- Occasional (O) – continuous HP management that requires periodic HP surveying and posting of any restrictions prior to entry such as time limits or standard PPE; occasional access for sampling or maintenance;
- Exceptional (E) – Requires HP intervention before any person can enter the room to perform any activity. HP must determine, based on sampling, the time allowed and any special PPE (anti-contamination clothing, breathing protection, etc.) required before access is granted. Special work procedures may also be required prior to access. infrequent access for limited time; and
- Restricted (R) – Remote monitoring of dose rates must be implemented. HP must confirm that the area is suitable for personnel access prior to entry and then determine any special requirements as noted for Exceptional Access.

For example, room 226 – Concrete Container Loading has a Zone 3 designation and an E personnel access level. This indicates that, based on previous experience and process knowledge, a maximum occupancy of less than eight (8) hours is foreseen but that HP must grant access with any further restrictions regarding work time and PPE.

The following table presents the Radiation Zone and Personnel Occupancy for each of the rooms in the facility:

Table 6.5.1-1 Facility Room Zoning List

Room Number	Rad Zone	Room Designation	Floor Level	Personnel Occupancy
101	1	Staircase	-8.500	C
102	1	Staircase Airlock	-8.500	C
103	1	Material lifting	-8.500	C
104	1	Corridor	-8.500	C
105	1	Warehouse	-8.500	O
106	1	Spare parts	-8.500	O
107	1	Free	-8.500	O
108	2	Pump room	-8.500	O
109	4	Active vessels cell	-8.500	R
110	4	Active vessels cell	-8.500	R
111	4	Active vessels cell	-8.500	R
201	2	Truck bay,concrete containers storage	+-0.000	P
202	1	Corridor	+-0.000	C
203	1	Staircase	+-0.000	C
204	1	Spare parts	+-0.000	O
205	1	Chilled water	+-0.000	O
206	2	Blowers	+-0.000	O

Table 6.5.1-1 Facility Room Zoning List (continued)

207	1	Transformer	+-0.000	C
208	1	Electrical room	+-0.000	O
209	1	Electrical room	+-0.000	O
210	1	Reductant (Sugar) Storage	+-0.000	C
211	2	Decon. Reagents	+-0.000	O
212	2	Material airlocks	+-0.000	C
213	1	Staircase Airlock	+-0.000	C
214	1	Corridor	+-0.000	C
215	2	Pump room	+-0.000	O
216	1	Free	+-0.000	O
217	1	Spare parts	+-0.000	O
218	4	Blend and feed tanks	+-0.000	R
219	1	Staff airlock	+-0.000	C
220	1	Material airlock	+-0.000	C
221	1	Corridor	+-0.000	C
222	2	Melter	+-0.000	O
223	3	Offgas Filters	+-0.000	O
224	3	Offgas	+-0.000	O
225	4	Controlled cooling area	+-0.000	E
226	3	Concrete Container loading	+-0.000	E
227	2	Mixers	+-0.000	O
228	3	Off-spec container storage	+-0.000	E
229	2	Off-spec glass reprocessing	+-0.000	O

Table 6.5.1-1 Facility Room Zoning List (continued)

230	2	Disposal Package Decon	+-0.000	O
231	2	Disposal Package Decon	+-0.000	O
301	1	Staircase Airlock	+5.100	C
302	1	Corridor	+5.100	C
303	1	Toilets	+5.100	
304	1	Electrical Room	+5.100	O
305	1	Control room	+5.100	P
306	1	Meeting room	+5.100	P
307	1	Office	+5.100	P
308	1	Office	+5.100	P
309	1	Office	+5.100	P
310	1	Personnel airlock Entrance	+5.100	C
311	1	Personnel airlock Exit	+5.100	C
312	1	Staircase Airlock	+5.100	C
313	1	Corridor	+5.100	C
314	1	Material storage area	+5.100	
315	1	Spare parts	+5.100	O
316	1	Personnel airlock	+5.100	C
317	1	Material airlock	+5.100	C
318	1	Corridor	+5.100	C
319	2	Glass additive (raw material feeding tank)	+5.100	E
320	1	Laboratory	+5.100	P
321	3	Offgas prefilter	+5.100	O

Table 6.5.1-1 Facility Room Zoning List (continued)

401	1	Building ventilation HVAC (blowers)	+12.580	O
402	1	Building ventilation Exhausters	+12.580	O
403	1	Staircase Airlock	+12.580	C
404	1	Staircase Airlock	+12.580	C
405	1	Corridor	+12.580	C
406	1	Demineralized water	+12.580	O
407	1	Demineralized water distribution	+12.580	O
408	1	Transmitters	+12.580	O
409	3	Reagents and decontamination distribution	+12.580	O
410	3	Glass additive (raw material feeding tank)and glove box	+12.580	O
411	1	Airlock	+12.580	C
412	1	Free	+12.580	
413	1	Building ventilation Filters	+12.580	O

6.5 System Design Descriptions

6.5.1 System Numbers and Descriptions

The following table contains the system numbers and their corresponding description for the full-scale design. These systems are shown on the PFDs for the vitrification plant equipment.

Table 6.5.1-1 System Identification Numbers

System No.	System Name	Description
15	Silos Residue & Feed Blending	Silos Residue receipt, storage, transfer and melter feed blending.
16	Melter Feeding	Melter feed tanks, recirculation line and feeding devices.
17	Melter	Melter and support systems.
18	Offgas Process	Filtration, lLiquid scrubbing, HEPA and Fan.
19	Secondary Waste Treatment	Handling and treatment of secondary wastes.
20	RCS	FDF provided equipment.
23	Pouring and Material Handling	Transfer, filling, cooling, and storage of the glass subcontainers.
24	Disposal Package Loading	Filling of disposal packages with subcontainers.
26	Off-spec Product Recycle	Handling, storage, and reprocessing of off-spec glass product.
44	Dry Glass Additives	Truck unloading of glass additives to Blend Tank.
45	Liquid Materials	Collection and transfer of liquid materials into the Blend Tank.

6.5.2 Primary Process Characteristics

6.5.2.1 Melter Feed Preparation

The Silos Residues are prepared for vitrification by blending the waste with glass additives which, when heated, yield the proper composition to convert the residue into a vitreous wasteform. The waste is weighed into a Hold and Blend Tank where it is sampled and analyzed. Glass additives are fed from the storage silos to a weigh station, then re-weighed into the Hold and Blend Tank. Liquid additives are added directly to the Hold and Blend Tank. The mixture of waste and additives (melter feed) is then transferred to the Feed Tank.

Melter feed preparation processes are controlled remotely from the main control room. Equipment is designed for contact maintenance. The following is a list of primary equipment functions:

- pneumatic transport of glass additives to silo storage;
- dry glass additive storage in steel silo system;
- liquid glass additive storage in tanks;
- glass additive metering and weighing;
- glass additive transport to blending;
- metering of glass additives to the Blend Tank;
- receipt and addition of offgas filter solids to Blend Tank;
- weight confirmation and blending of waste and glass additives;
- transfer of blended waste feed slurry; and
- blended waste feed slurry storage and transfer to melter.

6.5.2.2 Vitrification

The vitrification of the melter feed is accomplished using an Envitco WASTE-VIT® Melter. The basic design of the melter is a Joule-heated, ceramic-lined tank with an exterior structural shell of water-cooled panels. The melter is designed for contact maintenance, which is possible due to the shielding provided by the refractory construction. The shell is designed to contain the refractory and provide protection from contact burns or glass leaks. The water-cooled shells cool the exterior surface of the tank, effectively freezing off any possible pathways that could result in a glass leak. The melter has overall dimensions of 6.5m wide x 9.0m long x 4.5m high.

The following is a list of major equipment features included as part of the melter system:

- slurry feed device for presentation of melter feed slurry onto melt surface;
- molybdenum electrodes;
- resistance-heated plenum;

- bottom drain for possible removal of sludges and reduced metal species;
- salt drain for possible draining of molten salt species;
- replaceable glass drain with dual drain orifices;
- constant power or temperature control strategy;
- nitrogen purge system for molybdenum parts; and
- computer interface system for process control and data monitoring functions

6.5.2.3 Offgas Treatment

The main functions of the proposed offgas treatment process are:

1. Clean the melter offgas and vessel ventilation gases to meet the RCS inlet requirements.
2. Maintain negative pressure in the melter to control dust and radon.
3. Capture the radionuclide particles as a solid for recycling to the melter without condensing the volatiles (SO_x) which have low solubility in the glass matrix.

The melter offgas treatment system consists of two different offgas treatment lines: the Normal Offgas System and the Emergency Offgas System (EOG). The offgas is routed to the Normal Offgas system or to the EOG line depending on the melter operating status. Four (4) modes of operation are considered for the offgas system design:

1. Initial start-up - nonradioactive glass;
2. Normal operation - waste slurry feeding;
3. Hot hold - melter operation without feeding; and
4. Emergency - failure of normal offgas system.

For initial start-up and emergency operation, the offgas is routed to the EOG line. This relieves the loading off of the RCS and permits operation with higher exhaust temperatures over extended time periods.

During operation and hot-hold, the offgas is routed to the normal offgas system. During normal operation, the temperature of the offgas leaving the melter is

approximately 400°C at a flow rate of about 1600 Nm^3/h, wet (940 scfm wet). During melter hot-hold operating conditions, injection of water into the melter will be required to cool the offgas to a temperature compatible with piping and filtration equipment located downstream. Higher temperatures are the result of increased heat transfer from the molten glass surface when no cold-cap is present.

The offgas stream primarily consists of four (4) components:

1. entrained solids (oxides);
2. steam (H_2O vapor);
3. other species
   - permanent gases (O_2, N_2)
   - decomposition products (NOx, SOx, CO_2, organic compounds,)
   - volatile metals (Pb, Se, etc.)
4. radionuclides (Pb-210, Po-210, Ra-226 and U primarily as particulate; radon-222 gas).

In order to capture these components, the offgas treatment system must serve the following functions:

- high-temperature filtration with a decontamination factor of at least $2x10^5$;
- acid gas removal to meet the requirements of the RCS;
- first-stage HEPA filtration (first regulatory containment barrier) before discharging to the RCS;
- redundant fans to maintain a constant negative pressure in the melter and contaminated sections of the offgas equipment; and
- emergency offgas treatment system to maintain negative pressure on melter and offgas equipment. EOG should provide redundancy and HEPA filtration of offgas before release to the atmosphere.

6.5.2.4 Glass Wasteform Pouring and Handling

The molten glass is drained from the melter into 0.75m (l) x 0.50 m (w) x 1.0 m (h) metal subcontainers. Each full subcontainer will contain approximately 1 MT of glass. Based on the total glass production of 10,800 MT, this should result in 10,800 subcontainers. Four subcontainers will be placed in the concrete final disposal package. The estimated number of disposal packages is 2700.

The subcontainers are automatically handled through the pouring process. Empty subcontainers are staged for pouring and indexed beneath the pour station as each subcontainer is filled. The shell of the subcontainers will be jacketed with a water-cooled shell while being poured. This is designed to prevent thermal distortion of the subcontainer. The filled subcontainers are transferred via motor-driven roller conveyors and overhead cranes to a dedicated cooling area, and allowed to cool over the course of 48 hours. The following is a list of primary equipment functions in the glass pouring and handling process:

- subcontainer indexing system beneath the glass drain;
- temperature conditioning of subcontainer during pouring;
- subcontainer conveyance to cooling room; and
- subcontainer conveyance for transfer to disposal packaging.

6.5.2.5 Secondary Waste

Most secondary waste is collected and transferred to the secondary waste treatment area (e.g., offgas residues, salts, metals). The following table lists the anticipated secondary wastes with the estimated production rate and disposition of each.

Secondary wastes will be classified into two categories and identified for recycle or disposal. Recyclable secondary waste streams include normal process streams that will be treated and/or returned to the process on a regular basis. Other recycled secondary waste streams include off-spec product, salts and metals which will be accumulated and treated at the end of the campaign.

Non-recyclable secondary wastes include maintenance and job wastes and other equipment or facility-related debris. Treatment of this material will be based on determination of its RCRA designation as hazardous or non-hazardous. Determination of RCRA designation will be based on process knowledge, survey data and chemical analysis, as required.

Table 6.5.2.5-1 Secondary Waste Estimates

Waste Stream	Estimated Generation Rate	Recycle / Dispose
Reduced Metallic Species	Variable (Approximately 250 kg/week)	Recycle
Salt	0 kg/hr	Recycle
Offspec Product	40 MT per year	Recycle
Offgas Filter Solids	0.8 – 1.0 kg/hr	Recycle
Offgas Scrubber Liquids	800 – 1000 kg/hr	Dispose
Facility & Maintenance Wastewater	2000 – 3000 liters per week	Dispose
Offgas Filter Media (HEMF & Prefilter)	3-5 m^3 per year (9-15 m^3 total)	Dispose
HEMF Decon Solution	100 liters per week	Recycled
Spent Melter	1 melter at completion of campaign (130 MT melter/3 year campaign)	Dispose
Glass Drain Bay	Approximately 3 m^3	Dispose

The metals drain material accumulation rate in Table 6.6.2.5-1 is based on an accumulation of approximately 13 kg of metals during the POPT. This is based on the calculations presented in Section 5.3. The 13 kg of metal could have been formed from a total of 4505 kg of dry surrogate treated before (pre-process optimization), during, and after the POPT demonstration run. This results in a metals production rate of 0.0029 kg metal per kg of residue. Distributed over the entire Silos 1 and 2 inventory (9031 MT), the metals accumulation would total 26 MT with an approximate generation rate of 250 kg/week.

Secondary waste from the salt and metal drain is poured into subcontainers of the same design as the glass pouring subcontainers. The transfer of these containers is done using conveyors and overhead cranes, as necessary. The offgas solids are containerized into drums and recycled to the melter feed system as shown on the PFDs. This approach is successfully used in applications in France. Detailed design optimization could result in a direct transfer from the filter to the melter but is not currently performed and, therefore, not considered in the pre-conceptual design.

Treatment of non-recyclable secondary solid radioactive waste (as noted in Table 6.5.2.5-1) will be macroencapsulation, per 40 CFR, and performed outside the vitrification facility as described later in this chapter. Secondary liquid waste from flush water and other liquids will be collected, analyzed and transferred back to the AWR transfer tanks for use in sluicing operations and transfer of waste to the vitrification facility. Wastewater sent to the AWR system will be characterized prior to transfer to ensure no constituents are added which would impact the AWR wastewater pretreatment facility. Typical chemicals for decontamination include dilute acids, caustic, permanganate and trisodium phosphate. After neutralization, these are all similar to components already in the waste. Details of the AWR system design and operation will be needed to properly evaluate compatibility in the full-scale design. Scrubber liquids are treated on-site in order to meet AWWT release standards. The following are the basic equipment functions for scrubber water treatment:

- Receive liquid waste from the melter offgas scrubbers;
- Treat the waste to allow sodium sulfite, sulfate, and water to be purged to the AWWT;
- Recycle contaminants solids to melter feed preparation; and
- Produce relatively clean process water for recycle and reuse within the plant.

6.5.2.6 Secondary Waste Recycle Streams

Four (4) streams will be recycled during the operation of the full-scale system.

1. Overflow water from the thickener will be sent back to AWR for use in sluicing and transferring wastes to the facility.
2. Wastewater from cleaning and flushing will be sent back to AWR for use in sluicing and transferring wastes to the facility.
3. The pre-filter solids captured in the offgas treatment system will be recycled back to the melter feed system. (The composition of the solids is anticipated to be very similar to the melter feed chemistry.)
4. Insoluble solids collected from the offgas scrubber water will be returned to the melter feed preparation system. (Insoluble materials are expected to have a low salt concentration and should be compatible with the feed composition.)

A fifth possible recycle stream is the water produced from the reverse osmosis system in the scrubber water treatment system. The reverse osmosis system is not operated unless: 1) required to reduce the input to the AWWT or 2) a use of partially contaminated water is found in the facility.

Three secondary waste streams will be recycled through the melter at the end of the treatment campaign.

1) Metals drain material;
2) Salt Drain material; and
3) Off-spec product.

6.5.3 Basic Equipment Data

6.5.3.1 System Availability Factors

The Silos Residue vitrification system, which includes the raw material storage and handling system, melter feed preparation, melter process equipment and offgas treatment system, will be available to produce glass 24 hours per day, 12 months per year. A minimum facility availability factor of 70% is assumed during the 12-month production period. The extra processing rate capacity built into the 70% availability will also allow for the recycle of the off-spec product, metals, and any salt material within the 36-month campaign. This is possible as the amount of glass produced from the treatment of these streams is less than 3% of the total glass produced over the campaign as noted in Section 6.6.4.5.

The availability factor is based on several sources or assumptions:

- historical demonstration of uptimes (melter utilization) in excess of 95% for commercial glass plants;
- demonstrated availability factor of approximately 97% (5 hours of downtime out of 200 operating hours) while processing the 7800 kg during the POPT; and
- demonstrated availability factor of 99.9% (4 minutes of downtime out of 72 operating hours) during the official 72-hour POPT.

6.5.3.2 System Throughput

The slurry-based feed preparation system will be sized to process a minimum of 27.6 MT of residue slurry per day. On a dry basis, the treatment rate must be at least 8.3 MT per day. Assuming an availability factor of 70% for the slurry system and a slurry density of 1.23 kg/L, the processing rate for the slurry system is 32,000 L/day of residue slurry (30% solids).

The throughput of the vitrification system will be at least 9.9 MT per day of glass. Assuming an availability factor of 70% for the melter, the throughput requirement increases to 14 MT per day. The primary process streams and their corresponding consumption or generation rates are estimated as follows:

Table 6.5.3.2-1 System Throughput and Design Capacity

Material	Consumption or Generation Rate
Silos Residue (Slurry)	39,200 kg/day
Blended Melter Feed (Slurry)	44,400 kg/day
Offgas Solids Recycle	~20 kg/day
Glass Additives	5,200 kg/day
Offgas to RCS	13.2 Nm^3/min (470 scfm)
Glass product	14,000 kg/day
Subcontainers	14 per day

The process rates take into account the availability factor as noted above. The total amount of glass, additives, subcontainers, and final disposal packages do not change as there is only a finite amount of waste to be treated (9031 MT). The rate at which the materials are consumed or produced is increased in order to facilitate "catching-up" should any other part of the facility go off-line.

6.5.3.3 Equipment Life

The design life of the plant will be five years, exceeding the required three year operating campaign requirements. Those components not having lives greater than 3 years have either redundant systems or are replaceable within the 30% downtime window assumed for the facility. Typical life expectancy of major equipment is shown in the following table:

Table 6.5.3.3-1 Estimated Equipment Life

System Component	Life (years)
Glass Additive Storage Silos	10
Additives Scale and Hopper	10
Pneumatic Transfer Receiving Vessel	10
Pneumatic Transfer Piping	5
Additive Receiving Vessel and check-scale	10
Screw Feeders	5
Blend Tank	10
Slurry Pumps	1
Melter Feed Tanks	10
Mixers	3
WASTE-VIT® Melter	3
Glass Drain Orifice	1
Glass Drain Bay	1.5 - 2
Molybdenum Electrode	1
Electrode Holder	3
Offgas Treatment Blower	5
Offgas Filter Element	1
Reverse Osmosis Filter	5
Subcontainer Conveyor	10

6.5.4 *Process Descriptions*

6.5.4.1 Vitrification System Processes

The primary processes that will occur in and around the melter (17-M-101) are:

- startup/melter heatup;
- Joule-heating via molybdenum electrodes;
- slurry feeding;
- glass pouring;
- reduced metallic species draining – as required; and
- salt phase draining – as required.

Melter Start-up

The melter will be started with resistance-heated elements located in the plenum of the melter. Once the glass is molten, electric current can be passed through the glass resulting in Joule-heating. The resistance of the molten glass under high current conditions causes a heat release, which serves as the primary energy source for the melting process under normal operating conditions. Once Joule-heating is established, the resistance heating elements will be used to maintain the head space temperature at 400 to 800°C.

Joule-heating via Molybdenum Electrodes

Electrodes will enter the melter through the side-wall similar to the EV-101 melter used in the POPT. The electrode holders permit adjustment and optimization of the melt process by allowing the operator to adjust the electrode insertion depth remotely from the control room. Electrode length will be adjusted periodically to compensate for wear and will be remotely controlled from the main control room. As the electrodes wear, additional electrodes will be advanced into the melter. Additional segments of electrode material can be added to the back end of the electrode and then advanced into the melter as part of the normal wear compensation scheme. Additional electrode segments will most likely be added once a month.

Melter Feeding

Slurry will be fed to the melter through a system of one or more slurry feed nozzles. This slurry feed device will be capable of presenting the slurry over the entire melter surface, forming an evenly-distributed blanket of feed over the glass pool. The blanket will be maintained as to allow molten areas to release decomposition gasses as the feed melts. The water-cooled feed tube will be inserted through the refractory structure and translated through external control systems. This will provide for adjustment of the feed distribution in accordance with process changes and optimization. Motion of the feed nozzle will be under operator control from the control room.

Product Draining

The full-scale WASTE-VIT® melter has three drain systems, each designed to match the characteristics of the salt, metallic sludge or glass streams for which it is dedicated. Each drain system operates independently as required: continuous draining of the molten glass product from the glass drain bay, periodic draining of salts from the melt surface, and periodic draining of any accumulated sludges from the bottom of the chamber.

Glass Drain

The glass product will be drained from the melter through an orifice located in the glass drain bay. The blended waste feed will melt in the main chamber and then flow into the glass drain bay. The glass will then flow out of one of two drain orifices. Two orifices will be installed in the melter so that if one should malfunction, the other can be put into operation within minutes.

It is anticipated that the life of the glass drain bay may be shorter than the rest of the melter. The estimated campaign life of the drain bay is 1.5 to 2 years. Therefore, the glass drain bay is replaceable while the melter is still at operating temperature. This would be done by partially draining the melter to isolate the drain bay from the melter; the drain bay can then be removed and replaced. A similar replacement operation has been performed in the commercial industry for forehearths which are analogous to the glass drain bay in the Envitco melter. Envitco's affiliated companies have replaced forehearths while the melter was at operating temperature.

Each of the glass drain orifices has a water-cooled plunger that can stop the flow of glass in an emergency. The water-cooled plunger and drain valve design allows for very rapid and positive shutoff, providing both safe and controllable management of the glass pouring process.

Salt Drain

Salt draining will be conducted only if necessary. Salt solubility and evaporation were demonstrated in the POPT to preclude the use of the salt drain during normal operations. A separate salt wastestream is not desirable from both radiological and waste management perspectives. Radiological concerns exist with the concentration of Ra-226 and Pb-210 in the salt phase resulting in a high activity secondary waste stream.

If an upset condition occurs and salt is exsolved from the melt, the salt drain will skim the molten salt from the top of the glass surface and direct it to a subcontainer. The anticipated normal flow rate of salt is 0 kg/hr as the salt is mostly solubilized in the glass with a small amount vaporized into the offgas. The salt drain is designed to handle the full input rate of sulfate to the melter should an upset condition occur in which salt accumulates on the melt surface.

The salt will be transferred out of the vitrification room to an interim storage area via conveyors and overhead cranes as required. These are not shown on the facility layouts for clarity in depicting the primary treatment stream of the glass wasteform.

Metals Drain

The metals drain, located at the bottom of the main melt chamber, can be opened periodically to purge the melter of any accumulated sludges or reduced metallic species. It is anticipated that reduced metal species may occur under normal operating conditions due to the electroreduction of the lead with molybdenum electrode material. The metal drain is designed to accommodate rates as high as 1000 kg/day under upset conditions. The anticipated rate of metal draining will be based on accumulation rates. The accumulation rate will be judged according to observation of the periodic metals drain pour.

A periodic draining scheme will be established as a preventative maintenance measure to remove any accumulations from the bottom of the melter. This material may be metallic or glass-like in nature. Depending on the composition/characteristics of the material drained, the frequency of metal drain operation will be adjusted. If the pour appears to be more metallic, it will be operated more often. If the metal drain appears to be more glass-like, the frequency will be decreased. The availability of the drain system to eliminate sludges and reduced metallic species from the melt chamber minimizes the potential for electrical short circuiting and metal attack on the refractory.

The reduced metallic species will be poured into subcontainers and transferred out of the vitrification room to an interim storage area via conveyors and

overhead cranes as required. These are not shown on the facility layouts for clarity in depicting the primary treatment stream of the glass wasteform.

6.5.4.2 Material Handling Processes

Silos Residue Transfer System

The Silos Residue will be transferred from the AWR storage tanks as provided during the Advanced Waste Retrieval Project. The slurry retrieval system used to remove the residue from the silos during the AWR Project will be used to transfer the slurry to the vitrification facility Slurry Receipt Tank (15-TK-510).

Melter Feed Preparation

The Silos Residue Slurry will be received into the Receipt Tank (15-TK-510) which is sized to hold 100,000 liters of residue slurry. The residue slurry will then be transferred to a Thickener Tank (15-TK-525) that is sized to produce 1650 kg/hr of 30 wt% solids slurry. The overflow from the Thickener Tank is directed to the Overflow Tank (15-TK-570) which is returned to the AWR facility for use in transferring Silos Residue.

The underflow of the Thickener Tank will be sent to one (1) of three (3) Hold / Blend Tanks (15-TK-210, 310, 410). These tanks are sized to hold approximately one and a half (1.5) days of melter feed or 55,000 liters. The Hold / Blend Tanks will be mounted on load cells (15-WW-215, 315, 415) so that the weight of residue slurry transferred into the tank can be measured. The residue slurry will be analyzed prior to determining the amount of glass additives. Glass additives will then be added to the Hold / Blend Tank and blended with the waste to produce the melter feed.

The glass additives will be stored in steel silos (44-B-102, 112, 122, 132, 142) outside the process facility in a non-contaminated area. Each of the ingredients will be metered from the silo, individually weighed (15-V-305), and pneumatically transferred to a receiving vessel (15-B-510) directly above the Blend Tanks. This receiving vessel will empty into a check scale (15-B-105) to verify each additive weight. The additive will then be metered into the Blend Tank by a screw feeder (15-CV-145). The screw feeders will have variable speed drive capability to allow slow metering of the fine materials. Slow feeding of the fine, high surface area materials facilitates their wetting and incorporation into the blended slurry feed.

Once all of the glass additives have been blended with the residue slurry, the melter feed slurry will be transferred into the Melter Feed Tank (15-TK-610). The Melter Feed Tank is capable of holding 75,000 liters of feed or approximately two

and one-half (2.5) days of melter feed. The Melter Feed Tank is designed with a cooling jacket and will be continuously stirred and recirculated. The slurry will be recirculated from the Melter Feed Tank to the melter and back to the tank. A slipstream of approximately 30 lpm will be taken off for feeding the melter. The slipstream will be metered through variable speed, positive displacement pumps (15-P-330A & B) that control the actual feed rate.

The transfer of slurry between the tanks and the melter will be done through stainless steel pipes. Vaneless centrifugal pumps will be used to move the blended slurry between tanks and through the feed recirculation headers. Vaneless centrifugal pumps allow for pumping very thick or shear-sensitive slurries, and tend to experience less wear in slurry applications. Backup pumps are provided to maintain recirculation of the slurry back into the Melter Feed Tank in the event of a failure in the primary pump.

Glass Pouring and Subcontainer Cooling

Drawings FDFG-06 and FDFG-07 included with the Pouring Enclosure Equipment Data Sheet in Section 23 show the material handling process for the primary waste stream of glass product. Metal subcontainers are automatically positioned under the glass drain via motorized conveyor. CCTV and remote sensors will be used to position and monitor the pouring process. The glass stream is not stopped while indexing subcontainers to minimize the wear of the glass drain components. Offgas from the area above the subcontainer will be vented to the offgas treatment system to control volatile metals and radon. The subcontainer will also be cooled with a water-cooled jacket at the pouring station to insure subcontainer integrity.

After each of the subcontainers is filled, they will be transferred to a cooling room. A motorized conveyor will move the full subcontainer to the entrance of the cooling room. An overhead crane will then lift the subcontainer and place it in the cooling room. The cooling area will be isolated from other working areas by the appropriate level of shielding. Access will be allowed only if the room is empty of subcontainers due to the anticipated radiation fields. Access for maintenance can be obtained through the disposal container loading area. Further access and material flow optimization will be required for the detailed full-scale design.

Final Wasteform Packaging

Once cooled to contact-handled temperatures, the subcontainers will be transferred to the disposal package filling area. The cooling room overhead crane will place the subcontainer directly into a disposal package. The lid will be installed and the exterior checked to confirm that the package meets the surface

contact dose rate limits. The package will be moved through an airlock into the package storage area and placed by forklift.

6.5.4.3 Normal Offgas Treatment

The offgas generated from the melter is treated to meet the RCS inlet requirements. The offgas treatment system consists of independent systems: the normal offgas system and EOG.

The vessel vents are also connected to the offgas treatment system. However, the vessel vents are only HEPA-filtered prior to being discharged to the RCS. Secondary wastes generated as a result of the offgas treatment are either recycled to the melter or treated to meet the AWWT acceptance criteria.

After the feed decomposes and melts in the vitrification system, the gases and water vapor from the slurry are removed from the melter through a water-cooled pipe. The water-cooled pipe is used to trim the offgas temperature down to within 300 – 500°C when operating conditions result in higher plenum temperatures. The offgas must be cooled to prevent damage to the downstream equipment. However, the gas must be maintained above 300°C to prevent condensation of volatile species that could build up in the offgas pipes. After temperature trim, the offgas passes into a pre-filter.

Solids Filtering

The pre-filter (18-F-101) is a high-temperature filter used to collect the particulate matter entrained in the offgas. Among high-temperature filtration technologies, ceramic filter technology has the advantage of attaining high capture efficiencies (>99% at 1 μm) and continuous declogging capabilities. Moreover, ceramic filters are not sensitive to temperature excursions since they can withstand temperatures as high as 900°C.

The dust-laden offgas enters at the bottom of the filter, dust is retained on the ceramic filter, and the clean offgas is discharged at the top. A special pre-coating of the filter is applied at the manufacturer to improve the filter efficiency.

A timer which controls the injection of a compressed air jet pulse ensures declogging of the filter. The dust then drops towards the filter hopper. Dust is recovered at the bottom of the hopper by rotary valves and transferred by screw conveyor for loading into a drum. The drum is then sent to the filter solids glovebox (15-GB-605) for unloading. The dust is then loaded into a bin for interim storage. The dust is metered into the dry additives check scale for addition to each batch of melter feed. This is possible because the dust that is collected in the high-temperature filter will primarily contain melter feed material

that was entrained during the feeding and melting process. The concentration of sulfur should not differ from the melter feed. This was proven in the POPT via analysis of the filter form the Method 29 sample. The particulate material on the heated filter in the front half of the sampling train had lower sulfur content than the volatile material caught in the impingers.

The filter assembly has to be kept at sufficiently high temperature to prevent condensation of volatile materials and acid gases. This is insured through insulation and heat tracing. The volatile gases will include a significant amount of sulfur that cannot be recycled to the melter due to their low glass solubility. If the sulfur were recycled, the build-up of salt in the melter could result in the production of a secondary salt waste from the melter salt drain. This is not desirable as the salt would likely contain high Ra-226 and Pb-210 concentrations.

After passing through the high-temperature filter, the offgas passes through a polishing filter which captures the small amount of dust not captured by the pre-filter. The BAT available to operate at high temperature is the High Efficiency Metal Filter (HEMF) (18-F-202).

This filter is composed of fine stainless steel fibers sintered into a mat. The filtering system consists of several vertical cylindrical welded filter assemblies. A sufficient number of assemblies are included in the design to enable the cleaning of a filter off-line without impacting the system capacity. The filter can be cleaned in-place and efficiency can reach up to 99.97% for 0.3 μm particles. The cleaning design consists of a back-wash flow of water or acid solution. The decontamination solution (with solids) is recovered in a dedicated tank and can be recycled to the melter through the scrubber water filtering.

Volatile Scrubbing

The offgases leaving the HEMF at high temperature (350 – 400°C) are cooled down by water evaporation in a venturi quencher (included in 18-V-301) until they reach the saturation temperature. The water vapor in the offgas is condensed and water is recovered in the scrubber tank for recycling in the scrubber columns. The offgases pass through a packed tower scrubber (18-V-301) where acid gases (SO_2, SO_3) are absorbed by contact with an alkaline reagent such as sodium hydroxide.

The overflow from the scrubber tank is directed to the blowdown tank and transferred by pump to one of two filter feed adjustment tanks (FFAT) (19-TK-003 & 004) in the secondary waste treatment area.

The fine aerosols produced by the scrubber must be efficiently captured by a mist eliminator to ensure good operation of the HEPA filter. This mist eliminator is included with the scrubber system.

Final Filtering

The offgas is dried by the subsequent cooling, condensing and reheating steps. The water from these steps is sent to the scrubber for use. This step will improve the operation of the HEPA filter (18-FH-420) to capture any particulate matter that has gotten through the other components.

The offgas is finally discharged to the RCS by two redundant fans (18-BL-501 and 502) which maintain a negative pressure in the offgas equipment and the melter. The fans are driven by variable-speed drives in order to maintain a constant negative pressure in the melter during process fluctuations.

Glass Pouring Station Offgas

Negative pressure is maintained in the pouring station area. During glass pouring, gases are continuously extracted from the pouring area and filtered through a HEMF (18-F-221), then directed to the scrubber (18-V-301).

NO_x Abatement

The RCS requirement for maximum NO_x concentration is 20 ppm. According to the material balance, which assumes that nitrate in the waste is converted to NO_x, the concentration of NO_x is approximately 20 ppm. Since all of the nitrate would not be reduced to NO_x, the offgas treatment system does not require NO_x abatement.

If, after further study, it is determined that NO_x abatement is required, a catalytic deNO_x technology would be recommended. In this technology, NO_x abatement is performed by injecting ammonia (CNH_3) in a catalytic reactor at a controlled temperature of about 350°C. Location of the deNO_x system before the scrubbing step could be an easy solution since the offgas is approximately 400°C after the pre-filter.

Specific care should be taken in the choice of the catalyst due to the presence of SO_x. Heat release, offgas temperature and NH_3 injection should be carefully controlled to avoid formation of ammonium sulfates or nitrates.

6.5.4.4 Emergency Offgas Treatment (EOG)

The EOG ductwork is not connected to the RCS but to a dedicated EOG stack. The melter offgas is routed to the EOG line only for the initial start-up of the melter or, in case of upset operating conditions, leading to an emergency situation or loss of the normal offgas system.

During initial start-up, the melter offgas can reach temperatures of 800 - 1100°C with an offgas flow rate of approximately 400 Nm^3/h. The function of the EOG line, in this case, is to cool the offgas prior to release to the stack and to maintain a negative pressure in the melter.

In an emergency such as melter upset or loss of the normal offgas system, immediate suspension of the melter feed is required. The function of the EOG is then to maintain a negative pressure in the melter and, as the offgas temperature rises, the EOG process must also cool the gas to allow for HEPA filtration before release to the stack. To accomplish these requirements, the EOG consists of a quencher, gas drying, HEPA filtration,and fans.

The EOG quench (18-TK-610, 18-P-611) implements specific design and construction materials to resist high temperatures (800 – 1000°C) and the risk of acid corrosion. The quencher technology is a falling-film quench which is a safe way to rapidly cool the offgas to saturation temperature and minimize aerosol formation. The offgas is condensed in a cooler (18-E-630) and reheated (18-H-640) before passing through a two-stage HEPA filter (18-FH-650). The offgas is discharged to the EOG stack by two redundant fans (18-BL-701 & 702) which maintain a negative pressure in the equipment located upstream and in the melter. The EOG stack requires air quality and radiological monitoring similar to the stack located after the RCS.

6.5.4.5 Secondary Waste Treatment

The secondary waste generated in the vitrification facility can be categorized into three major categories. These include: a) facility wastewater from flushes or maintenance, b) secondary solid waste, or spent equipment, and c) offgas scrubber water.

Facility Wastewater

The functions of the Facility Wastewater Handling and Treatment System is to collect and accumulate miscellaneous contaminated liquid waste generated by operations and maintenance, and to treat the waste sufficiently to allow discharge of the treated water fraction to the AWWT.

Maintenance work, equipment flushing, leaks, and facility decontamination will generate contaminated wastewater. This waste will be accumulated in two tanks, the Waste Accumulation and Return Tank (WART) (19-TK-001) and the Decontamination Waste Accumulation Tank (DWAT) (19-TK-002). Wastes from sumps, drip pans, and in-place equipment flushes are transferred to the WART via headers installed in the facility. Waste from flushing and decontamination of equipment in the maintenance shop is accumulated in the DWAT and is periodically batch-transferred to the WART. Typical chemicals for decontamination include dilute acids, caustic, permanganate and trisodium phosphate. After neutralization, these are all similar to components already in the waste. Details of the AWR system design and operation will be needed to properly evaluate compatibility in the full-scale design. As discussed below, accumulated waste is periodically transferred from the WART to the AWR transfer tanks for treatment or recycle in the residue transfer system. No additional treatment of this waste is performed in the vitrification facility.

The miscellaneous decontamination and facility waste will contain small amounts of the silo residue. Water for flushing will be the main component added to this waste. The liquid phase is assumed to be similar to the liquid phase of the bulk retrieved slurry, except more dilute. Materials added during melter feed are not expected to significantly effect the properties of the waste other than moderately increasing the dissolved solids content because of the addition of soluble sodium and lithium.

Since this wastewater stream will be very similar to the waste that the AWR system is designed to handle, the AWR is expected to be capable of treating this waste to AWWT specifications. The approach for handling this waste is, therefore, to periodically transfer it to AWR for treatment. Residual liquid will be discharged to the AWWT system after treatment at AWR. Any solids removed will be transferred to the residue transfer system where they will be blended with other waste and eventually recycled to the melter feed. Because they consist primarily of the existing residue and constitute a relatively small volume, they will not materially effect the plant feed composition. Therefore, the quantity of recycled solids is considered negligible and is not included in the material balance.

There are two ways that the waste can be transferred to AWR. It can be transferred directly to the feed tank for the AWR waste treatment system, or it can be blended into the vitrification plant feed at the slurry receipt tank (15-TK-510). The preferred approach is to send the wastewater to AWR. In the second case, suspended solids will settle in the thickener and be blended into the melter feed. The liquid phase will be blended into the liquid fraction reporting primarily to the overflow. Both piping routes are provided for operational flexibility. Piping

is provided to allow return of bulk feed material, and flushes from preparation tanks containing large quantities of solids directly to the slurry receipt tank.

Secondary Solid Waste

Secondary radioactive solid waste (RSW) will be generated from several sources during normal operation and maintenance of the plant. Primary categories of RSW include the following:

- Gloves, rags, wipes, plastic sheeting, protective clothing and similar, referred to as "job waste";
- Failed equipment, instrumentation, piping and similar items that have been in contact with the waste; and
- Filter elements, including single use and elements that can be partially cleaned by blowback.

The material in Silos 1 and 2 is classified as 11(e)(2) byproduct material as defined by the Atomic Energy Act of 1954 and is excluded from management as hazardous waste under 40 CFR Part 261.4(a)(4). Due to the high leach rate of lead as measured by the TCLP, the Silos 1 and 2 material poses a potential threat to impact groundwater that may be used for human consumption. Therefore, the Silos 1 and 2 material is being remediated under the Comprehensive Environmental Response and Liability Act. However, RSW generated during the remediation process that exhibits a characteristic of hazardous waste may not be able to claim the exclusion under 40 CFR Part 261.4(a)(4) and may, therefore, be classified as low-level mixed waste (LLMW). The RSW would be classified as low-level waste (LLW) if it does not exhibit a characteristic of hazardous waste. The RSW handling concept is designed to minimize the amount of waste classified as hazardous, allowing most RSW to be disposed on-site as LLW."

The primary means of segregating non-hazardous versus hazardous waste is by "process knowledge" combined with radiation surveys and chemical analysis, if required. The lead comes from a radioactive waste. For a given process stream, the amount of lead is roughly proportional to the amount of radioactive components. The maximum amount of lead present is estimated from the radiation survey based on knowledge of the ratio of radioactive components to lead in the waste material at the point in the process where the waste was generated. If a radiation survey shows contamination below a specified level (to be determined), it is safe to assume that lead is below the hazardous waste limit. Some items originate in areas with very low contamination, such as wastewater treatment. The lack of a source of hazardous waste contamination from such

areas may also be used as "process knowledge" to exclude items from the hazardous waste category.

The plant design includes a decontamination station where most failed equipment such as pumps, valves, and piping are decontaminated. It is expected that after decontamination, most failed equipment can be classified as non-hazardous LLW based on a radiation survey and process knowledge as described above.

Potentially contaminated waste from radiation zones will be screened and segregated into one of three categories at or near the point of generation.

1. Items with contamination below levels that result in a characteristic hazardous waste designation. These items, contaminated with less than 5 ppm lead, will be disposed as LLW.

2. Items with sufficient contamination to be designated as toxic characteristic hazardous waste but which are amenable to decontamination. This category is expected to consist primarily of failed equipment, piping, instruments, tools, and miscellaneous hardware items that are reasonably amenable to decontamination with routine methods such as flushing with water and decontamination chemicals, brushing, and wiping. More sophisticated decontamination methods are not justified because of the relatively small volume of material to be handled.

3. Items with contamination above levels that result in designation as toxic characteristic hazardous waste, but which are not reasonably amenable to decontamination. Examples of this type of waste include filter elements, clothing, wipes, and other fibrous wastes. Some failed equipment will also be in this category. Items of this type are classified as LLMW "debris" by 40#CFR268.2, and 40#CFR268.45.

Items below the hazardous waste content limits are packaged for disposal as LLW. Most, if not all, of this waste is expected to meet on-site disposal acceptance criteria and will be packaged for on-site disposal.

The RSW classified as LLMW debris and which cannot be decontaminated must be treated prior to disposal. This waste is packaged and periodically shipped off-site for treatment in accordance with 40#CFR268.45 followed by disposal. The LLMW containers will be properly labeled, documented, and segregated from the non-hazardous LLW. While awaiting shipment, they will be placed in a storage area that complies with the hazardous waste regulations.

The metals drain residues could potentially be the largest source of RSW. Based on instrumentation of the melter to detect accumulation of secondary phases,

coupled with observations of the drain through remote cameras, the nature of the material removed from the metals drain can be evaluated. The material will be accumulated with the off-spec product and recycled to the melter in a special feed blend. The blend will be matched to the typical lead levels that are present in the production waste glasses in order to meet the TCLP requirements.

With good operating practices and attention to waste minimization and segregation at the source, material that must be disposed as hazardous waste will be a small fraction of the total waste generated.

No major special equipment is expected to be required for RSW handling. Routine survey instruments used to identify radioactive contamination will be used for screening waste. Carts and a forklift will be used for handling waste packages.

Offgas Scrubber Water

Summary

Waste received from the melter offgas scrubber is chemically adjusted (if needed) to precipitate contaminants (primarily Se). Suspended solids are then removed with a crossflow filter. If volume reduction or recycle process water is needed, the filtrate is transferred to a reverse osmosis unit (ROU) which divides the stream into a concentrated salt solution to be released to the AWWT and a relatively clean water stream to be recycled for process uses. Concentrated solids slurry from the filter is recycled to melter feed preparation. If needed, solids slurry is diluted with water and filtered again to reduce soluble components prior to recycle.

Filter Feed Adjustment

Based on the following assumptions and data, scrubber water is periodically transferred to one of two FFAT (19-TK-003 and 004). If needed, chemicals or filter-aid are added to help precipitate soluble metals and maximize capture in the crossflow filter. The waste is then transferred to the FFT (19-TK-005).

Some Silo waste will be entrained in the melter offgas as particulate matter. Most entrained material and metals will be removed by the pre-filter and HEMF upstream of the scrubbers. However, a trace amount will penetrate through and report to the scrubber solution. After exposure to high temperatures in the melter, the material should be primarily in an oxide form which is generally inert and insoluble. This material is also expected to be inert and insoluble under the dilute alkaline conditions of the scrubber. Some residue components, such as lead, are amphoteric and could begin dissolving if the hydroxide concentration is excessive. A portion of the CO_2 in the offgas will absorb in the scrubber solution,

providing a buffer that prevents high hydroxide concentrations in the scrub solutions.

Another contaminant of concern is selenium. A significant fraction of the selenium in the melter feed is evaporated during the melting process. Most of this will be gaseous under the relatively high temperature of the offgas system upstream of the scrubber. It may not be efficiently removed by the particulate removal equipment. A substantial fraction of the selenium in the melter feed may, therefore, report to the scrubber solution. Preliminary information on expected behavior of selenium in offgas scrubbing systems indicates that in the sulfation roasting process, selenium is released to the offgas as SeO_2 along with SO_2 (Kirk & Othmer). Also, under the conditions present in the scrubber, SO_2 reduces the SeO_2 to elemental selenium. Elemental selenium is essentially insoluble in water, but may be dissolved by caustic solutions. Therefore, as in the case of lead, it is necessary to avoid high-hydroxide concentrations to ensure that elemental selenium is precipitated as a solid that can be removed by the filter. If further pH adjustment or other chemical additives or filter aids are needed, these will be added in the FFT. As mentioned in the Scale-Up Section, additional information and evaluation are needed to make a final determination on additives needed to assure precipitation of most of the selenium and any other volatile elements.

Two FFATs (19-TK-003 and 19-TK-004) are provided. In addition, the FFT (19-TK-005) is provided as part of the filtration package unit. A typical FFAT batch is equivalent to eight hours of scrubber water production. This batch size allows switchover once per eight-hour shift. Typical operation is as follows: assuming scrubber waste is initially flowing to 19-TK-004, while 19-TK-003 is transferring to the FFT.

- When 19-TK-003 is nearly empty, transfer to the filter feed tank is stopped. The FFT is nearly full at this point.
- Scrubber waste flow is switched from 19-TK-004 to 19-TK-003.
- If chemical additives or filter aid are needed, they are added to 19-TK-004 and tank contents are mixed with an agitator.
- During the time that the batch in 19-TK-004 is being prepared, the volume in the FFT continues to drop. If solids have built up to the point that they need to be purged, the solids slurry batch is transferred out after the FFT batch volume is reduced to increase solids concentration. If desired, dilution water may be added to the FFT to reduce the dissolved salt concentration. For example:

1) liquid volume in the FFT is initially 2000 L;

2) FFT volume drops to 500 L after waste transfer-in stops;

3) 1500 L of water are added;

4) filtration is continued to reduce the volume to 500 L; and

5) the residual slurry is then transferred to 15-TK-510.

This dilution and re-filtering step results in purging about 75 percent of the soluble salts to reduce recycle to the melter. This optional step may be skipped or it can be repeated depending on the need to control recycle of soluble salts to the melter.

- Waste transfer from 19-TK-004 to the FFT is started. This is a semi-continuous transfer based on maintaining the desired liquid level in the FFT.

The FFAT tank size provides significant contingency space above the normal batch volume. This is important to allow for routine filter cleaning outages (estimated at four hours per week), failures, maintenance, and other outages. The upstream offgas scrubbing system will have limited capacity to store condensate and must discharge accumulated condensate frequently to continue operation, which is essential for continued feeding of the melter. During normal operation, total inventory in the two FFATs should not exceed 10 hours of equivalent scrubber solution production (14,000 L). Assuming a maximum fill volume of 90 percent of the gross 20,000 L capacity, the combined working capacity is 36,000 L. The difference (22,000 L) allows continued receipt of scrubber solutions for nearly 16 hours if transfers to the FFT are interrupted and no actions are taken to reduce the scrubber solution production rate (for example, reducing feed rate to the melter). This should be adequate time to correct most downstream outages.

Filtration

Waste pumped from the FFT flows through the crossflow filter (19-F-001). A portion of the liquid flows through the filter elements, which removes the insoluble solids. The solids plus the balance of the liquid return to the FFT. Solids accumulate in the FFT and are periodically purged. Prior to the solids purge, waste transfer to the FFT is stopped for a short period of time. Continued filtration causes the liquid level in the FFT to gradually drop, increasing the suspended solids concentration. The solids suspension may then be diluted one or more times with water and re-filtered if reduced dissolved solids content is needed. The solids suspension is then batch-transferred to the Slurry Receipt Tank (15-TK-510) where it is blended with incoming Silos Residue for recycle to

the melter. Filtrate either flows directly to treated waste lag storage tanks (TWST) (19-TK-008 & 009), or to the reverse osmosis concentrator (ROC) unit (19-RO-001).

The AWWT does not have limits for the primary soluble salts in the scrubber solution. Therefore, it is intended to purge these to the AWWT with the water from the TWSTs. These components include sodium sulfate, sodium sulfite, sodium carbonate, sodium chloride, and sodium phosphate.

Reverse Osmosis

A relatively low processing capacity of 40 lpm (10 gpm) has been allocated to the Silos Division Facilities. This must be shared between the vitrification facility and other Silos Division Facilities at the site. In order to reduce waste volume produced by the vitrification plant and improve confidence that operations will not be constrained by AWWT capacity, a wastewater concentrator is included in the full-scale design. This is an optional processing step that is only needed when and if waste discharges are constrained by AWWT capacity.

When wastewater concentration is to be performed, filtrate from the crossflow filter is directed to the ROU (19-RO-001). From the ROU feed tank (ROFT) (19-TK-006), the solution is pumped at relatively high pressure through the semi-permeable membranes. The membranes selectively allow water to pass through while restricting flow of the salts. The permeate is relatively pure water with salts concentration less than 1% of the feed concentration. The permeate flows to the Recycle Water Storage Tank (RWST) (19-TK-007). The residual feed solution (now more concentrated in dissolved salts) flows to one of the TWSTs (19-TK-008 & 009). If waste concentration is not being performed, the reverse osmosis unit is bypassed and the filtrate flows directly to one of the TWSTs.

Off-Spec Product Recycle

Any glass that does not meet the final wasteform criteria will be held until the end of the project. Off-spec subcontainers will be loaded into disposal packages and isolated from the acceptable packages.

At the end of the project, the off-spec product will be transferred to a Glass Container Opening Station (26-TA-105) where the subcontainers will be removed from the disposal package. The contents of the subcontainer will be emptied onto a size reduction table (26-CR-110). The subcontainer has an open top which will allow the glass to fall out upon inverting the subcontainer. An automated mechanical hammer will rap the box to break free any remaining glass. The glass will fall onto a heavy steel grate and be hammered through it. The hammering operation will be performed by a hammer attachment with a maximum 2m height working zone. The size-reduced glass will then pass into a

mill (26-MI-115) for final size reduction prior to transfer to a cullet recycle bin (26-B-125). The cullet will then be fed to the melter with additional glass-forming additives. The emptied subcontainers will be transferred to secondary waste treatment, compacted and disposal as LLW.

The waste loading of off-spec product in the final reprocessed glass is expected to be 90 to 95 wt% with the remainder being durability / glass additives. The processing of the off-spec product will result in an additional thirty-three (33) disposal packages. The processing time required is approximately 2 weeks.

Metal Drain Material Recycle

The material collected form the metal drain will be poured into subcontainers similar to the glass. The subcontainer will be indexed under the drain and then conveyed to a storage area in disposal packages. After treatment of the Silos waste, the metals drain material will be handled the same as the off-spec product. The resulting glass will have a low waste loading of metals drain material but will be able to be disposed at the NTS with the other glass.

Based on the total production of 26 MT of metals at a 15% waste loading in the glass, an additional forty-five (45) disposal packages will be required. This is in addition to the estimated 2733 required to treat the residue and off-spec product for a total of 2778 disposal packages. Three (3) weeks of melter operation is required to treat the metals drain material.

Salt Drain Material Recycle

The material collected form the salt drain will be poured into subcontainers. The subcontainer will be indexed under the drain and then conveyed to a storage area in disposal packages. After treatment of the silos waste, the salt drain material will be handled the same as the off-spec product. The small amount of salt drain material that could be generated will be recycled with the metals drain material as noted above.

6.5.4.6 Nuclearization Issues

Detailed design will be conducted in accordance with the key elements of ALARA philosophy, including

Reduction of time spent within radiological areas;

Reduction of the time spent within radiological areas is addressed through the general operating philosophy of the vitrification process. All operations will be conducted remotely through a central control station capable of monitoring and

controlling the melt process, batching operations, subcontainer handling sequences, and all routine activities associated with the vitrification process. Regular offgas system and secondary waste operations will be conducted automatically to the degree possible and justified.

Redundancy to minimize both process downtime and maintenance intervention will be based on formal RAMI analysis.

Reduction of the source(s) of radioactivity;

The processing objective is to maximize the waste loading in the glass wasteform. No separations are planned to reduce the radioactivity of the waste. Reduction of the sources of radioactivity will be carried out through planning of the process and maintenance activities to maximize recycle, and minimize secondary wastes that must be handled and treated by other processes. This includes recycle of solids generated from the offgas system, and recycle/reprocessing of any secondary process streams from the vitrification melter, including secondary phase lead/metals, salts, or off-spec product.

During maintenance activities, certain precautions may be required to minimize the source term prior to initiation of the work. This may include flushing of the melter to reduce the radionuclide inventory in the tank, removal of filled subcontainers from the pouring enclosure, or transfer/flushing of waste from a tank/pump/transfer pipe.

Shielding (both permanent and temporary) will be utilized based on the maintenance or access requirements as determined by RAMI analysis and subsequent dose calculations.

Increased distance from sources of radioactivity;

During operations, the control room and regularly occupied areas will be isolated by distance and shielding appropriate for the source term expected of the melter, waste slurry, feed, poured glass, and any other source terms associated with the product. Other design considerations will be applied to the melter and supporting system to maximize the distance required for maintenance, sampling, inspection or monitoring that requires personnel to be in the immediate area of a given source.

Provisions for containment of, and shielding from, sources of radioactivity;

By design, the melter is well-suited to radioactive applications. This is due to the shielding characteristics of the refractory lining (high chrome refractory, 3.2 g/cc at 25-50 cm thick), and the external skin of stainless steel (12-17 mm). This will

provide a significant attenuation over the life of the melter. Additional shielding or controls will be required for some maintenance activities.

Waste tank design will include shielding integral to the facility construction to permit maintenance of pumps, mixer drives, and monitoring. Additional shielding (temporary or permanent) will be considered in areas where frequent maintenance or intervention is expected.

Piping design will include consideration for other (non-piping) maintenance activities that will be impacted by the location and routing of the piping. Shielding will be required for piping that cannot be otherwise routed to a non-accessed/shielded area.

The pouring enclosure and other areas where molten glass will be present will be ventilated to capture any volatile radionuclides before they contribute to the contamination of the area. This includes general ventilation of the pouring enclosure, and localized ventilation around the pour stream and newly filled subcontainers.

Administrative controls will be required to minimize and/or avoid contamination to the extent possible, allowing maximum accessibility based on the primary source term (tank inventory, glass inventory, etc.) without secondary contribution of localized contamination.

Special steps will be required during detailed design to minimize the exposure time associated with regular maintenance activities. This includes the use of quick change devices and redundancy to the degree possible:

Minimized internal exposure through the use of confinement and ventilation;

Process and facility ventilation will be designed to capture radon, volatiles, and vapors that may be generated during waste handling, feed blending, melting and cooling processes.

As noted previously, all vessels containing the waste (as raw waste, feed, or contaminated cleaning/flush solutions) will be maintained under negative pressure and vented to the offgas treatment system. This includes all waste receipt, blend and feed tanks, the melter, and all tankage associated with decontamination wastes, offgas scrubbing, and other contaminated liquid wastes.

The melter will be the primary customer of the offgas treatment system, and will be serviced with redundant systems (main offgas and emergency offgas (EOG) system) to minimize the potential for contamination to the working area.

The pouring enclosure will be ventilated (general and localized) to the offgas treatment system to ensure control and treatment of radon and volatiles that may occur during the pouring and initial cooling stages.

Facility design (personnel access, process flow, etc.) will require cascaded ventilation design to ensure that potentially contaminated areas do not impact non-contaminated areas. Redundancy of the HVAC and controls must also be considered.

Reduction of the labor requirements for operations;

The melter will be operated remotely from a central control station. Instrumentation will provide the operator with the necessary monitoring capabilities to ensure safe and proper operation of the melter and supporting systems. This will be implemented using quick exchange capabilities on devices that are anticipated to require repair or replacement over the three-year treatment period. No remote maintenance is anticipated, though will be considered based on complete assessment the maintenance requirements as determined by a RAMI analysis, and determination of the expected dose related to those maintenance requirements.

Design considerations have been made to achieve ALARA principals for operation and maintenance of the melter and peripheral systems. This includes use of the following approaches:

- Instrumentation and process monitoring to avoid operator exposure;
- Video monitoring of melter, blending, melt process, secondary processes;
- Remote adjustments and controls (electrodes, drain control devices, subcontainer transfers and advancements, automated filter purge cycles, others);
- Quick change devices (video monitoring, temperature monitoring, pressure monitoring, level monitoring, others);
- Automated material handling (subcontainer exchange, movement, storage, transfer); and
- Semi-remote transfer of subcontainers to cooling area; loading of subcontainers into disposal package.

The radiological control design details associated with the waste handling, melter and product handling require formal analysis of the source terms (Microshield, other) and maintenance requirements as determined through a RAMI

assessment. The actual design considerations will include value analysis on a case-by-case basis to determine the level of automation or engineered facilities required for exchange, repair, or replacement of process equipment. The same considerations will be made for operator activities that involve exposure to or contact with the waste, waste product, or secondary wastes (e.g. sampling and analysis, equipment repair, etc.).

6.5.5 Monitoring and Control

Primary control of the vitrification process will be conducted from the main control room. The control system will consist of operator work stations/control interfaces for the individual systems such as the melter, batch facilities, slurry feeding, product pouring and offgas treatment.

Satellite local control stations will also be provided near the melter for startup, process development, and as a backup control system. The satellite local control stations will be interlocked to the main control so as to avoid conflicting control functions and commands.

The control system will also be equipped for data collection, general monitoring, and alarm condition monitoring.

To the extent possible, video or remote monitoring will be used for the primary processes in accordance with ALARA philosophies. Some hands-on monitoring functions (inspections, local preventative maintenance, testing) will be carried out based on allowable procedures.

6.5.5.1 Melter Control

The melter will be controlled via PLC with a workstation operator interface located in the control room. A secondary satellite local control station will be installed in the melter room, and will serve as a backup system for control interface, as well as for process development and troubleshooting. The satellite local control stations will access and control the same functions as the primary system, but will be locked out while not in use.

The following is a partial list of the control variables that will be adjusted from the control room:

- melter plenum pressure;
- feed rate;

- glass pour rate;
- glass temperature;
- power input;
- resistance heater output;
- electrode position; and
- feed nozzle position.

6.5.5.2 Feed System Control

Upon receipt of raw material into the bulk storage system, the computer control system will allow for automatic or operator control of the weighing and transfer functions for each individual raw material. Once batch recipes are developed and confirmed (see section 6.5.5.4), the operator can initiate automatic batch blending sequences where the computer will control all weighing, checking, and transfer functions.

The blending of the residue slurry and dry additives will also be managed by the control system. The waste will be pumped to the Blend Tank and weighed. Upon verification of the composition by chemical analysis, the glass additives will be blended. Once mixed, the blended melter feed will be transferred to the Melter Feed Tank. From the Melter Feed Tank, the feed will be presented to the melter at a rate specified by the operator through the operator interface in the control room.

The following is a partial list of the variables that will be checked:

- Waste and additive weights;
- Mixing speed and duration during holding and blending operations;
- Pump and valve functions;
- Melter feed viscosity;
- Melter feed temperature;
- Melter feed solids content; and
- Raw material addition rate to blending tank.

6.5.5.3 Offgas Treatment System Control

The offgas system is controlled through computer interface in the control room. The efficiency of the process will be controlled through instrumentation and continuous emission monitors (CEMs). Feedback from the instrumentation will dictate the need to adjust the process. The following key variables will be monitored:

- Melter pressure;
- Pre-filter differential pressure;
- HEMF differential pressure; and
- Scrubber pH.

The melter pressure will be controlled through the use of feedback loops to the variable speed drive of the offgas fans. As pressure increases, the fans will increase speed. As the pressure falls, the fans will slow down and draw less air through the system.

The high-temperature pre-filter differential pressure is monitored to prevent clogging. When the differential pressure across the filter is high, air pulses will knock the dust from the filter to clean it.

When the HEMF filters are at high differential pressure, the clean one is brought on line and the clogged filter is cleaned with a water or acid solution.

The scrubber pH is adjusted to insure good acid gas removal. When the pH is low, NaOH is added to the scrubber liquid to compensate.

6.5.5.4 Product Composition Control

Consistent production of a satisfactory wasteform will require process control techniques that verify the composition of the waste prior to committing it to the melter. This pre-process control approach is directly linked to the statistical understanding of the waste, and will be adjusted throughout the treatment program to optimize costs while assuring a satisfactory product.

The vitrification process will be based on establishment of a glass composition region that has been statistically validated to produce a satisfactory wasteform in terms of glass leaching, while also meeting the process requirements of the melter. This glass forming region will serve as the target for glass batch formulations developed from the waste compositions.

The process control technique is based on the composition and statistical variability of the waste which will change over the course of the treatment program. Upon initiation of the treatment process, the sampling and analysis strategy will require that all constituents impacting the glass performance/melter performance be characterized prior to being converted to feed. This characterization will be fed into the glass formulation model which will calculate the additive package required to get the glass matrix into the validated glass composition region. The waste analysis will also be fed into the statistical database that defines the waste itself. As additional information is generated on the waste variability, the analytical requirements will be reviewed for changes, depending on the amount of variation, and the impact of the variation on the glass formulation/performance.

In summary, the strategy requires:

a) Establishment of baseline statistical definition of waste (waste statistical database);

b) Establishment of baseline waste analysis requirements based on glass formulation requirements and waste statistical database;

c) Sampling and analysis of the waste as received and homogenized in the mix/holding tanks;

d) Entry of the analysis data into the glass formulation model;

e) Entry of the analysis into the waste statistical database;

f) Addition of glass forming additives in accordance with glass formulation model guidance;

g) Review of sampling and analytical requirements based on changes in waste composition statistics;

h) Periodic analysis of the glass samples and glass leaching characteristics; entry of data into glass formulation model; and

i) Revise glass formulation model as required based on glass composition/glass leaching data.

In addition to the chemical process control strategy described above, there will be other in-process control indicators integrated into the system. These devices will monitor the process to confirm that melter control parameters are maintained within the established limits. This includes more traditional indicators such as

glass and plenum temperature, glass level indicators, power/voltage/current inputs and ratios, and temperature profiles.

Finally, the performance of the pre-process and in-process control techniques will be verified through the testing and analysis of the final vitrified product. Periodic testing of the glass formulation and leaching behavior will be required for quality control purposes, and will provide data for updating and refining the glass formulation model.

This will be implemented beginning with the waste received in the facility. It will be thickened and transferred to a Blend Tank, where it will be sampled and analyzed within 24 hours. The results of the analysis will then be used to calculate a glass formulation based on the amount of certain waste constituents such as lead. The process engineer will evaluate the data generated from the analysis and use the batch calculation program included in the control system to determine the proper additives. The operator will then prompt the control system to add the appropriate amount of glass additives. This process is performed every other day as each of the Blend Tanks holds two (2) days' inventory and there are three (3) tanks. At any given time, one tank will be feeding the melter, one will be holding residue for analysis, and one will be either in the filling process or waiting to be fed to the melter.

The melting process control will be done using feedback loops (PIDs) that monitor the variation in a control-specific data point, then adjust the control function incrementally to bring the parameter back within its boundary limits. For example, melter temperature can be automatically controlled within a range through adjustments in the power applied. The plenum pressure can be automatically controlled by adjusting the speed of the offgas system blowers. Each of these loops is set up in the computer control system employing standard and proprietary PID loops. All out of boundary conditions will be alarmed through the operator interface in the control room, and will be logged in an alarm history file.

6.5.5.5 Radiation Exposure Estimates

Exposure is anticipated during visual inspections of the melter and supporting systems, sampling, and during maintenance. Waste and feed sampling will occur every two to three days, while glass sampling will occur daily. Inspections and sampling are estimated to require approximately one hour per day in the melter area at various distances from the melter and pouring enclosure. Frequency of inspections will vary with melter condition and operational state. More visual inspection and maintenance activities will occur during startup and at the end of the melter life compared with normal operations.

6.6 Equipment Data Sheets and Equipment List

The following table presents the equipment list for the full-scale treatment system. The equipment list includes each piece of equipment shown on the PFDs. Data sheets are provided for the major pieces of equipment in addition to the equipment list. The data sheets are provided in Section 23.

Table 6.6-1 Equipment List

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Silo (Lithium Carbonate)	44-B-122	FDFP-01	15 m (h) x 2.4 m	70m3
Transporter Inlet Valve	44-FE-401	FDFP-01	400 mm	n.a.
Manual Fill Dust Collector w/ Exhaust	44-BH-155	FDFP-01	1 x 1 x 1.9 m (h)	20 Nm3/min
Silo Discharge Rotary Vane Feeder	44-FE-133	FDFP-01	0.25 m dia. x 0.46 m long	0.08m3/m
Silo Discharge Rotary Vane Feeder	44-FE-103	FDFP-01	0.25 m dia. x 0.46 m long	0.08m3/m
Silo Discharge Rotary Vane Feeder	44-FE-113	FDFP-01	0.25 m dia. x 0.46 m long	0.08m3/m
Silo Discharge Rotary Vane Feeder	44-FE-123	FDFP-01	0.25 m dia. x 0.46 m long	0.08m3/m
Silo (Minor Additives)	44-B-142	FDFP-01	7.5 m (h) x 2.4 m	35m3
Silo Discharge Rotary Vane Feeder	44-FE-143	FDFP-01	0.25 m dia. x 0.46 m long	0.08m3/m
Silo (Calcium Carbonate)	44-B-132	FDFP-01	7.5 m (h) x 2.4 m	35m3
Silo Dust Collector	44-BH-101	FDFP-01	1 x 1 x 1.9 m (h)	20 Nm3/min
Silo Dust Collector	44-BH-121	FDFP-01	1 x 1 x 1.9 m (h)	20 Nm3/min
Silo Dust Collector	44-BH-111	FDFP-01	1 x 1 x 1.9 m (h)	20 Nm3/min
Manual Silo Fill Equipment	44-PN-150	FDFP-01	n.a.	n.a.
Silo Dust Collector	44-BH-131	FDFP-01	1 x 1 x 1.9 m (h)	20 Nm3/min
Silo (Sodium Carbonate)	44-B-112	FDFP-01	15 m (h) x 2.4 m	70m3
Silo (Aluminum Tri-Hydrate)	44-B-102	FDFP-01	15 m (h) x 2.4 m	70m3
Scale Inlet Transition	44-V-305	FDFP-01	2 m dia. x 2 m (h)	6.5m3
Silo Dust Collector	44-BH-141	FDFP-01	1 x 1 x 1.9 m (h)	20 Nm3/min
Scale Inlet Load Cell	44-WW-310	FDFP-01	.2 x .2 x .2m	3000 kg

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
2-way Diverter	44-FE-425	FDFP-02	1.4 x 0.6 x 0.6 m	n.a.
Bad Weighment Bin Dust Collector	44-BH-445	FDFP-02	1 x 1 x 1.9 m (h)	20 Nm3/min
Load Cell Package	44-WW-411	FDFP-02	.2 x .2 x .2m	3000 kg
Transporter Discharge Valve	44-FE-420	FDFP-02	100 mm Pinch Valve	n.a.
Bad Weighment Bin Discharge Valve	44-FE-450	FDFP-02	.25 x .5	n.a.
Bad Weighment Storage Bin	44-B-440	FDFP-02	2.4 m dia. X 6.1 m (h)	20 m3
Weighed Material Transporter	44-PN-410	FDFP-02	1.4 m d x 2.5 m h 1600 lb.	2 m3
Air Receiver for Transporter	44-V-405	FDFP-02	1.5m dia x 2.5M (h)	4 m3
Transporter Vent	44-FE-415	FDFP-02	100 mm	n.a.
Rotary Vane Feeder	15-FE-610	FDFP-03	0.25m dia x 0.46m	.08m3/m
Offgas Solids Unloading Glove Box	15-GB-605	FDFP-03	1.5m x 1.5m x 2m (h)	1 drum
Check Scale Bin	15-B-105	FDFP-03	2m dia x 2m (h)	6.5 m3
Offgas Solids Screw Feeder	15-CV-615	FDFP-03	0.25m dia x 3m (1)	0 – 1 m3/m
Dust Collector for Pneumatic Receiver	44-BH-505	FDFP-03	1 x 1 x 3 m (h)	20 Nm3/min
Offgas Solids Collection Bin	15-B-620	FDFP-03	1.5m dia x 2.5m (h)	4 m3
Dust Collector for 15-B-620	15-BH-625	FDFP-03	1 x 1 x 1.9m (h)	20 Nm3/min
Rotary Vane Feeder	15-FE-630	FDFP-03	0.25m dia x 0.46m	.08m3/m
Rotary Vane Feeder	44-FE-515	FDFP-03	0.3 x 0.3 x 1 m (h)	.08m3/m
Screw Feeder to Blend Tank	15-CV-145	FDFP-03	0.25 m dia. X 6 m (l)	0 – 1m3/m
Pneumatic Receiver Bin	44-B-510	FDFP-03	1.4m dia x 2.5m (h)	2 m3

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Rotary Vane Feeder	15-FE-140	FDFP-03	0.3 x 0.3 x 1 m (h)	1 m3/m
Dust Collector for Check Scale	15-BH-110	FDFP-03	1 x 1 x 1.2 m (h)	20 Nm3/min
Load Cell Pkg.	15-WW-115	FDFP-03	0.2 x 0.2 x 0.2 m	3,000 kg
Liquid Additives Unload Pump	45-P-105	FDFP-04	.5m x .5m x .5m	200 l/min
Liquid Additives Transfer Pump	45-P-140	FDFP-04	.5m x .5m x .5m	40 l/min
Liquid Additives Mixer	45-MX-125	FDFP-04	1m x 1m x 3m (h)	n.a.
Liquid Additives Mixer	45-MX-115	FDFP-04	1m x 1m x 3m (h)	n.a.
Liquid Additives Unload Pump	45-P-106	FDFP-04	.5m x .5m x .5m	200 l/min
Liquid Additives Tank	45-TK-120	FDFP-04	2.5m dia x 2.5m (h)	12 m3
Liquid Additives Tank	45-TK-110	FDFP-04	2.5m dia x 2.5m (h)	12 m3
Liquid Additives Transfer Pump	45-P-130	FDFP-04	.5m x .5m x .5m	40 l/min
Underflow Transfer Pump	15-P-536	FDFP-05	1m x 1.5m x 1m	100 l/m
Overflow Transfer Pump	15-P-580	FDFP-05	.5m x .5m x .5m	50 l/m
Residue Transfer Pump	15-P-521	FDFP-05	1m x 1.5m x 1m	100 l/m
Overflow Transfer Pump	15-P-565	FDFP-05	.5m x .5m x .5m	50 l/m
Thickener / Clarifier	15-TK-525	FDFP-05	5.15m dia x 3.45m (h)	70 m3
Thickener Overflow Tank	15-TK-570	FDFP-05	2.5m dia x 3m (h)	10 m3
Residue Receipt Tank	15-TK-510	FDFP-05	6m dia x 3.5m (h)	100 m3
Underflow Transfer Pump	15-P-535	FDFP-05	1m x 1.5m x 1m	100 l/m
Residue Transfer Pump	15-P-520	FDFP-05	1m x 1.5m x 1m	100 l/m

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Receipt Tank Mixer	15-MX-515	FDFP-05	1m x 1m x 4m (h)	n.a.
Pinch Valve Flow Control	45-FE-430	FDFP-06	0.3 x 0.3 x 1 m (h)	90 psi
Rotary Vane Feeder	15-FE-300A,B	FDFP-06	0.3 x 0.3 x 1 m (h)	0 – 1 me/m
Rotary Vane Feeder	15-FE-200A,B	FDFP-06	0.3 x 0.3 x 1 m (h)	0 – 1 m3/m
Rotary Vane Feeder	15-FE-400A,B	FDFP-06	.3 x .3 x 1m (h)	0 – 1 m3/m
Load Cell Package	15-WW-415	FDFP-06	n.a.	300 mt
Feed Tank Mixer	15-MX-605	FDFP-06	0.9 x 2.1 x 4.0 m (h)	n.a.
Load Cell Package	15-WW-215	FDFP-06	0.2 x 0.2 x 0.2 m (h)	300 MT
Hold & Blend Tank	15-TK-210	FDFP-06	4.75m dia. X 3.15m (h)	55 m3
Feed Transfer Pump (centrifugal)	15-P-225A/B	FDFP-06	1m x 1.5m x 1m (h)	250 l/min
Pinch Flow Control Valve	15-FE-220	FDFP-06	.3 x .3 x 1lm (h)	90 psi
Hold & Blend Tank Mixer	15-MX-205	FDFP-06	0.9 x 2.1 x 3.5 m (h)	n.a.
Feed Tank Load Cell	15-WW-615	FDFP-06	n.a.	450 MT
Hold & Blend Tank Mixer	15-MX-405	FDFP-06	0.9 x 2.1 x 3.5m (h)	n.a.
Hold & Blend Tank Mixer	15-MX-305	FDFP-06	0.9 x 2.1 x 3.5m (h)	n.a.
Pinch Flow Control Valve	15-FE-420	FDFP-06	.3 x .3 x 1m (h)	90 psi
Slurry Feed Tank	15-TK-610	FDFP-06	5.25m dia. X 3.5m (h)	75 m3
Pinch Flow Control Valve	15-FE-320	FDFP-06	.3 x .3 x 1m (h)	90 psi
Backup Recirculation Pump	15-P-620A	FDFP-06	1m x 1.5m x 1m (h)	400 l/min
Slurry Feed Recirculation Pump	15-P-620B	FDFP-06	1m x 1.5m x 1m (h)	400 l/min
Feed Transfer Pump	15-P-325A/B	FDFP-06	1m x 1.5m x 1m (h)	250 l/m

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Feed Transfer Pump	15-P-425A/B	FDFP-06	1m x 1.5m x 1m (h)	250 l/m
Hold & Blend Tank	15-TK-310	FDFP-06	4.75m dia x 3.15m (h)	55 m3
Load Cell Package	15-WW-315	FDFP-06	n.a.	300 MT
Hold & Blend Tank	15-TK-410	FDFP-06	4.75m dia x 3.15m (h)	55 m3
Pinch Valve Flow Control	45-FE-431	FDFP-06	.3 x .3 x 1m (h)	90 psi
Pinch Valve Flow Control	45-FE-432	FDFP-06	.3 x .3 x 1m (h)	90 psi
Vitrification Melter	17-M-101	FDFP-07	6.5m x 11.3m x 8.6m (h)	14.0 MTPD
Pouring Conveyor Station	23-TA-001	FDFP-07	See System 23 details	
Slurry Metering Pump	15-P-330 A,B	FDFP-07	2m (l) x .5m (w) x 1m (h)	20 l/min
Cullet Recycle Feed System	26-FE-135	FDFP-07	n.a.	n.a.
Slurry Feeder Nozzle Drive	15-FE-335 A,B	FDFP-07	2m x 2m x 3m	n.a.
Emergency Water Tank	18-TK-350	FDFP-08	n.a.	n.a.
Scrubber Blowdown Tank	18-TK-330	FDFP-08	n.a.	n.a.
Scrubber Water Pump	18-P-320	FDFP-08	n.a.	n.a.
Scrubber Heat Exchanger	18-E-310	FDFP-08	n.a.	n.a.
Scrubber	18-V-301	FDFP-08	3m x 1.6m x 6.1m (h)	1800 m3/hr
Emergency Water Pump	18-P-351	FDFP-08	n.a.	n.a.
Scrubber Blowdown Pump	18-P-331	FDFP-08	n.a.	1000 l/hr
Offgas Fan	18-BL-501	FDFP-08	n.a.	1000 m3/hr
First Stage HEPA Filter	18-FH-420A&B	FDFP-08	1.5 x 0.6 x 1.5m (h)	800 m3/hr
Electric Reheater	18-H-410	FDFP-08	n.a.	n.a.
NaOH Storage Tank	18-TK-340	FDFP-08	n.a.	n.a.

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
High Efficiency Metal Filter	18-F-202	FDFP-08	n.a.	1600 m3/hr
High Efficiency Metal Filter	18-F-201	FDFP-08	n.a.	1600 m3/hr
High Temperature Pre-filter	18-F-101	FDFP-08	1.5 x 0.6 x 1.5m (h)	3000 m3/hr
Rotary Feeder	18-FE-102	FDFP-08	n.a.	n.a.
Rotary Feeder	18-FE-103	FDFP-08	n.a.	n.a.
Screw Conveyor	18-CV-110	FDFP-08	n.a.	n.a.
Dust Loading Station	18-V-111	FDFP-08	n.a.	n.a.
NaOH Pump	18-P-341	FDFP-08	n.a.	n.a.
High Efficiency Metal Filter	18-F-221	FDFP-08	n.a.	n.a.
Cooler	18-E-401	FDFP-08	n.a.	n.a.
Offgas Decontamination Tank	18-TK-210	FDFP-08	n.a.	n.a.
HEMF Decon Solution Pump	18-P-211	FDFP-08	n.a.	10 l/m
Electric Reheater	18-H-640	FDFP-09	n.a.	n.a.
EOG Fan	18-BL-702	FDFP-09	n.a.	1000 m3/hr
EOG HEPA Filter	18-FH-650	FDFP-09	1.5 x 1.0 x 1.5m (h)	n.a.
Cooler	18-E-630	FDFP-09	n.a.	n.a.
EOG Quench Tank	18-TK-610	FDFP-09	n.a.	n.a.
EOG Quench Pump	18-P-612	FDFP-09	n.a.	n.a.
EOG Heat Exchanger	18-E-620	FDFP-09	n.a.	n.a.
Offgas Fan	18-BL-502	FDFP-09	n.a.	1000 m3/hr
EOG Fan	18-BL-701	FDFP-09	n.a.	1000 m3/hr
Screw Conveyor	26-CV-135	FDFP-10	.25m dia x 3m (l)	0 – 1 m3/m

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Rotary Valve Feeder	26-FE-130	FDFP-10	.3 m x 3m x 1m (h)	1 m3/m
Cullet Recycle Bin	26-B-115	FDFP-10	3m dia x 3m (h)	20 m3
Screw Conveyor	26-CV-110	FDFP-10	.25m dia x 8m (l)	0 – 1 m3/m
Glass Mill	26-MI-115	FDFP-10	n.a.	n.a.
Glass Size Reduction Crusher	26-CR-110	FDFP-10	n.a.	n.a.
Glass Subcontainer Opening Station	26-TA-105	FDFP-10	n.a.	n.a.
Waste Return Pump	19-P-001	FDFP-11	.5 x .5 x .5	230 L/min
Decon. Waste Transfer Pump	19-P-002	FDFP-11	.3 x .3 x .5m	60 L/min
Waste Accumulation Tank Agitator	19-AG-001	FDFP-11	n.a.	n.a.
Decontamination Waste Tank Agitator	19-AG-002	FDFP-11	n.a.	1 HP
Waste Accumulation and Return Tank	19-TK-001	FDFP-11	n.a.	11 m3
Decon. Waste Accumulation Tank	19-TK-002	FDFP-11	n.a.	2 m3
Recycle Water Transfer Pump	19-P-009	FDFP-12	.3 x .3 x .5m	40 L/min
Treated Waste Transfer Pump	19-P-010	FDFP-12	.3 x .3 x .5m	40 L/min
Treated Waste Transfer Pump	19-P-011	FDFP-12	.3 x .3 x .5m	40 L/min
Filter Feed Adjustment Tank Agitator	19-AG-002	FDFP-12	n.a.	n.a.
Filter Feed Adjustment Tank Agitator	19-AG-003	FDFP-12	n.a.	n.a.

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Scrubber Waste Reverse Osmosis	19-RO-001	FDFP-12	6 m x 2.1 m x 1.8 m (h)	700 L/hour
Recycle Water Transfer Pump	19-P-008	FDFP-12	.3 x .3 x .5m	40 L/min
Filter Feed Adjustment Tank (FFAT)	19-TK-003	FDFP-12	n.a.	20 m3
Treated Waste Storage Tank (TWST)	19-TK-009	FDFP-12	6m dia x 3.6m	110 m3
Scrubber Waste Filter Unit	19-F-001	FDFP-12	2.5m x 3.7m x 1.8m (h)	1750 L/hour
Reverse Osmosis Feed Pump	19-P-007	FDFP-12	.3 x .3 x .5m	30 L/min
Feed Tank Cleanout Pump	19-P-006	FDFP-12	.3 x .3 x .5m	40 L/min
Filter Feed Pump	19-P-005	FDFP-12	.5 x .5 x .5	800 L/min
Filter Feed Transfer Pump	19-P-003	FDFP-12	.3 x .3 x .5	40 L/min
Treated Waste Storage Tank (TWST)	19-TK-008	FDFP-12	6m dia x 3.6m	110 m3
Recycle Water Storage Tank (RWST)	19-TK-007	FDFP-12	n.a.	20 m3
Reverse Osmosis Feed Tank (ROFT)	19-TK-006	FDFP-12	n.a.	2 m3
Filter Feed Tank (FFT)	19-TK-005	FDFP-12	n.a.	2.4 m3
Filter Feed Adjustment Tank (FFAT)	19-TK-004	FDFP-12	n.a.	20 m3
Filter Feed Transfer Pump	19-P-004	FDFP-12	.3 x .3 x .5	40 L/min
Low Pressure Nitrogen Tank	17-TK-235	FDFP-13	3m dia x 10m (l)	70 m3
Water Chiller Package (Cooling Tower)	17-CT-220	FDFP-13		2000 lpm
Air Filter System	17-AF-215	FDFP-13	n.a.	1200 Nm3/hr

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Receiver	17-PV-210	FDFP-13	3m dia x 10m (l)	70 m3
Air Compressor	17-CA-205	FDFP-13	n.a.	1200 Nm3/hr
Forklift	23-FK-110	FDFG-06	n.a.	8 MT
Subcontainer Conveyor	23-CV-120	FDFG-06	n.a.	300 kg
Pouring Enclosure Airlock	23-EC-130	FDFG-06	2m x 2m x 2m (h)	n.a.
Trap Door	23-TP-140	FDFG-06	1m x 1m	n.a.
Airlock Monorail Crane	23-CN-150	FDFG-06	n.a.	20 kN
Pouring Tunnel Enclosure	23-EC-160	FDFG-06	2m x 9.5m x 2m (h)	n.a.
Pouring Conveyor	23-CV-180	FDFG-06	9.5 m long	n.a.
Pouring Enclosure	23-EC-190	FDFG-06	1m long	n.a.
Cooling Tunnel Airlock	23-EC-200	FDFG-06	2m x 2m x 2m (h)	n.a.
Airlock Monorail Crane	23-CN-210	FDFG-06	n.a.	20 kN
Trap Door	23-TP-215	FDFG-06	1m x 1m	n.a.
Cooling Conveyor	23-CV-220	FDFG-06	4.5m long	n.a.
Cooling Tunnel Enclosure	23-EC-230	FDFG-06	2m x 4.5m x 2m (h)	n.a.
Trap Door	23-TP-235	FDFG-06	1m x 1m	n.a.
Cooling Jacket	23-CS-250	FDFG-06	0.75m x 0.5m x 1m (h)	n.a.
Full Subcontainer Handling Crane	23-CN-240	FDFG-06	SPAN = 4m	20 kN
Handling Crane	24-CN-110	FDFG-06	SPAN = 6m	100 kN
Disposal Package Transfer Trolley	24-TT-120	FDFG-06	n.a.	8 MT
Disposal Package Lid Lifting Device	24-CN-130	FDFG-06	n.a.	10 kN

Table 6.6-1 Equipment List (continued)

EQUIPMENT NAME	ID #	Drawing	SIZE	CAPACITY
Package Loading Hatch	24-TP-140	FDFG-06	n.a.	

6.7 Process Issues

The vitrification process is based on commercial glass melting technology and equipment. The hazards associated with the technology are not new. The reliability or robustness of commercial melter technology has been enhanced for nuclear waste treatment by certain features incorporated into the WASTE-VIT® system.

6.7.1 Safety

The safety issues inherent to a Joule-heated vitrification system revolve mainly around temperature and electrical hazards. The following sections provide melter specific safety risks and mitigating actions as identified in the POPT demonstration safety review done at CETL, the Envitco POPT Proposal, and in the Comparative Low-Level Waste Melter Safety and Environmental Evaluation report written by Westinghouse Hanford Company (Colby 1995).

6.7.1.1 Electrical Shock

The power supply for the vitrification system normally operates at 50 to 200 volts which poses a potential shock hazard. Electrically-live components are isolated as best possible. Double isolation from ground is also provided to prevent a short circuit. Personnel guards are always provided for electrically-live components. Standard operating procedures are also implemented to help mitigate the risk. For example, the power should be locked-out when working directly with the electrodes. PPE, such as non-conductive gloves, are also required.

6.7.1.2 Thermal Exposure

The melter operates at high temperature. Glass is normally poured at 1000 to 1300°C. Working in the area near the melter requires protection from the heat. A water-cooled shell to prevent burns surrounds the glass contact area of the melter. The glass-filled subcontainers prior to cooling and parts of the offgas

treatment system are also at high temperatures. Therefore, most of the normal operating procedures are conducted remotely to prevent the need for manual intervention. Remote operations minimize personnel contact with the high temperature processes.

Extreme low-temperature exposure can also occur when using liquid nitrogen. Nitrogen is used to protect some of the melter parts. Storage of bulk nitrogen is normally done in the liquid form at low temperature. Standard handling and storage procedures, along with proper PPE, should be used to protect against liquid nitrogen exposure.

6.7.1.3 UV Radiation

Molten glass emits UV radiation that can damage the human eye. Remote operations and high-temperature cameras limit exposure. Special UV filtering glass is used for manual inspection of the glass pool.

6.7.1.4 Glass Leak

If glass leaked from the melter, personnel and equipment could be exposed to high temperatures. The melter is designed with water-cooled panels covering the glass contact areas. If glass should penetrate the refractory, the water-cooled shell will freeze the glass before it leaks from the melter. Since the cooling water is a critical component to melter safety, a back-up water pump and a city water or fire water backup to the cooling water supply are considered in the design. As a secondary precaution, the area below the melter is lined with refractory to create a spill sump. The glass would be contained within the sump and prevent damage to equipment and personnel exposure.

6.7.1.5 Mechanical Hazards

No special mechanical hazards are associated with vitrification systems. Standard hazards include pinch points or getting caught by a rotating piece of equipment. These hazards will be present with the slurry mixers, pumps, and the subcontainer conveying equipment.

6.7.1.6 High Pressure Exposure

The vitrification facility will contain a number of streams at high pressure. These include compressed air, possible nitrogen storage tanks, and the slurry feed system. The main concern to personnel safety is harm due to material being propelled from a leak and possible exposure to the radioactive slurry. Standard

procedures exist to handle the compressed gases. Special precautions and design controls will be implemented to prevent and detect slurry leaks. This would be addressed in the detailed design of the facility.

6.7.1.7 Inhalation Exposure

Control of radon is an overall concern in the full-scale facility. Therefore, as was mentioned in the design basis, vessels that are in contact with untreated residue or molten glass are kept under negative pressure and vented to the RCS.

A major issue identified in the WHC report on melter safety was the use of water-cooled devices in and around the melter. A water leak could result in excessive steam evolution, which could cause an overpressure event in the melter. Positive pressure in the melter offgas system could cause gasses to be released and expose personnel to hazardous and radioactive gasses. In order to enhance the safety of the offgas control system, seal pots and conservative engineering of the offgas system to handle positive pressure events should be considered in the detailed design.

Inhalation of the dry glass additives could be hazardous. The operation of the glass additive system is done remotely to prevent personnel exposure. The vessels that contain non-contaminated materials also have dust collectors to remove the majority of dust when transferring glass additives.

6.7.1.8 Radiation Exposure (ALARA Principles)

The vitrification system employs a number of features to keep radiation exposure to ALARA levels. The main feature to mitigate this hazard is remote operation under normal conditions. Exposure during off-normal events or normal hands-on maintenance will employ temporary shielding when possible. Quick connect couplings, standardization of tooling, and remote monitoring also contribute to reducing radiation exposure. Operating the slurry tanks and the melter at negative pressure also mitigates the risk of personnel exposure to gaseous (Radon) or volatile radioactive species.

6.7.1.9 High Pressure Excursions

High pressure excursions, including steam explosions, are not generally associated with glass melting processes due to the high viscosity of the molten glass (above 10 poise), and the lower heat transfer characteristics of the glass. Events of this type are more typical of molten metals or molten salts where the

viscosity is very low (4-5 centipoise) and the heat transfer rate is very high (Marra 1994).

The conditions for pressure excursions associated with steam explosions may exist during processing of the Fernald Silo waste due to the potential for accumulations of molten salts. Accumulated salt layers on top of the melter can provide the energy transfer to form a steam explosion if direct mixing can occur between the salt layer and a water/liquid stream.

With the amount of salt being processed, some accumulation of salt is anticipated, as was observed during the POPT demonstration. The salts were typically mixed with the unmelted feed that covered the melt surface and, as such, were not free-flowing. Feed presented to the melter tended to accumulate and not readily intermix with free salts. This does not avoid the fact that water and salt may be required to coexist in the melter.

To minimize the potential for steam explosions and minimize the secondary effects, certain design and process controls will be required in the full-scale production facility. This will include rheology controls on the feed to inhibit free mixing of the water with the salt, and administrative/operations controls when a free salt layer is present on the melt surface. Precautions will need to be taken to avoid presenting water to the melter when a molten salt layer exists.

Other design considerations include the offgas system, which is designed to accommodate pressure excursions that result in glass flow rates in excess of the design capacity of the main offgas train. This will be done through connection of the primary offgas train with the EOG. The EOG will be in operating standby at all times to accept offgases from overpressurization. The EOG will be connected to the primary offgas system at the quench reservoir. In the event of an overpressure event, the gases will overcome the seal pot isolation and will enter the EOG. In operation, the EOG will be running with an existing negative draft, with independent isolation from the main offgas and melter by the seal pot and an isolation valve. The detailed design of the EOG will consider the capacity requirements of a steam explosion and the required automatic, fail-safe valving and interfaces.

6.7.2 *Reliability*

The reliability of the vitrification system is related to the robustness of the process including the ability to handle variations in process conditions, redundancy, and easily replaceable parts. The following sections describe features of the WASTE-VIT® melter that enhance the reliability of the melter.

6.7.2.1 Glass Drain

The control and operation of the glass drain were proven in the demonstration. In order to make the full-scale melter more reliable, dual drain orifices are included in the glass drain bay. Since the life of the orifice is anticipated to be shorter than the thirty-six month campaign, a back-up orifice could be started if the first fails. Also, the glass drain bay can be replaced while the melter is at operating temperature. This will increase the reliability of the system because a complete shutdown and restart will not be required.

6.7.2.2 Metals Drain

Reduced metallic species can form in the melter due to interaction with the electrodes or shifts in the redox potential of the glass. Metallic species that collect in the bottom of the melter can contribute to short circuiting and refractory damage.

Process control is fundamental to the control of metallic species as oxides in the glass. Characterization of the waste redox and control of the amount of reductant added to the melter feed are the primary methods of preventing the glass from becoming too reducing. In the event of process upsets that result in precipitation, the melter is designed with a metal-resistant refractory sump and a metals drain for removal of the material. This approach is based on commercial experience in the lead glass industry.

Adjustable electrodes in the full-scale melter are also used to mitigate short-circuiting. The electrodes can be adjusted to minimize the influence of metallic species in the bottom of the melter. This is not possible with fixed electrode systems. Power-conditioning methodologies from the commercial glass industry mitigate the interaction of lead with the molybdenum electrodes, which will reduce the amount of lead precipitation.

All of the above features increase the reliability of the melter by mitigating a potential shutdown condition.

6.7.2.3 Salt Drain

The salt drain will not be required during normal operation because the sulfur compounds will either be solubilized into the glass or volatilized into the offgas. However, if upset conditions occur such as a temperature excursion or spike in the salt content of the feed, the salt drain is available to permit draining the salt and continue normal operations. Alternatively, the salt can be evaporated from the melt surface which would delay re-establishment of normal operations. The

availability of the drain increases the reliability of the melter as it removes corrosive salt buildups and helps to prevent short circuits through the highly conductive salt layer.

6.7.2.4 Melter Wear-Reducing Features

The highest wear areas of the melter include the electrodes and refractory. These components of the melter are protected by design mechanisms to increase the reliability of the melter.

The electrodes are protected from interaction with lead by power conditioning used in commercial lead glass melters. Lower current density in the full-scale melter, as compared to the demonstration melter, will also be employed to reduce overall electrode wear (Tooley 1984).

Refractory wear is minimized by: 1) using chrome-bearing refractory which is more resistant to glass dissolution than other refractories, and 2) encasing the refractory in a water-cooled shell. Refractory wear increases logarithmically as temperature increases (Tooley1984). Commercial glass experience shows that the wear rate will decrease as the refractory wears. This is due to the mean temperature of the refractory being lower (hence, lower wear) nearer to the water-cooled shell. As the refractory becomes thinner, heat transfer to the water-cooled shell is increased resulting in a lower glass-refractory interface temperature. The water-cooled shell then acts to reduce the refractory wear and provide assurance that refractory wear does not result in a glass leak.

Significant improvements in safety, electrode wear and refractory wear can be realized by using vertical, top-entry electrodes. These electrodes would enter the furnace through the superstructure and replace side-entry electrodes. The following are the technical advantages of including top-entry electrodes:

- Vertical electrodes improve current density distribution and, hence, wear by using more of the length of the electrode to conduct current than side-entry electrodes primarily using the horizontally-opposed electrode tips.

- Vertical-entry electrodes are positioned further from the refractory walls so that convective currents caused by the electrodes result in lower wear. Commercial experience shows that side-entry electrodes cause more damage to the sidewall refractories.

- Top-entry vertical electrodes eliminate wall penetrations below the glass. This increases the safety against glass leaks from any side-wall or bottom penetrations. Top-entry electrodes also allow for the replacement of electrodes and holders while the melter is at temperature should one fail.

Bottom-entry electrodes are replaceable, though the process is difficult and increases the risk of injury to personnel during replacement.

The following bullets provide the experience base with vertical and top-entry electrodes:

- Envitco, through its affiliated companies, has over 35 years of experience and over 1000 installations with advanceable, vertical electrodes.
- Top-entry electrodes have been used commercially in glass manufacturing for approximately ten (10) years and are currently in use in a number of applications in the United States and many others in Europe. (Due to the desire of our commercial customers to maintain confidentiality, we are unable to site specific examples.)

6.7.2.5 Waste Variability

The Silos Residue is expected to be a non-uniform stream entering the vitrification facility. The as-received composition is expected to vary depending on the method of waste retrieval and the location of the waste in the silo or storage tank.

Process control through sampling and analysis of the waste will mitigate the risk of processing an out-of spec batch of material. This strategy includes determination of acceptable glass forming composition ranges, large scale blending, qualification of the waste, and feedback of treated waste performance and characteristics. Having the ability to vary each glass additive independently also contributes to the ability to process a varying waste stream. The melter system is also equipped with the features, as previously mentioned, to mitigate upset conditions or spikes in waste constituents such as salts and metals.

6.7.3 Waste Minimization Summary

One of the goals of the full-scale design is to minimize waste generated from the processing of the Silos Residue. The process technologies chosen to treat the Silos Residue minimizes the waste through volume reduction and internal waste stream recycle.

The primary waste stream from the facility is the treated Silos Residue. Vitrification is an excellent technology for volume reduction of soils and sludges. The resulting glass wasteform is more dense than the in-situ waste which leads to a volume reduction. The calculated bulking factor of 43.7% means that for one (1) cubic meter of in-situ waste, only 0.437 cubic meters of glass is produced.

This is a volume reduction of 56.3%. Efforts were also made during the POPT demonstration to maximize the waste loading of the Silos Residue so that the least amount of glass would be produced per unit of waste. Also, the solubility of salt in the glass was maximized in order to eliminate a separate secondary waste salt stream.

Dry solid waste will also undergo volume reduction. PPE and other compressible waste can be compacted into smaller volumes and stored in drums. This will minimize the volume produced during operation of the facility. Empty subcontainers from the recycle of off-spec product, metals material, and any salt material will be compacted.

A number of waste streams are recycled within the facility for treatment in the vitrification system. Water from the slurry-thickening system and facility wastewater are recycled for use in transfer of the Silos Residue to the facility. Water can also be recycled from the offgas scrubber waste stream after passing through a reverse osmosis unit. Solids collected in the offgas high-temperature filter and the insoluble solids from the scrubber water are recycled to the melter feed system and eventually vitrified. The metal drain material can be recycled with the off-spec product at the end of the project.

6.7.4 Treatment Recipe Impacts

The laboratory studies conducted as part of the POPT concluded that the demonstration surrogate recipe could be used for the S1 and S2 recipes. The key factor is that the waste loading would not change. This means that the full-scale design would not need to change in order to process the S1 and S2 waste to meet 50% of the TCLP leachate values.

The laboratory results indicate that the waste loading must be reduced to meet the UTS limits. It is estimated that a recipe with 55% waste loading on a dry basis could be achieved. This primarily has an impact on the vitrification process equipment. The slurry preparation equipment and the offgas treatment system will change slightly to accommodate a small change in the amount of water released from the melter during normal operation.

The size of the melter would increase to accommodate production of approximately 21 MTPD of glass compared to the 14 MTPD based on 83% waste loading. The total glass produced would increase from an estimated 10,800 MT (approximately 2700 disposal packages) to 16,400 MT (approximately 4100 disposal packages).

The physical size of the melter would increase by approximately 2 meters in overall length and width, plus 1 meter in height. The facility would have to be

modified to accommodate the larger melter. Additional services would be required to support the increased power and cooling water requirements.

7.0 CONCLUSIONS

Envitco successfully completed the Proof-of-Principle Test as defined in Contract 98WO002240 between Envitco and Fluor Daniel Fernald. Treatment recipes were developed, a continuous demonstration was performed, and a conceptual full-scale design was developed.

7.1 Results Summary

The following are results from the POPT that support the conclusions drawn in Section 7.2:

1. Waste loadings of 83% and 50% were achieved for 50% of TCLP and the UTS limits respectively for S1, S2 and S0 surrogates. NOTE: Higher waste loadings for both the TCLP and UTS limit glasses may be possible based on durability enhancement experiments cut short due to POPT schedule constraints. Use of the full TCLP limits as required by NTS WAC offer additional opportunity for waste loading improving.

2. All treatment recipes passed the Contract Wasteform Performance Requirements as shown in Section 4 of the report.

3. Treatment Recipe S0-D5B-2 was chosen for use in the demonstration based on consideration of the following as discussed in Section 4 of the report :

   - Below Contract-required 50% of TCLP limit (~2.0 vs 2.5 ppm limit);
   - Minimize residual salts through sulfate destruction and maximize solubility (reductant addition assisted in sulfate destruction and solubility enhancement was proven successful)
   - Acceptable redox based on reductant (sugar) additions (0.1 wt% carbon as sugar was determined for use in the demonstration based on a target redox ratio of 0.15 – 0.2 $Fe^{+2}/\Sigma Fe$); and
   - Homogeneous glass free of phase separation and unmelted batch

4. The 72-hour continuous test was performed between January 18 and January 21, 1999. Four (4) minutes of unplanned downtime was experienced.

5. 7800 kg of demonstration surrogate were treated between January 15 and January 23, 1999. A total of approximately one (1) hour of downtime was recorded during the eight (8) day processing period.

6. The process was very stable during the demonstration as noted in the data charts included in Section 5.4 of this Report. This is indicative of steady-state and stable process control with minimal operator intervention.

7. Demonstration glass sulfate solubility was increased to 1.2 wt%, (almost twice the standard glass industry solubility) as a result of the treatment recipe development.

8. Excess salt was evaporated into the offgas with assistance from reductant additions as proven in the treatment recipe development program.

9. Secondary waste was minimized by not draining any molten salt. Only 0.1 wt% of the melter feed was entrained into the offgas during the 72-hour test, minimizing offgas solids generation. The offgas solids were characteristically hazardous based on TCLP results.

10. The capability to drain salts from the melter was successfully demonstrated following conclusion of the 72-hour demonstration, proving its benefit as a reduntant method of salt control.

11. The redox of the glass was maintained at 0.15 $Fe^{+2}/\Sigma Fe$ for the entire demonstration. Redox control was an important objective that minimized metallic species precipitation due to redox reactions while allowing the use of reductant to assist in destroying molten sulfate salts.

12. Minimal metallic phase precipitation did occur (15 – 20 kg/33 – 44 lbs.), due to two possible sources: 1) a spike in the lead input during the post demonstration cleanup, and 2) lead – molybdenum reduction reactions between the waste and the electrodes.

13. The presence of lead confirms the necessity of a metals drain and/or other means of mitigating metals precipitation. Improvement in the heat distribution in the metals drain will be required, and is not considered a significant technical issued based on successful operation of the glass drain system.

14. Glass produced during the demonstration passed the Contract Wasteform Performance Requirements.

15. Demonstration glass leaching durability averaged 25% better than the Contract Requirement and 60% better than the current TCLP limits for lead.

16. The Bulking Factor for the demonstration run was 43%.

17. 98.6% of the surrogate fed to the melter was maintained in the glass.

18. Lead volatility was limited to 0.0002 wt% of the feed input.

19. Evaluation of the offgas solids and Method 29 results confirm the use of high temperature filtration in the full-scale design instead of an ESP. High temperature filtration will allow recycle of the offgas solids without return of the high sulfur species. Sulfur (as volatile SOx) passes through the filter and is captured in the wet scrubbing process. Blowdown from the scrubber is sent to AWWT after pre-treatment.

20. Minimal refractory wear was experienced (~0.05 mm/~0.002" per day).

21. Molybdenum electrode wear was acceptable during the demonstration. Additional investigation is required with respect to the reaction zone near the melt surface.

22. A conceptual full-scale design was developed based on the demonstration results. The following are key full-scale design attributes:

    - Offgas solids, wastewater, off-spec product, salts and metals will be recycled to the vitrication process;
    - All Silo waste and recycled materials will be processed by vitrification. Offgas scrubber water will be sent to AWWT, offgas routed to the RCS, and a small amount of secondary solid waste (spent equipment, PPE, etc.) will be macroencapsulated;
    - 2800 final disposal packages will be produced, including recycled secondary waste and off-spec product recycle; and
    - The vitrification facility will be capable of meeting the RCS inlet flow restriction of 500 scfm and the AWWT inlet restriction of 10 gpm.

7.2 Joule-heated Vitrification POPT Conclusions

Based on the results of the POPT, conclusions can be drawn regarding Joule-heated vitrification of Silos Residue. These conclusions are as follows:

- Joule-heated vitrification is an acceptable, proven and commercially-available technology for treatment of Silos Residue;
- Waste loading to meet 50% of TCLP leachate limits can be increased beyond 83 wt% based on durability enhancement work performed on the UTS recipes after the demonstration;

- Waste loading is reduced from 83% to 50% in order to meet the UTS leaching criteria. NOTE: Higher waste loadings for both the TCLP and UTS limit glasses may be possible based on durability enhancement experiments cut short due to POPT schedule constraints.

- A Joule-heated melter with molybdenum electrodes will be able to process the Silos Residue without imminent failure or excessive electrode consumption;

- Treatment of the Silos Residue can be accomplished without creating a secondary salt stream through maximizing salt solubility in the glass combined with evaporation of the salt into the offgas stream; and

- Recycle of most secondary waste to the vitrification system can be accomplished, based on demonstration that most sulfur passed through filtration and partitioned from the entrained non-volatile oxide fraction of the offgas.

8.0 REFERENCES

Bechtel Jacobs, Demonstration Project Report For The Transportable Vitrification System At The Oak Ridge East Tennessee Technology Park, Report No. K/WM-186, May, 1998, Jantzen, C.M., Picket, J.B., And Richards, R.S., Vitrification Of Simulated Fernald K65 Silo Waste At Low Temperature, Wsrc-Ms-97-00854, Rev 1, Presented At The 100th American Ceramic Society Annual Meeting In Cincinnati, Oh, May 3-6, 1998.

Bennert, D.. POPT Weekly Report – Week 18 (Contract No. 98WO002240), FDF Submittal No. 40720-2240-C5-001, October 5, 1998.

Bennert, D.. POPT Weekly Report – Week 44 (Contract No. 98WO002240), FDF Submittal No. 40720-2240-C5-001, April 5, 1999)

Bowan, B. W. and Brandys, M. M.. "Development of a Vitrification Process to Solidify Savannah River M Area Waste". *Environmental Issues and Waste Management Technologies in the Ceramic and Nuclear Industries*, 61, pp. 213 - (1995)

Brewer, L., (editor), "Molybdenum: Physico-Chemical Properties of its Compounds and Alloys", Special Issue No. 7; pg. 295; IAEA, Vienna, 1980

Colby, J. M. and Leach, C. E.. *Comparative Low-Level Waste Melter Safety and Environmental Evaluation.* USDOE Report WHC-SD-WM-ES-350, Rev. 0, Westinghouse Hanford Company, Richland, WA 99352 (1995).

Faught, R.F., Barr, R.Q., and Gilbert, R.W. Jr., "Electrodes: Facts & Figures to Know", *Ceramic Age*, February, 1972.

Feng, X., Hrma, P.R., et. al.; PNNL Report to WHC DOE PNNL-10918; Glass Optimization for Vitrification of Hanford Site Low Level Tank Wastes, March 1996

Fluor Daniel Fernald, Silos 1 & 2 Feasibility Study Basis for Design. Report 40430-RP-0001, Draft Revision D, January, 1999.

Fu, S. S., Matlack, K. S., Mohr, R. K., Paul, C. M., Pegg, I. L. and Macedo, P. B.. *Vitrification Testing for Fernald CRU4 Silo Wastes,* submitted to Fernald Environmental Restoration Management Company, (1996).

Hrma, P.R., et.al.; PNNL Report to WHC DOE PNNL-10359;"Properties / Compositional Studies for Hanford High Level Glasses Melting at 1100 C"; December, 1994

Jantzen, C. et.al WRSC DOE Report WRSC-TK-92-214; "Solidification of CIF Waste in Soda-Lime Glass;.; August, 1998

Kirk & Othmer, "Selenium," in Encyclopedia of Chemical Technology, Volume 21, page 693.

Marra, J. C., Andrews, M. K., Schumacher, R. F., Vitrification in the Presence of Molten Sales, Proceedings of the Environmental and Waste Management Issues in the Ceramic Industry II, Ceramic Transactions Vlume 45, 96th Annual Meeting of the American Ceramic Society, April 25-27, 1994, page 401.

Morse, M., "Plasticity Graph Developed by FDF", facsimile correspondence, September 28, 1998.

Perez, J. M., Whitney, L. D., Buchmiller, W. C., Daume, T. J. and Whyatt, G. A., *HWVP Pilot-Scale Vitrification System Campaign – LFCM-8 Summary Report, Rev. 0.* Pacific Northwest Laboratory Report PHTD-K963, prepared for the USDOE Contract DE-AC06-76RLO 1830 (1994).

Scholes S.R., and Greene, C.H., "Modern Glass Practice – Seventh Revised Version", Cahners Books, 1975

Tooley, F. V., *The Handbook of Glass Manufacture.* 3rd ed., vol. 1, Ashlee Publishing Co., Inc. (1984)

U.S. Department of Energy, Vitrification Pilot Plant Melter Incident Final Report, Report No. 40100-RP-00049, February, 1997.

Vogel, W., "Chemistry of Glass; American Ceramic Society; 1985; Chapters 4 and 7

Volf, M.B., "Chemical Approach to Glass, Glass Science and Technology 7, Elsevier Publishers, 1984, Part II.A.7

Weyl, W.A., "Coloured Glasses:; Society of Glass Technology; Sheffield, 1951

Wilson, C.N., WHC Interoffice Memo; "Impact of C-103 Separable Organic on HLW and LLW Vitrification,"; December 22, 1995

WSRC DOE Report WSRC-MS-97-00854; Vitrification of Simulated Fernald K65 Silo Waste at Low Temperatures"; C.Jantzen, J. Pickett, R. Richards; presented at American Ceramic Society Annual Meeting, May, 1998

CONTENTS

2291

Introduction 1

Experimental Work 2

Discussion of Results and Conclusions 3

Equipment Specifications and Information 4

Process and Customer Information 5

Characteristics of the Source Emissions 6

Emissions Data and Experimental Conditions 7

Appendix 1 – Test Data Sheets 8

Appendix 2 – Field Voltages and Currents 9

Appendix 3 – EP Operating Data 10

Appendix 4 – Operating Notes 11

Appendix 5 – Summary Graphs 242 12

OneStep® INDEX SYSTEM

2291

REPORT ON THE McGILL AIRCLEAN CORPORATION

PILOT ELECTROSTATIC PRECIPITATOR PROJECT

FOR ENVITCO, INCORPORATED

at

CLEMSON ENVIRONMENTAL TESTING LABORATORIES

IN THE CLEMSON RESEARCH PARK

CLEMSON, SOUTH CAROLINA

Envitco, Inc., Project No. 98703
Envitco, Inc., Purchase Order No. 36011
Trigon Engineering Consultants, Inc., Project No. 046-98-158
McGill AirClean Corporation, Project No. D-5704-9

Prepared by: David T. Poole
Project Administrator

Approved by: Tom Maurer
Applications Engineer,
Product Development

McGill AirClean Corporation
1777 Refugee Road
Columbus, Ohio 43207

NOVEMBER 1998 - JANUARY 1999

243

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
STATEMENT OF PROPRIETARY RIGHTS iii
TEST RESULTS SUMMARY iv

I. INTRODUCTION
- 1.1 Background 1
- 1.2 Purpose 2
- 1.2 Objectives 2

II. EXPERIMENTAL WORK
- 2.1 Discussion of Objectives 3
- 2.2 System Description and Operation 4
- 2.3 Testing Methods 10

III. DISCUSSION OF RESULTS AND CONCLUSIONS
- 3.1 Melter Emissions and EP Performance 13
- 3.2 Long Term Operation 17
- 3.3 Conclusions and Recommendations 18

IV. EXHIBIT 1 - EQUIPMENT SPECIFICATIONS AND INFORMATION
- 1a. - Drawing of Mobile EP
- 1b. - Drawing of Electrode Plates
- 1c. - EP Specifications
- 1d. - Drawing of EP Inlet Duct
- 1e. - Fan Curve and Balancing Report
- 1f. - Rapping Set-up
- 1g. - Spare Parts List
- 1h. - Calibration Data

V. EXHIBIT 2 - PROCESS AND CUSTOMER INFORMATION
- 2a. - CETL Brochure and Map
- 2b. - Operators Log Sheets
- 2c. - Graph of Propane Flow VS. Differential Pressure
- 2d. - Graph of Burner Airflow VS. Pressure
- 2e. - Melter Exhaust Duct Drawings

VI. EXHIBIT 3 - CHARACTERISTICS OF THE SOURCE EMISSIONS
- 3a. - Electrical Resistivity Analysis (of the collected particulate matter)
- 3b. - Aerodynamic Particle Size Analysis (of the collected particulate matter)
- 3c. - Chain of Custody Report

VII. EXHIBIT 4 - EMISSIONS DATA AND EXPERIMENTAL CONDITIONS
- 4a. - Emissions Test Data Summary Sheets (supplied by Trigon)
- 4b. - Test Equipment Calibration Sheets (supplied by Trigon)
- 4c. - EP Operating Conditions during Testing
- 4d. - Current-Voltage (I-V) Characteristics
- 4e. - Metals Removal Efficiency Graphs

VIII. Appendix 1 - Test Data Sheets (supplied by Trigon)

IX. Appendix 2 - Daily Performance Reports - Field Voltages, Currents and Power Levels

X. Appendix 3 - Daily Performance Reports - EP Operating Data

XI. Appendix 4 - Operating Notes

XII. Appendix 5 - Operating and Performance Data - Summary Graphs

EXECUTIVE SUMMARY

A pilot project which utilized a Mobile Electrostatic Precipitator supplied by McGill AirClean Corporation was conducted at the facilities of Clemson Environmental Testing Laboratory (CETL) in Clemson, South Carolina by Envitco, Incorporated. An experimental glass melter built by Envitco was used to demonstrate the feasibility of vitrifying contaminated soil. The pilot electrostatic precipitator was provided by McGill AirClean Corporation during the months of November, 1998 through January, 1999. Trigon Engineering Consultants, Inc. performed emissions testing to determine melter exhaust emissions and the performance of the McGill AirClean Electrostatic Precipitator.

Testing was performed at the melter exhaust and at the Electrostatic Precipitator outlet stack during a designated 72 hour test period. The melter was operated nearly continuously during the test period with only a minor process problem which caused an interruption in flow of material to the melter. The melter pull rate was typically around 25 kilograms per minute during the testing. The test period was needed to demonstrate that the process was feasible and would not have critical control problems or require an extraordinary amount of maintenance.

Sampling was performed during the test period by Trigon to determine the gaseous emissions including NOx, SO_2, SO_3, O_2 , CO_2 and also volatile organic compounds (VOC's). Other parameters measured included the volumetric flow rate, moisture content and particulate emissions at the two locations mentioned above. Particulate matter emission rates at the Mobile EP stack were as low as 0.0006 grains per dry standard cubic feet and 0.01 lbs per hour. The average EP emission rate was 0.023 lbs per hour. Purge air and other air in-leakage into the system was minimized in order to maintain the exhaust gas temperatures above the expected acid gas dewpoints. The operating temperatures achieved during the test

were within the range of what would be expected in a full scale system. It is suspected that the system temperatures or other variables had not stabilized for a long enough time prior to testing, resulting in higher removal efficiencies with each test.

The focus of this report is on the removal of particulate and metals emissions with a dry electrostatic precipitator and the applicability of the McGill AirClean equipment. The application appeared to be particularly well suited to the McGill AirClean needle plate electrode design. There was very little buildup on the precipitator plates and distribution screen. The excess particulate collected on the plates was easily removed with periodic plate rapping.

After the unit was shut down, residual dust was cleaned from the collection plates in the EP. All of the solid particulate was carefully collected and weighed by Envitco personnel. The duct system and Mobile EP internals were washed down using a power washer. The wash water was collected and pumped to 55 gallon drums for analysis and disposal.

STATEMENT OF PROPRIETARY RIGHTS

McGill Airclean Corporation does not relinquish any of its proprietary rights, titles, or interests in rendering this report on testing. Any inventions or discoveries reflected in this report are the sole and exclusive property of McGill AirClean Corporation.

For a period of one (1) year after the conclusion of this agreement, under which time McGill AirClean provides test reports, should customer apply for a patent on the aforementioned inventions or discoveries, the customer hereby grants to McGill AirClean Corporation an exclusive, irrevocable, royalty-free license of such patent with full power to sub-license.

TEST RESULTS SUMMARY

A Mobile Electrostatic Precipitator pilot project was completed by McGill AirClean Corporation for Envitco, Incorporated, near Anderson, South Carolina. The project investigated the suitability of a dry Electrostatic Precipitator (EP) for collecting particulate and other emissions in the exhaust from an LP gas fired glass melter. Emissions testing at the glass melter and EP stack was conducted by Trigon Engineering Consultants at the direction of Envitco. McGill AirClean was on site to coordinate the set-up, testing and de-commissioning of the Mobile EP.

The data was taken over only a limited operating range due to constraints imposed by the volume of process gas. The purpose of the first three tests performed on January 19 was to characterize emissions from the melter. The purpose of the second series of tests performed January 20 at both the melter exhaust and the Mobile EP outlet stack was to determine the particulate and metals removal efficiency as well as SO_2, NO_x, VOC, CO_2 emissions.

A total of 3 pairs of simultaneous melter exhaust/EP outlet EPA Method 5 tests for particulate were conducted. An emission rate as low as 0.010 pounds per hour was achieved. This resulted in a collection efficiency (based on pounds per hour) of 81.5% for filterable particulate matter. The removal efficiency was limited due to the low inlet loading.

Additional testing was performed as follows: Method 6C testing for SO_2 (instrumental analyzer procedure), Method 7e testing for NO_x (instrumental analyzer procedure), Method 10 testing for CO and Method 25a for total hydrocarbons were performed simultaneously. Testing for metals by USEPA Method 29 was

performed as part of the emissions characterization. The results of these tests are included in Exhibit 4a. An extensive analysis of the metals removal efficiencies can be found in Exhibit 4e.

The Trigon Engineering Consultants test data summary sheets along with Mobile EP operating conditions, are presented in Exhibits 4a and 4c. The test equipment calibration sheets for Trigon Engineering are found in their report No. 046-98-158. Calibration data for equipment supplied by McGill AirClean is in Exhibit 1h. A summary of results for SO_2 is included in Exhibit 4a. Summary graphs of the actual operating conditions over the entire duration of the project are presented in Appendix 5.

I. INTRODUCTION

An air pollution control system pilot project was conducted at Envitco, Incorporated at a site near Anderson, South Carolina in the Clemson Research Park utilizing a McGill AirClean Corporation Mobile Electrostatic Precipitator (Mobile EP) in conjunction with Trigon Engineering Consultants, Inc. who performed emissions testing. The Mobile EP was used to control emissions from the exhaust of a proprietary LP gas fired glass melter. The Mobile EP system was on-site from November 19th,1998 until January 28th, 1999. McGill AirClean personnel on-site for part of the pilot project were David Poole, and Wade Shoemaker. McGill AirClean would like to thank key personnel for Envitco Incorporated, Dreicor Construction, Trigon Engineering Consultants and the Clemson Environmental Technologies Laboratory (see brochure in exhibit 2a) for their assistance with setting up, operating and testing the air pollution control system.

1.1 Background

McGill AirClean Corporation has conducted nearly 100 pilot scale studies for air pollution control. These studies have proven invaluable at providing full scale sizing and operating guidelines. They allow McGill AirClean to supply appropriate systems which will meet the customers needs. Envitco Inc., has experience in designing systems for stabilizing waste materials in glass. As part of the U. S. Department of Energy clean-up at the former uranium enrichment plant in Fernald Ohio, Fluor Daniels contracted with Envitco to design a glass melter which could be used to vitrify the waste contaminated soil at the plant. A large quantity of radium contaminated soil exists at the plant. The radium can decay and form radon 222, a low level radioactive gas. To prevent this from occurring, the radium in the soil is to be solidified and chemically stabilized or "fixed" in the glass. EPA regulations require

that emissions from the clean up process be carefully controlled. As part of their overall strategy, Envitco is planning to install electrostatic precipitators on the exhausts of the full scale glass melters to control the particulate emissions. Because of their experience and the applicability in controlling fine particulate matter from many different glass furnaces and processes, McGill AirClean was selected for the pilot project. The Mobile EP had the ability to be easily transported and set up at the site, and was ideal for the project.

1.2 Purpose

The purpose of the pilot study was to characterize the performance of the McGill AirClean Corporation Electrostatic Precipitator design when applied to emissions from a novel glass melter and to provide McGill AirClean with information to size an EP for a full scale glass melter application.

1.3 Objectives

The specific objectives of the investigation were as follows:

1. Characterize the emissions from the process entering and exiting the Mobile EP.
2. Evaluate the ability of the air pollution equipment to control the emissions.
3. Verify that operating parameters for collection chamber temperature, gas velocity and rapping cycle time are optimum.
4. Assess the performance and reliability of the equipment and summarize the performance in terms of variables which could be scaled to full size EP designs.

II. EXPERIMENTAL WORK

2.1 Discussion of Objectives

Objective 1: Characterize Emissions

The performance of the Mobile EP system is defined in terms of removal of pollutants or removal efficiency as related to the concentrations of pollutants measured at the inlet of the system and at the outlet of the Mobile EP. Measurements of particulate emissions consisted of simultaneous pairs of tests performed at the glass melter exhaust and the Mobile EP outlet. Process emissions and emissions from the Mobile EP system are characterized as to concentrations, gas composition, and temperature. The aerodynamic particle size distribution and electrical resistivity are important characteristics which can effect electrostatic precipitator performance, and were also determined.

Objective 2: Ability to Control Emissions

The performance of the Mobile EP system is dependent on gas temperature, gas moisture, gas velocity, specific collection area (SCA), the number of energized fields and the power applied per field. Any operating characteristics peculiar to the process or Mobile EP were evaluated with consideration of a full-scale design.

Objective 3: Verify Operating Parameters

Pilot projects and emissions testing is needed to confirm the operating parameters such as temperature, flow through velocity and rapping cycle time are acceptable. As previously mentioned, it was not possible to experimentally determine the effect of altering all of these parameters due to the limited amount of process gas available.

Objective 4: Performance Summary

To help evaluate the long term reliability and performance, an internal inspection of the equipment was made. The system operated for several weeks prior to testing and was operated intermittently over about a two month period. Data was logged and notes were kept as well as electronic historical information from the automated data acquisition system to help evaluate the performance.

2.2 System Description and Operation

Background

The experimental glass melter built by Envitco, Inc. was used to demonstrate the feasibility of vitrifying contaminated soil. Envitco asked McGill AirClean to supply the pilot scale Mobile Electrostatic Precipitator (EP) to confirm the effectiveness of an EP in collecting the particulate emissions which escape in the exhaust of the LP gas fired glass melter, and to provide an effective means of particulate matter control. A limited volume of process gas was available and was drawn to the Mobile EP through the duct system. Drawings of the duct system can be found in Exhibits 1d and 2e.

Testing was performed at the melter exhaust and at the Electrostatic Precipitator outlet stack during a designated 72 hour test period. The test period began at about 10:00 a.m. on January 18th. The melter was operated nearly continuously during the test period except for a very brief period at the end of the demonstration when batch/surrogate feed to the melter was interupted. The melter pull rate was typically around 25 kilograms per minute during the test period. The test period was needed to demonstrate that the process would not have critical control problems or require an extraordinary amount of maintenance.

Process Description and Operation

The novel design glass melter consisted of a glass batch and surrogate matter mixing area and batch pumping system. For demonstration purposes in this pilot project, it was not desirable to use radioactively contaminated soil. A "surrogate" material was used which closely simulated the chemical composition of the actual contaminated soil. The surrogate material made up 85.6% of the batch but also contained some of the ingredients for glass production especially silica. Other components of the surrogate material included sodium, calcium and lithium sulfates along with minor amounts of lead sulfate, potassium sulfate and molybdate. The balance of the batch (14.4%) was made up of glass additives. The glass additives were mostly sodium, lithium and calcium carbonates along with aluminum trihydrate. Other minor constituents helped to condition the glass.

The melter area consisting of an octagonal main tank and plenum with four batch/surrogate slurry injection lances, a salt drain section with plenum and orifice, a glass drain section with plenum and orifice, laser based glass level detectors, a metal drain (center) section with orifice, and proprietary cooling and refractory design. An extensive water jacket cooling system was used to control temperatures of the melter. Glass which contained vitrified surrogate material was drained into barrels and carefully weighed as were all materials in and out of the process in order to make a mass balance determination.

The glass batch/surrogate material was pumped to the melter in liquid form. Nitrate, sulfate and carbonate salts were formed in fairly high amounts in the furnace. These compounds needed to be drained from the vessel periodically to avoid build up which could be detrimental to the melter. The batch and surrogate material were very aggressive chemically which required careful attention

to wall and refractory design of the melter. The refractory lining and wall design are proprietary. The design included refractory lining containing chromium. Another refractory called mullite, a type of high temperature ceramic, was used in the design. A camera mounted in the vessel allowed for continuous monitoring of the melting process inside the vessel.

Graphs of the propane gas flow versus differential pressure and the burner airflow versus pressure provided by Envitco are included in Exhibits 2c and 2d. Exhaust from the melter was cooled with air and a water lance operating at 0.4 gpm. As previously mentioned, the duct system is shown in Exhibit 2e. It consisted mostly of 5 and 6 inch diameter schedule 40 steel pipe. Components in the high temperature zone above the furnace were all stainless steel. A tee fitting with a butterfly damper was located just upstream of the Mobile EP. This was provided in case further cooling of the gas was required.

Air Pollution Control System Description and Operation

The Mobile electrostatic precipitator system was designed specifically for pilot-scale investigations. The Mobile EP was operated dry during this project. The Mobile EP consists of an inlet transition from the twenty inch duct to the twenty-five square foot cross section of the collection chamber, a gas diffusion screen, four electrically independent collection fields with hoppers, screw conveyors and rotary valves, a leading and trailing edge spray header, an outlet mist eliminator, a vortex type fan damper at the inlet to the fan, an outlet fan and an eight foot exhaust stack. A fan curve and balancing report are included in Exhibit 1e.

An operator interface computer system running Intellution FIX software allowed for full control of the unit's systems including the outlet damper position, field voltages and currents, rapping

events. For this project, a process control loop was set up so the damper could be operated automatically to maintain the desired pressure in the melter chamber. The operator interface allowed automatic data acquisition and monitoring of field voltages and currents, fan amps, damper position, inlet/outlet temperatures and system alarms.

A drawing of the Mobile EP is provided in Exhibit 1a. Specifications of the unit are presented in Exhibit 1c. A pictorial drawing of the electrical fields is presented in Exhibit 1b. The discharge electrode needle arrangement and collection plates used in Mobile EP 1 are identical to those in a full scale McGill AirClean EP. A list of recommended spare parts for the Mobile EP was developed at the request of Envitco to ensure successful operation during the 72 hour test period. The recommended spare list can be found in Exhibit 1g.

Gas was drawn from the process through a six inch schedule 40 pipe system. There was no need for an extractor elbow since all of the gas was directed to the Mobile EP. It was not possible to vary the gas volume through the EP to a significant degree since doing so would adversely effect the pressures in the melter. The static pressure was monitored at the EP inlet as well as in the melter vessel. As previously mentioned, melter pressure could be controlled automatically based on melter vessel pressure, or manually if so desired.

The Mobile EP is equipped with four electrically independent fields or cells in series. From zero to four fields can be energized at one time. Increasing the number of fields increases the plate area available for particle collection. Fields one and three were set up with a plate spacing of 100 millimeters (clearance between high voltage discharge plate and grounded plate), while fields two and four were set up for 80 millimeter spacing. Field power levels were kept at near maximum

during continuous operation. Some variation in these levels occurred with changes in process temperatures and other variables. The field power levels were controlled using the automatic voltage control (AVC) system. In this system, voltages are maintained as high as possible until a sparkover event occurs in the energized field. At that time the power to the field is interupted for only a few milliseconds and the power re-applied at a percentage of the previously achieved level. During the testing, field one was operated in manual voltage control due to a problem with the fields' AVC system.

The rapping set-up during the project was based on computer generated estimates of the time intervals which could be expected between required field rapping (cleaning). The estimates were based on process parameters such as concentration and nature of the particulate. The rapping set up information is provided in Exhibit 1f. At the request of Envitco, rapping was performed manually during the test period to insure that a more consistent amount of dust was generated from the Mobile EP hopper discharge. Rapping occured around 8:30 a.m. and around 1:00 p.m. the day of the testing and did not occur during the EP outlet testing. However, it is not known whether the the fairly extensive amount of manual rapping could have effected the results of the testing. Previous experience has suggested that somewhat degraded performance can occur for a period of time following a rap event.

Initially, continuous opacity data was to be obtained at the Mobile EP stack location. An opacity monitor was set up and calibrated successfully. However the unit did not prove reliable due to excessive vibration from the fan directly below it. The data is included in the daily reports mostly as zero opacity values. These reported values should be ignored. Visual opacity was monitored from time to time. There never appeared to be any visible opacity or emissions from the EP stack.

Prior to testing, it was desired that the Mobile EP outlet temperature be maintained above the expected acid gas dewpoints (approximately 110 degrees C or 230 degrees F). One reason for this was to insure the particulate does not form a cake or crust on the collection surface and become difficult to remove. Another reason to keep the outlet temperature higher was to insure the electrical resistivity was in a range which was conducive to collection in an EP. An inspection of the Mobile EP system revealed a number of leaks which were sealed in order to reduce the amount of in-leakage to the system. Purge air which is normally used to keep dust from accumulating on the insulators over long term periods under high grain loading conditions was also restricted in order to increase the temperature at the Mobile EP outlet. It was possible to limit the purge air due to the low inlet grain loading conditions and little need for purge air.

All of the solid particulate was carefully collected and weighed. The duct system and Mobile EP internals were washed down using a power washer. The wash water was collected and pumped to 55 gallon drums for analysis and later disposal.

2.3 Testing Methods

Particulate Matter

Measurements of particulate matter (PM) as well as gas volumes, moisture contents and molecular weights were made according to the most up-to-date USEPA test methods (Methods 1-5). The emissions from the process were measured by Trigon Engineering Consultants at the sample ports located upstream of Mobile EP in the melter exhaust duct and the EP outlet stack. Process emissions were characterized by temperature, moisture content, volumetric flow rate, molecular weight of the gas, particulate matter (PM) concentration, metals concentrations, as well as sulfur dioxide (SO_2), sulfuric acid mist (SO_3), nitrogen oxides (NO_x), oxygen (O_2) and carbon dioxide

(CO_2) concentrations. The major controllable factors influencing PM collection efficiency in the Mobile EP were the gas volume and the number of electrical fields energized. EP inlet and outlet USEPA Method 5 testing was performed simultaneously to determine the particulate matter collection efficiency. The location of the EP outlet measurement site is shown in Exhibit 1a. A drawing of the duct arrangement is presented in Exhibit 2e.

Metals and Gases

Sulfur dioxide (SO_2), and oxides of nitrogen (NO_x) were measured for two 24 hour periods during the three day test. Method 6C for SO_2, and Method 7E for NO_x, were the test methods used. The data was collected with a computerized data acquisition system. Sulfuric acid mist (SO_3) was determined at the melter exhaust only using Method 8. Total gaseous organics were also measured during an 8 hour period at the melter exhaust using Method 25A. As previously mentioned, this report focuses on particulate and metals emissions.

Data Collection

Calibration data for McGill AirClean supplied equipment can be found in exhibit 1h. Trigon Engineering test equipment calibration sheets can be found in Trigon's report No. 046-98-158.

The basic requirement of the testing was to determine the dependence of the Mobile EP system particulate collection efficiency and the relationship of the efficiency to controllable factors such as the number of energized fields and the EP flow through velocity. The testing was also needed to support mass balance equations performed by Envitco.

Particulate data collection was achieved by a series of stack tests which were performed simultaneously at the melter exhaust and at the Mobile EP stack test ports. The major controllable variables for the testing were the number of fields energized and EP flow-through velocity. At the request of the customer, all four energized fields were utilized to collect the emissions during the testing. As previously mentioned, it was not possible to vary the flow through velocity due to the importance of maintaining the desired pressure in the melter.

Six tests were used to initially measure SO_2 and sulfuric acid mist (SO_3) emissions at the melter exhaust only. The following day, a set of three tests simultaneously measured melter exhaust and Mobile EP outlet stack emissions from flue gas pulled through the ductwork using the Mobile EP ID fan. Tests 1-3 performed on January 20 measured particulate and metals and are of primary interest.

Electrical Resistivity and Particle Size analysis

Electrical resistivity was determined as a function of temperature using a radial test cell as described in IEEE Standard 548. The test was conducted in an environment containing a specified moisture concentration as described in EPA Report 600/7-78-035. The test was performed at both 3.6% and 9% moisture by volume. Results of the tests can be found in Exhibit 3a.

Aerodynamic particle size distribution was determined using a Bahco Micro Particle Classifier. The percentage of particles less than 10 microns and 2 microns in size was determined in accordance with ASME Power Test Code 28, section 4. The particle sizing is provided in Exhibit 3b.

The sample for analysis was provided by Envitco and was taken in the afternoon the day of the particulate testing at the Mobile EP stack. The chain-of-custody form was completed and is included in Exhibit 3c.

III. DISCUSSION OF RESULTS AND CONCLUSIONS

3.1 Melter Emissions and Mobile EP Performance

Particulate Matter Emissions

Gas velocity through the Mobile EP varied only slightly during the three tests. The EP flow through velocity was around 1.7 feet per second. As previously mentioned it was not possible to vary the volumetric flow rate and EP flow through velocity due to the limited amount of exhaust gases available. Flow and pressure control were accomplished by either manual or automatic adjustment of the Mobile EP outlet fan damper. A water quench spray lance was used to control temperature of the exhaust out of the melter. The water injection rate was 0.4 gpm on a continuous basis. Temperatures at the EP inlet ranged from 177°C to 185°C, (350°F to 365°F) during the three tests. A detailed log of the process conditions was maintained during the particulate testing (see Exhibit 2b). Temperatures at the EP inlet and outlet, as well as damper position and other EP operating parameters were recorded continuously (see Appendix 3) using the automated data acquisition features in the FIX operator interface software package. Results of the particulate testing and associated system conditions are presented in Exhibit 4. It was suspected the system temperatures or that a test measurement variable may not have stabilized for a long enough time period prior to testing . This most likely resulted in the wide variation in the particulate matter measurements at the Mobile EP outlet stack. The test results became progressively better with time.

Inlet particulate emission rates (front half only) taken during the 3 tests at the melter exhaust averaged 0.0117 gr/dscf (0.051 lbs per hour) with a range of 0.045 to 0.054 lbs per hour. Measured outlet concentrations, as low as 0.0006 gr/scfd (0.010 lbs per hour) were achieved during the program (EP flow through velocity of 1.66 fps with four fields energized.) All tests

were performed with water spray to quench the very hot gases at the melter exhaust as well as dilution air near the melter exhaust. Outlet particulate emissions determined during the 3 tests at the EP stack averaged 0.023 lbs per hour with a range of 0.010 to 0.041 lbs per hour. Plate rapping and screw conveyor operation was off during all particulate and metals testing.

Particulate emissions were compared to data collected from other soda-lime and lead glass processes. The concentrations were plotted against SCA (the ratio of plate area to volume flow). The test results were plotted on a curve with the existing data. The data was found to be comparable to data from glass applications at other McGill AirClean projects, although EP outlet data was slightly higher than expected during the first test. However, the nature of the particulate was also somewhat different from comparable projects. When looking at removal efficiency percentage, it was apparent that the Mobile EP performance was steadily improving indicating that perhaps the temperatures in the system or other variables had not stabilized for a long enough time prior to testing.

Metals Emissions

Results of the extensive metals analysis were somewhat mixed. The data may reflect some of the difficulties associated with measuring the low levels of metals in the exhaust gases. With regards to front half metals, there were 7 metals which had consistently high average removal efficiencies. They were:

Lithium (Li) 99.0%

Lead (Pb) 98.8%

Barium (Ba) 95.7%

Chromium (Cr) 90.1%

Phosphorous (P) 89.8%

Arsenic (As) 88.6%

Zinc (Zn) 85.4%

(Data was not available for front half silicon.)

The highest front half metals emissions from the melter exhaust were lead (Pb) at 1.41 x 10^{-2} lbs per hour followed by phosphorous at 3.11x10^{-3} lbs per hour. Both of these had high removal efficiencies. The highest front half metals measured at the Mobile EP stack were sulfur at 2.13 x 10^{-3} lbs per hour and sodium at 1.78 x10^{-3} lbs per hour which both had low removal efficiencies.

Negative efficiencies (front half metals being generated) between the melter exhaust and the Mobile EP stack was somewhat common. The poorest performing front half metals were the following:

Cadmium (Cd) -189.7%

Vanadium (V) -168.3%

Selenium (Se) -97.6%

Aluminum (Al) -56.3%

Sulfur (S) -40.4%

Calcium (Ca) -34.9 %

Magnesium (Mg) -12.2%

Front half cadmium (Cd) which had a negative average removal efficiency (-189.7%) had the lowest average emission rate from the melter.

Some back half metals seemed to be generated between the melter exhaust and the Mobile EP stack. The reason for this apparent metals generation is not fully understood, but could be related to the accuracy of the test at low measurement concentrations, or corrosion of metals from the inside walls of the duct system and the extensive square feet of surfaces inside the Mobile EP used as collection area. The metals that were generated most were zinc, arsenic and iron.

The back half metals with the highest emission rates from the melter were sulfur (S), (3.32×10^{-2} lbs per hour) and selenium (Se) at 7.37×10^{-3} lbs per hour. Only selenium had a positive average removal efficiency (52.4%). The back half metals were not as easily collected as the front half metals which is typical of EP performance.

The analyses for total metals emissions (combined front half and back half emissions) showed that lead (Pb) was consistently the element most readily removed averaging 98.7% removal. Lithium, phosphorous, barium, chromium, molybdenum, arsenic and zinc were also consistently removed at relatively high percentages. Of the total metals, silicon seemed to be by far the most difficult to remove, (this is consistent with McGill AirCleans's experience) while cadmium, vanadium, aluminum, calcium, sodium, magnesium, and potassium all seemed to be less readily removed.

The "total" metals with the highest emission rate from the melter were sulfur at 3.48×10^{-2} lbs per hour followed by lead at 1.41×10^{-2} lbs per hour, and selenium at 7.75×10^{-3} lbs per hour. The highest emission of "total" metals from the EP stack were for sulfur, selenium and sodium which is consistent with the high melter emission rates and relatively low removal efficiencies for these three elements totaling 0.00493 lbs per hour. Lead, again, was readily removed from the gas stream.

VOC'S and Gaseous emissions

VOC and SO_2 emissions were extremely low directly out of the melter. The precipitator had little, if any, effect on the removal of NO_X, SO_2 and VOC's.

3.2 Long Term Operation

Near the end of the test period, the voltage and current characteristics were recorded. This was done by slowly increasing and then decreasing the voltage applied to each field and graphing the data. The resulting graphs are known as I-V curves. The I-V curves can be useful in troubleshooting operational problems associated with electrical performance. The I-V curves are presented in Exhibit 4d.

Inspection of the internals of the Mobile EP showed a particulate buildup of about 1/16 inch of residue. Progressively less buildup occurred through the units four fields. The coating was easily washed off with a water hose. The amount of residue extracted by the screw conveyor was very low. The low discharge rate was attributable to the low emission rate from the melter. All material collected by the EP was discharged through the screw conveyor and carefully measured.

The Mobile EP was operated intermittently for about 40 days with no significant deterioration in equipment or performance during the period. There were no unplanned shut downs during the 72 hour test period.

3.3 Conclusions and Recommendations

2291

The following conclusions can be made based on the data and the information collected during the program:

- The testing program effectively characterized the emissions from the melter. Emissions measurements demonstrated expected outlet emissions data.

- The performance of the Mobile EP system can be described by analysis of the obtained data.

- Particulate matter and most of the predominant metals emissions were readily removed by the McGill AirClean Mobile EP.

- Testing upstream of the dry EP did not show a correlation between the emission rate from the melter and outlet emissions. Test results may have been affected by the low levels of emissions that where being determined.

- Lead (Pb) emissions were the predominant metals species. Lead emissions as well as soda lime glass emissions have been primary applications for McGill AirClean electrostatic precipitators. The data compares well with data from other applications.

- Pluggage of the distribution screen was not a problem. There was very little buildup on the internal surfaces of the Mobile EP.

- The collected material was removed easily from all of the plates. Rapping mechanisms on the Mobile EP appeared to be adequate for plate cleaning.

- McGill AirClean Corporation obtained sufficient information from the testing program to confidently size a full scale EP for the process.

- The dry Mobile Electrostatic Precipitator effectively reduced the emissions from the melter exhaust.

F:\...\EP\D-5704-9\JTS\ENVITCOTESTREPORT.WPD

Listing for Exhibit 1

EXHIBIT 1 - EQUIPMENT SPECIFICATIONS AND INFORMATION

1a. - Drawing of Mobile EP

1b. - Drawing of Electrode Plates

1c. - EP Specifications

1d. - Drawing of EP Inlet Duct

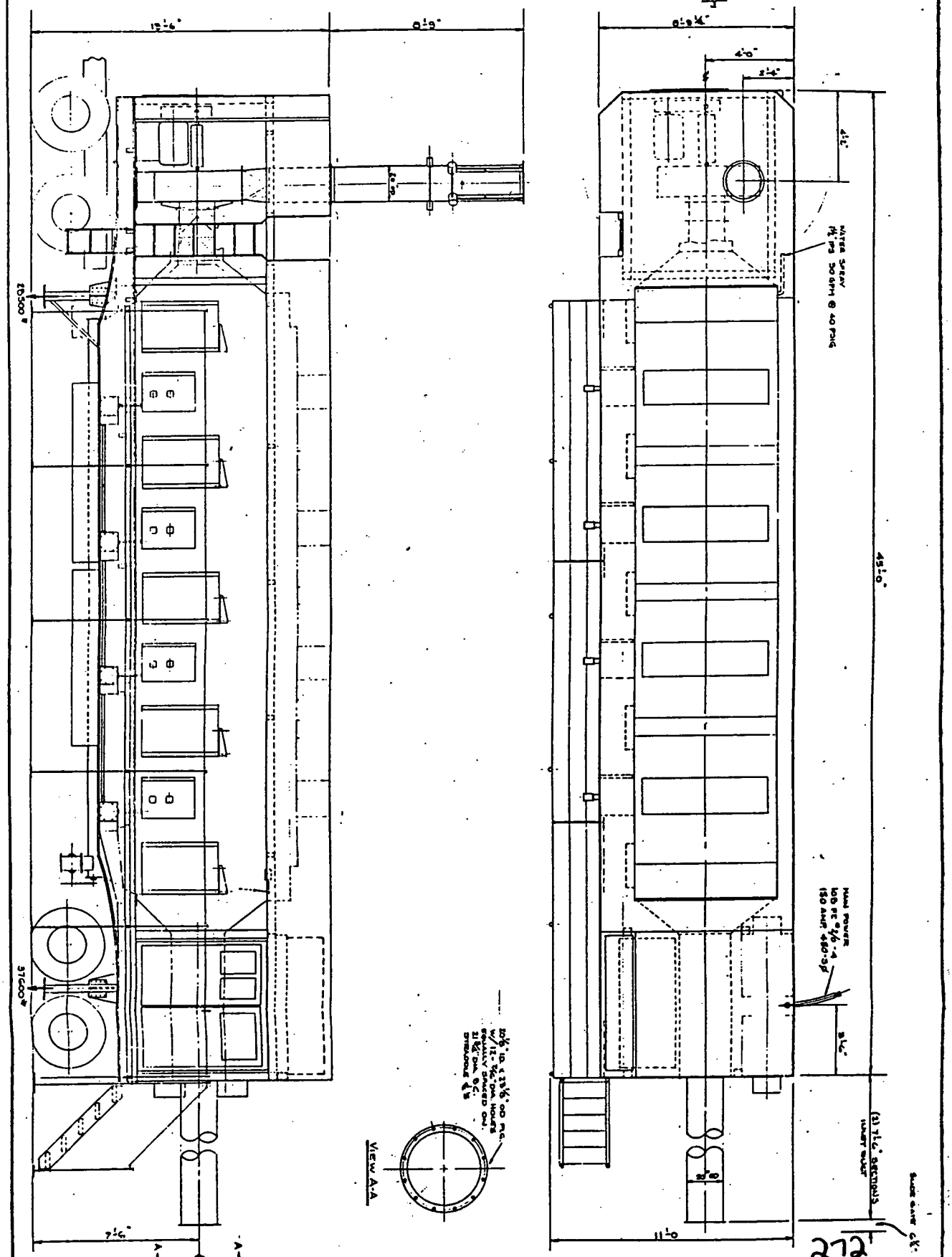
1e. - Fan Curve and Balancing Report

1f. - Rapping Set-up

1g. - Spare Parts List

1h. - Calibration Data

1a. - Drawing of Mobile EP



272

GENERAL ARRANGEMENT 4-25
MOBILE PRECIPITATOR

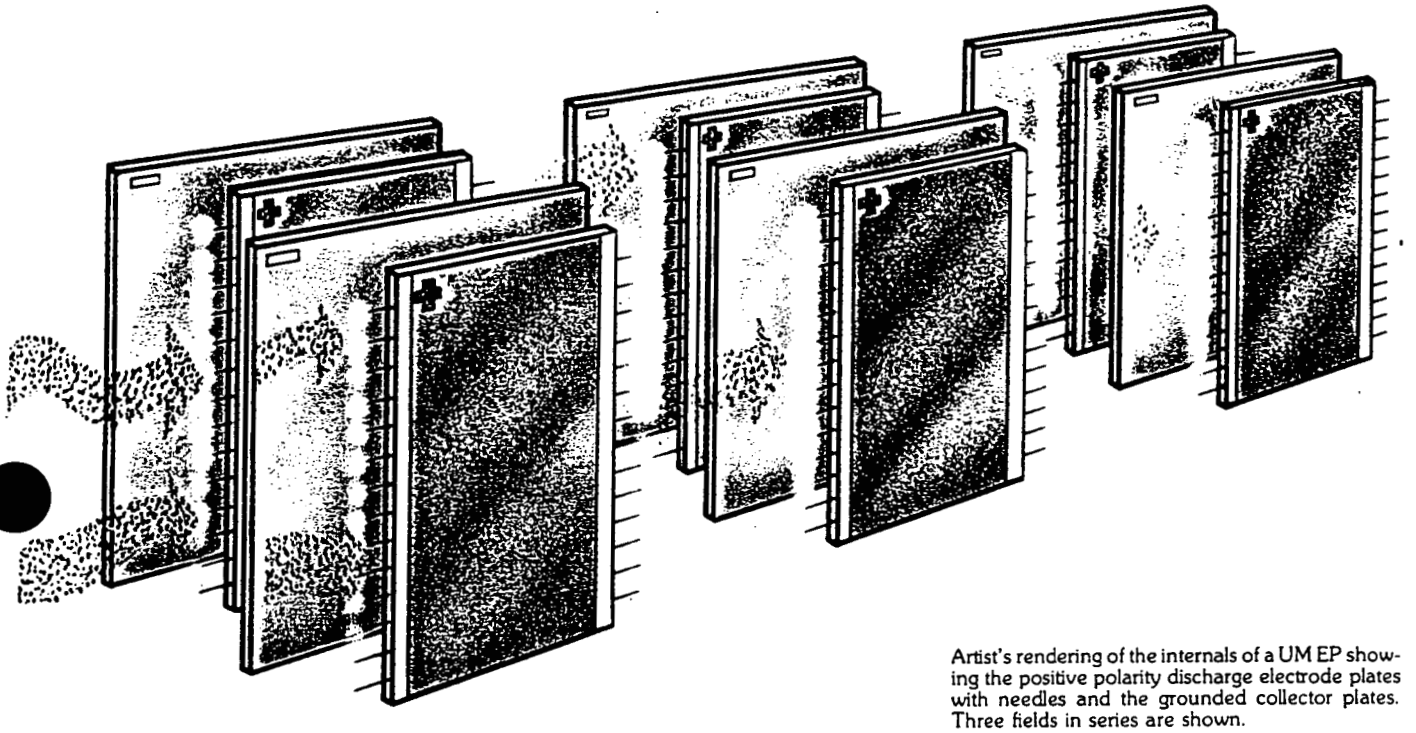
SCALE 1/4"
JOB NO P-1515-80
DWG NO 110-95
SHEET 1 REV 0

United McGill Corporation

DRAWN MS/Rev 10-4-82
CHECKED
APPROVED
APPROVED

No.	Date	By	Chk'd	Appr'd	Description of Revision

1b. - Drawing of Electrode Plates



Artist's rendering of the internals of a UM EP showing the positive polarity discharge electrode plates with needles and the grounded collector plates. Three fields in series are shown.

1c. - EP Specifications

Revised November 1998

Specifications for Mobile EP

Fields 1 and 3
(80mm)

1. Collector plates per field - 10
2. Discharge plates per field - 9
3. Height of field - 5'5"
4. Width of field - 5'5"
5. Effective cross sectional area - 25.4 square feet
6. Total number of needles per field - 684

Fields 2 and 4
(100mm)

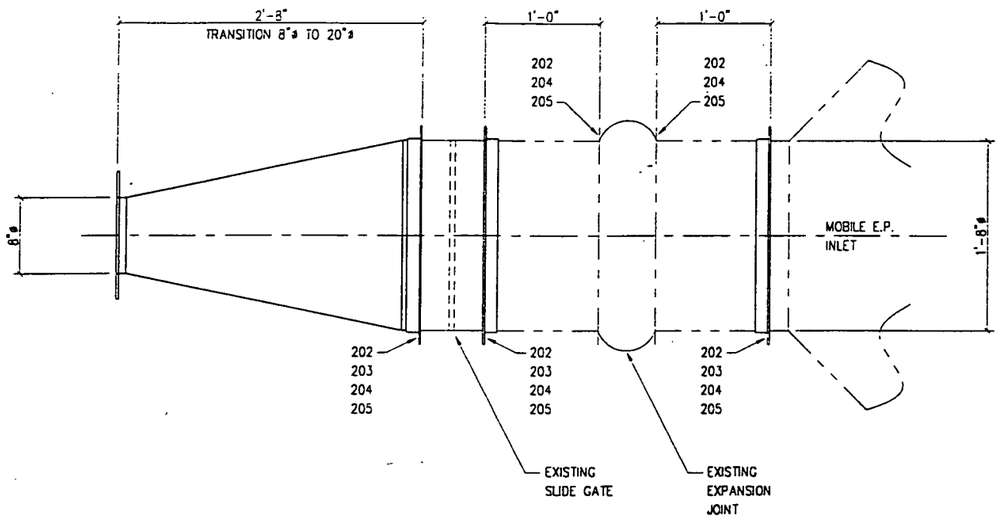
1. Collector plates per field - 8
2. Discharge plates per field - 7
3. Height of field - 5'5"
4. Width for field - 5'5"
5. Effective cross sectional area - 25.4 square feet
6. Total number of needles per field - 532

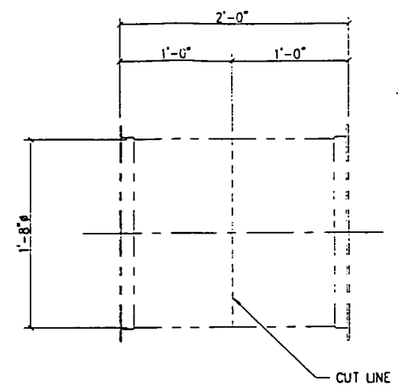
DTP:ejs:1793L

1d. - Drawing of EP Inlet Duct

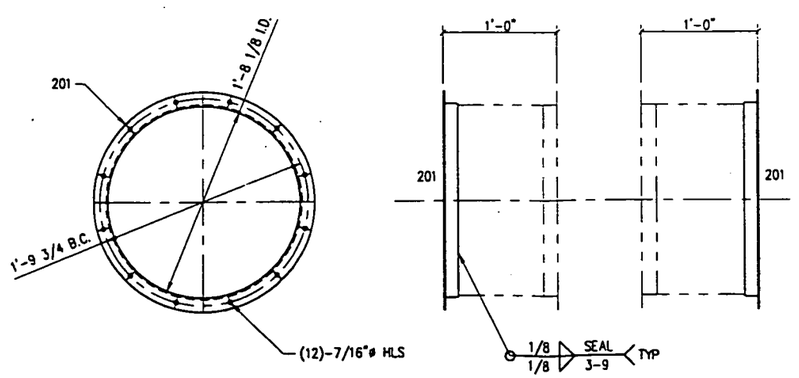
Bill of Materials

ITEM	QTY.	SPEC.	PROGRAM No./ INVENTORY No.	DESCRIPTION
201	2	A36		L-RING 1 1/2 x 1 1/2 x 3/16 x [illegible] 1/8 I.D. (LEG CUT)
202	60	A307		3/8-16 x 1 1/4 HEX HD BOLTS
203	36	A307		3/8-16 HEX NUTS
204	36	STL.		3/8"ø NOM LOCK WASHERS
205	35ft.	----		1/8 x 2" FIBERGLASS BOLT HOLE TAPE





EXISTING 20" DIA. DUCT



2 - 20" DIA. DUCT SECTIONS FROM EXISTING

No.	Date	By	Chk'd	Appr'd	Description

TOLERANCE (UNLESS OTHERWISE SPECIFIED): FRACTIONS ±1/1

This drawing is based on the condition that it is submitted without charge and is to be used on request. It must not be used for any other purpose than that for which it was originally submitted. Reproduction or use any another infringement.

DRAWN:	D.COX	11/3/98
CHECKED:		
APPROVED:		
APPROVED:		

COLUMBUS, OH

McGill AirClean® Corporation

INLET DUCT

ENVITCO

SCALE: 1 1/2" = 1'-0"

JOB No. D-5704-9

CUST. No.

DRAWING No. 35704-

SHEET 2

REV 0

Plot Date: 11/04/98 @ 8:54 PM

Drawing Name: 2200-02.dwg

Plot Scale: 1:1

1e. - Fan Curve and Balancing Report

ROBINSON
INDUSTRIES, INC.
INDUSTRIAL FANS • BLOWERS • ENGINEERED • SINCE 1882
P. O. BOX 100
ZELIENOPLE, PENNA. 16063
PHONE 412/452-6121
TELEX 866-311

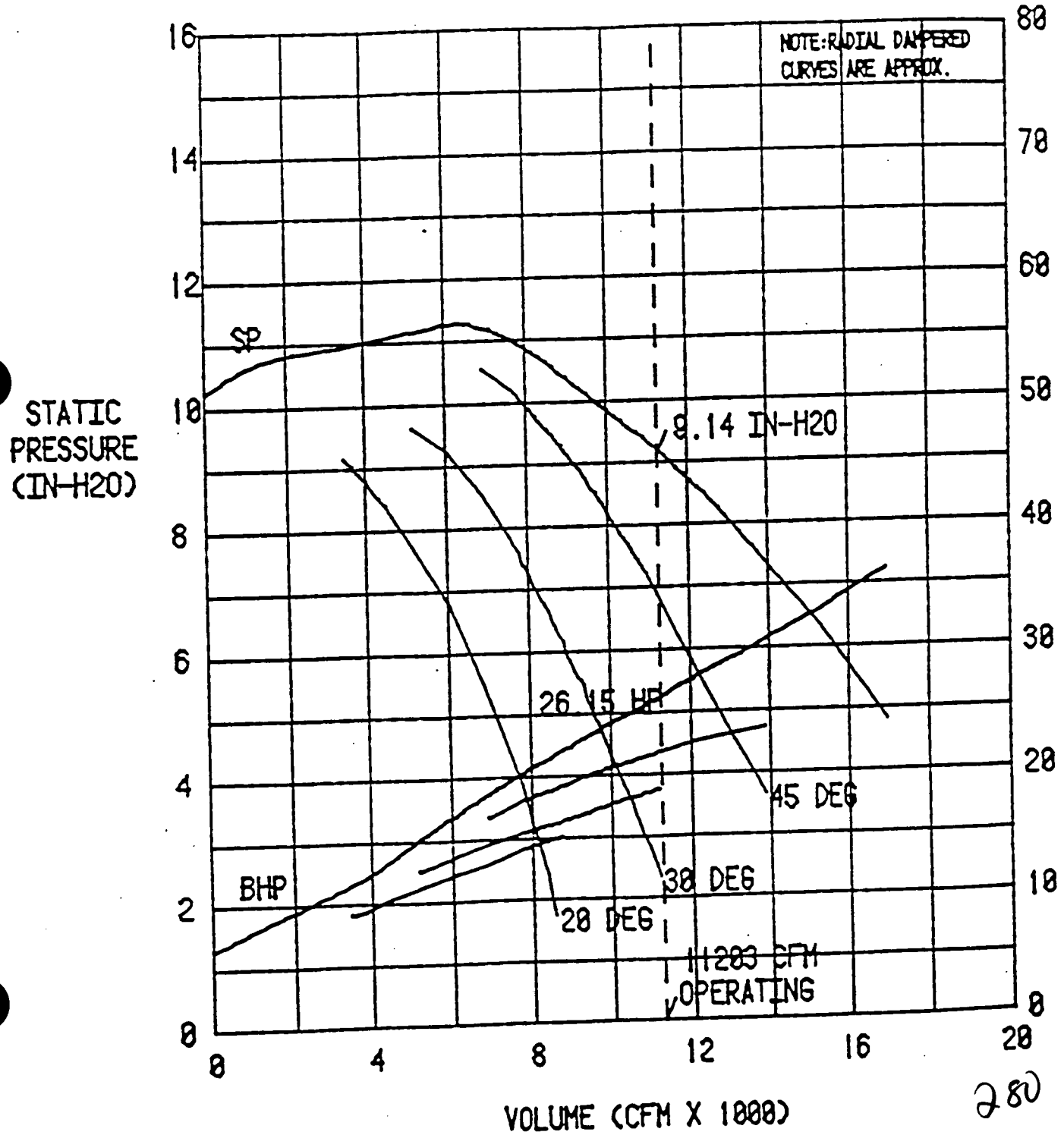
2291

SS-33MHIE-0068

ROBINSON INDUSTRIES INC.
FAN: 33 X 9.75 MHIE-SWSI
FOR: UNITED MCGILL

SPEED: 1687 RPM
TEMP: 350 DEG F
DENSITY: .049 #/FT3

DATE: 08-APR-83
QUOTE #:
RII FO#:66084



B

280

BALMAC

BALMAC, INC.

4010 Main Street • Hilliard, Ohio 43026-1423 U.S.A.
Phone: 614-876-1296 • Fax: 614-771-5608

2291

10 November 1998

RECEIVED
NOV 20 1998
UNIVERSAL FILES

MCGILL AIRCLEAN CORPORATION
P.O. Box 820
Columbus, OH 43216

Attention: Mr. Dave Poole

RE: Service Report Balancing Fan on Mobile EP

On initial inspection of fan, Initial vibration velocity readings taken on Bearing #1 (closest to pulley) was .1 ips. This reading indicates the fan was running at the high end of the Smooth range per the Vibration Severity Chart. (See attached)

Initial unbalance readings taken on the fan at 1546 RPM showed approximately .8 mils of displacement on Bearing #1 and 2.4 mils of displacement on Bearing #2. After balancing the fan on the Bearing #2 side, the final readings were .6 mils on Bearing #1 and 2.2 mils on Bearing #2. This corresponds to Smooth and Good on the Vibration Severity Chart.

The final vibration velocity reading taken on the overall system remained at .1 ips which is at the high end of the Smooth range.

Balmac performed the fan balancing operation on 11-6-98.

Regards,
BALMAC, INC.

Steve Crawford
Vice President—Sales & Marketing
Enclose: Vibration Severity Chart

We Accept VISA and MasterCard

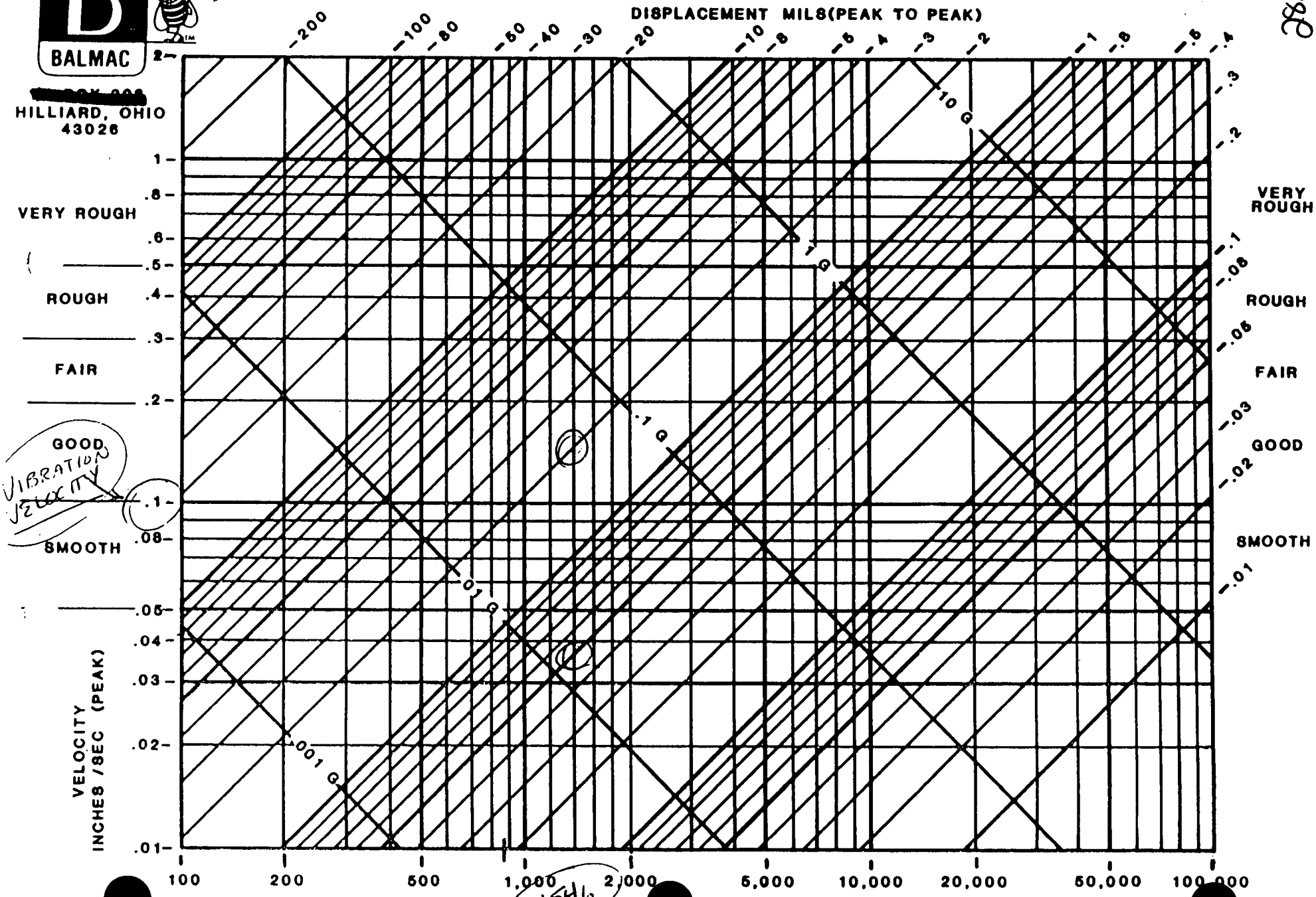
281

2291

BALMAC

[redacted]
HILLIARD, OHIO
43026

VIBRATION SEVERITY CHART



1546

PH. 6[illegible] 6-1295 TELEX 469944 (BALMAC HLRD OH)

1f. - Rapping Set-up

AUTOMATIC RAPPING SET-UP

	Time Interval
Inlet Screen	3 hours, 0 minutes
Field 1	3 hours, 0 minutes
Field 2	9 hours, 0 minutes
Field 3	1 day, 3 hours
Field 4	3 days, 18 hours

Notes:

1. The rapping air pressure was maintained at 40 psi.
2. The duration of the rapping was set at 5 seconds.
3. The rapping speed or frequency was about 1 in/out stroke per second.
4. The hopper vibrators were set up to vibrate for 20 seconds every 10 minutes.
5. All rapping and vibrating was performed in manual during the 3 day test period. Rapping was not initiated during emissions testing.

229 1

RAPPING OPTIMIZATION

UT TIME: 08:35:13

IALS OR Q TO QUIT----> tjm

JOB NAME	=	ENVITCO	
EP SIZE - CSA	=	25	
FIELDS	=	4	
LEVELS HIGH	=	1	
PLATE SPACING	=	100	MM (80 OR 100 MM)
INLET SCFMD	=	1,500	SCFMD
INLET PARTICULATE	=	0.7	GR/SCFD

DO YOU WISH TO MODIFY INPUT ? DEFAULT = N0

DO YOU WISH TO MODIFY DEFAULT DATA ? DEFAULT = N0

DEFAULT VALUES		FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5
LLECTION EFFY (%)		85	85	85	85	85
APPING POINT (IN)		0.1	0.1	0.1	0.1	0.1
DENSITY (LB/FT^3)		5	5	5	5	5
RAPPING METHOD		3	3	3	3	3
1-SINGLE PLATE	--	15	% RE-ENTRAINMENT			
2-TWO CYLINDER	--	25	% RE-ENTRAINMENT			
3-THREE CYLINDER	--	20	% RE-ENTRAINMENT			
RAPPING POSITIONS		2	2	2	2	2
ACTUAL EP TOTAL		9				

USE ARROWS TO INPUT DATA - PRESS ENTER TO CONTINUE

285

2291

RESULTS	FIELD 1	FIELD 2	FIELD 3	FIELD 4
ENTRAINMENT (%)	20	20	20	20
PLATE AREA (FT^2)	549	549	549	549
PARTIC IN (LB/MIN)	0.150	0.048	0.015	0.005
PARTIC OUT (LB/MIN)	0.048	0.015	0.005	0.002
OPTIMUM VALUES:				
INTERVAL COUNTER	1.00	3.13	9.77	30.52
INTERVAL TIME (MIN)	19.93			
RAP INTERVAL (HRS)	2.99	9.34	29.20	91.25
ACTUAL VALUES:				
INTERVAL COUNTER	1	3	9	30
INTERVAL TIME (MIN)	19			
RAP INTERVAL(HRS)	2.85	8.55	25.65	85.50

AVG EMMISION: 0.0073 GR/SCF (INCLUDES RAPPING)
MAX EMMISION: 2.1357 GR/SCF (5 MIN AVG)

Old Setup
F1 1.178
F2 3.174
F3 8.292
F4 26.223

286

1g. - Spare Parts List

Mobile EP Recommended Spare Parts

November 25, 1998

Equipment Description	Notes	Recommended Quantity
Lumigraph	McGill Stk. #673040	1
J-Type Thermocouple		1
High Voltage Insulator w/Gaskets	McGill Stk. #685445	1
High Voltage Insulator w/Gaskets	McGill Stk. #672230	1
HV Termination Kit	3M5696-K	2
Control Panel Light Bulbs		6
Flow Meter (Wet Operation)	0 - 30 gpm	1
Silicon Controlled Rectifier	HDR 480V, Phase Fired, 15A, 0-10VDC Input	1
Action Pak Power Supply	#9050-105 McGill Stk. #673053	1
Overload Heater Element	Allen Bradley W-61	3
Rapping Cylinder	AFP 200A-2-SD-S1B-01000-AB	2
20 Amp Fuse	Tron FNQ20	3
1 Amp Fuse	Limitron KTK	2
Overload Heater Elements	Allen Bradley W-42	3
Overload Heater Elements	Allen Bradley W-48	3
15 Amp Fuse	Fusetron FNM	3
10 Amp Fuse	Bussman Gbb-10	3
3 Amp Fuse	Littlefuse FLM	1
2 Amp Fuse	Fusetron FNM	1
½ Amp Fuse (24VAC Power Fuse)	Fusetron FNM	1
Rapping Solenoid Valves	McGill Stk. #687527	1
Bolts for Air Cylinders		2
Fan Belts		2
Screw Conveyors Belts		2
Door Gasketing	McGill Stk. #639634	
Fan Damper Actuator	L&N Series, 102f0	1
TR Feedback Transmitter	Telmar #51500	1
PLC 5/10 Processor	Allen-Bradley 1786-LT4	1
PLC Processor Power Supply	Allen-Bradley 1771-P7	1

Mobile EP Recommended Spare Parts

November 25, 1998

Equipment Description	Notes	Recommended Quantity
120 VAC Input Module	Allen-Bradley 1771-IAD	1
24 VAC Input Module	Allen-Bradley 1771-IND	1
120 VAC Output Module	Allen-Bradley 1771-OAD	1
120 VAC Output Module	Allen-Bradley 1771-OA	1
24 VAC Output Module	Allen-Bradley 1771-OND	1
Isolated Analog Input Module	Allen-Bradley 1771-IL	1
Analog Input Module	Allen-Bradley 1771-IFE	1
Analog Output Module	Allen-Bradley 1771-OFE1	1
Analog Output Module	Allen-Bradley 1771-OFE2	1
AC Current Transmitter	0-100A, 4-20 ma DC, 2 wire	1
Temperature Transmitter	Wilkerson MM413OL	1
Control Relay	Potter & Brumfield #KRP5AG	1
Pressure Transmitters	Rosemount	1
Filter Capacitors 10μf 250V	10 Microfarad, 250V	4
24VPC Power Supply	McGill Stk. #673045	1

DTP:ejs:1645L

1h. - Calibration Data

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY _____

INSTRUMENT TYPE OR MEASURING DEVICE DUCT PRESSURE TRANSMITTER

MANUFACTURER _____

MODEL _____

SERIAL NO. OR PERMANENT ID NO. _____

REFERENCE STANDARD DEVICE _____

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE) _____

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
4mA	0.02"		
12mA	7.55"		
20mA	14.98"		

CALIBRATION PERFORMED BY Wade Shoemaker

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY

INSTRUMENT TYPE OR MEASURING DEVICE FLD / KILOVOLT READINGS

MANUFACTURER

MODEL

SERIAL NO. OR PERMANENT ID NO.

REFERENCE STANDARD DEVICE

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
~~21.4 KV~~			
0 KV	0 KV		
21.4 KV	20.2 KV		
40.1 KV	40 KV		

CALIBRATION PERFORMED BY Wade Shoemaker

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY

INSTRUMENT TYPE OR MEASURING DEVICE FLD / milliamp READINGS

MANUFACTURER

MODEL

SERIAL NO. OR PERMANENT ID NO.

REFERENCE STANDARD DEVICE

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
0.0mA	0.3mA		
2.0mA	2.1mA		
11mA	10.5mA		

CALIBRATION PERFORMED BY Wade Shoemaker

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY _____

INSTRUMENT TYPE OR MEASURING DEVICE FLD 2 KILOVOLT READINGS

MANUFACTURER _____

MODEL _____

SERIAL NO. OR PERMANENT ID NO. _____

REFERENCE STANDARD DEVICE _____

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE) _____

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
0.0 KV	0.2 KV		
20 KV	20.5 KV		
39 KV	39.9 KV		

CALIBRATION PERFORMED BY Wade Shoemaker

calib1.xls

294

229 1

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY

INSTRUMENT TYPE OR MEASURING DEVICE FLD 2 milliamp Readings

MANUFACTURER

MODEL

SERIAL NO. OR PERMANENT ID NO.

REFERENCE STANDARD DEVICE

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
0.0 mA	0.3 mA		
2.35 mA	2.6 mA		
18.18 mA	18.6 mA		

CALIBRATION PERFORMED BY Nate Skoomba

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY

INSTRUMENT TYPE OR MEASURING DEVICE FLO 3 KILOVOLT READING

MANUFACTURER

MODEL

SERIAL NO. OR PERMANENT ID NO.

REFERENCE STANDARD DEVICE

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
0.0KV	0.7KV		
18KV	19KV		
39KV	39.9KV		

CALIBRATION PERFORMED BY Wade Shoemaker

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY _____

INSTRUMENT TYPE OR MEASURING DEVICE FLD 3 MILLIAMP READINGS

MANUFACTURER _____

MODEL _____

SERIAL NO. OR PERMANENT ID NO. _____

REFERENCE STANDARD DEVICE _____

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE) _____

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
0.0 mA	0.3 mA		
0.81 mA	1.3 mA		
6.53 m	7.0 mA		

CALIBRATION PERFORMED BY Wade Shoemaker

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY

INSTRUMENT TYPE OR MEASURING DEVICE FLO 4 milliamp READINGS

MANUFACTURER

MODEL

SERIAL NO. OR PERMANENT ID NO.

REFERENCE STANDARD DEVICE

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
0.0 mA	0.0 mA		
9 mA	8.2 mA		
12 mA	12.5 mA		

CALIBRATION PERFORMED BY Rick Shoemaker

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 12-1-98

REQUIRED CALIBRATION FREQUENCY

INSTRUMENT TYPE OR MEASURING DEVICE FLD 4 KV READINGS

MANUFACTURER

MODEL

SERIAL NO. OR PERMANENT ID NO. Ø

REFERENCE STANDARD DEVICE

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
0.0KV	0.0KV		
22KV	20.6KV		
34KV	32.4KV		

CALIBRATION PERFORMED BY Wade Stevenson

calib1.xls

2291

CALIBRATION RECORD FORM

CALIBRATION DATE 11-30-98

REQUIRED CALIBRATION FREQUENCY

INSTRUMENT TYPE OR MEASURING DEVICE INLET TEMP

MANUFACTURER

MODEL

SERIAL NO. OR PERMANENT ID NO.

REFERENCE STANDARD DEVICE

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)

REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
70.1	70.7		
100	95.7		
200	195.1		
300	296.7		
400	398.5		
500	500.4		

CALIBRATION PERFORMED BY Wade Shoemaker

calib1.xls

300

2291

CALIBRATION RECORD FORM

CALIBRATION DATE_____

REQUIRED CALIBRATION FREQUENCY_____

INSTRUMENT TYPE OR MEASURING DEVICE OUTLET TEMP & OFFTAKE TEMP

MANUFACTURER_____

MODEL_____

SERIAL NO. OR PERMANENT ID NO._____

REFERENCE STANDARD DEVICE_____

IS REFERENCE DEVICE NIST TRACEABLE? (ATTACH CERTIFICATE)_____

	REFERENCE STANDARD VALUE	INDICATED VALUE	ACCEPTABLE VARIANCE	IS DEVICE WITHIN TOLERANCE
OUTLET TEMP	70.1	69.9		
	100	96.2		
	200	195.0		
	300	296.2		
	400	398.5		
	500	500.4		
OFFTAKE TEMP	70.1	68.8		
	100	98		
	200	197.2		
	300	299.4		
	400	398.6		
	500	501.0		

CALIBRATION PERFORMED BY Wade Shoemaker

Listing for Exhibit 2

EXHIBIT 2 - PROCESS AND CUSTOMER INFORMATION

2a. - CETL Brochure and Map

2b. - Operators Log Sheets

2c. - Graph of Propane Flow VS. Differential Pressure

2d. - Graph of Burner Airflow VS. Pressure

2e. - Melter Exhaust Duct Drawings

2a. - CETL Brochure and Map

LICENSES AND PERMITS

Radioactive Material License:

- Atomic Nos. 2 - 92: 2 curies
- Atomic Nos. >92: 100 millicuries
- Tritium: 10 curies
- Source Material: 1000 kilograms
- Special: 350 grams ^{235}U
  200 grams ^{233}U
  200 grams Pu

Hazardous Waste Treatability Exemptions

Daily Treatment Limits:
- Contaminated Media
  10,000 kg w/non-acute haz waste
  2,500 kg w/acute haz waste
- Other
  250 kg non-acute
  1 kg acute

Storage: (Total material onsite not to exceed 10,000 kg)
- Contaminated Media
  10,000 kg w/non-acute haz waste
  2,500 kg w/acute haz waste
- Other
  1,000 kg non-acute haz waste
  1 kg acute haz waste

Air Permit

Due to the limit amount of hazardous materials processed during treatability studies, the CETL has been exempted from air quality permits.

204

RESEARCH PARTNERSHIPS

Clemson University
in Partnership
with Industry for:

Treatment process development

Process demonstration

Proprietary technology evaluation

For Additional Information contact:

Donald L. Erich
Telephone: (864) 646-2413 x207
Fax: (864) 656-7310
email: derich@clemson.edu
http://www.ces.clemson.edu/cetl

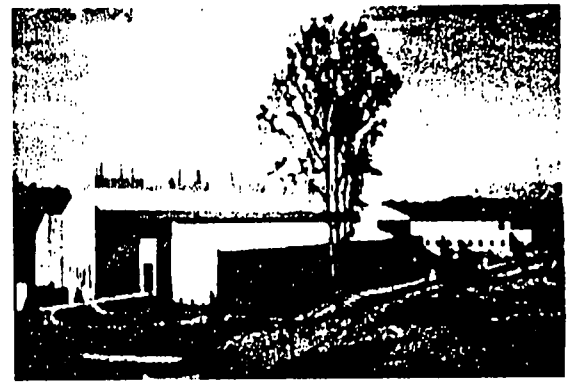
Clemson Environmental
Technologies Laboratory

Clemson University

100 Technology Drive
Anderson, SC 29625

CLEMSON ENVIRONMENTAL TECHNOLOGIES LABORATORY

Clemson University



SUPPORTING WASTE TREATMENT TECHNOLOGY DEVELOPMENT, DEMONSTRATION & DEPLOYMENT

- STATE OF THE ART FACILITY
  - Analytical Laboratories
  - Technology Development & Demonstration Laboratories
  - High Bay/Pilot Plant
- LICENSES & PERMITS
- EXPERIENCED STAFF
- ACCESS TO OTHER UNIVERSITY RESOURCES

TECHNOLOGY DEVELOPMENT & DEMONSTRATION LABORATORIES

Hazardous and Mixed-Waste Capability

Bench Scale Development and Demonstration of Concept

- Vitrification (crucible studies)
- Thermal treatment
- Chemical stabilization
- Waste form durability testing

Pilot-Scale Equipment Operation for Technology Demonstration and Evaluation

Full Complement of Utilities, Process Monitoring and Containment - Including Offgas Treatment and Byproduct Waste Collection/Treatment.

Selected Prior Research:

Optimization of glass formulations for vitrification of low-level and mixed wastes from DOE sites.

Evaluation of proprietary chemical waste-stabilization formulations for a commercial client.

Design and assembly of a dry, glove box-contained offgas system for a Pu melter.

Site preparation, set up and operational support for the Transportable Vitrification System, a full-size mixed waste treatment facility.

Processing Equipment:

- Envitco WASTE-VIT MM-005 & EV-16 (Joule-heated, continuous feed, 1,000 lb. glass/day)
- Stir Melter (Joule-heated, continuous feed, 250 lb. glass/day)
- EPI DC-Arc Melter (Contained graphite arc, batch feed, 100 lb. capacity)
- Ceramic brick extrusion press and kilns

ANALYTICAL LABORATORIES

Hazardous and Mixed-Waste Capability

Waste Characterization, Offgas Analysis and Stabilized Product Analysis

Metals Lab Instrumentation:

- ICP
- AA (flame, GFAA, and cold vapor)
- Ion Chromatography
- Spectrophotometry

Organics Lab Instrumentation:

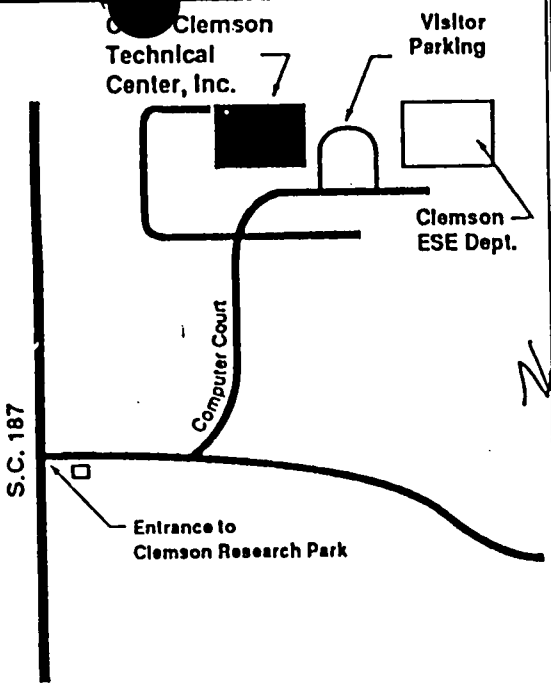
- Gas Chromatography
  - GC/MS
  - GC/FID
  - GC/EC

Radionuclides Lab Instrumentation:

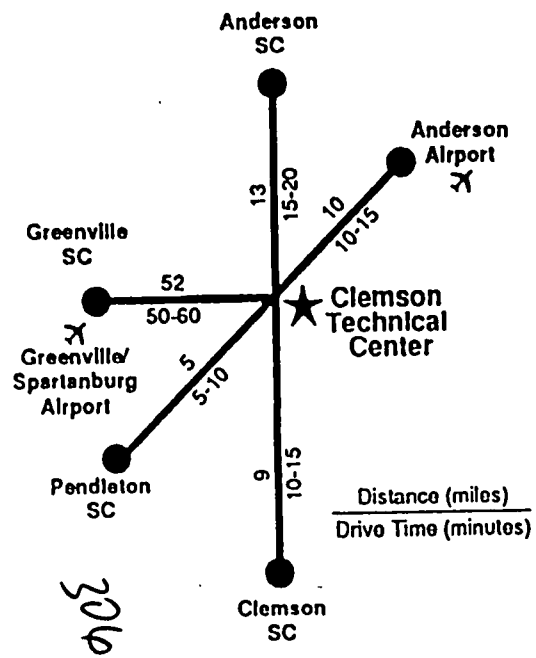
- Alpha/Beta Counters
- Alpha Spectrometers
- Gamma Spectrometers
- Liquid Scintillation Counters

Other

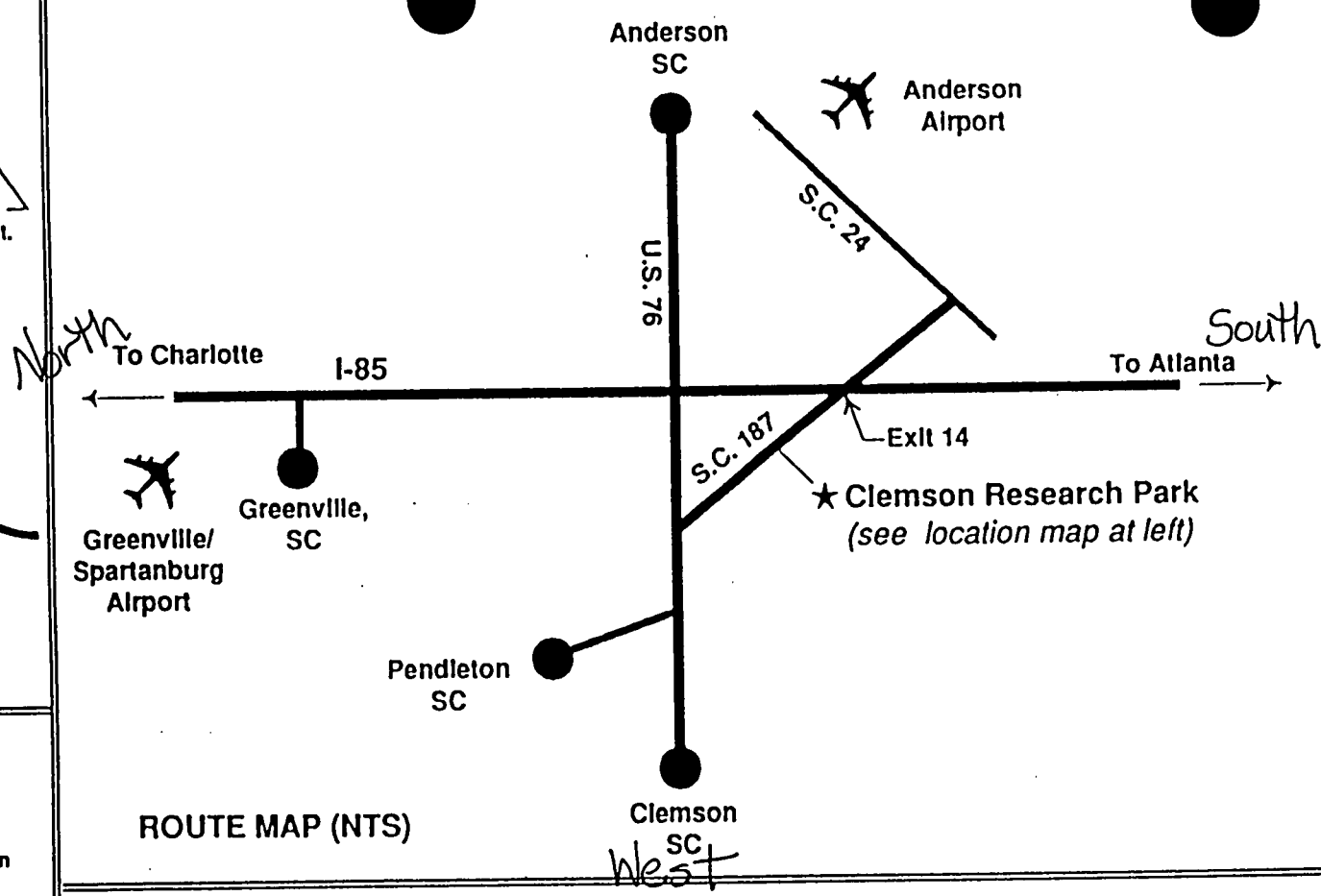
- X-ray Fluorescence (B - U)



LOCATION MAP



TIME/DISTANCE CHART



ROUTE MAP (NTS)

DIRECTIONS

FROM GREENVILLE/SPARTANBURG AIRPORT (50 Miles)

1-85 South toward Atlanta (47 miles ±) to Exit 14 (S.C. Hwy. 187). Right on 187 toward Clemson to Clemson Research Park entrance (3 miles ±) on left. Turn into Park, take first (and only) left onto Computer Court.

FROM ANDERSON AIRPORT (10 Miles)

Left onto S.C. Hwy. 24, crossing Lake Hartwell (6 miles ±). Right onto S.C. Hwy. 187 North at Garrett's Fish and Marine, crossing 1-85, to Clemson Research Park entrance on left (4 miles ±). Turn into Park, take first (and only) left onto Computer Court.

2291

2b. - Operators Log Sheets

PG Cop 8

2291

POPT EV-101 DATA LOG SHEET

CONTROL PANEL: _____

	Control Point	Location	Data Collected	Detection Device	Range							
					Date	1/21	1/21	1/21	1/21	1/21	1/21	
					Time	0600	0700	0800	0900	DW	HEC	
					By	RDM	RDM	RDM	LT	LT	LT	
100	Offgas Offtake Temperature	offgas module	deg. C	Type ? TC	120-400 C	207.4	208.8	213.0	206.8		204.9	
101	Furnace Pressure	plenum	inches WC	Rosemount DP	-0.1 to -0.01	-0.00	-0.06	-0.09	-0.10		-0.10	
102	Offgas Inlet Temperature	offgas module	deg. C	Type ? TC	>100 C	189.5	191.1	189.2	189		187.7	
103	Offgas Duct Pressure	offgas module	inches WC	Rosemount DP	-6.0 to -2.0	-5.46	-5.43	-5.45	-5.43		-5.43	
104	Field 1	offgas module	kV	power monitor		35.1	35.5	34.9	34.9		34.8	
105	Field 1	offgas module	mA	power monitor		9.4	9.1	9.5	9.4		9.4	
106	Field 2	offgas module	kV	power monitor		29.9	28.0	26.7	27.4		26.3	
107	Field 2	offgas module	mA	power monitor		11.5	9.2	7.8	9.1		8.0	
108	Field 3	offgas module	kV	power monitor		37.1	35.6	36.4	34.7		34.3	
109	Field 3	offgas module	mA	power monitor		11.6	10.2	11.1	9.8		9.6	
110	Field 4	offgas module	kV	power monitor		30.1	30.7	29.9	28.2		28.6	
111	Field 4	offgas module	mA	power monitor		12.5	12.7	12.3	10.3		10.9	
112	Opacity	offgas module	%			0	0	0	0		0	
113	External Damper	offgas module	%			7.4	7.7	7.4	7.4		7.1	
114	Outlet Temperature	offgas module	deg. C	Type ? TC		110.3	112.0	112.3	111.9		113.3	
115	Exhaust Fan	offgas module	Amps	power monitor		17.2	17.2	18.7	18.1		18.8	
116	Power Module Cooling Fan	power module	pass/fail			Pass	Pass	Pass	pass	pass	pass	
117	Pulse-Air Mixers	high bay ext.	pass/fail			Pass	Pass	Pass	pass	pass	pass	
118	glass drain rate	conveyor load cells	kg/min	stopwatch/ load cells	0.15-0.4 kg/min	0.32	0.32	.2	0.28	0.26		
199	Slurry strainer differntial pressure	slurry feed tank	delta P	pressure gauge	< 5 psi		3	2	3	2	* —	—
120	Combustion Skid Propane Diff Press	Combustion Skid	in. wg.	Magnehellic DP gauge	0.2-2.5 in. wg.		1.0	1.0	1.0	1.0	1.0	0.1
121	Combustion Air Pressure	Level 3 Torch	osi	pressure gauge	0-5 osi		2.0	2	2	2	2	
122	Compressed Air Pressure	Level 2 Melter	psi	pressure gauge	80-110 psi		85	84	84	88	84	86

Surging

*using redundant feed loop

308

POPT .01 DATA LOG SHEET

CONTROL PANEL: _____

						Date	1/20	1/20	1-20	1-20	1/20	1-20	1-20	1-20	1-20	1/20	1-20	1-20	1/21 RDW	1/21	1/21	1/21	1/21
						Time	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500
	Control Point	Location	Data Collected	Detection Device	Range	By	LT	LT	KJH	KJH	DCR	KJH	JP	JP	KJH	DCR	KJH	JP	RDW	MCW	MCW	MCW	RDM
100	Offgas Offtake Temperature	offgas module	deg. C	Type ? TC	120-400 C		191.3	202.4	201.1		195.3	197.4	212.5	204.9	206.1	203.3	203.6	214.5	207.9	207.6	206.3	204.9	205.1
101	Furnace Pressure	plenum	inches WC	Rosemount DP	-0.1 to -0.01		-0.04	-0.07	-0.08		-0.09	-0.09	-0.10	-0.10	-0.09	-0.10	-0.09	-0.09	-0.09	-0.09	-0.08	-0.09	-0.10
102	Offgas Inlet Temperature	offgas module	deg. C	Type ? TC	>100 C		173.0	176.8	183.2		179.1	181.2	192.9	188.5	189.1	187.0	186.9	195.8	189.6	189.5	188.0	188.3	188.7
103	Offgas Duct Pressure	offgas module	inches WC	Rosemount DP	-6.0 to -2.0		-5.11	-5.28	-5.28		-5.32	-5.36	-5.49	-5.41	-5.39	-5.41	-5.43	-5.43	-5.44	-5.41	-5.45	-5.43	-5.44
104	Field 1	offgas module	kV	power monitor			34.6	34.5	34.4		34.5	34.4	34.6	34.7	34.8	35.0	34.9	34.9	35.4	35.2	35.1	35.2	36.0
105	Field 1	offgas module	mA	power monitor			9.1	9.1	9.2		9.3	9.3	9.3	9.4	9.4	9.4	9.5	9.5	9.2	9.4	9.4	9.4	9.5
106	Field 2	offgas module	kV	power monitor			31.8	31.3	30.2		31.0	29.7	29.2	29.7	31.5	31.9	26.6	27.5	26.1	27.5	31.7	30.3	26.7
107	Field 2	offgas module	mA	power monitor			13.4	12.6	11.7		13.5	10.9	11.3	10.9	13.1	13.4	8.0	8.7	8.4	8.7	13.7	11.8	7.5
108	Field 3	offgas module	kV	power monitor			33.1	37.2	34.3		37.4	37.4	39.1	35.5	39.3	37.9	37.0	36.3	32.3	34.7	38.1	37.5	34.2
109	Field 3	offgas module	mA	power monitor			9.8	12.5	10.1	Online	12.7	12.5	14.3	8.0	12.2	12.4	11.5	10.8	7.7	9.5	12.5	13.0	9.2
110	Field 4	offgas module	kV	power monitor			29.6	27.9	30.7		26.9	28.8	29.4	28.6	30.8	29.3	30.5	29.1	23.5	28.1	25.5	31.4	30.8
111	Field 4	offgas module	mA	power monitor			12.7	11.1	14.2		12.0	11.7	11.3	11.7	13.3	12.4	14.2	12.3	6.4	11.4	9.7	13.4	13.4
112	Opacity	offgas module	%				0	0	0	McGill	0	0	0	0	0	0	0	0	0	0	0	0	0
113	External Damper	offgas module	%				7.4	7.2	7.2		7.4	7.2	7.4	7.4	7.4	7.4	7.5	7.4	7.7	7.3	7.4	7.3	7.5
114	Outlet Temperature	offgas module	deg. C	Type ? TC			113.3	112.2	113.9		112.0	113.3	111.5	112.9	114.4	112.5	112.5	112.4	112.9	112.2	111.8	112.4	114.9
115	Exhaust Fan	offgas module	Amps	power monitor			18.6	17.8	18.2		18.4	18.8	18.8	18.8	17.9	18.5	18.9	18.4	17.4	17.9	18.1	17.6	17.8
116	Power Module Cooling Fan	power module	pass/fail				pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
117	Pulse-Air Mixers	high bay ext.	pass/fail				pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
118	glass drain rate	conveyor load cells	kg/min	stopwatch/ load cells	0.15-0.4 kg/min		0.23	0.32	0.24	0.27	0.23	0.26	0.34	0.28	0.23	0.24	0.22	0.26	0.31	0.29	0.31	0.16	.27
199	Slurry strainer differntial pressure	slurry feed tank	delta P	pressure gauge	< 5 psi		2	2	1	2	3	2	2	1	2	3	1	1	3	3	2	3	3
120	Combustion Skid Propane Diff Press	Combustion Skid	in. wg.	Magnehellic DP gauge	0.2-2.5 in. wg.		1	1	0.8	0.8	1.0	.9	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0
121	Combustion Air Pressure	Level 3 Torch	osi	pressure gauge	0-5 osi		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
122	Compressed Air Pressure	Level 2 Melter	psi	pressure gauge	80-110 psi		86	86	86	82	86	86	86	86	86	86	86	86	86	82	82	84	82

POPT 101 DATA LOG SHEET

CONTROL PANEL: _____ 1-20 RW

	Control Point	Location	Data Collected	Detection Device	Range	Date																
						Time																
						By																
100	Offgas Offtake Temperature	offgas module	deg. C	Type ? TC	120-400 C		195.2	194.9	198.4	197.1	195.7	198.4	198.3	197.8	197.6	197.6	198.2	194.8		198.0	197.1	206.1	195.3
101	Furnace Pressure	plenum	inches WC	Rosemount DP	-0.1 to -0.01		-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.05		-0.07	-0.06	-0.07	-0.08
102	Offgas Inlet Temperature	offgas module	deg. C	Type ? TC	>100 C		179.9	179.1	182.4	182.3	180.8	182.8	182.8	182.4	181.6	181.5	182.0	179.4		182.4	181.8	185.3	179.4
103	Offgas Duct Pressure	offgas module	inches WC	Rosemount DP	-6.0 to -2.0		-5.40	-5.40	-5.37	-5.37	-5.38	-5.35	-5.35	-5.39	-5.40	-5.42	-5.42	-5.40		-5.41	-5.37	-5.34	-5.30
104	Field 1	offgas module	kV	power monitor			36.2	36.5	37.0	36.6	36.8	36.8	36.7	36.9	36.6	36.7	36.7	37.0		35.7	35.3	35.3	34.6
105	Field 1	offgas module	mA	power monitor			9.9	9.9	9.6	10.0	9.9	9.9	9.9	9.8	10.0	10.2	9.9	9.8		9.0	9.2	9.2	9.3
106	Field 2	offgas module	kV	power monitor			32.0	31.4	29.3	25.7	32.3	22.9	28.3	28.1	24.3	21.7	31.2	29.4		28.1	31.3	27.8	29.1
107	Field 2	offgas module	mA	power monitor			12.9	11.1	9.9	7.0	13.8	4.7	9.0	8.8	5.7	4.2	11.3	9.9		7.9	12.5	9.3	10.2
108	Field 3	offgas module	kV	power monitor			39.8	38.0	36.2	36.7	38.8	26.8	35.9	36.7	29.8	26.2	37.4	37.6		37.4	39.9	35.7	36.3
109	Field 3	offgas module	mA	power monitor			13.7	11.8	10.0	6.3	12.4	4.1	9.1	10.2	5.5	3.4	10.1	10.8		10.9	13.9	10.1	11.3
110	Field 4	offgas module	kV	power monitor			27.8	30.8	27.5	22.5	26.9	22.9	27.2	27.0	24.9	21.5	27.3	29.5		22.1	31.4	26.1	29.8
111	Field 4	offgas module	mA	power monitor			10.2	13.2	9.8	5.9	9.5	6.2	8.8	9.8	5.1	5.0	10.1	12.6		12.3	13.9	9.1	13.3
112	Opacity	offgas module	%				0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
113	External Damper	offgas module	%				7.4	7.2	7.4	7.4	7.4	7.7	7.1	7.4	8.0	7.4	7.7	7.5		7.4	7.4	7.3	7.1
114	Outlet Temperature	offgas module	deg. C	Type ? TC			108.1	107.8	109.4	110.4	113.5	112.9	111.1	108.5	109.5	109.8	108.1	107.2		105.2	110.7	117.8	113.6
115	Exhaust Fan	offgas module	Amps	power monitor			17.9	18.1	17.9	17.8	18.1	17.8	18.6	17.6	18.8	17.3	17.4	17.7		17.8	17.5	18.8	18.0
116	Power Module Cooling Fan	power module	pass/fail				Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
117	Pulse-Air Mixers	high bay ext.	pass/fail				Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
118	glass drain rate	conveyor loac cells	kg/min	stopwatch/ load cells	0.15-0.4 kg/min		0.24	0.26	0.30	0.30	.26	0.20	0.15	0.19	.20	.20	0.235	0.21	0.22	0.31	0.33		0.31
199	Slurry strainer differntial pressure	slurry feed tank	delta P	pressure gauge	< 5 psi		4	4	2	4	3	3	3	2	2	3	3	3	3	1	2	2	2
120	Combustion Skid Propane Diff Press	Combustion Skid	in. wg.	Magnehellic DP gauge	0.2-2.5 in. wg.		1	1	1	1	1	0.9	1	1	1	1	1	1	1	0.8	1	0.8	0.8
121	Combustion Air Pressure	Level 3 Torch	osi	pressure gauge	0-5 osi		2	2	2	2	2	2	2	2	2	2	2	2		2	2		2
122	Compressed Air Pressure	Level 2 Melter	psi	pressure gauge	80-110 psi		100	100	100+	100+	100+	84	84	85	86	86	87	84	84	82	82	84	

310

229 I

POP7 '01 DATA LOG SHEET

CONTROL PANEL: _____

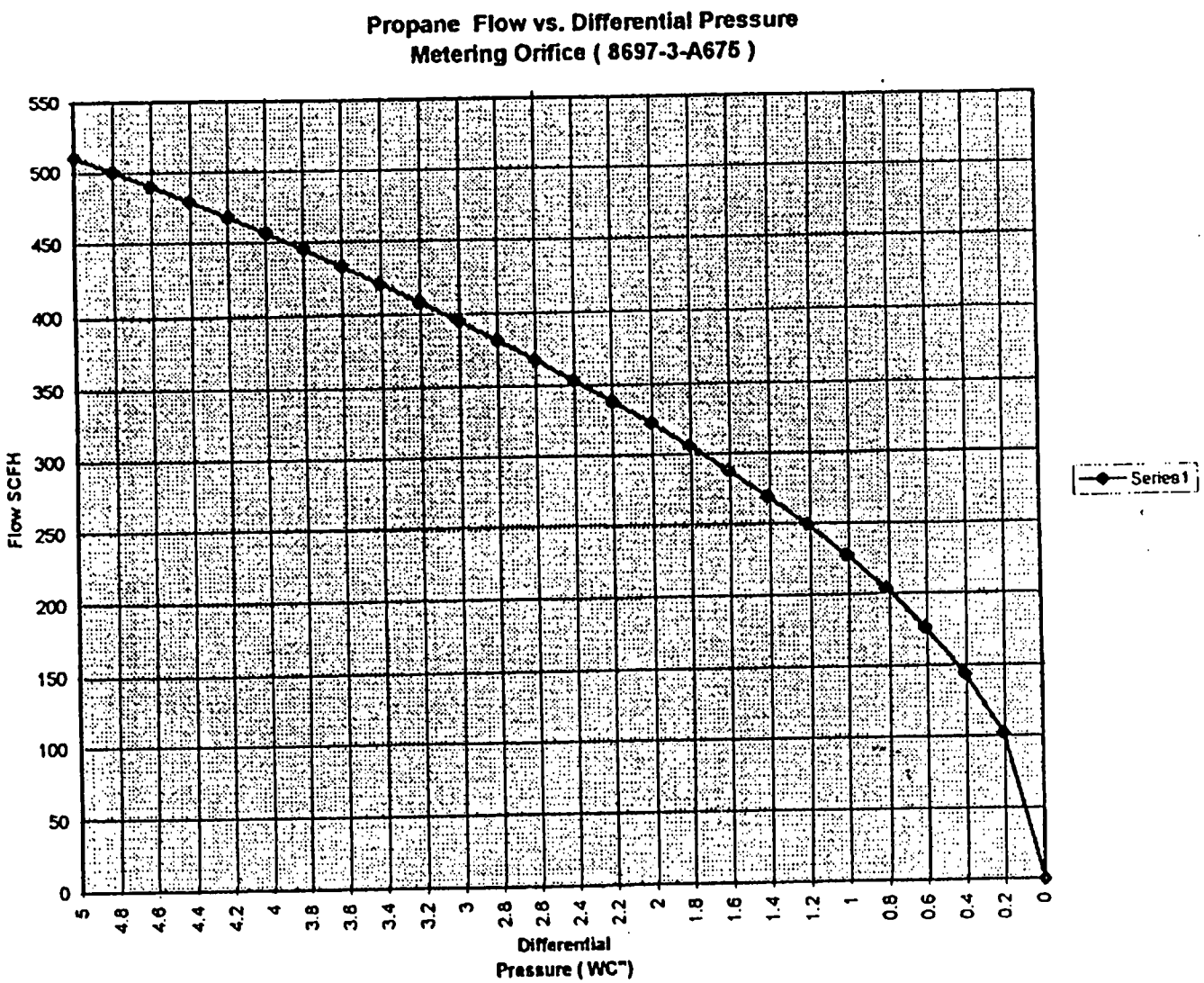
	Control Point	Location	Data Collected	Detection Device	Range	Date	1/19	1/19	1/19	1/19	1/19	1/19	1/19	1/19	1/19	1-19	1/19	1/19	1-19	1-19	1-19	1-19	1/19
						Time	0300	0400	0500	0600	0700	0800	0900	1000	1120	1200	1309	1400	1500	1600	1700	1800	1900
						By	MCW	RDW	RDM	MCW	MCW	MCW	LT	[illegible]	LT	KJH	LT	LT	KJH	LT	LT	KJH	[illegible]
100	Offgas Offtake Temperature	offgas module	deg. C	Type ? TC	120-400 C		182.4	180.7	180.6	185.3	181.6	186.4	190.3			187.2	185.6	187.0		182.4	185.4	187.9	183.3
101	Furnace Pressure	plenum	inches WC	Rosemount DP	-0.1 to -0.01		-0.04	-0.04	-0.05	-0.05	-0.05	-0.04	-0.06	*		-0.06	-0.07	-0.07		-0.04	-0.13*	-0.08	-0.04
102	Offgas Inlet Temperature	offgas module	deg. C	Type ? TC	>100 C		161.6	158.4	158.9	162.8	160.0	163.6	173.9	McGill Unit On-line		172.2	170.5	171.5		168.2	170.9	173.2	170.6
103	Offgas Duct Pressure	offgas module	inches WC	Rosemount DP	-6.0 to -2.0		-4.31	-4.34	-4.35	-4.31	-4.29	-4.33	-4.62			-4.72	-4.64	-4.66		-4.55	-6.94	-5.47	-5.21
104	Field 1	offgas module	kV	power monitor			38.1	38.2	38.1	38.2	38.3	38.2	38.3			37.1	37.1	36.6		36.6	36.0	36.0	36.3
105	Field 1	offgas module	mA	power monitor			9.1	9.1	9.1	9.1	9.0	9.0	9.1			9.4	9.5	9.6		9.4	9.7	9.7	9.7
106	Field 2	offgas module	kV	power monitor			36.7	36.9	34.6	37.5	39.4	36.0	36.0			33.0	34.4	29.1		32.9	33.5	31.0	30.1
107	Field 2	offgas module	mA	power monitor			15.3	15.4	12.8	16.2	12.6	14.0	14.6			11.9	14.7	8.7		11.7	13.8	11.7	11.0
108	Field 3	offgas module	kV	power monitor			45.8	45.9	45.8	42.0	46.5	45.1	46.0			40.6	39.7	35.7		39.1	41.7	44.5	36.6
109	Field 3	offgas module	mA	power monitor			16.9	16.8	16.8	19.0	17.0	15.2	17.0			12.9	12.3	8.7		13.5	14.1	19.7	10.8
110	Field 4	offgas module	kV	power monitor			33.9	33.4	33.3	33.7	33.5	33.7	33.8			32.1	32.3	27.5		33.3	30.9	33.2	30.8
111	Field 4	offgas module	mA	power monitor			12.8	12.1	12.1	12.4	12.1	12.4	12.7			12.1	12.6	7.8	McGill offline	13.6	12.8	14.2	13.0
112	Opacity	offgas module	%				0	0	0	0	0	0	0			0	0	0		0	0	0	–
113	External Damper	offgas module	%				27.2	27.2	27.2	27.1	27.2	27.2	27.3			27.1	27.1	27.1		27.2	27.1	7.8	7.4
114	Outlet Temperature	offgas module	deg. C	Type ? TC			62.4	66.7	66.1	71.2	65.0	63.3	66.1	*		74.6	81.4	78.3		77.1	86.7	100.3	106.1
115	Exhaust Fan	offgas module	Amps	power monitor			19.6	18.7	18.2	18.3	18.3	17.9	18.1			18.7	18.2	18.0		19.3	18.0	18.3	18.6
116	Power Module Cooling Fan	power module	pass/fail				Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	pass	PASS	pass	pass	PASS	PASS	PASS	PASS	PASS
117	Pulse-Air Mixers	high bay ext.	pass/fail				Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	pass	PASS	pass	pass	PASS	PASS	PASS	PASS	PASS
118	glass drain rate	conveyor load cells	kg/min	stopwatch/ load cells	0.15-0.4 kg/min		.19		.22	.22	.18	.22	.15	0.18		0.18	0.23	0.21	0.23	0.27	0.19	0.20	0.23
199	Slurry strainer differntial pressure	slurry feed tank	delta P	pressure gauge	< 5 psi		1	1	2	1	1	1	2	3	2	3	0	4	4	4	1	3	1
120	Combustion Skid Propane Diff Press	Combustion Skid	in. wg.	Magnehellic DP gauge	0.2-2.5 in. wg.		0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.8	0.9
121	Combustion Air Pressure	Level 3 Torch	osi	pressure gauge	0-5 osi		2	2	2	2	2	2	2	–		2	2	2	2	2	2	2	2
122	Compressed Air Pressure	Level 2 Melter	psi	pressure gauge	80-110 psi		102	98	100	102	104	102	102	100	90	95	100	98	100	98	98	100	100

*see log book
JJ

311

2c. - Graph of Propane Flow VS. Differential Pressure

Propane Flow vs. Differential Pressure



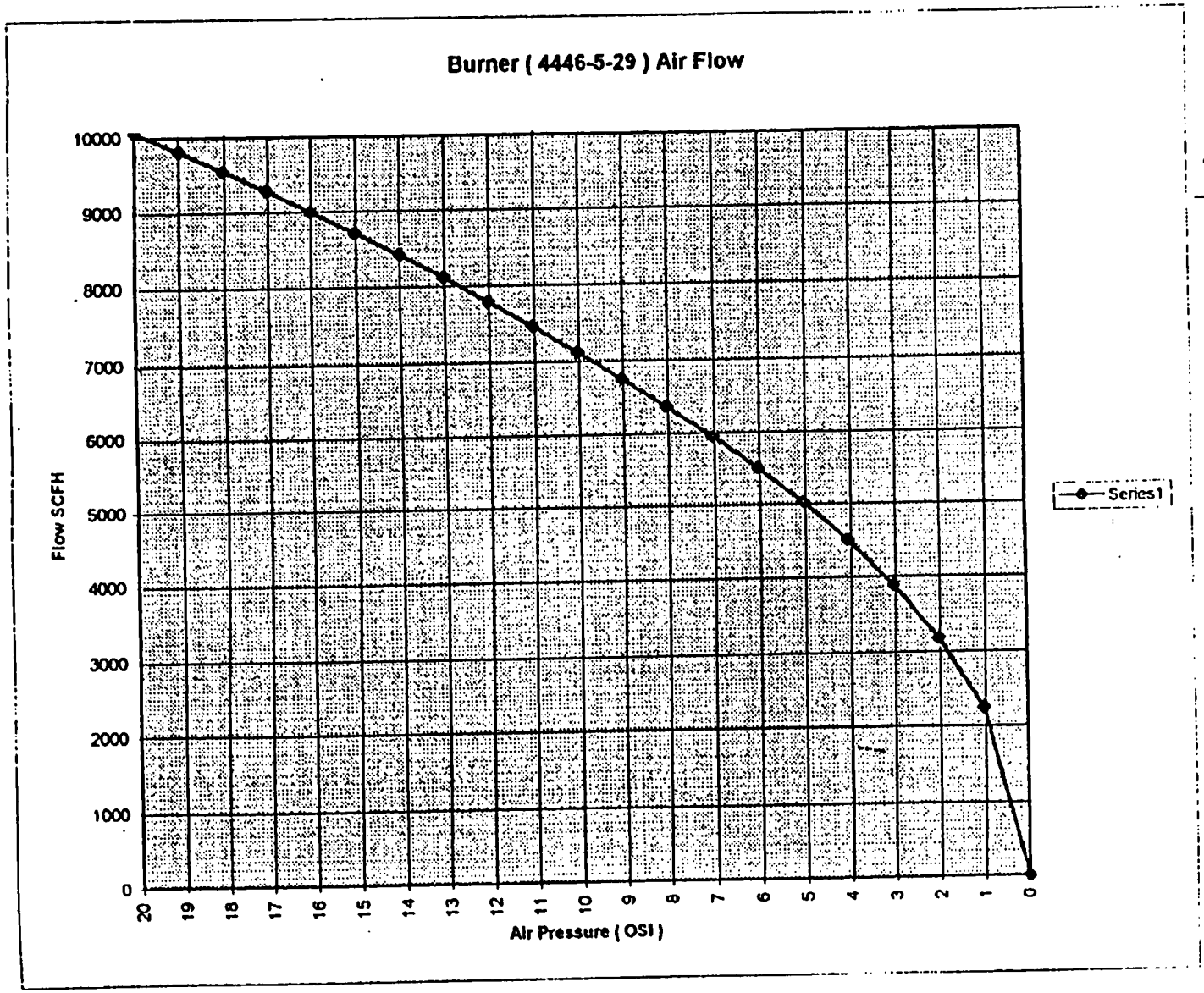
Gas Pressure WC"	Flow Rate SCFH
5	510
4.8	500
4.6	490
4.4	479
4.2	468
4	456
3.8	445
3.6	433
3.4	421
3.2	408
3	395
2.8	382
2.6	368
2.4	354
2.2	339
2	323
1.8	306
1.6	289
1.4	270
1.2	250
1	228
0.8	204
0.6	177
0.4	144
0.2	102
0	0

2291

313

2d. - Graph of Burner Airflow VS. Pressure

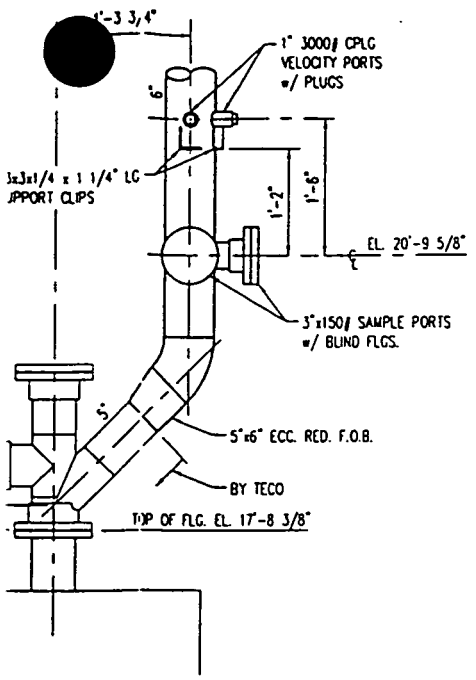
Burner Air Flow vs. Pressure



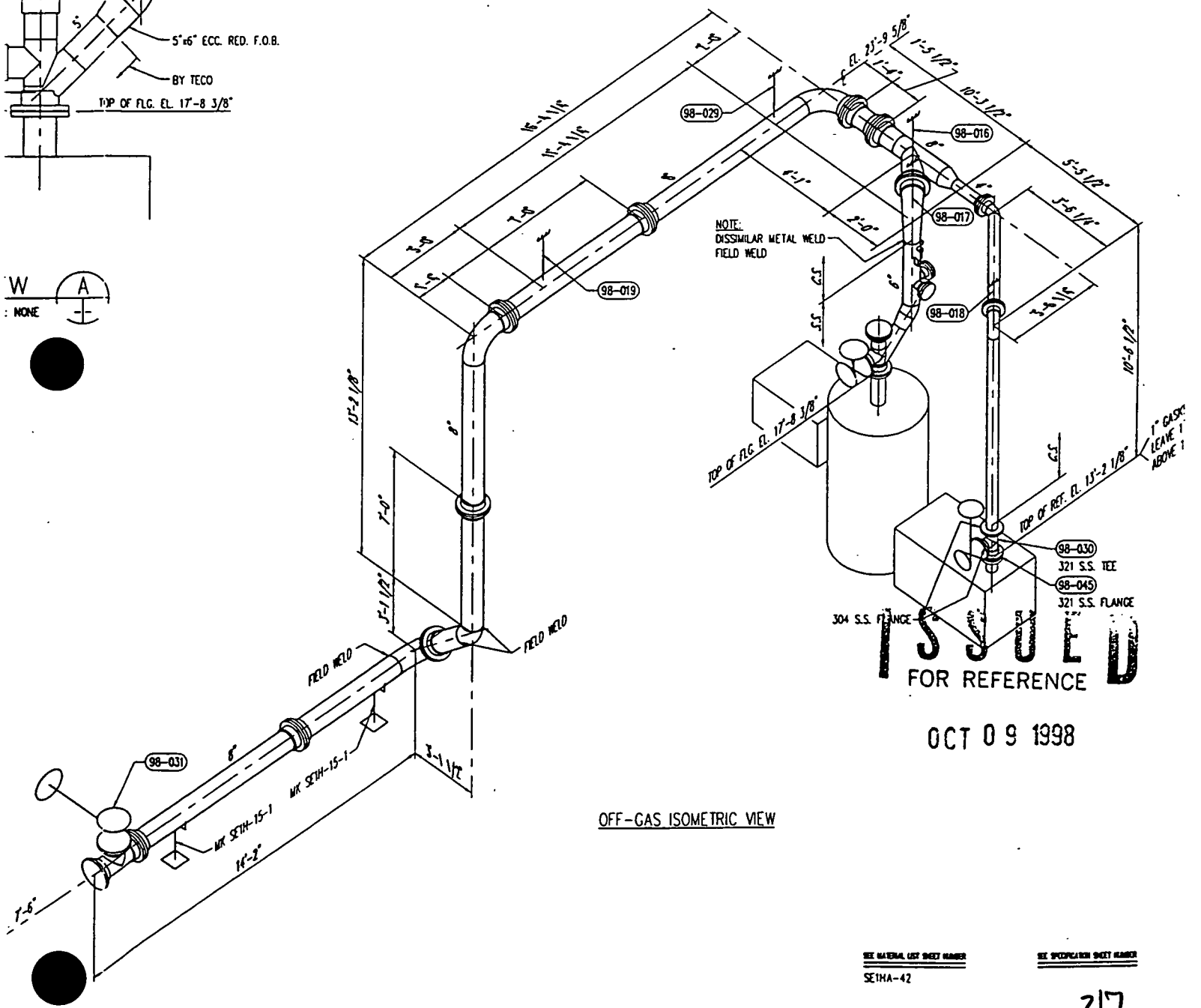
Air Pressure OSI	Flow Rate SCFH
20	10062
19	9808
18	9546
17	9277
16	9000
15	8714
14	8419
13	8112
12	7794
11	7462
10	7115
9	6750
8	6364
7	5953
6	5511
5	5031
4	4500
3	3897
2	3182
1	2250
0	0

Fig 1

2e. - Melter Exhaust Duct Drawings



229 11



ISSUED
FOR REFERENCE
OCT 09 1998

OFF-GAS ISOMETRIC VIEW

SEE MATERIAL LIST SHEET NUMBER
SE1HA-42

SEE SPECIFICATION SHEET NUMBER

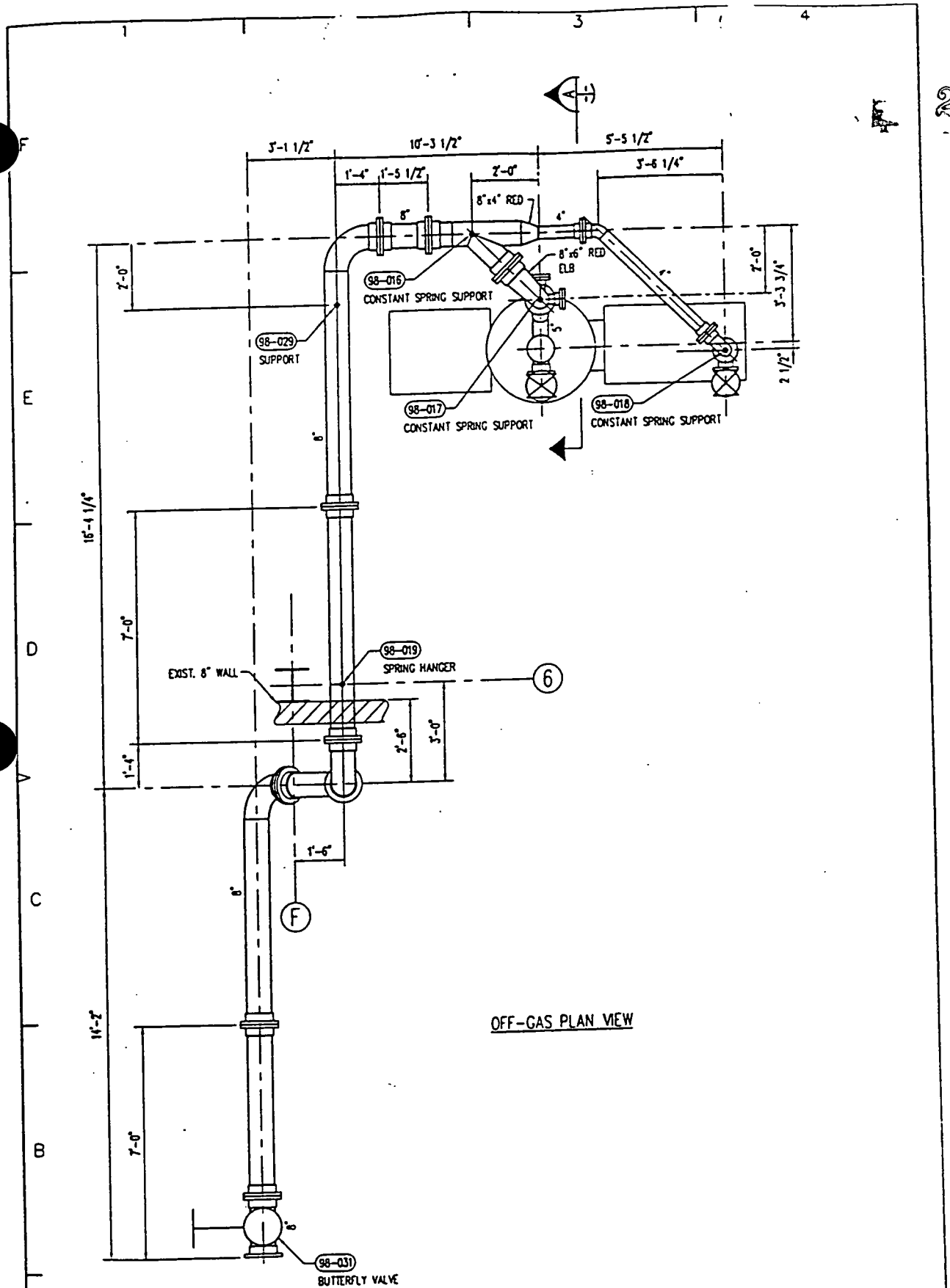
317

COPYRIGHT
© ENVITCO, INC. 1993
This drawing is confidential and comprises proprietary information belonging to ENVITCO INC. All rights of copyright are vested in ENVITCO INC. The drawing is supplied on condition that it will be kept in conditions of security and that no part of the drawing or of any information included thereon may be reproduced, used, disclosed or

EnVitCo, Inc.
8400 W. CENTRAL AVE
SYLVANIA, OHIO 43560

TITLE: OFFGAS COLLECTION DUCT LAYOUT
FOR: EV 101-1998 MODIFICATIONS

2291



OFF-GAS PLAN VIEW

318

Listing for Exhibit 3

EXHIBIT 3 - CHARACTERISTICS OF THE SOURCE EMISSIONS

3a. - Electrical Resistivity Analysis (of the collected particulate matter)

3b. - Aerodynamic Particle Size Analysis (of the collected particulate matter)

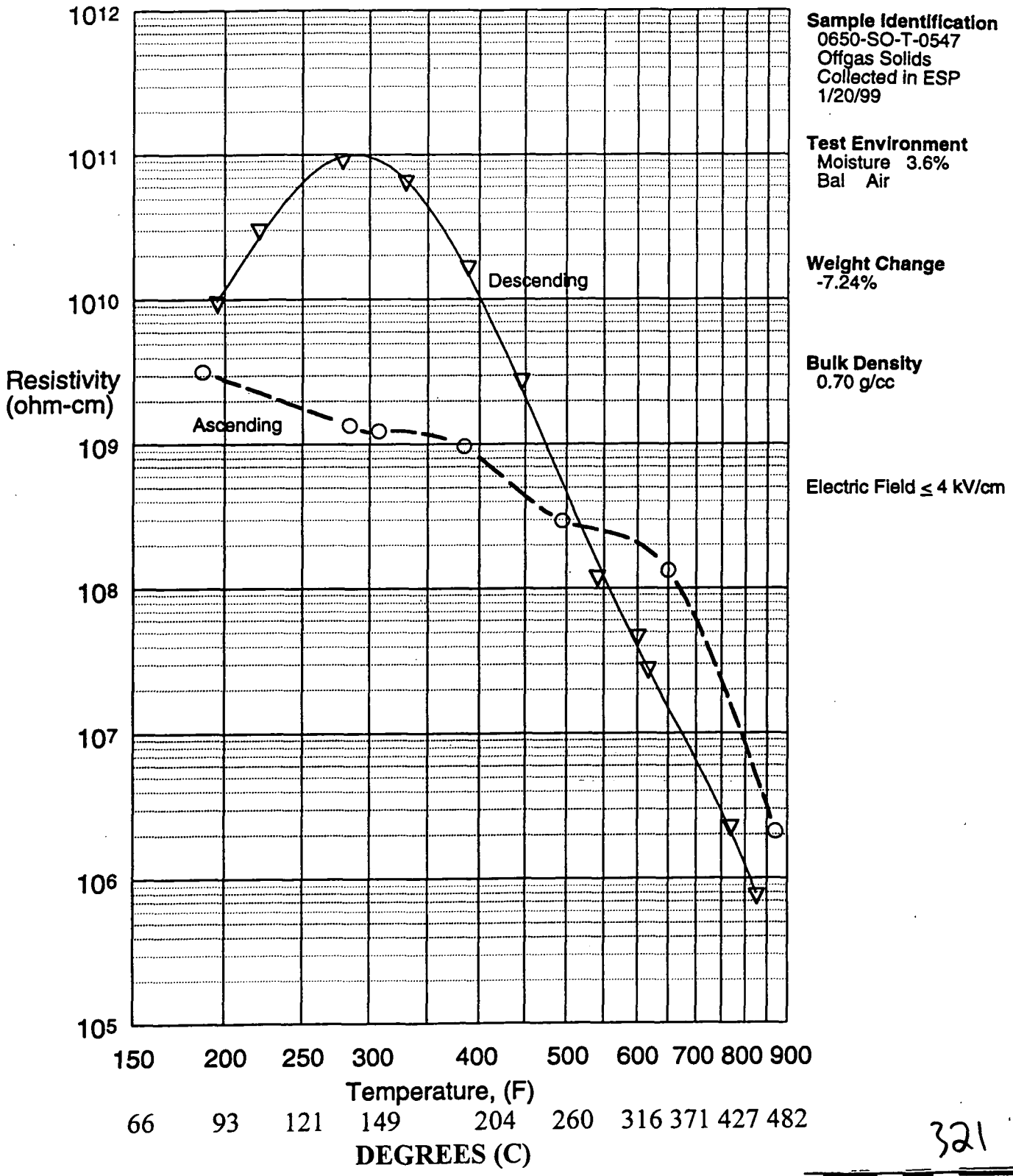
3c. - Chain of Custody Report

3a. - Electrical Resistivity Analysis (of the collected particulate matter)

Figure 3: Resistivity Determined in Accordance with IEEE Standard 548-1984, Ascending and Descending Temperature Modes.

2291

McGill AirClean Corporation



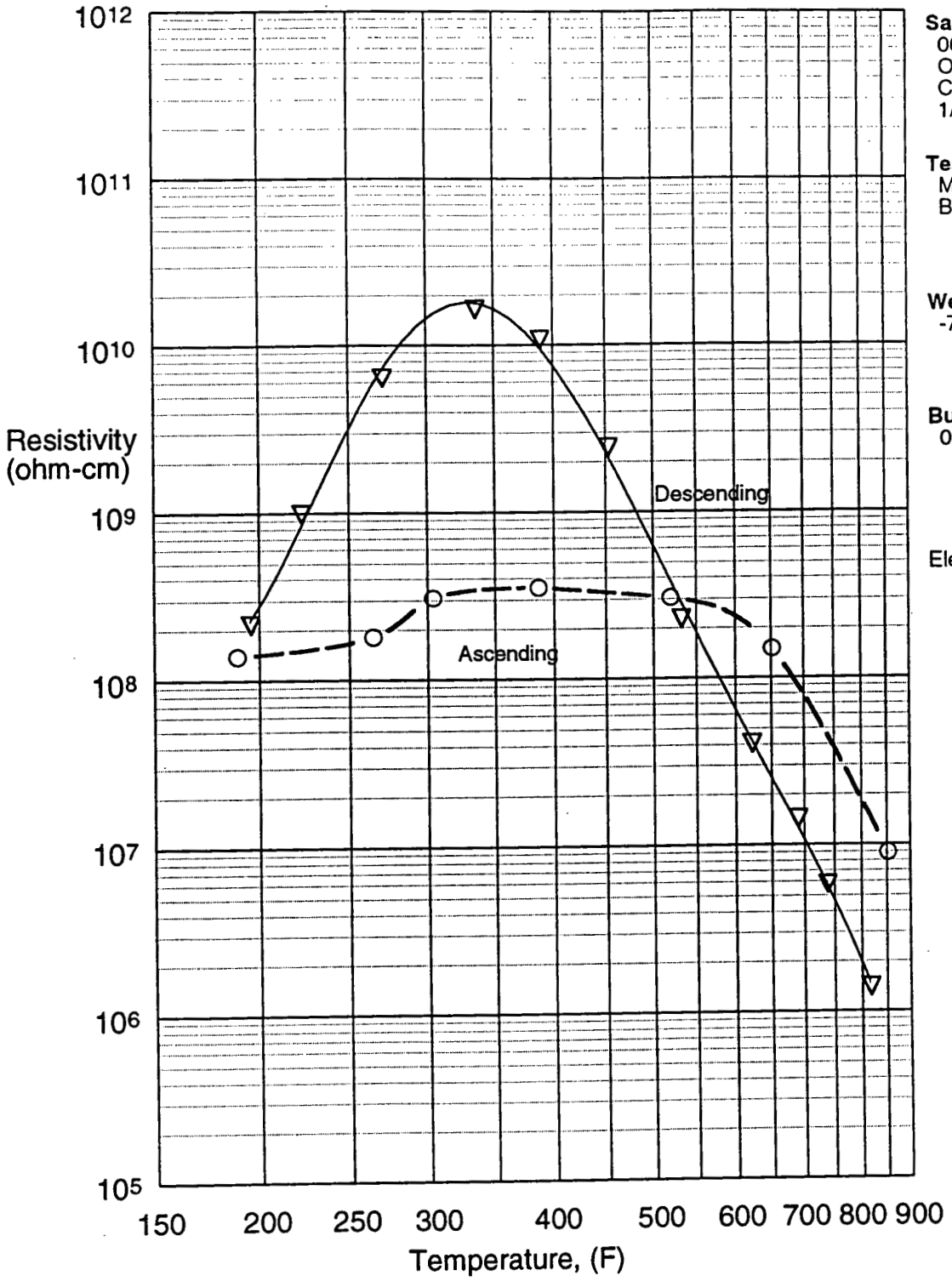
321

CAE Project No: 26908
February 1999

Figure 2: Resistivity Determined in Accordance with IEEE Standard 548-1984, Ascending and Descending Temperature Modes.

McGill AirClean Corporation

2291



Sample Identification
0650-SO-T-0547
Offgas Solids
Collected in ESP
1/20/99

Test Environment
Moisture 9.0%
Bal Air

Weight Change
-7.17%

Bulk Density
0.70 g/cc

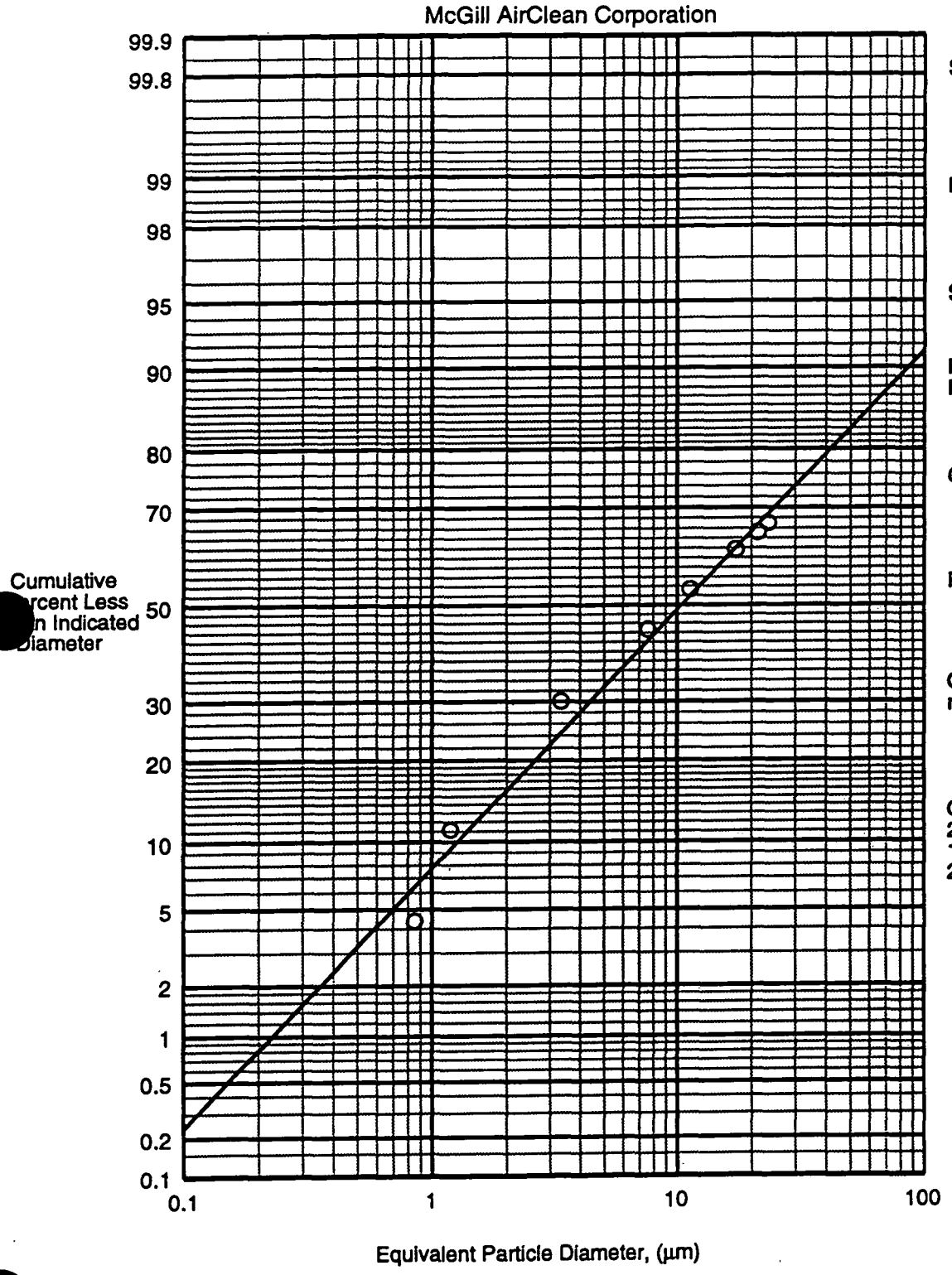
Electric Field $\leq$ 4 kV/cm

322

CAE Project No: 26908
February 1999

3b. - Aerodynamic Particle Size Analysis (of the collected particulate matter)

Figure 1: Bahco™ Centrifugal Particle Size Classification



Sample Identification
0650-SO-T-0547
Offgas Solids
Collected in ESP
1/20/99

Measured Particle Density
ρ_p = 3.67 g/cc

Statistical Analysis

Mass Median Diameter
MMD = 10.25 µm

Geometric Std. Deviation
σ_g = 5.19

Relative Std. Deviation
α = 0.51

Coeff. of Correlation
r^2 = 0.981

Cumulative % Less Than
20 µm = 65.77
10 µm = 49.41
2.5 µm = 19.58
2 µm = 16.05
1 µm = 7.88

324

CAE Project No: 26908
February 1999

3c. - Chain of Custody Report

CHAIN OF CUSTODY RECORD

Clemson Environmental Technologies Laboratory

Lab: Clean Air Engineering via United McGill Corporation Attn: Dave Poole	Sampler Name(s) Dan Rohrer	Clemson Environmental Technologies Laboratory Attn: Rob Wilson 100 Technology Drive Phone: 864-646-2413 x 209 Anderson, SC 29625 Fax: 864-656-7310

Sample #	Date	Time	Initials	Analysis	Container Description	Comments
0650-SO-T-0547	1/20/99	1730	DCR	Particle Size/Resistivity	250 ml poly bottle	Offgas solids collected in McGill ESP

Relinquished by:	Date/Time	Received by:	Date/Time	Delivery by:
(print) Robert A. Wilson (sign) Robert A. Wilson	1/28/99 15:20	(print) WADE SHOOMAKER (sign) Wade Shoomaker	1-28-99 3:30 pm	Way Bill #
Relinquished by:	Date/Time	Received by:	Date/Time	Note: All information concerning sample preparation, retrieval, storage, and sampling method are kept in bound log books at the:
(print) WADE SHOOMAKER (sign) Wade Shoomaker	2-1-99 8:00 A.M.	(print) (sign) David T. Poole	2-1-99 0800	Clemson Environmental Technologies Laboratory Clemson University 100 Technology Drive Anderson, SC 29625
Relinquished by:	Date/Time	Received by:	Date/Time	
(print) David T. Poole (sign)	2/2/99 1700	(print) Douglas D. Rhoades (sign)	2/8/99 0800	

Distribution: White and yellow - return to sender, Pink - lab copy, Orange - originator's copy

Listing for Exhibit 4

EXHIBIT 4 - EMISSIONS DATA AND EXPERIMENTAL CONDITIONS
(See Appendix 5 for summary graphs)

4a. - Emissions Test Data Summary Sheets (supplied by Trigon)

4b. - Test Equipment Calibration Sheets (supplied by Trigon)

4c. - EP Operating Conditions During Testing

4d. - Current-Voltage (I-V) Characteristics

4e. - Metals Removal Efficiency Graphs

4a. - Emissions Test Data Summary Sheets (supplied by Trigon)

1.0 INTRODUCTION

This section describes the purpose, a brief outline including the sampling and analytical strategy, and the personnel involved in the test program.

1.1 Purpose

The purpose of this sampling project was to determine concentrations and emission rates of the following pollutants. The table below details the test parameters, methods, number of sampling runs and sample location. The envitrification unit tested was at Clemson University Research Park in Clemson, South Carolina.

Parameter	EPA Method	No. Runs/Time	Sample Location
Particulate Matter and Metal (listed below)	5/29	6/1-hour	Melter Exhaust & ESP Stack
Sulfuric Acid Mist (SO_2 and SO_3)	8	6/1-hour	Melter Exhaust
Sulfur Dioxide	6C	2/24-hour	Melter Exhaust & ESP Stack
Oxides of Nitrogen	7E	2/24-hour	Melter Exhaust & ESP Stack
Total Gaseous Organics	25A	1/8-hour	Melter Exhaust

Metals List

Aluminum (Al)
Barium (Ba)
Iron (Fe)
Nickel (Ni)
Silicon (Si)
Sodium (Na)
Calcium (Ca)
Potassium (K)
Cadmium (Cd)
Lithium (Li)
Vanadium (V)
Sulfur (S)
Arsenic (As)
Chromium (Cr)
Magnesium (Mg)
Selenium (Se)
Zinc (Zn)
Phosphorus (P)
Molybdenum (Mo)
Lead (Pb)

1.2 Outline of Test Program

Stationary source sampling was performed January 19-21, 1999 by the Environmental, Health & Safety (EHS) Division of Trigon Engineering Consultants, Inc. on the envitrification unit. United States Environmental Protection Agency (US EPA) Methods 1 through 5 and Method 29 were used to

4.0 RESULTS

This section presents the mean particulate matter, multi-metals, sulfuric acid mist, NO_x, SO_2, and VOC sampling results. Tabular results are also provided to present data from individual sampling runs collected during this project. Detailed sampling results and example calculations for the test program can be found in Appendix A. Field data sheets and sample recovery documentation are presented in Appendix B.

4.1 Summary of Results

The tables below is a synopsis of the sampling conducted at the Envitrification Unit.

Particulate Matter - Envitrification Unit - 1/20/99			
Source	Melter Exhaust	ESP Stack	Removal Efficiency
Concentration, gr/dscf	0.0117	0.0014	
Emission Rate, lbs/hr	0.051	0.023	54.9

Method 8 - Envitrification Unit - 1/19/99		
Pollutants	Sulfur Acid Mist including SO_3	Sulfur Dioxide
Concentration, lbs/dscf	2.42E-07	1.86E-06
Emission Rate, lbs/hr	0.0077	0.060

Method 25A - Envitrification Unit - 1/19/99									
Total Gaseous Organic(s)[1]									
	1st hr	2nd hr	3rd hr	4th hr	5th hr	6th hr	7th hr	8th hr	Average
Concentration, ppm	3.2	2.6	2.3	2.6	5.2	4.2	4.8	2.2	3.4
Emission Rate, lbs/hr	0.0048	0.0039	0.0034	0.0039	0.0065	0.0041	0.0072	0.0035	0.0047

[1] as carbon, dry

330

Multiple metals emission rate results shown below are as a total emission rate. Emission rates of the front-half and back-half fractions can be found in Appendix A.

Multi-Metals Envitrification Unit - 1/20/99		
Metals	Melter Exhaust	ESP Stack
Emission Rate	lbs/hr	lbs/hr
Aluminum (Al)	4.54E-04	7.95E-04
Arsenic (As)	<4.45E-05	<9.74E-06
Barium (Ba)	<5.24E-04	<2.48E-05
Calcium (Ca)	3.79E-04	7.26E-04
Cadmium (Cd)	<7.62E-07	<2.47E-06
Chromium (Cr)	9.69E-05	1.68E-05
Iron (Fe)	<3.47E-04	2.65E-04
Potassium (K)	3.49E-04	3.70E-04
Lithium (Li)	<5.00E-04	<7.44E-06
Magnesium (Mg)	<8.82E-05	<1.21E-04
Molybdenum (Mo)	<2.37E-04	<4.27E-05
Sodium (Na)	2.42E-03	3.61E-03
Nickel (Ni)	4.07E-05	2.95E-05
Phosphorus (P)	3.13E-03	1.34E-04
Lead (Pb)	1.41E-02	1.66E-04
Sulfur (S)	3.48E-02	<4.14E-02
Selenium (Se)	7.75E-03	4.25E-03
Silicon (Si)	2.29E-04	1.07E-03
Vanadium (V)	<2.90E-06	<6.19E-06
Zinc (Zn)	2.13E-04	6.00E-05

The CEM data (EPA Methods 3A, 6C and 7E) was separated into nine different time periods during the 48-hour test. Periods were bracketed by CEM calibrations, times of each period varied. The CEM analyzers passed all system bias and drift checks during each calibration. The following CEM data is presented as a concentration only, SO_2 and NO_x are presented as parts per million (ppm), while O_2 and CO_2 are presented as a percent (%).

CEM Data - Envitrification Unit - 1/19-21/99						
Pollutant			O_2	CO_2	SO_2	NO_x
	Date	Time	%	%	PPM	PPM
Period 1	1/19/99	0831-1000	18.45	1.70	3.8	34.63
Period 2	1/19/99	1101-1550	18.44	1.80	6.6	38.11
Period 3	1/19/99	1646-1900	18.42	1.83	7.95	38.54
Period 4	1/19-20/99	2145-0800	19.91	0.69	6.59	13.47
Period 5	1/20/99	0826-1300	20.01	0.67	5.59	12.29
Period 6	1/20/99	1321-1600	20.06	0.69	7.46	12.72
Period 7	1/20-21/99	1631-0049	19.94	0.74	7.88	13.44
Period 8	1/21/99	0050-0900	19.91	0.71	8.76	13.34
Period 9	1/21/99	0921-1445	19.96	0.73	15.16	13.60
		Average	19.46	1.06	7.75	21.13

4.2 Detailed Stack Sampling Results

Tables 1 - 4 presents the data from individual sampling runs at the envitrification unit. Included in these tables are gas velocity, volumetric flow rates, exhaust gas temperatures, and the concentrations and emission rates for particulate matter, sulfuric acid mist and sulfur dioxide.

TABLE 1

Summary of Results - Particulate Matter Sampling

Melter Exhaust

Run Number	1	2	3	Avg.
Date	1/20/99	1/20/99	1/20/99	
Sample Identification	8158-08	8158-09	8158-10	
Run Duration, Minutes	60	60	60	
Sample Time, 24-hour clock	1000-1102	1150-1252	1402-1505	
Percent Isokinetic	96.9	97.4	98.4	97.6
Volume of Gas Sampled, dry standard cubic feet*(dscf)	52.25	47.72	50.23	50.07
Average Stack Temperature, °F	661.3	642.5	650.3	651.4
Stack Gas Velocity, feet/second	107.2	98.2	103.7	103.0
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	530	489	510	510
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	1261	1154	1220	1212
Particulate Matter:				
Catch, mg	40.5	33.5	40.5	38..2
Concentration, grains/dscf*	0.0119	0.0108	0.0124	0.0117
Emission Rate, lbs/hr	0.054	0.045	0.054	0.051

* 68°F, 29.92 Inches Hg

TABLE 2

Summary of Results - Particulate Matter Sampling

ESP Stack

Run Number	1	2	3	Avg.
Date	1/20/99	1/20/99	1/20/99	
Sample Identification	8158-11	8158-12	8158-13	
Run Duration, Minutes	60	60	60	
Sample Time, 24-hour clock	1000-1110	1150-1250	1402-1502	
Percent Isokinetic	99.2	98.9	100.8	99.6
Volume of Gas Sampled, dry standard cubic feet*(dscf)	40.85	41.93	40.65	41.14
Average Stack Temperature, °F	194.4	197.2	202.9	198.2
Stack Gas Velocity, feet/second	19.2	19.9	19.3	19.5
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	1922	1979	1884	1928
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	2510	2608	2524	2547
Particulate Matter:				
Catch, mg	6.6	3.0	1.6	3.7
Concentration, grains/dscf*	0.0025	0.0011	0.0006	0.0014
Emission Rate, lbs/hr	0.041	0.019	0.010	0.023

*68°F, 29.92 Inches Hg

TABLE 3

Summary of Results - Sulfuric Acid Mist & Sulfur Dioxide Sampling

Melter Exhaust

Run Number	1	2	3	4
Date	1/19/99	1/19/99	1/19/99	1/19/99
Sample Identification	8158-01	8158-02	8158-03	8158-04
Run Duration, Minutes	60	70	60	60
Sample Time, 24-hour clock	1254-1358	1442-1555	1620-1727	1750-1853
Percent Isokinetic	100.9	99.2	94.5	95.5
Volume of Gas Sampled, dry standard cubic feet*(dscf)	32.20	30.21	49.70	55.14
Average Stack Temperature, °F	629.3	607.6	608.0	623.1
Stack Gas Velocity, feet/second	102.6	100.0	102.0	110.1
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	530	523	543	572
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	1207	1175	1200	1295
Sulfur Acid Mist:				
Concentration, lbs/dscf*	3.24E-07	2.47E-07	1.73E-07	2.24E-07
Emission Rate, lbs/hr	0.0103	0.0077	0.0056	0.0077
Sulfur Dioxide:				
Concentration, lbs/dscf*	9.31E-07	1.36E-06	1.03E-06	1.90E-06
Emission Rate, lbs/hr	0.030	0.043	0.033	0.065

* 68°F, 29.92 Inches Hg

TABLE 4

Summary of Results - Sulfuric Acid Mist & Sulfur Dioxide Sampling con't.

Melter Exhaust

Run Number	5	6	Avg.
Date	1/19/99	1/19/99	
Sample Identification	8158-05	8158-06	
Run Duration, Minutes	60	60	
Sample Time, 24-hour clock	1912-2014	2028-2130	
Percent Isokinetic	97.5	97.9	97.6
Volume of Gas Sampled, dry standard cubic feet*(dscf)	50.02	51.66	44.82
Average Stack Temperature, °F	628.4	644.8	623.5
Stack Gas Velocity, feet/second	103.8	103.2	103.6
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	529	519	536
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	1221	1213	1219
Sulfur Acid Mist:			
Concentration, grains/dscf*	2.40E-07	2.41E-07	2.42E-07
Emission Rate, lbs/hr	0.0076	0.0075	0.0077
Sulfur Dioxide:			
Concentration, lbs/dscf*	2.62E-06	3.34E-06	1.86E-06
Emission Rate, lbs/hr	0.083	0.104	0.060

*68°F, 29.92 Inches Hg

336

TRIGON

4b. - Test Equipment Calibration Sheets (supplied by Trigon)

See Trigon Engineering Consultants, Inc. Report for Envitco - Trigon Project No. 046-98-158, Appendix F.

4c. - EP Operating Conditions During Testing

McGill Air Clean Corporation

Selected Testdata Report

File No.: D-5704-9

Locid 487
Location CLEMSON SC
Title MOBILE EP

Client ENVITCO, INC.
Process VITRIFICATION

Date 3/17/1999
Time 10:18:34

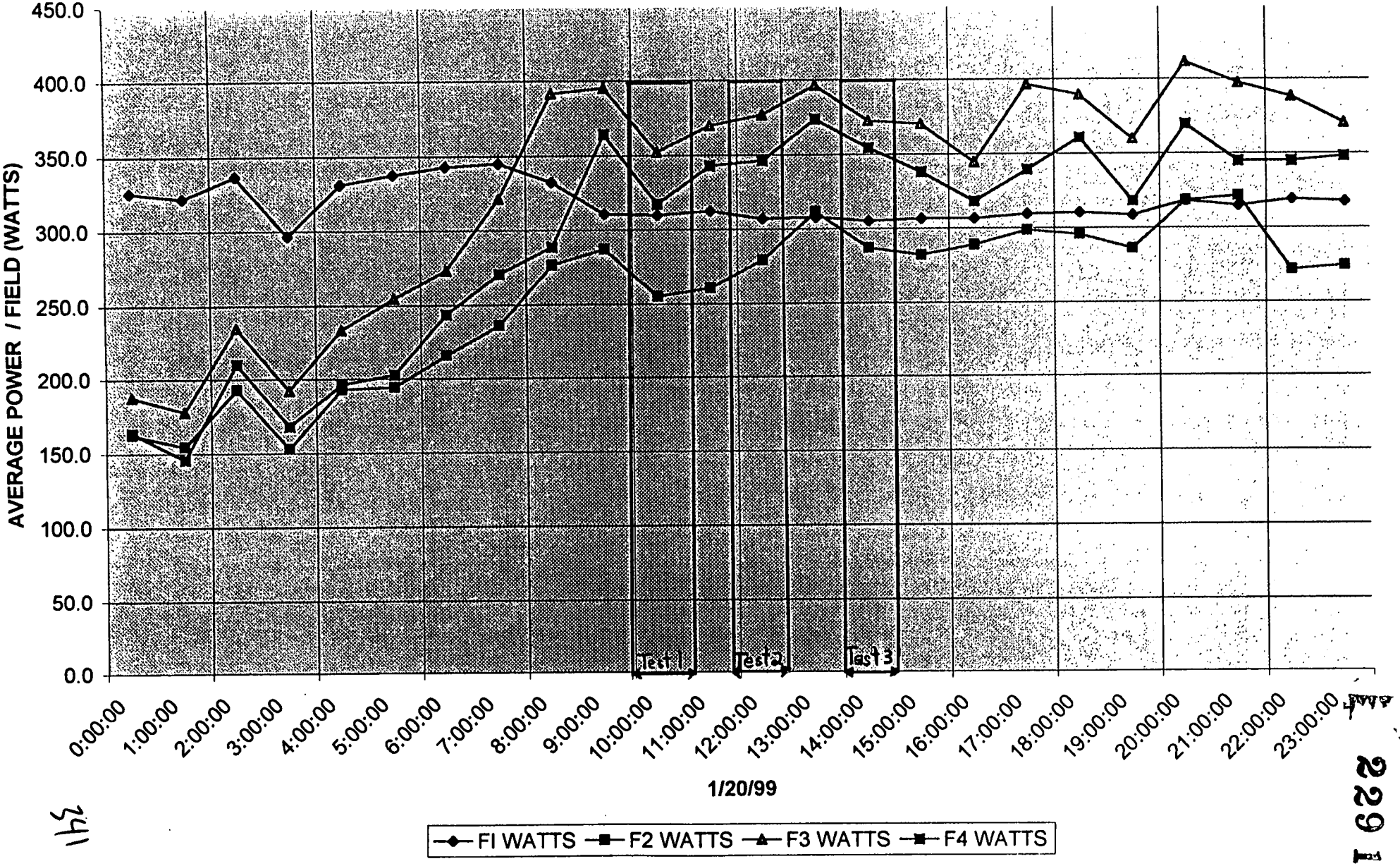
Test	Date	EP Voltage (KV)	EP Current (MA)	Velocity	EP Temp	Temp In	Wetin	Scfin	Acfin	Grsin	Pndsin	Temp Out	Wetout	Scfout	Acfout	Grsout	Pndsout	% Removal
1.00	01/99	37. 36. 46. 32.	8.8 16. 18. 12.	1.65000	361	390	8.0000	530	1261	0.01190	0.0540	232	3.0000	1922	2510	0.002	0.0410	24.0741
	Test Notes: 1																	
2.00	01/99	36. 36. 44. 32.	8.7 16. 17. 12.	1.71000	354	383	8.6000	489	1154	0.01080	0.0450	235	3.4000	1979	2608	0.001	0.0190	57.7778
	Test Notes:																	
3.00	01/99	36. 35. 42. 32.	8.7 15. 15. 12.	1.66000	354	387	9.0000	510	1220	0.01240	0.0540	232	4.0000	1884	2524	0.000	0.0100	81.4815
	Test Notes:																	

1 Test performed January 1999

240

229

FIELD POWER



341

summary watts.xls

Chart7

229

Envitco Mobile EP

Test 1 CEM time is 1.5 min faster than the bill time 2291 1/20/99 OTP

	09:55	1005	1015	1025	1035	1045	1055	End test 1056
O_2 %	19.9	19.9	20.0	20.0	20.0	20	–	
CO_2 %	0.7	0.7	0.7	0.7	0.7	0.7	–	
SO_2 ppm	3.1	4.9	6	5.4	5.4	5.4	–	
NO_x ppm	14.8	13	12	12.4	12.6	12.5	–	
Offtake °C	200	199	198	194	198	199	202	
EP In °C	183	182	182	179	182	183	185	
EP Out °C	111	108	111	112	112	113	112	
Furn. Press	-0.06	-0.07	-0.07	-0.04	-0.05	-0.06	-0.07	
Duct Press	-5.4	-5.4	-5.4	-5.14	-5.4	-5.3	-5.3	
Fan Dmpr %	7.3	7.1	7.4	7.8	7.4	7.4	7.3	
Fan Amps	17.5	17.4	17.4	17.3	17.7	17.8	17.9	
F1 kV/mA	35.6/9.1	35.3/9.3	35.1/9.3	35.2/9.2	35.6/9	35/9.3	35.2/9.2	
F2 kV/mA	32.5/13.7	28.5/8	27.6/8.3	26.8/8	31.1/11.9	25.6/7.3	30.3/11.4	
F3 kV/mA	39.3/12.9	35.6/10	35.8/10	35.3/9.6	38.1/11.9	34.1/8.8	37.8/12.2	
F4 kV/mA	31.3/14.8	29.9/13.5	27.8/10.9	28.2/11.5	29.7/13.0	26.5/9.6	29.4/12.7	
Rapping	Off →							
Vibrators	Off →							
Scr. Convey.	Off →							

Notes:

Per TriGon ~~At Meter~~

Yesterday O_2 18.5 ± 0.2

Yesterday CO_2 1.5

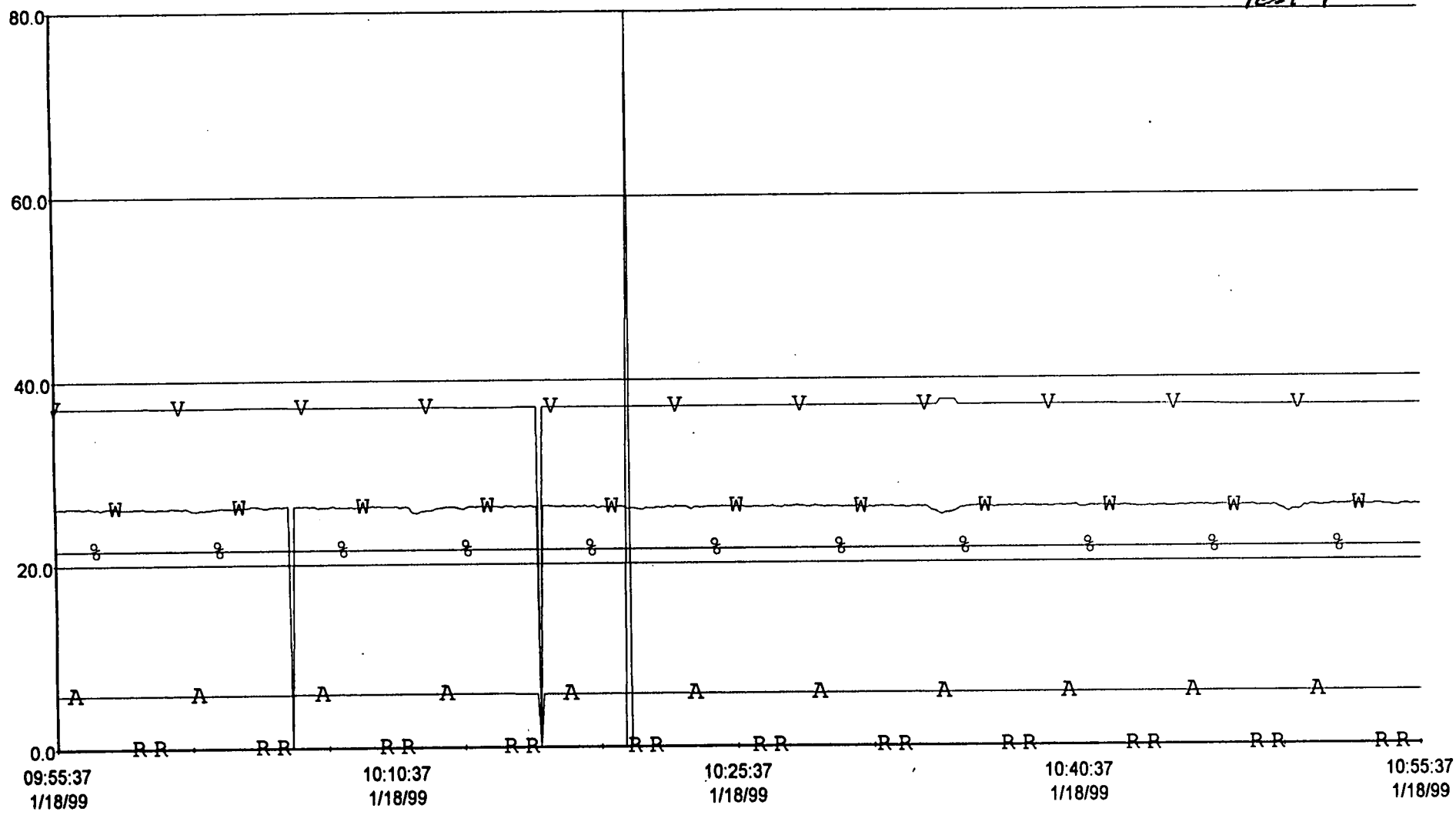
(2) F1 in Manual, F2, F3 & F4 in Auto

(3) Dust sample collected just prior to test.

(4) Opac. Mon. - Inop

342

Test 1

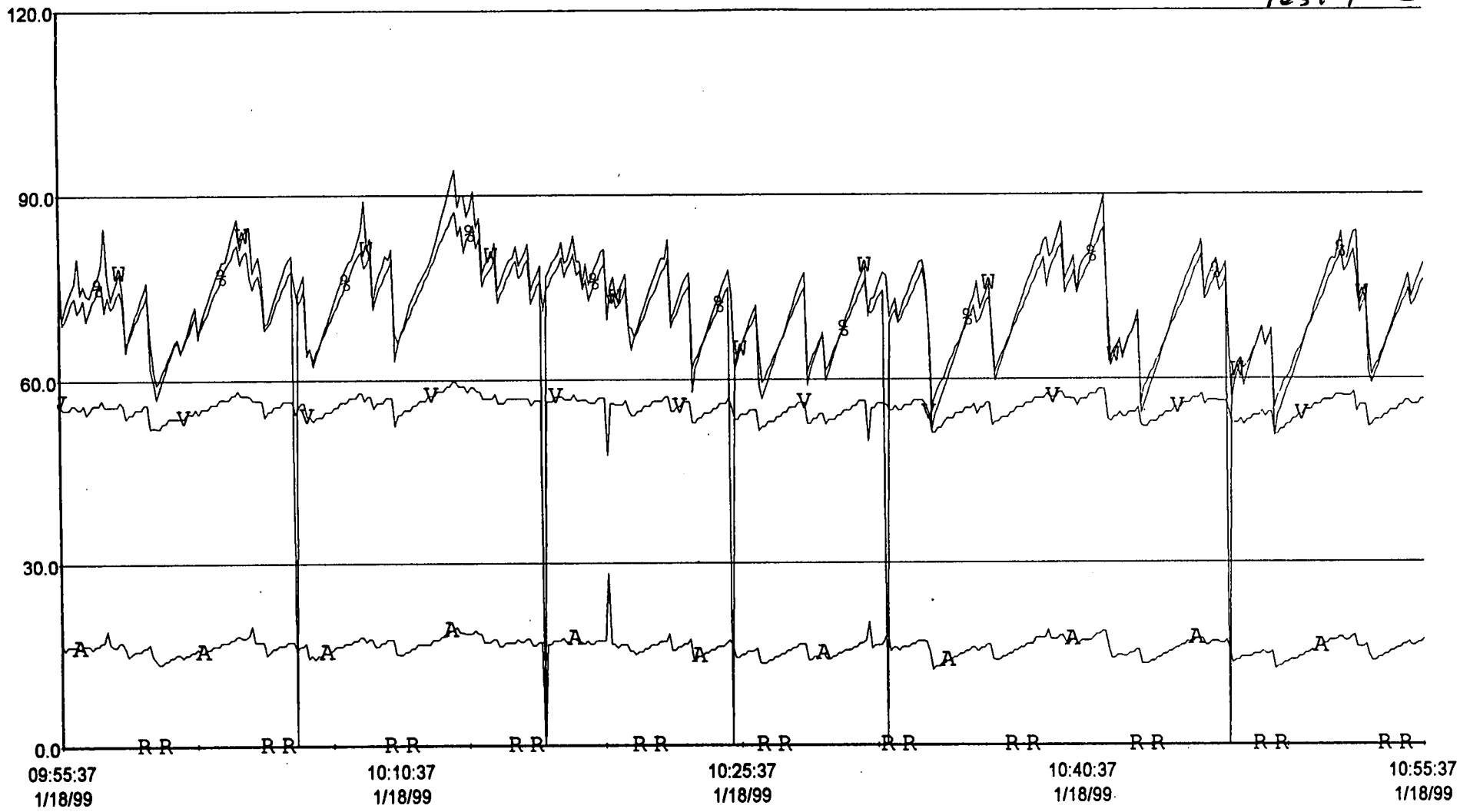


V	FIELD 1 VOLTAGE, KV	37.1	37.0
A	FIELD 1 CURRENT, MA	8.8	8.8
%	FIELD 1 CONTROL OUTPUT, %	27.0	27.0
W	Field 1 Power in WATTS	326	324
R	FIELD 1 POSITIVE COLLECTOR RAPPING	OFF	0
R	FIELD 1 NEGATIVE COLLECTOR RAPPING	OFF	0

243

229

Test 1

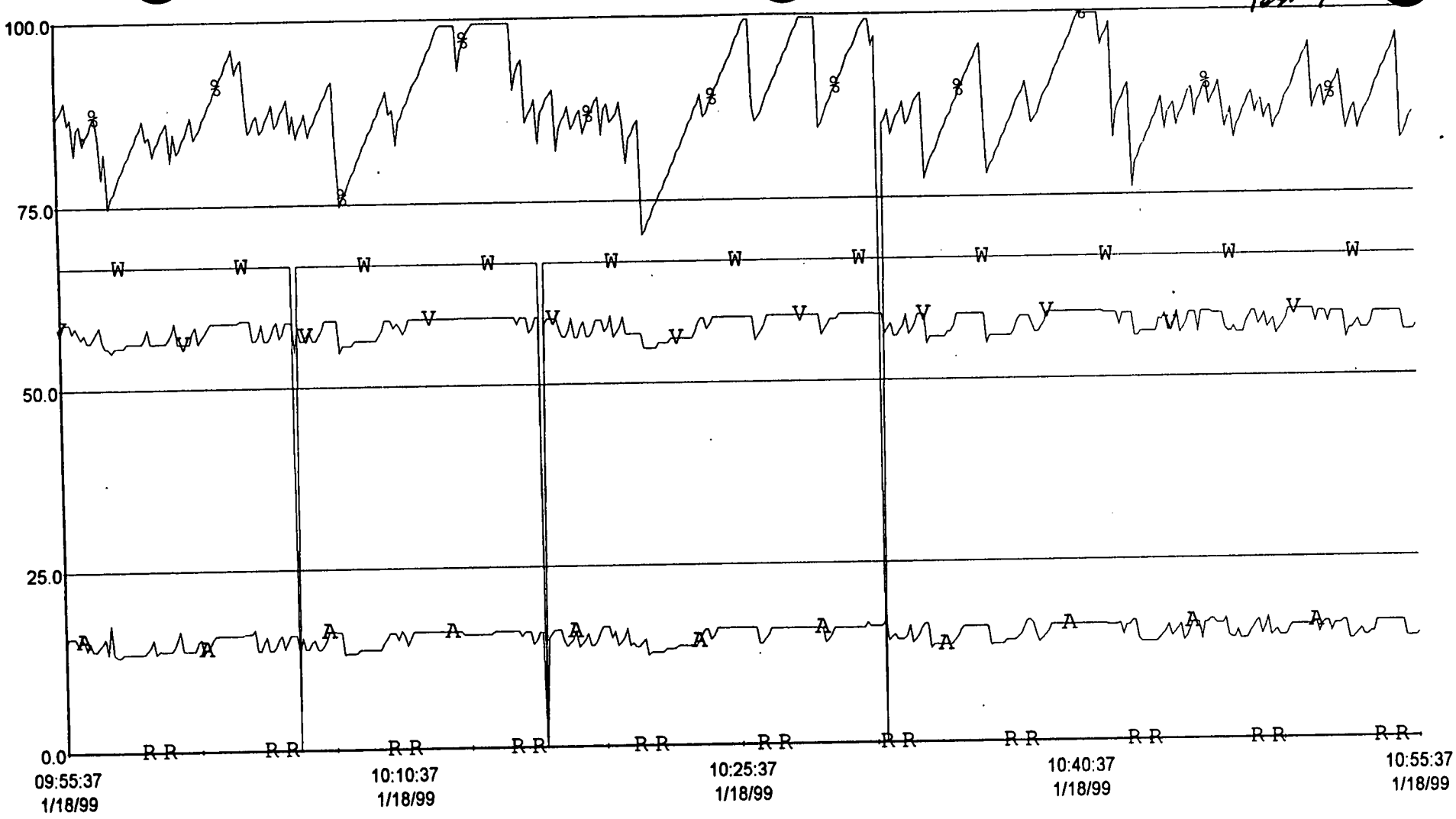


V	FIELD 2 VOLTAGE, KV	35.7	36.9
A	FIELD 2 CURRENT, MA	14.4	16.1
%	FIELD 2 CONTROL OUTPUT, %	53.4	59.2
W	Field 2 Power in WATTS	527	604
R	FIELD 2 NEGATIVE COLLECTOR RAPPING	OFF	0
R	FIELD 2 POSITIVE COLLECTOR RAPPING	OFF	0

344

229

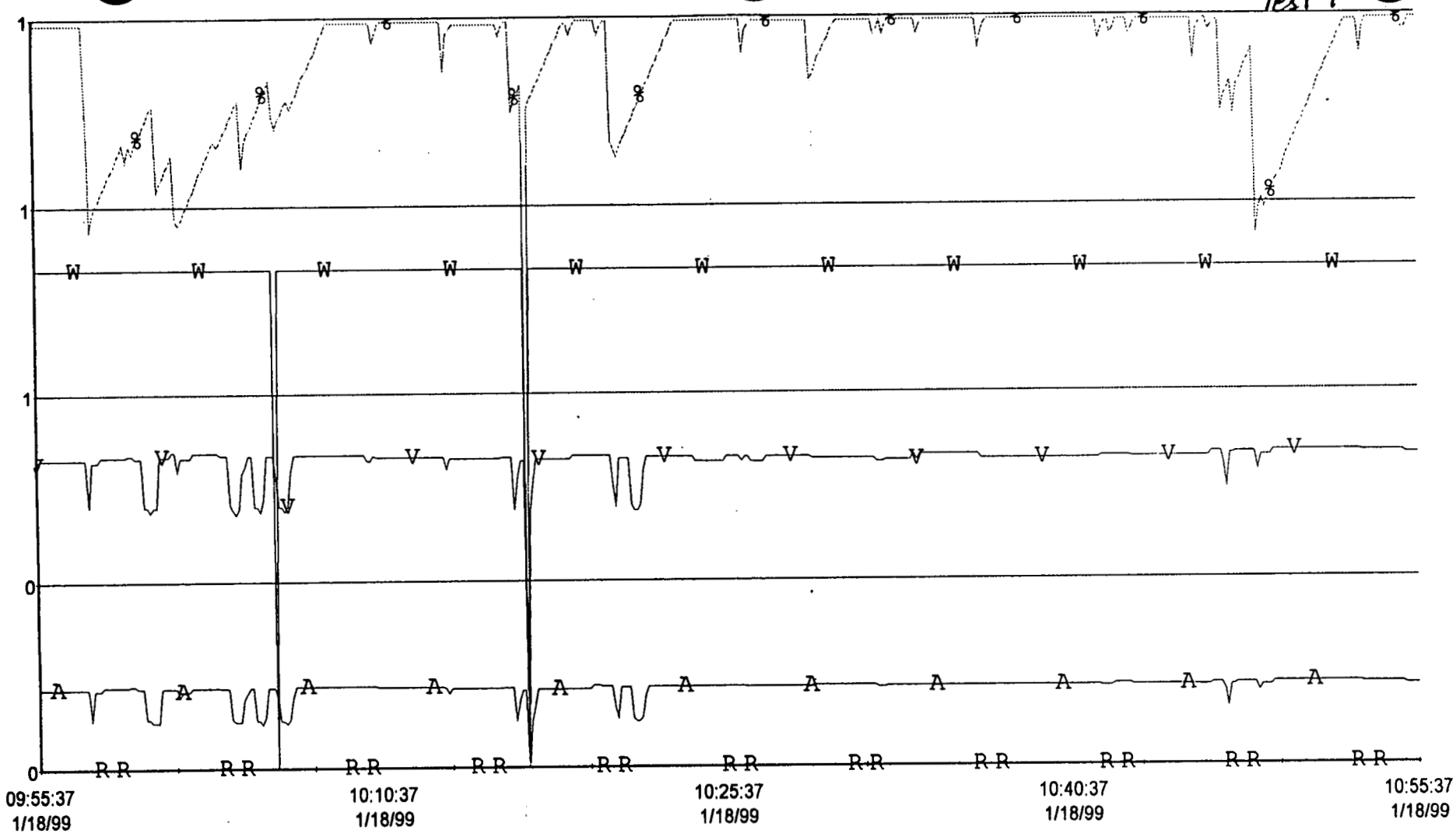
Test 1



V	FIELD 3 VOLTAGE, KV	47.1	46.1
A	FIELD 3 CURRENT, MA	19.5	18.2
%	FIELD 3 CONTROL OUTPUT, %	94.3	88.0
W	Field 3 Power in WATTS	100.00	99.56
R	FIELD 3 POSITIVE COLLECTOR RAPPING	OFF	0
R	FIELD 3 NEGATIVE COLLECTOR RAPPING	OFF	0

245

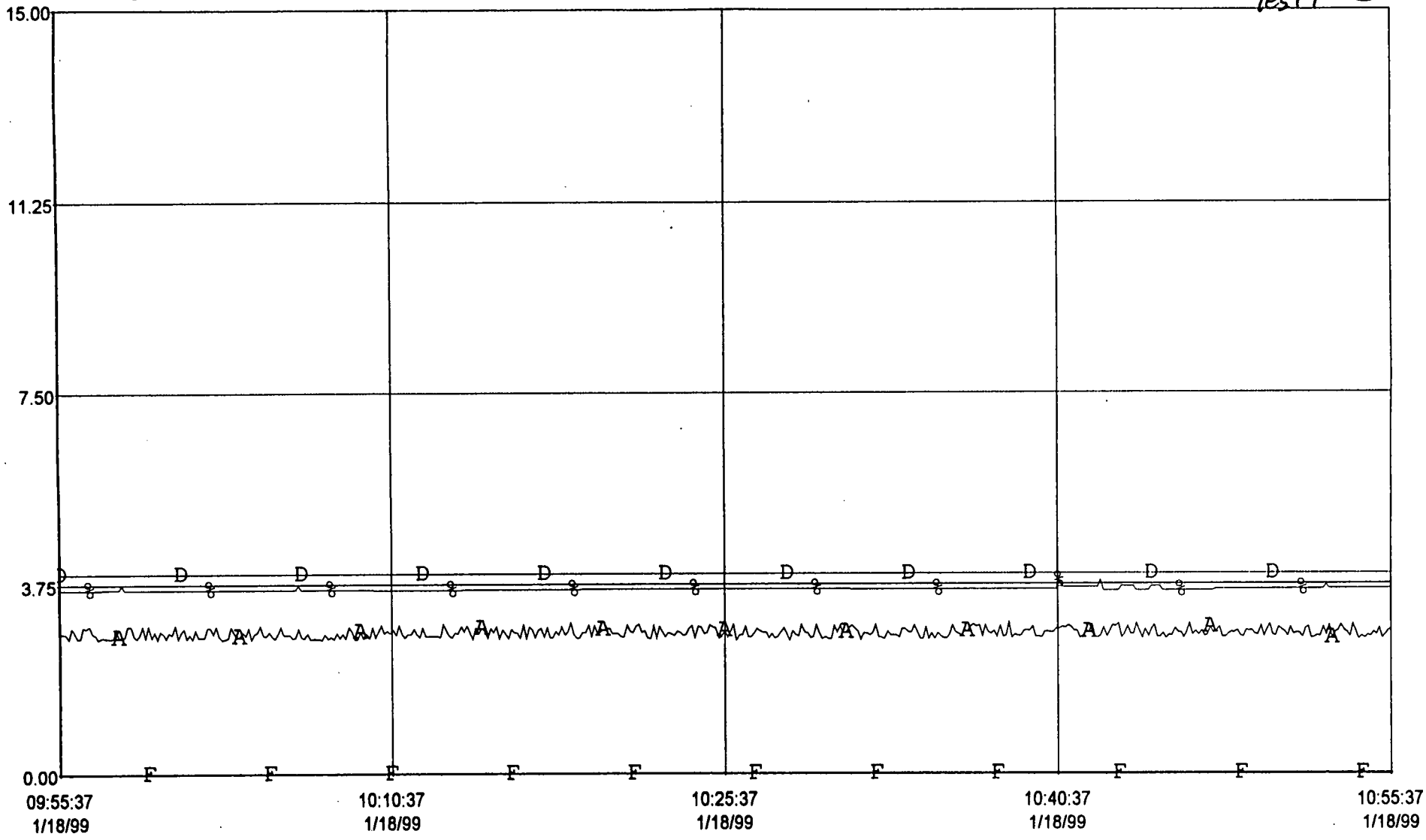
Test 1



V	FIELD 4 VOLTAGE, KV	32.6	32.7
A	FIELD 4 CURRENT, MA	12.8	12.5
W	Field 4 Power in WATTS	100.00	99.56
R	FIELD 4 POSITIVE COLLECTOR RAPPING	OFF	0
R		OPEN	0
%	FIELD 4 CONTROL OUTPUT, %	99.51	94.40

246

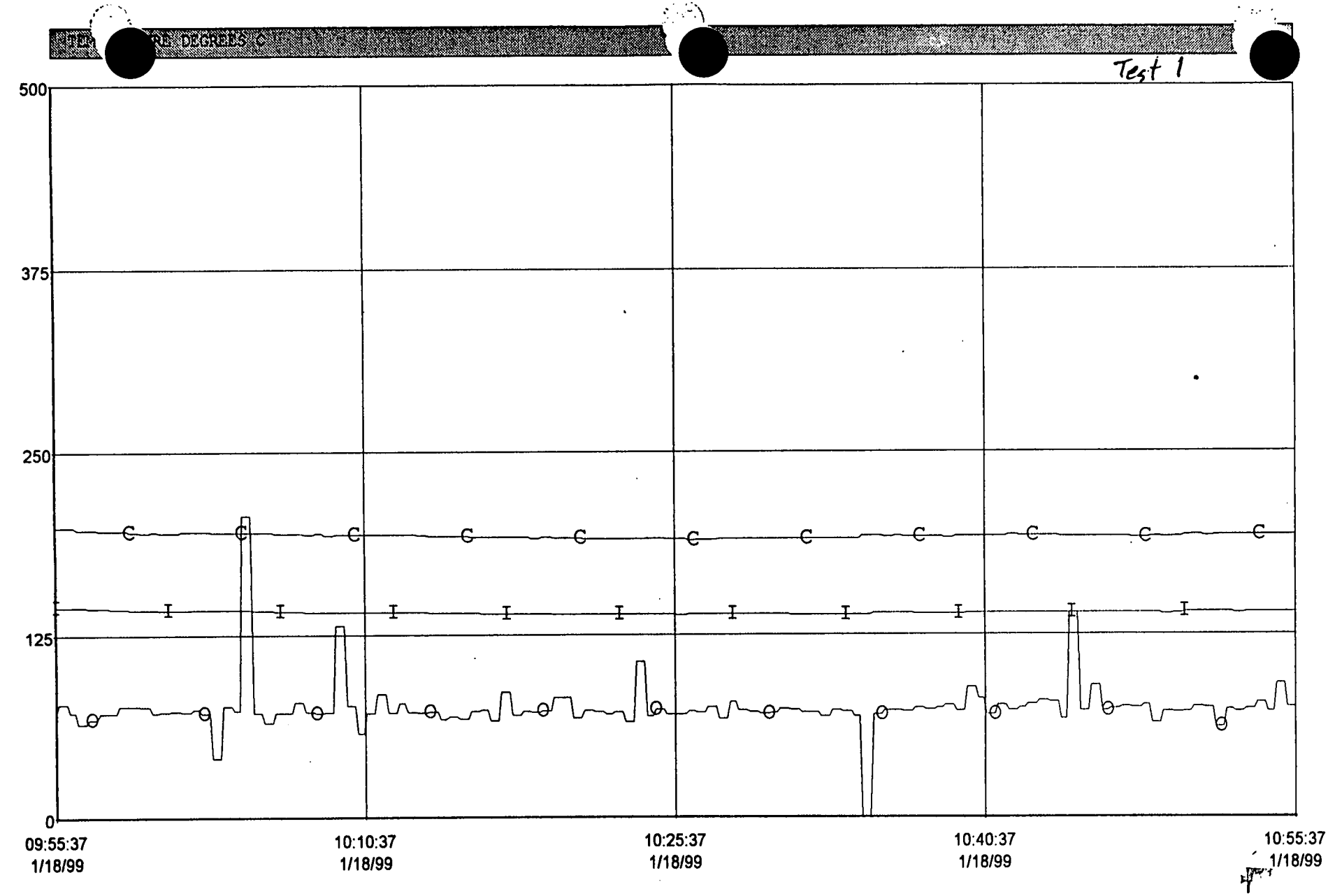
Test 1



D	DUCT PRESSURE	3.96
%	FAN DAMPER POSITION	24.40
A	FAN MOTOR CURRENT, AMPS	18.05
F	Furnace Pressure	0.00

2291

347


TEMPERATURE DEGREES C
Test 1
500
375
250
125
0
09:55:37
1/18/99
10:10:37
1/18/99
10:25:37
1/18/99
10:40:37
1/18/99
10:55:37
1/18/99
EP INLET TEMPERATUR 139
EP OUTLET TEMPERATURE 70.26
EP OFFTAKE TEMPERATURE 190

1 of 2

248

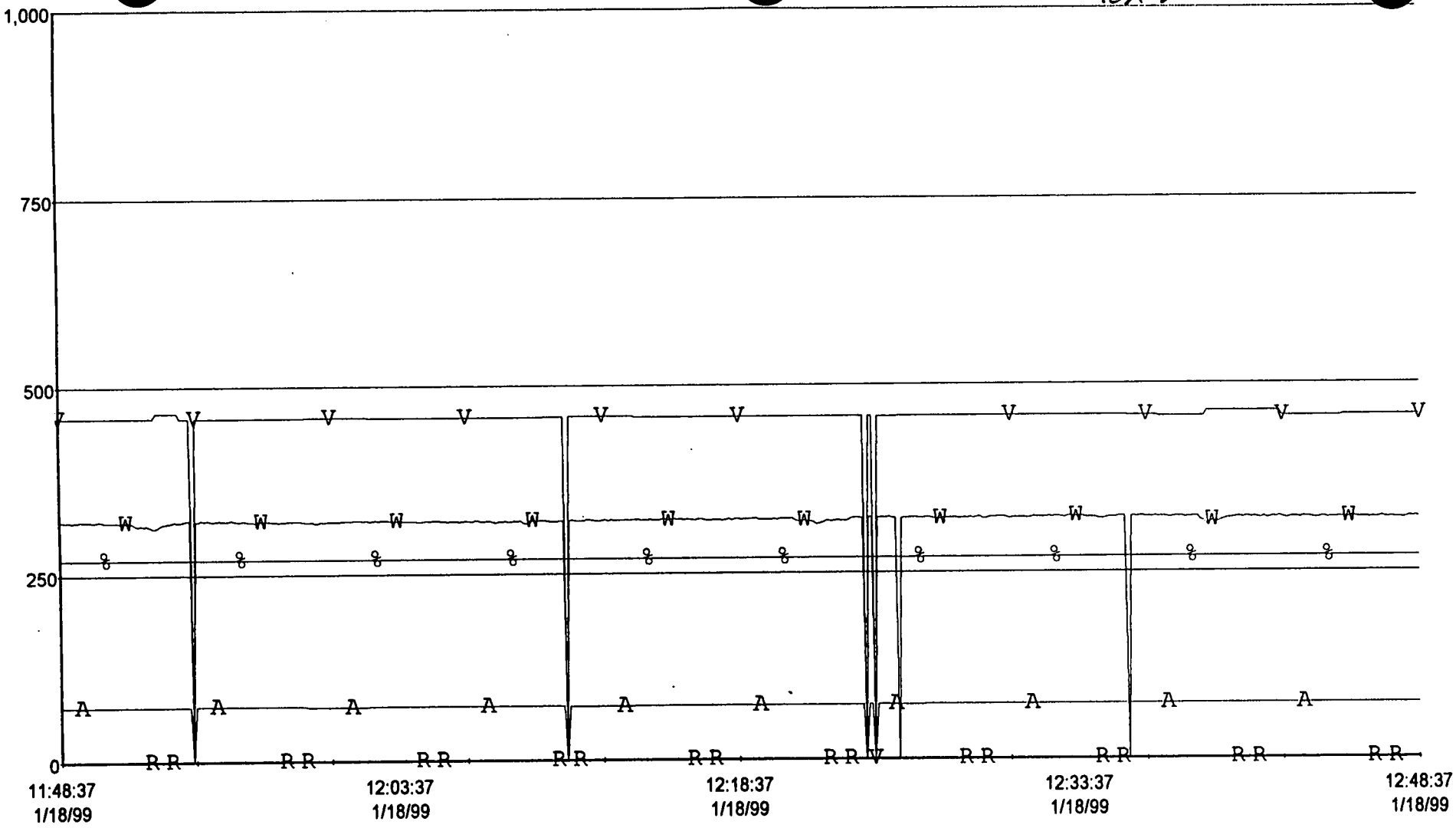
Envirco Mobile EP 1/20/99 DTP

2291

Test 2 start

	1148	1200	1210	1220	1230	1240	1250		
O_2 %	20	20	–	20	20.0	20	20		
CO_2 %	0.7	0.7	–	0.73	0.71	0.78	0.71		
SO_2 ppm	6.4	5.5	–	8.0	6.0	6.5	7.3		
NOx ppm	12.6	13.4	–	13.4	13.0	13	12.6		
Offtake °C	195	195	198	192	195	195	193		
EP In °C	179	179	179	176	179	177	178		
EP Out °C	113	113	113	113	113	113	113		
Furn. Pres.	-0.07	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07		
Duct Pres	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3		
Fan Damper %	7.3	7.2	7.5	7.5	7.4	7.3	7.5		
Fan Amps	17.3	18.8	17.8	18.8	17.6	17.5	17.4		
kV/mA	35/9.2	34.7/9.3	34.7/9.2	34.6/9.2	34.7/9.1	34.4/9.2	34.6/9.1		
F2 kV/mA	28.7/11.9	27.8/9.3	25.8/7	30.1/11.5	31.8/13.8	30.9/11.9	28.7/10		
F3 kV/mA	34.6/9.8	35.5/10.3	33.4/8.8	35.9/11.1	39.2/14.2	37.6/12.7	35/10.5		
F4 kV/mA	30.8/14.6	30.4/14.2	28.7/12.3	29.5/13	31.1/14.5	29.5/12.8	26.9/9.8		
Rapping	Off	Off	Off	Off	Off	Off	Off		
Vibrators	Off	Off	Off	Off	Off	Off	Off		
Scr. Conveyor	Off	Off	Off	Off	Off	Off	Off		
Notes:									
(1) Op. Mon. - inoperable									

Test 2

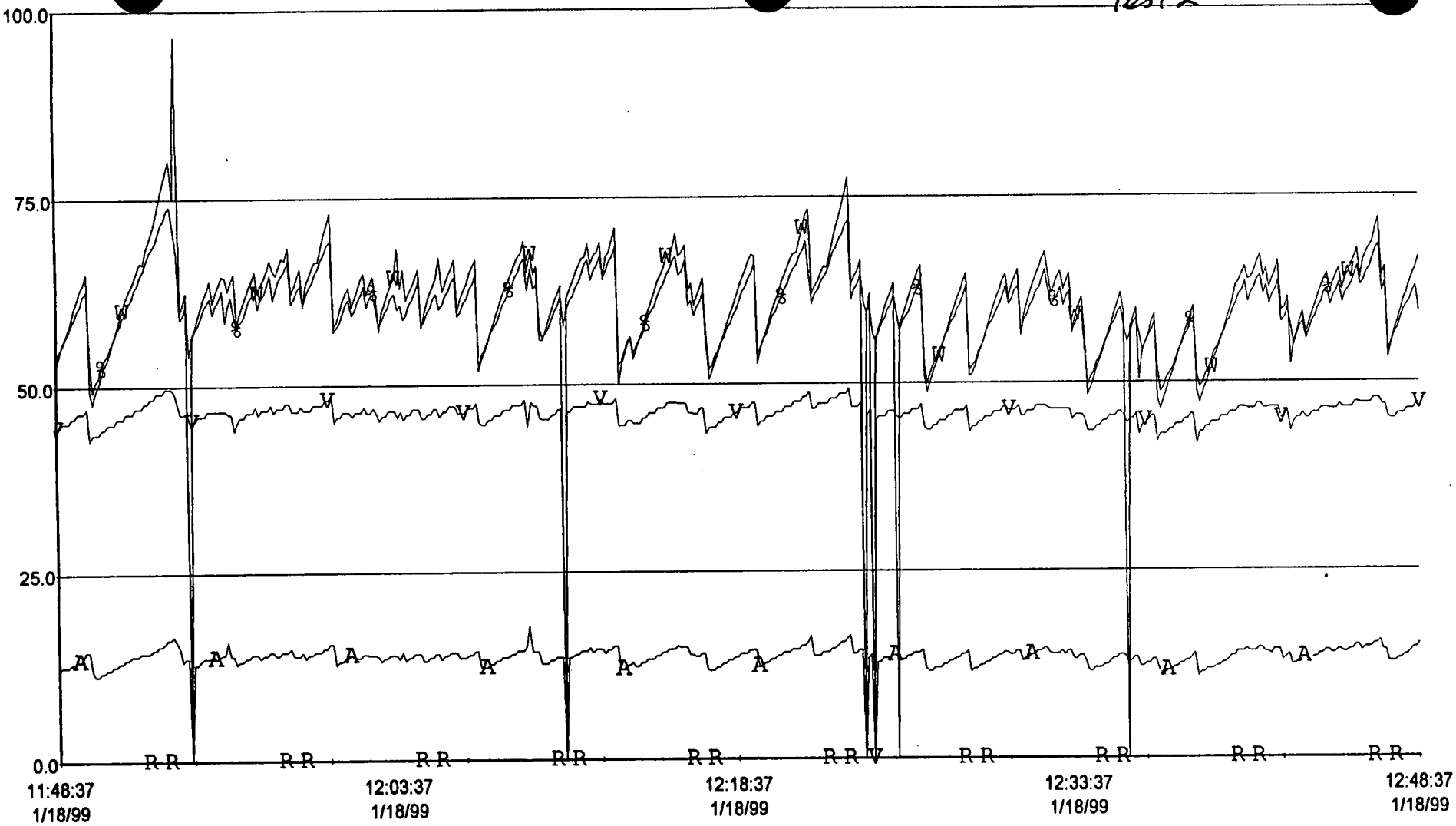


V	FIELD 1 VOLTAGE, KV	36.6	36.3
A	FIELD 1 CURRENT, MA	8.8	8.7
%	FIELD 1 CONTROL OUTPUT, %	27.0	27.0
W	Field 1 Power in WATTS 0-100	323	317
R	FIELD 1 POSITIVE COLLECTOR RAPPING	OFF	0
R	FIELD 1 NEGATIVE COLLECTOR RAPPING	OFF	0

350

2291

Test 2

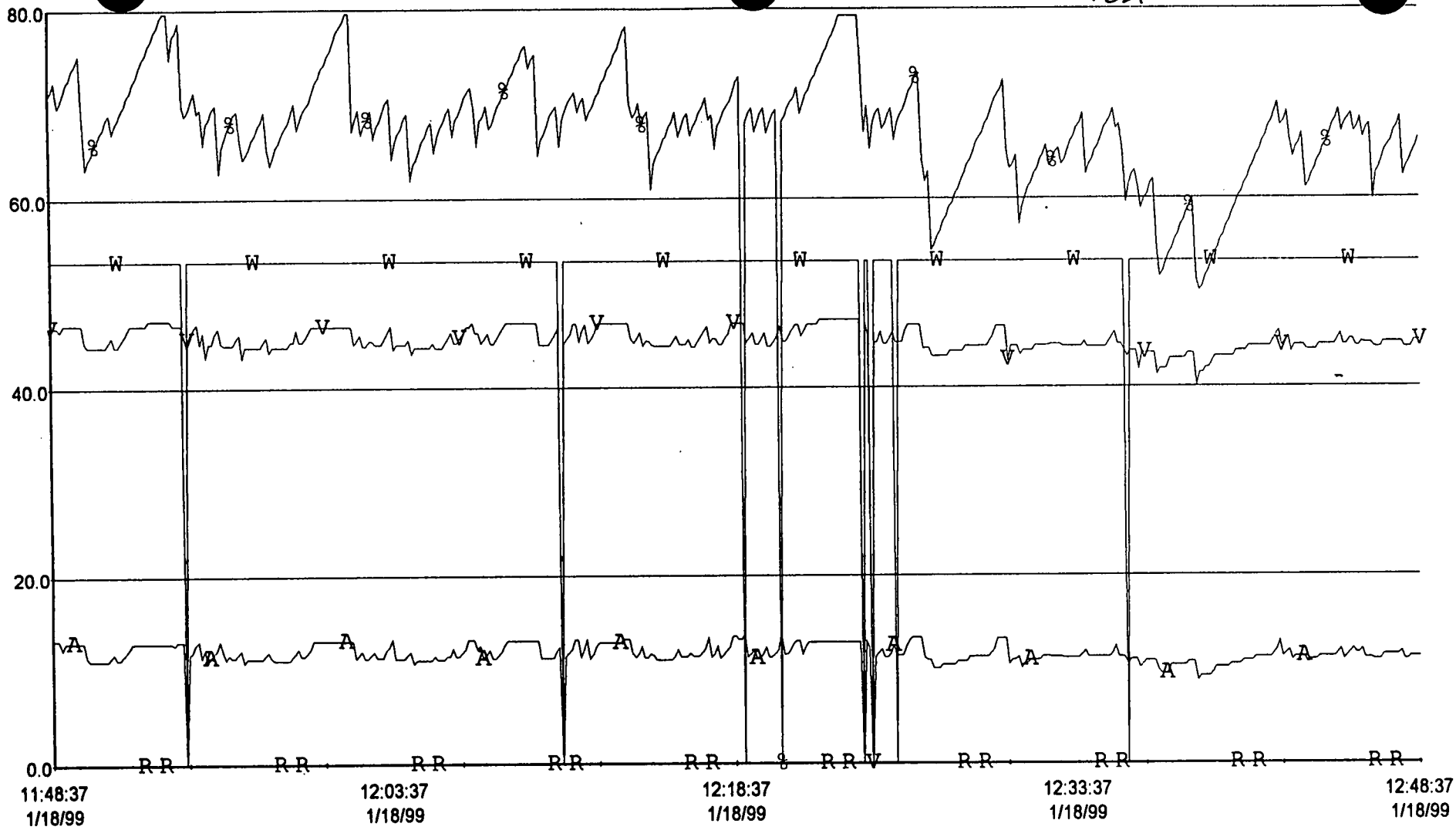


—V—	FIELD 2 VOLTAGE, KV	36.9	36.6
—A—	FIELD 2 CURRENT, MA	16.3	16.2
—%—	FIELD 2 CONTROL OUTPUT, %	59.8	60.1
—W—	Field 2 Power in WATTS 0-100	617	607
—R—	FIELD 2 NEGATIVE COLLECTOR RAPPING	OFF	0
—R—	FIELD 2 POSITIVE COLLECTOR RAPPING	OFF	0

152

2291

Test 2

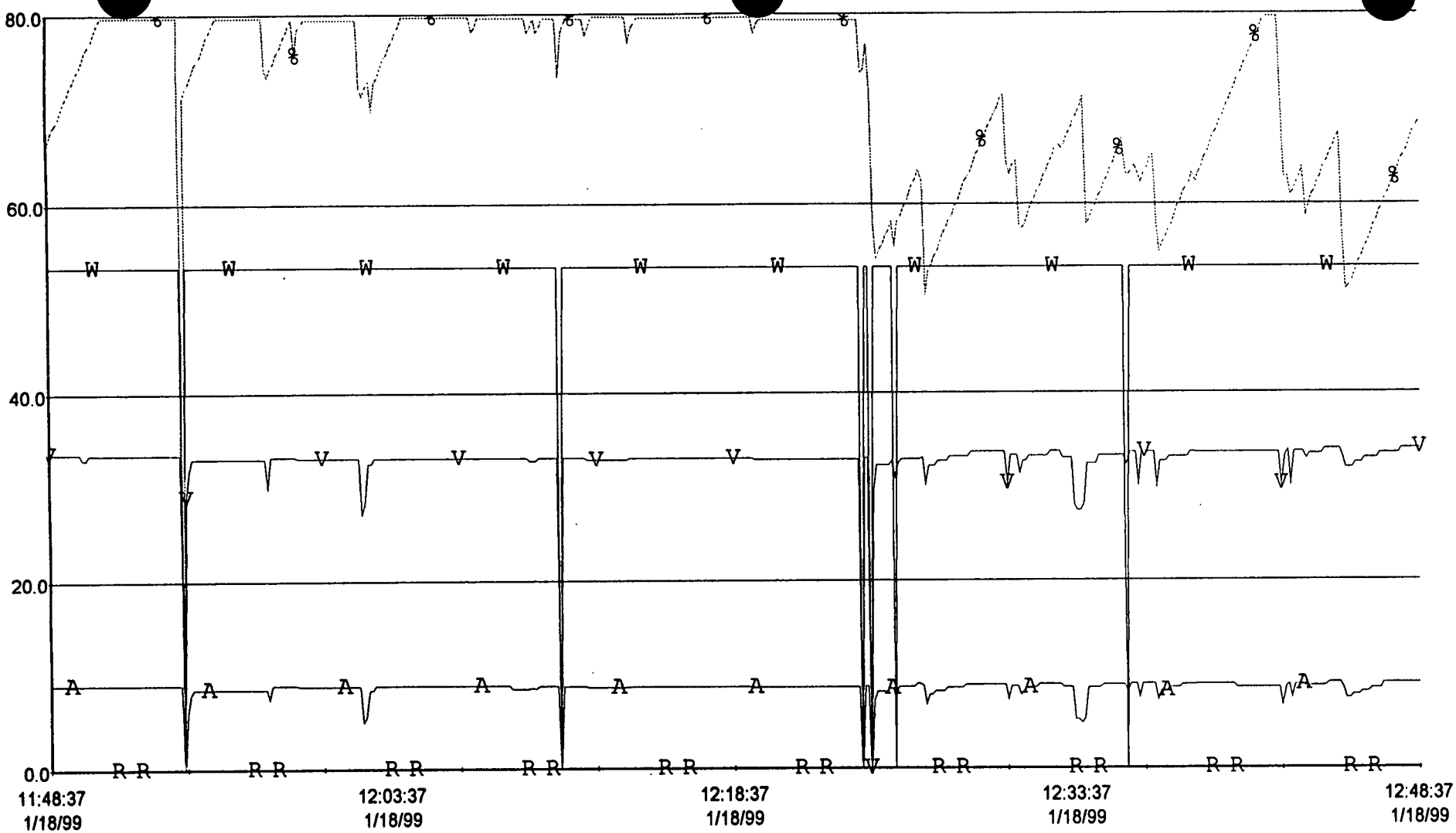


—V—	FIELD 3 VOLTAGE, KV	46.8	44.6
—A—	FIELD 3 CURRENT, MA	20.4	17.4
—%—	FIELD 3 CONTROL OUTPUT, %	89.0	84.0
—W—	Field 3 Power in WATTS 0-150	100.00	98.67
—R—	FIELD 3 POSITIVE COLLECTOR RAPPING	OFF	0
—R—	FIELD 3 NEGATIVE COLLECTOR RAPPING	OFF	0

2291

352

Test 2

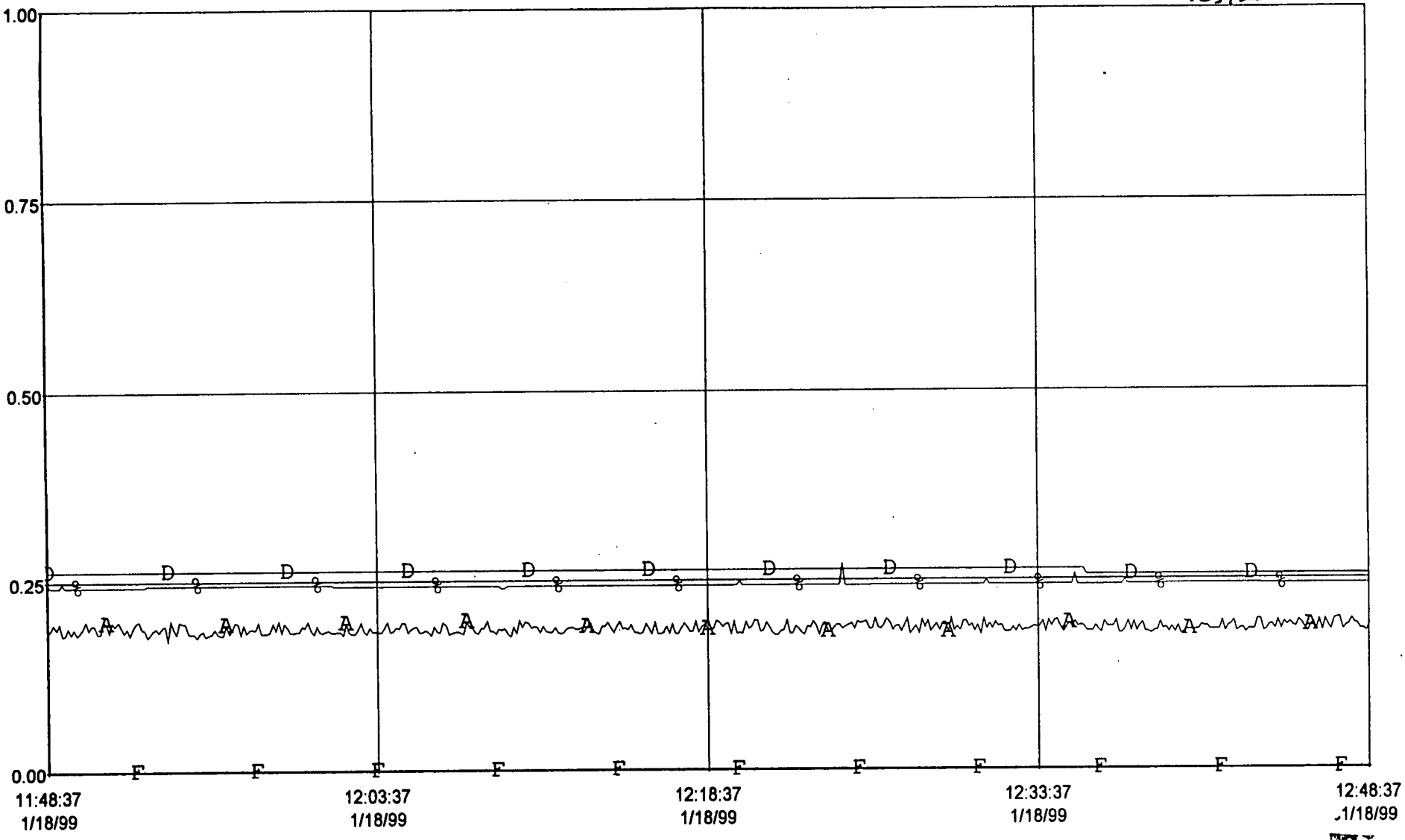


—V—	FIELD 4 VOLTAGE, KV	33.1	32.7
—A—	FIELD 4 CURRENT, MA	13.1	12.9
—W—	Field 4 Power in WATTS 0-150	100.00	98.67
—R—	FIELD 4 POSITIVE COLLECTOR RAPPING	OFF	0
—R—	" " Negative " "	OPEN	0
—%—	FIELD 4 CONTROL OUTPUT, %	99.44	90.17

252

1 of 2

Test 2

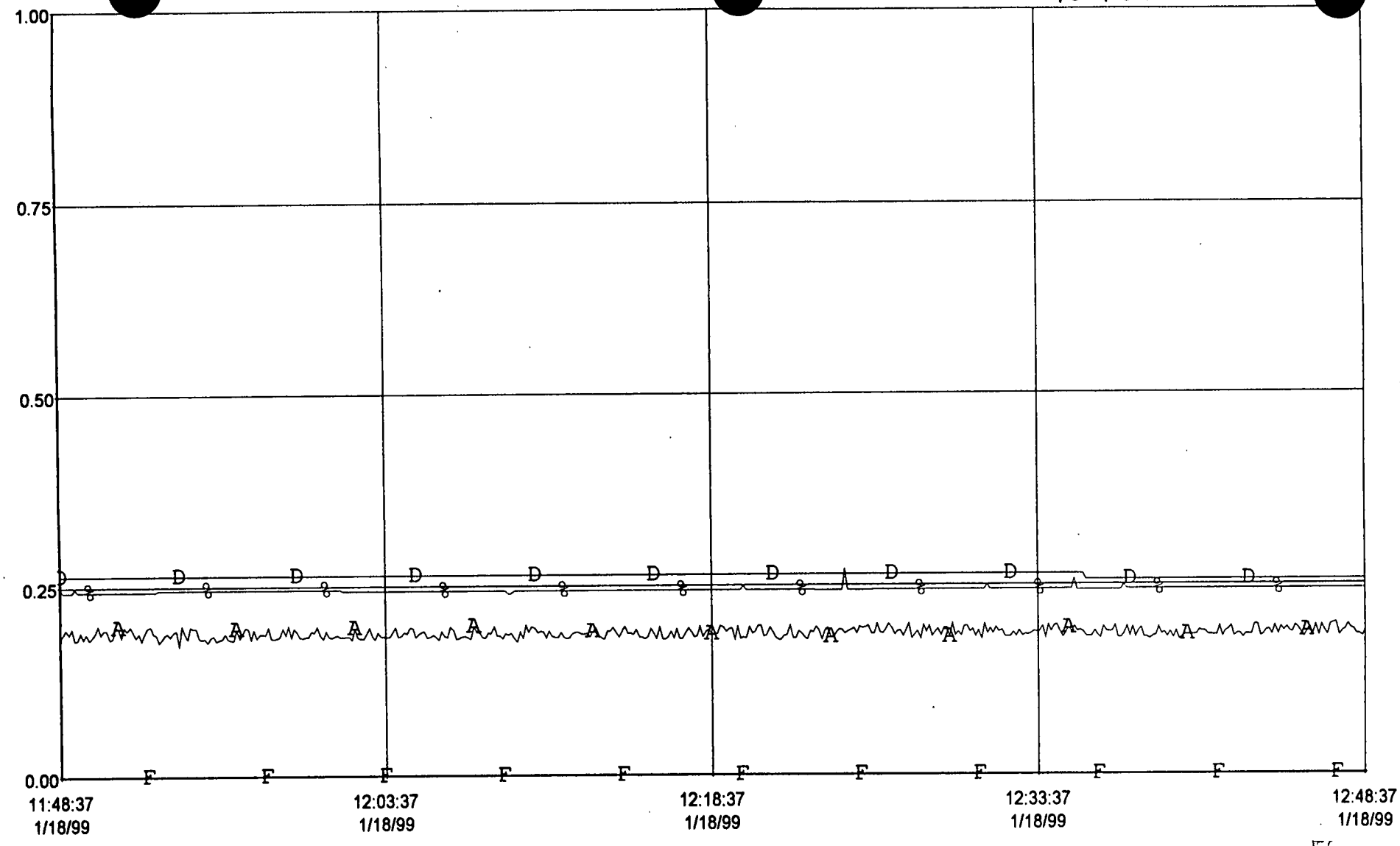


D DUCT PRESSURE 0-15	3.96
% FAN DAMPER POSITION	24.35
A FAN MOTOR CURRENT, AMPS	19.22
F Furnace Pressure . 0-1	0.00

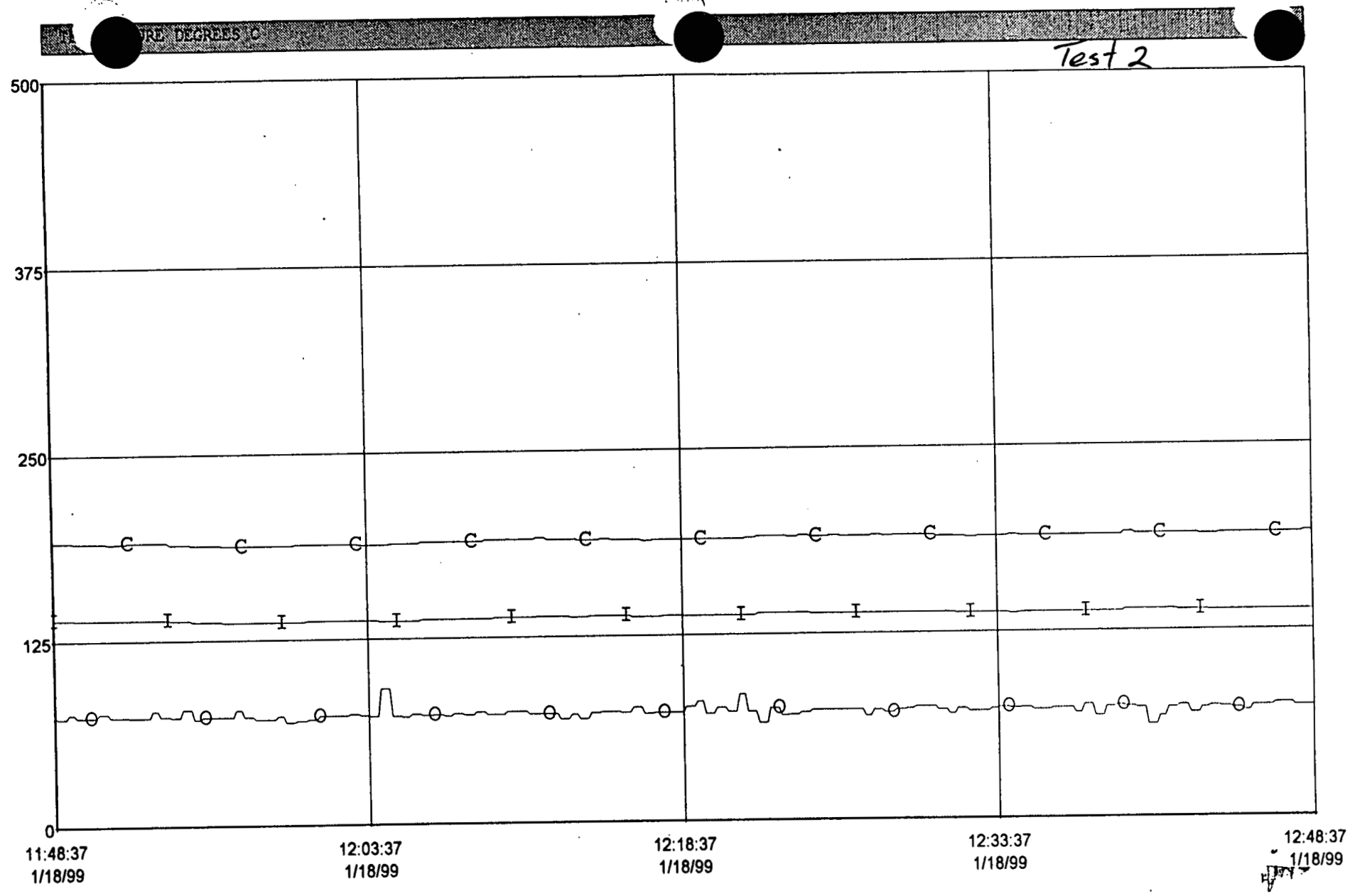
354

2291

Test 2



D	DUCT PRESSURE	3.96
%	FAN DAMPER POSITION	24.35
A	FAN MOTOR CURRENT, AMPS	19.22
F	Furnace Pressure	0.00



I EP INLET TEMPERATUR	138	
O EP OUTLET TEMPERATURE	73.41	
C EP OFFTAKE TEMPERATURE	189	

356

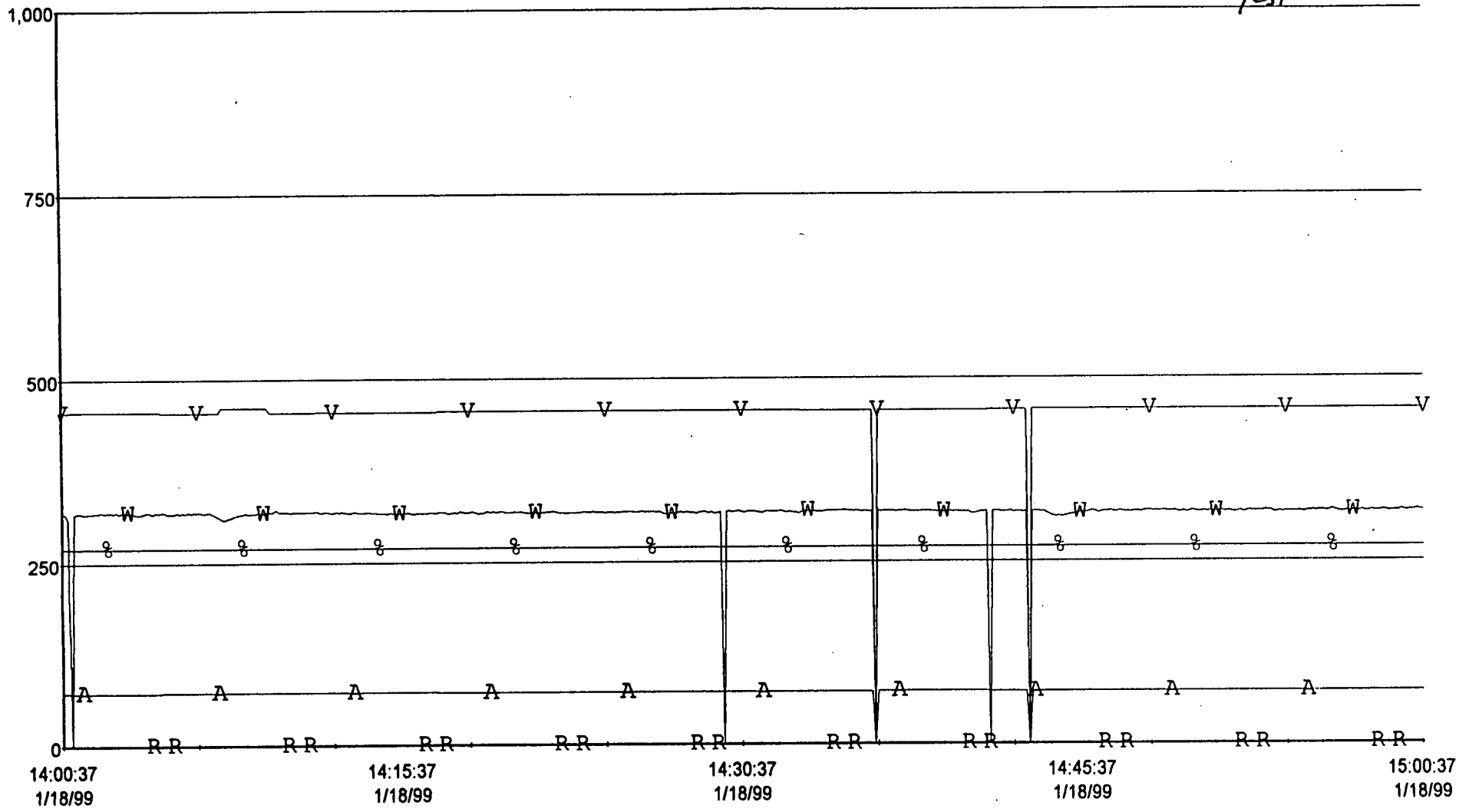
Envitco Mobile EP 229 I 1/20/99 DCP

Test 3

	1400	1410	1420	1430	1440	1450	1500	1502 End Test	
O_2 %	-	20.02	20	20	20	20.02	20.		
CO_2 %	-	0.7	0.73	0.7	0.73	0.72	0.72		
SO_2 ppm	-	7.4	7.0	7.0	6.8	6.3	~~13~~ 14		
NOx ppm	-	13.1	13.0	12.7	12.2	13.5	13.3		
Offtake °F	-	194	195	196	199	197	201		
EP In °C	-	177	178	177	182	180	182		
EP Out °C	-	113	114	113	114	113	113		
Furn. Pres	-	-0.07	-0.07	-0.07	-0.09	-0.08	-0.07		
Duct Pres	-	-5.3	-5.3	-5.3	-5.4	-5.3	-5.3		
Fan Damper	-	7.4	7.4	7.4	7.4	7.5	7.6		
Fan Amps	-	17.6	17.9	17.2	17.5	17.6	17.9		
F1 kV/mA	-	34.4/9.1	34.6/9	34.6/9	34.4/9.1	34.3/9.2	34.4/9.2		
F2 kV/mA	-	28.4/9.9	28.9/10.1	30.2/11.5	28.2/9.6	30.6/12.1	31.0/12.4		
F3 kV/mA	-	36.6/12	34.7/10.3	35.5/11	34.4/10.1	37.5/13	37.2/12.6		
F4 kV/mA	-	29.9/12.4	29.4/12.5	29.5/12.6	27.4/10.3	29.4/13.3	30.1/13.5		
Rapping	-	Off	off	Off	off	Off	off		
Vibrators	-	Off	Off	off	Off	Off	Off		
Scr. Conveyor	-	Off	Off	Off	Off	Off	Off		

Notes: Rapped EP manually + collected dust just prior to test.

Test 3

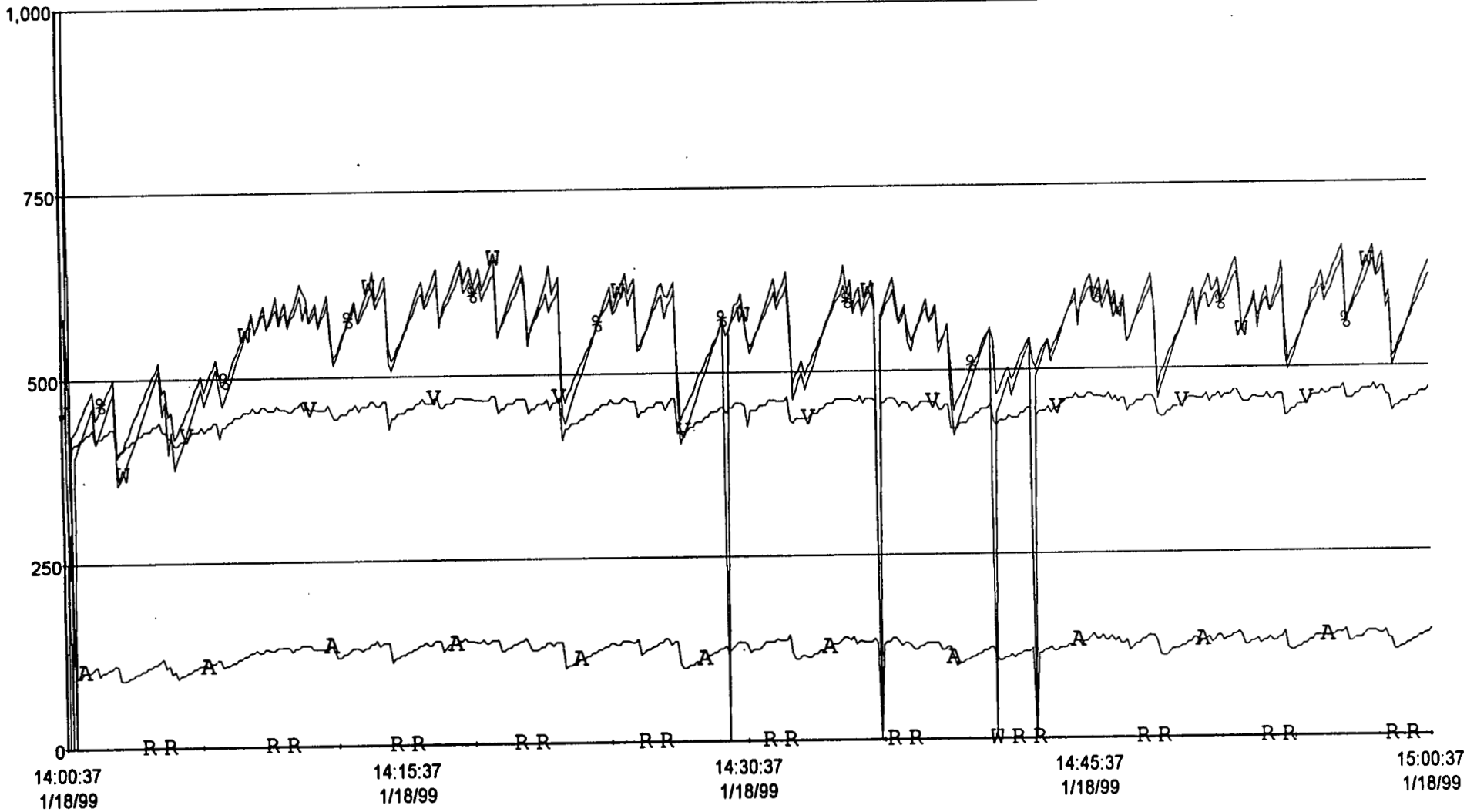


—V—	FIELD 1 VOLTAGE, KV	36.5	36.3
—A—	FIELD 1 CURRENT, MA	8.7	8.7
—%—	FIELD 1 CONTROL OUTPUT, %	27.0	27.0
—W—	Field 1 Power in WATTS	318	314
—R—	FIELD 1 POSITIVE COLLECTOR RAPPING	OFF	0
—R—	FIELD 1 NEGATIVE COLLECTOR RAPPING	OFF	0

358

2291

Test 3

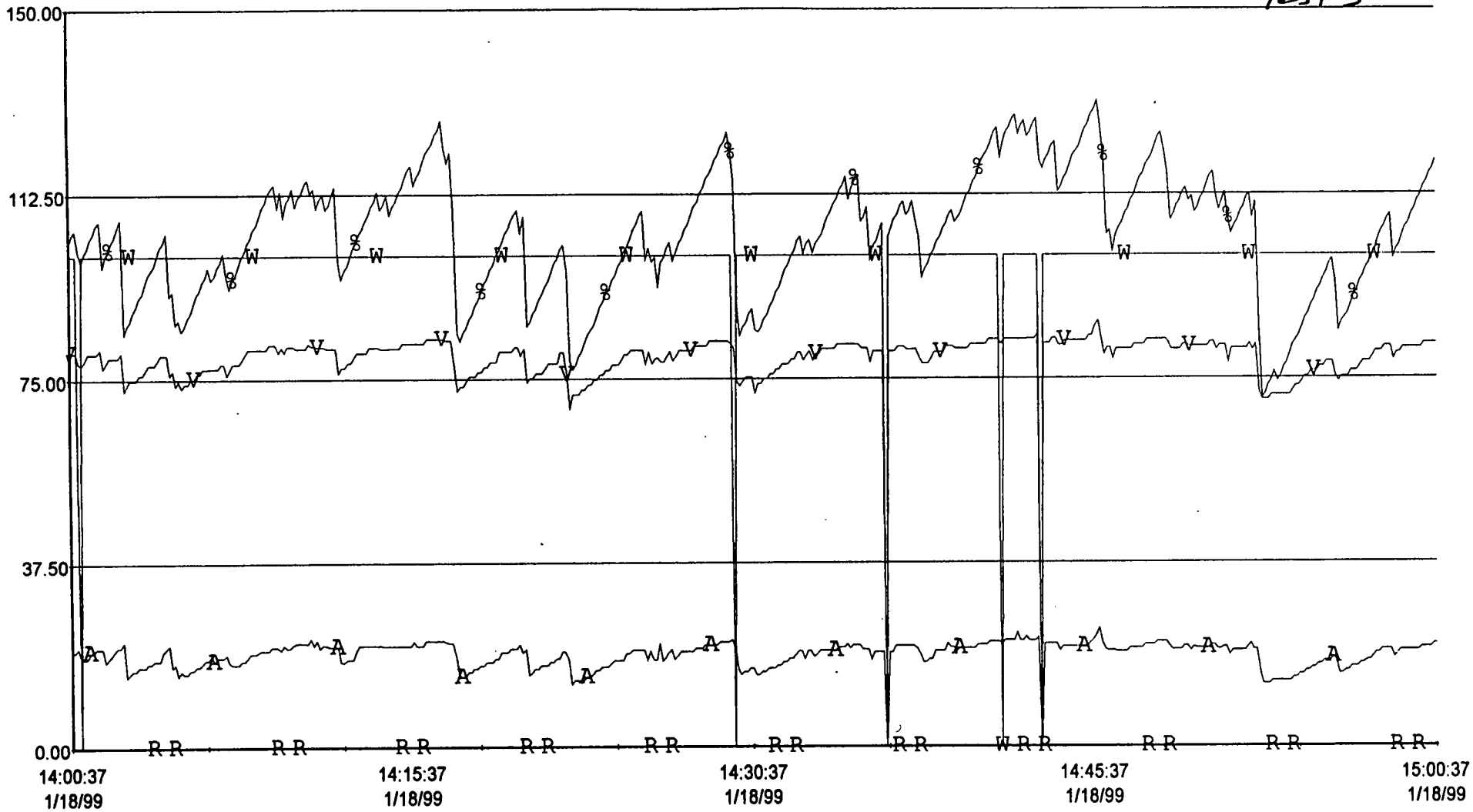


—V—	FIELD 2 VOLTAGE, KV	36.6	35.8
—A—	FIELD 2 CURRENT, MA	16.1	15.1
—%—	FIELD 2 CONTROL OUTPUT, %	59.3	55.4
—W—	Field 2 Power in WATTS	607	550
—R—	FIELD 2 NEGATIVE COLLECTOR RAPPING	OFF	0
—R—	FIELD 2 POSITIVE COLLECTOR RAPPING	OFF	0

359

229 II

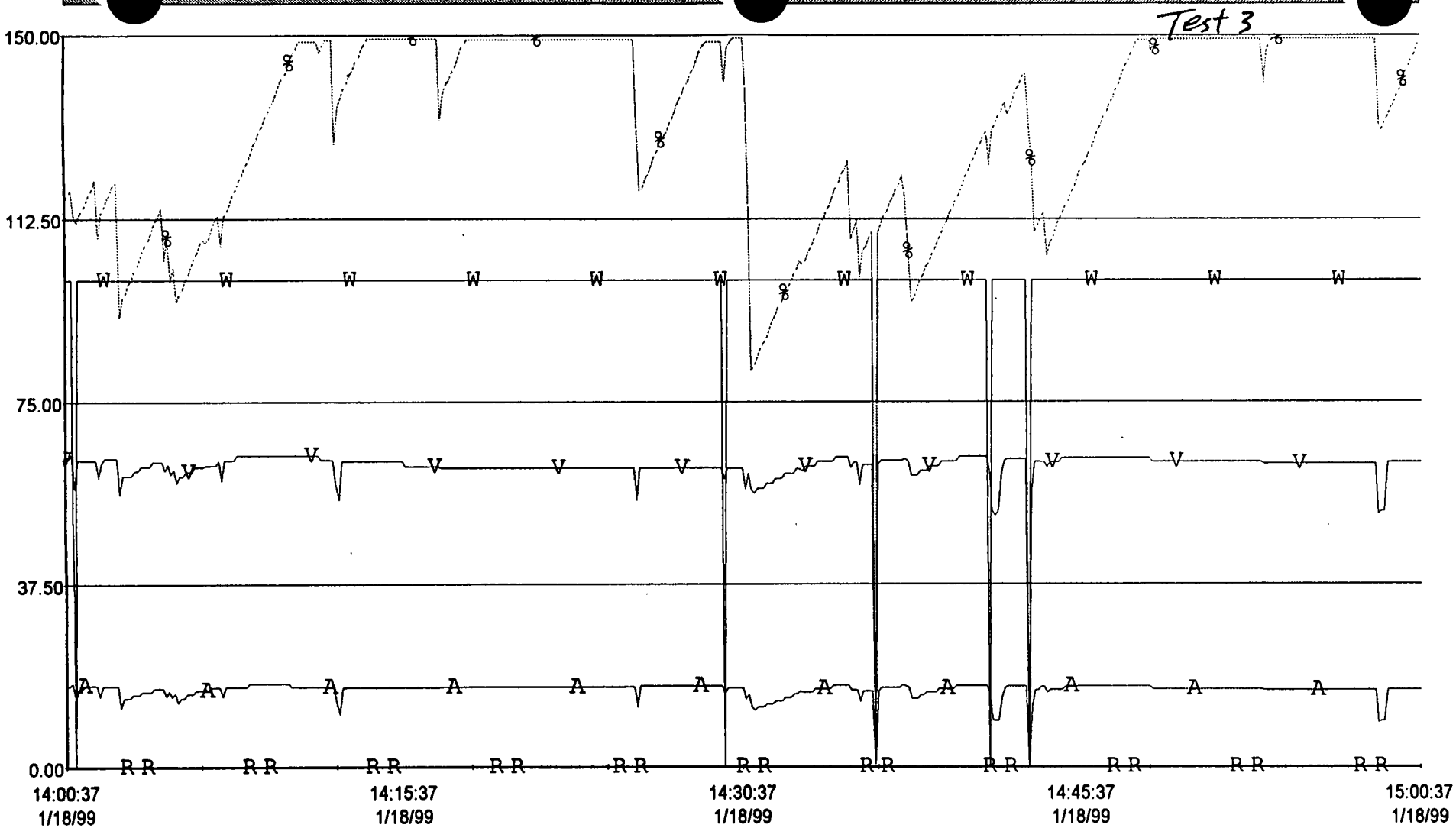
Test 3



—V—	FIELD 3 VOLTAGE, KV	40.2	42.2
—A—	FIELD 3 CURRENT, MA	12.8	15.0
—%—	FIELD 3 CONTROL OUTPUT, %	58.8	69.4
—W—	Field 3 Power in WATTS 0-150	100.00	98.89
—R—	FIELD 3 POSITIVE COLLECTOR RAPPING	OFF	0
—R—	FIELD 3 NEGATIVE COLLECTOR RAPPING	OFF	0

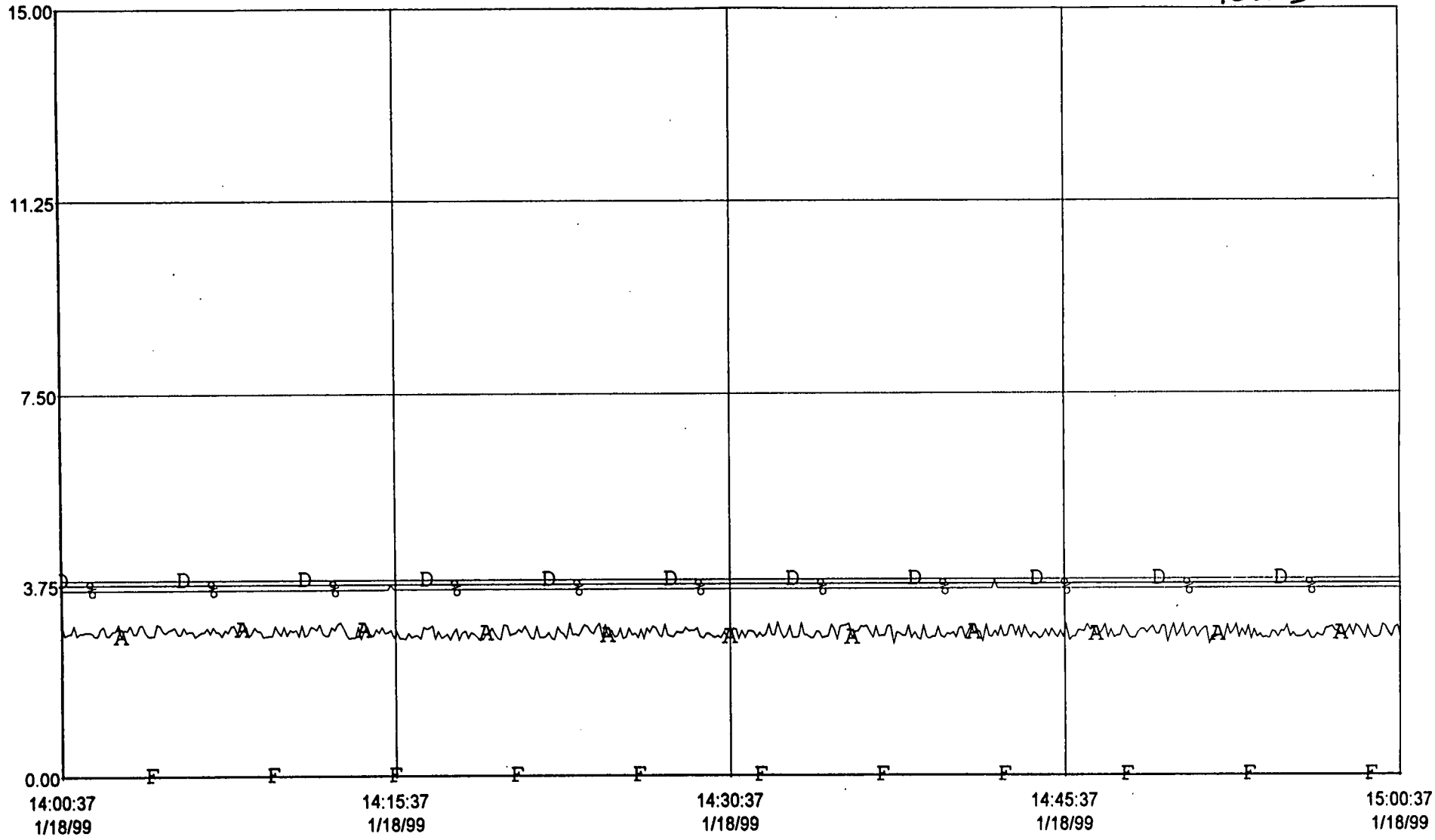
260

1 of 2



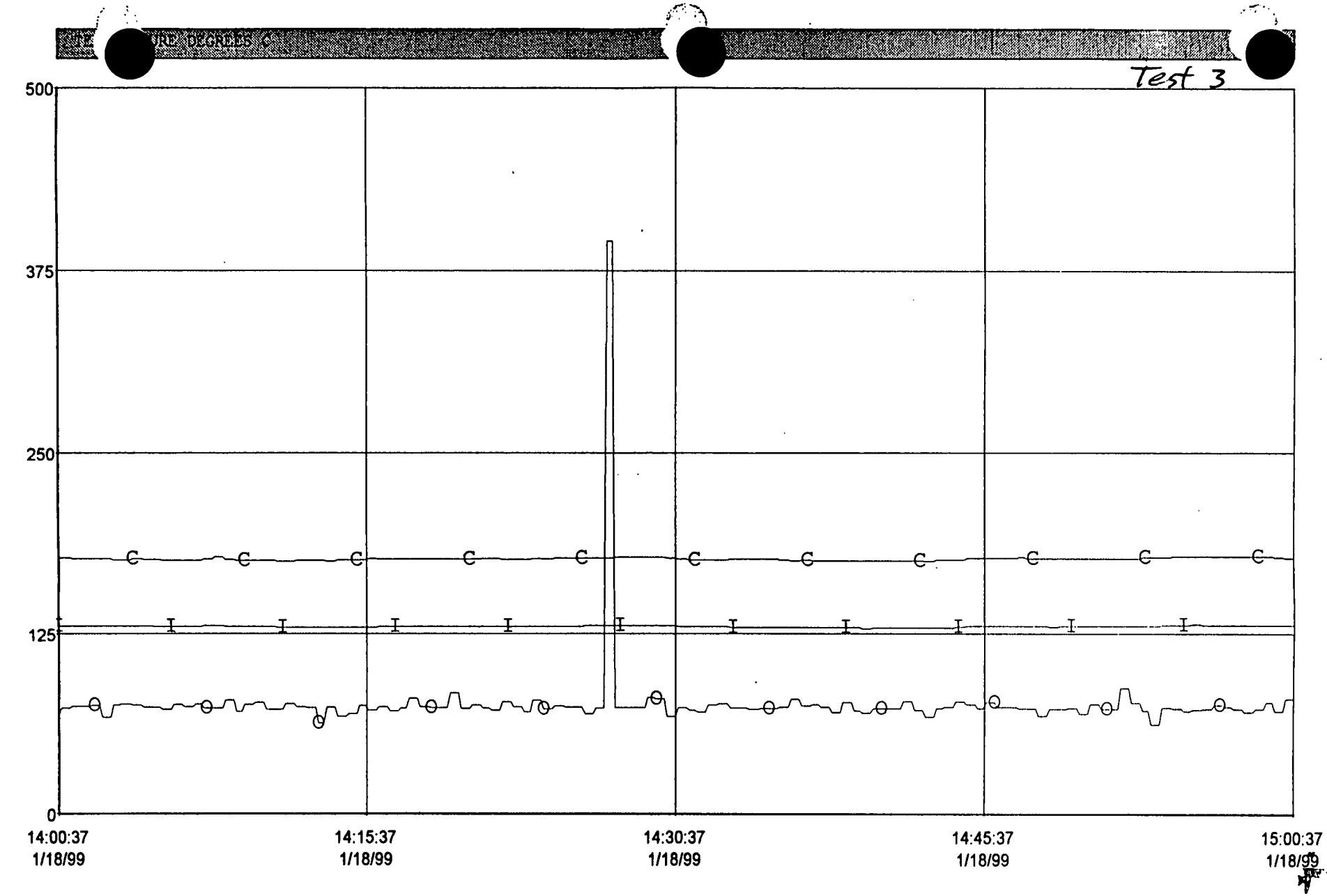
V	FIELD 4 VOLTAGE, KV	32.6	32.8
A	FIELD 4 CURRENT, MA	13.1	12.8
W	Field 4 Power in WATTS 0-150	100.00	98.89
R	FIELD 4 POSITIVE COLLECTOR RAPPING	OFF	0
R	Field 4 Negative Collector Rapping	OPEN	0
%	FIELD 4 CONTROL OUTPUT, %	99.49	87.92

Test 3



D	DUCT PRESSURE	3.84
%	FAN DAMPER POSITION	24.37
A	FAN MOTOR CURRENT, AMPS	18.05
F	Furnace Pressure	0.00

362



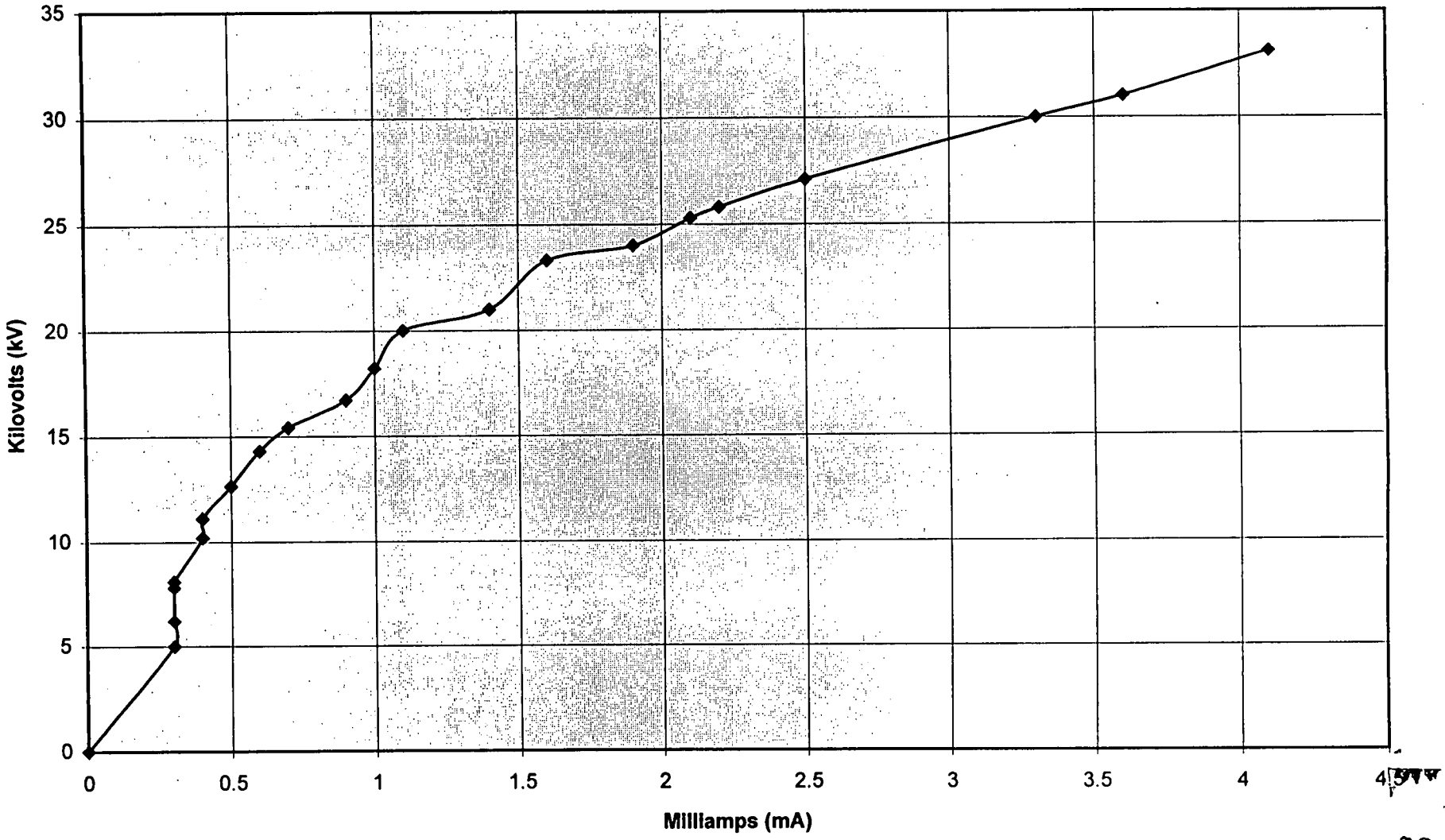
—I— EP INLET TEMPERATUR	131
—O— EP OUTLET TEMPERATURE	67.63
—C— EP OFFTAKE TEMPERATURE	177

363

2291

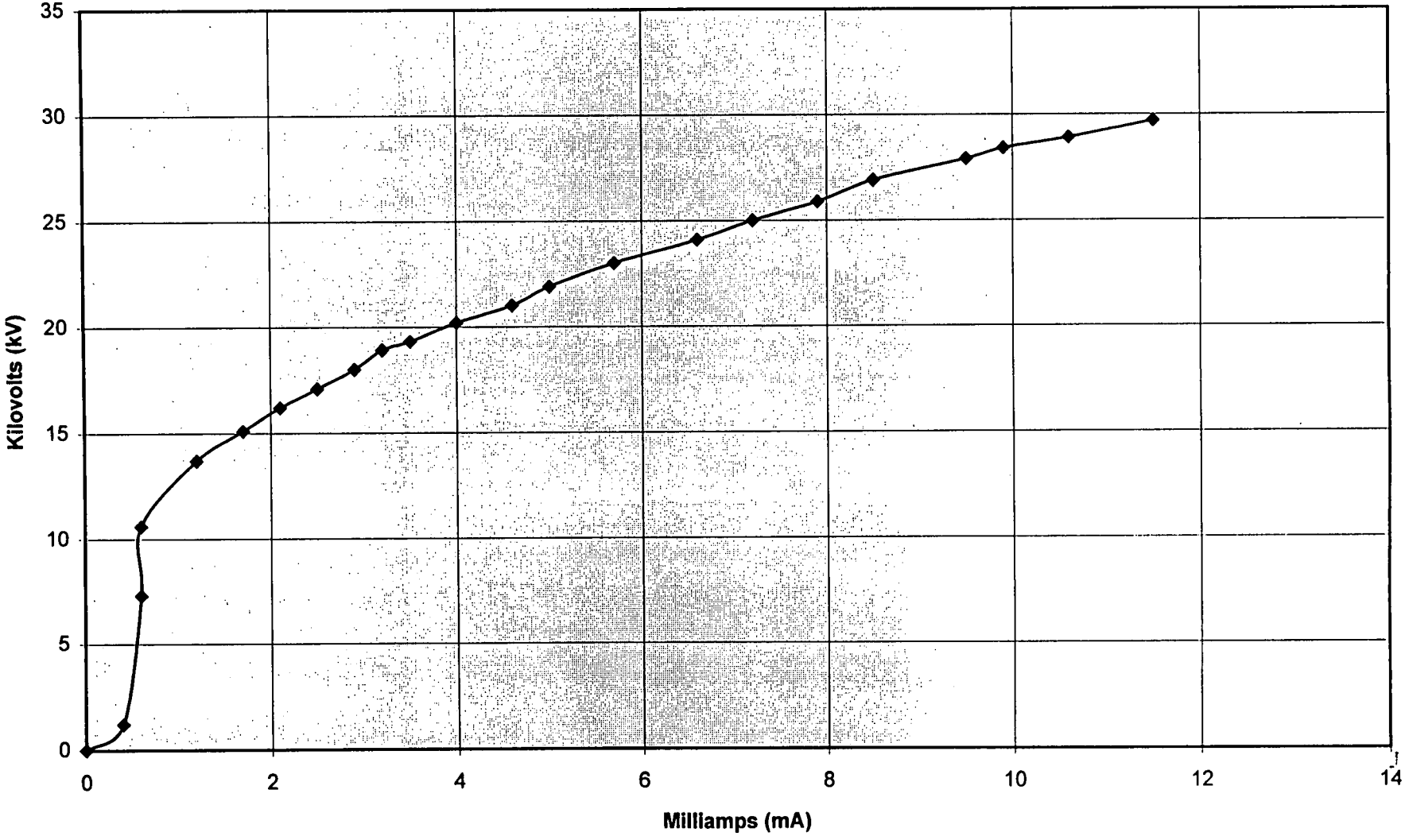
4d. - Current-Voltage (I-V) Characteristics

I - V CURVE - FIELD 1



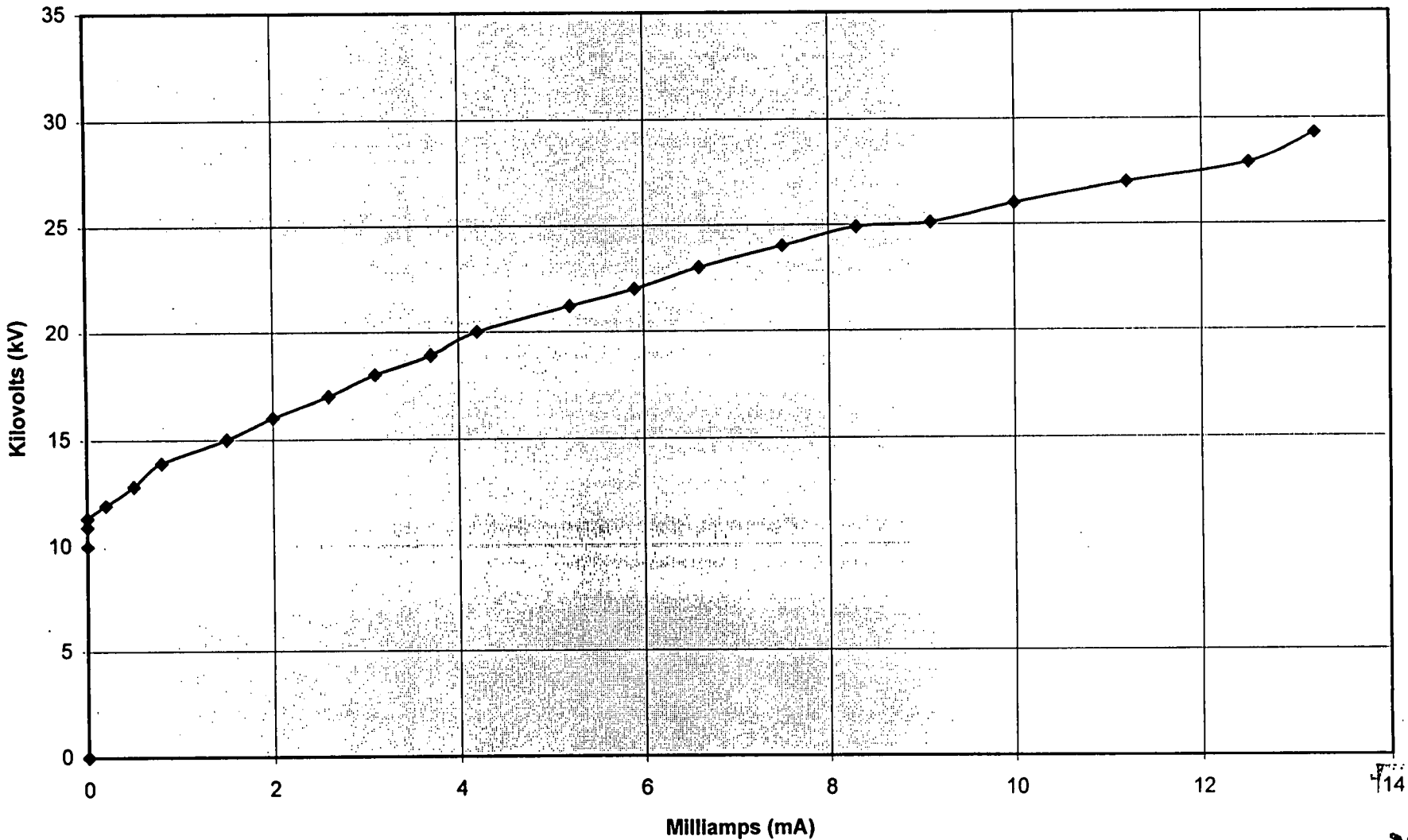
295

I - V CURVE - FIELD 2



366

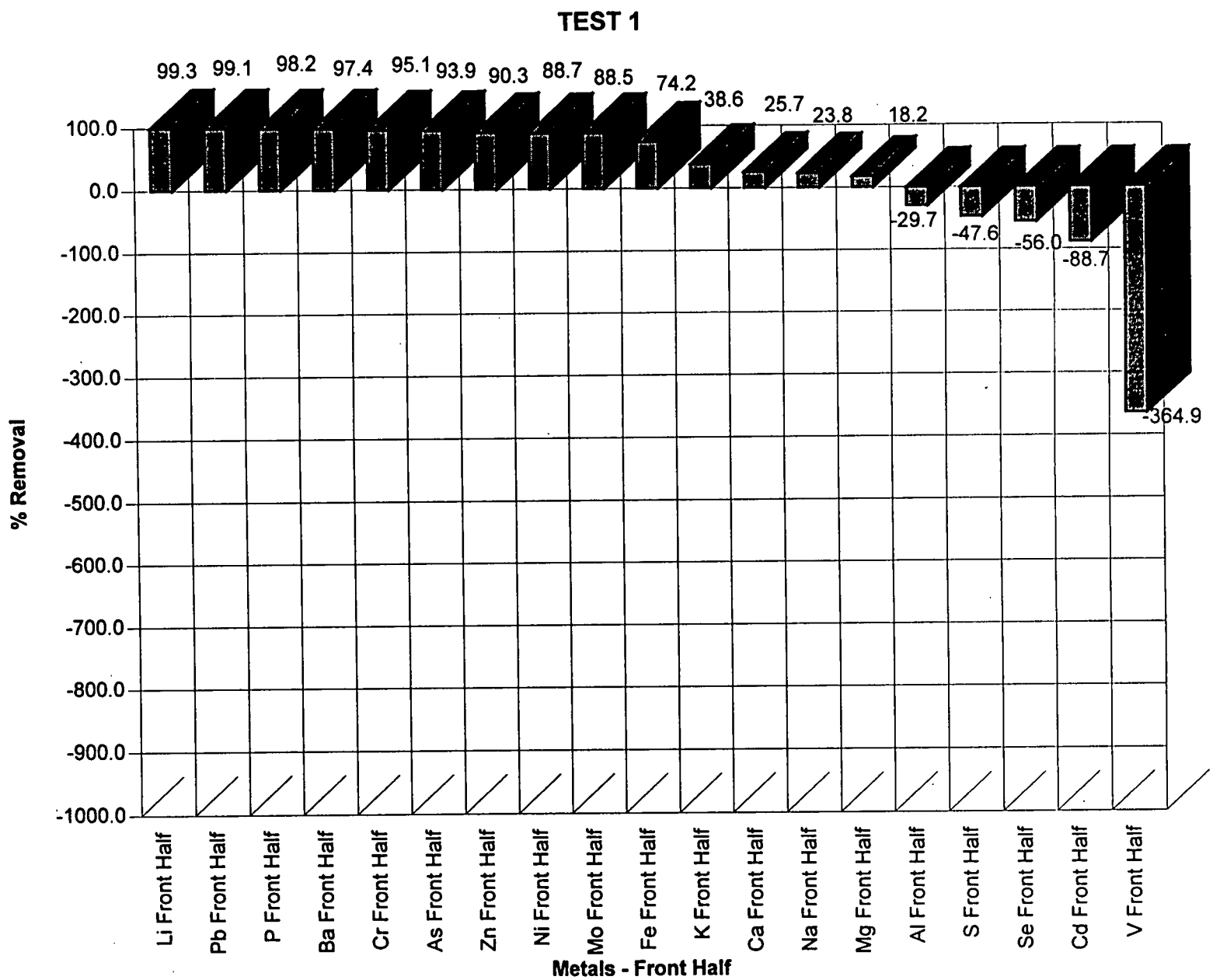
I - V CURVE - FIELD 4



2291

367

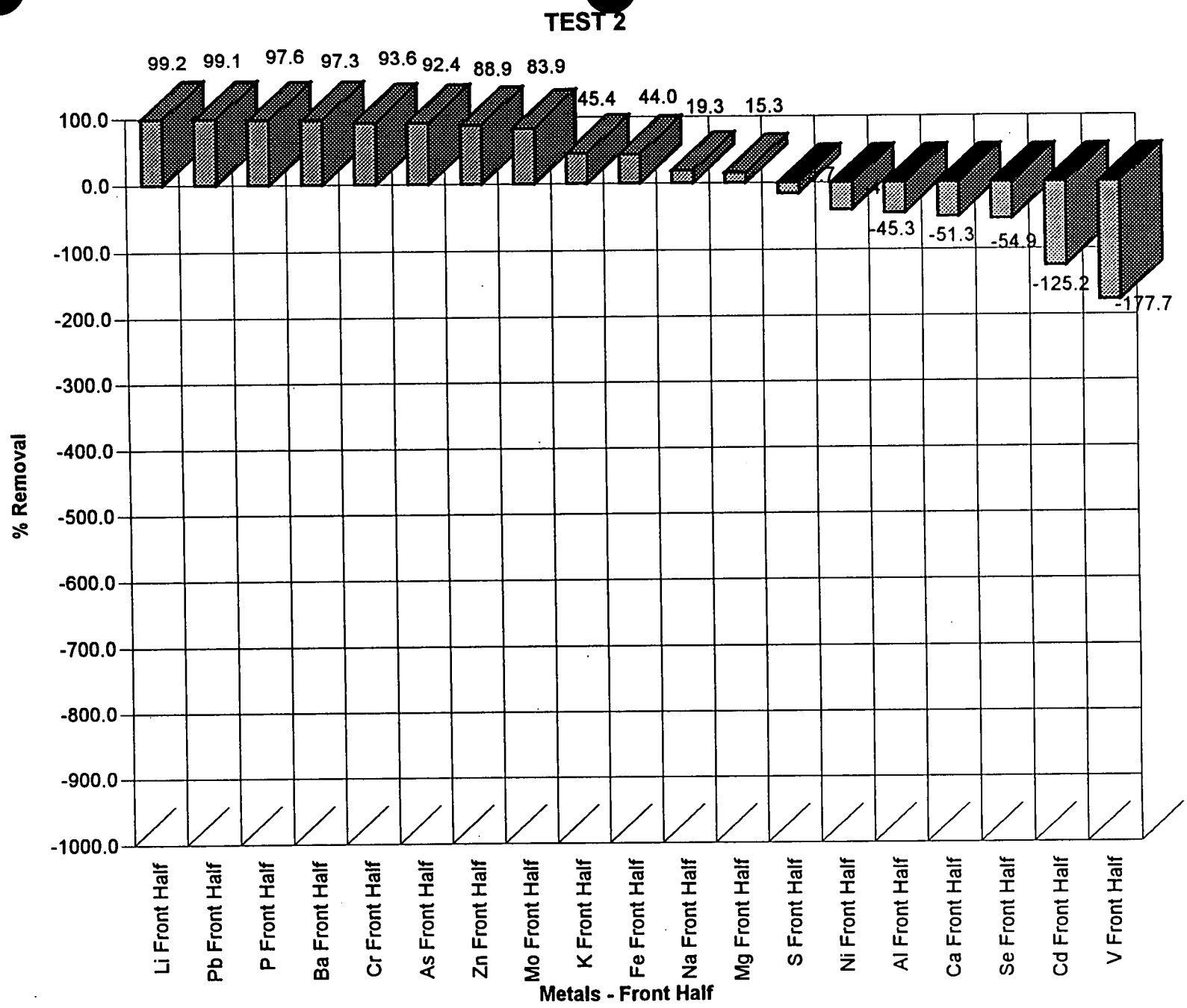
4e. - Metals Removal Efficiency Graphs



229

Test Summary.xls

Chart11

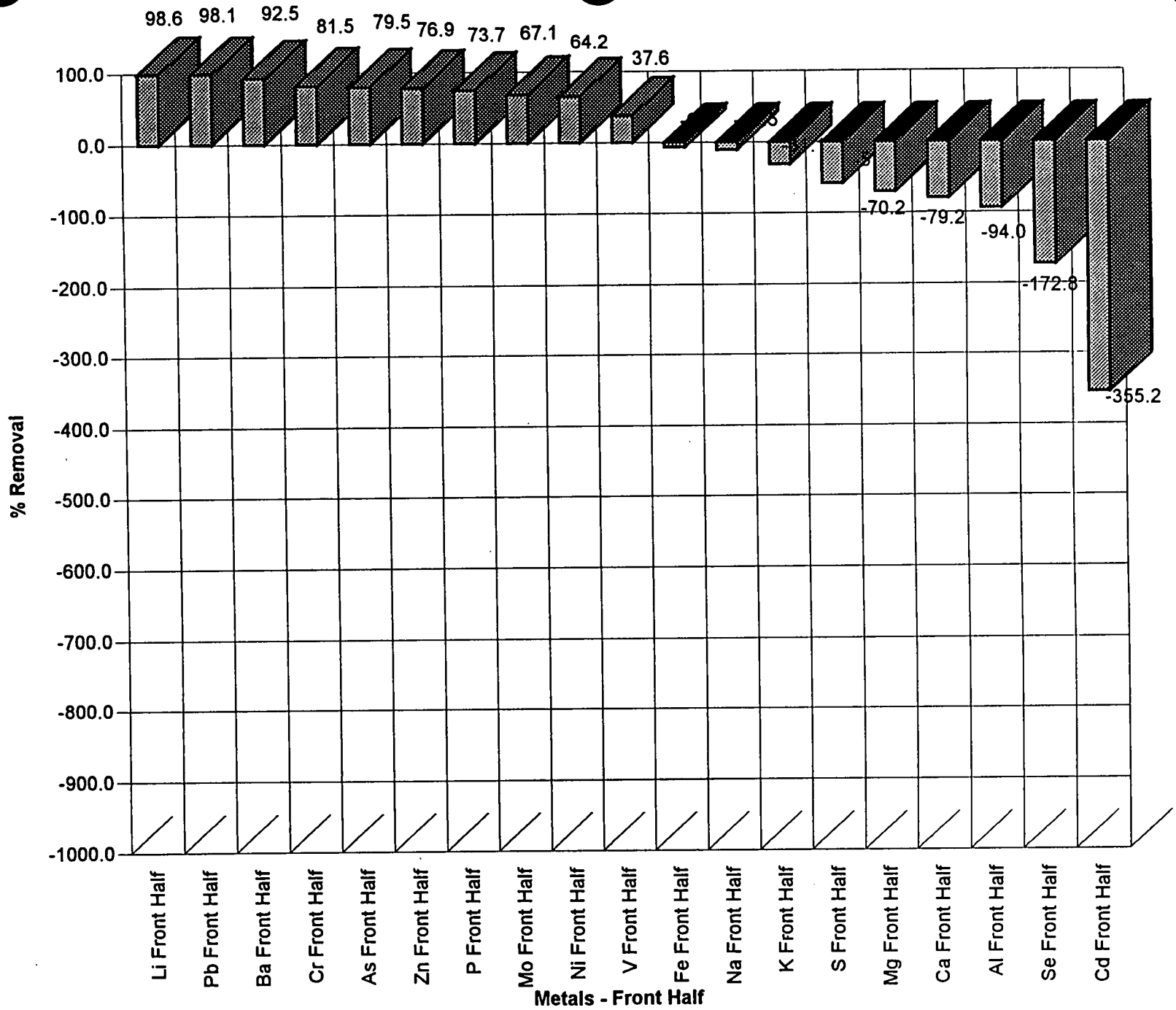


370

Test Summary.xls

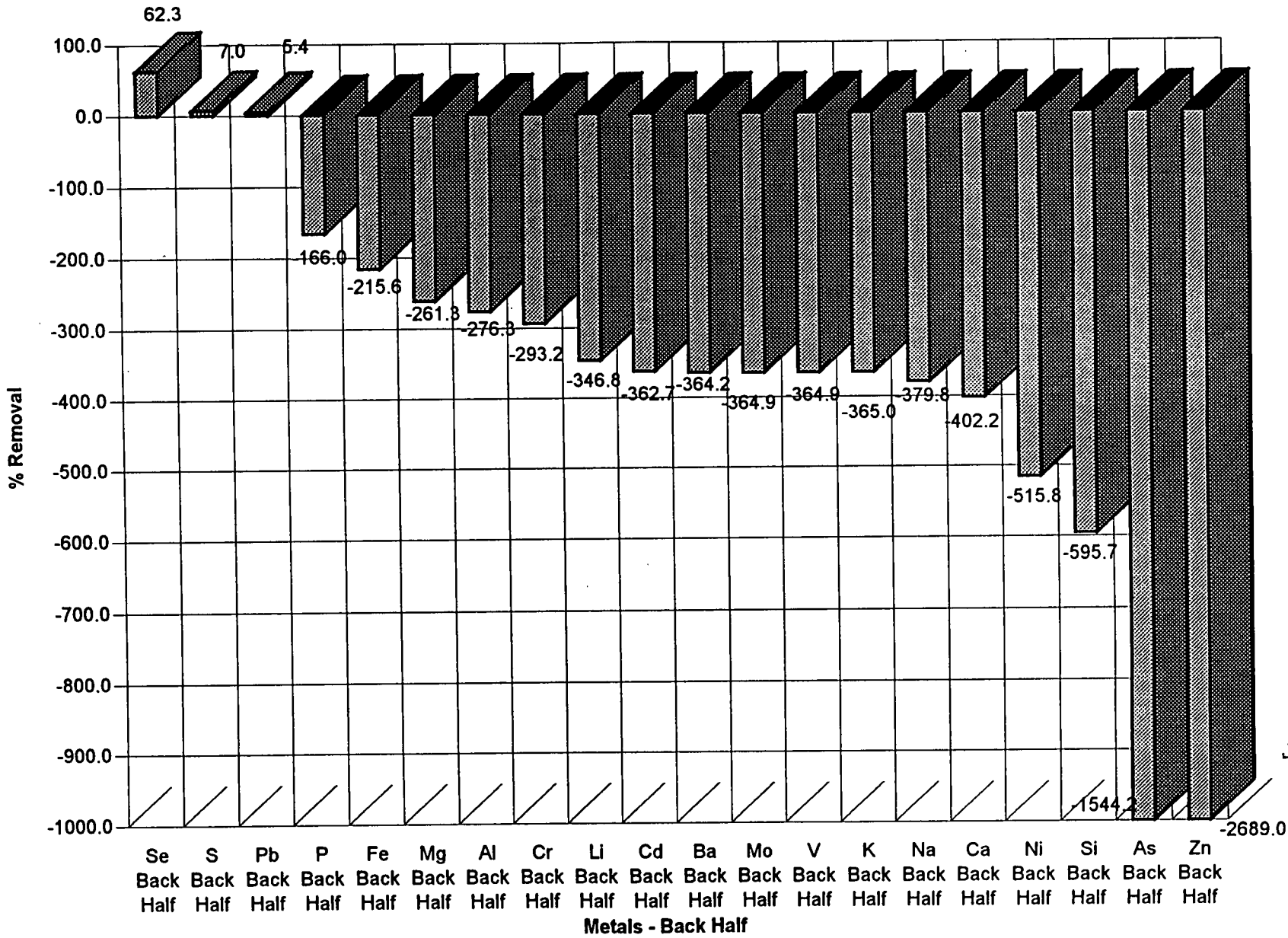
Chart12

2291



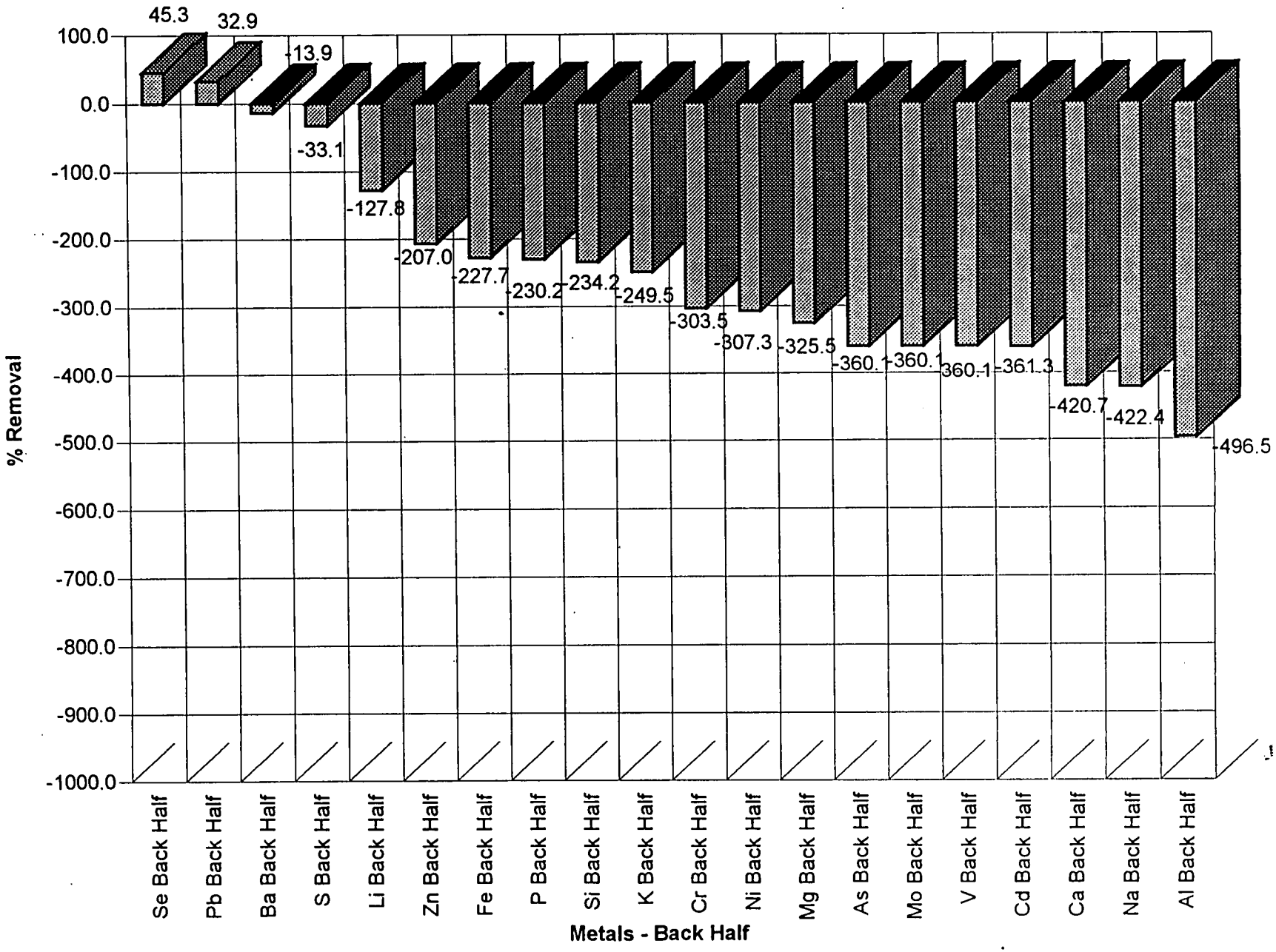
Test Summary.xls

Chart13



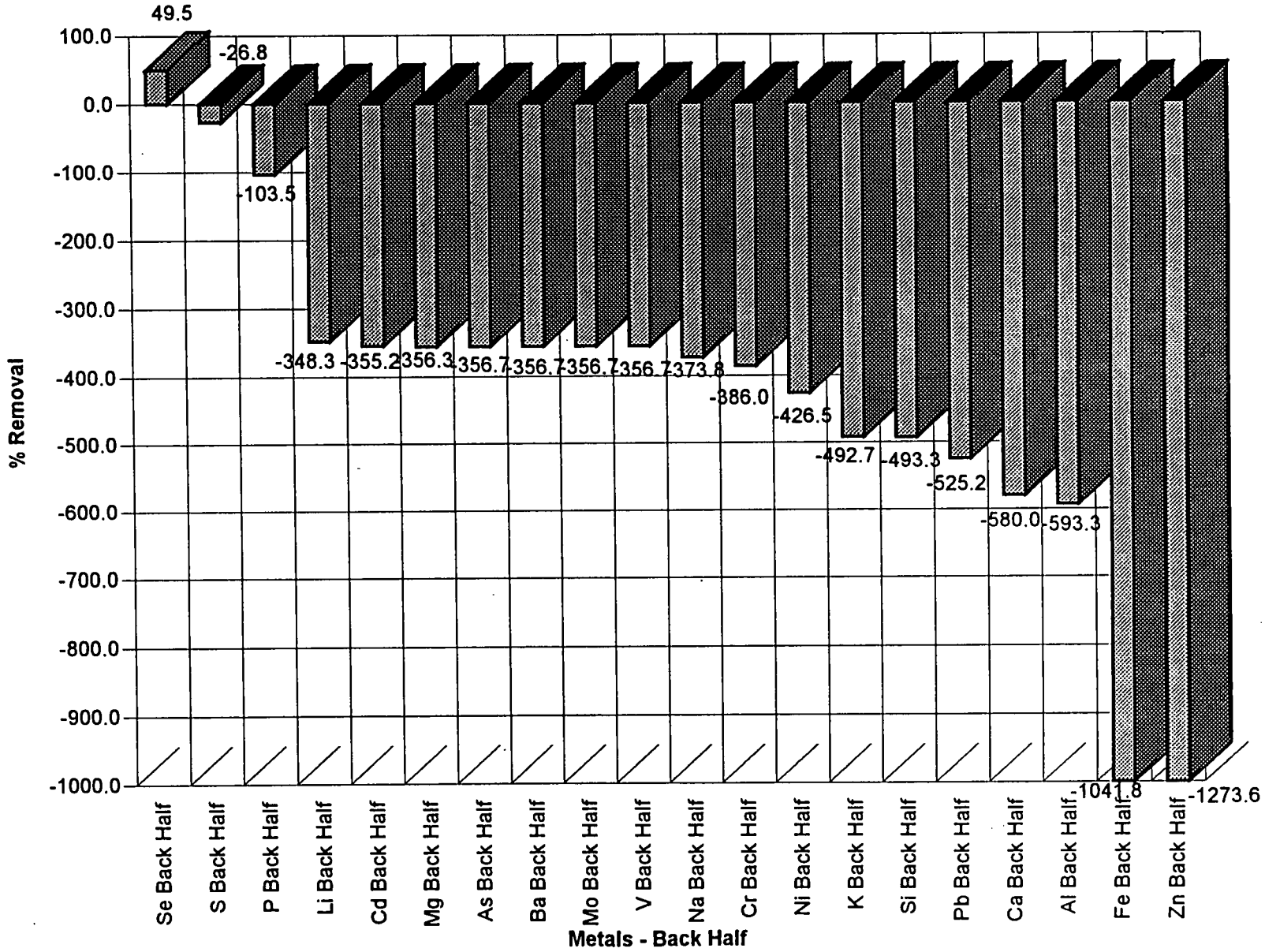
Test Summary.xls

Chart14


% Removal
100.0
0.0
-100.0
-200.0
-300.0
-400.0
-500.0
-600.0
-700.0
-800.0
-900.0
-1000.0
45.3
32.9
-13.9
-33.1
-127.8
-207.0
-227.7
-230.2
-234.2
-249.5
-303.5
-307.3
-325.5
-360.1
-360.1
-360.1
-361.3
-420.7
-422.4
-496.5
Se Back Half
Pb Back Half
Ba Back Half
S Back Half
Li Back Half
Zn Back Half
Fe Back Half
P Back Half
Si Back Half
K Back Half
Cr Back Half
Ni Back Half
Mg Back Half
As Back Half
Mo Back Half
V Back Half
Cd Back Half
Ca Back Half
Na Back Half
Al Back Half
Metals - Back Half

275

TEST 3

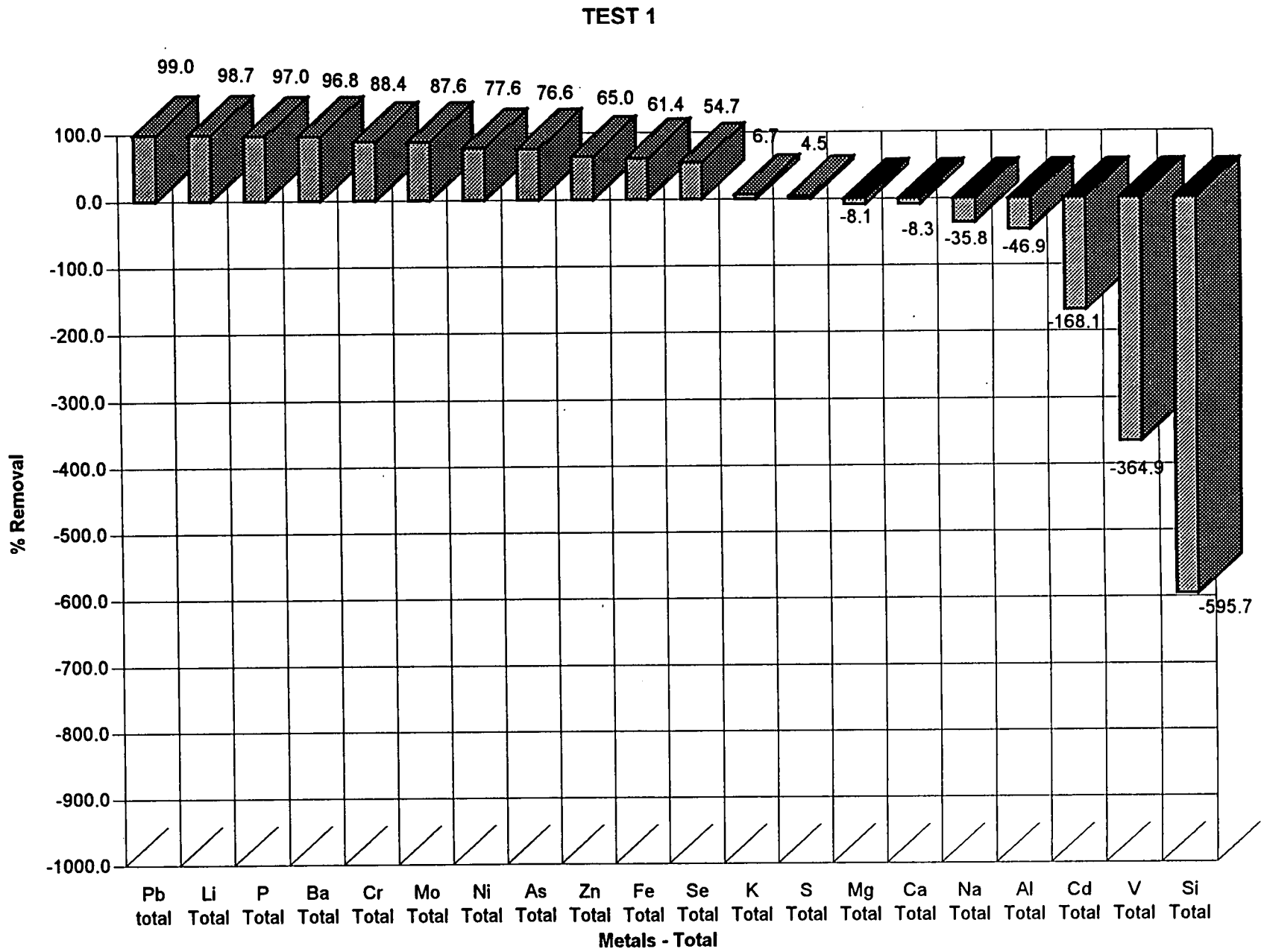


Test Summary.xls

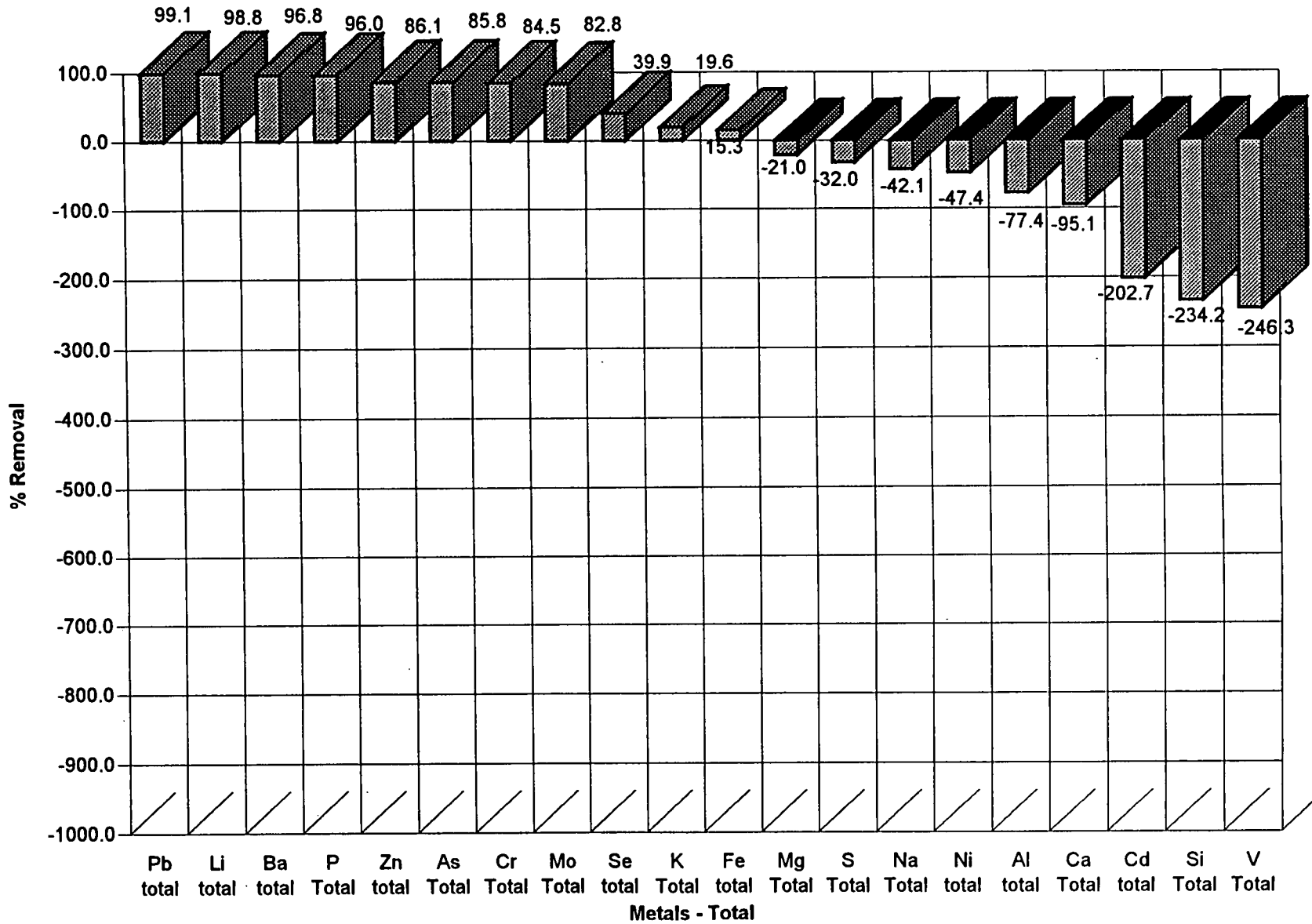
Chart16

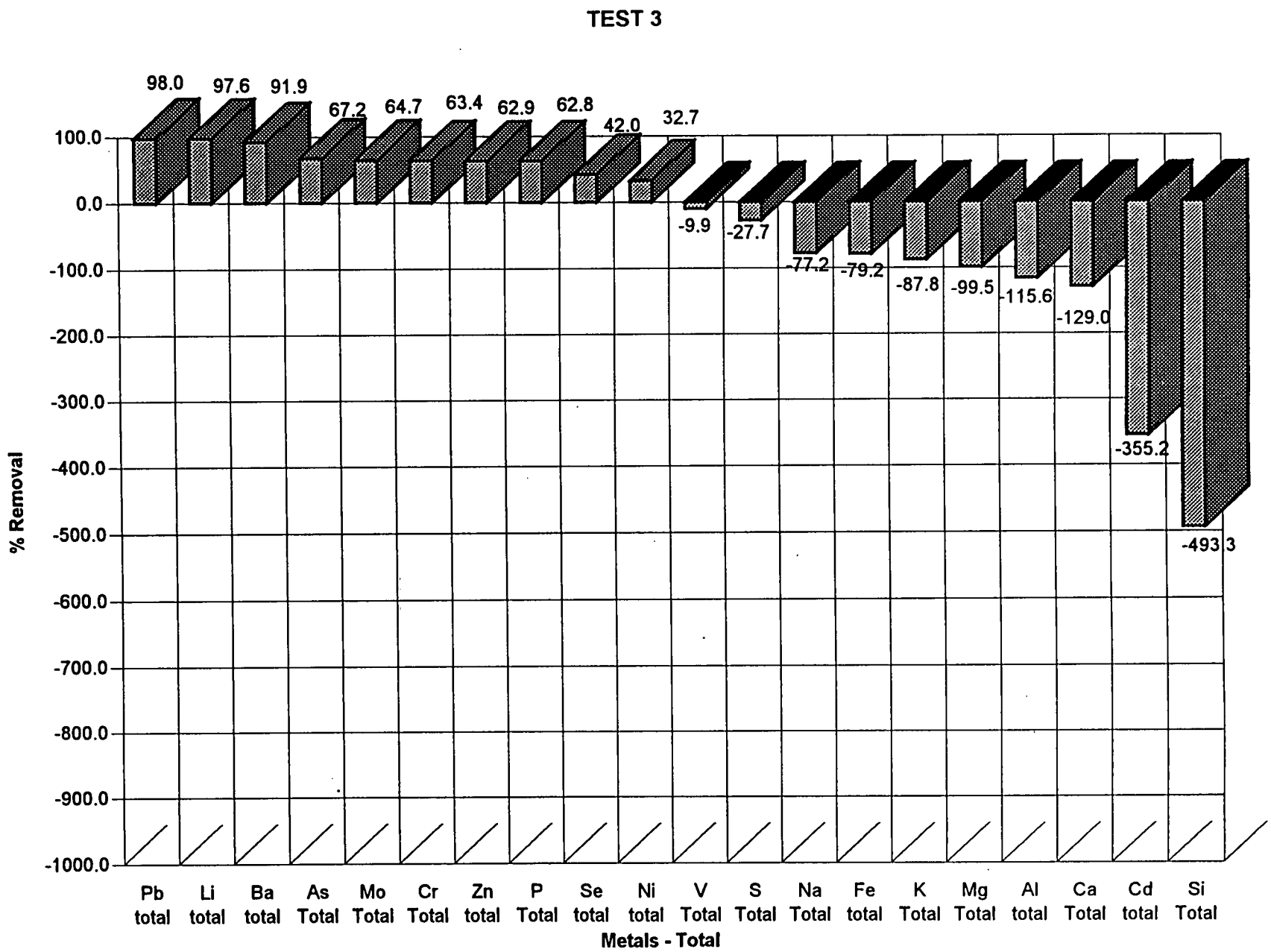
34

2229


TEST 1
% Removal
100.0
0.0
-100.0
-200.0
-300.0
-400.0
-500.0
-600.0
-700.0
-800.0
-900.0
-1000.0
99.0
98.7
97.0
96.8
88.4
87.6
77.6
76.6
65.0
61.4
54.7
6.7
4.5
-8.1
-8.3
-35.8
-46.9
-168.1
-364.9
-595.7
Pb total
Li Total
P Total
Ba Total
Cr Total
Mo Total
Ni Total
As Total
Zn Total
Fe Total
Se Total
K Total
S Total
Mg Total
Ca Total
Na Total
Al Total
Cd Total
V Total
Si Total
Metals - Total

TEST 2


% Removal
100.0
0.0
-100.0
-200.0
-300.0
-400.0
-500.0
-600.0
-700.0
-800.0
-900.0
-1000.0
99.1
98.8
96.8
96.0
86.1
85.8
84.5
82.8
39.9
19.6
15.3
-21.0
-32.0
-42.1
-47.4
-77.4
-95.1
-202.7
-234.2
-246.3
Pb total
Li total
Ba total
P Total
Zn total
As Total
Cr Total
Mo Total
Se total
K Total
Fe total
Mg Total
S Total
Na Total
Ni total
Al total
Ca Total
Cd total
Si Total
V Total
Metals - Total


TEST 3
% Removal
100.0
0.0
-100.0
-200.0
-300.0
-400.0
-500.0
-600.0
-700.0
-800.0
-900.0
-1000.0
98.0
97.6
91.9
67.2
64.7
63.4
62.9
62.8
42.0
32.7
-9.9
-27.7
-77.2
-79.2
-87.8
-99.5
-115.6
-129.0
-355.2
-493.3
Pb total
Li total
Ba total
As Total
Mo Total
Cr Total
Zn total
P Total
Se total
Ni total
V Total
S Total
Na Total
Fe total
K Total
Mg Total
Al total
Ca Total
Cd total
Si Total
Metals - Total

2229 11

(All un[illegible] Lbs per Hr)	Test 1			Test 2			Test 3		
PARAMETER	Melter Exhaust	Mobile EP Stack	Removal %	Melter Exhaust	Mobile EP Stack	Removal %	Melter Exhaust	Mobile EP Stack	Removal
Mo Front Half	3.34E-04	3.84E-05	88.50	2.56E-04	4.11E-05	83.95	1.19E-04	3.92E-05	67.06
Mo Back Half	6.69E-07	3.11E-06	-364.87	6.76E-07	3.11E-06	-360.06	6.70E-07	3.06E-06	-356.72
Mo Total	3.35E-04	4.15E-05	87.60	2.57E-04	4.42E-05	82.78	1.20E-04	4.23E-05	64.69
Na Front Half	2.14E-03	1.63E-03	23.83	2.49E-03	2.01E-03	19.28	1.53E-03	1.69E-03	-10.46
Na Back Half	3.71E-04	1.78E-03	-379.78	4.02E-04	2.10E-03	-422.39	3.44E-04	1.63E-03	-373.84
Na Total	2.51E-03	3.41E-03	-35.80	2.89E-03	4.11E-03	-42.12	1.87E-03	3.32E-03	-77.16
Ni Front Half	6.10E-05	6.89E-06	88.70	4.14E-05	5.82E-05	-40.58	1.65E-05	5.91E-06	64.18
Ni Back Half	1.14E-06	7.02E-06	-515.79	1.09E-06	4.44E-06	-307.34	1.13E-06	5.95E-06	-426.55
Ni total	6.21E-05	1.39E-05	77.62	4.25E-05	6.26E-05	-47.42	1.76E-05	1.19E-05	32.73
P Front Half	4.67E-03	8.39E-05	98.20	4.45E-03	1.07E-04	97.60	2.17E-04	5.70E-05	73.73
P Back Half	2.06E-05	5.48E-05	-166.02	2.15E-05	7.10E-05	-230.23	1.43E-05	2.91E-05	-103.50
P Total	4.69E-03	1.39E-04	97.04	4.47E-03	1.78E-04	96.02	2.31E-04	8.61E-05	62.78
Pb Front Half	1.75E-02	1.61E-04	99.08	1.54E-02	1.32E-04	99.14	9.47E-03	1.84E-04	98.06
Pb Back Half	5.79E-06	5.48E-06	5.35	8.88E-06	5.96E-06	32.88	1.35E-06	8.44E-06	-525.19
Pb total	1.75E-02	1.66E-04	99.05	1.54E-02	1.38E-04	99.10	9.47E-03	1.92E-04	97.97
S Front Half	1.45E-03	2.14E-03	-47.59	1.85E-03	2.14E-03	-15.68	1.33E-03	2.10E-03	-57.89
S Back Half	3.02E-02	2.81E-02	6.95	2.69E-02	3.58E-02	-33.09	4.26E-02	5.40E-02	-26.76
S Total	3.17E-02	3.02E-02	4.45	2.88E-02	3.79E-02	-31.97	4.39E-02	5.61E-02	-27.70
Se Front Half	4.70E-04	7.33E-04	-55.96	4.06E-04	6.29E-04	-54.93	2.87E-04	7.83E-04	-172.82
Se Back Half	6.77E-03	2.55E-03	62.33	7.08E-03	3.87E-03	45.34	8.25E-03	4.17E-03	49.45
Se total	7.24E-03	3.28E-03	54.65	7.49E-03	4.50E-03	39.90	8.54E-03	4.95E-03	41.98
Si Front Half	0	0	#DIV/0!	0	0	#DIV/0!	0	0	#DIV/0!
Si Back Half	1.61E-04	1.12E-03	-595.65	3.92E-04	1.31E-03	-234.18	1.34E-04	7.95E-04	-493.28
Si Total	1.61E-04	1.12E-03	-595.65	3.92E-04	1.31E-03	-234.18	1.34E-04	7.95E-04	-493.28
V Front Half	6.69E-07	3.11E-06	-364.87	1.12E-06	3.11E-06	-177.68	4.90E-06	3.06E-06	37.55
V Back Half	6.69E-07	3.11E-06	-364.87	6.76E-07	3.11E-06	-360.06	6.70E-07	3.06E-06	-356.72
V Total	1.34E-06	6.22E-06	-364.87	1.80E-06	6.22E-06	-246.33	5.57E-06	6.12E-06	-9.87
Zn Front Half	2.38E-04	2.32E-05	90.25	2.21E-04	2.45E-05	88.91	1.73E-04	3.99E-05	76.94
Zn Back Half	2.18E-06	6.08E-05	-2688.99	2.15E-06	6.60E-06	-206.98	1.82E-06	2.50E-05	-1273.63
Zn total	2.40E-04	8.40E-05	65.03	2.23E-04	3.11E-05	86.06	1.75E-04	6.49E-05	62.88

(All un[illegible]e Lbs per Hr)	Test 1			Test 2			Test 3		
PARAMETER	Melter Exhaust	Mobile EP Stack	Removal %	Melter Exhaust	Mobile EP Stack	Removal %	Melter Exhaust	Mobile EP Stack	Removal %
PM (M5 FHO)	0.054	0.041	24.07	0.045	0.019	57.78	0.054	0.01	81.48
METALS									
Al Front Half	4.98E-04	6.46E-04	-29.72	4.46E-04	6.48E-04	-45.29	3.31E-04	6.42E-04	-93.96
Al Back Half	3.72E-05	1.40E-04	-276.34	3.42E-05	2.04E-04	-496.49	1.50E-05	1.04E-04	-593.33
Al total	5.35E-04	7.86E-04	-46.86	4.80E-04	8.52E-04	-77.43	3.46E-04	7.46E-04	-115.61
As Front Half	6.29E-05	3.86E-06	93.86	4.55E-05	3.44E-06	92.44	2.32E-05	4.76E-06	79.48
As Back Half	6.69E-07	1.10E-05	-1544.25	6.76E-07	3.11E-06	-360.06	6.70E-07	3.06E-06	-356.72
As Total	6.36E-05	1.49E-05	76.62	4.62E-05	6.55E-06	85.82	2.39E-05	7.82E-06	67.24
Ba Front Half	5.28E-04	1.37E-05	97.41	5.56E-04	1.50E-05	97.30	4.85E-04	3.63E-05	92.52
Ba Back Half	6.70E-07	3.11E-06	-364.18	2.73E-06	3.11E-06	-13.92	6.70E-07	3.06E-06	-356.72
Ba total	5.29E-04	1.68E-05	96.82	5.59E-04	1.81E-05	96.76	4.86E-04	3.94E-05	91.90
Ca Front Half	5.25E-04	3.90E-04	25.71	3.41E-04	5.16E-04	-51.32	3.17E-04	5.68E-04	-79.18
Ca Back Half	4.54E-05	2.28E-04	-402.20	4.59E-05	2.39E-04	-420.70	3.50E-05	2.38E-04	-580.00
Ca Total	5.70E-04	6.18E-04	-8.35	3.87E-04	7.55E-04	-95.14	3.52E-04	8.06E-04	-128.98
Cd Front Half	6.57E-07	1.24E-06	-88.74	5.55E-07	1.25E-06	-125.23	2.68E-07	1.22E-06	-355.22
Cd Back Half	2.68E-07	1.24E-06	-362.69	2.71E-07	1.25E-06	-361.25	2.68E-07	1.22E-06	-355.22
Cd total	9.25E-07	2.48E-06	-168.11	8.26E-07	2.50E-06	-202.66	5.36E-07	2.44E-06	-355.22
Cr Front Half	1.36E-04	6.71E-06	95.07	9.80E-05	6.23E-06	93.64	4.96E-05	9.17E-06	81.51
Cr Back Half	2.37E-06	9.32E-06	-293.25	2.30E-06	9.28E-06	-303.48	2.00E-06	9.72E-06	-386.00
Cr Total	1.38E-04	1.60E-05	88.42	1.00E-04	1.55E-05	84.54	5.16E-05	1.89E-05	63.39
Fe Front Half	5.54E-04	1.43E-04	74.19	2.41E-04	1.35E-04	43.98	1.78E-04	1.90E-04	-6.74
Fe Back Half	2.56E-05	8.08E-05	-215.63	2.85E-05	9.34E-05	-227.72	1.34E-05	1.53E-04	-1041.79
Fe total	5.80E-04	2.24E-04	61.39	2.70E-04	2.28E-04	15.25	1.91E-04	3.43E-04	-79.21
K Front Half	3.65E-04	2.24E-04	38.63	4.10E-04	2.24E-04	45.37	1.77E-04	2.32E-04	-31.07
K Back Half	3.14E-05	1.46E-04	-364.97	3.92E-05	1.37E-04	-249.49	2.48E-05	1.47E-04	-492.74
K Total	3.96E-04	3.70E-04	6.66	4.49E-04	3.61E-04	19.63	2.02E-04	3.79E-04	-87.81
Li Front Half	5.16E-04	3.42E-06	99.34	6.56E-04	5.04E-06	99.23	3.25E-04	4.62E-06	98.58
Li Back Half	6.96E-07	3.11E-06	-346.84	1.33E-06	3.03E-06	-127.82	6.96E-07	3.12E-06	-348.28
Li total	5.17E-04	6.53E-06	98.74	6.57E-04	8.07E-06	98.77	3.26E-04	7.74E-06	97.62
Mg Front Half	9.19E-05	7.52E-05	18.17	8.09E-05	6.85E-05	15.33	6.52E-05	1.11E-04	-70.25
Mg Back Half	9.55E-06	3.45E-05	-261.26	9.66E-06	4.11E-05	-325.47	7.43E-06	3.39E-05	-356.26
Mg Total	1.01E-04	1.10E-04	-8.13	9.06E-05	1.10E-04	-21.02	7.26E-05	1.45E-04	-99.50

Appendix 1 - Field Test Data Sheets (supplied by Trigon)

See Trigon Engineering Consultants, Inc. Report for Envitco - Trigon Project No. 046-98-158, Appendix B

Appendix 2 - Daily Performance Reports - Field Voltages and Currents

McGill AirClean Mobile EP
Daily Performance Report

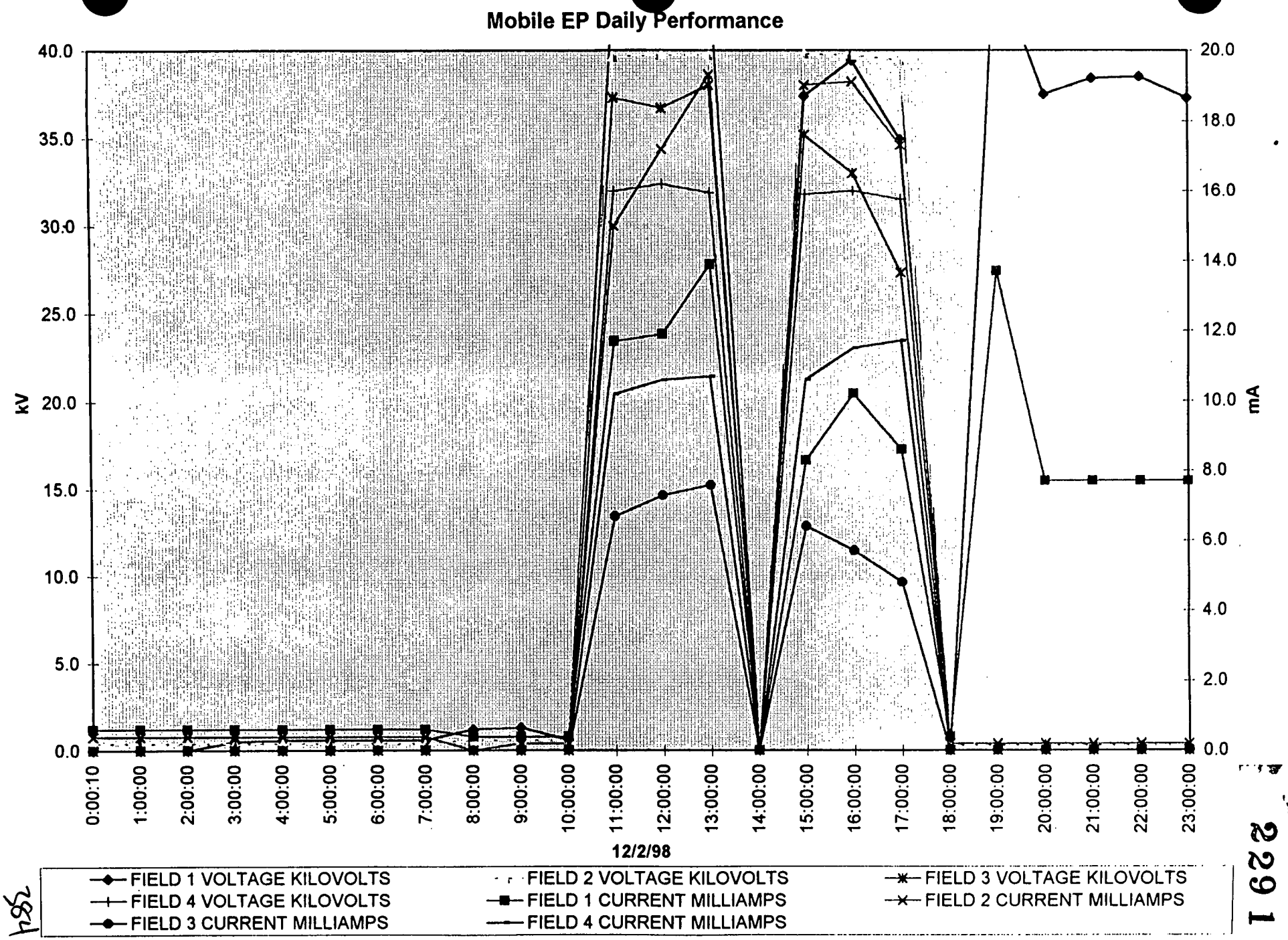
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/2/98
Start Date: 12/1/98
Days Operation: 1

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/2/98	0:00:10	0.0	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	1:00:00	0	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	2:00:00	0.0	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	3:00:00	0.5	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	4:00:00	0.6	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	5:00:00	0.6	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	6:00:00	0.6	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	7:00:00	0.6	0.6	0.4	0.4	0.0	0.0	0.0	0.0
12/2/98	8:00:00	1.2	0.4	0.6	0.0	0.0	0.0	0.0	0.0
12/2/98	9:00:00	1.3	0.4	0.6	0.0	0.4	0.0	0.0	0.0
12/2/98	10:00:00	0.6	0.4	0.6	0.0	0.4	0.0	0.0	0.0
12/2/98	11:00:00	42.7	11.7	39.6	15.0	37.3	6.7	32.0	10.2
12/2/98	12:00:00	42.4	11.9	39.7	17.2	36.7	7.3	32.4	10.6
12/2/98	13:00:00	45.5	13.9	39.7	19.3	38.0	7.6	31.9	10.7
12/2/98	14:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/2/98	15:00:00	37.4	8.3	39.8	19.0	35.2	6.4	31.8	10.6
12/2/98	16:00:00	39.4	10.2	39.7	19.1	33.0	5.7	32.0	11.5
12/2/98	17:00:00	34.9	8.6	39.4	17.3	27.3	4.8	31.5	11.7
12/2/98	18:00:00	0.0	0.4	0.3	0.2	0.0	0.0	0.0	0.0
12/2/98	19:00:00	45.1	13.7	0.3	0.2	0.0	0.0	0.0	0.0
12/2/98	20:00:00	37.5	7.7	0.3	0.2	0.0	0.0	0.0	0.0
12/2/98	21:00:00	38.4	7.7	0.3	0.2	0.0	0.0	0.0	0.0
12/2/98	22:00:00	38.5	7.7	0.3	0.2	0.0	0.0	0.0	0.0
12/2/98	23:00:00	37.3	7.7	0.3	0.2	0.0	0.0	0.0	0.0
Daily Average		18.5	4.8	10.2	4.6	8.7	1.6	8.0	2.7

383


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/2/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

284

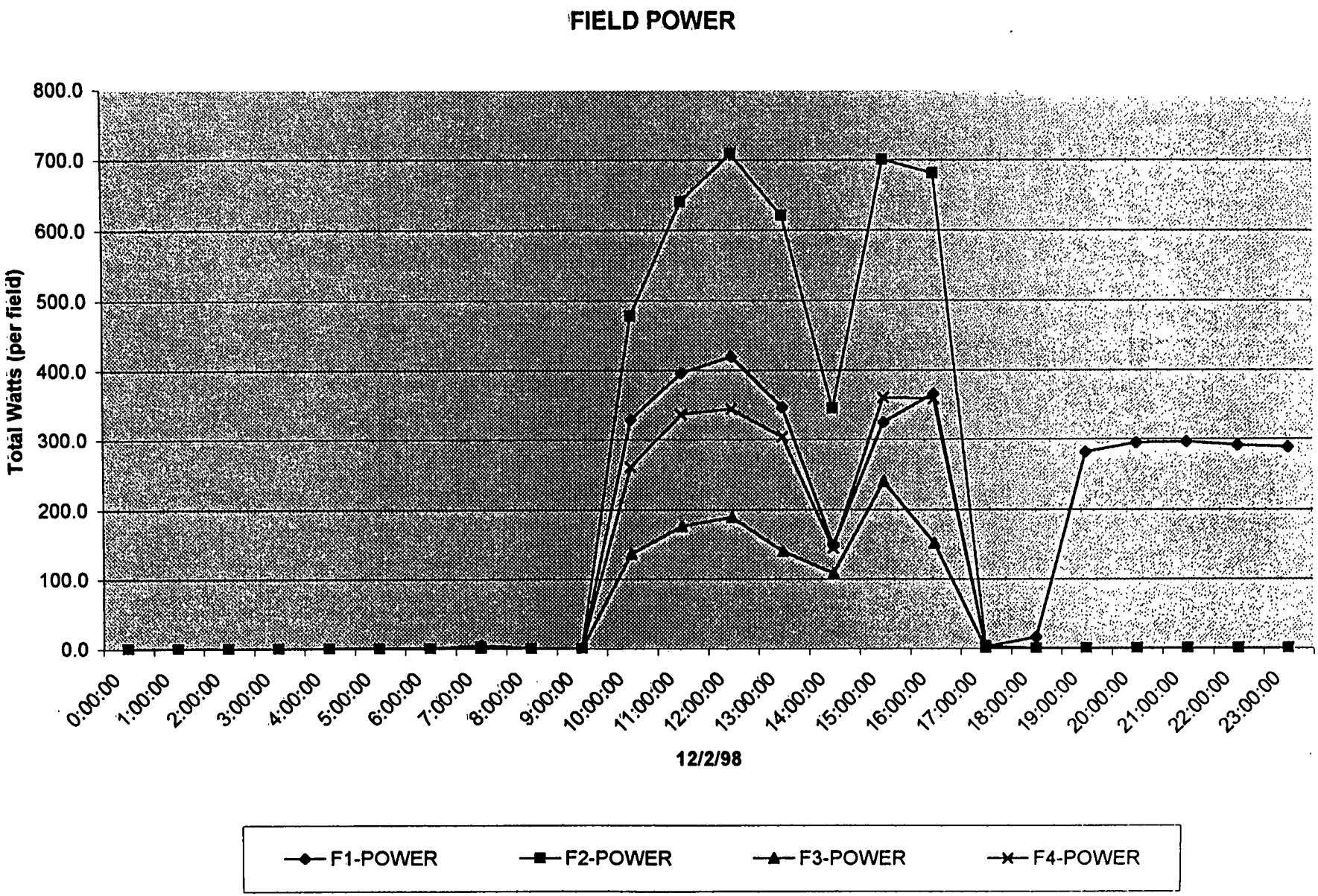
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/2/99
Start Date: 12/1/98
Days Operation: 1

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/2/98	0:00:00	0.0	0.2	0.0	0.0
12/2/98	1:00:00	0.0	0.2	0.0	0.0
12/2/98	2:00:00	0.1	0.2	0.0	0.0
12/2/98	3:00:00	0.2	0.2	0.0	0.0
12/2/98	4:00:00	0.4	0.2	0.0	0.0
12/2/98	5:00:00	0.4	0.2	0.0	0.0
12/2/98	6:00:00	0.4	0.2	0.0	0.0
12/2/98	7:00:00	5.0	2.8	1.3	1.0
12/2/98	8:00:00	0.5	0.0	0.0	0.0
12/2/98	9:00:00	0.3	0.0	0.0	0.0
12/2/98	10:00:00	328.4	477.9	136.4	261.0
12/2/98	11:00:00	396.0	639.9	175.4	335.9
12/2/98	12:00:00	419.2	708.8	188.7	343.5
12/2/98	13:00:00	346.0	619.9	140.1	302.9
12/2/98	14:00:00	147.9	344.4	108.1	144.8
12/2/98	15:00:00	324.2	699.5	239.4	360.5
12/2/98	16:00:00	365.8	680.3	151.4	358.0
12/2/98	17:00:00	2.3	3.8	0.5	1.3
12/2/98	18:00:00	16.5	0.1	0.0	0.0
12/2/98	19:00:00	281.6	0.1	0.0	0.0
12/2/98	20:00:00	294.1	0.1	0.0	0.0
12/2/98	21:00:00	295.7	0.1	0.0	0.0
12/2/98	22:00:00	291.1	0.1	0.0	0.0
12/2/98	23:00:00	288.0	0.1	0.0	0.0
DAILY AVERAGE		158.5	174.1	47.6	87.9

385


FIELD POWER
Total Watts (per field)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/2/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

286

McGill AirClean Mobile EP
Daily Performance Report

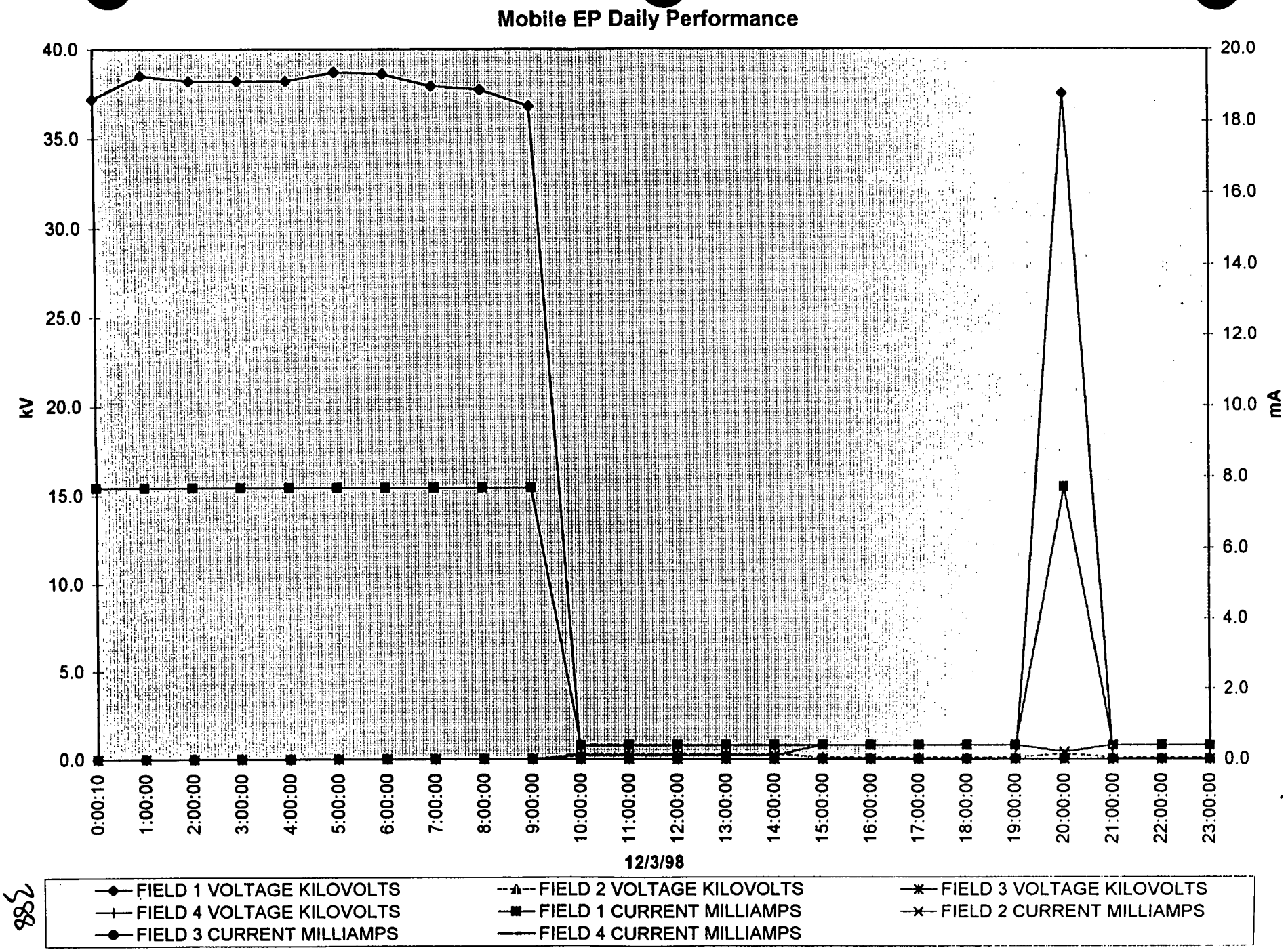
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/3/98
Start Date: 12/1/98
Days Operation: 2

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/3/98	0:00:10	37.2	7.7	#######	#######	#######	#######	#######	#######
12/3/98	1:00:00	38.5	7.7	#######	#######	#######	#######	#######	#######
12/3/98	2:00:00	38.2	7.7	#######	#######	#######	#######	#######	#######
12/3/98	3:00:00	38.2	7.7	#######	#######	#######	#######	#######	#######
12/3/98	4:00:00	38.2	7.7	#######	#######	#######	#######	#######	#######
12/3/98	5:00:00	38.7	7.7	#######	#######	#######	#######	#######	#######
12/3/98	6:00:00	38.6	7.7	#######	#######	#######	#######	#######	#######
12/3/98	7:00:00	37.9	7.7	#######	#######	#######	#######	#######	#######
12/3/98	8:00:00	37.7	7.7	#######	#######	#######	#######	#######	#######
12/3/98	9:00:00	36.8	7.7	#######	#######	#######	#######	#######	#######
[illegible]/98	10:00:00	0.0	0.4	0.3	0.1	0.0	0.0	0.0	0.0
[illegible]8	11:00:00	0.0	0.4	0.3	0.1	0.0	0.0	0.0	0.0
[illegible]/98	12:00:00	0.0	0.4	0.3	0.1	0.0	0.0	0.0	0.0
12/3/98	13:00:00	0.0	0.4	0.3	0.1	0.0	0.0	0.0	0.0
12/3/98	14:00:00	0.0	0.4	0.3	0.1	0.0	0.0	0.0	0.0
12/3/98	15:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
12/3/98	16:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
12/3/98	17:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
12/3/98	18:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
12/3/98	19:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
oup or Ti	20:00:00	37.5	7.7	0.3	0.2	0.0	0.0	0.0	0.0
12/3/98	21:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
12/3/98	22:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
12/3/98	23:00:00	0.0	0.4	0.1	0.4	0.0	0.0	0.0	0.0
Daily Average		17.4	3.7	0.2	0.3	0.0	0.0	0.0	0.0

387


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/3/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

McGill AirClean Mobile EP

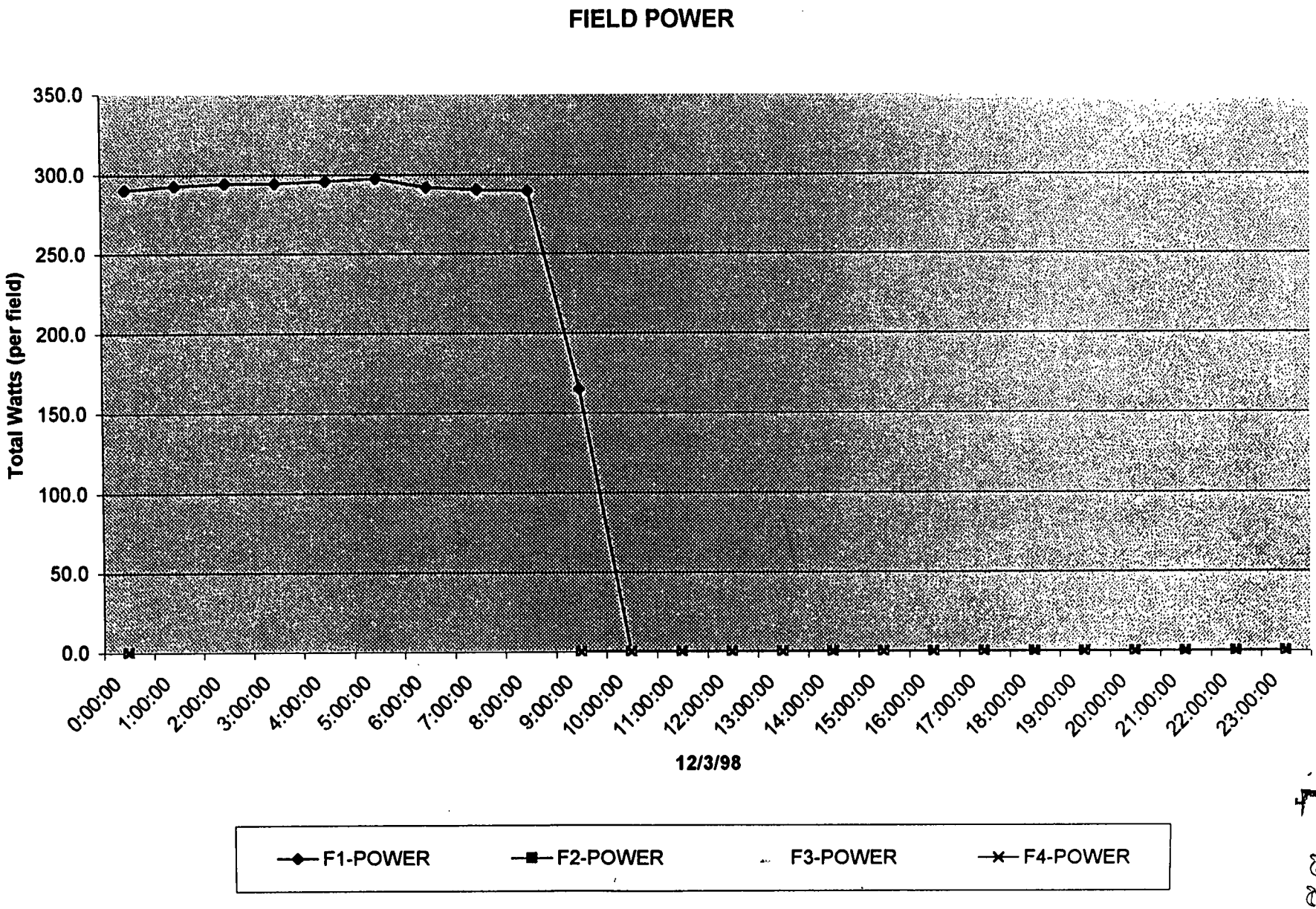
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/3/98
Start Date: 12/1/98
Days Operation: 2

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/3/98	0:00:00	290.3	0.1	0.0	0.0
12/3/98	1:00:00	292.6			
12/3/98	2:00:00	294.1			
12/3/98	3:00:00	294.1			
12/3/98	4:00:00	295.7			
12/3/98	5:00:00	297.2			
12/3/98	6:00:00	291.8			
12/3/98	7:00:00	290.3			
12/3/98	8:00:00	289.5			
12/3/98	9:00:00	165.2	0.0	0.0	0.0
12/3/98	10:00:00	0.0	0.0	0.0	0.0
12/3/98	11:00:00	0.0	0.0	0.0	0.0
12/3/98	12:00:00	0.0	0.0	0.0	0.0
12/3/98	13:00:00	0.0	0.0	0.0	0.0
12/3/98	14:00:00	0.0	0.0	0.0	0.0
12/3/98	15:00:00	0.0	0.0	0.0	0.0
12/3/98	16:00:00	0.0	0.0	0.0	0.0
12/3/98	17:00:00	0.0	0.0	0.0	0.0
12/3/98	18:00:00	0.0	0.0	0.0	0.0
12/3/98	19:00:00	0.0	0.0	0.0	0.0
12/3/98	20:00:00	0.0	0.0	0.0	0.0
12/3/98	21:00:00	0.0	0.0	0.0	0.0
12/3/98	22:00:00	0.0	0.0	0.0	0.0
12/3/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE					

389


FIELD POWER
Total Watts (per field)
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/3/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

L 2291

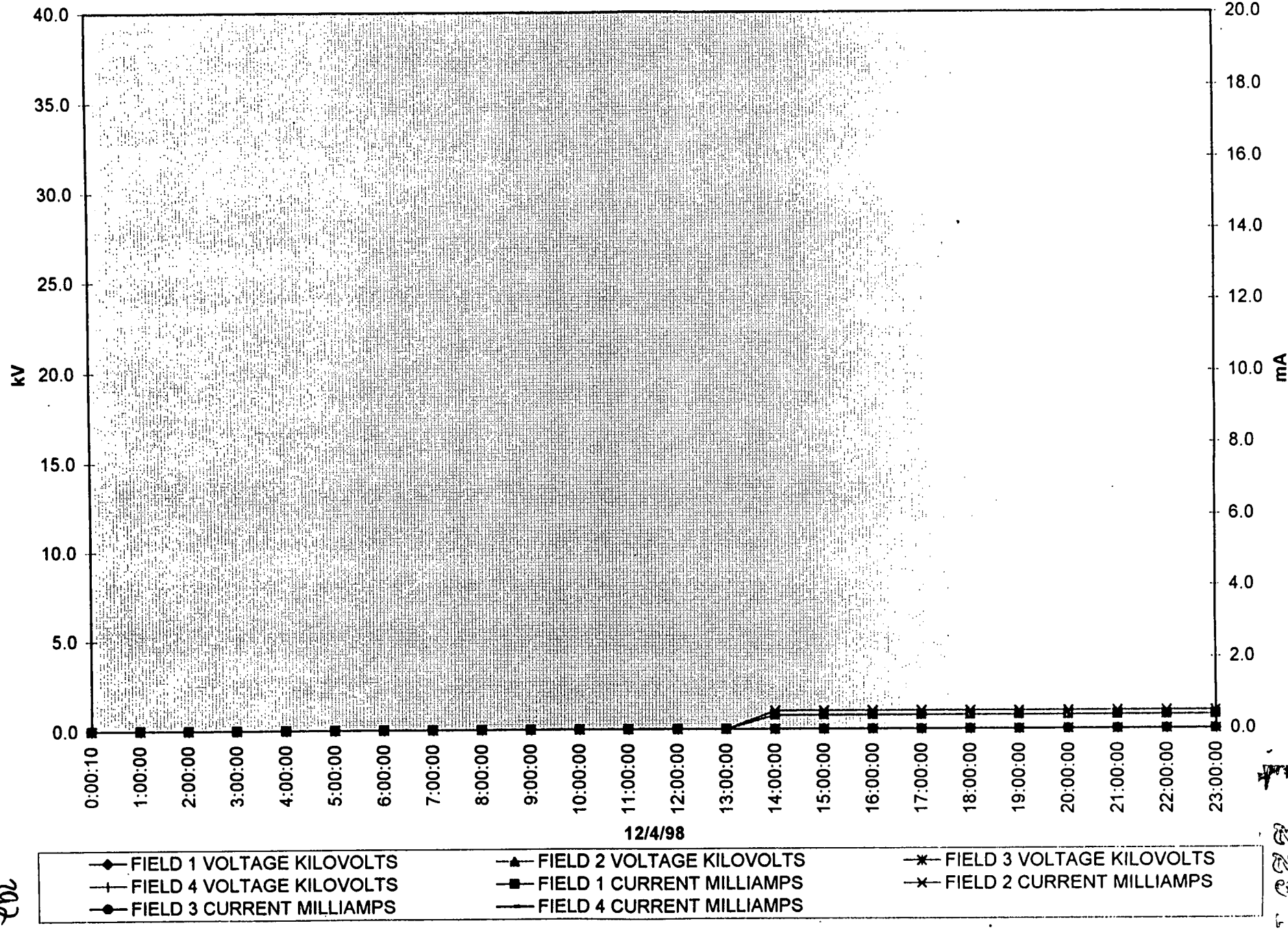
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/4/98
Start Date: 12/1/98
Days Operation: 3

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/4/98	0:00:10	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	1:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	2:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	3:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	4:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	5:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	6:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	7:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	8:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	9:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	10:00:00	#######	#######	#######	#######	#######	#######	#######	#######
[illegible]8	11:00:00	#######	#######	#######	#######	#######	#######	#######	#######
[illegible]8	12:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	13:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/4/98	14:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	15:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	16:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	17:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	18:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	19:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	20:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	21:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	22:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/4/98	23:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
Daily Average		0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0

391

Mobile EP Daily Performance



McGill AirClean Mobile EP

2291

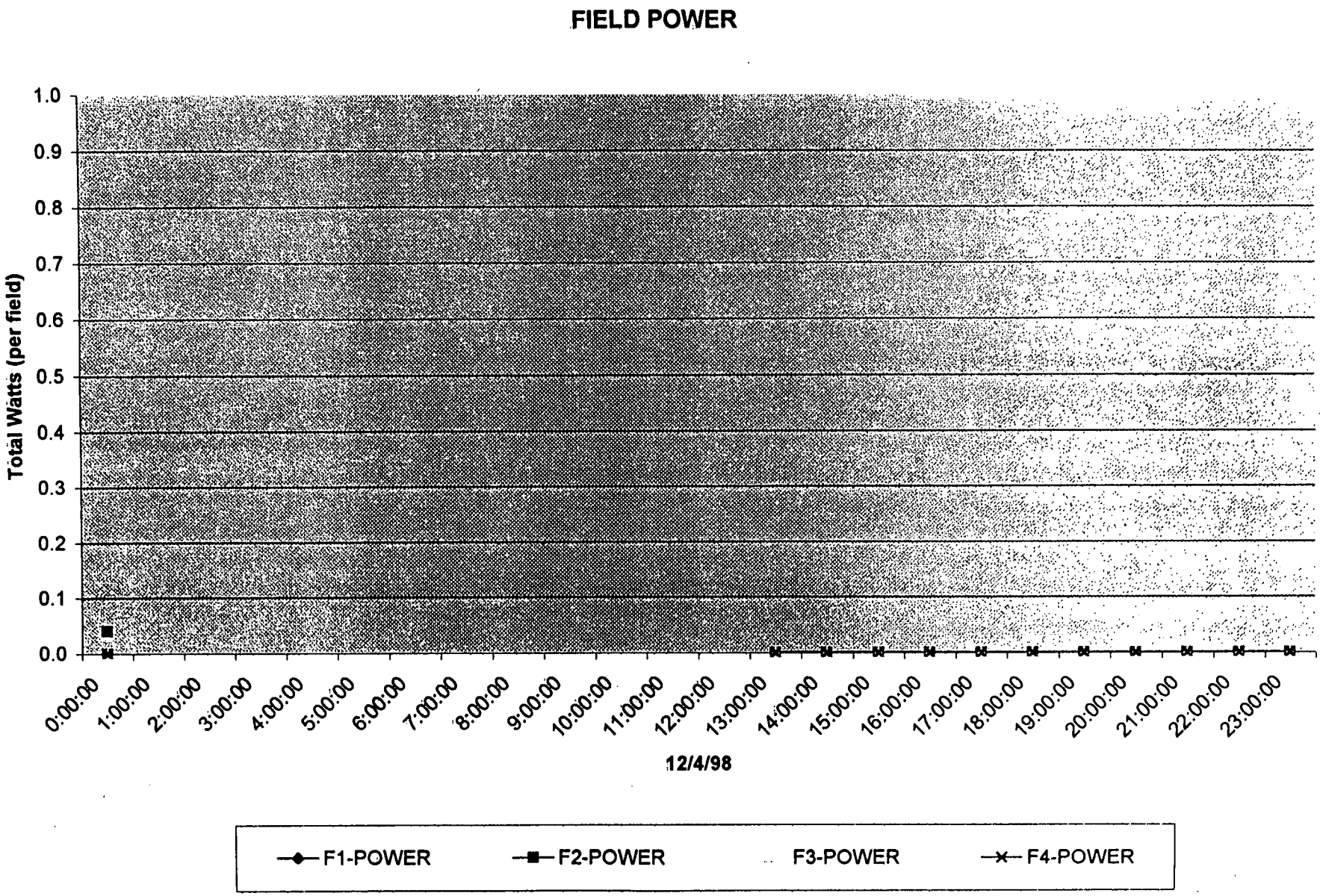
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/4/98
Start Date: 12/1/98
Days Operation: 3

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/4/98	0:00:00	0.0	0.0	0.0	0.0
12/4/98	1:00:00				
12/4/98	2:00:00				
12/4/98	3:00:00				
12/4/98	4:00:00				
12/4/98	5:00:00				
12/4/98	6:00:00				
12/4/98	7:00:00				
12/4/98	8:00:00				
12/4/98	9:00:00				
12/4/98	10:00:00				
12/4/98	11:00:00				
12/4/98	12:00:00				
12/4/98	13:00:00	0.0	0.0	0.0	0.0
12/4/98	14:00:00	0.0	0.0	0.0	0.0
12/4/98	15:00:00	0.0	0.0	0.0	0.0
12/4/98	16:00:00	0.0	0.0	0.0	0.0
12/4/98	17:00:00	0.0	0.0	0.0	0.0
12/4/98	18:00:00	0.0	0.0	0.0	0.0
12/4/98	19:00:00	0.0	0.0	0.0	0.0
12/4/98	20:00:00	0.0	0.0	0.0	0.0
12/4/98	21:00:00	0.0	0.0	0.0	0.0
12/4/98	22:00:00	0.0	0.0	0.0	0.0
12/4/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE		0.0	0.0	0.0	0.0

393


FIELD POWER
Total Watts (per field)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/4/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

229 1

254

2291

McGill AirClean Mobile EP
Daily Performance Report

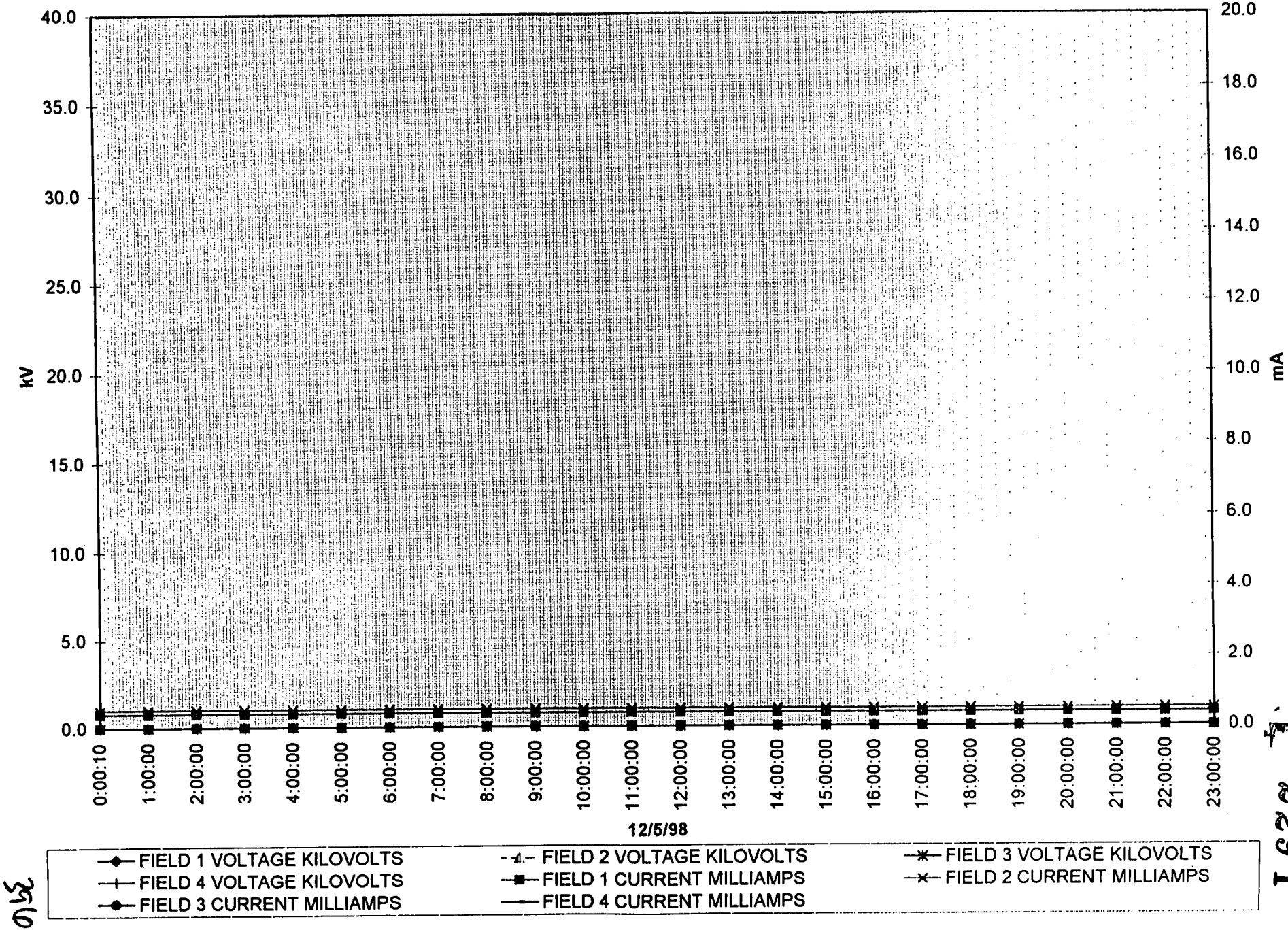
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/5/98
Start Date: 12/1/98
Days Operation: 4

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/5/98	0:00:10	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	1:00:00	0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	2:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	3:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	4:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	5:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	6:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	7:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	8:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	9:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
[illegible]/98	10:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
[illegible]8	11:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
[illegible]/98	12:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	13:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	14:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	15:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	16:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	17:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	18:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	19:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	20:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	21:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	22:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/5/98	23:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
Daily Average		0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0

395

Mobile EP Daily Performance



2291

250

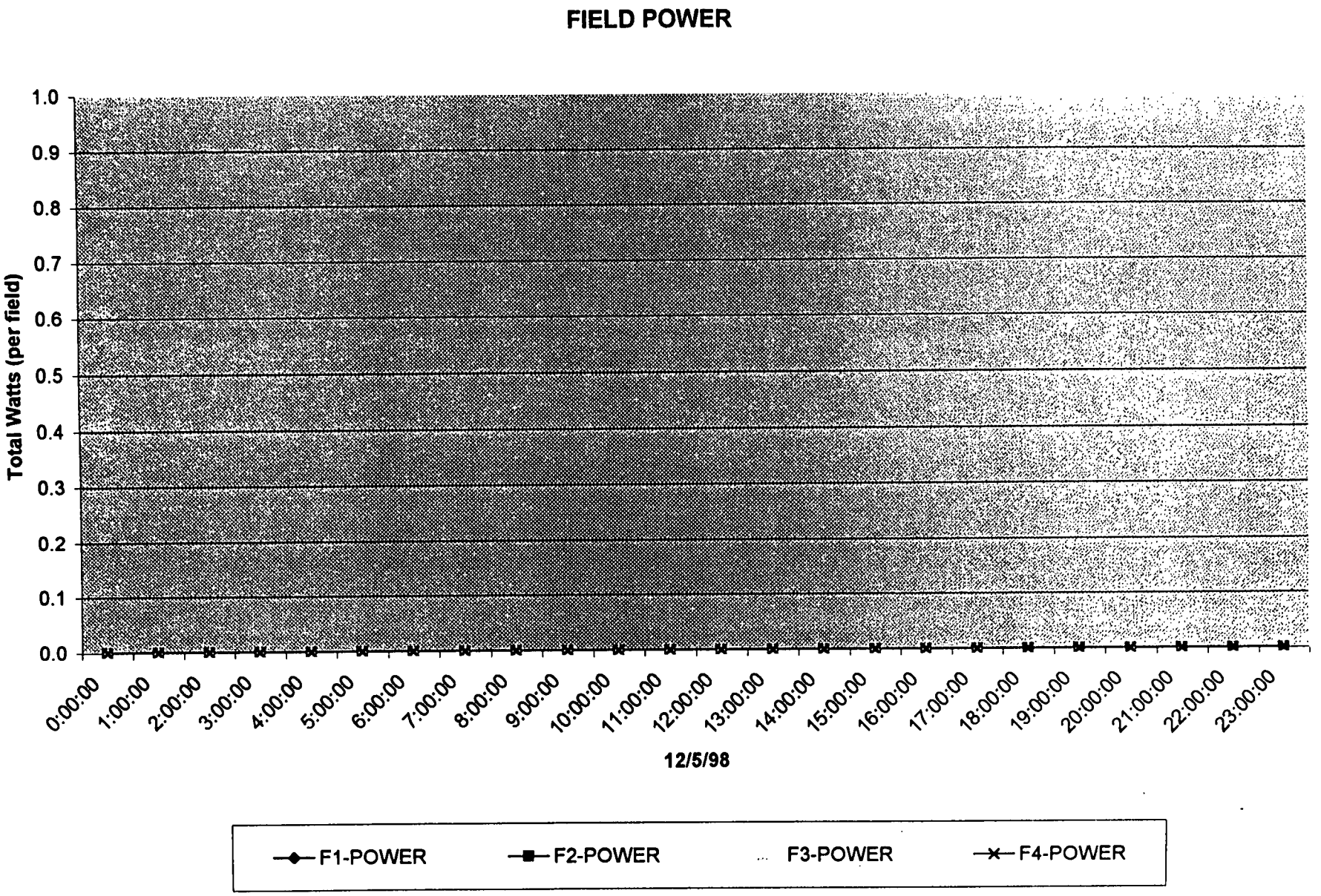
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/5/98
Start Date: 12/1/98
Days Operation: 4

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/5/98	0:00:00	0.0	0.0	0.0	0.0
12/5/98	1:00:00	0.0	0.0	0.0	0.0
12/5/98	2:00:00	0.0	0.0	0.0	0.0
12/5/98	3:00:00	0.0	0.0	0.0	0.0
12/5/98	4:00:00	0.0	0.0	0.0	0.0
12/5/98	5:00:00	0.0	0.0	0.0	0.0
12/5/98	6:00:00	0.0	0.0	0.0	0.0
12/5/98	7:00:00	0.0	0.0	0.0	0.0
12/5/98	8:00:00	0.0	0.0	0.0	0.0
12/5/98	9:00:00	0.0	0.0	0.0	0.0
12/5/98	10:00:00	0.0	0.0	0.0	0.0
12/5/98	11:00:00	0.0	0.0	0.0	0.0
12/5/98	12:00:00	0.0	0.0	0.0	0.0
12/5/98	13:00:00	0.0	0.0	0.0	0.0
12/5/98	14:00:00	0.0	0.0	0.0	0.0
12/5/98	15:00:00	0.0	0.0	0.0	0.0
12/5/98	16:00:00	0.0	0.0	0.0	0.0
12/5/98	17:00:00	0.0	0.0	0.0	0.0
12/5/98	18:00:00	0.0	0.0	0.0	0.0
12/5/98	19:00:00	0.0	0.0	0.0	0.0
12/5/98	20:00:00	0.0	0.0	0.0	0.0
12/5/98	21:00:00	0.0	0.0	0.0	0.0
12/5/98	22:00:00	0.0	0.0	0.0	0.0
12/5/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE		0.0	0.0	0.0	0.0

397


FIELD POWER
Total Watts (per field)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/5/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

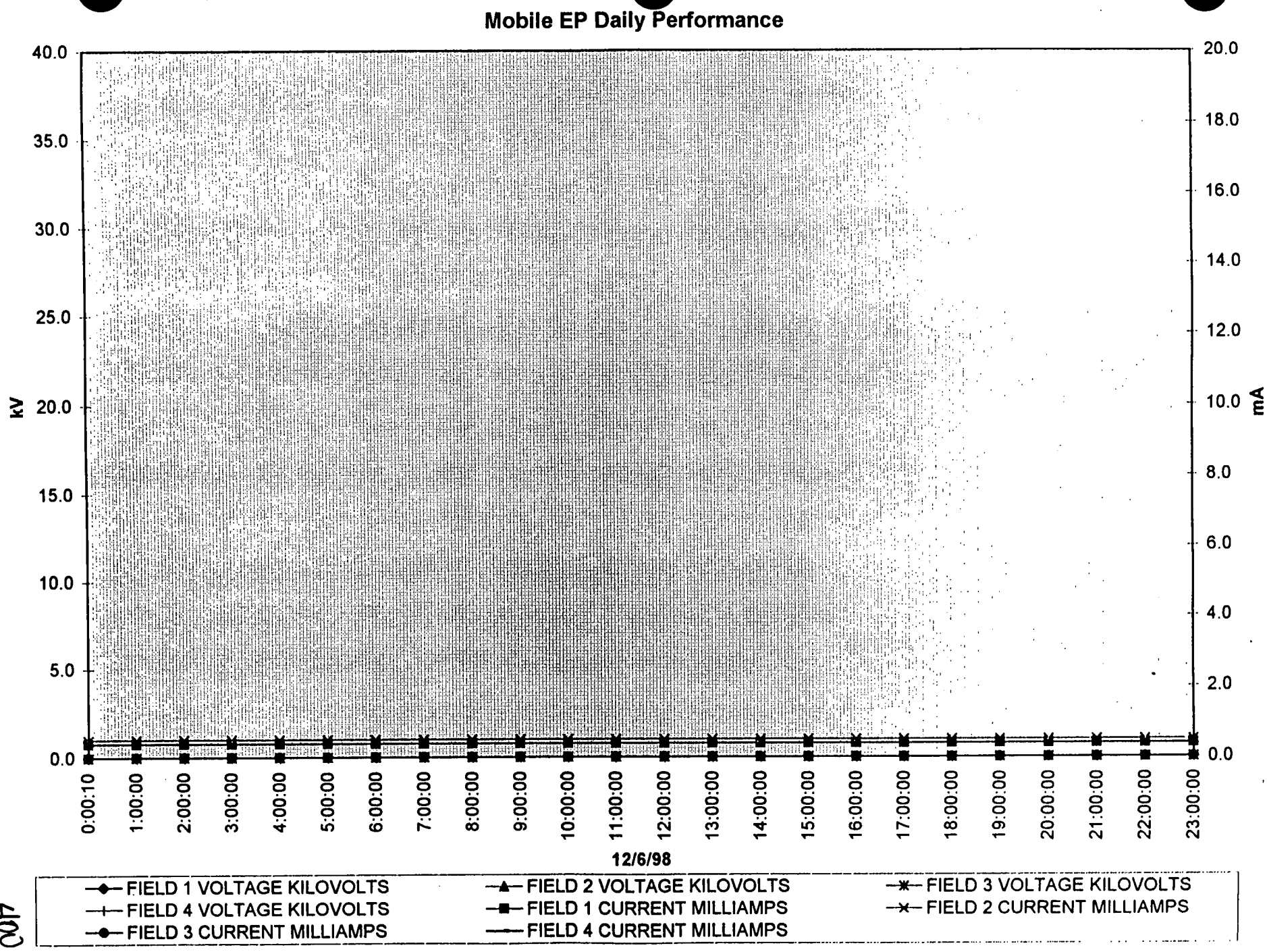
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/6/98
Start Date: 12/1/98
Days Operation: 5

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/6/98	0:00:10	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	1:00:00	0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	2:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	3:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	4:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	5:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	6:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	7:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	8:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	9:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
[illegible]/98	10:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
[illegible]98	11:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
[illegible]/98	12:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	13:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	14:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	15:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	16:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	17:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	18:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	19:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	20:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	21:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	22:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/6/98	23:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
Daily Average		0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0

399


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/6/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

400

2291

McGill AirClean Mobile EP
Daily Performance Report

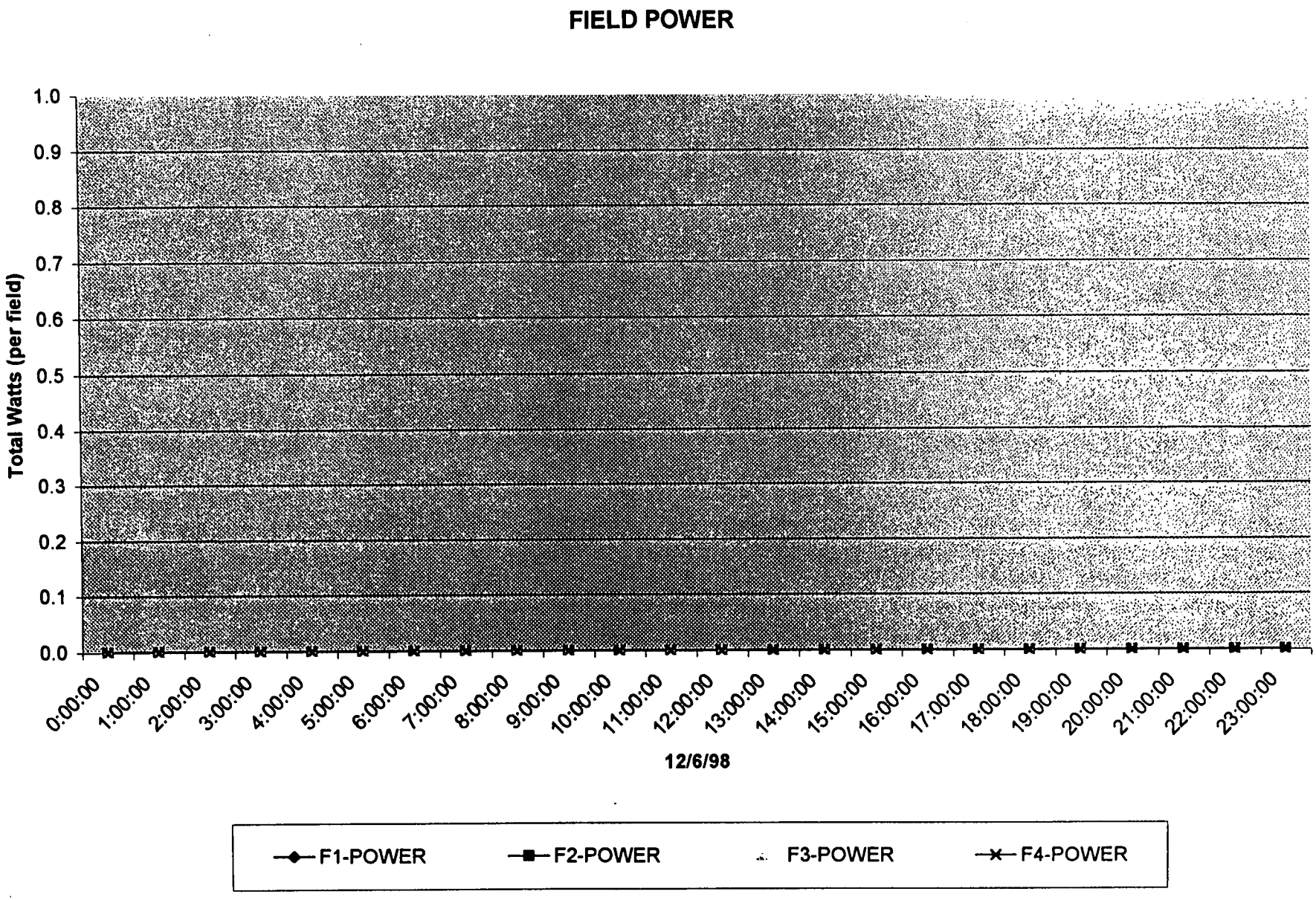
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/6/98
Start Date: 12/1/98
Days Operation: 5

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/6/98	0:00:00	0.0	0.0	0.0	0.0
12/6/98	1:00:00	0.0	0.0	0.0	0.0
12/6/98	2:00:00	0.0	0.0	0.0	0.0
12/6/98	3:00:00	0.0	0.0	0.0	0.0
12/6/98	4:00:00	0.0	0.0	0.0	0.0
12/6/98	5:00:00	0.0	0.0	0.0	0.0
12/6/98	6:00:00	0.0	0.0	0.0	0.0
12/6/98	7:00:00	0.0	0.0	0.0	0.0
12/6/98	8:00:00	0.0	0.0	0.0	0.0
12/6/98	9:00:00	0.0	0.0	0.0	0.0
12/6/98	10:00:00	0.0	0.0	0.0	0.0
12/6/98	11:00:00	0.0	0.0	0.0	0.0
12/6/98	12:00:00	0.0	0.0	0.0	0.0
12/6/98	13:00:00	0.0	0.0	0.0	0.0
12/6/98	14:00:00	0.0	0.0	0.0	0.0
12/6/98	15:00:00	0.0	0.0	0.0	0.0
12/6/98	16:00:00	0.0	0.0	0.0	0.0
12/6/98	17:00:00	0.0	0.0	0.0	0.0
12/6/98	18:00:00	0.0	0.0	0.0	0.0
12/6/98	19:00:00	0.0	0.0	0.0	0.0
12/6/98	20:00:00	0.0	0.0	0.0	0.0
12/6/98	21:00:00	0.0	0.0	0.0	0.0
12/6/98	22:00:00	0.0	0.0	0.0	0.0
12/6/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE		0.0	0.0	0.0	0.0

401

R6dec98b.xls


FIELD POWER
Total Watts (per field)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/6/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

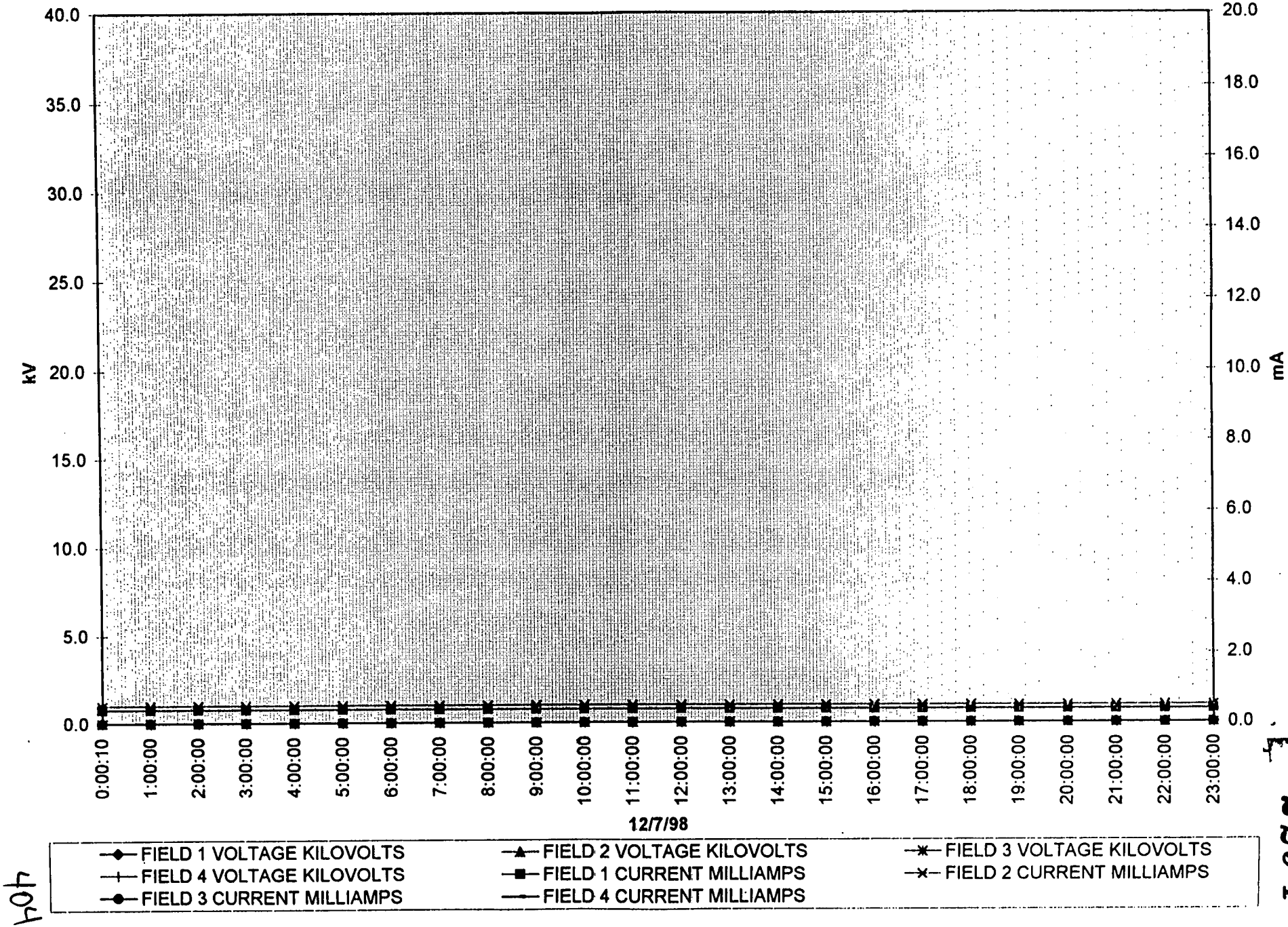
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/7/98
Start Date: 12/1/98
Days Operation: 6

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/7/98	0:00:10	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	1:00:00	0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	2:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	3:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	4:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	5:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	6:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	7:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	8:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	9:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	10:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	11:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	12:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	13:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	14:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	15:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	16:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	17:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	18:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	19:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	20:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	21:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	22:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
12/7/98	23:00:00	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0
Daily Average		0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0

Mobile EP Daily Performance



404

2291

McGill AirClean Mobile EP
Daily Performance Report

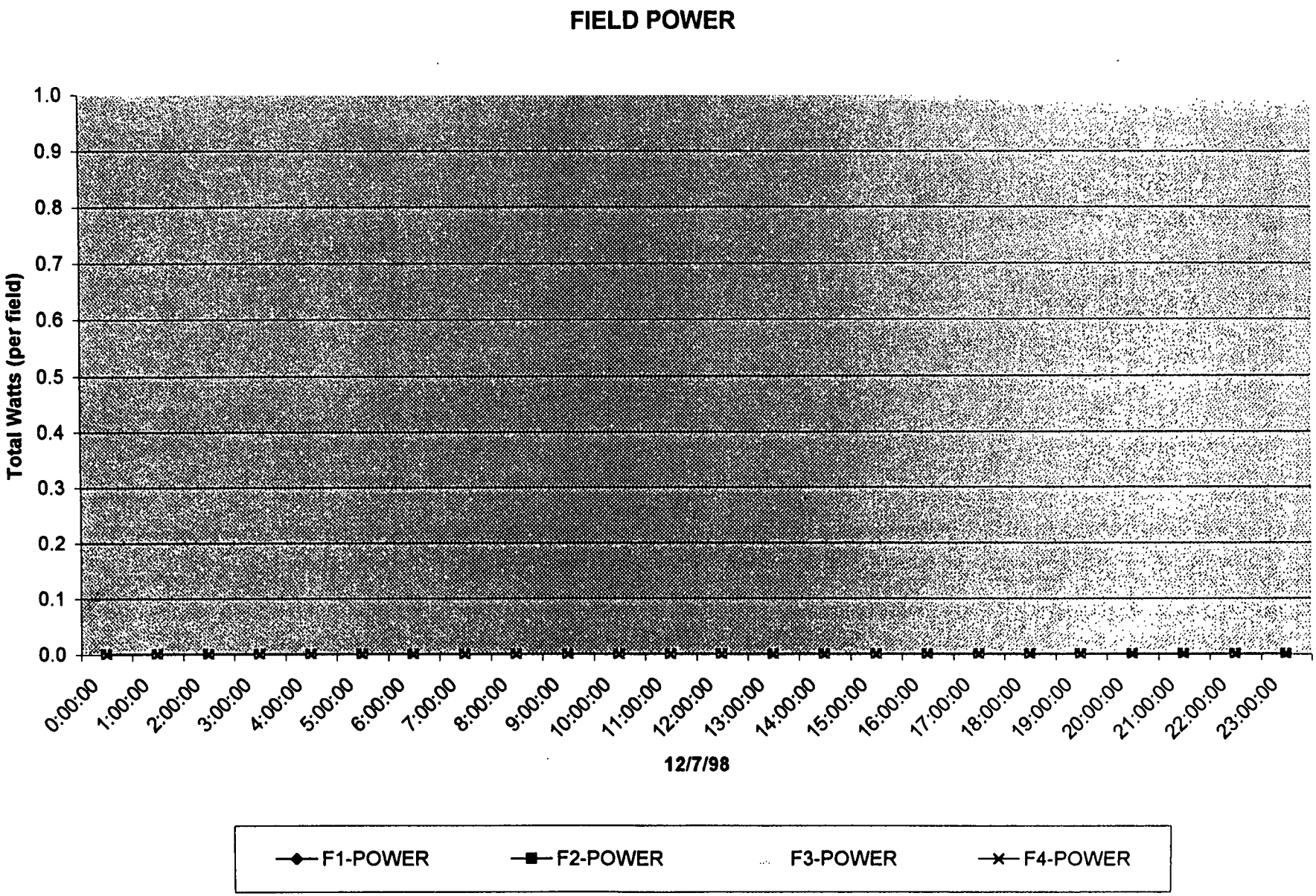
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/7/98
Start Date: 12/1/98
Days Operation: 6

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/7/98	0:00:00	0.0	0.0	0.0	0.0
12/7/98	1:00:00	0.0	0.0	0.0	0.0
12/7/98	2:00:00	0.0	0.0	0.0	0.0
12/7/98	3:00:00	0.0	0.0	0.0	0.0
12/7/98	4:00:00	0.0	0.0	0.0	0.0
12/7/98	5:00:00	0.0	0.0	0.0	0.0
12/7/98	6:00:00	0.0	0.0	0.0	0.0
12/7/98	7:00:00	0.0	0.0	0.0	0.0
12/7/98	8:00:00	0.0	0.0	0.0	0.0
12/7/98	9:00:00	0.0	0.0	0.0	0.0
12/7/98	10:00:00	0.0	0.0	0.0	0.0
12/7/98	11:00:00	0.0	0.0	0.0	0.0
12/7/98	12:00:00	0.0	0.0	0.0	0.0
12/7/98	13:00:00	0.0	0.0	0.0	0.0
12/7/98	14:00:00	0.0	0.0	0.0	0.0
12/7/98	15:00:00	0.0	0.0	0.0	0.0
12/7/98	16:00:00	0.0	0.0	0.0	0.0
12/7/98	17:00:00	0.0	0.0	0.0	0.0
12/7/98	18:00:00	0.0	0.0	0.0	0.0
12/7/98	19:00:00	0.0	0.0	0.0	0.0
12/7/98	20:00:00	0.0	0.0	0.0	0.0
12/7/98	21:00:00	0.0	0.0	0.0	0.0
12/7/98	22:00:00	0.0	0.0	0.0	0.0
12/7/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE		0.0	0.0	0.0	0.0

405

R7dec98b.xls


FIELD POWER
Total Watts (per field)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/7/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

406

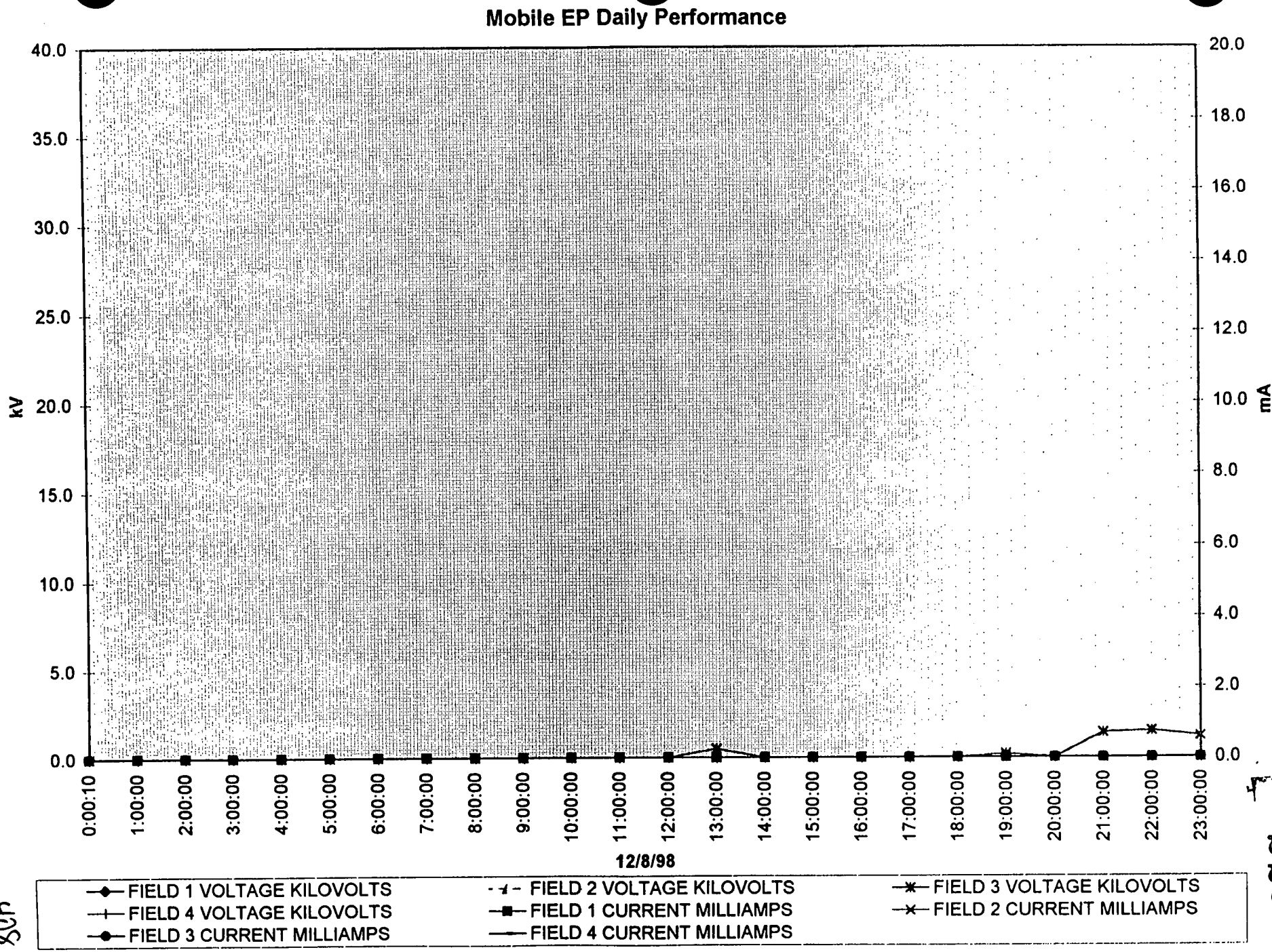
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/8/98
Start Date: 12/1/98
Days Operation: 7

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/8/98	0:00:10	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	1:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	2:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	3:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	4:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	5:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	6:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	7:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	8:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	9:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
[illegible]/98	10:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
[illegible]98	11:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
[illegible]/98	12:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	13:00:00	#######	#######	#######	#######	0.5	0.0	#######	#######
12/8/98	14:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	15:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	16:00:00	#######	#######	#######	#######	0.0	0.0	#######	#######
12/8/98	17:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/8/98	18:00:00	#######	#######	#######	#######	0.0	#######	#######	#######
12/8/98	19:00:00	#######	#######	#######	#######	0.2	#######	#######	#######
12/8/98	20:00:00	#######	#######	#######	#######	0.0	#######	#######	#######
12/8/98	21:00:00	#######	#######	#######	#######	1.4	#######	#######	#######
12/8/98	22:00:00	#######	#######	#######	#######	1.5	#######	#######	#######
12/8/98	23:00:00	#######	#######	#######	#######	1.2	#######	#######	#######
Daily Average		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.2	0.0	#DIV/0!	#DIV/0!

407


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/8/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

808

McGill AirClean Mobile EP

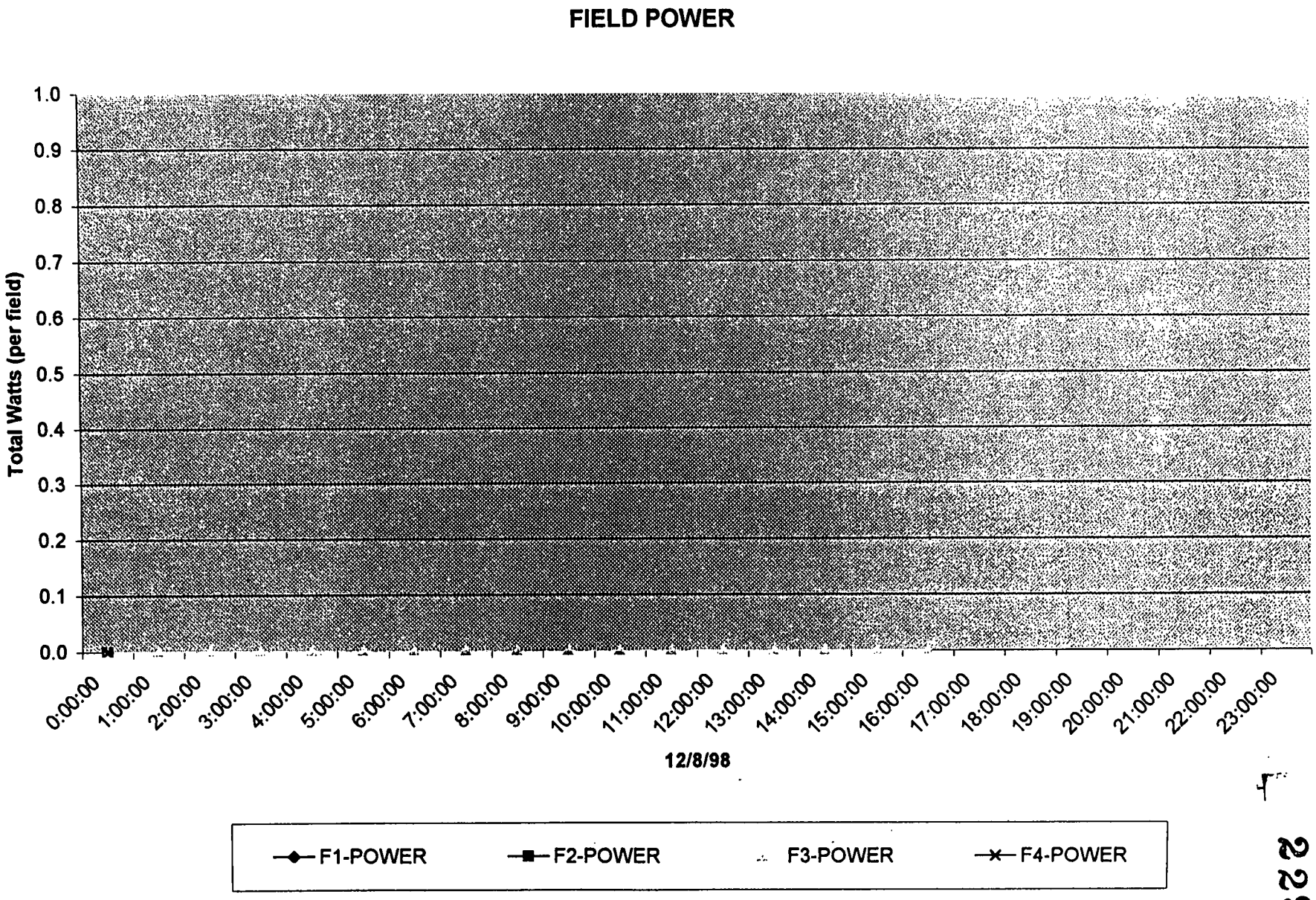
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/8/98
Start Date: 12/1/98
Days Operation: 7

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/8/98	0:00:00	0.0	0.0	0.0	0.0
12/8/98	1:00:00			0.0	
12/8/98	2:00:00			0.0	
12/8/98	3:00:00			0.0	
12/8/98	4:00:00			0.0	
12/8/98	5:00:00			0.0	
12/8/98	6:00:00			0.0	
12/8/98	7:00:00			0.0	
12/8/98	8:00:00			0.0	
12/8/98	9:00:00			0.0	
12/8/98	10:00:00			0.0	
12/8/98	11:00:00			0.0	
12/8/98	12:00:00			0.0	
12/8/98	13:00:00			0.0	
12/8/98	14:00:00			0.0	
12/8/98	15:00:00			0.0	
12/8/98	16:00:00			0.0	
12/8/98	17:00:00				
12/8/98	18:00:00				
12/8/98	19:00:00				
12/8/98	20:00:00				
12/8/98	21:00:00				
12/8/98	22:00:00				
12/8/98	23:00:00				
DAILY AVERAGE		0.0	0.0	0.0	0.0

409


FIELD POWER
Total Watts (per field)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/8/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

410

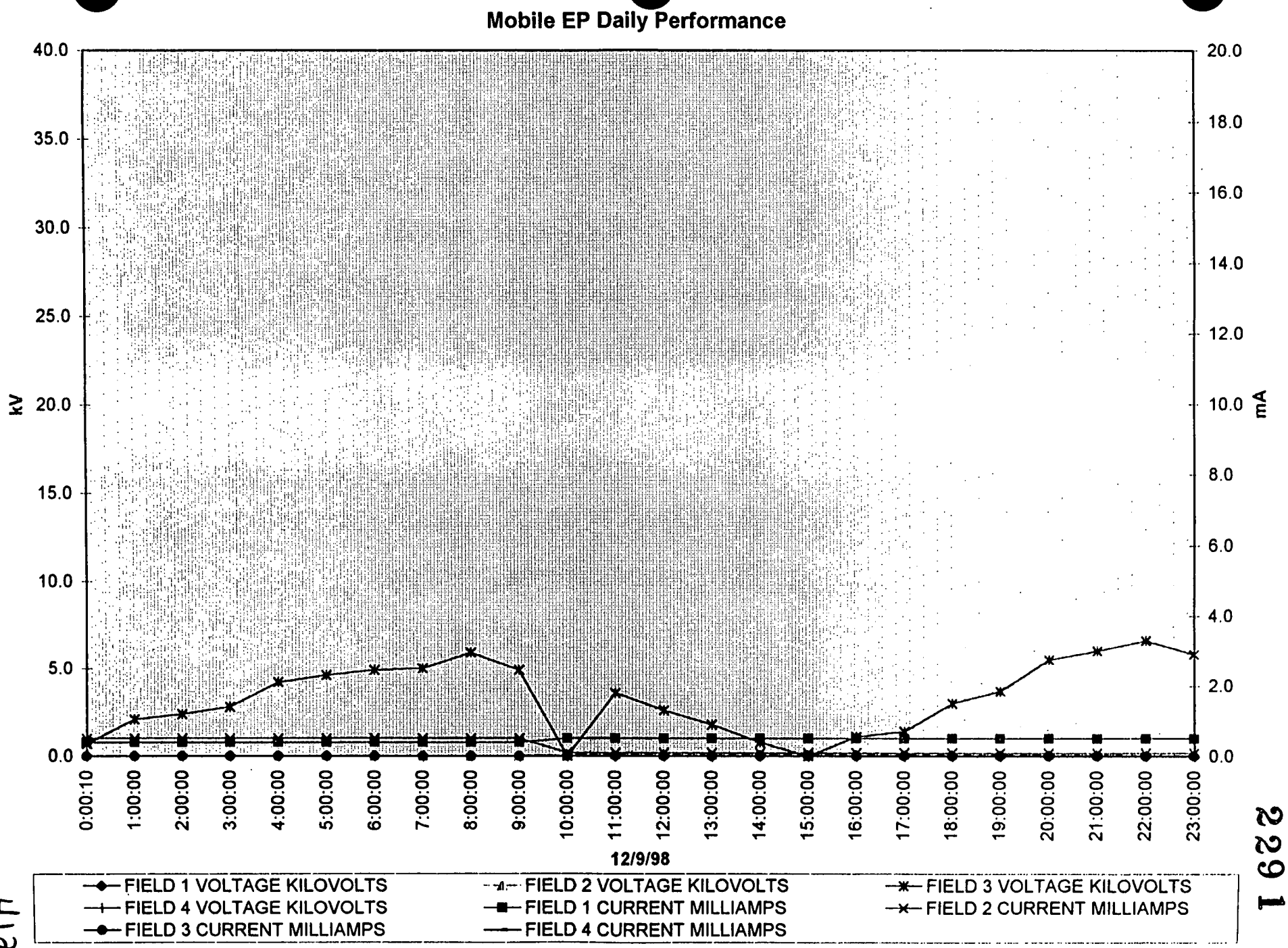
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/9/98
Start Date: 12/1/98
Days Operation: 8

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/9/98	0:00:10	0.0	0.4	0.0	0.5	0.7	0.0	0.0	0.0
12/9/98	1:00:00	0	0.4	0.0	0.5	2.1	0.0	0.0	0.0
12/9/98	2:00:00	0.0	0.4	0.0	0.5	2.4	0.0	0.0	0.0
12/9/98	3:00:00	0.0	0.4	0.0	0.5	2.8	0.0	0.0	0.0
12/9/98	4:00:00	0.0	0.4	0.0	0.5	4.2	0.0	0.0	0.0
12/9/98	5:00:00	0.0	0.4	0.0	0.5	4.6	0.0	0.0	0.0
12/9/98	6:00:00	0.0	0.4	0.0	0.5	4.9	0.0	0.0	0.0
12/9/98	7:00:00	0.0	0.4	0.0	0.5	5.0	0.0	0.0	0.0
12/9/98	8:00:00	0.0	0.4	0.0	0.5	5.9	0.0	0.0	0.0
12/9/98	9:00:00	0.0	0.4	0.0	0.5	4.9	0.0	0.0	0.0
12/9/98	10:00:00	0.0	0.5	0.1	0.1	0.0	0.0	0.0	0.0
12/9/98	11:00:00	0.0	0.5	0.1	0.1	3.6	0.0	0.0	0.0
12/9/98	12:00:00	0.0	0.5	0.1	0.1	2.6	0.0	0.0	0.0
12/9/98	13:00:00	0.0	0.5	0.1	0.1	1.8	0.0	0.0	0.0
12/9/98	14:00:00	0.0	0.5	0.1	0.1	0.8	0.0	0.0	0.0
12/9/98	15:00:00	0.0	0.5	0.1	0.1	0.0	0.0	0.0	0.0
12/9/98	16:00:00	0.0	0.5	0.1	0.1	1.1	0.0	0.0	0.0
12/9/98	17:00:00	0.0	0.5	0.1	0.1	1.4	0.0	0.0	0.0
12/9/98	18:00:00	0.0	0.5	0.1	0.1	3.0	0.0	0.0	0.0
12/9/98	19:00:00	0.0	0.5	0.1	0.1	3.7	0.0	0.0	0.0
12/9/98	20:00:00	0.0	0.5	0.1	0.1	5.5	0.0	0.0	0.0
12/9/98	21:00:00	0.0	0.5	0.1	0.1	6.0	0.0	0.0	0.0
12/9/98	22:00:00	0.0	0.5	0.1	0.1	6.6	0.0	0.0	0.0
12/9/98	23:00:00	0.0	0.5	0.1	0.1	5.8	0.0	0.0	0.0
Daily Average		0.0	0.5	0.1	0.3	3.3	0.0	0.0	0.0

411


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/9/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

418

McGill AirClean Mobile EP
Daily Performance Report

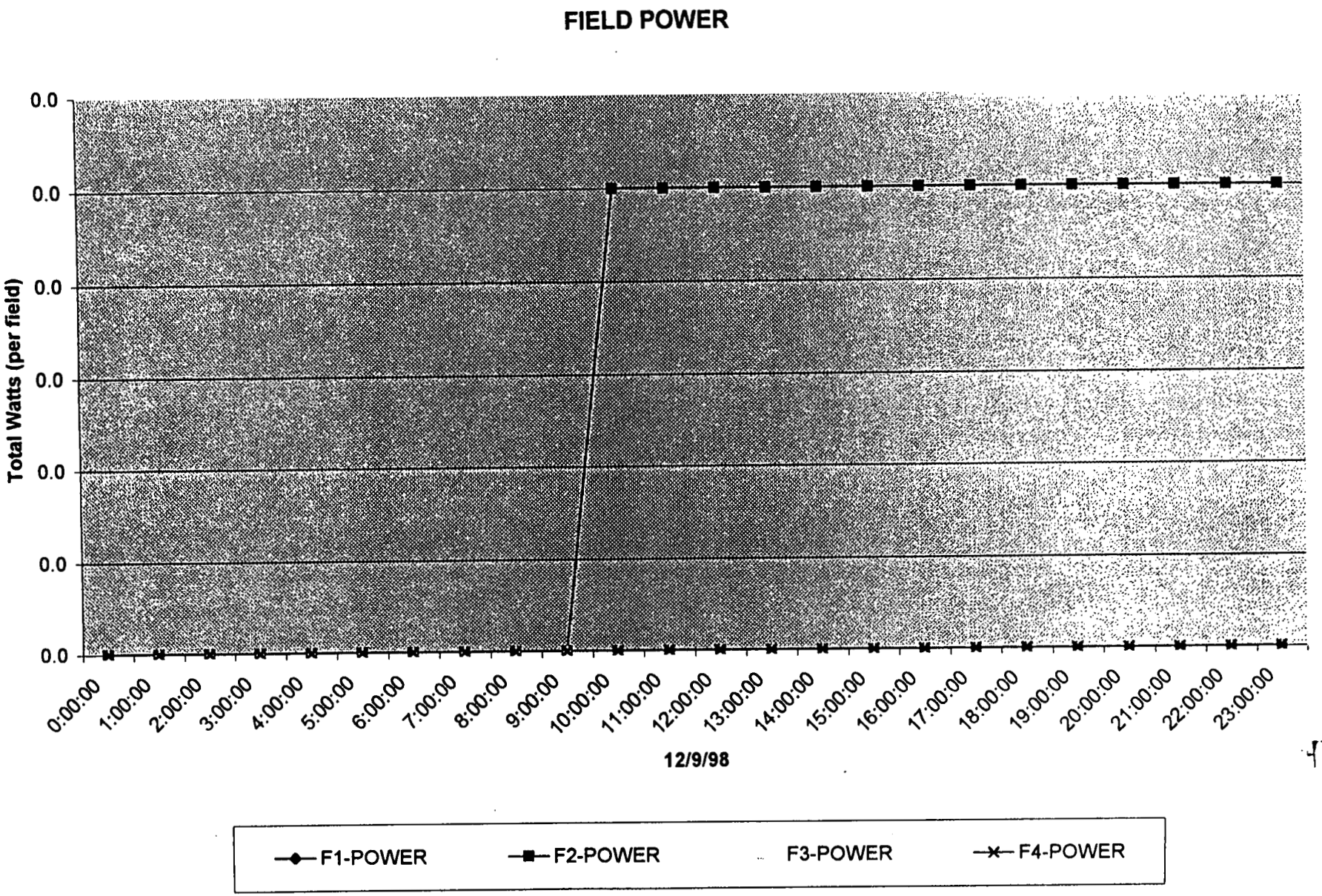
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/9/98
Start Date: 12/1/98
Days Operation: 8

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/9/98	0:00:00	0.0	0.0	0.0	0.0
12/9/98	1:00:00	0.0	0.0	0.0	0.0
12/9/98	2:00:00	0.0	0.0	0.0	0.0
12/9/98	3:00:00	0.0	0.0	0.0	0.0
12/9/98	4:00:00	0.0	0.0	0.0	0.0
12/9/98	5:00:00	0.0	0.0	0.0	0.0
12/9/98	6:00:00	0.0	0.0	0.0	0.0
12/9/98	7:00:00	0.0	0.0	0.0	0.0
12/9/98	8:00:00	0.0	0.0	0.0	0.0
12/9/98	9:00:00	0.0	0.0	0.0	0.0
12/9/98	10:00:00	0.0	0.0	0.0	0.0
12/9/98	11:00:00	0.0	0.0	0.0	0.0
12/9/98	12:00:00	0.0	0.0	0.0	0.0
12/9/98	13:00:00	0.0	0.0	0.0	0.0
12/9/98	14:00:00	0.0	0.0	0.0	0.0
12/9/98	15:00:00	0.0	0.0	0.0	0.0
12/9/98	16:00:00	0.0	0.0	0.0	0.0
12/9/98	17:00:00	0.0	0.0	0.0	0.0
12/9/98	18:00:00	0.0	0.0	0.0	0.0
12/9/98	19:00:00	0.0	0.0	0.0	0.0
12/9/98	20:00:00	0.0	0.0	0.0	0.0
12/9/98	21:00:00	0.0	0.0	0.0	0.0
12/9/98	22:00:00	0.0	0.0	0.0	0.0
12/9/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE		0.0	0.0	0.0	0.0

413


FIELD POWER
Total Watts (per field)
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/9/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

414

McGill AirClean Mobile EP
Daily Performance Report

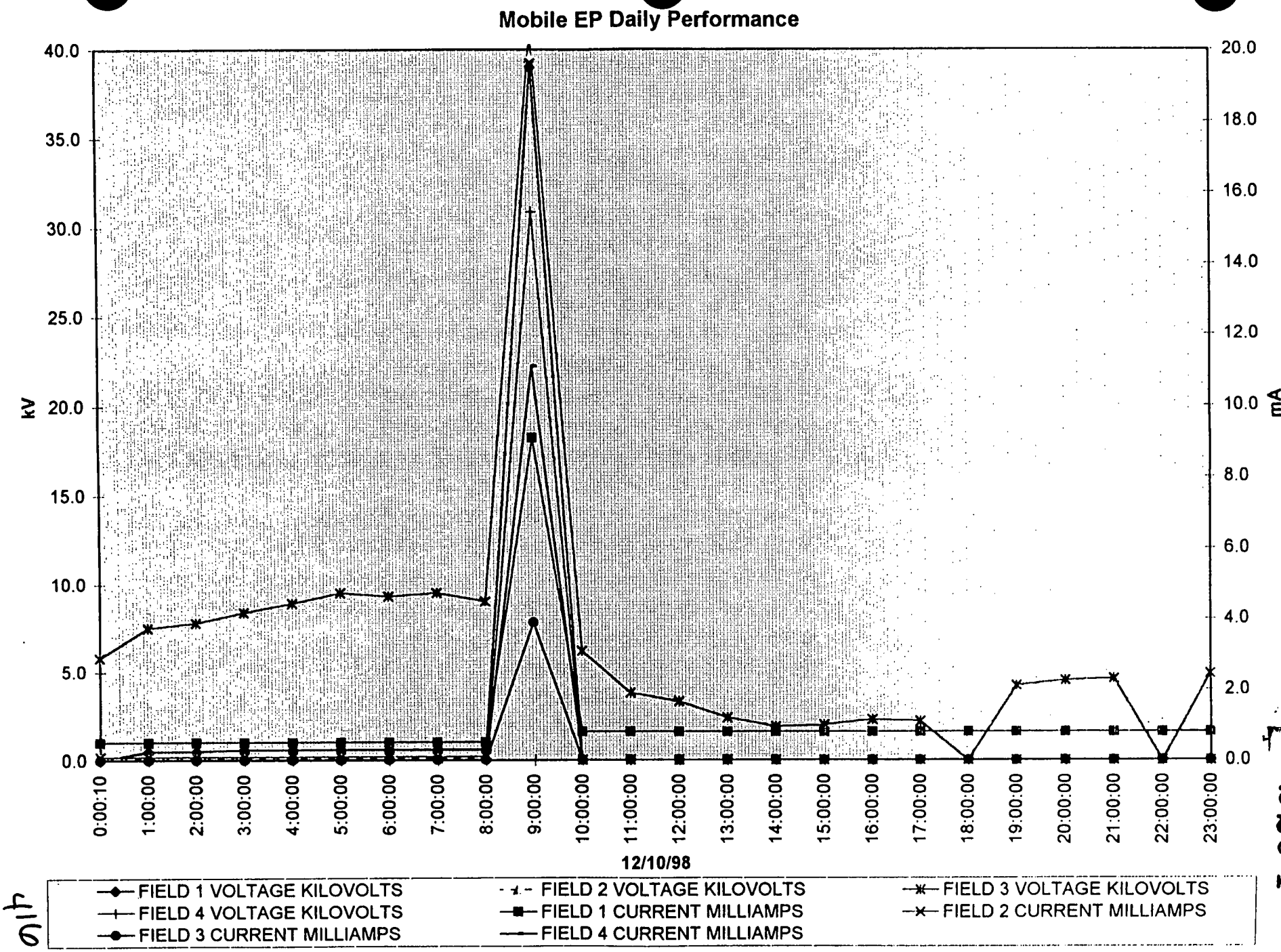
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/10/98
Start Date: 12/1/98
Days Operation: 9

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/10/98	0:00:10	0.0	0.5	0.1	0.1	5.8	0.0	0.0	0.0
12/10/98	1:00:00	0.5	0.5	0.1	0.1	7.5	0.0	0.0	0.0
12/10/98	2:00:00	0.5	0.5	0.1	0.1	7.8	0.0	0.0	0.0
12/10/98	3:00:00	0.6	0.5	0.1	0.1	8.4	0.0	0.0	0.0
12/10/98	4:00:00	0.6	0.5	0.1	0.1	8.9	0.0	0.0	0.0
12/10/98	5:00:00	0.6	0.5	0.1	0.1	9.5	0.0	0.0	0.0
12/10/98	6:00:00	0.6	0.5	0.1	0.1	9.3	0.0	0.0	0.0
12/10/98	7:00:00	0.6	0.5	0.1	0.1	9.5	0.0	0.0	0.0
12/10/98	8:00:00	0.6	0.5	0.1	0.1	9.0	0.0	0.0	0.0
12/10/98	9:00:00	39.0	9.1	39.5	19.6	40.9	3.9	30.9	11.1
12/10/98	10:00:00	0.0	0.8	0.0	0.0	6.2	0.0	0.0	0.0
12/10/98	11:00:00	0.0	0.8	0.0	0.0	3.8	0.0	0.0	0.0
12/10/98	12:00:00	0.0	0.8	0.0	0.0	3.3	0.0	0.0	0.0
12/10/98	13:00:00	0.0	0.8	0.0	0.0	2.4	0.0	0.0	0.0
12/10/98	14:00:00	0.0	0.8	0.0	0.0	1.9	0.0	0.0	0.0
12/10/98	15:00:00	0.0	0.8	0.0	0.0	2.0	0.0	0.0	0.0
12/10/98	16:00:00	0.0	0.8	0.0	0.0	2.3	0.0	0.0	0.0
12/10/98	17:00:00	0.0	0.8	0.0	0.0	2.2	0.0	0.0	0.0
12/10/98	18:00:00	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
12/10/98	19:00:00	0.0	0.8	0.0	0.0	4.2	0.0	0.0	0.0
12/10/98	20:00:00	0.0	0.8	0.0	0.0	4.5	0.0	0.0	0.0
12/10/98	21:00:00	0.0	0.8	0.0	0.0	4.6	0.0	0.0	0.0
12/10/98	22:00:00	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
12/10/98	23:00:00	0.0	0.8	0.0	0.0	4.9	0.0	0.0	0.0
Daily Average		1.8	1.0	1.7	0.9	6.6	0.2	1.3	0.5

415


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/10/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

McGill AirClean Mobile EP

Daily Performance Report

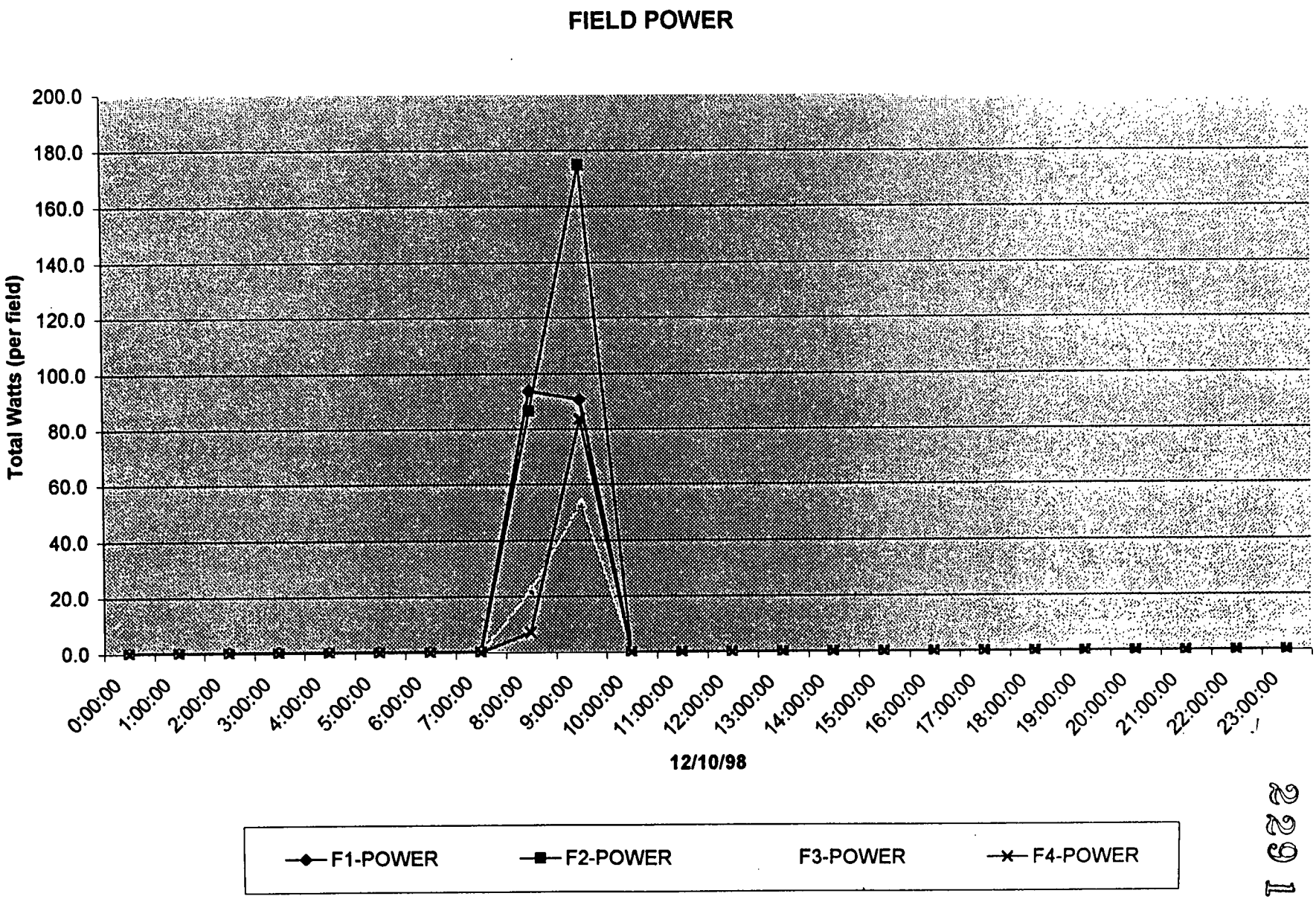
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/10/98
Start Date: 12/1/98
Days Operation: 9

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/10/98	0:00:00	0.1	0.0	0.0	0.0
12/10/98	1:00:00	0.3	0.0	0.0	0.0
12/10/98	2:00:00	0.3	0.0	0.0	0.0
12/10/98	3:00:00	0.3	0.0	0.0	0.0
12/10/98	4:00:00	0.3	0.0	0.0	0.0
12/10/98	5:00:00	0.3	0.0	0.0	0.0
12/10/98	6:00:00	0.3	0.0	0.0	0.0
12/10/98	7:00:00	0.3	0.0	0.0	0.0
12/10/98	8:00:00	93.6	86.5	22.5	7.2
12/10/98	9:00:00	90.7	174.8	53.4	83.6
12/10/98	10:00:00	0.0	0.0	0.0	0.0
12/10/98	11:00:00	0.0	0.0	0.0	0.0
12/10/98	12:00:00	0.0	0.0	0.0	0.0
12/10/98	13:00:00	0.0	0.0	0.0	0.0
12/10/98	14:00:00	0.0	0.0	0.0	0.0
12/10/98	15:00:00	0.0	0.0	0.0	0.0
12/10/98	16:00:00	0.0	0.0	0.0	0.0
12/10/98	17:00:00	0.0	0.0	0.0	0.0
12/10/98	18:00:00	0.0	0.0	0.0	0.0
12/10/98	19:00:00	0.0	0.0	0.0	0.0
12/10/98	20:00:00	0.0	0.0	0.0	0.0
12/10/98	21:00:00	0.0	0.0	0.0	0.0
12/10/98	22:00:00	0.0	0.0	0.0	0.0
12/10/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE		7.8	10.9	3.2	3.8

417


FIELD POWER
Total Watts (per field)
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/10/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

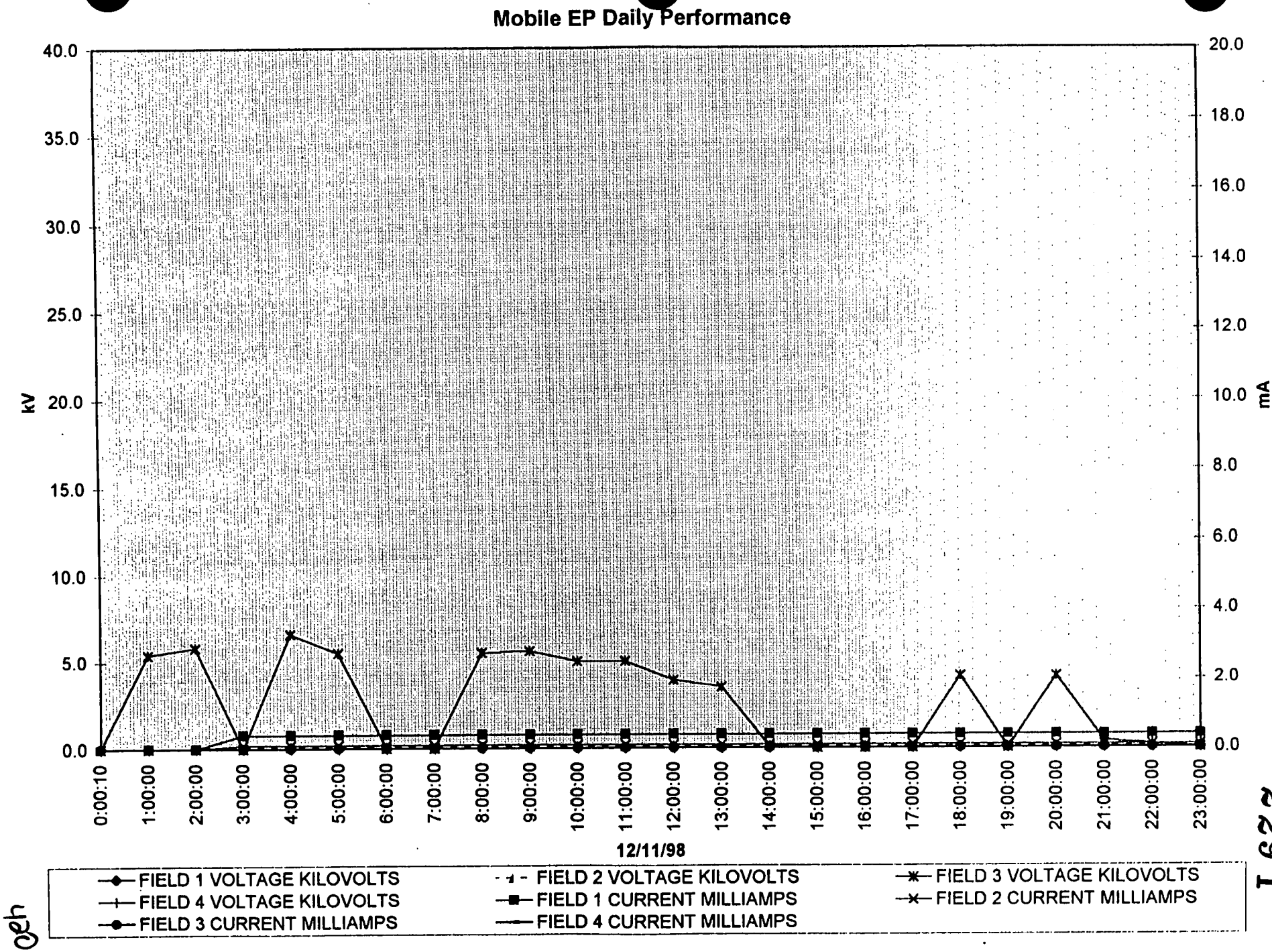
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/11/98
Start Date: 12/1/98
Days Operation: 10

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/11/98	0:00:10	#######	#######	#######	#######	0.0	0.0	#######	#######
12/11/98	1:00:00	#######	#######	#######	#######	5.4	0.0	#######	#######
12/11/98	2:00:00	#######	#######	#######	#######	5.8	0.0	#######	#######
12/11/98	3:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/11/98	4:00:00	0.0	0.4	0.1	0.1	6.6	0.0	0.0	0.0
12/11/98	5:00:00	0.0	0.4	0.1	0.1	5.5	0.0	0.0	0.0
12/11/98	6:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/11/98	7:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/11/98	8:00:00	0.0	0.4	0.1	0.1	5.5	0.0	0.0	0.0
12/11/98	9:00:00	0.0	0.4	0.1	0.1	5.6	0.0	0.0	0.0
12/11/98	10:00:00	0.0	0.4	0.1	0.1	5.0	0.0	0.0	0.0
[illegible]98	11:00:00	0.0	0.4	0.1	0.1	5.0	0.0	0.0	0.0
[illegible]98	12:00:00	0.0	0.4	0.1	0.1	3.9	0.0	0.0	0.0
12/11/98	13:00:00	0.0	0.4	0.1	0.1	3.5	0.0	0.0	0.0
12/11/98	14:00:00	0.0	0.4	0.1	0.1	0.1	0.0	0.0	0.0
12/11/98	15:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/11/98	16:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/11/98	17:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/11/98	18:00:00	0.0	0.4	0.1	0.1	4.1	0.0	0.0	0.0
12/11/98	19:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/11/98	20:00:00	0.0	0.4	0.1	0.1	4.1	0.0	0.0	0.0
12/11/98	21:00:00	0.0	0.4	0.1	0.1	0.4	0.0	0.0	0.0
12/11/98	22:00:00	0.0	0.4	0.1	0.1	0.2	0.0	0.0	0.0
12/11/98	23:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
Daily Average		0.0	0.4	0.1	0.1	2.5	0.0	0.0	0.0

419


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/11/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

McGill AirClean Mobile EP
Daily Performance Report

2291

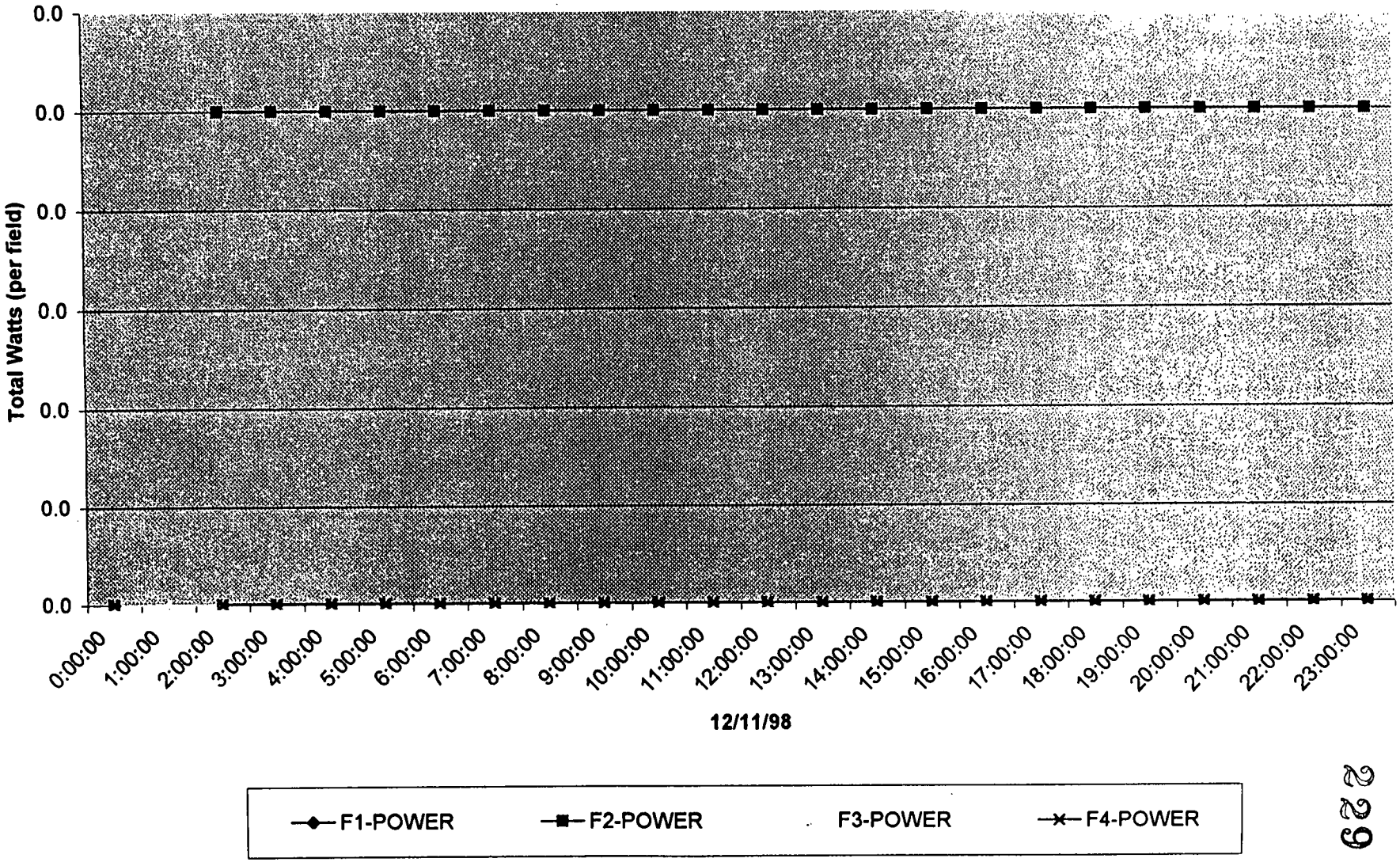
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/11/98
Start Date: 12/1/98
Days Operation: 10

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/11/98	0:00:00	0.0	0.0	0.0	0.0
12/11/98	1:00:00			0.0	
12/11/98	2:00:00	0.0	0.0	0.0	0.0
12/11/98	3:00:00	0.0	0.0	0.0	0.0
12/11/98	4:00:00	0.0	0.0	0.0	0.0
12/11/98	5:00:00	0.0	0.0	0.0	0.0
12/11/98	6:00:00	0.0	0.0	0.0	0.0
12/11/98	7:00:00	0.0	0.0	0.0	0.0
12/11/98	8:00:00	0.0	0.0	0.0	0.0
12/11/98	9:00:00	0.0	0.0	0.0	0.0
12/11/98	10:00:00	0.0	0.0	0.0	0.0
12/11/98	11:00:00	0.0	0.0	0.0	0.0
12/11/98	12:00:00	0.0	0.0	0.0	0.0
12/11/98	13:00:00	0.0	0.0	0.0	0.0
12/11/98	14:00:00	0.0	0.0	0.0	0.0
12/11/98	15:00:00	0.0	0.0	0.0	0.0
12/11/98	16:00:00	0.0	0.0	0.0	0.0
12/11/98	17:00:00	0.0	0.0	0.0	0.0
12/11/98	18:00:00	0.0	0.0	0.0	0.0
12/11/98	19:00:00	0.0	0.0	0.0	0.0
12/11/98	20:00:00	0.0	0.0	0.0	0.0
12/11/98	21:00:00	0.0	0.0	0.0	0.0
12/11/98	22:00:00	0.0	0.0	0.0	0.0
12/11/98	23:00:00	0.0	0.0	0.0	0.0
DAILY AVERAGE		0.0	0.0	0.0	0.0

421

FIELD POWER



8ch

McGill AirClean Mobile EP
Daily Performance Report

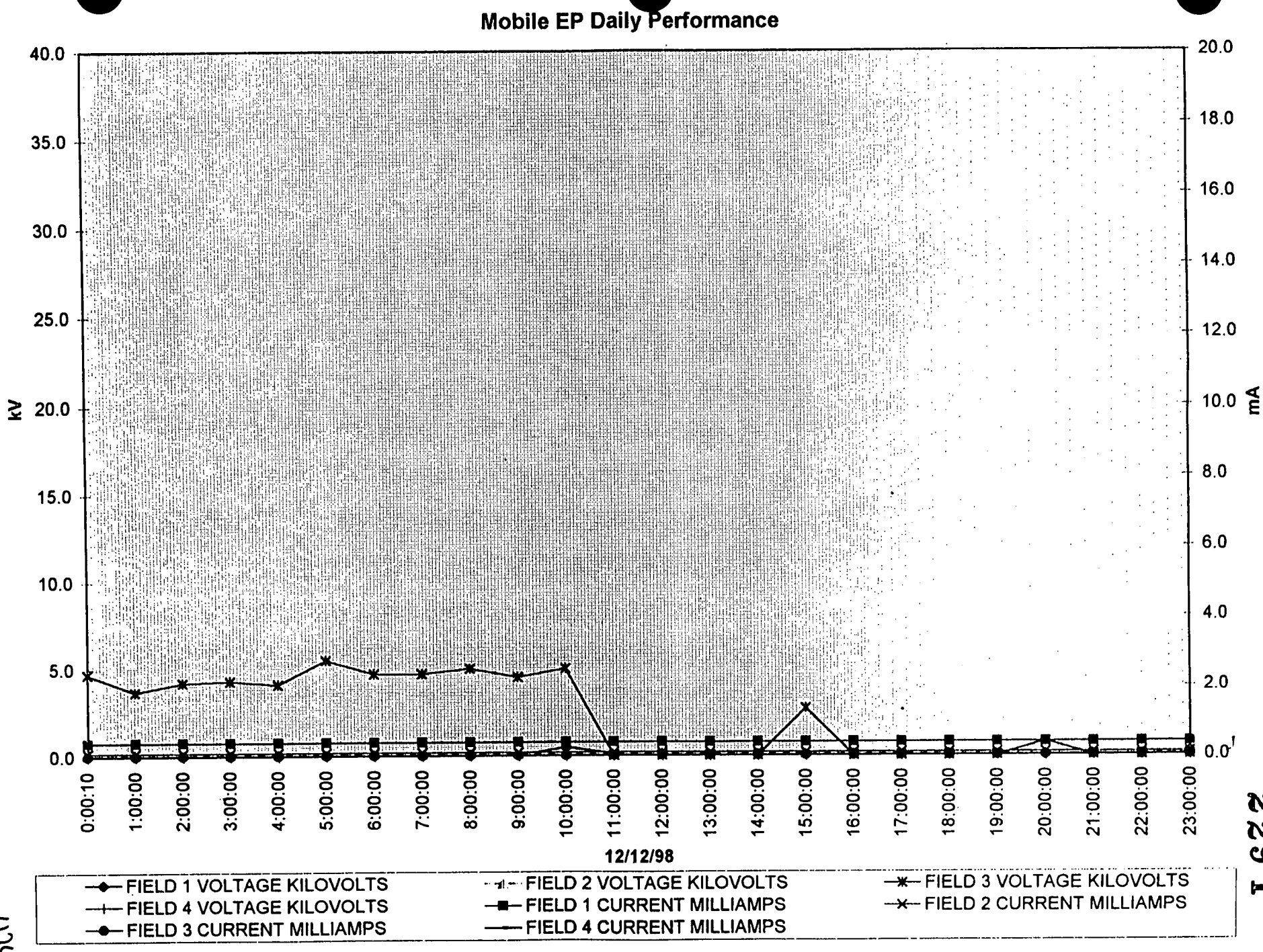
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/12/98
Start Date: 12/1/98
Days Operation: 11

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/12/98	0:00:10	0.0	0.4	0.1	0.1	4.7	0.0	0.0	0.0
12/12/98	1:00:00	0	0.4	0.1	0.1	3.7	0.0	0.0	0.0
12/12/98	2:00:00	0.0	0.4	0.1	0.1	4.2	0.0	0.0	0.0
12/12/98	3:00:00	0.0	0.4	0.1	0.1	4.3	0.0	0.0	0.0
12/12/98	4:00:00	0.0	0.4	0.1	0.1	4.1	0.0	0.0	0.0
12/12/98	5:00:00	0.0	0.4	0.1	0.1	5.5	0.0	0.0	0.0
12/12/98	6:00:00	0.0	0.4	0.1	0.1	4.7	0.0	0.0	0.0
12/12/98	7:00:00	0.0	0.4	0.1	0.1	4.7	0.0	0.0	0.0
12/12/98	8:00:00	0.0	0.4	0.1	0.1	5.0	0.0	0.0	0.0
12/12/98	9:00:00	0.0	0.4	0.1	0.1	4.5	0.0	0.0	0.0
12/12/98	10:00:00	0.5	0.4	0.1	0.1	5.0	0.0	0.0	0.0
12/12/98	11:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	12:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	13:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	14:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	15:00:00	0.1	0.4	0.1	0.1	2.7	0.0	0.0	0.0
12/12/98	16:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	17:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	18:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	19:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	20:00:00	0.0	0.4	0.1	0.1	0.8	0.0	0.0	0.0
12/12/98	21:00:00	0.1	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	22:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/12/98	23:00:00	0.2	0.4	0.1	0.1	0.0	0.0	0.0	0.0
Daily Average		0.1	0.4	0.1	0.1	2.2	0.0	0.0	0.0

423


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/12/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

424

McGill AirClean Mobile EP
Daily Performance Report

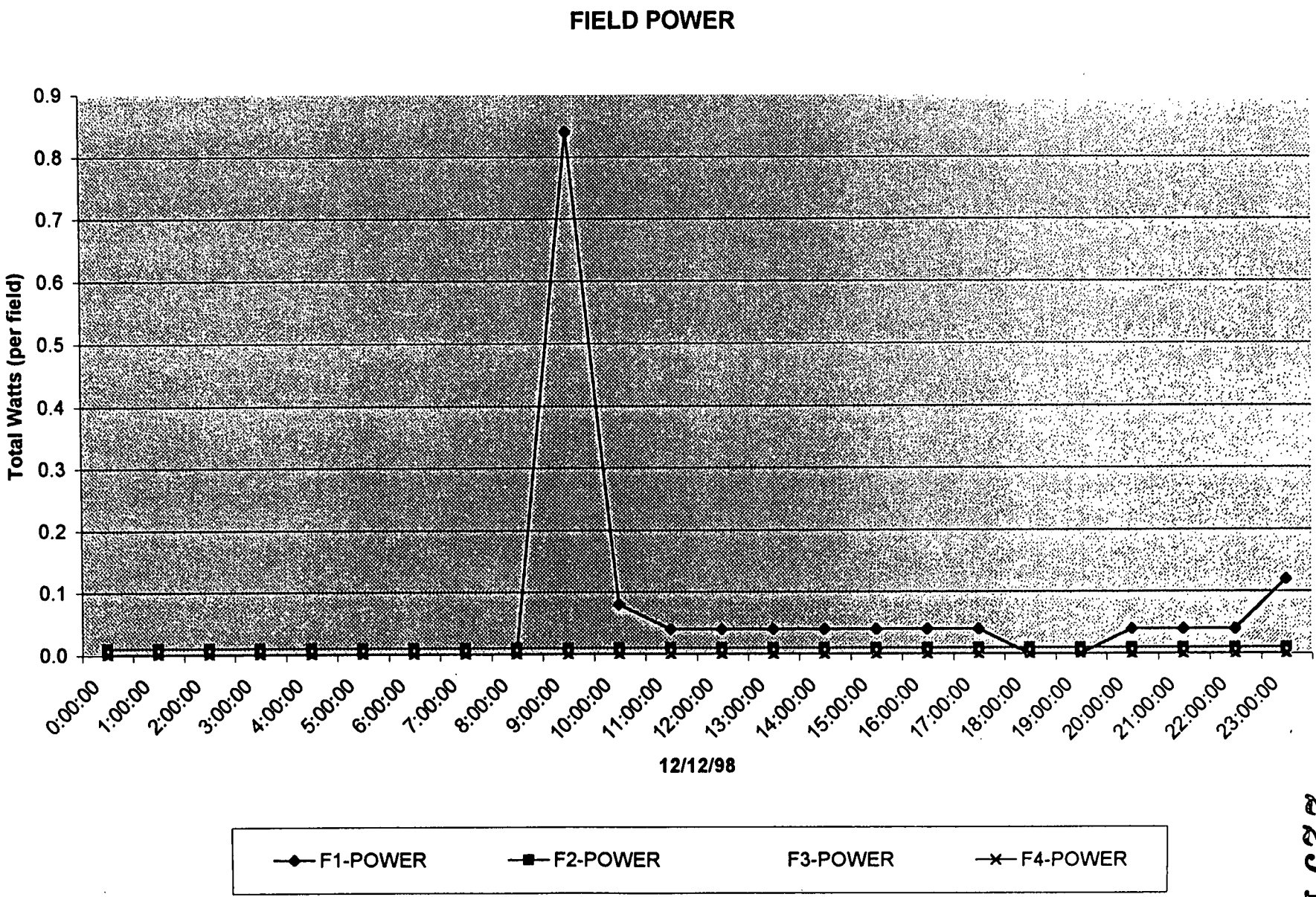
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/12/98
Start Date: 12/1/98
Days Operation: 11

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/12/98	0:00:00	0.0	0.0	0.0	0.0
12/12/98	1:00:00	0.0	0.0	0.0	0.0
12/12/98	2:00:00	0.0	0.0	0.0	0.0
12/12/98	3:00:00	0.0	0.0	0.0	0.0
12/12/98	4:00:00	0.0	0.0	0.0	0.0
12/12/98	5:00:00	0.0	0.0	0.0	0.0
12/12/98	6:00:00	0.0	0.0	0.0	0.0
12/12/98	7:00:00	0.0	0.0	0.0	0.0
12/12/98	8:00:00	0.0	0.0	0.0	0.0
12/12/98	9:00:00	0.8	0.0	0.0	0.0
12/12/98	10:00:00	0.1	0.0	0.0	0.0
12/12/98	11:00:00	0.0	0.0	0.0	0.0
12/12/98	12:00:00	0.0	0.0	0.0	0.0
12/12/98	13:00:00	0.0	0.0	0.0	0.0
12/12/98	14:00:00	0.0	0.0	0.0	0.0
12/12/98	15:00:00	0.0	0.0	0.0	0.0
12/12/98	16:00:00	0.0	0.0	0.0	0.0
12/12/98	17:00:00	0.0	0.0	0.0	0.0
12/12/98	18:00:00	0.0	0.0	0.0	0.0
12/12/98	19:00:00	0.0	0.0	0.0	0.0
12/12/98	20:00:00	0.0	0.0	0.0	0.0
12/12/98	21:00:00	0.0	0.0	0.0	0.0
12/12/98	22:00:00	0.0	0.0	0.0	0.0
12/12/98	23:00:00	0.1	0.0	0.0	0.0
DAILY AVERAGE		0.1	0.0	0.0	0.0

425


FIELD POWER
Total Watts (per field)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/12/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

4/26

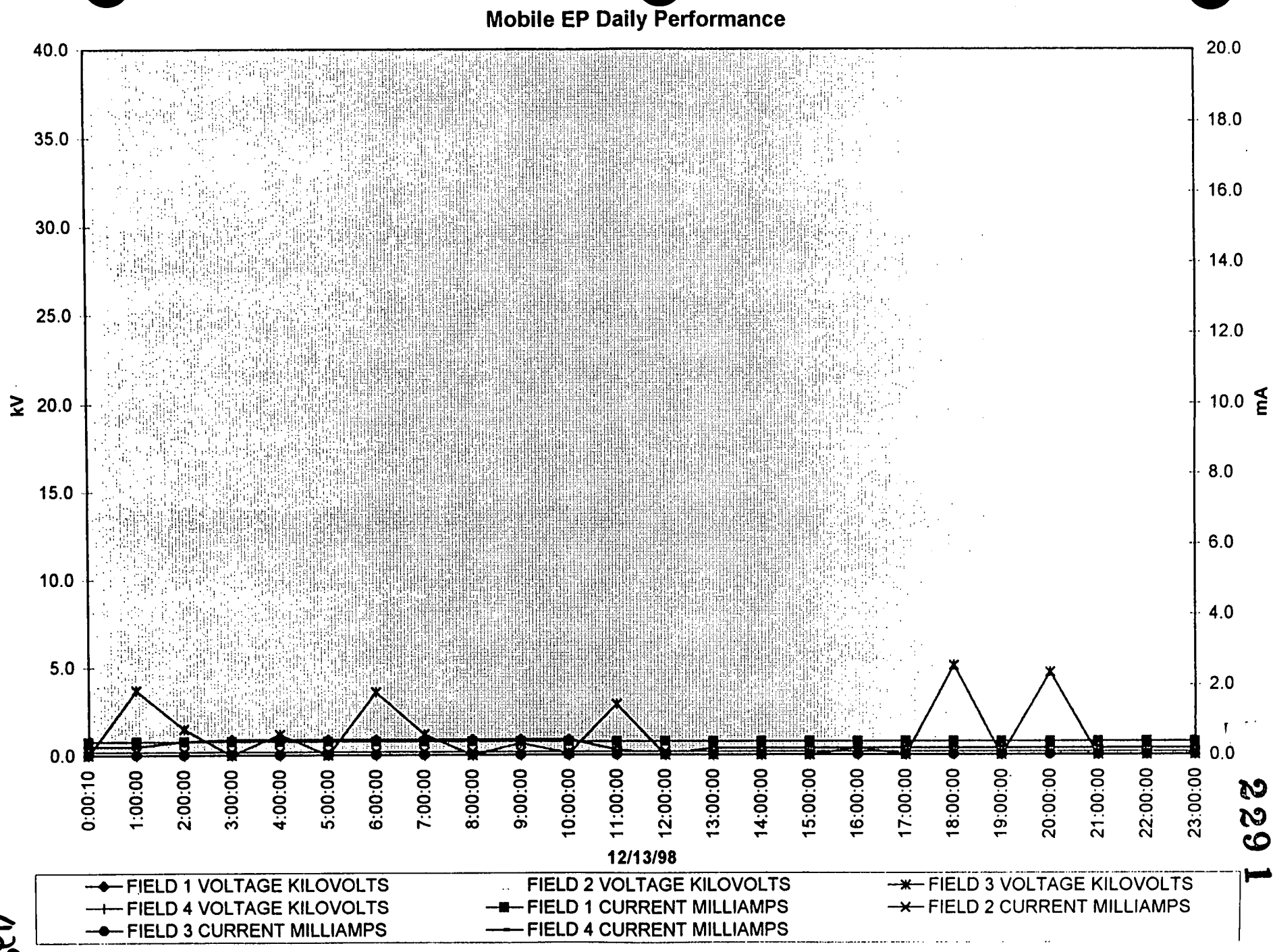
McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/13/98
Start Date: 12/1/98
Days Operation: 12

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/13/98	0:00:10	0.5	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	1:00:00	0.5	0.4	0.1	0.1	3.7	0.0	0.0	0.0
12/13/98	2:00:00	0.8	0.4	0.1	0.1	1.5	0.0	0.0	0.0
12/13/98	3:00:00	0.9	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	4:00:00	0.9	0.4	0.1	0.1	1.2	0.0	0.0	0.0
12/13/98	5:00:00	0.9	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	6:00:00	0.9	0.4	0.1	0.1	3.6	0.0	0.0	0.0
12/13/98	7:00:00	0.9	0.4	0.1	0.1	1.2	0.0	0.0	0.0
12/13/98	8:00:00	0.9	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	9:00:00	0.9	0.4	0.1	0.1	0.7	0.0	0.0	0.0
1[illegible]/98	10:00:00	0.9	0.4	0.1	0.1	0.1	0.0	0.0	0.0
[illegible]/8	11:00:00	0.3	0.4	0.1	0.1	2.9	0.0	0.0	0.0
[illegible]/98	12:00:00	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	13:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	14:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	15:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	16:00:00	0.4	0.4	0.1	0.1	0.4	0.0	0.0	0.0
12/13/98	17:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	18:00:00	0.4	0.4	0.1	0.1	5.1	0.0	0.0	0.0
12/13/98	19:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	20:00:00	0.4	0.4	0.1	0.1	4.7	0.0	0.0	0.0
12/13/98	21:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	22:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/13/98	23:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
Daily Average		0.6	0.4	0.1	0.1	1.0	0.0	0.0	0.0


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/13/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

428

McGill AirClean Mobile EP
Daily Performance Report

2291

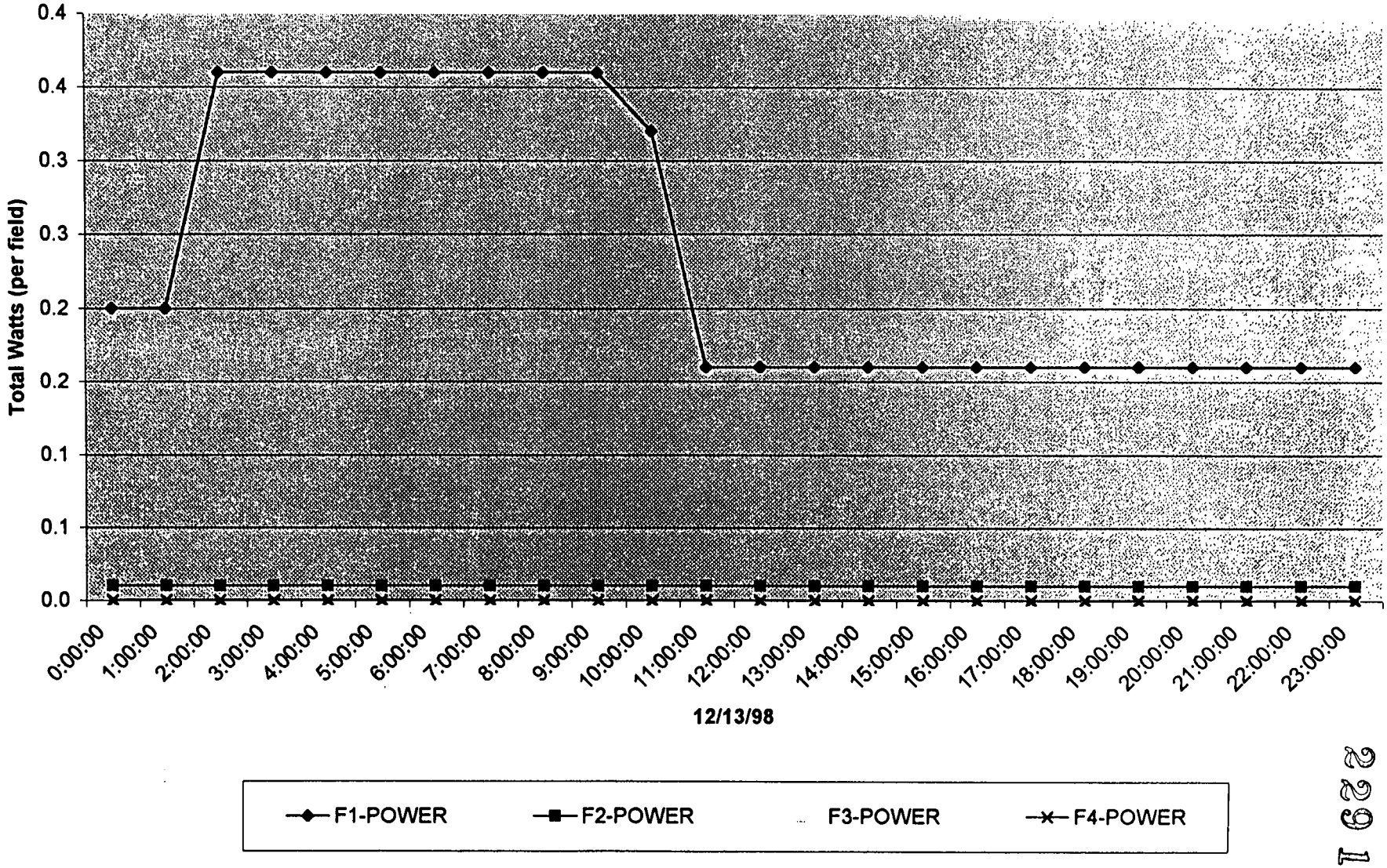
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/13/98
Start Date: 12/1/98
Days Operation: 12

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/13/98	0:00:00	0.2	0.0	0.0	0.0
12/13/98	1:00:00	0.2	0.0	0.0	0.0
12/13/98	2:00:00	0.4	0.0	0.0	0.0
12/13/98	3:00:00	0.4	0.0	0.0	0.0
12/13/98	4:00:00	0.4	0.0	0.0	0.0
12/13/98	5:00:00	0.4	0.0	0.0	0.0
12/13/98	6:00:00	0.4	0.0	0.0	0.0
12/13/98	7:00:00	0.4	0.0	0.0	0.0
12/13/98	8:00:00	0.4	0.0	0.0	0.0
12/13/98	9:00:00	0.4	0.0	0.0	0.0
12/13/98	10:00:00	0.3	0.0	0.0	0.0
12/13/98	11:00:00	0.2	0.0	0.0	0.0
12/13/98	12:00:00	0.2	0.0	0.0	0.0
12/13/98	13:00:00	0.2	0.0	0.0	0.0
12/13/98	14:00:00	0.2	0.0	0.0	0.0
12/13/98	15:00:00	0.2	0.0	0.0	0.0
12/13/98	16:00:00	0.2	0.0	0.0	0.0
12/13/98	17:00:00	0.2	0.0	0.0	0.0
12/13/98	18:00:00	0.2	0.0	0.0	0.0
12/13/98	19:00:00	0.2	0.0	0.0	0.0
12/13/98	20:00:00	0.2	0.0	0.0	0.0
12/13/98	21:00:00	0.2	0.0	0.0	0.0
12/13/98	22:00:00	0.2	0.0	0.0	0.0
12/13/98	23:00:00	0.2	0.0	0.0	0.0
DAILY AVERAGE		0.2	0.0	0.0	0.0

429

FIELD POWER


Total Watts (per field)
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/13/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

2291

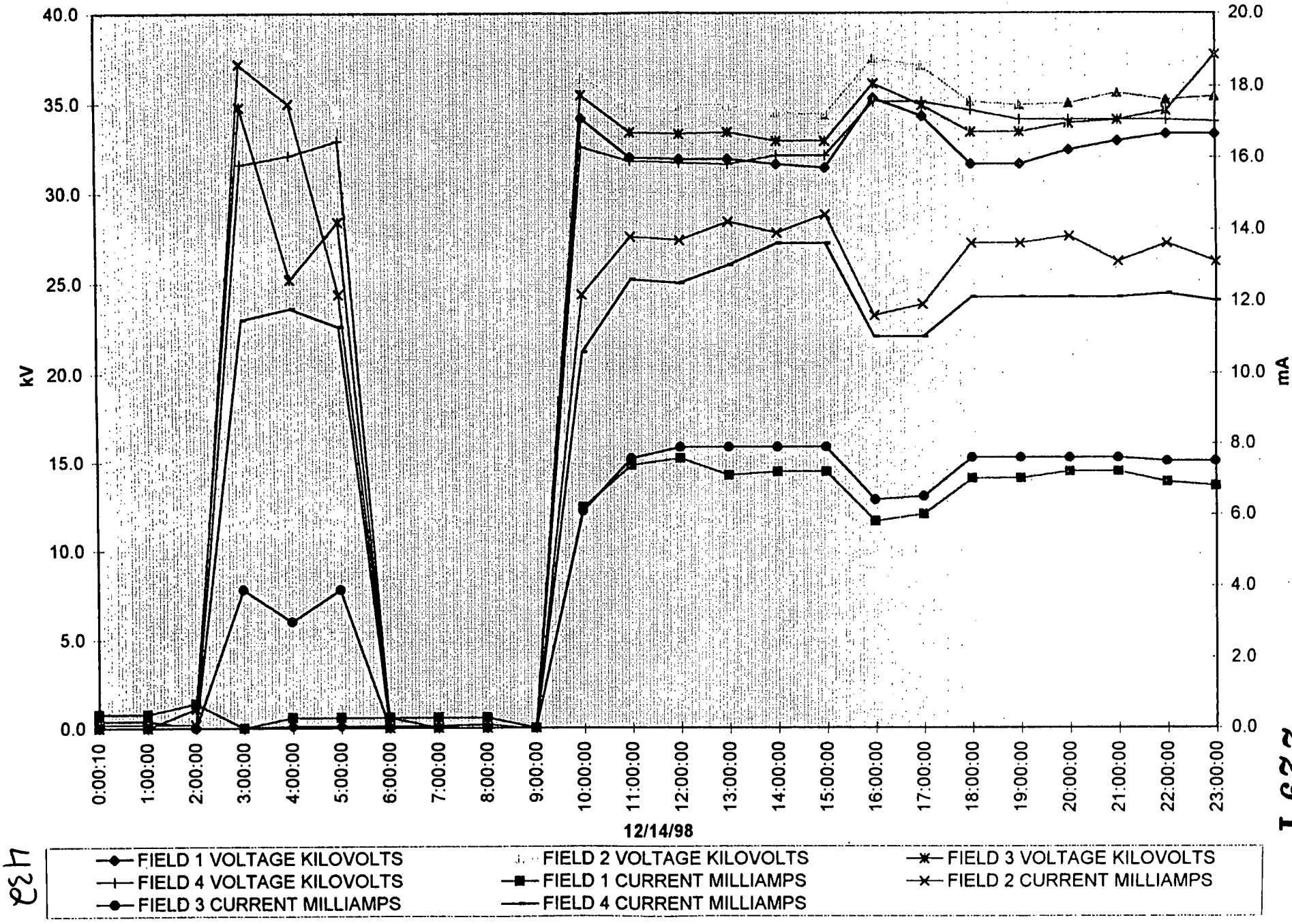
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/14/98
Start Date: 12/1/98
Days Operation: 13

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/14/98	0:00:10	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/14/98	1:00:00	0.4	0.4	0.1	0.1	0.0	0.0	0.0	0.0
12/14/98	2:00:00	0.0	0.7	0.1	0.1	1.1	0.0	0.0	0.0
12/14/98	3:00:00	0.0	0.0	38.5	18.6	34.8	3.9	31.6	11.5
12/14/98	4:00:00	0.1	0.3	37.8	17.5	25.2	3.0	32.1	11.8
12/14/98	5:00:00	0.1	0.3	34.6	12.2	28.4	3.9	32.9	11.3
12/14/98	6:00:00	0.1	0.3	0.4	0.3	0.0	0.0	0.0	0.0
12/14/98	7:00:00	0.1	0.3	0.3	0.0	0.0	0.0	0.0	0.0
12/14/98	8:00:00	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0
12/14/98	9:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/14/98	10:00:00	34.2	6.2	36.7	12.2	35.5	6.1	32.6	10.6
12/14/98	11:00:00	32.0	7.4	34.8	13.8	33.4	7.6	31.8	12.6
12/14/98	12:00:00	31.9	7.6	34.9	13.7	33.3	7.9	31.7	12.5
12/14/98	13:00:00	31.9	7.1	34.9	14.2	33.4	7.9	31.6	13.0
12/14/98	14:00:00	31.6	7.2	34.5	13.9	32.9	7.9	32.1	13.6
12/14/98	15:00:00	31.4	7.2	34.4	14.4	32.9	7.9	32.1	13.6
12/14/98	16:00:00	35.3	5.8	37.5	11.6	36.1	6.4	35.1	11.0
12/14/98	17:00:00	34.3	6.0	37.1	11.9	34.9	6.5	35.1	11.0
12/14/98	18:00:00	31.6	7.0	35.1	13.6	33.4	7.6	34.6	12.1
12/14/98	19:00:00	31.6	7.0	34.9	13.6	33.4	7.6	34.1	12.1
12/14/98	20:00:00	32.4	7.2	35.0	13.8	33.9	7.6	34.1	12.1
12/14/98	21:00:00	32.9	7.2	35.6	13.1	34.1	7.6	34.1	12.1
12/14/98	22:00:00	33.3	6.9	35.2	13.6	34.6	7.5	34.1	12.2
12/14/98	23:00:00	33.3	6.8	35.4	13.1	37.7	7.5	34.0	12.0
Daily Average		20.0	4.3	26.4	10.2	24.7	5.0	24.5	8.9

431

Mobile EP Daily Performance



McGill AirClean Mobile EP
Daily Performance Report

2291

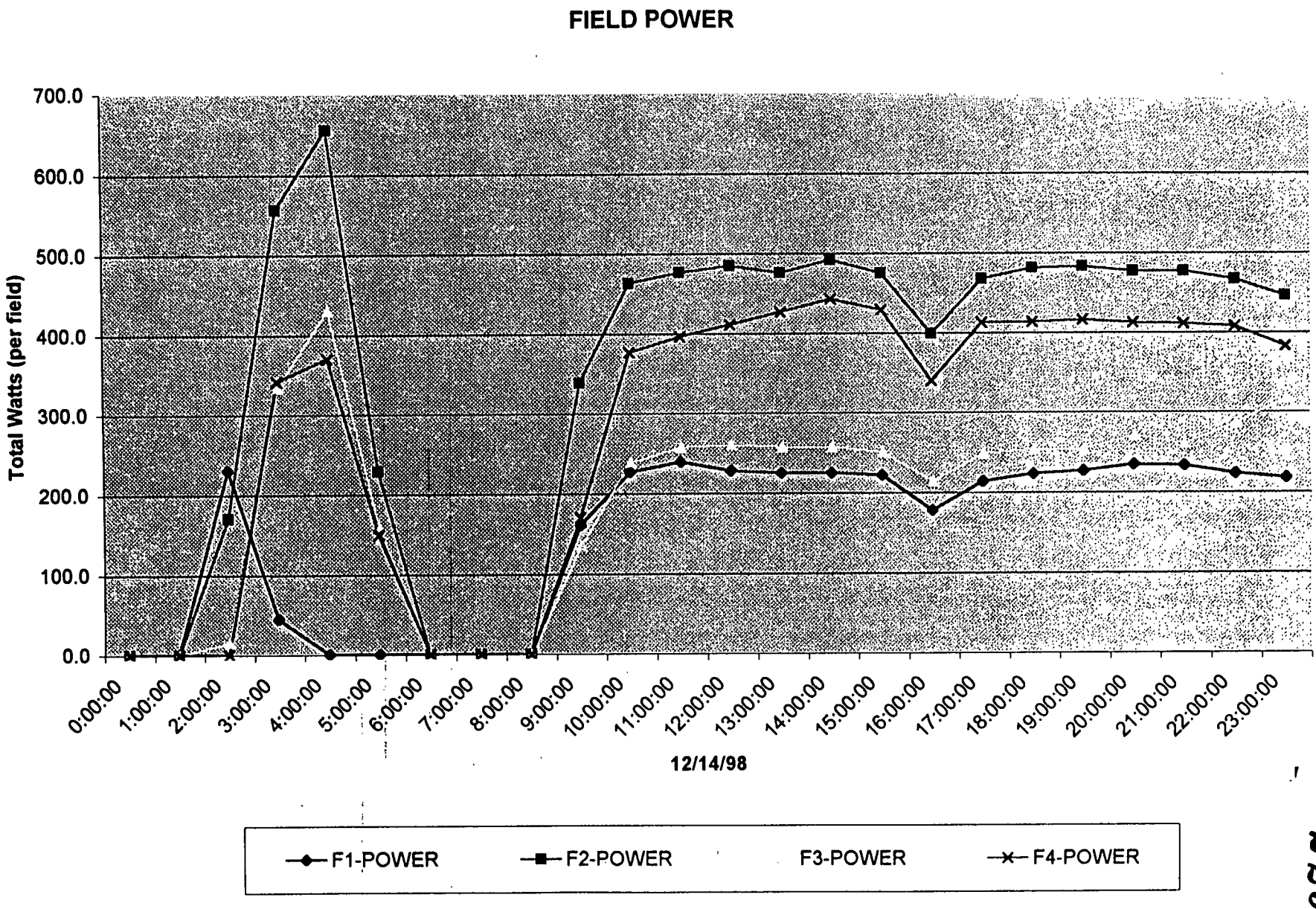
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/14/98
Start Date: 12/1/98
Days Operation: 13

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/14/98	0:00:00	0.2	0.0	0.0	0.0
12/14/98	1:00:00	0.6	0.0	0.0	0.0
12/14/98	2:00:00	230.5	170.3	15.1	0.1
12/14/98	3:00:00	45.2	556.5	334.6	342.3
12/14/98	4:00:00	0.0	655.7	429.8	370.3
12/14/98	5:00:00	0.0	228.9	156.8	149.8
12/14/98	6:00:00	0.0	0.1	0.0	0.0
12/14/98	7:00:00	0.1	0.0	0.0	0.0
12/14/98	8:00:00	0.1	0.0	0.0	0.0
12/14/98	9:00:00	161.2	339.1	135.4	170.0
12/14/98	10:00:00	227.0	463.7	238.7	376.7
12/14/98	11:00:00	239.4	476.8	257.4	396.3
12/14/98	12:00:00	228.2	485.1	260.7	411.5
12/14/98	13:00:00	225.1	476.1	257.4	426.9
12/14/98	14:00:00	225.4	492.5	257.5	443.0
12/14/98	15:00:00	221.9	475.4	250.8	429.0
12/14/98	16:00:00	178.0	399.0	214.2	340.5
12/14/98	17:00:00	213.9	467.7	248.9	412.9
12/14/98	18:00:00	223.3	481.6	253.8	413.8
12/14/98	19:00:00	227.2	483.0	253.8	416.0
12/14/98	20:00:00	234.7	477.4	270.6	412.6
12/14/98	21:00:00	233.6	477.4	260.7	411.4
12/14/98	22:00:00	223.0	467.1	286.4	407.8
12/14/98	23:00:00	217.8	446.7	317.4	382.8
DAILY AVERAGE		148.2	355.0	195.8	279.7

433

R14dec98b.xls


FIELD POWER
Total Watts (per field)
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/14/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

434

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/15/98
Start Date: 12/1/98
Days Operation: 14

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/15/98	0:00:10	35.0	6.8	34.1	14.5	38.9	7.3	33.6	12.1
12/15/98	1:00:00	35.3	6.7	35.6	13.1	50.5	7.3	33.8	12.2
12/15/98	2:00:00	35.3	6.7	35.8	13.0	50.6	7.3	32.7	12.0
12/15/98	3:00:00	34.7	7.0	34.1	14.3	50.5	7.3	31.1	12.6
12/15/98	4:00:00	33.8	7.4	32.3	15.9	36.1	7.6	30.6	13.2
12/15/98	5:00:00	33.6	7.5	31.7	16.2	35.9	7.7	30.5	12.9
12/15/98	6:00:00	32.7	8.2	32.8	15.3	51.0	7.3	30.5	12.5
12/15/98	7:00:00	32.9	8.0	32.9	15.3	51.5	7.1	30.9	12.6
12/15/98	8:00:00	32.8	8.2	33.3	15.0	51.4	7.0	30.9	12.6
12/15/98	9:00:00	32.9	8.1	33.3	15.1	49.6	7.6	30.6	13.2
12/15/98	10:00:00	34.6	7.2	34.5	13.9	47.9	7.4	31.1	12.9
[illegible]8	11:00:00	35.6	6.3	35.4	13.4	46.7	6.9	31.7	12.5
[illegible]8	12:00:00	35.7	6.4	35.8	13.0	45.7	7.4	31.4	12.0
12/15/98	13:00:00	0.7	0.0	0.0	0.0	6.1	0.0	0.0	0.0
12/15/98	14:00:00	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/15/98	15:00:00	28.2	11.1	30.5	17.7	33.9	8.4	29.9	14.4
12/15/98	16:00:00	29.0	10.6	31.5	16.9	34.1	8.3	30.7	14.0
12/15/98	17:00:00	30.3	9.9	32.7	15.9	34.4	8.2	31.1	13.5
12/15/98	18:00:00	33.4	8.1	33.7	14.9	35.2	7.8	31.3	12.3
12/15/98	19:00:00	36.1	6.6	36.8	12.6	36.0	7.1	32.1	10.9
12/15/98	20:00:00	35.6	6.6	36.0	13.0	36.3	7.1	31.7	11.4
12/15/98	21:00:00	35.6	6.6	35.9	13.1	36.3	7.1	31.6	11.4
12/15/98	22:00:00	35.6	6.9	36.1	12.8	36.4	7.2	32.0	11.6
12/15/98	23:00:00	35.6	6.9	36.1	12.9	36.4	7.2	31.5	11.6
Daily Average		31.1	7.0	31.3	13.2	38.8	6.8	28.8	11.4

435

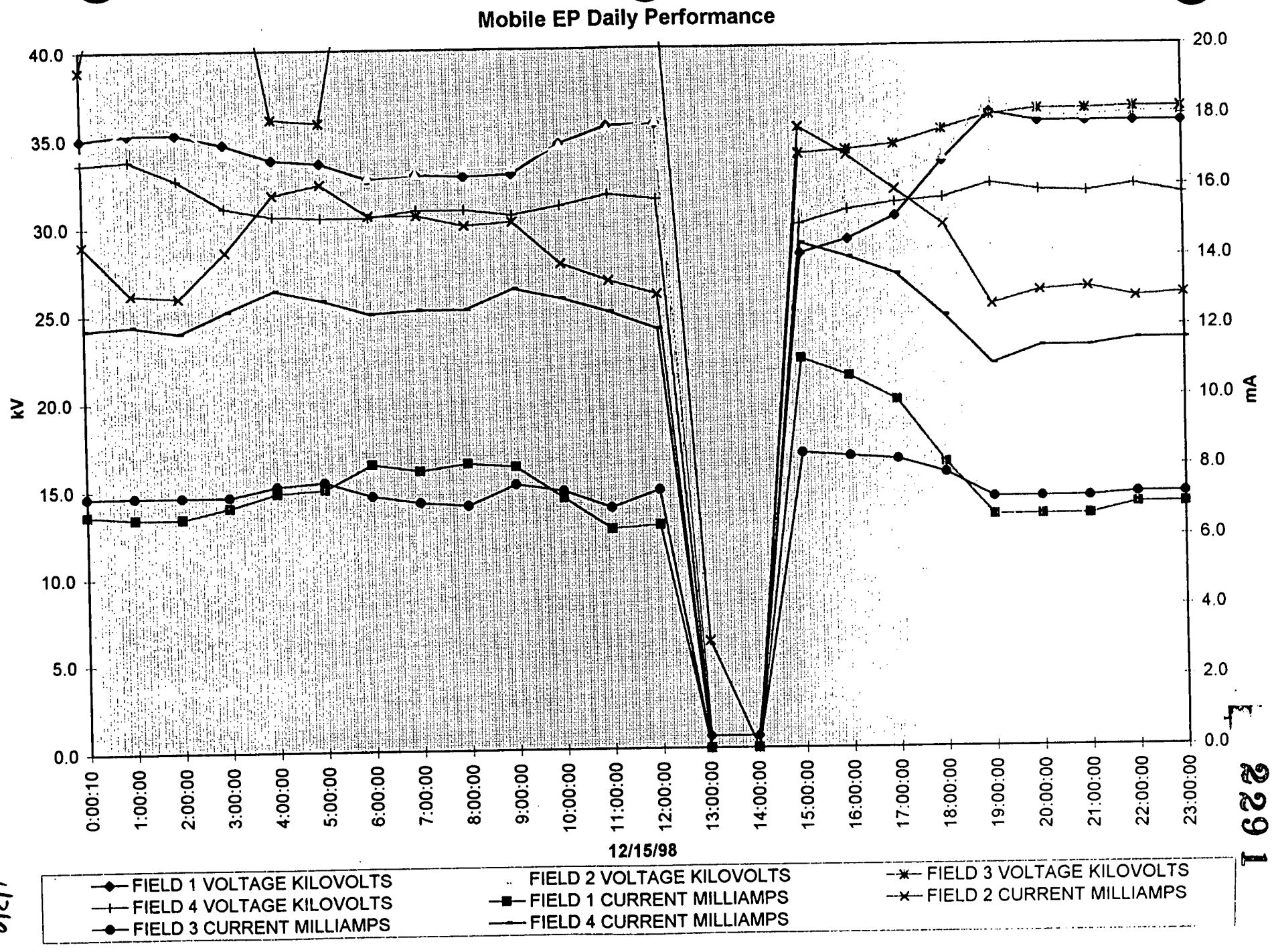

Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/15/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

Fig 29

McGill AirClean Mobile EP

Daily Performance Report

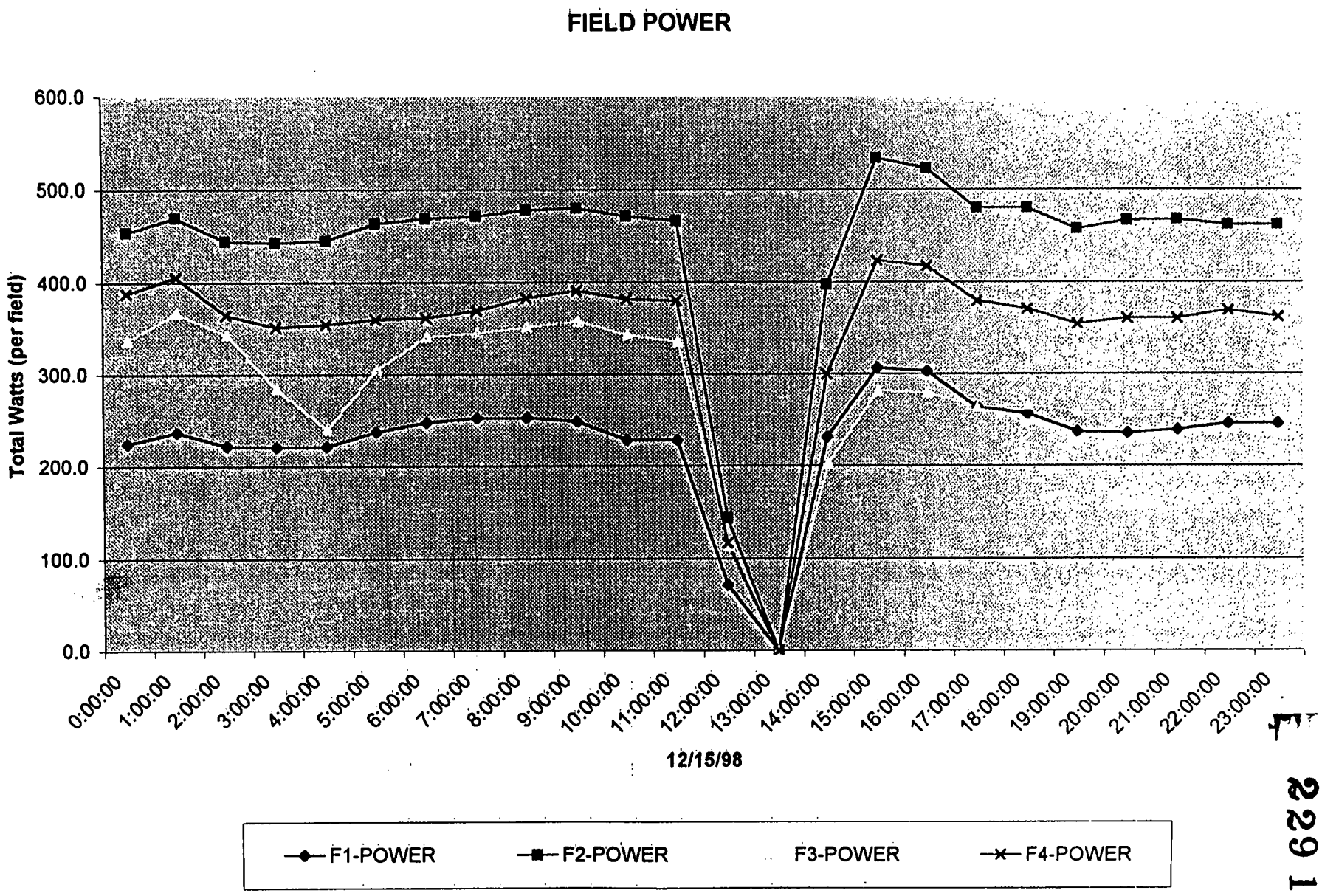
L 2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/15/98
Start Date: 12/1/98
Days Operation: 14

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/15/98	0:00:00	224.5	454.0	337.0	387.6
12/15/98	1:00:00	236.5	469.9	366.5	405.4
12/15/98	2:00:00	221.7	444.6	342.9	364.6
12/15/98	3:00:00	220.8	443.3	284.0	350.9
12/15/98	4:00:00	221.2	445.3	240.0	354.2
12/15/98	5:00:00	237.0	463.5	305.3	359.6
12/15/98	6:00:00	247.3	468.9	340.9	361.1
12/15/98	7:00:00	252.0	471.6	345.0	369.0
12/15/98	8:00:00	252.8	478.0	350.7	382.7
12/15/98	9:00:00	248.6	480.0	357.4	390.4
12/15/98	10:00:00	227.8	471.2	342.0	381.2
12/15/98	11:00:00	227.8	466.4	335.2	379.9
12/15/98	12:00:00	71.6	143.8	113.2	116.6
12/15/98	13:00:00	0.0	0.0	0.0	0.0
12/15/98	14:00:00	230.9	396.8	202.3	299.5
12/15/98	15:00:00	306.3	533.5	281.4	422.8
12/15/98	16:00:00	302.8	523.1	278.8	417.5
12/15/98	17:00:00	263.6	480.2	263.4	379.4
12/15/98	18:00:00	256.5	480.2	265.5	370.5
12/15/98	19:00:00	236.9	457.4	258.4	354.2
12/15/98	20:00:00	235.0	466.7	257.7	360.2
12/15/98	21:00:00	238.5	468.0	257.7	360.2
12/15/98	22:00:00	245.6	462.1	262.1	368.9
12/15/98	23:00:00	245.6	462.1	262.1	361.9
DAILY AVERAGE		227.1	434.6	277.1	345.8

437


FIELD POWER
Total Watts (per field)
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/15/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

428

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/16/98
Start Date: 12/1/98
Days Operation: 15

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/16/98	0:00:10	35.6	6.9	36.1	12.8	36.4	7.2	32.0	11.6
12/16/98	1:00:00	35.6	6.9	36.1	12.8	36.4	7.2	32.0	11.6
12/16/98	2:00:00	35.6	6.9	36.1	12.8	36.4	7.2	32.0	11.6
12/16/98	3:00:00	35.3	7.0	35.6	13.0	36.1	7.4	31.7	12.0
12/16/98	4:00:00	35.4	7.0	35.2	13.2	36.0	7.5	31.6	12.0
12/16/98	5:00:00	38.6	5.8	37.8	11.1	38.0	6.6	32.6	10.3
12/16/98	6:00:00	34.9	7.4	35.4	13.1	35.8	7.8	31.5	12.2
12/16/98	7:00:00	36.0	6.8	36.5	12.6	36.9	7.2	32.1	11.2
12/16/98	8:00:00	36.1	6.7	36.4	12.5	36.9	7.0	32.1	11.0
12/16/98	9:00:00	36.6	6.6	36.5	12.3	37.3	6.9	32.1	11.0
[illegible]98	10:00:00	36.0	6.6	35.9	12.3	37.0	6.9	32.1	11.5
[illegible]8	11:00:00	36.0	6.6	35.7	13.0	36.0	7.4	32.1	12.0
[illegible]16/98	12:00:00	35.5	6.6	35.7	13.0	35.9	7.4	31.6	12.0
12/16/98	13:00:00	34.8	6.6	36.1	12.5	35.3	7.4	32.2	11.6
12/16/98	14:00:00	34.6	7.0	35.8	12.9	35.2	7.6	32.0	11.6
12/16/98	15:00:00	35.1	6.5	35.8	12.9	35.2	7.6	32.0	11.6
12/16/98	16:00:00	35.6	6.5	35.7	13.1	34.6	7.6	32.0	12.2
12/16/98	17:00:00	36.0	6.3	35.8	13.0	34.8	7.9	31.7	12.3
12/16/98	18:00:00	35.9	6.3	35.7	12.6	35.3	7.9	31.7	11.8
12/16/98	19:00:00	35.9	6.3	36.2	12.7	35.3	7.9	31.7	11.8
12/16/98	20:00:00	36.6	6.7	36.2	12.8	35.8	7.7	32.0	12.0
12/16/98	21:00:00	35.9	6.8	36.7	12.3	36.5	7.2	32.5	11.0
12/16/98	22:00:00	37.1	6.3	36.7	12.3	36.5	7.2	32.5	11.0
12/16/98	23:00:00	37.6	6.2	36.5	12.4	36.5	7.2	32.3	11.6
Daily Average		35.9	6.6	36.1	12.7	36.1	7.4	32.0	11.6

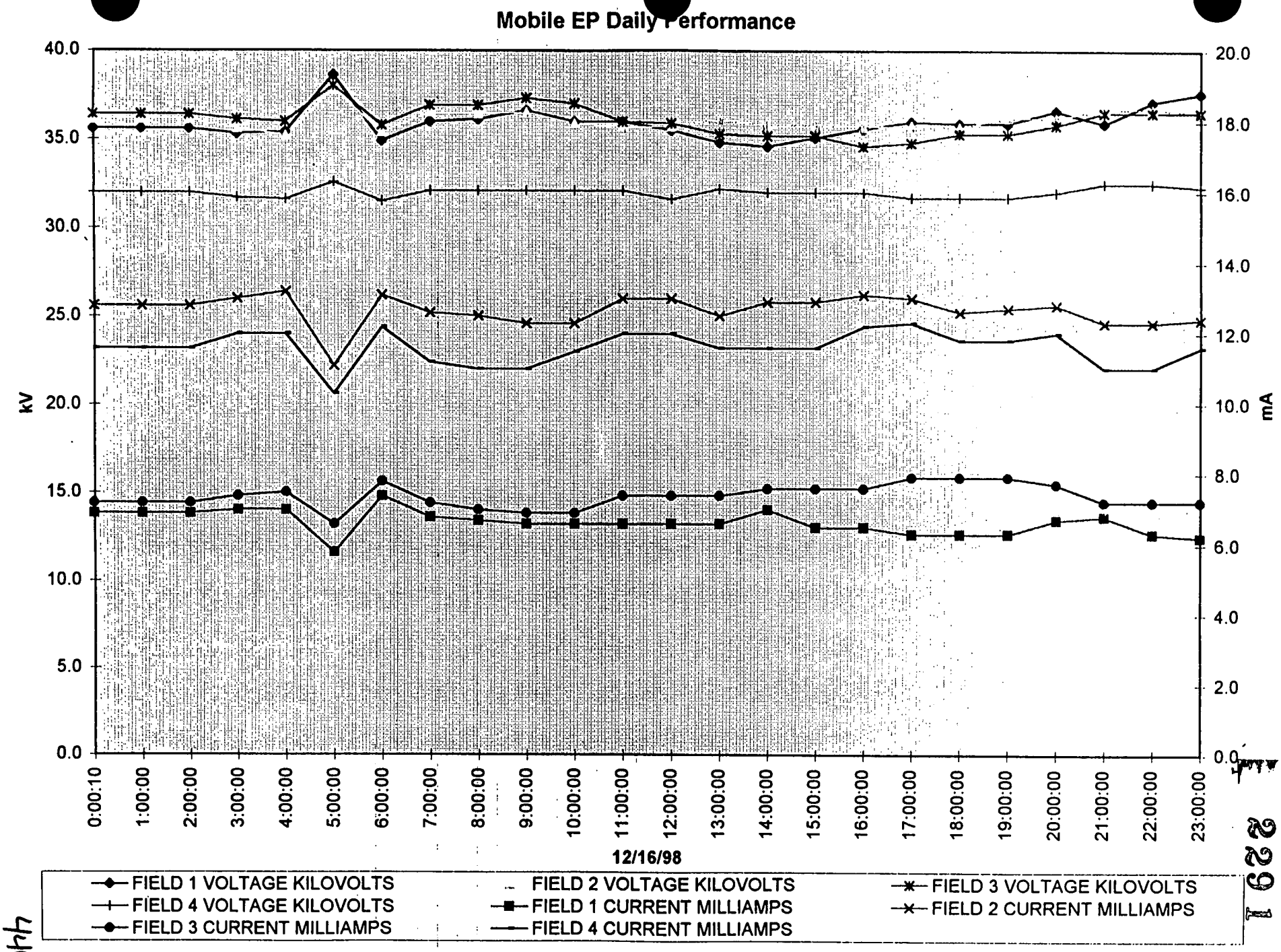

Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/16/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

Fig 22

410

McGill AirClean Mobile EP

Daily Performance Report

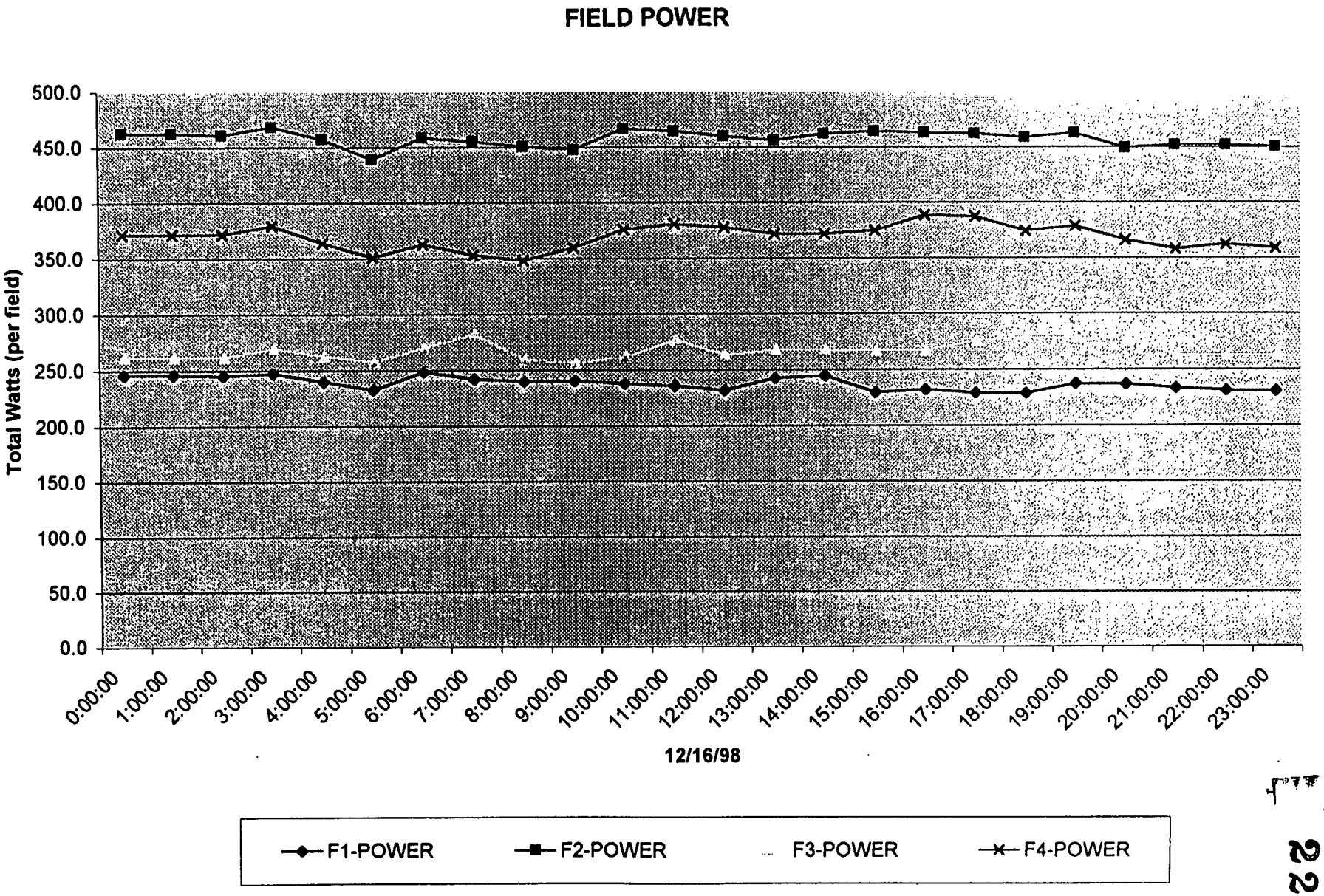
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/16/98
Start Date: 12/1/98
Days Operation: 15

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/16/98	0:00:00	245.6	462.1	262.1	371.2
12/16/98	1:00:00	245.6	462.1	262.1	371.2
12/16/98	2:00:00	245.0	460.5	262.1	371.2
12/16/98	3:00:00	247.1	468.2	269.3	379.2
12/16/98	4:00:00	239.6	457.2	262.8	363.7
12/16/98	5:00:00	232.3	439.2	257.7	350.8
12/16/98	6:00:00	248.4	458.5	270.1	362.5
12/16/98	7:00:00	241.9	455.0	282.1	353.1
12/16/98	8:00:00	239.6	450.2	259.4	347.8
12/16/98	9:00:00	240.2	447.7	256.0	359.5
12/16/98	10:00:00	237.6	466.7	262.1	375.6
12/16/98	11:00:00	235.6	464.1	276.8	380.4
12/16/98	12:00:00	231.4	459.5	263.4	377.2
12/16/98	13:00:00	242.2	455.9	267.5	371.2
12/16/98	14:00:00	244.3	461.8	267.5	371.2
12/16/98	15:00:00	229.5	464.1	266.8	374.4
12/16/98	16:00:00	232.1	462.8	267.2	388.0
12/16/98	17:00:00	229.1	461.8	275.7	386.7
12/16/98	18:00:00	228.7	458.5	278.9	374.1
12/16/98	19:00:00	236.9	462.1	277.7	378.4
12/16/98	20:00:00	236.6	449.0	276.6	365.9
12/16/98	21:00:00	233.1	451.4	262.8	357.5
12/16/98	22:00:00	231.3	451.4	262.8	361.8
12/16/98	23:00:00	230.6	450.2	262.8	358.5
DAILY AVERAGE		237.7	457.5	267.2	368.8

441


FIELD POWER
Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/16/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

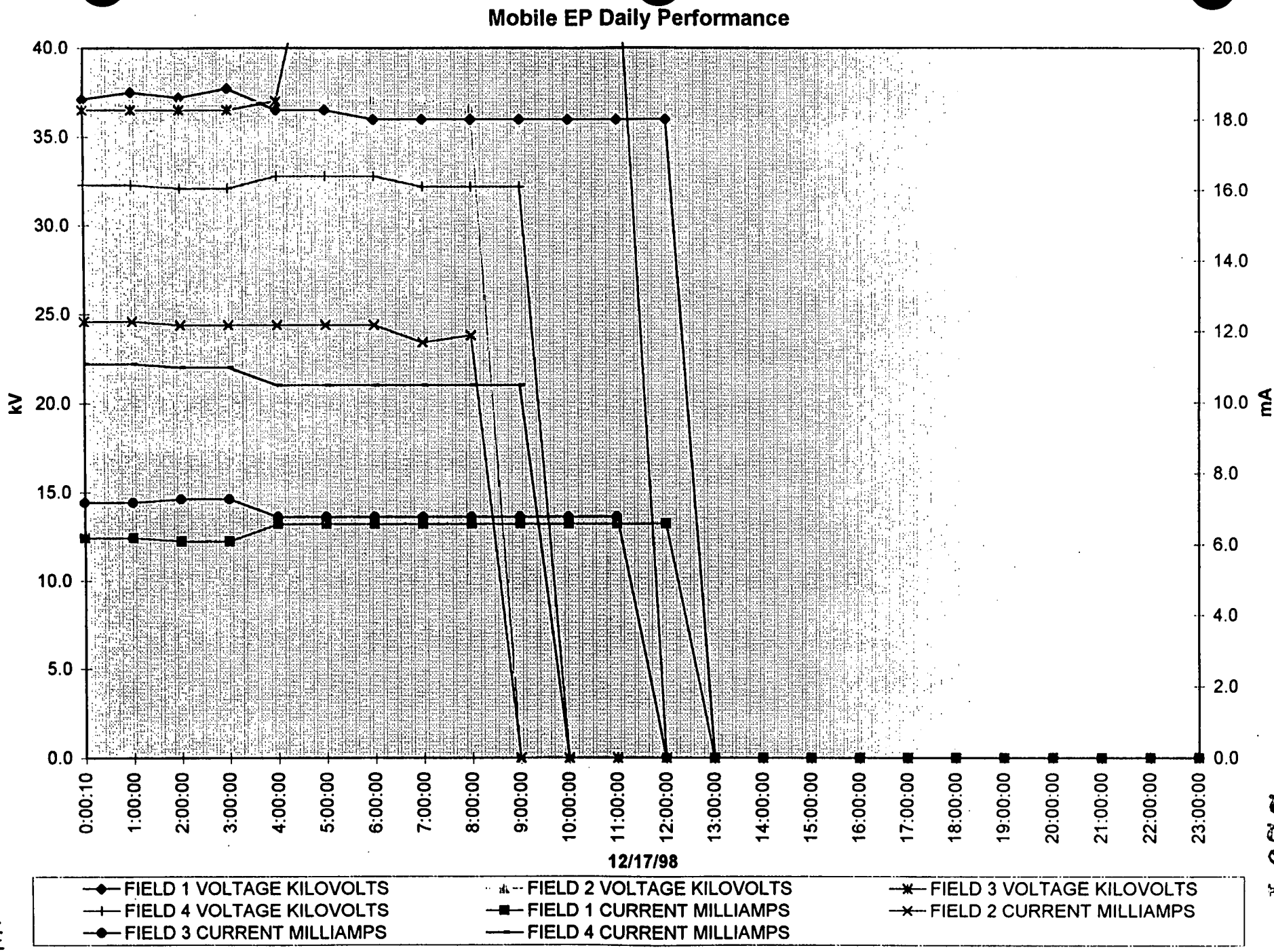
McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/17/98
Start Date: 12/1/98
Days Operation: 16

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/17/98	0:00:10	37.1	6.2	36.6	12.3	36.5	7.2	32.3	11.1
12/17/98	1:00:00	37.5	6.2	36.6	12.3	36.5	7.2	32.3	11.1
12/17/98	2:00:00	37.2	6.1	36.8	12.2	36.5	7.3	32.1	11.0
12/17/98	3:00:00	37.7	6.1	36.8	12.2	36.5	7.3	32.1	11.0
12/17/98	4:00:00	36.5	6.6	37.1	12.2	37.0	6.8	32.8	10.5
12/17/98	5:00:00	36.5	6.6	37.1	12.2	49.2	6.8	32.8	10.5
12/17/98	6:00:00	36.0	6.6	37.1	12.2	49.2	6.8	32.8	10.5
12/17/98	7:00:00	36.0	6.6	37.1	11.7	49.2	6.8	32.2	10.5
12/17/98	8:00:00	36.0	6.6	36.6	11.9	49.7	6.8	32.2	10.5
12/17/98	9:00:00	36.0	6.6	#######	#######	49.2	6.8	32.2	10.5
[illegible]98	10:00:00	36.0	6.6	#######	#######	48.2	6.8	#######	#######
[illegible]8	11:00:00	36.0	6.6	#######	#######	47.1	6.8	#######	#######
[illegible]/98	12:00:00	36.0	6.6	#######	#######	#######	#######	#######	#######
12/17/98	13:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	14:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	15:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	16:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	17:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	18:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	19:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	20:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	21:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	22:00:00	#######	#######	#######	#######	#######	#######	#######	#######
12/17/98	23:00:00	#######	#######	#######	#######	#######	#######	#######	#######
Daily Average		36.5	6.5	36.9	12.1	43.7	7.0	32.4	10.7


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/17/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

McGill AirClean Mobile EP
Daily Performance Report

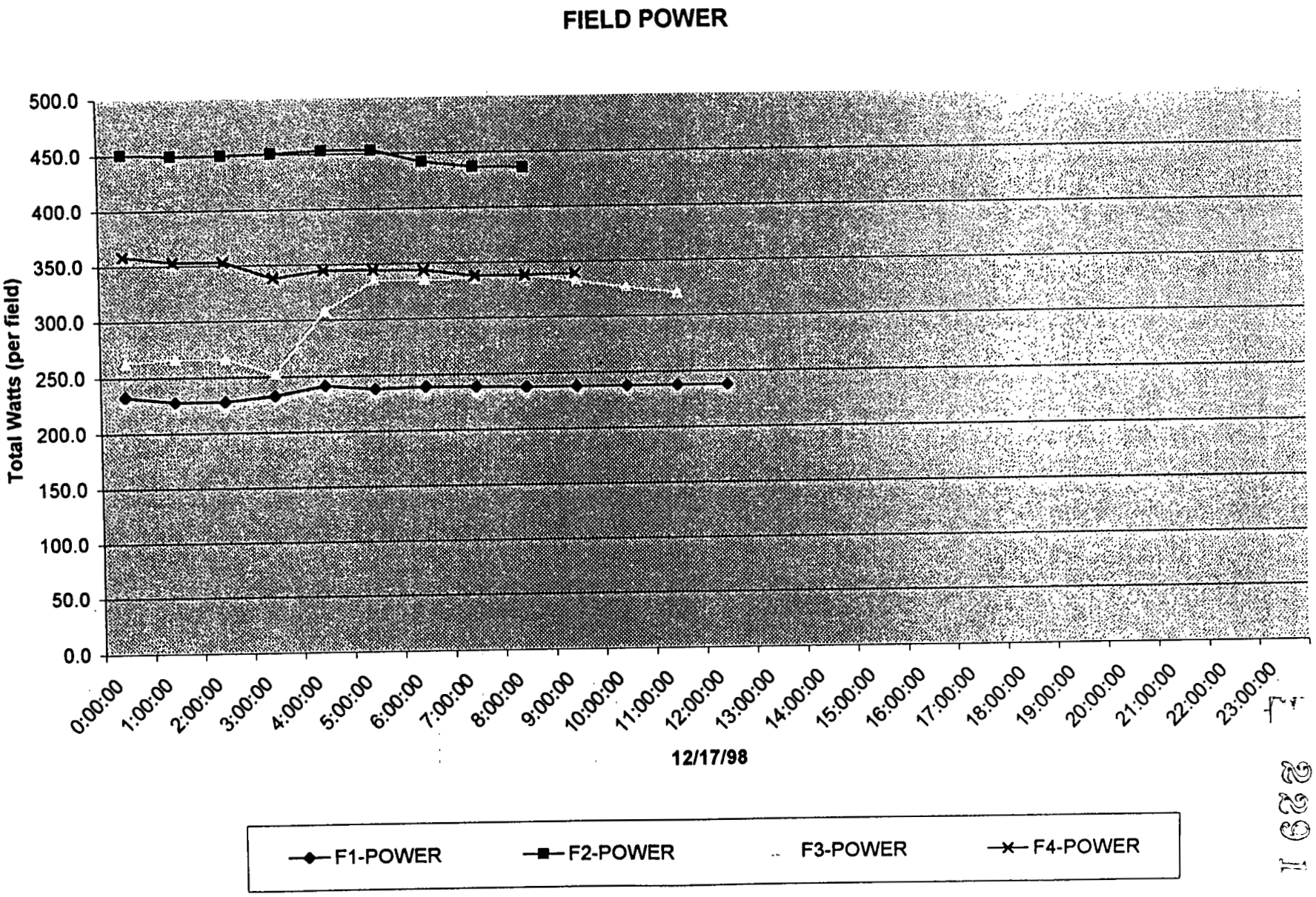
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/17/98
Start Date: 12/1/98
Days Operation: 16

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/17/98	0:00:00	232.5	450.2	262.8	358.5
12/17/98	1:00:00	227.5	449.0	266.5	353.1
12/17/98	2:00:00	227.5	449.0	266.5	353.1
12/17/98	3:00:00	232.5	450.1	252.3	338.1
12/17/98	4:00:00	240.9	452.6	308.0	344.4
12/17/98	5:00:00	237.6	452.6	334.6	344.4
12/17/98	6:00:00	238.9	441.5	334.6	343.4
12/17/98	7:00:00	238.3	436.6	335.9	338.1
12/17/98	8:00:00	237.6	435.5	338.0	338.1
12/17/98	9:00:00	237.6		331.8	339.2
12/17/98	10:00:00	237.6		325.7	
12/17/98	11:00:00	237.6		320.3	
12/17/98	12:00:00	237.6			
12/17/98	13:00:00				
12/17/98	14:00:00				
12/17/98	15:00:00				
12/17/98	16:00:00				
12/17/98	17:00:00				
12/17/98	18:00:00				
12/17/98	19:00:00				
12/17/98	20:00:00				
12/17/98	21:00:00				
12/17/98	22:00:00				
12/17/98	23:00:00				
DAILY AVERAGE		235.7	446.3	306.4	345.0

R17dec98b.xls


FIELD POWER
Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/17/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

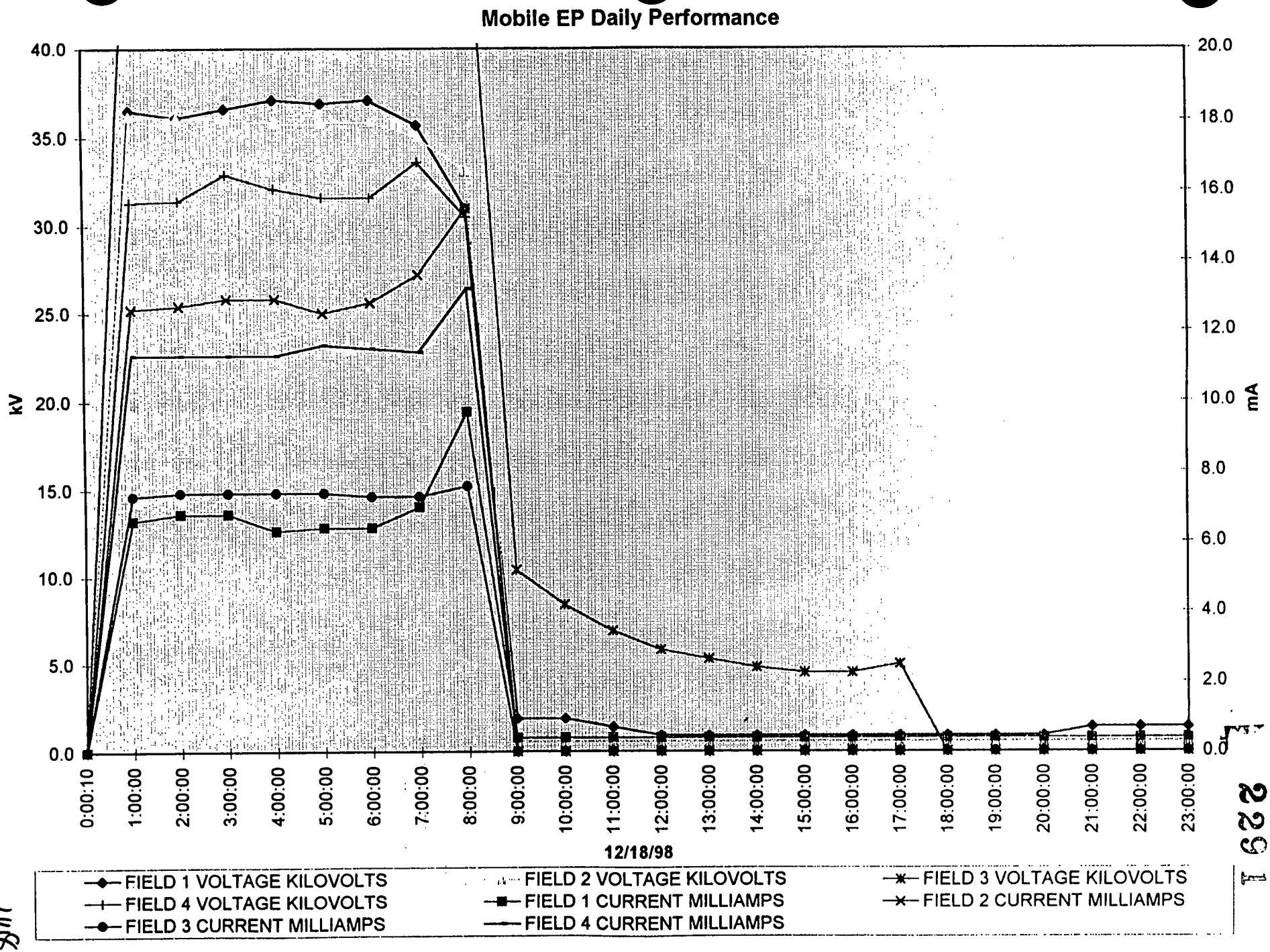
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/18/98
Start Date: 12/1/98
Days Operation: 17

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
12/18/98	0:00:10	#######	#######	#######	#######	#######	#######	#######	#######
12/18/98	1:00:00	36.5	6.6	36.2	12.6	49.9	7.3	31.3	11.3
12/18/98	2:00:00	36.1	6.8	36.1	12.7	49.9	7.4	31.4	11.3
12/18/98	3:00:00	36.6	6.8	36.0	12.9	50.9	7.4	32.9	11.3
12/18/98	4:00:00	37.1	6.3	35.8	12.9	50.9	7.4	32.1	11.3
12/18/98	5:00:00	36.9	6.4	35.8	12.5	51.2	7.4	31.6	11.6
12/18/98	6:00:00	37.1	6.4	35.9	12.8	51.8	7.3	31.6	11.5
12/18/98	7:00:00	35.7	7.0	35.0	13.6	52.7	7.3	33.6	11.4
12/18/98	8:00:00	31.0	9.7	33.1	15.5	52.1	7.6	30.5	13.2
12/18/98	9:00:00	1.9	0.4	0.6	0.0	10.4	0.0	0.0	0.0
[illegible]98	10:00:00	1.9	0.4	0.6	0.0	8.4	0.0	0.0	0.0
[illegible]98	11:00:00	1.4	0.4	0.6	0.0	6.9	0.0	0.0	0.0
[illegible]8/98	12:00:00	0.9	0.4	0.6	0.0	5.8	0.0	0.0	0.0
12/18/98	13:00:00	0.9	0.4	0.6	0.0	5.3	0.0	0.0	0.0
12/18/98	14:00:00	0.9	0.4	0.6	0.0	4.8	0.0	0.0	0.0
12/18/98	15:00:00	0.9	0.4	0.6	0.0	4.5	0.0	0.0	0.0
12/18/98	16:00:00	0.9	0.4	0.6	0.0	4.5	0.0	0.0	0.0
12/18/98	17:00:00	0.9	0.4	0.6	0.0	5.0	0.0	0.0	0.0
12/18/98	18:00:00	0.9	0.4	0.6	0.0	0.0	0.0	0.0	0.0
12/18/98	19:00:00	0.9	0.4	0.6	0.0	0.0	0.0	0.0	0.0
12/18/98	20:00:00	0.9	0.4	0.6	0.0	0.0	0.0	0.0	0.0
12/18/98	21:00:00	1.4	0.4	0.6	0.0	0.0	0.0	0.0	0.0
12/18/98	22:00:00	1.4	0.4	0.6	0.0	0.0	0.0	0.0	0.0
12/18/98	23:00:00	1.4	0.4	0.6	0.0	0.0	0.0	0.0	0.0
Daily Average		13.2	2.7	12.7	4.6	20.2	2.6	11.1	4.0

R18dec98a.xls


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/18/98
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2229

48

McGill AirClean Mobile EP
Daily Performance Report

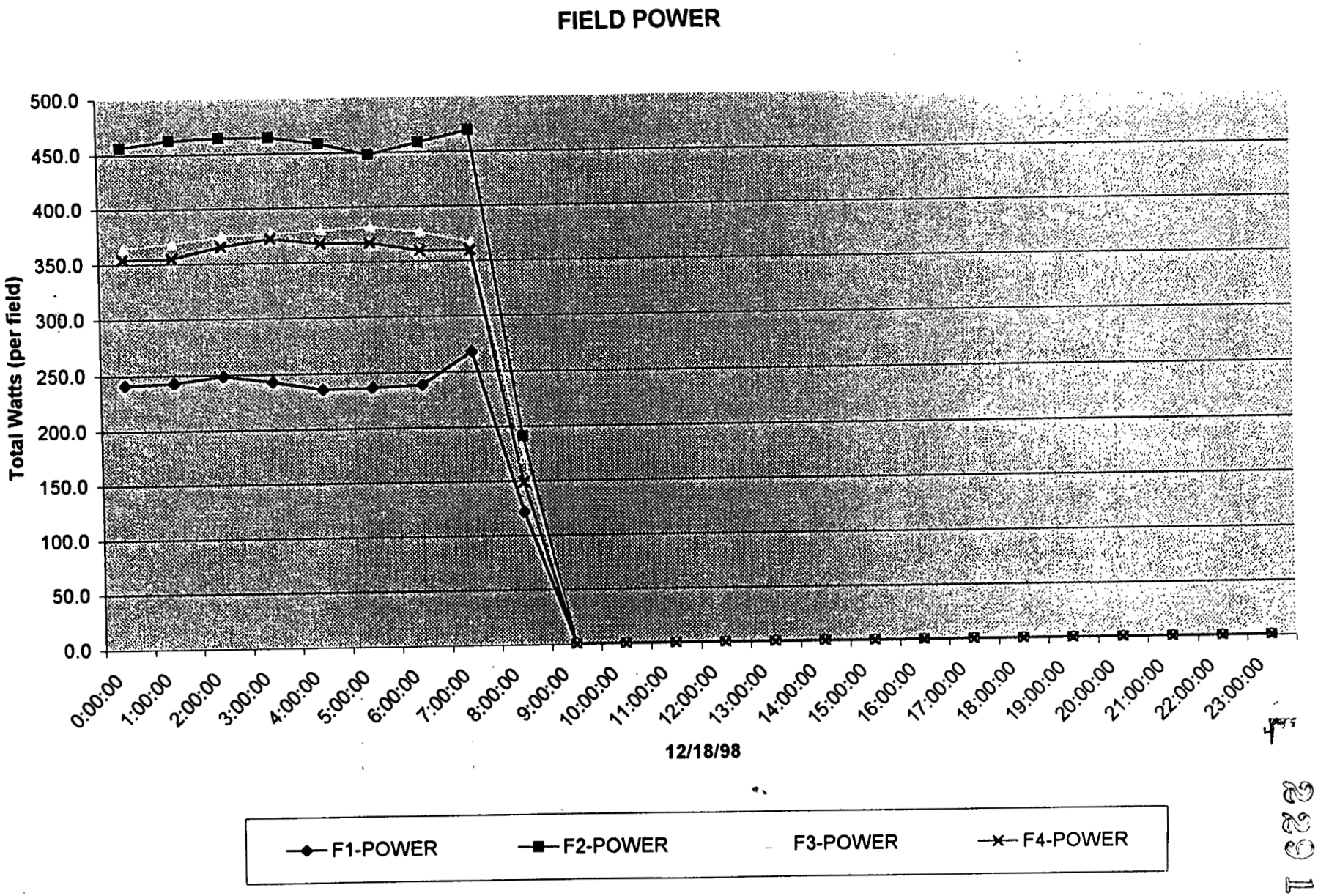
229

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/18/98
Start Date: 12/1/98
Days Operation: 17

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
12/18/98	0:00:00	240.9	456.1	364.3	353.7
12/18/98	1:00:00	242.5	462.1	368.5	354.8
12/18/98	2:00:00	248.2	464.4	374.4	365.0
12/18/98	3:00:00	242.9	464.4	376.7	371.8
12/18/98	4:00:00	235.5	458.2	378.9	366.6
12/18/98	5:00:00	236.2	447.5	381.1	366.6
12/18/98	6:00:00	238.3	458.5	376.7	359.3
12/18/98	7:00:00	268.1	469.0	366.5	359.4
12/18/98	8:00:00	121.5	190.8	170.6	149.0
12/18/98	9:00:00	0.8	0.0	0.0	0.0
12/18/98	10:00:00	0.6	0.0	0.0	0.0
12/18/98	11:00:00	0.5	0.0	0.0	0.0
12/18/98	12:00:00	0.4	0.0	0.0	0.0
12/18/98	13:00:00	0.4	0.0	0.0	0.0
12/18/98	14:00:00	0.4	0.0	0.0	0.0
12/18/98	15:00:00	0.4	0.0	0.0	0.0
12/18/98	16:00:00	0.4	0.0	0.0	0.0
12/18/98	17:00:00	0.4	0.0	0.0	0.0
12/18/98	18:00:00	0.4	0.0	0.0	0.0
12/18/98	19:00:00	0.4	0.0	0.0	0.0
12/18/98	20:00:00	0.4	0.0	0.0	0.0
12/18/98	21:00:00	0.6	0.0	0.0	0.0
12/18/98	22:00:00	0.6	0.0	0.0	0.0
12/18/98	23:00:00	0.6	0.0	0.0	0.0
DAILY AVERAGE		86.7	161.3	131.6	126.9

449


FIELD POWER
Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/18/98
F1-POWER
F2-POWER
F3-POWER
F4-POWER

450

McGill AirClean Mobile EP
Daily Performance Report

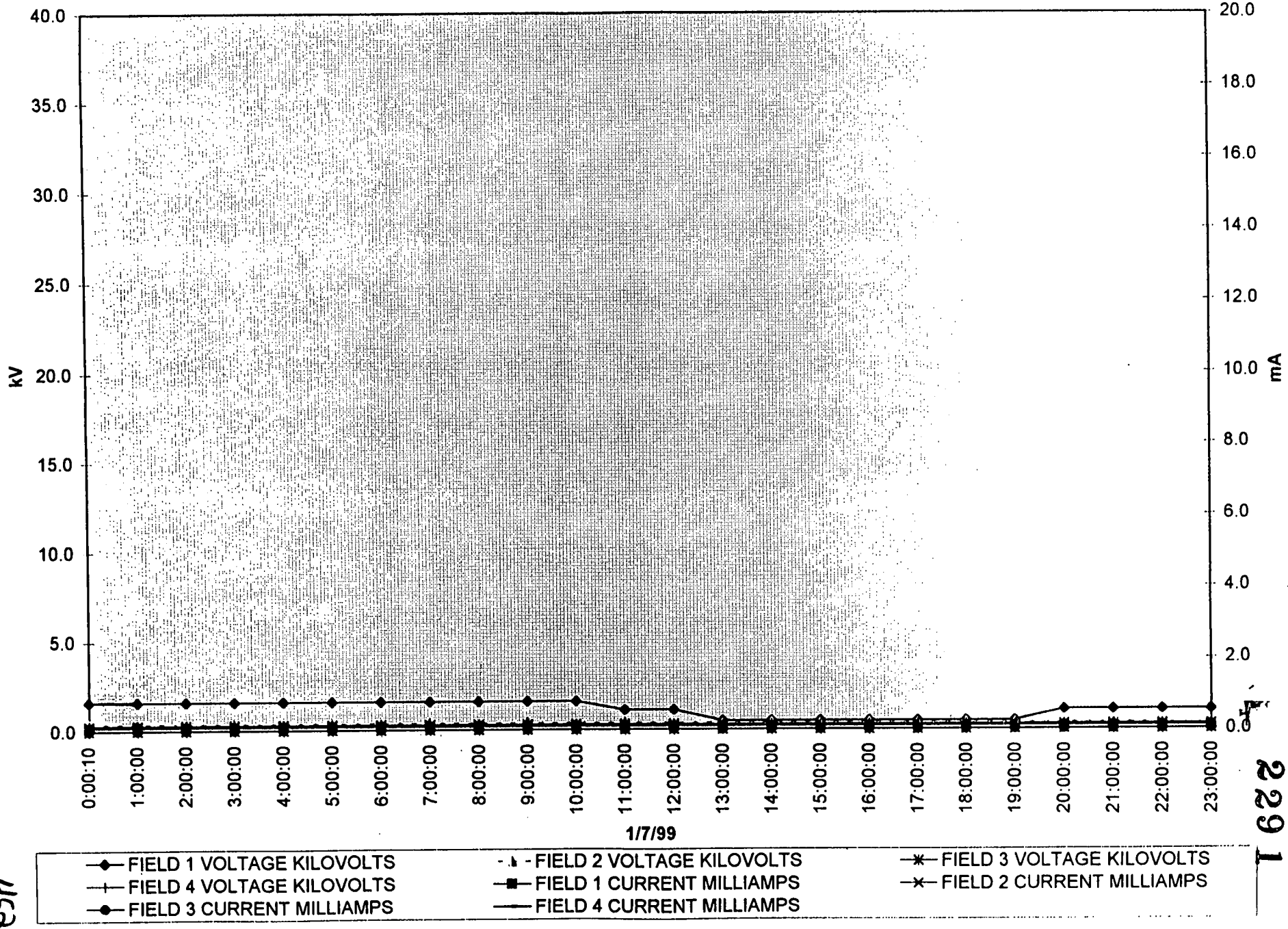
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/7/99
Start Date: 12/1/98
Days Operation: 18

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/7/99	0:00:10	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	1:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	2:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	3:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	4:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	5:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	6:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	7:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	8:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	9:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]	10:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]	11:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]99	12:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	13:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	14:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	15:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	16:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	17:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	18:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	19:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	20:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	21:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	22:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/7/99	23:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
Daily Average		1.2	0.1	0.4	0.0	0.3	0.0	0.0	0.0

Mobile EP Daily Performance



229 1

45a

McGill AirClean Mobile EP
Daily Performance Report

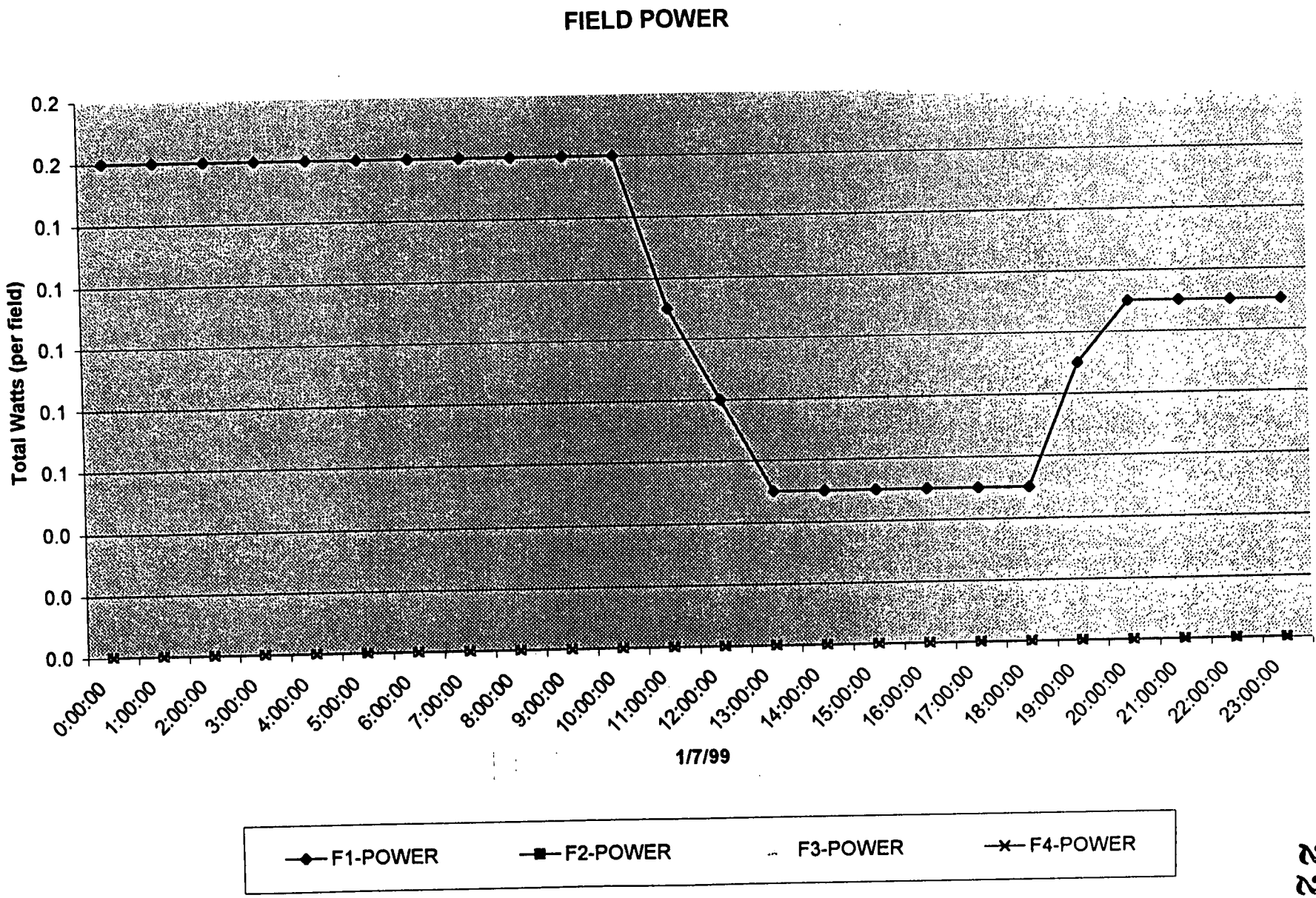
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/7/99
Start Date: 12/1/98
Days Operation: 18

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/7/99	0:00:00	0.2	0.0	0.0	0.0
1/7/99	1:00:00	0.2	0.0	0.0	0.0
1/7/99	2:00:00	0.2	0.0	0.0	0.0
1/7/99	3:00:00	0.2	0.0	0.0	0.0
1/7/99	4:00:00	0.2	0.0	0.0	0.0
1/7/99	5:00:00	0.2	0.0	0.0	0.0
1/7/99	6:00:00	0.2	0.0	0.0	0.0
1/7/99	7:00:00	0.2	0.0	0.0	0.0
1/7/99	8:00:00	0.2	0.0	0.0	0.0
1/7/99	9:00:00	0.2	0.0	0.0	0.0
1/7/99	10:00:00	0.2	0.0	0.0	0.0
1/7/99	11:00:00	0.1	0.0	0.0	0.0
1/7/99	12:00:00	0.1	0.0	0.0	0.0
1/7/99	13:00:00	0.1	0.0	0.0	0.0
1/7/99	14:00:00	0.1	0.0	0.0	0.0
1/7/99	15:00:00	0.1	0.0	0.0	0.0
1/7/99	16:00:00	0.1	0.0	0.0	0.0
1/7/99	17:00:00	0.1	0.0	0.0	0.0
1/7/99	18:00:00	0.1	0.0	0.0	0.0
1/7/99	19:00:00	0.1	0.0	0.0	0.0
1/7/99	20:00:00	0.1	0.0	0.0	0.0
1/7/99	21:00:00	0.1	0.0	0.0	0.0
1/7/99	22:00:00	0.1	0.0	0.0	0.0
1/7/99	23:00:00	0.1	0.0	0.0	0.0
DAILY AVERAGE		0.1	0.0	0.0	0.0

453


FIELD POWER
Total Watts (per field)
0.2
0.2
0.1
0.1
0.1
0.1
0.0
0.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/7/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

454

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

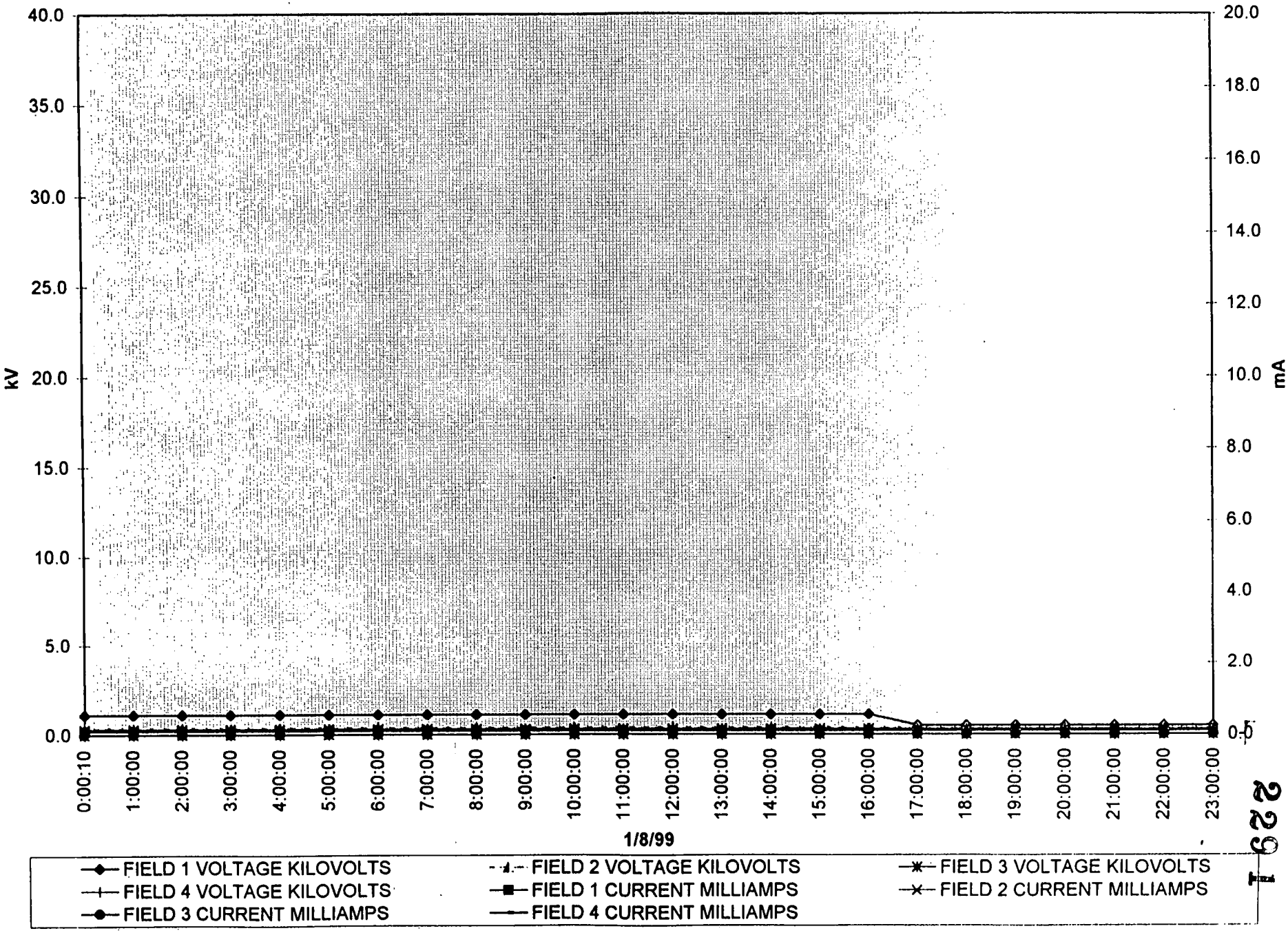
Report Date: 1/8/99
Start Date: 12/1/98
Days Operation: 19

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/8/99	0:00:10	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	1:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	2:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	3:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	4:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	5:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	6:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	7:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	8:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	9:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	10:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	11:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	12:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	13:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	14:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	15:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	16:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	17:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	18:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	19:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	20:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	21:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	22:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/8/99	23:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
Daily Average		0.9	0.1	0.4	0.0	0.3	0.0	0.0	0.0

455

R8jan99a.xls

Mobile EP Daily Performance



229

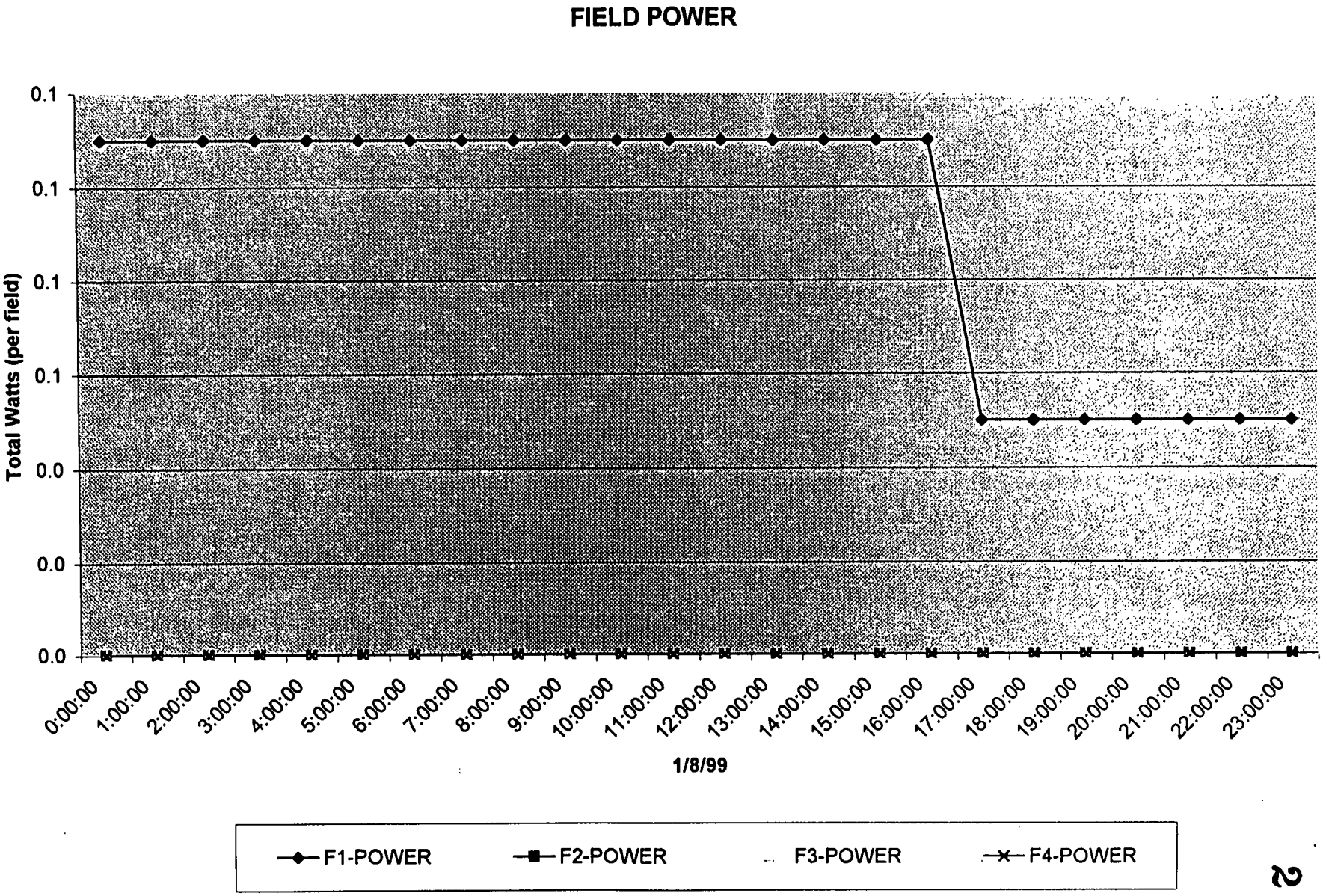
456

McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/8/99
Start Date: 12/1/98
Days Operation: 19

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/8/99	0:00:00	0.1	0.0	0.0	0.0
1/8/99	1:00:00	0.1	0.0	0.0	0.0
1/8/99	2:00:00	0.1	0.0	0.0	0.0
1/8/99	3:00:00	0.1	0.0	0.0	0.0
1/8/99	4:00:00	0.1	0.0	0.0	0.0
1/8/99	5:00:00	0.1	0.0	0.0	0.0
1/8/99	6:00:00	0.1	0.0	0.0	0.0
1/8/99	7:00:00	0.1	0.0	0.0	0.0
1/8/99	8:00:00	0.1	0.0	0.0	0.0
1/8/99	9:00:00	0.1	0.0	0.0	0.0
1/8/99	10:00:00	0.1	0.0	0.0	0.0
1/8/99	11:00:00	0.1	0.0	0.0	0.0
1/8/99	12:00:00	0.1	0.0	0.0	0.0
1/8/99	13:00:00	0.1	0.0	0.0	0.0
1/8/99	14:00:00	0.1	0.0	0.0	0.0
1/8/99	15:00:00	0.1	0.0	0.0	0.0
1/8/99	16:00:00	0.1	0.0	0.0	0.0
1/8/99	17:00:00	0.1	0.0	0.0	0.0
1/8/99	18:00:00	0.1	0.0	0.0	0.0
1/8/99	19:00:00	0.1	0.0	0.0	0.0
1/8/99	20:00:00	0.1	0.0	0.0	0.0
1/8/99	21:00:00	0.1	0.0	0.0	0.0
1/8/99	22:00:00	0.1	0.0	0.0	0.0
1/8/99	23:00:00	0.1	0.0	0.0	0.0
DAILY AVERAGE		0.1	0.0	0.0	0.0


FIELD POWER
Total Watts (per field)
0.1
0.1
0.1
0.1
0.0
0.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/8/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

458

McGill AirClean Mobile EP
Daily Performance Report

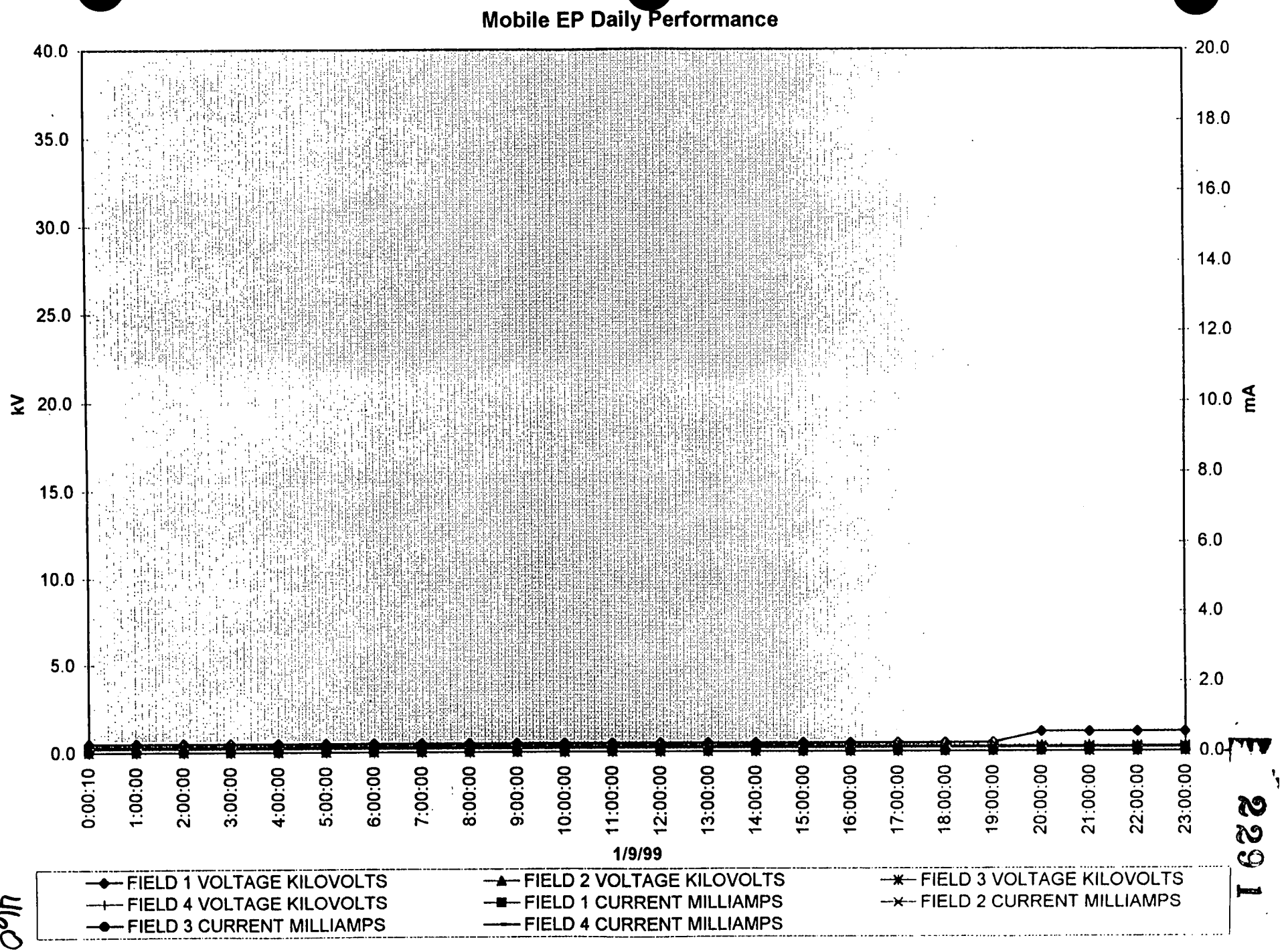
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/9/99
Start Date: 12/1/98
Days Operation: 20

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/9/99	0:00:10	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	1:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	2:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	3:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	4:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	5:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	6:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	7:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	8:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	9:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]	10:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]	11:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]/99	12:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	13:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	14:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	15:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	16:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	17:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	18:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	19:00:00	0.5	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	20:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	21:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	22:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/9/99	23:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
Daily Average:		0.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0

459


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/9/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

McGill AirClean Mobile EP

Daily Performance Report

2291

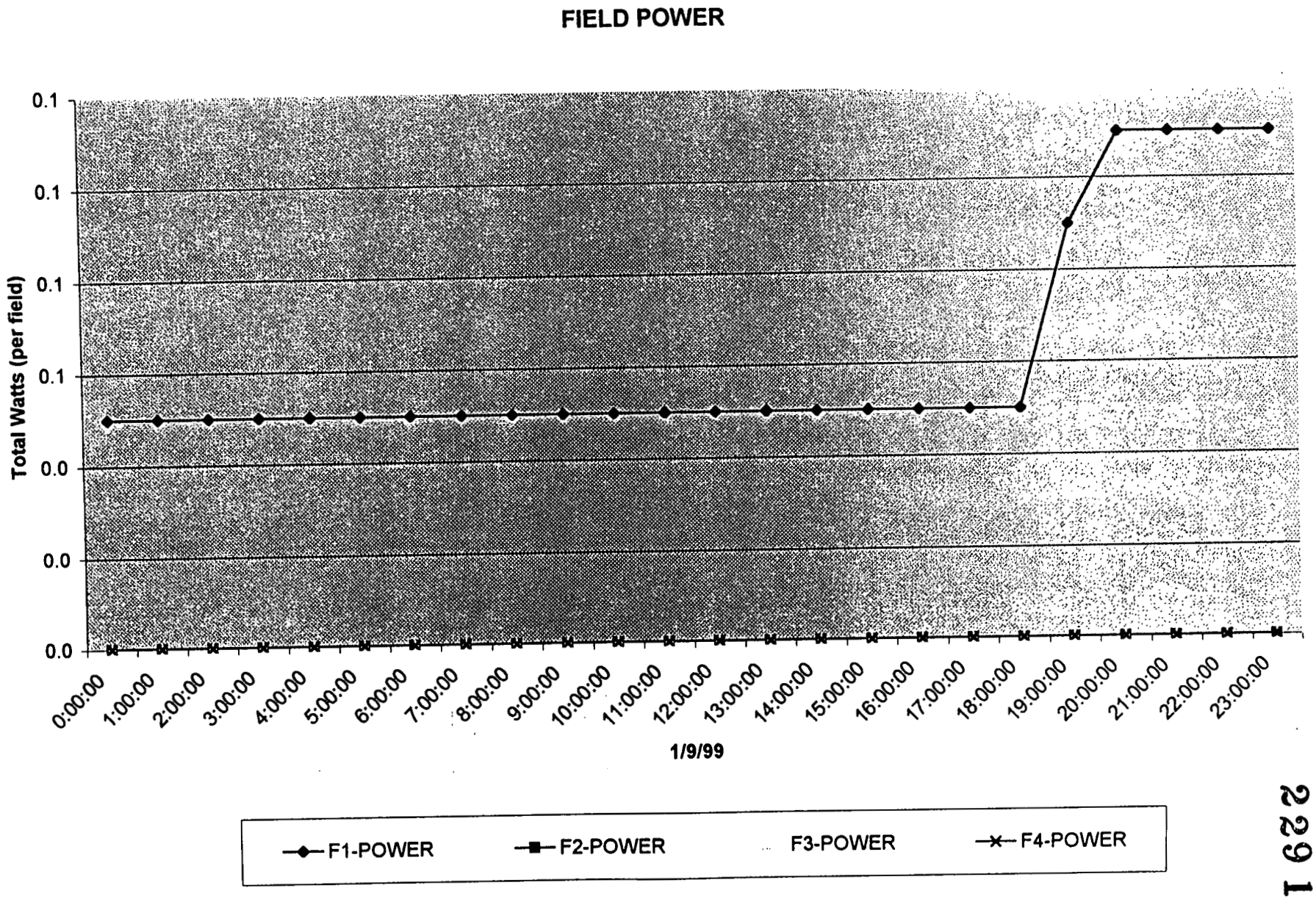
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/9/99
Start Date: 12/1/98
Days Operation: 20

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/9/99	0:00:00	0.1	0.0	0.0	0.0
1/9/99	1:00:00	0.1	0.0	0.0	0.0
1/9/99	2:00:00	0.1	0.0	0.0	0.0
1/9/99	3:00:00	0.1	0.0	0.0	0.0
1/9/99	4:00:00	0.1	0.0	0.0	0.0
1/9/99	5:00:00	0.1	0.0	0.0	0.0
1/9/99	6:00:00	0.1	0.0	0.0	0.0
1/9/99	7:00:00	0.1	0.0	0.0	0.0
1/9/99	8:00:00	0.1	0.0	0.0	0.0
1/9/99	9:00:00	0.1	0.0	0.0	0.0
1/9/99	10:00:00	0.1	0.0	0.0	0.0
1/9/99	11:00:00	0.1	0.0	0.0	0.0
1/9/99	12:00:00	0.1	0.0	0.0	0.0
1/9/99	13:00:00	0.1	0.0	0.0	0.0
1/9/99	14:00:00	0.1	0.0	0.0	0.0
1/9/99	15:00:00	0.1	0.0	0.0	0.0
1/9/99	16:00:00	0.1	0.0	0.0	0.0
1/9/99	17:00:00	0.1	0.0	0.0	0.0
1/9/99	18:00:00	0.1	0.0	0.0	0.0
1/9/99	19:00:00	0.1	0.0	0.0	0.0
1/9/99	20:00:00	0.1	0.0	0.0	0.0
1/9/99	21:00:00	0.1	0.0	0.0	0.0
1/9/99	22:00:00	0.1	0.0	0.0	0.0
1/9/99	23:00:00	0.1	0.0	0.0	0.0
DAILY AVERAGE		0.1	0.0	0.0	0.0

461

R09jan99b.xls


FIELD POWER
Total Watts (per field)
0.1
0.1
0.1
0.1
0.0
0.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/9/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

4/6

McGill AirClean Mobile EP

Daily Performance Report

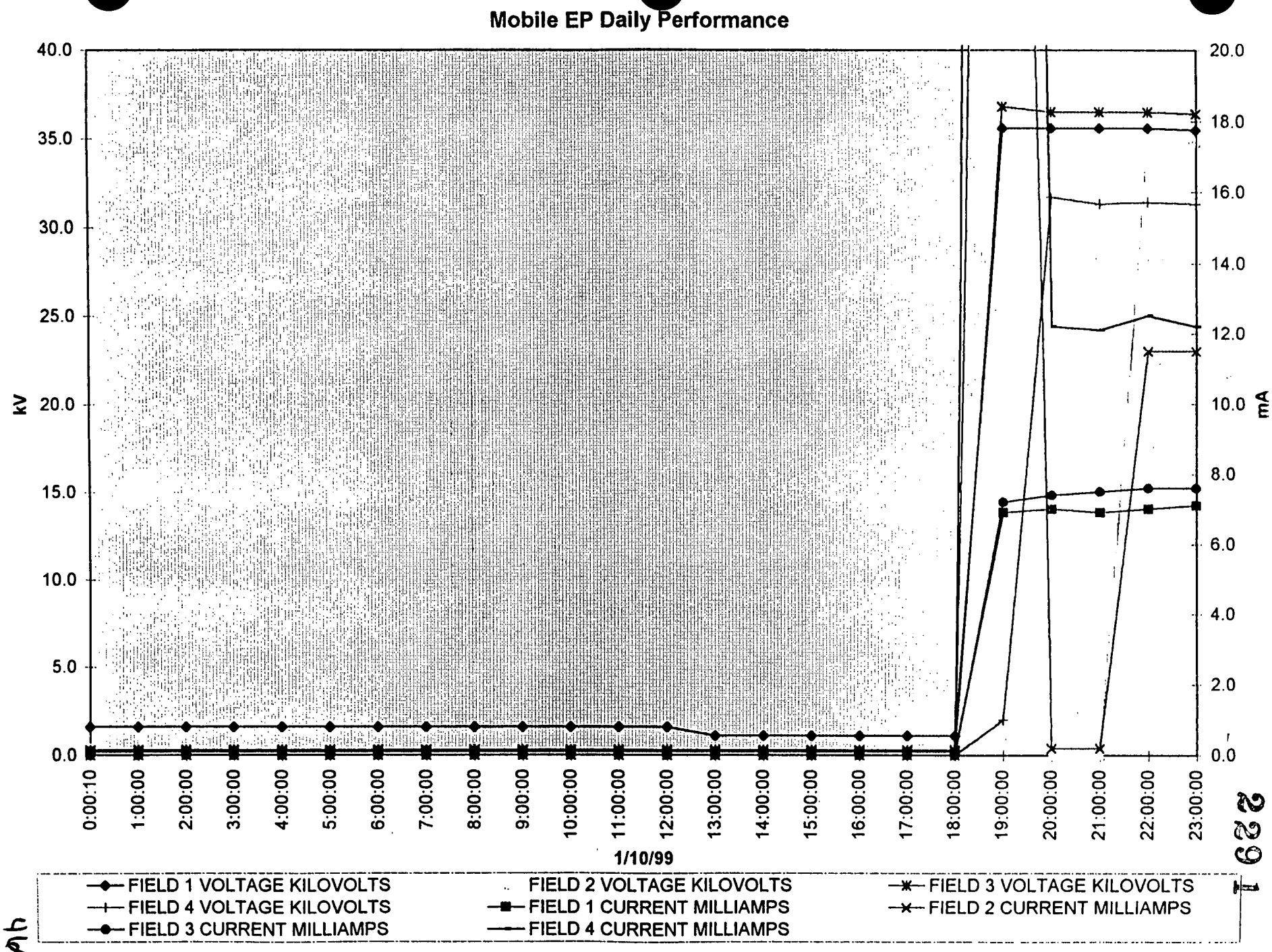
229 1

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/10/99
Start Date: 12/1/98
Days Operation: 21

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/10/99	0:00:10	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	1:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	2:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	3:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	4:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	5:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	6:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	7:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	8:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	9:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]	10:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]	11:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
[illegible]/99	12:00:00	1.6	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	13:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	14:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	15:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	16:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	17:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	18:00:00	1.1	0.1	0.4	0.0	0.3	0.0	0.0	0.0
1/10/99	19:00:00	35.6	6.9	1.2	63.8	36.8	7.2	2.0	111.2
1/10/99	20:00:00	35.6	7.0	0.0	0.2	36.5	7.4	31.7	12.2
1/10/99	21:00:00	35.6	6.9	0.0	0.2	36.5	7.5	31.3	12.1
1/10/99	22:00:00	35.6	7.0	34.5	11.5	36.5	7.6	31.4	12.5
1/10/99	23:00:00	35.5	7.1	34.8	11.5	36.4	7.6	31.3	12.2
Daily Average		8.6	1.5	3.3	3.6	7.9	1.6	5.3	6.7

463


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/10/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

229

464

McGill AirClean Mobile EP
Daily Performance Report

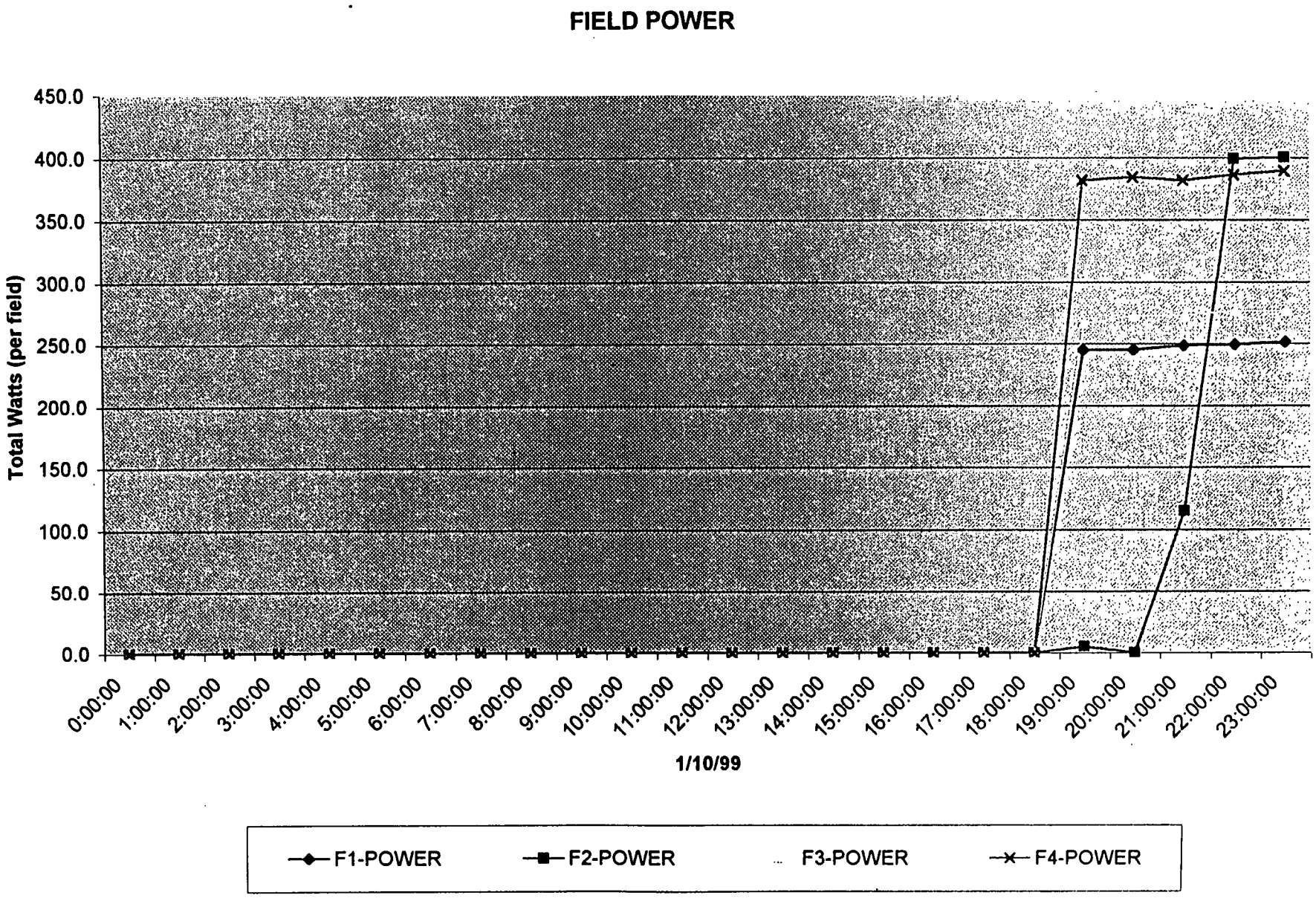
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/10/99
Start Date: 12/1/98
Days Operation: 21

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/10/99	0:00:00	0.2	0.0	0.0	0.0
1/10/99	1:00:00	0.2	0.0	0.0	0.0
1/10/99	2:00:00	0.2	0.0	0.0	0.0
1/10/99	3:00:00	0.2	0.0	0.0	0.0
1/10/99	4:00:00	0.2	0.0	0.0	0.0
1/10/99	5:00:00	0.2	0.0	0.0	0.0
1/10/99	6:00:00	0.2	0.0	0.0	0.0
1/10/99	7:00:00	0.2	0.0	0.0	0.0
1/10/99	8:00:00	0.2	0.0	0.0	0.0
1/10/99	9:00:00	0.2	0.0	0.0	0.0
1/10/99	10:00:00	0.2	0.0	0.0	0.0
1/10/99	11:00:00	0.2	0.0	0.0	0.0
1/10/99	12:00:00	0.1	0.0	0.0	0.0
1/10/99	13:00:00	0.1	0.0	0.0	0.0
1/10/99	14:00:00	0.1	0.0	0.0	0.0
1/10/99	15:00:00	0.1	0.0	0.0	0.0
1/10/99	16:00:00	0.1	0.0	0.0	0.0
1/10/99	17:00:00	0.1	0.0	0.0	0.0
1/10/99	18:00:00	0.1	0.1	0.0	0.0
1/10/99	19:00:00	245.0	4.9	266.5	381.9
1/10/99	20:00:00	245.0	0.0	273.0	384.3
1/10/99	21:00:00	248.5	114.8	273.0	381.9
1/10/99	22:00:00	249.2	399.1	276.6	386.2
1/10/99	23:00:00	251.3	400.2	276.6	389.4
DAILY AVERAGE		51.7	38.3	56.9	80.2

465


FIELD POWER
Total Watts (per field)
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/10/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/11/99
Start Date: 12/1/98
Days Operation: 22

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/11/99	0:00:00	35.2	7.1	34.3	11.8	36.5	7.6	31.3	12.2
1/11/99	1:00:00	35.7	6.8	34.6	11.8	36.9	7.6	31.2	11.9
1/11/99	2:00:00	36.2	6.7	34.9	11.8	37.0	7.5	31.8	11.9
1/11/99	3:00:00	36.2	6.7	34.9	11.4	37.1	7.2	31.7	11.8
1/11/99	4:00:00	36.2	6.7	34.9	11.4	37.2	7.2	32.0	11.9
1/11/99	5:00:00	35.9	6.7	34.9	11.5	37.2	7.2	32.0	11.9
1/11/99	6:00:00	35.6	6.9	34.4	11.6	36.7	7.3	31.5	12.4
1/11/99	7:00:00	36	6.7	34.5	11.5	36.9	7.3	31.5	12.3
1/11/99	8:00:00	36.1	6.7	34.5	11.6	36.8	7.4	31.5	12.3
[illegible]	9:00:00	35.9	6.9	34.5	11.6	36.7	7.4	33.3	12.4
[illegible]	10:00:00	35.6	7.1	34.4	11.7	36.3	7.5	33.5	12.6
1/11/99	11:00:00	35.1	7.1	34.3	11.9	35.8	7.7	33.4	12.9
1/11/99	12:00:00	34.5	7.2	33.8	12.1	35.1	7.9	33.1	13.3
1/11/99	13:00:00	34.2	7.1	33.5	12.1	34.6	8.0	32.6	13.6
1/11/99	14:00:00	34.1	7.4	34.0	12.1	35.0	8.0	33.3	13.3
1/11/99	15:00:00	34.9	6.5	10.0	16.1	35.0	7.2	32.9	12.2
1/11/99	16:00:00	35.2	7.0	0.3	0.2	35.9	7.5	33.7	12.8
1/11/99	17:00:00	35.5	6.8	0.3	1.0	36.2	7.3	33.9	12.6
1/11/99	18:00:00	35.6	6.9	0.3	0.5	36.4	7.5	33.7	12.6
1/11/99	19:00:00	36	6.7	0.3	0.5	36.5	7.6	33.7	12.7
1/11/99	20:00:00	36.3	6.6	0.3	0.5	36.5	7.4	33.7	12.9
1/11/99	21:00:00	36.2	6.5	0.3	0.5	36.5	7.3	33.8	12.7
1/11/99	22:00:00	36.2	6.6	0.3	0.5	36.8	7.2	34.0	12.6
1/11/99	23:00:00	35.8	6.6	0.3	0.5	36.6	7.1	33.8	12.4
Daily Average		35.6	6.8	22.0	8.2	36.3	7.5	32.8	12.5

467

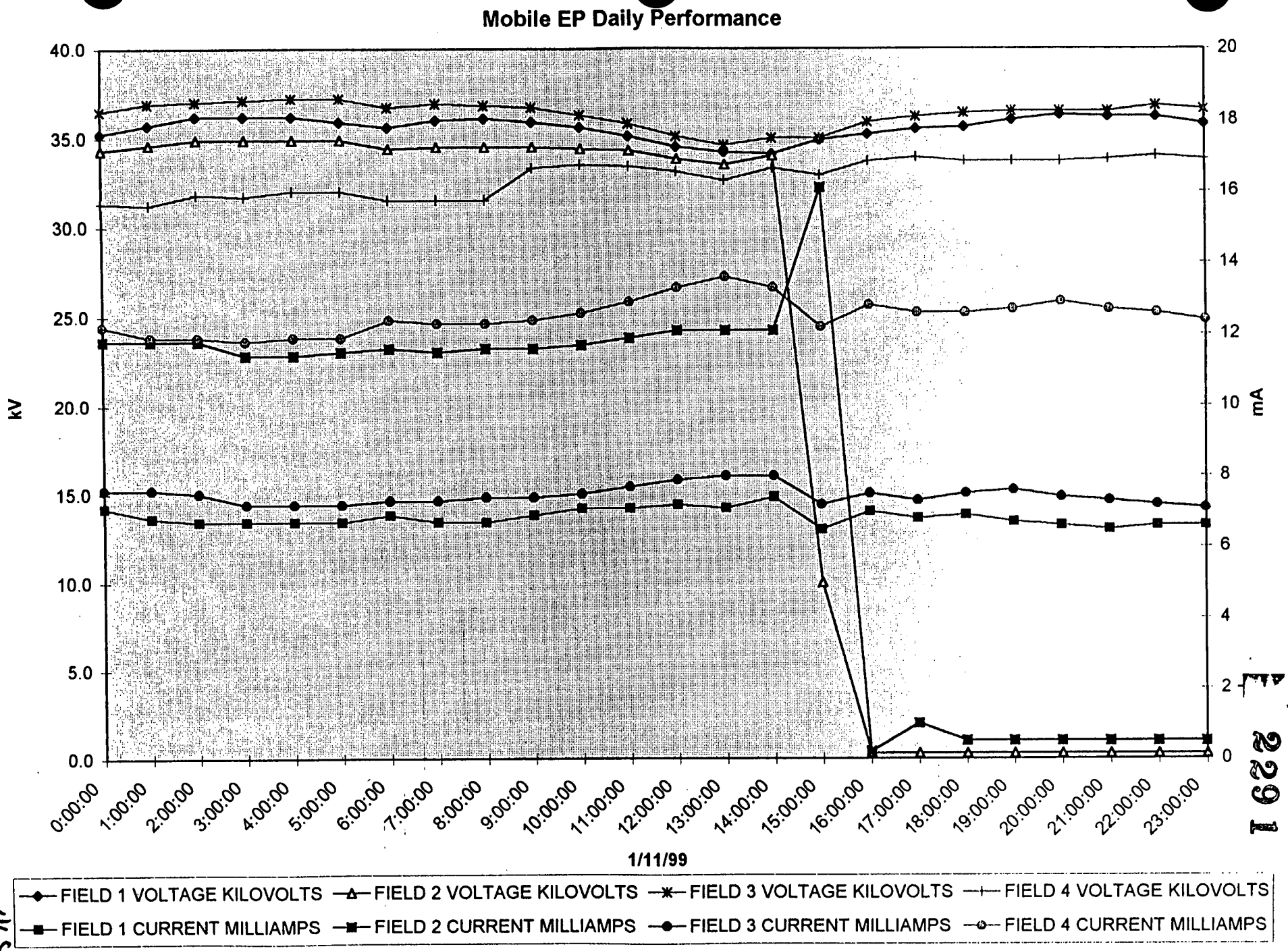

Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20
18
16
14
12
10
8
6
4
2
0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/11/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

Fig 29

McGill AirClean Mobile EP
Daily Performance Report

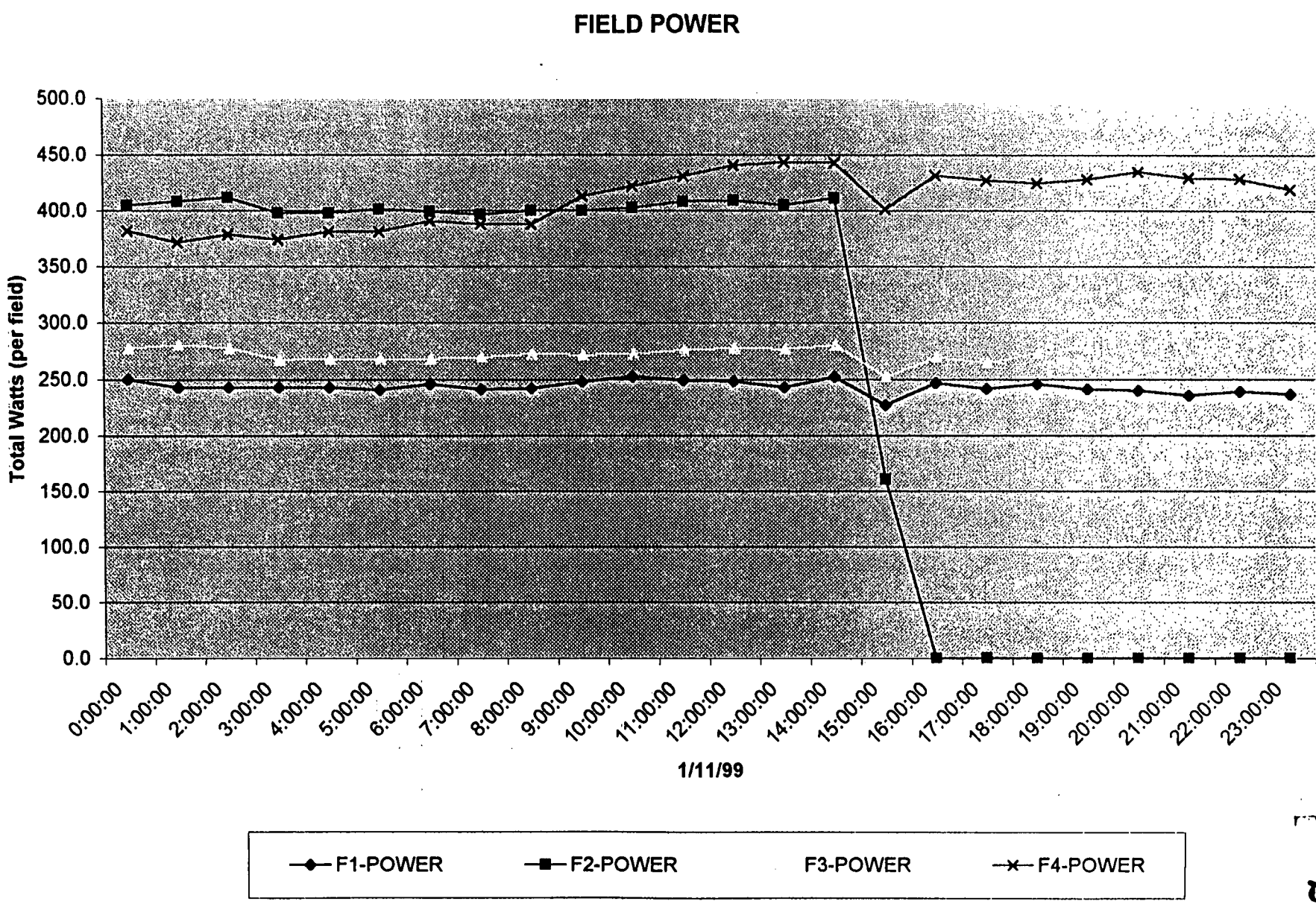
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/11/99
Start Date: 12/1/98
Days Operation: 22

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/11/99	0:00:00	249.9	404.7	277.4	381.9
1/11/99	1:00:00	242.8	408.3	280.4	371.3
1/11/99	2:00:00	242.5	411.8	277.5	378.4
1/11/99	3:00:00	242.5	397.9	267.1	374.1
1/11/99	4:00:00	242.5	397.9	267.8	380.8
1/11/99	5:00:00	240.5	401.4	267.8	380.8
1/11/99	6:00:00	245.6	399.0	267.9	390.6
1/11/99	7:00:00	241.2	396.8	269.4	387.5
1/11/99	8:00:00	241.9	400.2	272.3	387.5
1/11/99	9:00:00	247.7	400.2	271.6	412.9
1/11/99	10:00:00	252.8	402.5	272.3	422.1
1/11/99	11:00:00	249.2	408.2	275.7	430.9
1/11/99	12:00:00	248.4	409.0	277.3	440.2
1/11/99	13:00:00	242.8	405.4	276.8	443.4
1/11/99	14:00:00	252.3	411.4	280.0	442.9
1/11/99	15:00:00	226.9	161.0	252.0	401.4
1/11/99	16:00:00	246.4	0.1	269.3	431.4
1/11/99	17:00:00	241.4	0.3	264.3	427.1
1/11/99	18:00:00	245.6	0.2	273.0	424.6
1/11/99	19:00:00	241.2	0.2	277.4	428.0
1/11/99	20:00:00	239.6	0.2	270.1	434.7
1/11/99	21:00:00	235.3	0.2	266.5	429.3
1/11/99	22:00:00	238.9	0.2	265.0	428.4
1/11/99	23:00:00	236.3	0.2	259.9	419.1
DAILY AVERAGE		243.1	259.0	270.8	410.4

469


FIELD POWER
Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/11/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

470

McGill AirClean Mobile EP

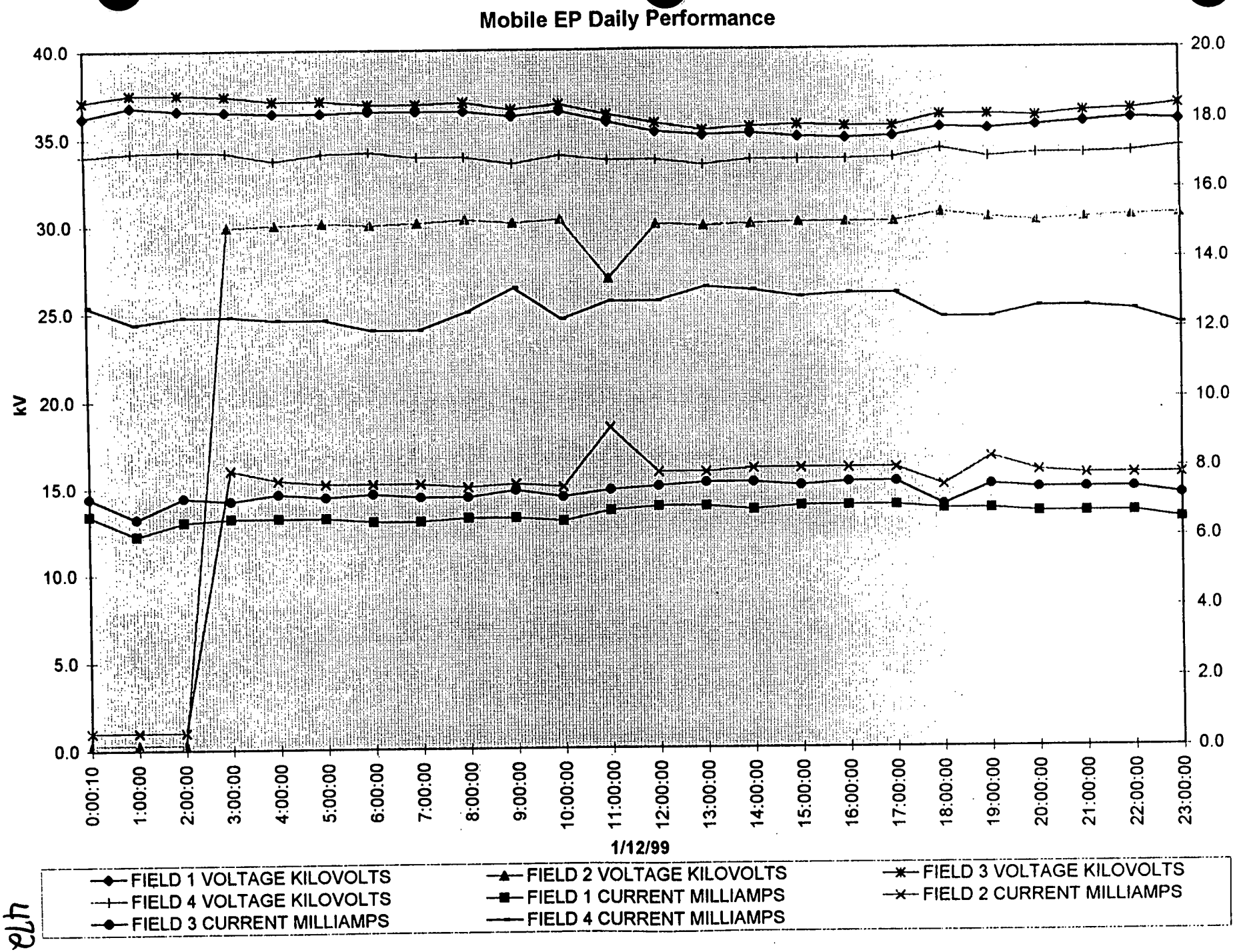
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/12/99
Start Date: 12/1/98
Days Operation: 23

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/12/99	0:00:10	36.2	6.7	0.3	0.5	37.1	7.2	34.0	12.7
1/12/99	1:00:00	36.8	6.1	0.3	0.5	37.5	6.6	34.2	12.2
1/12/99	2:00:00	36.6	6.5	0.3	0.5	37.5	7.2	34.3	12.4
1/12/99	3:00:00	36.5	6.6	29.9	8.0	37.4	7.1	34.2	12.4
1/12/99	4:00:00	36.4	6.6	30.0	7.7	37.1	7.3	33.7	12.3
1/12/99	5:00:00	36.4	6.6	30.1	7.6	37.1	7.2	34.1	12.3
1/12/99	6:00:00	36.5	6.5	30.0	7.6	36.9	7.3	34.2	12.0
1/12/99	7:00:00	36.5	6.5	30.1	7.6	36.9	7.2	33.9	12.0
1/12/99	8:00:00	36.5	6.6	30.3	7.5	37.0	7.2	33.9	12.5
[illegible]/99	9:00:00	36.2	6.6	30.1	7.6	36.6	7.4	33.5	13.2
[illegible]/99	10:00:00	36.5	6.5	30.3	7.5	36.9	7.2	34.0	12.3
[illegible]/99	11:00:00	35.9	6.8	26.9	9.2	36.3	7.4	33.7	12.8
1/12/99	12:00:00	35.3	6.9	30.0	7.9	35.8	7.5	33.7	12.8
1/12/99	13:00:00	35.1	6.9	29.9	7.9	35.4	7.6	33.4	13.2
1/12/99	14:00:00	35.2	6.8	30.0	8.0	35.6	7.6	33.7	13.1
1/12/99	15:00:00	35.0	6.9	30.1	8.0	35.7	7.5	33.7	12.9
1/12/99	16:00:00	34.9	6.9	30.1	8.0	35.6	7.6	33.7	13.0
1/12/99	17:00:00	35.0	6.9	30.1	8.0	35.6	7.6	33.8	13.0
1/12/99	18:00:00	35.5	6.8	30.6	7.5	36.2	6.9	34.3	12.3
1/12/99	19:00:00	35.4	6.8	30.3	8.3	36.2	7.5	33.8	12.3
1/12/99	20:00:00	35.6	6.7	30.1	7.9	36.1	7.4	34.0	12.6
1/12/99	21:00:00	35.8	6.7	30.3	7.8	36.4	7.4	34.0	12.6
1/12/99	22:00:00	36.0	6.7	30.4	7.8	36.5	7.4	34.1	12.5
1/12/99	23:00:00	35.9	6.5	30.5	7.8	36.8	7.2	34.4	12.1
Daily Average		35.9	6.7	26.3	6.9	36.5	7.3	33.9	12.6


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/12/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2229

418

McGill AirClean Mobile EP

Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED

Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE

Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/12/99

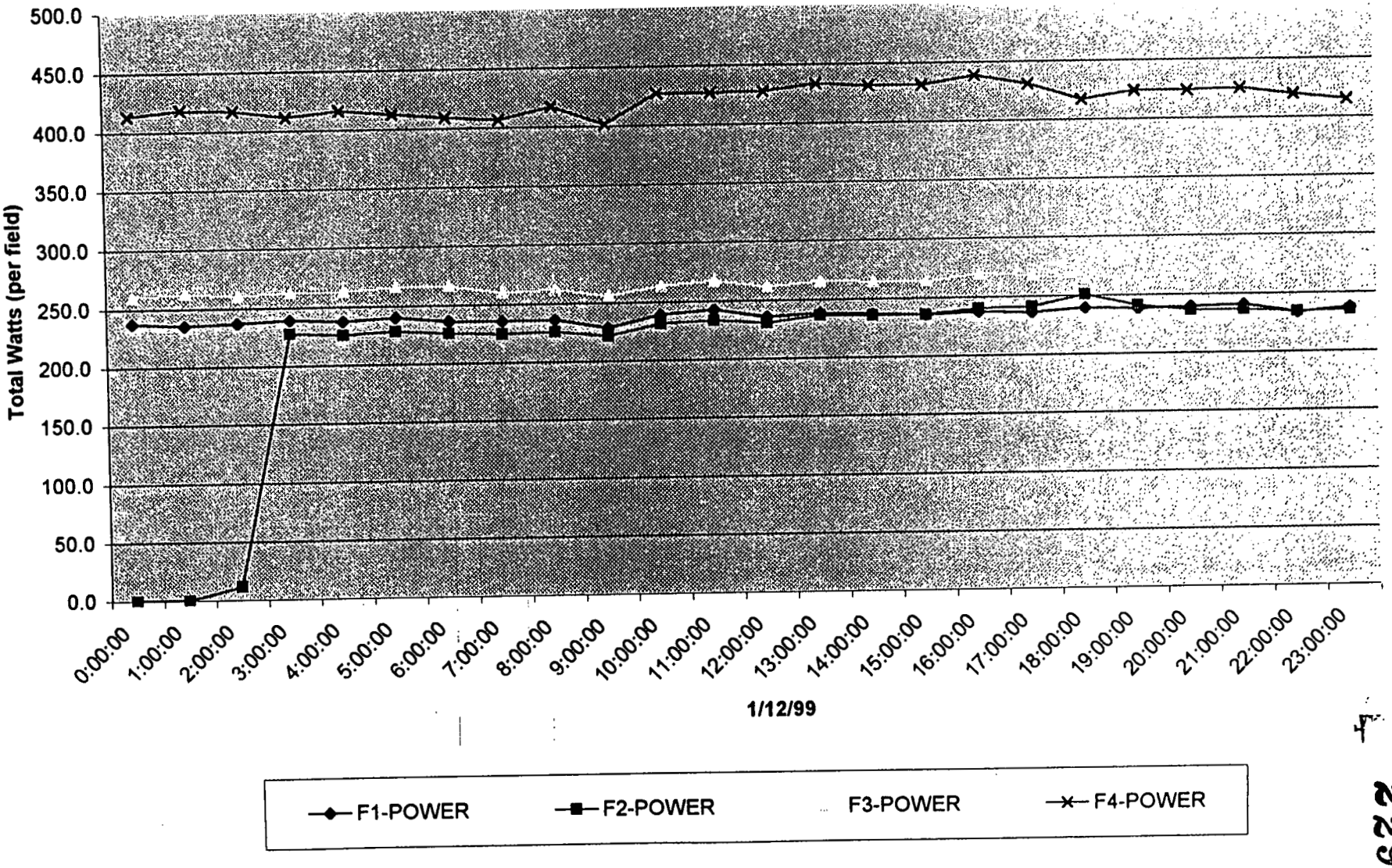
Start Date: 12/1/98

Days Operation: 23

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/12/99	0:00:00	237.3	0.2	260.4	413.6
1/12/99	1:00:00	234.9	0.2	262.5	418.2
1/12/99	2:00:00	236.6	11.4	260.4	417.0
1/12/99	3:00:00	238.9	227.2	262.7	411.1
1/12/99	4:00:00	237.3	225.8	262.7	415.7
1/12/99	5:00:00	239.6	228.0	265.7	412.4
1/12/99	6:00:00	236.0	225.8	265.7	409.0
1/12/99	7:00:00	235.3	224.3	259.9	406.6
1/12/99	8:00:00	236.0	225.8	262.0	417.0
1/12/99	9:00:00	228.1	221.3	255.5	402.0
1/12/99	10:00:00	238.9	231.0	263.5	427.1
1/12/99	11:00:00	242.1	233.2	267.1	426.7
1/12/99	12:00:00	235.3	230.1	261.8	427.7
1/12/99	13:00:00	238.0	236.2	265.5	432.9
1/12/99	14:00:00	236.6	235.4	264.8	430.9
1/12/99	15:00:00	235.3	235.4	264.0	430.9
1/12/99	16:00:00	237.3	240.0	269.8	438.1
1/12/99	17:00:00	235.8	240.8	267.8	430.5
1/12/99	18:00:00	239.4	250.7	264.3	417.0
1/12/99	19:00:00	237.9	240.8	267.1	423.8
1/12/99	20:00:00	239.2	236.3	268.6	423.8
1/12/99	21:00:00	240.5	236.3	269.4	425.0
1/12/99	22:00:00	233.4	234.1	265.7	419.4
1/12/99	23:00:00	236.9	234.9	267.9	414.8
DAILY AVERAGE		236.9	204.4	264.4	420.5

473

FIELD POWER


Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/12/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP

Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED

Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE

Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/13/99

Start Date: 12/1/98

Days Operation: 24

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/13/99	0:00:10	36.0	6.7	30.5	7.7	36.7	7.3	33.9	12.5
1/13/99	1:00:00	36.2	6.6	30.6	7.6	36.8	7.3	34.2	12.2
1/13/99	2:00:00	36.7	6.1	30.5	7.4	37.1	7.1	33.8	12.3
1/13/99	3:00:00	36.3	6.5	30.4	8.0	37.1	7.0	34.0	12.3
1/13/99	4:00:00	36.3	6.5	30.4	7.7	37.1	7.0	34.0	12.3
1/13/99	5:00:00	36.3	6.5	30.4	7.7	37.1	7.0	34.0	12.3
1/13/99	6:00:00	36.3	6.6	30.5	7.5	37.0	7.2	33.9	12.2
1/13/99	7:00:00	36.6	6.4	30.6	7.5	36.9	7.3	33.9	12.3
1/13/99	8:00:00	36.2	6.6	30.5	7.5	36.9	7.2	34.0	12.4
[illegible]	9:00:00	36.1	6.7	30.5	7.5	36.9	7.2	34.1	12.3
[illegible]	10:00:00	36.1	6.7	30.5	7.5	36.9	7.2	34.1	12.3
[illegible]99	11:00:00	35.7	6.8	30.4	7.7	36.5	7.3	34.0	12.5
1/13/99	12:00:00	35.5	6.9	30.2	7.9	36.4	7.4	34.0	12.6
1/13/99	13:00:00	35.0	6.9	30.1	7.9	35.8	7.4	34.0	12.6
1/13/99	14:00:00	38.0	8.1	30.6	7.7	36.0	7.3	34.4	12.5
1/13/99	15:00:00	37.5	8.1	30.6	7.7	36.0	7.3	33.9	12.5
1/13/99	16:00:00	37.5	8.1	30.6	7.7	36.0	7.3	33.9	12.5
1/13/99	17:00:00	37.4	8.1	30.1	7.7	36.0	7.3	33.9	12.5
1/13/99	18:00:00	37.8	8.1	30.2	7.9	35.8	7.5	34.0	12.5
1/13/99	19:00:00	38.7	7.5	30.2	7.9	35.5	7.7	33.8	12.8
1/12/99	20:00:00	35.6	6.7	30.1	7.9	36.1	7.4	34.0	12.6
1/13/99	21:00:00	38.2	8.1	30.2	7.9	36.0	7.5	34.2	12.8
1/13/99	22:00:00	38.1	8.0	30.3	7.9	35.9	7.5	34.2	12.3
1/13/99	23:00:00	38.4	7.7	30.7	7.4	36.5	7.0	34.8	12.1
Daily Average		36.8	7.1	30.4	7.7	36.5	7.3	34.0	12.4

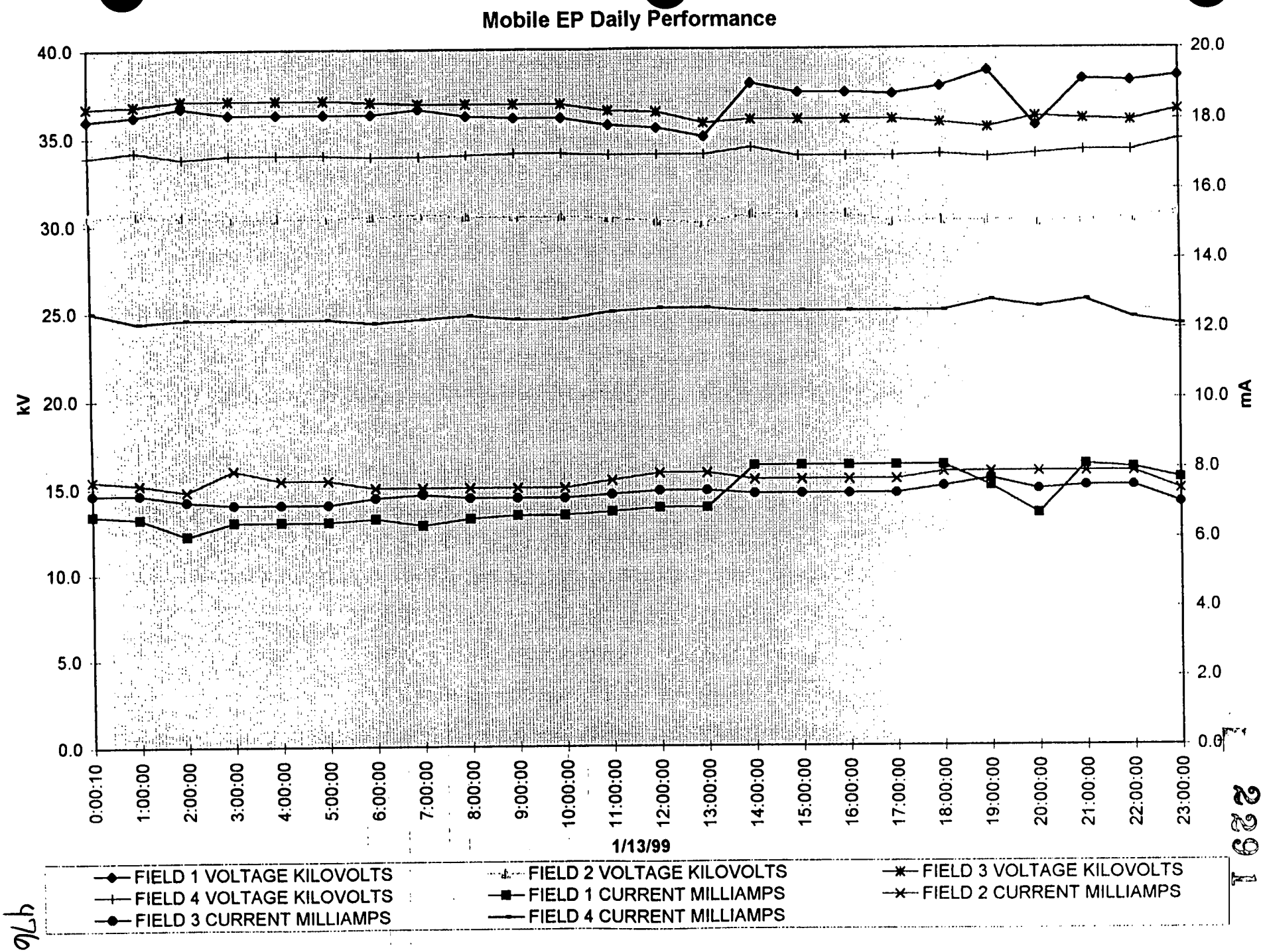

Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/13/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

FIG 2

9/6

McGill AirClean Mobile EP

Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED

Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE

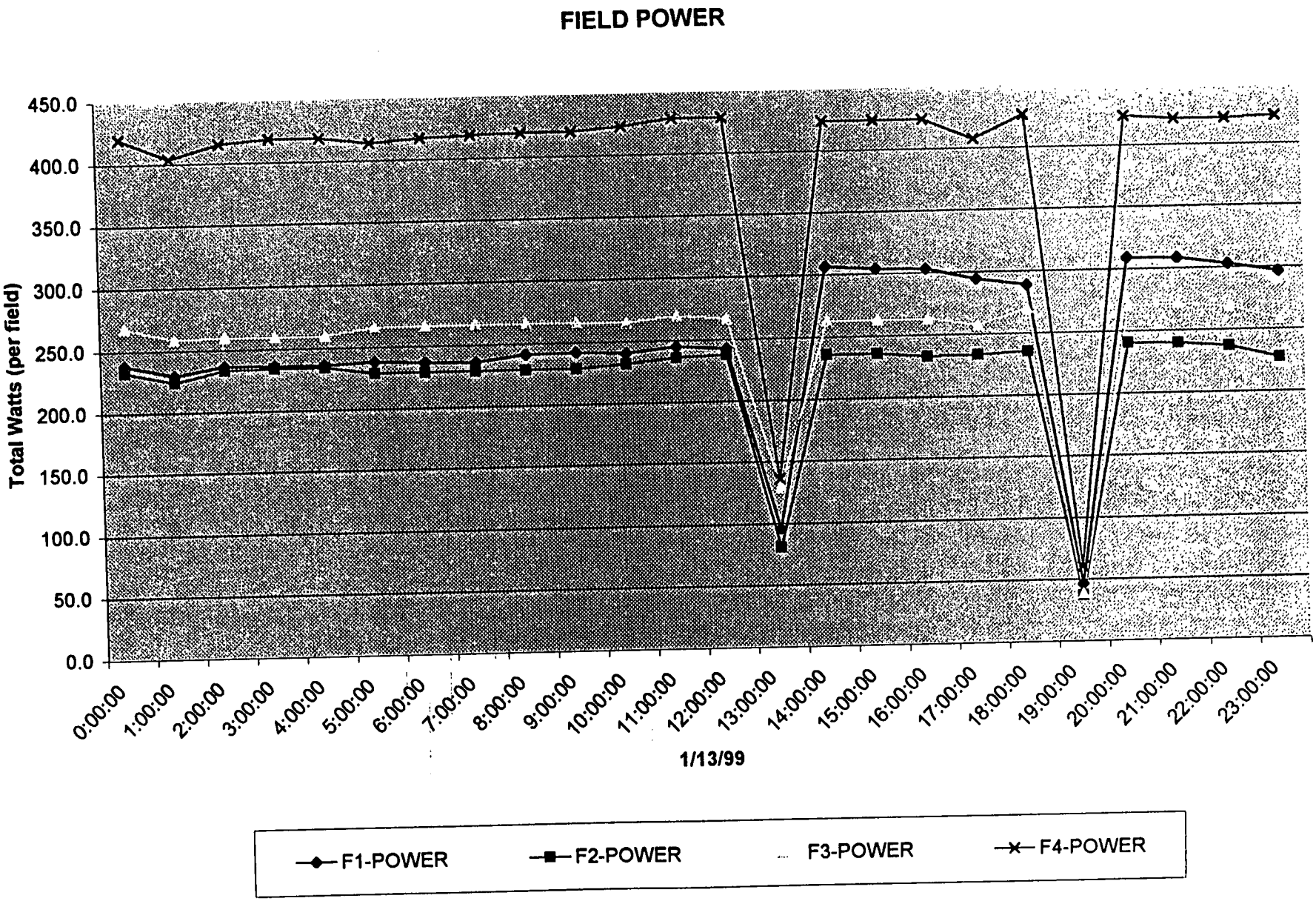
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/13/99

Start Date: 12/1/98

Days Operation: 24

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/13/99	0:00:00	238.3	232.6	267.9	419.4
1/13/99	1:00:00	229.8	224.2	258.4	403.2
1/13/99	2:00:00	236.6	233.3	259.7	414.8
1/13/99	3:00:00	236.0	234.1	259.7	418.2
1/13/99	4:00:00	236.0	234.1	259.7	418.2
1/13/99	5:00:00	238.3	228.8	265.7	413.6
1/13/99	6:00:00	236.6	228.8	265.7	417.0
1/13/99	7:00:00	236.0	228.8	265.7	418.2
1/13/99	8:00:00	241.2	228.8	265.7	419.4
1/13/99	9:00:00	241.9	228.8	265.7	419.4
1/13/99	10:00:00	240.5	231.8	265.0	422.8
1/13/99	11:00:00	245.0	236.3	269.4	428.4
1/13/99	12:00:00	242.9	237.8	266.4	428.4
1/13/99	13:00:00	95.9	80.5	129.2	136.3
1/13/99	14:00:00	306.2	235.6	262.8	423.8
1/13/99	15:00:00	303.8	235.6	262.8	423.8
1/13/99	16:00:00	302.9	232.5	262.8	423.8
1/13/99	17:00:00	294.1	233.3	257.0	407.0
1/13/99	18:00:00	288.8	235.6	269.8	425.9
1/13/99	19:00:00	46.2	37.4	38.6	60.5
1/13/99	20:00:00	308.6	240.8	269.3	423.4
1/13/99	21:00:00	308.0	240.2	270.8	420.7
1/13/99	22:00:00	302.6	237.1	267.9	420.7
1/13/99	23:00:00	296.5	227.2	257.7	422.1
DAILY AVERAGE		248.0	218.5	249.3	392.9


FIELD POWER
Total Watts (per field)
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/13/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

478

2291

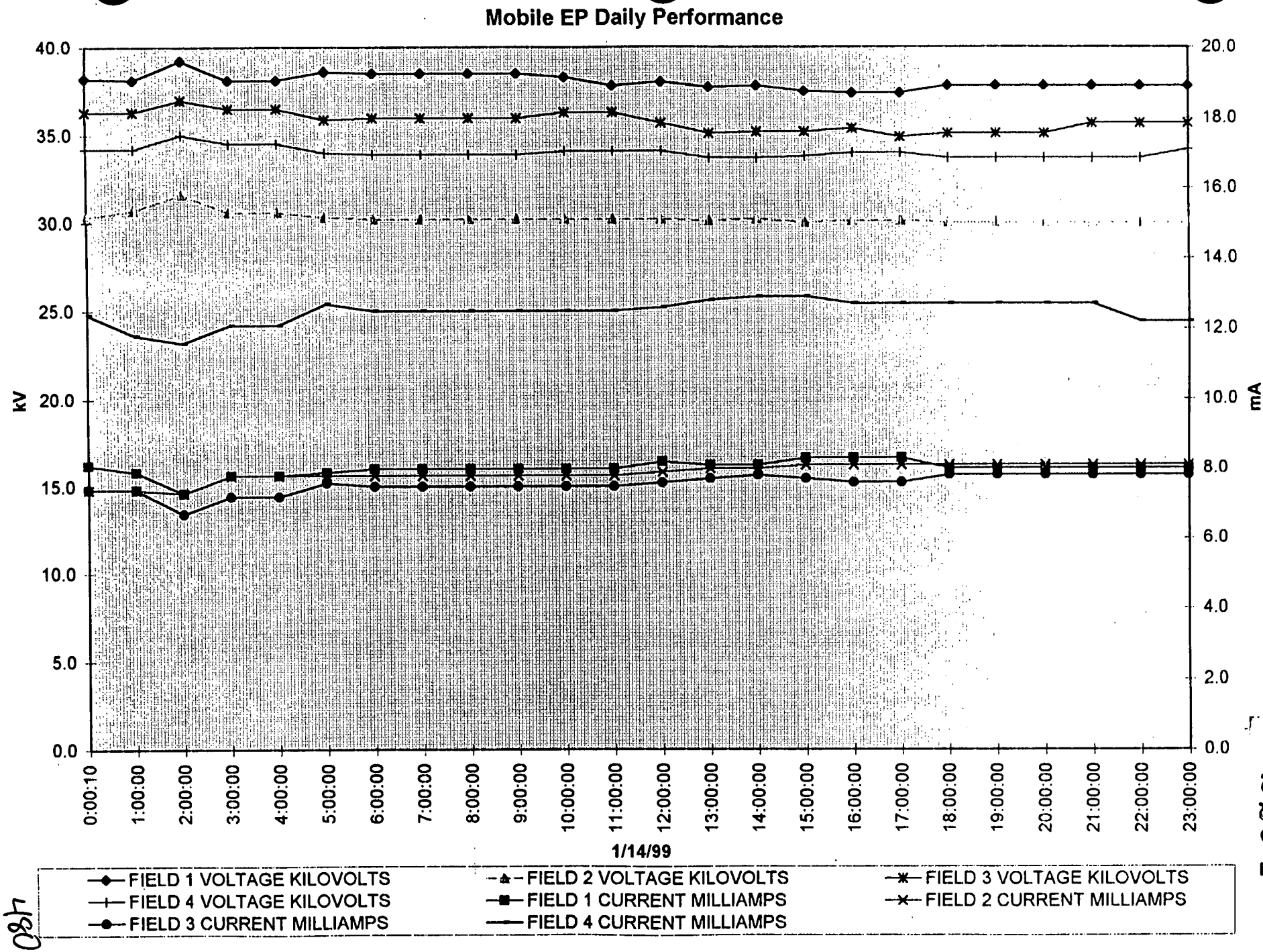
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/14/99
Start Date: 12/1/98
Days Operation: 25

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/14/99	0:00:10	38.2	8.1	30.3	7.4	36.3	7.4	34.2	12.4
1/14/99	1:00:00	38.1	7.9	30.7	7.4	36.3	7.4	34.2	11.8
1/14/99	2:00:00	39.2	7.3	31.6	7.3	37.0	6.7	35.0	11.6
1/14/99	3:00:00	38.1	7.8	30.6	7.8	36.5	7.2	34.5	12.1
1/14/99	4:00:00	38.1	7.8	30.6	7.8	36.5	7.2	34.5	12.1
1/14/99	5:00:00	38.6	7.9	30.3	7.8	35.9	7.6	34.0	12.7
1/14/99	6:00:00	38.5	8.0	30.2	7.8	36.0	7.5	33.9	12.5
1/14/99	7:00:00	38.5	8.0	30.2	7.8	36.0	7.5	33.9	12.5
1/14/99	8:00:00	38.5	8.0	30.2	7.8	36.0	7.5	33.9	12.5
1/14/99	9:00:00	38.5	8.0	30.2	7.8	36.0	7.5	33.9	12.5
[illegible]99	10:00:00	38.3	8.0	30.2	7.8	36.3	7.5	34.1	12.5
[illegible]99	11:00:00	37.8	8.0	30.2	7.8	36.3	7.5	34.1	12.5
[illegible]4/99	12:00:00	38.0	8.2	30.2	7.9	35.7	7.6	34.1	12.6
1/14/99	13:00:00	37.7	8.1	30.1	8.0	35.1	7.7	33.7	12.8
1/14/99	14:00:00	37.8	8.1	30.2	8.0	35.2	7.8	33.7	12.9
1/14/99	15:00:00	37.5	8.3	30.0	8.1	35.2	7.7	33.8	12.9
1/14/99	16:00:00	37.4	8.3	30.1	8.1	35.4	7.6	34.0	12.7
1/14/99	17:00:00	37.4	8.3	30.1	8.1	34.9	7.6	34.0	12.7
1/14/99	18:00:00	37.8	8.0	30.0	8.1	35.1	7.8	33.7	12.7
1/14/99	19:00:00	37.8	8.0	30.0	8.1	35.1	7.8	33.7	12.7
1/14/99	20:00:00	37.8	8.0	30.0	8.1	35.1	7.8	33.7	12.7
1/14/99	21:00:00	37.8	8.0	30.0	8.1	35.7	7.8	33.7	12.7
1/14/99	22:00:00	37.8	8.0	30.0	8.1	35.7	7.8	33.7	12.2
1/14/99	23:00:00	37.8	8.0	30.0	8.1	35.7	7.8	34.2	12.2
Daily Average		38.0	8.0	30.3	7.9	35.8	7.6	34.0	12.5

R14ian99a.XLS


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/14/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

480

229 1

McGill AirClean Mobile EP
Daily Performance Report

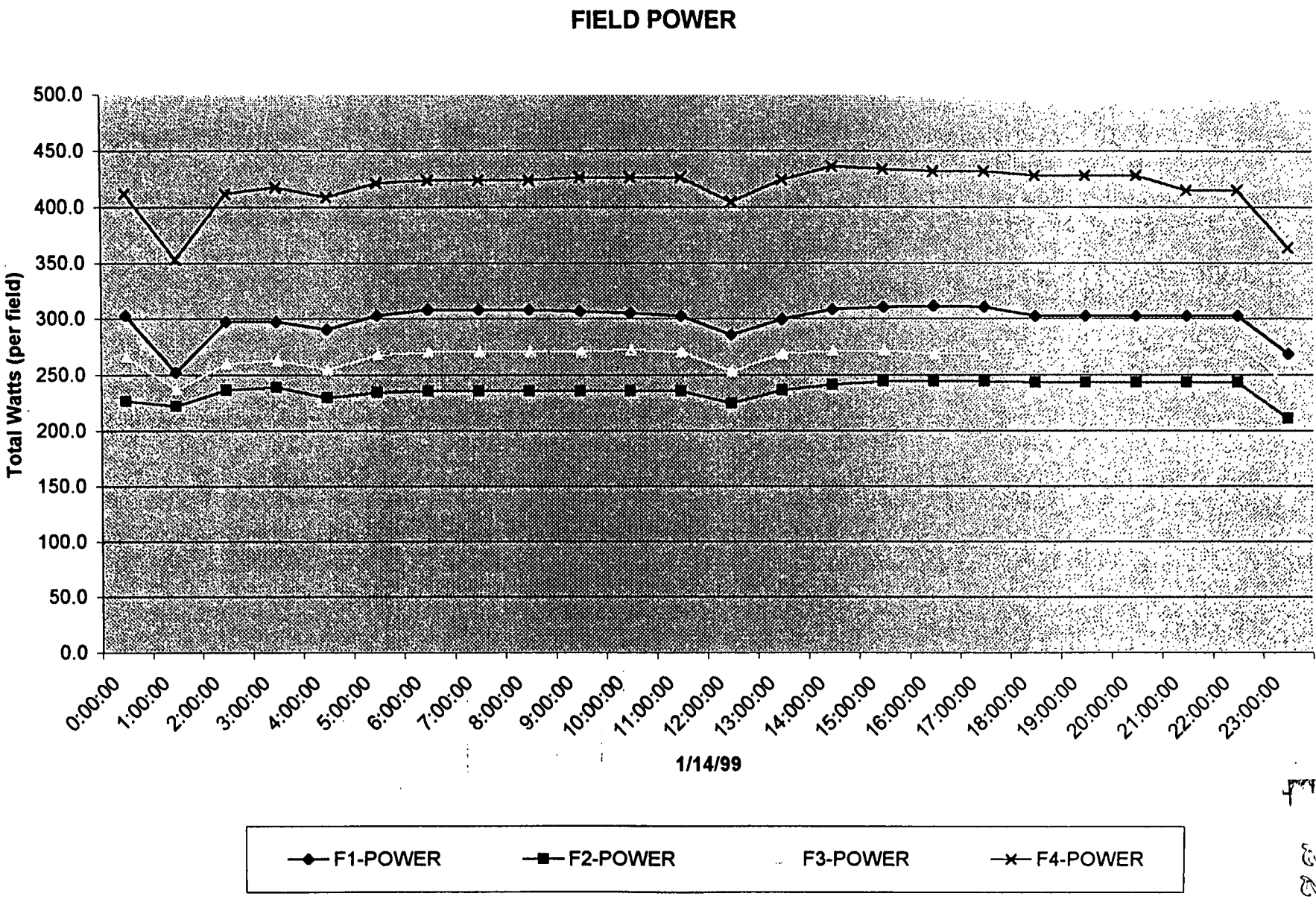
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY-FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/14/99
Start Date: 12/1/98
Days Operation: 25

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/14/99	0:00:00	302.6	226.4	265.7	411.6
1/14/99	1:00:00	252.0	221.7	236.8	353.0
1/14/99	2:00:00	297.2	236.4	259.9	411.7
1/14/99	3:00:00	297.2	238.7	262.8	417.5
1/14/99	4:00:00	290.3	229.5	254.9	408.7
1/14/99	5:00:00	302.6	234.0	267.8	421.3
1/14/99	6:00:00	308.0	235.6	270.0	423.8
1/14/99	7:00:00	308.0	235.6	270.0	423.8
1/14/99	8:00:00	308.0	235.6	270.0	423.8
1/14/99	9:00:00	306.4	235.6	270.8	426.3
1/14/99	10:00:00	304.8	235.6	272.3	426.3
1/14/99	11:00:00	302.4	235.6	270.0	426.3
1/14/99	12:00:00	285.5	224.1	253.1	404.2
1/14/99	13:00:00	299.2	236.2	268.7	424.2
1/14/99	14:00:00	308.3	240.8	271.0	436.0
1/14/99	15:00:00	310.4	243.8	271.8	433.9
1/14/99	16:00:00	311.3	243.8	268.3	431.8
1/14/99	17:00:00	310.4	243.8	268.7	431.8
1/14/99	18:00:00	302.4	243.0	273.8	428.0
1/14/99	19:00:00	302.4	243.0	273.8	428.0
1/14/99	20:00:00	302.4	243.0	275.3	428.0
1/14/99	21:00:00	302.4	243.0	278.5	414.5
1/14/99	22:00:00	302.4	243.0	278.5	414.8
1/14/99	23:00:00	268.3	210.8	239.8	363.7
DAILY AVERAGE		299.4	235.8	266.3	417.2

481


FIELD POWER
Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/14/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

329 1

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/15/99
Start Date: 12/1/98
Days Operation: 26

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/15/99	0:00:10	37.8	8.2	30.2	8.0	35.8	7.6	33.9	12.3
1/15/99	1:00:00	38.2	8.2	30.2	8.0	35.8	7.6	33.9	12.3
1/15/99	2:00:00	37.6	8.2	30.2	8.0	35.8	7.6	33.9	12.3
1/15/99	3:00:00	38.1	8.3	30.3	7.9	36.0	7.6	33.7	12.0
1/15/99	4:00:00	38.2	8.1	30.3	7.9	35.9	7.6	34.0	12.6
1/15/99	5:00:00	38.2	8.1	30.3	7.9	35.9	7.6	34.0	12.6
1/15/99	6:00:00	38.2	8.1	30.3	7.9	35.9	7.6	34.0	12.1
1/15/99	7:00:00	38.2	8.1	30.3	7.9	36.5	7.6	34.0	12.1
1/15/99	8:00:00	38.2	8.1	30.3	7.9	36.5	7.6	34.0	12.1
1/15/99	9:00:00	38.7	8.1	30.3	7.9	36.5	7.6	34.0	12.1
1/15/99	10:00:00	38.2	8.1	30.3	7.9	36.5	7.6	34.0	12.1
1/15/99	11:00:00	38.2	8.1	30.3	7.9	35.9	7.6	34.0	12.6
1/15/99	12:00:00	37.7	8.1	30.3	7.9	35.9	7.6	34.0	12.6
1/15/99	13:00:00	37.4	8.4	29.9	8.1	35.4	7.7	33.9	13.0
1/15/99	14:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/15/99	15:00:00	37.3	8.4	29.9	8.2	35.2	7.7	33.8	13.0
1/15/99	16:00:00	0.0	1.0	0.0	0.5	0.0	0.0	0.0	0.0
1/15/99	17:00:00	37.6	8.4	36.9	15.4	43.7	15.0	34.2	12.9
1/15/99	18:00:00	37.7	8.4	37.3	16.1	45.1	16.5	33.6	12.5
1/15/99	19:00:00	38.1	8.3	35.9	14.3	47.5	18.3	33.4	12.2
1/15/99	20:00:00	38.2	8.4	37.5	16.0	47.9	18.7	33.8	12.2
1/15/99	21:00:00	38.4	8.3	38.5	17.3	45.4	15.8	33.9	12.2
1/15/99	22:00:00	38.5	8.3	36.1	14.2	46.7	16.3	33.6	11.9
1/15/99	23:00:00	38.7	8.4	39.7	18.9	47.2	17.2	34.2	12.1
Daily Average		34.9	7.6	29.8	9.7	36.0	9.7	31.1	11.3

483

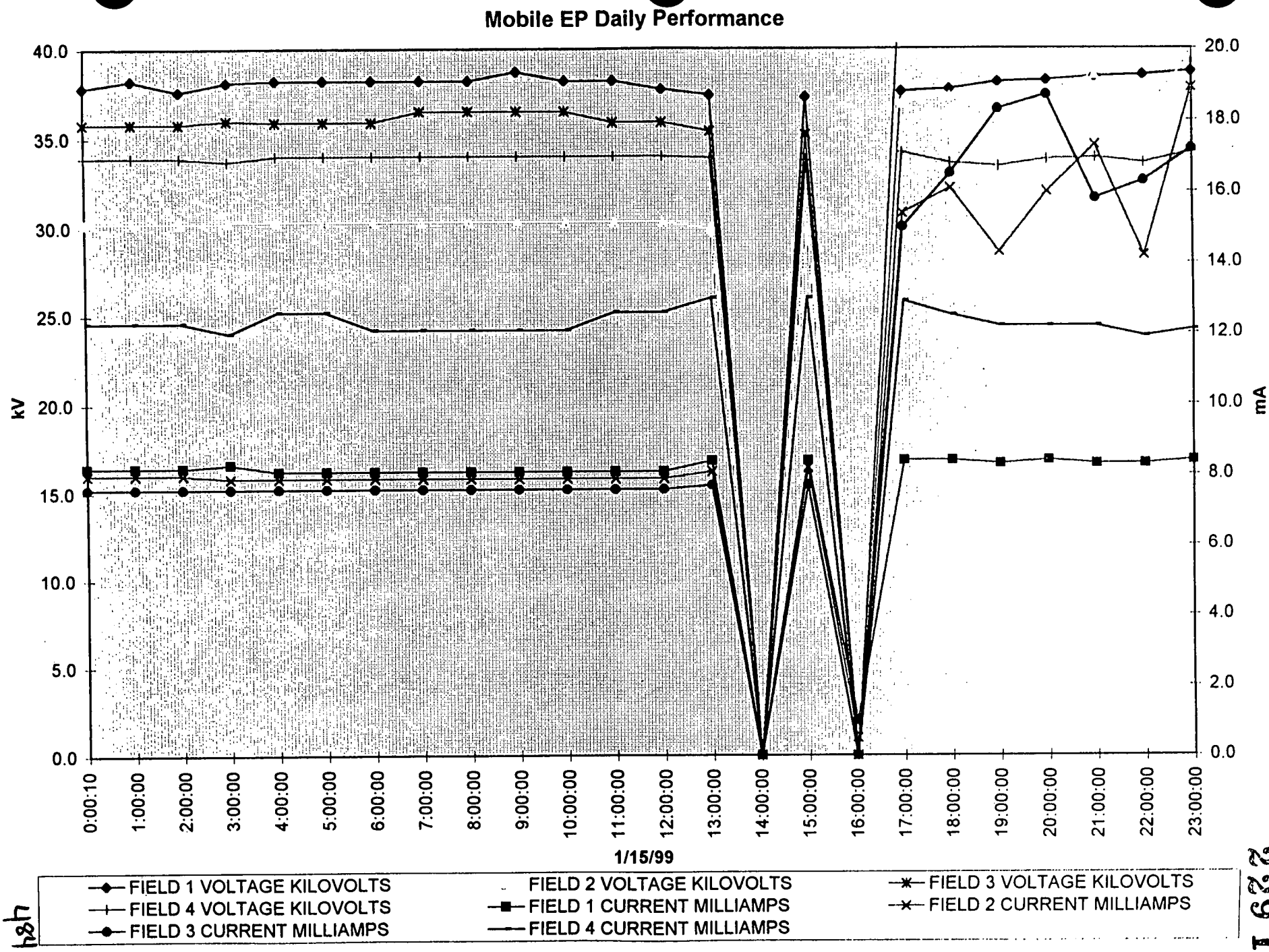

Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/15/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

FIG 22

48h

McGill AirClean Mobile EP
Daily Performance Report

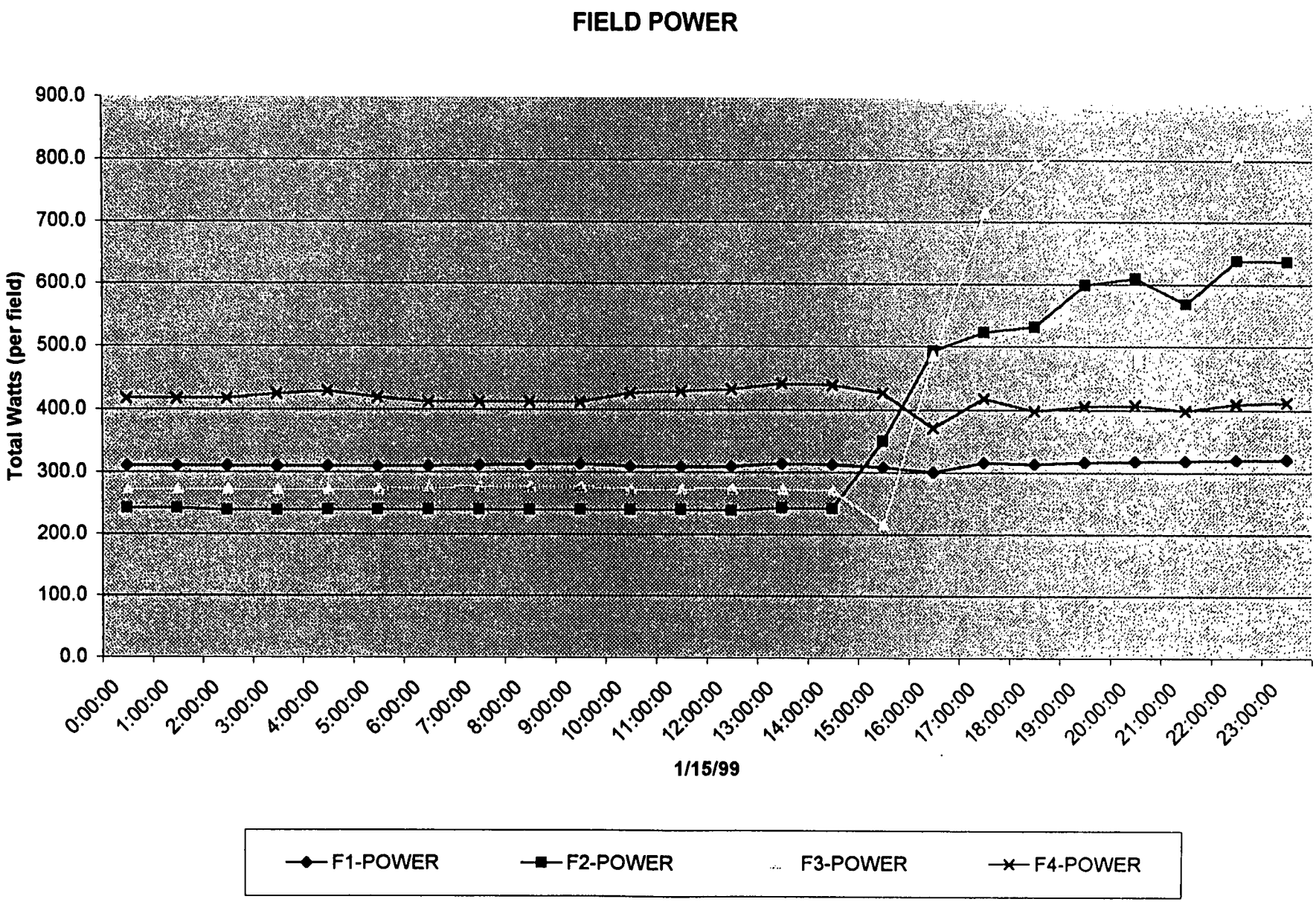
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/15/99
Start Date: 12/1/98
Days Operation: 26

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/15/99	0:00:00	310.0	241.6	272.1	417.0
1/15/99	1:00:00	310.0	241.6	272.1	417.0
1/15/99	2:00:00	310.0	238.6	272.8	417.0
1/15/99	3:00:00	309.4	238.6	272.8	423.8
1/15/99	4:00:00	309.4	239.4	272.8	428.4
1/15/99	5:00:00	309.4	239.4	272.8	418.2
1/15/99	6:00:00	309.4	239.4	275.1	411.4
1/15/99	7:00:00	311.0	239.4	277.4	411.4
1/15/99	8:00:00	312.7	239.4	277.4	411.4
1/15/99	9:00:00	313.5	239.4	277.4	411.4
1/15/99	10:00:00	309.4	239.4	272.8	425.0
1/15/99	11:00:00	308.6	239.4	272.8	428.4
1/15/99	12:00:00	309.1	238.6	274.1	431.8
1/15/99	13:00:00	314.2	242.2	272.6	440.7
1/15/99	14:00:00	312.5	241.4	270.3	438.1
1/15/99	15:00:00	307.9	349.9	214.5	426.2
1/15/99	16:00:00	300.1	492.7	484.6	370.5
1/15/99	17:00:00	315.8	522.7	715.2	417.5
1/15/99	18:00:00	313.7	530.7	791.2	397.2
1/15/99	19:00:00	316.2	598.4	830.1	405.4
1/15/99	20:00:00	317.9	609.1	838.4	406.6
1/15/99	21:00:00	318.7	568.3	843.7	398.7
1/15/99	22:00:00	320.4	637.9	808.4	409.0
1/15/99	23:00:00	321.2	636.3	836.0	411.4
DAILY AVERAGE		312.1	356.0	436.2	415.6

485


FIELD POWER
Total Watts (per field)
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/15/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

229 I

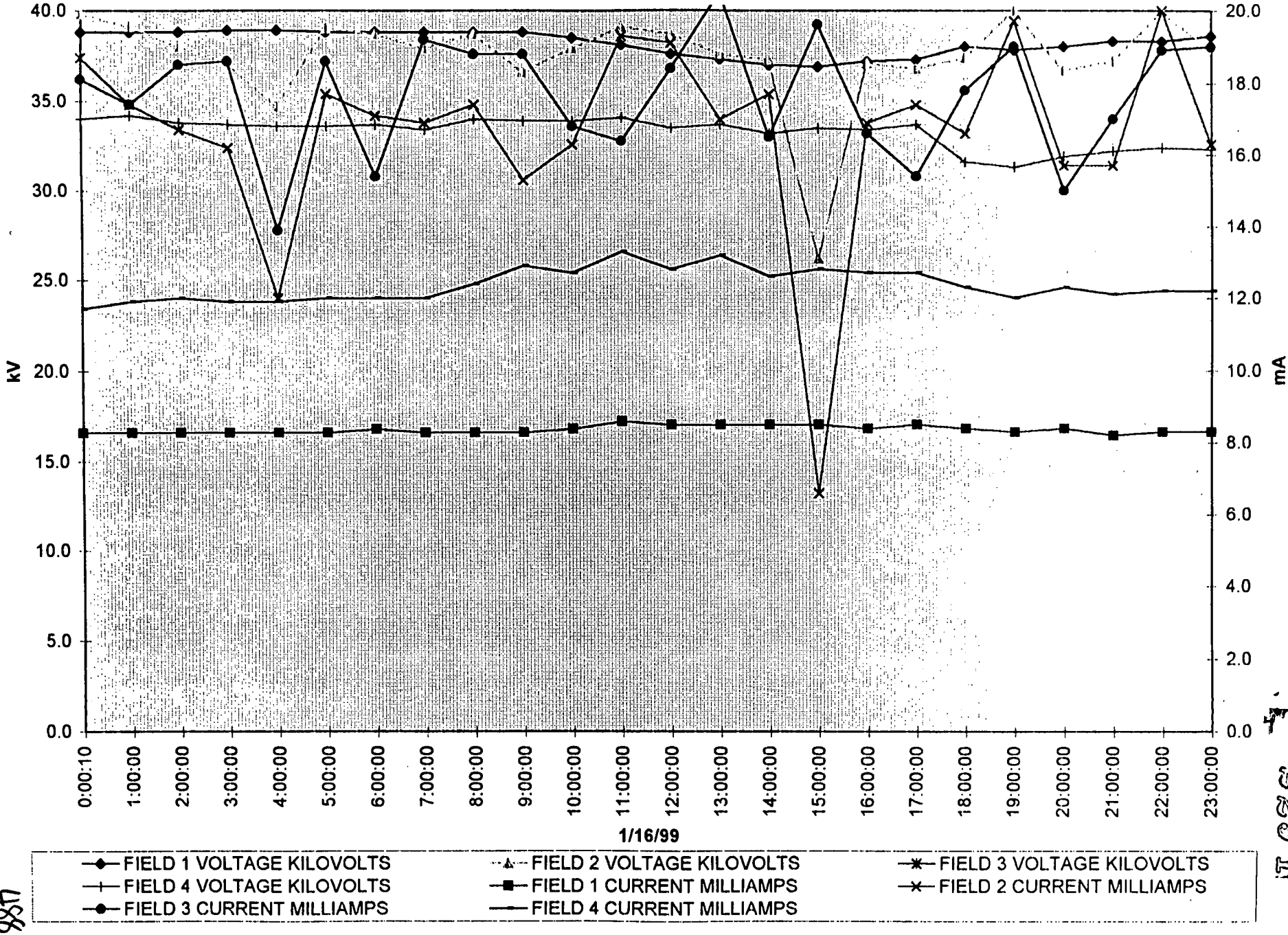
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/16/99
Start Date: 12/1/98
Days Operation: 27

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/16/99	0:00:10	38.8	8.3	39.8	18.7	48.4	18.1	34.0	11.7
1/16/99	1:00:00	38.8	8.3	39.1	17.4	47.6	17.4	34.2	11.9
1/16/99	2:00:00	38.8	8.3	38.0	16.7	48.6	18.5	33.8	12.0
1/16/99	3:00:00	38.9	8.3	37.1	16.2	48.4	18.6	33.7	11.9
1/16/99	4:00:00	38.9	8.3	34.7	12.0	44.2	13.9	33.6	11.9
1/16/99	5:00:00	38.8	8.3	39.0	17.7	48.4	18.6	33.6	12.0
1/16/99	6:00:00	38.8	8.4	38.7	17.1	45.7	15.4	33.7	12.0
1/16/99	7:00:00	38.8	8.3	37.9	16.9	48.0	19.2	33.4	12.0
1/16/99	8:00:00	38.8	8.3	38.7	17.4	48.5	18.8	34.0	12.4
1/16/99	9:00:00	38.8	8.3	36.6	15.3	48.4	18.8	33.9	12.9
[illegible]	10:00:00	38.5	8.4	37.9	16.3	46.9	16.8	33.9	12.7
[illegible]	11:00:00	38.1	8.6	39.1	19.3	45.1	16.4	34.1	13.3
1/16/99	12:00:00	37.6	8.5	38.7	19.1	46.2	18.4	33.5	12.8
1/16/99	13:00:00	37.3	8.5	37.6	17.0	46.9	20.5	33.7	13.2
1/16/99	14:00:00	37.0	8.5	37.3	17.7	44.0	16.5	33.2	12.6
1/16/99	15:00:00	36.9	8.5	26.2	6.6	46.3	19.6	33.5	12.8
1/16/99	16:00:00	37.2	8.4	37.1	16.9	44.2	16.6	33.4	12.7
1/16/99	17:00:00	37.3	8.5	36.8	17.4	43.3	15.4	33.7	12.7
1/16/99	18:00:00	38.0	8.4	37.4	16.6	46.0	17.8	31.6	12.3
1/16/99	19:00:00	37.8	8.3	40.0	19.7	47.2	19.0	31.3	12.0
1/16/99	20:00:00	38.0	8.4	36.7	15.7	44.1	15.0	31.9	12.3
1/16/99	21:00:00	38.3	8.2	37.2	15.7	46.2	17.0	32.2	12.1
1/16/99	22:00:00	38.3	8.3	39.9	20.0	48.0	18.9	32.4	12.2
1/16/99	23:00:00	38.6	8.3	37.9	16.3	48.3	19.0	32.3	12.2
Daily Average		38.2	8.4	37.5	16.7	46.6	17.7	33.3	12.4

487

Mobile EP Daily Performance

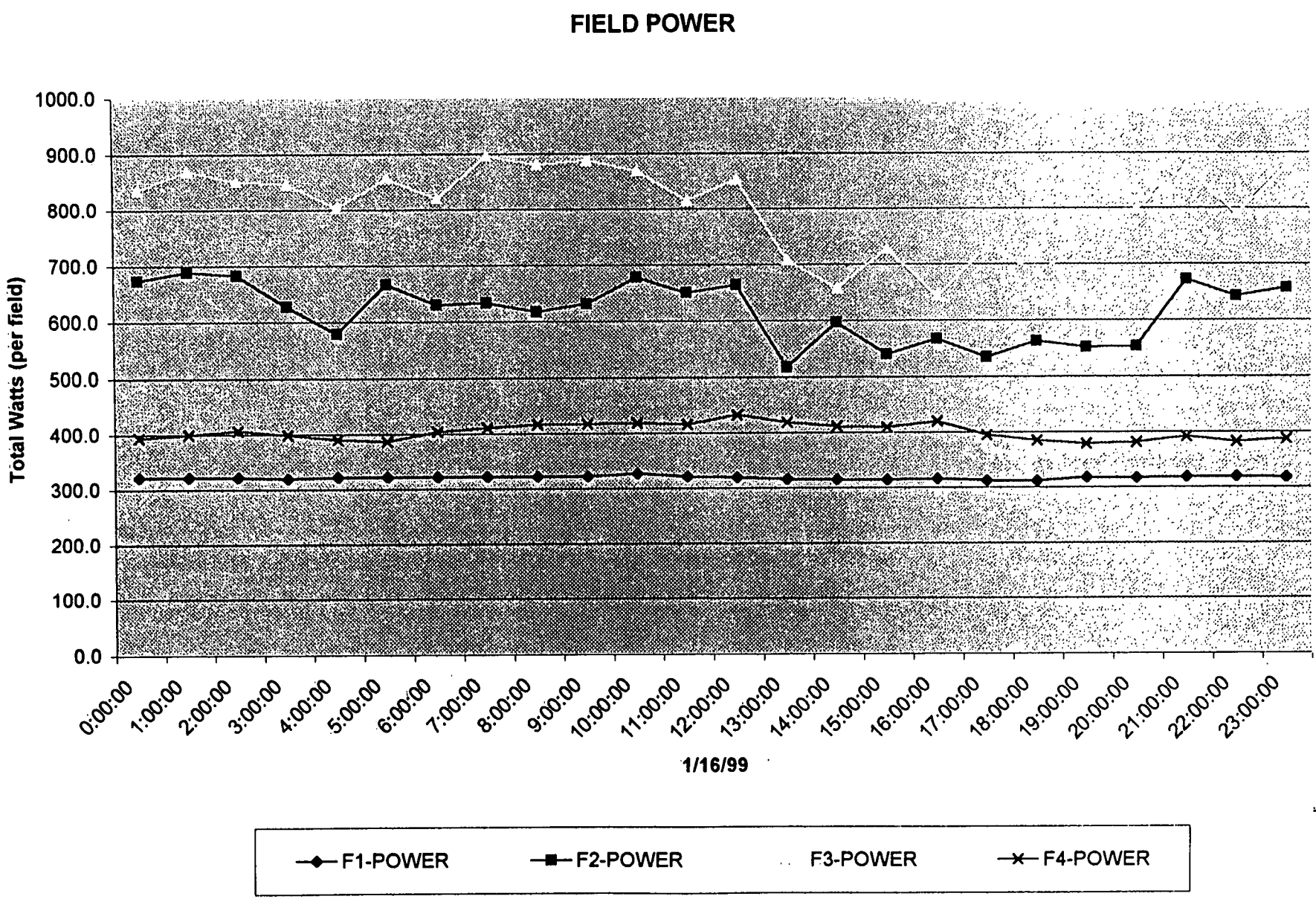


McGill AirClean Mobile EP
Daily Performance Report

Customer:	ENVITCO, INCORPORATED	Report Date:	1/16/99
Process:	SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE	Start Date:	12/1/98
Operators:	DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL	Days Operation:	27

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/16/99	0:00:00	321.2	673.4	836.0	393.1
1/16/99	1:00:00	322.0	688.5	868.8	398.8
1/16/99	2:00:00	322.0	682.9	850.8	405.6
1/16/99	3:00:00	319.0	627.0	846.1	397.7
1/16/99	4:00:00	321.2	578.8	803.7	389.6
1/16/99	5:00:00	322.0	666.1	855.6	386.3
1/16/99	6:00:00	321.2	629.1	820.0	403.2
1/16/99	7:00:00	322.0	632.9	895.4	410.2
1/16/99	8:00:00	322.0	616.6	880.2	415.7
1/16/99	9:00:00	322.0	631.3	888.0	416.6
1/16/99	10:00:00	326.4	677.9	868.5	418.8
1/16/99	11:00:00	320.5	650.5	815.2	415.0
1/16/99	12:00:00	318.8	663.5	853.7	432.2
1/16/99	13:00:00	315.4	517.4	706.3	418.3
1/16/99	14:00:00	314.5	597.0	657.6	410.4
1/16/99	15:00:00	313.7	539.6	727.1	409.2
1/16/99	16:00:00	315.4	566.8	643.3	419.6
1/16/99	17:00:00	312.5	534.0	729.3	394.3
1/16/99	18:00:00	311.3	562.7	684.8	384.3
1/16/99	19:00:00	317.5	551.8	731.9	378.0
1/16/99	20:00:00	316.2	553.3	797.5	380.4
1/16/99	21:00:00	317.9	672.0	874.0	390.8
1/16/99	22:00:00	318.7	642.2	788.8	382.0
1/16/99	23:00:00	317.3	657.0	872.9	387.2
DAILY AVERAGE		318.8	617.2	804.0	401.6

489


FIELD POWER
Total Watts (per field)
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/16/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

E 229 1

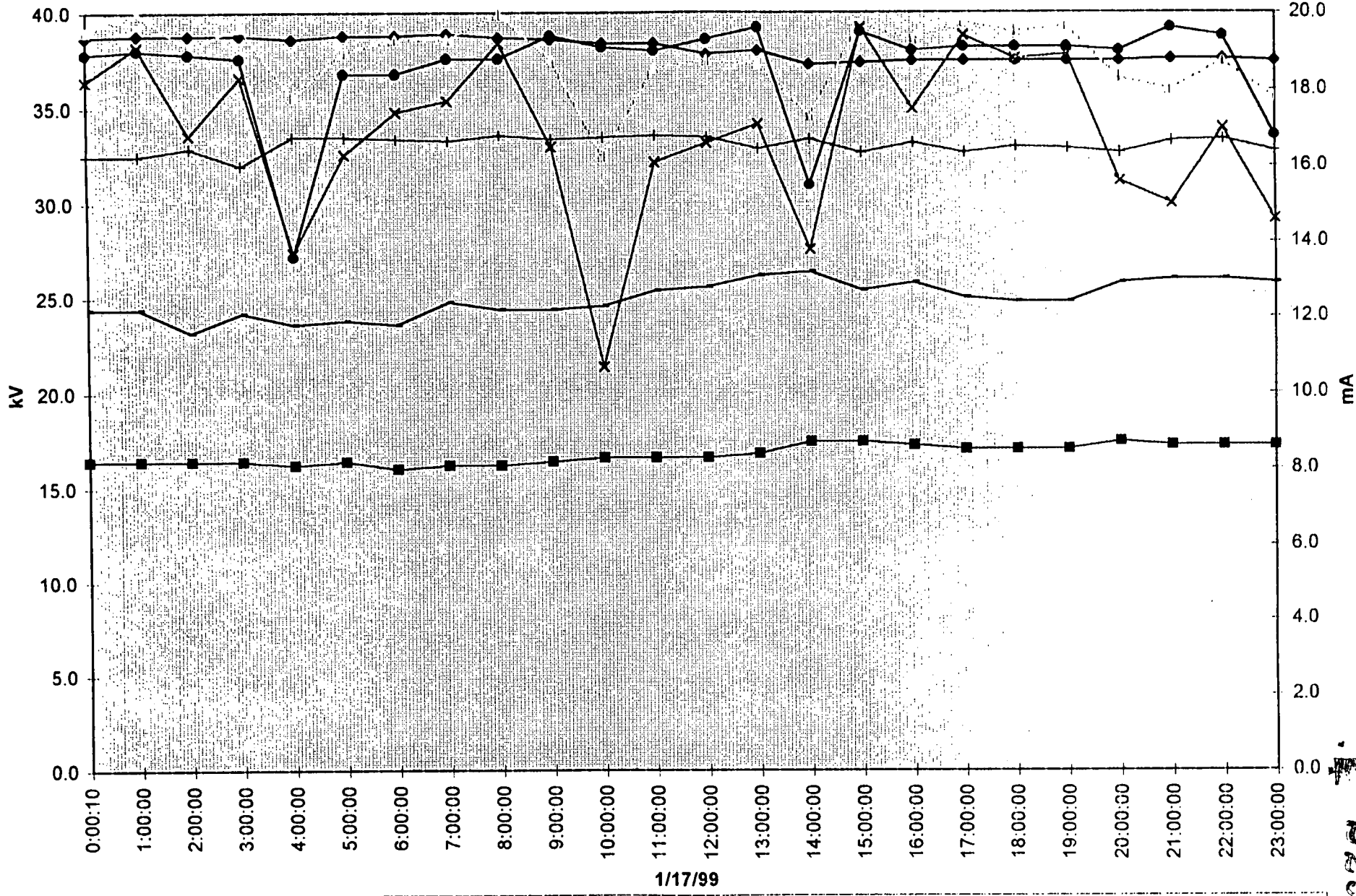
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/17/99
Start Date: 12/1/98
Days Operation: 28

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/17/99	0:00:10	38.7	8.2	39.0	18.2	48.3	18.9	32.5	12.2
1/17/99	1:00:00	38.8	8.2	39.9	19.1	48.3	19.0	32.5	12.2
1/17/99	2:00:00	38.8	8.2	38.2	16.8	48.3	18.9	32.9	11.6
1/17/99	3:00:00	38.8	8.2	39.2	18.3	48.5	18.8	32.0	12.1
1/17/99	4:00:00	38.6	8.1	35.6	13.7	43.4	13.6	33.5	11.8
1/17/99	5:00:00	38.8	8.2	37.9	16.3	48.2	18.4	33.5	11.9
1/17/99	6:00:00	38.8	8.0	38.6	17.4	48.1	18.4	33.4	11.8
1/17/99	7:00:00	38.9	8.1	38.6	17.7	48.1	18.8	33.3	12.4
1/17/99	8:00:00	38.7	8.1	39.9	19.2	48.1	18.8	33.6	12.2
[illegible]/99	9:00:00	38.6	8.2	37.6	16.5	48.0	19.4	33.4	12.2
[illegible]99	10:00:00	38.4	8.3	32.5	10.7	48.1	19.1	33.5	12.3
[illegible]99	11:00:00	38.4	8.3	37.1	16.1	47.9	19.0	33.6	12.7
[illegible]/99	12:00:00	37.8	8.3	37.5	16.6	47.6	19.3	33.5	12.8
1/17/99	13:00:00	38.0	8.4	37.3	17.1	47.4	19.6	32.9	13.1
1/17/99	14:00:00	37.3	8.7	34.6	13.8	44.1	15.5	33.4	13.2
1/17/99	15:00:00	37.4	8.7	39.4	19.6	47.3	19.5	32.7	12.7
1/17/99	16:00:00	37.5	8.6	38.6	17.5	47.3	19.0	33.2	12.9
1/17/99	17:00:00	37.5	8.5	39.5	19.4	47.4	19.1	32.7	12.5
1/17/99	18:00:00	37.5	8.5	39.0	18.8	47.6	19.1	33.0	12.4
1/17/99	19:00:00	37.5	8.5	39.3	18.9	47.4	19.1	32.9	12.4
1/17/99	20:00:00	37.5	8.7	36.6	15.6	47.4	19.0	32.7	12.9
1/17/99	21:00:00	37.6	8.6	36.0	15.0	47.3	19.6	33.3	13.0
1/17/99	22:00:00	37.6	8.6	37.5	17.0	47.6	19.4	33.4	13.0
1/17/99	23:00:00	37.5	8.6	35.6	14.6	45.3	16.8	32.8	12.9
Daily Average		38.1	8.4	37.7	16.8	47.4	18.6	33.1	12.5

491

Mobile EP Daily Performance



FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

McGill AirClean Mobile EP
Daily Performance Report

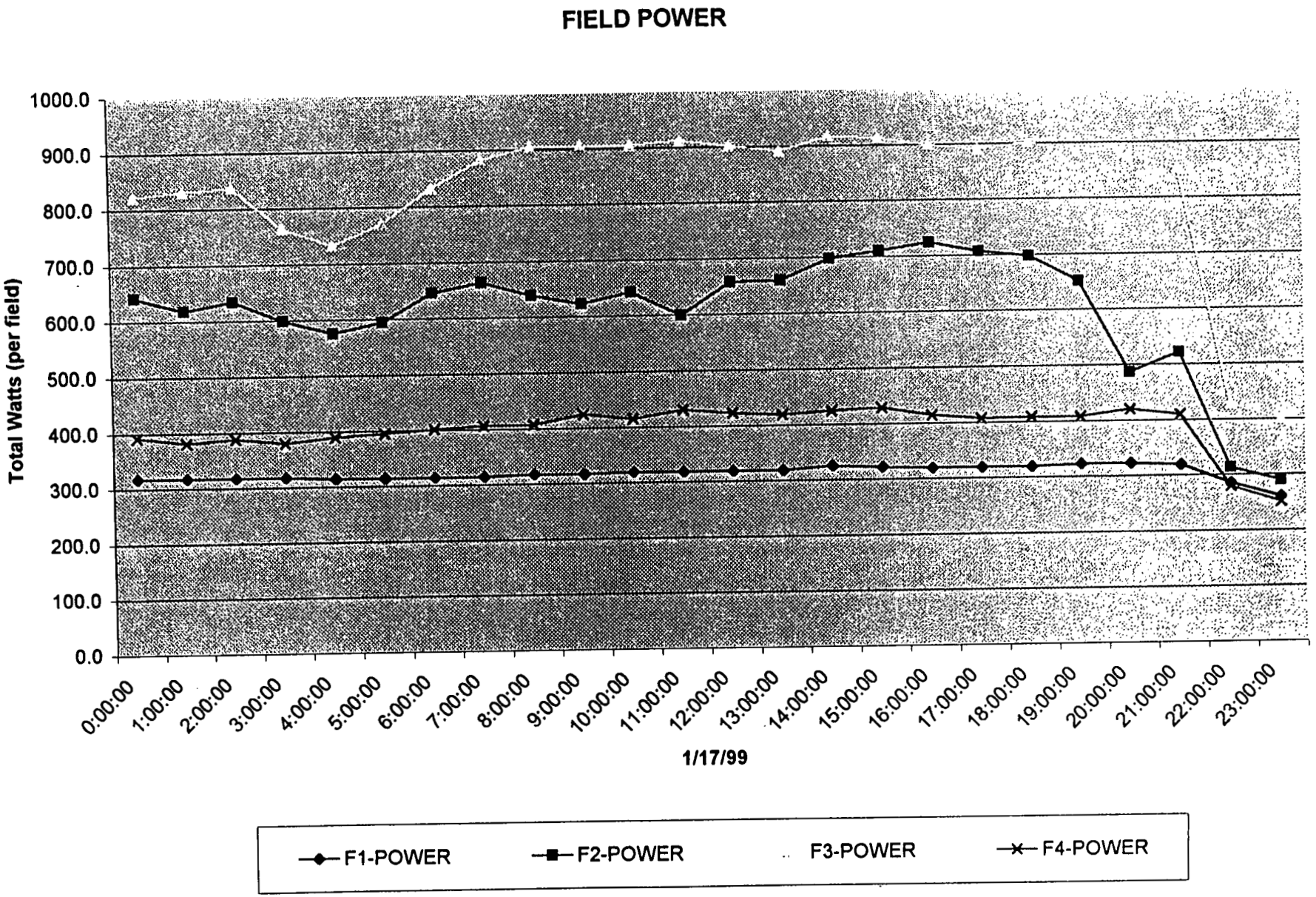
2991

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/17/99
Start Date: 12/1/98
Days Operation: 28

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/17/99	0:00:00	317.3	642.2	822.5	390.8
1/17/99	1:00:00	317.3	618.3	830.7	381.1
1/17/99	2:00:00	317.3	634.6	837.2	387.9
1/17/99	3:00:00	317.3	598.4	764.0	379.3
1/17/99	4:00:00	313.5	575.1	732.8	388.4
1/17/99	5:00:00	313.5	594.7	770.2	394.1
1/17/99	6:00:00	314.3	645.6	832.5	400.8
1/17/99	7:00:00	314.3	662.6	881.4	405.4
1/17/99	8:00:00	317.3	638.8	904.3	406.6
1/17/99	9:00:00	316.5	622.5	905.3	423.4
1/17/99	10:00:00	318.7	642.6	904.4	414.2
1/17/99	11:00:00	317.9	599.4	912.0	428.8
1/17/99	12:00:00	318.4	657.7	901.5	421.6
1/17/99	13:00:00	317.9	659.8	891.1	417.8
1/17/99	14:00:00	325.4	697.1	915.7	423.7
1/17/99	15:00:00	321.6	710.2	912.9	428.3
1/17/99	16:00:00	318.8	723.5	898.7	413.3
1/17/99	17:00:00	318.8	706.4	889.2	406.7
1/17/99	18:00:00	318.8	696.9	900.6	408.0
1/17/99	19:00:00	322.5	652.2	883.6	407.5
1/17/99	20:00:00	322.5	486.5	873.3	419.1
1/17/99	21:00:00	318.8	521.2	853.8	408.8
1/17/99	22:00:00	284.8	313.0	427.5	278.4
1/17/99	23:00:00	259.5	289.0	399.8	250.2
DAILY AVERAGE		314.3	607.8	826.9	395.2

493


FIELD POWER
Total Watts (per field)
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/17/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

494

McGill AirClean Mobile EP
Daily Performance Report

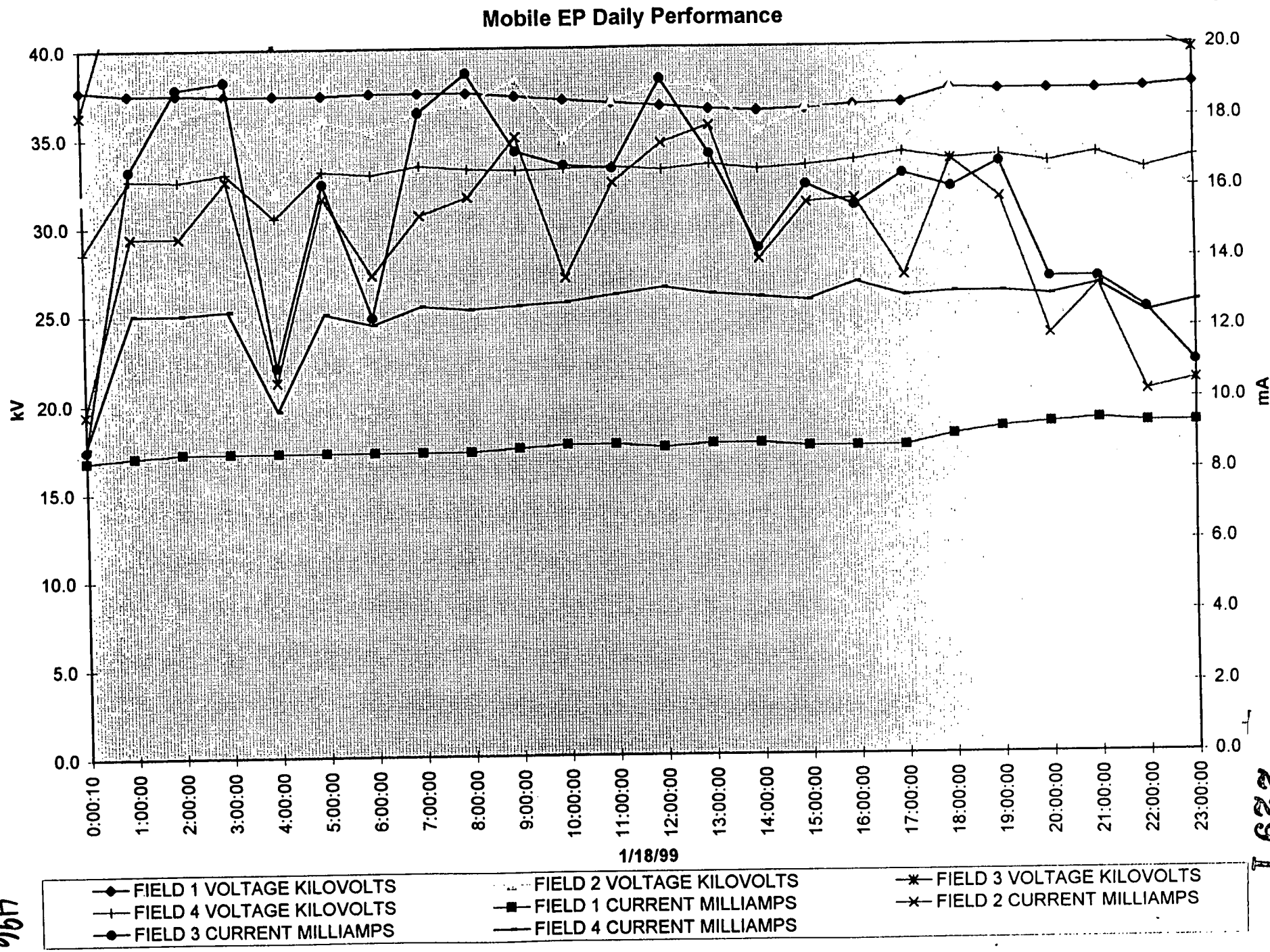
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/18/99
Start Date: 12/1/98
Days Operation: 29

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/18/99	0:00:10	37.7	8.4	31.6	9.7	36.3	8.7	28.5	8.8
1/18/99	1:00:00	37.5	8.5	35.9	14.7	45.3	16.6	32.7	12.5
1/18/99	2:00:00	37.5	8.6	36.2	14.7	47.4	18.9	32.6	12.5
1/18/99	3:00:00	37.4	8.6	37.0	16.3	47.2	19.1	33.0	12.6
1/18/99	4:00:00	37.4	8.6	31.9	10.6	40.2	11.0	30.5	9.8
1/18/99	5:00:00	37.4	8.6	36.0	15.8	45.2	16.2	33.1	12.5
1/18/99	6:00:00	37.5	8.6	35.3	13.6	41.3	12.4	32.9	12.2
1/18/99	7:00:00	37.5	8.6	36.4	15.3	46.3	18.2	33.4	12.7
1/18/99	8:00:00	37.5	8.6	36.9	15.8	47.7	19.3	33.2	12.6
1/18/99	9:00:00	37.3	8.7	38.2	17.5	46.1	17.1	33.1	12.7
[illegible]	10:00:00	37.1	8.8	34.8	13.5	45.0	16.7	33.2	12.8
[illegible]	11:00:00	36.9	8.8	37.0	16.2	44.9	16.6	33.3	13.0
1/18/99	12:00:00	36.7	8.7	37.9	17.3	46.5	19.1	33.1	13.2
1/18/99	13:00:00	36.5	8.8	37.7	17.8	44.5	17.0	33.4	13.0
1/18/99	14:00:00	36.4	8.8	35.2	14.0	41.3	14.3	33.1	12.9
1/18/99	15:00:00	36.5	8.7	36.6	15.6	43.8	16.1	33.3	12.8
1/18/99	16:00:00	36.7	8.7	36.5	15.7	42.9	15.5	33.6	13.3
1/18/99	17:00:00	36.8	8.7	34.4	13.5	43.3	16.4	34.0	12.9
1/18/99	18:00:00	37.6	9.0	37.6	16.8	44.6	16.0	33.6	13.0
1/18/99	19:00:00	37.5	9.2	36.6	15.7	44.8	16.7	33.8	13.0
1/18/99	20:00:00	37.5	9.3	33.1	11.8	41.9	13.4	33.4	12.9
1/18/99	21:00:00	37.5	9.4	34.7	13.2	41.5	13.4	33.9	13.2
1/18/99	22:00:00	37.6	9.3	31.5	10.2	40.9	12.5	33.0	12.4
1/18/99	23:00:00	37.8	9.3	32.3	10.5	39.7	11.0	33.7	12.7
Daily Average		37.2	8.8	35.5	14.4	43.7	15.5	33.0	12.5

495


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/18/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

229

496

McGill AirClean Mobile EP
Daily Performance Report

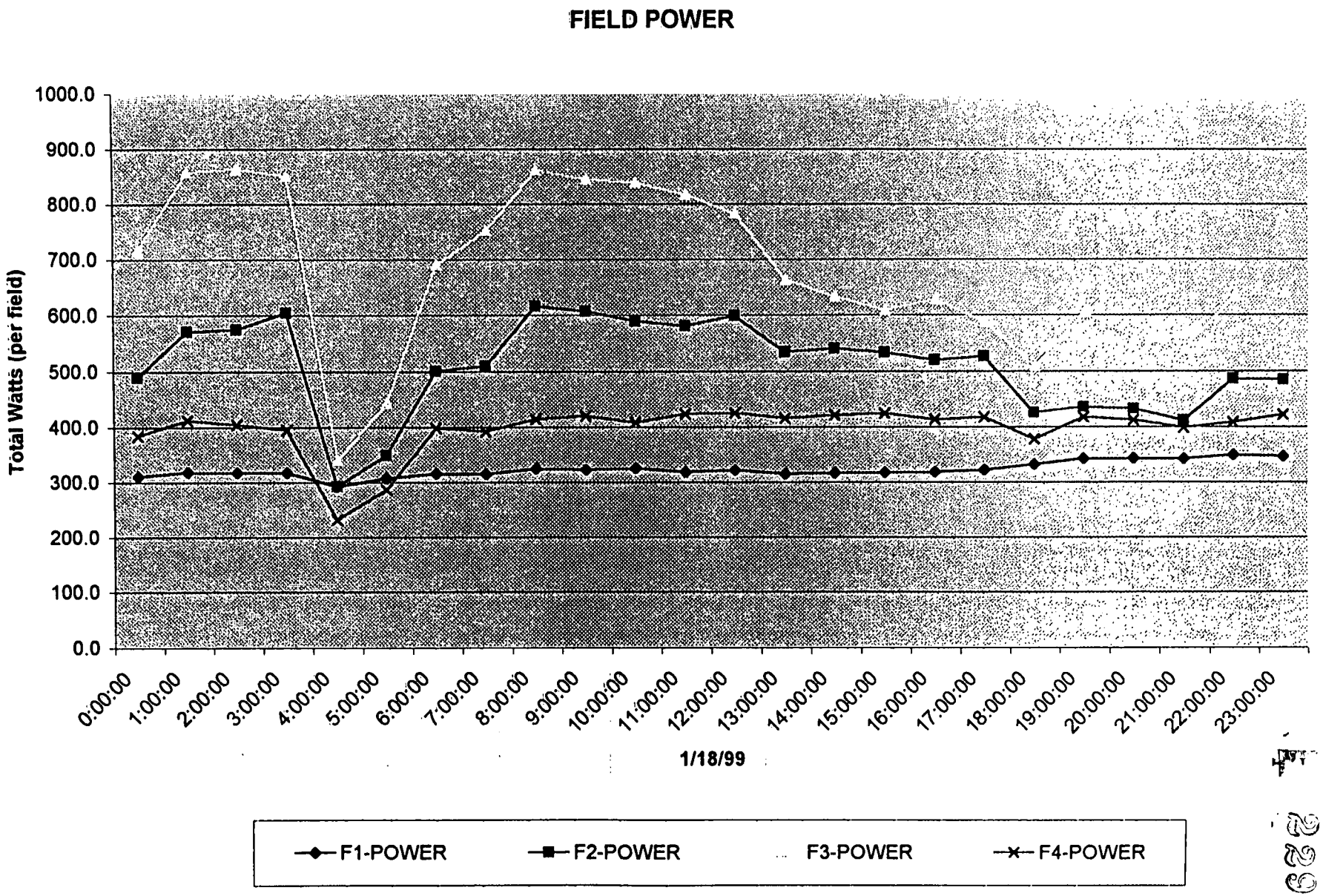
229 1

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/18/99
Start Date: 12/1/98
Days Operation: 29

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/18/99	0:00:00	310.4	490.0	716.0	384.0
1/18/99	1:00:00	317.9	571.0	857.4	412.0
1/18/99	2:00:00	317.1	574.6	864.0	403.8
1/18/99	3:00:00	317.1	604.7	851.0	394.8
1/18/99	4:00:00	292.7	292.1	339.5	231.2
1/18/99	5:00:00	307.4	348.7	443.5	286.2
1/18/99	6:00:00	315.4	501.3	689.5	397.7
1/18/99	7:00:00	314.5	509.8	751.5	392.0
1/18/99	8:00:00	324.5	615.5	861.1	413.8
1/18/99	9:00:00	322.8	606.8	844.5	419.1
1/18/99	10:00:00	324.7	588.8	839.0	407.5
1/18/99	11:00:00	318.4	580.4	817.2	422.4
1/18/99	12:00:00	321.2	598.2	782.3	424.4
1/18/99	13:00:00	314.9	534.5	663.0	415.3
1/18/99	14:00:00	316.7	540.6	633.0	419.8
1/18/99	15:00:00	317.6	533.4	609.0	423.7
1/18/99	16:00:00	318.4	519.8	629.0	412.5
1/18/99	17:00:00	321.9	526.3	586.6	417.1
1/18/99	18:00:00	332.1	425.5	509.3	377.6
1/18/99	19:00:00	342.2	436.0	603.5	417.1
1/18/99	20:00:00	343.2	432.6	560.3	411.3
1/18/99	21:00:00	342.2	410.8	539.7	397.7
1/18/99	22:00:00	348.8	486.5	633.6	407.1
1/18/99	23:00:00	346.8	484.4	640.8	420.8
DAILY AVERAGE		322.9	508.8	677.7	396.2

497

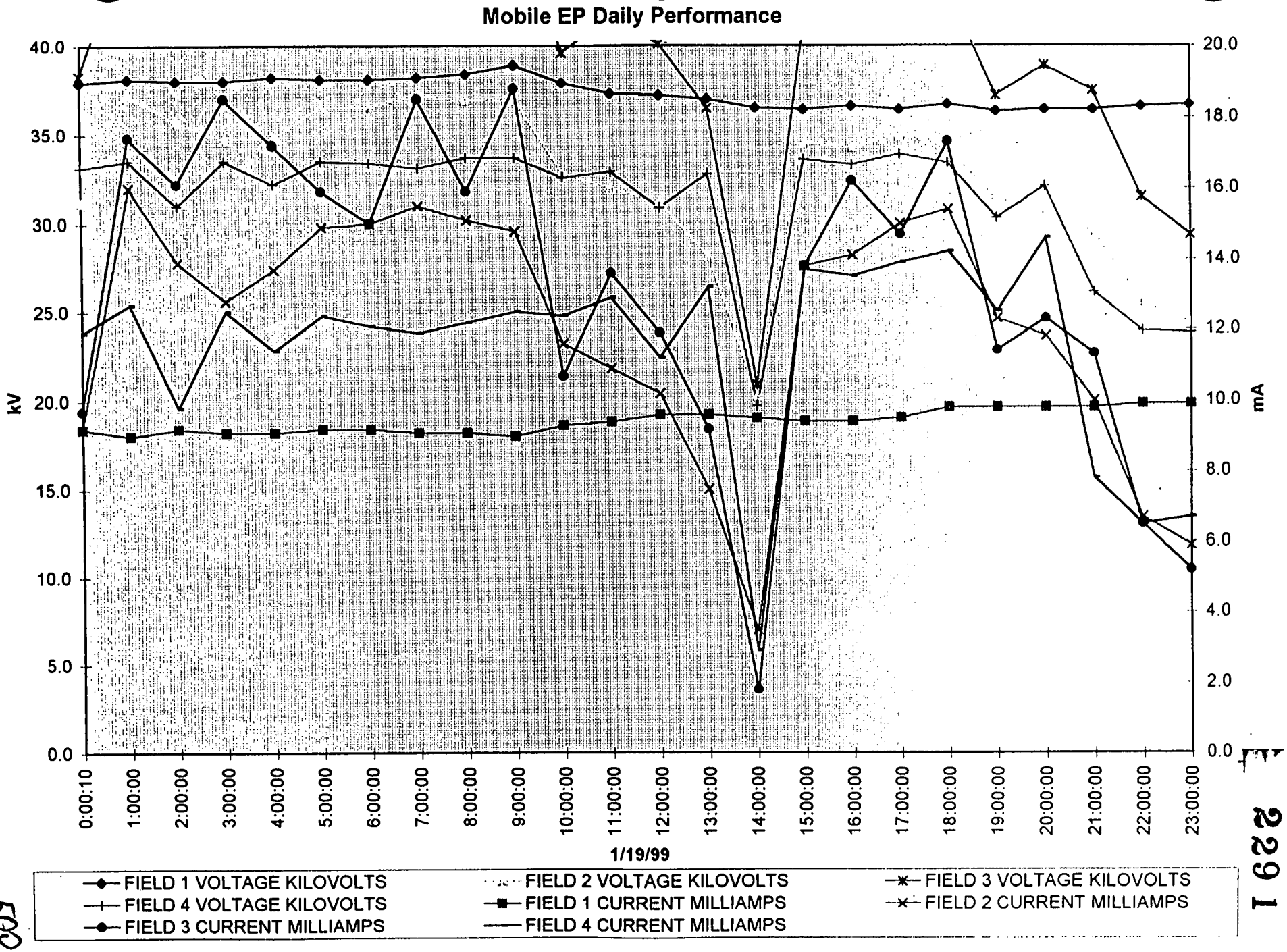

FIELD POWER
Total Watts (per field)
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/18/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/19/99
Start Date: 12/1/98
Days Operation: 30

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/19/99	0:00:10	37.9	9.2	31.2	9.2	38.3	9.7	33.1	11.9
1/19/99	1:00:00	38.1	9.0	37.2	16.0	46.1	17.4	33.5	12.7
1/19/99	2:00:00	38.0	9.2	35.7	13.9	45.5	16.1	31.0	9.8
1/19/99	3:00:00	38.0	9.1	34.7	12.8	47.4	18.5	33.5	12.5
1/19/99	4:00:00	38.2	9.1	34.8	13.7	45.5	17.2	32.2	11.4
1/19/99	5:00:00	38.1	9.2	36.6	14.9	45.6	15.9	33.5	12.4
1/19/99	6:00:00	38.1	9.2	36.5	15.0	44.5	15.0	33.4	12.1
1/19/99	7:00:00	38.2	9.1	37.2	15.5	47.8	18.5	33.1	11.9
1/19/99	8:00:00	38.4	9.1	36.9	15.1	45.9	15.9	33.7	12.2
1/19/99	9:00:00	38.9	9.0	37.0	14.8	48.4	18.8	33.7	12.5
1/19/99	10:00:00	37.9	9.3	32.8	11.6	39.6	10.7	32.6	12.4
1/19/99	11:00:00	37.3	9.4	32.0	10.9	41.7	13.6	32.9	12.9
1/19/99	12:00:00	37.2	9.6	31.2	10.2	40.1	11.9	30.9	11.2
1/19/99	13:00:00	37.0	9.6	28.1	7.5	36.5	9.2	32.8	13.2
1/19/99	14:00:00	36.5	9.5	20.2	3.5	20.9	1.8	19.7	2.9
1/19/99	15:00:00	36.4	9.4	34.5	13.8	40.8	13.8	33.6	13.7
1/19/99	16:00:00	36.6	9.4	34.3	14.1	43.2	16.2	33.3	13.5
1/19/99	17:00:00	36.4	9.5	34.9	15.0	41.8	14.7	33.9	13.9
1/19/99	18:00:00	36.7	9.8	34.3	15.4	43.4	17.3	33.4	14.2
1/19/99	19:00:00	36.3	9.8	31.4	12.3	37.2	11.4	30.3	12.5
1/19/99	20:00:00	36.4	9.8	30.8	11.8	38.9	12.3	32.1	14.6
1/19/99	21:00:00	36.4	9.8	29.6	10.0	37.5	11.3	26.1	7.8
1/19/99	22:00:00	36.6	9.9	25.5	6.7	31.5	6.5	23.9	6.5
1/19/99	23:00:00	36.7	9.9	24.4	5.9	29.4	5.2	23.8	6.7
Daily Average		37.3	9.4	32.6	12.1	40.7	13.3	31.3	11.5


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/19/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

500

McGill AirClean Mobile EP
Daily Performance Report

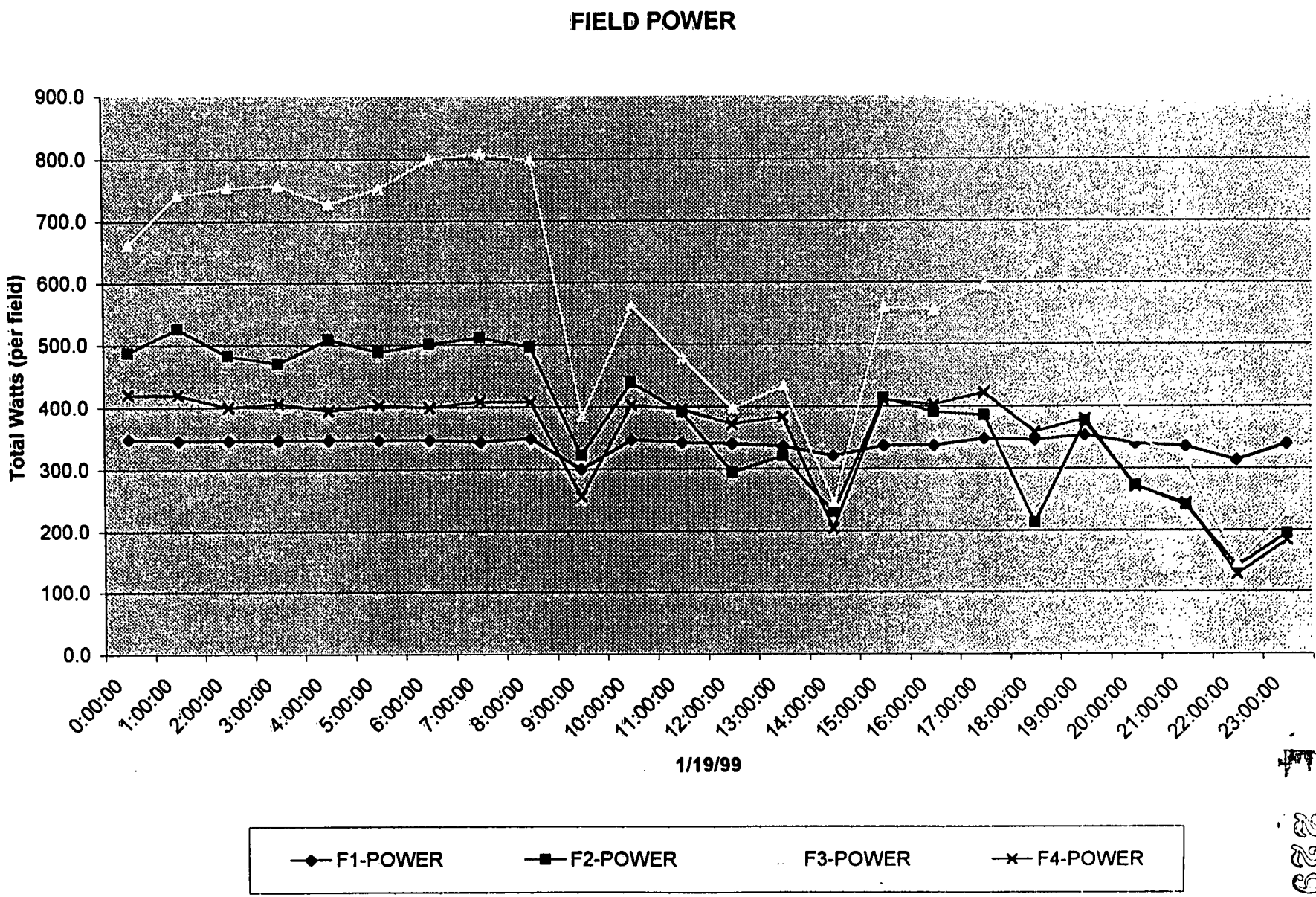
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/19/99
Start Date: 12/1/98
Days Operation: 30

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/19/99	0:00:00	347.8	487.9	661.4	419.6
1/19/99	1:00:00	345.8	525.6	741.3	418.8
1/19/99	2:00:00	345.8	482.2	753.6	399.3
1/19/99	3:00:00	346.7	470.3	757.0	405.0
1/19/99	4:00:00	346.7	508.4	727.7	393.9
1/19/99	5:00:00	346.7	488.5	752.4	402.9
1/19/99	6:00:00	346.7	501.2	798.1	398.4
1/19/99	7:00:00	343.8	511.2	807.9	408.7
1/19/99	8:00:00	348.5	496.2	796.9	407.5
1/19/99	9:00:00	299.2	321.8	382.7	255.8
1/19/99	10:00:00	346.9	439.4	561.6	401.8
1/19/99	11:00:00	342.2	391.2	478.0	395.6
1/19/99	12:00:00	339.5	294.0	396.4	371.3
1/19/99	13:00:00	335.7	320.3	432.1	383.1
1/19/99	14:00:00	320.3	229.9	246.2	204.1
1/19/99	15:00:00	336.7	413.3	558.9	410.2
1/19/99	16:00:00	336.7	390.8	554.9	401.8
1/19/99	17:00:00	347.3	385.0	595.4	421.8
1/19/99	18:00:00	345.3	212.4	543.7	358.2
1/19/99	19:00:00	352.8	375.1	535.8	378.8
1/19/99	20:00:00	339.8	272.6	350.0	270.3
1/19/99	21:00:00	335.4	240.2	313.7	243.7
1/19/99	22:00:00	312.8	141.5	146.9	128.0
1/19/99	23:00:00	338.9	194.6	228.5	183.2
DAILY AVERAGE		339.5	378.9	546.7	352.6

501


FIELD POWER
Total Watts (per field)
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/19/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

McGill AirClean Mobile EP
Daily Performance Report

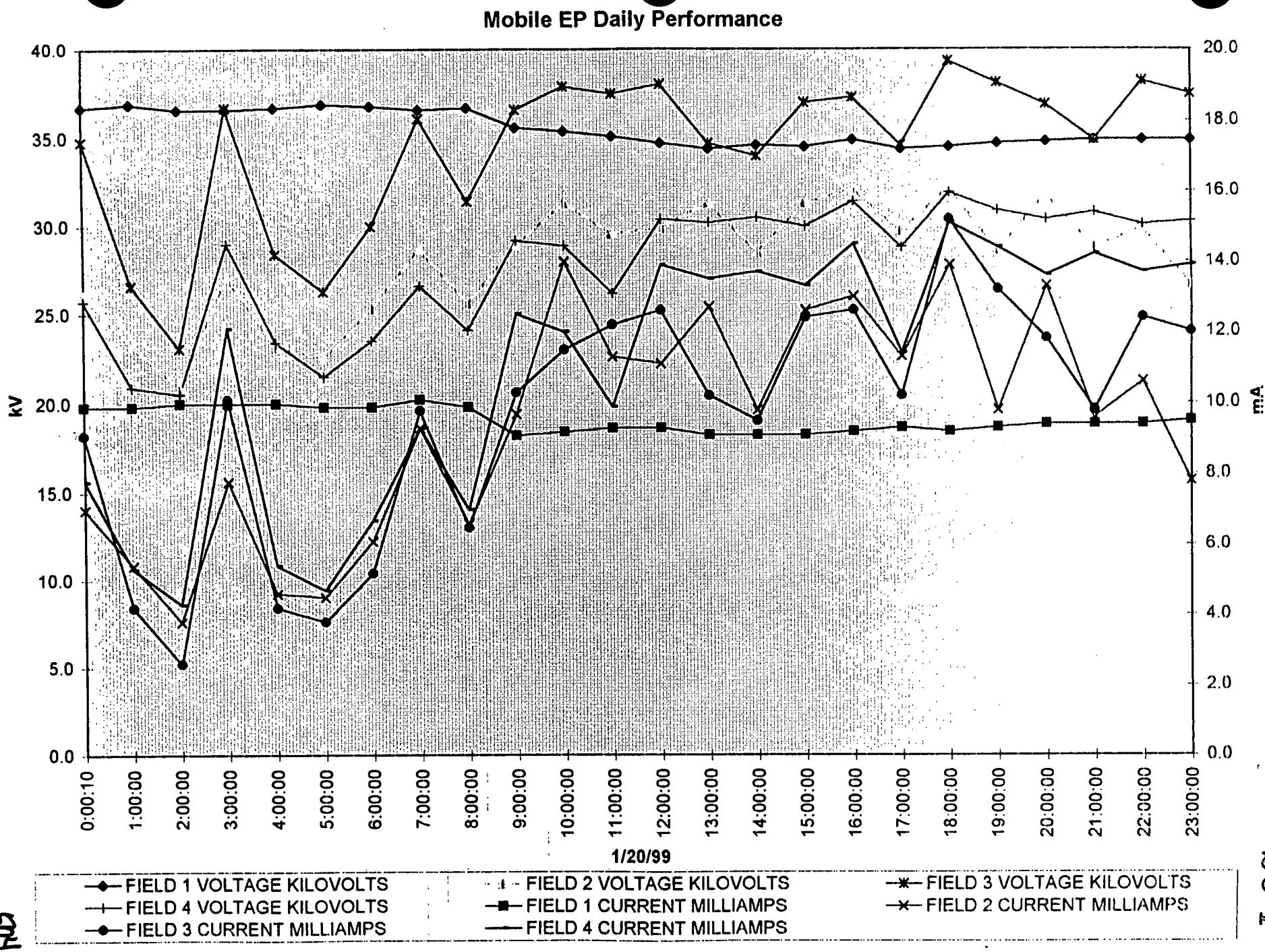
L 329 M

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/20/99
Start Date: 12/1/98
Days Operation: 31

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/20/99	0:00:10	36.7	9.9	26.1	7.0	34.8	9.1	25.7	7.8
1/20/99	1:00:00	36.9	9.9	23.2	5.4	26.6	4.2	20.9	5.3
1/20/99	2:00:00	36.6	10.0	20.9	3.8	23.1	2.6	20.5	4.3
1/20/99	3:00:00	36.6	10.0	27.1	7.8	36.7	10.1	29.0	12.1
1/20/99	4:00:00	36.7	10.0	23.2	4.6	28.4	4.2	23.4	5.4
1/20/99	5:00:00	36.9	9.9	22.5	4.5	26.3	3.8	21.5	4.7
1/20/99	6:00:00	36.8	9.9	25.3	6.1	30.0	5.2	23.5	6.7
1/20/99	7:00:00	36.6	10.1	28.7	9.3	36.1	9.8	26.6	9.3
1/20/99	8:00:00	36.7	9.9	25.6	6.6	31.4	6.5	24.1	7.0
[illegible]/99	9:00:00	35.6	9.1	28.9	9.7	36.6	10.3	29.2	12.5
[illegible]9	10:00:00	35.4	9.2	31.3	14.0	37.9	11.5	28.9	12.0
[illegible]/99	11:00:00	35.1	9.3	29.6	11.3	37.5	12.2	26.2	9.9
1/20/99	12:00:00	34.7	9.3	29.9	11.1	38.0	12.6	30.4	13.9
1/20/99	13:00:00	34.4	9.1	31.3	12.7	34.7	10.2	30.2	13.5
1/20/99	14:00:00	34.6	9.1	28.5	9.8	34.0	9.5	30.5	13.7
1/20/99	15:00:00	34.5	9.1	31.3	12.6	37.0	12.4	30.0	13.3
1/20/99	16:00:00	34.9	9.2	32.1	13.0	37.3	12.6	31.4	14.5
1/20/99	17:00:00	34.4	9.3	29.7	11.3	34.6	10.2	28.8	11.4
1/20/99	18:00:00	34.5	9.2	32.2	13.9	39.3	15.2	31.9	15.1
1/20/99	19:00:00	34.7	9.3	28.6	9.8	38.1	13.2	30.9	14.4
1/20/99	20:00:00	34.8	9.4	31.8	13.3	36.9	11.8	30.4	13.6
1/20/99	21:00:00	34.9	9.4	28.8	9.6	34.9	9.8	30.8	14.2
1/20/99	22:00:00	34.9	9.4	29.9	10.6	38.2	12.4	30.1	13.7
1/20/99	23:00:00	34.9	9.5	26.7	7.8	37.5	12.0	30.3	13.9
Daily Average		35.5	9.5	28.1	9.4	34.4	9.6	27.7	10.9

503


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/20/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

2291

204

McGill AirClean Mobile EP
Daily Performance Report

2291

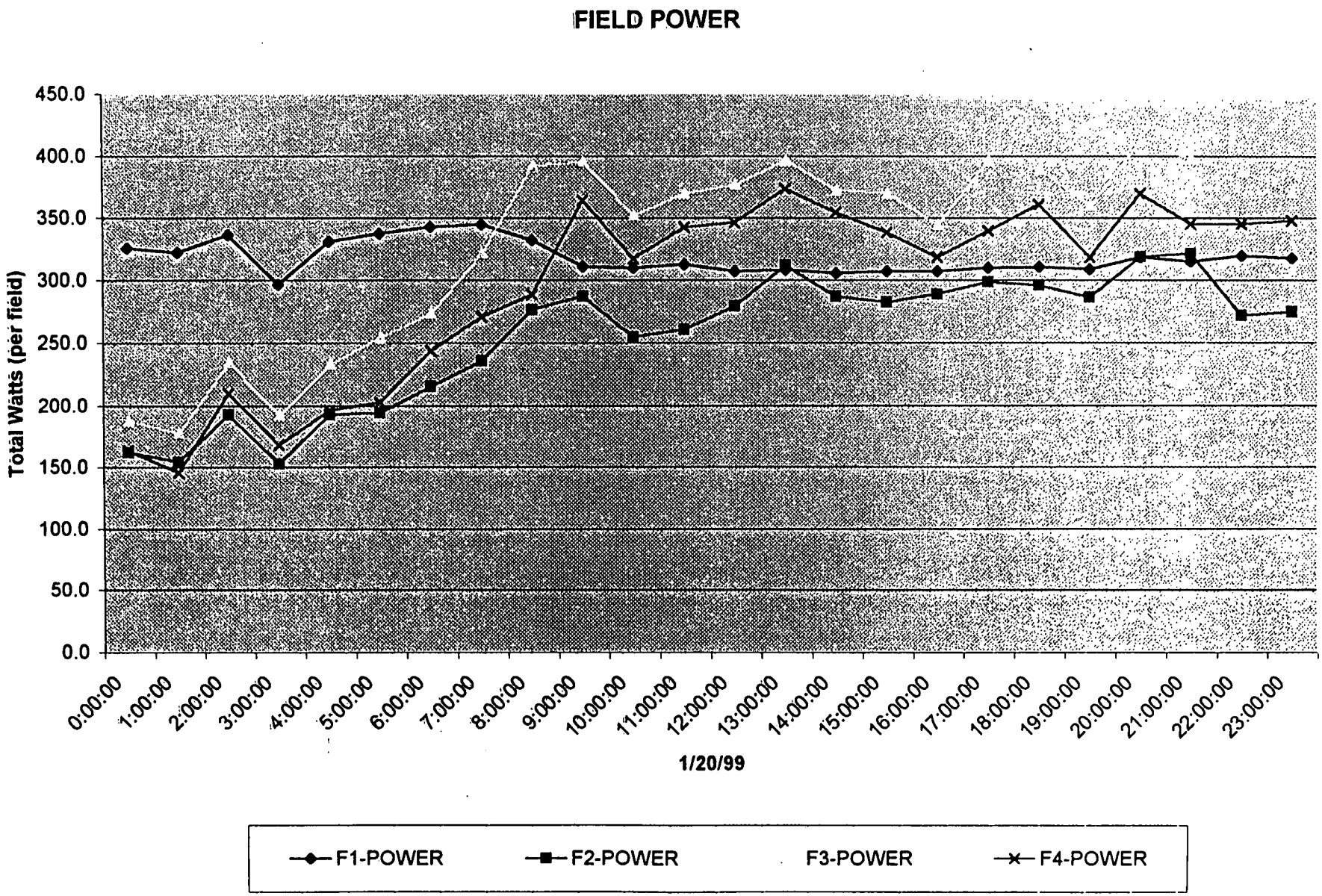
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/20/99
Start Date: 12/1/98
Days Operation: 31

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/20/99	0:00:00	325.2	162.1	187.5	163.3
1/20/99	1:00:00	321.8	154.2	177.5	145.6
1/20/99	2:00:00	336.3	192.8	234.6	210.0
1/20/99	3:00:00	296.4	152.8	192.1	167.8
1/20/99	4:00:00	330.9	192.8	233.1	195.9
1/20/99	5:00:00	337.3	194.3	254.3	202.5
1/20/99	6:00:00	342.7	215.5	273.1	243.5
1/20/99	7:00:00	344.6	235.6	321.1	270.7
1/20/99	8:00:00	332.0	276.5	391.6	288.3
1/20/99	9:00:00	310.6	287.0	395.3	364.1
1/20/99	10:00:00	309.6	254.8	352.0	316.9
1/20/99	11:00:00	312.1	260.4	369.6	342.4
1/20/99	12:00:00	306.9	279.2	376.6	346.1
1/20/99	13:00:00	307.8	311.4	396.5	373.8
1/20/99	14:00:00	305.1	286.8	372.4	354.2
1/20/99	15:00:00	306.7	282.0	370.2	338.0
1/20/99	16:00:00	306.7	288.7	344.4	318.1
1/20/99	17:00:00	309.4	298.5	396.5	339.2
1/20/99	18:00:00	310.3	295.6	389.4	360.8
1/20/99	19:00:00	308.5	285.8	359.8	318.1
1/20/99	20:00:00	318.1	318.3	411.5	369.6
1/20/99	21:00:00	314.6	321.2	397.4	344.9
1/20/99	22:00:00	319.0	271.6	388.0	344.9
1/20/99	23:00:00	317.4	274.4	370.7	347.7
DAILY AVERAGE		317.9	253.8	331.5	294.4

505

R20jan99b.xls


FIELD POWER
Total Watts (per field)
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/20/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

906

229 1

229 1

McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/21/99
Start Date: 12/1/98
Days Operation: 32

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/21/99	0:00:10	34.9	9.5	26.5	7.7	33.9	9.2	26.1	9.2
1/21/99	1:00:00	35.3	9.3	25.3	6.7	30.9	6.9	23.3	6.7
1/21/99	2:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/21/99	3:00:00	35.3	9.4	30.8	12.8	37.6	12.1	30.6	12.6
1/21/99	4:00:00	35.2	9.4	26.2	8.0	38.6	13.3	31.5	13.8
1/21/99	5:00:00	35.0	9.5	28.8	9.9	36.5	11.2	31.3	14.1
1/21/99	6:00:00	35.1	9.4	25.3	6.8	34.2	9.0	30.4	13.0
1/21/99	7:00:00	35.2	9.3	27.9	9.0	35.1	9.8	30.4	12.0
1/21/99	8:00:00	34.8	9.6	29.0	10.5	36.6	11.2	29.9	12.5
1/21/99	9:00:00	34.9	9.5	27.2	8.4	35.8	10.5	29.2	11.5
[illegible]	10:00:00	35.1	9.3	30.7	12.4	36.5	11.6	29.0	11.1
[illegible]99	11:00:00	34.6	9.5	28.0	9.4	34.5	9.5	29.6	12.2
1/21/99	12:00:00	34.5	9.1	22.0	4.8	26.3	4.3	21.2	4.7
1/21/99	13:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/21/99	14:00:00	35.0	9.6	21.8	4.4	24.7	3.4	21.0	5.1
1/21/99	15:00:00	35.2	9.5	24.5	6.6	33.5	8.7	29.5	12.8
1/21/99	16:00:00	35.3	9.2	26.4	8.2	29.6	6.3	24.2	7.6
1/21/99	17:00:00	34.7	9.6	26.8	9.4	33.3	9.6	24.5	9.1
1/21/99	18:00:00	34.4	9.8	25.7	8.5	33.1	9.0	26.9	10.5
1/21/99	19:00:00	34.8	9.7	25.3	7.5	39.0	0.4	26.9	10.5
1/21/99	20:00:00	34.9	9.8	24.0	6.1	38.1	0.2	22.9	6.7
1/21/99	21:00:00	34.9	9.6	27.1	8.2	39.1	0.3	25.7	8.9
1/21/99	22:00:00	35.4	9.4	27.5	8.8	35.6	0.7	30.8	14.0
1/21/99	23:00:00	35.4	9.7	29.1	10.5	38.9	0.4	29.7	13.6
Daily Average		32.1	8.7	24.4	7.7	31.7	6.6	25.2	9.7

509

Mobile EP Daily Performance

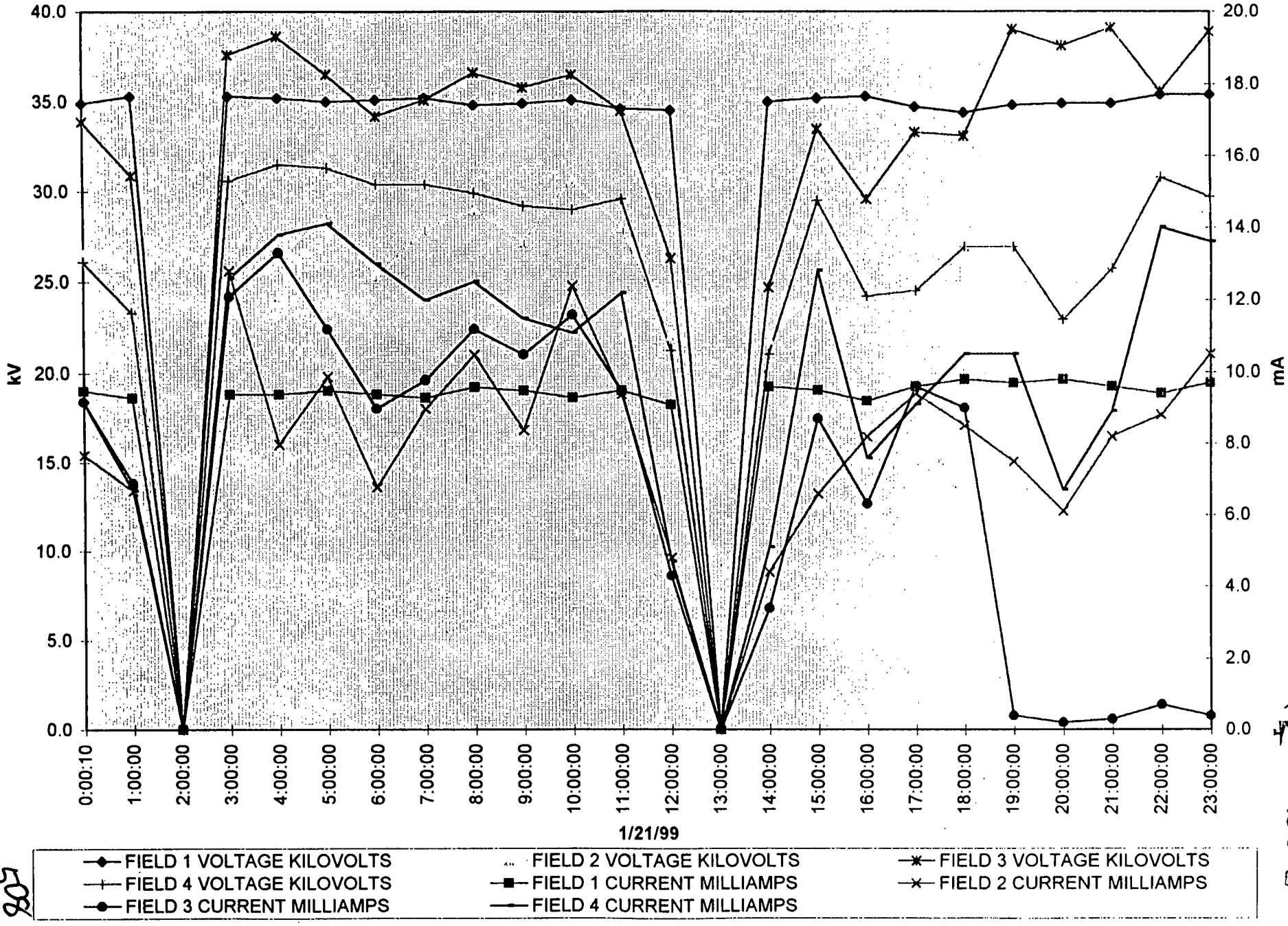


Fig 1

2229

205

McGill AirClean Mobile EP

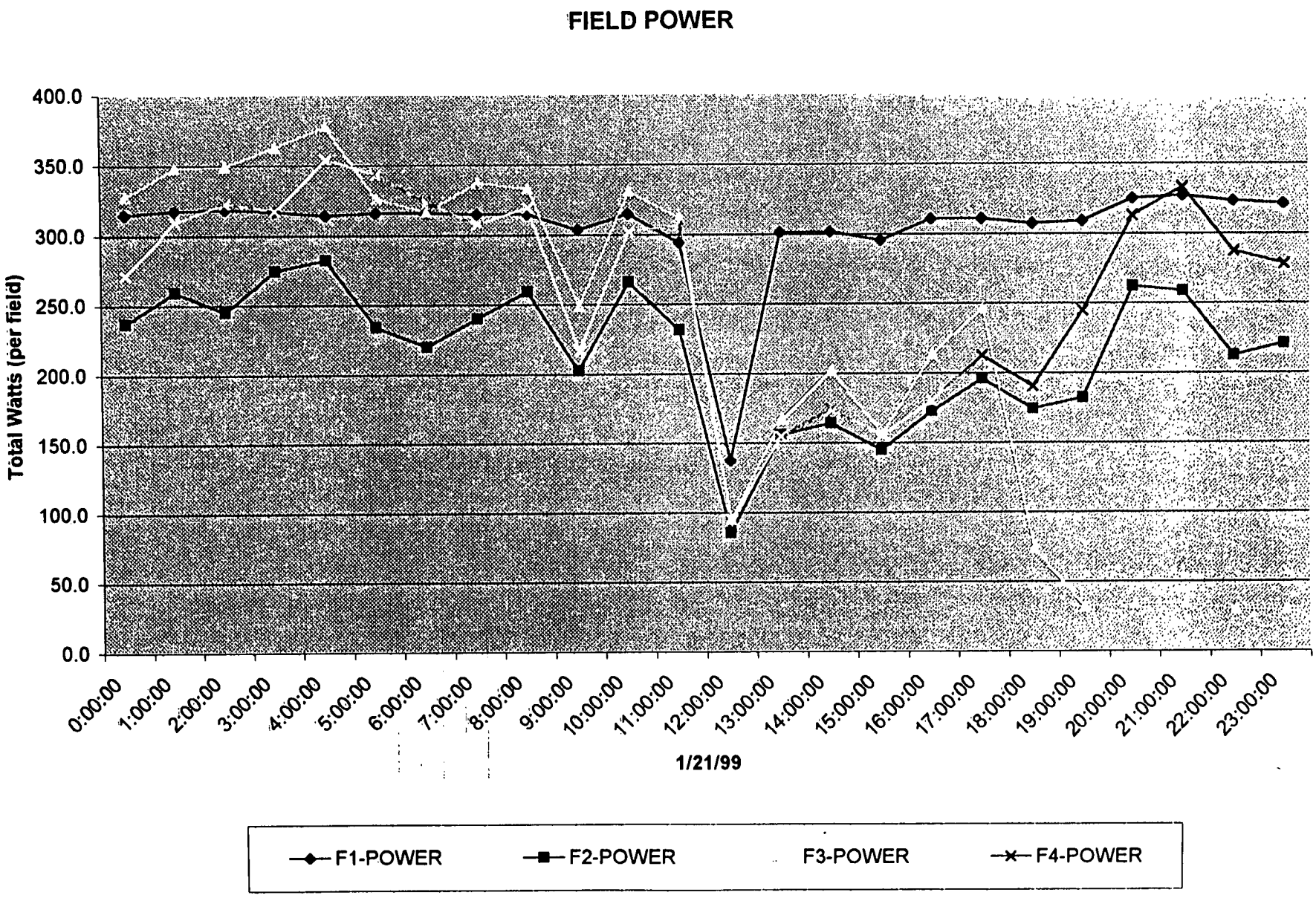
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/21/99
Start Date: 12/1/98
Days Operation: 32

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/21/99	0:00:00	314.6	236.7	327.4	271.3
1/21/99	1:00:00	317.4	259.4	348.0	309.1
1/21/99	2:00:00	318.3	244.8	349.0	322.6
1/21/99	3:00:00	316.5	274.4	362.6	317.5
1/21/99	4:00:00	314.0	282.0	377.4	354.0
1/21/99	5:00:00	315.6	234.0	325.9	343.4
1/21/99	6:00:00	315.6	220.0	316.2	323.2
1/21/99	7:00:00	314.6	240.3	337.1	307.4
1/21/99	8:00:00	314.6	259.4	332.7	319.2
1/21/99	9:00:00	303.3	202.2	248.9	216.8
1/21/99	10:00:00	314.6	265.9	330.8	302.4
1/21/99	11:00:00	293.9	231.4	311.6	306.3
1/21/99	12:00:00	137.3	85.4	95.0	95.2
1/21/99	13:00:00	301.2	155.8	166.8	154.6
1/21/99	14:00:00	301.5	163.9	202.2	174.0
1/21/99	15:00:00	295.2	144.9	156.6	155.4
1/21/99	16:00:00	310.6	172.5	213.8	180.2
1/21/99	17:00:00	310.6	195.8	246.4	212.3
1/21/99	18:00:00	306.9	174.2	73.3	190.4
1/21/99	19:00:00	308.8	182.0	32.0	244.4
1/21/99	20:00:00	324.9	262.2	33.6	312.4
1/21/99	21:00:00	326.8	258.5	33.8	333.2
1/21/99	22:00:00	323.0	212.4	30.0	287.3
1/21/99	23:00:00	321.1	221.0	29.9	277.7
DAILY AVERAGE		305.0	215.8	220.0	262.9

509


FIELD POWER
Total Watts (per field)
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/21/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

510

2291

2291

McGill AirClean Mobile EP
Daily Performance Report

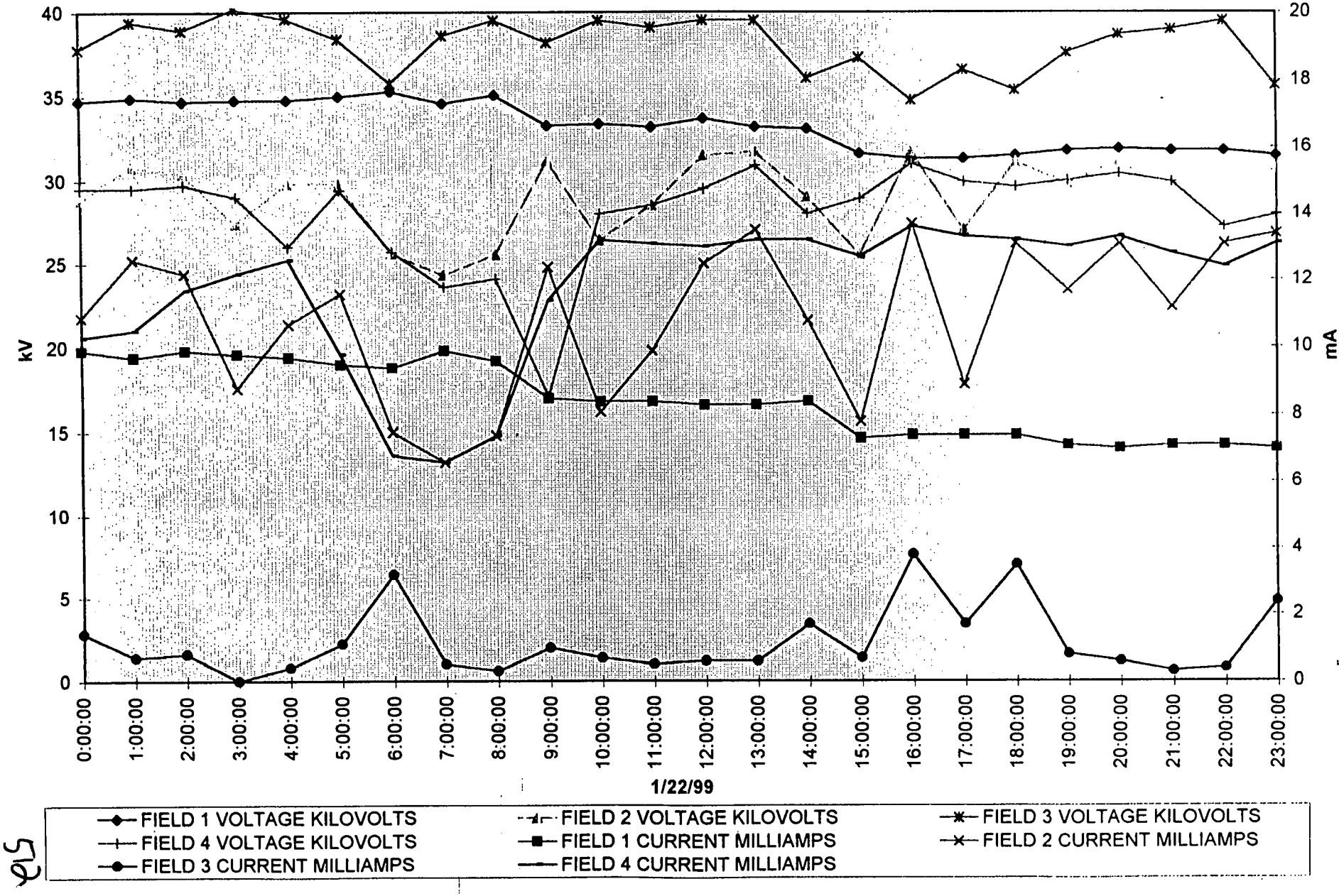
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/22/99
Start Date: 12/1/98
Days Operation: 33

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/22/99	0:00:00	34.7	9.9	28.8	10.9	37.8	1.4	29.5	10.3
1/22/99	1:00:00	34.9	9.7	30.8	12.6	39.4	0.7	29.5	10.5
1/22/99	2:00:00	34.7	9.9	30.4	12.2	38.9	0.8	29.7	11.7
1/22/99	3:00:00	34.8	9.8	27.4	8.8	40.2	0.0	29.0	12.2
1/22/99	4:00:00	34.8	9.7	29.8	10.7	39.6	0.4	26.0	12.6
1/22/99	5:00:00	35.0	9.5	29.8	11.6	38.4	1.1	29.4	9.8
1/22/99	6:00:00	35.3	9.4	25.6	7.5	35.8	3.2	25.7	6.8
1/22/99	7:00:00	34.6	9.9	24.3	6.6	38.6	0.5	23.6	6.6
1/22/99	8:00:00	35.1	9.6	25.5	7.4	39.5	0.3	24.1	7.4
1[illegible]	9:00:00	33.3	8.5	31.2	12.4	38.2	1.0	17.1	11.4
[illegible]	10:00:00	33.4	8.4	26.4	8.1	39.5	0.7	28.0	13.2
[illegible]/99	11:00:00	33.2	8.4	28.5	9.9	39.1	0.5	28.5	13.1
1/22/99	12:00:00	33.7	8.3	31.5	12.5	39.5	0.6	29.5	13.0
1/22/99	13:00:00	33.2	8.3	31.7	13.5	39.5	0.6	30.9	13.2
1/22/99	14:00:00	33.1	8.4	29.0	10.8	36.1	1.7	28.0	13.2
1/22/99	15:00:00	31.6	7.3	25.5	7.8	37.3	0.7	28.9	12.7
1/22/99	16:00:00	31.3	7.4	31.7	13.7	34.8	3.8	31.0	13.6
1/22/99	17:00:00	31.3	7.4	27.0	8.9	36.6	1.7	29.9	13.3
1/22/99	18:00:00	31.5	7.4	31.1	13.1	35.4	3.5	29.6	13.2
1/22/99	19:00:00	31.8	7.1	29.8	11.7	37.6	0.8	30.0	13.0
1/22/99	20:00:00	31.9	7.0	31.2	13.1	38.7	0.6	30.4	13.3
1/22/99	21:00:00	31.8	7.1	29.0	11.2	39.0	0.3	29.9	12.8
1/22/99	22:00:00	31.8	7.1	30.6	13.1	39.5	0.4	27.2	12.4
1/22/99	23:00:00	31.5	7.0	30.7	13.4	35.7	2.4	27.9	13.1
ily Average		33.3	8.4	29.1	10.9	38.1	1.2	28.1	11.8

511

Mobile EP Daily Performance



McGill AirClean Mobile EP

Daily Performance Report

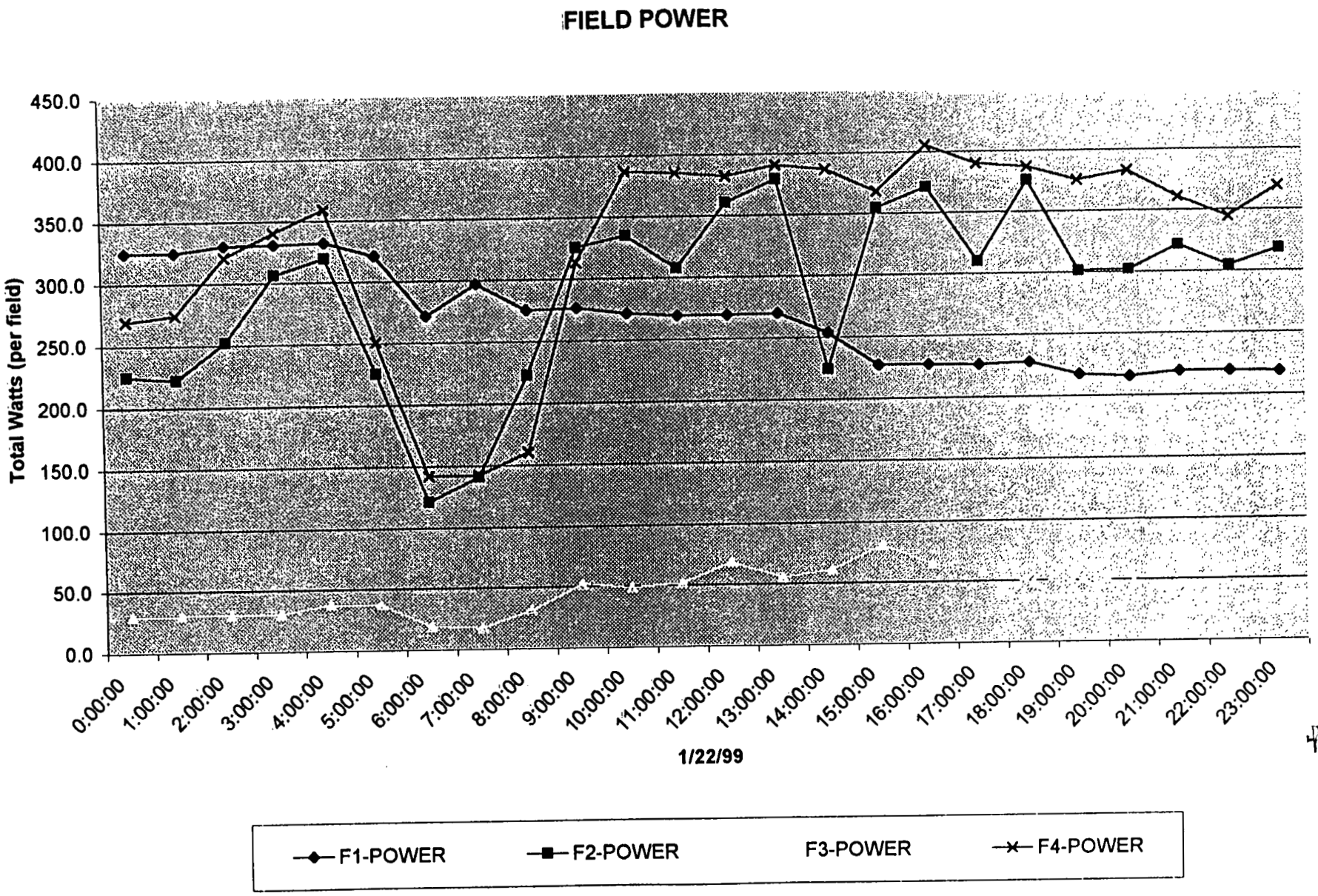
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/22/99
Start Date: 12/1/98
Days Operation: 33

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/22/99	0:00:00	324.5	224.5	29.8	268.8
1/22/99	1:00:00	324.5	221.9	29.9	274.1
1/22/99	2:00:00	329.8	252.0	30.4	320.6
1/22/99	3:00:00	330.8	306.0	30.3	340.4
1/22/99	4:00:00	331.7	319.0	37.8	359.1
1/22/99	5:00:00	320.5	225.3	37.1	250.9
1/22/99	6:00:00	271.4	120.8	19.0	142.1
1/22/99	7:00:00	296.7	140.7	17.2	142.6
1/22/99	8:00:00	275.2	222.7	31.5	160.6
1/22/99	9:00:00	276.4	325.2	52.1	313.5
1/22/99	10:00:00	271.4	334.5	48.5	386.8
1/22/99	11:00:00	269.0	307.4	51.8	385.1
1/22/99	12:00:00	269.0	360.6	68.8	382.2
1/22/99	13:00:00	269.8	379.4	55.4	390.7
1/22/99	14:00:00	253.6	224.4	61.4	386.8
1/22/99	15:00:00	227.0	354.6	80.7	368.3
1/22/99	16:00:00	227.0	371.5	64.8	405.3
1/22/99	17:00:00	226.3	310.0	58.4	389.7
1/22/99	18:00:00	227.8	375.7	48.2	386.8
1/22/99	19:00:00	217.4	301.0	51.4	375.7
1/22/99	20:00:00	215.3	301.7	47.6	383.0
1/22/99	21:00:00	219.1	321.4	37.5	361.0
1/22/99	22:00:00	219.1	304.6	44.8	344.7
1/22/99	23:00:00	218.4	318.1	40.9	369.4
DAILY AVERAGE		267.1	288.5	44.8	328.7

513


FIELD POWER
Total Watts (per field)
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/22/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

514

McGill AirClean Mobile EP
Daily Performance Report

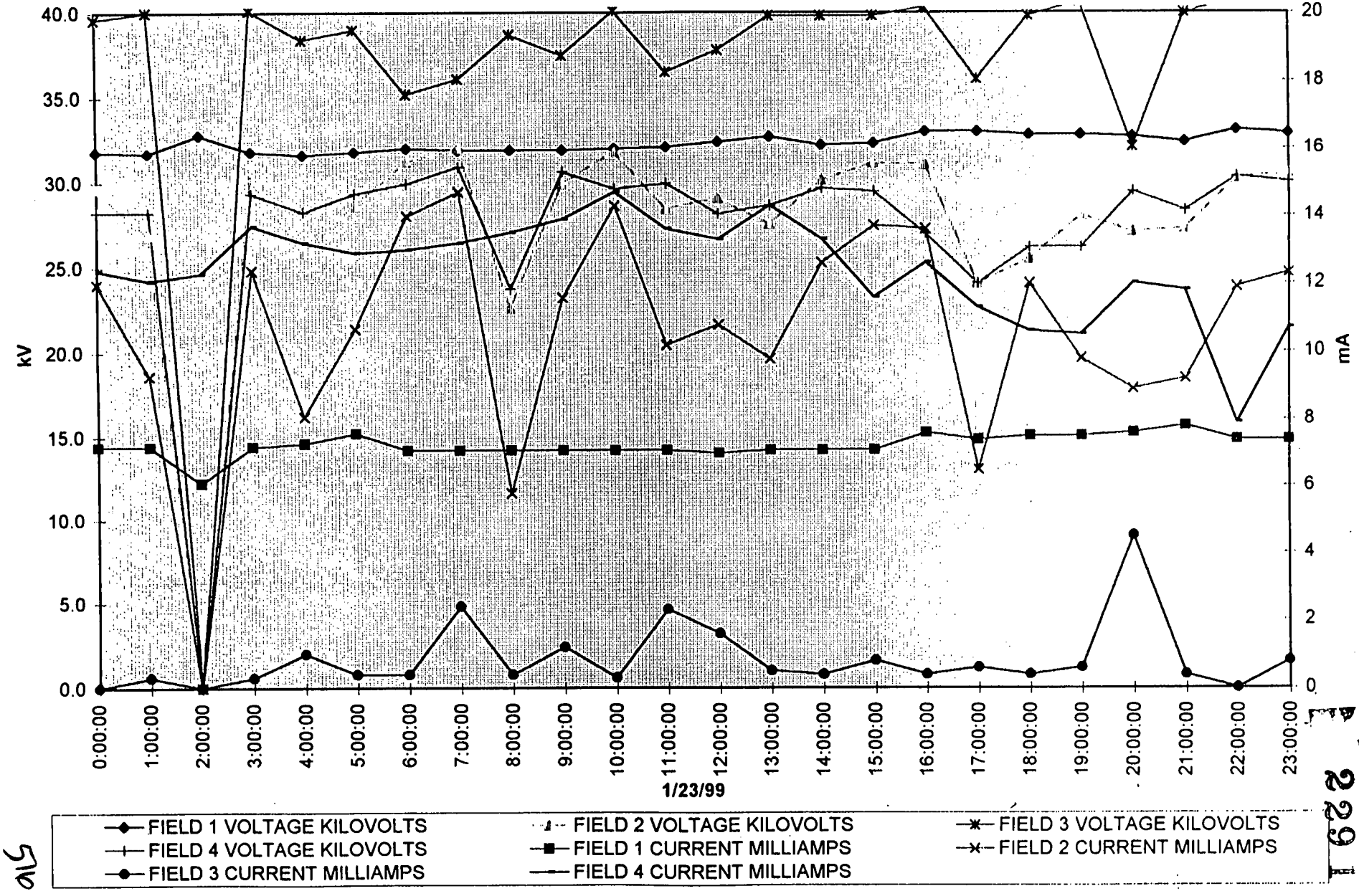
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/23/99
Start Date: 12/1/98
Days Operation: 34

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/23/99	0:00:00	31.8	7.2	29.6	12.0	39.6	0.0	28.2	12.4
1/23/99	1:00:00	31.7	7.2	26.9	9.3	40.0	0.3	28.2	12.1
1/23/99	2:00:00	32.8	6.1	0.0	0.0	0.0	0.0	0.0	12.3
1/23/99	3:00:00	31.8	7.2	30.2	12.4	40.1	0.3	29.3	13.7
1/23/99	4:00:00	31.6	7.3	25.8	8.1	38.4	1.0	28.2	13.2
1/23/99	5:00:00	31.8	7.6	28.6	10.7	39.0	0.4	29.3	12.9
1/23/99	6:00:00	32.0	7.1	31.2	14.0	35.2	0.4	29.9	13.0
1/23/99	7:00:00	31.9	7.1	32.0	14.7	36.1	2.4	30.9	13.2
1/23/99	8:00:00	31.9	7.1	22.6	5.8	38.7	0.4	23.7	13.5
1/23/99	9:00:00	31.9	7.1	29.9	11.6	37.5	1.2	30.6	13.9
1/23/99	10:00:00	32.0	7.1	31.8	14.3	40.1	0.3	29.6	14.7
1/23/99	11:00:00	32.1	7.1	28.4	10.2	36.5	2.3	29.9	13.6
1/23/99	12:00:00	32.4	7.0	29.0	10.8	37.8	1.6	28.1	13.3
1/23/99	13:00:00	32.7	7.1	27.5	9.8	39.8	0.5	28.6	14.3
1/23/99	14:00:00	32.2	7.1	30.1	12.6	39.8	0.4	29.6	13.3
1/23/99	15:00:00	32.3	7.1	31.1	13.7	39.8	0.8	29.4	11.6
1/23/99	16:00:00	33.0	7.6	31.0	13.6	40.3	0.4	26.9	12.6
1/23/99	17:00:00	33.0	7.4	24.0	6.5	36.1	0.6	24.0	11.3
1/23/99	18:00:00	32.8	7.5	25.4	12.0	39.8	0.4	26.1	10.6
1/23/99	19:00:00	32.8	7.5	28.0	9.8	40.6	0.6	26.1	10.5
1/23/99	20:00:00	32.7	7.6	27.0	8.9	32.1	4.5	29.4	12.0
1/23/99	21:00:00	32.4	7.8	27.2	9.2	40.0	0.4	28.3	11.8
1/23/99	22:00:00	33.1	7.4	30.2	11.9	40.7	0.0	30.3	7.9
1/23/99	23:00:00	32.9	7.4	30.5	12.3	40.8	0.8	30.0	10.7
Daily Average		32.3	7.2	27.4	10.6	37.0	0.8	27.3	12.4

515

Mobile EP Daily Performance



2291

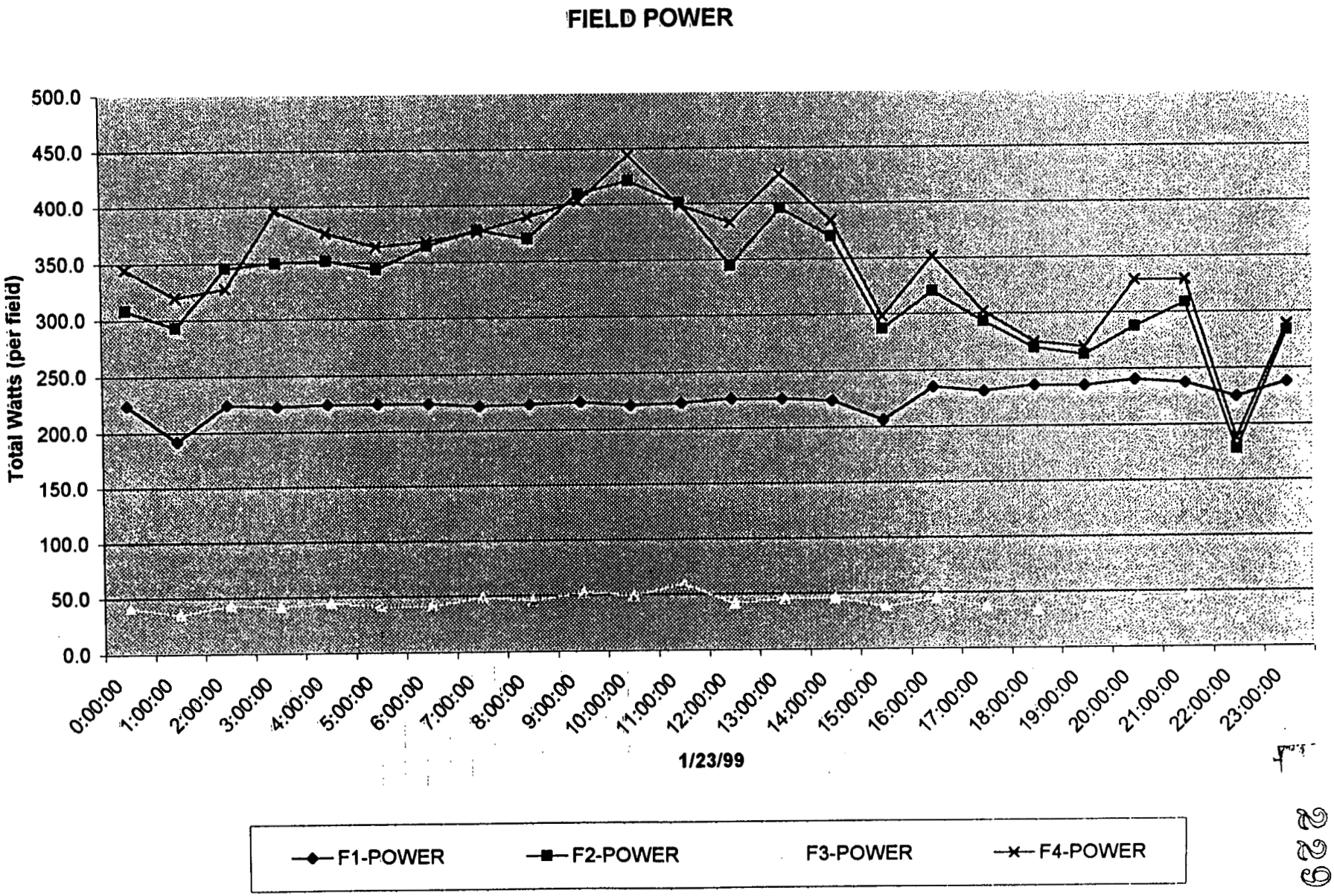
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/23/99
Start Date: 12/1/98
Days Operation: 34

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/23/99	0:00:00	223.9	308.5	41.4	344.7
1/23/99	1:00:00	191.8	292.7	35.3	319.4
1/23/99	2:00:00	223.7	345.1	43.3	327.2
1/23/99	3:00:00	222.2	349.9	41.4	395.9
1/23/99	4:00:00	223.7	351.6	45.0	376.2
1/23/99	5:00:00	223.7	343.4	41.1	363.8
1/23/99	6:00:00	223.7	364.1	41.4	367.9
1/23/99	7:00:00	221.2	378.0	48.9	376.2
1/23/99	8:00:00	222.6	369.5	45.6	388.8
1/23/99	9:00:00	224.4	410.0	52.6	403.1
1/23/99	10:00:00	220.8	421.2	49.1	443.9
1/23/99	11:00:00	222.6	400.9	59.5	398.5
1/23/99	12:00:00	225.8	344.6	41.7	383.0
1/23/99	13:00:00	225.4	395.2	45.8	426.1
1/23/99	14:00:00	223.3	369.5	45.8	384.4
1/23/99	15:00:00	205.6	286.8	37.8	298.1
1/23/99	16:00:00	235.1	320.3	44.9	351.5
1/23/99	17:00:00	231.1	293.0	37.3	301.7
1/23/99	18:00:00	236.1	269.3	33.8	274.5
1/23/99	19:00:00	235.3	262.9	37.5	269.9
1/23/99	20:00:00	240.0	287.4	45.0	328.8
1/23/99	21:00:00	237.3	308.9	45.4	329.2
1/23/99	22:00:00	224.6	177.4	25.1	188.0
1/23/99	23:00:00	237.5	283.6	37.9	288.9
DAILY AVERAGE		225.0	330.6	42.6	347.1

5M


FIELD POWER
Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/23/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

22911

518

McGill AirClean Mobile EP

Daily Performance Report

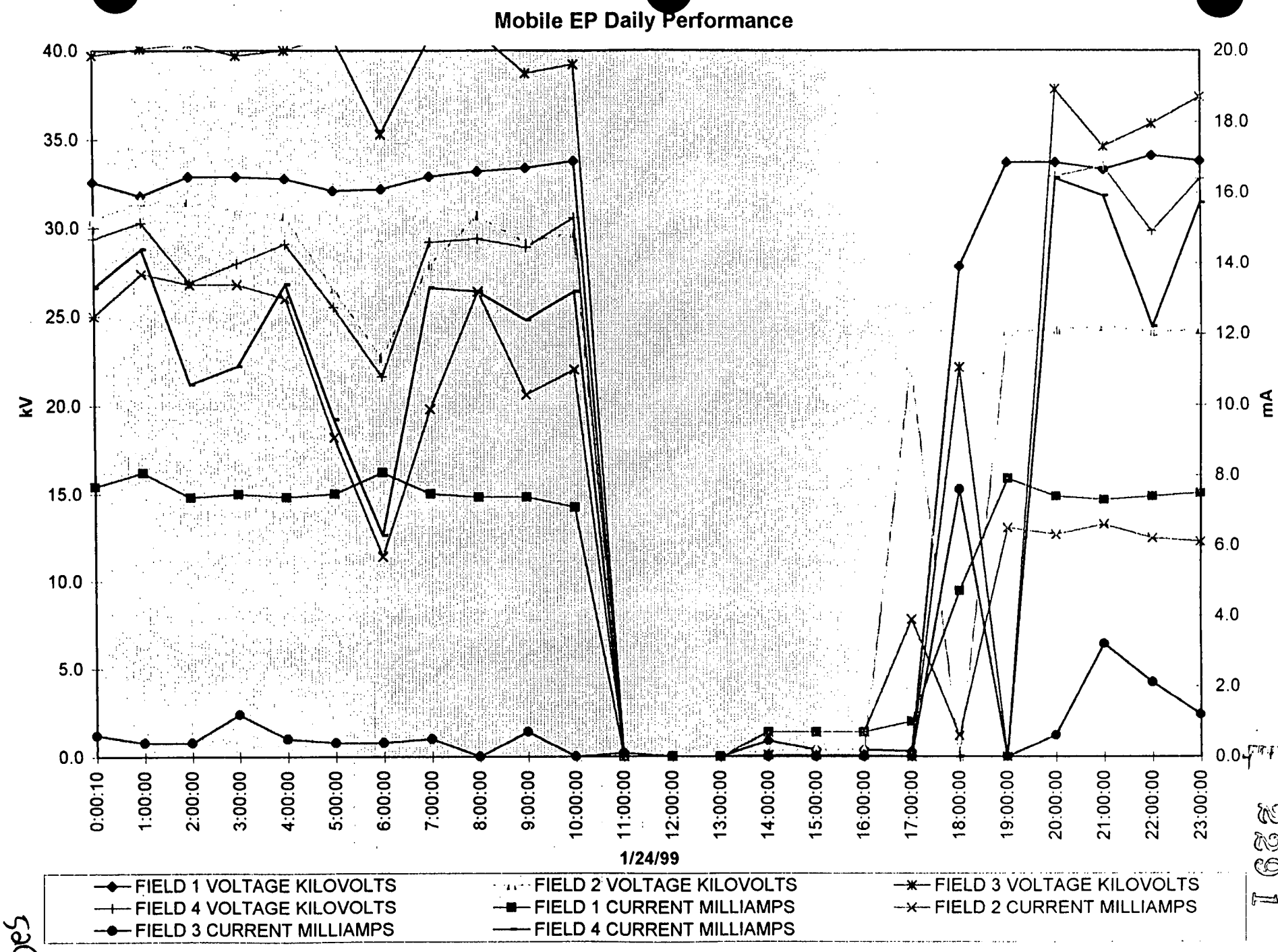
229

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/24/99
Start Date: 12/1/98
Days Operation: 35

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/24/99	0:00:10	32.6	7.7	30.4	12.5	39.7	0.6	29.4	13.3
1/24/99	1:00:00	31.8	8.1	31.5	13.7	40.1	0.4	30.3	14.4
1/24/99	2:00:00	32.9	7.4	31.5	13.4	40.4	0.4	26.9	10.6
1/24/99	3:00:00	32.9	7.5	31.0	13.4	39.7	1.2	28.0	11.1
1/24/99	4:00:00	32.8	7.4	30.7	13.0	40.0	0.5	29.1	13.4
1/24/99	5:00:00	32.1	7.5	26.6	9.1	40.8	0.4	25.5	9.6
1/24/99	6:00:00	32.2	8.1	22.7	5.7	35.3	0.4	21.6	6.3
1/24/99	7:00:00	32.9	7.5	27.9	9.9	40.6	0.5	29.2	13.3
1/24/99	8:00:00	33.2	7.4	30.7	13.2	41.1	0.0	29.4	13.2
1/24/99	9:00:00	33.4	7.4	29.2	10.3	38.7	0.7	28.9	12.4
1/24/99	10:00:00	33.8	7.1	29.7	11.0	39.2	0.0	30.6	13.2
1/24/99	11:00:00	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
1/24/99	12:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/24/99	13:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/24/99	14:00:00	0.9	0.7	0.4	0.7	0.1	0.0	0.0	0.0
1/24/99	15:00:00	0.4	0.7	0.4	0.7	0.1	0.0	0.0	0.0
1/24/99	16:00:00	0.4	0.7	0.4	0.7	0.1	0.0	0.0	0.0
1/24/99	17:00:00	0.3	1.0	22.2	3.9	0.0	0.0	0.0	0.0
1/24/99	18:00:00	27.8	4.7	0.0	0.6	22.1	7.6	0.0	0.0
1/24/99	19:00:00	33.7	7.9	24.1	6.5	0.0	0.0	0.0	0.0
1/24/99	20:00:00	33.7	7.4	24.2	6.3	37.8	0.6	32.9	16.4
1/24/99	21:00:00	33.3	7.3	24.4	6.6	34.6	3.2	33.5	15.9
1/24/99	22:00:00	34.1	7.4	24.1	6.2	35.9	2.1	29.8	12.2
1/24/99	23:00:00	33.8	7.5	24.2	6.1	37.4	1.2	32.8	15.7
Daily Average		25.4	5.8	21.2	7.4	27.4	0.9	19.9	8.7

579


Mobile EP Daily Performance
kV
mA
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/24/99
FIELD 1 VOLTAGE KILOVOLTS
FIELD 2 VOLTAGE KILOVOLTS
FIELD 3 VOLTAGE KILOVOLTS
FIELD 4 VOLTAGE KILOVOLTS
FIELD 1 CURRENT MILLIAMPS
FIELD 2 CURRENT MILLIAMPS
FIELD 3 CURRENT MILLIAMPS
FIELD 4 CURRENT MILLIAMPS

520

1 of 2

McGill AirClean Mobile EP
Daily Performance Report

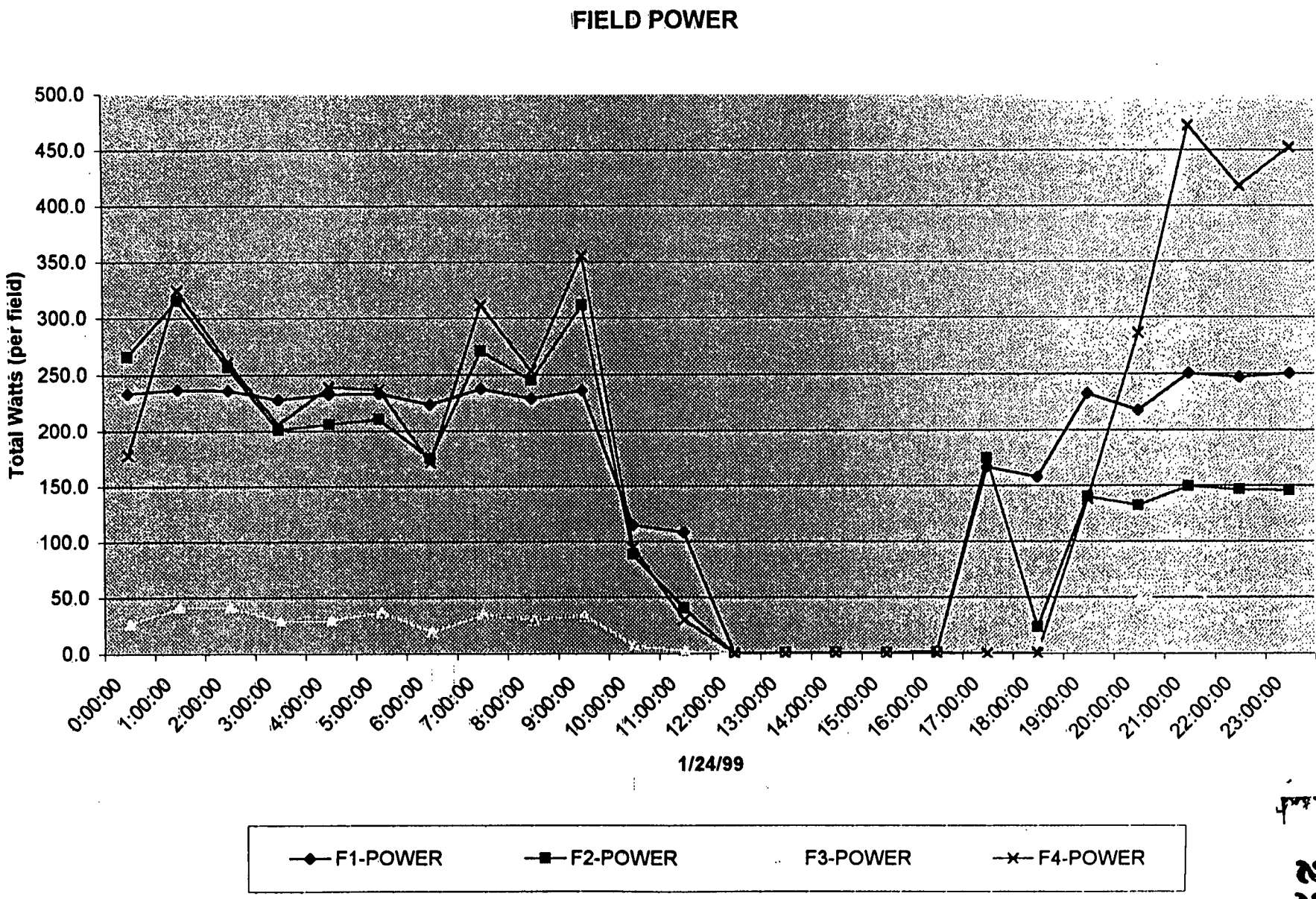
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/24/99
Start Date: 12/1/98
Days Operation: 35

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/24/99	0:00:00	233.3	266.0	27.0	177.8
1/24/99	1:00:00	236.8	315.7	41.3	324.5
1/24/99	2:00:00	236.1	256.5	41.3	260.6
1/24/99	3:00:00	227.8	200.9	29.2	205.5
1/24/99	4:00:00	232.4	205.8	30.1	239.0
1/24/99	5:00:00	233.1	210.0	37.3	236.6
1/24/99	6:00:00	223.5	174.8	19.1	170.9
1/24/99	7:00:00	237.3	270.5	34.9	311.2
1/24/99	8:00:00	228.6	244.8	30.2	252.8
1/24/99	9:00:00	235.7	311.4	34.0	355.5
1/24/99	10:00:00	114.4	88.4	7.0	94.6
1/24/99	11:00:00	108.1	40.5	2.0	30.0
1/24/99	12:00:00	0.0	0.1	0.0	0.0
1/24/99	13:00:00	0.6	0.3	0.0	0.0
1/24/99	14:00:00	0.4	0.3	0.0	0.0
1/24/99	15:00:00	0.3	0.3	0.0	0.0
1/24/99	16:00:00	1.7	1.0	0.1	0.1
1/24/99	17:00:00	166.2	174.7	2.0	0.0
1/24/99	18:00:00	157.2	23.7	10.5	0.0
1/24/99	19:00:00	232.4	139.7	33.3	137.7
1/24/99	20:00:00	217.3	132.2	48.5	286.2
1/24/99	21:00:00	250.1	149.4	57.8	471.9
1/24/99	22:00:00	246.7	146.4	29.9	417.5
1/24/99	23:00:00	250.1	145.2	30.1	451.9
DAILY AVERAGE		169.6	145.8	22.7	184.3

521


FIELD POWER
Total Watts (per field)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/24/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

2291

522

2291

McGill AirClean Mobile EP
Daily Performance Report

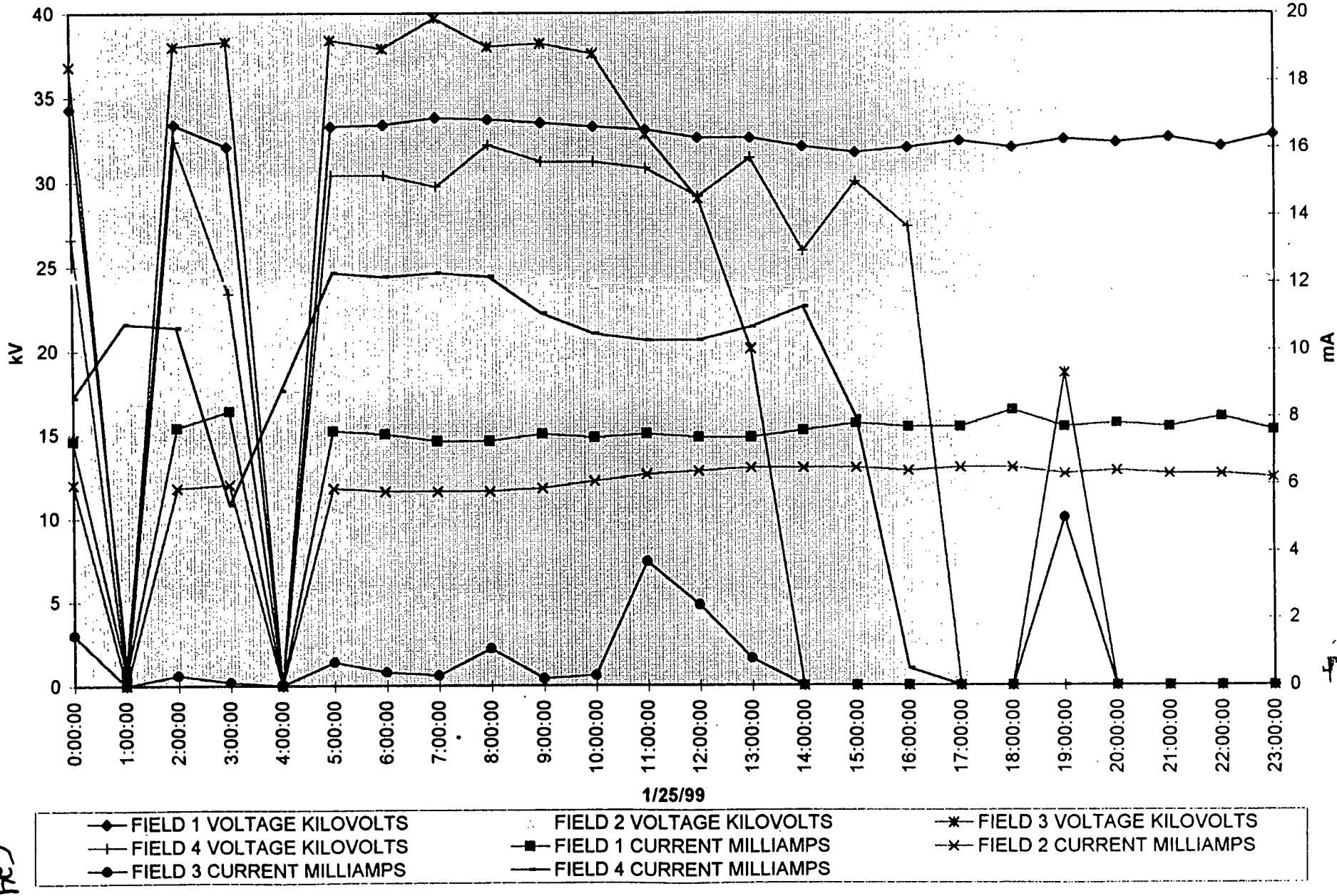
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/25/99
Start Date: 12/1/98
Days Operation: 36

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/25/99	0:00:00	34.3	7.3	24.4	6.0	36.8	1.5	26.6	8.6
1/25/99	1:00:00	1.1	0.3	0.4	0.0	0.2	0.0	0.0	10.8
1/25/99	2:00:00	33.4	7.7	24.5	5.9	38.0	0.3	32.4	10.7
1/25/99	3:00:00	32.1	8.2	24.3	6.0	38.3	0.1	23.4	5.4
1/25/99	4:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8
1/25/99	5:00:00	33.3	7.6	24.4	5.9	38.4	0.7	30.4	12.3
1/25/99	6:00:00	33.4	7.5	24.4	5.8	37.9	0.4	30.4	12.2
1/25/99	7:00:00	33.8	7.3	24.4	5.8	39.7	0.3	29.7	12.3
1/25/99	8:00:00	33.7	7.3	24.4	5.8	38.0	1.1	32.2	12.2
1/25/99	9:00:00	33.5	7.5	24.2	5.9	38.2	0.2	31.2	11.1
[illegible]	10:00:00	33.3	7.4	24.0	6.1	37.6	0.3	31.2	10.5
[illegible]	11:00:00	33.1	7.5	23.9	6.3	32.8	3.7	30.8	10.3
1/25/99	12:00:00	32.6	7.4	23.9	6.4	29.0	2.4	29.1	10.3
1/25/99	13:00:00	32.6	7.4	23.9	6.5	20.1	0.8	31.4	10.7
1/25/99	14:00:00	32.1	7.6	23.8	6.5	0.0	0.0	25.9	11.3
1/25/99	15:00:00	31.7	7.8	23.6	6.5	0.0	0.0	30.0	8.0
1/25/99	16:00:00	32.0	7.7	23.8	6.4	0.0	0.0	27.3	0.5
1/25/99	17:00:00	32.4	7.7	23.7	6.5	0.0	0.0	0.0	0.0
1/25/99	18:00:00	32.0	8.2	23.5	6.5	0.0	0.0	0.0	0.0
1/25/99	19:00:00	32.5	7.7	24.0	6.3	18.6	5.0	0.0	0.0
1/25/99	20:00:00	32.3	7.8	23.7	6.4	0.0	0.0	0.0	0.0
1/25/99	21:00:00	32.6	7.7	24.1	6.3	0.0	0.0	0.0	0.0
1/25/99	22:00:00	32.1	8.0	24.2	6.3	0.0	0.0	0.0	0.0
1/25/99	23:00:00	32.8	7.6	24.4	6.2	0.0	0.0	0.0	0.0
Daily Average		30.1	7.0	22.1	5.7	18.5	0.7	18.4	6.9

523

Mobile EP Daily Performance



1622

McGill AirClean Mobile EP
Daily Performance Report

2291

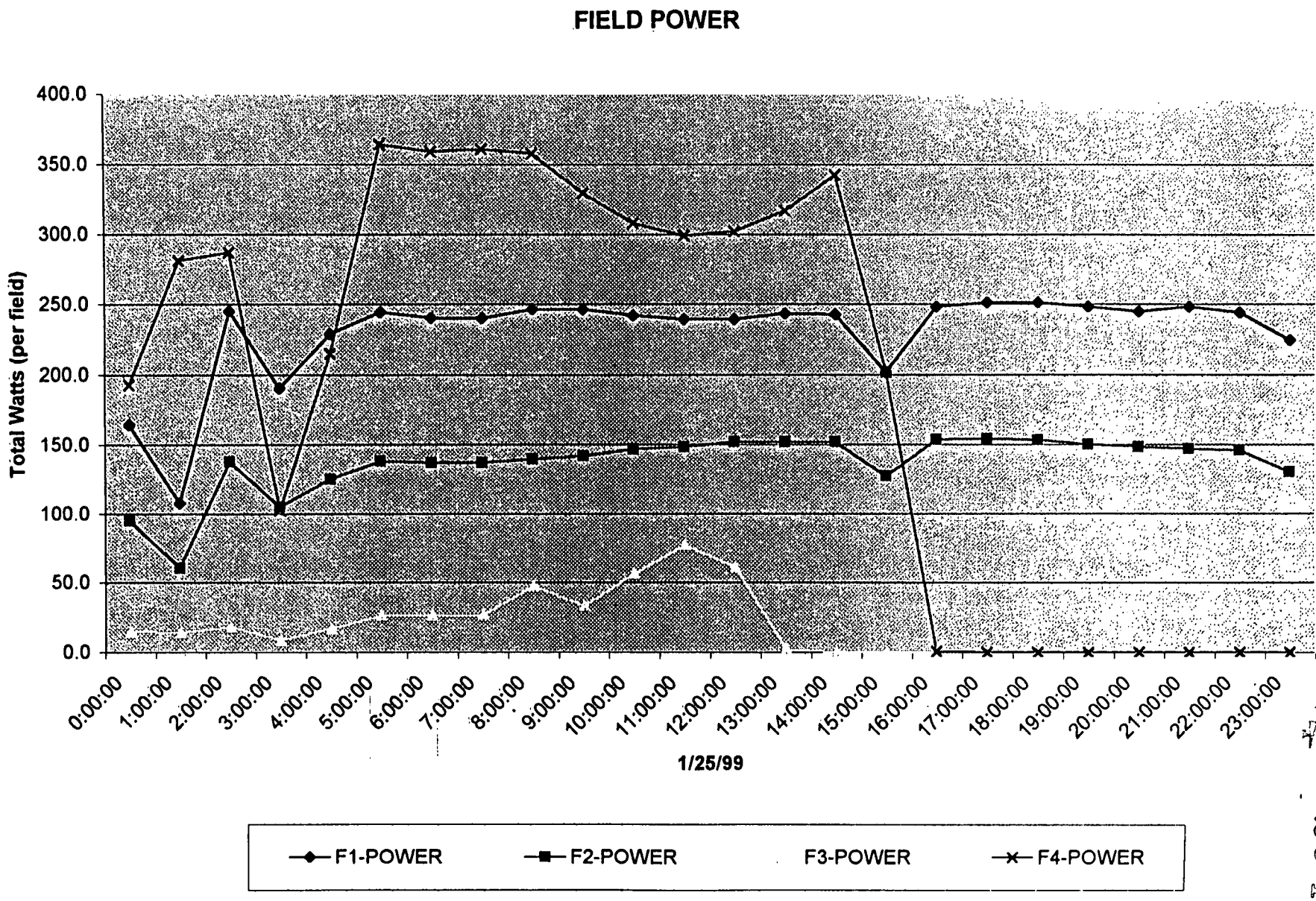
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/25/99
Start Date: 12/1/98
Days Operation: 36

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/25/99	0:00:00	164.0	94.6	14.9	192.6
1/25/99	1:00:00	107.5	60.4	13.8	280.8
1/25/99	2:00:00	244.9	137.5	17.9	286.8
1/25/99	3:00:00	190.3	104.6	8.6	102.1
1/25/99	4:00:00	228.8	124.9	16.9	214.7
1/25/99	5:00:00	244.2	137.9	26.2	364.1
1/25/99	6:00:00	240.2	136.8	26.0	358.7
1/25/99	7:00:00	239.8	136.8	26.9	360.4
1/25/99	8:00:00	246.4	139.2	47.2	357.5
1/25/99	9:00:00	246.4	141.6	32.9	329.7
1/25/99	10:00:00	242.0	146.3	56.2	307.7
1/25/99	11:00:00	239.0	148.1	76.8	298.7
1/25/99	12:00:00	239.0	151.7	61.0	301.8
1/25/99	13:00:00	243.2	151.7	2.2	316.7
1/25/99	14:00:00	242.4	151.7	0.0	342.4
1/25/99	15:00:00	201.6	126.9	0.0	201.6
1/25/99	16:00:00	247.9	153.4	0.0	0.8
1/25/99	17:00:00	251.2	154.1	0.0	0.0
1/25/99	18:00:00	251.2	153.0	0.1	0.0
1/25/99	19:00:00	247.9	149.9	0.1	0.0
1/25/99	20:00:00	244.7	148.2	0.0	0.0
1/25/99	21:00:00	248.0	146.9	0.0	0.0
1/25/99	22:00:00	244.0	145.8	0.0	0.0
1/25/99	23:00:00	224.2	130.0	0.0	0.0
DAILY AVERAGE		229.9	136.3	17.8	192.4

525

R25jan99b.xls


FIELD POWER
Total Watts (per field)
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/25/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

526

2291

McGill AirClean Mobile EP
Daily Performance Report

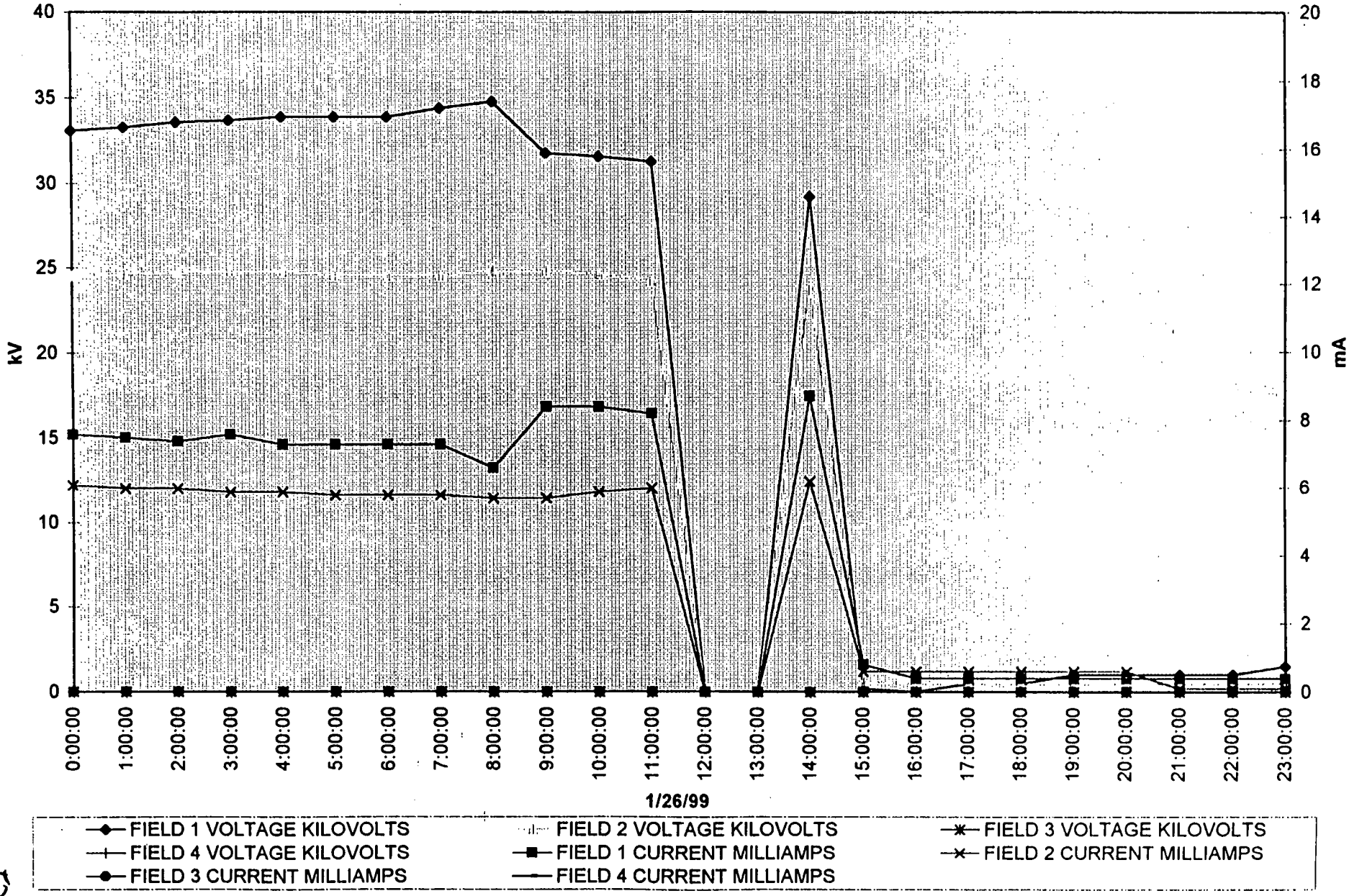
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/26/99
Start Date: 12/1/98
Days Operation: 37

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/26/99	0:00:00	33.1	7.6	24.5	6.1	0.0	0.0	0.0	0.0
1/26/99	1:00:00	33.3	7.5	24.6	6.0	0.0	0.0	0.0	0.0
1/26/99	2:00:00	33.6	7.4	24.7	6.0	0.0	0.0	0.0	0.0
1/26/99	3:00:00	33.7	7.6	24.8	5.9	0.0	0.0	0.0	0.0
1/26/99	4:00:00	33.9	7.3	24.8	5.9	0.0	0.0	0.0	0.0
1/26/99	5:00:00	33.9	7.3	24.5	5.8	0.0	0.0	0.0	0.0
1/26/99	6:00:00	33.9	7.3	24.5	5.8	0.0	0.0	0.0	0.0
1/26/99	7:00:00	34.4	7.3	24.5	5.8	0.0	0.0	0.0	0.0
1/26/99	8:00:00	34.8	6.6	24.8	5.7	0.0	0.0	0.0	0.0
1/26/99	9:00:00	31.8	8.4	24.8	5.7	0.0	0.0	0.0	0.0
[illegible]	10:00:00	31.6	8.4	24.6	5.9	0.0	0.0	0.0	0.0
[illegible]	11:00:00	31.3	8.2	24.2	6.0	0.0	0.0	0.0	0.0
[illegible]	12:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/26/99	13:00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/26/99	14:00:00	29.2	8.7	23.9	6.2	0.0	0.0	0.0	0.0
1/26/99	15:00:00	0.2	0.8	0.6	0.6	0.0	0.0	0.0	0.0
1/26/99	16:00:00	0.0	0.4	0.5	0.6	0.0	0.0	0.0	0.0
1/26/99	17:00:00	0.5	0.4	0.5	0.6	0.0	0.0	0.0	0.0
1/26/99	18:00:00	0.5	0.4	0.5	0.6	0.0	0.0	0.0	0.0
1/26/99	19:00:00	1.0	0.4	0.5	0.6	0.0	0.0	0.0	0.0
1/26/99	20:00:00	1.0	0.4	0.5	0.6	0.0	0.0	0.0	0.0
1/26/99	21:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/26/99	22:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/26/99	23:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
ily Average		18.1	4.3	13.5	3.4	0.0	0.0	0.0	0.0

527

Mobile EP Daily Performance



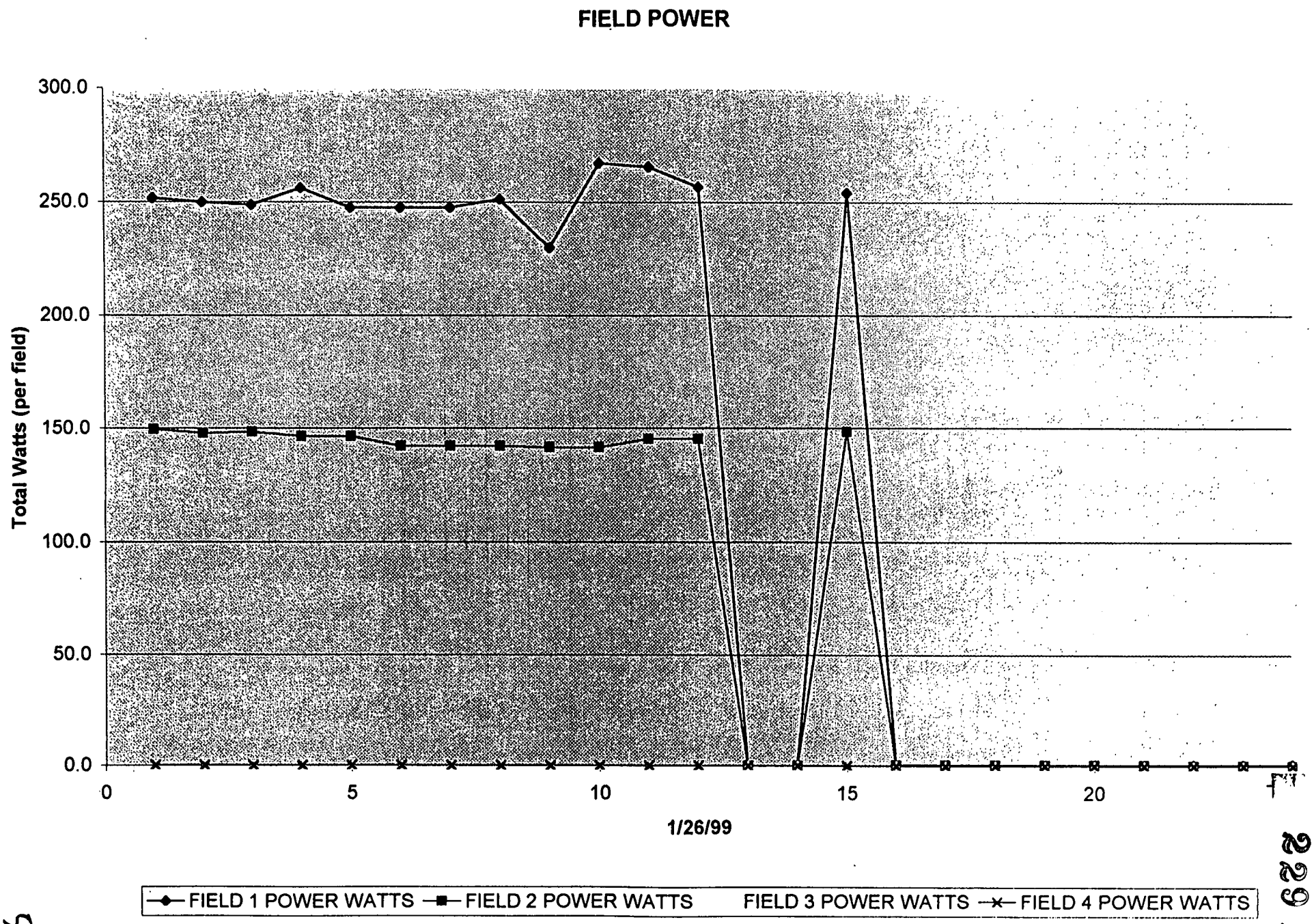
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/26/99
Start Date: 12/1/98
Days Operation: 37

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/26/99	0:00:00	251.6	149.5	0.0	0.0
1/26/99	1:00:00	249.8	147.6	0.0	0.0
1/26/99	2:00:00	248.6	148.2	0.0	0.0
1/26/99	3:00:00	256.1	146.3	0.0	0.0
1/26/99	4:00:00	247.5	146.3	0.0	0.0
1/26/99	5:00:00	247.5	142.1	0.0	0.0
1/26/99	6:00:00	247.5	142.1	0.0	0.0
1/26/99	7:00:00	251.1	142.1	0.0	0.0
1/26/99	8:00:00	229.7	141.4	0.0	0.0
1/26/99	9:00:00	267.1	141.4	0.0	0.0
1/26/99	10:00:00	265.4	145.1	0.0	0.0
1/26/99	11:00:00	256.7	145.2	0.0	0.0
1/26/99	12:00:00	0.0	0.0	0.0	0.0
1/26/99	13:00:00	0.0	0.0	0.0	0.0
1/26/99	14:00:00	254.0	148.2	0.0	0.0
1/26/99	15:00:00	0.2	0.4	0.0	0.0
1/26/99	16:00:00	0.0	0.3	0.0	0.0
1/26/99	17:00:00	0.2	0.3	0.0	0.0
1/26/99	18:00:00	0.2	0.3	0.0	0.0
1/26/99	19:00:00	0.4	0.3	0.0	0.0
1/26/99	20:00:00	0.4	0.3	0.0	0.0
1/26/99	21:00:00	0.4	0.1	0.0	0.0
1/26/99	22:00:00	0.4	0.1	0.0	0.0
1/26/99	23:00:00	0.6	0.1	0.0	0.0
DAILY AVERAGE		136.5	78.6	0.0	0.0

529


FIELD POWER
Total Watts (per field)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0
5
10
15
20
1/26/99
FIELD 1 POWER WATTS
FIELD 2 POWER WATTS
FIELD 3 POWER WATTS
FIELD 4 POWER WATTS

22291

McGill AirClean Mobile EP
Daily Performance Report

2291

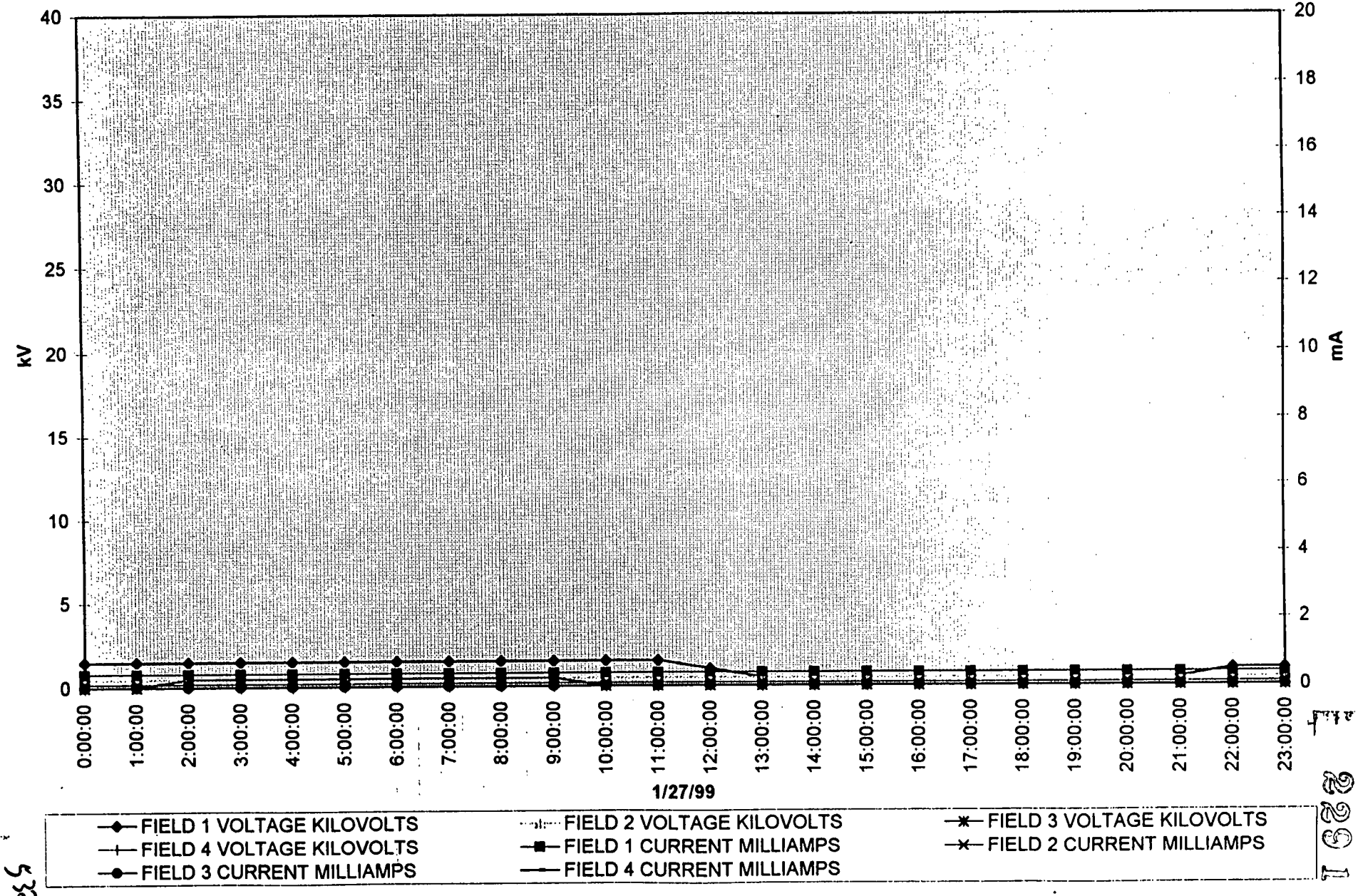
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/27/99
Start Date: 12/1/98
Days Operation: 38

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/27/99	0:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	1:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	2:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
1/27/99	3:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
1/27/99	4:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
1/27/99	5:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
1/27/99	6:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
1/27/99	7:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
1/27/99	8:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
1/27/99	9:00:00	1.5	0.4	0.5	0.1	0.5	0.0	0.0	0.0
[illegible]	10:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
[illegible]	11:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	12:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	13:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	14:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	15:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	16:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	17:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	18:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	19:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	20:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	21:00:00	0.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	22:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/27/99	23:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
ily Average		1.1	0.4	0.5	0.1	0.2	0.0	0.0	0.0

531

Mobile EP Daily Performance



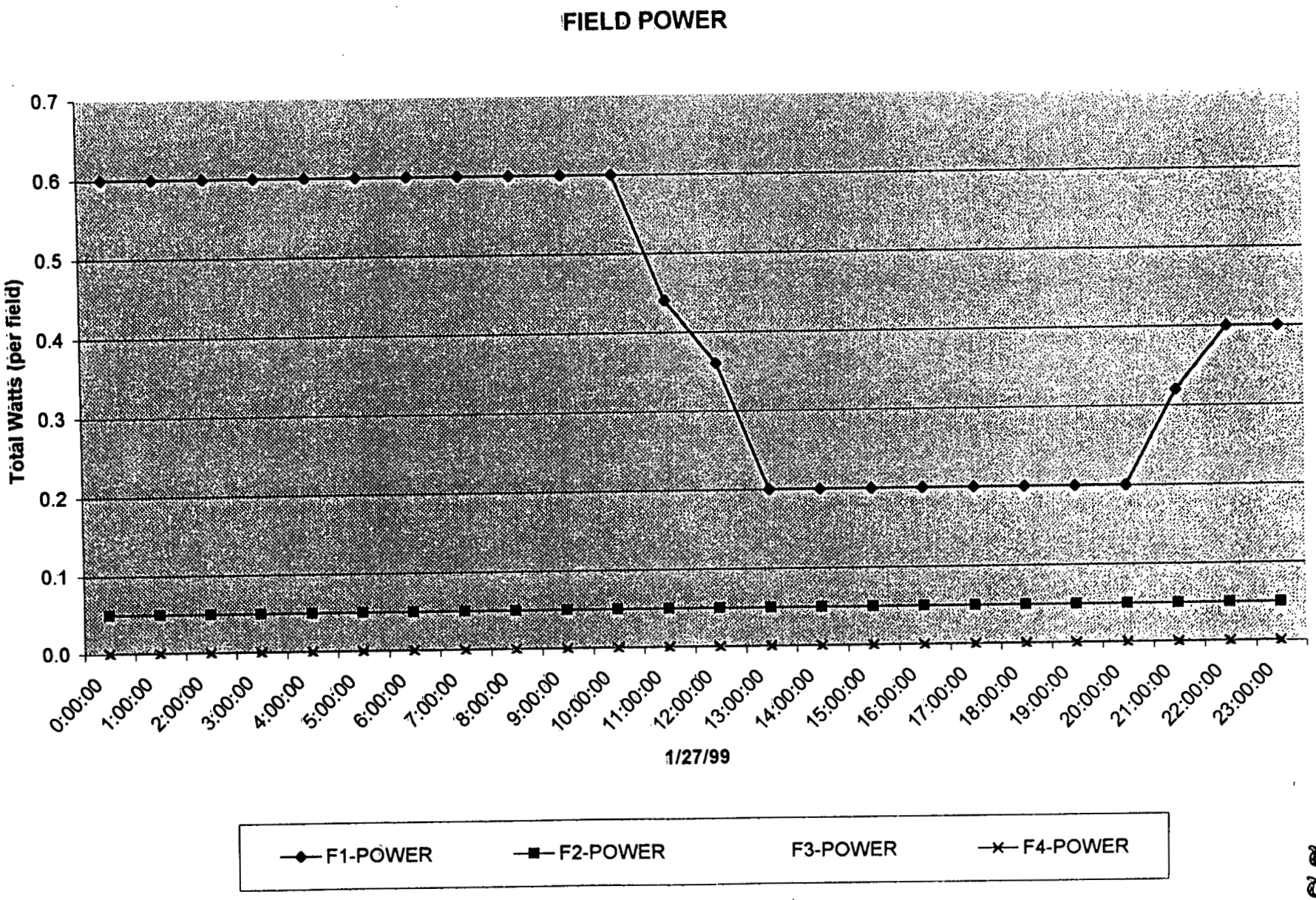
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/27/99
Start Date: 12/1/98
Days Operation: 38

Date	Time	FIELD 1 POWER WATTS	FIELD 2 POWER WATTS	FIELD 3 POWER WATTS	FIELD 4 POWER WATTS
1/27/99	0:00:00	0.6	0.1	0.0	0.0
1/27/99	1:00:00	0.6	0.1	0.0	0.0
1/27/99	2:00:00	0.6	0.1	0.0	0.0
1/27/99	3:00:00	0.6	0.1	0.0	0.0
1/27/99	4:00:00	0.6	0.1	0.0	0.0
1/27/99	5:00:00	0.6	0.1	0.0	0.0
1/27/99	6:00:00	0.6	0.1	0.0	0.0
1/27/99	7:00:00	0.6	0.1	0.0	0.0
1/27/99	8:00:00	0.6	0.1	0.0	0.0
1/27/99	9:00:00	0.6	0.1	0.0	0.0
1/27/99	10:00:00	0.6	0.1	0.0	0.0
1/27/99	11:00:00	0.4	0.1	0.0	0.0
1/27/99	12:00:00	0.4	0.1	0.0	0.0
1/27/99	13:00:00	0.2	0.1	0.0	0.0
1/27/99	14:00:00	0.2	0.1	0.0	0.0
1/27/99	15:00:00	0.2	0.1	0.0	0.0
1/27/99	16:00:00	0.2	0.1	0.0	0.0
1/27/99	17:00:00	0.2	0.1	0.0	0.0
1/27/99	18:00:00	0.2	0.1	0.0	0.0
1/27/99	19:00:00	0.2	0.1	0.0	0.0
1/27/99	20:00:00	0.2	0.1	0.0	0.0
1/27/99	21:00:00	0.3	0.1	0.0	0.0
1/27/99	22:00:00	0.4	0.1	0.0	0.0
1/27/99	23:00:00	0.4	0.1	0.0	0.0
DAILY AVERAGE		0.4	0.1	0.0	0.0

533


FIELD POWER
Total Watts (per field)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:00:00
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/27/99
F1-POWER
F2-POWER
F3-POWER
F4-POWER

534

McGill AirClean Mobile EP
Daily Performance Report

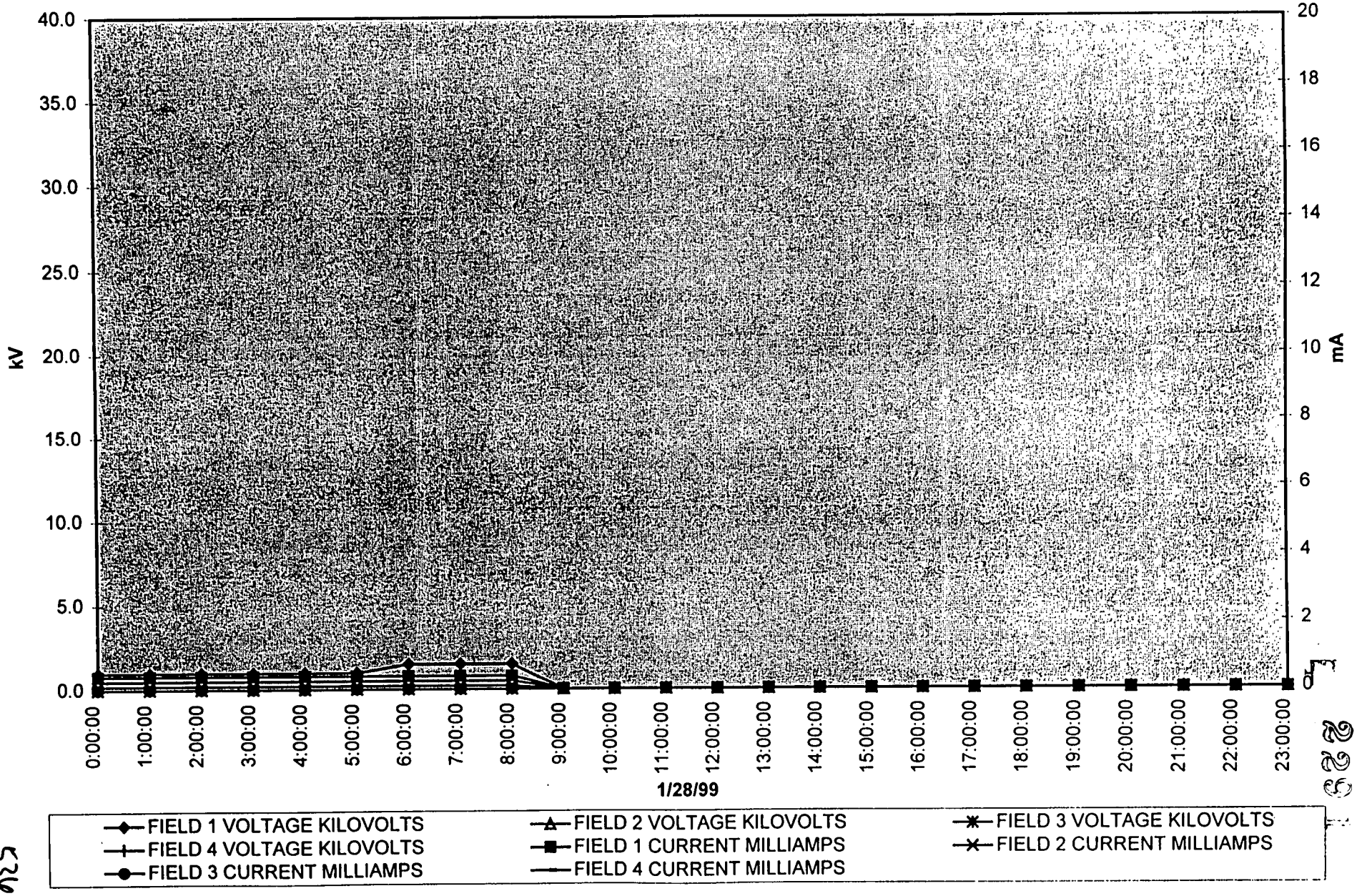
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/28/99
Start Date: 12/1/98
Days Operation: 39

Date	Time	FIELD 1 VOLTAGE KILOVOLTS	FIELD 1 CURRENT MILLIAMPS	FIELD 2 VOLTAGE KILOVOLTS	FIELD 2 CURRENT MILLIAMPS	FIELD 3 VOLTAGE KILOVOLTS	FIELD 3 CURRENT MILLIAMPS	FIELD 4 VOLTAGE KILOVOLTS	FIELD 4 CURRENT MILLIAMPS
1/28/99	0:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	1:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	2:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	3:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	4:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	5:00:00	1.0	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	6:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	7:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	8:00:00	1.5	0.4	0.5	0.1	0.0	0.0	0.0	0.0
1/28/99	9:00:00	#######	#######	#######	#######	#######	#######	#######	#######
[illegible]	10:00:00	#######	#######	#######	#######	#######	#######	#######	#######
[illegible]	11:00:00	#######	#######	#######	#######	#######	#######	#######	#######
[illegible]99	12:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	13:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	14:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	15:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	16:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	17:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	18:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	19:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	20:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	21:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	22:00:00	#######	#######	#######	#######	#######	#######	#######	#######
1/28/99	23:00:00	#######	#######	#######	#######	#######	#######	#######	#######
ily Average		1.2	0.4	0.5	0.1	0.0	0.0	0.0	0.0

535

Mobile EP Daily Performance



526

Appendix 3 - Daily Performance Reports - EP Operating Data

McGill AirClean Mobile EP
Daily Performance Report

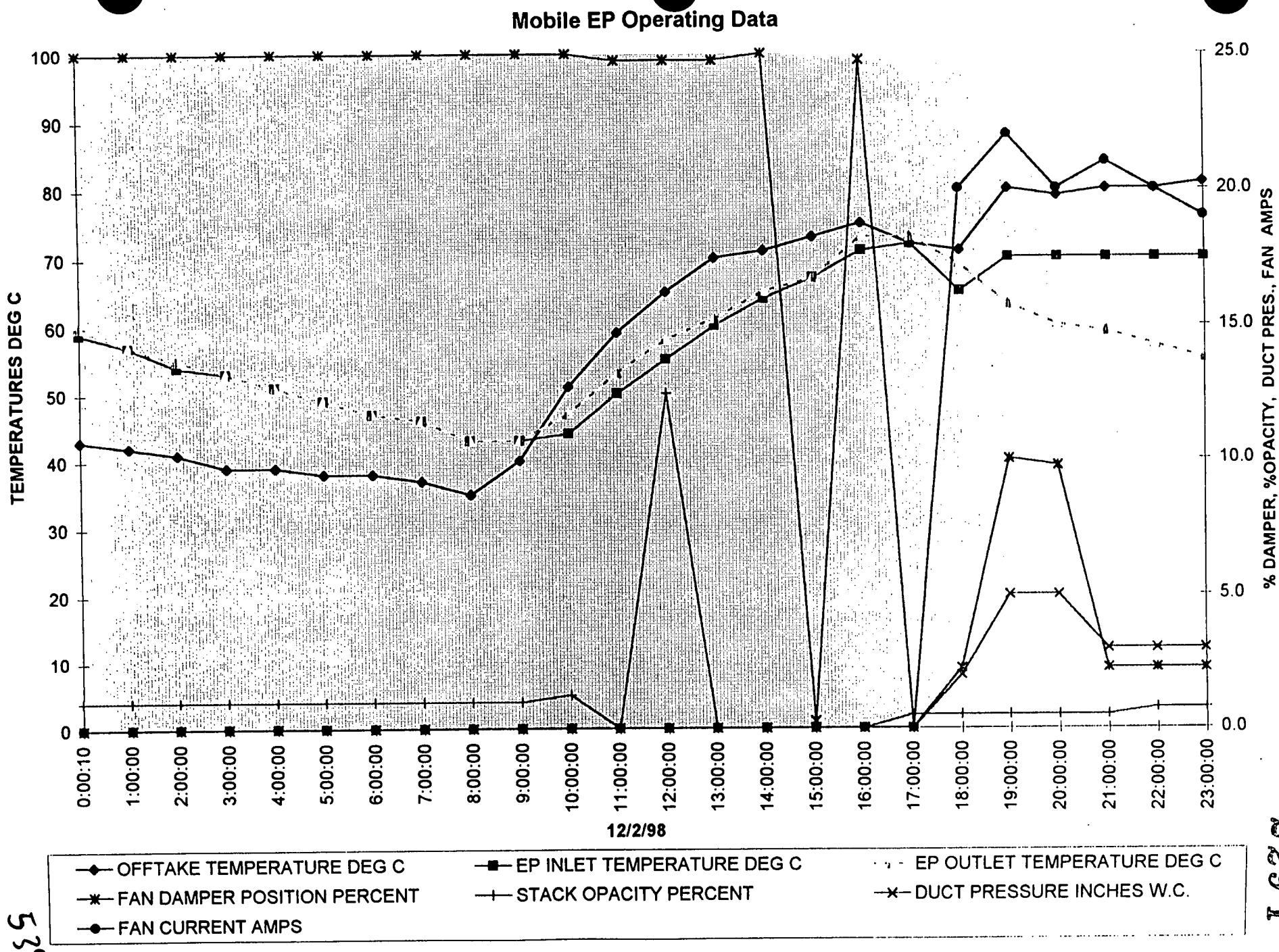
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/2/98
Start Date: 12/1/98
Days Operation: 1

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/2/98	0:00:10	43	59	60.0	0.0	100.0	0.0	4.0
12/2/98	1:00:00	42	57.0	57.0	0.0	100.0	0.0	4.0
12/2/98	2:00:00	41	54.0	55.0	0.0	100.0	0.0	4.0
12/2/98	3:00:00	39	53.0	53.0	0.0	100.0	0.0	4.0
12/2/98	4:00:00	39	51.0	51.0	0.0	100.0	0.0	4.0
12/2/98	5:00:00	38	49.0	49.0	0.0	100.0	0.0	4.0
12/2/98	6:00:00	38	47.0	47.0	0.0	100.0	0.0	4.0
12/2/98	7:00:00	37	46.0	46.0	0.0	100.0	0.0	4.0
12/2/98	8:00:00	35	43.0	43.0	0.0	100.0	0.0	4.0
12/2/98	9:00:00	40	43.0	43.0	0.0	100.0	0.0	4.0
12/2/98	10:00:00	51	44.0	47.0	0.0	100.0	0.0	5.0
12/2/98	11:00:00	59	50.0	53.0	0.0	99.0	0.0	0.0
12/2/98	12:00:00	65	55.0	58.0	0.0	99.0	0.0	50.0
12/2/98	13:00:00	70	60.0	61.0	0.0	99.0	0.0	0.0
12/2/98	14:00:00	71	64.0	65.0	0.0	100.0	0.0	0.0
12/2/98	15:00:00	73	67.0	67.0	0.0	1.0	0.0	0.0
12/2/98	16:00:00	75	71.0	73.0	0.0	99.0	0.0	0.0
12/2/98	17:00:00	72	72.0	73.0	0.0	0.0	0.0	2.0
12/2/98	18:00:00	71	65.0	69.0	2.0	9.0	20.0	2.0
12/2/98	19:00:00	80	70.0	63.0	5.0	40.0	22.0	2.0
12/2/98	20:00:00	79	70.0	60.0	5.0	39.0	20.0	2.0
12/2/98	21:00:00	80	70.0	59.0	3.0	9.0	21.0	2.0
12/2/98	22:00:00	80	70.0	57.0	3.0	9.0	20.0	3.0
12/2/98	23:00:00	81	70.0	55.0	3.0	9.0	19.0	3.0
Daily Average		58.3	58.3	56.8	0.9	71.3	5.1	4.6

538


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
100
90
80
70
60
50
40
30
20
10
0
25.0
20.0
15.0
10.0
5.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/2/98
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

529

2291

McGill AirClean Mobile EP
Daily Performance Report

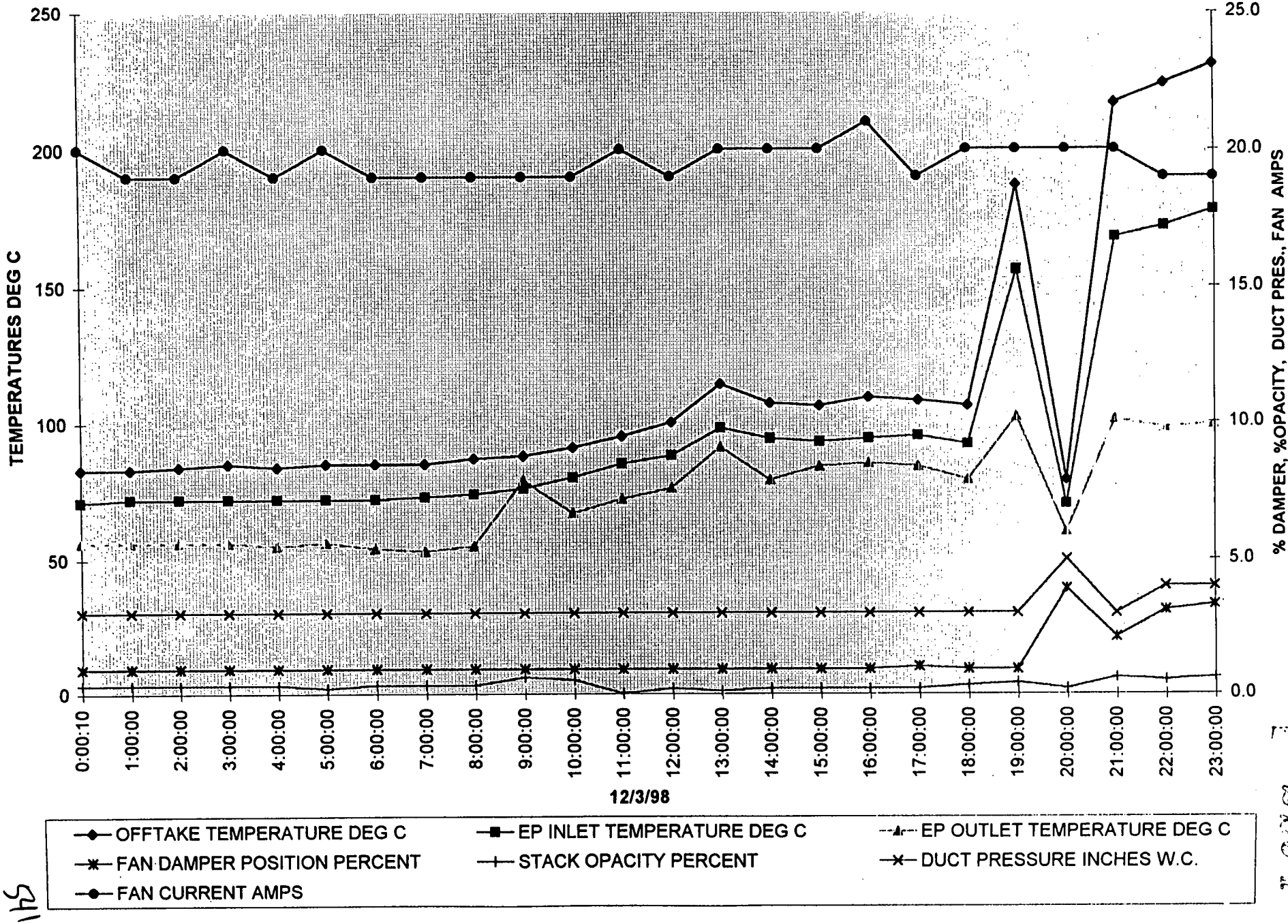
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/3/98
Start Date: 12/1/98
Days Operation: 2

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/3/98	0:00:10	83	71	56.0	3.0	9.0	20.0	3.0
12/3/98	1:00:00	83	72.0	56.0	3.0	9.0	19.0	3.0
12/3/98	2:00:00	84	72.0	56.0	3.0	9.0	19.0	3.0
12/3/98	3:00:00	85	72.0	56.0	3.0	9.0	20.0	3.0
12/3/98	4:00:00	84	72.0	55.0	3.0	9.0	19.0	3.0
12/3/98	5:00:00	85	72.0	56.0	3.0	9.0	20.0	2.0
12/3/98	6:00:00	85	72.0	54.0	3.0	9.0	19.0	3.0
12/3/98	7:00:00	85	73.0	53.0	3.0	9.0	19.0	3.0
12/3/98	8:00:00	87	74.0	55.0	3.0	9.0	19.0	3.0
12/3/98	9:00:00	88	76.0	79.0	3.0	9.0	19.0	6.0
12/3/98	10:00:00	91	80.0	67.0	3.0	9.0	19.0	5.0
12/3/98	11:00:00	95	85.0	72.0	3.0	9.0	20.0	0.0
12/3/98	12:00:00	100	88.0	76.0	3.0	9.0	19.0	2.0
12/3/98	13:00:00	114	98.0	91.0	3.0	9.0	20.0	1.0
12/3/98	14:00:00	107	94.0	79.0	3.0	9.0	20.0	2.0
12/3/98	15:00:00	106	93.0	84.0	3.0	9.0	20.0	2.0
12/3/98	16:00:00	109	94.0	85.0	3.0	9.0	21.0	2.0
12/3/98	17:00:00	108	95.0	84.0	3.0	10.0	19.0	2.0
12/3/98	18:00:00	106	92.0	79.0	3.0	9.0	20.0	3.0
12/3/98	19:00:00	187	156.0	102.0	3.0	9.0	20.0	4.0
12/3/98	20:00:00	79	70.0	60.0	5.0	39.0	20.0	2.0
12/3/98	21:00:00	217	168.0	101.0	3.0	21.0	20.0	6.0
12/3/98	22:00:00	224	172.0	98.0	4.0	31.0	19.0	5.0
12/3/98	23:00:00	231	178.0	99.0	4.0	33.0	19.0	6.0
Daily Average		113.5	95.4	73.0	3.2	12.7	19.5	3.1

540

Mobile EP Operating Data



54

McGill AirClean Mobile EP
Daily Performance Report

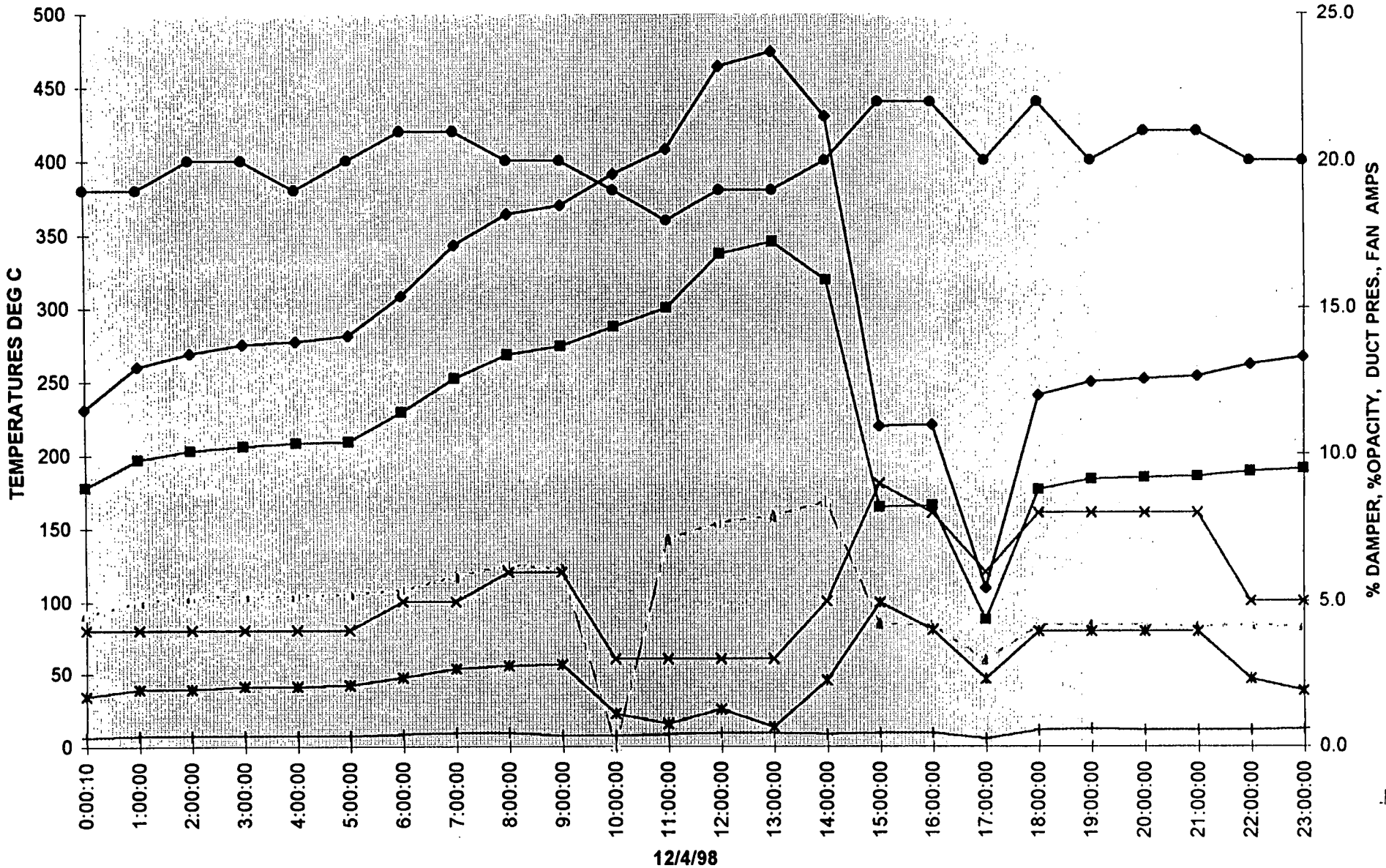
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/4/98
Start Date: 12/1/98
Days Operation: 3

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/4/98	0:00:10	231	178	91.0	4.0	34.0	19.0	6.0
12/4/98	1:00:00	260	197.0	100.0	4.0	39.0	19.0	7.0
12/4/98	2:00:00	269	203.0	103.0	4.0	39.0	20.0	7.0
12/4/98	3:00:00	275	206.0	104.0	4.0	41.0	20.0	7.0
12/4/98	4:00:00	277	208.0	104.0	4.0	41.0	19.0	7.0
12/4/98	5:00:00	281	209.0	105.0	4.0	42.0	20.0	7.0
12/4/98	6:00:00	308	229.0	108.0	5.0	47.0	21.0	8.0
12/4/98	7:00:00	343	252.0	117.0	5.0	53.0	21.0	9.0
12/4/98	8:00:00	364	268.0	125.0	6.0	55.0	20.0	9.0
12/4/98	9:00:00	370	274.0	122.0	6.0	56.0	20.0	7.0
12/4/98	10:00:00	391	287.0	0.0	3.0	22.0	19.0	7.0
12/4/98	11:00:00	408	300.0	142.0	3.0	15.0	18.0	8.0
12/4/98	12:00:00	464	337.0	154.0	3.0	25.0	19.0	9.0
12/4/98	13:00:00	474	345.0	158.0	3.0	13.0	19.0	9.0
12/4/98	14:00:00	430	319.0	168.0	5.0	45.0	20.0	8.0
12/4/98	15:00:00	219	164.0	84.0	9.0	99.0	22.0	9.0
12/4/98	16:00:00	220	165.0	83.0	8.0	80.0	22.0	9.0
12/6/98	17:00:00	109	87.0	59.0	6.0	46.0	20.0	5.0
12/4/98	18:00:00	240	176.0	83.0	8.0	79.0	22.0	11.0
12/4/98	19:00:00	249	183.0	83.0	8.0	79.0	20.0	12.0
12/4/98	20:00:00	251	184.0	83.0	8.0	79.0	21.0	11.0
12/4/98	21:00:00	253	185.0	82.0	8.0	79.0	21.0	11.0
12/4/98	22:00:00	261	188.0	83.0	5.0	46.0	20.0	11.0
12/4/98	23:00:00	266	190.0	82.0	5.0	38.0	20.0	12.0
Daily Average		300.5	222.3	101.0	5.3	49.7	20.1	8.6

542

Mobile EP Operating Data



- OFFTAKE TEMPERATURE DEG C
- EP INLET TEMPERATURE DEG C
- EP OUTLET TEMPERATURE DEG C
- FAN DAMPER POSITION PERCENT
- STACK OPACITY PERCENT
- DUCT PRESSURE INCHES W.C.
- FAN CURRENT AMPS

McGill AirClean Mobile EP
Daily Performance Report

2291

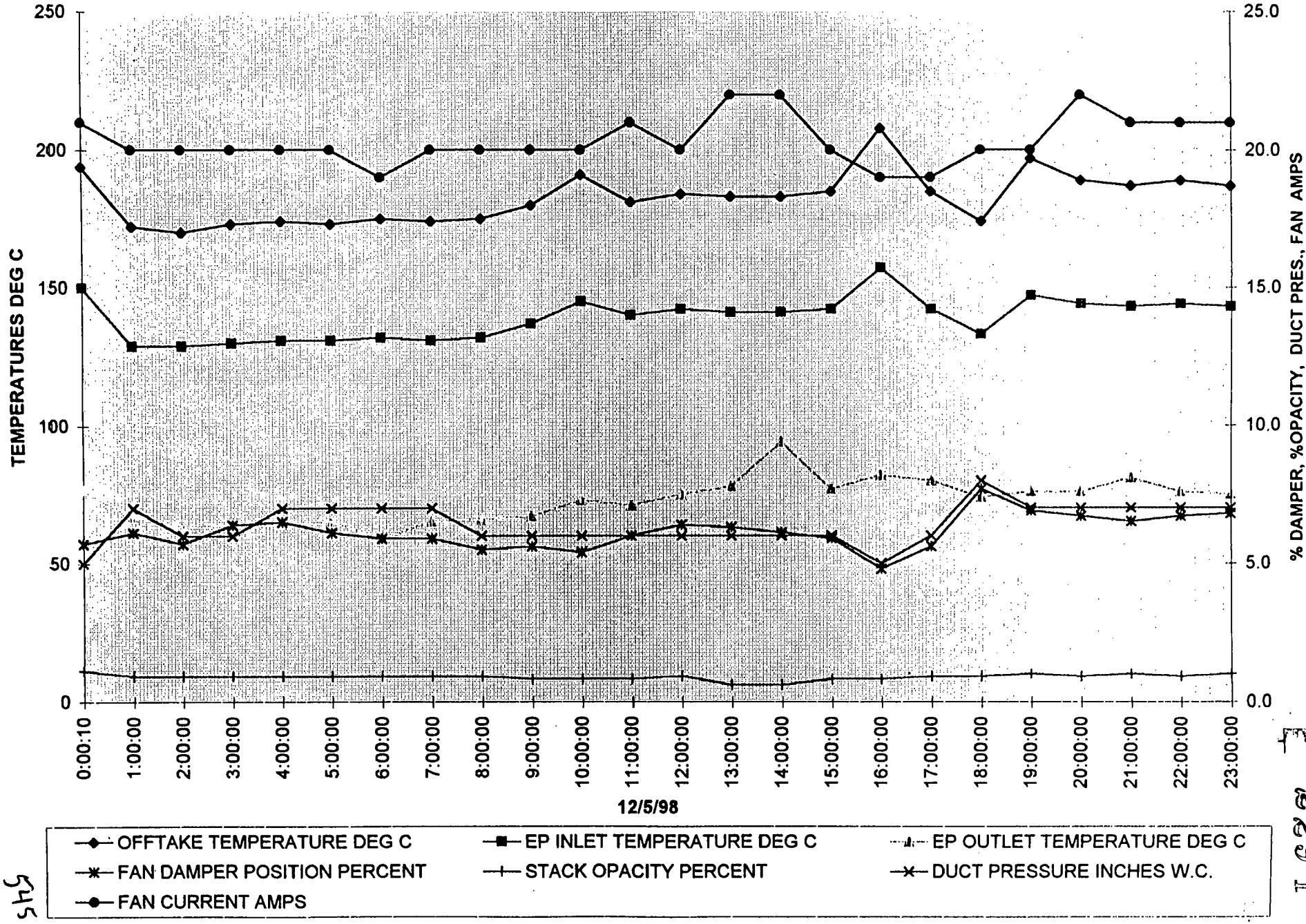
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/5/98
Start Date: 12/1/98
Days Operation: 4

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/5/98	0:00:10	194	150	77.0	5.0	57.0	21.0	11.0
12/5/98	1:00:00	172	129.0	67.0	7.0	61.0	20.0	9.0
12/5/98	2:00:00	170	129.0	63.0	6.0	57.0	20.0	9.0
12/5/98	3:00:00	173	130.0	64.0	6.0	64.0	20.0	9.0
12/5/98	4:00:00	174	131.0	64.0	7.0	65.0	20.0	9.0
12/5/98	5:00:00	173	131.0	65.0	7.0	61.0	20.0	9.0
12/5/98	6:00:00	175	132.0	59.0	7.0	59.0	19.0	9.0
12/5/98	7:00:00	174	131.0	65.0	7.0	59.0	20.0	9.0
12/5/98	8:00:00	175	132.0	66.0	6.0	55.0	20.0	9.0
12/5/98	9:00:00	180	137.0	67.0	6.0	56.0	20.0	8.0
12/5/98	10:00:00	191	145.0	73.0	6.0	54.0	20.0	8.0
12/5/98	11:00:00	181	140.0	71.0	6.0	60.0	21.0	8.0
12/5/98	12:00:00	184	142.0	75.0	6.0	64.0	20.0	9.0
12/5/98	13:00:00	183	141.0	78.0	6.0	63.0	22.0	6.0
12/5/98	14:00:00	183	141.0	94.0	6.0	61.0	22.0	6.0
12/5/98	15:00:00	185	142.0	77.0	6.0	59.0	20.0	8.0
12/5/98	16:00:00	208	157.0	82.0	5.0	48.0	19.0	8.0
12/5/98	17:00:00	185	142.0	80.0	6.0	56.0	19.0	9.0
12/5/98	18:00:00	174	133.0	74.0	8.0	77.0	20.0	9.0
12/5/98	19:00:00	197	147.0	76.0	7.0	69.0	20.0	10.0
12/5/98	20:00:00	189	144.0	76.0	7.0	67.0	22.0	9.0
12/5/98	21:00:00	187	143.0	81.0	7.0	65.0	21.0	10.0
12/5/98	22:00:00	189	144.0	76.0	7.0	67.0	21.0	9.0
12/5/98	23:00:00	187	143.0	75.0	7.0	68.0	21.0	10.0
Daily Average		182.6	139.0	72.7	6.4	61.3	20.3	8.8

544

Mobile EP Operating Data



545

McGill AirClean Mobile EP
Daily Performance Report

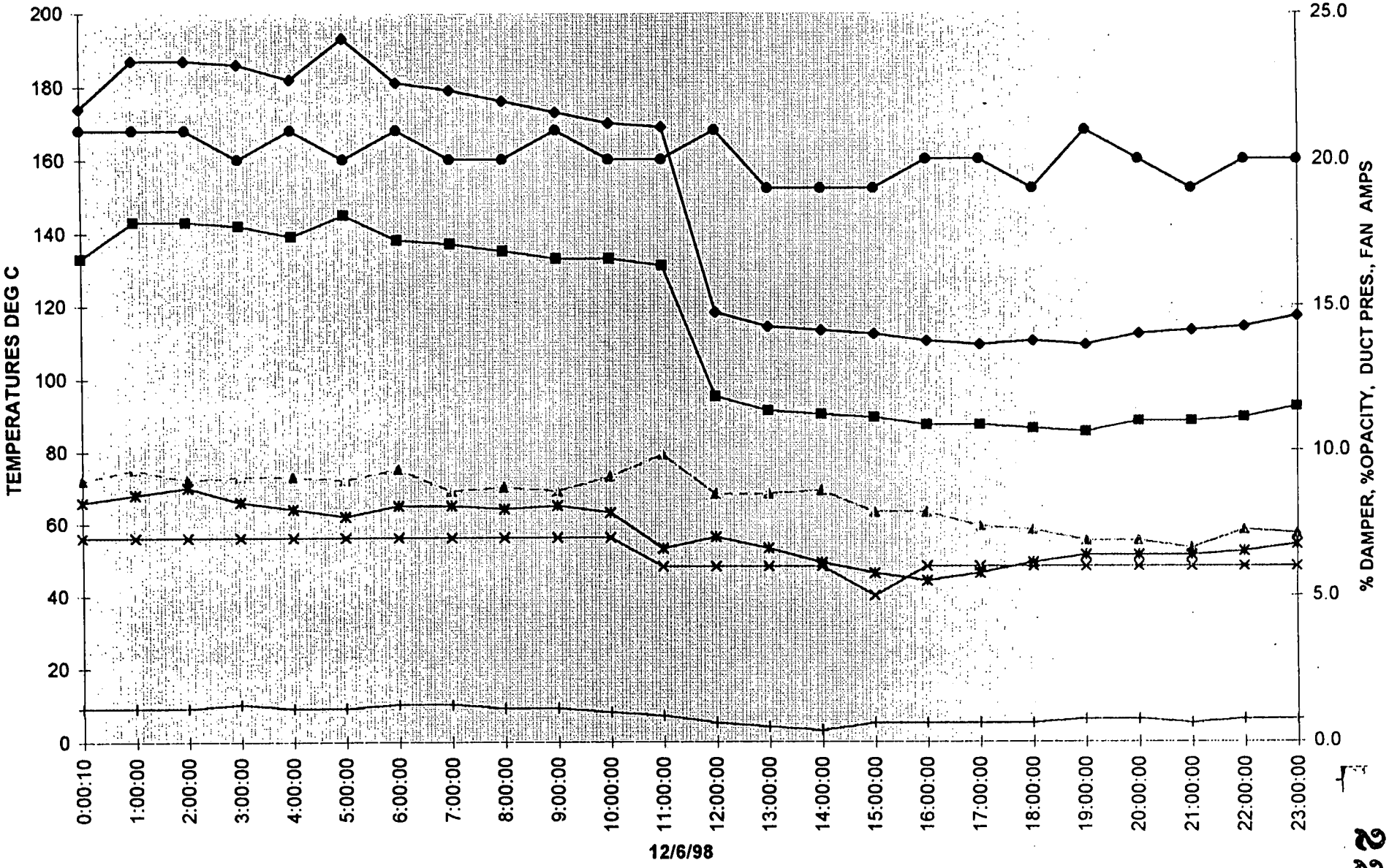
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/6/98
Start Date: 12/1/98
Days Operation: 5

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/6/98	0:00:10	174	133	72.0	7.0	66.0	21.0	9.0
12/6/98	1:00:00	187	143.0	75.0	7.0	68.0	21.0	9.0
12/6/98	2:00:00	187	143.0	72.0	7.0	70.0	21.0	9.0
12/6/98	3:00:00	186	142.0	73.0	7.0	66.0	20.0	10.0
12/6/98	4:00:00	182	139.0	73.0	7.0	64.0	21.0	9.0
12/6/98	5:00:00	193	145.0	72.0	7.0	62.0	20.0	9.0
12/6/98	6:00:00	181	138.0	75.0	7.0	65.0	21.0	10.0
12/6/98	7:00:00	179	137.0	69.0	7.0	65.0	20.0	10.0
12/6/98	8:00:00	176	135.0	70.0	7.0	64.0	20.0	9.0
12/6/98	9:00:00	173	133.0	69.0	7.0	65.0	21.0	9.0
12/6/98	10:00:00	170	133.0	73.0	7.0	63.0	20.0	8.0
12/6/98	11:00:00	169	131.0	79.0	6.0	53.0	20.0	7.0
12/6/98	12:00:00	118	95.0	68.0	6.0	56.0	21.0	5.0
12/6/98	13:00:00	114	91.0	68.0	6.0	53.0	19.0	4.0
12/6/98	14:00:00	113	90.0	69.0	6.0	49.0	19.0	3.0
[illegible]/98	15:00:00	112	89.0	63.0	5.0	46.0	19.0	5.0
[illegible]/98	16:00:00	110	87.0	63.0	6.0	44.0	20.0	5.0
[illegible]/98	17:00:00	109	87.0	59.0	6.0	46.0	20.0	5.0
12/6/98	18:00:00	110	86.0	58.0	6.0	49.0	19.0	5.0
12/6/98	19:00:00	109	85.0	55.0	6.0	51.0	21.0	6.0
12/6/98	20:00:00	112	88.0	55.0	6.0	51.0	20.0	6.0
12/6/98	21:00:00	113	88.0	53.0	6.0	51.0	19.0	5.0
12/6/98	22:00:00	114	89.0	58.0	6.0	52.0	20.0	6.0
12/6/98	23:00:00	117	92.0	57.0	6.0	54.0	20.0	6.0
Daily Average		146.2	113.3	66.6	6.4	57.2	20.1	7.0

546

Mobile EP Operating Data



- OFFTAKE TEMPERATURE DEG C
- EP INLET TEMPERATURE DEG C
- EP OUTLET TEMPERATURE DEG C
- FAN DAMPER POSITION PERCENT
- STACK OPACITY PERCENT
- DUCT PRESSURE INCHES W.C.
- FAN CURRENT AMPS

McGill AirClean Mobile EP
Daily Performance Report

2291

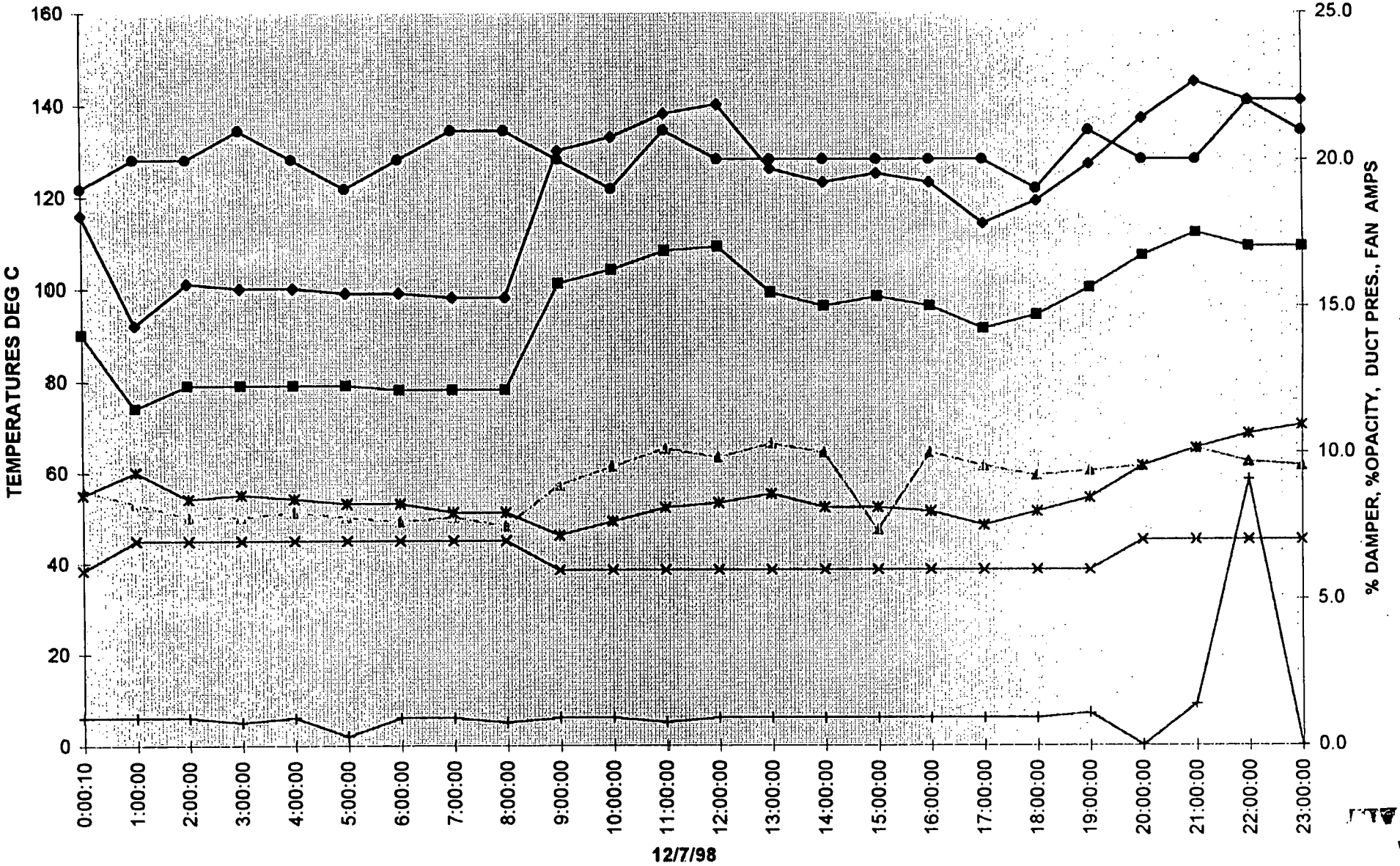
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/7/98
Start Date: 12/1/98
Days Operation: 6

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/7/98	0:00:10	116	90	56.0	6.0	55.0	19.0	6.0
12/7/98	1:00:00	92	74.0	53.0	7.0	60.0	20.0	6.0
12/7/98	2:00:00	101	79.0	50.0	7.0	54.0	20.0	6.0
12/7/98	3:00:00	100	79.0	50.0	7.0	55.0	21.0	5.0
12/7/98	4:00:00	100	79.0	51.0	7.0	54.0	20.0	6.0
12/7/98	5:00:00	99	79.0	50.0	7.0	53.0	19.0	2.0
12/7/98	6:00:00	99	78.0	49.0	7.0	53.0	20.0	6.0
12/7/98	7:00:00	98	78.0	50.0	7.0	51.0	21.0	6.0
12/7/98	8:00:00	98	78.0	48.0	7.0	51.0	21.0	5.0
12/7/98	9:00:00	130	101.0	57.0	6.0	46.0	20.0	6.0
12/7/98	10:00:00	133	104.0	61.0	6.0	49.0	19.0	6.0
12/7/98	11:00:00	138	108.0	65.0	6.0	52.0	21.0	5.0
12/7/98	12:00:00	140	109.0	63.0	6.0	53.0	20.0	6.0
12/7/98	13:00:00	126	99.0	66.0	6.0	55.0	20.0	6.0
12/7/98	14:00:00	123	96.0	64.0	6.0	52.0	20.0	6.0
12/7/98	15:00:00	125	98.0	47.0	6.0	52.0	20.0	6.0
12/7/98	16:00:00	123	96.0	64.0	6.0	51.0	20.0	6.0
12/7/98	17:00:00	114	91.0	61.0	6.0	48.0	20.0	6.0
12/7/98	18:00:00	119	94.0	59.0	6.0	51.0	19.0	6.0
12/7/98	19:00:00	127	100.0	60.0	6.0	54.0	21.0	7.0
12/7/98	20:00:00	137	107.0	61.0	7.0	61.0	20.0	0.0
12/7/98	21:00:00	145	112.0	65.0	7.0	65.0	20.0	9.0
12/7/98	22:00:00	141	109.0	62.0	7.0	68.0	22.0	58.0
12/7/98	23:00:00	141	109.0	61.0	7.0	70.0	21.0	0.0
Daily Average		119.4	93.6	57.2	6.5	54.7	20.2	7.5

548

Mobile EP Operating Data



54

1622

E 2291

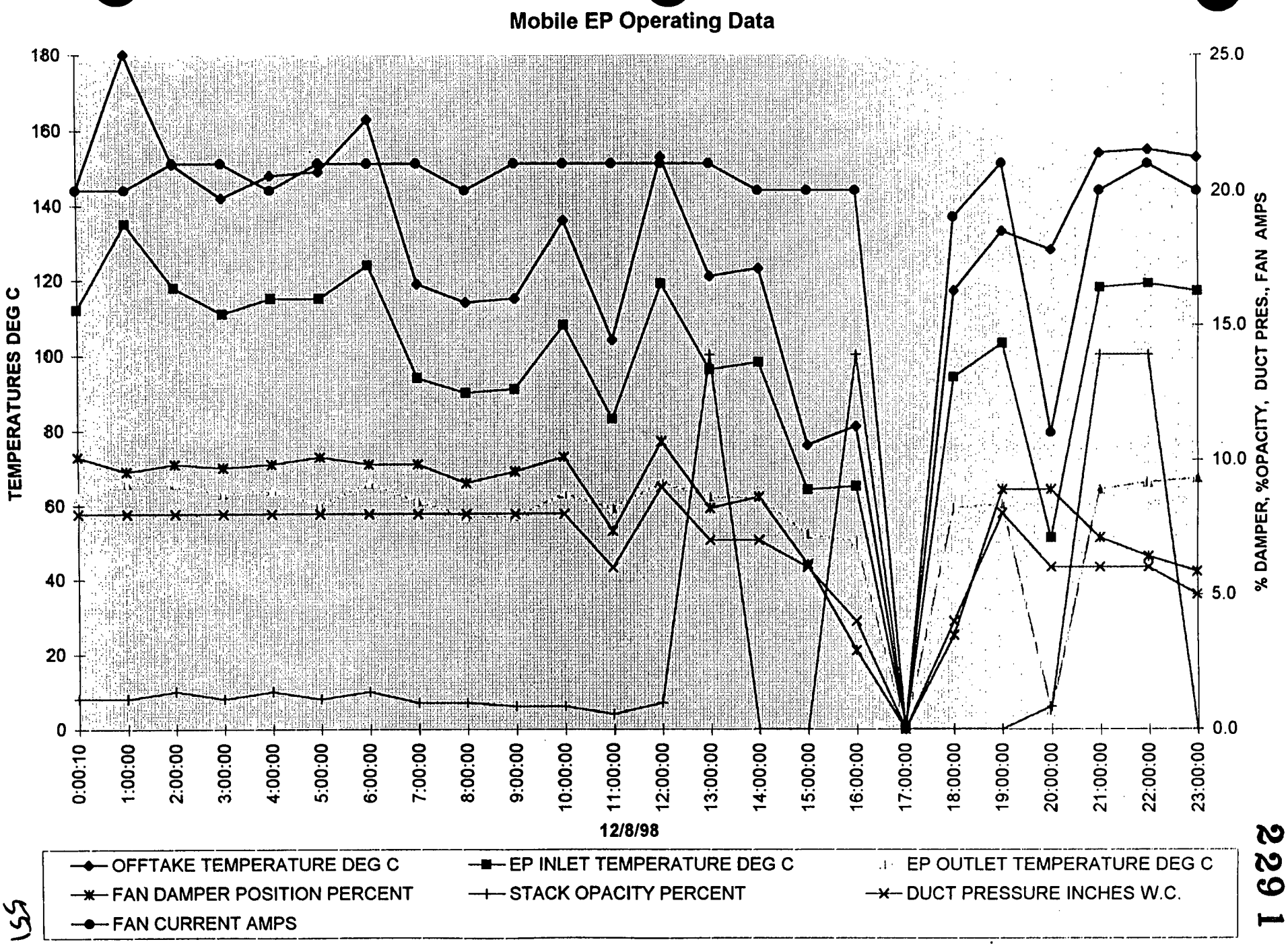
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/8/98
Start Date: 12/1/98
Days Operation: 7

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/8/98	0:00:10	144	112	62.0	8.0	73.0	20.0	8.0
12/8/98	1:00:00	180	135.0	66.0	8.0	69.0	20.0	8.0
12/8/98	2:00:00	151	118.0	66.0	8.0	71.0	21.0	10.0
12/8/98	3:00:00	142	111.0	63.0	8.0	70.0	21.0	8.0
12/8/98	4:00:00	148	115.0	64.0	8.0	71.0	20.0	10.0
12/8/98	5:00:00	149	115.0	60.0	8.0	73.0	21.0	8.0
12/8/98	6:00:00	163	124.0	66.0	8.0	71.0	21.0	10.0
12/8/98	7:00:00	119	94.0	61.0	8.0	71.0	21.0	7.0
12/8/98	8:00:00	114	90.0	57.0	8.0	66.0	20.0	7.0
12/8/98	9:00:00	115	91.0	57.0	8.0	69.0	21.0	6.0
12/8/98	10:00:00	136	108.0	63.0	8.0	73.0	21.0	6.0
12/8/98	11:00:00	104	83.0	59.0	6.0	53.0	21.0	4.0
12/8/98	12:00:00	153	119.0	66.0	9.0	77.0	21.0	7.0
12/8/98	13:00:00	121	96.0	62.0	7.0	59.0	21.0	100.0
12/8/98	14:00:00	123	98.0	62.0	7.0	62.0	20.0	0.0
12/8/98	15:00:00	76	64.0	52.0	6.0	44.0	20.0	0.0
12/8/98	16:00:00	81	65.0	50.0	4.0	21.0	20.0	100.0
12/8/98	17:00:00	#######	#######	#######	#######	#######	#######	#######
12/8/98	18:00:00	117	94.0	59.0	4.0	25.0	19.0	0.0
12/8/98	19:00:00	133	103.0	60.0	8.0	64.0	21.0	0.0
12/8/98	20:00:00	128	51.0	5.0	6.0	64.0	11.0	6.0
12/8/98	21:00:00	154	118.0	64.0	6.0	51.0	20.0	100.0
12/8/98	22:00:00	155	119.0	66.0	6.0	46.0	21.0	100.0
12/8/98	23:00:00	153	117.0	67.0	5.0	42.0	20.0	0.0
Daily Average		133.0	101.7	59.0	7.0	60.2	20.1	22.0

550


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
180
160
140
120
100
80
60
40
20
0
25.0
20.0
15.0
10.0
5.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/8/98
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

55

2291

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

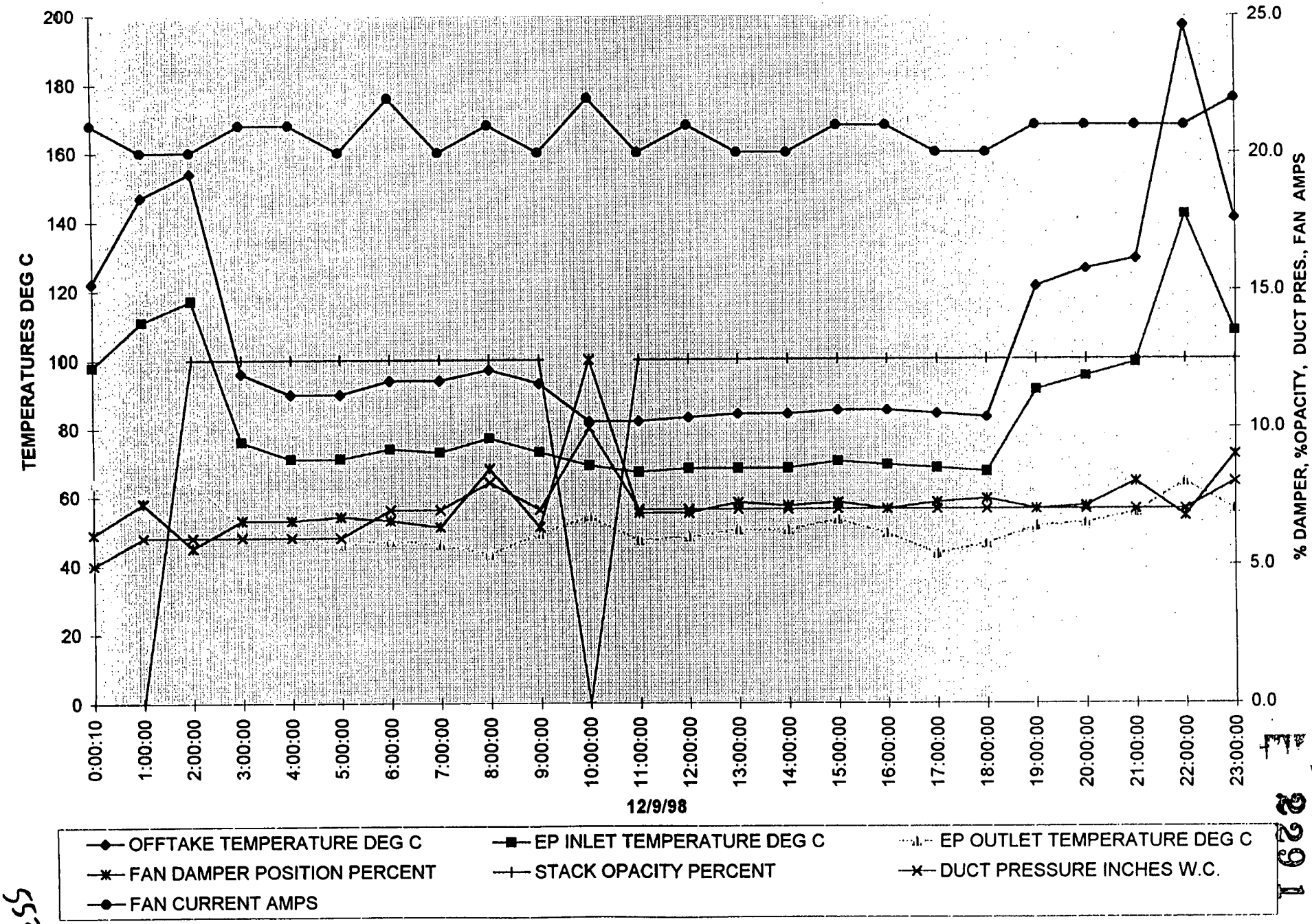
Report Date: 12/9/98
Start Date: 12/1/98
Days Operation: 8

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/9/98	0:00:10	122	98	64.0	5.0	49.0	21.0	0.0
12/9/98	1:00:00	147	111.0	60.0	6.0	58.0	20.0	0.0
12/9/98	2:00:00	154	117.0	65.0	6.0	45.0	20.0	100.0
12/9/98	3:00:00	96	76.0	51.0	6.0	53.0	21.0	100.0
12/9/98	4:00:00	90	71.0	48.0	6.0	53.0	21.0	100.0
12/9/98	5:00:00	90	71.0	46.0	6.0	54.0	20.0	100.0
12/9/98	6:00:00	94	74.0	47.0	7.0	53.0	22.0	100.0
12/9/98	7:00:00	94	73.0	46.0	7.0	51.0	20.0	100.0
12/9/98	8:00:00	97	77.0	43.0	8.0	68.0	21.0	100.0
12/9/98	9:00:00	93	73.0	49.0	7.0	51.0	20.0	100.0
12/9/98	10:00:00	82	69.0	54.0	10.0	100.0	22.0	0.0
12/9/98	11:00:00	82	67.0	47.0	7.0	55.0	20.0	100.0
12/9/98	12:00:00	83	68.0	48.0	7.0	55.0	21.0	100.0
12/9/98	13:00:00	84	68.0	50.0	7.0	58.0	20.0	100.0
12/9/98	14:00:00	84	68.0	50.0	7.0	57.0	20.0	100.0
12/9/98	15:00:00	85	70.0	53.0	7.0	58.0	21.0	100.0
12/9/98	16:00:00	85	69.0	49.0	7.0	56.0	21.0	100.0
12/9/98	17:00:00	84	68.0	43.0	7.0	58.0	20.0	100.0
12/9/98	18:00:00	83	67.0	46.0	7.0	59.0	20.0	100.0
12/9/98	19:00:00	121	91.0	51.0	7.0	56.0	21.0	100.0
12/9/98	20:00:00	126	95.0	52.0	7.0	57.0	21.0	100.0
12/9/98	21:00:00	129	99.0	55.0	7.0	64.0	21.0	100.0
12/9/98	22:00:00	197	142.0	64.0	7.0	54.0	21.0	100.0
12/9/98	23:00:00	141	108.0	56.0	8.0	72.0	22.0	100.0
Daily Average		106.0	82.9	51.5	6.9	58.1	20.7	87.5

552

R9dec98a.xls

Mobile EP Operating Data



553

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

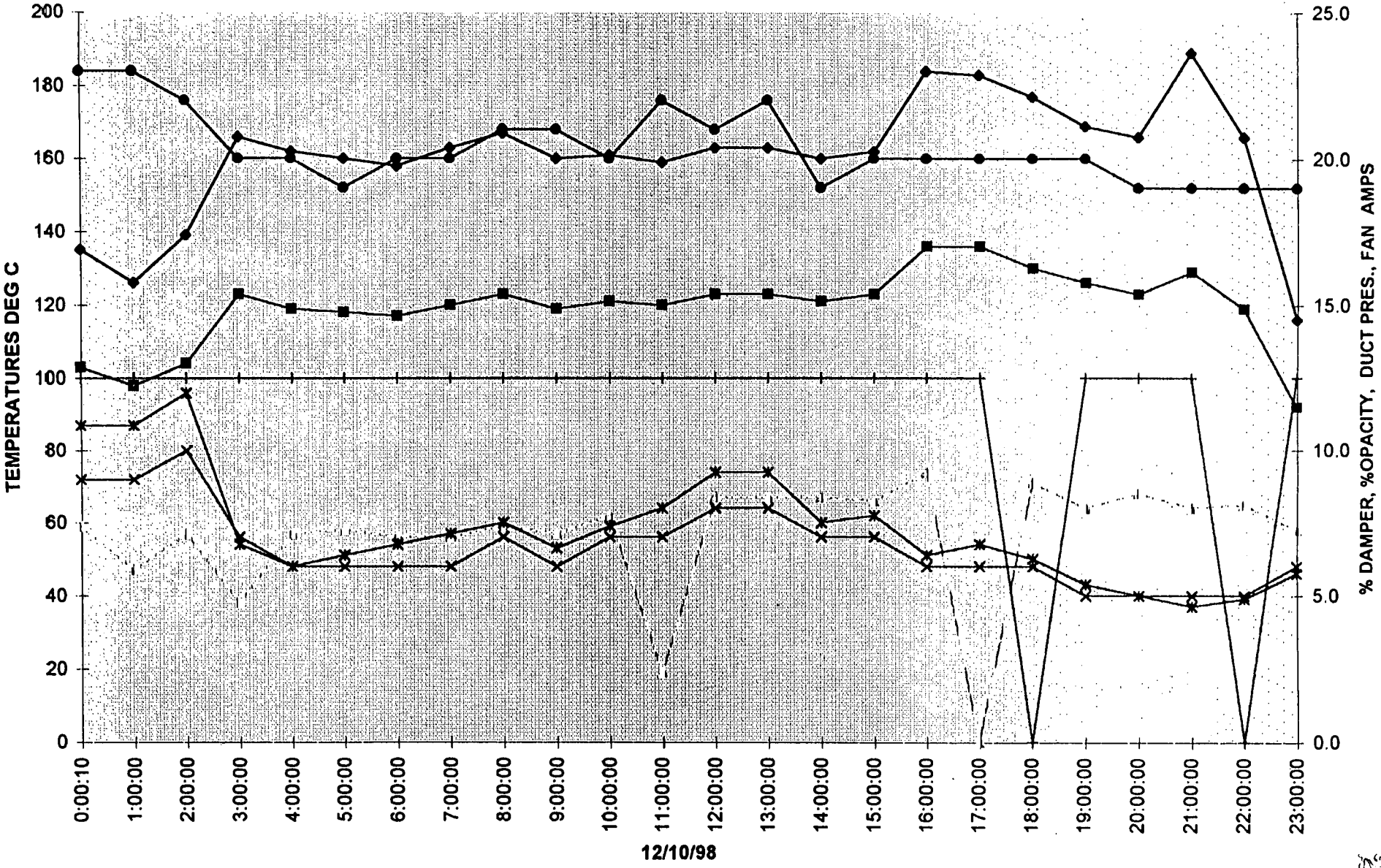
Report Date: 12/10/98
Start Date: 12/1/98
Days Operation: 9

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/10/98	0:00:10	135	103	59.0	9.0	87.0	23.0	100.0
12/10/98	1:00:00	126	98.0	47.0	9.0	87.0	23.0	100.0
12/10/98	2:00:00	139	104.0	57.0	10.0	96.0	22.0	100.0
12/10/98	3:00:00	166	123.0	38.0	7.0	54.0	20.0	100.0
12/10/98	4:00:00	162	119.0	57.0	6.0	48.0	20.0	100.0
12/10/98	5:00:00	160	118.0	58.0	6.0	51.0	19.0	100.0
12/10/98	6:00:00	158	117.0	56.0	6.0	54.0	20.0	100.0
12/10/98	7:00:00	163	120.0	56.0	6.0	57.0	20.0	100.0
12/10/98	8:00:00	167	123.0	59.0	7.0	60.0	21.0	100.0
12/10/98	9:00:00	160	119.0	57.0	6.0	53.0	21.0	100.0
12/10/98	10:00:00	161	121.0	62.0	7.0	59.0	20.0	100.0
12/10/98	11:00:00	159	120.0	19.0	7.0	64.0	22.0	100.0
12/10/98	12:00:00	163	123.0	67.0	8.0	74.0	21.0	100.0
12/10/98	13:00:00	163	123.0	67.0	8.0	74.0	22.0	100.0
12/10/98	14:00:00	160	121.0	67.0	7.0	60.0	19.0	100.0
12/10/98	15:00:00	162	123.0	66.0	7.0	62.0	20.0	100.0
12/10/98	16:00:00	184	136.0	74.0	6.0	51.0	20.0	100.0
12/10/98	17:00:00	183	136.0	0.0	6.0	54.0	20.0	100.0
12/10/98	18:00:00	177	130.0	71.0	6.0	50.0	20.0	0.0
12/10/98	19:00:00	169	126.0	64.0	5.0	43.0	20.0	100.0
12/10/98	20:00:00	166	123.0	68.0	5.0	40.0	19.0	100.0
12/10/98	21:00:00	189	129.0	64.0	5.0	37.0	19.0	100.0
12/10/98	22:00:00	166	119.0	65.0	5.0	39.0	19.0	0.0
12/10/98	23:00:00	116	92.0	58.0	6.0	46.0	19.0	100.0
Daily Average		160.6	119.4	56.5	6.7	58.3	20.4	91.7

554

R10dec98a.xls

Mobile EP Operating Data



- OFFTAKE TEMPERATURE DEG C
- EP INLET TEMPERATURE DEG C
- EP OUTLET TEMPERATURE DEG C
- FAN DAMPER POSITION PERCENT
- STACK OPACITY PERCENT
- DUCT PRESSURE INCHES W.C.
- FAN CURRENT AMPS

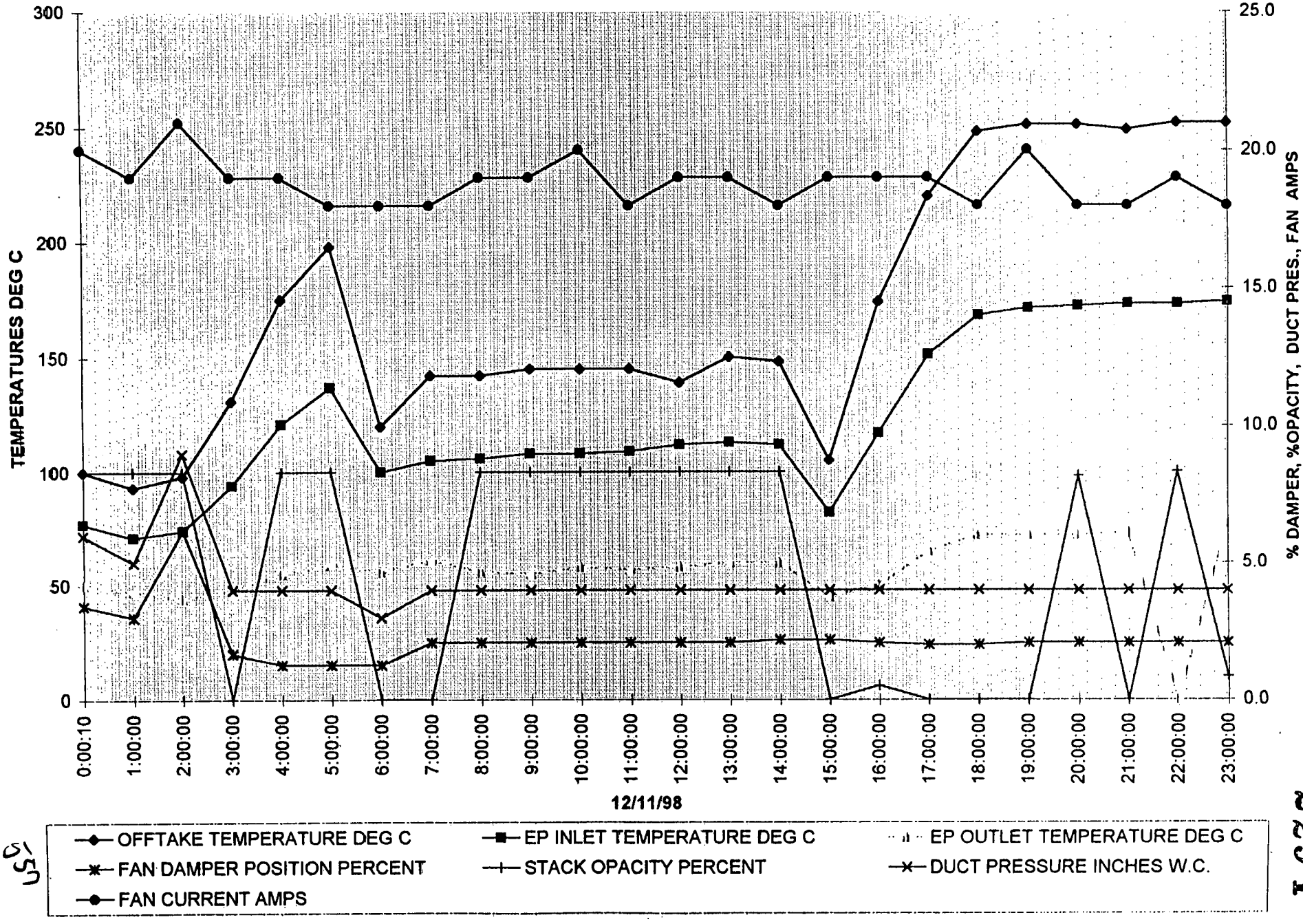
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/11/98
Start Date: 12/1/98
Days Operation: 10

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/11/98	0:00:10	100	77	50.0	6.0	41.0	20.0	100.0
12/11/98	1:00:00	93	71.0	47.0	5.0	36.0	19.0	100.0
12/11/98	2:00:00	98	74.0	44.0	9.0	74.0	21.0	100.0
12/11/98	3:00:00	131	94.0	48.0	4.0	20.0	19.0	0.0
12/11/98	4:00:00	175	121.0	55.0	4.0	15.0	19.0	100.0
12/11/98	5:00:00	198	137.0	59.0	4.0	15.0	18.0	100.0
12/11/98	6:00:00	120	100.0	56.0	3.0	15.0	18.0	0.0
12/11/98	7:00:00	142	105.0	61.0	4.0	25.0	18.0	0.0
12/11/98	8:00:00	142	106.0	56.0	4.0	25.0	19.0	100.0
12/11/98	9:00:00	145	108.0	55.0	4.0	25.0	19.0	100.0
12/11/98	10:00:00	145	108.0	58.0	4.0	25.0	20.0	100.0
12/11/98	11:00:00	145	109.0	57.0	4.0	25.0	18.0	100.0
12/11/98	12:00:00	139	112.0	58.0	4.0	25.0	19.0	100.0
12/11/98	13:00:00	150	113.0	60.0	4.0	25.0	19.0	100.0
12/11/98	14:00:00	148	112.0	60.0	4.0	26.0	18.0	100.0
12/11/98	15:00:00	105	82.0	45.0	4.0	26.0	19.0	0.0
12/11/98	16:00:00	174	117.0	50.0	4.0	25.0	19.0	6.0
12/11/98	17:00:00	220	151.0	65.0	4.0	24.0	19.0	0.0
12/11/98	18:00:00	248	168.0	72.0	4.0	24.0	18.0	0.0
12/11/98	19:00:00	251	171.0	72.0	4.0	25.0	20.0	0.0
12/11/98	20:00:00	251	172.0	72.0	4.0	25.0	18.0	98.0
12/11/98	21:00:00	249	173.0	73.0	4.0	25.0	18.0	0.0
12/11/98	22:00:00	252	173.0	0.0	4.0	25.0	19.0	100.0
12/11/98	23:00:00	252	174.0	77.0	4.0	25.0	18.0	10.0
Daily Average		169.7	122.0	56.3	4.3	26.7	18.8	58.9

Mobile EP Operating Data



2291

151

McGill AirClean Mobile EP
Daily Performance Report

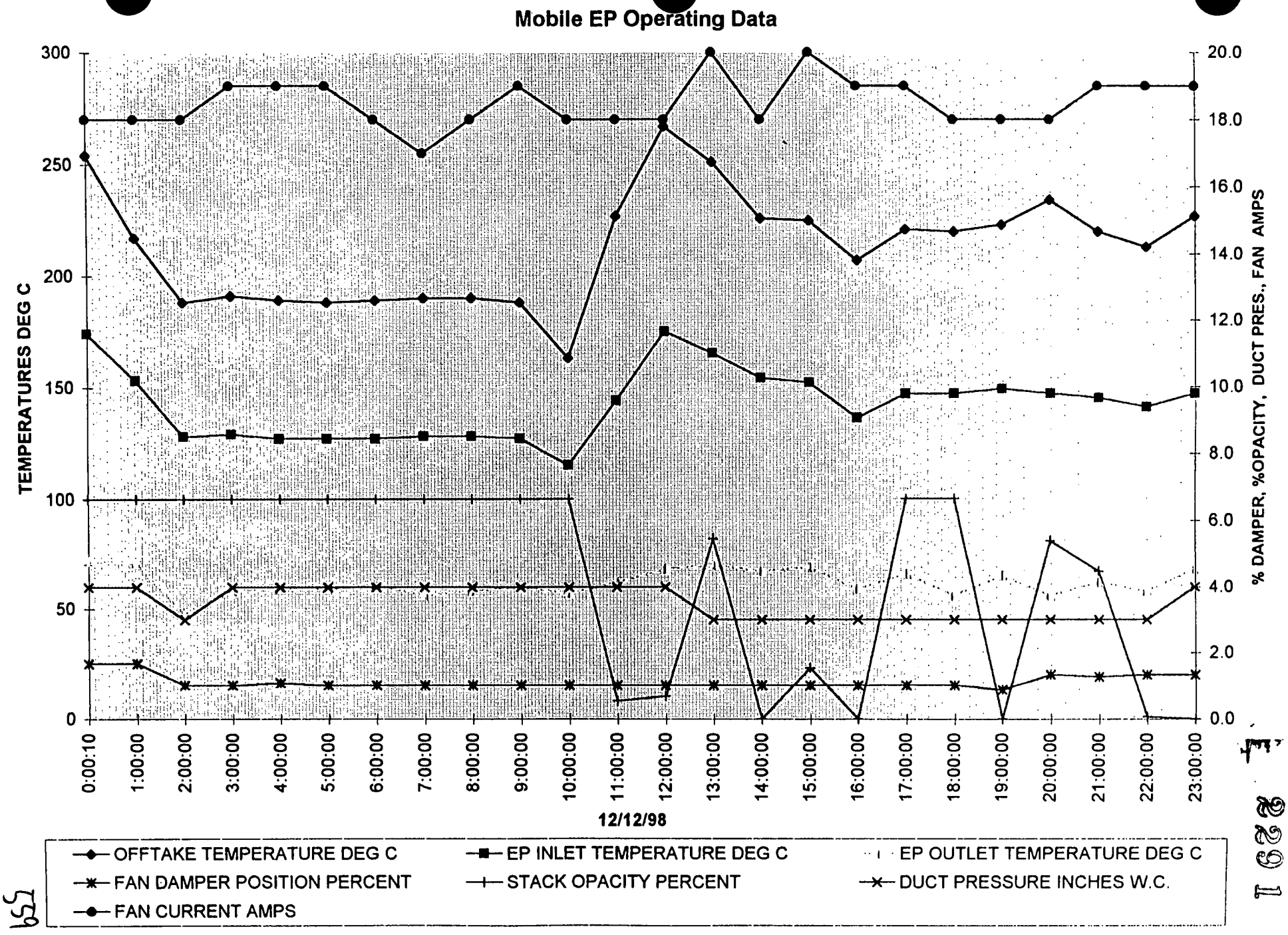
2291

Customer: ENVITCO. INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/12/98
Start Date: 12/1/98
Days Operation: 11

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/12/98	0:00:10	254	174	72.0	4.0	25.0	18.0	100.0
12/12/98	1:00:00	217	153.0	71.0	4.0	25.0	18.0	100.0
12/12/98	2:00:00	188	128.0	48.0	3.0	15.0	18.0	100.0
12/12/98	3:00:00	191	129.0	58.0	4.0	15.0	19.0	100.0
12/12/98	4:00:00	189	127.0	59.0	4.0	16.0	19.0	100.0
12/12/98	5:00:00	188	127.0	59.0	4.0	15.0	19.0	100.0
12/12/98	6:00:00	189	127.0	61.0	4.0	15.0	18.0	100.0
12/12/98	7:00:00	190	128.0	56.0	4.0	15.0	17.0	100.0
12/12/98	8:00:00	190	128.0	58.0	4.0	15.0	18.0	100.0
12/12/98	9:00:00	188	127.0	60.0	4.0	15.0	19.0	100.0
12/12/98	10:00:00	163	115.0	57.0	4.0	15.0	18.0	100.0
12/12/98	11:00:00	227	144.0	62.0	4.0	15.0	18.0	8.0
12/12/98	12:00:00	267	175.0	68.0	4.0	15.0	18.0	10.0
12/12/98	13:00:00	251	165.0	70.0	3.0	15.0	20.0	82.0
12/12/98	14:00:00	226	154.0	67.0	3.0	15.0	18.0	0.0
12/12/98	15:00:00	225	152.0	69.0	3.0	15.0	20.0	23.0
12/12/98	16:00:00	207	136.0	59.0	3.0	15.0	19.0	0.0
12/12/98	17:00:00	221	147.0	66.0	3.0	15.0	19.0	100.0
12/12/98	18:00:00	220	147.0	56.0	3.0	15.0	18.0	100.0
12/12/98	19:00:00	223	149.0	65.0	3.0	13.0	18.0	0.0
12/12/98	20:00:00	234	147.0	56.0	3.0	20.0	18.0	81.0
12/12/98	21:00:00	220	145.0	62.0	3.0	19.0	19.0	67.0
12/12/98	22:00:00	213	141.0	58.0	3.0	20.0	19.0	1.0
12/12/98	23:00:00	227	147.0	68.0	4.0	20.0	19.0	0.0
Daily Average		212.8	142.2	61.9	3.5	16.6	18.5	65.5

558


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
300
250
200
150
100
50
0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/12/98
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

159

McGill AirClean Mobile EP
Daily Performance Report

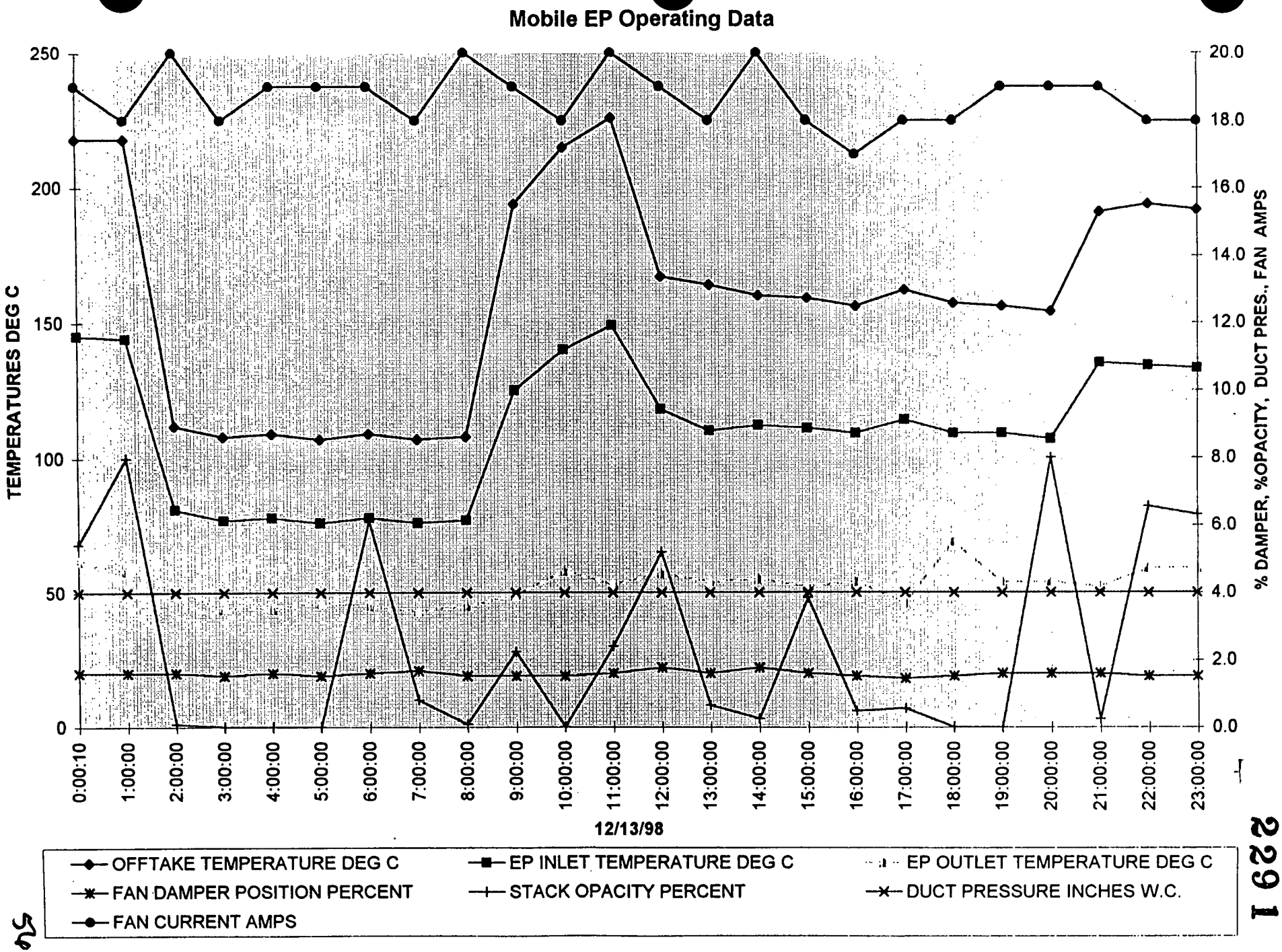
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/13/98
Start Date: 12/1/98
Days Operation: 12

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/13/98	0:00:10	218	145	62.0	4.0	20.0	19.0	68.0
12/13/98	1:00:00	218	144.0	58.0	4.0	20.0	18.0	100.0
12/13/98	2:00:00	112	81.0	51.0	4.0	20.0	20.0	1.0
12/13/98	3:00:00	108	77.0	44.0	4.0	19.0	18.0	0.0
12/13/98	4:00:00	109	78.0	44.0	4.0	20.0	19.0	0.0
12/13/98	5:00:00	107	76.0	46.0	4.0	19.0	19.0	0.0
12/13/98	6:00:00	109	78.0	45.0	4.0	20.0	19.0	77.0
12/13/98	7:00:00	107	76.0	43.0	4.0	21.0	18.0	10.0
12/13/98	8:00:00	108	77.0	45.0	4.0	19.0	20.0	1.0
12/13/98	9:00:00	194	125.0	49.0	4.0	19.0	19.0	28.0
12/13/98	10:00:00	215	140.0	58.0	4.0	19.0	18.0	0.0
12/13/98	11:00:00	226	149.0	53.0	4.0	20.0	20.0	30.0
12/13/98	12:00:00	167	118.0	57.0	4.0	22.0	19.0	65.0
12/13/98	13:00:00	164	110.0	54.0	4.0	20.0	18.0	8.0
12/13/98	14:00:00	160	112.0	55.0	4.0	22.0	20.0	3.0
12/13/98	15:00:00	159	111.0	52.0	4.0	20.0	18.0	48.0
12/13/98	16:00:00	156	109.0	54.0	4.0	19.0	17.0	6.0
12/13/98	17:00:00	162	114.0	46.0	4.0	18.0	18.0	7.0
12/13/98	18:00:00	157	109.0	69.0	4.0	19.0	18.0	0.0
12/13/98	19:00:00	156	109.0	54.0	4.0	20.0	19.0	0.0
12/13/98	20:00:00	154	107.0	54.0	4.0	20.0	19.0	100.0
12/13/98	21:00:00	191	135.0	52.0	4.0	20.0	19.0	3.0
12/13/98	22:00:00	194	134.0	59.0	4.0	19.0	18.0	82.0
12/13/98	23:00:00	192	133.0	59.0	4.0	19.0	18.0	79.0
Daily Average		160.1	110.3	52.6	4.0	19.8	18.7	29.8

560


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
250
200
150
100
50
0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/13/98
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

2291

105

McGill AirClean Mobile EP
Daily Performance Report

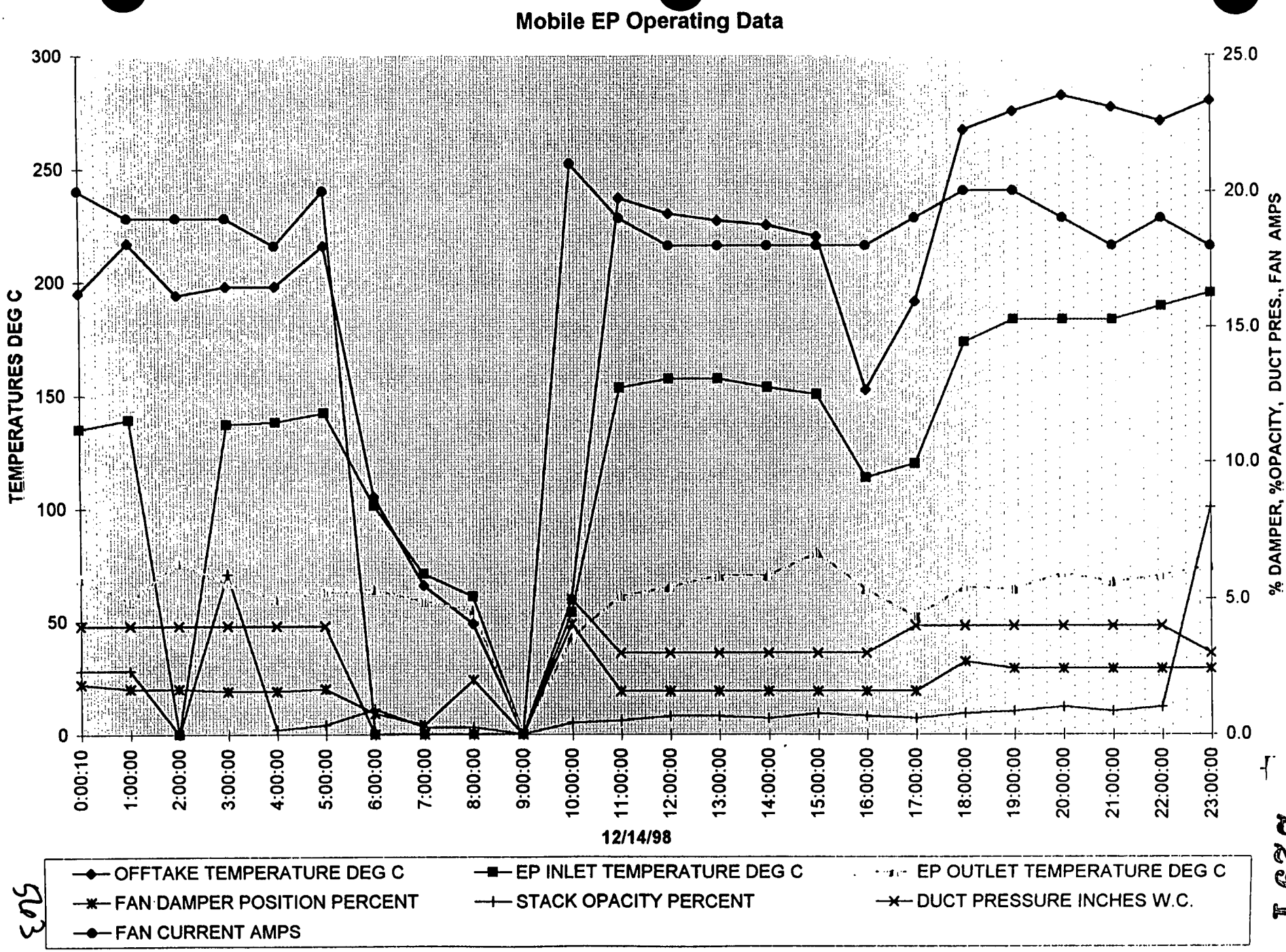
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/14/98
Start Date: 12/1/98
Days Operation: 13

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/14/98	0:00:10	195	135	69.0	4.0	22.0	20.0	28.0
12/14/98	1:00:00	217	139.0	59.0	4.0	20.0	19.0	28.0
12/14/98	2:00:00	194	0.0	76.0	4.0	20.0	19.0	0.0
12/14/98	3:00:00	198	137.0	67.0	4.0	19.0	19.0	71.0
12/14/98	4:00:00	198	138.0	60.0	4.0	19.0	18.0	2.0
12/14/98	5:00:00	216	142.0	63.0	4.0	20.0	20.0	4.0
12/14/98	6:00:00	105	101.0	64.0	0.0	9.0	0.0	11.0
12/14/98	7:00:00	66	71.0	59.0	0.0	4.0	0.0	3.0
12/14/98	8:00:00	49	61.0	55.0	0.0	24.0	0.0	3.0
12/14/98	9:00:00	#######	#######	#######	#######	#######	#######	#######
12/14/98	10:00:00	60	54.0	43.0	5.0	49.0	21.0	5.0
12/14/98	11:00:00	237	153.0	61.0	3.0	19.0	19.0	6.0
12/14/98	12:00:00	230	157.0	65.0	3.0	19.0	18.0	8.0
12/14/98	13:00:00	227	157.0	70.0	3.0	19.0	18.0	8.0
12/14/98	14:00:00	225	153.0	70.0	3.0	19.0	18.0	7.0
12/14/98	15:00:00	220	150.0	80.0	3.0	19.0	18.0	9.0
12/14/98	16:00:00	152	113.0	64.0	3.0	19.0	18.0	8.0
12/14/98	17:00:00	191	119.0	52.0	4.0	19.0	19.0	7.0
12/14/98	18:00:00	267	173.0	65.0	4.0	32.0	20.0	9.0
12/14/98	19:00:00	275	183.0	64.0	4.0	29.0	20.0	10.0
12/14/98	20:00:00	282	183.0	71.0	4.0	29.0	19.0	12.0
12/14/98	21:00:00	277	183.0	67.0	4.0	29.0	18.0	10.0
12/14/98	22:00:00	271	189.0	70.0	4.0	29.0	19.0	12.0
12/14/98	23:00:00	280	195.0	74.0	3.0	29.0	18.0	100.0
Daily Average		201.4	134.2	64.7	3.2	22.4	16.4	15.7

562


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
300
250
200
150
100
50
0
25.0
20.0
15.0
10.0
5.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
12/14/98
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

2291

305

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer: ENVITCO, INCORPORATED

Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE

Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/15/98

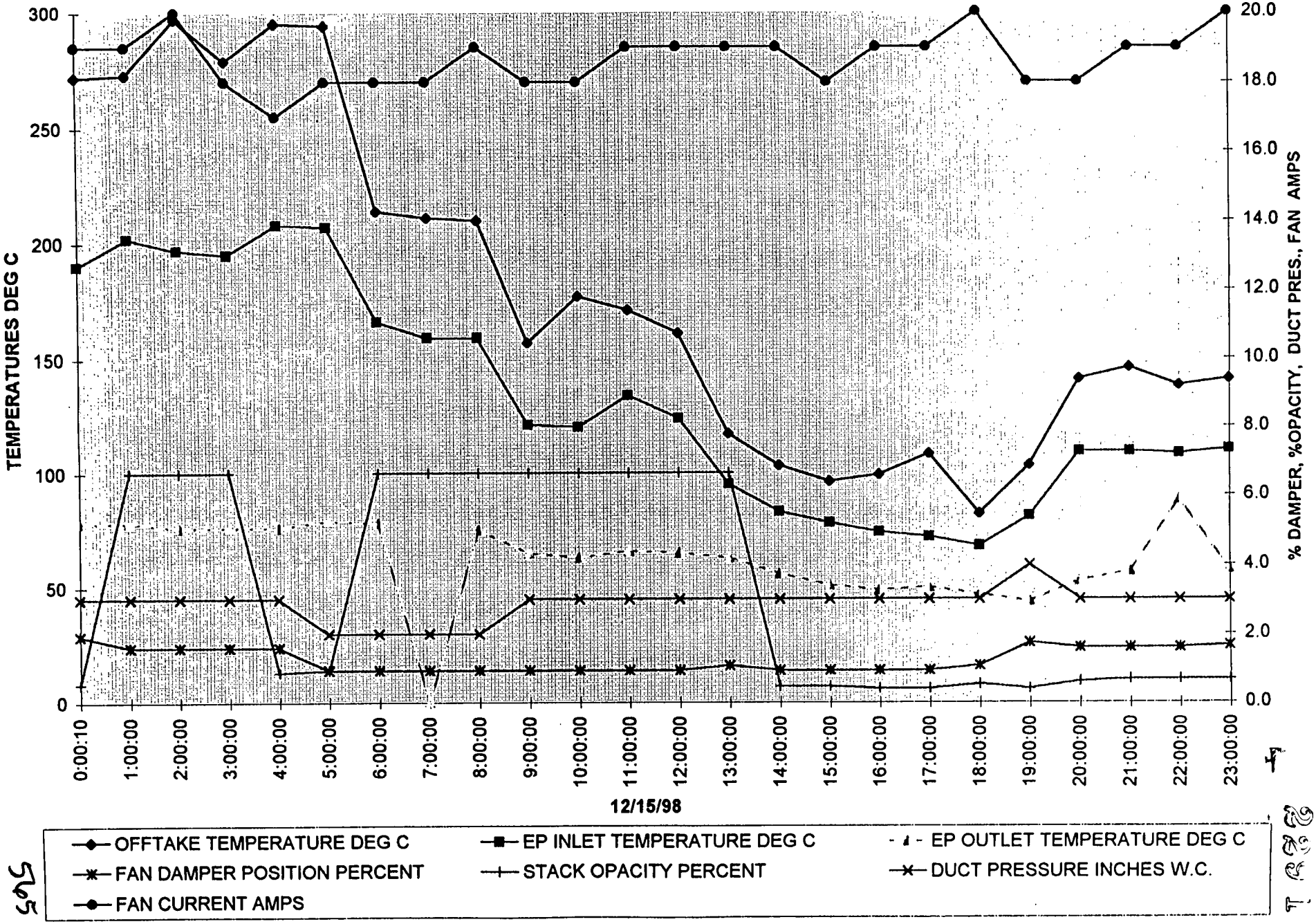
Start Date: 12/1/98

Days Operation: 14

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/15/98	0:00:10	272	190	78.0	3.0	29.0	19.0	8.0
12/15/98	1:00:00	273	202.0	78.0	3.0	24.0	19.0	100.0
12/15/98	2:00:00	297	197.0	76.0	3.0	24.0	20.0	100.0
12/15/98	3:00:00	279	195.0	76.0	3.0	24.0	18.0	100.0
12/15/98	4:00:00	295	208.0	76.0	3.0	24.0	17.0	13.0
12/15/98	5:00:00	294	207.0	79.0	2.0	14.0	18.0	14.0
12/15/98	6:00:00	214	166.0	78.0	2.0	14.0	18.0	100.0
12/15/98	7:00:00	211	159.0	0.0	2.0	14.0	18.0	100.0
12/15/98	8:00:00	210	159.0	75.0	2.0	14.0	19.0	100.0
12/15/98	9:00:00	157	121.0	65.0	3.0	14.0	18.0	100.0
12/15/98	10:00:00	177	120.0	63.0	3.0	14.0	18.0	100.0
12/15/98	11:00:00	171	134.0	66.0	3.0	14.0	19.0	100.0
12/15/98	12:00:00	161	124.0	65.0	3.0	14.0	19.0	100.0
12/15/98	13:00:00	117	95.0	63.0	3.0	16.0	19.0	100.0
12/15/98	14:00:00	103	83.0	56.0	3.0	14.0	19.0	7.0
12/15/98	15:00:00	96	78.0	51.0	3.0	14.0	18.0	7.0
12/15/98	16:00:00	99	74.0	49.0	3.0	14.0	19.0	6.0
12/15/98	17:00:00	108	72.0	50.0	3.0	14.0	19.0	6.0
12/15/98	18:00:00	82	68.0	47.0	3.0	16.0	20.0	8.0
12/15/98	19:00:00	103	81.0	44.0	4.0	26.0	18.0	6.0
12/15/98	20:00:00	141	109.0	53.0	3.0	24.0	18.0	9.0
12/15/98	21:00:00	146	109.0	57.0	3.0	24.0	19.0	10.0
12/15/98	22:00:00	138	108.0	88.0	3.0	24.0	19.0	10.0
12/15/98	23:00:00	141	110.0	58.0	3.0	25.0	20.0	10.0
Daily Average		178.5	132.0	62.1	2.9	18.7	18.7	50.6

964

Mobile EP Operating Data



505

McGill AirClean Mobile EP
Daily Performance Report

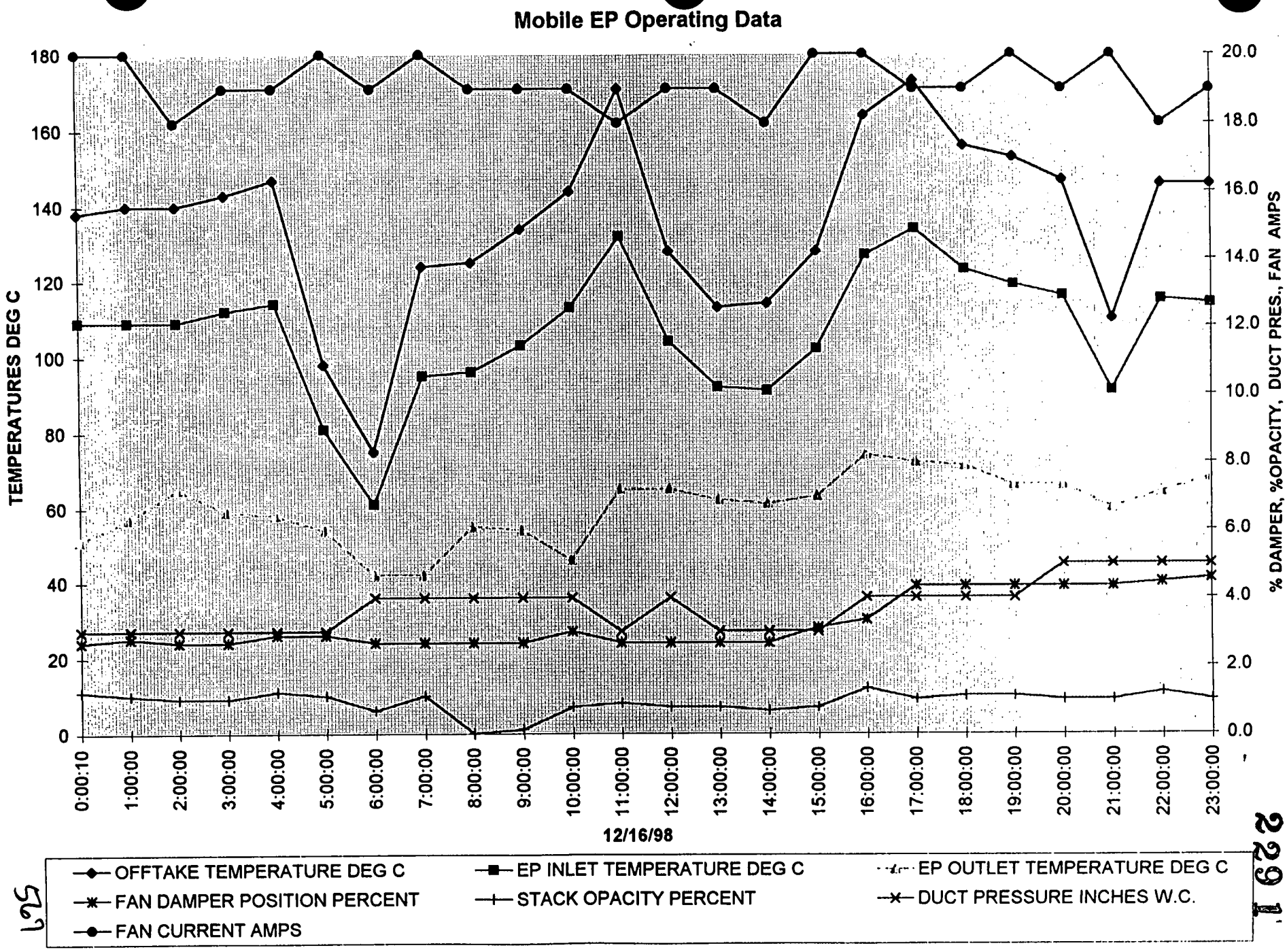
2291

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/16/98
Start Date: 12/1/98
Days Operation: 15

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/16/98	0:00:10	138	109	51.0	3.0	24.0	20.0	11.0
12/16/98	1:00:00	140	109.0	57.0	3.0	25.0	20.0	10.0
12/16/98	2:00:00	140	109.0	65.0	3.0	24.0	18.0	9.0
12/16/98	3:00:00	143	112.0	59.0	3.0	24.0	19.0	9.0
12/16/98	4:00:00	147	114.0	58.0	3.0	26.0	19.0	11.0
12/16/98	5:00:00	98	81.0	54.0	3.0	26.0	20.0	10.0
12/16/98	6:00:00	75	61.0	42.0	4.0	24.0	19.0	6.0
12/16/98	7:00:00	124	95.0	42.0	4.0	24.0	20.0	10.0
12/16/98	8:00:00	125	96.0	55.0	4.0	24.0	19.0	0.0
12/16/98	9:00:00	134	103.0	54.0	4.0	24.0	19.0	1.0
12/16/98	10:00:00	144	113.0	46.0	4.0	27.0	19.0	7.0
12/16/98	11:00:00	171	132.0	65.0	3.0	24.0	18.0	8.0
12/16/98	12:00:00	128	104.0	65.0	4.0	24.0	19.0	7.0
12/16/98	13:00:00	113	92.0	62.0	3.0	24.0	19.0	7.0
12/16/98	14:00:00	114	91.0	61.0	3.0	24.0	18.0	6.0
12/16/98	15:00:00	128	102.0	63.0	3.0	28.0	20.0	7.0
12/16/98	16:00:00	164	127.0	74.0	4.0	30.0	20.0	12.0
12/16/98	17:00:00	173	134.0	72.0	4.0	39.0	19.0	9.0
12/16/98	18:00:00	156	123.0	71.0	4.0	39.0	19.0	10.0
12/16/98	19:00:00	153	119.0	66.0	4.0	39.0	20.0	10.0
12/16/98	20:00:00	147	116.0	66.0	5.0	39.0	19.0	9.0
12/16/98	21:00:00	110	91.0	60.0	5.0	39.0	20.0	9.0
12/16/98	22:00:00	146	115.0	64.0	5.0	40.0	18.0	11.0
12/16/98	23:00:00	146	114.0	68.0	5.0	41.0	19.0	9.0
Daily Average		135.7	106.8	60.0	3.8	29.3	19.2	8.3

566


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
12/16/98
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

McGill AirClean Mobile EP
Daily Performance Report

2291

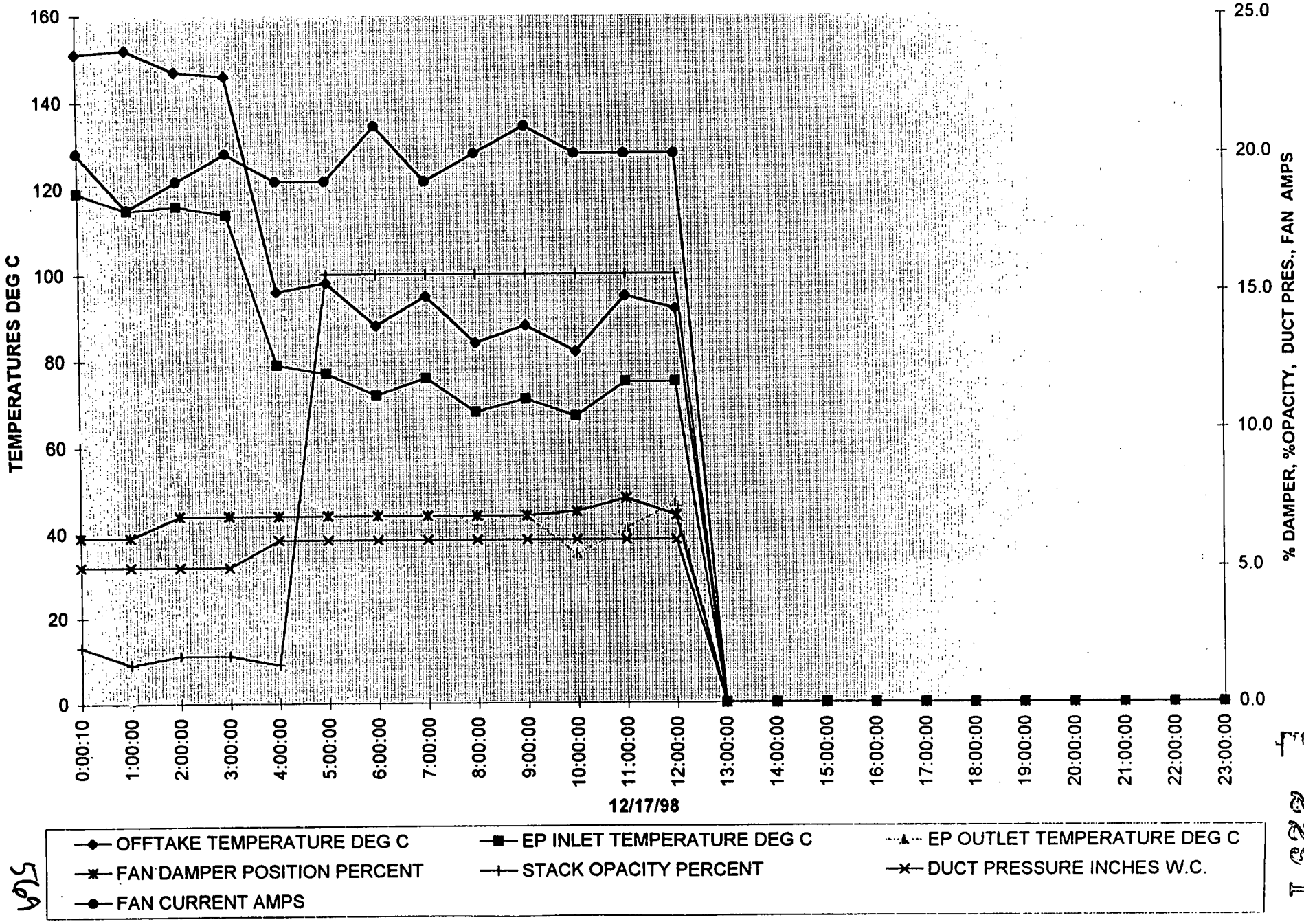
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/17/98
Start Date: 12/1/98
Days Operation: 16

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/17/98	0:00:10	151	119	63.0	5.0	39.0	20.0	13.0
12/17/98	1:00:00	152	115.0	0.0	5.0	39.0	18.0	9.0
12/17/98	2:00:00	147	116.0	60.0	5.0	44.0	19.0	11.0
12/17/98	3:00:00	146	114.0	59.0	5.0	44.0	20.0	11.0
12/17/98	4:00:00	96	79.0	51.0	6.0	44.0	19.0	9.0
12/17/98	5:00:00	98	77.0	45.0	6.0	44.0	19.0	100.0
12/17/98	6:00:00	88	72.0	45.0	6.0	44.0	21.0	100.0
12/17/98	7:00:00	95	76.0	45.0	6.0	44.0	19.0	100.0
12/17/98	8:00:00	84	68.0	43.0	6.0	44.0	20.0	100.0
12/17/98	9:00:00	88	71.0	44.0	6.0	44.0	21.0	100.0
12/17/98	10:00:00	82	67.0	35.0	6.0	45.0	20.0	100.0
12/17/98	11:00:00	95	75.0	41.0	6.0	48.0	20.0	100.0
12/17/98	12:00:00	92	75.0	47.0	6.0	44.0	20.0	100.0
12/17/98	13:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	14:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	15:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	16:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	17:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	18:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	19:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	20:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	21:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	22:00:00	#######	#######	#######	#######	#######	#######	#######
12/17/98	23:00:00	#######	#######	#######	#######	#######	#######	#######
Daily Average		108.8	86.5	44.5	5.7	43.6	19.7	65.6

568

Mobile EP Operating Data



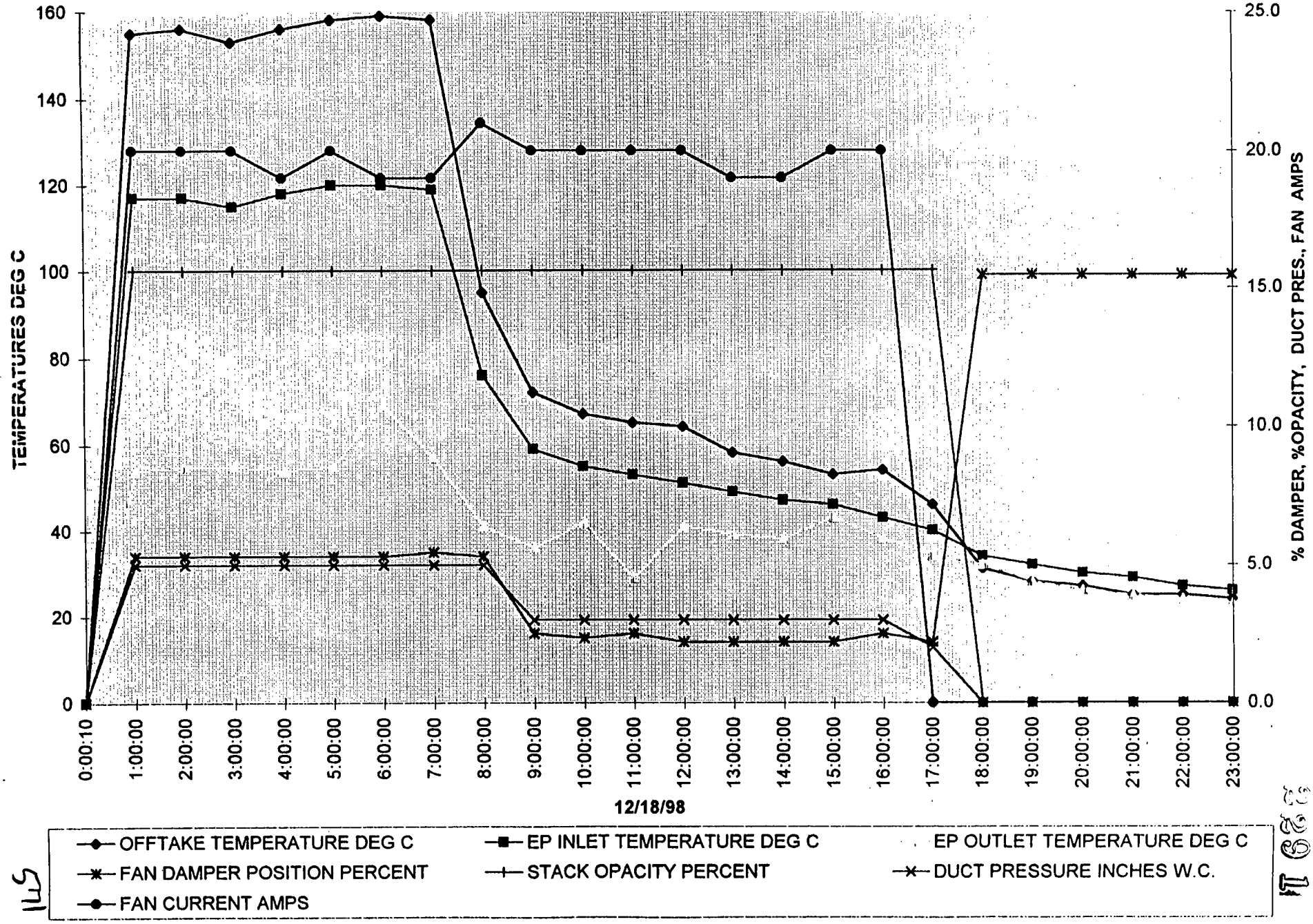
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 12/18/98
Start Date: 12/1/98
Days Operation: 17

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
12/18/98	0:00:10	#######	#######	#######	#######	#######	#######	#######
12/18/98	1:00:00	155	117.0	54.0	5.0	34.0	20.0	100.0
12/18/98	2:00:00	156	117.0	55.0	5.0	34.0	20.0	100.0
12/18/98	3:00:00	153	115.0	55.0	5.0	34.0	20.0	100.0
12/18/98	4:00:00	156	118.0	54.0	5.0	34.0	19.0	100.0
12/18/98	5:00:00	158	120.0	55.0	5.0	34.0	20.0	100.0
12/18/98	6:00:00	159	120.0	69.0	5.0	34.0	19.0	100.0
12/18/98	7:00:00	158	119.0	57.0	5.0	35.0	19.0	100.0
12/18/98	8:00:00	95	76.0	41.0	5.0	34.0	21.0	100.0
12/18/98	9:00:00	72	59.0	36.0	3.0	16.0	20.0	100.0
12/18/98	10:00:00	67	55.0	42.0	3.0	15.0	20.0	100.0
12/18/98	11:00:00	65	53.0	29.0	3.0	16.0	20.0	100.0
12/18/98	12:00:00	64	51.0	41.0	3.0	14.0	20.0	100.0
12/18/98	13:00:00	58	49.0	39.0	3.0	14.0	19.0	100.0
12/18/98	14:00:00	56	47.0	38.0	3.0	14.0	19.0	100.0
12/18/98	15:00:00	53	46.0	43.0	3.0	14.0	20.0	100.0
12/18/98	16:00:00	54	43.0	38.0	3.0	16.0	20.0	100.0
12/18/98	17:00:00	46	40.0	34.0	2.0	14.0	0.0	100.0
12/18/98	18:00:00	31	34.0	32.0	0.0	99.0	0.0	0.0
12/18/98	19:00:00	28	32.0	28.0	0.0	99.0	0.0	0.0
12/18/98	20:00:00	27	30.0	26.0	0.0	99.0	0.0	0.0
12/18/98	21:00:00	25	29.0	25.0	0.0	99.0	0.0	0.0
12/18/98	22:00:00	25	27.0	24.0	0.0	99.0	0.0	0.0
12/18/98	23:00:00	24	26.0	23.0	0.0	99.0	0.0	0.0
Daily Average		82.0	66.2	40.8	2.9	43.5	13.7	73.9

Mobile EP Operating Data



115

McGill AirClean Mobile EP
Daily Performance Report

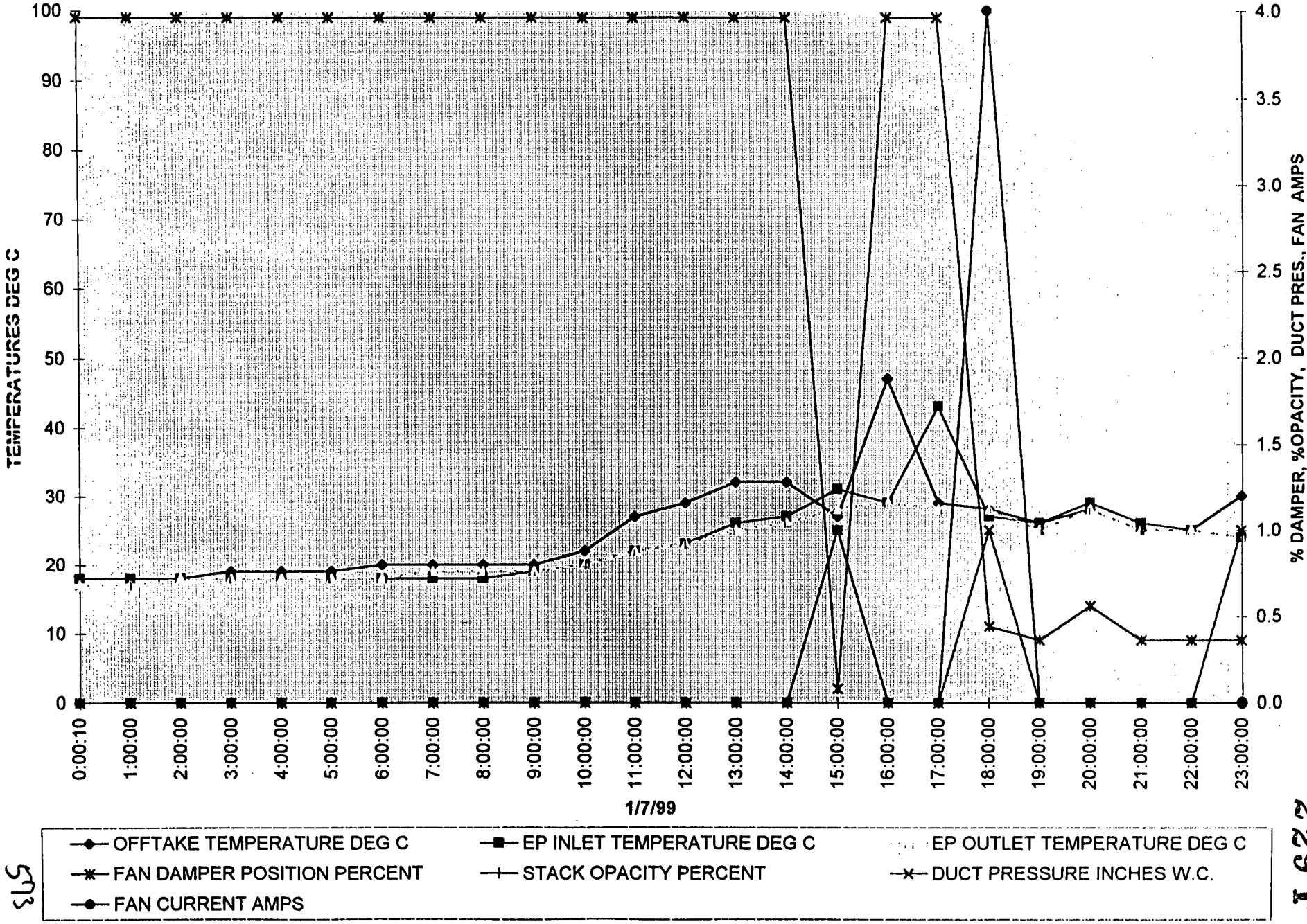
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/7/99
Start Date: 12/1/98
Days Operation: 18

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/7/99	0:00:10	18	18	17.0	0.0	99.0	0.0	0.0
1/7/99	1:00:00	18	18.0	17.0	0.0	99.0	0.0	0.0
1/7/99	2:00:00	18	18.0	18.0	0.0	99.0	0.0	0.0
1/7/99	3:00:00	19	18.0	18.0	0.0	99.0	0.0	0.0
1/7/99	4:00:00	19	18.0	18.0	0.0	99.0	0.0	0.0
1/7/99	5:00:00	19	18.0	18.0	0.0	99.0	0.0	0.0
1/7/99	6:00:00	20	18.0	18.0	0.0	99.0	0.0	0.0
1/7/99	7:00:00	20	18.0	19.0	0.0	99.0	0.0	0.0
1/7/99	8:00:00	20	18.0	19.0	0.0	99.0	0.0	0.0
1/7/99	9:00:00	20	19.0	19.0	0.0	99.0	0.0	0.0
1/7/99	10:00:00	22	20.0	20.0	0.0	99.0	0.0	0.0
1/7/99	11:00:00	27	22.0	22.0	0.0	99.0	0.0	0.0
1/7/99	12:00:00	29	23.0	23.0	0.0	99.0	0.0	0.0
1/7/99	13:00:00	32	26.0	25.0	0.0	99.0	0.0	0.0
1/7/99	14:00:00	32	27.0	26.0	0.0	99.0	0.0	0.0
[illegible]	15:00:00	27	31.0	28.0	1.0	2.0	1.0	0.0
[illegible]	16:00:00	47	29.0	29.0	0.0	99.0	0.0	0.0
[illegible]/99	17:00:00	29	43.0	28.0	0.0	99.0	0.0	0.0
1/7/99	18:00:00	28	27.0	28.0	1.0	11.0	4.0	0.0
1/7/99	19:00:00	26	26.0	25.0	0.0	9.0	0.0	0.0
1/7/99	20:00:00	28	29.0	28.0	0.0	14.0	0.0	0.0
1/7/99	21:00:00	25	26.0	25.0	0.0	9.0	0.0	0.0
1/7/99	22:00:00	25	25.0	25.0	0.0	9.0	0.0	0.0
1/7/99	23:00:00	30	24.0	24.0	1.0	9.0	0.0	0.0
Daily Average		24.9	23.3	22.4	0.1	72.8	0.2	0.0

572

Mobile EP Operating Data



2291

515

McGill AirClean Mobile EP
Daily Performance Report

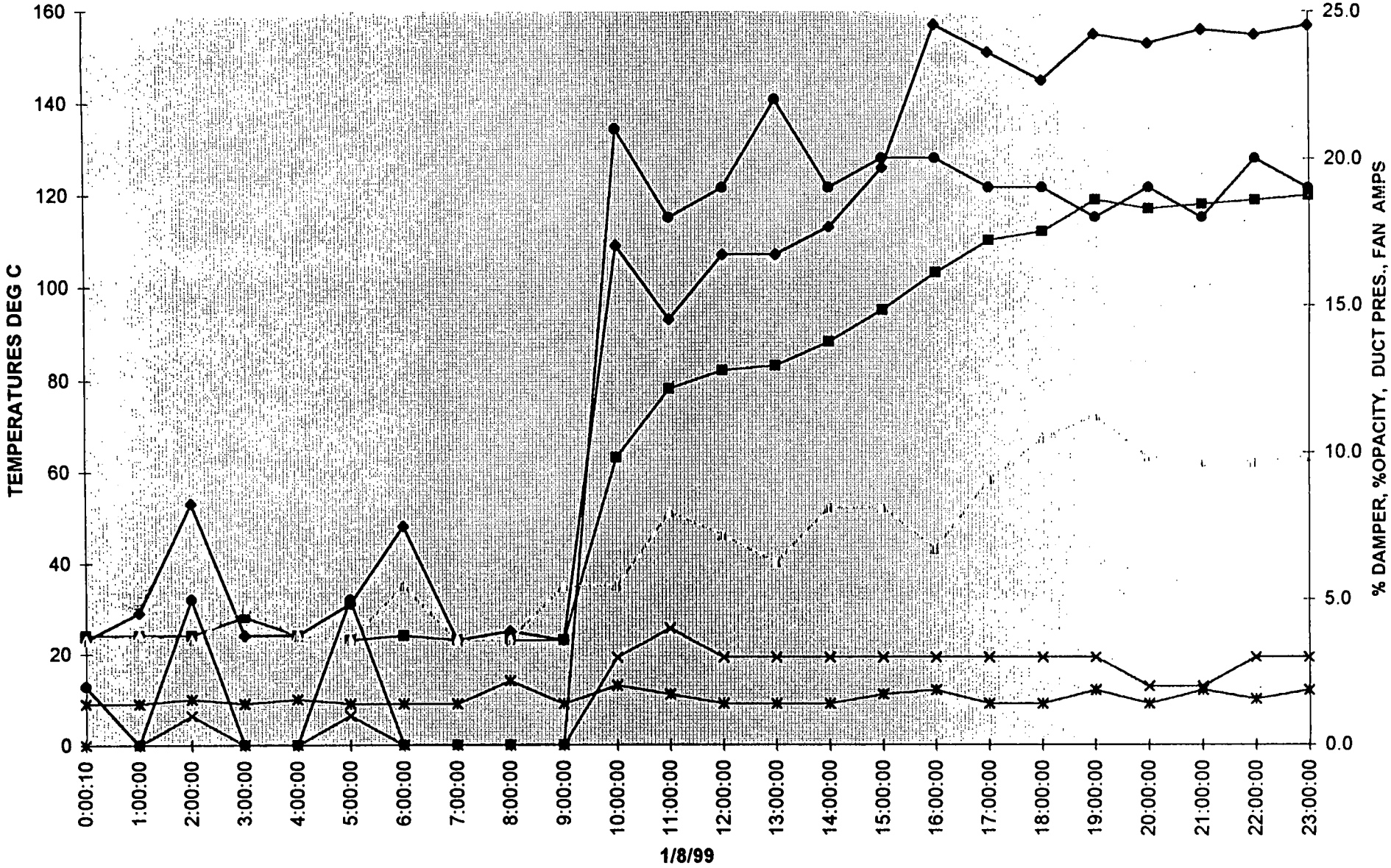
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/8/99
Start Date: 12/1/98
Days Operation: 19

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/8/99	0:00:10	23	24	23.0	0.0	9.0	2.0	0.0
1/8/99	1:00:00	29	24.0	24.0	0.0	9.0	0.0	0.0
1/8/99	2:00:00	53	24.0	23.0	1.0	10.0	5.0	0.0
1/8/99	3:00:00	24	28.0	30.0	0.0	9.0	0.0	0.0
1/8/99	4:00:00	24	24.0	24.0	0.0	10.0	0.0	0.0
1/8/99	5:00:00	31	23.0	23.0	1.0	9.0	5.0	0.0
1/8/99	6:00:00	48	24.0	35.0	0.0	9.0	0.0	0.0
1/8/99	7:00:00	23	23.0	23.0	0.0	9.0	0.0	0.0
1/8/99	8:00:00	25	23.0	23.0	0.0	14.0	0.0	0.0
1/8/99	9:00:00	23	23.0	35.0	0.0	9.0	0.0	0.0
1/8/99	10:00:00	109	63.0	35.0	3.0	13.0	21.0	0.0
1/8/99	11:00:00	93	78.0	51.0	4.0	11.0	18.0	0.0
1/8/99	12:00:00	107	82.0	46.0	3.0	9.0	19.0	0.0
1/8/99	13:00:00	107	83.0	40.0	3.0	9.0	22.0	0.0
1/8/99	14:00:00	113	88.0	52.0	3.0	9.0	19.0	0.0
[illegible]	15:00:00	126	95.0	52.0	3.0	11.0	20.0	0.0
[illegible]	16:00:00	157	103.0	43.0	3.0	12.0	20.0	0.0
[illegible]/99	17:00:00	151	110.0	58.0	3.0	9.0	19.0	0.0
1/8/99	18:00:00	145	112.0	67.0	3.0	9.0	19.0	0.0
1/8/99	19:00:00	155	119.0	72.0	3.0	12.0	18.0	0.0
1/8/99	20:00:00	153	117.0	63.0	2.0	9.0	19.0	0.0
1/8/99	21:00:00	156	118.0	62.0	2.0	12.0	18.0	0.0
1/8/99	22:00:00	155	119.0	62.0	3.0	10.0	20.0	0.0
1/8/99	23:00:00	157	120.0	63.0	3.0	12.0	19.0	0.0
Daily Average		91.1	68.6	42.9	1.8	10.2	11.8	0.0

574

Mobile EP Operating Data



- OFFTAKE TEMPERATURE DEG C
- EP INLET TEMPERATURE DEG C
- EP OUTLET TEMPERATURE DEG C
- FAN DAMPER POSITION PERCENT
- STACK OPACITY PERCENT
- DUCT PRESSURE INCHES W.C.
- FAN CURRENT AMPS

575

McGill AirClean Mobile EP
Daily Performance Report

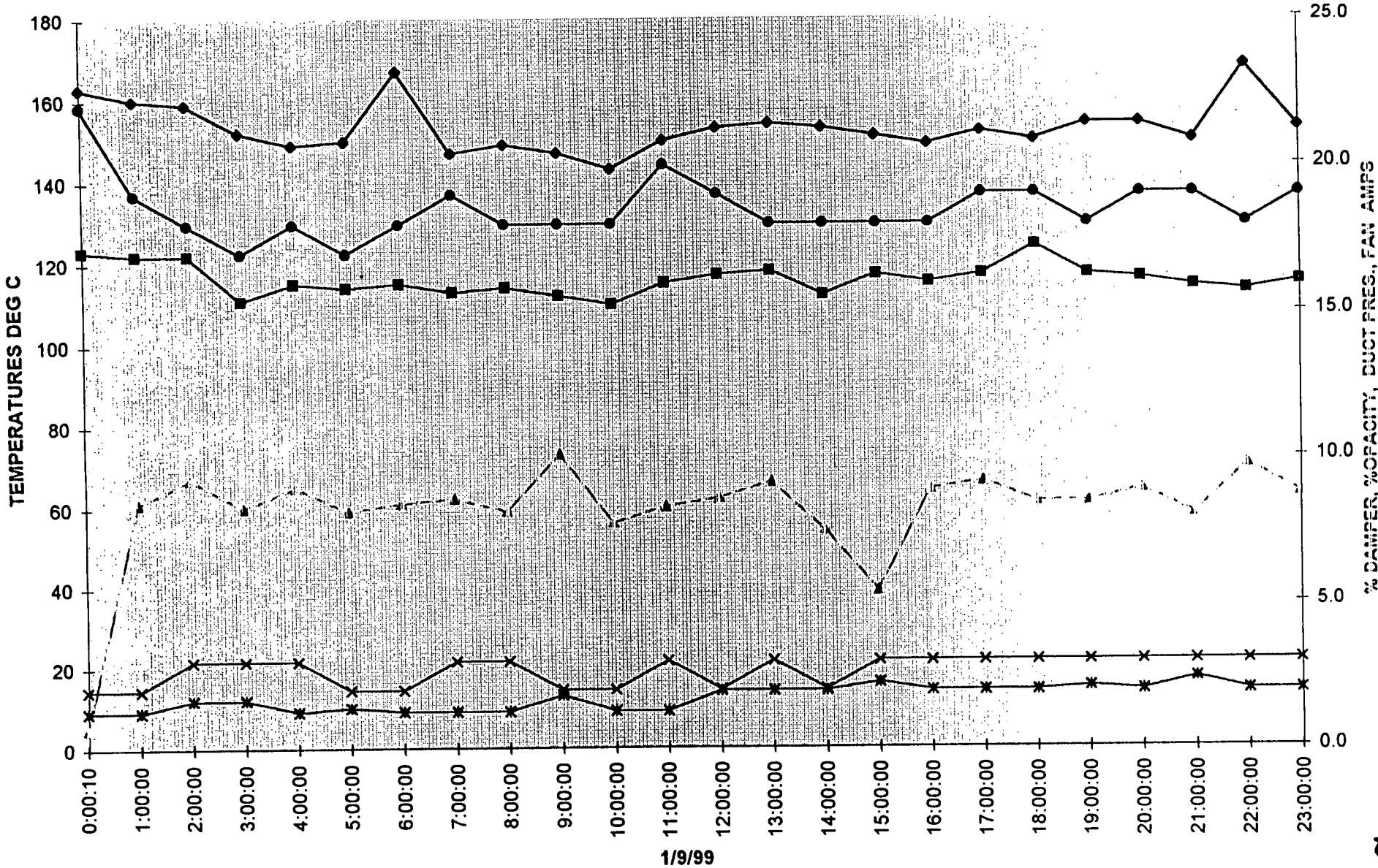
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/9/99
Start Date: 12/1/98
Days Operation: 20

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/9/99	0:00:10	163	123	5.0	2.0	9.0	22.0	0.0
1/9/99	1:00:00	160	122.0	61.0	2.0	9.0	19.0	0.0
1/9/99	2:00:00	159	122.0	67.0	3.0	12.0	18.0	0.0
1/9/99	3:00:00	152	111.0	60.0	3.0	12.0	17.0	0.0
1/9/99	4:00:00	149	115.0	65.0	3.0	9.0	18.0	0.0
1/9/99	5:00:00	150	114.0	59.0	2.0	10.0	17.0	0.0
1/9/99	6:00:00	167	115.0	61.0	2.0	9.0	18.0	0.0
1/9/99	7:00:00	147	113.0	62.0	3.0	9.0	19.0	0.0
1/9/99	8:00:00	149	114.0	59.0	3.0	9.0	18.0	0.0
1/9/99	9:00:00	147	112.0	73.0	2.0	13.0	18.0	0.0
1/9/99	10:00:00	143	110.0	56.0	2.0	9.0	18.0	0.0
1/9/99	11:00:00	150	115.0	60.0	3.0	9.0	20.0	0.0
1/9/99	12:00:00	153	117.0	62.0	2.0	14.0	19.0	0.0
1/9/99	13:00:00	154	118.0	66.0	3.0	14.0	18.0	0.0
[illegible]	14:00:00	153	112.0	54.0	2.0	14.0	18.0	0.0
[illegible]	15:00:00	151	117.0	39.0	3.0	16.0	18.0	0.0
[illegible]99	16:00:00	149	115.0	64.0	3.0	14.0	18.0	0.0
1/9/99	17:00:00	152	117.0	66.0	3.0	14.0	19.0	0.0
1/9/99	18:00:00	150	124.0	61.0	3.0	14.0	19.0	0.0
1/9/99	19:00:00	154	117.0	61.0	3.0	15.0	18.0	0.0
1/9/99	20:00:00	154	116.0	64.0	3.0	14.0	19.0	0.0
1/9/99	21:00:00	150	114.0	58.0	3.0	17.0	19.0	0.0
1/9/99	22:00:00	168	113.0	70.0	3.0	14.0	18.0	0.0
1/9/99	23:00:00	153	115.0	63.0	3.0	14.0	19.0	0.0
Daily Average		153.2	115.9	59.0	2.7	12.2	18.5	0.0

576

Mobile EP Operating Data



- OFFTAKE TEMPERATURE DEG C
- EP INLET TEMPERATURE DEG C
- EP OUTLET TEMPERATURE DEG C
- FAN DAMPER POSITION PERCENT
- STACK OPACITY PERCENT
- DUCT PRESSURE INCHES W.C.
- FAN CURRENT AMPS

McGill AirClean Mobile EP
Daily Performance Report

2291

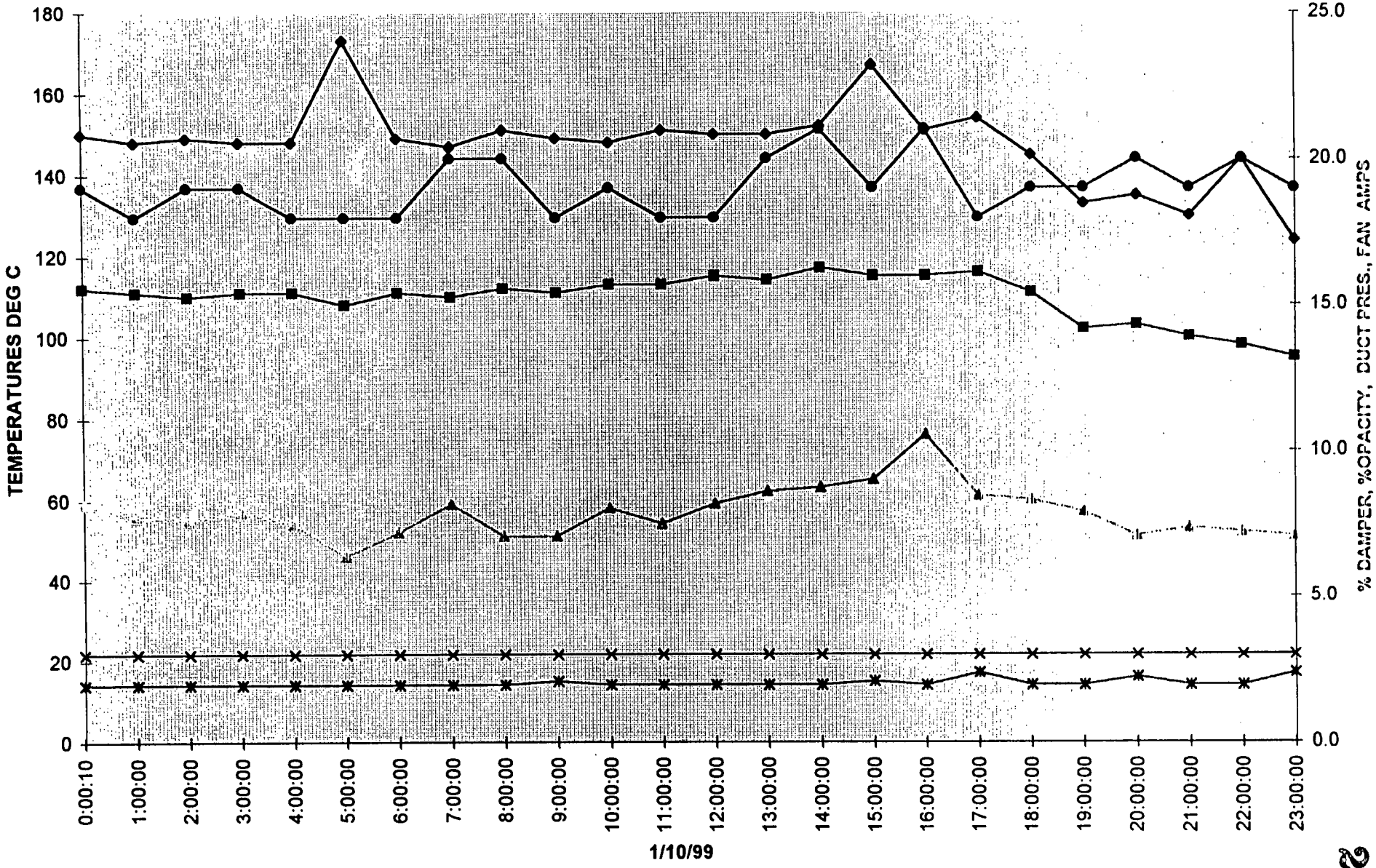
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/10/99
Start Date: 12/1/98
Days Operation: 21

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/10/99	0:00:10	150	112	59.0	3.0	14.0	19.0	0.0
1/10/99	1:00:00	148	111.0	56.0	3.0	14.0	18.0	0.0
1/10/99	2:00:00	149	110.0	55.0	3.0	14.0	19.0	0.0
1/10/99	3:00:00	148	111.0	57.0	3.0	14.0	19.0	0.0
1/10/99	4:00:00	148	111.0	54.0	3.0	14.0	18.0	0.0
1/10/99	5:00:00	173	108.0	46.0	3.0	14.0	18.0	0.0
1/10/99	6:00:00	149	111.0	52.0	3.0	14.0	18.0	0.0
1/10/99	7:00:00	147	110.0	59.0	3.0	14.0	20.0	0.0
1/10/99	8:00:00	151	112.0	51.0	3.0	14.0	20.0	0.0
1/10/99	9:00:00	149	111.0	51.0	3.0	15.0	18.0	0.0
1/10/99	10:00:00	148	113.0	58.0	3.0	14.0	19.0	0.0
1/10/99	11:00:00	151	113.0	54.0	3.0	14.0	18.0	0.0
1/10/99	12:00:00	150	115.0	59.0	3.0	14.0	18.0	0.0
1/10/99	13:00:00	150	114.0	62.0	3.0	14.0	20.0	0.0
1/[illegible]/99	14:00:00	152	117.0	63.0	3.0	14.0	21.0	0.0
[illegible]	15:00:00	167	115.0	65.0	3.0	15.0	19.0	0.0
[illegible]/99	16:00:00	151	115.0	76.0	3.0	14.0	21.0	0.0
1/10/99	17:00:00	154	116.0	61.0	3.0	17.0	18.0	0.0
1/10/99	18:00:00	145	111.0	60.0	3.0	14.0	19.0	0.0
1/10/99	19:00:00	133	102.0	57.0	3.0	14.0	19.0	0.0
1/10/99	20:00:00	135	103.0	51.0	3.0	16.0	20.0	0.0
1/10/99	21:00:00	130	100.0	53.0	3.0	14.0	19.0	0.0
1/10/99	22:00:00	144	98.0	52.0	3.0	14.0	20.0	0.0
1/10/99	23:00:00	124	95.0	51.0	3.0	17.0	19.0	0.0
Daily Average		147.8	109.8	56.8	3.0	14.4	19.0	0.0

578

Mobile EP Operating Data



- OFFTAKE TEMPERATURE DEG C
- EP INLET TEMPERATURE DEG C
- EP OUTLET TEMPERATURE DEG C
- FAN DAMPER POSITION PERCENT
- STACK OPACITY PERCENT
- DUCT PRESSURE INCHES W.C.
- FAN CURRENT AMPS

McGill AirClean Mobile EP
Daily Performance Report

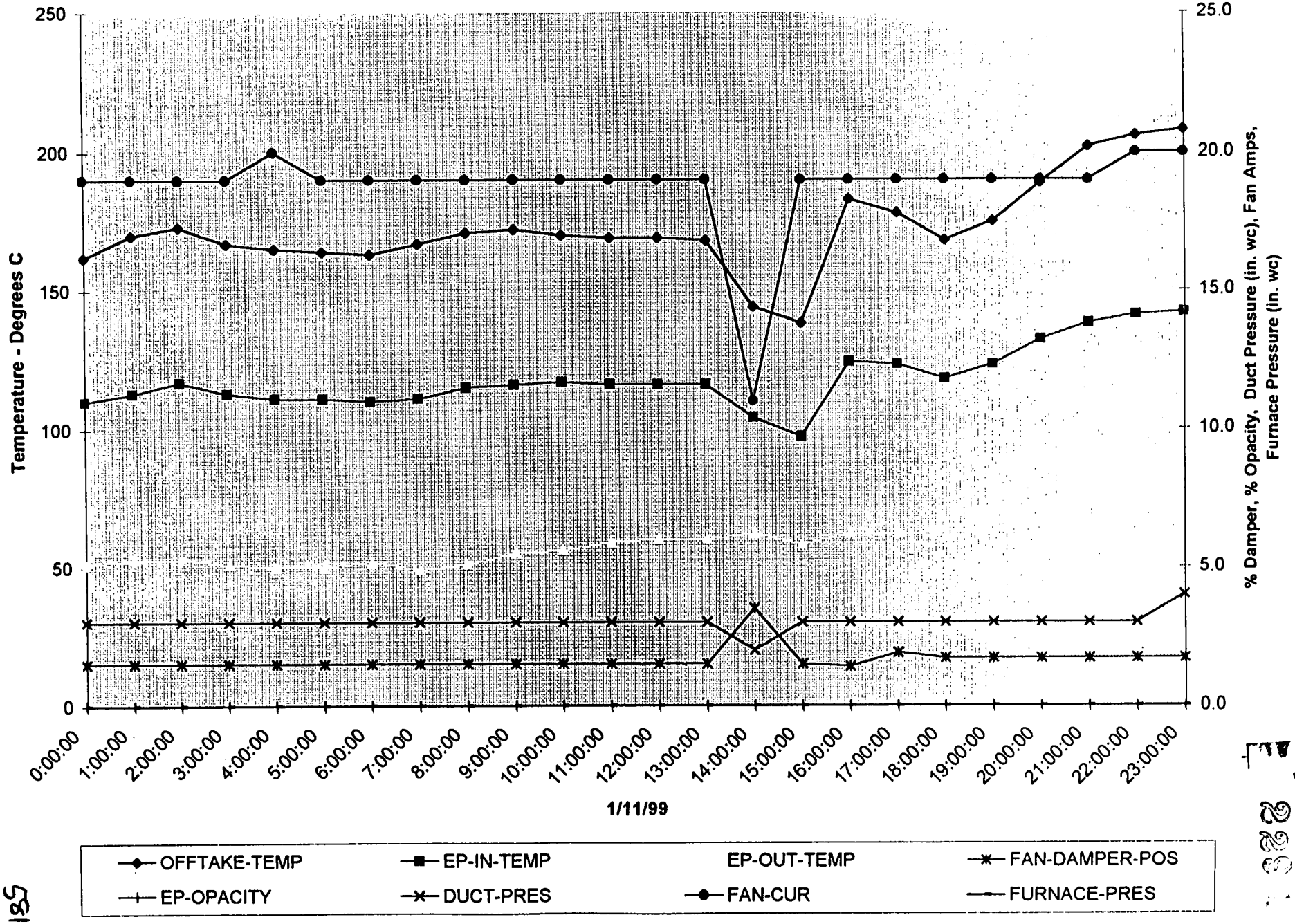
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/11/99
Start Date: 12/1/98
Days Operation: 22

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT	FURNACE PRESSURE INCHES W.C.
1/11/99	0:00:00	162	110	51	3.0	15.0	19.0	0.0	0.0
1/11/99	1:00:00	170	113.0	53.0	3.0	15.0	19.0	0.0	0.0
1/11/99	2:00:00	173	117.0	53.0	3.0	15.0	19.0	0.0	0.0
1/11/99	3:00:00	167	113.0	51.0	3.0	15.0	19.0	0.0	0.0
1/11/99	4:00:00	165	111.0	50.0	3.0	15.0	20.0	0.0	0.0
1/11/99	5:00:00	164	111.0	50.0	3.0	15.0	19.0	0.0	0.0
1/11/99	6:00:00	163	110.0	52.0	3.0	15.0	19.0	0.0	0.0
1/11/99	7:00:00	167	111.0	49.0	3.0	15.0	19.0	0.0	0.0
1/11/99	8:00:00	171	115.0	51.0	3.0	15.0	19.0	0.0	0.0
1/11/99	9:00:00	172	116.0	55.0	3.0	15.0	19.0	0.0	0.0
1/11/99	10:00:00	170	117.0	56.0	3.0	15.0	19.0	0.0	0.0
1/11/99	11:00:00	169	116.0	59.0	3.0	15.0	19.0	0.0	0.0
1/11/99	12:00:00	169	116.0	60.0	3.0	15.0	19.0	0.0	0.0
1/11/99	13:00:00	168	116.0	60.0	3.0	15.0	19.0	0.0	0.0
1/11/99	14:00:00	144	104.0	62.0	2.0	35.0	11.0	0.0	0.0
1/11/99	15:00:00	138	97.0	58.0	3.0	15.0	19.0	0.0	0.0
1/11/99	16:00:00	183	124.0	62.0	3.0	14.0	19.0	0.0	0.0
1/11/99	17:00:00	178	123.0	62.0	3.0	19.0	19.0	0.0	0.0
1/11/99	18:00:00	168	118.0	61.0	3.0	17.0	19.0	0.0	0.0
1/11/99	19:00:00	175	123.0	62.0	3.0	17.0	19.0	0.0	0.0
1/11/99	20:00:00	189	132.0	63.0	3.0	17.0	19.0	0.0	0.0
1/11/99	21:00:00	202	138.0	64.0	3.0	17.0	19.0	0.0	0.0
1/11/99	22:00:00	206	141.0	63.0	3.0	17.0	20.0	0.0	0.0
1/11/99	23:00:00	208	142.0	69.0	4.0	17.0	20.0	0.0	0.0
Daily Average		172.5	118.1	57.3	3.0	16.5	18.8	0.0	

580

MOBILE EP OPERATING DATA



185

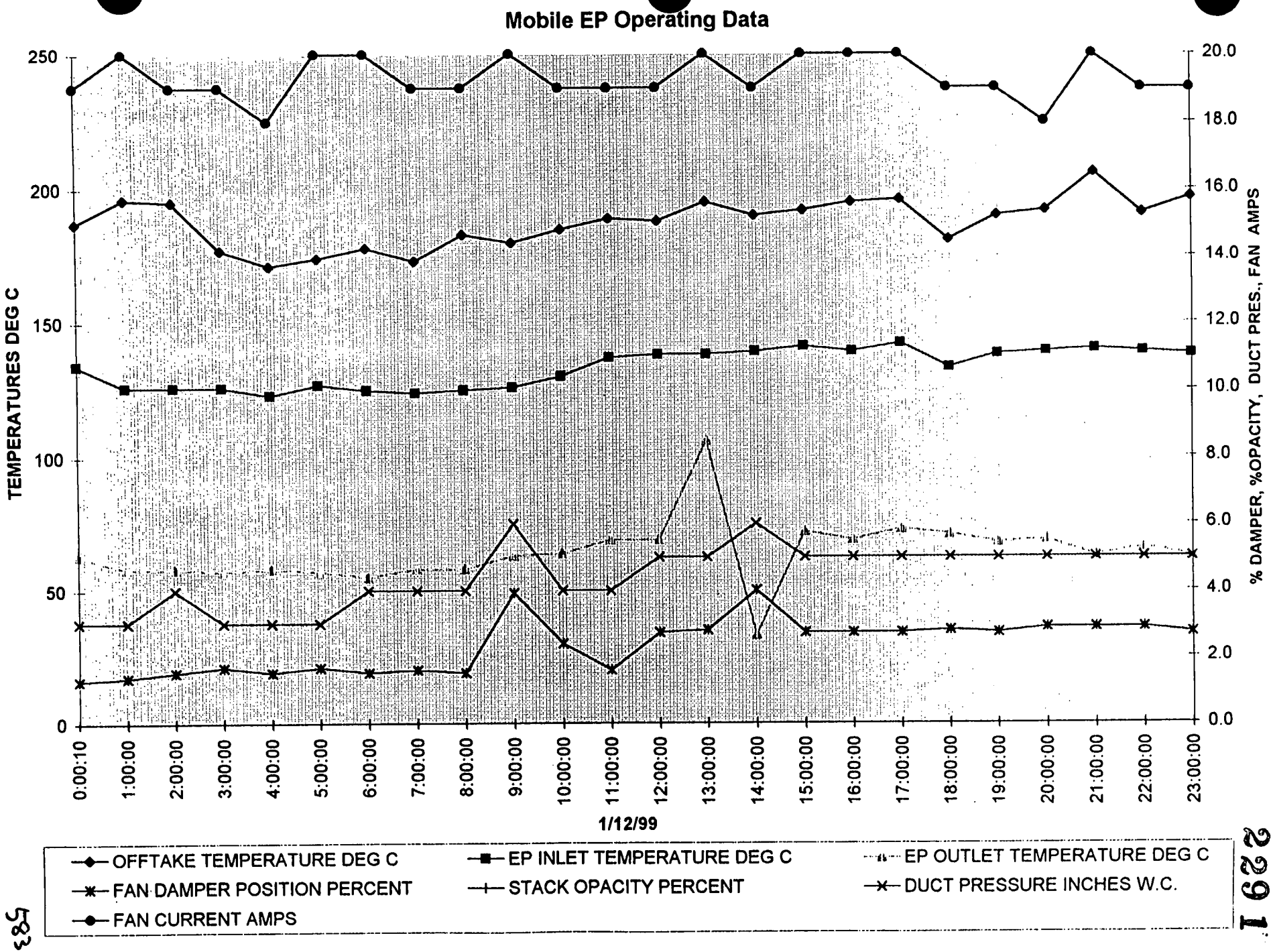
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/12/99
Start Date: 12/1/98
Days Operation: 23

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/12/99	0:00:10	187	134	63.0	3.0	16.0	19.0	0.0
1/12/99	1:00:00	196	126.0	58.0	3.0	17.0	20.0	0.0
1/12/99	2:00:00	195	126.0	58.0	4.0	19.0	19.0	0.0
1/12/99	3:00:00	177	126.0	57.0	3.0	21.0	19.0	0.0
1/12/99	4:00:00	171	123.0	58.0	3.0	19.0	18.0	0.0
1/12/99	5:00:00	174	127.0	57.0	3.0	21.0	20.0	0.0
1/12/99	6:00:00	178	125.0	55.0	4.0	19.0	20.0	0.0
1/12/99	7:00:00	173	124.0	58.0	4.0	20.0	19.0	0.0
1/12/99	8:00:00	183	125.0	58.0	4.0	19.0	19.0	0.0
1/12/99	9:00:00	180	126.0	63.0	6.0	49.0	20.0	0.0
1/12/99	10:00:00	185	130.0	64.0	4.0	30.0	19.0	0.0
1/12/99	11:00:00	189	137.0	69.0	4.0	20.0	19.0	0.0
1/12/99	12:00:00	188	138.0	69.0	5.0	34.0	19.0	0.0
1/12/99	13:00:00	195	138.0	106.0	5.0	35.0	20.0	0.0
1/12/99	14:00:00	190	139.0	33.0	6.0	50.0	19.0	0.0
[illegible]	15:00:00	192	141.0	72.0	5.0	34.0	20.0	0.0
[illegible]/99	16:00:00	195	139.0	69.0	5.0	34.0	20.0	0.0
[illegible]/99	17:00:00	196	142.0	73.0	5.0	34.0	20.0	0.0
1/12/99	18:00:00	181	133.0	71.0	5.0	35.0	19.0	0.0
1/12/99	19:00:00	190	138.0	68.0	5.0	34.0	19.0	0.0
1/12/99	20:00:00	192	139.0	69.0	5.0	36.0	18.0	0.0
1/12/99	21:00:00	206	140.0	63.0	5.0	36.0	20.0	0.0
1/12/99	22:00:00	191	139.0	66.0	5.0	36.0	19.0	0.0
1/12/99	23:00:00	197	138.0	63.0	5.0	34.0	19.0	0.0
Daily Average		187.5	133.0	64.2	4.4	29.3	19.3	0.0

582


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
250
200
150
100
50
0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/12/99
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

2291

585

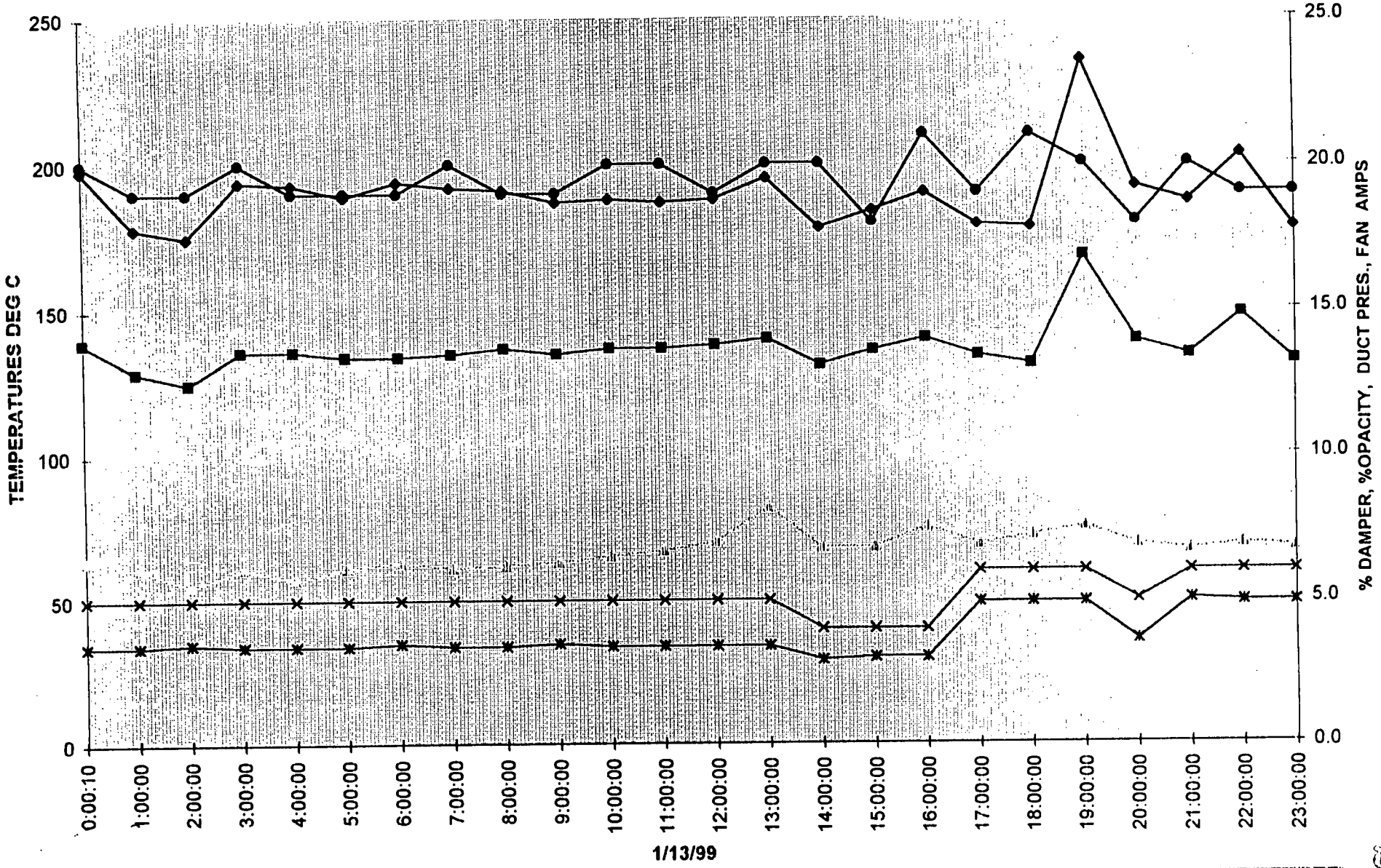
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/13/99
Start Date: 12/1/98
Days Operation: 24

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/13/99	0:00:10	198	139	64.0	5.0	34.0	20.0	0.0
1/13/99	1:00:00	178	129.0	61.0	5.0	34.0	19.0	0.0
1/13/99	2:00:00	175	125.0	55.0	5.0	35.0	19.0	0.0
1/13/99	3:00:00	194	136.0	61.0	5.0	34.0	20.0	0.0
1/13/99	4:00:00	193	136.0	57.0	5.0	34.0	19.0	0.0
1/13/99	5:00:00	189	134.0	61.0	5.0	34.0	19.0	0.0
1/13/99	6:00:00	194	134.0	63.0	5.0	35.0	19.0	0.0
1/13/99	7:00:00	192	135.0	61.0	5.0	34.0	20.0	0.0
1/13/99	8:00:00	191	137.0	62.0	5.0	34.0	19.0	0.0
1/13/99	9:00:00	187	135.0	63.0	5.0	35.0	19.0	0.0
1/13/99	10:00:00	188	137.0	65.0	5.0	34.0	20.0	0.0
1/13/99	11:00:00	187	137.0	67.0	5.0	34.0	20.0	0.0
1/13/99	12:00:00	188	138.0	70.0	5.0	34.0	19.0	0.0
1/13/99	13:00:00	195	140.0	82.0	5.0	34.0	20.0	0.0
1/13/99	14:00:00	178	131.0	68.0	4.0	29.0	20.0	0.0
1/13/99	15:00:00	184	136.0	68.0	4.0	30.0	18.0	0.0
1/13/99	16:00:00	190	140.0	75.0	4.0	30.0	21.0	0.0
1/13/99	17:00:00	179	134.0	69.0	6.0	49.0	19.0	0.0
1/13/99	18:00:00	178	131.0	72.0	6.0	49.0	21.0	0.0
1/13/99	19:00:00	235	168.0	75.0	6.0	49.0	20.0	0.0
1/12/99	20:00:00	192	139.0	69.0	5.0	36.0	18.0	0.0
1/13/99	21:00:00	187	134.0	67.0	6.0	50.0	20.0	0.0
1/13/99	22:00:00	203	148.0	69.0	6.0	49.0	19.0	0.0
1/13/99	23:00:00	178	132.0	68.0	6.0	49.0	19.0	0.0
Daily Average		189.7	136.9	66.3	5.1	37.5	19.5	0.0

Mobile EP Operating Data



McGill AirClean Mobile EP

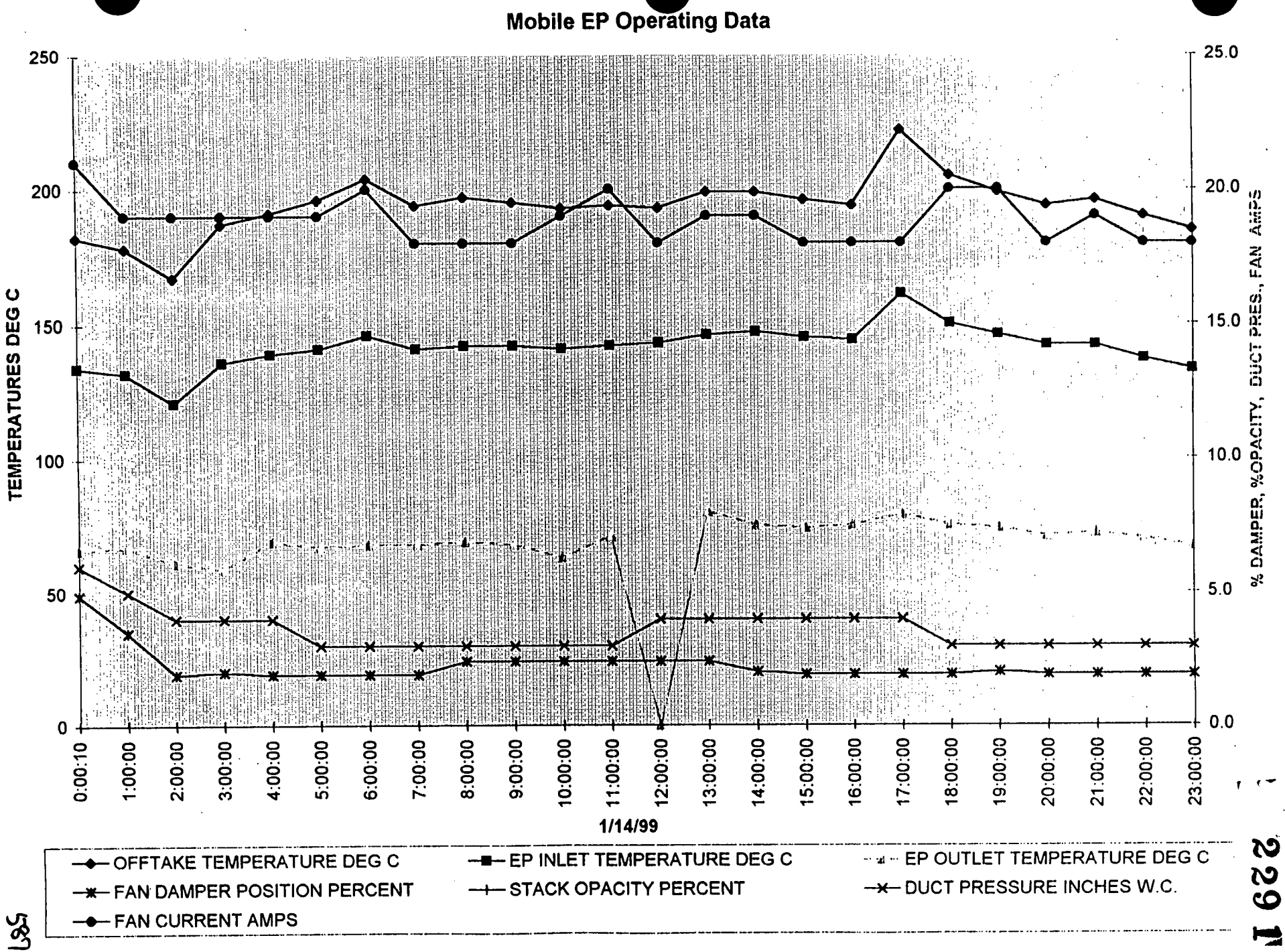
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/14/99
Start Date: 12/1/98
Days Operation: 25

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/14/99	0:00:10	182	134	66.0	6.0	49.0	21.0	0.0
1/14/99	1:00:00	178	132.0	67.0	5.0	35.0	19.0	0.0
1/14/99	2:00:00	167	121.0	61.0	4.0	19.0	19.0	0.0
1/14/99	3:00:00	187	136.0	59.0	4.0	20.0	19.0	0.0
1/14/99	4:00:00	191	139.0	69.0	4.0	19.0	19.0	0.0
1/14/99	5:00:00	196	141.0	67.0	3.0	19.0	19.0	0.0
1/14/99	6:00:00	204	146.0	68.0	3.0	19.0	20.0	0.0
1/14/99	7:00:00	194	141.0	68.0	3.0	19.0	18.0	0.0
1/14/99	8:00:00	197	142.0	69.0	3.0	24.0	18.0	0.0
1/14/99	9:00:00	195	142.0	68.0	3.0	24.0	18.0	0.0
1/14/99	10:00:00	193	141.0	63.0	3.0	24.0	19.0	0.0
1/14/99	11:00:00	194	142.0	71.0	3.0	24.0	20.0	0.0
1/14/99	12:00:00	193	143.0	0.0	4.0	24.0	18.0	0.0
1/14/99	13:00:00	199	146.0	80.0	4.0	24.0	19.0	0.0
1/14/99	14:00:00	199	147.0	75.0	4.0	20.0	19.0	0.0
1/14/99	15:00:00	196	145.0	74.0	4.0	19.0	18.0	0.0
1/14/99	16:00:00	194	144.0	75.0	4.0	19.0	18.0	0.0
1/14/99	17:00:00	222	161.0	79.0	4.0	19.0	18.0	0.0
1/14/99	18:00:00	205	150.0	75.0	3.0	19.0	20.0	0.0
1/14/99	19:00:00	199	146.0	74.0	3.0	20.0	20.0	0.0
1/14/99	20:00:00	194	142.0	71.0	3.0	19.0	18.0	0.0
1/14/99	21:00:00	196	142.0	72.0	3.0	19.0	19.0	0.0
1/14/99	22:00:00	190	137.0	70.0	3.0	19.0	18.0	0.0
1/14/99	23:00:00	185	133.0	67.0	3.0	19.0	18.0	0.0
Daily Average		193.8	141.4	67.0	3.6	22.3	18.8	0.0

586

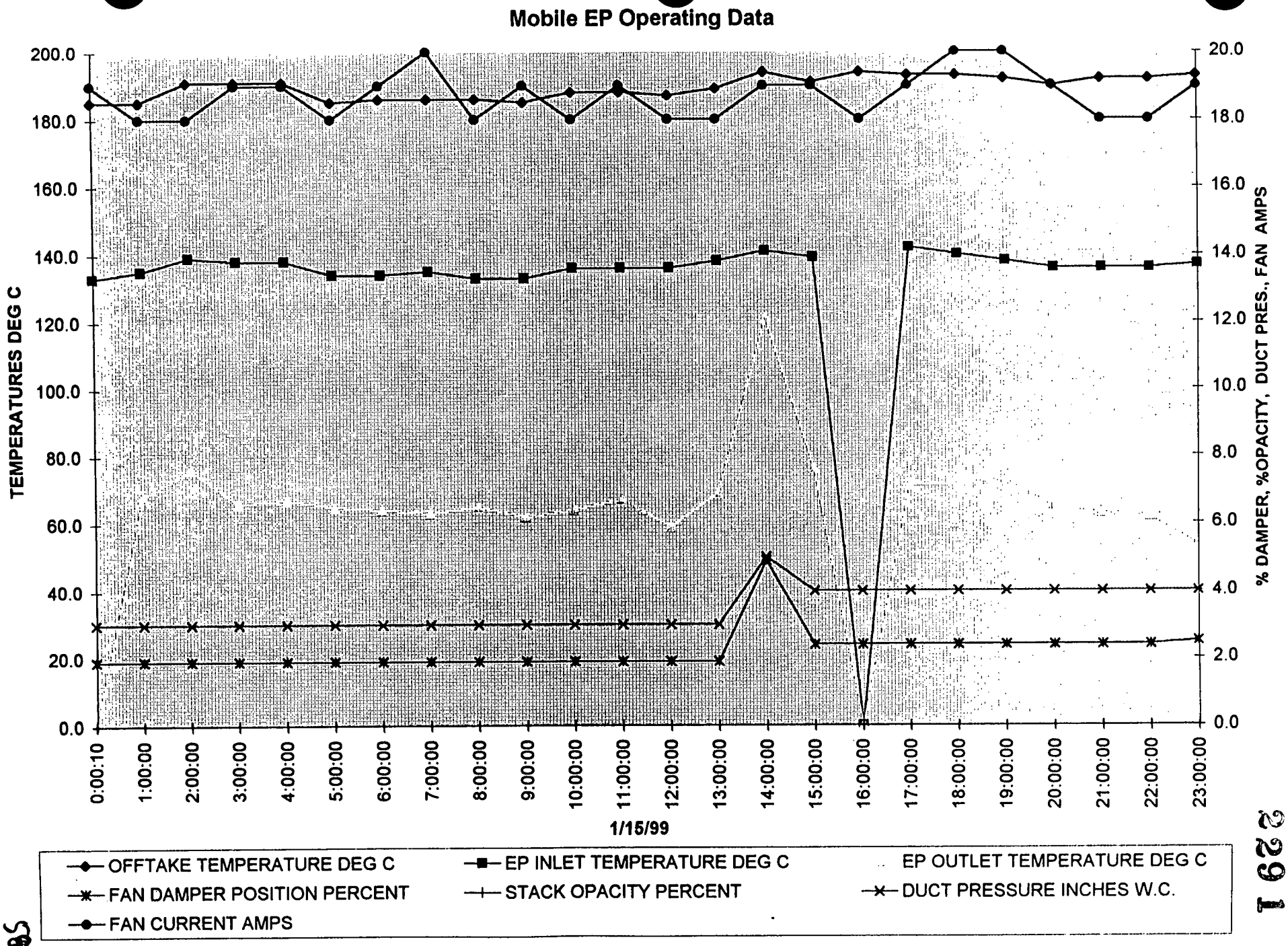

Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
250
200
150
100
50
0
25.0
20.0
15.0
10.0
5.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/14/99
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/15/99
Start Date: 12/1/98
Days Operation: 26

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/15/99	0:00:10	185.0	133.0	0.0	3.0	19.0	19.0	0.0
1/15/99	1:00:00	185.0	135.0	68.0	3.0	19.0	18.0	0.0
1/15/99	2:00:00	191.0	139.0	76.0	3.0	19.0	18.0	0.0
1/15/99	3:00:00	191.0	138.0	66.0	3.0	19.0	19.0	0.0
1/15/99	4:00:00	191.0	138.0	67.0	3.0	19.0	19.0	0.0
1/15/99	5:00:00	185.0	134.0	65.0	3.0	19.0	18.0	0.0
1/15/99	6:00:00	186.0	134.0	64.0	3.0	19.0	19.0	0.0
1/15/99	7:00:00	186.0	135.0	63.0	3.0	19.0	20.0	0.0
1/15/99	8:00:00	186.0	133.0	65.0	3.0	19.0	18.0	0.0
1/15/99	9:00:00	185.0	133.0	62.0	3.0	19.0	19.0	0.0
1/15/99	10:00:00	188.0	136.0	64.0	3.0	19.0	18.0	0.0
1/15/99	11:00:00	188.0	136.0	67.0	3.0	19.0	19.0	0.0
1/15/99	12:00:00	187.0	136.0	59.0	3.0	19.0	18.0	0.0
1/15/99	13:00:00	189.0	138.0	69.0	3.0	19.0	18.0	0.0
[illegible]/99	14:00:00	194.0	141.0	121.0	5.0	49.0	19.0	0.0
[illegible]/99	15:00:00	191.0	139.0	76.0	4.0	24.0	19.0	0.0
[illegible]/99	16:00:00	194.0	0.0	0.0	4.0	24.0	18.0	0.0
1/15/99	17:00:00	193.0	142.0	71.0	4.0	24.0	19.0	0.0
1/15/99	18:00:00	193.0	140.0	71.0	4.0	24.0	20.0	0.0
1/15/99	19:00:00	192.0	138.0	73.0	4.0	24.0	20.0	0.0
1/15/99	20:00:00	190.0	136.0	65.0	4.0	24.0	19.0	0.0
1/15/99	21:00:00	192.0	136.0	63.0	4.0	24.0	18.0	0.0
1/15/99	22:00:00	192.0	136.0	62.0	4.0	24.0	18.0	0.0
1/15/99	23:00:00	193.0	137.0	54.0	4.0	25.0	19.0	0.0
Daily Average		189.5	131.0	63.0	3.5	22.2	18.7	0.0


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/15/99
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

229 I'

McGill AirClean Mobile EP
Daily Performance Report

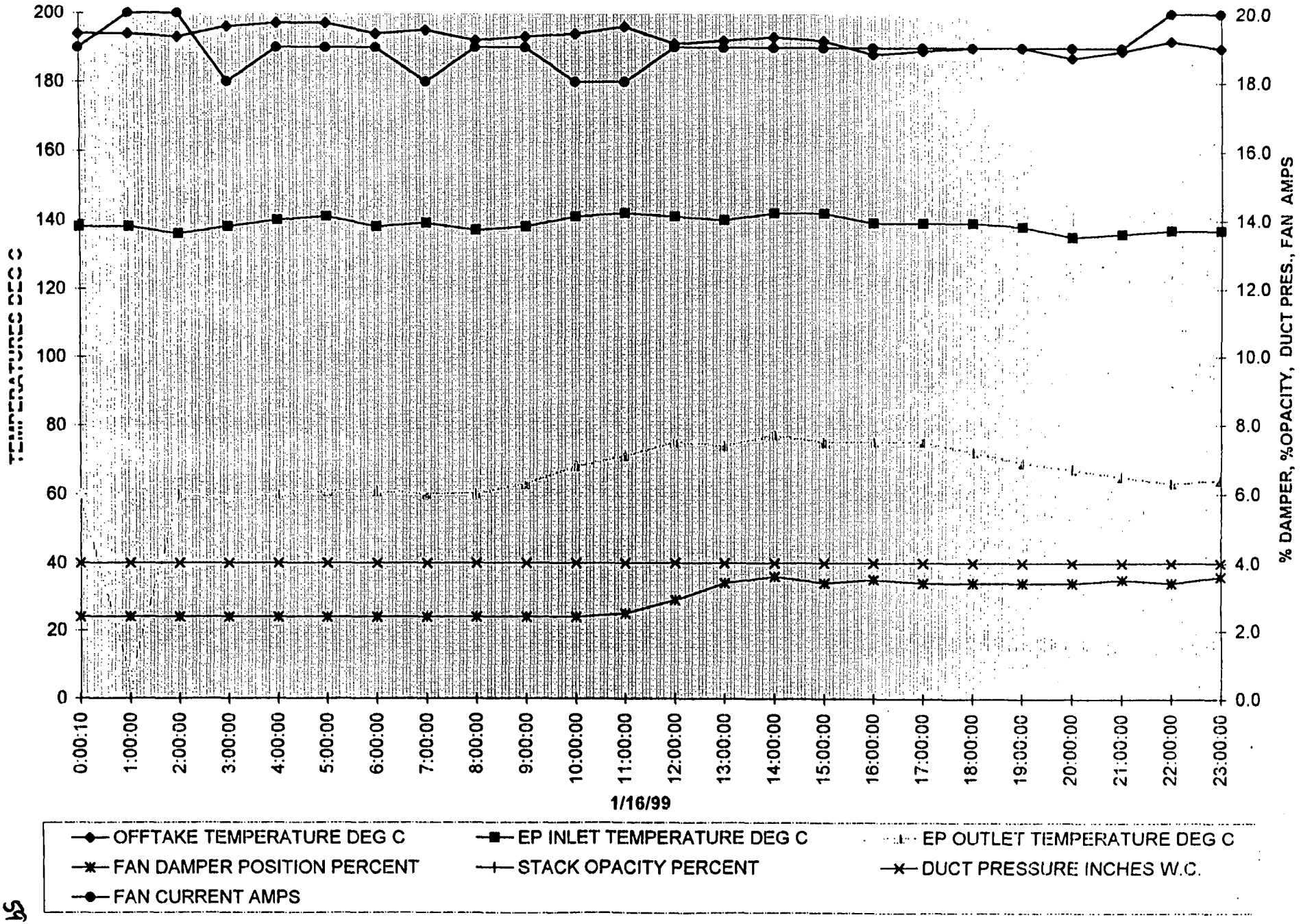
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/16/99
Start Date: 12/1/98
Days Operation: 27

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/16/99	0:00:10	194	138	60.0	4.0	24.0	19.0	0.0
1/16/99	1:00:00	194	138.0	6.0	4.0	24.0	20.0	0.0
1/16/99	2:00:00	193	136.0	60.0	4.0	24.0	20.0	0.0
1/16/99	3:00:00	196	138.0	59.0	4.0	24.0	18.0	0.0
1/16/99	4:00:00	197	140.0	60.0	4.0	24.0	19.0	0.0
1/16/99	5:00:00	197	141.0	61.0	4.0	24.0	19.0	0.0
1/16/99	6:00:00	194	138.0	61.0	4.0	24.0	19.0	0.0
1/16/99	7:00:00	195	139.0	60.0	4.0	24.0	18.0	0.0
1/16/99	8:00:00	192	137.0	60.0	4.0	24.0	19.0	0.0
1/16/99	9:00:00	193	138.0	63.0	4.0	24.0	19.0	0.0
1/16/99	10:00:00	194	141.0	68.0	4.0	24.0	18.0	0.0
1/16/99	11:00:00	196	142.0	71.0	4.0	25.0	18.0	0.0
1/16/99	12:00:00	191	141.0	75.0	4.0	29.0	19.0	0.0
1/16/99	13:00:00	192	140.0	74.0	4.0	34.0	19.0	0.0
1/16/99	14:00:00	193	142.0	77.0	4.0	36.0	19.0	0.0
1/16/99	15:00:00	192	142.0	75.0	4.0	34.0	19.0	0.0
1/16/99	16:00:00	188	139.0	75.0	4.0	35.0	19.0	0.0
1/16/99	17:00:00	189	139.0	75.0	4.0	34.0	19.0	0.0
1/16/99	18:00:00	190	139.0	72.0	4.0	34.0	19.0	0.0
1/16/99	19:00:00	190	138.0	69.0	4.0	34.0	19.0	0.0
1/16/99	20:00:00	187	135.0	67.0	4.0	34.0	19.0	0.0
1/16/99	21:00:00	189	136.0	65.0	4.0	35.0	19.0	0.0
1/16/99	22:00:00	192	137.0	63.0	4.0	34.0	20.0	0.0
1/16/99	23:00:00	190	137.0	64.0	4.0	36.0	20.0	0.0
Daily Average		192.4	138.8	64.2	4.0	29.1	19.0	0.0

590

Mobile EP Operating Data



- OFFTAKE TEMPERATURE DEG C
- EP INLET TEMPERATURE DEG C
- EP OUTLET TEMPERATURE DEG C
- FAN DAMPER POSITION PERCENT
- STACK OPACITY PERCENT
- DUCT PRESSURE INCHES W.C.
- FAN CURRENT AMPS

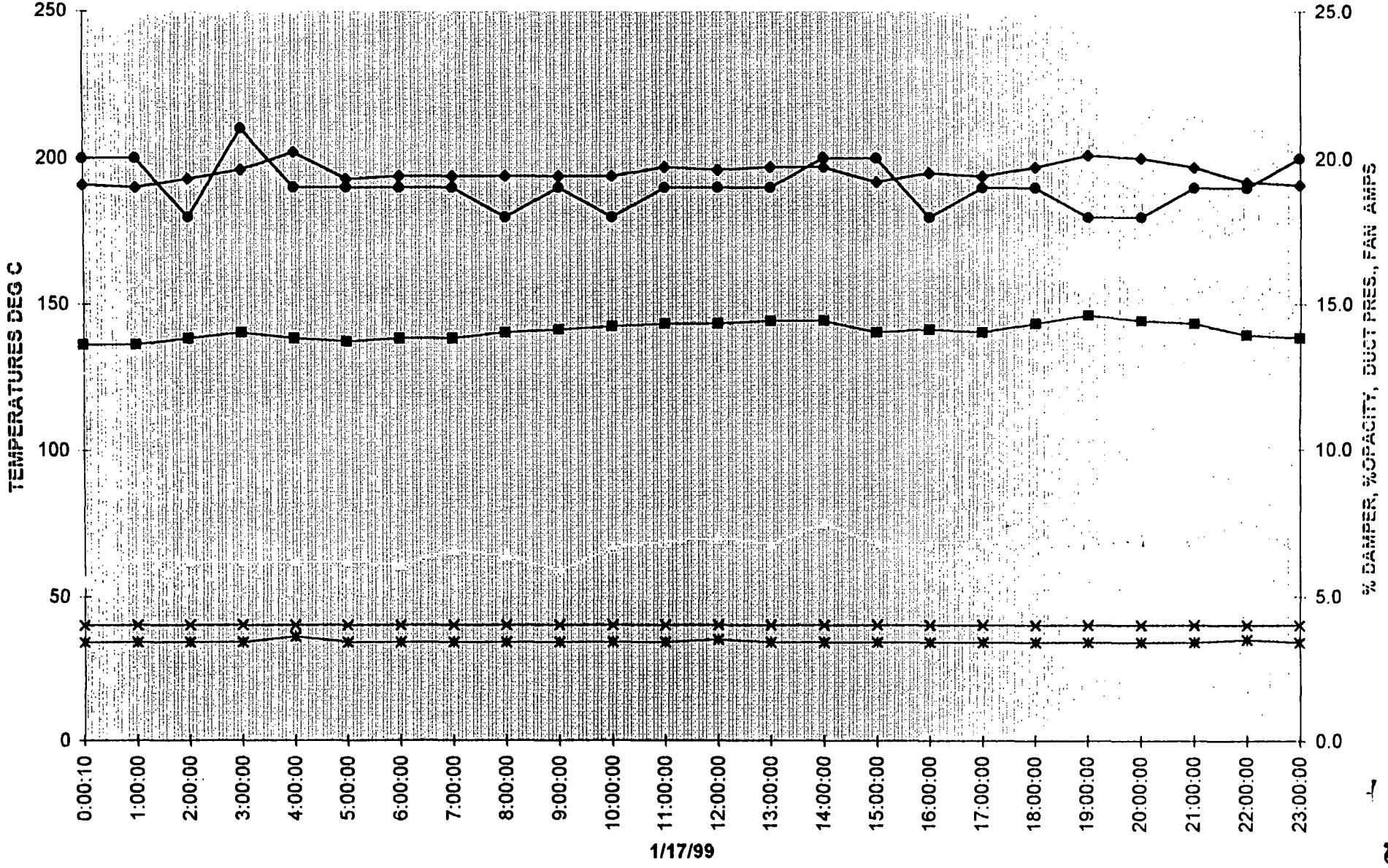
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/17/99
Start Date: 12/1/98
Days Operation: 28

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/17/99	0:00:10	191	136	55.0	4.0	34.0	20.0	0.0
1/17/99	1:00:00	190	136.0	63.0	4.0	34.0	20.0	0.0
1/17/99	2:00:00	193	138.0	62.0	4.0	34.0	18.0	0.0
1/17/99	3:00:00	196	140.0	62.0	4.0	34.0	21.0	0.0
1/17/99	4:00:00	202	138.0	62.0	4.0	36.0	19.0	0.0
1/17/99	5:00:00	193	137.0	62.0	4.0	34.0	19.0	0.0
1/17/99	6:00:00	194	138.0	61.0	4.0	34.0	19.0	0.0
1/17/99	7:00:00	194	138.0	66.0	4.0	34.0	19.0	0.0
1/17/99	8:00:00	194	140.0	64.0	4.0	34.0	18.0	0.0
1/17/99	9:00:00	194	141.0	59.0	4.0	34.0	19.0	0.0
1/17/99	10:00:00	194	142.0	67.0	4.0	34.0	18.0	0.0
1/17/99	11:00:00	197	143.0	69.0	4.0	34.0	19.0	0.0
1/17/99	12:00:00	196	143.0	70.0	4.0	35.0	19.0	0.0
1/17/99	13:00:00	197	144.0	68.0	4.0	34.0	19.0	0.0
[illegible]	14:00:00	197	144.0	75.0	4.0	34.0	20.0	0.0
[illegible]	15:00:00	192	140.0	68.0	4.0	34.0	20.0	0.0
[illegible]99	16:00:00	195	141.0	68.0	4.0	34.0	18.0	0.0
1/17/99	17:00:00	194	140.0	69.0	4.0	34.0	19.0	0.0
1/17/99	18:00:00	197	143.0	66.0	4.0	34.0	19.0	0.0
1/17/99	19:00:00	201	146.0	68.0	4.0	34.0	18.0	0.0
1/17/99	20:00:00	200	144.0	69.0	4.0	34.0	18.0	0.0
1/17/99	21:00:00	197	143.0	69.0	4.0	34.0	19.0	0.0
1/17/99	22:00:00	192	139.0	77.0	4.0	35.0	19.0	0.0
1/17/99	23:00:00	191	138.0	65.0	4.0	34.0	20.0	0.0
Daily Average		195.0	140.5	66.0	4.0	34.2	19.0	0.0

Mobile EP Operating Data



2291

593

McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/18/99
Start Date: 12/1/98
Days Operation: 29

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/18/99	0:00:10	211.0	152.0	72.0	5.0	35.0	18.0	0.0
1/18/99	1:00:00	195.0	142.0	69.0	5.0	34.0	18.0	0.0
1/18/99	2:00:00	194.0	140.0	62.0	5.0	35.0	18.0	0.0
1/18/99	3:00:00	190.0	139.0	67.0	5.0	34.0	20.0	0.0
1/18/99	4:00:00	189.0	138.0	69.0	4.0	35.0	18.0	0.0
1/18/99	5:00:00	186.0	136.0	67.0	4.0	34.0	20.0	0.0
1/18/99	6:00:00	184.0	134.0	68.0	4.0	39.0	20.0	0.0
1/18/99	7:00:00	185.0	135.0	0.0	4.0	40.0	19.0	0.0
1/18/99	8:00:00	178.0	131.0	67.0	4.0	39.0	19.0	0.0
1/18/99	9:00:00	205.0	146.0	69.0	4.0	24.0	18.0	0.0
1/18/99	10:00:00	195.0	143.0	76.0	4.0	24.0	18.0	0.0
1/18/99	11:00:00	192.0	140.0	72.0	4.0	24.0	18.0	0.0
1/18/99	12:00:00	188.0	137.0	69.0	4.0	25.0	18.0	0.0
1/18/99	13:00:00	190.0	139.0	74.0	4.0	24.0	19.0	0.0
[illegible]/99	14:00:00	177.0	130.0	74.0	4.0	24.0	19.0	0.0
[illegible]	15:00:00	178.0	131.0	72.0	4.0	24.0	18.0	0.0
[illegible]/99	16:00:00	178.0	132.0	72.0	4.0	24.0	19.0	0.0
[illegible]/99	17:00:00	180.0	132.0	71.0	4.0	24.0	20.0	0.0
1/18/99	18:00:00	183.0	135.0	71.0	4.0	27.0	18.0	0.0
1/18/99	19:00:00	182.0	161.0	72.0	4.0	27.0	19.0	0.0
1/18/99	20:00:00	187.0	165.0	72.0	4.0	27.0	19.0	0.0
1/18/99	21:00:00	189.0	167.0	72.0	4.0	27.0	20.0	0.0
1/18/99	22:00:00	187.0	166.0	73.0	4.0	27.0	18.0	0.0
1/18/99	23:00:00	183.0	163.0	70.0	4.0	27.0	18.0	0.0
Daily Average		187.8	143.1	67.5	4.2	29.3	18.7	0.0

594

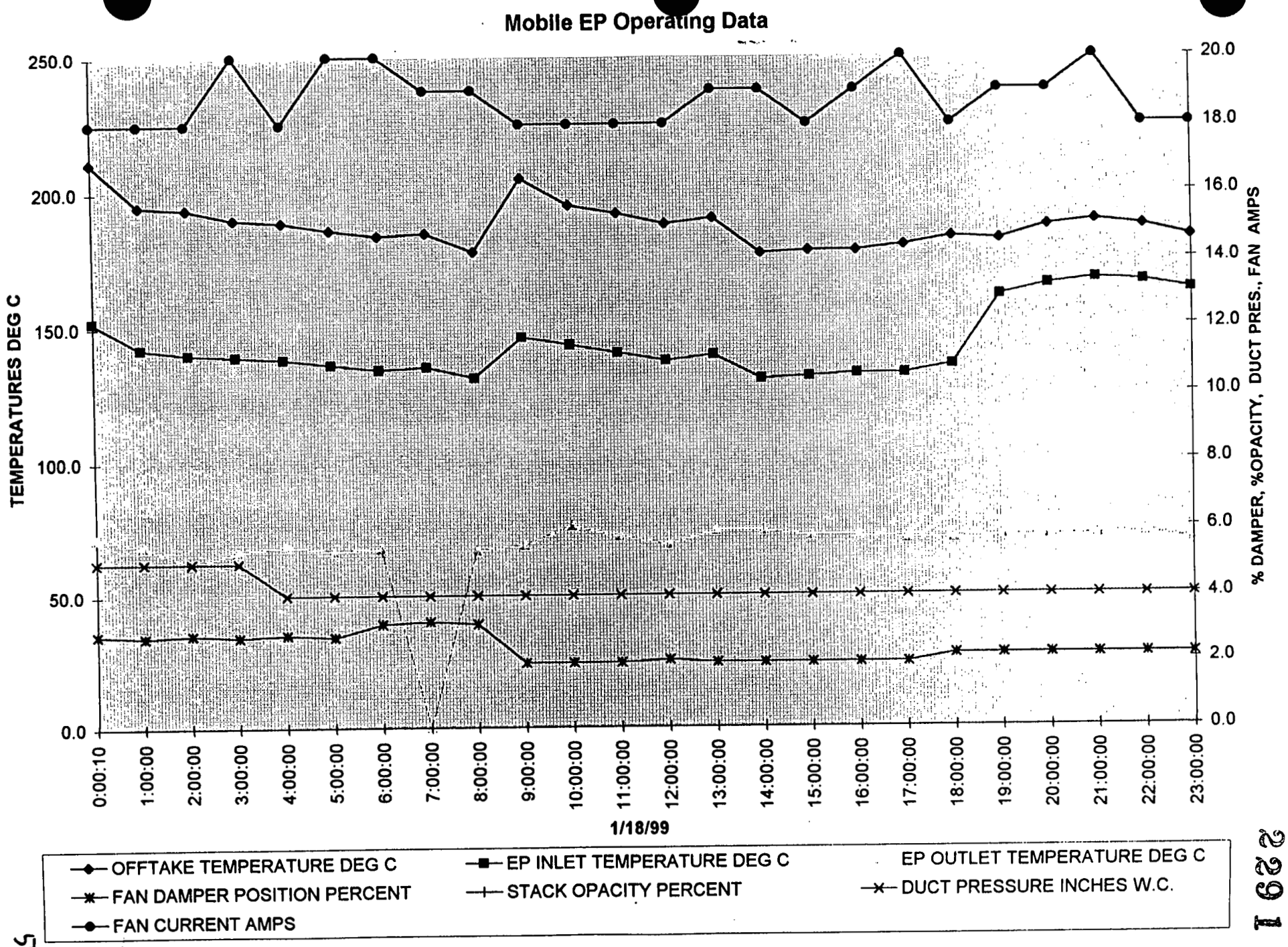

Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
250.0
200.0
150.0
100.0
50.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/18/99
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

FIGURE 2

545

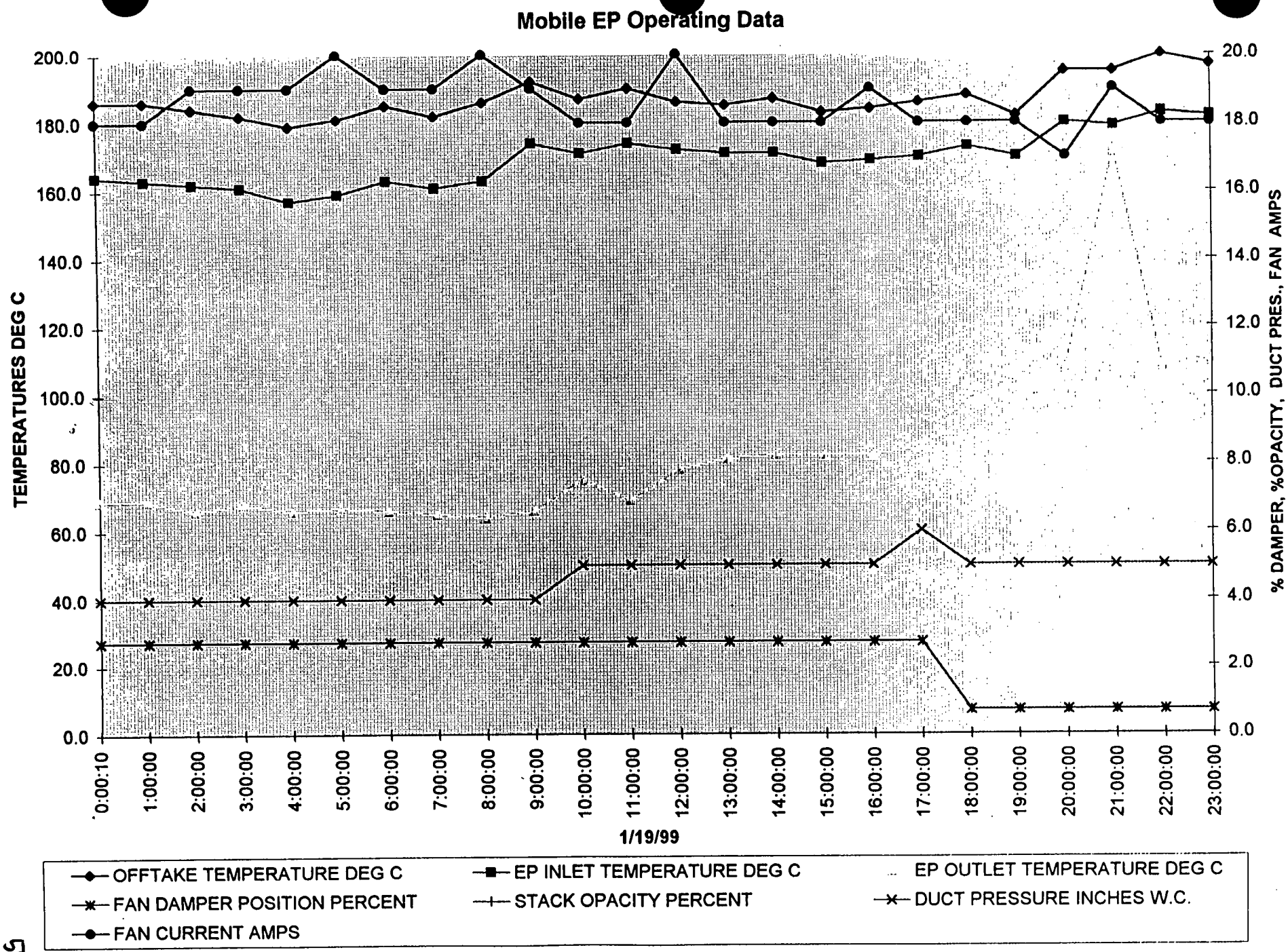
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/19/99
Start Date: 12/1/98
Days Operation: 30

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/19/99	0:00:10	186.0	164.0	69.0	4.0	27.0	18.0	0.0
1/19/99	1:00:00	186.0	163.0	69.0	4.0	27.0	18.0	0.0
1/19/99	2:00:00	184.0	162.0	66.0	4.0	27.0	19.0	0.0
1/19/99	3:00:00	182.0	161.0	68.0	4.0	27.0	19.0	0.0
1/19/99	4:00:00	179.0	157.0	66.0	4.0	27.0	19.0	0.0
1/19/99	5:00:00	181.0	159.0	67.0	4.0	27.0	20.0	0.0
1/19/99	6:00:00	185.0	163.0	66.0	4.0	27.0	19.0	0.0
1/19/99	7:00:00	182.0	161.0	65.0	4.0	27.0	19.0	0.0
1/19/99	8:00:00	186.0	163.0	64.0	4.0	27.0	20.0	0.0
1/19/99	9:00:00	192.0	174.0	66.0	4.0	27.0	19.0	0.0
1/19/99	10:00:00	187.0	171.0	75.0	5.0	27.0	18.0	0.0
1/19/99	11:00:00	190.0	174.0	69.0	5.0	27.0	18.0	0.0
1/19/99	12:00:00	186.0	172.0	78.0	5.0	27.0	20.0	0.0
1/19/99	13:00:00	185.0	171.0	81.0	5.0	27.0	18.0	0.0
1/[illegible]/99	14:00:00	187.0	171.0	82.0	5.0	27.0	18.0	0.0
[illegible]	15:00:00	183.0	168.0	82.0	5.0	27.0	18.0	0.0
[illegible]/99	16:00:00	184.0	169.0	82.0	5.0	27.0	19.0	0.0
[illegible]/99	17:00:00	186.0	170.0	84.0	6.0	27.0	18.0	0.0
1/19/99	18:00:00	188.0	173.0	100.0	5.0	7.0	18.0	0.0
1/19/99	19:00:00	182.0	170.0	105.0	5.0	7.0	18.0	0.0
1/19/99	20:00:00	195.0	180.0	108.0	5.0	7.0	17.0	0.0
1/19/99	21:00:00	195.0	179.0	172.0	5.0	7.0	19.0	0.0
1/19/99	22:00:00	200.0	183.0	108.0	5.0	7.0	18.0	0.0
1/19/99	23:00:00	197.0	182.0	110.0	5.0	7.0	18.0	0.0
Daily Average		187.0	169.2	83.4	4.6	22.0	18.5	0.0

596


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/19/99
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

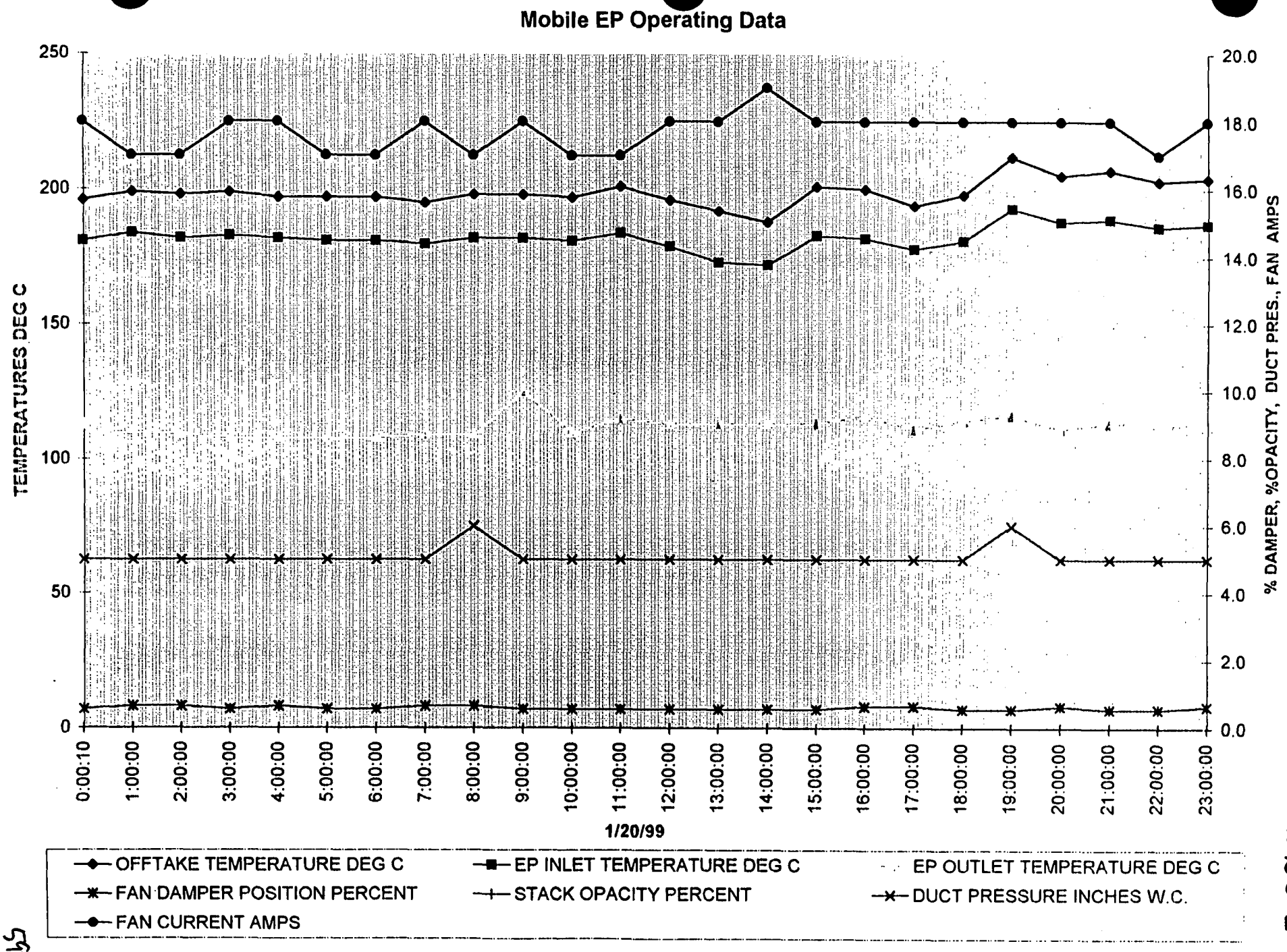
McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/20/99
Start Date: 12/1/98
Days Operation: 31

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/20/99	0:00:10	196	181	113.0	5.0	7.0	18.0	0.0
1/20/99	1:00:00	199	184.0	111.0	5.0	8.0	17.0	0.0
1/20/99	2:00:00	198	182.0	109.0	5.0	8.0	17.0	0.0
1/20/99	3:00:00	199	183.0	108.0	5.0	7.0	18.0	0.0
1/20/99	4:00:00	197	182.0	108.0	5.0	8.0	18.0	0.0
1/20/99	5:00:00	197	181.0	108.0	5.0	7.0	17.0	0.0
1/20/99	6:00:00	197	181.0	108.0	5.0	7.0	17.0	0.0
1/20/99	7:00:00	195	180.0	109.0	5.0	8.0	18.0	0.0
1/20/99	8:00:00	198	182.0	109.0	6.0	8.0	17.0	0.0
1/20/99	9:00:00	198	182.0	125.0	5.0	7.0	18.0	0.0
1/20/99	10:00:00	197	181.0	110.0	5.0	7.0	17.0	0.0
1/20/99	11:00:00	201	184.0	115.0	5.0	7.0	17.0	0.0
1/20/99	12:00:00	196	179.0	113.0	5.0	7.0	18.0	0.0
1/20/99	13:00:00	192	173.0	113.0	5.0	7.0	18.0	0.0
1/20/99	14:00:00	188	172.0	113.0	5.0	7.0	19.0	0.0
[illegible]	15:00:00	201	183.0	113.0	5.0	7.0	18.0	0.0
[illegible]/99	16:00:00	200	182.0	116.0	5.0	8.0	18.0	#######
[illegible]/99	17:00:00	194	178.0	111.0	5.0	8.0	18.0	#######
1/20/99	18:00:00	198	181.0	114.0	5.0	7.0	18.0	#######
1/20/99	19:00:00	212	193.0	116.0	6.0	7.0	18.0	#######
1/20/99	20:00:00	205	188.0	111.0	5.0	8.0	18.0	#######
1/20/99	21:00:00	207	189.0	113.0	5.0	7.0	18.0	#######
1/20/99	22:00:00	203	186.0	113.0	5.0	7.0	17.0	#######
1/20/99	23:00:00	204	187.0	112.0	5.0	8.0	18.0	#######
Daily Average		198.8	182.3	112.1	5.1	7.4	17.7	0.0

598


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
250
200
150
100
50
0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/20/99
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

2291

545

McGill AirClean Mobile EP
Daily Performance Report

E 229 1

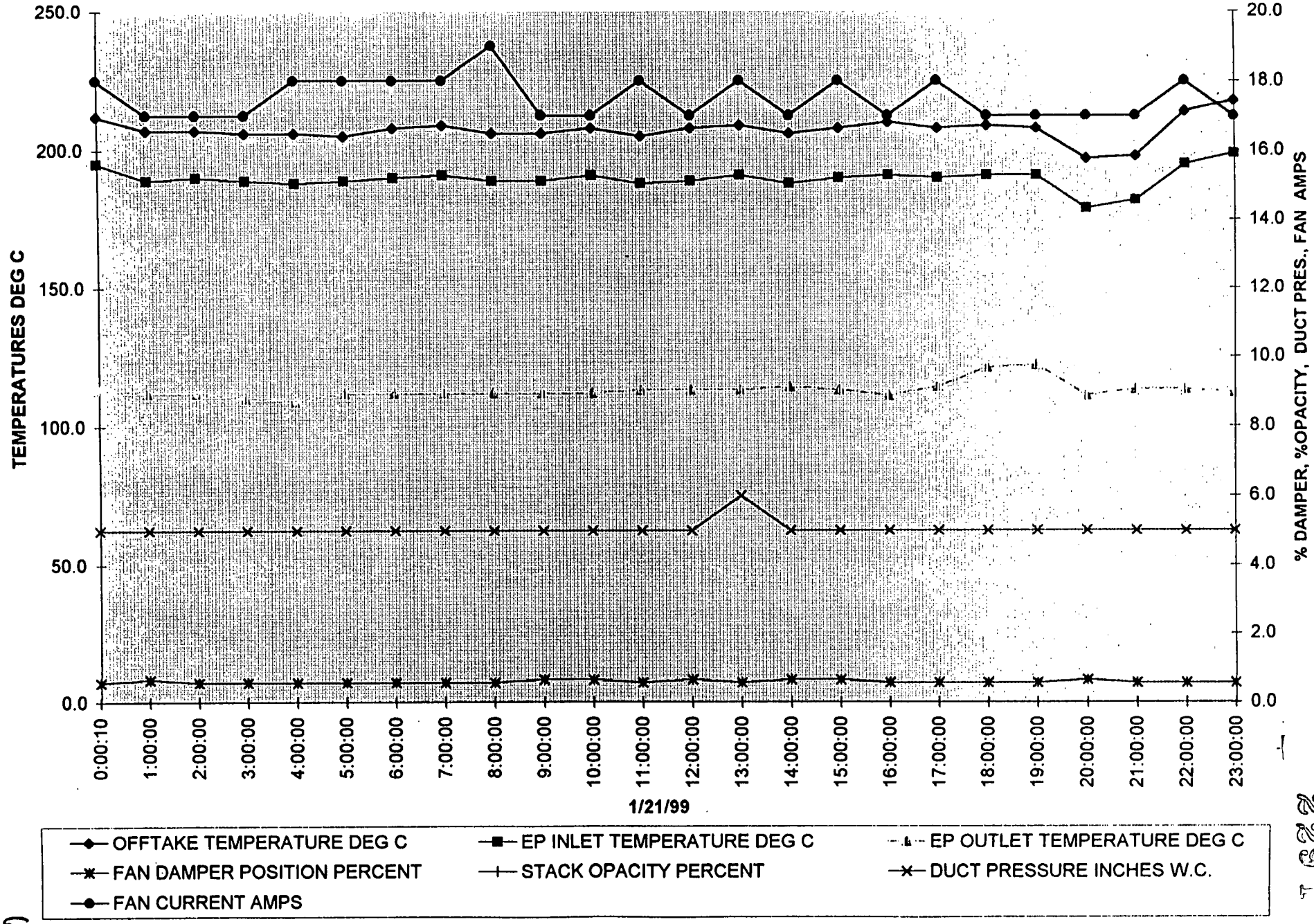
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/21/99
Start Date: 12/1/98
Days Operation: 32

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/21/99	0:00:10	212.0	195.0	113.0	5.0	7.0	18.0	0.0
1/21/99	1:00:00	207.0	189.0	112.0	5.0	8.0	17.0	0.0
1/21/99	2:00:00	207.0	190.0	112.0	5.0	7.0	17.0	0.0
1/21/99	3:00:00	206.0	189.0	110.0	5.0	7.0	17.0	0.0
1/21/99	4:00:00	206.0	188.0	109.0	5.0	7.0	18.0	0.0
1/21/99	5:00:00	205.0	189.0	112.0	5.0	7.0	18.0	0.0
1/21/99	6:00:00	208.0	190.0	112.0	5.0	7.0	18.0	0.0
1/21/99	7:00:00	209.0	191.0	112.0	5.0	7.0	18.0	0.0
1/21/99	8:00:00	206.0	189.0	112.0	5.0	7.0	19.0	0.0
1/21/99	9:00:00	206.0	189.0	112.0	5.0	8.0	17.0	0.0
1/21/99	10:00:00	208.0	191.0	112.0	5.0	8.0	17.0	0.0
1/21/99	11:00:00	205.0	188.0	113.0	5.0	7.0	18.0	0.0
1/21/99	12:00:00	208.0	189.0	113.0	5.0	8.0	17.0	0.0
1/21/99	13:00:00	209.0	191.0	113.0	6.0	7.0	18.0	0.0
1/21/99	14:00:00	206.0	188.0	114.0	5.0	8.0	17.0	0.0
[illegible]	15:00:00	208.0	190.0	113.0	5.0	8.0	18.0	0.0
[illegible]/99	16:00:00	210.0	191.0	111.0	5.0	7.0	17.0	0.0
1/21/99	17:00:00	208.0	190.0	114.0	5.0	7.0	18.0	0.0
1/21/99	18:00:00	209.0	191.0	121.0	5.0	7.0	17.0	0.0
1/21/99	19:00:00	208.0	191.0	122.0	5.0	7.0	17.0	0.0
1/21/99	20:00:00	197.0	179.0	111.0	5.0	8.0	17.0	0.0
1/21/99	21:00:00	198.0	182.0	113.0	5.0	7.0	17.0	0.0
1/21/99	22:00:00	214.0	195.0	113.0	5.0	7.0	18.0	0.0
1/21/99	23:00:00	218.0	199.0	112.0	5.0	7.0	17.0	0.0
Daily Average		207.4	189.8	113.0	5.0	7.3	17.5	0.0

600

Mobile EP Operating Data



109

McGill AirClean Mobile EP
Daily Performance Report

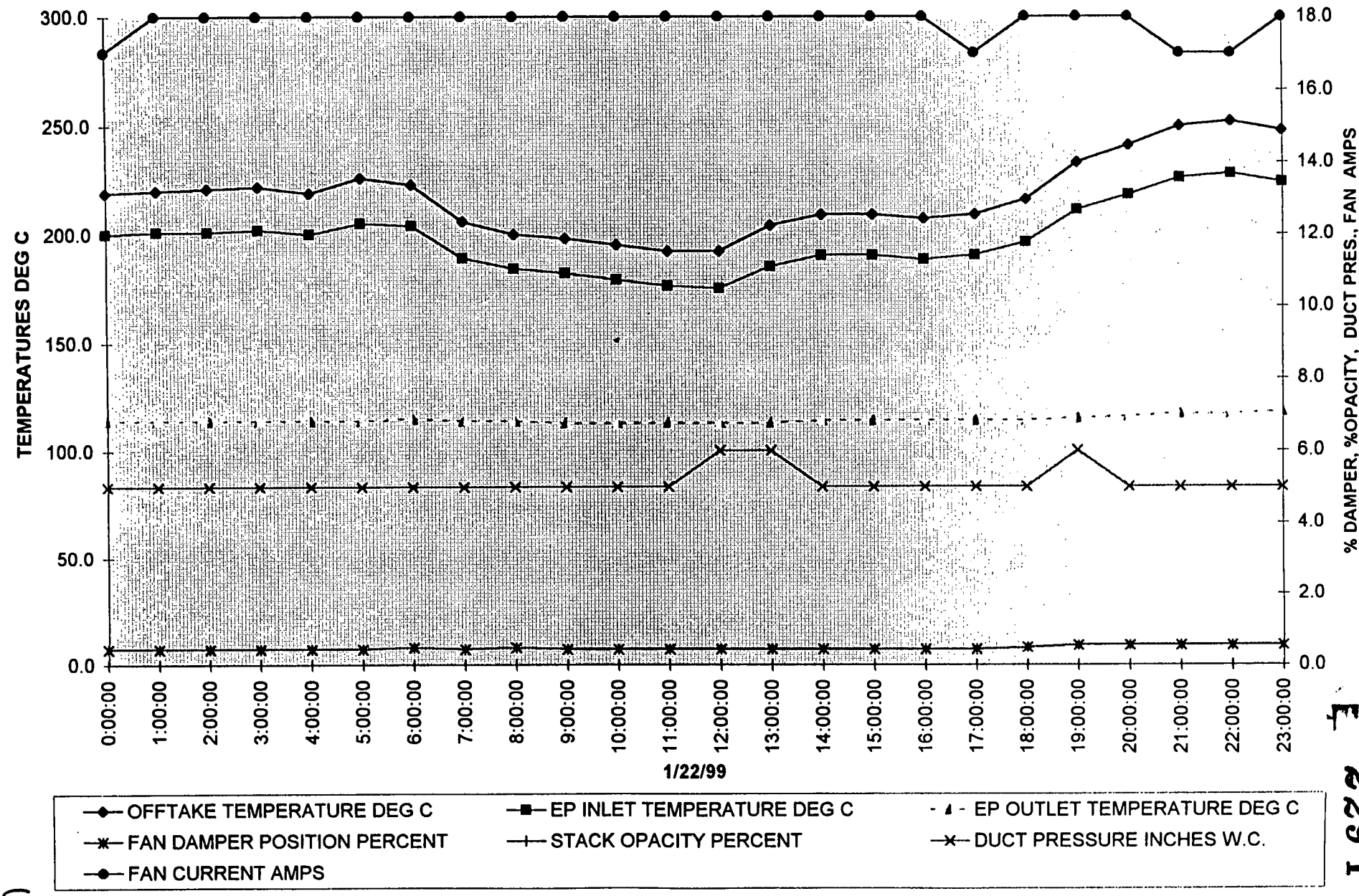
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/22/99
Start Date: 12/1/98
Days Operation: 33

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/22/99	0:00:00	219.0	200.0	114.0	5.0	7.0	17.0	0.0
1/22/99	1:00:00	220.0	201.0	114.0	5.0	7.0	18.0	0.0
1/22/99	2:00:00	221.0	201.0	114.0	5.0	7.0	18.0	0.0
1/22/99	3:00:00	222.0	202.0	114.0	5.0	7.0	18.0	0.0
1/22/99	4:00:00	219.0	200.0	114.0	5.0	7.0	18.0	0.0
1/22/99	5:00:00	226.0	205.0	114.0	5.0	7.0	18.0	0.0
1/22/99	6:00:00	223.0	204.0	115.0	5.0	8.0	18.0	0.0
1/22/99	7:00:00	206.0	189.0	114.0	5.0	7.0	18.0	0.0
1/22/99	8:00:00	200.0	184.0	114.0	5.0	8.0	18.0	0.0
1/22/99	9:00:00	198.0	182.0	113.0	5.0	7.0	18.0	0.0
1/22/99	10:00:00	195.0	179.0	113.0	5.0	7.0	18.0	0.0
1/22/99	11:00:00	192.0	176.0	113.0	5.0	7.0	18.0	0.0
1/22/99	12:00:00	192.0	175.0	113.0	6.0	7.0	18.0	0.0
1/22/99	13:00:00	204.0	185.0	113.0	6.0	7.0	18.0	0.0
1/[illegible]	14:00:00	209.0	190.0	114.0	5.0	7.0	18.0	0.0
1[illegible]	15:00:00	209.0	190.0	114.0	5.0	7.0	18.0	0.0
[illegible]9	16:00:00	207.0	188.0	114.0	5.0	7.0	18.0	0.0
1/22/99	17:00:00	209.0	190.0	114.0	5.0	7.0	17.0	0.0
1/22/99	18:00:00	216.0	196.0	114.0	5.0	8.0	18.0	0.0
1/22/99	19:00:00	233.0	211.0	115.0	6.0	9.0	18.0	0.0
1/22/99	20:00:00	241.0	218.0	116.0	5.0	9.0	18.0	0.0
1/22/99	21:00:00	250.0	226.0	117.0	5.0	9.0	17.0	0.0
1/22/99	22:00:00	252.0	228.0	117.0	5.0	9.0	17.0	0.0
1/22/99	23:00:00	248.0	224.0	118.0	5.0	9.0	18.0	0.0
Daily Average		217.1	197.7	114.4	5.1	7.5	17.8	0.0

602

Mobile EP Operating Data



2291

McGill AirClean Mobile EP
Daily Performance Report

2291

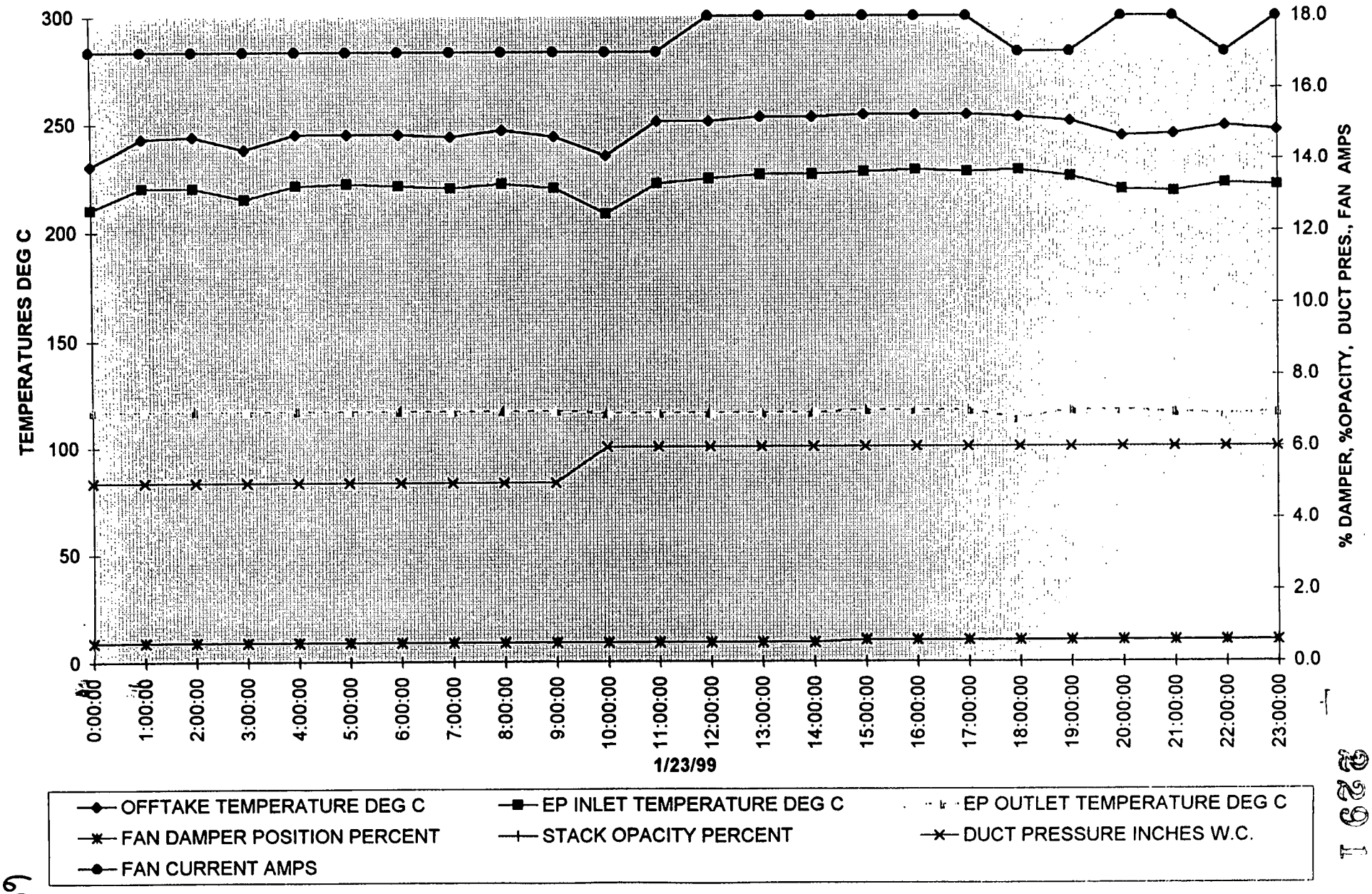
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/23/99
Start Date: 12/1/98
Days Operation: 34

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/23/99	0:00:00	230	210.0	117.0	5.0	9.0	17.0	0.0
1/23/99	1:00:00	243	220.0	117.0	5.0	9.0	17.0	0.0
1/23/99	2:00:00	244	220.0	117.0	5.0	9.0	17.0	0.0
1/23/99	3:00:00	238	215.0	117.0	5.0	9.0	17.0	0.0
1/23/99	4:00:00	245	221.0	117.0	5.0	9.0	17.0	0.0
1/23/99	5:00:00	245	222.0	117.0	5.0	9.0	17.0	0.0
1/23/99	6:00:00	245	221.0	117.0	5.0	9.0	17.0	0.0
1/23/99	7:00:00	244	220.0	117.0	5.0	9.0	17.0	0.0
1/23/99	8:00:00	247	222.0	117.0	5.0	9.0	17.0	0.0
1/23/99	9:00:00	244	220.0	117.0	5.0	9.0	17.0	0.0
1/23/99	10:00:00	235	208.0	116.0	6.0	9.0	17.0	0.0
1/23/99	11:00:00	251	222.0	116.0	6.0	9.0	17.0	0.0
1/23/99	12:00:00	251	224.0	116.0	6.0	9.0	18.0	0.0
1/23/99	13:00:00	253	226.0	116.0	6.0	9.0	18.0	0.0
1/[illegible]	14:00:00	253	226.0	116.0	6.0	9.0	18.0	0.0
[illegible]	15:00:00	254	227.0	117.0	6.0	10.0	18.0	0.0
[illegible]	16:00:00	254	228.0	117.0	6.0	10.0	18.0	0.0
1/[illegible]/99	17:00:00	254	227.0	117.0	6.0	10.0	18.0	0.0
1/23/99	18:00:00	253	228.0	113.0	6.0	10.0	17.0	0.0
1/23/99	19:00:00	251	225.0	117.0	6.0	10.0	17.0	0.0
1/23/99	20:00:00	244	219.0	117.0	6.0	10.0	18.0	0.0
1/23/99	21:00:00	245	218.0	116.0	6.0	10.0	18.0	0.0
1/23/99	22:00:00	249	222.0	115.0	6.0	10.0	17.0	0.0
1/23/99	23:00:00	247	221.0	116.0	6.0	10.0	18.0	0.0
Daily Average		246.6	221.3	116.5	5.6	9.4	17.4	0.0

604

Mobile EP Operating Data

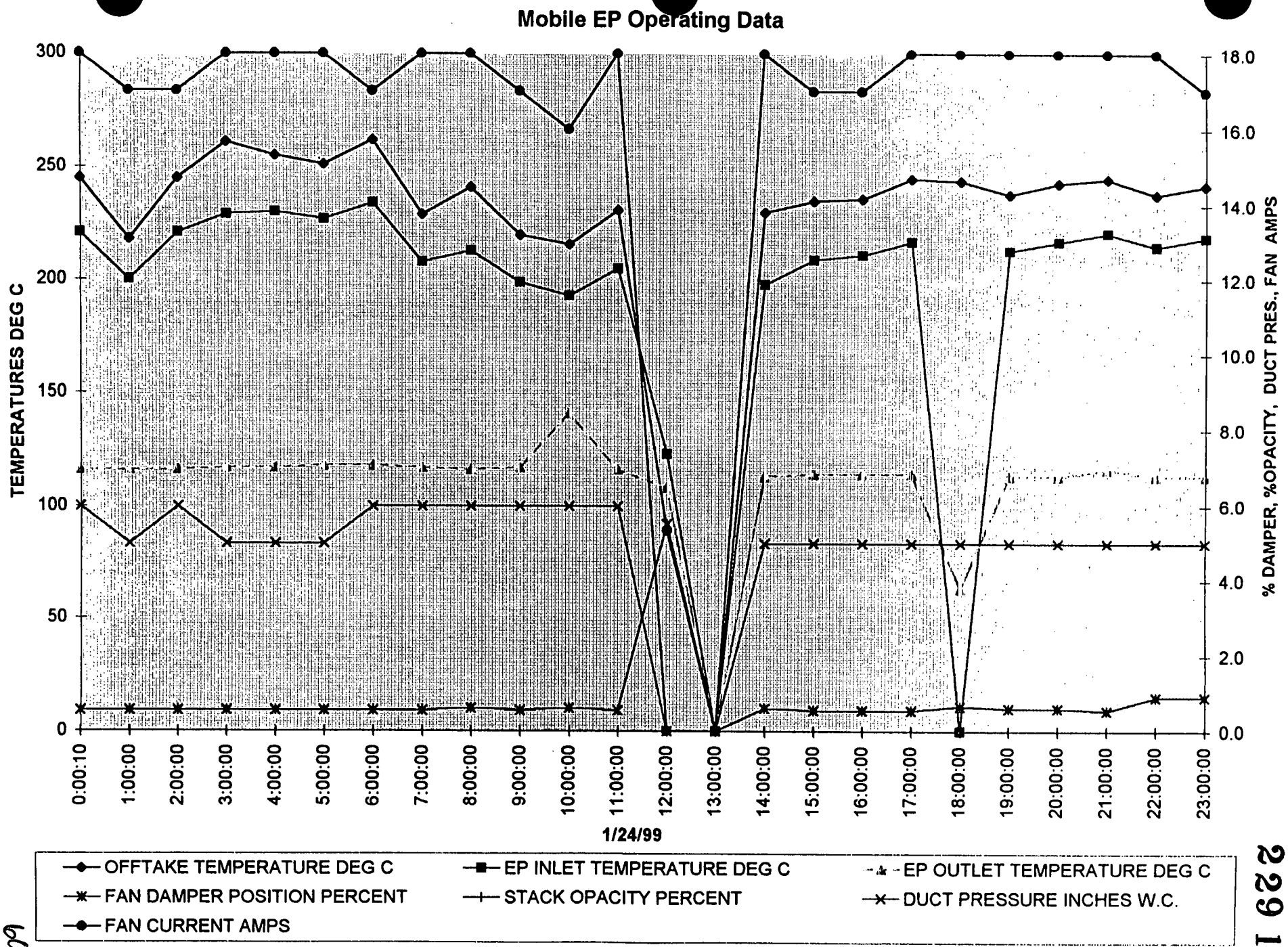


McGill AirClean Mobile EP
Daily Performance Report

Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/24/99
Start Date: 12/1/98
Days Operation: 35

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/24/99	0:00:10	245	221	116.0	6.0	9.0	18.0	0.0
1/24/99	1:00:00	218	200.0	116.0	5.0	9.0	17.0	0.0
1/24/99	2:00:00	245	221.0	116.0	6.0	9.0	17.0	0.0
1/24/99	3:00:00	261	229.0	117.0	5.0	9.0	18.0	0.0
1/24/99	4:00:00	255	230.0	117.0	5.0	9.0	18.0	0.0
1/24/99	5:00:00	251	227.0	118.0	5.0	9.0	18.0	0.0
1/24/99	6:00:00	262	234.0	118.0	6.0	9.0	17.0	0.0
1/24/99	7:00:00	229	208.0	117.0	6.0	9.0	18.0	0.0
1/24/99	8:00:00	241	213.0	116.0	6.0	10.0	18.0	0.0
1/24/99	9:00:00	220	199.0	117.0	6.0	9.0	17.0	0.0
1/24/99	10:00:00	216	193.0	141.0	6.0	10.0	16.0	0.0
1/24/99	11:00:00	231	205.0	116.0	6.0	9.0	18.0	0.0
1/24/99	12:00:00	89	123.0	108.0	0.0	92.0	0.0	0.0
1/24/99	13:00:00	#######	#######	#######	#######	#######	#######	#######
1/24/99	14:00:00	230	198.0	113.0	5.0	10.0	18.0	0.0
1/24/99	15:00:00	235	209.0	114.0	5.0	9.0	17.0	0.0
1/24/99	16:00:00	236	211.0	114.0	5.0	9.0	17.0	0.0
1/24/99	17:00:00	245	217.0	114.0	5.0	9.0	18.0	0.0
1/24/99	18:00:00	244	0.0	63.0	5.0	11.0	18.0	0.0
1/24/99	19:00:00	238	213.0	113.0	5.0	10.0	18.0	0.0
1/24/99	20:00:00	243	217.0	113.0	5.0	10.0	18.0	0.0
1/24/99	21:00:00	245	221.0	116.0	5.0	9.0	18.0	0.0
1/24/99	22:00:00	238	215.0	113.0	5.0	15.0	18.0	0.0
1/24/99	23:00:00	242	219.0	113.0	5.0	15.0	17.0	0.0
Daily Average		233.0	201.0	113.9	5.1	13.4	16.8	0.0


Mobile EP Operating Data
TEMPERATURES DEG C
% DAMPER, %OPACITY, DUCT PRES., FAN AMPS
300
250
200
150
100
50
0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0:00:10
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
1/24/99
OFFTAKE TEMPERATURE DEG C
EP INLET TEMPERATURE DEG C
EP OUTLET TEMPERATURE DEG C
FAN DAMPER POSITION PERCENT
STACK OPACITY PERCENT
DUCT PRESSURE INCHES W.C.
FAN CURRENT AMPS

2291

60

McGill AirClean Mobile EP
Daily Performance Report

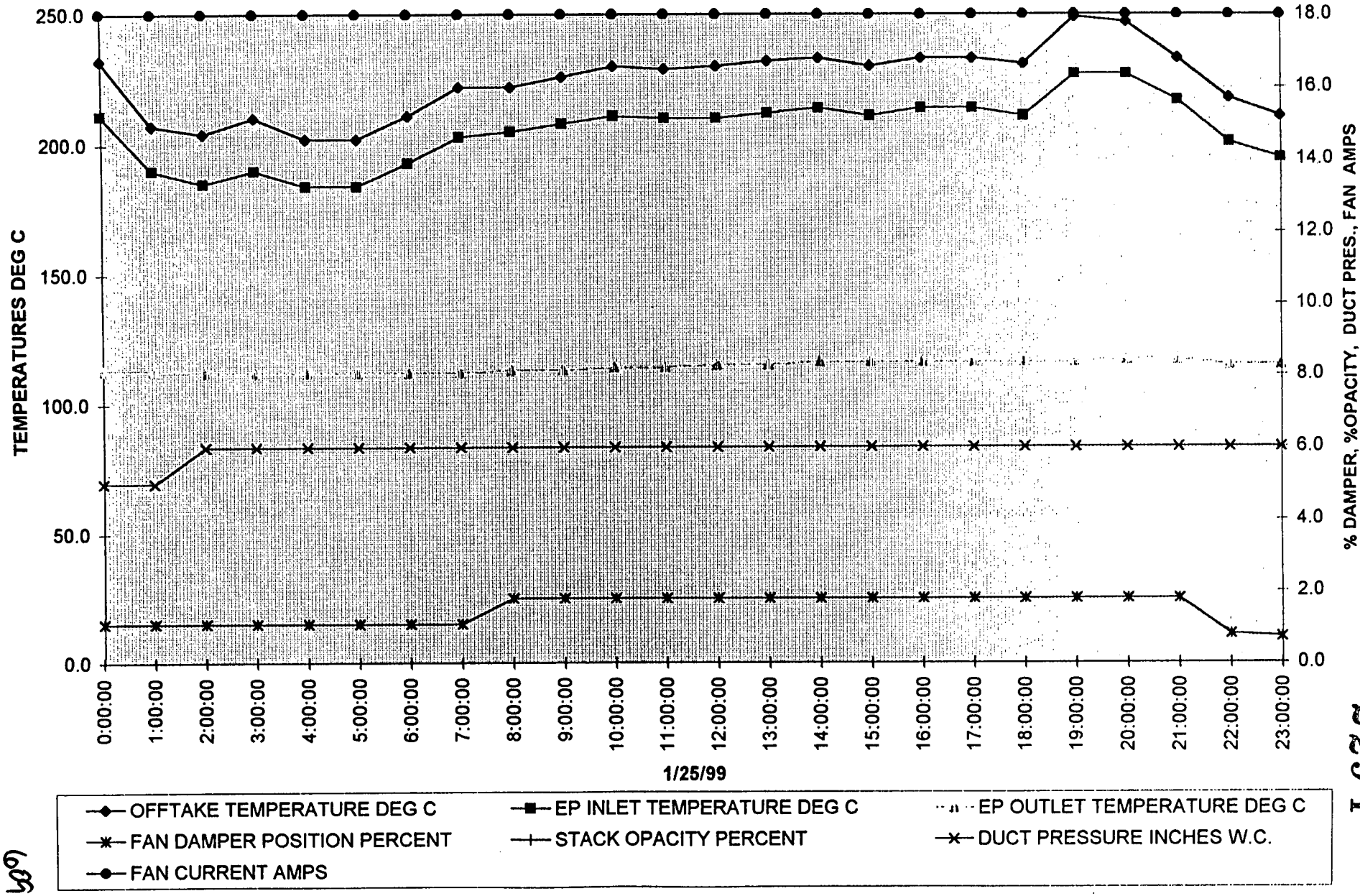
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/25/99
Start Date: 12/1/98
Days Operation: 36

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/25/99	0:00:00	232.0	211.0	113.0	5.0	15.0	18.0	0.0
1/25/99	1:00:00	207.0	190.0	113.0	5.0	15.0	18.0	0.0
1/25/99	2:00:00	204.0	185.0	112.0	6.0	15.0	18.0	0.0
1/25/99	3:00:00	210.0	190.0	112.0	6.0	15.0	18.0	0.0
1/25/99	4:00:00	202.0	184.0	112.0	6.0	15.0	18.0	0.0
1/25/99	5:00:00	202.0	184.0	112.0	6.0	15.0	18.0	0.0
1/25/99	6:00:00	211.0	193.0	112.0	6.0	15.0	18.0	0.0
1/25/99	7:00:00	222.0	203.0	112.0	6.0	15.0	18.0	0.0
1/25/99	8:00:00	222.0	205.0	113.0	6.0	25.0	18.0	0.0
1/25/99	9:00:00	226.0	208.0	113.0	6.0	25.0	18.0	0.0
1/25/99	10:00:00	230.0	211.0	114.0	6.0	25.0	18.0	0.0
1/25/99	11:00:00	229.0	210.0	114.0	6.0	25.0	18.0	0.0
1/25/99	12:00:00	230.0	210.0	115.0	6.0	25.0	18.0	0.0
1/25/99	13:00:00	232.0	212.0	115.0	6.0	25.0	18.0	0.0
1/25/99	14:00:00	233.0	214.0	116.0	6.0	25.0	18.0	0.0
1/25/99	15:00:00	230.0	211.0	116.0	6.0	25.0	18.0	0.0
1/25/99	16:00:00	233.0	214.0	116.0	6.0	25.0	18.0	0.0
1/25/99	17:00:00	233.0	214.0	116.0	6.0	25.0	18.0	0.0
1/25/99	18:00:00	231.0	211.0	116.0	6.0	25.0	18.0	0.0
1/25/99	19:00:00	249.0	227.0	116.0	6.0	25.0	18.0	0.0
1/25/99	20:00:00	247.0	227.0	117.0	6.0	25.0	18.0	0.0
1/25/99	21:00:00	233.0	217.0	117.0	6.0	25.0	18.0	0.0
1/25/99	22:00:00	218.0	201.0	115.0	6.0	11.0	18.0	0.0
1/25/99	23:00:00	211.0	195.0	115.0	6.0	10.0	18.0	0.0
Daily Average		224.0	205.3	114.3	5.9	20.5	18.0	0.0

608

Mobile EP Operating Data



McGill AirClean Mobile EP
Daily Performance Report

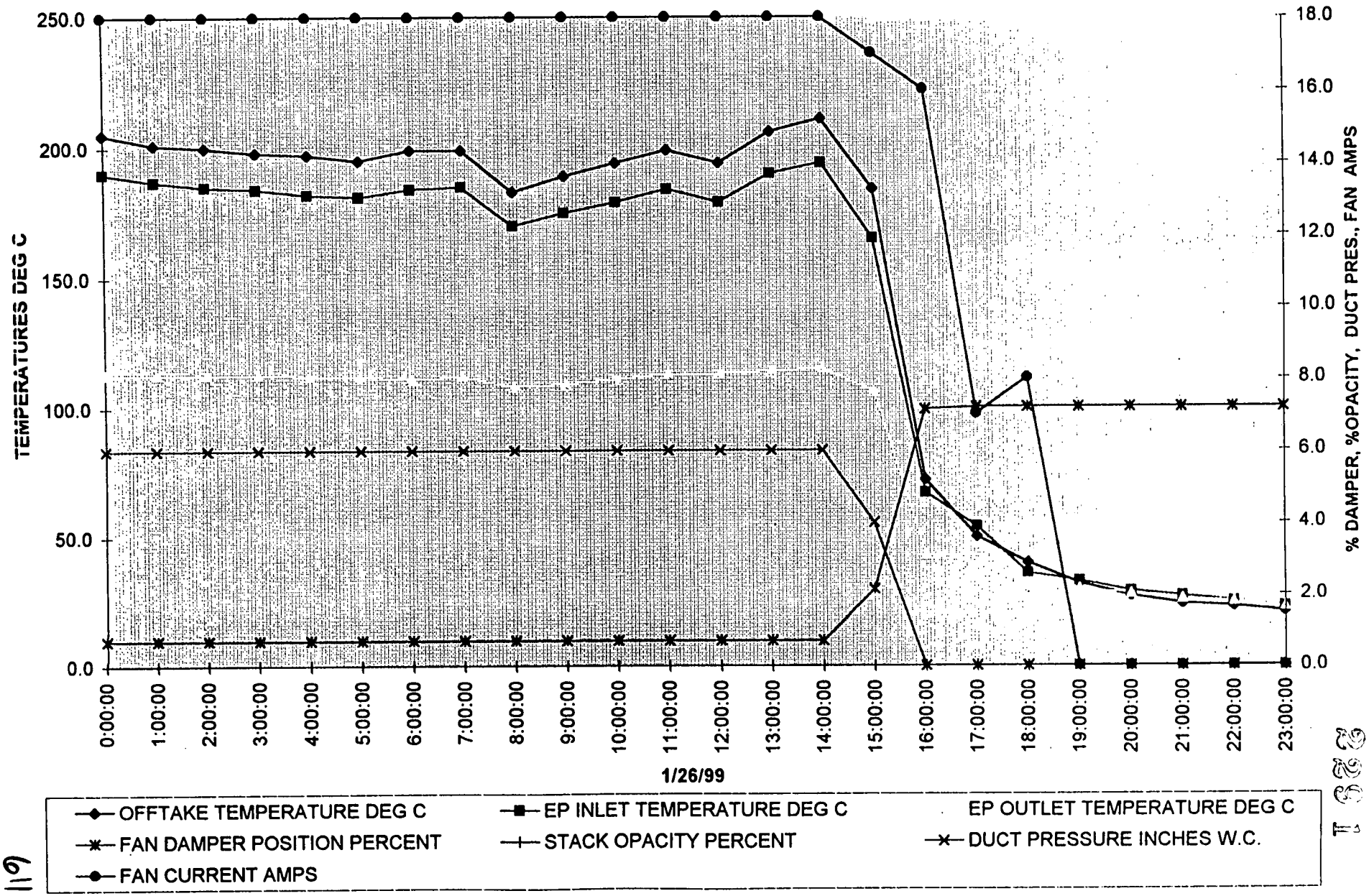
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/26/99
Start Date: 12/1/98
Days Operation: 37

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/26/99	0:00:00	205.0	190.0	113.0	6.0	10.0	18.0	0.0
1/26/99	1:00:00	201.0	187.0	113.0	6.0	10.0	18.0	0.0
1/26/99	2:00:00	200.0	185.0	113.0	6.0	10.0	18.0	0.0
1/26/99	3:00:00	198.0	184.0	113.0	6.0	10.0	18.0	0.0
1/26/99	4:00:00	197.0	182.0	112.0	6.0	10.0	18.0	0.0
1/26/99	5:00:00	195.0	181.0	112.0	6.0	10.0	18.0	0.0
1/26/99	6:00:00	199.0	184.0	111.0	6.0	10.0	18.0	0.0
1/26/99	7:00:00	199.0	185.0	112.0	6.0	10.0	18.0	0.0
1/26/99	8:00:00	183.0	170.0	108.0	6.0	10.0	18.0	0.0
1/26/99	9:00:00	189.0	175.0	109.0	6.0	10.0	18.0	0.0
1/26/99	10:00:00	194.0	179.0	111.0	6.0	10.0	18.0	0.0
1/26/99	11:00:00	199.0	184.0	113.0	6.0	10.0	18.0	0.0
1/26/99	12:00:00	194.0	179.0	113.0	6.0	10.0	18.0	0.0
1/26/99	13:00:00	206.0	190.0	114.0	6.0	10.0	18.0	0.0
1/[illegible]	14:00:00	211.0	194.0	115.0	6.0	10.0	18.0	0.0
[illegible]	15:00:00	184.0	165.0	106.0	4.0	30.0	17.0	0.0
[illegible]9	16:00:00	72.0	67.0	43.0	0.0	99.0	16.0	0.0
1/26/99	17:00:00	50.0	54.0	40.0	0.0	100.0	7.0	0.0
1/26/99	18:00:00	40.0	36.0	30.0	0.0	100.0	8.0	0.0
1/26/99	19:00:00	32.0	33.0	30.0	0.0	100.0	0.0	0.0
1/26/99	20:00:00	27.0	29.0	28.0	0.0	100.0	0.0	0.0
1/26/99	21:00:00	24.0	27.0	26.0	0.0	100.0	0.0	0.0
1/26/99	22:00:00	23.0	25.0	25.0	0.0	100.0	0.0	0.0
1/26/99	23:00:00	21.0	23.0	23.0	0.0	100.0	0.0	0.0
Daily Average		143.5	133.7	84.7	3.9	40.8	13.3	0.0

610

Mobile EP Operating Data



119

McGill AirClean Mobile EP
Daily Performance Report

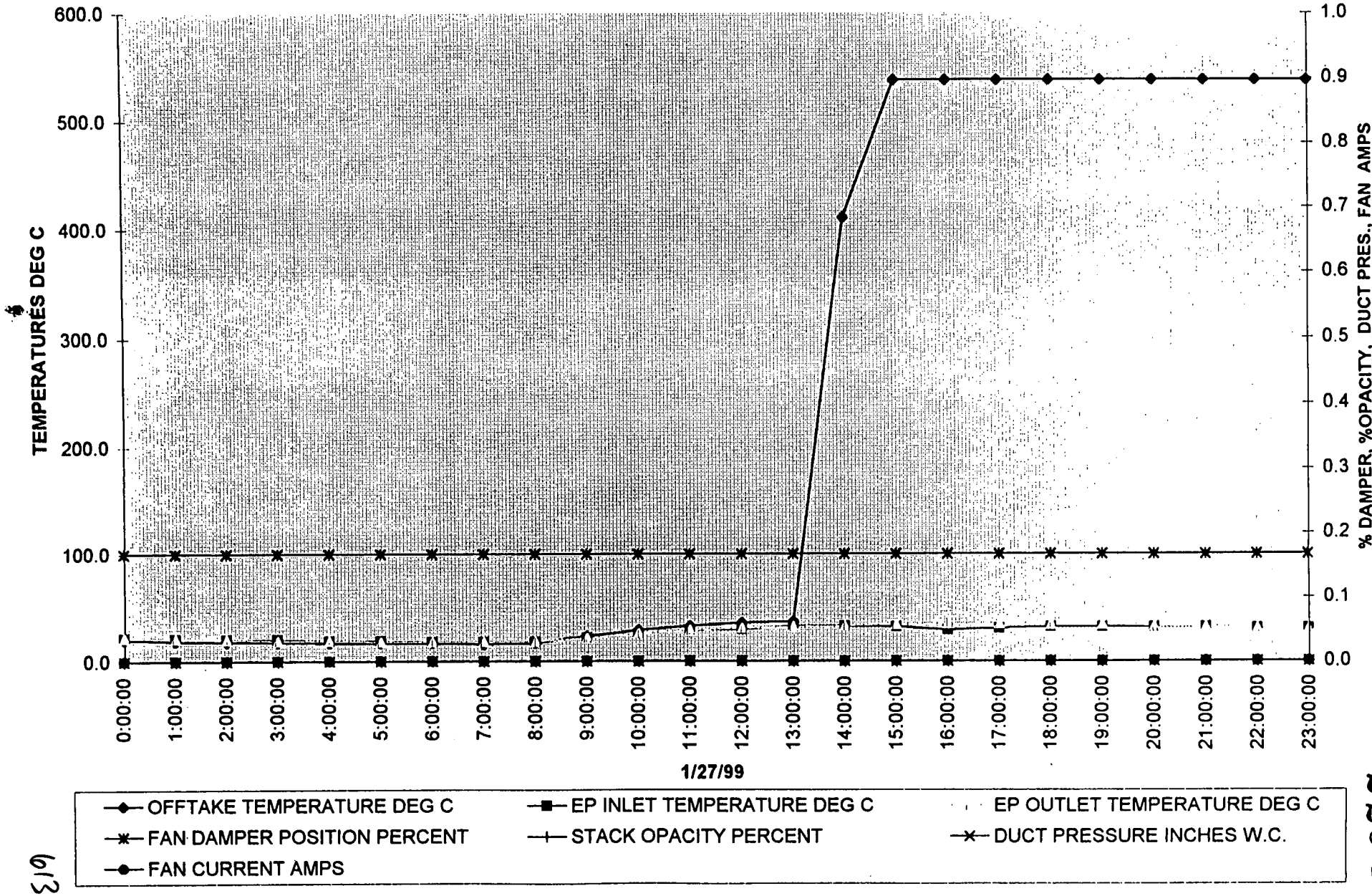
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/27/99
Start Date: 12/1/98
Days Operation: 38

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/27/99	0:00:00	20.0	22.0	22.0	0.0	100.0	0.0	0.0
1/27/99	1:00:00	19.0	21.0	21.0	0.0	100.0	0.0	0.0
1/27/99	2:00:00	18.0	20.0	20.0	0.0	100.0	0.0	0.0
1/27/99	3:00:00	18.0	20.0	19.0	0.0	100.0	0.0	0.0
1/27/99	4:00:00	17.0	19.0	19.0	0.0	100.0	0.0	0.0
1/27/99	5:00:00	17.0	19.0	18.0	0.0	100.0	0.0	0.0
1/27/99	6:00:00	17.0	18.0	18.0	0.0	100.0	0.0	0.0
1/27/99	7:00:00	16.0	18.0	18.0	0.0	100.0	0.0	0.0
1/27/99	8:00:00	17.0	18.0	18.0	0.0	100.0	0.0	0.0
1/27/99	9:00:00	23.0	22.0	22.0	0.0	100.0	0.0	0.0
1/27/99	10:00:00	29.0	26.0	26.0	0.0	100.0	0.0	0.0
1/27/99	11:00:00	33.0	29.0	29.0	0.0	100.0	0.0	0.0
1/27/99	12:00:00	36.0	30.0	31.0	0.0	100.0	0.0	0.0
1/27/99	13:00:00	37.0	33.0	32.0	0.0	100.0	0.0	0.0
1/[illegible]	14:00:00	410.0	33.0	33.0	0.0	100.0	0.0	0.0
[illegible]	15:00:00	538.0	32.0	34.0	0.0	100.0	0.0	0.0
[illegible]/99	16:00:00	538.0	29.0	35.0	0.0	100.0	0.0	0.0
1/[illegible]/99	17:00:00	538.0	31.0	35.0	0.0	100.0	0.0	0.0
1/27/99	18:00:00	538.0	32.0	34.0	0.0	100.0	0.0	0.0
1/27/99	19:00:00	538.0	32.0	34.0	0.0	100.0	0.0	0.0
1/27/99	20:00:00	538.0	32.0	33.0	0.0	100.0	0.0	0.0
1/27/99	21:00:00	538.0	32.0	32.0	0.0	100.0	0.0	0.0
1/27/99	22:00:00	538.0	31.0	31.0	0.0	100.0	0.0	0.0
1/27/99	23:00:00	538.0	31.0	31.0	0.0	100.0	0.0	0.0
Daily Average		232.0	26.3	26.9	0.0	100.0	0.0	0.0

612

Mobile EP Operating Data



2291

613

McGill AirClean Mobile EP
Daily Performance Report

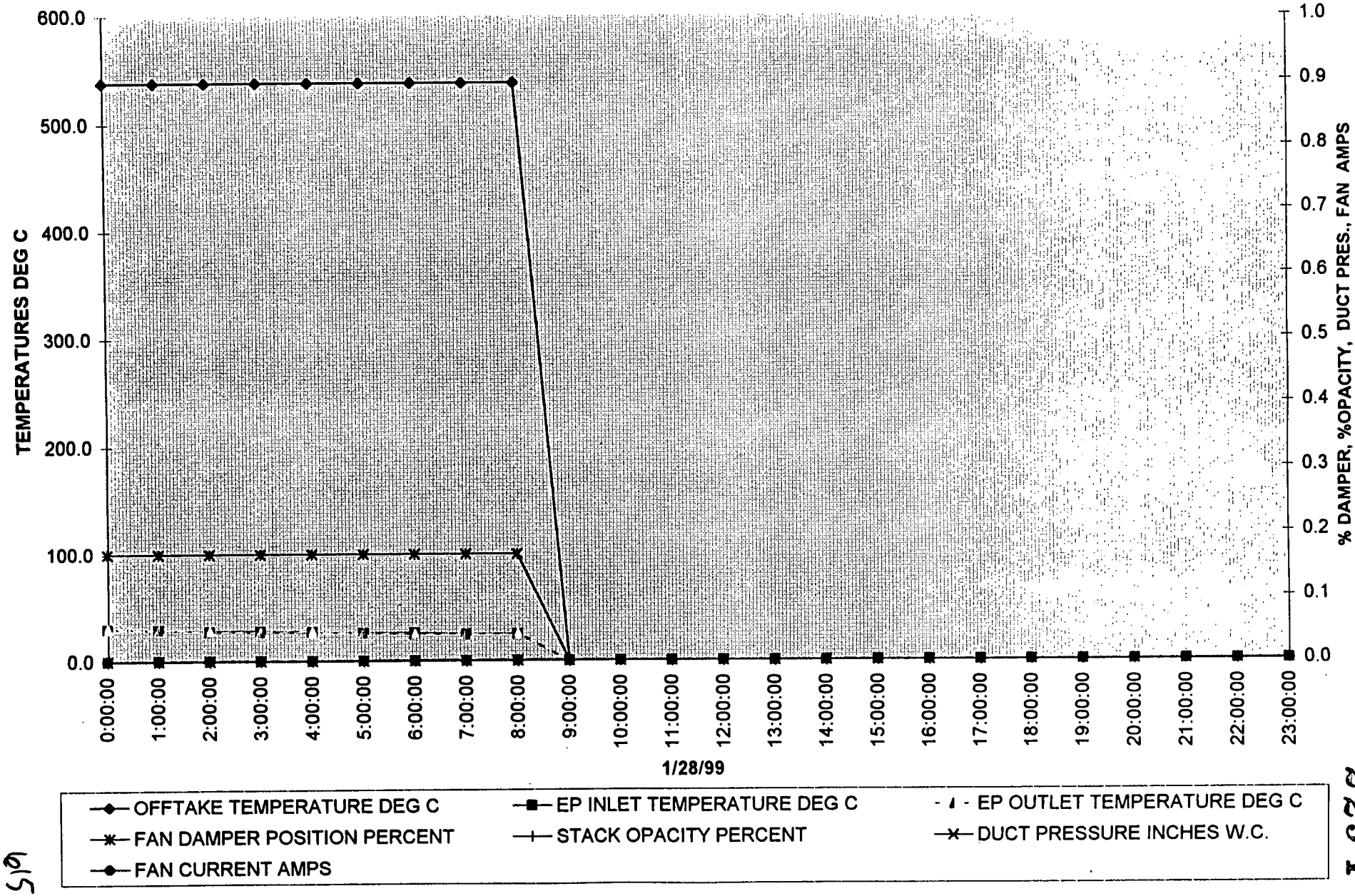
Customer: ENVITCO, INCORPORATED
Process: SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE
Operators: DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL

Report Date: 1/28/99
Start Date: 12/1/98
Days Operation: 39

Date	Time	OFFTAKE TEMPERATURE DEG C	EP INLET TEMPERATURE DEG C	EP OUTLET TEMPERATURE DEG C	DUCT PRESSURE INCHES W.C.	FAN DAMPER POSITION PERCENT	FAN CURRENT AMPS	STACK OPACITY PERCENT
1/28/99	0:00:00	538.0	30.0	30.0	0.0	100.0	0.0	0.0
1/28/99	1:00:00	538.0	29.0	29.0	0.0	100.0	0.0	0.0
1/28/99	2:00:00	538.0	28.0	28.0	0.0	100.0	0.0	0.0
1/28/99	3:00:00	538.0	28.0	27.0	0.0	100.0	0.0	0.0
1/28/99	4:00:00	538.0	27.0	27.0	0.0	100.0	0.0	0.0
1/28/99	5:00:00	538.0	26.0	26.0	0.0	100.0	0.0	0.0
1/28/99	6:00:00	538.0	26.0	25.0	0.0	100.0	0.0	0.0
1/28/99	7:00:00	538.0	25.0	25.0	0.0	100.0	0.0	0.0
1/28/99	8:00:00	538.0	25.0	25.0	0.0	100.0	0.0	0.0
1/28/99	9:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	10:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	11:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	12:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	13:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	14:00:00	#######	#######	#######	#######	#######	#######	#######
[illegible]9	15:00:00	#######	#######	#######	#######	#######	#######	#######
[illegible]9	16:00:00	#######	#######	#######	#######	#######	#######	#######
[illegible]99	17:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	18:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	19:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	20:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	21:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	22:00:00	#######	#######	#######	#######	#######	#######	#######
1/28/99	23:00:00	#######	#######	#######	#######	#######	#######	#######
Daily Average		538.0	27.1	26.9	0.0	100.0	0.0	0.0

614

Mobile EP Operating Data



2291

615

Appendix 4 - Operating Notes

McGill AirClean Mobile EP
Daily Performance Report

229 1

Customer:	ENVITCO, INCORPORATED	Report Date:	12/2/98
Process:	SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE	Start Date:	12/1/98
Operators:	DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL	Days Operation:	1

OPERATING NOTES

MOBILE EP:

W. Shoemaker confirmed the shipping brackets for the plate packs had been removed.
W. Shoemaker performed instrument calibrations on the field voltage/current transmitters and thermocouples.
W. Shoemaker replaced the Telmar unit for field 3 to allow operation in AVC mode.

PROCESS/CUSTOMER INFORMATION:

Prior to this date, D. Poole explained to R. Wilson that the Auto/Manual pushbuttons on the panel now function as local/Remote switches since the Mobile EP system was computerized.
emaker reported that he re-calibrated the customer's pressure transmitter from -1 to +1, to -5 - 0.0 inches of water at customer request.
oemaker reported that he is working with J. Hubler (McGill AirClean EE) to coordinate terminations of furnace pressure and opacity signal wires.

EMISSIONS TESTING NOTES:

W. Shoemaker set up the opacity monitor.

MISCELLANEOUS:

Prior to the current date, D. Poole was on site from 11/11 to 11/19 to receive and set up the Mobile EP. W. Shoemaker was on site from 11/29 to 12/5/98 to checkout (including instrument calibrations) and start up the Mobile EP.

CC:
D. POOLE / FILE
T. MAURER

617

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer:	ENVITCO, INCORPORATED	Report Date:	12/14/98
Process:	SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE	Start Date:	12/1/98
Operators:	DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL	Days Operation:	13

OPERATING NOTES

MOBILE EP:

The Mobile EP fan shut down around 0600 hours. McGill Service and Electrical engineering departments worked with Envitco personnel to determine the cause of the shut down. The problem was traced to a blown fuse in the PLC rack. The system was back on-line by around 0900 hours. Envitco reported field 1 operating very erratically causing inlet, outlet temperature and pressure alarms. W. Shoemaker believes this could be due to some shielded wires which are not properly grounded. McGill AirClean EE department believes this could be due to a bad PLC card.
It has become apparent that the alarm setpoints are based on degrees F, however, all the units for temperature have been changed to indicate degrees C.

PROCESS/CUSTOMER INFORMATION:

[illegible]eported that the operator interface computer indicates short term cycling of the furnace pressure and outlet temperature (every 3-10 seconds). [illegible]tomer was given full access to the operator interface computer programs. McGill personnel also enabled the alarm logger in the FIXX [illegible]tor interface to allow for detailed information during troubleshooting procedures. The customer requested a report on why the fan went down and what was recommended in order to ensure it did not happen again.

EMISSIONS TESTING NOTES:

It was reported that testing of the system was re-scheduled for Jan. 18, 1999 due to testing company scheduling problems.

MISCELLANEOUS:

D. POOLE / FILE
T. MAURER

618

McGill AirClean Mobile EP
Daily Performance Report

2291

Customer:	ENVITCO, INCORPORATED	Report Date:	1/28/99
Process:	SLURRY FED GLASS MELTER - FOR VITRIFICATION OF WASTE	Start Date:	12/1/98
Operators:	DAVID POOLE, WADE SHOEMAKER AND ENVITCO PERSONNEL	Days Operation:	39

OPERATING NOTES

MOBILE EP:

Final preparations for transit are being made per W. Shoemaker. Tractor rig for transport is expected around noon this day.

Observations during decommissioning indicated that field 2 was the dirtiest and remaining fields progressively cleaner.
A 5 gallon bucket of material was removed from the Mobile EP hopper prior to washing with water.

The fiber wool in the expansion joint evidently fell apart upon attempting to clean.

PROCESS/CUSTOMER INFORMATION:

R. Wilson gave McGill AirClean the go ahead to get the particle size analysis completed at an outside laboratory. He requested we hold o[illegible] electrical resistivity testing for now and stated it will probably not be desired.

EMISSIONS TESTING NOTES:

MISCELLANEOUS:

CC:
D. POOLE / FILE
T. MAURER

619

McGill AirClean Corporation 1779 Refugee Road, Columbus, Ohio 43207-2119, 614/443-0192, Fax: 614/443-3931

2291

FIELD SERVICE REPORT

Customer:	Envitco	**Date:**	January 28, 1999
Location:	Anderson, SC	**Contact:**	Rob Wilson
Application:	Prototype glass furnace testing	**McGill Job No:**	O-5710-9
System:	Mobile EP	**Engineer:**	Wade Shoemaker
Purpose:	Complete tear down and cleaning of the unit.		

1) Made a copy of the data files and excel files on a recordable CD-ROM for Dave Poole.
2) Shutdown the unit after the tank draining was complete.
3) Opened up all access doors to allow for quicker cooling of the unit.
4) Took pictures of the buildup inside the unit while cooling was taking place.
5) Once the unit had cooled down, I then began scrapping the plates to remove most of the buildup from the unit.
6) Removed two 5-gallon buckets of dust from the unit after scrapping down the plates.
7) Using a power washer, I began cleaning the plates throughly from top structures to screw conveyors.
8) Using a pump, transferred the hazardous liquid into a 55-gallon barrel provided by the customer.
9) Disconnected the inlet duct work as well as the stack and stored the components on top of the mobile.
10) Found dust buildup in the expansion joint and attempted to clean with the power washer which ruined the insulation. Dave Poole told me not to worry about the expansion joint since it is not typically used.
11) Put the computer and printer in the control cabinet for shipping.
12) Locked up the control cabinet once I was finished using the power washer that was purchased for the mobile.
13) Installed the shipping braces in all four fields as well as taped the top structure baffle plates to the catwalks inside.
14) Removed all rapping air cylinders and stored under the cat walk in the gang box for shipping.
15) Lowered the catwalk and secured for shipping purposes.
16) Locked up all gang boxes and removed all timber from around the unit awaiting the truck to arrive.
17) Once the unit had departed the site, I cleaned up the area before leaving the site.

WES:jlc:I:\APCG\FLDSRV\FIELDSVC.RPT\envitco January teardown.wpd

cc: E. Brabham/Cust. file
D. Luttenberger
T. Maurer
D. Poole
R. Takos

620

Appendix 5 - Operating and Performance Data - Summary Graphs

Chart 1 - EP Voltage and Current

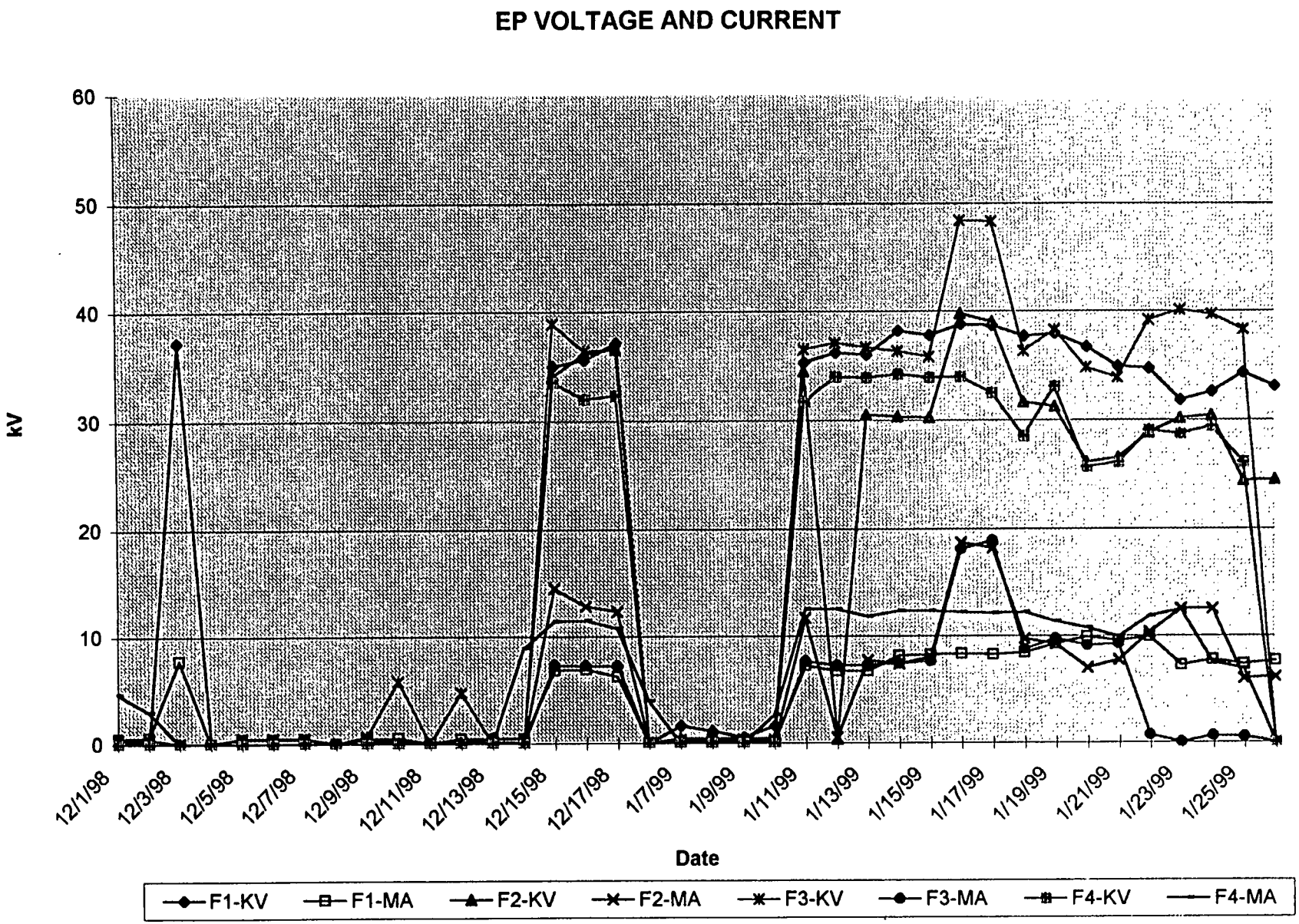
Chart 2 - EP Voltages

Chart 3 - EP Currents

Chart 4 - Temperatures - Degrees C

Chart 5 - EP Operating Conditions

Chart 6 - Field Power - Watts

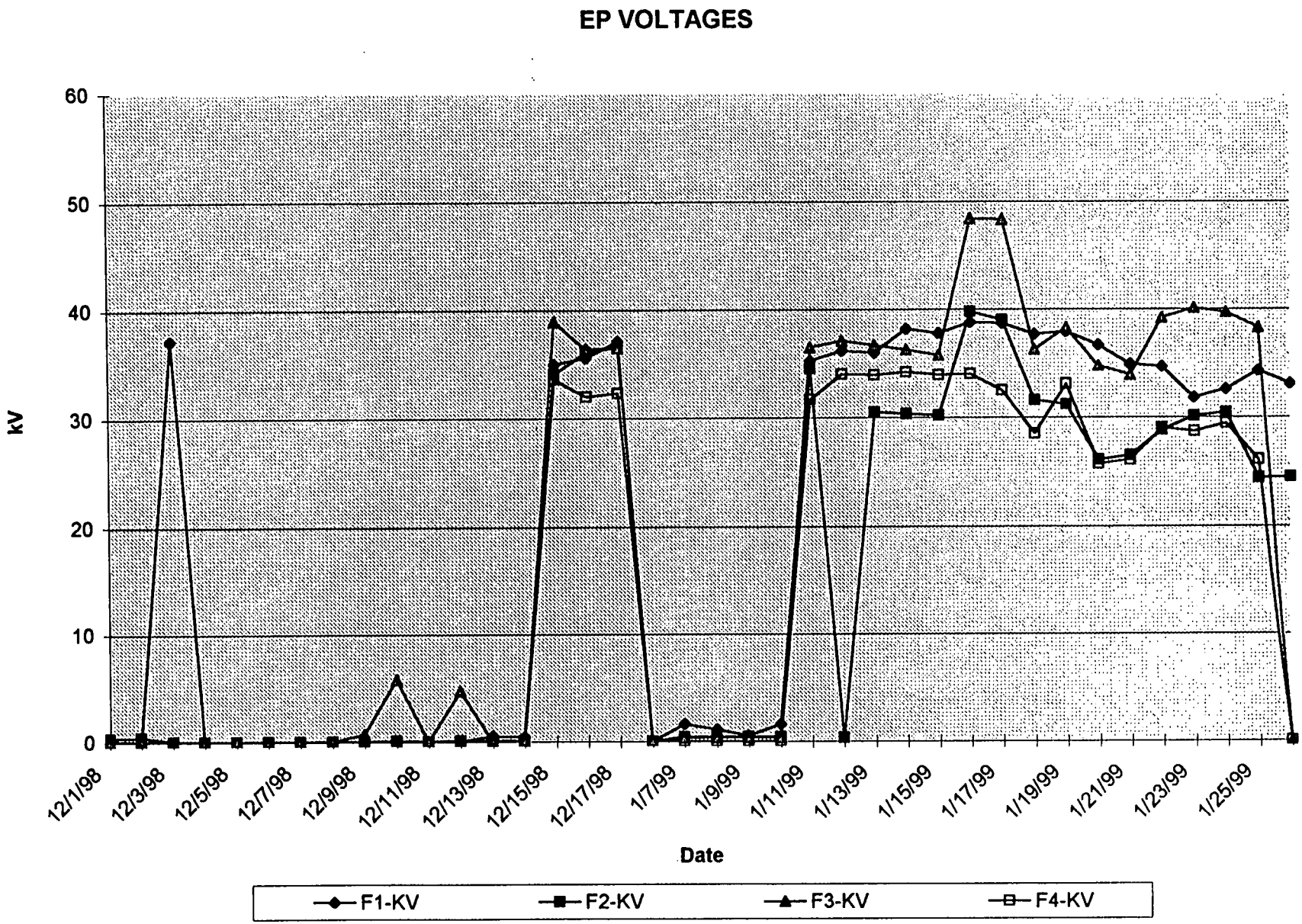


2291

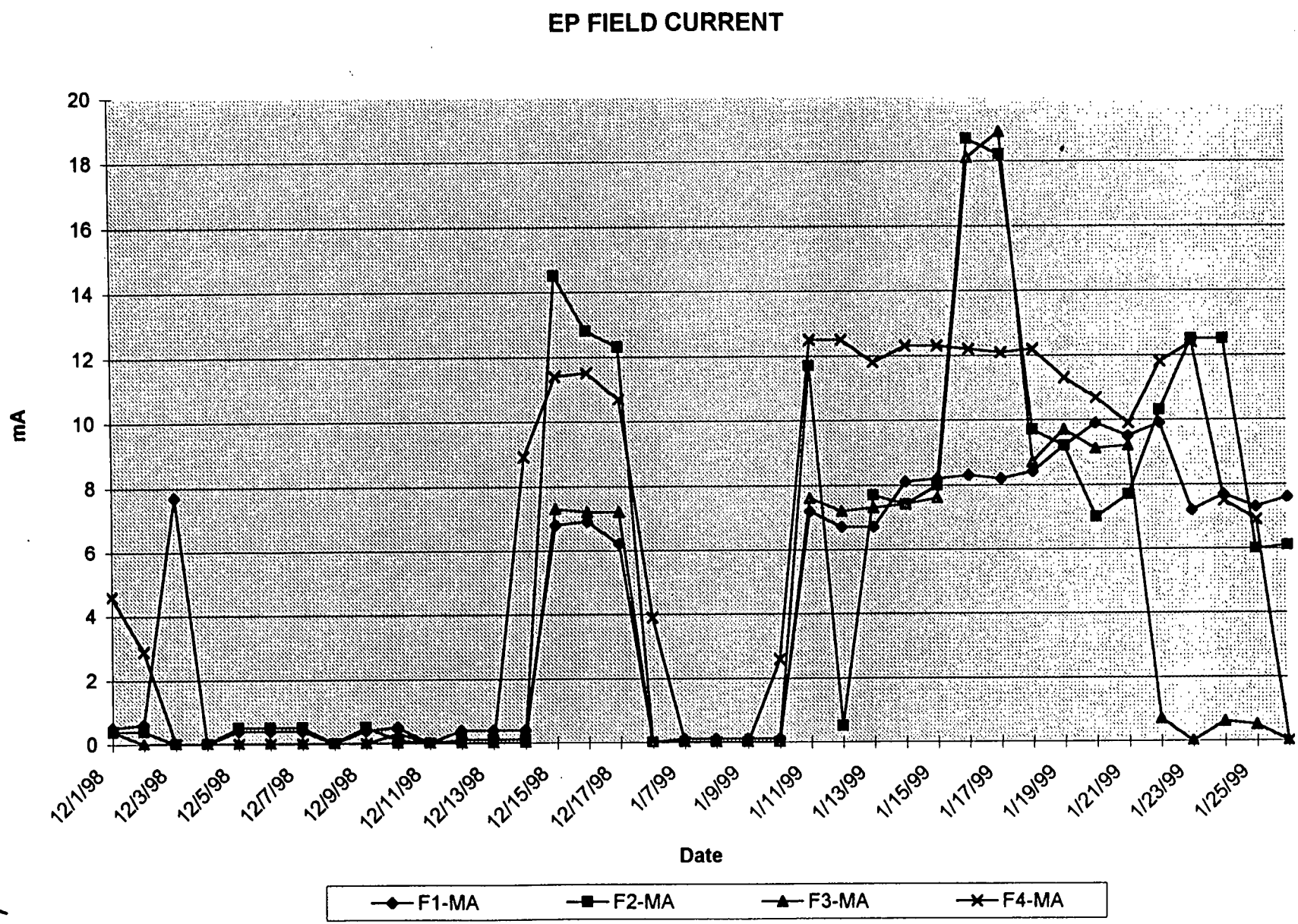
(28)

40 DAY.xls

Chart1


EP VOLTAGES
kV
60
50
40
30
20
10
0
12/1/98
12/3/98
12/5/98
12/7/98
12/9/98
12/11/98
12/13/98
12/15/98
12/17/98
1/7/99
1/9/99
1/11/99
1/13/99
1/15/99
1/17/99
1/19/99
1/21/99
1/23/99
1/25/99
Date
F1-KV
F2-KV
F3-KV
F4-KV

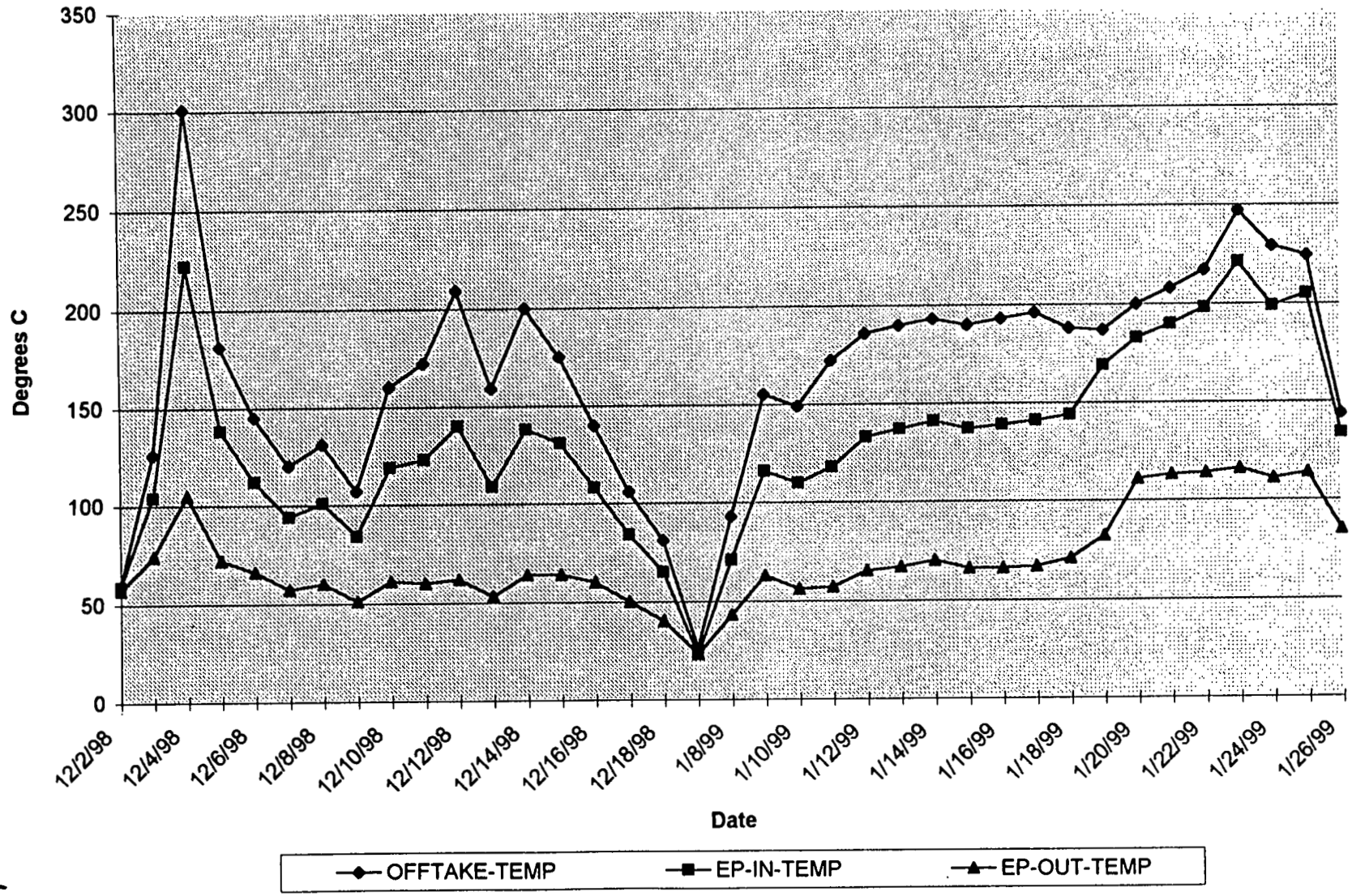
2229 I



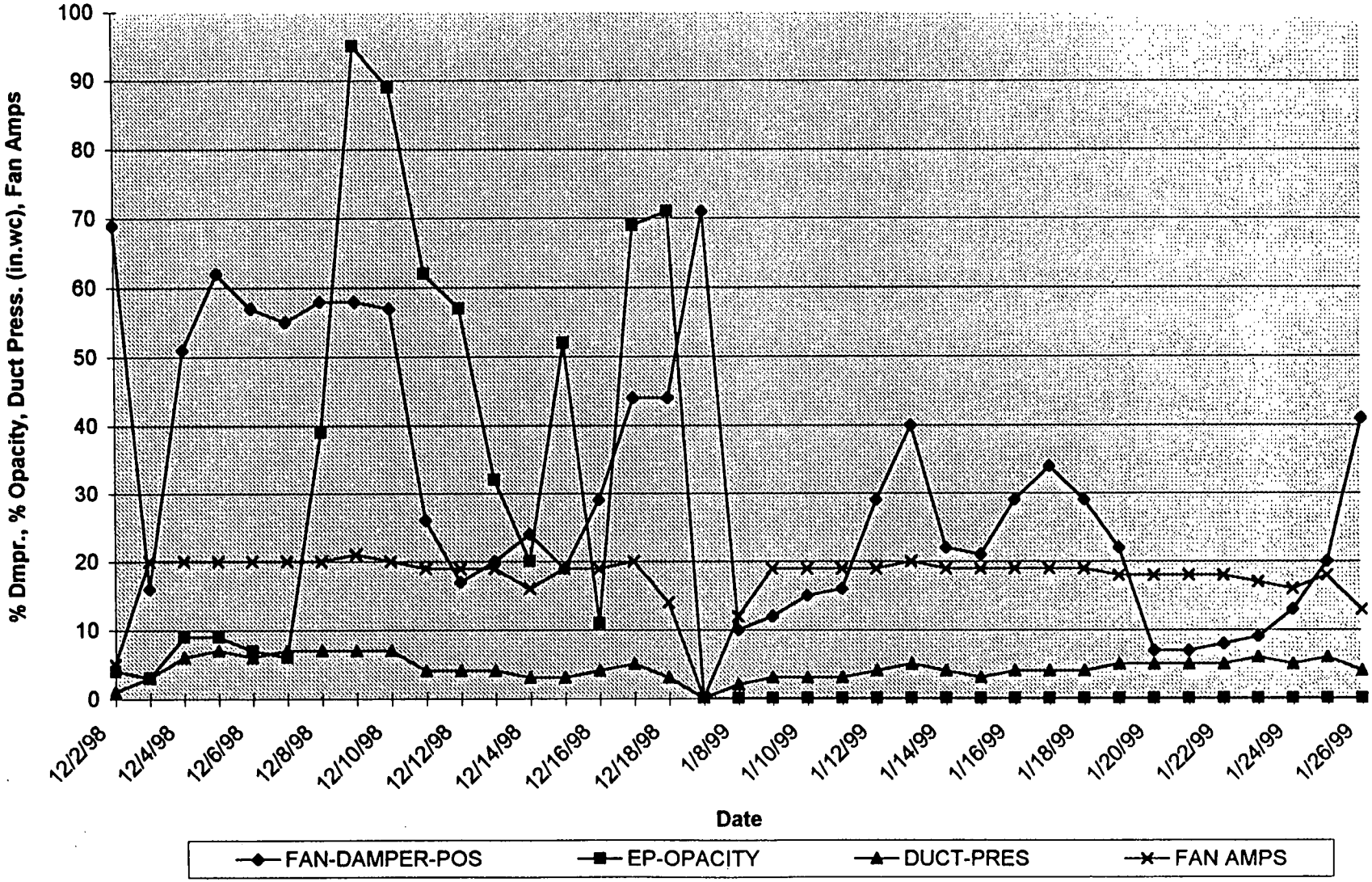
40 DAY.xls

Chart3

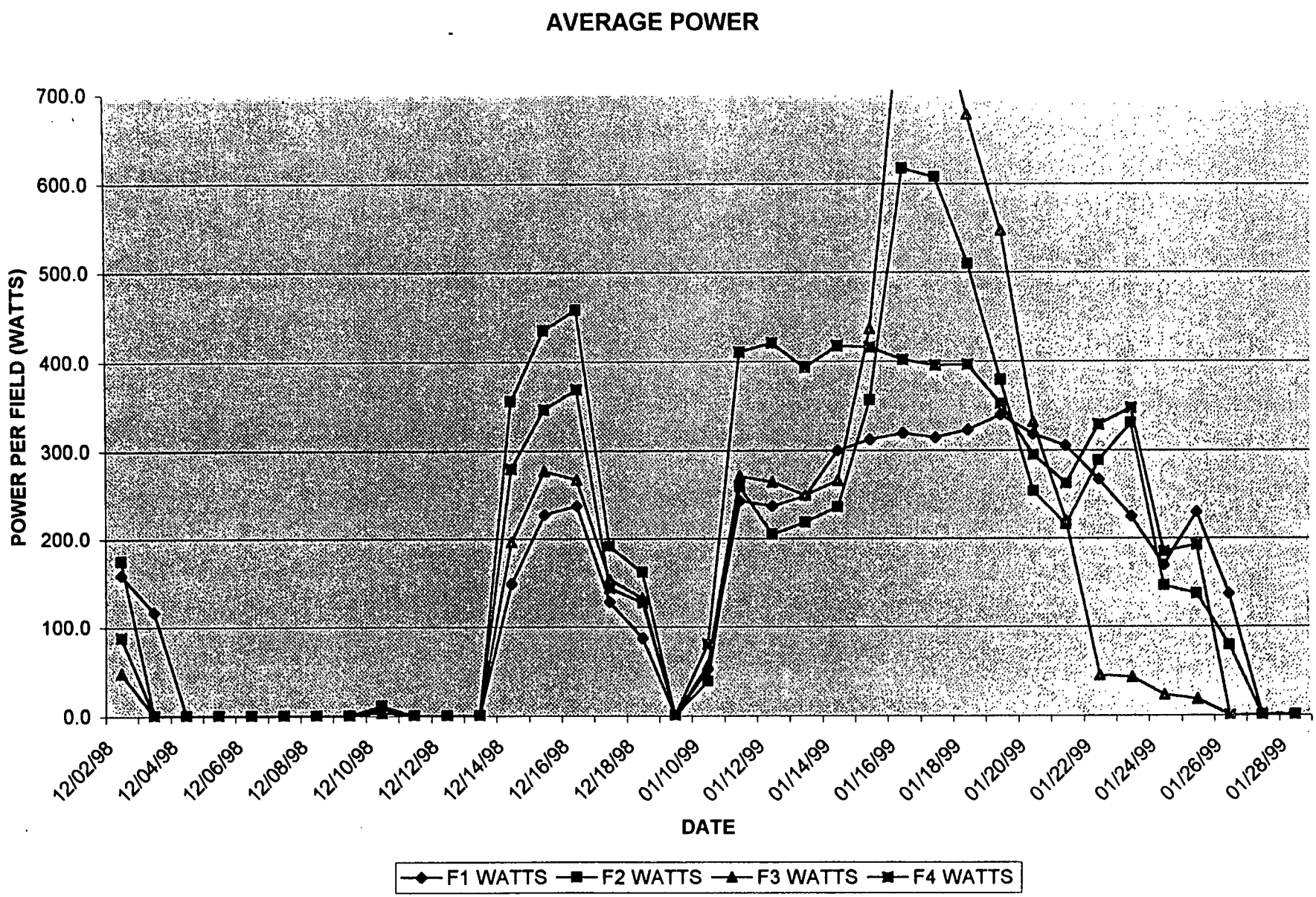
TEMPERATURES - DEGREES C



EP OPERATING CONDITIONS



2291


AVERAGE POWER
POWER PER FIELD (WATTS)
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
12/02/98
12/04/98
12/06/98
12/08/98
12/10/98
12/12/98
12/14/98
12/16/98
12/18/98
01/10/99
01/12/99
01/14/99
01/16/99
01/18/99
01/20/99
01/22/99
01/24/99
01/26/99
01/28/99
DATE
F1 WATTS
F2 WATTS
F3 WATTS
F4 WATTS

2291

2291

STATIONARY SOURCE SAMPLING REPORT

FOR

ENVITCO

Clemson University Research Park

Clemson, South Carolina

Envitrification Unit

Performed by:

Trigon Engineering Consultants, Inc.
Environmental, Health & Safety Division
6200 Harris Technology Blvd.
Charlotte, North Carolina 28269
704/598-1049

Trigon Project No. 046-98-158
January 1999

628

TRIGON

REPORT CERTIFICATION

This report, all testing details, and the final results have been performed under the supervision and reviewed by the persons named below.

Date FEBRUARY 24, 1999 Signature _____

Robert F. Callahan
Project Manager
Environmental, Health & Safety Division
Trigon Engineering Consultants, Inc.

Date February 24, 1999 Signature _____

Paul R. Jenkins, Jr.
Quality Assurance Manager
Environmental, Health & Safety Division
Trigon Engineering Consultants, Inc.

Date February 24, 1999 Signature _____

J.A. "Tony" Blanton
Stack Testing Department Manager
Environmental, Health & Safety Division
Trigon Engineering Consultants, Inc.

629

TRIGON

TABLE OF CONTENTS

2291

1.0 INTRODUCTION 1
- 1.1 Purpose 1
- 1.2 Outline of Test Program 1
- 1.3 Test Participants 2

2.0 PROCESS DESCRIPTION 3
- 2.1 Discussion 3
  - Figure 1 - Process Air Flow Schematic 4

3.0 SAMPLING METHODS 5
- 3.1 Sampling Strategy 5
- 3.2 Sampling and Analytical Procedures 5
  - 3.2.1 Sampling Ports, Traverse Points and Cyclonic Flow Determination 5
  - 3.2.2 Stack Gas Velocity and Volumetric Flow Rate Determination 6
  - 3.2.3 Dry Molecular Weight Determination 7
  - 3.2.4 Moisture Determination 7
  - 3.2.5 Particulate Matter Sampling and Analysis 8
  - 3.2.6 Sulfuric Acid Mist (SO_2 and SO_3) Sampling and Analysis 9
  - 3.2.7 Gaseous Pollutant Instrumental Analyzer Procedures 10
  - 3.2.8 Oxygen and Carbon Dioxide Instrumental Analyzer Description 12
  - 3.2.9 Sulfur Dioxide Instrumental Analyzer Description 13
  - 3.2.10 Oxides of Nitrogen Instrumental Analyzer Description 14
  - 3.2.11 Total Gaseous Organic(s) Flame Ionization Analyzer Procedure 15
  - 3.2.12 Sampling Ports and Points 16
  - Figure 2 - Melter Exhaust- Location of Sampling Ports and Points 17
  - Figure 3 - ESP Stack - Location of Sampling Ports and Points 18
- 3.3 Quality Assurance and Quality Control 19

4.0 RESULTS 20
- 4.1 Summary of Results 20
- 4.2 Detailed Stack Sampling Results 22
  - Table 1 - Summary of Results - Particulate Matter Sampling Melter Exhaust 23
  - Table 2 - Summary of Results - Particulate Matter Sampling ESP Stack 24
  - Table 3 - Summary of Results - Sulfuric Acid Mist & Sulfur Dioxide Sampling Melter Exhaust 25
  - Table 4 - Summary of Results - Sulfuric Acid Mist & Sulfur Dioxide Sampling con't. 26

630

TRIGON

2291

5.0 APPENDICES 27

A. Summary of Results and Example Calculations
B. Field Data Sheets
C. Data Acquisition System Uncorrected Values
D. CEM & VOC Strip Chart Recorder Data
E. Laboratory Data
F. Calibration Data

631

TRIGON

1.0 INTRODUCTION

This section describes the purpose, a brief outline including the sampling and analytical strategy, and the personnel involved in the test program.

1.1 Purpose

The purpose of this sampling project was to determine concentrations and emission rates of the following pollutants. The table below details the test parameters, methods, number of sampling runs and sample location. The envitrification unit tested was at Clemson University Research Park in Clemson, South Carolina.

Parameter	EPA Method	No. Runs/Time	Sample Location
Particulate Matter and Metal (listed below)	5/29	6/1-hour	Melter Exhaust & ESP Stack
Sulfuric Acid Mist (SO_2 and SO_3)	8	6/1-hour	Melter Exhaust
Sulfur Dioxide	6C	2/24-hour	Melter Exhaust & ESP Stack
Oxides of Nitrogen	7E	2/24-hour	Melter Exhaust & ESP Stack
Total Gaseous Organics	25A	1/8-hour	Melter Exhaust

Metals List

Aluminum (Al)
Barium (Ba)
Iron (Fe)
Nickel (Ni)
Silicon (Si)
Sodium (Na)
Calcium (Ca)
Potassium (K)
Cadmium (Cd)
Lithium (Li)
Vanadium (V)
Sulfur (S)
Arsenic (As)
Chromium (Cr)
Magnesium (Mg)
Selenium (Se)
Zinc (Zn)
Phosphorus (P)
Molybdenum (Mo)
Lead (Pb)

1.2 Outline of Test Program

Stationary source sampling was performed January 19-21, 1999 by the Environmental, Health & Safety (EHS) Division of Trigon Engineering Consultants, Inc. on the envitrification unit. United States Environmental Protection Agency (US EPA) Methods 1 through 5 and Method 29 were used to

632

TRIGON

determine the concentrations and emission rates of particulate matter and multi-metals. EPA Methods 6C and 7E were used for the determination of sulfur dioxide and oxides of nitrogen. Determination of sulfuric acid mist including SO_2 and SO_3 was performed using EPA Method 8. Total gaseous organic(s) were determined using EPA Method 25A. Sampling and analytical procedures used in this test program were those established by the US EPA in standard reference test methods and appropriate state-of-the-art analytical procedures. The test runs were conducted during normal operating conditions.

1.3 Test Participants

A list of the project participants, titles, affiliation and telephone numbers can be found below.

Participant	Title	Affiliation	Contact
Robert F. Callahan	Project Manager	Trigon Engineering Consultants, Inc.	Telephone: (704) 598-1049 Facsimile: (704) 598-1050
Robert J. Bivens	Assistant Project Manager	Trigon Engineering Consultants, Inc.	
Paul R. Jenkins, Jr.	Quality Assurance Manager	Trigon Engineering Consultants, Inc.	
Joseph P. Konzelmann	Environmental Scientist	Trigon Engineering Consultants, Inc.	
Ken Hewlett	Project Manager	EnVitCo	Telephone: (419) 539-7297 Facsimile: (419) 537-7299
Rob Wilson	Principle Investigator	EnVitCo	

633

TRIGON

2.0 PROCESS DESCRIPTION

This section contains a brief description of the envitrification unit the control equipment, and air flow schematic.

2.1 Discussion

The Envitrification Unit at the Clemson University Research Park in Clemson, South Carolina is part of a pilot study being performed by EnVitCo, Inc. in Toledo, Ohio.

The flue gases passed from the Envitrification Unit through ductwork, an electrostatic precipitator (ESP) induced draft (I.D.) fan and stack to the atmosphere. Figure 1 details the air flow schematic of Pilot Envitrification Unit.

Envitrification Unit

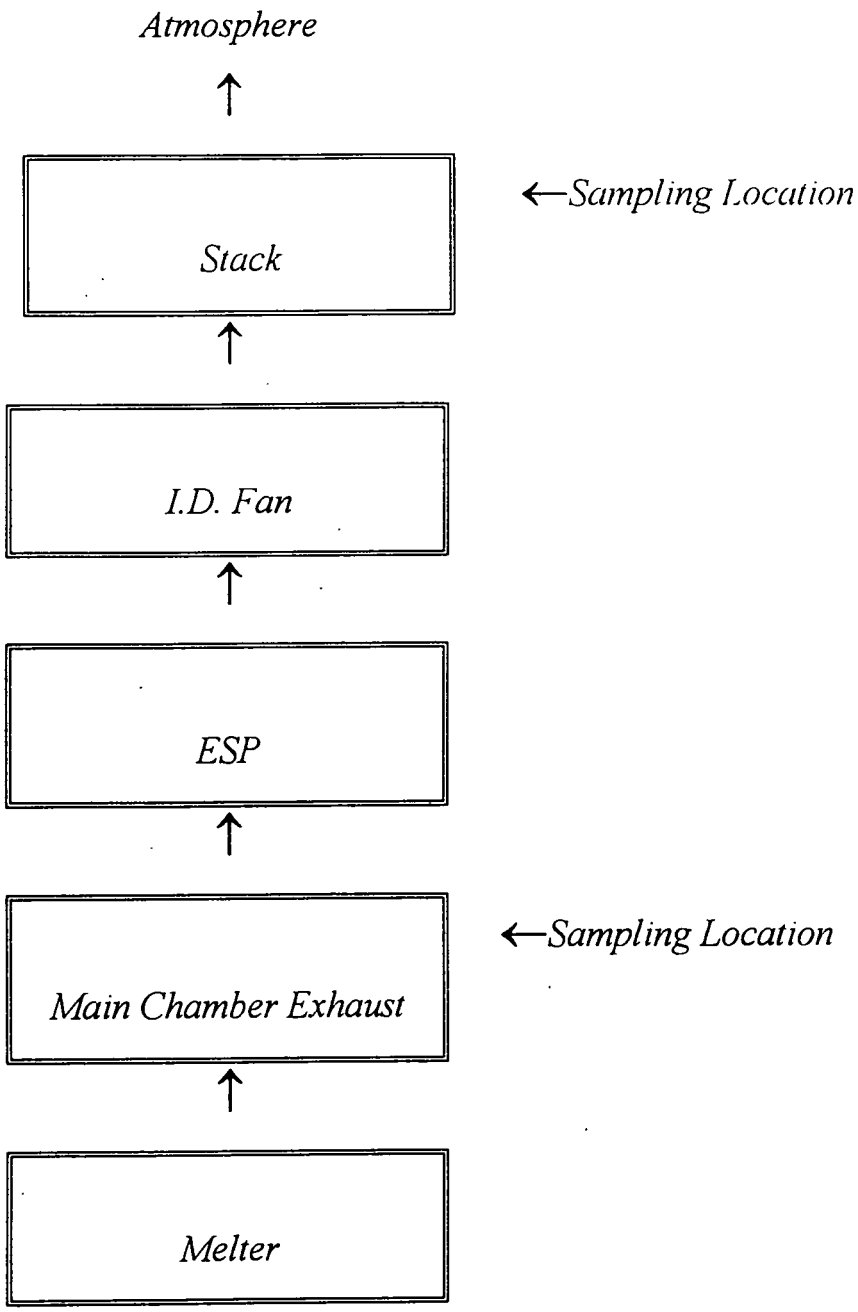


Figure 1

Process Air Flow Schematic

635

3.0 SAMPLING METHODS

This section describes the sampling strategy, sampling and analytical methods, and quality assurance/quality control procedures implemented during this project.

3.1 Sampling Strategy

The sampling and analytical procedures used during this test program were those established by the US EPA. Tests were conducted during normal operating conditions. There were no unusual conditions noted during the sampling.

3.2 Sampling and Analytical Procedures

The US EPA methods used in this sampling program were Method 1 for the location of sampling ports and points, and determination of cyclonic flow, Method 2 for volumetric flow rate determination, Method 3A for the determination of dry molecular weight of the stack gas, and Method 4 for the determination of moisture in the stack gas. Methods 5 and 29 were used to determine concentrations and emission rates of particulate matter and multiple metals. Methods 6C and 7E were used for determination of sulfur dioxide and oxides of nitrogen. Method 8 was used for determination of sulfuric acid mist including SO_2 and SO_3. Method 25A was used for determination of total gaseous organics. A sampling and analysis synopsis is discussed briefly in the following subsection. These test methods are available in the Code of Federal Regulations Volume 40, Part 60 or by request from Trigon.

3.2.1 Sampling Ports, Traverse Points and Cyclonic Flow Determination

The Envitrification Unit sampling locations were prepared according to the criteria in Method 1. The duct diameters upstream and downstream from the sampling ports were determined prior to sampling. The number of traverse points were chosen with respect to sampling port location. For particulate traverses Method 1 specifies a minimum of 8 traverse points for sampling ports located >8/>2 downstream/upstream stack diameters from flow disturbances and 24 traverse points when located >2/>0.5. The amount of cyclonic flow was determined according to the criteria detailed in Method 1.

3.2.2 Stack Gas Velocity and Volumetric Flow Rate Determination

Method 2 is used for determining the average gas velocity in a stack from measurements of gas density and the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube. This method is applicable for quantifying gas flows which meet the criteria of Method 1.

In principle measurements of velocity head and temperature are performed at the traverse points specified by Method 1. A properly scaled differential pressure gauge was selected for the range of Δp values encountered during the traverse. A 0 - 10 inches of water inclined manometer was used as the differential pressure gauge.

During this project, the sampling location met the criteria detailed in Method 1. Gas stream density was determined by Method 3A. Moisture determination was performed by Method 4. The principal components of the gas velocity measurement system were sequentially:

- A calibrated stainless steel Type S pitot tube and Type K thermocouple;
- Leak-free interface tubing between pitot tube and differential pressure gauge;
- A 0 to 10 inch inclined manometer, and
- An NIST traceable pyrometer.

The apparatus was set-up according to manufacturer and reference method recommendations. Pre-test and post-test leak checks were conducted using procedures outlined in Method 2, Section 3.1. Velocity head and temperature measurements were performed at the traverse points specified by Method 1. The atmospheric and static pressure of the stack was also determined for each set of velocity head readings. The volumetric flow rate calculations used were those specified in Method 2, Section 5. A more comprehensive explanation of the reference method is detailed in the Environmental Protection Agency's (EPA) Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III (EPA/600/R-94/038c).

3.2.3 Dry Molecular Weight Determination

Method 3A is applicable for determining carbon dioxide and oxygen concentrations and dry molecular weight of a sample gas stream of a fossil-fuel combustion process. This method may also be applicable to other processes where it has been determined that compounds other than carbon dioxide, oxygen, carbon monoxide, and nitrogen are not present in concentrations sufficient to affect the results.

In principle, a continuous gas sample was withdrawn from the emission source. The collected sample was then analyzed for percent carbon dioxide and percent oxygen by separate oxygen and carbon dioxide analyzers. A detailed sampling description is provided in Section 3.2.7 titled Gaseous Pollutant Instrumental Analyzer Procedures.

3.2.4 Moisture Determination

Method 4 involves the determination of stack gas moisture. The moisture content is used to correct the emission concentration or mass emission rate to a dry basis. EPA Method 4 and *Field Procedure* 4 of the EPA's Quality Assurance Handbook, Volume III, EPA-600/R-94/038c, was used to measure stack gas moisture content. *Field Procedure* 4 of the Quality Assurance Handbook, provides detailed information on the application of Method 4.

Preliminary flue gas moisture content (for purposes of setting the isokinetic flow rate) was determined using wet bulb/dry bulb thermometers and partial pressure, vapor and saturated vapor pressure equations. This technique is described in Method 4 and is summarized below:

- Moisten the wet bulb thermometer wick with deionized water;
- Insert both thermometers into the flue gas stream and monitor the wet bulb temperature;
- When the wet bulb temperature has stabilized, record both the wet bulb and dry bulb thermometer temperatures;
- Calculate the flue gas moisture content (PMV) using the equations below.

SVP = Vapor Pressure of Water at Saturation, inches of Mercury

$$SVP = 10x^{y}(6.6911 - (3144/(\text{Wet Bulb} + 390.86)))$$

638

TRIGON

PMV = Percent Moisture by Volume

$$PMV = (SVP-(0.000367(P_{abs})(\text{Dry Bulb-Wet Bulb})(1+((\text{Wet Bulb-32})/1571))))/(P_{abs})x100$$

P_{abs} = Absolute Pressure of Stack Gas

P_{abs} = (Barometric Pressure + (Static Pressure/13.6))

The moisture content for emission rate calculations was determined in conjunction with the Method 5 isokinetic sampling train. The reference method involves the withdrawal of gaseous and particulate pollutants from the emission source at an isokinetic rate using a Method 5 sampling system. The sampling and analytical procedure for reference Method 4 will be discussed in detail in Section 3.2.5 with the isokinetic sampling procedures.

3.2.5 Particulate Matter Sampling and Analysis

Testing for particulate matter was performed according to US EPA Method 5. Gaseous and particulate pollutants were withdrawn isokinetically from the emission source and collected in a multicomponent sampling train. In principle, particulate matter includes any material that was condensed at or above the filtration temperature of approximately 250 degrees Fahrenheit and was collected on a tared glass fiber filter. The gaseous components were then bubbled through a measured volume of deionized water to determine the moisture content of the emission source. The principal components of the sampling system were sequentially:

- A stainless steel sample nozzle and inconnell probe liner;
- A heated (248°F ±25°F) probe and filter assembly with tared glass fiber filter;
- An impinger train consisting of four sequential impingers. The first two impingers containing 100 ml each of deionized water followed by an empty impinger and a final impinger containing 200 grams of silica gel; and
- A metering system capable of maintaining an isokinetic sampling rate and accurately determining the sample volume according to those specifications in APTD-0581.

After each test run, the filter which collected the sample was carefully removed from the glass filter support and sealed in a petri dish. The liquid in the first three impingers was measured to the nearest milliliter. The moisture collected by the silica gel in the fourth impinger was determined to the nearest 0.1 gram. Collected condensate measurements were recorded on the Method 4 moisture determination data analysis form. The nozzle, probe liner, and front filter-half of the filter assembly were rinsed with acetone into a glass storage container which was sealed and the liquid level was marked. The sample containers were transported to Trigon's Air Quality Laboratory in Charlotte, North Carolina.

The particulate matter analyses began by transferring the acetone samples to tared beakers. These samples were taken to dryness, placed in an oven at 104°C for one hour and then placed in a desiccator along with the filters for an initial drying period of 24 hours. The particulate mass was determined gravimetrically. The tare weights of the filters and beakers were subtracted from the final weights to determine the gross particulate weight.

An aliquot of the reagent grade acetone was analyzed to determine the blank correction factor. The acetone rinse (corrected for the blank) was added to the filter catch to obtain the total particulate weight. The particulate samples and method blanks were analyzed by Trigon Engineering Consultants, Inc. personnel. The laboratory analyses and chain of custody documentation can be found in Appendix E.

3.2.6 Sulfuric Acid Mist (SO_2 and SO_3) Sampling and Analysis

Testing for sulfuric acid mist and sulfur dioxide was performed using an EPA Method 8 sampling system. In principle, sulfuric acid mist which includes sulfur trioxide was separated from sulfur dioxide. Gaseous pollutants were withdrawn isokinetically from the Melter Exhaust and collected in a multicomponent sampling train. The principle components of the train were sequentially:

- A stainless steel sample nozzle;
- A heated (248°F±25°F) probe liner and filter bypass; and

- An impinger train consisting of four sequential impingers. The first impinger containing 100 ml of an absorbing solution consisting of 80% isopropanol followed by a glass fiber filter on a glass frit filter support and two impingers containing a 3% hydrogen peroxide (H_2O_2) absorbing solution. The final impinger was filled with 200 grams of indicating silica gel.

Following each run, a fifteen-minute purge with clean dry ambient air was conducted at the average sampling rate observed during the sampling run. The first impinger containing 80% isopropanol is used to absorb the sulfuric acid mist including sulfur trioxide (SO_3). After passing through the glass fiber filter the sample gas is then bubbled through the 3% H_2O_2 absorbing solution of the second and third impingers to capture the sulfur dioxide (SO_2). The silica gel impinger was used to collect any remaining moisture in the sample stream before entering into the dry gas meter.

The samples were measured to the nearest milliliter for moisture determination and recovered by transferring the impinger solutions to laboratory prepared polyethylene sample bottles. The probe, first impinger, all connecting glassware before the filter, and front half of filter holder were subsequently rinsed with 80% isopropanol. The rinse solution plus the filter was added to the first impinger solution and diluted to 250 ml with 80% isopropanol. The second and third impingers plus connecting glassware were rinsed with distilled, deionized water. The rinse was added to initial impinger solutions and diluted to 1000 ml with DI water. All sample containers were sealed and marked. The sulfur dioxide fraction and the sulfuric acid mist fraction were measured by titration according to Method 8. Blanks of the absorbing solution and rinsing reagents were submitted and analyzed. Solution blanks which yield a positive concentration were subtracted from the actual sample concentrations. The samples and appropriate blanks were analyzed in-house by Trigon Engineering Consultants, Inc.

3.2.7 Gaseous Pollutant Instrumental Analyzer Procedures

Gaseous pollutant concentrations and emission rates were determined according to EPA instrumental analyzer procedures. All analytical procedures used by Trigon conformed with the requirements of EPA Test Methods 3A, 6C and 7E. This methodology utilizes an analyzer that senses the gas to be measured and generates an output proportional to its concentration. A portion of the sample gas

stream was continuously withdrawn from the emission source at a constant rate and analyzed by the measurement system. The principal components of the measurement system were sequentially:

- An in-situ 2.0 micron particulate filter and heated stainless steel sample probe;
- A heated stainless steel calibration valve assembly, secondary 0.5 micron particulate filter, and heated Teflon sample transfer line;
- A refrigerator-type moisture removal system;
- Teflon sample transport line and pump with pressure and flow control;
- Stainless steel sample gas manifold;
- Instrumental analyzers with EPA Protocol I calibration gases; and
- A data acquisition system that continually logged thirty second concentrations.

The pollutant laden gas stream was continuously withdrawn from the emission source through a particulate filter, heated stainless steel probe and calibration valve assembly and transferred to the moisture removal system via a 10 foot heated Teflon sample transfer line maintained at approximately 235°F to prevent premature condensation of moisture. The moisture removal system was a refrigerant unit with two peristaltic pumps used for sample conditioning before sample transport to the instrumental analyzer. The moisture removal system was maintained at a constant temperature of 34°F ±2°F.

Prior to the test series the analyzers were calibrated using multipoint calibration gases in the appropriate pollutant range. Calibration gases at three points were first sent directly to the analyzer for an instrument calibration error check. Acceptable tolerance was ±2 percent of the span. The same calibration gases were then introduced at the outlet of the sampling probe at the calibration valve assembly and conveyed through the entire measurement system for determination of any system bias.

The sample and calibration gases were delivered to the analyzer at a constant pressure and flow to ensure that no bias was being created by pressurizing the sample cell of the analyzer. All calibration gases met EPA Protocol I criteria. The system bias, the difference between the analyzer calibration

response and the initial system calibration response was less than 5 percent of the span for the zero and upscale calibration gases before sampling commenced. At the conclusion of the first run, the zero and upscale calibrations gases were reintroduced and their respective responses recorded on the field data sheet. Again, the final system bias was less than 5 percent of the span. The zero and calibration drift check was performed immediately following completion of each test run. Analyzer drift is determined by the difference in initial system calibration value from the final system calibration value. The acceptable tolerance for drift was ±3 percent of span. The system bias check and analyzer drift checks must meet specifications for all runs to be considered valid. Each final zero and upscale calibration value also served as the initial zero and calibration value for the following run.

Sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) concentrations (dry-basis) are displayed by the data acquisition system (DAS) and recorded in parts per million (ppm) while the oxygen (O_2) and carbon dioxide (CO_2) concentrations were recorded on a percent basis. The SO_2 and NO_x concentrations were subsequently corrected for any system bias before using these values in determining the pollutant emission rates. All data obtained during the test program from Trigon's DAS was archived on a strip chart and magnetic disk and is presented in Appendix C.

3.2.8 Oxygen and Carbon Dioxide Instrumental Analyzer Description

The oxygen concentration in the effluent was determined by a California Analytical Instruments, Inc. Model 100P analyzer. Due to the magnetic properties of oxygen, the analyzer utilizes the phenomenon of paramagnetism to measure oxygen in the sample stream and generates a proportional electrical current. The sensor consists of two sealed spheres at each end of a bar forming a dumbbell. The dumbbell is suspended in a symmetrical non-uniform magnetic field. Being slightly diamagnetic the spheres are pushed away from the most intense part of the magnetic field. When the gas surrounding the spheres contains oxygen, the spheres are pushed further out of the field by the relatively stronger paramagnetic oxygen.

The transducer incorporates a strong metal band suspension mechanism mounted to the dumbbell. In the zero position (oxygen free gas) light is reflected from an attached mirror to a photocell. In

the feedback loop, when oxygen is present, a current is sent through the suspension system creating an electromagnetic countertorque. This torque restores the mirror to a position so that the photocell again detects the light. The amount of restoration required is related to the oxygen concentration. The current simultaneously generates an output signal of 0-1 V which corresponds to 0-25% oxygen that can be recorded by the data acquisition system.

The carbon dioxide concentration in the effluent was determined by a California Analytical Instruments, Inc. Model 3300A Infrared Gas Analyzer. The analyzer utilizes a nondispersive infrared (NDIR) microflow detector to measure carbon dioxide in the sample stream and generates a proportional electrical current. A single infrared light beam is modulated by a chopper and passed through a sample cell of predetermined length containing the gas sample to be analyzed. As the beam passes through the cell, the sample gas absorbs some of its energy.

The attenuated beam emerges from the cell and is introduced to the front chamber of a two-chamber infrared detector. The detector is filled with the component of interest and consequently the beam experiences further energy absorption. The absorption process increases the pressure in both of the chambers. The differential pressure between the front and rear chambers of the detector causes a slight gas flow between the two chambers. The flow is detected by a mass-flow sensor and is converted into an AC electrical signal, which is amplified and rectified into a DC voltage signal which is recorded by the data acquisition system in a percent range of 0 to 20. The electrical output signal is directly proportional the concentration of the sample gas.

3.2.9 Sulfur Dioxide Instrumental Analyzer Description

Sulfur dioxide concentrations were determined according to EPA Method 6C. A Bovar Model 721 ATM nondispersive ultraviolet analyzer measures the absorbency of light at a discrete wavelength and then calculates the concentration of sulfur dioxide in the sample cell using the Beer-Lambert Law extended by using a system of linear equations.

The Beer-Lambert Law is made possible by "differential absorption", a technique in which the difference of the absorption between two wavelengths is measured; a wavelength at which a molecule absorbs light and a wavelength at which it does not absorb light. Light from a mercury discharge lamp passes through the sample cell to a set of band-pass filters rotating on a filter wheel and then to a photomultiplier tube. The measurement filter allows light centered in a narrow band at 285 nm to pass through to the detector. The other band-pass filter, the reference filter, allows light only in the region of 578 nm to pass through. Light will be absorbed at 285 nm by the sulfur dioxide in the sample gas, whereas no absorption will occur at 578 nm. The resultant photomultiplier signals are amplified and the logarithm of the reciprocal of the transmittance gives an output that is directly proportional to the sulfur dioxide concentration which is sent to the DAS. During the testing, the analyzer was operated in the 0 - 1000 ppm range.

The DAS employed by Trigon Engineering Consultants, Inc. for this project was a IBM-compatible portable computer with hard disk storage and a Yokogawa HR2400 Hybrid recorder. The recorder is capable of scanning 30 points in one second and printing in 10 different colors. The DAS is capable of providing an instantaneous display of analyzer responses, compiling the data collected, calculating emission rates and documenting all analyzer calibrations. The test data was stored on hard disk.

3.2.10 Oxides of Nitrogen Instrumental Analyzer Description

Oxides of nitrogen concentrations were determined according to EPA Method 7E. This methodology utilizes an analyzer based on the principles of chemiluminescent absorption analytical techniques. The oxides of nitrogen concentrations were determined using a Thermo Environmental Corporation (TECO) Model 10AR analyzer which utilizes 8 linear full scale ranges from 2.5 to 10,000 ppm. The TECO Model 10AR houses a self contained nitrogen dioxide to nitric oxide converter for the dissociation of nitrogen dioxide to nitric oxide.

In the determination of nitric oxides, the sample was routed directly to a reaction chamber filled with ozone. To measure nitric oxide, the gas sample was blended with ozone which quantitatively converts the nitric oxide to nitrogen dioxide through gas phase oxidation. During this reaction, the molecules

are elevated to an electronically excited state and then immediately reverted to a non-excited ground state. The result is the emission of light or photons which was monitored through an optical filter by a high-sensitivity photomultiplier positioned at one end of the chamber. A low level DC current was then amplified to produce an output signal that was linearly proportional to the nitric oxide concentration. The signal was directed to a front panel meter and the DAS.

Nitrogen dioxide does not react with ozone and therefore must first be converted to nitric oxide. For the determination of oxides of nitrogen (nitric oxide + nitrogen dioxide), the sample was first directed through a heated stainless steel converter chamber which dissociates nitrogen dioxide to nitric oxide. From that point on, the sample undergoes the same sequence of events as in the determination of nitric oxide. The instrument was operated in the 0 to 100 ppm range during the sampling project.

3.2.11 Total Gaseous Organic(s) Flame Ionization Analyzer Procedure

Total gaseous organic(s) concentrations and emission rates were determined according to EPA Method 25A. Method 25A applies to the measurement of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon. Results are reported as volume concentration equivalents of the calibration gas or carbon equivalents.

Testing for total gaseous organic(s) was performed using one Ratfisch Instruments, Inc. Model RS55CA total hydrocarbon analyzer systems at the Melter Exhaust. Gaseous pollutants were withdrawn at a constant rate from the emission source and analyzed by a flame ionization analyzer (FIA). The principal components of the sampling system were sequentially:

- A heated stainless steel sample probe and in-situ filter;
- Heated calibration assembly and secondary filter;
- A heated sample line;
- A FIA analyzer;
- Protocol I calibration gases; and

- A data acquisition system that continuously logs 1 minute concentrations.

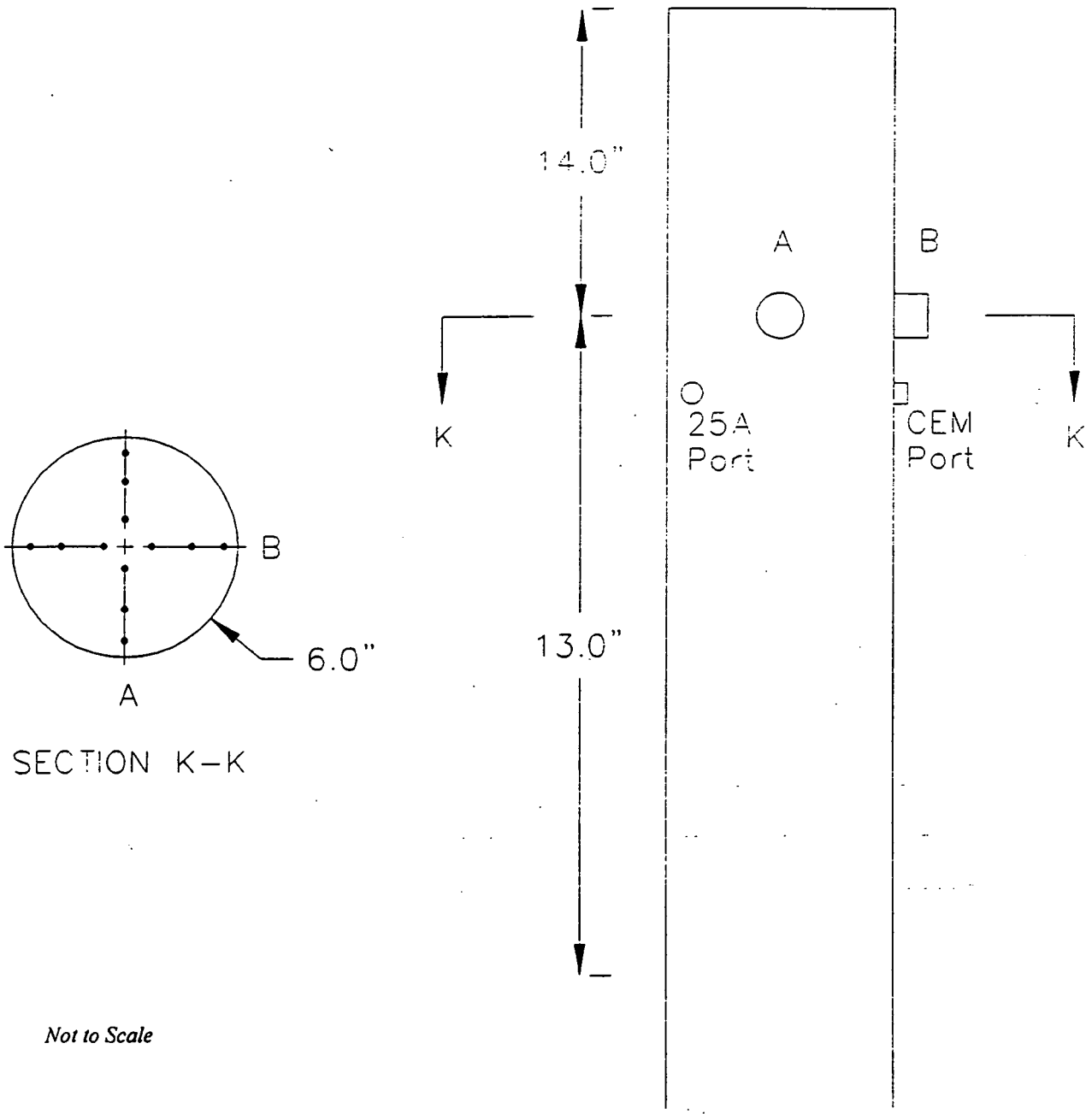
Prior to the test series, the heated sampling system and hydrocarbon analyzers were heated above 250°F to prevent condensation. After temperatures were stabilized the hydrocarbon analyzer was ignited using zero grade hydrogen and hydrocarbon free air for combustion. Calibration procedures commenced with the introduction of zero and high-level calibration gas into the sampling systems. All necessary adjustments were made and the response for low-level and mid-level gases were recorded. The predicted values for the calibration gases and the actual responses were recorded on the field data sheet and by the data acquisition system. High-level and zero gas concentrations were introduced into the measurement systems and the response times were recorded on the field data sheet. Sampling was initiated immediately following instrument calibration.

At the conclusion of the first hour, the zero and mid-level calibration gases were reintroduced and their respective responses recorded on the field data sheet. The zero and calibration drift check was performed immediately following completion of each test run (approximately one hour) and at the conclusion of the test program. Data collected during the test program was archived on a magnetic disc and is presented in Appendix C.

3.2.12 Sampling Ports and Points

The dimensions of the stack and the location of the sampling ports and points are detailed in Figure 2. Method 1 sampling criteria was maintained. The melter-main chamber exhaust cross section was divided into 12 equal areas. The ports were labeled A and B. During the runs each point was sampled for a period of 5 minutes, which yielded a total test time of 60 minutes per run. In addition, dedicated sampling ports were setup for the CEM sampling probe and the total gaseous organics sampling probe at the melter-main chamber exhaust. Sampling from the ESP stack was performed from a single port. A 6 point traverse was conducted, each point was sampled for 10 minutes. Sampling from a single port was conducted because cyclonic flow in excess of 30 degrees was determined to exist in one of the ports.

Melter - Main Chamber Exhaust



Not to Scale

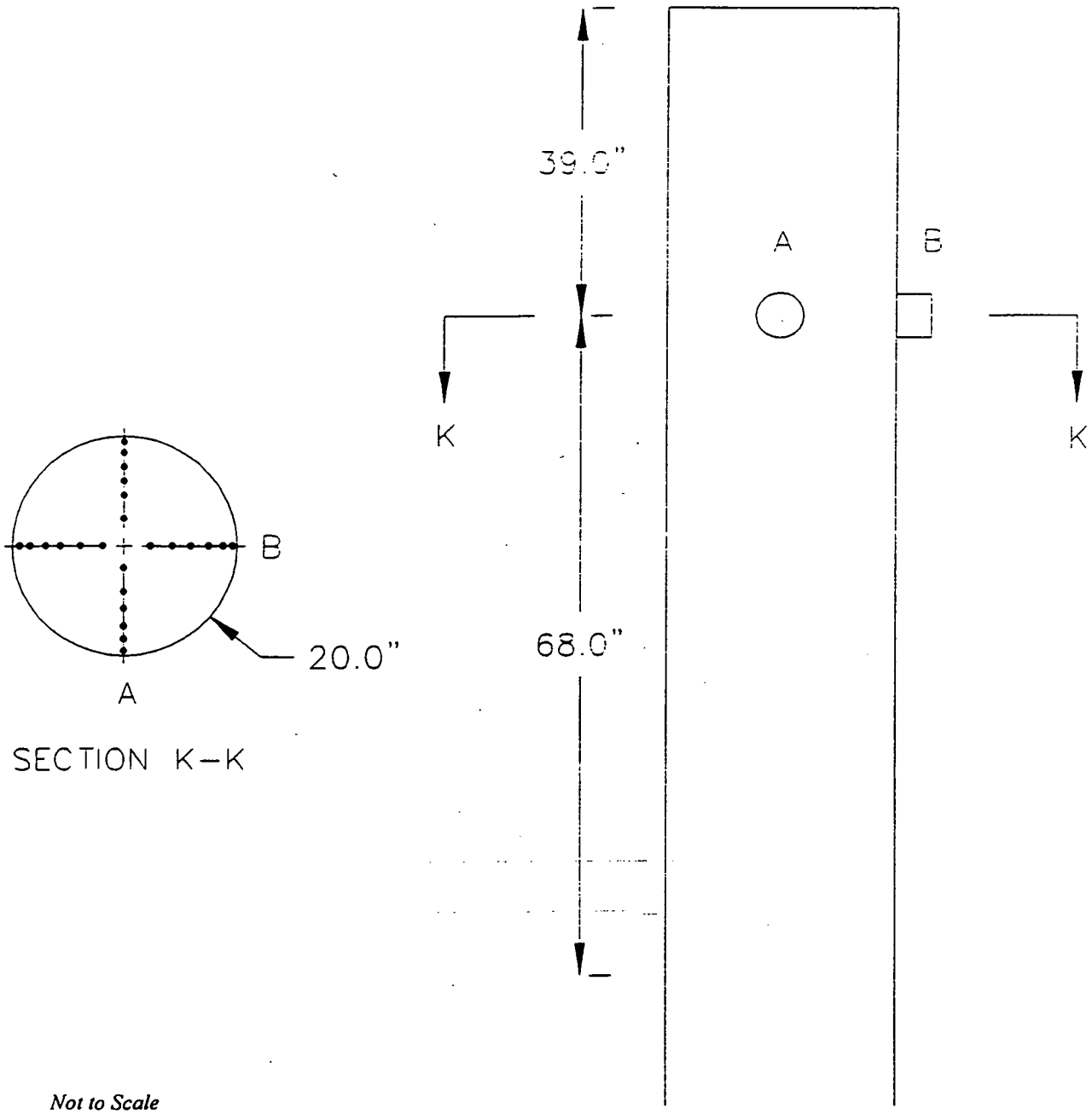
Figure 2

Location of Sampling Ports and Points

648

TRIGON

ESP Stack



Not to Scale

Figure 3

Location of Sampling Ports and Points

3.3 Quality Assurance and Quality Control

Trigon Engineering Consultants, Inc., has established quality assurance and quality control (QA/QC) guidelines for providing the highest quality sampling and analytical data from source tests. These QA/QC procedures were implemented to ensure the acceptability and reliability of the data generated.

In summary, a high degree of data quality was maintained throughout this project. The VOC and CEM analyzers were calibrated with EPA Protocol 1 gas. System bias and calibration drift checks were passed. Leak checks and isokinetic QA criteria were met. Each sampling train was leak checked prior to and immediately after sampling. Leak rates for all of the isokinetic sampling trains were less than the maximum criterion of 0.02 cubic feet per minute. Sampling rates were also within the 100% ±10% criterion established for isokinetic sampling. Quality control procedures for the isokinetic sampling have included the analysis of field blanks, reagent blanks, and where appropriate the matrix spikes. The results of these samples are reported in Appendix E with the laboratory data.

Field data and final laboratory results were entered into Trigon's Air Quality Data System by an environmental scientist, independently audited by the Project Manager, and reviewed by the Quality Assurance Manager for verification of data. After QC review by the QA Manager, the Department Manager verified the final report for completeness and reasonableness of data. The report was returned to the Project Manager for review and preparation of the final draft. The report requires the signature of the Project Manager, QA Manager, and the Department Manager before release to the client. Data and final reports are archived in a secured area for a minimum period of three years.

Trigon's field and laboratory test equipment has been maintained and calibrated in accordance with quality assurance procedures established by the US EPA in the Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III. Equipment calibrations including pre-test and post-test calibration data are presented in Appendix F.

4.0 RESULTS

This section presents the mean particulate matter, multi-metals, sulfuric acid mist, NO_x, SO_2, and VOC sampling results. Tabular results are also provided to present data from individual sampling runs collected during this project. Detailed sampling results and example calculations for the test program can be found in Appendix A. Field data sheets and sample recovery documentation are presented in Appendix B.

4.1 Summary of Results

The tables below is a synopsis of the sampling conducted at the Envitrification Unit.

Particulate Matter - Envitrification Unit - 1/20/99			
Source	Melter Exhaust	ESP Stack	Removal Efficiency
Concentration, gr/dscf	0.0117	0.0014	
Emission Rate, lbs/hr	0.051	0.023	54.9

Method 8 - Envitrification Unit - 1/19/99		
Pollutants	Sulfur Acid Mist including SO_3	Sulfur Dioxide
Concentration, lbs/dscf	2.42E-07	1.86E-06
Emission Rate, lbs/hr	0.0077	0.060

Method 25A - Envitrification Unit - 1/19/99									
Total Gaseous Organic(s)[1]									
	1st hr	2nd hr	3rd hr	4th hr	5th hr	6th hr	7th hr	8th hr	Average
Concentration, ppm	3.2	2.6	2.3	2.6	5.2	4.2	4.8	2.2	3.4
Emission Rate, lbs/hr	0.0048	0.0039	0.0034	0.0039	0.0065	0.0041	0.0072	0.0035	0.0047

[1] as carbon, dry

Multiple metals emission rate results shown below are as a total emission rate. Emission rates of the front-half and back-half fractions can be found in Appendix A.

Multi-Metals Envitrification Unit - 1/20/99		
Metals Emission Rate	Melter Exhaust lbs/hr	ESP Stack lbs/hr
Aluminum (Al)	4.54E-04	7.95E-04
Arsenic (As)	<4.45E-05	<9.74E-06
Barium (Ba)	<5.24E-04	<2.48E-05
Calcium (Ca)	3.79E-04	7.26E-04
Cadmium (Cd)	<7.62E-07	<2.47E-06
Chromium (Cr)	9.69E-05	1.68E-05
Iron (Fe)	<3.47E-04	2.65E-04
Potassium (K)	3.49E-04	3.70E-04
Lithium (Li)	<5.00E-04	<7.44E-06
Magnesium (Mg)	<8.82E-05	<1.21E-04
Molybdenum (Mo)	<2.37E-04	<4.27E-05
Sodium (Na)	2.42E-03	3.61E-03
Nickel (Ni)	4.07E-05	2.95E-05
Phosphorus (P)	3.13E-03	1.34E-04
Lead (Pb)	1.41E-02	1.66E-04
Sulfur (S)	3.48E-02	<4.14E-02
Selenium (Se)	7.75E-03	4.25E-03
Silicon (Si)	2.29E-04	1.07E-03
Vanadium (V)	<2.90E-06	<6.19E-06
Zinc (Zn)	2.13E-04	6.00E-05

TRIGON

The CEM data (EPA Methods 3A, 6C and 7E) was separated into nine different time periods during the 48-hour test. Periods were bracketed by CEM calibrations, times of each period varied. The CEM analyzers passed all system bias and drift checks during each calibration. The following CEM data is presented as a concentration only, SO_2 and NO_x are presented as parts per million (ppm), while O_2 and CO_2 are presented as a percent (%).

CEM Data - Envitrification Unit - 1/19-21/99						
Pollutant			O_2	CO_2	SO_2	NO_x
	Date	Time	%	%	PPM	PPM
Period 1	1/19/99	0831-1000	18.45	1.70	3.8	34.63
Period 2	1/19/99	1101-1550	18.44	1.80	6.6	38.11
Period 3	1/19/99	1646-1900	18.42	1.83	7.95	38.54
Period 4	1/19-20/99	2145-0800	19.91	0.69	6.59	13.47
Period 5	1/20/99	0826-1300	20.01	0.67	5.59	12.29
Period 6	1/20/99	1321-1600	20.06	0.69	7.46	12.72
Period 7	1/20-21/99	1631-0049	19.94	0.74	7.88	13.44
Period 8	1/21/99	0050-0900	19.91	0.71	8.76	13.34
Period 9	1/21/99	0921-1445	19.96	0.73	15.16	13.60
		Average	19.46	1.06	7.75	21.13

4.2 Detailed Stack Sampling Results

Tables 1 - 4 presents the data from individual sampling runs at the envitrification unit. Included in these tables are gas velocity, volumetric flow rates, exhaust gas temperatures, and the concentrations and emission rates for particulate matter, sulfuric acid mist and sulfur dioxide.

TRIGON

TABLE 1

Summary of Results - Particulate Matter Sampling

Melter Exhaust

Run Number	1	2	3	Avg.
Date	1/20/99	1/20/99	1/20/99	
Sample Identification	8158-08	8158-09	8158-10	
Run Duration, Minutes	60	60	60	
Sample Time, 24-hour clock	1000-1102	1150-1252	1402-1505	
Percent Isokinetic	96.9	97.4	98.4	97.6
Volume of Gas Sampled, dry standard cubic feet*(dscf)	52.25	47.72	50.23	50.07
Average Stack Temperature, °F	661.3	642.5	650.3	651.4
Stack Gas Velocity, feet/second	107.2	98.2	103.7	103.0
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	530	489	510	510
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	1261	1154	1220	1212
Particulate Matter:				
Catch, mg	40.5	33.5	40.5	38..2
Concentration, grains/dscf*	0.0119	0.0108	0.0124	0.0117
Emission Rate, lbs/hr	0.054	0.045	0.054	0.051

* 68°F, 29.92 Inches Hg

654

TRIGON

TABLE 2

Summary of Results - Particulate Matter Sampling

ESP Stack

Run Number	1	2	3	Avg.
Date	1/20/99	1/20/99	1/20/99	
Sample Identification	8158-11	8158-12	8158-13	
Run Duration, Minutes	60	60	60	
Sample Time, 24-hour clock	1000-1110	1150-1250	1402-1502	
Percent Isokinetic	99.2	98.9	100.8	99.6
Volume of Gas Sampled, dry standard cubic feet*(dscf)	40.85	41.93	40.65	41.14
Average Stack Temperature, °F	194.4	197.2	202.9	198.2
Stack Gas Velocity, feet/second	19.2	19.9	19.3	19.5
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	1922	1979	1884	1928
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	2510	2608	2524	2547
Particulate Matter:				
Catch, mg	6.6	3.0	1.6	3.7
Concentration, grains/dscf*	0.0025	0.0011	0.0006	0.0014
Emission Rate, lbs/hr	0.041	0.019	0.010	0.023

* 68°F, 29.92 Inches Hg

655

TRIGON

TABLE 3

Summary of Results - Sulfuric Acid Mist & Sulfur Dioxide Sampling

Melter Exhaust

Run Number	1	2	3	4
Date	1/19/99	1/19/99	1/19/99	1/19/99
Sample Identification	8158-01	8158-02	8158-03	8158-04
Run Duration, Minutes	60	70	60	60
Sample Time, 24-hour clock	1254-1358	1442-1555	1620-1727	1750-1853
Percent Isokinetic	100.9	99.2	94.5	95.5
Volume of Gas Sampled, dry standard cubic feet*(dscf)	32.20	30.21	49.70	55.14
Average Stack Temperature, °F	629.3	607.6	608.0	623.1
Stack Gas Velocity, feet/second	102.6	100.0	102.0	110.1
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	530	523	543	572
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	1207	1175	1200	1295
Sulfur Acid Mist:				
Concentration, lbs/dscf*	3.24E-07	2.47E-07	1.73E-07	2.24E-07
Emission Rate, lbs/hr	0.0103	0.0077	0.0056	0.0077
Sulfur Dioxide:				
Concentration, lbs/dscf*	9.31E-07	1.36E-06	1.03E-06	1.90E-06
Emission Rate, lbs/hr	0.030	0.043	0.033	0.065

* 68°F, 29.92 Inches Hg

656

TRIGON

TABLE 4

Summary of Results - Sulfuric Acid Mist & Sulfur Dioxide Sampling con't.

Melter Exhaust

Run Number	5	6	Avg.
Date	1/19/99	1/19/99	
Sample Identification	8158-05	8158-06	
Run Duration, Minutes	60	60	
Sample Time, 24-hour clock	1912-2014	2028-2130	
Percent Isokinetic	97.5	97.9	97.6
Volume of Gas Sampled, dry standard cubic feet*(dscf)	50.02	51.66	44.82
Average Stack Temperature, °F	628.4	644.8	623.5
Stack Gas Velocity, feet/second	103.8	103.2	103.6
Stack Gas Flow Rate, dry standard cubic feet/minute*(dscfm)	529	519	536
Stack Gas Flow Rate, actual cubic feet/minute(acfm)	1221	1213	1219
Sulfur Acid Mist:			
Concentration, grains/dscf*	2.40E-07	2.41E-07	2.42E-07
Emission Rate, lbs/hr	0.0076	0.0075	0.0077
Sulfur Dioxide:			
Concentration, lbs/dscf*	2.62E-06	3.34E-06	1.86E-06
Emission Rate, lbs/hr	0.083	0.104	0.060

* 68°F, 29.92 Inches Hg

TRIGON

5.0 APPENDICES

This section contains detailed supportive documentation that encompasses all aspects of the emission test program. Its contents serve as the foundation for the test report. The emission test report presents a summary of the information gathered during the sampling activities. The information contained in the appendices is necessary to facilitate the review of the emission test report and determine whether proper procedures were used to accomplish the test plan objectives.

Defensible data and the subsequent pollutant concentrations and emission rates is one of the primary objectives of any emission test program. To this end, all results, example calculations, field data sheets, sample recovery, laboratory results, chain of custody documentation, and equipment calibrations have been provided to support these objectives.

SUMMARY OF RESULTS AND EXAMPLE CALCULATIONS

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Run Number		1	2	3	Avg
Date:		01/20/99	01/20/99	01/20/99	---
θ	Net Time of Test, minutes	60	60	60	---
P_{bar}	Barometric Pressure, in. Hg	29.29	29.26	29.21	29.25
P_g	Static Pressure, in. Hg	-0.001	-0.001	-0.001	-0.001
P_S	Stack Pressure, Absolute, in. Hg	29.289	29.259	29.209	29.253
V_M	Actual Meter Volume Sampled, cu. ft.	41.44	43.64	43.36	42.81
ΔH	Avg. Delta H, in. H_20	1.67	1.78	1.72	1.72
T_M	Avg. Gas Meter Temp., Deg. F	66.6	79.8	92.2	79.5
V_{STD}	Volume Sampled at Stand. Cond., cu. ft.	40.85	41.93	40.65	41.14
V_C	Volume of Water Collected, ml	27.0	31.6	36.2	31.6
V_{WC}	Volume of Water Vapor at Std. Cond.,SCF	1.27	1.49	1.70	1.49
B_{WS}	Moisture Content of Gas Stream	0.030	0.034	0.040	0.035
P_{MV}	Percent Moisture in Stack	3.0	3.4	4.0	3.5
M_{FD}	Mole Fraction of Dry Gas	0.970	0.966	0.960	0.965
$\%O_2$	Percent Oxygen, Dry	20.24	20.28	20.28	20.27
$\%CO_2$	Percent Carbon Dioxide, Dry	0.59	0.62	0.58	0.60
%CO	Percent Carbon Monoxide, Dry	0.00	0.00	0.00	0.00
M_d	Mole. Wt. Stack Gas, Dry Basis, lb/lb mole	28.904	28.910	28.904	28.906
M_S	Mole. Wt. Stack Gas, Wet Basis, lb/lb mole	28.575	28.536	28.465	28.525
Cp	Pitot Tube Constant	0.84	0.86	0.84	0.85
ΔPS	Avg. Sqrt. Delta P, in. H20	0.302	0.305	0.301	0.303
T_S	Avg. Stack Temp., Deg. F	194.4	197.2	202.9	198.2
V_S	Avg. Stack Velocity, ft/sec	19.2	19.9	19.3	19.5
A	Area Stack, ft^2	2.18	2.18	2.18	2.18

660

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Q_{SD}	Gas Volume Flow, Dry Std. Cond. CFM	1922	1979	1884	1928
Q_A	Actual Gas Volume Flow, CFM	2510	2608	2524	2547
Q_{SW}	Gas Volume Flow, Wet Std. Cond., CFM	1982	2049	1963	1998
D_n	Sample Nozzle Diameter, inches	0.378	0.378	0.378	0.378
A_n	Area of Nozzle, ft^2	0.00078	0.00078	0.00078	0.00078
I	Percent Isokinetic	99.2	98.9	100.8	99.6

Particulate Matter Concentration and Emission Rates

m_n	Particulate Matter Catch, mg	6.6	3.0	1.6	3.7
C_s	Particulate Matter Concentration, gr/dscf	0.0025	0.0011	0.0006	0.0014
C_{AW}	Particulate Matter Emission Rate, lbs/hr	0.041	0.019	0.010	0.023

661

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Aluminum Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Aluminum Catch, mg	0.10400	0.10400	0.10500	0.10433
C_s	Aluminum Concentration, gr/dscf	3.92E-05	3.82E-05	3.98E-05	3.91E-05
C_{AW}	Aluminum Emission Rate, lbs/hr	6.46E-04	6.48E-04	6.42E-04	6.45E-04
	Back-Half Catch Results				
m_n	Aluminum Catch, mg	0.02260	0.03280	0.01700	0.02413
C_s	Aluminum Concentration, gr/dscf	8.52E-06	1.20E-05	6.44E-06	9.00E-06
C_{AW}	Aluminum Emission Rate, lbs/hr	1.40E-04	2.04E-04	1.04E-04	1.50E-04
C_{AW}	**Total Aluminum Emission Rate, lbs/hr**	**7.86E-04**	**8.52E-04**	**7.46E-04**	**7.95E-04**

Arsenic Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Arsenic Catch, mg	0.00062	0.00055	0.00078	0.00065
C_s	Arsenic Concentration, gr/dscf	2.35E-07	2.03E-07	2.95E-07	2.44E-07
C_{AW}	Arsenic Emission Rate, lbs/hr	3.86E-06	3.44E-06	4.76E-06	4.02E-06
	Back-Half Catch Results				
m_n	Arsenic Catch, mg	0.00177	<0.00050	<0.00050	0.00092
C_s	Arsenic Concentration, gr/dscf	6.67E-07	<1.84E-07	<1.89E-07	<3.47E-07
C_{AW}	Arsenic Emission Rate, lbs/hr	1.10E-05	<3.11E-06	<3.06E-06	<5.72E-06
C_{AW}	**Total Arsenic Emission Rate, lbs/hr**	**1.49E-05**	**<6.56E-06**	**<7.82E-06**	**<9.74E-06**

Barium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Barium Catch, mg	0.00221	0.00241	0.00594	0.00352
C_s	Barium Concentration, gr/dscf	8.33E-07	8.85E-07	2.25E-06	1.32E-06
C_{AW}	Barium Emission Rate, lbs/hr	1.37E-05	1.50E-05	3.63E-05	2.17E-05
	Back-Half Catch Results				
m_n	Barium Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Barium Concentration, gr/dscf	<1.89E-07	<1.84E-07	<1.89E-07	<1.87E-07
C_{AW}	Barium Emission Rate, lbs/hr	<3.11E-06	<3.11E-06	<3.06E-06	<3.09E-06
C_{AW}	**Total Barium Emission Rate, lbs/hr**	**<1.68E-05**	**<1.81E-05**	**<3.94E-05**	**<2.48E-05**

662

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Calcium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Calcium Catch, mg	0.06280	0.08280	0.09280	0.07947
C_s	Calcium Concentration, gr/dscf	2.37E-05	3.04E-05	3.52E-05	2.97E-05
C_{AW}	Calcium Emission Rate, lbs/hr	3.90E-04	5.16E-04	5.68E-04	4.91E-04
	Back-Half Catch Results				
m_n	Calcium Catch, mg	0.03670	0.03830	0.03890	0.03797
C_s	Calcium Concentration, gr/dscf	1.38E-05	1.41E-05	1.47E-05	1.42E-05
C_{AW}	Calcium Emission Rate, lbs/hr	2.28E-04	2.39E-04	2.38E-04	2.35E-04
C_{AW}	**Total Calcium Emission Rate, lbs/hr**	**6.18E-04**	**7.54E-04**	**8.05E-04**	**7.26E-04**

Cadmium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Cadmium Catch, mg	<0.00020	<0.00020	<0.00020	<0.00020
C_s	Cadmium Concentration, gr/dscf	<7.54E-08	<7.35E-08	<7.58E-08	<7.49E-08
C_{AW}	Cadmium Emission Rate, lbs/hr	<1.24E-06	<1.25E-06	<1.22E-06	<1.24E-06
	Back-Half Catch Results				
m_n	Cadmium Catch, mg	<0.00020	<0.00020	<0.00020	<0.00020
C_s	Cadmium Concentration, gr/dscf	<7.54E-08	<7.35E-08	<7.58E-08	<7.49E-08
C_{AW}	Cadmium Emission Rate, lbs/hr	<1.24E-06	<1.25E-06	<1.22E-06	<1.24E-06
C_{AW}	**Total Cadmium Emission Rate, lbs/hr**	**<2.48E-06**	**<2.49E-06**	**<2.45E-06**	**<2.47E-06**

Chromium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Chromium Catch, mg	0.00108	0.00100	0.00150	0.00119
C_s	Chromium Concentration, gr/dscf	4.07E-07	3.67E-07	5.68E-07	4.48E-07
C_{AW}	Chromium Emission Rate, lbs/hr	6.71E-06	6.23E-06	9.17E-06	7.37E-06
	Back-Half Catch Results				
m_n	Chromium Catch, mg	0.00150	0.00149	0.00159	0.00153
C_s	Chromium Concentration, gr/dscf	5.66E-07	5.47E-07	6.02E-07	5.72E-07
C_{AW}	Chromium Emission Rate, lbs/hr	9.32E-06	9.28E-06	9.72E-06	9.44E-06
C_{AW}	**Total Chromium Emission Rate, lbs/hr**	**1.60E-05**	**1.55E-05**	**1.89E-05**	**1.68E-05**

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Iron Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Iron Catch, mg	0.02310	0.02160	0.03110	0.02527
C_s	Iron Concentration, gr/dscf	8.71E-06	7.93E-06	1.18E-05	9.47E-06
C_{AW}	Iron Emission Rate, lbs/hr	1.43E-04	1.35E-04	1.90E-04	1.56E-04
	Back-Half Catch Results				
m_n	Iron Catch, mg	0.01300	0.01500	0.02510	0.01770
C_s	Iron Concentration, gr/dscf	4.90E-06	5.51E-06	9.51E-06	6.64E-06
C_{AW}	Iron Emission Rate, lbs/hr	8.08E-05	9.34E-05	1.53E-04	1.09E-04
C_{AW}	**Total Iron Emission Rate, lbs/hr**	**2.24E-04**	**2.28E-04**	**3.44E-04**	**2.65E-04**

Potassium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Potassium Catch, mg	0.03600	0.03600	0.03800	0.03667
C_s	Potassium Concentration, gr/dscf	1.36E-05	1.32E-05	1.44E-05	1.37E-05
C_{AW}	Potassium Emission Rate, lbs/hr	2.24E-04	2.24E-04	2.32E-04	2.27E-04
	Back-Half Catch Results				
m_n	Potassium Catch, mg	0.02350	0.02200	0.02400	0.02317
C_s	Potassium Concentration, gr/dscf	8.86E-06	8.08E-06	9.09E-06	8.68E-06
C_{AW}	Potassium Emission Rate, lbs/hr	1.46E-04	1.37E-04	1.47E-04	1.43E-04
C_{AW}	**Total Potassium Emission Rate, lbs/hr**	**3.70E-04**	**3.61E-04**	**3.79E-04**	**3.70E-04**

Lithium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Lithium Catch, mg	0.00055	0.00081	0.00076	0.00071
C_s	Lithium Concentration, gr/dscf	2.07E-07	2.97E-07	2.86E-07	2.64E-07
C_{AW}	Lithium Emission Rate, lbs/hr	3.42E-06	5.04E-06	4.62E-06	4.36E-06
	Back-Half Catch Results				
m_n	Lithium Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Lithium Concentration, gr/dscf	<1.89E-07	<1.84E-07	<1.89E-07	<1.87E-07
C_{AW}	Lithium Emission Rate, lbs/hr	<3.11E-06	<3.03E-06	<3.12E-06	<3.08E-06
C_{AW}	**Total Lithium Emission Rate, lbs/hr**	**<6.52E-06**	**<8.06E-06**	**<7.74E-06**	**<7.44E-06**

664

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

P-2291

Magnesium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Magnesium Catch, mg	0.01210	0.01100	0.01820	0.01377
C_s	Magnesium Concentration, gr/dscf	4.56E-06	4.04E-06	6.89E-06	5.17E-06
C_{AW}	Magnesium Emission Rate, lbs/hr	7.52E-05	6.85E-05	1.11E-04	8.50E-05
	Back-Half Catch Results				
m_n	Magnesium Catch, mg	<0.00555	0.00659	<0.00555	<0.00590
C_s	Magnesium Concentration, gr/dscf	<2.09E-06	2.42E-06	<2.10E-06	<2.21E-06
C_{AW}	Magnesium Emission Rate, lbs/hr	<3.45E-05	4.11E-05	<3.39E-05	<3.65E-05
C_{AW}	**Total Magnesium Emission Rate, lbs/hr**	**<1.10E-04**	**1.10E-04**	**<1.45E-04**	**<1.21E-04**

Molybdenum Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Molybdenum Catch, mg	0.00619	0.00659	0.00641	0.00640
C_s	Molybdenum Concentration, gr/dscf	2.33E-06	2.42E-06	2.43E-06	2.39E-06
C_{AW}	Molybdenum Emission Rate, lbs/hr	3.84E-05	4.11E-05	3.92E-05	3.96E-05
	Back-Half Catch Results				
m_n	Molybdenum Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Molybdenum Concentration, gr/dscf	<1.89E-07	<1.84E-07	<1.89E-07	<1.87E-07
C_{AW}	Molybdenum Emission Rate, lbs/hr	<3.11E-06	<3.11E-06	<3.06E-06	<3.09E-06
C_{AW}	**Total Molybdenum Emission Rate, lbs/h**	**<4.16E-05**	**<4.42E-05**	**<4.23E-05**	**<4.27E-05**

Sodium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Sodium Catch, mg	0.26200	0.32200	0.27700	0.28700
C_s	Sodium Concentration, gr/dscf	9.88E-05	1.18E-04	1.05E-04	1.07E-04
C_{AW}	Sodium Emission Rate, lbs/hr	1.63E-03	2.01E-03	1.69E-03	1.78E-03
	Back-Half Catch Results				
m_n	Sodium Catch, mg	0.28700	0.33700	0.26700	0.29700
C_s	Sodium Concentration, gr/dscf	1.08E-04	1.24E-04	1.01E-04	1.11E-04
C_{AW}	Sodium Emission Rate, lbs/hr	1.78E-03	2.10E-03	1.63E-03	1.84E-03
C_{AW}	**Total Sodium Emission Rate, lbs/hr**	**3.41E-03**	**4.11E-03**	**3.33E-03**	**3.61E-03**

165

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Nickel Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Nickel Catch, mg	0.00111	0.00934	0.00097	0.00381
C_s	Nickel Concentration, gr/dscf	4.19E-07	3.43E-06	3.66E-07	1.41E-06
C_{AW}	Nickel Emission Rate, lbs/hr	6.89E-06	5.82E-05	5.91E-06	2.37E-05
	Back-Half Catch Results				
m_n	Nickel Catch, mg	0.00113	0.00071	0.00097	0.00094
C_s	Nickel Concentration, gr/dscf	4.26E-07	2.62E-07	3.69E-07	3.52E-07
C_{AW}	Nickel Emission Rate, lbs/hr	7.02E-06	4.44E-06	5.95E-06	5.80E-06
C_{AW}	**Total Nickel Emission Rate, lbs/hr**	**1.39E-05**	**6.26E-05**	**1.19E-05**	**2.95E-05**

Phosphorus Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Phosphorus Catch, mg	0.01350	0.01720	0.00932	0.01334
C_s	Phosphorus Concentration, gr/dscf	5.09E-06	6.32E-06	3.53E-06	4.98E-06
C_{AW}	Phosphorus Emission Rate, lbs/hr	8.39E-05	1.07E-04	5.70E-05	8.27E-05
	Back-Half Catch Results				
m_n	Phosphorus Catch, mg	0.00882	0.01140	0.00476	0.00833
C_s	Phosphorus Concentration, gr/dscf	3.33E-06	4.19E-06	1.80E-06	3.11E-06
C_{AW}	Phosphorus Emission Rate, lbs/hr	5.48E-05	7.10E-05	2.91E-05	5.16E-05
C_{AW}	**Total Phosphorus Emission Rate, lbs/hr**	**1.39E-04**	**1.78E-04**	**8.61E-05**	**1.34E-04**

Lead Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Lead Catch, mg	0.02590	0.02120	0.03010	0.02573
C_s	Lead Concentration, gr/dscf	9.77E-06	7.79E-06	1.14E-05	9.65E-06
C_{AW}	Lead Emission Rate, lbs/hr	1.61E-04	1.32E-04	1.84E-04	1.59E-04
	Back-Half Catch Results				
m_n	Lead Catch, mg	0.00088	0.00096	0.00138	0.00107
C_s	Lead Concentration, gr/dscf	3.33E-07	3.51E-07	5.23E-07	4.02E-07
C_{AW}	Lead Emission Rate, lbs/hr	5.48E-06	5.96E-06	8.44E-06	6.63E-06
C_{AW}	**Total Lead Emission Rate, lbs/hr**	**1.66E-04**	**1.38E-04**	**1.93E-04**	**1.66E-04**

6/6

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Sulfur Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Sulfur Catch, mg	<0.34400	<0.34400	0.34400	<0.34400
C_s	Sulfur Concentration, gr/dscf	<1.30E-04	<1.26E-04	1.30E-04	<1.29E-04
C_{AW}	Sulfur Emission Rate, lbs/hr	<2.14E-03	<2.14E-03	2.10E-03	<2.13E-03
	Back-Half Catch Results				
m_n	Sulfur Catch, mg	4.5300	5.7400	8.8300	6.3667
C_s	Sulfur Concentration, gr/dscf	1.71E-03	2.11E-03	3.35E-03	2.39E-03
C_{AW}	Sulfur Emission Rate, lbs/hr	2.81E-02	3.58E-02	5.40E-02	3.93E-02
C_{AW}	**Total Sulfur Emission Rate, lbs/hr**	**<3.03E-02**	**<3.79E-02**	**5.61E-02**	**<4.14E-02**

Selenium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Selenium Catch, mg	0.11800	0.10100	0.12800	0.11567
C_s	Selenium Concentration, gr/dscf	4.45E-05	3.71E-05	4.85E-05	4.34E-05
C_{AW}	Selenium Emission Rate, lbs/hr	7.33E-04	6.29E-04	7.83E-04	7.15E-04
	Back-Half Catch Results				
m_n	Selenium Catch, mg	0.41100	0.62200	0.68200	0.57167
C_s	Selenium Concentration, gr/dscf	1.55E-04	2.28E-04	2.58E-04	2.14E-04
C_{AW}	Selenium Emission Rate, lbs/hr	2.55E-03	3.87E-03	4.17E-03	3.53E-03
C_{AW}	**Total Selenium Emission Rate, lbs/hr**	**3.29E-03**	**4.50E-03**	**4.95E-03**	**4.25E-03**

Silicon Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Silicon Catch, mg	0.00000	0.00000	0.00000	0.00000
C_s	Silicon Concentration, gr/dscf	0.0000	0.0000	0.0000	0.0000
C_{AW}	Silicon Emission Rate, lbs/hr	0.000	0.000	0.000	0.000
	Back-Half Catch Results				
m_n	Silicon Catch, mg	0.18000	0.21000	0.13000	0.17333
C_s	Silicon Concentration, gr/dscf	6.79E-05	7.71E-05	4.92E-05	6.47E-05
C_{AW}	Silicon Emission Rate, lbs/hr	1.12E-03	1.31E-03	7.95E-04	1.07E-03
C_{AW}	**Total Silicon Emission Rate, lbs/hr**	**1.12E-03**	**1.31E-03**	**7.95E-04**	**1.07E-03**

667

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Vanadium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Vanadium Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Vanadium Concentration, gr/dscf	<1.89E-07	<1.84E-07	<1.89E-07	<1.87E-07
C_{AW}	Vanadium Emission Rate, lbs/hr	<3.11E-06	<3.11E-06	<3.06E-06	<3.09E-06
	Back-Half Catch Results				
m_n	Vanadium Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Vanadium Concentration, gr/dscf	<1.89E-07	<1.84E-07	<1.89E-07	<1.87E-07
C_{AW}	Vanadium Emission Rate, lbs/hr	<3.11E-06	<3.11E-06	<3.06E-06	<3.09E-06
C_{AW}	**Total Vanadium Emission Rate, lbs/hr**	**<6.21E-06**	**<6.23E-06**	**<6.12E-06**	**<6.19E-06**

Zinc Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Zinc Catch, mg	0.00373	0.00393	0.00653	0.00473
C_s	Zinc Concentration, gr/dscf	1.41E-06	1.44E-06	2.47E-06	1.77E-06
C_{AW}	Zinc Emission Rate, lbs/hr	2.32E-05	2.45E-05	3.99E-05	2.92E-05
	Back-Half Catch Results				
m_n	Zinc Catch, mg	0.00979	0.00106	0.00408	0.00498
C_s	Zinc Concentration, gr/dscf	3.69E-06	3.89E-07	1.55E-06	1.88E-06
C_{AW}	Zinc Emission Rate, lbs/hr	6.08E-05	6.60E-06	2.50E-05	3.08E-05
C_{AW}	**Total Zinc Emission Rate, lbs/hr**	**8.40E-05**	**3.11E-05**	**6.49E-05**	**6.00E-05**

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Example Calculations Run 1

Stack Pressure, Absolute, in. Hg

$P_S = P_{bar} + P_g =$ 29.289

Volume Sampled at Stand. Cond., cu. ft.

$$V_{STD} = \frac{17.647 * V_M * (P_{bar} + \Delta H / 13.6)}{T_M + 460} =$$ 40.8

Volume of Water Vapor at Std. Cond.,SCF

$V_{WC} = 0.04709 * V_C =$ 1.27

Moisture Content of Gas Stream

$$B_{WS} = \frac{V_{WC}}{V_{STD} + V_{WC}} =$$ 0.030

Percent Moisture in Stack

$$P_{MV} = \frac{100 * V_{WC}}{V_{STD} + V_{WC}} =$$ 3.0

Mole Fraction of Dry Gas

$$M_{FD} = \frac{100 - P_{MV}}{100} =$$ 0.970

Mole. Wt. Stack Gas, Dry Basis, lb/lb mole

$M_d = 0.44 * \%CO_2 + 0.32 * \%O_2 + 0.28 * (100 - \%CO_2 - \%O_2) =$ 28.904

Mole. Wt. Stack Gas, Wet Basis, lb/lb mole

$M_S = M_d * (1 - B_{ws}) + 18.0 * B_{ws} =$ 28.575

Avg. Stack Velocity, ft/sec

$V_S = 85.49 * C_P * \Delta PS *$ SQRT ---------- = 19.2

Gas Volume Flow, Dry Std. Cond. CFM

$$Q_{SD} = \frac{1058.82 * V_S * A * P_S * (1 - B_{ws})}{T_S + 460} =$$ 1922

Actual Gas Volume Flow, CFM

$Q_A = V_S * A * 60 =$ 2510

Gas Volume Flow, Wet Std. Cond., CFM

$Q_{SW} = Q_{SD} * [1/(1-B_{WS})] =$ 1982

669

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
ESP Stack

2291

Area of Nozzle, ft^2

$A_n = ((D_n / 2)^{\wedge 2} * 3.14159)/144 =$ 0.00078

Percent Isokinetic

$$I = \frac{0.0945 * (T_S + 460) * V_{STD}}{\theta * V_S * P_S * (1 - B_{ws}) * A_n} =$$ 99.2

Particulate Matter Concentration, gr/dscf
(At Standard Conditions)

$C_S = 0.0154 * m_n / V_{STD} =$ 0.0025

$(T_S + 460)$

Particulate Matter Emission Rate, lbs/hr
(At Standard Conditi $(P_S * M_s)$

$C_{AW} = 0.00857 * C_s * Q_{SD} =$ 0.041

Standard Conditions 68 Deg. F, 29.92 in. Hg

670

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Run Number		1	2	3	Avg
Date:		01/20/99	01/20/99	01/20/99	---
θ	Net Time of Test, minutes	60	60	60	---
P_{bar}	Barometric Pressure, in. Hg	29.29	29.26	29.21	29.25
P_g	Static Pressure, in. Hg	-0.276	-0.294	-0.331	-0.300
P_S	Stack Pressure, Absolute, in. Hg	29.014	28.966	28.879	28.953
V_M	Actual Meter Volume Sampled, cu. ft.	55.86	51.48	54.82	54.05
ΔH	Avg. Delta H, in. H_20	3.00	2.47	2.80	2.76
T_M	Avg. Gas Meter Temp., Deg. F	96.8	100.5	106.5	101.3
V_{STD}	Volume Sampled at Stand. Cond., cu. ft.	52.25	47.72	50.23	50.07
V_C	Volume of Water Collected, ml	96.7	95.4	105	99.0
V_{WC}	Volume of Water Vapor at Std. Cond.,SCF	4.55	4.49	4.94	4.66
B_{WS}	Moisture Content of Gas Stream	0.080	0.086	0.090	0.085
P_{MV}	Percent Moisture in Stack	8.0	8.6	9.0	8.5
M_{FD}	Mole Fraction of Dry Gas	0.920	0.914	0.910	0.915
$\%O_2$	Percent Oxygen, Dry	20.24	20.28	20.28	20.27
$\%CO_2$	Percent Carbon Dioxide, Dry	0.59	0.62	0.58	0.60
%CO	Percent Carbon Monoxide, Dry	0.00	0.00	0.00	0.00
M_d	Mole. Wt. Stack Gas, Dry Basis, lb/lb mole	28.904	28.910	28.904	28.906
M_S	Mole. Wt. Stack Gas, Wet Basis, lb/lb mole	28.030	27.972	27.927	27.976
Cp	Pitot Tube Constant	0.84	0.84	0.84	0.84
ΔPS	Avg. Sqrt. Delta P, in. H20	1.272	1.172	1.231	1.225
T_S	Avg. Stack Temp., Deg. F	661.3	642.5	650.3	651.4
V_S	Avg. Stack Velocity, ft/sec	107.2	98.2	103.7	103.0
A	Area Stack, ft^2	0.20	0.20	0.20	0.20

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

Q_{SD}	Gas Volume Flow, Dry Std. Cond. CFM	530	489	510	510
Q_A	Actual Gas Volume Flow, CFM	1261	1154	1220	1212
Q_{SW}	Gas Volume Flow, Wet Std. Cond., CFM	576	535	560	557
D_n	Sample Nozzle Diameter, inches	0.247	0.245	0.245	0.245667
A_n	Area of Nozzle, ft^2	0.00033	0.00033	0.00033	0.00033
I	Percent Isokinetic	96.9	97.4	98.4	97.6
Particulate Matter Concentration and Emission Rates					
m_n	Particulate Matter Catch, mg	40.5	33.5	40.5	38.2
C_s	Particulate Matter Concentration, gr/dscf	0.0119	0.0108	0.0124	0.0117
C_{AW}	Particulate Matter Emission Rate, lbs/hr	0.054	0.045	0.054	0.051

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Aluminum Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Aluminum Catch, mg	0.37200	0.33000	0.24700	0.31633
C_s	Aluminum Concentration, gr/dscf	1.10E-04	1.06E-04	7.57E-05	9.73E-05
C_{AW}	Aluminum Emission Rate, lbs/hr	4.98E-04	4.46E-04	3.31E-04	4.25E-04
	Back-Half Catch Results				
m_n	Aluminum Catch, mg	0.02780	0.02530	0.01120	0.02143
C_s	Aluminum Concentration, gr/dscf	8.19E-06	8.16E-06	3.43E-06	6.60E-06
C_{AW}	Aluminum Emission Rate, lbs/hr	3.72E-05	3.42E-05	1.50E-05	2.88E-05
C_{AW}	**Total Aluminum Emission Rate, lbs/hr**	**5.35E-04**	**4.81E-04**	**3.46E-04**	**4.54E-04**

Arsenic Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Arsenic Catch, mg	0.04700	0.03360	0.01730	0.03263
C_s	Arsenic Concentration, gr/dscf	1.39E-05	1.08E-05	5.30E-06	1.00E-05
C_{AW}	Arsenic Emission Rate, lbs/hr	6.29E-05	4.55E-05	2.32E-05	4.38E-05
	Back-Half Catch Results				
m_n	Arsenic Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Arsenic Concentration, gr/dscf	<1.47E-07	<1.61E-07	<1.53E-07	<1.54E-07
C_{AW}	Arsenic Emission Rate, lbs/hr	<6.69E-07	<6.76E-07	<6.70E-07	<6.72E-07
C_{AW}	**Total Arsenic Emission Rate, lbs/hr**	**<6.35E-05**	**<4.61E-05**	**<2.38E-05**	**<4.45E-05**

Barium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Barium Catch, mg	0.39500	0.41100	0.36200	0.38933
C_s	Barium Concentration, gr/dscf	1.16E-04	1.33E-04	1.11E-04	1.20E-04
C_{AW}	Barium Emission Rate, lbs/hr	5.28E-04	5.56E-04	4.85E-04	5.23E-04
	Back-Half Catch Results				
m_n	Barium Catch, mg	0.00050	0.00202	<0.00050	<0.00101
C_s	Barium Concentration, gr/dscf	1.48E-07	6.52E-07	<1.53E-07	<3.18E-07
C_{AW}	Barium Emission Rate, lbs/hr	6.70E-07	2.73E-06	<6.70E-07	<1.36E-06
C_{AW}	**Total Barium Emission Rate, lbs/hr**	**5.29E-04**	**5.59E-04**	**<4.86E-04**	**<5.24E-04**

673

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Calcium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Calcium Catch, mg	0.26300	0.25200	0.23700	0.25067
C_s	Calcium Concentration, gr/dscf	7.75E-05	8.13E-05	7.27E-05	7.72E-05
C_{AW}	Calcium Emission Rate, lbs/hr	3.52E-04	3.41E-04	3.17E-04	3.37E-04
	Back-Half Catch Results				
m_n	Calcium Catch, mg	0.03390	0.03390	0.02610	0.03130
C_s	Calcium Concentration, gr/dscf	9.99E-06	1.09E-05	8.00E-06	9.64E-06
C_{AW}	Calcium Emission Rate, lbs/hr	4.54E-05	4.59E-05	3.50E-05	4.21E-05
C_{AW}	**Total Calcium Emission Rate, lbs/hr**	**3.97E-04**	**3.87E-04**	**3.52E-04**	**3.79E-04**

Cadmium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Cadmium Catch, mg	0.00049	0.00041	<0.00020	<0.00037
C_s	Cadmium Concentration, gr/dscf	1.45E-07	1.32E-07	<6.13E-08	<1.13E-07
C_{AW}	Cadmium Emission Rate, lbs/hr	6.57E-07	5.55E-07	<2.68E-07	<4.93E-07
	Back-Half Catch Results				
m_n	Cadmium Catch, mg	<0.00020	<0.00020	<0.00020	<0.00020
C_s	Cadmium Concentration, gr/dscf	<5.90E-08	<6.45E-08	<6.13E-08	<6.16E-08
C_{AW}	Cadmium Emission Rate, lbs/hr	<2.68E-07	<2.71E-07	<2.68E-07	<2.69E-07
C_{AW}	**Total Cadmium Emission Rate, lbs/hr**	**<9.24E-07**	**<8.25E-07**	**<5.36E-07**	**<7.62E-07**

Chromium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Chromium Catch, mg	0.10200	0.07240	0.03700	0.07047
C_s	Chromium Concentration, gr/dscf	3.01E-05	2.34E-05	1.13E-05	2.16E-05
C_{AW}	Chromium Emission Rate, lbs/hr	1.36E-04	9.80E-05	4.96E-05	9.47E-05
	Back-Half Catch Results				
m_n	Chromium Catch, mg	0.00177	0.00170	0.00149	0.00165
C_s	Chromium Concentration, gr/dscf	5.22E-07	5.49E-07	4.57E-07	5.09E-07
C_{AW}	Chromium Emission Rate, lbs/hr	2.37E-06	2.30E-06	2.00E-06	2.22E-06
C_{AW}	**Total Chromium Emission Rate, lbs/hr**	**1.39E-04**	**1.00E-04**	**5.16E-05**	**9.69E-05**

674

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Iron Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Iron Catch, mg	0.41400	0.17800	0.13300	0.24167
C_s	Iron Concentration, gr/dscf	1.22E-04	5.74E-05	4.08E-05	7.34E-05
C_{AW}	Iron Emission Rate, lbs/hr	5.54E-04	2.41E-04	1.78E-04	3.24E-04
	Back-Half Catch Results				
m_n	Iron Catch, mg	0.01910	0.02110	<0.01000	<0.01673
C_s	Iron Concentration, gr/dscf	5.63E-06	6.81E-06	<3.07E-06	<5.17E-06
C_{AW}	Iron Emission Rate, lbs/hr	2.56E-05	2.85E-05	<1.34E-05	<2.25E-05
C_{AW}	**Total Iron Emission Rate, lbs/hr**	**5.79E-04**	**2.69E-04**	**<1.92E-04**	**<3.47E-04**

Potassium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Potassium Catch, mg	0.27300	0.30300	0.13200	0.23600
C_s	Potassium Concentration, gr/dscf	8.05E-05	9.78E-05	4.05E-05	7.29E-05
C_{AW}	Potassium Emission Rate, lbs/hr	3.65E-04	4.10E-04	1.77E-04	3.17E-04
	Back-Half Catch Results				
m_n	Potassium Catch, mg	0.02350	0.02900	0.01850	0.02367
C_s	Potassium Concentration, gr/dscf	6.93E-06	9.36E-06	5.67E-06	7.32E-06
C_{AW}	Potassium Emission Rate, lbs/hr	3.14E-05	3.92E-05	2.48E-05	3.18E-05
C_{AW}	**Total Potassium Emission Rate, lbs/hr**	**3.97E-04**	**4.49E-04**	**2.02E-04**	**3.49E-04**

Lithium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Lithium Catch, mg	0.38600	0.48500	0.24300	0.37133
C_s	Lithium Concentration, gr/dscf	1.14E-04	1.57E-04	7.45E-05	1.15E-04
C_{AW}	Lithium Emission Rate, lbs/hr	5.16E-04	6.56E-04	3.25E-04	4.99E-04
	Back-Half Catch Results				
m_n	Lithium Catch, mg	<0.00050	0.00091	<0.00050	<0.00064
C_s	Lithium Concentration, gr/dscf	<1.47E-07	2.94E-07	<1.53E-07	<1.98E-07
C_{AW}	Lithium Emission Rate, lbs/hr	<6.69E-07	1.33E-06	<6.96E-07	<9.00E-07
C_{AW}	**Total Lithium Emission Rate, lbs/hr**	**<5.17E-04**	**6.58E-04**	**<3.26E-04**	**<5.00E-04**

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Magnesium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Magnesium Catch, mg	0.06870	0.05980	0.04870	0.05907
C_s	Magnesium Concentration, gr/dscf	2.03E-05	1.93E-05	1.49E-05	1.82E-05
C_{AW}	Magnesium Emission Rate, lbs/hr	9.19E-05	8.09E-05	6.52E-05	7.93E-05
	Back-Half Catch Results				
m_n	Magnesium Catch, mg	0.00714	0.00714	<0.00555	<0.00661
C_s	Magnesium Concentration, gr/dscf	2.10E-06	2.30E-06	<1.70E-06	<2.04E-06
C_{AW}	Magnesium Emission Rate, lbs/hr	9.55E-06	9.66E-06	<7.43E-06	<8.88E-06
C_{AW}	**Total Magnesium Emission Rate, lbs/hr**	**1.01E-04**	**9.06E-05**	**<7.27E-05**	**<8.82E-05**

Molybdenum Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Molybdenum Catch, mg	0.25000	0.18900	0.08890	0.17597
C_s	Molybdenum Concentration, gr/dscf	7.37E-05	6.10E-05	2.73E-05	5.40E-05
C_{AW}	Molybdenum Emission Rate, lbs/hr	3.34E-04	2.56E-04	1.19E-04	2.36E-04
	Back-Half Catch Results				
m_n	Molybdenum Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Molybdenum Concentration, gr/dscf	<1.47E-07	<1.61E-07	<1.53E-07	<1.54E-07
C_{AW}	Molybdenum Emission Rate, lbs/hr	<6.69E-07	<6.76E-07	<6.70E-07	<6.72E-07
C_{AW}	**Total Molybdenum Emission Rate, lbs/h**	**<3.35E-04**	**<2.56E-04**	**<1.20E-04**	**<2.37E-04**

Sodium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Sodium Catch, mg	1.6000	1.8400	1.1400	1.5267
C_s	Sodium Concentration, gr/dscf	4.72E-04	5.94E-04	3.49E-04	4.72E-04
C_{AW}	Sodium Emission Rate, lbs/hr	2.14E-03	2.49E-03	1.53E-03	2.05E-03
	Back-Half Catch Results				
m_n	Sodium Catch, mg	0.27700	0.29700	0.25700	0.27700
C_s	Sodium Concentration, gr/dscf	8.16E-05	9.58E-05	7.88E-05	8.54E-05
C_{AW}	Sodium Emission Rate, lbs/hr	3.71E-04	4.02E-04	3.44E-04	3.72E-04
C_{AW}	**Total Sodium Emission Rate, lbs/hr**	**2.51E-03**	**2.89E-03**	**1.87E-03**	**2.42E-03**

676

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

Nickel Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Nickel Catch, mg	0.04560	0.03060	0.01230	0.02950
C_s	Nickel Concentration, gr/dscf	1.34E-05	9.88E-06	3.77E-06	9.03E-06
C_{AW}	Nickel Emission Rate, lbs/hr	6.10E-05	4.14E-05	1.65E-05	3.96E-05
	Back-Half Catch Results				
m_n	Nickel Catch, mg	0.00085	0.00081	0.00084	0.00083
C_s	Nickel Concentration, gr/dscf	2.51E-07	2.61E-07	2.58E-07	2.56E-07
C_{AW}	Nickel Emission Rate, lbs/hr	1.14E-06	1.09E-06	1.13E-06	1.12E-06
C_{AW}	**Total Nickel Emission Rate, lbs/hr**	**6.21E-05**	**4.25E-05**	**1.76E-05**	**4.07E-05**

Phosphorus Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Phosphorus Catch, mg	3.4900	3.2900	0.16200	2.3140
C_s	Phosphorus Concentration, gr/dscf	1.03E-03	1.06E-03	4.97E-05	7.13E-04
C_{AW}	Phosphorus Emission Rate, lbs/hr	4.67E-03	4.45E-03	2.17E-04	3.11E-03
	Back-Half Catch Results				
m_n	Phosphorus Catch, mg	0.01540	0.01590	0.01070	0.01400
C_s	Phosphorus Concentration, gr/dscf	4.54E-06	5.13E-06	3.28E-06	4.32E-06
C_{AW}	Phosphorus Emission Rate, lbs/hr	2.06E-05	2.15E-05	1.43E-05	1.88E-05
C_{AW}	**Total Phosphorus Emission Rate, lbs/hr**	**4.69E-03**	**4.47E-03**	**2.31E-04**	**3.13E-03**

Lead Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Lead Catch, mg	13.100	11.400	7.0700	10.523
C_s	Lead Concentration, gr/dscf	3.86E-03	3.68E-03	2.17E-03	3.24E-03
C_{AW}	Lead Emission Rate, lbs/hr	1.75E-02	1.54E-02	9.47E-03	1.41E-02
	Back-Half Catch Results				
m_n	Lead Catch, mg	0.00433	0.00656	0.00101	0.00397
C_s	Lead Concentration, gr/dscf	1.28E-06	2.12E-06	3.10E-07	1.23E-06
C_{AW}	Lead Emission Rate, lbs/hr	5.79E-06	8.88E-06	1.35E-06	5.34E-06
C_{AW}	**Total Lead Emission Rate, lbs/hr**	**1.75E-02**	**1.54E-02**	**9.47E-03**	**1.41E-02**

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Sulfur Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Sulfur Catch, mg	1.0700	1.3700	0.99600	1.145
C_s	Sulfur Concentration, gr/dscf	3.15E-04	4.42E-04	3.05E-04	3.54E-04
C_{AW}	Sulfur Emission Rate, lbs/hr	1.43E-03	1.85E-03	1.33E-03	1.54E-03
	Back-Half Catch Results				
m_n	Sulfur Catch, mg	22.600	19.900	31.800	24.767
C_s	Sulfur Concentration, gr/dscf	6.66E-03	6.42E-03	9.75E-03	7.61E-03
C_{AW}	Sulfur Emission Rate, lbs/hr	3.02E-02	2.69E-02	4.26E-02	3.33E-02
C_{AW}	**Total Sulfur Emission Rate, lbs/hr**	**3.17E-02**	**2.88E-02**	**4.39E-02**	**3.48E-02**

Selenium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Selenium Catch, mg	0.35100	0.30000	0.21400	0.28833
C_s	Selenium Concentration, gr/dscf	1.03E-04	9.68E-05	6.56E-05	8.86E-05
C_{AW}	Selenium Emission Rate, lbs/hr	4.70E-04	4.06E-04	2.87E-04	3.87E-04
	Back-Half Catch Results				
m_n	Selenium Catch, mg	5.0600	5.2300	6.1600	5.4833
C_s	Selenium Concentration, gr/dscf	1.49E-03	1.69E-03	1.89E-03	1.69E-03
C_{AW}	Selenium Emission Rate, lbs/hr	6.77E-03	7.08E-03	8.25E-03	7.37E-03
C_{AW}	**Total Selenium Emission Rate, lbs/hr**	**7.24E-03**	**7.48E-03**	**8.54E-03**	**7.75E-03**

Silicon Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Silicon Catch, mg	0.00000	0.00000	0.00000	0.00000
C_s	Silicon Concentration, gr/dscf	0.0000	0.0000	0.0000	0.0000
C_{AW}	Silicon Emission Rate, lbs/hr	0.000	0.000	0.000	0.000
	Back-Half Catch Results				
m_n	Silicon Catch, mg	0.12000	0.29000	0.10000	0.17000
C_s	Silicon Concentration, gr/dscf	3.54E-05	9.36E-05	3.07E-05	5.32E-05
C_{AW}	Silicon Emission Rate, lbs/hr	1.61E-04	3.92E-04	1.34E-04	2.29E-04
C_{AW}	**Total Silicon Emission Rate, lbs/hr**	**1.61E-04**	**3.92E-04**	**1.34E-04**	**2.29E-04**

678

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Vanadium Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Vanadium Catch, mg	<0.0005	0.00083	0.00366	<0.00166
C_s	Vanadium Concentration, gr/dscf	<1.47E-07	2.68E-07	1.12E-06	<5.12E-07
C_{AW}	Vanadium Emission Rate, lbs/hr	<6.69E-07	1.12E-06	4.90E-06	<2.23E-06
	Back-Half Catch Results				
m_n	Vanadium Catch, mg	<0.00050	<0.00050	<0.00050	<0.00050
C_s	Vanadium Concentration, gr/dscf	<1.47E-07	<1.61E-07	<1.53E-07	<1.54E-07
C_{AW}	Vanadium Emission Rate, lbs/hr	<6.69E-07	<6.76E-07	<6.70E-07	<6.72E-07
C_{AW}	**Total Vanadium Emission Rate, lbs/hr**	**<1.34E-06**	**<1.80E-06**	**<5.57E-06**	**<2.90E-06**

Zinc Concentration and Emission Rates

	Front-Half Catch Results				
m_n	Zinc Catch, mg	0.17800	0.16300	0.12900	0.15667
C_s	Zinc Concentration, gr/dscf	5.25E-05	5.26E-05	3.95E-05	4.82E-05
C_{AW}	Zinc Emission Rate, lbs/hr	2.38E-04	2.21E-04	1.73E-04	2.10E-04
	Back-Half Catch Results				
m_n	Zinc Catch, mg	0.00163	0.00159	0.00136	0.00153
C_s	Zinc Concentration, gr/dscf	4.80E-07	5.13E-07	4.17E-07	4.70E-07
C_{AW}	Zinc Emission Rate, lbs/hr	2.18E-06	2.15E-06	1.82E-06	2.05E-06
C_{AW}	**Total Zinc Emission Rate, lbs/hr**	**2.40E-04**	**2.23E-04**	**1.75E-04**	**2.13E-04**

679

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Example Calculations Run 1

Stack Pressure, Absolute, in. Hg

$P_S = P_{bar} + P_g =$ 29.014

Volume Sampled at Stand. Cond., cu. ft.

$$V_{STD} = \frac{17.647 * V_M * (P_{bar} + \Delta H / 13.6)}{T_M + 460} =$$ 52.2

Volume of Water Vapor at Std. Cond.,SCF

$V_{WC} = 0.04709 * V_C =$ 4.55

Moisture Content of Gas Stream

$$B_{WS} = \frac{V_{WC}}{V_{STD} + V_{WC}} =$$ 0.080

Percent Moisture in Stack

$$P_{MV} = \frac{100 * V_{WC}}{V_{STD} + V_{WC}} =$$ 8.0

Mole Fraction of Dry Gas

$$M_{FD} = \frac{100 - P_{MV}}{100} =$$ 0.920

Mole. Wt. Stack Gas, Dry Basis, lb/lb mole

$M_d = 0.44 * \%CO_2 + 0.32 * \%O_2 + 0.28 * (100 - \%CO_2 - \%O_2) =$ 28.904

Mole. Wt. Stack Gas, Wet Basis, lb/lb mole

$M_S = M_d * (1 - B_{ws}) + 18.0 * B_{ws} =$ 28.030

Avg. Stack Velocity, ft/sec

$V_S = 85.49 * C_P * \Delta PS * SQRT$ ---------- = 107.2

Gas Volume Flow, Dry Std. Cond. CFM

$$Q_{SD} = \frac{1058.82 * V_S * A * P_S * (1 - B_{ws})}{T_S + 460} =$$ 530

Actual Gas Volume Flow, CFM

$Q_A = V_S * A * 60 =$ 1261

Gas Volume Flow, Wet Std. Cond., CFM

$Q_{SW} = Q_{SD} * [1/(1-B_{WS})] =$ 576

680

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

Area of Nozzle, ft^2

$A_n = ((D_n / 2)^{\wedge 2} * 3.14159)/144 =$ 0.00033

Percent Isokinetic

$$I = \frac{0.0945 * (T_s + 460) * V_{STD}}{\theta * V_s * P_s * (1 - B_{ws}) * A_n} =$$ 96.9

Particulate Matter Concentration, gr/dscf
(At Standard Conditions)

$C_S = 0.0154 * m_n / V_{STD} =$ 0.0119

$(T_S + 460)$

Particulate Matter Emission Rate, lbs/hr
(At Standard Conditi $(P_S * M_s)$

$C_{AW} = 0.00857 * C_s * Q_{SD} =$ 0.054

Standard Conditions 68 Deg. F, 29.92 in. Hg

681

SUMMARY OF RESULTS
EPA METHODS 5 & 29
Determination of Particulate Matter and Multiple Metal Emissions
EnVitCo
Clemson, South Carolina
Melter Stack

2291

(682)

SUMMARY OF RESULTS
EPA METHOD 8
Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions
EnVitCo
Clemson, South Carolina
Melter - Main Chamber Exhaust

2291

Run Number		1	2	3	Avg
Date:		01/19/99	01/19/99	01/19/99	---
θ	Net Time of Test, minutes	60	70	60	---
P_{bar}	Barometric Pressure, in. Hg	29.38	29.29	29.29	29.32
P_g	Static Pressure, in. Hg	-0.279	-0.272	-0.301	-0.284
P_s	Stack Pressure, Absolute, in. Hg	29.101	29.018	28.989	29.036
V_M	Actual Meter Volume Sampled, cu. ft.	34.06	32.39	53.48	39.98
ΔH	Avg. Delta H, in. H_2O	1.09	0.68	2.70	1.49
T_M	Avg. Gas Meter Temp., Deg. F	89.9	95.1	100.0	95.0
V_{STD}	Volume Sampled at Stand. Cond., cu. ft.	32.20	30.21	49.70	37.37
V_C	Volume of Water Collected, ml	50.2	50.2	62.3	54.2
V_{WC}	Volume of Water Vapor at Std. Cond., SCF	2.36	2.36	2.93	2.55
B_{WS}	Moisture Content of Gas Stream	0.068	0.073	0.056	0.066
P_{MV}	Percent Moisture in Stack	6.8	7.3	5.6	6.6
M_{FD}	Mole Fraction of Dry Gas	0.932	0.927	0.944	0.934
$\%O_2$	Percent Oxygen, Dry	18.53	18.69	19.02	18.75
$\%CO_2$	Percent Carbon Dioxide, Dry	1.80	1.68	1.39	1.62
%CO	Percent Carbon Monoxide, Dry	0.00	0.00	0.00	0.00
M_d	Mole. Wt. Stack Gas, Dry Basis, lb/lb mole	29.029	29.016	28.983	29.010
M_S	Mole. Wt. Stack Gas, Wet Basis, lb/lb mole	28.275	28.217	28.371	28.288
Cp	Pitot Tube Constant	0.84	0.84	0.84	0.84
ΔPS	Avg. Sqrt. Delta P, in. H_2O	1.242	1.219	1.247	1.236
T_S	Avg. Stack Temp., Deg. F	629.3	607.6	608.0	615.0
V_S	Avg. Stack Velocity, ft/sec	102.6	100.0	102.0	101.5
A	Area Stack, ft^2	0.196	0.196	0.196	0.196

683

TRIGON

SUMMARY OF RESULTS
EPA METHOD 8
Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions
EnVitCo
Clemson, South Carolina
Melter - Main Chamber Exhaust

2291

Q_{SD}	Gas Volume Flow, Dry Std. Cond., CFM	530	523	543	532
Q_A	Actual Gas Volume Flow, CFM	1207	1175	1200	1194
Q_{SW}	Gas Volume Flow, Wet Std. Cond., CFM	569	564	575	569
D_n	Sample Nozzle Diameter, inches	0.190	0.173	0.241	0.201
A_n	Area of Nozzle, ft^2	0.00020	0.00016	0.00032	0.00023
I	Percent Isokinetic	100.9	99.2	94.5	98.2

684

TRIGON

SUMMARY OF RESULTS
EPA METHOD 8
Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions
EnVitCo
Clemson, South Carolina
Melter - Main Chamber Exhaust

2291

Sulfuric Acid Mist (Including SO3) Concentrations And Emission Rates

N	Normality of Barium Perchlorate, g-eq./liter	0.0106	0.0106	0.0106	0.0106
V_{soln}	Volume of Sample Solution, ml	250.0	250.0	250.0	250.0
V_t	Volume of Titrant Used in Sample, ml	3.63	2.60	3.00	3.08
V_{tb}	Volume of Titrant Used in Blank, ml	0.00	0.00	0.00	0.00
V_a	Volume of Sample Aliquot Titrated, ml	100.0	100.0	100.0	100.0
CH_2SO_4	Sulfuric Acid Mist Concentration, lbs/dscf	3.24E-07	2.47E-07	1.73E-07	2.48E-07
C_{AW}	Sulfuric Acid Mist Emission Rate, lbs/hr	0.0103	0.0077	0.0056	0.0079

Sulfur Dioxide Concentrations And Emission Rates

N	Normality of Barium Perchlorate, g-eq./liter	0.0106	0.0106	0.0106	0.0106
V_{soln}	Volume of Sample Solution, ml	1000.0	1000.0	1000.0	1000.0
V_t	Volume of Titrant Used in Sample, ml	0.45	0.60	0.73	0.59
V_{tb}	Volume of Titrant Used in Blank, ml	0.05	0.05	0.05	0.05
V_a	Volume of Sample Aliquot Titrated, ml	10.0	10.0	10.0	10.0
CSO_2	Sulfur Dioxide Concentration, lbs/dscf	9.31E-07	1.36E-06	1.03E-06	1.11E-06
C_{AW}	Sulfur Dioxide Emission Rate, lbs/hr	0.030	0.043	0.033	0.035

685

TRIGON

SUMMARY OF RESULTS
EPA METHOD 8
Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions
EnVitCo
Clemson, South Carolina
Melter - Main Chamber Exhaust

2291

Run Number		4	5	6	Avg
Date:		01/19/99	01/19/99	01/19/99	---
θ	Net Time of Test, minutes	60	60	60	---
P_{bar}	Barometric Pressure, in. Hg	29.32	29.29	29.29	29.30
P_g	Static Pressure, in. Hg	-0.316	-0.324	-0.301	-0.314
P_S	Stack Pressure, Absolute, in. Hg	29.004	28.966	28.989	28.986
V_M	Actual Meter Volume Sampled, cu. ft.	59.19	53.39	54.73	55.77
ΔH	Avg. Delta H, in. H_2O	3.38	2.74	2.87	3.00
T_M	Avg. Gas Meter Temp., Deg. F	100.1	95.5	91.5	95.7
V_{STD}	Volume Sampled at Stand. Cond., cu. ft.	55.14	50.02	51.66	52.28
V_C	Volume of Water Collected, ml	81.5	88.6	91.3	87.1
V_{WC}	Volume of Water Vapor at Std. Cond., SCF	3.84	4.17	4.30	4.10
B_{WS}	Moisture Content of Gas Stream	0.065	0.077	0.077	0.073
P_{MV}	Percent Moisture in Stack	6.5	7.7	7.7	7.3
M_{FD}	Mole Fraction of Dry Gas	0.935	0.923	0.923	0.927
$\%O_2$	Percent Oxygen, Dry	18.28	18.64	18.64	18.52
$\%CO_2$	Percent Carbon Dioxide, Dry	1.91	1.76	1.76	1.81
%CO	Percent Carbon Monoxide, Dry	0.00	0.00	0.00	0.00
M_d	Mole. Wt. Stack Gas, Dry Basis, lb/lb mole	29.037	29.027	29.027	29.030
M_S	Mole. Wt. Stack Gas, Wet Basis, lb/lb mole	28.319	28.178	28.180	28.226
Cp	Pitot Tube Constant	0.84	0.84	0.84	0.84
ΔPS	Avg. Sqrt. Delta P, in. H_2O	1.335	1.252	1.235	1.274
T_S	Avg. Stack Temp., Deg. F	623.1	628.4	644.8	632.1
V_S	Avg. Stack Velocity, ft/sec	110.1	103.8	103.2	105.7
A	Area Stack, ft^2	0.196	0.196	0.196	0.196

686

TRIGON

SUMMARY OF RESULTS
EPA METHOD 8
Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions
EnVitCo
Clemson, South Carolina
Melter - Main Chamber Exhaust

2291

Q_{SD}	Gas Volume Flow, Dry Std. Cond., CFM	572	529	519	540
Q_A	Actual Gas Volume Flow, CFM	1295	1221	1213	1243
Q_{SW}	Gas Volume Flow, Wet Std. Cond., CFM	612	573	562	582
D_n	Sample Nozzle Diameter, inches	0.246	0.241	0.247	0.245
A_n	Area of Nozzle, ft^2	0.00033	0.00032	0.00033	0.00033
I	Percent Isokinetic	95.5	97.5	97.9	96.9

687

TRIGON

SUMMARY OF RESULTS
EPA METHOD 8
Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions
EnVitCo
Clemson, South Carolina
Melter - Main Chamber Exhaust

Sulfuric Acid Mist (Including SO3) Concentrations And Emission Rates

N	Normality of Barium Perchlorate, g-eq./liter	0.0106	0.0106	0.0106	0.0106
V_{soln}	Volume of Sample Solution, ml	250.0	250.0	250.0	250.0
V_t	Volume of Titrant Used in Sample, ml	4.30	4.18	4.33	4.27
V_{tb}	Volume of Titrant Used in Blank, ml	0.00	0.00	0.00	0.00
V_a	Volume of Sample Aliquot Titrated, ml	100.0	100.0	100.0	100.0
CH_2SO_4	Sulfuric Acid Mist Concentration, lbs/dscf	2.24E-07	2.40E-07	2.41E-07	2.35E-07
C_{AW}	Sulfuric Acid Mist Emission Rate, lbs/hr	0.0077	0.0076	0.0075	0.0076

Sulfur Dioxide Concentrations And Emission Rates

N	Normality of Barium Perchlorate, g-eq./liter	0.0106	0.0106	0.0106	0.0106
V_{soln}	Volume of Sample Solution, ml	1000.0	1000.0	1000.0	1000.0
V_t	Volume of Titrant Used in Sample, ml	1.45	1.80	2.35	1.87
V_{tb}	Volume of Titrant Used in Blank, ml	0.05	0.05	0.05	0.05
V_a	Volume of Sample Aliquot Titrated, ml	10.0	10.0	10.0	10.0
CSO_2	Sulfur Dioxide Concentration, lbs/dscf	1.90E-06	2.62E-06	3.34E-06	2.62E-06
C_{AW}	Sulfur Dioxide Emission Rate, lbs/hr	0.065	0.083	0.104	0.084

688

TRIGON

2291

Example Calculations Run 1

Stack Pressure, Absolute, in. Hg

$P_s = P_{bar} + P_g =$ 29.101

Volume Sampled at Stand. Cond., cu. ft.

$$V_{STD} = \frac{17.647 * V_M * (P_{bar} + \Delta H / 13.6)}{T_M + 460} =$$ 32.20

Volume of Water Vapor at Std. Cond., SCF

$V_{WC} = 0.04709 * V_C =$ 2.36

Moisture Content of Gas Stream

$$B_{WS} = \frac{V_{WC}}{V_{STD} + V_{WC}} =$$ 0.068

Percent Moisture in Stack

$$P_{MV} = \frac{100 * V_{WC}}{V_{STD} + V_{WC}} =$$ 6.8

Mole Fraction of Dry Gas

$$M_{FD} = \frac{100 - P_{MV}}{100} =$$ 0.932

Mole. Wt. Stack Gas, Dry Basis, lb/lb mole

$M_d = 0.44 * \%CO_2 + 0.32 * \%O_2 + 0.28 * (100 - \%CO_2 - \%O_2) =$ 29.029

Mole. Wt. Stack Gas, Wet Basis, lb/lb mole

$M_S = M_d * (1 - B_{ws}) + 18.0 * B_{ws} =$ 28.275

Avg. Stack Velocity, ft/sec

$$V_S = 85.49 * C_p * \Delta PS * \text{SQRT} \frac{(T_S + 460)}{(P_S * M_s)} =$$ 102.6

Gas Volume Flow, Dry Std. Cond., CFM

$$Q_{SD} = \frac{1058.82 * V_S * A * P_S * (1 - B_{ws})}{T_S + 460} =$$ 530

689

TRIGON

SUMMARY OF RESULTS
EPA METHOD 8
Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions
EnVitCo
Clemson, South Carolina
Melter - Main Chamber Exhaust

2291

Actual Gas Volume Flow, CFM
$Q_A = V_S * A * 60 =$ 1207

Gas Volume Flow, Wet Std. Cond., CFM
$Q_{SW} = Q_{SD} * [1/(1-B_{WS})] =$ 569

Area of Nozzle, ft2
$A_n = ((D_n / 2)^2 * 3.14159)/144 =$ 0.00020

Percent Isokinetic

$$I = \frac{0.0945 * (T_S + 460) * V_{STD}}{\theta * V_S * P_S * (1 - B_{ws}) * A_n} =$$ 100.9

Sulfuric Acid Mist Concentration, lbs/dscf

$$CH_2SO_4 = 1.081E\text{-}04 * \frac{N(Vt - Vtb) * (Vsoln/Va)}{V_{STD}} =$$ 3.24E-07

Sulfur Dioxide Concentration, lbs/dscf

$$CSO_2 = 7.061E\text{-}05 * \frac{N(Vt - Vtb) * (Vsoln/Va)}{V_{STD}} =$$ 9.31E-07

Sulfuric Acid Mist Emission Rate, lbs/hr
$C_{AW} = CH_2SO_4 * 60 * Q_{Sd} =$ 0.010

Standard Conditions 68 Deg. F, 29.92 in. Hg

690

TRIGON

EPA Method 3A - Determination of Oxygen Concentrations Using Instrumental Analyzer Procedure Bias Correction

CLIENT: EnVitCo

CITY / STATE: Clemson, SC

SOURCE: Melter - Main Chamber Exhaust

DATE: 01/19/99

Run 1	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.04	0.01	0.03	12.65	18.30	**18.53**
Upscale	12.50	12.50	12.50			

Run 2	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.04	0.01	0.03	12.65	18.46	**18.69**
Upscale	12.50	12.50	12.50			

Run 3	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.01	0.00	0.01	12.65	18.84	**19.02**
Upscale	12.50	12.56	12.53			

Corrected Concentration = $[C_{actual} * (C_{avg} - C_{zero})] / [(C_{upscale} - C_{zero})]$

Where:

C_{avg} = average reference method value of test run
C_{zero} = average system zero calibration response
$C_{upscale}$ = average system upscale calibration response
C_{actual} = actual upscale calibration gas concentration

EPA Method 3A - Determination of Carbon Dioxide Concentrations Using Instrumental Analyzer Procedure Bias Correction

CLIENT: EnVitCo

CITY / STATE: Clemson, SC

SOURCE: Melter - Main Chamber Exhaust

DATE: 01/19/99

Run 1	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.05	0.09	0.07	10.13	1.91	**1.80**
Upscale	10.34	10.46	10.40			

Run 2	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.05	0.09	0.07	10.13	1.78	**1.68**
Upscale	10.34	10.46	10.40			

Run 3	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.09	0.09	0.09	10.13	1.52	**1.39**
Upscale	10.46	10.50	10.48			

Corrected Concentration = $[C_{actual} * (C_{avg} - C_{zero})] / [(C_{upscale} - C_{zero})]$

Where:

C_{avg} = average reference method value of test run
C_{zero} = average system zero calibration response
$C_{upscale}$ = average system upscale calibration response
C_{actual} = actual upscale calibration gas concentration

162

EPA Method 3A - Determination of Oxygen Concentrations Using Instrumental Analyzer Procedure Bias Correction

CLIENT: EnVitCo

CITY / STATE: Clemson, SC

SOURCE: Melter - Main Chamber Exhaust

DATE: 01/19/99

Run 4	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.01	0.00	0.01	12.65	18.10	**18.28**
Upscale	12.50	12.56	12.53			

Run 5	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.09	0.07	0.08	12.65	18.43	**18.64**
Upscale	12.57	12.50	12.54			

Run 6	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.09	0.07	0.08	12.65	18.43	**18.64**
Upscale	12.57	12.50	12.54			

Corrected Concentration = $[C_{actual} * (C_{avg} - C_{zero})] / [(C_{upscale} - C_{zero})]$

Where:

C_{avg} = average reference method value of test run
C_{zero} = average system zero calibration response
$C_{upscale}$ = average system upscale calibration response
C_{actual} = actual upscale calibration gas concentration

EPA Method 3A - Determination of Carbon Dioxide Concentrations Using Instrumental Analyzer Procedure Bias Correction

CLIENT: EnVitCo

CITY / STATE: Clemson, SC

SOURCE: Melter - Main Chamber Exhaust

DATE: 01/19/99

Run 4	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.09	0.09	0.09	10.13	2.05	**1.91**
Upscale	10.46	10.50	10.48			

Run 5	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.09	0.02	0.06	10.13	1.82	**1.76**
Upscale	10.32	10.14	10.23			

Run 6	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.09	0.02	0.06	10.13	1.82	**1.76**
Upscale	10.32	10.14	10.23			

Corrected Concentration = $[C_{actual} * (C_{avg} - C_{zero})] / [(C_{upscale} - C_{zero})]$

Where:

C_{avg} = average reference method value of test run
C_{zero} = average system zero calibration response
$C_{upscale}$ = average system upscale calibration response
C_{actual} = actual upscale calibration gas concentration

694

EPA Method 3A - Determination of Oxygen Concentrations Using Instrumental Analyzer Procedure Bias Correction

CLIENT: EnVitCo

CITY / STATE: Clemson, SC

SOURCE: Melter & ESP Stack

DATE: 01/20/99

Run 1	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.07	0.09	0.08	12.65	19.98	**20.24**
Upscale	12.50	12.53	12.52			

Run 2	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.07	0.09	0.08	12.65	20.02	**20.28**
Upscale	12.50	12.53	12.52			

Run 3	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration O_2 (%d)
Zero	0.09	0.11	0.10	12.65	20.02	**20.28**
Upscale	12.53	12.52	12.53			

Corrected Concentration = $[C_{actual} * (C_{avg} - C_{zero})] / [(C_{upscale} - C_{zero})]$

Where:

C_{avg} = average reference method value of test run
C_{zero} = average system zero calibration response
$C_{upscale}$ = average system upscale calibration response
C_{actual} = actual upscale calibration gas concentration

EPA Method 3A - Determination of Carbon Dioxide Concentrations Using Instrumental Analyzer Procedure Bias Correction

CLIENT: EnVitCo

CITY / STATE: Clemson, SC

SOURCE: Melter & ESP Stack

DATE: 01/20/99

Run 1	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.02	0.10	0.06	10.13	0.66	**0.59**
Upscale	10.14	10.42	10.28			

Run 2	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.02	0.10	0.06	10.13	0.69	**0.62**
Upscale	10.14	10.42	10.28			

Run 3	Initial System Response (%)	Final System Response (%)	Average Calibration Response (%)	Upscale Calibration Gas (%)	Average Measured Response (%)	Corrected Concentration CO_2 (%d)
Zero	0.10	0.12	0.11	10.13	0.70	**0.58**
Upscale	10.42	10.42	10.42			

Corrected Concentration = $[C_{actual} * (C_{avg} - C_{zero})] / [(C_{upscale} - C_{zero})]$

Where:

C_{avg} = average reference method value of test run
C_{zero} = average system zero calibration response
$C_{upscale}$ = average system upscale calibration response
C_{actual} = actual upscale calibration gas concentration

696

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 1-4)

2291

Run Number		1	2	3	4
Date:		01/19/99	01/19/99	01/19/99	01/19/99
θ	Net Time of Test, minutes	60	60	60	60
P_{bar}	Barometric Pressure, in. Hg *	29.38	29.38	29.38	29.38
P_g	Static Pressure, in. Hg *	-0.279	-0.279	-0.279	-0.279
P_S	Stack Pressure, Absolute, in. Hg	29.101	29.101	29.101	29.101
V_M	Actual Meter Volume Sampled, cu. ft.	34.06	34.06	34.06	34.06
ΔH	Avg. Delta H, in. H20	1.09	1.09	1.09	1.09
T_M	Avg. Gas Meter Temp., Deg. F	89.9	89.9	89.9	89.9
V_{STD}	Volume Sampled at Stand. Cond., cu. ft.	32.2	32.2	32.2	32.2
V_C	Volume of Water Collected, ml	50.2	50.2	50.2	50.2
V_{WC}	Volume of Water Vapor at Std. Cond., SCF	2.36	2.36	2.36	2.36
B_{WS}	Moisture Content of Gas Stream	0.068	0.068	0.068	0.068
P_{MV}	Percent Moisture in Stack	6.8	6.8	6.8	6.8
M_{FD}	Mole Fraction of Dry Gas	0.932	0.932	0.932	0.932
$\%O_2$	Percent Oxygen, Dry	18.53	18.53	18.53	18.53
$\%CO_2$	Percent Carbon Dioxide, Dry	1.80	1.80	1.80	1.80
%CO	Percent Carbon Monoxide, Dry	0.00	0.00	0.00	0.00
M_d	Mole. Wt. Stack Gas, Dry Basis, lb/lb mole	29.03	29.03	29.03	29.03
M_S	Mole. Wt. Stack Gas, Wet Basis, lb/lb mole	28.275	28.275	28.275	28.275
Cp	Pitot Tube Constant	0.84	0.84	0.84	0.84
ΔPS	Avg. Sqrt. Delta P, in. H_20 *	1.886	1.886	1.886	1.886
T_S	Avg. Stack Temp., Deg. F *	629.3	629.3	629.3	629.3
V_S	Avg. Stack Velocity, ft/sec	155.9	155.9	155.9	155.9

697

TRIGON

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 1-4)

2291

A	Area Stack, ft^2	0.196	0.196	0.196	0.196
Q_{sd}	Gas Volume Flow, Dry Std. Cond. CFM	805	805	805	805
Q_A	Actual Gas Volume Flow, CFM	1833	1833	1833	1833
Q_{sw}	Gas Volume Flow, Wet Std. Cond., CFM	864	864	864	864
Total Gaseous Organic(s) Concentrations and Emission Rates					
M_{WC}	Mole Weight of Carbon, g/mole	12.01	12.01	12.01	12.01
C_{meas}	Organic Concentration, ppm as propane (wet)	1.0	0.8	0.7	0.8
C_c	Organic Concentration, ppm as carbon (wet)	3.0	2.4	2.1	2.4
C_d	Organic Concentration, ppm as carbon (dry)	3.2	2.6	2.3	2.6
C_{ON}	Organic Concentration, mg/dscm as carbon	1.6	1.3	1.1	1.3
C_{AN}	Organic Concentration, gr/dscf as carbon	0.0007	0.0006	0.0005	0.0006
C_{AW}	Organic Emission Rate, lbs/hr	0.0048	0.0039	0.0034	0.0039

698

TRIGON

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 1-4)

Example Calculations Run 1

Stack Pressure, Absolute, in. Hg

$P_S = P_{bar} + P_g =$ 29.101

Volume Sampled at Stand. Cond., cu. ft.

$$V_{STD} = \frac{17.647 * V_M * (P_{bar} + \Delta H / 13.6)}{T_M + 460} =$$ 32.2

Volume of Water Vapor at Std. Cond., SCF

$V_{WC} = 0.04709 * V_C =$ 2.36

Moisture Content of Gas Stream

$$B_{WS} = \frac{V_{WC}}{V_{STD} + V_{WC}} =$$ 0.068

Percent Moisture in Stack

$$P_{MV} = \frac{100 * V_{WC}}{V_{STD} + V_{WC}} =$$ 6.8

Mole Fraction of Dry Gas

$$M_{FD} = \frac{100 - P_{MV}}{100} =$$ 0.932

Mole. Wt. Stack Gas, Dry Basis, lb/lb mole

$M_d = 0.44 * \%CO_2 + 0.32 * \%O_2 + 0.28 * (100 - \%CO_2 - \%O_2) =$ 29.029

Mole. Wt. Stack Gas, Wet Basis, lb/lb mole

$M_S = M_d * (1 - B_{ws}) + 18.0 * B_{ws} =$ 28.275

Avg. Stack Velocity, ft/sec

$$V_S = 85.49 * C_P * \Delta PS * SQRT \frac{(T_S + 460)}{(P_S * M_d)} =$$ 155.9

Gas Volume Flow, Dry Std. Cond. CFM

$$Q_{Sd} = \frac{1058.82 * V_S * A * P_S * (1 - B_{ws})}{T_S + 460} =$$ 805

699

TRIGON

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 1-4)

2291

Actual Gas Volume Flow, CFM $Q_A = V_S * A * 60 =$	1833
Gas Volume Flow, Wet Std. Cond., CFM $Q_{SW} = Q_{Sd} * [1/(1-B_{WS})] =$	864
Organic Concentration, ppm as carbon (wet) $C_c = C_{meas} * 3 =$	3.0
Organic Concentration, ppm as carbon (dry) $C_d = \frac{C_c}{(1 - B_{WS})} =$	3.2
Organic Concentration, mg/dscm as carbon (At Standard Conditions) $C_{ON} = C_d * \frac{(M_{WC})}{24.054048} =$	1.6
Organic Concentration, gr/dscf as carbon (At Standard Conditions) $C_{an} = C_{ON} * 0.0004371 =$	0.0007
Organic Emission Rate, lbs/hr (At Standard Conditions) $C_{AW} = 0.00857 * C_{AN} * Q_{Sd} =$	0.0048

* Values Represent Beginning and Ending Run Averages
Standard Conditions 68 Deg. F, 29.92 in. Hg

700

TRIGON

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 5-8)

2291

Run Number		5	6	7	8
Date:		01/19/99	01/19/99	01/19/99	01/19/99
θ	Net Time of Test, minutes	60	70	60	60
P_{bar}	Barometric Pressure, in. Hg *	29.34	29.29	29.29	29.31
P_g	Static Pressure, in. Hg *	-0.276	-0.272	-0.287	-0.309
P_S	Stack Pressure, Absolute, in. Hg	29.059	29.018	29.003	28.996
V_M	Actual Meter Volume Sampled, cu. ft.	34.06	32.39	53.48	53.48
ΔH	Avg. Delta H, in. H20	1.09	0.68	2.70	2.70
T_M	Avg. Gas Meter Temp., Deg. F	89.9	95.1	100.0	100.0
V_{STD}	Volume Sampled at Stand. Cond., cu. ft.	32.2	30.2	49.7	49.7
V_C	Volume of Water Collected, ml	50.2	50.2	62.3	62.3
V_{WC}	Volume of Water Vapor at Std. Cond., SCF	2.36	2.36	2.93	2.93
B_{WS}	Moisture Content of Gas Stream	0.068	0.073	0.056	0.056
P_{MV}	Percent Moisture in Stack	6.8	7.3	5.6	5.6
M_{FD}	Mole Fraction of Dry Gas	0.932	0.927	0.944	0.944
$\%O_2$	Percent Oxygen, Dry	18.53	18.69	19.02	19.02
$\%CO_2$	Percent Carbon Dioxide, Dry	1.80	1.68	1.39	1.39
%CO	Percent Carbon Monoxide, Dry	0.00	0.00	0.00	0.00
M_d	Mole. Wt. Stack Gas, Dry Basis, lb/lb mole	29.03	29.02	28.98	28.98
M_S	Mole. Wt. Stack Gas, Wet Basis, lb/lb mole	28.274	28.217	28.371	28.371
Cp	Pitot Tube Constant	0.84	0.84	0.84	0.84
ΔPS	Avg. Sqrt. Delta P, in. H_20 *	1.562	1.219	1.865	1.958
T_S	Avg. Stack Temp., Deg. F *	618.5	607.6	607.8	615.6
V_S	Avg. Stack Velocity, ft/sec	128.5	100.0	152.6	160.8

701

TRIGON

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 5-8)

A	Area Stack, ft^2	0.196	0.196	0.196	0.196
Q_{Sd}	Gas Volume Flow, Dry Std. Cond. CFM	669	523	812	850
Q_A	Actual Gas Volume Flow, CFM	1511	1175	1794	1891
Q_{SW}	Gas Volume Flow, Wet Std. Cond., CFM	718	564	860	900
Total Gaseous Organic(s) Concentrations and Emission Rates					
M_{WC}	Mole Weight of Carbon, g/mole	12.01	12.01	12.01	12.01
C_{meas}	Organic Concentration, ppm as propane (wet)	1.6	1.3	1.5	0.7
C_c	Organic Concentration, ppm as carbon (wet)	4.8	3.9	4.5	2.1
C_d	Organic Concentration, ppm as carbon (dry)	5.2	4.2	4.8	2.2
C_{ON}	Organic Concentration, mg/dscm as carbon	2.6	2.1	2.4	1.1
C_{AN}	Organic Concentration, gr/dscf as carbon	0.0011	0.0009	0.0010	0.0005
C_{AW}	Organic Emission Rate, lbs/hr	0.0065	0.0041	0.0072	0.0035

702

TRIGON

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 5-8)

2291

Example Calculations Run 1

Stack Pressure, Absolute, in. Hg

$P_S = P_{bar} + P_g =$ 29.059

Volume Sampled at Stand. Cond., cu. ft.

$$V_{STD} = \frac{17.647 * V_M * (P_{bar} + \Delta H / 13.6)}{T_M + 460} =$$ 32.2

Volume of Water Vapor at Std. Cond., SCF

$V_{WC} = 0.04709 * V_C =$ 2.36

Moisture Content of Gas Stream

$$B_{WS} = \frac{V_{WC}}{V_{STD} + V_{WC}} =$$ 0.068

Percent Moisture in Stack

$$P_{MV} = \frac{100 * V_{WC}}{V_{STD} + V_{WC}} =$$ 6.8

Mole Fraction of Dry Gas

$$M_{FD} = \frac{100 - P_{MV}}{100} =$$ 0.932

Mole. Wt. Stack Gas, Dry Basis, lb/lb mole

$M_d = 0.44 * \%CO_2 + 0.32 * \%O_2 + 0.28 * (100 - \%CO_2 - \%O_2) =$ 29.029

Mole. Wt. Stack Gas, Wet Basis, lb/lb mole

$M_S = M_d * (1 - B_{ws}) + 18.0 * B_{ws} =$ 28.274

Avg. Stack Velocity, ft/sec

$$V_S = 85.49 * C_P * \Delta PS * SQRT \frac{(T_S + 460)}{(P_S * M_d)} =$$ 128.5

Gas Volume Flow, Dry Std. Cond. CFM

$$Q_{Sd} = \frac{1058.82 * V_S * A * P_S * (1 - B_{ws})}{T_S + 460} =$$ 669

703

TRIGON

SUMMARY OF RESULTS
EPA METHOD 25A
Determination of Total Gaseous Organics as Carbon
EnVitCo
Clemson, South Carolina
Melter - Main Chamber (Runs 5-8)

2291

Actual Gas Volume Flow, CFM
$Q_A = V_S * A * 60 =$ 1511

Gas Volume Flow, Wet Std. Cond., CFM
$Q_{SW} = Q_{Sd} * [1/(1-B_{WS})] =$ 718

Organic Concentration, ppm as carbon (wet)
$C_c = C_{meas} * 3 =$ 4.8

Organic Concentration, ppm as carbon (dry)

$$C_d = \frac{C_c}{(1 - B_{WS})} =$$ 5.2

Organic Concentration, mg/dscm as carbon
(At Standard Conditions)

$$C_{ON} = C_d * \frac{(M_{WC})}{24.054048} =$$ 2.6

Organic Concentration, gr/dscf as carbon
(At Standard Conditions)
$C_{an} = C_{ON} * 0.0004371 =$ 0.0011

Organic Emission Rate, lbs/hr
(At Standard Conditions)
$C_{AW} = 0.00857 * C_{AN} * Q_{Sd} =$ 0.0065

* Values Represent Beginning and Ending Run Averages
Standard Conditions 68 Deg. F, 29.92 in. Hg

704

TRIGON

APPENDIX B

FIELD DATA SHEETS

705

TRIGON

EPA Method 1
Determination of Sampling Ports and Points

2291

Client: ENVITCO
Sampling Location: MELTER - MAIN CHAMBER EXHAUST
City/State: CLEMSON, SC
Date: 1-19-99

Sampling Location Dimensions:

From Far Wall to Outside of Port	8.25
Nipple Length	2.25
Depth of Duct	6.00
Width (Rectangular Duct)	—

Equivalent Diameter Calculation (DE):

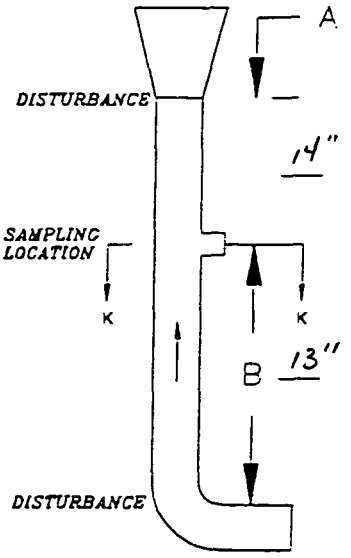
$$DE = \frac{2 \times \text{Length} \times \text{Width}}{\text{Length} - \text{Width}} = \frac{2(\_\_)(\_\_)}{(\_\_ + \_\_)} = \_\_$$

Distance to Ports From Nearest Flow Disturbance:

	Upstream - A	Downstream - B
Dimensions in Inches	14	13
Duct Diameters	2.33	2.17

Stack Area, in Square Feet 0.196

Calculations By RFC



Schematic of Sampling Location

Location of Traverse Points in Circular Stacks

	4	6	8	10	12
1	6.7	4.4	3.2	2.6	2.1
2	25.0	14.6	10.5	8.2	6.7
3	75.0	29.6	19.4	14.6	11.8
4	93.3	70.4	32.3	22.6	17.7
5		85.4	67.7	34.2	25.0
6		95.6	80.6	65.8	35.6
7			89.5	77.4	64.4
8			96.8	85.4	75.0
9				91.8	82.3
10				97.4	88.2
11					93.3
12					97.9

Location of Traverse Points in Rectangular Stacks

	2	3	4	5	6	7	8
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8
3		83.3	62.5	50.0	41.7	35.7	31.3
4			87.5	70.0	58.3	50.0	43.8
5				90.0	75.0	64.3	56.3
6					91.7	78.6	68.8
7						92.9	81.3
8							93.8
9							
10							
11							
12							

Point No.	% of Stack ID	Stack ID, in.	Distance From Inside Wall, in.	Nipple Length, in.	Distance From Outside of Port, in.
1	4.4	6.0	0.265 (.50)	2.25	2.75
2	14.6		0.876		3.13
3	29.6		1.776		4.03
4	70.4		4.224		6.47
5	85.4		5.124		7.37
6	95.6		5.736 (5.50)		7.75

Stack Diameter = 12 - 24 inches Relocate to 0.50 inches
Stack Diameter > 24 inches Relocate to 1.00 inches

706

Audited by: RJP Date: 01/19/99

PASSED QA

STACK RE-ADJUSTED TO 12 POINT TRAVERSE FOR ENGINEERING AND AESTHETIC CONSIDERATIONS

TRIGON

EPA Method 1
Determination of Sampling Ports and Points

2291

Client: EnVitco
City/State: Clemson, SC
Sampling Location: Melter - Main Chamber Exhaust
Date: 12-4-98

Sampling Location Dimensions:

From Far Wall to Outside of Port	8.25
Nipple Length	2.25
Depth of Duct	6.00
Width (Rectangular Duct)	—

Equivalent Diameter Calculation (DE):

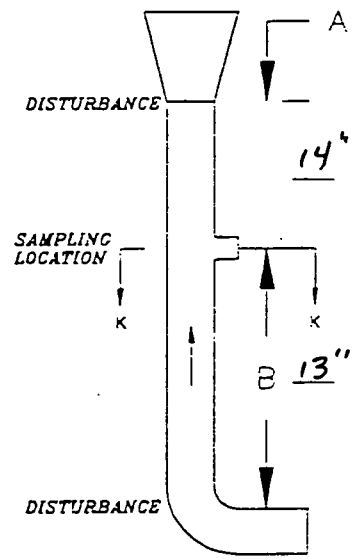
$$DE = \frac{2 \times \text{Length} \times \text{Width}}{\text{Length} - \text{Width}} = \frac{2(\_\_)(\_\_)}{(\_\_ + \_\_)} = \_\_$$

Distance to Ports From Nearest Flow Disturbance:

	Upstream - A	Downstream - B
Dimensions in Inches	14"	13"
Duct Diameters	2.33	2.17

Stack Area, in Square Feet 0.196

Calculations By RFC



Schematic of Sampling Location

Location of Traverse Points in Circular Stacks

	4	6	8	10	12
1	6.7	4.4	3.2	2.6	2.1
2	25.0	14.6	10.5	8.2	6.7
3	75.0	29.6	19.4	14.6	11.8
4	93.3	70.4	32.3	22.6	17.7
5		85.4	67.7	34.2	25.0
6		95.6	80.6	65.8	35.6
7			89.5	77.4	64.4
8			96.8	85.4	75.0
9				91.8	82.3
10				97.4	88.2
11					93.3
12					97.9

Location of Traverse Points in Rectangular Stacks

	2	3	4	5	6	7	8
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8
3		83.3	62.5	50.0	41.7	35.7	31.3
4			87.5	70.0	58.3	50.0	43.8
5				90.0	75.0	64.3	56.3
6					91.7	78.6	68.8
7						92.9	81.3
8							93.8
9							
10							
11							
12							

Point No.	% of Stack ID	Stack ID, in.	Distance From Inside Wall, in.	Nipple Length, in.	Distance From Outside of Port, in.
1	2.1	6.0	0.126	2.25	2.75
2	6.7		0.402		2.75
3	11.8		0.708		2.96
4	17.7		1.062		3.31
5	25.0		1.500		3.75
6	35.6		2.136		4.39
7	64.4		3.864		6.11
8	75.0		4.500		6.75
9	82.3		4.938		7.19
10	88.2		5.292		7.54
11	93.3		5.600 5.78 LRC		7.75
12	97.9		5.874		7.75

Stack Diameter = 12 - 24 inches Relocate to 0.50 inches
Stack Diameter > 24 inches Relocate to 1.00 inches

707

Audited by: MY Date: 02/10/99

PASSED QA

TRIGON

EPA Method 2

Determination of Stack Gas Velocity, Volumetric Flow Rate and Cyclonic Flow

Client: ENVITCO
Sampling Location: MELTER - MAIN CHAMBER EXHAUST
Run Date: 1-19-99
Barometric Pressure, in. Hg: ~~29.47~~ 29.38 RFC
Static Pressure, in. H_2O: -3.8
Static Pressure, in. Hg: -0.279
Stack Pressure, in. Hg: 29.101
Stack Dimensions, in., diameter/side 1: 6.0

City, State: CLEMSON, SC
Operators: RFC, JPK
Time: 1200
Pitot Tube I.D. No.: 200.049
Date Calibrated: 1-4-99
Pitot Tube Coefficient: 0.84
Leak Check, in. H_2O <0.1 @: +3.0, -3.0
Side 2, in.: ——

Field Data

Traverse Point Number	Velocity Head Δp Inches H_2O		Stack Temperature °F		Cyclonic Flow Determination: Δp_s at 0° Reference		Cyclonic Flow Determination: Angle Which Yields a Null Δp	
A 1	0.89		570		0.15		13	
2	1.10		576		0.12		11	
3	1.55		634		0.10		10	
4	2.35		632		0.10		10	
5	2.50		691		0.10		10	
6	0.67		635		0.07		8	
B 1	2.10		676		0.08		10	
2	2.00		682		0.10		10	
3	1.70		642		0.12		5	
4	1.60		501		0.14		11	
5	1.40		488		0.10		9	
6	1.25		475		0.05		7	
Averages	1.59 ✓		600.2 ✓				9.5 ✓	

Stack Temperature, Dry, °F (A): 600
Difference (A - B): 455

Stack Temperature, Wet °F (B): 145 (ESTIMATE)
Preliminary Percent Moisture: 5.0 (ESTIMATE)

Comments: 708

PASSED QA

Audited by: RJB Date: 01/19/99

TRIGON

Isokinetic Field Data Sheet - EPA Method 8

Client: ENVITCO

Run Number: 2291

City/State: CLEMSON, SC

Date: 1-19-99

Sampling Location: MELTER - MAIN CHAMBER EXHAUST

Operators: JPK, RFC

Bar. Press., In. Hg: 29.38

Static Press., In. H_2O: -3.8

Meter Box No.: 300.045

Sample Box No.: FRAME 15

Probe/Pitot No.: 20297 200.049

Probe Temp. Setting: 250

Sample ID No.: 8158-01

Filter No.: ~~8158-01~~

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00

Meter Temp.: 90

Stack Temp.: 600

Pitot Coeff.: 0.84

% Moisture: 5

C Factor: 1.017

Start Time: 1254

Avg. Δ P: 1.59

Ref. Δ P: 2.69

Desired Nozzle: 0.217

Nozzle No.: 300.029

Nozzle Calibration: 0.190 0.189 0.191

Nozzle Diameter: 0.190

End Time: 1358

LEAK CHECKS

Pre-Test: 0.001 @ 16 In. Hg.

Post-Test: 0.001 @ 6 In. Hg.

Pre-Test Pitot <0.1 @ 7.3, 4.2 In. H_2O

Post-Test Pitot <0.1 @ 6.6, 3.5 In. H_2O

Observer: —

Agency: —

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading Δ P In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	477.18	0.89	0.61	0.61	83	83	2.0	548	NA	67
2	5	479.44	1.10	0.75	0.75	84	83	2.5	572		49
3	10	481.70	1.55	1.06	1.06	86	84	3.0	618		46
4	15	484.52	2.35	1.61	1.61	89	84	4.0	631		48
5	20	487.97	2.50	1.71	1.71	93	86	4.0	647		54
6	25	491.50	0.67	0.46	0.46	95	87	2.0	608		63
B 1	30	493.43	2.10	1.44	1.44	92	87	3.5	637		65
2	35	496.69	2.00	1.37	1.37	95	88	3.5	653		59
3	40	499.97	1.70	1.16	1.16	98	89	3.0	664		60
4	45	502.92	1.60	1.09	1.09	99	90	3.0	672		57
5	50	505.87	1.40	0.96	0.96	100	91	3.0	647		57
6	55	508.63	1.25	0.85	0.85	100	91	3.0	654		58
	60	511.24									
		34.06	1.59		1.09		89.9		629.3		

Audited by: RJB Date: 01/19/99

PASSED QA

709

TRIGON

Isokinetic Field Data Sheet - EPA Method 8

2291

Client: ENVITCO
City/State: CLEMSON, SC
Sampling Location: MELTER - MAIN CHAMBER EXHAUST
Run Number: E
Date: 01/19/99
Operators: JPK/RFC

Bar. Press., In. Hg: 29.29
Static Press., In. H_2O: -3.70
Meter Box No.: 300.045
Sample Box No.: Frame 14
Probe/Pitot No.: 200.049
Probe Temp. Setting: 250
Sample ID No.: 8158-02
Filter No.:

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00
Meter Temp.: 97
Stack Temp.: 630
Pitot Coeff.: 0.84
% Moisture: 1
C Factor: 0.995
Start Time: ~~1442~~ 1442
Avg. ΔP: 1.57
Ref. ΔP: 4.12
Desired Nozzle: 0.220
Nozzle No.: 300.028
Nozzle Calibration: 0.172 0.173 0.174
Nozzle Diameter: 0.173
End Time: 1555

LEAK CHECKS

Pre-Test: 0.002 @ 15 In. Hg.
Post-Test: 0.002 @ 4 In. Hg.
Pre-Test Pitot <0.1 @ +3.0,-3.0 In. H_2O
Post-Test Pitot <0.1 @ +3.0,-3.0 In. H_2O
Observer: NONE
Agency: NONE

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading ΔP In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	511.55	0.79	0.35	0.35	91	91	1.5	534	NA	57
2	5	513.38	1.00	0.45	0.45	91	92	1.5	545		46
3	10	515.21	1.50	0.67	0.67	94	92	2.0	643		50
4	15	517.52	2.30	1.03	1.03	95	93	3.0	674		47
5	20	520.30	2.20	0.98	0.98	98	93	3.0	627		52
6	25	522.85	1.80	0.80	0.80	100	94	3.0	634		56
B 1	30	525.56	2.00	0.89	0.89	99	95	3.0	614		65
2	35	528.19	1.90	0.85	0.85	102	96	3.0	611		59
3	40	530.77	1.80	0.80	0.80	100	95	2.5	610		56
4	45	533.32	1.70	0.76	0.76	98	95	2.5	604		59
5	50	535.63	0.85	0.38	0.38	97	95	2.0	615		60
6	55	537.93	1.05	0.47	0.47	96	95	2.0	595		60
5	60	539.63	0.85	0.38	0.38	95	94	1.5	598		59
4	65	541.49	1.70	~~0.38~~ 0.76	0.76	94	94	2.5	602		63
3	70	543.94	~~1.80~~ ~~0.80~~ PK								
			1.53		0.68						
		32.39	~~1.5~~ RJD		0.70 RJD		95.1		607.6		

Audited by: [illegible] Date: 01/19/99

710

PASSED QA

TRIGON

Isokinetic Field Data Sheet - EPA Method 8

Client: EnviTCo | Run Number: 3 | 2291

City/State: Clemson, SC | Date: 1-19-99

Sampling Location: Melter - Main Chamber Exhaust | Operators: RFC, JPK

Bar. Press., In. Hg: 29.29

Static Press., In. H_2O: -4.10

Meter Box No.: 300.045

Sample Box No.: Frame 15

Probe/Pitot No.: 200.049

Probe Temp. Setting: 250

Sample ID No.: 8158-03

Filter No.: NA

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00

Meter Temp.: 100

Stack Temp.: 620

Pitot Coeff.: 0.84

% Moisture: 7

C Factor: 1.000

Start Time: 1620

Avg. ΔP: 1.58

Ref. ΔP: 1.08

Desired Nozzle: 0.219

Nozzle No.: 300.289

Nozzle Calibration: .241, .242, .241

Nozzle Diameter: 0.241

End Time: 1727

LEAK CHECKS

Pre-Test 0.001 @ 16 In. Hg.

Post-Test 0.002 @ 7 In. Hg.

Pre-Test Pitot <0.1 @ 7.7, 3.8 In. H_2O

Post-Test Pitot <0.1 @ 8.0, 4.1 In. H_2O

Observer:

Agency:

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading ΔP In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	544.51	0.79	1.35	1.35	91	92	2.50	552	NA	67
2	5	547.70	1.20	2.05	2.05	94	93	3.5	562		55
3	10	551.53	1.60	2.73	2.73	100	94	5.0	589		60
4	15	556.61	2.10	3.59	3.59	105	95	6.0	668		55
5	20	561.27	2.20	3.76	3.76	109	96	6.5	657		54
6	25	566.42	2.20	3.76	3.76	110	97	6.5	654		57
B 1	30	571.73	1.70	2.90	2.90	100	97	5.0	627		59
2	35	576.31	1.60	2.73	2.73	105	97	5.0	622		54
3	40	580.84	1.55	2.65	2.65	107	97	5.0	592		52
4	45	585.34	1.40	2.39	2.39	108	98	5.0	~~583~~ 593		53
5	50	589.62	1.40	2.39	2.39	108	98	4.5	590		51
6	55	593.94	1.25	2.13	2.13	109	99	4.0	590		55
	60	597.99									
		53.48	1.58		2.70		~~95.5~~ 100.0		608.0		

Audited by: MY Date: 01/19/99

711

PASSED QA

TRIGON

Isokinetic Field Data Sheet - EPA Method 8

2291

Client: ENVITCO

Run Number:

City/State: CLEMSON, SC

Date: 1-19-99

Sampling Location: MELTER - MAIN CHAMBER EXHAUST

Operators: RFC, JPK

Bar. Press., In. Hg: 29.32

Static Press., In. H_2O: -4.3

Meter Box No.: 300.045

Sample Box No.: FRAME 14

Probe/Pitot No.: 200.049

Probe Temp. Setting: 250

Sample ID No.: 8158-04

Filter No.: NA

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00

Meter Temp.: 100

Stack Temp.: 610

Pitot Coeff.: 0.84

% Moisture: 7.0

C Factor: 1.000

Start Time: 1750

Avg. Δ P: 1.80

Ref. Δ P: 0.98

Desired Nozzle: 0.241

Nozzle No.: 300.024

Nozzle Calibration: 0.246, 0.246, 0.247

Nozzle Diameter: 0.246

End Time: 1853

LEAK CHECKS

Pre-Test 0.002 @ 14 In. Hg.

Post-Test 0.002 @ 13 In. Hg.

Pre-Test Pitot <0.1 @ 7.2, 3.1 In. H_2O

Post-Test Pitot <0.1 @ 6.5, 3.3 In. H_2O

Observer: —

Agency: —

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading Δ P In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	598.33	1.10	2.06	2.06	94	94	4.0	555	NA	66
2	5	602.06	1.70	3.18	3.18	96	95	7.0	597		46
3	10	606.85	1.90	3.56	3.56	101	95	10.0	633		64
4	15	612.13	2.50	4.68	4.68	105	95	12.0	644		65
5	20	617.48	2.40	4.49	4.49	107	96	12.0	648		67
6	25	623.18	2.10	3.93	3.93	107	96	10.5	626		67
B 1	30	628.57	1.90	3.56	3.56	109	96	9.0	647		66
2	35	633.71	1.90	3.56	3.56	106	96	9.0	639		62
3	40	638.80	1.80	3.37	3.37	108	96	9.0	646		57
4	45	643.86	1.50	2.81	2.81	108	96	7.0	615		55
5	50	648.54	1.50	2.81	2.81	108	96	7.0	613		55
6	55	653.14	1.35	2.53	2.53	107	96	6.0	614		53
	60	657.52									
		59.19	1.80		3.38		100.1		623.1		

94.77 ft³

Audited by: MY Date: 01/19/99

PASSED QA

712

TRIGON

Isokinetic Field Data Sheet - EPA Method 8

Client: ENVITCO
City/State: CLEMSON, SC
Sampling Location: MELTER - MAIN CHAMBER EXHAUST

Run Number: 2291
Date: 1-19-99
Operators: RFC, JPK

Bar. Press., In. Hg: 29.29
Static Press., In. H_2O: -4.4
Meter Box No.: 300,045
Sample Box No.: FRAME 14
Probe/Pitot No.: 200.049
Probe Temp. Setting: 250
Sample ID No.: 8158-05
Filter No.: NA

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00
Meter Temp.: 100
Stack Temp.: 620
Pitot Coeff.: 0.84
% Moisture: 7.0
C Factor: 1.000
Start Time: 1912

Avg. ΔP: 1.61
Ref. ΔP: 1.08
Desired Nozzle: 0.218
Nozzle No.: 300.289
Nozzle Calibration: 0.241, 0.240, 0.241
Nozzle Diameter: 0.241
End Time: 2014

LEAK CHECKS

Pre-Test 0.003 @ 14 In. Hg.
Post-Test 0.002 @ 9 In. Hg.
Pre-Test Pitot <0.1 @ 7.4, 4.0 In. H_2O
Post-Test Pitot <0.1 @ +3.0, -3.0 In. H_2O
Observer: —
Agency: —

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading ΔP In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	657.80	0.95	1.62	1.62	94	93	3.0	616	NA	63
2	5	661.22	1.20	2.05	2.05	93	92	3.5	598		50
3	10	665.10	1.75	2.99	2.99	98	93	3.5	596		50
4	15	669.76	2.45	4.18	4.18	100	91	8.0	699		56
5	20	675.19	2.45	4.18	4.18	104	92	8.0	715		64
6	25	680.76	1.00	1.71	1.71	104	92	3.5	605		67
B 1	30	684.48	1.90	3.25	3.25	96	91	5.5	637		65
2	35	689.35	1.80	3.07	3.07	100	91	5.5	655		64
3	40	694.03	1.85	3.16	3.16	101	91	5.5	660		65
4	45	699.00	1.45	2.48	2.48	101	91	5.0	592		60
5	50	703.27	1.50	2.56	2.56	101	91	5.0	586		59
6	55	707.62	0.98	1.67	1.67	100	91	3.5	582		60
	60	711.19									
		53.39	1.61		2.74		95.5		628.4		

Audited by: RJB Date: 01/20/99

PASSED QA

713

TRIGON

Isokinetic Field Data Sheet - EPA Method 8

Run Number 2291

Client ENVITCO

City/State CLEMSON, SC

Date ~~01/20/99~~ 1/19/99 RFC

Sampling Location MELTER - MAIN CHAMBER EXHAUST

Operators JPK

Bar. Press., In. Hg 29.29

Static Press., In. H_2O -4.10

Meter Box No. 300.045

Sample Box No. Train 14

Probe/Pitot No. 200.049 (200.047)

Probe Temp. Setting 250

Sample ID No. 8158-06

Filter No. N/A

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00

Meter Temp. 97

Stack Temp. 630

Pitot Coeff. 0.84

% Moisture 7

C Factor 0.995

Start Time 2028

Avg. Δ P 1.55

Ref. Δ P 0.99

Desired Nozzle 0.221

Nozzle No. 300.024

Nozzle Calibration 0.247 0.247 0.246

Nozzle Diameter 0.247

End Time JPK ~~2135~~ 2130

LEAK CHECKS

Pre-Test 0.002 @ 15 In. Hg.

Post-Test 0.002 @ 12 In. Hg.

Pre-Test Pitot <0.1 @ +3.0,-3.0 In. H_2O

Post-Test Pitot <0.1 @ +3.0,-3.0 In. H_2O

Observer NONE

Agency NONE

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading Δ P In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	711.35	1.25	2.32	2.32	86	87	5.5	JPK ~~5.5~~ 612	NA	59
2	5	715.46	1.20	2.23	2.23	89	87	5.5	603		49
3	10	719.50	2.00	3.71	3.71	94	87	9.5	698		52
4	15	724.63	2.20	4.09	4.09	97	88	10.5	699		59
5	20	730.04	2.15	3.99	3.99	99	88	11.0	718		62
6	25	735.50	1.65	3.06	3.06	100	88	8.5	611		65
B 1	30	740.45	1.50	2.79	2.79	94	88	7.0	649		67
2	35	744.90	1.20	2.23	2.23	97	88	6.0	655		67
3	40	749.01	1.20	2.23	2.23	97	87	6.0	663		61
4	45	753.13	1.25	2.32	2.32	97	87	6.0	622		59
5	50	757.24	1.45	2.69	2.69	97	87	6.5	614		57
6	55	761.65	1.50	2.79	2.79	98	88	6.5	594		58
	60	766.08									
					2.87						
		54.73	1.55		JPK ~~2.88~~		91.5		644.8		

Audited by: RJB Date: 01/20/99

PASSED QA

714

TRIGON

EPA Methods 4 and 8 - Moisture Determination and Sample Recovery - Data Analysis

2291

Client Name: EnviTco
City/State: CLEMSON, SC
Sampling Location: MELTER EXHAUST
Clean-Up Box Number: M8
Chain of Custody: Date Received: 01/20/99

Project Number: 046-98-158
Sample Date: 1-19-99
Samples Recovered By: RFC
Recovery Date: 1-19-99
Received By: PRJ Locked? ✓

Equipment Documentation

Run Number	1	2	3	4
Sample ID Number	8158-01	8158-02	8158-03	8158-04
Sample Box Number	FRAME 15	FRAME 14	FRAME 15	Frame 14
Probe Number	200.297	200.066	200.297	200.066

Analysis of Moisture and Sample Recovery - Sulfuric Acid

Reagent Recovery Container #	8158-01	8158-02	8158-03	8158-04
Impinger Absorbing Solution	80% IPA	80% IPA	80% IPA	80% IPA
Description of Reagent	CLEAR	clear	clear	clear
Reagent Level Marked?	✓	✓	✓	✓
Final Volume, ml	56	61	54	65
Initial Volume, ml	100	100	100	100
Net Condensed Volume, ml	-44	-39	-46	-35
80% Isopropanol Rinse?	✓	✓	✓	✓
Dilute to 250 ml in Isopropanol?	✓	✓	✓	✓

Analysis of Moisture and Sample Recovery - Sulfur Dioxide

Reagent Recovery Container #	8158-01	8158-02	8158-03	8158-04
Impinger Absorbing Solution	3% H_2O_2	3% H_2O_2	3% H_2O_2	3% H_2O_2
Description of Reagent	CLEAR	clear	clear	clear
Reagent Level Marked?	✓	✓	✓	✓
Final Volume, ml	270	265	270	275
Initial Volume, ml	200	200	200	200
Net Condensed Volume, ml	70	65	70	75
Distilled Water Rinse?	✓	✓	✓	✓
Dilute to 1000 ml in DI Water?	✓	✓	✓	✓

Analysis of Moisture Recovery

Silica Gel Recovery Container #	1	2	3	4
Percent Silica Gel Spent	70%	70%	90%	90%
Final Weight, g	224.2	224.2	238.3	241.5
Initial Weight, g	200.0	200.0	200.0	200.0
Net Absorbed Water, g	24.2	24.2	38.3	41.5
Total Moisture Collected, ml	50.2	50.2	62.3	81.5

Reagent Blanks

Absorbing Reagent Blank	80% IPA	Rinsing Reagent Blank	80% IPA
Absorbing Blank Identification #	8158-07	Rinsing Blank Identification #	8158-07
Absorbing Reagent Blank	3% H_2O_2	Rinsing Reagent Blank	DI
Absorbing Blank Identification #	8158-07	Rinsing Blank Identification #	8158-07

PASSED QA

RJB 9/20/99

715

TRIGON

EPA Methods 4 and 8 - Moisture Determination and Sample Recovery - Data Analysis

2291

Client Name: EnVitCo
City/State: Clemson, SC
Sampling Location: Melter Exhaust
Clean-Up Box Number: M8
Chain of Custody: Date Received: 01/20/99

Project Number: 046-98-158
Sample Date: 01/19/99
Samples Recovered By: PKS
Recovery Date: 01/19/99
Received By: PRJ Locked? ✓

Equipment Documentation

Run Number	5	6		
Sample ID Number	8158-05	8158-06		
Sample Box Number	Frame 15	Frame 14		
Probe Number	200.297	200.066		

Analysis of Moisture and Sample Recovery - Sulfuric Acid

Reagent Recovery Container #	8158-05	8158-06		
Impinger Absorbing Solution	80% IPA	80% IPA		
Description of Reagent	clear	clear		
Reagent Level Marked?	✓	✓		
Final Volume, ml	58	50		
Initial Volume, ml	100	100		
Net Condensed Volume, ml	-42	-50		
80% Isopropanol Rinse?	✓	✓		
Dilute to 250 ml in Isopropanol?	✓	✓		

Analysis of Moisture and Sample Recovery - Sulfur Dioxide

Reagent Recovery Container #	8158-05	8158-06		
Impinger Absorbing Solution	3% H_2O_2	3% H_2O_2		
Description of Reagent	clear	clear		
Reagent Level Marked?	✓	✓		
Final Volume, ml	288	305		
Initial Volume, ml	200	200		
Net Condensed Volume, ml	88	105		
Distilled Water Rinse?	✓	✓		
Dilute to 1000 ml in DI Water?	✓	✓		

Analysis of Moisture Recovery

Silica Gel Recovery Container #	5	6		
Percent Silica Gel Spent	80%	90%		
Final Weight, g	242.6	236.3		
Initial Weight, g	200.0	200.0		
Net Absorbed Water, g	42.6	36.3		
Total Moisture Collected, ml	88.6	91.3		

Reagent Blanks

Absorbing Reagent Blank	80% IPA	Rinsing Reagent Blank	80% IPA
Absorbing Blank Identification #	8158-07	Rinsing Blank Identification #	8158-07
Absorbing Reagent Blank	3% H_2O_2	Rinsing Reagent Blank	DI
Absorbing Blank Identification #	8158-07	Rinsing Blank Identification #	8158-07

RJB 01/20/99

716

TRIGON

Isokinetic Field Data Sheet - EPA Method 5/29

F 2291

Client: EnVitCo

Run Number:

City/State: Clemson, SC

Date: 01-20-99

Sampling Location: Melter - Main Chamber Exhaust

Operators: JPK RFC

Bar. Press., In. Hg: 29.29

Static Press., In. H_2O: -3.75

Meter Box No.: 300.045

Sample Box No.: 4

Probe/Pitot No.: 200.049 (200.297)

Probe Temp. Setting: 250

Sample ID No.: 8158-08

Filter No.: 9147

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00

Meter Temp.: 90

Stack Temp.: 640

Pitot Coeff.: 0.84

% Moisture: 7

C Factor: 0.983

Start Time: 1000

Avg. ΔP: 1.65

Ref. ΔP: 1.01

Desired Nozzle: 0.219

Nozzle No.: 300.091

Nozzle Calibration: 0.247 0.247 0.246

Nozzle Diameter: 0.247

End Time: 1102

LEAK CHECKS

Pre-Test: 0.002 @ 15 In. Hg.

Post-Test: 0.002 @ 6 In. Hg.

Pre-Test Pitot <0.1 @ 7.4 3.5 In. H_2O

Post-Test Pitot <0.1 @ 7.2, 3.4 In. H_2O

Observer: —

Agency: —

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading ΔP In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	766.46	0.96	1.74	~~1.74~~ JPK 1.74	88	87	2.5	629	265	67
2	5	770.03	1.10	2.00	2.00	90	88	2.5	631	259	57
3	10	775.87	1.70	3.09	3.09	93	88	4.0	646	248	59
4	15	778.63	2.50	4.54	4.54	98	90	5.5	684	252	64
5	20	784.26	2.30	4.18	4.18	102	91	5.0	729	252	65
6	25	789.86	2.40	4.36	4.36	105	93	5.0	730	252	66
B 1	30	795.48	1.30	2.36	2.36	102	95	3.0	648	250	65
2	35	799.67	1.40	2.54	2.54	104	95	4.0	682	250	64
3	40	804.04	1.60	2.91	2.91	106	95	4.0	669	250	66
4	45	808.67	1.55	2.82	2.82	107	96	4.0	682	249	64
5	50	813.26	1.65	3.00	3.00	108	97	4.0	615	250	65
6	55	818.01	1.35	2.45	2.45	109	97	3.5	590	249	67
	60	822.32									
									661.3		
		55.86	1.65		3.00		96.8		~~661.3~~ JPK		

Audited by: RFC Date: 1/21/99

PASSED QA

717

TRIGON

Isokinetic Field Data Sheet - EPA Method 5/29

Client: EnVitCo

City/State: Clemson, SC

Sampling Location: Melter - Main Chamber Exhaust

Run Number: F2 2291

Date: 01-20-99

Operators: JPK RJB

Bar. Press., In. Hg: 29.26

Static Press., In. H_2O: -4.00

Meter Box No.: 300.045

Sample Box No.: ~~JPK 200.049~~ 300.10

Probe/Pitot No.: 200.066 200.049

Probe Temp. Setting: 250

Sample ID No.: 8158-09

Filter No.: Q148

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00

Meter Temp.: 105

Stack Temp.: 660

Pitot Coeff.: 0.84

% Moisture: 7

C Factor: 1.009

Start Time: 1150

Avg. Δ P: 1.40

Ref. Δ P: 1.04

Desired Nozzle: 0.227

Nozzle No.: 300.267

Nozzle Calibration: 0.245 0.246 0.245

Nozzle Diameter: 0.245

End Time: 1252

LEAK CHECKS

Pre-Test: 0.002 @ 15 In. Hg.

Post-Test: 0.002 @ 5 In. Hg.

Pre-Test Pitot <0.1 @ 74, 3.5 In. H_2O

Post-Test Pitot <0.1 @ 7.2, 3.6 In. H_2O

Observer: —

Agency: —

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading Δ P In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	822.56	0.93	1.65	1.65	93	95	2.0	622	253	67
2	5	826.13	0.91	1.62	1.62	95	95	2.0	623	253	47
3	10	829.59	0.55	2.75	2.75	98	95	3.0	664	253	45
4	15	834.48	2.20	3.90	3.90	103	95	4.5	664	253	49
5	20	839.37	1.85	3.28	3.28	106	96	4.0	663	254	56
6	25	~~844.34~~	1.20	2.13	2.13	107	96	3.0	655	253	63
B 1	30	848.48	1.20	2.13	2.13	103	98	2.5	663	252	64
2	35	852.39	1.10	1.95	1.95	106	98	2.5	649	252	58
3	40	856.30	1.40	2.48	2.48	107	99	3.0	666	254	57
4	45	860.65	1.45	2.57	2.57	109	99	3.0	624	251	56
5	50	865.12	1.50	2.66	2.66	110	99	3.0	614	251	58
6	55	869.61	1.45	2.57	2.57	109	100	3.0	603	250	59
	60	~~847.04~~									
		874.04									
		51.48	1.40		2.47		100.5		642.5		

Audited by: RFC Date: 1/21/99

PASSED QA

718

TRIGON

Isokinetic Field Data Sheet - EPA Method 5/29

Client: EnVitCo

Run Number: F 229 1

City/State: Clemson, SC

Date: 01-20-99

Sampling Location: Mecter - Main Chamber Exhaust

Operators: JPK RJB

Bar. Press., In. Hg: 29.21

Static Press., In. H_2O: -4.5

Meter Box No.: 300.045

Sample Box No.: 4

Probe/Pitot No.: 200.049

Probe Temp. Setting: 250

Sample ID No.: 8158-10

Filter No.: Q152

NOMOGRAPH SET-UP

ΔH @ 1.84 Y = 1.00

Meter Temp.: 105

Stack Temp.: 640

Pitot Coeff.: 0.84

% Moisture: 7

C Factor: 1.009

Start Time: 1402

Avg. Δ P: 1.55

Ref. Δ P: 1.02

Desired Nozzle: 0.221

Nozzle No.: ~~300.031~~ JPK 300267

Nozzle Calibration: 0.245 0.246 0.245

Nozzle Diameter: 0.245

End Time: 1505

LEAK CHECKS

Pre-Test 0.002 @ 15 In. Hg.

Post-Test 0.001 @ 7 In. Hg.

Pre-Test Pitot <0.1 @ 7.3, 35 In. H_2O

Post-Test Pitot <0.1 @ 7.2, 3.6 In. H_2O

Observer:

Agency:

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading Δ P In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	874.28	0.84	1.52	1.52	100	99	2.5	629	250	65
2	5	877.72	0.98	1.77	1.77	102	100	2.5	631	252	56
3	10	881.38	1.50	2.71	2.71	104	100	3.5	619	252	53
4	15	885.82	2.35	4.25	4.25	109	101	5.5	690	252	56
5	20	891.40	2.15	3.89	3.89	112	101	5.0	706	253	60
6	25	896.77	2.15	3.89	3.89	115	102	5.0	703	253	65
B 1	30	902.43	1.60	2.89	2.89	115	102	4.0	617	253	66
2	35	906.97	1.55	2.80	2.80	113	103	4.0	655	254	61
3	40	911.58	1.30	2.35	2.35	114	104	3.5	653	252	60
4	45	915.82	1.45	2.62	2.62	115	105	4.0	616	253	62
5	50	920.28	1.40	2.53	2.53	115	105	4.0	634	252	63
6	55	924.73	1.30	2.35	2.35	116	105	4.0	626	251	65
	60	929.10									
									650.3		
		54.82	1.55		2.80		106.5		650.3		

Audited by: RFC Date: 1/21/99

PASSED QA

719

TRIGON

EPA Methods 4 and 29 - Moisture Determination and Sample Recovery - Data Analysis

2291

Client Name: EnVirCo
Project Number: 046-98-158
City/State: Clemson, SC
Sample Date: 1-20-99
Sampling Location: Melter - Main Chamber Exh.
Samples Recovered By:
Clean-Up Box Number: M5/29
Recovery Date: 1-20-99
Chain of Custody: Date Received: 1-21-99
Received By: MV
Locked? ✓

Equipment Documentation

Run Number	1	2	3	
Sample ID Number	8158-08	8158-09	8158-10	
Sample Box Number	4	10	4	
Probe Number	200.297	200.066	200.297	

Inorganic Metals Sample Recovery - Fraction 1

Filter Container #	Q147	Q148	Q152	
Particulate Description	gray w/ particles	gray w/ particles	gray w/ particles	
Filter Container Sealed?	✓	✓	✓	

Inorganic Metals Sample Recovery - Fraction 3

Probe Rinse Container #	8158-08	8158-09	8158-10	
Rinsing Solution	0.1N HNO_3	0.1N HNO_3	0.1N HNO_3	
Sample Container Sealed?	✓	✓	✓	
Liquid Level Marked?	✓	✓	✓	

Analysis of Moisture and Sample Recovery - Fraction 4

Reagent Recovery Container #	8158-11	8158-12	8158-13	
Impinger Absorbing Solution	5% HNO_3/10% H_2O_2	5% HNO_3/10% H_2O_2	5% HNO_3/10% H_2O_2	
Description of Reagent	clear	clear	clear	
Reagent Level Marked?	✓	✓	✓	
Final Volume, ml	276	280	290	
Initial Volume, ml	200	200	200	
Net Condensed Volume, ml	76	80	90	
Silica Gel Recovery Container #	1	2	3	
Percent Silica Gel Spent	50	40	40	
Final Weight, g	220.7	215.4	215.0	
Initial Weight, g	200.0	200.0	200.0	
Net Absorbed Water, g	20.7	15.4	15.0	
Total Reagent Collected, g	96.7	95.4	105.0	

Reagent Blanks

Absorbing Reagent Blank	5% HNO_3/10% H_2O_2	Rinsing Reagent Blank	acetone i 0.1N HNO_3
Absorbing Blank Identification #	8158-14	Rinsing Blank Identification #	8158-14
Analyst Initials	MR		
Reviewer Initials	RFC		

PASSED QA

720

TRIGON

EPA Method 1
Determination of Sampling Ports and Points

2291

Client: EnVitco
Sampling Location: ESP STACK
City/State: Clemson, SC
Date: 12-4-98

Sampling Location Dimensions:

From Far Wall to Outside of Port	24.0
Nipple Length	4.0
Depth of Duct	20.0
Width (Rectangular Duct)	—

Equivalent Diameter Calculation (DE):

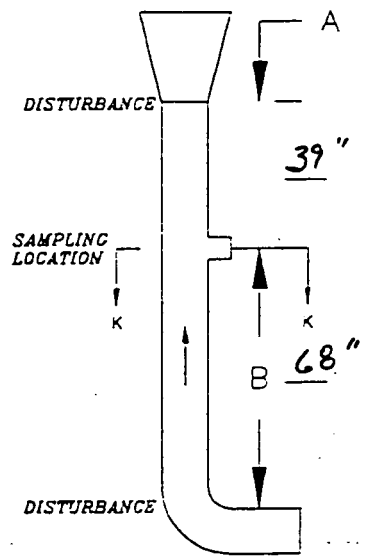
$$DE = \frac{2 \times \text{Length} \times \text{Width}}{\text{Length} - \text{Width}} = \frac{2(\_\_)(\_\_)}{(\_\_ + \_\_)} = \_\_$$

Distance to Ports From Nearest Flow Disturbance:

	Upstream - A	Downstream - B
Dimensions in Inches	39	68
Duct Diameters	1.95	3.40

Stack Area, in Square Feet 2.182

Calculations By RFC



Schematic of Sampling Location

Location of Traverse Points in Circular Stacks

	4	6	8	10	12
1	6.7	4.4	3.2	2.6	2.1
2	25.0	14.6	10.5	8.2	6.7
3	75.0	29.6	19.4	14.6	11.8
4	93.3	70.4	32.3	22.6	17.7
5		85.4	67.7	34.2	25.0
6		95.6	80.6	65.8	35.6
7			89.5	77.4	64.4
8			96.8	85.4	75.0
9				91.8	82.3
10				97.4	88.2
11					93.3
12					97.9

Location of Traverse Points in Rectangular Stacks

	2	3	4	5	6	7	8
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8
3		83.3	62.5	50.0	41.7	35.7	31.3
4			87.5	70.0	58.3	50.0	43.8
5				90.0	75.0	64.3	56.3
6					91.7	78.6	68.8
7						92.9	81.3
8							93.8
9							
10							
11							
12							

Point No.	% of Stack ID	Stack ID, in.	Distance From Inside Wall, in.	Nipple Length, in.	Distance From Outside of Port, in.
1	2.1	20.0	0.420	4.0	4.50
2	6.7		1.340		5.34
3	11.8		2.360		6.36
4	17.7		3.540		7.54
5	25.0		5.000		9.00
6	35.6		7.120		11.12
7	64.4		12.880		16.88
8	75.0		15.000		19.00
9	82.3		16.460		20.46
10	88.2		17.640		21.64
11	93.3		18.660		22.66
12	97.9		19.580		23.50

Stack Diameter = 12 - 24 inches Relocate to 0.50 inches
Stack Diameter > 24 inches Relocate to 1.00 inches

Audited by: RFC Date: 1/21/99

PASSED QA

721

TRIGON

EPA Method 2
Determination of Stack Gas Velocity, Volumetric Flow Rate and Cyclonic Flow

2291

Client: ENVITCO
Sampling Location: ESP STACK
Run Date: 1-20-99
Barometric Pressure, in. Hg: 24.26
Static Pressure, in. H_2O: -0.010
Static Pressure, in. Hg: -0.001
Stack Pressure, in. Hg: 29.25
Stack Dimensions, in., diameter/side 1: 20.0

City, State: CLEMSON, SC
Operators: RRS
Time: 0832
Pitot Tube I.D. No.: 200.037
Date Calibrated: 01/04/99
Pitot Tube Coefficient: 0.84
Leak Check, in. H_2O <0.1 @ 3.6, 3.2
Side 2, in.: –

Field Data

Traverse Point Number	Velocity Head Δp Inches H_2O		Stack Temperature °F		Cyclonic Flow Determination: Δp_s at 0° Reference		Cyclonic Flow Determination: Angle Which Yields a Null Δp	
A 1	0.105		188		-0.015		5	
2	0.100		188		-0.015		5	
3	0.090		189		-0.020		10	
4	0.100		189		-0.020		10	
5	0.095		185		-0.025		15	
6	0.085		188		-0.025		15	
7	0.070		187		-0.025		15	
8	0.070		187		-0.020		10	
9	0.075		187		-0.015		5	
10	0.075		187		-0.005		5	
11	0.085		186		0.000		0	
12	0.070		186		0.000		0	
B 1	0.085		185		possible		angle finder	
2	0.085		186		turbulance		indicates	
3	0.090		186		from		25 - 45	
4	0.080		187		extra port		degrees	
5	0.085		187		: opacity		↓	
6	0.095		187		monitor			
7	0.105		185		-0.010		10	
8	0.105		186		-0.005		5	
9	0.110		185		-0.020		10	
10	0.100		185		-0.020		10	
11	0.105		185		-0.015		5	
12	0.085		185		-0.015		5	
Averages	0.090		186.6				<15	

Stack Temperature, Dry, °F (A): 185
Stack Temperature, Wet °F (B): 98
Difference (A - B): 87
Preliminary Percent Moisture: 2.9

Comments:

PASSED QA Audited by: RFC Date: 1/21/99

722

TRIGON

Isokinetic Field Data Sheet - EPA Method 5/29

Client: EnVitCo
City/State: Clemson, SC
Sampling Location: ESP Stack

Run Number: 1 — 2291
Date: 1-20-99
Operators: RFC

Bar. Press., In. Hg: ~~29.36~~ Rec 29.29

NOMOGRAPH SET-UP

Static Press., In. H_2O: -0.010 | ΔH @ 1.39 | Y = 1.00 | Avg. ΔP: 0.090
Meter Box No.: 300.200 | Meter Temp.: 70 | Ref. ΔP: 0.10
Sample Box No.: B3 | Stack Temp.: 186 | Desired Nozzle: 0.340
Probe/Pitot No.: 200.037 | Pitot Coeff.: 0.84 | Nozzle No.: 300.077
Probe Temp. Setting: 240 | % Moisture: 2.9 | Nozzle Calibration: 0.378, 0.378, 0.379
Sample ID No.: 8158-11 | C Factor: 1.042 | Nozzle Diameter: 0.378
Filter No.: Q149 | Start Time: 1000 | End Time: 1100

LEAK CHECKS

Pre-Test: 0.001 @ 15 In. Hg.
Post-Test: 0.011 @ 5 In. Hg.
Pre-Test Pitot <0.1 @ 0.25, 0.25 In. H_2O
Post-Test Pitot <0.1 @ 0.25, 0.20 In. H_2O
Observer: —
Agency: —

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading ΔP In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	386.85	0.11	2.00	2.00	55	53	2.00	192	242	57
2	2.5	388.67	0.10	1.82	1.82	58	53	2.0	194	240	42
3	5.0	390.40	0.10	1.82	1.82	59	54	2.0	193	243	40
4	7.5	392.17	0.07	1.27	1.27	60	54	2.0	193	240	40
5	10.0	393.70	0.085	1.55	1.55	61	54	2.0	193	244	42
6	12.5	395 —	0.09	1.64	1.64	61	55	2.0	192	243	42
7	15.0	397.06	0.095	1.73	1.73	64	55	2.0	195	241	44
8	17.5	398.82	0.085	1.55	1.55	67	56	2.0	196	243	46
9	20.0	400.47	0.08	1.45	1.45	69	56	2.0	197	243	47
10	22.5	402.25	0.08	1.45	1.45	70	56	2.0	196	247	48
11	25.0	403.97	0.08	1.45	1.45	72	58	2.0	196	244	48
12	27.5	405.66	0.085	1.55	1.55	72	58	2.0	184	243	49
~~B~~ 1 A	30.0	407.35	0.115	2.09	2.09	74	60	2.0	195	242	52
2	32.5	408.91	0.110	2.00	2.00	76	60	2.0	197	243	52
3	35.0	410.83	0.105	1.91	1.91	78	61	2.0	197	244	54
4	37.5	412.70	0.095	1.73	1.73	80	62	2.0	198	243	56
5	40.0	414 —	0.10	1.82	1.82	82	62	2.0	198	244	57
6	42.5	416.50	0.095	1.73	1.73	83	65	2.0	198	244	58
7	45.0	418.42	0.085	1.55	1.55	84	66	2.0	199	243	59
8	47.5	419.74	0.085	1.55	1.55	84	66	2.0	200	243	59
9	50.0	421.43	0.085	1.55	1.55	85	67	2.0	200	244	59
10	52.5	423 —	0.09	1.64	1.64	86	69	2.0	195	244	59
11	55.0	424.95	0.085	1.55	1.55	87	70	2.0	189	243	60
12	57.5	426.5	0.085	1.55	1.55	87	70	2.0	179	240	60
	60.0	428.29									
					1.67 RM		✓		✓		
		41.44 ✓	0.091 ✓		~~1.66~~		66.6		194.4		

Audited by: RJB Date: 01/20/99

PASSED QA

SAMPLED FROM SINGLE PORT DUE TO HIGH CYCLONIC FLOW IN SECOND PORT.

27 m/s

723

1754

TRIGO

Isokinetic Field Data Sheet - EPA Method 5/29

Client: EnVitCo

Run Number: 2 [illegible] 829 1

City/State: Clemson, SC

Date: 1-20-99

Sampling Location: ESP Stack

Operators: RFC

Bar. Press., In. Hg	29.26	*NOMOGRAPH SET-UP*			*LEAK CHECKS*
Static Press., In. H_2O	-0.01	ΔH @ 1.89	Y = 1.00	Avg. Δ P 0.091	Pre-Test 0.001 @ 15 In. Hg.
Meter Box No.	300.200	Meter Temp.	75	Ref. Δ P 0.10	Post-Test 0.001 @ 6 In. Hg.
Sample Box No.	1	Stack Temp.	195	Desired Nozzle 0.385	Pre-Test Pitot <0.1 @ 0.25, 0.25 In. H_2O
Probe/Pitot No.	200.036	Pitot Coeff.	0.86	Nozzle No. 300.077	Post-Test Pitot <0.1 @ 0.25, 0.25 In. H_2O
Probe Temp. Setting	250	% Moisture	3.0	Nozzle Calibration	0.378, 0.378, 0.379
Sample ID No.	8158-12	C Factor	1.102	Nozzle Diameter 0.378	Observer
Filter No.	Q150	Start Time	1150	End Time 1250	Agency

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading Δ P In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	428.64	0.115	2.18	2.18	79	75	2	198	243	66
2	5	432.54	0.11	2.09	2.09	85	77	2	202	243	46
3	10	436.46	0.11	2.09	2.09	78	74	2.0	200	237	49
4	15	440.3	0.105	1.99	1.99	79	76	2	202	240	55
5	20	444.33	0.10	1.90	1.90	81	78	2	204	242	59
6	25	448.00	0.095	1.80	1.80	81	79	2	205	243	61
7	30	451.65	0.08	1.52	1.52	82	79	2	205	242	61
8	35	455 —	0.085	1.61	1.61	81	79	2	204	242	59
9	40	458.35	0.08	1.52	1.52	82	80	2	193	244	59
10	45	461.80	0.08	1.52	1.52	82	80	2	190	244	59
11	50	464.97	0.085	1.61	1.61	83	80	2	185	243	60
12	55	468.79	0.08	1.52	1.52	83	81	2	178	240	63
	60	472.18									
		43.64 ✓	0.094 ✓		1.78 ✓		79.8 ✓		197.2 ✓		

31.6

Checked by: RJB Date: 01/20/99

TRIGON

PASSED QA

724

Isokinetic Field Data Sheet - EPA Method 5/29

Client: EnVirCo
City/State: Clemson, SC
Sampling Location: ESP STACK

Run Number: 3
Date: 1-20-99 2291
Operators: RFC

Bar. Press., In. Hg: 29.21
Static Press., In. H_2O: -0.01
Meter Box No.: 300.200
Sample Box No.: 3
Probe/Pitot No.: 200.037
Probe Temp. Setting: 240
Sample ID No.: 8158-13
Filter No.: Q151

NOMOGRAPH SET-UP

ΔH @ 1.89 Y = 1.00
Meter Temp.: ~~85~~ 100
Stack Temp.: 198
Pitot Coeff.: 0.84
% Moisture: 3
C Factor: 1.101
Start Time: 1402

Avg. Δ P: 0.094
Ref. Δ P: 0.10
Desired Nozzle: 0.383
Nozzle No.: 300.077
Nozzle Calibration: 0.378, 0.378, 0.379
Nozzle Diameter: ~~0.379~~ 0.378
End Time: 1502

LEAK CHECKS

Pre-Test 0.001 @ 15 In. Hg.
Post-Test 0.001 @ 7 In. Hg.
Pre-Test Pitot <0.1 @ 0.25, 0.25 In. H_2O
Post-Test Pitot <0.1 @ 0.25, 0.25 In. H_2O
Observer: RFC
Agency: —

Sample Point	Clock Time	Dry Gas Meter Cubic Feet	Pitot Reading Δ P In. H_2O	Orifice Setting ΔH Inches H_2O Ideal	Orifice Setting ΔH Inches H_2O Actual	Dry Gas Meter Temperature °F Inlet	Dry Gas Meter Temperature °F Outlet	Pump Vacuum Inches Hg	Stack Temp °F	Filter Box °F	Imp. Temp °F
A 1	0	472.54	0.11	2.08	2.08	94	92	2	196	252	67
2	5	476.41	0.11	2.08	2.08	98	93	2	203	247	54
3	10	480.46	0.11	2.08	2.08	97	93	2	203	248	55
4	15	484.40	0.10	1.89	1.89	96	93	2	207	248	58
5	20	488.18	0.09	1.70	1.70	93	90	2	205	243	55
6	25	492.01	0.09	1.70	1.70	92	89	2	204	242	55
7	30	495.36	0.075	1.41	1.41	91	89	2	206	246	55
8	35	498.71	0.08	1.51	1.51	93	92	2	209	255	57
9	40	502.14	0.08	1.51	1.51	93	92	2	207	251	55
10	45	505.57	0.08	1.51	1.51	92	92	2	203	250	55
11	50	509.00	0.085	1.60	1.60	90	88	2	199	247	56
12	55	512.41	0.08	1.51	1.51	91	89	2	193	249	57
	60	515.90									
		43.36	0.091		1.72		92.2		202.9		

Checked by: MT Date: 02/10/99

PASSED QA

725

TRIGON

EPA Methods 4 and 29 - Moisture Determination and Sample Recovery - Data Analysis

2291

Client Name: ENVIRCO
City/State: CLEMSON, SC
Sampling Location: M5 ESP STACK
Clean-Up Box Number: M5/29
Chain of Custody: Date Received: 1-21-99

Project Number: 046-98-158
Sample Date: 1-20-99
Samples Recovered By: ~~1-20-99~~ RFC
Recovery Date: 1-20-99
Received By: MY Locked? ✓

Equipment Documentation

Run Number	1	2	3	
Sample ID Number	8158-11	8158-12	8158-13	
Sample Box Number	3	1	3	
Probe Number	200.037	200.036	200.037	

Inorganic Metals Sample Recovery - Fraction 1

Filter Container #	Q149	Q150	Q151	
Particulate Description	none visible	none visible	none visible	
Filter Container Sealed?	✓	✓	✓	

Inorganic Metals Sample Recovery - Fraction 3

Probe Rinse Container #	8158-11	8158-12	8158-13	
Rinsing Solution	0.1N HNO_3	0.1N HNO_3	0.1N HNO_3	
Sample Container Sealed?	✓	✓	✓	
Liquid Level Marked?	✓	✓	✓	

Analysis of Moisture and Sample Recovery - Fraction 4

Reagent Recovery Container #	8158-11	8158-12	8158-13	
Impinger Absorbing Solution	5% HNO_3/10% H_2O_2	5% HNO_3/10% H_2O_2	5% HNO_3/10% H_2O_2	
Description of Reagent	clear	clear	clear	
Reagent Level Marked?	✓	✓	✓	
Final Volume, ml	217	222	227	
Initial Volume, ml	200	200	200	
Net Condensed Volume, ml	17	22	27	
Silica Gel Recovery Container #	1	2	3	
Percent Silica Gel Spent	25%	25%	25%	
Final Weight, g	210.0	209.6	209.2	
Initial Weight, g	200.0	200.0	200.0	
Net Absorbed Water, g	10.0	9.6	9.2	
Total Reagent Collected, g	27.0	31.6	36.2	

Reagent Blanks

Absorbing Reagent Blank	5% HNO_3/10% H_2O_2	Rinsing Reagent Blank	acetone : 0.1N HNO_3
Absorbing Blank Identification #	8158-14	Rinsing Blank Identification #	8158-14
Analyst Initials	MY		
Reviewer Initials	RFC		

PASSED QA

726

TRIGON

EPA Method 3A Determination of Oxygen Concentrations Using Instrumental Analyzer Procedure

2291

Client ENVITCO

City/State CLEMSON, SC

Sampling Location MELTER STACK

Instrument 100P

Run Date: 01 / 19 / 99 Operators RJB

Observer NONE

Sample Flow: 1.0 LPM
Manifold Flow Rate: 4.0 LPM
Manifold Bypass Rate: 3.0 cc/min
Sample Time:
830 Start: 0830
1057 Stop: 1000

Calibration Gases:
Mid 12.65 % 1100 Tank psi
High 22.40 % 1150 Tank psi

Analyzer Calibration Data

Span: 25	Cylinder Value, %	Analyzer Response, %	Absolute Difference, %	Difference (percent of Span)	Spec. (% of Span)
Zero	0.00	0.00	0.00	0.00	± 2%
Mid Range	12.65	12.51	0.14	0.56	± 2%
High Range	22.40	22.40	0.00	0.00	± 2%

System Calibration Bias and Drift Data

Run 1	Analyzer Response, %	Initial System Response, %	Initial System Cal. Bias, %	Final System Response, %	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.00	0.00	0.04	0.16	± 5%	0.16	± 3%
Upscale	12.51	12.59	0.32	12.50	-0.04	± 5%	-0.36	± 3%

System Response Time

Zero — — — Avg. N/A Upscale — — — Avg. N/A

Note: Must be 95% of a step change in gas.

CALIBRATION CALCULATIONS

Difference = $\frac{\text{Cylinder Value - Analyzer Response}}{\text{Span}} \times 100$

System Calibration Bias = $\frac{\text{System Cal. Response - Analyzer Cal. Response}}{\text{Span}} \times 100$

Drift = $\frac{\text{Final System Cal. Response - Initial System Cal. Response}}{\text{Span}} \times 100$

Definitions:
Span: The upper limit of measurement range
Example: If range is 0 to 100, the span would be 100.

Audited by: JPK Date: 01 / 21 / 99

727

TRIGON

EPA Method 3A Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client: ENVITCO City/State: CLEMSON, SC

Sampling Location: MELTER STACK Instrument: 100P

Run Date: 01 / 19 / 99 Operators: RJB Observer: NONE

Sample Time
Start: 1100
Stop: 1550

System Calibration Bias and Drift Data

Run 2	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	RJB ~~0.00~~ 0.04	0.16	0.01	0.04	± 5%	-0.12	± 3%
Upscale	12.51	12.50	-0.04	12.50	-0.04	± 5%	0.00	± 3%

Sample Time
Start: RJB 1645
Stop: 1900

System Calibration Bias and Drift Data

Run 3	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.01	0.04	0.00	0.00	± 5%	-0.04	± 3%
Upscale	12.51	12.50	-0.04	12.56	0.20	± 5%	0.24	± 3%

Sample Time
Start: 2145
Stop: 0800 (01/20/99)

System Calibration Bias and Drift Data

Run 4	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.09	0.36	0.07	0.28	± 5%	-0.08	± 3%
Upscale	12.51	12.57	0.24	12.50	RJB ~~0.00~~ -0.04	± 5%	-0.28	± 3%

Audited by: JPK Date: 01/21/99

47.19
57.17
728

TRIGON

EPA Method 3A Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client ENVITCO City/State CLEMSON, SC

Sampling Location RD ~~MELTER~~ ESP STACK Instrument 100P

Run Date: 01 / 20 / 99 Operators RJB Observer NONE

Sample Time
Start: 0825
Stop: 1300

820

System Calibration Bias and Drift Data

Run 5	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.07	0.28	0.09	0.36	± 5%	C.C.C. ~~0.10~~	± 3%
Upscale	12.51	12.50	-0.04	12.53	0.08	± 5%	0.12 ~~0.24~~ RJB	± 3%

Sample Time
1320 Start: 1320
Stop: 1600

System Calibration Bias and Drift Data

Run 6	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.09	0.36	0.11	0.44	± 5%	0.08	± 3%
Upscale	12.51	12.53	0.08	12.52	0.04	± 5%	-0.04	± 3%

Sample Time
Start: 1630
Stop: 0900 (01/21/99)

System Calibration Bias and Drift Data

Run 7	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.11	0.44	0.08	0.32	± 5%	-0.12	± 3%
Upscale	12.51	12.52	0.04	12.58	0.28	± 5%	0.24	± 3%

#8 [05172] 0920 1445

Audited by: JPK Date: 01 / 21 / 99

90 250 729

TRIGON

EPA Method 3A Run Continuation Sheet
Using Instrumental Analyzer Procedure

Client EMITCO City/State CLEMSON, SC 2291

Sampling Location ESP STACK Instrument 100 P

Run Date: 01 / 21 / 99 Operators RJB Observer NONE

Sample Time
Start: 0920
Stop: 1445

System Calibration Bias and Drift Data

Run 8	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.08	0.32	0.12	0.48	± 5%	0.16	± 3%
Upscale	12.51	12.58	0.28	12.53	0.08	± 5%	-0.20	± 3%

Sample Time
Start: _____
Stop: _____

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Sample Time
Start: _____
Stop: _____

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Audited by: JPK Date: 01 / 21 / 99

730

TRIGON

EPA Method 3A Determination of Carbon Dioxide Concentrations Using Instrumental Analyzer Procedure

Client ENVITCO City/State CLEMSON, SC. 2291

Sampling Location MELTER STACK Instrument 3300A

Run Date: 01 / 19 / 99 Operators RJB Observer NONE

Sample Flow: 1.0 LPM

Sample Pressure: 0.0 in. H_2O

Sample Time:

Start: 0830

Stop: 1000

Calibration Gases:

Mid 10.13 % 1100 Tank psi

High 18.37 % 1150 Tank psi

Analyzer Calibration Data

Span: 20	Cylinder Value	Analyzer Response	Absolute Difference	Difference (percent of Span)	Spec. (% of Span)
Zero	0.00	0.00	0.00	0.00	± 2%
Mid Range	10.13	10.26	-0.13	-0.65	± 2%
High Range	18.37	18.37	0.00	0.00	± 2%

System Calibration Bias and Drift Data

Run 1	Analyzer Response	Initial System Response	Initial System Cal. Bias	Final System Response	Final System Cal. Bias	Spec. (% of Span)	Drift	Spec. (% Of Span)
Zero	0.00	0.01	0.05	0.05	0.25	± 5%	0.20	± 3%
Upscale	10.26	10.21	-0.25	10.34	0.40	± 5%	0.65	± 3%

System Response Time

Zero — — — Avg. N/A Upscale — — — Avg. N/A

Note: Must be 95% of a step change in gas.

CALIBRATION CALCULATIONS

$$\text{Difference} = \frac{\text{Cylinder Value} - \text{Analyzer Response}}{\text{Span}} \times 100$$

$$\text{System Calibration Bias} = \frac{\text{System Cal. Response} - \text{Analyzer Cal. Response}}{\text{Span}} \times 100$$

$$\text{Drift} = \frac{\text{Final System Cal. Response} - \text{Initial System Cal. Response}}{\text{Span}} \times 100$$

Definitions:

Span: The upper limit of measurement range

Example: If range is 0 to 100. the span would be 100.

Audited by: JPK Date: 01/21/99

731

TRIGON

EPA Method 3A Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client EMVITCO City/State CLEMSON, SC

Sampling Location MELTER STACK Instrument 3300 A

Run Date: 01 / 19 / 99 Operators RJB Observer NONE

Sample Time
Start: 1100
Stop: 1550

System Calibration Bias and Drift Data

Run 2	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.05	0.25	0.09	0.45	± 5%	0.20	± 3%
Upscale	10.26	10.34	0.40	10.46	1.00	± 5%	0.60	± 3%

Sample Time
Start: 1645
Stop: 1900

System Calibration Bias and Drift Data

Run 3	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.09	0.45	0.09	0.45	± 5%	0.00	± 3%
Upscale	10.26	10.46	1.00	10.50	1.20	± 5%	0.20	± 3%

Sample Time
Start: 2145
Stop: 0800 (01/20/99)

System Calibration Bias and Drift Data

ESP

Run 4	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.09	0.45	0.02	0.10	± 5%	-0.35	± 3%
Upscale	10.26	10.32	0.30	10.14	-0.60	± 5%	-0.90	± 3%

Audited by: JPk Date: 01/21/99

732

TRIGON

EPA Method 3A Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client EMVITCO City/State CLEMSON, SC

Sampling Location ESP STACK Instrument 3300 A

Run Date: 01 / 20 / 99 Operators RJB Observer NONE

Sample Time
Start: 0825
Stop: 1300

System Calibration Bias and Drift Data

Run 5	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.02	0.10	0.10	0.50	± 5%	0.40	± 3%
Upscale	10.26	10.14	-0.60	10.42	0.80	± 5%	1.40	± 3%

Sample Time
Start: 1320
Stop: 1600

System Calibration Bias and Drift Data

Run 6	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.10	0.50	0.12	0.60	± 5%	0.10	± 3%
Upscale	10.26	10.42	0.80	10.42	0.80	± 5%	0.00	± 3%

Sample Time
Start: 1630
Stop: 0900 (01/21/99)

System Calibration Bias and Drift Data

Run 7	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.12	0.60	0.04	0.20	± 5%	-0.40	± 3%
Upscale	10.26	10.42	0.80	10.22	-0.20	± 5%	-1.00	± 3%

Audited by: JDK Date: 01/21/99

733

TRIGON

EPA Method 3A Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client EMVITCO City/State CLEMSON, SC

Sampling Location ESP STACK Instrument 3300A

Run Date: 01 / 21 / 99 Operators RJB Observer NONE

Sample Time
Start: 0920
Stop: 1445

System Calibration Bias and Drift Data

Run 8	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.04	0.20	0.11	0.55	± 5%	0.35	± 3%
Upscale	10.26	10.22	-0.20	10.41	0.75	± 5%	0.95	± 3%

Sample Time
Start: _____
Stop: _____

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Sample Time
Start: _____
Stop: _____

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Audited by: JPK Date: 01 / 21 / 99

734

TRIGON

EPA Method 6C Determination of Sulfur Dioxide Emissions Using Instrumental Analyzer Procedure

2291

Client EMVITCO

City/State CLEMSON, SC

Sampling Location MELTER STACK

Instrument 93-721 ATM-7997-1

Run Date: 01 / 19 / 99 Operators RJB

Observer NONE

Sample Flow: 1.0 LPM

Sample Pressure: 0.5 in. H_2O

Sample Time:

Start: 0830

Stop: 1000

Calibration Gases:

Mid 450.3 ppm 1700 Tank psi

High 970.2 ppm RJB ~~1700~~ 1100 Tank psi

Analyzer Calibration Data

Span: 1000	Cylinder Value (ppm)	Analyzer Response (ppm)	Absolute Difference (ppm)	Difference (percent of Span)	Spec. (% of Span)
Zero	0.0	0.0	0.0	0.0	± 2%
Mid Range	450.3	451.5	-1.2	-0.1	± 2%
High Range	970.2	973.1	-2.9	-0.3	± 2%

System Calibration Bias and Drift Data

Run 1	Analyzer Response (ppm)	Initial System Response (ppm)	Initial System Cal. Bias, %	Final System Response (ppm)	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.0	0.6	0.1	2.1	0.2	± 5%	0.2	± 3%
Upscale	451.5	414.0	-3.8	420.2	-3.1	± 5%	0.6	± 3%

System Response Time

Zero — — — Avg. N/A Upscale — — — Avg. N/A

Note: Must be 95% of a step change in gas.

CALIBRATION CALCULATIONS

$$\text{Difference} = \frac{\text{Cylinder Value - Analyzer Response}}{\text{Span}} \times 100$$

$$\text{System Calibration Bias} = \frac{\text{System Cal. Response - Analyzer Cal. Response}}{\text{Span}} \times 100$$

$$\text{Drift} = \frac{\text{Final System Cal. Response - Initial System Cal. Response}}{\text{Span}} \times 100$$

Definitions:

Span: The upper limit of measurement range

Example: If range is 0 to 100, the span would be 100.

Audited by: JPK Date: 01/21/99

735

TRIGON

EPA Method 6C Run Continuation Sheet
Using Instrumental Analyzer Procedure

Client: ENVITCO — City/State: CLEMSON, SC — 2291

Sampling Location: MELTER STACK — Instrument: 93-721ATM-7997-1

Run Date: 01 / 19 / 99 — Operators: RJB — Observer: NONE

Sample Time
Start: 1100
Stop: 1550

System Calibration Bias and Drift Data

Run 2	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.0	2.1	0.2	4.0	0.4	± 5%	0.2	± 3%
Upscale	451.5	420.2	-3.1	408.3	-4.3	± 5%	-1.2	± 3%

Sample Time
Start: ~~1100~~ RJB
Stop: ~~1550~~ RJB

* SWITCHED TO 100 PPM RANGE AFTER RUN 2

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	~~0.0~~ RJB	~~4.0~~ RJB				± 5%		± 3%
Upscale	~~451.5~~ RJB	~~408.3~~ RJB				± 5%		± 3%

Sample Time
Start: _____
Stop: _____

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Audited by: JPR Date: 01/21/99

736

TRIGON

EPA Method 6C Determination of Sulfur Dioxide Emissions Using Instrumental Analyzer Procedure

2291

Client ENVITCO

City/State CLEMSON, SC

Sampling Location MELTER STACK

Instrument 93-721 ATM-7997-1

Run Date: 01 / 19 / 99 Operators RJB

Observer NONE

Sample Flow: 1.0 LPM

Sample Pressure: 0.5 in. H_2O

Sample Time:

Start: 1645

Stop: 1900

Calibration Gases:

Mid 47.19 ppm 250 Tank psi

High 87.17 ppm 1750 Tank psi

Analyzer Calibration Data

Span: 100	Cylinder Value (ppm)	Analyzer Response (ppm)	Absolute Difference (ppm)	Difference (percent of Span)	Spec. (% of Span)
Zero	0.00	0.07	-0.07	-0.07	± 2%
Mid Range	47.19	48.35	-1.16	-1.16	± 2%
High Range	87.17	87.61	-0.44	-0.44	± 2%

System Calibration Bias and Drift Data

Run 3	Analyzer Response (ppm)	Initial System Response (ppm)	Initial System Cal. Bias	Final System Response (ppm)	Final System Cal. Bias	Spec. (% of Span)	Drift	Spec. (% Of Span)
Zero	0.07	2.47	2.40	1.17	1.10	± 5%	-1.30	± 3%
Upscale	48.35	45.71	-2.64	43.76	-4.59	± 5%	-1.95	± 3%

System Response Time

Zero — — — Avg. N/A Upscale — — — Avg. N/A

Note: Must be 95% of a step change in gas.

CALIBRATION CALCULATIONS

Definitions:

Span: The upper limit of measurement range

Example: If range is 0 to 100. the span would be 100.

$$\text{Difference} = \frac{\text{Cylinder Value - Analyzer Response}}{\text{Span}} \times 100$$

$$\text{System Calibration Bias} = \frac{\text{System Cal. Response - Analyzer Cal. Response}}{\text{Span}} \times 100$$

$$\text{Drift} = \frac{\text{Final System Cal. Response - Initial System Cal. Response}}{\text{Span}} \times 100$$

-0.45
44.62

Audited by: JPK Date: 01 / 21 / 99

737

TRIGON

EPA Method 6C Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client ENVITCO City/State CLEMSON, SC

Sampling Location ESP OUTLET Instrument 93-721 ATM-7997-1

Run Date: 01 / 19-20/99 Operators RJB Observer NONE

Sample Time
Start: 2145
Stop: 0800 (01/20/99)

System Calibration Bias and Drift Data

RJB Run ~~2~~ 4	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.07	-0.49	-0.56	-1.71	-1.78	± 5%	-1.22	± 3%
Upscale	48.35	44.63	-3.72	43.71	-4.64	± 5%	-0.92	± 3%

Sample Time
Start: 0825
Stop: 1300

System Calibration Bias and Drift Data

Run 5	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.07	-1.71	-1.78	~~RJB 1.71~~ RJB -0.54	-0.61	± 5%	1.17	± 3%
Upscale	48.35	43.71	-4.64	43.54	-4.81	± 5%	-0.17	± 3%

Sample Time
Start: 1320
Stop: 1600

System Calibration Bias and Drift Data

Run 6	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.07	-0.54	-0.61	1.68	1.61	± 5%	2.22	± 3%
Upscale	48.35	43.54	-4.81	43.46	-4.89	± 5%	-0.08	± 3%

-0.27
44.55

Audited by: JPK Date: 01/21/99

738

TRIGON

EPA Method 6C Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client EMMTCO City/State CLEMSON, SC

Sampling Location ESP STACK Instrument 93-721 ATM-7997-1

Run Date: 01 / 21 / 99 Operators RJB Observer NONE

Sample Time
Start: 1630 (01/20/99)
Stop: 0900

System Calibration Bias and Drift Data

Run 7	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.07	1.68	1.61	-0.27	~~-0.03~~ -0.34 RJB	± 5%	-1.95	± 3%
Upscale	48.35	43.46	-4.89	44.59	-3.76	± 5%	1.13	± 3%

Sample Time
Start: 0920
Stop: 1445

System Calibration Bias and Drift Data

Run 8	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.07	-0.27	-0.34	1.04	0.97	± 5%	1.31	± 3%
Upscale	48.35	44.59	-3.76	43.79	-4.56	± 5%	-0.80	± 3%

Sample Time
Start:
Stop:

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Audited by: JPK Date: 01/21/99

739

TRIGON

EPA Method 7E Determination of Oxides of Nitrogen Emissions Using Instrumental Analyzer Procedure

2291

Client ENVITCO City/State CLEMSON, SC

Sampling Location MELTER STACK Instrument 10AR-34533-248

Run Date: 01 / 19 / 99 Operators RJB Observer NONE

Instrument Readiness:

Converter Temp. (650°C)	650	°C
Sample Pressure Vac (-5 in. Hg)	5.0	in. Hg
Reaction Chamber (<-29 in. Hg)	29.0	in. Hg
Bypass Flow (2 SCFH)	2.0	SCFH

Sample Time:
Start: 0830
Stop: 1000

Calibration Gases:

Mid	50.18	ppm	600	Tank psi
High	97.79	ppm	1900	Tank psi

Analyzer Calibration Data

Span: 100	Cylinder Value (ppm)	Analyzer Response (ppm)	Absolute Difference (ppm)	Difference (percent of Span)	Spec. (% of Span)
Zero	0.00	0.00	0.00	0.00	± 2%
Mid Range	50.18	49.92	0.26	0.26	± 2%
High Range	97.79	98.11	-0.32	- 0.32	± 2%

System Calibration Bias and Drift Data

Run 1	Analyzer Response (ppm)	Initial System Response (ppm)	Initial System Cal. Bias, %	Final System Response (ppm)	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.11	0.11	0.91	0.91	± 5%	0.80	± 3%
Upscale	49.92	49.59	-0.33	51.14	1.22	± 5%	1.55	± 3%

System Response Time

Zero — — — Avg. N/A Upscale — — — Avg. N/A

Note: Must be 95% of a step change in gas.

CALIBRATION CALCULATIONS

Definitions:
Span: The upper limit of measurement range
Example: If range is 0 to 100, the span would be 100.

$$\text{Difference} = \frac{\text{Cylinder Value - Analyzer Response}}{\text{Span}} \times 100$$

$$\text{System Calibration Bias} = \frac{\text{System Cal. Response - Analyzer Cal. Response}}{\text{Span}} \times 100$$

$$\text{Drift} = \frac{\text{Final System Cal. Response - Initial System Cal. Response}}{\text{Span}} \times 100$$

Audited by: JPK Date: 01/21/99

740

TRIGON

EPA Method 7E Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client EMVITCO City/State CLEMSON, SC

Sampling Location MELTER STACK Instrument 10AR-34533-248

Run Date: 01 / 19 / 99 Operators RJB Observer NONE

Sample Time
Start: 1100
Stop: 1550

System Calibration Bias and Drift Data

Run 2	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.91	0.91	2.85	2:85	± 5%	1.94	± 3%
Upscale	49.92	51.14	1.22	48.29	-1.63	± 5%	-2.85	± 3%

Sample Time
Start: 1645
Stop: 1900

System Calibration Bias and Drift Data

Run 3	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	2.85	2.85	2.56	2.56	± 5%	-0.29	± 3%
Upscale	49.92	48.29	-1.63	47.92	-2.00	± 5%	-0.37	± 3%

Sample Time
Start: 2145
Stop: 0800 (01/20/99)

System Calibration Bias and Drift Data

Run 4	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.83	0.83	0.07	0.07	± 5%	-0.76	± 3%
Upscale	49.92	46.77	-3.15	49.55	-0.37	± 5%	2.78	± 3%

Esp

Audited by: JPK Date: 01/21/99

741

TRIGON

EPA Method 7E Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client EMVITCO City/State CLEMSON, SC

Sampling Location ESP STACK Instrument 10AR-34533-248

Run Date: 01/20/99 Operators RJB Observer NONE

Sample Time
Start: 0825
Stop: 1300

System Calibration Bias and Drift Data

Run 5	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.07	0.07	1.71	1.71	± 5%	1.64	± 3%
Upscale	49.92	49.55	-0.37	46.88	-3.04	± 5%	-2.67	± 3%

Sample Time
Start: 1320
Stop: 1600

System Calibration Bias and Drift Data

Run 6	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	1.71	1.71	2.45	2.45	± 5%	0.74	± 3%
Upscale	49.92	46.88	-3.04	45.57	-4.35	± 5%	-1.31	± 3%

Sample Time
Start: 1630
Stop: 0900 (01/21/99)

System Calibration Bias and Drift Data

Run 7	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	2.45	2.45	0.63	0.63	± 5%	-1.82	± 3%
Upscale	49.92	45.57	-4.35	48.54	-1.38	± 5%	2.97	± 3%

Audited by: JPK Date: 01/21/99

742

TRIGON

EPA Method 7E Run Continuation Sheet
Using Instrumental Analyzer Procedure

2291

Client ENVITCO City/State CLEMSON, SC

Sampling Location ESP STACK Instrument 10AR-34533-248

Run Date: 01 / 21 / 99 Operators RJB Observer NONE

Sample Time
Start: 0920
Stop: 1445

System Calibration Bias and Drift Data

Run 8	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero	0.00	0.63	0.63	1.77		± 5%		± 3%
Upscale	49.92	48.54	-1.38	47.82		± 5%		± 3%

Sample Time
Start: _____
Stop: _____

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Sample Time
Start: _____
Stop: _____

System Calibration Bias and Drift Data

Run __	Analyzer Response	Initial System Response	Initial System Cal. Bias, %	Final System Response	Final System Cal. Bias, %	Spec. (% of Span)	Drift %	Spec. (% Of Span)
Zero						± 5%		± 3%
Upscale						± 5%		± 3%

Audited by: JPK Date: 01 / 21 / 99

743

TRIGON

EPA Method 25A Determination of Gaseous Organic Concentrations as Carbon Using Flame Ionization Analyzer Procedure

2291

Client ENVITCO City/State CLEMSON, SC

Sampling Location MELTER STACK Instrument RATFISCH RS55CA #112091

Run Date 01 / 19 / 99 Operators RJB Observer NONE Agency NONE

Instrument Readiness:

Oven Temperature: 149 °C Fuel Pressure: 5.0 psi

Sample Line Temperature: 261 °F Air Pressure: 12.0 psi

Sample Back Pressure: 2.2 psi Calibration Factor: 1.000

System Calibration Error Check

Span: 100	Cylinder Pressure (psig)	Cylinder Value (ppm)	Predicted Value (ppm)	System Value (ppm)	Difference (ppm)	Allowable Difference (ppm)	Spec.
Zero	500	0.0		0.2	-0.2	±3.0	± 3% of Span
High Range	1400	85.6		85.6	0.0	±4.3	± 5% of Gas Value
Mid Range	1000	50.5	50.5	50.3	0.2	±2.5	± 5% of Gas Value
Low Range	1500	31.0	31.0	31.6	-0.6	±1.6	± 5% of Gas Value

Hourly System and Drift Data

	Run Time 24 Hour Clock	Initial System Response (ppm)		Final System Response (ppm)		Drift Difference (ppm)		Calibration Drift (percent)		Spec. (% Of Span)
		Zero	Upscale	Zero	Upscale	Zero	Upscale	Zero	Upscale	± 3%
1st Run	0915 - 1115	0.2	50.3	0.0	48.1	-0.2	-2.2	-0.2	-2.2	± 3%
2nd Run	1120 - 1320	0.2	50.3	0.0	49.0	-0.2	-1.3	-0.2	-1.3	± 3%
3rd Run	1350 - 1750	0.2	50.3	-0.2	49.0	-0.4	-1.3	-0.4	-1.3	± 3%
4th Run										± 3%
5th Run										± 3%
6th Run										± 3%

System Response Time

Zero 33 32 33 Avg. 33 seconds Upscale 31 31 30 Avg. 31 sec

Must be a step change of at least 95%.

Comments:

Audited by: JPK Date: 01/21/99

744

TRIGON

APPENDIX C

DATA ACQUISITION SYSTEM UNCORRECTED VALUES

Trigon Engineering Consultants

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - Melter Exhaust

Tuesday 1/19/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
831	18.27	1.80	6.4	30.87
832	18.26	1.77	6.3	30.74
833	18.27	1.76	6.0	31.12
834	18.32	1.77	5.7	33.35
835	18.22	1.81	5.7	36.78
836	18.21	1.83	5.1	41.68
837	18.22	1.89	4.2	39.46
838	18.27	1.77	4.2	35.30
839	18.34	1.78	3.9	36.06
840	18.32	1.70	4.2	33.63
841	18.37	1.74	4.8	33.48
842	18.34	1.71	4.2	34.93
843	18.46	1.59	3.9	29.23
844	18.44	1.83	3.9	30.83
845	18.37	1.65	7.6	32.91
846	18.50	1.61	5.1	34.83
847	18.44	1.65	4.2	34.75
848	18.43	1.72	3.6	36.90
849	18.42	1.74	3.3	37.88
850	18.39	1.74	3.3	37.99
851	18.47	1.69	2.7	32.16
852	18.42	1.72	2.4	39.50
853	18.46	1.71	2.3	36.03
854	18.42	1.87	2.7	37.08
855	18.39	1.66	3.0	32.57
856	18.44	1.65	3.0	31.96
857	18.46	1.66	2.6	33.45
858	18.50	1.65	2.7	32.86
859	18.43	1.64	2.3	36.15
900	18.39	1.96	2.8	27.74
901	18.35	1.69	3.1	40.05
902	18.47	1.73	2.4	39.81
903	18.39	1.76	2.0	40.75
904	18.45	1.73	1.8	37.23
905	18.38	1.73	1.8	35.00
906	18.39	1.68	1.8	34.97
907	18.45	1.74	1.8	34.05
908	18.39	1.74	1.8	35.60
909	18.44	1.73	1.8	36.18
910	18.43	1.68	2.1	31.50
911	18.45	1.67	2.1	35.33
912	18.47	1.70	2.1	32.40

913	18.44	1.67	2.1	30.17
914	18.45	1.72	2.7	30.80
915	18.42	1.68	2.3	36.43
916	18.46	1.72	2.0	37.02
917	18.46	1.69	2.1	35.57
918	18.50	1.62	2.1	31.92
919	18.52	1.62	1.8	32.32
920	18.52	1.62	2.1	30.23
921	18.53	1.60	2.1	31.36
922	18.54	1.79	2.4	39.70
923	18.43	1.75	3.6	41.25
924	18.49	1.60	4.5	31.62
925	18.58	1.61	4.2	31.94
926	18.56	1.64	4.2	34.90
927	18.50	1.67	4.5	39.35
928	18.51	1.66	4.6	37.54
929	18.56	1.64	4.2	36.11
930	18.53	1.67	3.9	36.57
931	18.51	1.70	4.2	40.11
932	18.50	1.59	4.2	32.67
933	18.55	1.85	4.2	36.48
934	18.16	1.74	4.5	35.98
935	18.38	1.70	5.7	36.63
936	18.51	1.74	4.6	37.72
937	18.47	1.70	4.3	31.72
938	18.50	1.73	4.3	27.99
939	18.51	1.62	4.8	27.21
940	18.53	1.64	4.5	33.17
941	18.46	1.72	4.8	36.69
942	18.47	1.73	4.8	39.76
943	18.52	1.60	4.8	29.25
944	18.61	1.57	4.8	26.49
945	18.56	1.60	4.9	24.80
946	18.54	1.67	5.2	28.13
947	18.44	1.73	6.1	32.60
948	18.52	1.67	6.1	31.00
949	18.52	1.72	5.8	31.37
950	18.47	1.70	5.4	39.31
951	18.51	1.74	5.4	40.98
952	18.53	1.71	4.9	37.48
953	18.50	1.70	4.6	36.88
954	18.54	1.66	4.6	34.52
955	18.56	1.64	4.6	34.92
956	18.54	1.69	4.8	36.58
957	18.55	1.69	4.5	37.08
958	18.55	1.60	4.5	37.24
959	18.62	1.62	4.2	37.25
1000	18.64	1.66	4.0	34.99
Average	**18.45**	**1.70**	**3.8**	**34.63**

Trigon Engineering Consultants

2291

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - Melter Exhaust

Tuesday 1/19/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
1101	18.51	1.75	4.3	34.02
1102	18.47	1.75	4.3	35.30
1103	18.49	1.71	3.9	33.34
1104	18.49	1.69	3.9	34.68
1105	18.52	1.71	3.6	33.86
1106	18.51	1.72	4.0	35.15
1107	18.46	1.80	4.6	37.66
1108	18.46	1.75	4.6	36.37
1109	18.58	1.70	4.6	34.51
1110	18.55	1.71	4.9	36.66
1111	18.54	1.73	4.9	37.81
1112	18.55	1.71	4.9	37.79
1113	18.58	1.71	4.9	38.56
1114	18.56	1.79	5.2	50.43
1115	18.52	1.69	5.8	35.23
1116	18.57	1.72	4.9	34.55
1117	18.56	1.63	4.6	32.62
1118	18.56	1.81	4.6	44.38
1119	18.52	1.70	4.6	32.39
1120	18.54	1.74	4.3	37.57
1121	18.53	1.70	4.3	37.22
1122	18.54	1.73	4.3	38.47
1123	18.55	1.75	4.5	40.83
1124	18.50	1.79	4.5	37.37
1125	18.57	1.71	4.3	36.16
1126	18.53	1.78	4.3	40.77
1127	18.55	1.74	4.3	35.60
1128	18.54	1.71	4.0	33.62
1129	18.55	1.76	4.0	37.20
1130	18.44	1.79	4.0	39.69
1131	18.48	1.78	4.0	37.19
1132	18.46	1.78	4.0	38.27
1133	18.48	1.76	4.3	34.83
1134	18.50	1.71	4.3	36.31
1135	18.63	1.75	4.0	40.24
1136	18.52	1.79	4.3	38.72
1137	18.47	1.77	4.3	39.90
1138	18.56	1.72	3.7	37.11
1139	18.52	1.71	3.7	33.96
1140	18.33	1.74	3.7	38.90
1141	18.54	1.67	3.6	34.49

Period 2

748

TRIGON

1142	18.56	1.75	3.6	35.34
1143	18.53	1.74	3.9	37.13
1144	18.53	1.74	3.7	35.76
1145	18.47	1.77	3.7	38.01
1146	18.49	1.72	3.7	33.92
1147	18.33	2.14	3.7	43.66
1148	17.71	2.59	4.3	52.29
1149	17.73	1.89	5.2	41.04
1150	18.36	1.90	4.3	39.20
1151	18.32	1.88	4.3	39.38
1152	18.30	1.94	4.2	44.60
1153	18.28	1.93	3.9	44.69
1154	18.29	1.84	4.3	39.35
1155	18.31	1.87	4.0	36.61
1156	18.42	1.79	3.7	34.30
1157	18.44	1.85	4.0	36.11
1158	18.41	1.88	4.0	39.84
1159	18.43	1.84	4.0	39.18
1200	18.26	1.77	4.3	36.39
1201	18.43	1.93	3.6	36.14
1202	18.45	1.81	3.9	36.04
1203	18.36	1.94	4.3	34.48
1204	18.42	1.85	5.2	34.64
1205	18.28	1.89	5.9	39.64
1206	18.32	1.87	5.5	39.56
1207	18.25	1.93	5.2	40.83
1208	18.33	1.89	4.6	38.53
1209	18.39	1.80	4.9	37.46
1210	18.20	1.78	4.6	36.51
1211	18.48	1.83	4.9	37.42
1212	18.30	2.00	4.6	38.34
1213	18.01	2.01	10.6	45.36
1214	18.22	1.88	7.3	46.90
1215	18.38	1.94	5.2	42.86
1216	18.40	1.84	4.6	35.94
1217	18.39	1.82	4.6	28.69
1218	18.34	1.75	4.9	29.19
1219	18.44	1.73	4.9	34.31
1220	18.46	1.76	4.6	34.36
1221	18.63	1.55	4.6	30.09
1222	18.65	1.61	4.7	32.41
1223	18.69	1.60	4.4	34.88
1224	18.69	1.64	4.6	34.64
1225	18.66	1.63	5.0	34.60
1226	18.60	1.72	4.9	37.10
1227	18.56	1.72	5.5	36.26
1228	18.61	1.53	5.5	43.20
1229	18.56	1.73	6.1	32.61
1230	18.59	1.70	5.8	34.39
1231	18.62	1.71	5.2	34.99
1232	18.56	1.76	5.5	47.21
1233	18.42	1.85	7.0	44.62

2291

1234	18.53	1.74	6.7	38.65
1235	18.52	1.71	6.1	36.70
1236	18.53	1.73	5.9	37.18
1237	18.56	1.66	5.8	31.95
1238	18.63	1.67	6.2	30.62
1239	18.59	1.71	6.1	32.25
1240	18.59	1.69	6.8	30.52
1241	18.56	1.72	6.7	33.70
1242	18.57	1.75	6.4	39.67
1243	18.61	1.67	6.7	34.46
1244	18.61	1.74	6.1	38.22
1245	18.57	1.82	5.9	38.82
1246	18.14	1.98	10.1	40.07
1247	18.48	1.67	10.1	36.95
1248	18.69	1.70	6.5	37.29
1249	18.58	1.65	4.9	37.82
1250	18.61	1.75	4.3	39.39
1251	18.52	1.91	4.0	41.43
1252	18.25	1.97	4.0	44.41
1253	17.97	1.95	4.3	43.06
1254	18.24	1.93	4.3	39.97
1255	18.24	1.91	4.9	40.98
1256	18.29	2.00	4.9	44.06
1257	18.24	1.86	5.3	35.38
1258	18.34	1.84	5.6	36.77
1259	18.42	1.88	4.9	38.38
1300	18.29	2.04	4.9	46.62
1301	18.17	1.91	4.6	41.30
1302	18.33	1.98	4.9	39.57
1303	18.22	1.89	4.9	38.94
1304	18.25	1.94	4.9	39.72
1305	18.22	1.88	4.9	39.14
1306	18.36	1.83	4.6	36.09
1307	18.43	1.82	4.7	36.14
1308	18.39	1.89	4.9	40.50
1309	18.28	1.88	5.6	39.27
1310	18.40	1.80	5.6	36.34
1311	18.40	1.80	5.2	35.27
1312	18.41	1.80	5.2	35.54
1313	18.40	1.79	5.6	33.44
1314	18.44	1.90	5.6	34.31
1315	18.43	1.76	5.5	32.69
1316	18.44	1.75	5.3	32.04
1317	18.47	1.78	5.3	36.16
1318	18.45	1.74	5.5	32.00
1319	18.47	1.76	6.2	31.29
1320	18.44	1.80	5.9	33.15
1321	18.38	1.74	6.2	31.57
1322	18.51	1.75	7.1	30.64
1323	18.41	1.79	6.5	31.64
1324	18.42	1.81	6.5	30.36
1325	18.31	1.81	7.4	36.57

1326	18.16	1.83	7.7	39.73
1327	17.88	2.10	7.4	40.36
1328	18.11	1.91	7.1	35.98
1329	18.20	1.89	6.8	35.35
1330	18.27	1.88	6.8	36.80
1331	18.25	1.85	6.5	37.52
1332	18.34	2.15	6.5	46.23
1333	18.17	1.98	7.7	45.05
1334	18.18	2.04	8.6	47.76
1335	18.14	2.02	8.6	45.31
1336	18.22	2.03	8.3	49.66
1337	18.19	2.16	8.0	47.39
1338	18.23	1.98	7.7	44.04
1339	18.02	2.20	8.3	42.68
1340	18.08	2.03	11.0	35.04
1341	18.11	2.04	9.2	46.29
1342	18.11	2.14	8.0	55.67
1343	18.10	2.08	9.2	47.60
1344	18.09	2.08	9.8	45.49
1345	18.20	2.08	8.9	48.94
1346	18.18	1.95	8.9	42.04
1347	18.31	2.13	7.4	45.69
1348	18.31	1.84	6.1	39.50
1349	18.42	1.97	6.2	45.09
1350	18.39	1.82	6.5	36.55
1351	18.44	1.82	6.2	35.45
1352	18.43	1.86	5.9	36.42
1353	18.39	1.85	6.5	36.46
1354	18.31	1.88	6.5	36.00
1355	18.43	1.83	6.8	33.15
1356	18.41	1.84	6.8	35.19
1357	18.31	1.90	6.8	36.60
1358	18.48	1.75	7.4	34.07
1359	18.18	1.90	7.4	37.45
1400	18.48	1.76	7.7	32.69
1401	18.45	1.79	7.7	33.53
1402	18.52	1.72	7.4	33.21
1403	18.54	1.68	7.4	34.04
1404	18.54	1.73	7.4	35.00
1405	18.53	1.66	7.1	33.93
1406	18.36	1.81	8.9	40.35
1407	18.48	1.72	9.2	39.20
1408	18.64	1.64	7.1	37.07
1409	18.61	1.62	6.5	36.10
1410	18.66	1.66	5.9	35.97
1411	18.62	1.61	5.6	35.14
1412	18.69	1.60	5.6	34.67
1413	18.73	1.61	5.3	35.21
1414	18.72	1.57	5.3	33.74
1415	18.72	1.57	5.0	32.34
1416	18.73	1.67	5.6	35.22
1417	18.56	1.68	6.2	34.70

1418	18.59	1.67	7.1	35.37
1419	18.56	1.63	7.7	34.57
1420	18.54	1.78	7.1	37.95
1421	18.38	1.79	7.7	39.45
1422	18.38	1.84	8.3	38.47
1423	18.46	1.73	7.4	36.97
1424	18.46	1.72	7.1	36.25
1425	18.54	1.66	6.8	34.25
1426	18.57	1.69	7.1	35.98
1427	18.58	1.75	7.7	50.28
1428	18.50	1.70	9.5	36.05
1429	18.56	1.67	8.6	35.77
1430	18.63	1.69	8.0	37.51
1431	18.58	1.65	8.6	33.35
1432	18.64	1.58	9.5	27.03
1433	18.74	1.56	9.2	34.76
1434	18.71	1.80	8.0	48.23
1435	18.66	1.66	8.6	35.92
1436	18.65	1.62	7.7	32.61
1437	18.65	1.65	7.1	32.84
1438	18.71	1.62	6.8	32.47
1439	18.69	1.52	6.8	30.39
1440	18.75	1.58	6.8	32.17
1441	18.70	1.54	6.5	31.63
1442	18.28	2.03	6.5	40.93
1443	18.42	1.84	6.8	36.79
1444	18.40	1.74	7.1	34.05
1445	18.47	1.76	7.1	34.17
1446	18.44	1.78	7.4	34.90
1447	18.48	1.77	7.4	34.60
1448	18.49	1.74	6.8	33.56
1449	18.43	1.74	7.4	32.33
1450	18.45	1.78	7.4	32.82
1451	18.48	1.73	8.0	32.08
1452	18.50	1.69	8.3	32.77
1453	18.55	1.71	8.3	35.56
1454	18.53	1.66	8.5	34.14
1455	18.56	1.70	8.3	35.65
1456	18.52	1.74	8.3	36.05
1457	18.51	1.69	8.3	35.28
1458	18.54	1.72	8.9	35.60
1459	18.56	1.83	9.5	50.98
1500	18.34	1.88	14.1	48.60
1501	18.41	1.81	13.8	41.13
1502	18.42	1.88	11.4	47.41
1503	18.43	1.75	10.7	39.40
1504	18.43	1.82	9.9	40.07
1505	18.42	1.89	9.5	43.88
1506	18.39	1.82	11.0	39.52
1507	18.48	1.78	11.1	36.46
1508	18.49	1.74	10.1	37.13
1509	18.50	1.79	9.4	42.42

2291

1510	18.44	1.86	10.1	44.04
1511	18.42	1.83	11.9	37.02
1512	18.34	1.93	11.6	37.54
1513	18.32	2.11	11.0	47.23
1514	17.96	2.17	10.8	48.92
1515	17.99	2.12	10.1	46.31
1516	18.18	1.78	9.5	40.36
1517	18.42	1.91	10.4	47.10
1518	18.33	1.89	11.9	45.03
1519	18.43	1.79	11.6	39.48
1520	18.41	1.72	10.5	36.16
1521	18.50	1.73	9.8	35.66
1522	18.53	1.75	9.1	38.12
1523	18.45	1.79	9.1	41.82
1524	18.46	1.78	10.4	40.77
1525	18.44	1.67	10.1	36.43
1526	18.52	1.63	9.3	34.92
1527	18.57	1.65	8.5	36.67
1528	18.58	1.68	7.9	37.08
1529	18.58	1.64	7.3	36.95
1530	18.60	1.75	7.0	43.69
1531	18.50	1.76	7.9	45.27
1532	18.46	1.81	8.8	44.67
1533	18.42	1.86	9.5	45.63
1534	18.44	1.80	10.1	41.95
1535	18.49	1.72	9.5	37.13
1536	18.51	1.81	8.2	39.27
1537	18.55	1.74	7.0	38.60
1538	18.51	1.81	6.4	37.41
1539	18.42	1.80	6.4	39.62
1540	18.48	1.69	7.6	41.69
1541	18.56	1.70	7.0	43.21
1542	18.58	1.66	6.4	40.69
1543	18.60	1.73	6.7	42.54
1544	18.53	1.73	6.4	43.96
1545	18.52	1.74	6.4	46.27
1546	18.56	1.75	7.0	43.04
1547	18.55	1.77	7.7	48.23
1548	18.38	1.81	7.9	44.62
1549	18.56	1.78	8.2	40.96
1550	18.50	1.87	7.6	41.54
Average	**18.44**	**1.80**	**6.6**	**38.11**

Trigon Engineering Consultants

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - Melter Exhaust

Tuesday 1/19/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
1646	18.55	1.74	6.68	37.13
1647	18.43	1.78	6.35	37.89
1648	18.45	1.71	5.15	36.58
1649	18.48	1.75	6.00	44.54
1650	18.49	1.80	9.36	42.79
1651	18.57	1.80	6.41	38.70
1652	17.81	2.31	5.97	49.31
1653	17.91	2.29	8.54	54.83
1654	17.96	2.24	9.58	53.65
1655	18.02	1.73	8.45	41.20
1656	18.63	1.70	6.90	37.04
1657	18.65	1.64	6.50	35.01
1658	18.77	1.55	5.73	32.13
1659	18.80	1.52	5.61	33.34
1700	18.85	1.54	5.00	35.02
1701	18.81	1.53	5.49	35.22
1702	18.82	1.57	7.38	30.27
1703	18.79	1.51	6.83	35.54
1704	18.83	1.55	5.45	39.32
1705	18.91	1.68	4.11	40.08
1706	18.99	1.32	3.69	32.91
1707	19.09	1.34	3.11	33.03
1708	19.10	1.31	3.11	32.03
1709	19.12	1.32	3.32	33.51
1710	19.12	1.30	3.17	32.50
1711	19.15	1.27	2.83	31.56
1712	19.16	1.29	2.71	31.21
1713	19.17	1.24	3.05	29.63
1714	19.16	1.52	3.08	36.11
1715	19.16	1.28	2.96	30.60
1716	19.14	1.26	2.95	28.20
1717	19.16	1.27	2.96	29.08
1718	19.15	1.30	3.50	30.12
1719	19.12	1.29	4.26	28.40
1720	19.13	1.27	3.51	27.70
1721	19.16	1.19	2.98	26.09
1722	19.22	1.27	3.13	27.64
1723	19.04	1.31	2.90	28.23
1724	19.11	1.27	3.23	27.36

Period 3

754

TRIGON

1725	19.10	1.35	2.90	29.48
1726	19.09	1.33	2.99	31.14
1727	19.02	1.61	3.01	35.40
1728	18.65	1.67	3.60	35.71
1729	18.60	1.68	4.76	37.43
1730	18.61	1.70	4.30	38.02
1731	18.61	1.66	4.59	36.71
1732	18.67	1.64	7.66	39.28
1733	18.76	1.61	6.41	41.00
1734	18.72	1.64	6.15	35.53
1735	18.68	1.30	4.70	29.30
1736	19.12	1.35	3.75	29.09
1737	19.08	1.30	5.18	33.22
1738	19.17	1.23	3.57	28.18
1739	19.18	1.27	3.17	29.00
1740	19.08	1.42	3.23	32.62
1741	18.71	1.58	3.39	36.38
1742	18.68	1.68	6.47	40.06
1743	18.70	1.85	7.14	42.02
1744	18.52	1.79	6.32	38.51
1745	18.70	1.90	5.12	41.67
1746	18.37	1.60	5.24	36.51
1747	18.68	3.28	5.61	46.92
1748	17.27	1.89	16.58	38.22
1749	18.27	1.95	7.23	41.23
1750	18.22	1.93	8.97	40.83
1751	18.21	2.01	8.64	43.34
1752	18.22	1.95	8.54	40.55
1753	18.25	1.96	7.05	39.24
1754	18.28	1.89	7.02	36.67
1755	18.27	1.90	6.68	38.51
1756	18.30	2.11	11.49	53.83
1757	18.06	1.99	13.99	38.93
1758	18.13	2.07	12.89	38.34
1759	18.16	2.00	16.52	41.54
1800	18.20	2.31	12.00	40.32
1801	17.67	2.10	12.65	38.88
1802	18.01	2.08	13.56	34.07
1803	17.97	2.09	12.22	42.22
1804	18.04	2.07	11.73	43.88
1805	17.97	2.14	12.53	45.47
1806	17.93	2.23	9.46	44.14
1807	17.97	2.08	8.17	40.48
1808	18.05	2.09	7.81	41.83
1809	18.14	2.02	8.24	38.37
1810	18.12	2.04	9.15	39.56
1811	18.13	1.98	8.91	38.89
1812	18.15	1.99	8.20	38.98
1813	18.13	1.97	9.52	40.29
1814	18.21	1.98	9.73	40.11

1815	18.24	1.90	10.09	36.56
1816	18.27	1.92	10.42	35.52
1817	18.20	1.98	11.27	36.94
1818	18.15	2.00	10.69	36.56
1819	18.12	2.03	8.91	39.92
1820	18.13	2.01	8.90	40.83
1821	18.15	2.05	9.03	42.30
1822	18.11	3.19	10.78	70.29
1823	16.47	2.58	23.24	50.93
1824	18.09	2.02	13.93	37.71
1825	18.15	2.01	11.76	39.36
1826	18.15	2.01	9.00	41.44
1827	18.13	2.02	10.42	43.24
1828	18.12	2.05	14.02	41.01
1829	18.09	2.06	10.06	38.37
1830	18.11	2.06	11.18	39.46
1831	18.06	2.07	13.20	40.19
1832	18.08	2.10	12.59	36.90
1833	18.04	1.98	12.43	28.49
1834	18.17	1.98	9.91	41.90
1835	18.24	1.91	8.82	43.27
1836	18.12	2.16	10.87	51.34
1837	17.84	2.34	15.85	62.68
1838	18.00	2.11	11.94	49.24
1839	18.05	2.06	8.78	43.87
1840	18.12	2.00	7.23	40.96
1841	18.10	2.01	7.29	42.01
1842	18.16	2.07	8.60	43.99
1843	18.14	1.99	10.09	45.07
1844	18.23	1.90	10.97	38.12
1845	18.14	2.00	11.51	40.24
1846	18.16	2.04	9.97	40.71
1847	18.05	2.04	10.27	40.00
1848	18.14	1.98	10.54	39.47
1849	18.26	1.93	10.33	37.73
1850	18.31	2.02	10.24	40.70
1851	18.20	1.91	10.45	39.15
1852	18.27	1.90	7.66	37.64
1853	18.27	1.93	7.99	37.13
1854	18.18	2.16	7.69	41.49
1855	17.89	2.22	9.67	41.65
1856	17.87	2.24	10.72	45.16
1857	17.83	2.23	11.82	40.27
1858	17.87	2.20	11.36	39.50
1859	17.92	2.13	10.33	38.13
1900	17.95	2.14	10.16	38.11
Average	**18.42**	**1.83**	**7.95**	**38.54**

Trigon Engineering Consultants

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - ESP Stack

Tuesday 1/19/99 & Wednesday 1/20/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
2145	19.97	0.71	7.82	12.52
2150	19.95	0.70	7.82	11.23
2155	19.97	0.72	7.50	12.79
2200	19.98	0.73	7.78	13.09
2205	19.95	0.72	7.01	12.72
2210	19.94	0.72	13.12	17.77
2215	19.90	0.73	9.52	13.11
2220	19.89	0.72	11.01	13.99
2225	19.90	0.73	8.24	14.26
2230	19.85	0.74	9.02	13.01
2235	19.84	0.75	8.65	14.36
2240	19.82	0.73	10.00	12.36
2245	19.91	0.72	9.56	12.24
2250	19.96	0.71	9.25	12.63
2255	19.95	0.72	8.75	12.35
2300	19.96	0.73	8.08	13.64
2305	19.95	0.68	7.02	12.56
2310	19.94	0.67	7.02	12.65
2315	19.90	0.68	7.06	12.74
2320	19.89	0.68	7.01	11.45
2325	19.90	0.67	7.59	11.52
2330	19.85	0.68	8.02	11.99
2335	19.84	0.69	7.21	12.69
2340	19.82	0.69	6.02	13.25
2345	19.91	0.69	6.98	13.56
2350	19.96	0.69	9.91	14.11
2355	19.95	0.69	9.01	14.75
0	19.94	0.71	7.65	13.48
5	19.91	0.71	7.41	13.11
10	19.92	0.71	6.89	13.54
15	19.92	0.71	8.11	13.75
20	19.91	0.71	8.00	13.52
25	19.95	0.71	7.99	12.59
30	19.95	0.71	7.58	12.36
35	19.94	0.71	7.72	12.79
40	19.96	0.71	7.61	12.99
45	19.91	0.71	7.75	13.11
50	19.91	0.71	7.61	13.25
55	19.91	0.71	7.52	13.00

Period 4

TRIGON

100	19.90	0.71	8.07	10.26
105	19.95	0.69	6.02	14.98
110	19.94	0.69	6.23	14.25
115	19.90	0.70	6.00	13.24
120	19.89	0.70	9.11	12.77
125	19.90	0.71	9.12	12.25
130	19.85	0.69	8.50	13.56
135	19.84	0.68	7.11	12.72
140	19.82	0.69	8.52	14.47
145	19.91	0.69	6.21	17.21
150	19.96	0.70	7.52	14.59
155	19.95	0.70	9.01	12.56
200	19.91	0.70	6.76	13.14
205	19.91	0.68	5.98	12.79
210	19.91	0.67	5.84	12.65
215	19.91	0.68	6.00	12.52
220	19.92	0.68	6.65	12.99
225	19.92	0.67	7.21	13.85
230	19.91	0.68	7.52	11.47
235	19.91	0.69	7.56	13.12
240	19.91	0.69	7.77	19.12
245	19.92	0.69	7.87	13.11
250	19.90	0.69	6.11	13.25
255	19.89	0.69	5.25	12.79
300	19.91	0.70	4.11	13.72
305	19.91	0.70	5.11	13.79
310	19.92	0.71	8.12	14.12
315	19.92	0.70	6.11	13.01
320	19.91	0.70	7.25	15.11
325	19.95	0.70	7.65	14.25
330	19.95	0.70	8.01	12.52
335	19.94	0.69	7.25	12.25
340	19.96	0.70	7.01	13.25
345	19.91	0.70	6.67	13.00
350	19.91	0.70	4.52	14.85
355	19.91	0.69	3.12	14.52
400	19.89	0.70	5.14	13.83
405	19.89	0.68	5.12	12.79
410	19.90	0.67	4.98	11.98
415	19.90	0.68	5.22	16.11
420	19.91	0.68	5.12	13.79
425	19.87	0.67	5.11	14.77
430	19.91	0.68	5.00	14.52
435	19.91	0.69	3.98	13.12
440	19.91	0.69	5.01	13.52
445	19.92	0.69	6.12	13.01
450	19.93	0.69	11.11	12.56
455	19.94	0.69	8.99	11.52
500	19.89	0.69	4.73	14.57
505	19.95	0.68	6.61	13.36

510	19.94	0.69	4.12	13.24
515	19.90	0.69	3.99	14.02
520	19.89	0.69	3.78	13.01
525	19.90	0.68	3.76	14.79
530	19.85	0.67	3.11	14.60
535	19.84	0.67	3.25	13.89
540	19.82	0.67	4.25	17.26
545	19.91	0.66	5.13	11.81
550	19.96	0.67	7.12	14.22
555	19.95	0.68	6.58	13.11
600	19.88	0.67	5.34	12.47
605	19.91	0.68	5.25	12.11
610	19.92	0.67	8.01	12.79
615	19.92	0.68	6.52	12.77
620	19.91	0.68	4.22	12.21
625	19.95	0.67	3.19	13.75
630	19.95	0.68	3.00	14.01
635	19.94	0.69	3.06	13.84
640	19.96	0.69	5.11	12.77
645	19.91	0.69	5.25	18.00
650	19.91	0.69	4.25	13.88
655	19.91	0.69	4.39	13.11
700	19.88	0.68	5.71	13.41
705	19.89	0.68	5.52	15.21
710	19.90	0.67	6.36	13.24
715	19.90	0.68	5.00	17.21
720	19.91	0.68	5.01	13.75
725	19.87	0.67	6.25	12.36
730	19.91	0.68	7.01	12.89
735	19.91	0.69	5.52	13.75
740	19.91	0.69	3.89	14.56
745	19.92	0.69	4.87	14.21
750	19.93	0.69	4.11	13.52
755	19.94	0.69	4.10	14.12
800	19.91	0.67	4.50	12.37
Average	**19.91**	**0.69**	**6.59**	**13.47**

Trigon Engineering Consultants

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - ESP Stack

Wednesday 1/20/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
826	19.89	0.70	5.35	13.17
827	19.90	0.70	5.26	13.07
828	19.89	0.70	5.29	12.39
829	19.89	0.70	5.29	10.56
830	19.90	0.70	4.89	12.48
831	19.90	0.70	4.13	13.04
832	19.90	0.70	3.92	13.47
833	19.90	0.70	4.50	13.72
834	19.90	0.70	4.77	13.72
835	19.90	0.70	4.83	14.10
836	19.90	0.70	4.86	13.39
837	19.91	0.70	4.43	12.95
838	19.90	0.70	4.62	13.37
839	19.89	0.69	4.77	13.41
840	19.90	0.70	4.71	13.59
841	19.90	0.71	5.07	13.80
842	19.90	0.69	5.19	13.38
843	19.90	0.70	5.59	14.05
844	19.91	0.69	5.89	13.85
845	19.90	0.69	5.95	13.15
846	19.91	0.68	5.47	13.66
847	19.90	0.69	5.10	14.19
848	19.89	0.69	5.25	13.62
849	19.90	0.69	5.07	13.30
850	19.90	0.69	4.68	13.68
851	19.89	0.70	5.04	13.81
852	19.89	0.70	5.32	12.77
853	19.90	0.68	5.35	11.85
854	20.57	0.06	3.04	0.27
855	20.78	0.07	-0.52	0.22
856	20.78	0.06	-1.40	0.18
857	20.78	0.06	-1.74	0.15
858	20.78	0.06	-2.01	0.12
859	20.79	0.06	-2.22	0.08
900	20.79	0.06	-2.32	0.08
901	20.79	0.06	-2.38	0.09
902	20.79	0.06	-2.32	0.07
903	20.79	0.06	-2.50	0.03
904	20.79	0.06	-2.41	0.02

905	20.79	0.67	-2.56	11.56
906	19.94	0.69	-0.01	12.78
907	19.91	0.69	3.21	12.85
908	19.91	0.69	4.83	12.36
909	19.90	0.70	8.21	13.94
910	19.91	0.69	6.92	11.48
911	19.92	0.68	5.96	11.38
912	19.91	0.68	5.23	11.78
913	19.92	0.68	5.01	11.42
914	19.91	0.69	4.77	13.91
915	19.91	0.70	4.53	14.62
916	19.91	0.69	4.93	13.06
917	19.92	0.68	4.74	12.34
918	19.92	0.69	5.26	13.06
919	19.91	0.69	5.71	12.42
920	19.91	0.69	5.68	12.71
921	19.90	0.71	5.99	14.16
922	19.92	0.69	5.56	12.61
923	19.91	0.70	4.80	12.75
924	19.89	0.70	6.39	15.49
925	19.91	0.70	5.53	14.43
926	19.91	0.69	5.19	14.14
927	19.92	0.69	4.65	13.30
928	19.92	0.70	5.07	13.60
929	19.92	0.71	6.14	13.11
930	19.90	0.69	6.34	12.68
931	19.92	0.70	5.02	14.81
932	19.92	0.71	5.11	14.60
933	19.94	0.68	4.77	12.42
934	19.96	0.69	4.38	12.62
935	19.94	0.69	4.38	12.75
936	19.94	0.68	3.86	11.79
937	19.94	0.69	3.92	12.56
938	19.94	0.69	4.31	12.58
939	19.94	0.70	5.55	14.06
940	19.93	0.70	6.60	13.40
941	19.94	0.69	5.56	12.30
942	19.94	0.68	4.93	12.09
943	19.95	0.69	5.02	12.23
944	19.95	0.68	5.20	11.80
945	20.05	0.57	5.20	9.65
946	20.11	0.67	4.44	12.09
947	19.96	0.68	4.98	12.43
948	19.96	0.68	5.11	12.24
949	19.96	0.68	4.65	12.51
950	19.96	0.68	4.56	12.68
951	19.96	0.68	4.41	12.23
952	19.96	0.59	4.56	10.68
953	20.04	0.68	3.95	13.22
954	19.95	0.69	4.56	14.30

955	19.94	0.67	4.52	9.54
956	19.95	0.69	5.44	14.71
957	19.95	0.70	3.82	15.61
958	19.95	0.69	3.19	14.66
959	19.96	0.69	3.49	14.29
1000	19.96	0.69	3.62	14.09
1001	19.96	0.69	3.59	14.22
1002	19.95	0.69	3.62	13.96
1003	19.96	0.69	4.08	13.88
1004	19.97	0.69	4.77	14.73
1005	19.96	0.70	6.11	16.06
1006	19.96	0.70	6.67	14.68
1007	19.95	0.69	4.86	13.33
1008	19.96	0.70	4.28	13.42
1009	19.96	0.69	4.80	13.23
1010	19.97	0.69	4.89	13.25
1011	19.97	0.70	5.72	13.43
1012	19.97	0.68	6.30	12.71
1013	19.97	0.68	5.50	12.31
1014	19.97	0.68	5.39	11.90
1015	19.98	0.69	5.63	12.14
1016	19.96	0.69	5.78	12.15
1017	19.97	0.68	5.99	11.58
1018	19.98	0.68	6.17	11.62
1019	19.98	0.68	5.87	11.41
1020	19.97	0.67	6.11	11.14
1021	19.97	0.68	6.11	11.06
1022	19.97	0.69	5.55	11.46
1023	19.97	0.68	5.20	12.27
1024	19.98	0.68	4.80	12.66
1025	19.99	0.69	4.72	12.44
1026	19.96	0.68	4.96	12.80
1027	19.97	0.68	4.68	12.68
1028	19.98	0.68	4.93	11.98
1029	19.98	0.68	5.38	11.72
1030	19.99	0.67	5.54	10.77
1031	20.01	0.67	5.59	10.59
1032	19.98	0.68	5.96	11.29
1033	19.97	0.69	5.87	11.15
1034	19.98	0.68	6.23	11.89
1035	19.97	0.69	6.42	11.46
1036	19.96	0.68	7.04	7.80
1037	19.97	0.68	6.17	12.50
1038	19.97	0.69	5.38	12.57
1039	19.97	0.69	5.78	12.16
1040	19.96	0.69	6.17	11.92
1041	19.98	0.69	6.67	12.11
1042	19.99	0.68	6.94	12.16
1043	19.98	0.68	7.34	12.41
1044	19.98	0.69	7.47	12.38

1045	19.97	0.68	7.13	12.03
1046	19.99	0.68	6.86	12.14
1047	19.98	0.68	6.52	12.01
1048	19.98	0.68	6.55	12.31
1049	20.00	0.68	6.89	12.03
1050	19.99	0.69	7.28	11.72
1051	19.98	0.68	7.74	11.60
1052	19.99	0.69	7.34	12.26
1053	20.00	0.69	7.79	12.25
1054	19.98	0.71	9.17	14.06
1055	19.99	0.70	10.47	12.17
1056	19.99	0.70	8.87	11.63
1057	19.98	0.70	8.16	12.08
1058	19.99	0.69	7.59	12.48
1059	20.00	0.69	7.53	11.49
1100	19.99	0.69	7.83	11.05
1101	20.00	0.69	8.04	10.93
1102	19.99	0.69	7.19	11.94
1103	19.99	0.69	7.15	11.94
1104	19.99	0.69	6.48	11.78
1105	19.97	0.69	5.99	11.87
1106	19.99	0.70	5.60	12.68
1107	19.99	0.71	5.35	13.59
1108	19.98	0.70	5.45	13.03
1109	19.99	0.69	5.81	11.94
1110	19.99	0.70	6.17	11.83
1111	19.99	0.71	9.47	13.82
1112	19.98	0.72	11.01	14.38
1113	19.99	0.71	10.24	12.04
1114	19.96	0.71	10.80	10.60
1115	19.98	0.72	8.62	17.27
1116	19.98	0.72	7.13	14.56
1117	19.98	0.72	7.46	14.23
1118	19.99	0.71	7.07	13.50
1119	19.99	0.71	6.85	12.93
1120	19.98	0.71	6.58	12.57
1121	19.99	0.71	6.24	12.40
1122	20.00	0.71	6.18	12.95
1123	19.99	0.71	6.64	12.39
1124	20.00	0.70	6.21	11.87
1125	20.00	0.70	6.34	12.16
1126	20.00	0.71	6.98	12.39
1127	20.00	0.70	6.76	12.16
1128	20.01	0.70	6.09	12.10
1129	20.01	0.70	6.09	12.22
1130	20.00	0.70	5.81	12.29
1131	20.01	0.69	6.09	12.26
1132	19.99	0.70	6.31	12.15
1133	20.00	0.69	6.02	11.87
1134	20.01	0.69	6.43	11.76

1135	20.01	0.69	6.23	11.88
1136	20.01	0.70	6.58	14.22
1137	20.00	0.70	7.01	12.48
1138	20.00	0.70	6.86	12.96
1139	20.02	0.70	6.65	12.36
1140	20.01	0.71	6.92	14.29
1141	20.01	0.69	6.86	12.14
1142	20.01	0.70	5.78	12.14
1143	20.01	0.69	5.14	11.93
1144	20.01	0.70	5.03	12.34
1145	20.01	0.69	4.98	12.08
1146	20.01	0.70	4.87	12.54
1147	20.02	0.71	4.78	13.52
1148	20.00	0.70	5.17	12.83
1149	20.02	0.70	5.47	13.02
1150	20.02	0.70	5.32	13.49
1151	20.03	0.71	5.36	14.06
1152	20.00	0.71	5.48	13.72
1153	20.03	0.72	5.85	14.87
1154	20.00	0.71	7.13	13.88
1155	20.00	0.70	6.65	11.93
1156	20.01	0.71	5.60	13.97
1157	20.01	0.71	4.63	15.34
1158	20.01	0.71	4.56	15.78
1159	20.01	0.71	4.26	15.33
1200	20.01	0.71	4.04	14.69
1201	20.02	0.71	3.96	14.24
1202	20.02	0.71	3.90	13.74
1203	20.02	0.71	4.14	13.69
1204	20.02	0.71	4.75	13.59
1205	20.02	0.71	5.11	13.61
1206	20.02	0.70	5.05	13.60
1207	20.02	0.71	5.33	13.77
1208	20.02	0.71	5.52	13.33
1209	20.02	0.70	5.82	12.70
1210	20.03	0.70	5.60	12.92
1211	20.02	0.70	5.72	12.87
1212	20.02	0.70	5.45	13.24
1213	20.01	0.71	5.85	13.66
1214	20.02	0.72	6.74	16.83
1215	20.02	0.71	6.89	13.09
1216	20.02	0.71	6.00	13.21
1217	20.01	0.71	5.96	13.19
1218	20.02	0.71	6.55	13.88
1219	20.01	0.71	7.80	14.21
1220	20.01	0.70	7.57	12.51
1221	20.05	0.69	7.66	11.02
1222	20.03	0.71	7.44	12.65
1223	20.02	0.70	6.79	12.55
1224	20.02	0.71	6.68	12.47

1225	20.02	0.73	6.89	14.32
1226	19.99	0.72	8.78	13.57
1227	20.02	0.72	8.05	13.54
1228	20.02	0.71	7.50	13.39
1229	20.02	0.71	7.04	12.75
1230	20.02	0.71	7.07	12.55
1231	20.02	0.71	7.22	13.22
1232	20.02	0.71	7.02	12.85
1233	20.02	0.71	6.15	13.31
1234	20.01	0.71	6.18	12.80
1235	20.02	0.72	6.68	11.72
1236	20.01	0.72	8.99	12.25
1237	20.01	0.72	7.53	12.11
1238	20.02	0.71	6.89	12.31
1239	20.02	0.71	6.89	12.89
1240	20.03	0.71	6.83	12.94
1241	20.02	0.71	7.07	13.56
1242	20.02	0.71	7.90	12.72
1243	20.02	0.70	7.25	12.68
1244	20.02	0.71	6.70	13.23
1245	20.01	0.71	6.74	12.78
1246	20.02	0.71	7.01	13.02
1247	20.02	0.70	6.68	12.25
1248	20.03	0.70	6.12	11.87
1249	20.03	0.70	6.03	11.75
1250	20.01	0.70	6.59	11.92
1251	20.02	0.71	7.35	11.93
1252	20.01	0.70	7.13	11.15
1253	20.05	0.69	6.59	10.95
1254	20.04	0.69	6.34	11.22
1255	20.04	0.69	6.37	11.54
1256	20.03	0.70	5.75	11.82
1257	20.02	0.71	5.94	12.35
1258	20.02	0.71	6.74	11.50
1259	20.01	0.71	7.59	12.89
1300	20.01	0.71	6.61	12.11
Average	**20.01**	**0.67**	**5.59**	**12.29**

Trigon Engineering Consultants

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - ESP Stack

Wednesday 1/20/99

Time	O2 %	CO2 %	SO2 ppm	NOx ppm
1321	20.04	0.72	10.93	11.41
1322	20.04	0.71	10.44	11.36
1323	20.03	0.71	10.21	11.05
1324	20.03	0.72	9.61	11.68
1325	20.04	0.72	8.84	11.66
1326	20.03	0.73	9.36	13.59
1327	20.03	0.72	9.45	11.74
1328	20.02	0.72	10.18	11.09
1329	20.03	0.71	9.54	12.44
1330	20.03	0.71	9.55	12.69
1331	20.03	0.71	9.85	12.70
1332	20.04	0.71	11.30	12.19
1333	20.03	0.71	12.06	11.85
1334	20.04	0.72	12.21	12.66
1335	20.02	0.72	12.46	11.61
1336	20.03	0.71	12.09	11.92
1337	20.05	0.71	11.88	11.96
1338	20.05	0.71	12.56	11.11
1339	20.05	0.70	12.53	11.49
1340	20.04	0.71	12.39	11.55
1341	20.05	0.71	12.56	11.87
1342	20.04	0.72	11.84	12.85
1343	20.03	0.71	10.78	12.91
1344	20.05	0.71	10.78	13.07
1345	20.04	0.72	10.54	13.15
1346	20.04	0.72	10.66	13.32
1347	20.04	0.72	9.75	13.14
1348	20.04	0.72	9.73	12.86
1349	20.04	0.72	9.06	12.77
1350	20.04	0.72	8.88	12.78
1351	20.04	0.73	8.51	12.65
1352	20.04	0.72	8.27	12.10
1353	20.03	0.72	8.42	12.17
1354	20.04	0.72	8.63	12.54
1355	20.03	0.73	8.69	12.59
1356	20.02	0.74	9.09	13.52
1357	20.03	0.73	9.12	12.98
1358	20.02	0.72	9.06	12.56
1359	20.04	0.72	8.60	12.32
1400	20.04	0.71	8.81	12.14
1401	20.02	0.72	8.93	12.60
1402	20.02	0.72	8.11	12.72
1403	20.04	0.72	7.68	12.90
1404	20.00	0.73	7.65	12.94
1405	20.01	0.73	7.78	12.26
1406	20.02	0.73	7.53	13.56

Period 6

766

TRIGON

1407	20.02	0.73	7.71	13.45
1408	20.02	0.72	7.41	14.03
1409	20.02	0.72	7.50	14.08
1410	20.00	0.73	8.18	14.33
1411	20.02	0.73	7.94	13.92
1412	20.03	0.72	7.51	13.67
1413	20.02	0.73	7.90	13.64
1414	20.02	0.72	7.72	13.43
1415	20.03	0.72	7.35	13.24
1416	20.02	0.72	7.26	13.21
1417	20.03	0.72	7.14	13.07
1418	20.03	0.72	7.14	13.20
1419	20.03	0.72	6.65	13.36
1420	20.02	0.73	6.86	13.58
1421	20.02	0.72	6.83	12.98
1422	20.04	0.72	6.92	12.61
1423	20.04	0.73	7.08	12.97
1424	20.02	0.73	7.62	13.34
1425	20.03	0.73	8.05	14.33
1426	20.02	0.72	9.09	13.04
1427	20.03	0.72	8.69	12.19
1428	20.04	0.72	8.93	11.80
1429	20.04	0.71	8.32	12.14
1430	20.03	0.72	8.69	13.25
1431	20.01	0.73	9.97	14.19
1432	20.02	0.71	9.66	11.06
1433	20.04	0.70	9.14	9.88
1434	20.03	0.72	8.26	11.75
1435	20.02	0.73	6.71	13.30
1436	20.01	0.73	6.18	14.44
1437	20.02	0.73	5.81	14.55
1438	20.02	0.74	6.19	14.75
1439	20.02	0.73	7.08	14.21
1440	20.03	0.73	6.96	13.32
1441	20.02	0.73	6.59	13.43
1442	20.02	0.74	6.35	14.23
1443	20.02	0.73	6.59	14.05
1444	20.02	0.72	6.81	13.32
1445	20.03	0.73	7.26	13.59
1446	20.03	0.73	8.66	13.56
1447	20.03	0.73	9.18	13.83
1448	20.02	0.72	9.30	13.34
1449	20.05	0.73	8.33	13.19
1450	20.02	0.72	7.32	12.77
1451	20.02	0.72	7.42	13.15
1452	20.03	0.72	7.60	12.88
1453	20.03	0.72	7.63	14.32
1454	19.99	0.73	8.90	14.40
1455	20.02	0.72	7.60	13.60
1456	20.02	0.72	6.77	12.81
1457	20.02	0.72	6.87	12.43
1458	20.02	0.71	7.20	12.17
1459	20.02	0.72	6.71	13.12
1500	20.02	0.72	6.32	13.55
1501	20.02	0.72	6.56	12.57
1502	20.02	0.73	6.68	13.98
1503	20.02	0.72	5.94	13.09
1504	20.03	0.71	5.33	12.24

1505	20.04	0.71	5.24	12.80
1506	20.01	0.72	5.24	12.82
1507	20.02	0.72	5.24	13.09
1508	20.03	0.71	5.21	13.25
1509	20.02	0.72	5.09	13.29
1510	20.01	0.71	5.09	13.06
1511	20.03	0.71	5.11	13.02
1512	20.03	0.71	5.05	12.81
1513	20.02	0.72	4.97	13.26
1514	20.02	0.71	4.75	12.97
1515	20.03	0.71	5.08	13.07
1516	20.03	0.71	5.09	13.01
1517	20.02	0.72	5.21	13.86
1518	20.01	0.74	5.54	15.32
1519	20.02	0.73	6.40	15.06
1520	20.02	0.74	6.54	15.32
1521	20.01	0.73	6.80	14.46
1522	20.02	0.73	6.89	14.70
1523	20.03	0.73	7.01	14.73
1524	20.02	0.73	7.36	15.42
1525	20.02	0.73	7.56	14.70
1526	20.02	0.73	6.58	14.32
1527	20.02	0.75	6.66	16.82
1528	20.02	0.74	6.83	14.86
1529	20.02	0.73	5.45	14.67
1530	20.01	0.74	5.46	14.82
1531	20.02	0.73	4.97	12.86
1532	20.01	0.73	4.94	11.60
1533	20.02	0.72	5.40	13.44
1534	20.01	0.72	5.30	13.92
1535	20.01	0.73	5.67	14.15
1536	20.01	0.72	7.36	13.73
1537	20.03	0.72	7.84	13.08
1538	20.02	0.71	8.36	12.96
1539	20.03	0.72	8.06	12.82
1540	20.02	0.71	7.48	12.58
1541	20.08	0.40	5.09	9.83
1542	20.43	0.40	3.99	9.63
1543	20.39	0.39	3.75	9.53
1544	20.40	0.38	4.02	9.46
1545	20.39	0.40	4.24	9.17
1546	20.40	0.39	4.24	8.99
1547	20.39	0.38	4.05	9.09
1548	20.38	0.40	3.96	9.12
1549	20.39	0.40	3.78	9.14
1550	20.41	0.40	3.75	9.21
1551	20.39	0.39	3.72	9.47
1552	20.40	0.40	3.66	9.24
1553	20.39	0.40	3.20	9.36
1554	20.38	0.39	2.99	9.53
1555	20.38	0.39	3.08	9.25
1556	20.39	0.71	5.46	11.84
1557	19.98	0.71	5.70	11.79
1558	20.01	0.71	5.67	11.81
1559	20.00	0.71	5.76	12.34
1600	19.99	0.72	5.64	11.53
Average	**20.06**	**0.69**	**7.46**	**12.72**

Period 6

768

TRIGON

Trigon Engineering Consultants

E 229 1

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - ESP Stack

Wednesday 1/20/99 & Thursday 1/21/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
1631	19.98	0.75	8.45	14.53
1632	19.98	0.75	8.42	13.37
1633	19.98	0.75	8.76	13.99
1634	19.98	0.73	7.81	13.86
1635	20.00	0.74	7.36	14.71
1636	19.99	0.75	7.63	14.41
1637	19.99	0.75	7.59	14.74
1638	19.98	0.74	7.44	13.43
1639	19.99	0.75	7.33	13.30
1640	19.98	0.74	7.02	12.92
1641	19.99	0.73	6.56	13.24
1642	19.99	0.73	6.41	13.24
1643	20.00	0.72	6.40	12.21
1644	20.00	0.73	6.41	12.12
1645	20.00	0.72	6.72	12.01
1646	20.00	0.72	6.72	12.11
1647	20.00	0.71	6.77	11.88
1648	20.00	0.72	6.66	13.74
1649	20.00	0.73	6.28	14.00
1650	19.99	0.72	6.21	13.06
1651	20.00	0.72	6.50	12.89
1652	20.01	0.71	6.32	12.95
1653	20.01	0.72	6.35	13.35
1654	20.00	0.72	6.84	13.14
1655	20.00	0.72	6.65	13.19
1656	20.00	0.72	6.99	12.72
1657	20.00	0.73	6.99	12.64
1658	19.99	0.71	7.32	12.50
1659	20.00	0.72	7.05	12.70
1700	20.00	0.71	6.78	12.40
1701	19.99	0.71	6.41	12.43
1702	20.00	0.71	6.19	12.32
1703	20.00	0.71	6.26	12.33
1704	20.00	0.73	5.98	14.01
1705	20.00	0.72	6.13	13.42
1706	19.99	0.72	6.04	12.08
1707	19.98	0.71	6.04	12.71
1708	19.99	0.72	5.67	13.97
1709	19.97	0.73	5.30	13.52
1710	19.98	0.72	5.03	13.29
1711	19.99	0.72	4.91	13.20
1712	19.99	0.72	4.97	13.67
1713	19.99	0.72	5.18	13.92
1714	19.99	0.72	4.85	13.71
1715	19.99	0.72	4.97	13.76
1716	19.99	0.72	5.15	13.63
1717	20.00	0.72	5.46	14.01
1718	19.98	0.72	5.67	14.15

1719	19.99	0.73	6.26	14.89
1720	19.99	0.72	6.22	15.02
1721	19.98	0.72	6.22	14.40
1722	19.99	0.73	6.32	14.43
1723	19.98	0.73	6.29	14.48
1724	19.98	0.73	16.94	14.41
1725	19.98	0.73	19.14	14.30
1726	19.98	0.73	16.85	14.00
1727	19.98	0.72	12.53	13.86
1728	19.98	0.72	9.82	13.50
1729	19.99	0.72	8.08	13.33
1730	19.98	0.72	7.93	13.20
1731	19.97	0.73	7.02	12.81
1732	19.97	0.72	7.26	12.24
1733	19.98	0.72	7.02	13.59
1734	19.98	0.73	6.62	13.46
1735	19.99	0.72	6.53	13.11
1736	19.99	0.72	6.68	13.16
1737	19.98	0.72	6.59	13.24
1738	19.99	0.72	6.35	13.65
1739	19.98	0.72	6.50	13.65
1740	19.98	0.72	6.65	14.03
1741	19.98	0.72	6.68	14.09
1742	19.98	0.72	6.89	13.72
1743	19.98	0.72	7.08	13.42
1744	19.99	0.72	7.26	13.52
1745	19.99	0.72	7.87	13.34
1746	19.98	0.72	8.75	12.90
1747	19.98	0.72	9.18	12.76
1748	19.98	0.72	10.03	12.92
1749	19.98	0.72	10.29	13.30
1750	19.98	0.72	10.29	13.47
1751	19.97	0.72	10.57	13.33
1752	19.98	0.72	10.87	13.51
1753	19.98	0.72	10.54	13.42
1754	19.98	0.72	9.88	13.20
1755	19.98	0.72	9.18	13.12
1756	19.98	0.72	8.94	13.15
1757	19.98	0.72	8.54	13.55
1758	19.98	0.72	8.23	13.62
1759	19.98	0.72	8.05	14.04
1800	19.99	0.72	7.54	13.52
1801	19.98	0.73	7.66	11.67
1802	19.98	0.73	7.54	12.96
1803	19.97	0.73	7.44	14.05
1804	19.97	0.73	7.84	13.35
1805	19.98	0.73	7.60	13.52
1806	19.98	0.72	7.20	13.44
1807	19.98	0.72	6.83	13.42
1808	19.98	0.72	6.71	13.33
1809	19.98	0.72	6.65	13.52
1810	19.98	0.72	7.02	13.94
1811	19.98	0.73	7.57	13.48
1812	19.99	0.72	7.29	13.33
1813	19.98	0.72	7.47	13.99
1814	19.98	0.75	7.96	15.80
1815	19.96	0.74	9.06	13.64
1816	19.97	0.73	8.33	12.10
1817	19.98	0.72	7.60	11.82

1818	19.98	0.71	7.29	11.97
1819	19.99	0.72	6.90	12.01
1820	19.98	0.72	6.86	12.31
1821	19.99	0.72	6.28	12.67
1822	19.98	0.72	5.94	12.29
1823	19.98	0.72	6.00	12.13
1824	19.98	0.72	6.06	12.09
1825	19.99	0.72	6.22	12.45
1826	19.98	0.72	6.53	12.92
1827	19.98	0.73	6.18	14.28
1828	19.97	0.74	6.22	14.79
1829	19.98	0.73	6.62	12.75
1830	19.97	0.73	7.48	12.79
1831	19.98	0.72	7.93	12.40
1832	19.98	0.73	8.82	12.09
1833	19.96	0.72	10.12	12.20
1834	19.98	0.73	9.73	14.20
1835	19.97	0.73	9.12	13.62
1836	19.98	0.73	9.30	13.65
1837	19.97	0.72	8.91	13.20
1838	19.97	0.73	8.30	13.55
1839	19.98	0.72	8.63	13.01
1840	19.98	0.73	8.82	13.18
1841	19.96	0.73	9.12	13.28
1842	19.97	0.74	9.67	13.39
1843	19.97	0.73	10.12	12.92
1844	19.97	0.73	10.78	13.08
1845	19.97	0.73	10.51	13.21
1846	19.96	0.73	9.73	13.35
1847	19.97	0.72	8.69	13.48
1848	19.97	0.72	8.30	13.47
1849	19.96	0.73	8.09	13.69
1850	19.97	0.72	7.90	13.50
1851	19.97	0.73	8.21	13.34
1852	19.96	0.73	8.06	13.36
1853	19.96	0.73	8.15	13.21
1854	19.97	0.75	8.42	13.30
1855	19.97	0.75	8.48	13.66
1856	19.98	0.75	9.31	13.61
1857	19.98	0.74	9.20	13.60
1858	19.98	0.75	10.01	13.94
1859	19.97	0.75	10.01	13.44
1900	19.97	0.75	10.45	12.50
1901	19.97	0.75	9.00	13.39
1902	19.97	0.75	9.00	14.76
1903	19.97	0.75	9.05	14.88
1904	19.96	0.75	9.72	14.83
1905	19.97	0.75	10.57	14.95
1906	19.97	0.76	11.36	15.11
1907	19.97	0.75	10.50	14.92
1908	19.97	0.75	9.85	14.33
1909	19.98	0.74	10.29	14.19
1910	19.97	0.74	10.53	14.00
1911	19.98	0.74	9.54	14.56
1912	19.99	0.74	9.39	14.47
1913	19.99	0.74	9.60	14.84
1914	19.99	0.75	10.53	15.16
1915	19.97	0.75	11.42	14.85
1916	19.98	0.75	10.33	14.13

1917	19.97	0.75	8.66	13.56
1918	19.99	0.74	8.42	13.68
1919	19.98	0.74	8.17	13.76
1920	19.97	0.74	8.11	13.45
1921	19.98	0.74	7.96	13.52
1922	19.99	0.74	7.38	13.08
1923	19.98	0.74	7.66	13.54
1924	19.98	0.74	7.72	13.39
1925	19.99	0.75	8.45	14.03
1926	19.98	0.74	8.94	13.85
1927	19.98	0.75	9.15	15.11
1928	19.97	0.76	11.21	16.05
1929	19.97	0.74	11.94	13.12
1930	19.98	0.74	11.58	12.28
1931	19.99	0.74	11.97	12.34
1932	19.99	0.74	11.15	12.19
1933	19.98	0.73	10.30	12.24
1934	19.98	0.74	10.51	12.33
1935	19.99	0.74	10.57	11.31
1936	19.98	0.74	10.18	12.85
1937	19.98	0.75	9.15	13.52
1938	19.98	0.74	9.49	13.94
1939	19.98	0.74	9.70	13.65
1940	19.98	0.75	12.06	14.41
1941	19.98	0.74	13.25	14.21
1942	19.98	0.74	14.14	13.96
1943	19.97	0.75	14.29	14.45
1944	19.97	0.73	14.56	13.86
1945	19.98	0.74	12.24	13.77
1946	19.98	0.74	11.45	13.80
1947	19.98	0.74	10.32	13.26
1948	19.98	0.73	10.32	12.84
1949	19.98	0.73	10.96	12.93
1950	19.98	0.73	10.21	13.24
1951	19.98	0.73	9.09	13.38
1952	19.98	0.73	8.57	13.96
1953	19.98	0.74	8.42	14.29
1954	19.97	0.73	7.96	14.29
1955	19.98	0.74	7.84	14.24
1956	19.97	0.74	7.59	13.86
1957	19.97	0.74	7.53	13.97
1958	19.97	0.74	7.87	13.76
1959	19.97	0.76	7.90	14.83
2000	19.97	0.75	10.33	13.98
2001	19.96	0.74	8.42	12.77
2002	19.98	0.74	7.08	14.08
2003	19.97	0.74	6.47	13.80
2004	19.96	0.74	6.38	14.07
2005	19.97	0.75	6.81	14.25
2006	19.97	0.76	7.93	14.72
2007	19.96	0.77	8.06	15.51
2008	19.96	0.76	9.09	14.72
2009	19.98	0.74	7.17	13.69
2010	19.98	0.74	6.66	13.19
2011	19.97	0.74	5.54	13.23
2012	19.98	0.75	5.97	14.01
2013	19.97	0.76	7.16	15.06
2014	19.96	0.76	9.54	15.37
2015	19.97	0.74	7.93	13.00

772

TRIGON

2016	19.96	0.74	7.07	12.72
2017	19.97	0.75	7.68	13.12
2018	19.98	0.74	6.71	12.90
2019	19.97	0.74	6.50	13.28
2020	19.97	0.75	7.32	14.81
2021	19.97	0.75	8.54	14.64
2022	19.96	0.75	7.35	13.47
2023	19.97	0.75	6.83	14.00
2024	19.97	0.74	6.00	13.36
2025	19.96	0.73	5.33	13.17
2026	19.97	0.73	5.15	13.02
2027	19.97	0.73	5.09	12.83
2028	19.97	0.73	5.06	12.78
2029	19.97	0.73	5.03	12.95
2030	19.97	0.73	5.06	13.29
2031	19.97	0.73	4.94	13.46
2032	19.97	0.73	4.69	12.89
2033	19.97	0.74	4.96	12.57
2034	19.97	0.73	4.79	12.25
2035	19.96	0.74	4.99	13.63
2036	19.97	0.74	5.72	14.14
2037	19.97	0.74	7.29	14.22
2038	19.97	0.75	7.80	15.52
2039	19.96	0.77	11.93	18.36
2040	19.96	0.75	11.02	15.00
2041	19.96	0.75	7.22	14.54
2042	19.97	0.74	7.32	13.85
2043	19.97	0.74	6.95	13.74
2044	19.97	0.74	6.53	13.10
2045	19.97	0.74	6.00	13.29
2046	19.97	0.74	6.34	13.44
2047	19.97	0.74	5.85	13.61
2048	19.97	0.76	5.88	16.79
2049	19.96	0.75	6.89	15.33
2050	19.96	0.73	5.72	13.49
2051	19.97	0.73	4.99	13.38
2052	19.98	0.74	5.33	13.11
2053	19.97	0.73	4.63	12.39
2054	19.98	0.73	4.75	12.14
2055	19.98	0.73	4.75	12.50
2056	19.97	0.74	5.76	13.06
2057	19.97	0.73	5.58	11.72
2058	19.96	0.72	5.97	11.28
2059	19.98	0.74	4.69	13.04
2100	19.96	0.74	5.55	13.82
2101	19.97	0.74	4.91	14.17
2102	19.96	0.74	5.26	13.90
2103	19.96	0.74	6.15	14.16
2104	19.97	0.74	6.06	14.32
2105	19.97	0.74	6.18	14.13
2106	19.97	0.74	6.65	14.35
2107	19.96	0.75	8.14	14.48
2108	19.96	0.74	7.95	13.56
2109	19.96	0.74	7.62	13.65
2110	19.97	0.74	6.21	13.07
2111	19.97	0.73	5.24	12.91
2112	19.97	0.73	5.18	13.88
2113	19.97	0.72	5.54	13.30
2114	19.97	0.73	4.78	13.31

773

TRIGON

E 2291

2115	19.97	0.73	4.38	12.91
2116	19.97	0.73	4.45	13.48
2117	19.96	0.73	4.48	13.18
2118	19.96	0.73	4.69	13.36
2119	19.96	0.73	5.06	13.72
2120	19.97	0.72	5.24	12.55
2121	19.96	0.73	4.93	12.70
2122	19.96	0.72	5.00	12.23
2123	19.97	0.72	5.09	11.79
2124	19.98	0.72	5.06	11.82
2125	19.97	0.71	4.87	11.48
2126	19.98	0.72	4.69	12.38
2127	19.98	0.72	4.57	12.74
2128	19.97	0.71	5.51	11.84
2129	19.97	0.72	5.49	11.61
2130	19.97	0.72	5.79	11.55
2131	19.97	0.72	5.69	11.76
2132	19.97	0.72	5.51	11.50
2133	19.98	0.73	5.45	12.28
2134	19.97	0.73	6.64	12.78
2135	19.97	0.73	6.80	12.96
2136	19.97	0.73	7.71	11.35
2137	19.96	0.73	8.68	12.79
2138	19.95	0.73	7.29	13.04
2139	19.96	0.74	6.28	14.73
2140	19.95	0.74	5.66	14.20
2141	19.97	0.72	5.23	13.49
2142	19.96	0.74	7.59	15.40
2143	19.96	0.74	8.69	14.59
2144	19.96	0.75	8.96	15.94
2145	19.96	0.74	7.53	14.47
2146	19.96	0.72	5.11	14.02
2147	19.97	0.73	4.87	14.72
2148	19.96	0.74	4.63	15.16
2149	19.96	0.75	5.18	16.83
2150	19.95	0.76	6.31	17.57
2151	19.96	0.75	5.76	16.42
2152	19.96	0.74	4.97	14.28
2153	19.96	0.73	4.72	13.50
2154	19.97	0.73	4.91	13.08
2155	19.97	0.72	4.33	12.28
2156	19.97	0.73	4.57	12.72
2157	19.96	0.73	6.24	13.61
2158	19.97	0.72	5.72	13.23
2159	19.97	0.72	5.36	12.63
2200	19.96	0.72	5.23	12.86
2201	19.97	0.72	5.21	13.05
2202	19.97	0.72	5.14	13.00
2203	19.97	0.73	5.81	13.69
2204	19.97	0.72	5.63	12.94
2205	19.96	0.72	6.12	11.90
2206	19.97	0.73	5.93	14.68
2207	19.95	0.73	6.34	14.79
2208	19.97	0.72	5.87	13.83
2209	19.97	0.72	5.27	13.80
2210	19.96	0.73	4.93	13.53
2211	19.97	0.72	5.05	13.31
2212	19.97	0.72	5.02	13.08
2213	19.96	0.73	5.27	13.02

774

TRIGON

2291

2214	19.97	0.73	5.03	12.81
2215	19.96	0.71	4.96	12.57
2216	19.97	0.72	4.87	12.80
2217	19.97	0.72	4.75	12.79
2218	19.98	0.72	4.69	12.88
2219	19.97	0.72	5.06	13.34
2220	19.97	0.72	5.36	13.19
2221	19.97	0.72	5.51	12.68
2222	19.97	0.72	5.45	12.90
2223	19.97	0.72	5.18	12.29
2224	19.96	0.72	4.93	12.15
2225	19.96	0.71	5.11	11.85
2226	19.97	0.71	4.44	12.03
2227	19.97	0.71	4.59	11.84
2228	19.97	0.72	5.17	12.29
2229	19.96	0.71	4.73	12.32
2230	19.97	0.72	4.97	12.64
2231	19.96	0.72	4.53	12.46
2232	19.97	0.71	4.29	12.25
2233	19.97	0.71	4.29	12.26
2234	19.97	0.71	4.90	12.55
2235	19.96	0.71	6.52	11.18
2236	19.96	0.72	5.63	13.34
2237	19.95	0.72	5.02	14.53
2238	19.96	0.72	4.93	13.92
2239	19.97	0.72	5.17	13.92
2240	19.96	0.72	5.72	13.64
2241	19.96	0.72	6.15	13.73
2242	19.97	0.72	5.91	13.65
2243	19.97	0.72	4.96	13.65
2244	19.96	0.72	4.78	13.01
2245	19.96	0.72	4.81	12.75
2246	19.95	0.71	4.75	12.50
2247	19.96	0.72	5.39	11.05
2248	19.96	0.72	4.63	13.98
2249	19.95	0.73	3.99	14.29
2250	19.96	0.72	3.81	13.46
2251	19.96	0.72	3.75	13.75
2252	19.96	0.72	3.53	13.67
2253	19.96	0.71	3.31	14.02
2254	19.96	0.72	3.69	14.30
2255	19.96	0.72	3.87	14.19
2256	19.96	0.72	3.71	14.42
2257	19.96	0.72	3.96	13.73
2258	19.95	0.71	4.14	13.45
2259	19.95	0.71	4.20	13.39
2300	19.96	0.72	3.83	13.76
2301	19.96	0.72	3.95	13.81
2302	19.95	0.72	4.17	13.87
2303	19.96	0.72	3.74	13.62
2304	19.96	0.71	3.86	13.47
2305	19.90	1.06	4.84	14.85
2306	19.31	1.14	14.56	14.73
2307	19.24	1.14	20.90	13.81
2308	19.27	0.84	23.54	13.42
2309	19.87	0.74	10.84	12.22
2310	19.91	0.74	7.95	11.81
2311	19.93	0.73	7.44	13.10
2312	19.92	0.74	5.90	13.71

775

TRIGON

2313	19.91	0.74	5.75	13.80
2314	19.92	0.74	5.84	14.07
2315	19.92	0.74	5.18	14.23
2316	19.92	0.74	5.30	14.36
2317	19.92	0.74	4.99	14.13
2318	19.92	0.74	5.27	14.17
2319	19.92	0.75	7.53	14.55
2320	19.92	0.74	7.81	13.66
2321	19.92	0.75	7.28	13.61
2322	19.91	0.74	6.65	13.39
2323	19.92	0.74	6.18	13.27
2324	19.92	0.73	5.84	12.93
2325	19.92	0.74	5.87	12.28
2326	19.92	0.73	6.43	12.12
2327	19.91	0.73	5.84	13.18
2328	19.91	0.74	5.67	13.98
2329	19.90	0.74	5.81	14.01
2330	19.91	0.83	5.99	15.22
2331	19.69	0.89	8.38	16.44
2332	19.67	0.89	10.14	15.66
2333	19.67	0.89	9.57	14.88
2334	19.66	0.90	9.72	14.43
2335	19.66	0.89	10.71	13.71
2336	19.67	0.89	10.99	13.96
2337	19.67	0.89	12.02	13.62
2338	19.67	0.88	13.07	12.71
2339	19.66	0.89	13.43	12.92
2340	19.66	0.89	14.83	12.97
2341	19.65	0.89	15.11	12.94
2342	19.66	0.89	14.59	13.00
2343	19.66	0.88	14.31	13.30
2344	19.68	0.87	13.83	12.44
2345	19.68	0.87	12.64	14.06
2346	19.69	0.88	11.59	15.16
2347	19.69	0.88	11.97	14.47
2348	19.69	0.87	13.35	14.08
2349	19.69	0.87	13.43	14.02
2350	19.68	0.89	14.04	14.47
2351	19.68	0.87	14.09	14.17
2352	19.69	0.87	14.29	13.96
2353	19.69	0.88	16.07	14.21
2354	19.77	0.75	16.83	12.76
2355	19.90	0.75	13.58	12.67
2356	19.90	0.75	12.41	13.31
2357	19.91	0.74	11.38	13.20
2358	19.90	0.74	9.96	13.02
2359	19.90	0.74	9.72	13.24
0	19.91	0.75	12.02	13.28
1	19.90	0.75	11.59	12.98
2	19.90	0.75	12.55	12.97
3	19.91	0.74	12.33	12.44
4	19.91	0.74	11.78	12.75
5	19.90	0.74	11.41	12.58
6	19.91	0.74	11.41	11.97
7	19.90	0.74	10.50	11.75
8	19.90	0.74	11.87	11.84
9	19.91	0.74	10.73	11.77
10	19.91	0.73	10.47	11.90
11	19.90	0.73	11.20	12.13

12	19.90	0.73	11.42	12.65
13	19.91	0.74	11.32	12.89
14	19.90	0.75	11.69	12.76
15	19.89	0.74	12.70	11.25
16	19.91	0.74	9.78	13.51
17	19.90	0.74	9.27	14.13
18	19.90	0.74	9.39	14.64
19	19.90	0.75	9.20	14.89
20	19.90	0.74	9.08	14.43
21	19.90	0.74	9.41	14.30
22	19.90	0.75	10.03	14.34
23	19.90	0.74	9.73	13.67
24	19.90	0.73	10.05	13.38
25	19.90	0.73	9.41	13.23
26	19.91	0.73	9.48	13.00
27	19.91	0.73	9.32	13.02
28	19.90	0.73	9.93	13.16
29	19.91	0.73	11.53	13.64
30	19.91	0.73	9.99	13.07
31	19.90	0.73	10.50	13.05
32	19.90	0.73	10.20	13.19
33	19.92	0.72	11.14	12.88
34	19.90	0.73	10.50	12.88
35	19.91	0.73	10.92	12.68
36	19.91	0.72	11.20	12.47
37	19.90	0.73	11.02	12.67
38	19.90	0.73	11.87	12.97
39	19.90	0.74	10.62	14.00
40	19.89	0.74	11.81	14.13
41	19.91	0.73	12.64	14.10
42	19.89	0.73	13.22	13.62
43	19.89	0.74	13.49	13.68
44	19.90	0.73	13.80	13.15
45	19.90	0.73	15.44	12.02
46	19.91	0.73	12.66	13.53
47	19.89	0.73	11.66	11.36
48	19.90	0.72	12.14	10.94
49	19.90	0.73	11.02	11.75
Average	**19.94**	**0.74**	**7.88**	**13.44**

TRIGON

Trigon Engineering Consultants

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - ESP Stack

Thursday 1/21/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
50	19.87	0.72	11.79	11.99
55	19.91	0.73	11.81	12.72
100	19.89	0.74	20.50	13.91
105	19.91	0.72	13.98	11.65
110	19.92	0.72	12.75	12.47
115	19.93	0.72	12.74	11.74
120	19.94	0.72	11.00	13.17
125	19.89	0.72	10.74	13.61
130	19.95	0.72	9.89	13.29
135	19.94	0.72	9.64	15.25
140	19.90	0.72	10.51	13.85
145	19.89	0.72	8.25	11.89
150	19.90	0.72	12.09	13.71
155	19.85	0.72	9.11	15.81
200	19.87	0.73	9.68	14.11
205	19.82	0.73	9.50	13.74
210	19.91	0.73	9.89	12.69
215	19.96	0.73	9.33	13.00
220	19.95	0.73	8.01	11.81
225	19.88	0.73	11.79	14.11
230	19.91	0.73	13.11	11.11
235	19.92	0.73	10.00	14.82
240	19.92	0.73	10.21	13.23
245	19.91	0.73	7.71	13.65
250	19.95	0.73	7.89	13.63
255	19.95	0.73	6.22	14.19
300	19.88	0.73	5.84	13.88
305	19.96	0.71	6.11	13.70
310	19.84	0.71	6.21	12.69
315	19.82	0.71	6.17	12.81
320	19.91	0.71	5.67	13.69
325	19.96	0.71	6.50	12.50
330	19.95	0.71	4.66	14.61
335	19.96	0.71	3.89	13.21
340	19.95	0.71	4.51	12.54
345	19.94	0.71	6.44	12.69
350	19.90	0.71	7.01	12.71
355	19.89	0.71	6.89	13.33
400	19.89	0.71	5.97	14.45
405	19.85	0.70	6.79	13.51
410	19.84	0.69	10.12	13.00
415	19.82	0.69	8.01	13.37
420	19.91	0.69	7.25	13.24
425	19.96	0.69	6.33	12.33
430	19.95	0.69	9.61	13.63
435	19.94	0.71	10.65	17.87

440	19.91	0.71	9.31	11.61
445	19.92	0.71	10.99	15.17
450	19.92	0.71	7.79	11.76
455	19.91	0.71	6.61	15.11
500	19.88	0.71	7.67	11.88
505	19.95	0.71	4.41	12.51
510	19.94	0.71	5.35	13.00
515	19.96	0.71	4.10	14.41
520	19.91	0.71	3.85	13.89
525	19.91	0.71	5.26	14.11
530	19.91	0.71	7.01	13.01
535	19.90	0.71	7.81	12.69
540	19.95	0.69	7.56	12.47
545	19.94	0.69	6.61	13.24
550	19.90	0.70	7.64	12.79
555	19.89	0.70	7.75	12.25
600	19.88	0.72	10.46	12.22
605	19.85	0.72	7.66	11.41
610	19.84	0.72	5.99	15.21
615	19.82	0.72	6.75	13.98
620	19.91	0.72	7.75	15.11
625	19.96	0.72	7.99	12.96
630	19.95	0.71	7.11	12.01
635	19.91	0.72	6.81	12.11
640	19.91	0.72	7.16	13.54
645	19.91	0.72	6.77	13.02
650	19.91	0.72	7.51	13.24
655	19.92	0.72	8.77	14.11
700	19.89	0.72	10.98	13.15
705	19.91	0.70	14.41	14.11
710	19.91	0.70	16.11	14.52
715	19.91	0.70	15.42	16.79
720	19.92	0.70	13.85	13.53
725	19.90	0.70	14.79	14.10
730	19.89	0.70	13.21	12.33
735	19.91	0.70	11.79	12.17
740	19.91	0.70	8.01	12.29
745	19.92	0.71	7.89	12.61
750	19.92	0.70	8.61	13.21
755	19.91	0.70	5.31	13.47
800	19.92	0.72	6.08	12.91
805	19.95	0.71	6.52	12.61
810	19.94	0.70	8.12	13.27
815	19.96	0.70	9.99	12.81
820	19.91	0.70	6.74	13.01
825	19.91	0.70	8.52	13.16
830	19.91	0.70	9.43	13.31
835	19.89	0.70	8.51	13.56
840	19.89	0.70	17.41	17.87
845	19.90	0.70	8.56	12.81
850	19.90	0.70	8.11	13.56
855	19.91	0.70	7.52	13.54
900	19.93	0.70	7.65	12.29
Average	**19.91**	**0.71**	**8.76**	**13.34**

Trigon Engineering Consultants

EnVitCo, Inc. - Clemson University Research Park
Clemson, South Carolina
Envitrification Unit - ESP Stack

Thursday 1/21/99

Time	O_2 %	CO_2 %	SO_2 ppm	NO_x ppm
921	19.95	0.70	11.99	12.08
922	19.95	0.71	12.05	12.21
923	19.94	0.71	12.57	11.99
924	19.91	0.71	12.94	11.96
925	19.95	0.71	12.70	11.87
926	19.95	0.71	14.37	11.92
927	19.95	0.70	13.88	11.35
928	19.95	0.70	13.49	11.28
929	19.96	0.70	14.95	11.48
930	19.96	0.70	13.58	11.70
931	19.95	0.70	13.33	11.18
932	19.95	0.71	13.46	11.23
933	19.95	0.70	14.82	10.98
934	19.96	0.71	13.09	11.29
935	19.95	0.71	12.76	11.75
936	19.95	0.71	13.12	11.78
937	19.94	0.71	14.00	11.40
938	19.95	0.72	12.72	13.70
939	19.95	0.72	12.33	13.85
940	19.95	0.71	12.29	13.65
941	19.95	0.71	12.42	13.48
942	19.95	0.71	13.07	13.17
943	19.95	0.72	12.85	13.28
944	19.95	0.72	13.67	12.93
945	19.95	0.71	14.55	12.86
946	19.95	0.71	15.26	13.02
947	19.96	0.71	14.80	12.91
948	19.96	0.71	14.10	12.79
949	19.95	0.71	15.13	12.99
950	19.96	0.71	16.66	13.23
951	19.95	0.71	17.29	12.92
952	19.96	0.72	18.82	13.19
953	19.94	0.72	19.13	13.34
954	19.95	0.72	19.19	13.38
955	19.96	0.72	21.92	12.32
956	19.96	0.71	23.41	13.36
957	19.96	0.73	21.71	15.46
958	19.96	0.72	20.80	13.43
959	19.96	0.72	17.78	13.04

Period 9

780

TRIGON

1000	19.96	0.72	18.66	13.59
1001	19.96	0.72	19.22	13.64
1002	19.96	0.73	17.66	13.84
1003	19.95	0.72	17.38	14.98
1004	19.96	0.73	17.50	14.62
1005	19.95	0.73	16.92	14.67
1006	19.95	0.75	16.65	18.32
1007	19.95	0.72	19.46	14.84
1008	19.96	0.73	16.80	13.76
1009	19.95	0.72	15.46	13.16
1010	19.94	0.72	14.53	13.44
1011	19.96	0.72	14.31	13.41
1012	19.95	0.74	15.19	13.76
1013	19.95	0.71	15.67	13.10
1014	19.96	0.71	12.39	14.10
1015	19.96	0.71	11.38	13.99
1016	19.96	0.71	11.29	13.75
1017	19.96	0.72	11.17	13.83
1018	19.96	0.71	10.17	13.61
1019	19.96	0.72	9.20	13.84
1020	19.97	0.71	9.38	13.56
1021	19.96	0.72	8.74	13.93
1022	19.96	0.72	8.99	13.69
1023	19.96	0.71	8.17	13.44
1024	19.95	0.71	7.74	13.13
1025	19.97	0.71	7.95	12.48
1026	19.95	0.71	8.56	12.74
1027	19.97	0.70	8.65	12.67
1028	19.97	0.70	8.77	13.54
1029	19.97	0.70	8.77	13.31
1030	19.97	0.70	9.14	13.26
1031	19.97	0.71	9.08	13.47
1032	19.97	0.71	9.74	13.18
1033	19.97	0.71	10.34	13.16
1034	19.97	0.71	10.65	13.46
1035	19.96	0.71	10.38	13.19
1036	19.96	0.71	9.26	13.52
1037	19.97	0.71	8.77	13.34
1038	19.96	0.71	10.02	12.96
1039	19.96	0.71	11.90	12.91
1040	19.96	0.71	12.03	13.45
1041	19.97	0.72	10.81	13.40
1042	19.94	0.72	10.15	12.90
1043	19.96	0.71	9.05	12.70
1044	19.96	0.72	8.83	13.08
1045	19.96	0.72	9.26	13.46
1046	19.96	0.71	9.26	13.38
1047	19.96	0.72	9.26	13.50
1048	19.95	0.72	9.63	13.76
1049	19.95	0.72	10.86	14.17

2291

1050	19.95	0.72	10.77	13.74
1051	19.95	0.72	10.14	13.60
1052	19.95	0.73	9.84	13.46
1053	19.94	0.73	10.11	13.23
1054	19.95	0.73	10.50	13.42
1055	19.95	0.72	10.38	12.99
1056	19.95	0.72	11.05	12.57
1057	19.96	0.72	10.80	12.43
1058	19.96	0.71	10.59	12.56
1059	19.95	0.72	10.34	12.74
1100	19.95	0.71	10.56	13.05
1101	19.95	0.71	11.04	13.02
1102	19.95	0.71	11.80	13.03
1103	19.95	0.72	12.60	13.61
1104	19.94	0.72	12.73	13.85
1105	19.95	0.71	12.14	13.75
1106	19.96	0.71	11.10	13.67
1107	19.96	0.72	10.51	13.61
1108	19.94	0.74	10.59	11.69
1109	19.93	0.72	8.60	13.28
1110	19.95	0.74	6.65	15.79
1111	19.94	0.73	7.43	15.23
1112	19.94	0.73	8.26	14.56
1113	19.95	0.72	8.69	14.45
1114	19.95	0.73	8.57	14.29
1115	19.97	0.72	8.93	13.91
1116	19.96	0.72	8.66	13.71
1117	19.94	0.73	8.81	13.46
1118	19.95	0.73	9.72	13.43
1119	19.95	0.72	11.50	13.15
1120	19.95	0.72	11.84	13.30
1121	19.96	0.72	11.57	13.17
1122	19.96	0.72	11.93	12.89
1123	19.96	0.72	13.00	13.10
1124	19.96	0.72	13.09	13.38
1125	19.97	0.73	12.48	13.13
1126	19.96	0.73	12.70	14.20
1127	19.95	0.73	14.74	15.33
1128	19.96	0.74	15.59	15.11
1129	19.95	0.75	13.40	14.07
1130	19.95	0.74	14.43	15.03
1131	19.96	0.74	13.43	13.02
1132	19.96	0.73	11.99	12.81
1133	19.96	0.74	11.26	12.58
1134	19.96	0.74	12.52	13.62
1135	19.98	0.73	13.10	13.31
1136	19.97	0.74	13.62	13.64
1137	19.96	0.73	14.20	13.22
1138	19.96	0.74	13.34	12.71
1139	19.94	0.74	15.35	14.75

782

TRIGON

1140	19.96	0.74	13.68	15.42
1141	19.95	0.74	12.89	14.22
1142	19.96	0.74	10.99	14.69
1143	19.96	0.73	9.96	13.80
1144	19.96	0.74	9.45	14.49
1145	19.95	0.74	10.17	14.51
1146	19.96	0.74	10.02	14.44
1147	19.95	0.74	11.72	15.01
1148	19.97	0.73	11.08	14.11
1149	19.97	0.74	12.33	14.78
1150	19.96	0.73	15.23	14.41
1151	19.96	0.73	15.62	14.10
1152	19.97	0.73	15.50	14.16
1153	19.98	0.74	16.81	14.65
1154	19.97	0.74	18.92	14.37
1155	19.96	0.74	19.28	13.27
1156	19.97	0.73	17.96	12.84
1157	19.98	0.73	16.48	12.99
1158	19.98	0.73	14.31	12.82
1159	19.97	0.72	12.88	12.54
1200	19.98	0.73	12.32	13.21
1201	19.96	0.74	12.33	13.62
1202	19.96	0.74	13.35	14.63
1203	19.97	0.72	13.50	13.60
1204	19.96	0.73	13.92	13.47
1205	19.97	0.73	15.02	13.60
1206	19.98	0.72	14.96	13.51
1207	19.99	0.72	14.83	13.28
1208	19.99	0.73	15.38	13.95
1209	19.95	0.73	15.08	13.87
1210	19.97	0.74	14.53	14.39
1211	19.96	0.72	13.65	13.12
1212	19.98	0.72	13.61	14.85
1213	19.97	0.76	15.71	20.87
1214	19.96	0.73	15.62	14.56
1215	19.96	0.73	13.95	13.25
1216	19.95	0.73	14.95	12.64
1217	19.97	0.72	14.28	12.59
1218	19.98	0.72	13.13	12.44
1219	19.97	0.72	13.92	11.95
1220	19.97	0.72	14.61	13.15
1221	19.97	0.72	13.47	13.37
1222	19.97	0.72	12.73	15.04
1223	19.98	0.73	11.69	15.82
1224	19.97	0.74	12.56	15.62
1225	19.97	0.72	13.38	14.51
1226	19.99	0.72	12.18	14.38
1227	19.98	0.72	11.54	14.19
1228	19.98	0.73	11.17	14.12
1229	19.99	0.72	11.42	13.79

1230	19.98	0.72	10.75	13.66
1231	19.98	0.72	10.32	13.46
1232	19.99	0.72	10.56	13.38
1233	19.98	0.72	10.17	12.98
1234	19.99	0.71	10.35	13.07
1235	19.99	0.71	10.90	12.74
1236	19.99	0.72	11.44	12.86
1237	19.98	0.72	12.14	12.98
1238	19.98	0.72	12.23	12.68
1239	19.98	0.72	12.17	12.78
1240	19.98	0.72	12.15	12.26
1241	19.98	0.72	13.43	12.21
1242	19.98	0.72	13.38	13.20
1243	19.98	0.72	15.62	13.35
1244	19.98	0.72	17.21	12.72
1245	19.98	0.72	15.69	12.44
1246	19.99	0.73	14.84	13.40
1247	19.98	0.73	13.44	12.86
1248	19.98	0.73	14.04	13.41
1249	19.98	0.73	12.98	13.78
1250	19.97	0.73	15.32	13.28
1251	19.98	0.73	14.07	13.00
1252	19.98	0.73	13.37	12.02
1253	19.96	0.72	12.79	10.01
1254	19.97	0.72	11.87	13.41
1255	19.97	0.73	12.24	14.11
1256	19.97	0.73	11.96	13.77
1257	19.98	0.73	11.30	13.46
1258	19.98	0.73	11.53	13.80
1259	19.97	0.73	11.96	14.01
1300	19.97	0.74	12.89	14.69
1301	19.97	0.74	13.28	14.75
1302	19.97	0.74	15.98	14.36
1303	19.97	0.73	15.56	14.04
1304	19.97	0.73	14.01	14.38
1305	19.97	0.74	13.77	14.72
1306	19.98	0.74	15.08	14.61
1307	19.98	0.74	17.21	13.91
1308	19.97	0.74	15.11	13.68
1309	19.98	0.75	18.37	13.67
1310	19.96	0.74	17.09	14.26
1311	19.98	0.74	16.20	14.23
1312	19.98	0.74	15.84	14.10
1313	19.98	0.74	14.99	13.25
1314	19.97	0.73	15.23	13.99
1315	19.98	0.74	13.83	14.67
1316	19.96	0.74	13.71	15.00
1317	19.96	0.74	12.48	15.02
1318	19.97	0.75	11.93	15.00
1319	19.97	0.74	12.39	14.82

TRIGON

1320	19.97	0.75	12.45	14.76
1321	19.97	0.75	12.27	14.83
1322	19.97	0.74	12.73	14.84
1323	19.97	0.75	16.38	14.81
1324	19.97	0.75	19.29	14.48
1325	19.97	0.74	14.98	14.37
1326	19.98	0.75	14.26	14.74
1327	19.98	0.74	13.06	14.68
1328	19.98	0.75	14.11	14.25
1329	19.97	0.75	14.43	14.29
1330	19.98	0.75	14.84	14.16
1331	19.97	0.75	16.05	13.64
1332	19.97	0.75	15.57	13.93
1333	19.97	0.75	21.85	13.65
1334	19.98	0.74	19.84	13.23
1335	19.98	0.74	15.75	13.30
1336	19.98	0.74	15.69	13.31
1337	19.98	0.74	15.69	13.28
1338	19.97	0.75	17.03	13.95
1339	19.98	0.74	20.32	13.73
1340	19.99	0.74	17.94	12.66
1341	19.98	0.73	19.01	11.83
1342	19.98	0.74	19.23	13.00
1343	19.99	0.74	19.92	13.64
1344	19.98	0.73	22.39	13.54
1345	19.99	0.74	20.44	13.70
1346	19.98	0.74	19.59	14.06
1347	19.96	0.74	20.93	14.22
1348	19.98	0.75	22.57	13.82
1349	19.97	0.74	21.60	13.37
1350	19.99	0.74	20.65	13.70
1351	19.98	0.74	25.16	14.07
1352	19.98	0.74	23.02	13.11
1353	19.98	0.74	23.24	13.24
1354	19.97	0.74	22.02	12.59
1355	19.99	0.74	19.96	13.52
1356	19.98	0.76	22.78	14.89
1357	19.97	0.75	22.26	13.92
1358	19.97	0.75	20.54	14.14
1359	19.98	0.75	19.20	14.26
1400	19.97	0.75	18.40	14.17
1401	19.98	0.75	18.70	13.90
1402	19.97	0.75	18.80	14.53
1403	19.97	0.75	22.58	13.89
1404	19.97	0.75	23.69	13.40
1405	19.97	0.75	26.35	13.35
1406	19.97	0.75	22.58	13.62
1407	19.97	0.75	23.48	14.46
1408	19.97	0.74	25.01	13.95
1409	19.98	0.75	24.24	12.99

1410	19.96	0.75	26.96	12.79
1411	19.97	0.74	24.33	12.47
1412	19.97	0.74	22.99	12.47
1413	19.97	0.76	24.73	13.74
1414	19.97	0.75	28.12	12.83
1415	19.96	0.75	25.74	12.84
1416	19.97	0.75	23.90	13.33
1417	19.96	0.76	23.96	13.69
1418	19.94	0.76	24.03	12.82
1419	19.96	0.75	21.84	14.21
1420	19.96	0.76	21.39	16.39
1421	19.95	0.76	24.43	15.09
1422	19.96	0.75	21.84	14.67
1423	19.96	0.76	21.63	14.57
1424	19.95	0.75	21.48	14.23
1425	19.96	0.75	21.58	13.77
1426	19.97	0.74	21.35	13.60
1427	19.96	0.75	21.06	14.28
1428	19.96	0.75	20.36	14.03
1429	19.96	0.75	18.99	14.03
1430	19.98	0.76	18.00	14.08
1431	19.96	0.75	20.69	13.76
1432	19.80	1.11	26.57	13.16
1433	19.39	0.81	38.75	14.45
1434	19.93	0.76	28.58	14.86
1435	19.96	0.75	24.88	13.76
1436	19.92	0.82	23.42	14.54
1437	19.85	0.83	24.24	14.81
1438	19.83	0.83	25.80	14.26
1439	19.83	0.83	25.71	14.64
1440	19.84	0.81	26.87	13.32
1441	19.94	0.77	25.29	13.05
1442	19.93	0.76	24.61	11.93
1443	19.96	0.75	23.66	14.53
1444	19.97	0.75	24.01	14.11
1445	19.97	0.75	25.10	13.56
Average	**19.96**	**0.73**	**15.16**	**13.60**

TRIGON ENGINEERING CONSULTANTS

EPA METHOD 25A

2291

EnVirCo
Clemson, South Carolina
Melter Stack

January 19, 1999

Hour No. 1		*Hour No. 2*		*Hour No. 3*	
TIME	ppmw	TIME	ppmw	TIME	ppmw
916	1.1	1016	0.4	1121	0.6
917	1.0	1017	0.4	1122	0.5
918	1.0	1018	0.5	1123	0.6
919	0.9	1019	0.4	1124	0.5
920	1.0	1020	1.0	1125	0.5
921	0.9	1021	0.5	1126	0.5
922	1.0	1022	0.4	1127	0.5
923	1.1	1023	0.3	1128	1.0
924	1.1	1024	0.5	1129	0.7
925	1.1	1025	0.3	1130	0.4
926	1.0	1026	0.5	1131	0.5
927	1.3	1027	0.3	1132	0.4
928	1.5	1028	0.7	1133	0.4
929	1.6	1029	0.5	1134	0.5
930	1.7	1030	0.5	1135	0.4
931	1.9	1031	0.6	1136	0.5
932	1.6	1032	0.8	1137	0.4
933	1.3	1033	0.9	1138	0.4
934	2.5	1034	0.7	1139	0.5
935	1.3	1035	0.5	1140	0.4
936	1.1	1036	0.4	1141	0.5
937	1.0	1037	0.6	1142	0.4
938	0.9	1038	0.6	1143	0.5
939	1.0	1039	0.5	1144	0.5
940	1.0	1040	0.5	1145	0.4
941	1.0	1041	0.5	1146	0.4
942	1.0	1042	0.5	1147	0.6
943	0.9	1043	0.5	1148	0.5
944	0.9	1044	0.8	1149	0.6
945	0.9	1045	1.2	1150	0.5
946	1.0	1046	1.0	1151	0.5
947	0.9	1047	1.3	1152	0.5
948	0.9	1048	0.9	1153	0.4
949	0.9	1049	1.1	1154	0.4
950	1.0	1050	0.8	1155	0.4
951	1.0	1051	0.9	1156	0.4
952	0.9	1052	0.9	1157	0.3
953	0.9	1053	0.8	1158	0.5
954	0.8	1054	0.8	1159	0.4
955	0.9	1055	1.0	1200	0.5
956	0.9	1056	1.3	1201	0.4
957	0.8	1057	1.5	1202	0.5
958	0.9	1058	1.2	1203	0.4
959	0.8	1059	1.1	1204	1.0
1000	0.8	1100	1.2	1205	0.7
1001	0.7	1101	1.5	1206	0.8
1002	0.7	1102	1.7	1207	0.6
1003	0.8	1103	1.4	1208	1.0
1004	0.9	1104	0.9	1209	0.8
1005	0.8	1105	1.2	1210	1.6
1006	0.8	1106	0.8	1211	2.3
1007	0.7	1107	0.7	1212	1.9
1008	0.6	1108	0.7	1213	1.5
1009	0.5	1109	1.0	1214	0.9
1010	0.5	1110	1.7	1215	1.5
1011	0.4	1111	1.1	1216	1.1
1012	0.4	1112	1.2	1217	1.2
1013	0.4	1113	0.8	1218	1.6
1014	0.4	1114	0.7	1219	1.7
1015	0.3	1115	0.2	1220	0.9
AVERAGE	1.0	AVERAGE	0.8	AVERAGE	0.7

All ppm values are reported as propane.

787

TRIGON

TRIGON ENGINEERING CONSULTANTS

2291

EPA METHOD 25A

EnVitCo
Clemson, South Carolina
Melter Stack

January 19, 1999

Hour No. 4		*Hour No. 5*		*Hour No. 6*	
TIME	ppmw	TIME	ppmw	TIME	ppmw
1221	0.7	1351	1.9	1451	0.5
1222	0.6	1352	1.5	1452	0.5
1223	0.7	1353	1.1	1453	0.5
1224	0.5	1354	1.8	1454	0.6
1225	0.7	1355	1.6	1455	0.4
1226	0.6	1356	0.9	1456	0.5
1227	0.7	1357	1.4	1457	0.4
1228	0.6	1358	2.0	1458	0.6
1229	0.5	1359	2.5	1459	0.5
1230	0.6	1400	1.1	1500	0.6
1231	0.6	1401	1.7	1501	0.4
1232	0.5	1402	1.9	1502	0.5
1233	0.7	1403	1.5	1503	0.4
1234	0.5	1404	1.3	1504	0.5
1235	0.7	1405	1.9	1505	0.4
1236	0.6	1406	1.5	1506	0.4
1237	0.6	1407	1.9	1507	0.4
1238	0.7	1408	1.6	1508	0.4
1239	0.8	1409	2.3	1509	0.4
1240	0.7	1410	1.4	1510	0.5
1241	0.7	1411	1.7	1511	0.4
1242	0.8	1412	1.2	1512	0.5
1243	0.9	1413	0.8	1513	0.4
1244	5.8	1414	1.8	1514	0.6
1245	1.0	1415	1.4	1515	0.6
1246	0.9	1416	2.3	1516	0.8
1247	0.7	1417	1.9	1517	0.6
1248	0.8	1418	1.9	1518	0.7
1249	0.9	1419	1.4	1519	0.6
1250	1.0	1420	1.9	1520	0.7
1251	0.8	1421	1.9	1521	0.6
1252	0.6	1422	1.9	1522	1.5
1253	0.6	1423	1.9	1523	2.2
1254	0.9	1424	1.4	1524	2.1
1255	0.8	1425	1.7	1525	2.1
1256	0.8	1426	0.9	1526	1.3
1257	0.6	1427	1.4	1527	1.7
1258	0.6	1428	1.3	1528	1.9
1259	0.7	1429	1.5	1529	1.4
1300	0.5	1430	1.7	1530	1.8
1301	0.6	1431	2.2	1531	2.6
1302	0.5	1432	1.5	1532	2.2
1303	0.7	1433	1.5	1533	2.0
1304	1.0	1434	1.9	1534	2.6
1305	0.9	1435	1.0	1535	2.1
1306	0.5	1436	1.2	1536	2.9
1307	0.8	1437	1.9	1537	2.4
1308	0.5	1438	2.2	1538	1.8
1309	0.8	1439	0.9	1539	2.0
1310	0.7	1440	1.5	1540	2.6
1311	0.7	1441	1.2	1541	2.2
1312	0.9	1442	2.0	1542	2.7
1313	1.3	1443	1.8	1543	1.9
1314	1.0	1444	1.4	1544	2.3
1315	0.8	1445	1.3	1545	1.4
1316	1.0	1446	1.1	1546	1.7
1317	0.9	1447	1.0	1547	2.7
1318	1.1	1448	1.4	1548	2.7
1319	1.0	1449	0.8	1549	2.3
1320	0.7	1450	0.5	1550	2.8
AVERAGE	0.8	AVERAGE	1.6	AVERAGE	1.3

All ppm values are reported as propane.

788

TRIGON

TRIGON ENGINEERING CONSULTANTS

EPA METHOD 25A

2291

EnVitCo
Clemson, South Carolina
Melter Stack

January 19, 1999

Hour No. 7

TIME	ppmw
1551	2.5
1552	2.1
1553	2.8
1554	2.8
1555	2.2
1556	2.6
1557	2.0
1558	1.6
1559	1.5
1600	2.5
1601	2.2
1602	2.6
1603	2.2
1604	2.3
1605	2.8
1606	2.4
1607	2.0
1608	2.5
1609	2.7
1610	2.1
1611	1.9
1612	1.9
1613	2.1
1614	2.2
1615	2.4
1616	1.6
1617	1.7
1618	1.7
1619	2.2
1620	1.8
1621	2.0
1622	2.0
1623	1.1
1624	0.9
1625	0.8
1626	0.7
1627	0.7
1628	0.7
1629	0.8
1630	0.8
1631	0.8
1632	0.8
1633	0.7
1634	0.8
1635	0.8
1636	0.8
1637	0.9
1638	0.7
1639	0.8
1640	0.7
1641	0.7
1642	0.7
1643	0.8
1644	0.6
1645	0.6
1646	0.6
1647	0.7
1648	0.7
1649	0.7
1650	0.6
AVERAGE	1.5

Hour No. 8

TIME	ppmw
1651	0.6
1652	0.6
1653	0.7
1654	0.6
1655	0.7
1656	0.7
1657	0.7
1658	0.6
1659	0.6
1700	0.8
1701	0.7
1702	0.7
1703	0.8
1704	0.8
1705	0.7
1706	0.8
1707	0.7
1708	0.7
1709	0.7
1710	0.7
1711	0.7
1712	0.6
1713	0.7
1714	0.6
1715	0.8
1716	0.7
1717	0.7
1718	0.6
1719	0.9
1720	0.6
1721	1.0
1722	1.1
1723	0.9
1724	1.0
1725	0.9
1726	0.8
1727	0.8
1728	0.7
1729	0.6
1730	0.8
1731	0.7
1732	0.7
1733	0.8
1734	0.7
1735	1.0
1736	0.8
1737	0.8
1738	0.8
1739	0.8
1740	0.9
1741	0.8
1742	0.9
1743	0.7
1744	0.8
1745	0.8
1746	0.6
1747	0.7
1748	0.7
1749	0.7
1750	0.8
AVERAGE	0.7

All ppm values are reported as propane.

789

TRIGON

Trigon Engineering Consultant

EnVitCo - Clemson, South Carolina

2291

Method 3 - Oxygen and Carbon Dioxide Data

Run 1 19-Jan-99

Time	O_2 %	CO_2 %
1254	18.24	1.93
1255	18.24	1.91
1256	18.29	2.00
1257	18.24	1.86
1258	18.34	1.84
1259	18.42	1.88
1300	18.29	2.04
1301	18.17	1.91
1302	18.33	1.98
1303	18.22	1.89
1304	18.25	1.94
1305	18.22	1.88
1306	18.36	1.83
1307	18.43	1.82
1308	18.39	1.89
1309	18.28	1.88
1310	18.40	1.80
1311	18.40	1.80
1312	18.41	1.80
1313	18.40	1.79
1314	18.44	1.90
1315	18.43	1.76
1316	18.44	1.75
1317	18.47	1.78
1318	18.45	1.74
1319	18.47	1.76
1320	18.44	1.80
1321	18.38	1.74
1322	18.51	1.75
1323	18.41	1.79
1324	18.42	1.81
1325	18.31	1.81
1326	18.16	1.83
1327	17.88	2.10
1328	18.11	1.91
1329	18.20	1.89
1330	18.27	1.88
1331	18.25	1.85
1332	18.34	2.15
1333	18.17	1.98
1334	18.18	2.04
1335	18.14	2.02
1336	18.22	2.03
1337	18.19	2.16
1338	18.23	1.98
1339	18.02	2.20
1340	18.08	2.03
1341	18.11	2.04
1342	18.11	2.14
1343	18.10	2.08
1344	18.09	2.08
1345	18.20	2.08
1346	18.18	1.95
1347	18.31	2.13
1348	18.31	1.84
1349	18.42	1.97
1350	18.39	1.82
1351	18.44	1.82
1352	18.43	1.86
1353	18.39	1.85
1354	18.31	1.88
1355	18.43	1.83
1356	18.41	1.84
1357	18.31	1.90
1358	18.48	1.75
Average	**18.30**	**1.91**

Run 2 19-Jan-99

Time	O_2 %	CO_2 %
1442	18.28	2.03
1443	18.42	1.84
1444	18.40	1.74
1445	18.47	1.76
1446	18.44	1.78
1447	18.48	1.77
1448	18.49	1.74
1449	18.43	1.74
1450	18.45	1.78
1451	18.48	1.73
1452	18.50	1.69
1453	18.55	1.71
1454	18.53	1.66
1455	18.56	1.70
1456	18.52	1.74
1457	18.51	1.69
1458	18.54	1.72
1459	18.56	1.83
1500	18.34	1.88
1501	18.41	1.81
1502	18.42	1.88
1503	18.43	1.75
1504	18.43	1.82
1505	18.42	1.89
1506	18.39	1.82
1507	18.48	1.78
1508	18.49	1.74
1509	18.50	1.79
1510	18.44	1.86
1511	18.42	1.83
1512	18.34	1.93
1513	18.32	2.11
1514	17.96	2.17
1515	17.99	2.12
1516	18.18	1.78
1517	18.42	1.91
1518	18.33	1.89
1519	18.43	1.79
1520	18.41	1.72
1521	18.50	1.73
1522	18.53	1.75
1523	18.45	1.79
1524	18.46	1.78
1525	18.44	1.67
1526	18.52	1.63
1527	18.57	1.65
1528	18.58	1.68
1529	18.58	1.64
1530	18.60	1.75
1531	18.50	1.76
1532	18.46	1.81
1533	18.42	1.86
1534	18.44	1.80
1535	18.49	1.72
1536	18.51	1.81
1537	18.55	1.74
1538	18.51	1.81
1539	18.42	1.80
1540	18.48	1.69
1541	18.56	1.70
1542	18.58	1.66
1543	18.60	1.73
1544	18.53	1.73
1545	18.52	1.74
1546	18.56	1.75
1547	18.55	1.77
1548	18.38	1.81
1549	18.56	1.78
1550	18.50	1.87
Average	**18.44**	**1.78**

Run 3 19-Jan-99

Time	O_2 %	CO_2 %
1646	18.55	1.74
1647	18.43	1.78
1648	18.45	1.71
1649	18.48	1.75
1650	18.49	1.80
1651	18.57	1.80
1652	17.81	2.31
1653	17.91	2.29
1654	17.96	2.24
1655	18.02	1.73
1656	18.63	1.70
1657	18.65	1.64
1658	18.77	1.55
1659	18.80	1.52
1700	18.85	1.54
1701	18.81	1.53
1702	18.82	1.57
1703	18.79	1.51
1704	18.83	1.55
1705	18.91	1.68
1706	18.99	1.32
1707	19.09	1.34
1708	19.10	1.31
1709	19.12	1.32
1710	19.12	1.30
1711	19.15	1.27
1712	19.16	1.29
1713	19.17	1.24
1714	19.16	1.52
1715	19.16	1.28
1716	19.14	1.26
1717	19.16	1.27
1718	19.15	1.30
1719	19.12	1.29
1720	19.13	1.27
1721	19.16	1.19
1722	19.22	1.27
1723	19.04	1.31
1724	19.11	1.27
1725	19.10	1.35
1726	19.09	1.33
1727	19.02	1.61
Average	**18.84**	**1.52**

Run 4 19-Jan-99

Time	O_2 %	CO_2 %
1750	18.22	1.93
1751	18.21	2.01
1752	18.22	1.95
1753	18.25	1.96
1754	18.28	1.89
1755	18.27	1.90
1756	18.30	2.11
1757	18.06	1.99
1758	18.13	2.07
1759	18.16	2.00
1800	18.20	2.31
1801	17.67	2.10
1802	18.01	2.08
1803	17.97	2.09
1804	18.04	2.07
1805	17.97	2.14
1806	17.93	2.23
1807	17.97	2.08
1808	18.05	2.09
1809	18.14	2.02
1810	18.12	2.04
1811	18.13	1.98
1812	18.15	1.99
1813	18.13	1.97
1814	18.21	1.98
1815	18.24	1.90
1816	18.27	1.92
1817	18.20	1.98
1818	18.15	2.00
1819	18.12	2.03
1820	18.13	2.01
1821	18.15	2.05
1822	18.11	3.19
1823	16.47	2.58
1824	18.09	2.02
1825	18.15	2.01
1826	18.15	2.01
1827	18.13	2.02
1828	18.12	2.05
1829	18.09	2.06
1830	18.11	2.06
1831	18.06	2.07
1832	18.08	2.10
1833	18.04	1.98
1834	18.17	1.98
1835	18.24	1.91
1836	18.12	2.16
1837	17.84	2.34
1838	18.00	2.11
1839	18.05	2.06
1840	18.12	2.00
1841	18.10	2.01
1842	18.16	2.07
1843	18.14	1.99
1844	18.23	1.90
1845	18.14	2.00
1846	18.16	2.04
1847	18.05	2.04
1848	18.14	1.98
1849	18.26	1.93
1850	18.31	2.02
1851	18.20	1.91
1852	18.27	1.90
1853	18.27	1.93
Average	**18.10**	**2.05**

790

TRIGON

Trigon Engineering Consultant

EnVitCo - Clemson, South Carolina

2291

Method 5/29 - Oxygen and Carbon Dioxide Data

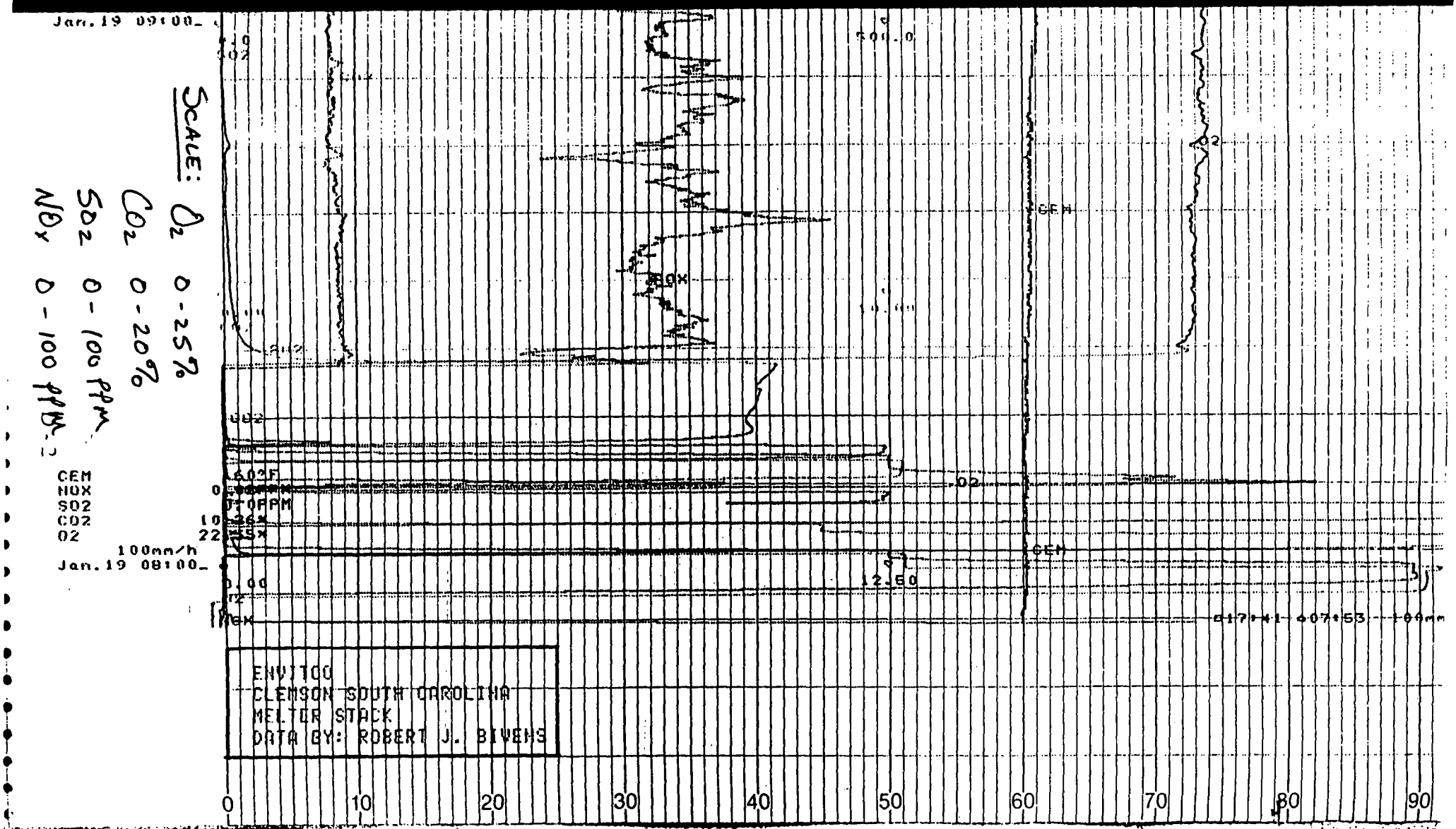
Run 1	20-Jan-99		Run 2	20-Jan-99		Run 3	20-Jan-99	
Time	O_2 %	CO_2 %	Time	O_2 %	CO_2 %	Time	O_2 %	CO_2 %
1000	19.96	0.69	1150	20.02	0.70	1402	20.02	0.72
1001	19.96	0.69	1151	20.03	0.71	1403	20.04	0.72
1002	19.95	0.69	1152	20.00	0.71	1404	20.00	0.73
1003	19.96	0.69	1153	20.03	0.72	1405	20.01	0.73
1004	19.97	0.69	1154	20.00	0.71	1406	20.02	0.73
1005	19.96	0.70	1155	20.00	0.70	1407	20.02	0.73
1006	19.96	0.70	1156	20.01	0.71	1408	20.02	0.72
1007	19.95	0.69	1157	20.01	0.71	1409	20.02	0.72
1008	19.96	0.70	1158	20.01	0.71	1410	20.00	0.73
1009	19.96	0.69	1159	20.01	0.71	1411	20.02	0.73
1010	19.97	0.69	1200	20.01	0.71	1412	20.03	0.72
1011	19.97	0.70	1201	20.02	0.71	1413	20.02	0.73
1012	19.97	0.68	1202	20.02	0.71	1414	20.02	0.72
1013	19.97	0.68	1203	20.02	0.71	1415	20.03	0.72
1014	19.97	0.68	1204	20.02	0.71	1416	20.02	0.72
1015	19.98	0.69	1205	20.02	0.71	1417	20.03	0.72
1016	19.96	0.69	1206	20.02	0.70	1418	20.03	0.72
1017	19.97	0.68	1207	20.02	0.71	1419	20.03	0.72
1018	19.98	0.68	1208	20.02	0.71	1420	20.02	0.73
1019	19.98	0.68	1209	20.02	0.70	1421	20.02	0.72
1020	19.97	0.67	1210	20.03	0.70	1422	20.04	0.72
1021	19.97	0.68	1211	20.02	0.70	1423	20.04	0.73
1022	19.97	0.69	1212	20.02	0.70	1424	20.02	0.73
1023	19.97	0.68	1213	20.01	0.71	1425	20.03	0.73
1024	19.98	0.68	1214	20.02	0.72	1426	20.02	0.72
1025	19.99	0.69	1215	20.02	0.71	1427	20.03	0.72
1026	19.96	0.68	1216	20.02	0.71	1428	20.04	0.72
1027	19.97	0.68	1217	20.01	0.71	1429	20.04	0.71
1028	19.98	0.68	1218	20.02	0.71	1430	20.03	0.72
1029	19.98	0.68	1219	20.01	0.71	1431	20.01	0.73
1030	19.99	0.67	1220	20.01	0.70	1432	20.02	0.71
1031	20.01	0.67	1221	20.05	0.69	1433	20.04	0.70
1032	19.98	0.68	1222	20.03	0.71	1434	20.03	0.72
1033	19.97	0.69	1223	20.02	0.70	1435	20.02	0.73
1034	19.98	0.68	1224	20.02	0.71	1436	20.01	0.73
1035	19.97	0.69	1225	20.02	0.73	1437	20.02	0.73
1036	19.96	0.68	1226	19.99	0.72	1438	20.02	0.74
1037	19.97	0.68	1227	20.02	0.72	1439	20.02	0.73
1038	19.97	0.69	1228	20.02	0.71	1440	20.03	0.73
1039	19.97	0.69	1229	20.02	0.71	1441	20.02	0.73
1040	19.96	0.69	1230	20.02	0.71	1442	20.02	0.74
1041	19.98	0.69	1231	20.02	0.71	1443	20.02	0.73
1042	19.99	0.68	1232	20.02	0.71	1444	20.02	0.72
1043	19.98	0.68	1233	20.02	0.71	1445	20.03	0.73
1044	19.98	0.69	1234	20.01	0.71	1446	20.03	0.73
1045	19.97	0.68	1235	20.02	0.72	1447	20.03	0.73
1046	19.99	0.68	1236	20.01	0.72	1448	20.02	0.72
1047	19.98	0.68	1237	20.01	0.72	1449	20.05	0.73
1048	19.98	0.68	1238	20.02	0.71	1450	20.02	0.72
1049	20.00	0.68	1239	20.02	0.71	1451	20.02	0.72
1050	19.99	0.69	1240	20.03	0.71	1452	20.03	0.72
1051	19.98	0.68	1241	20.02	0.71	1453	20.03	0.72
1052	19.99	0.69	1242	20.02	0.71	1454	19.99	0.73
1053	20.00	0.69	1243	20.02	0.70	1455	20.02	0.72
1054	19.98	0.71	1244	20.02	0.71	1456	20.02	0.72
1055	19.99	0.70	1245	20.01	0.71	1457	20.02	0.72
1056	19.99	0.70	1246	20.02	0.71	1458	20.02	0.71
1057	19.98	0.70	1247	20.02	0.70	1459	20.02	0.72
1058	19.99	0.69	1248	20.03	0.70	1500	20.02	0.72
1059	20.00	0.69	1249	20.03	0.70	1501	20.02	0.72
1100	19.99	0.69	1250	20.01	0.70	1502	20.02	0.73
Average	**19.98**	**0.66**	**Average**	**20.02**	**0.69**	**Average**	**20.02**	**0.70**

791

TRIGON

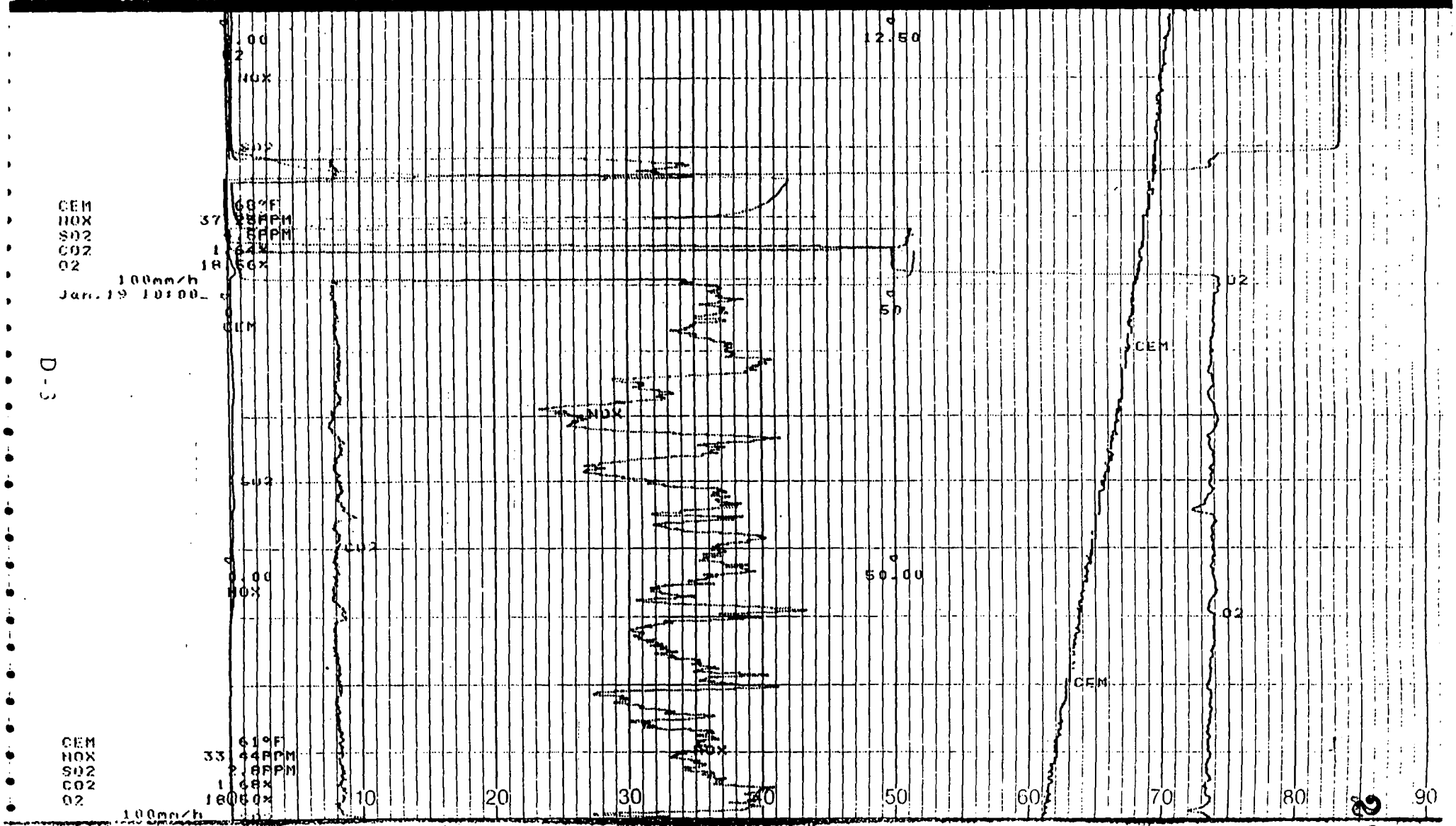
APPENDIX D

CEM & VOC STRIP CHART RECORDER DATA


Jan. 19 09:00
SCALE:
O2 0-25%
CO2 0-20%
SO2 0-100 PPM
NOx 0-100 PPM
CEM
NOX
SO2
CO2
O2
100mm/h
Jan. 19 08:00
ENVITCO
CLEMSON SOUTH CAROLINA
MELTER STACK
DATA BY: ROBERT J. BIVENS
0
10
20
30
40
50
60
70
80
90

793

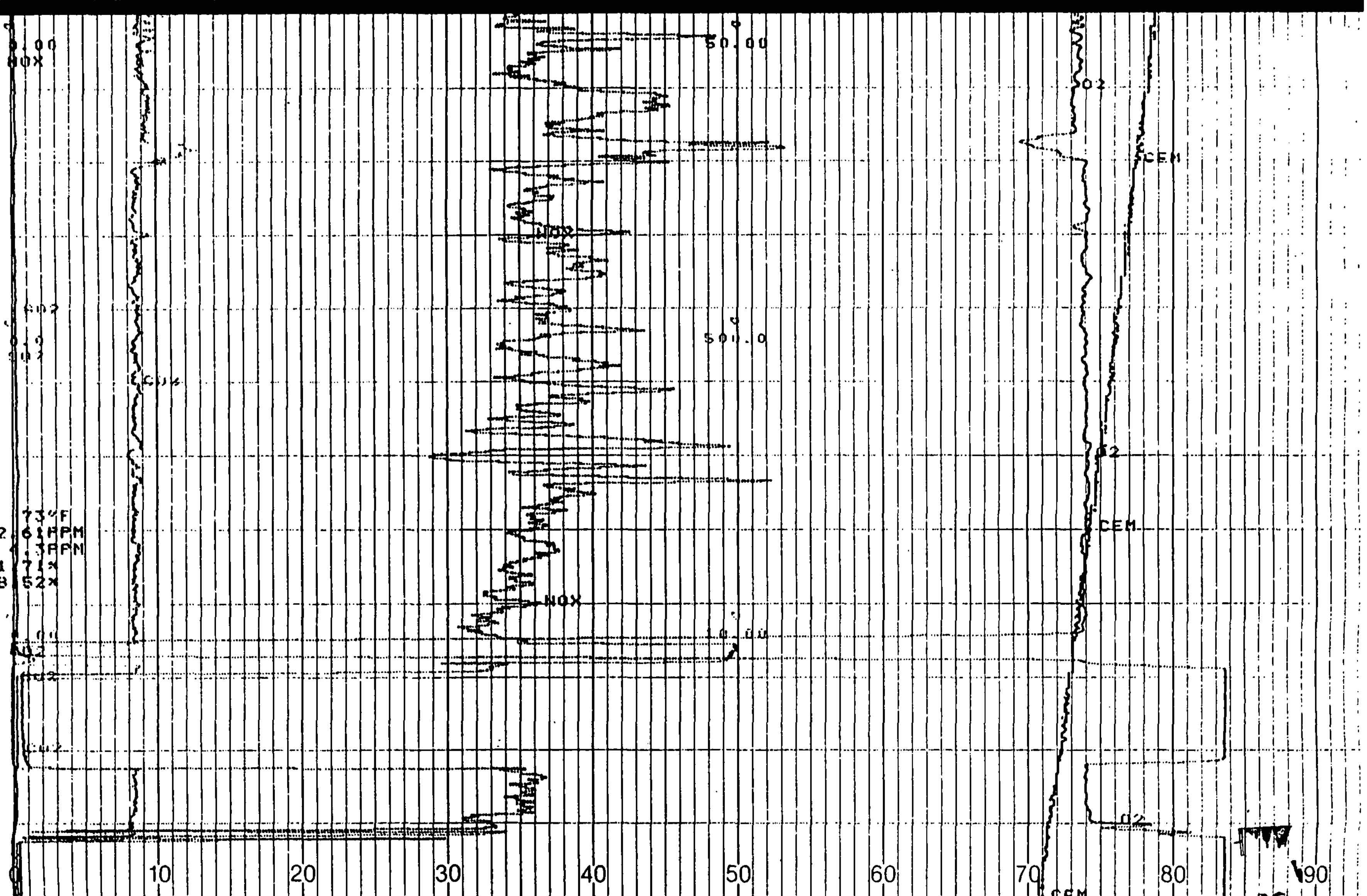
2291


CEM
NOX
SO2
CO2
O2
100mm/h
Jan.19 10:00
60°F
37 28PPM
1 62%
18 56%
61°F
33 44PPM
2.8PPM
1 68%
18 60%
12.50
50
50.00
10
20
30
40
50
60
70
80
90

D-3

794

1629

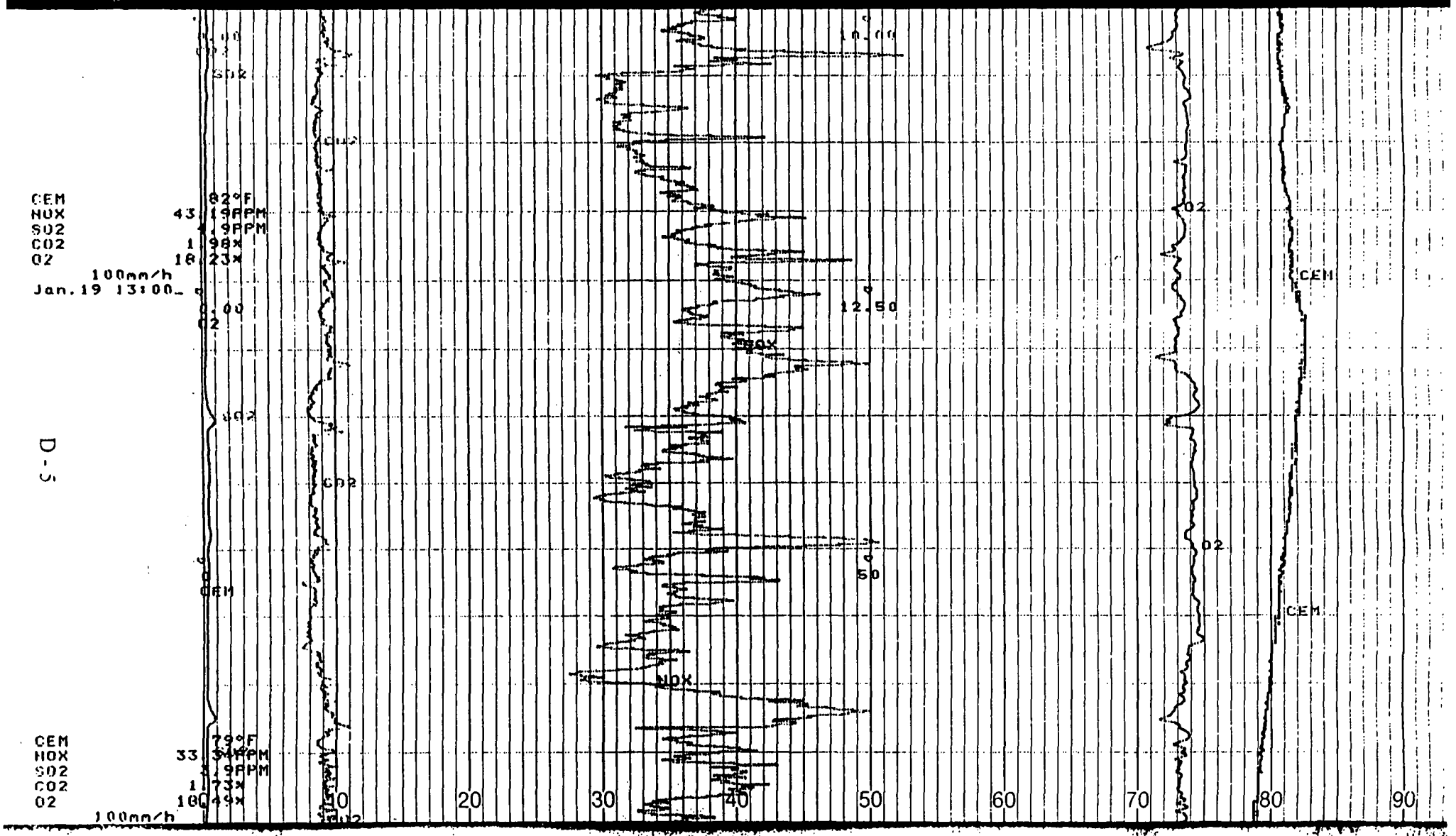


D-4

CEM 73°F
NOX 32.6 PPM
SO2 4.3 PPM
CO2 1.71%
O2 18.52%
100mm/h
Jan.19 11:00

795

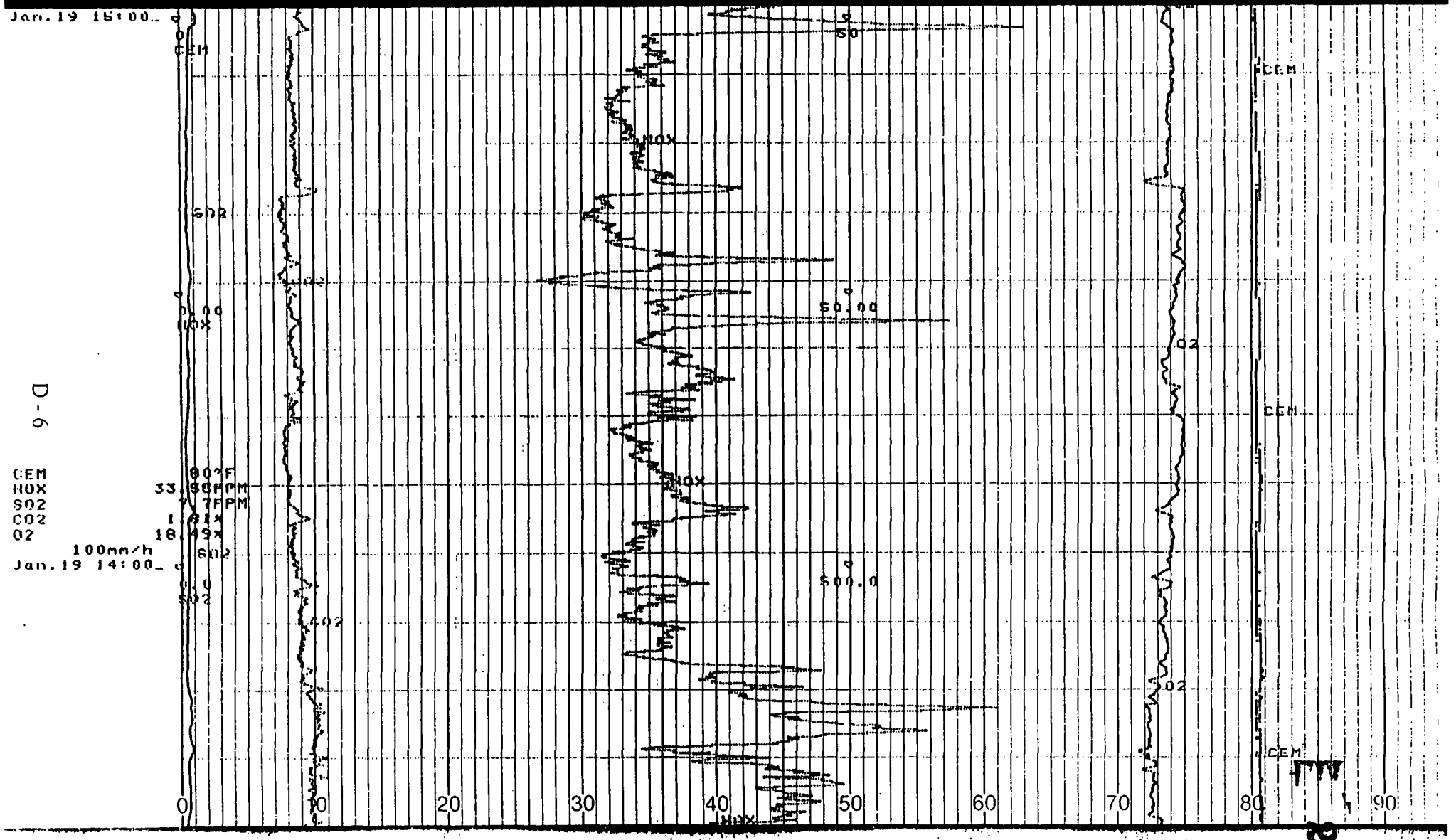
2291


CEM
NOX
SO2
CO2
O2
82°F
43.19PPM
1.98%
18.23%
100mm/h
Jan.19 13:00
79°F
33.34PPM
1.73%
18.49%
100mm/h
10
20
30
40
50
60
70
80
90
12.50
50
NOX
CO2
O2
CEM

D-5

2291

796

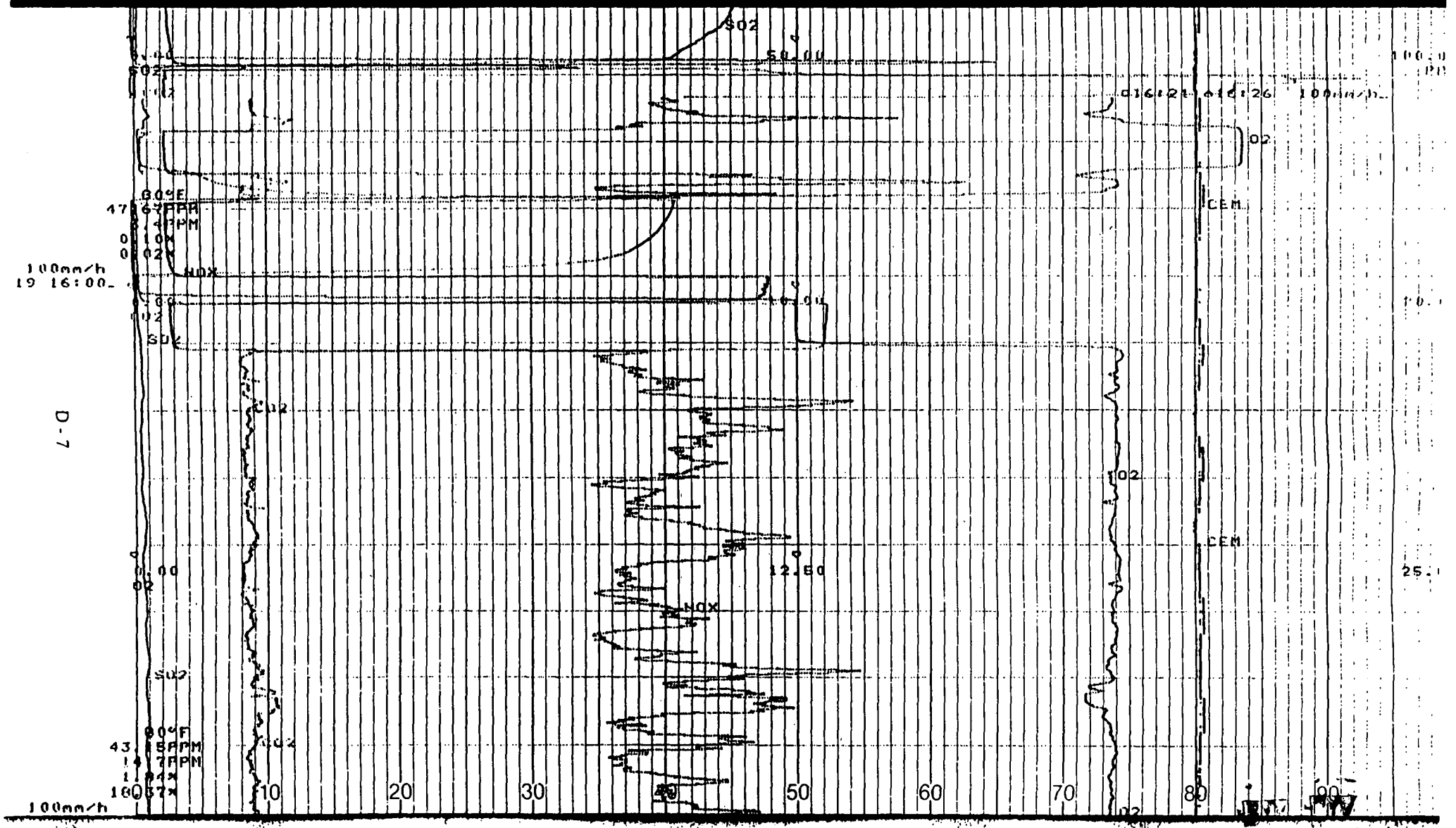


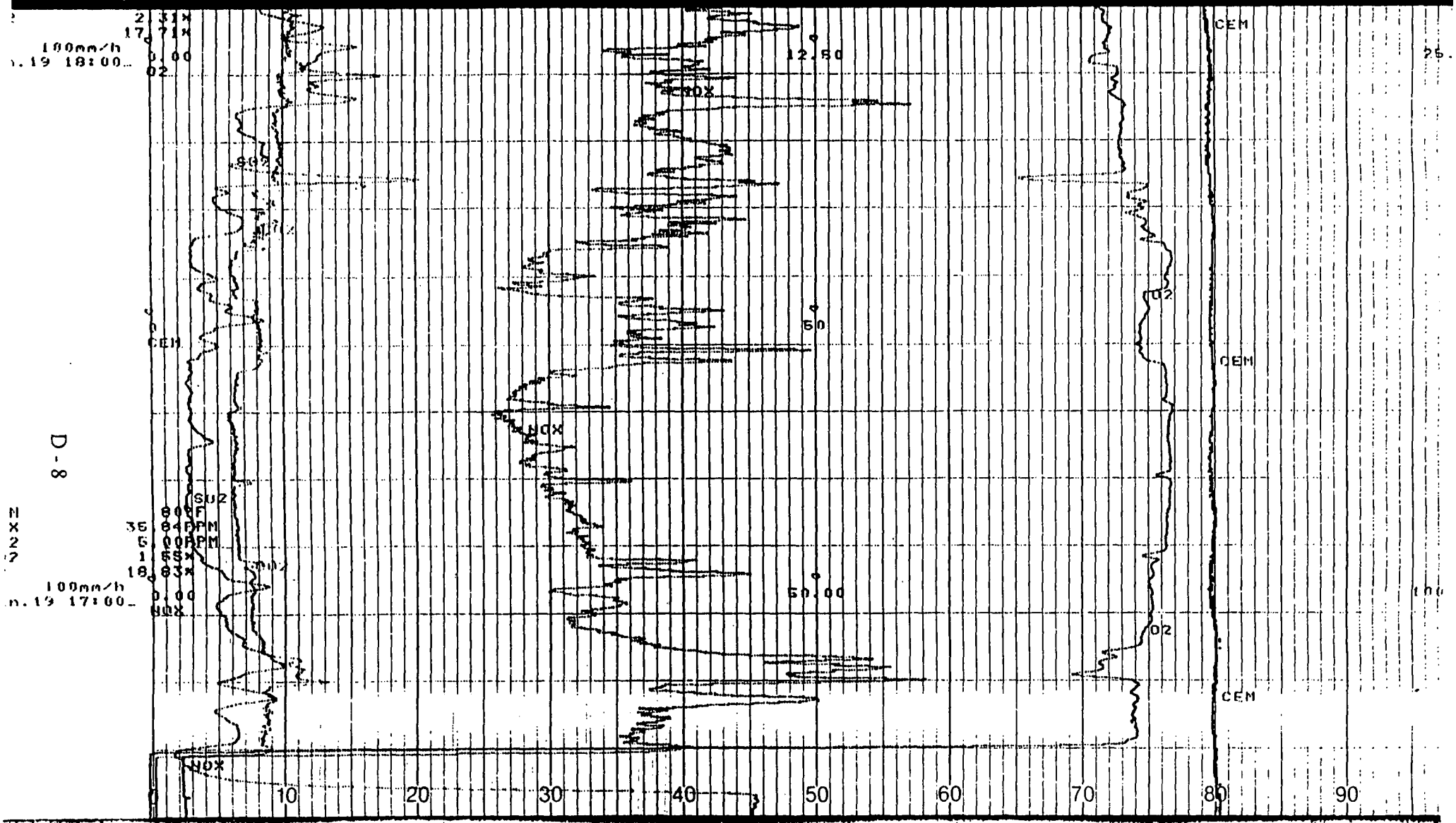
CEM
NOX
SO2
CO2
O2
100mm/h
Jan.19 14:00

D-6

797

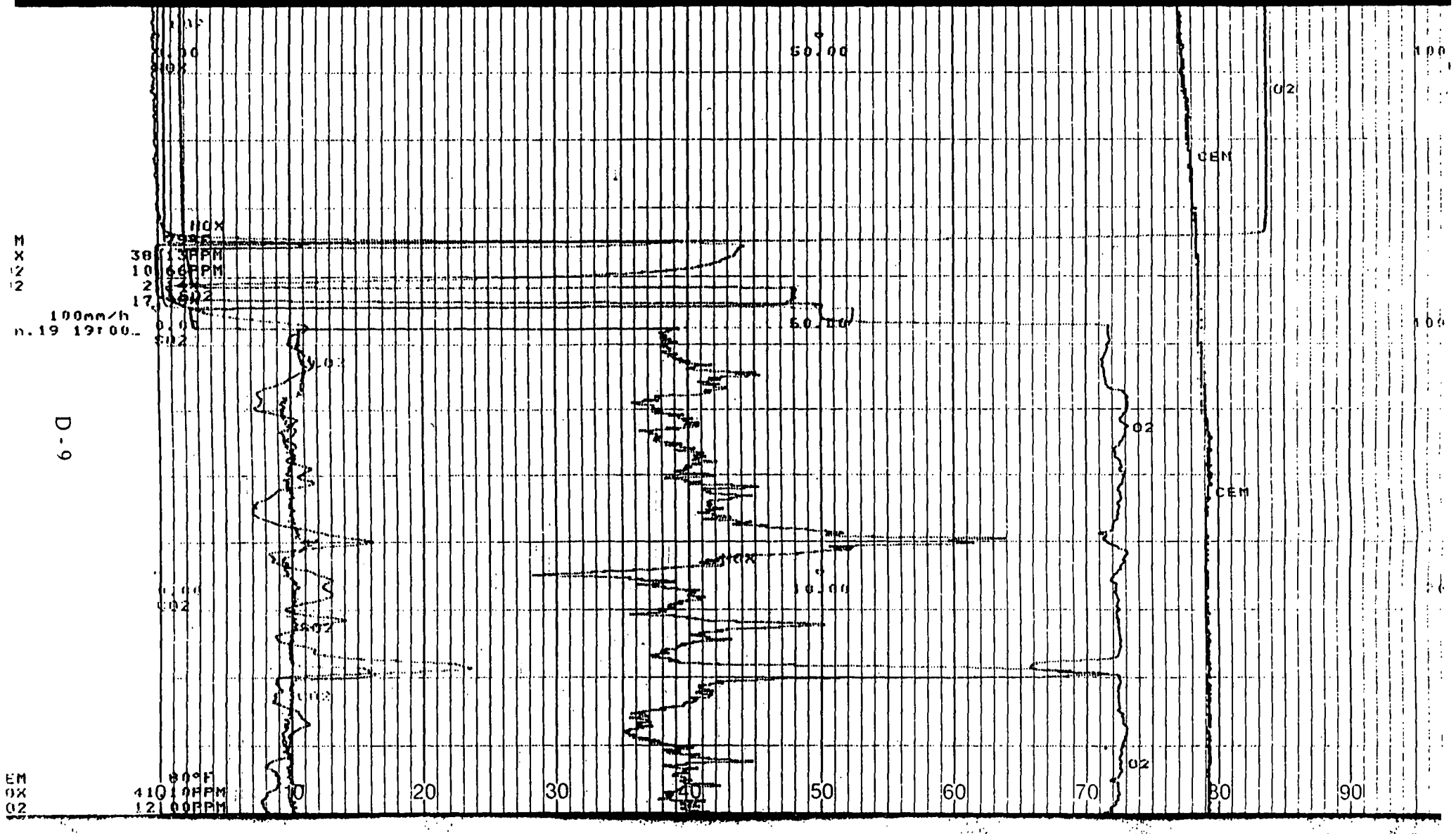
22911


SO2
50.00
O2
CEM
NOX
12.60
CO2
100mm/h
10
20
30
40
50
60
70
80
90

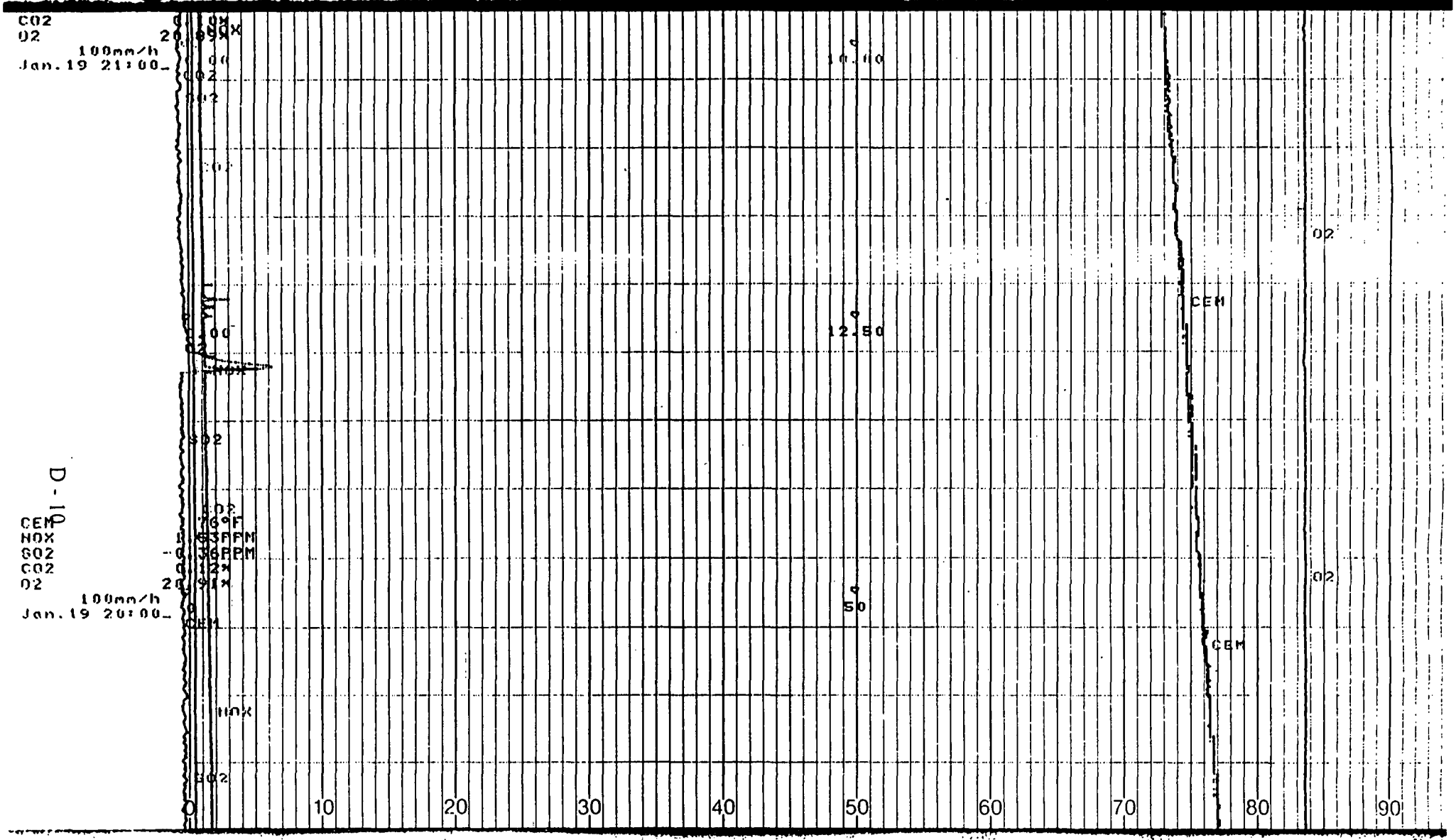

2.31%
17.71%
100mm/h
.19 18:00
0.00
O2
NOX
SO2
CEM
12.50
50
50.00
O2
CEM
NOX
SO2
80°F
35.84PPM
5.00PPM
1.55%
18.83%
100mm/h
n.19 17:00
0.00
NOX
O2
CEM
NOX
0
10
20
30
40
50
60
70
80
90

D-8

-2291



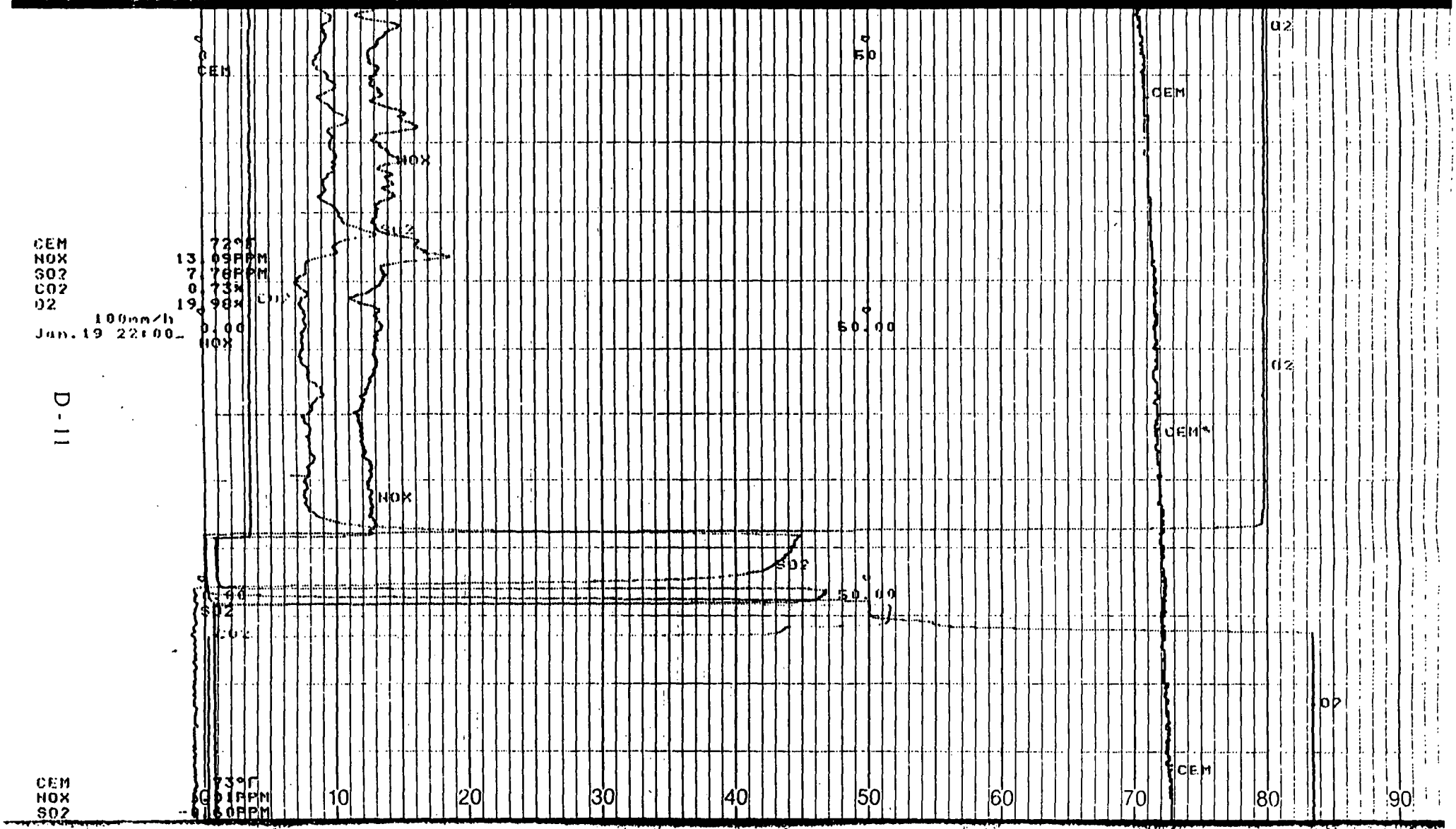
D-9



D-10

108

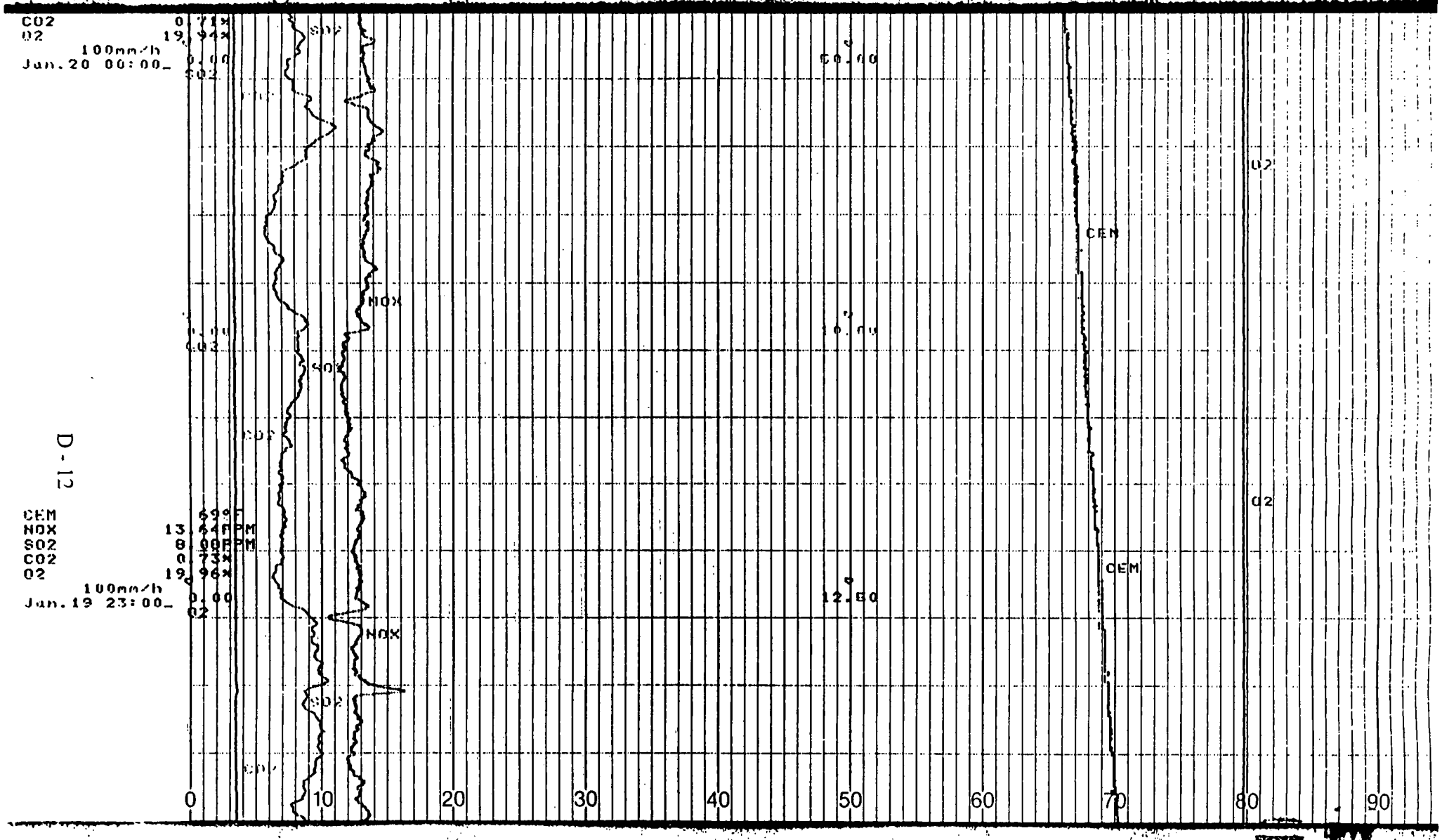
W 2291


CEM
NOX
SO2
CO2
O2
100mm/h
Jan.19 22:00
CEM
NOX
SO2
CO2
O2
10
20
30
40
50
60
70
80
90

D-11

203

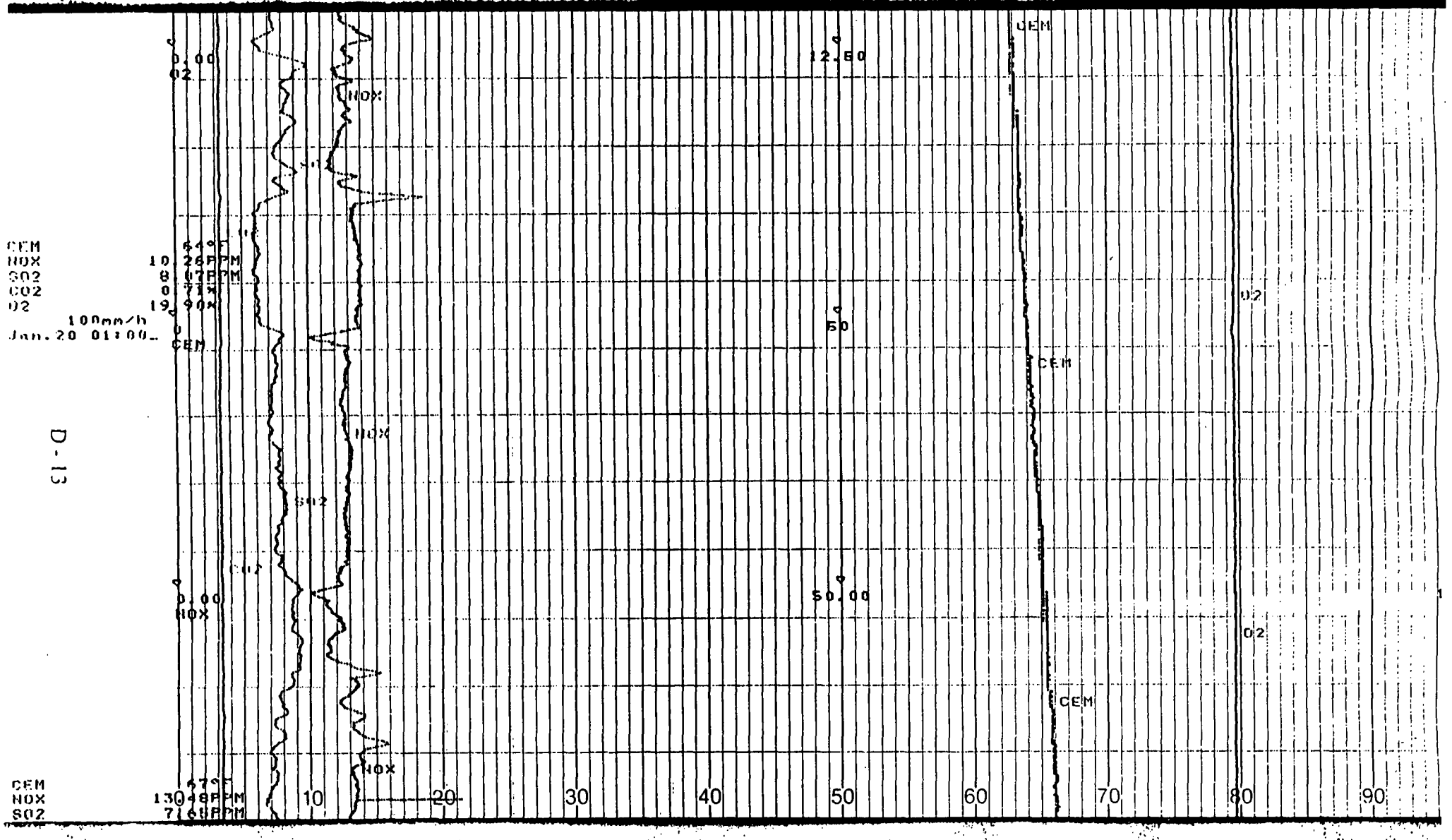
2291

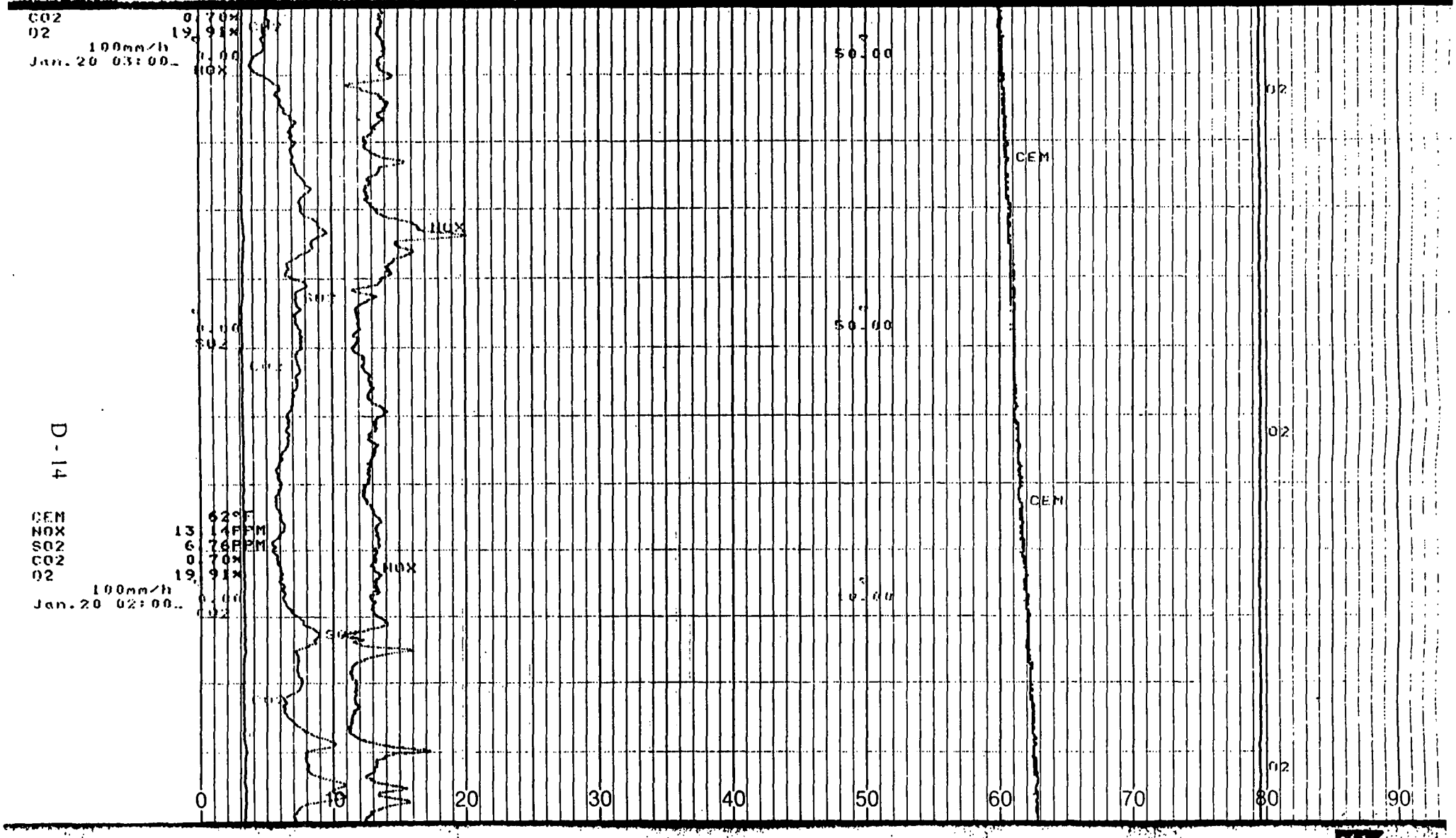

CO2
O2
100mm/h
Jan.20 00:00
CEM
NOX
SO2
CO2
O2
100mm/h
Jan.19 23:00
NOX
SO2
CEM
O2
0
10
20
30
40
50
60
70
80
90

D-12

803

829 I

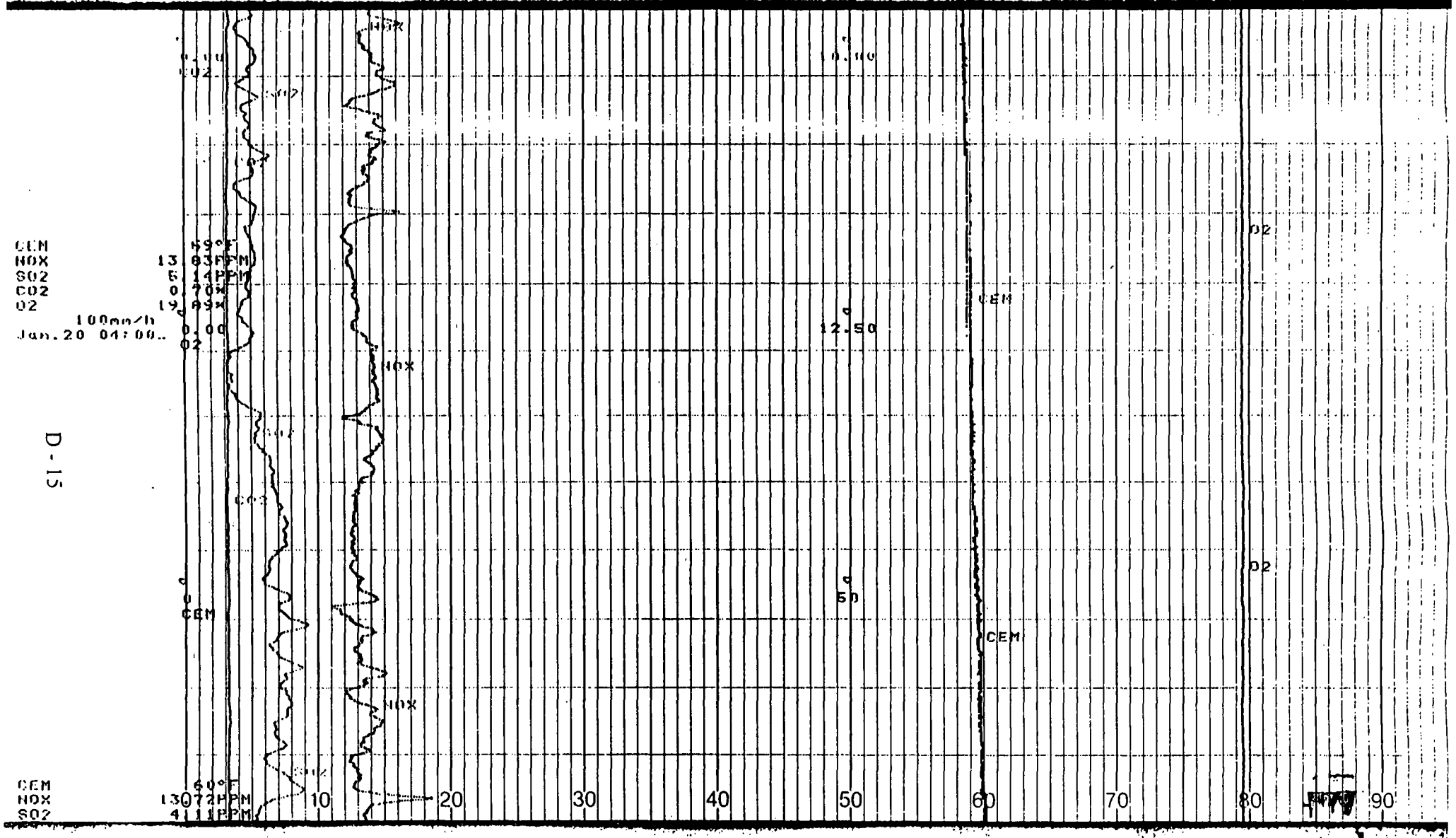

CEM
NOX
SO2
CO2
O2
100mm/h
Jan.20 01:00
0.00
12.50
50
50.00
10
20
30
40
50
60
70
80
90

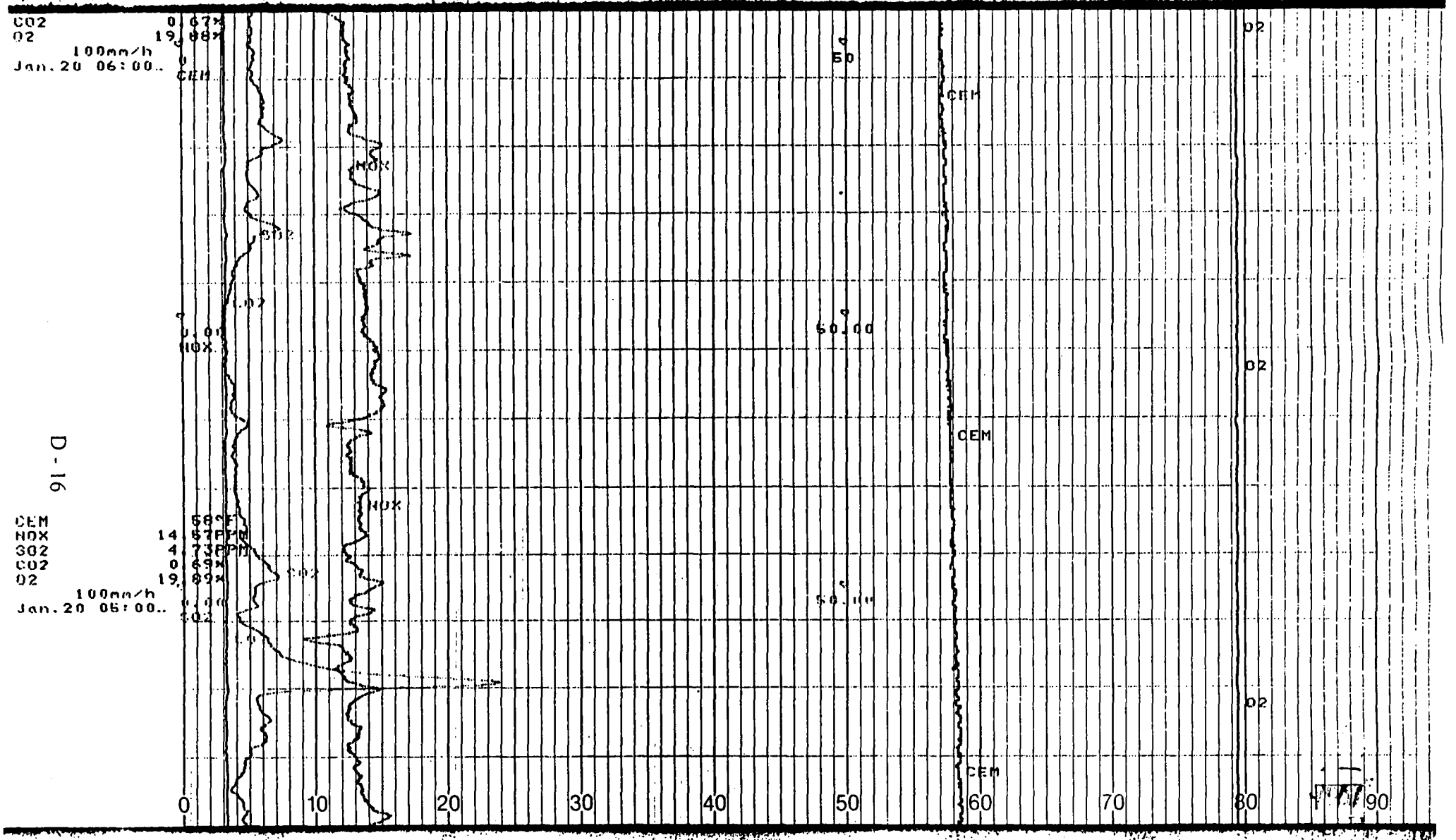

CO2
O2
100mm/h
Jan. 20 03:00
NOX
SO2
CO2
CEM
NOX
SO2
CO2
O2
100mm/h
Jan. 20 02:00
NOX
CEM
O2
0
10
20
30
40
50
60
70
80
90

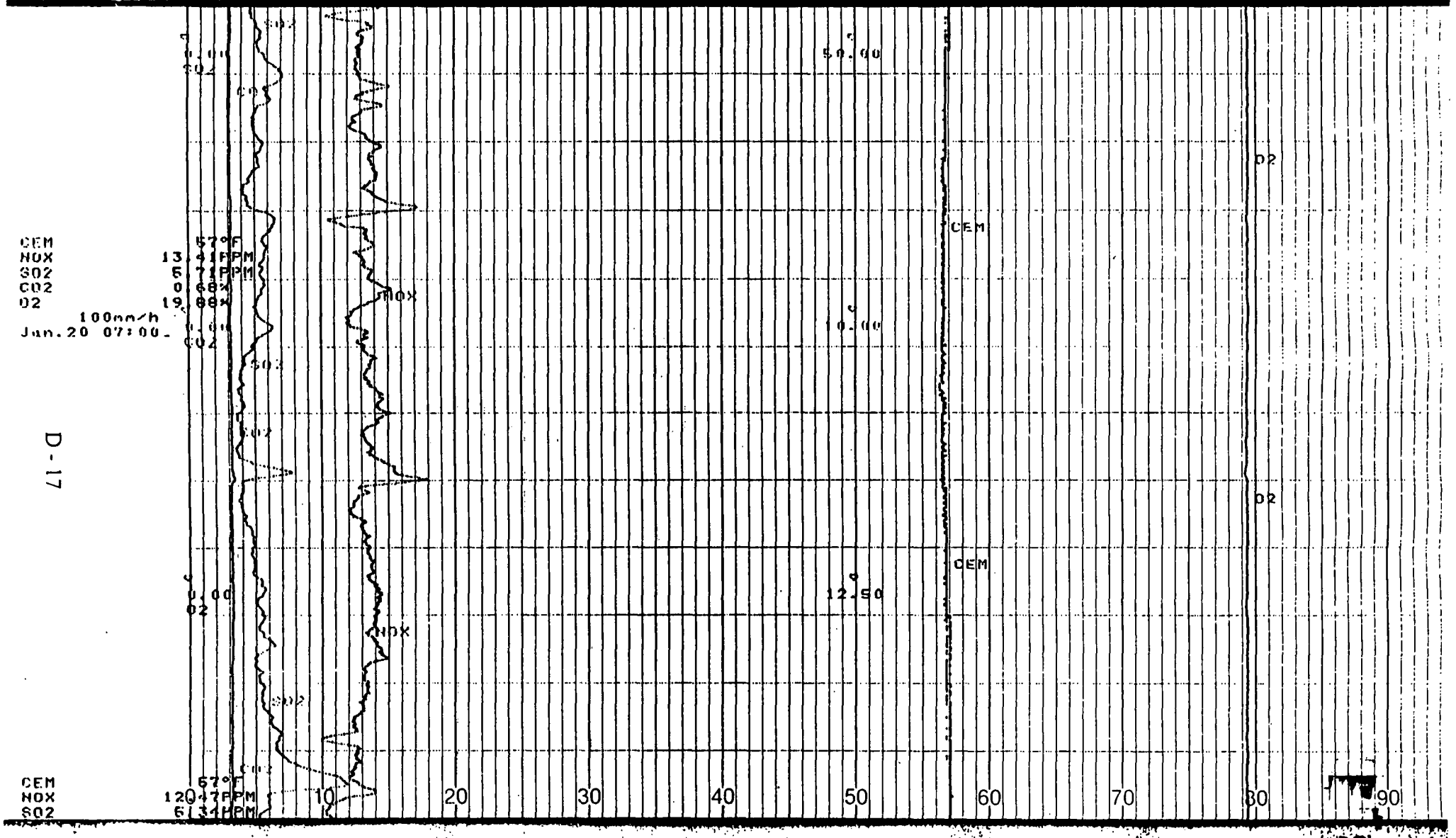
D-14

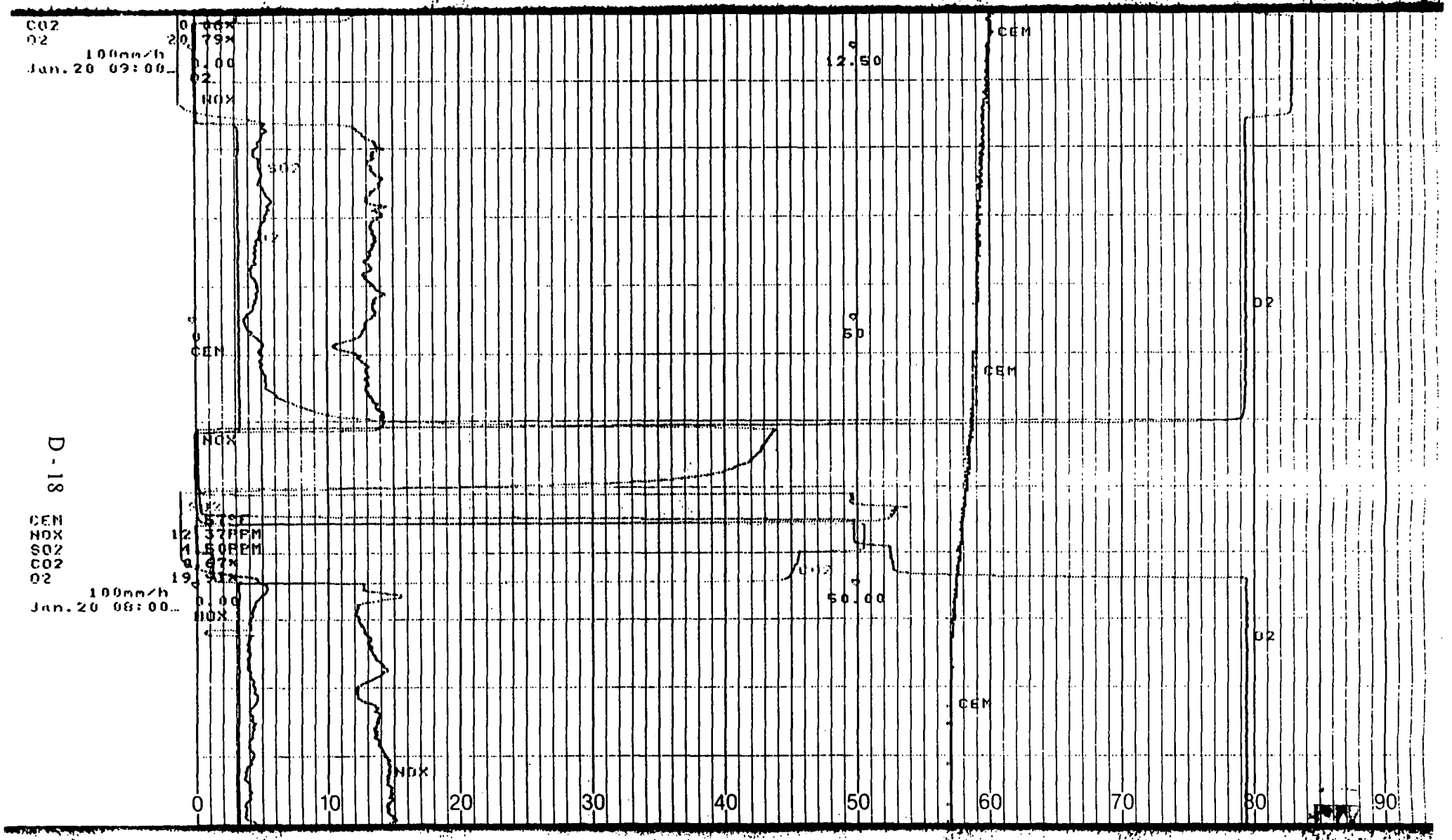
508

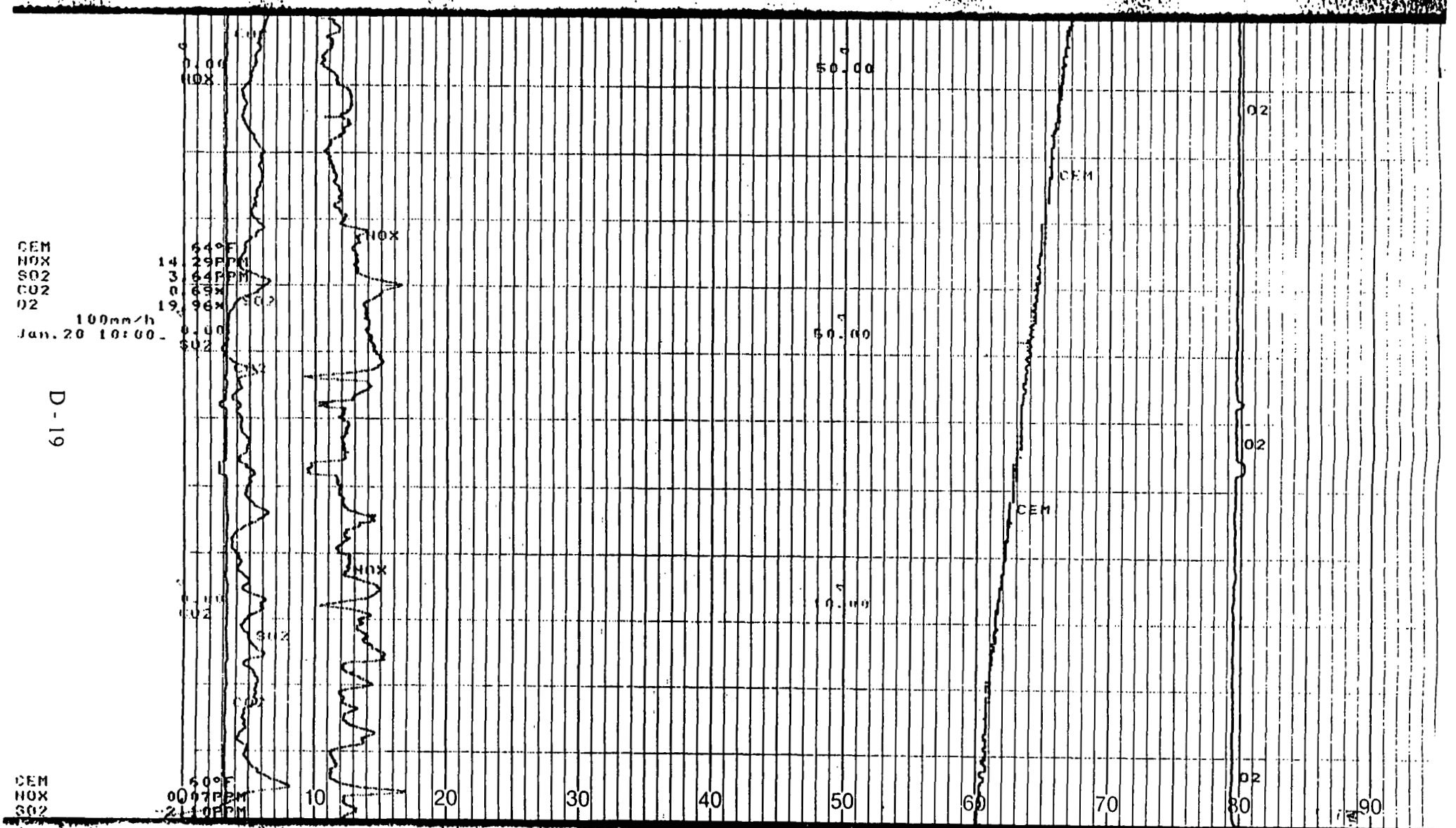
229

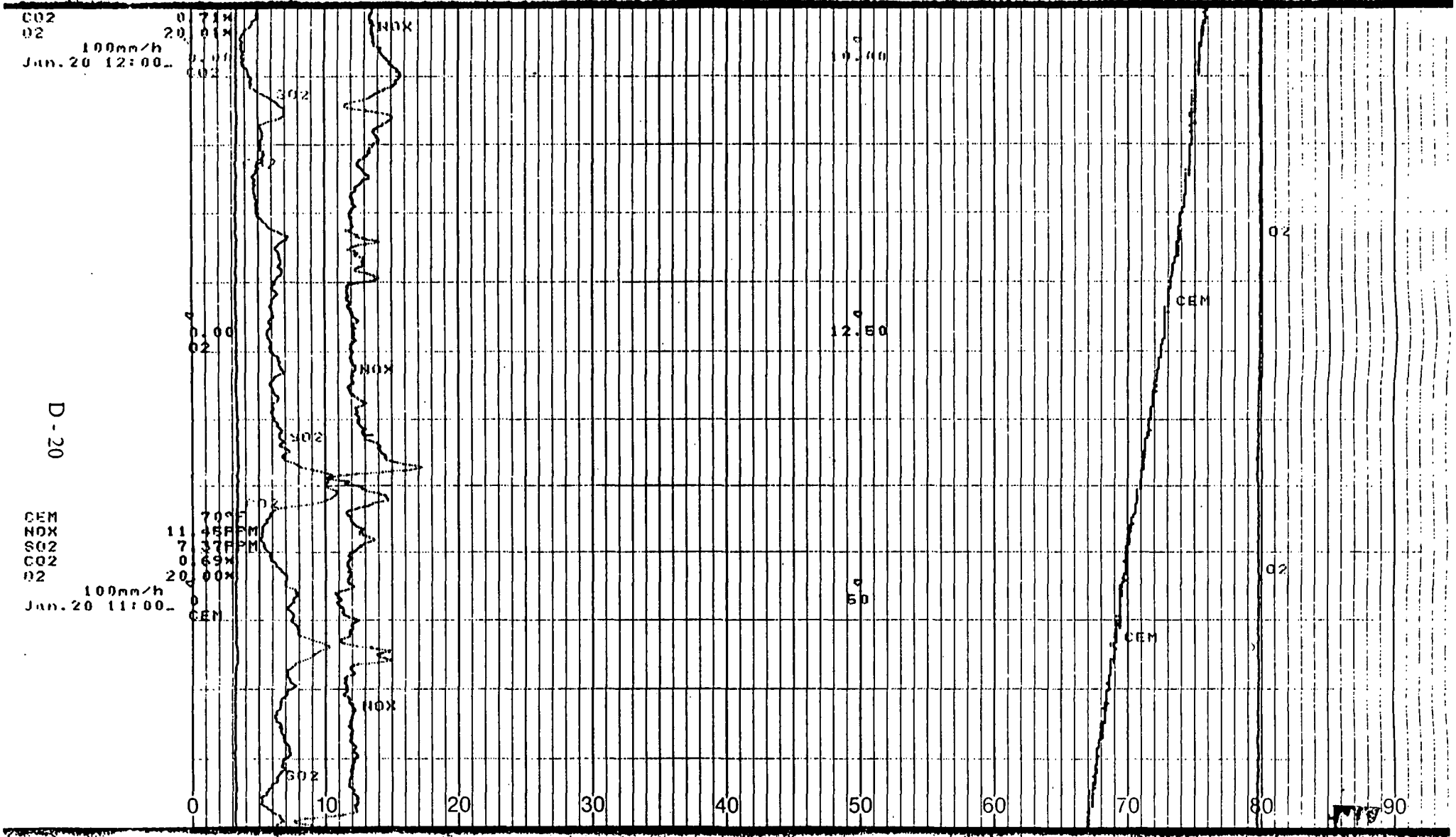

CEM
NOX
SO2
CO2
O2
100mm/h
Jan.20 04:00..
49°F
13.83PPM
5.14PPM
0.70%
19.99%
0.00
60°F
13072PPM
4111PPM
NOX
SO2
CO2
O2
CEM
10.00
12.50
5.0
10
20
30
40
50
60
70
80
90

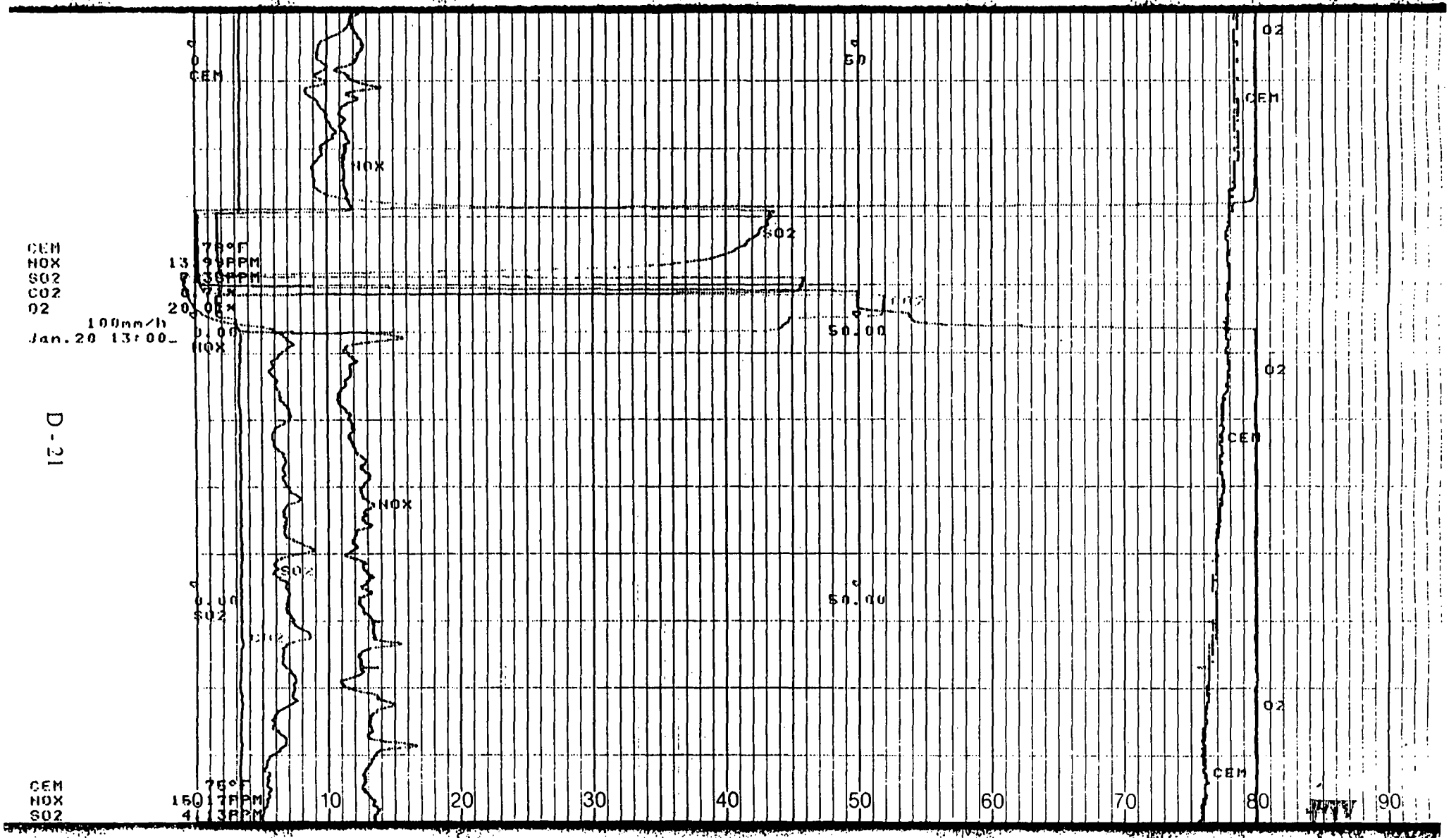

CO2
O2
100mm/h
Jan.20 06:00..
CEM
NOX
SO2
CO2
O2
100mm/h
Jan.20 06:00..
CEM
NOX
SO2
CO2
O2
0
10
20
30
40
50
60
70
80
90


CEM
NOX 13.41PPM
SO2 5.71PPM
CO2 0.68%
O2 19.88%
57°F
100mm/h
Jan.20 07:00
CEM
NOX 12047PPM
SO2 6131PPM
57°F
NOX
SO2
CO2
O2
CEM
O2
50.00
10.00
12.50
10
20
30
40
50
60
70
80
90

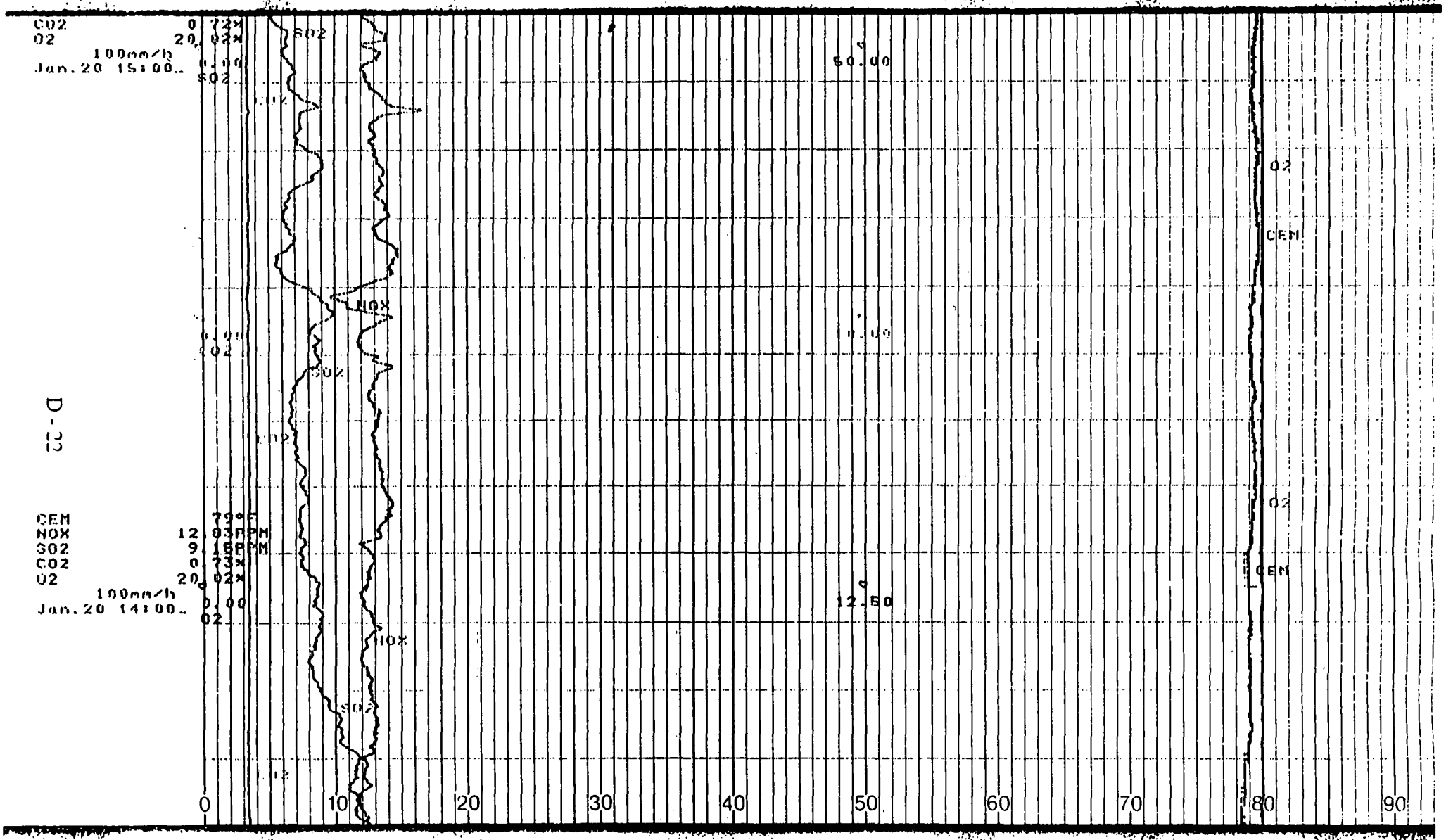

CO2
O2
100mm/h
Jan.20 09:00
NOX
SO2
CEM
NOX
CEM
NOX
SO2
CO2
O2
100mm/h
Jan.20 08:00
NOX
12.50
50
50.00
CEM
O2
CEM
O2
CEM
0
10
20
30
40
50
60
70
80
90

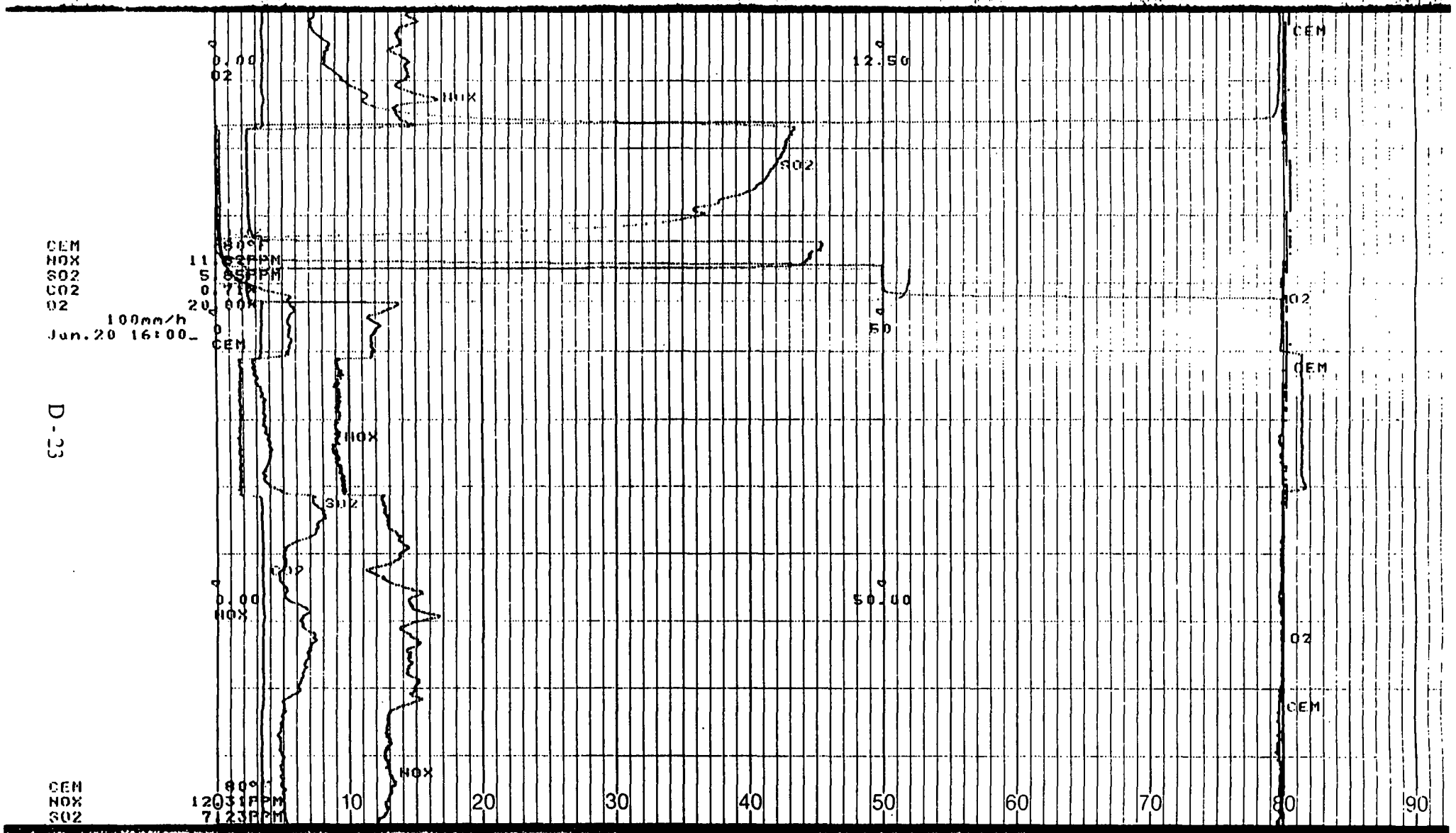

CEM
NOX
SO2
CO2
O2
14.29PPM
3.64PPM
19.96%
100mm/h
Jan.20 10:00
NOX
SO2
CO2
O2
CEM
NOX
SO2
0.07PPM
10
20
30
40
50
60
70
80
90
50.00
50.00
10.00
CEM
O2


CO2
O2
100mm/h
Jan.20 12:00
CEM
NOX
SO2
CO2
O2
100mm/h
Jan.20 11:00
NOX
SO2
O2
CEM
0
10
20
30
40
50
60
70
80
90

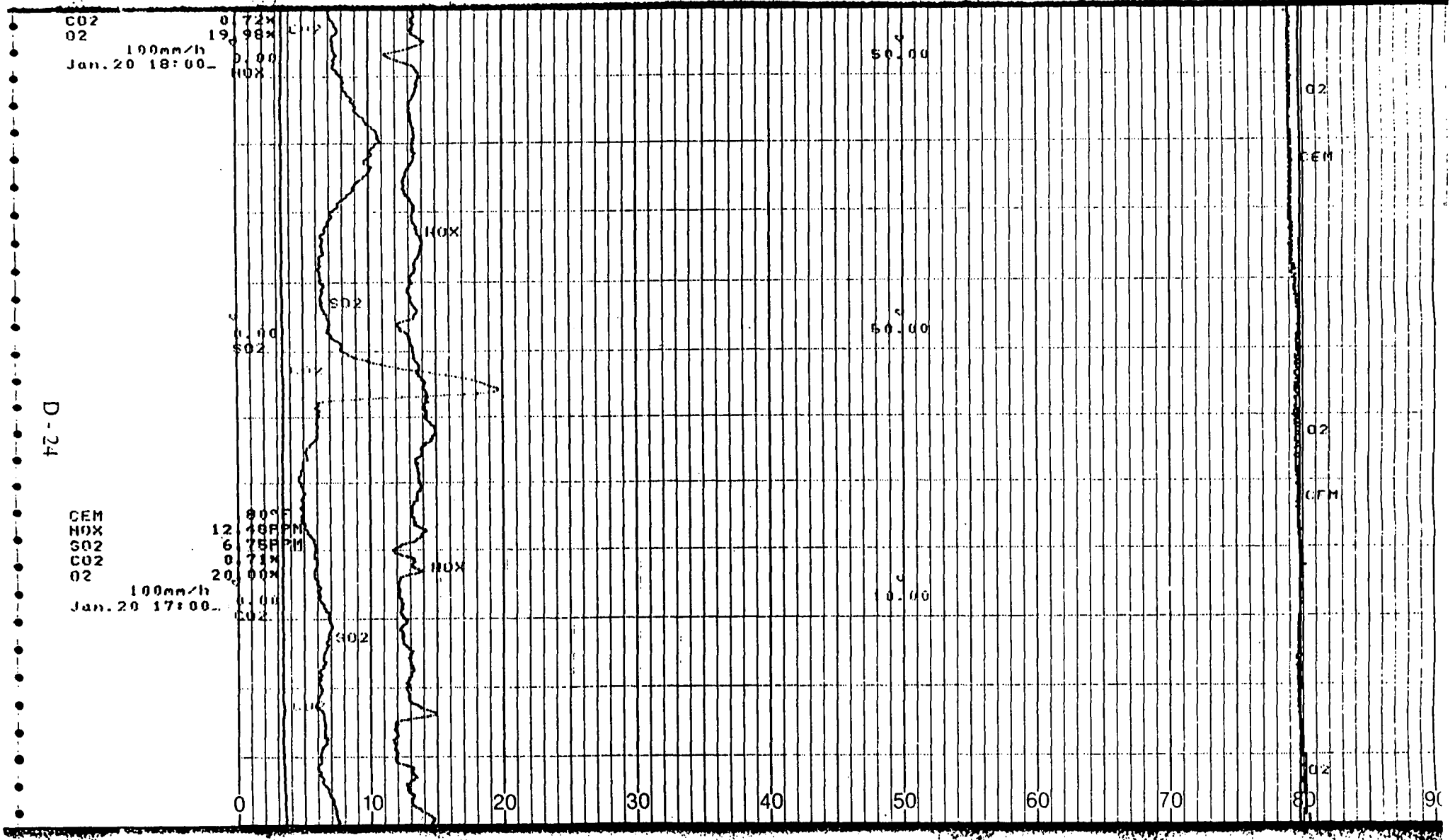

CEM
NOX
SO2
CO2
O2
100mm/h
Jan.20 13:00
76°F
13.99PPM
0.30PPM
0.77%
20.08%
0.00
NOX
SO2
50.00
CEM
O2
150.17PPM
4.13PPM
10
20
30
40
50
60
70
80
90

818

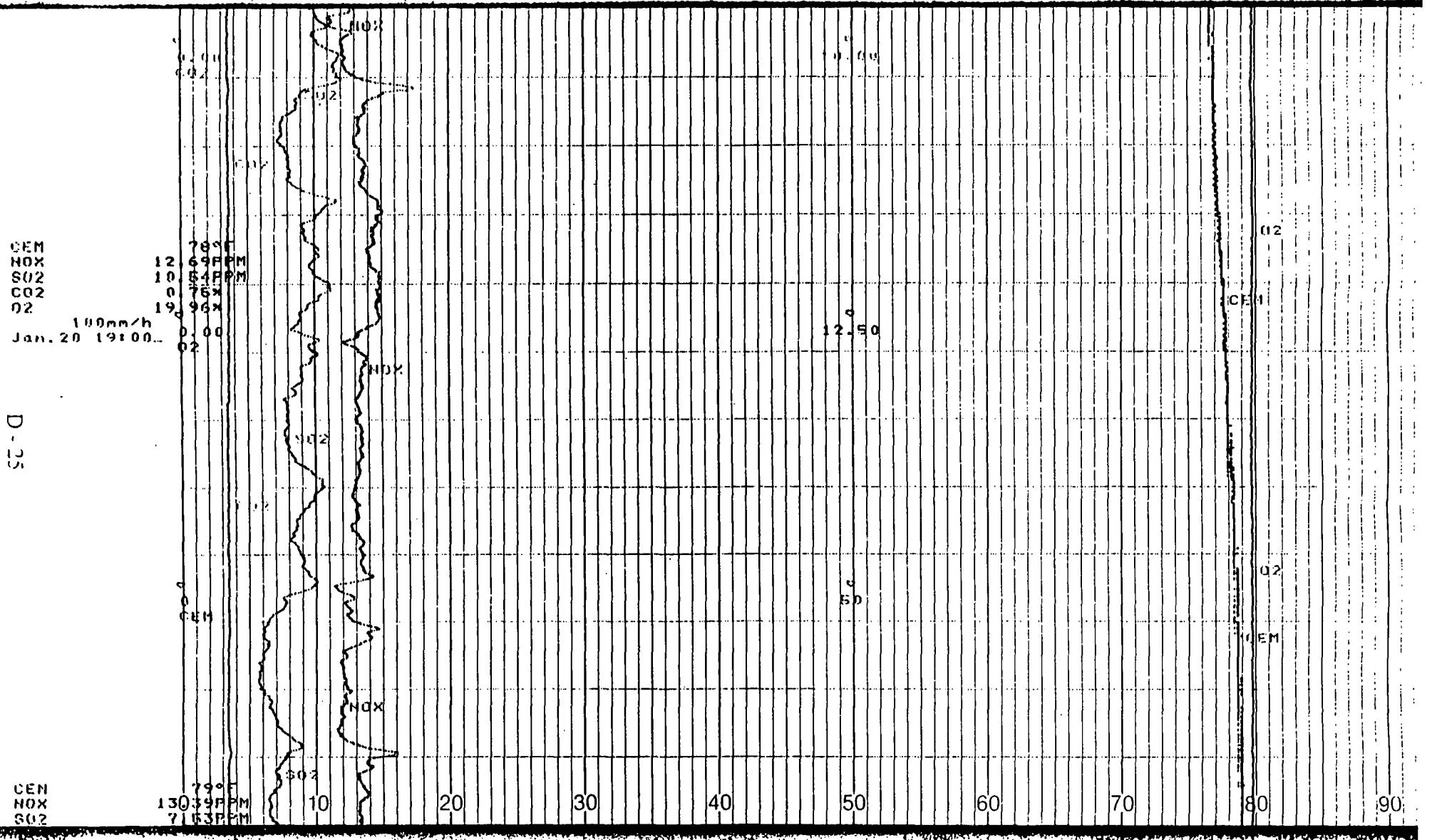

CO2 0.72%
O2 20.02%
100mm/h
Jan.20 15:00
SO2
NOX
SO2
O2
CEM 79°F
NOX 12.03PPM
SO2 9.18PPM
CO2 0.73%
O2 20.02%
100mm/h
Jan.20 14:00
O2
NOX
SO2
50.00
10.00
12.50
O2
CEM
O2
CEM
0
10
20
30
40
50
60
70
80
90


CEM
NOX
SO2
CO2
O2
100mm/h
Jan.20 16:00
0.00
O2
NOX
SO2
12.50
50
50.00
CEM
O2
NOX
SO2
CO2
0.00
NOX
NOX
CEM
NOX
SO2
10
20
30
40
50
60
70
80
90

D-33


CO2 0.72%
O2 19.98%
100mm/h
Jan.20 18:00
NOX
SO2
CEM
NOX 12.18PPM
SO2 6.75PPM
CO2 0.71%
O2 20.00%
100mm/h
Jan.20 17:00
50.00
10.00
O2
CEM
0
10
20
30
40
50
60
70
80
90

D-24

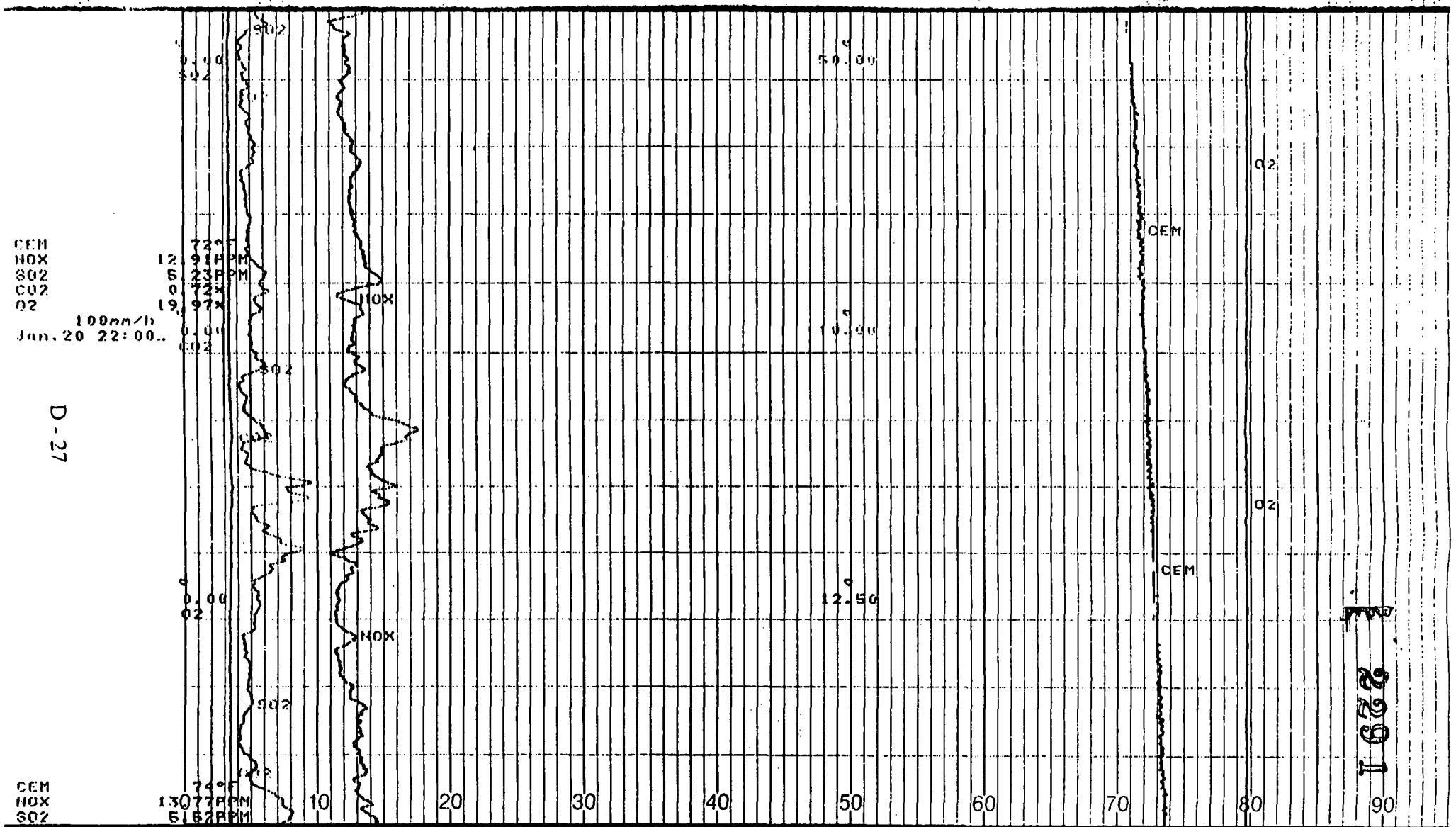

CEM
NOX
SO2
CO2
O2
78°F
12.69PPM
10.54PPM
0.76%
19.96%
100mm/h
Jan.20 19:00
CEM
NOX
SO2
79°F
13039PPM
7153PPM
10
20
30
40
50
60
70
80
90
12.50
5.0
O2
CEM

D-25

CO2 0.74%
O2 19.96%
100mm/h
Jan.20 21:00_
CEM
NOX
0.00
NOX
CEM 76%
NOX 13.77PPM
SO2 10.09PPM
CO2 0.79%
O2 19.97%
100mm/h
Jan.20 20:00_
SO2
50
50.00
50.00
O2
CEM
0
10
20
30
40
50
60
70
80
90

D-26

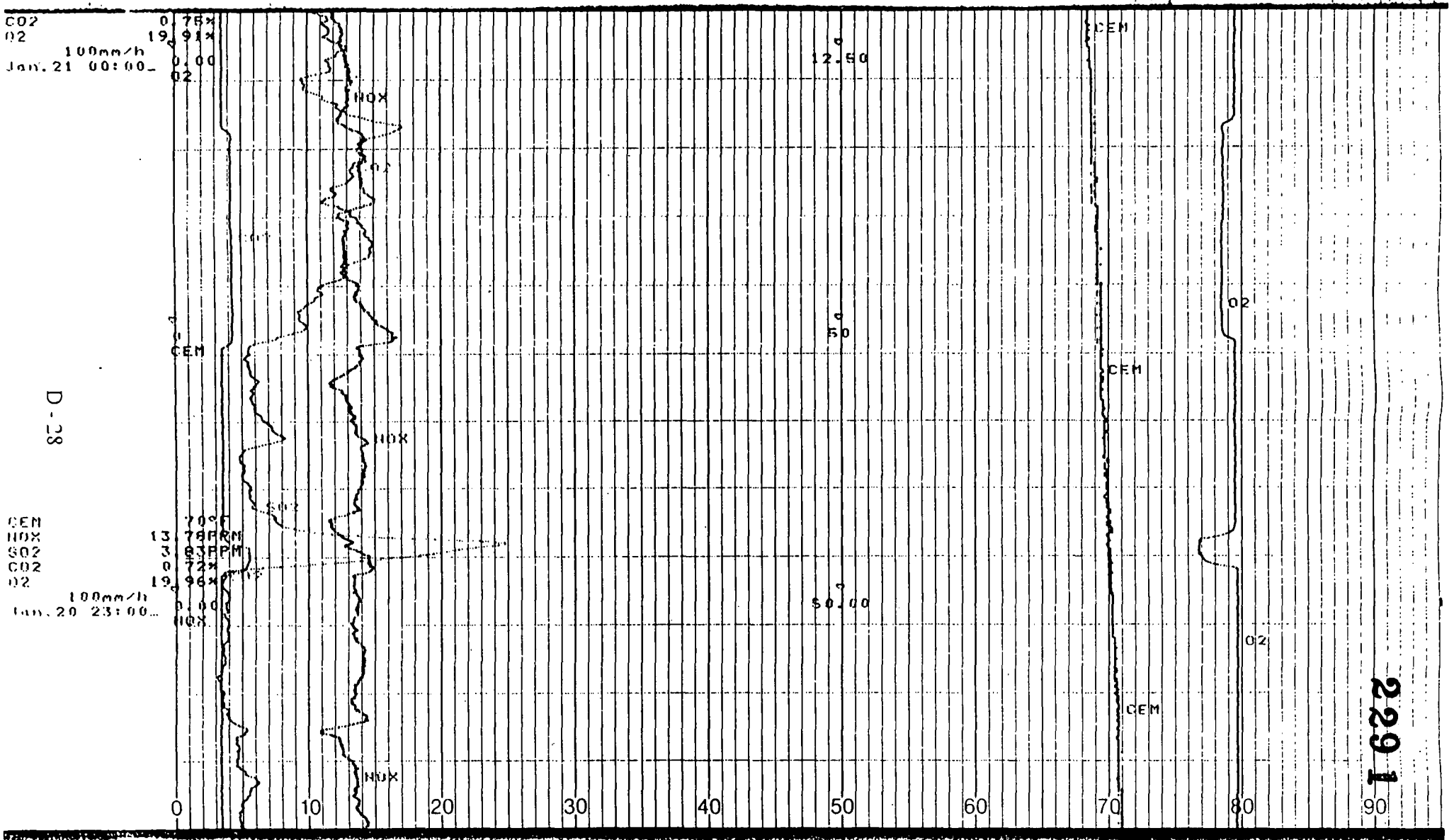
229 I


CEM
NOX
SO2
CO2
O2
72°F
12.91PPM
5.23PPM
0.72%
19.97%
100mm/h
Jan. 20 22:00..
74°F
13077PPM
5.62PPM
SO2
NOX
O2
CEM
50.00
10.00
12.50
10
20
30
40
50
60
70
80
90

D-27

818

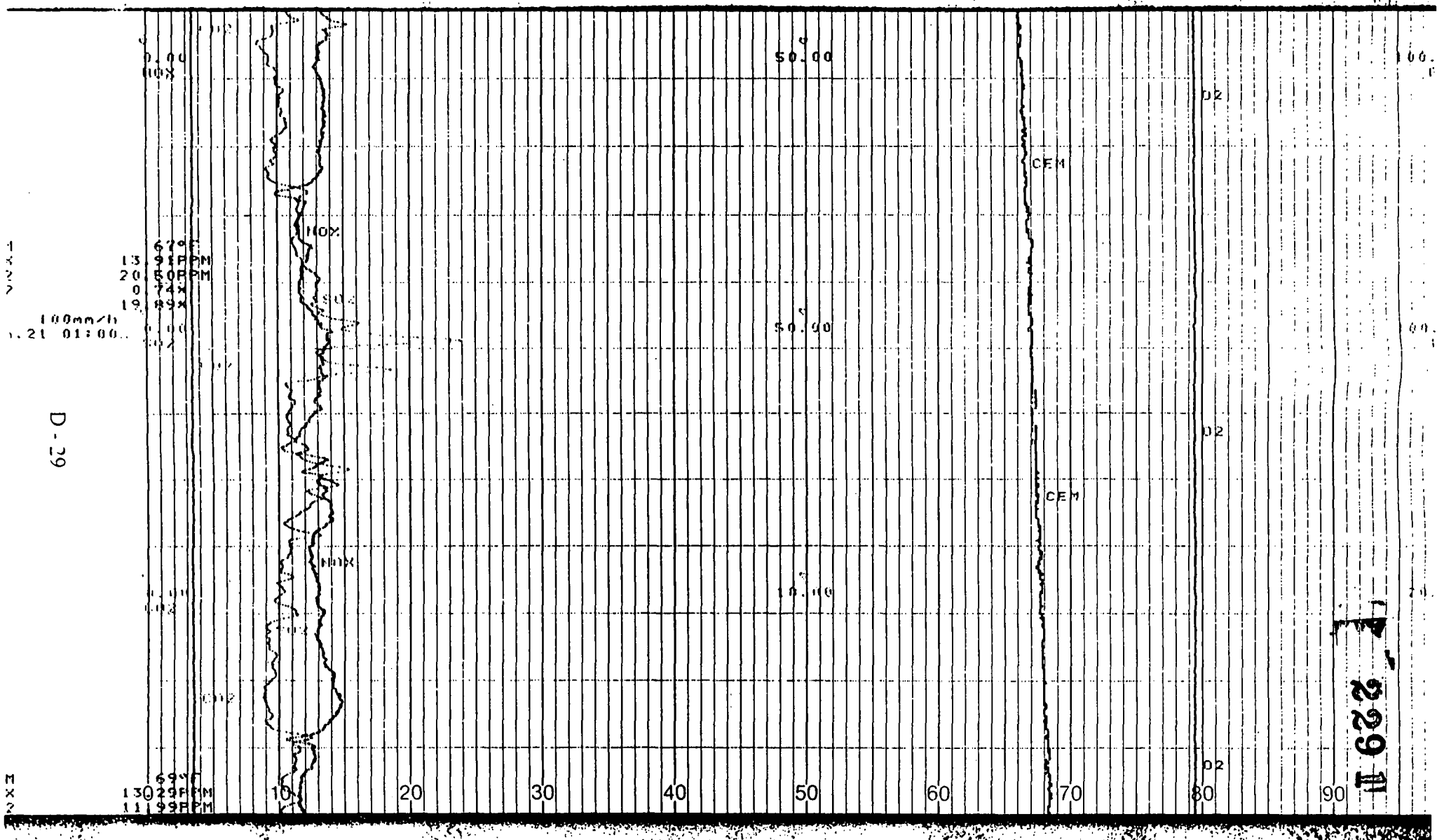
1672


CO2 0.75%
O2 19.91%
100mm/h
Jan.21 00:00
O2
NOX
CEM
CEM 70°C
NOX 13.78PPM
SO2 3.83PPM
CO2 0.72%
O2 19.96%
100mm/h
Jan.20 23:00
NOX
12.50
50
50.00
CEM
O2
0
10
20
30
40
50
60
70
80
90

D-28

229 1

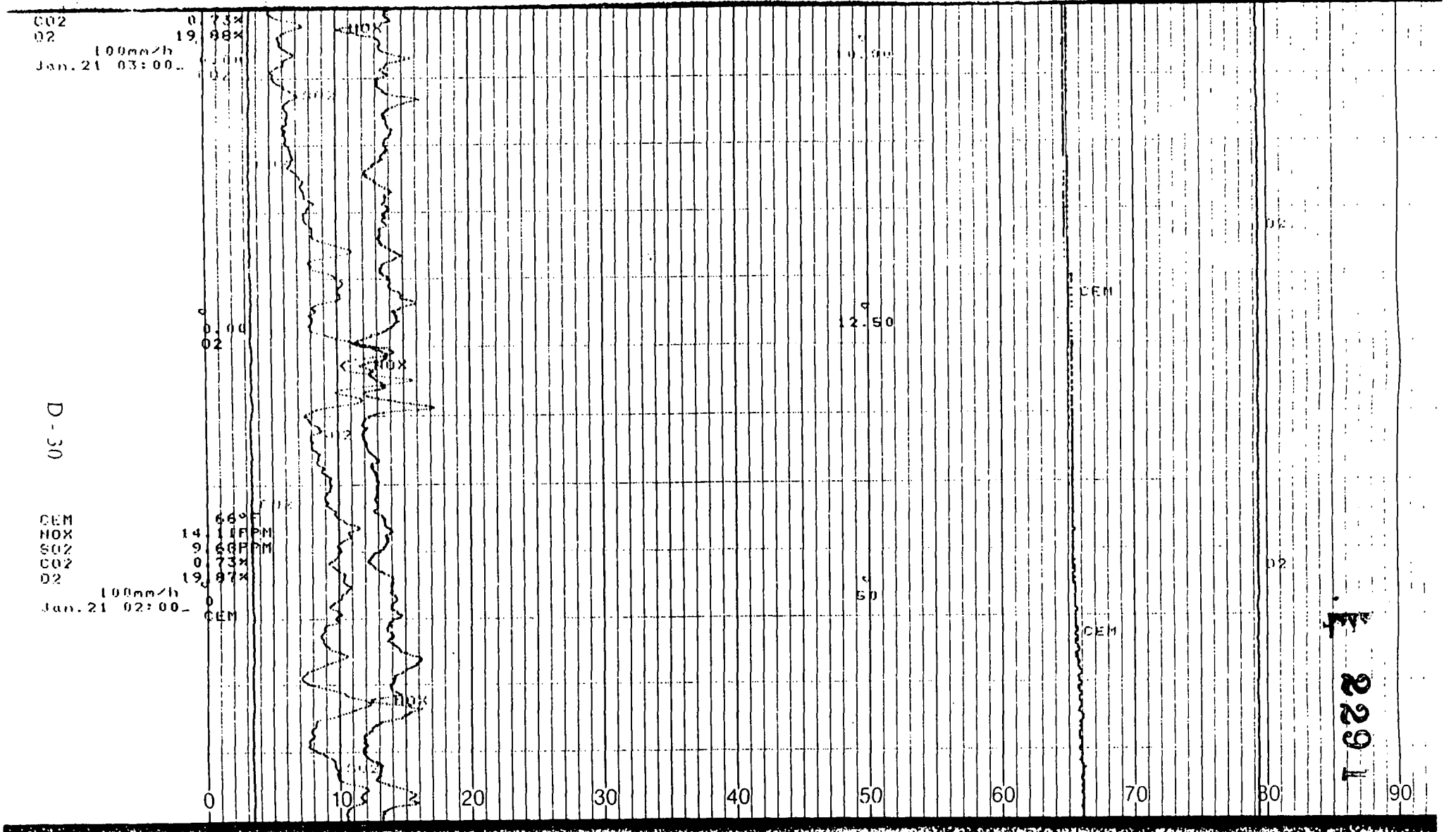
48


0.00
100%
50.00
100%
CEM
D2
67°F
13.95PPM
20.50PPM
0.74%
19.89%
100mm/h
1.21 01:00
50.00
CEM
D2
MAX
10.00
D2
69°F
13029PPM
11199PPM
10
20
30
40
50
60
70
80
90

D-29

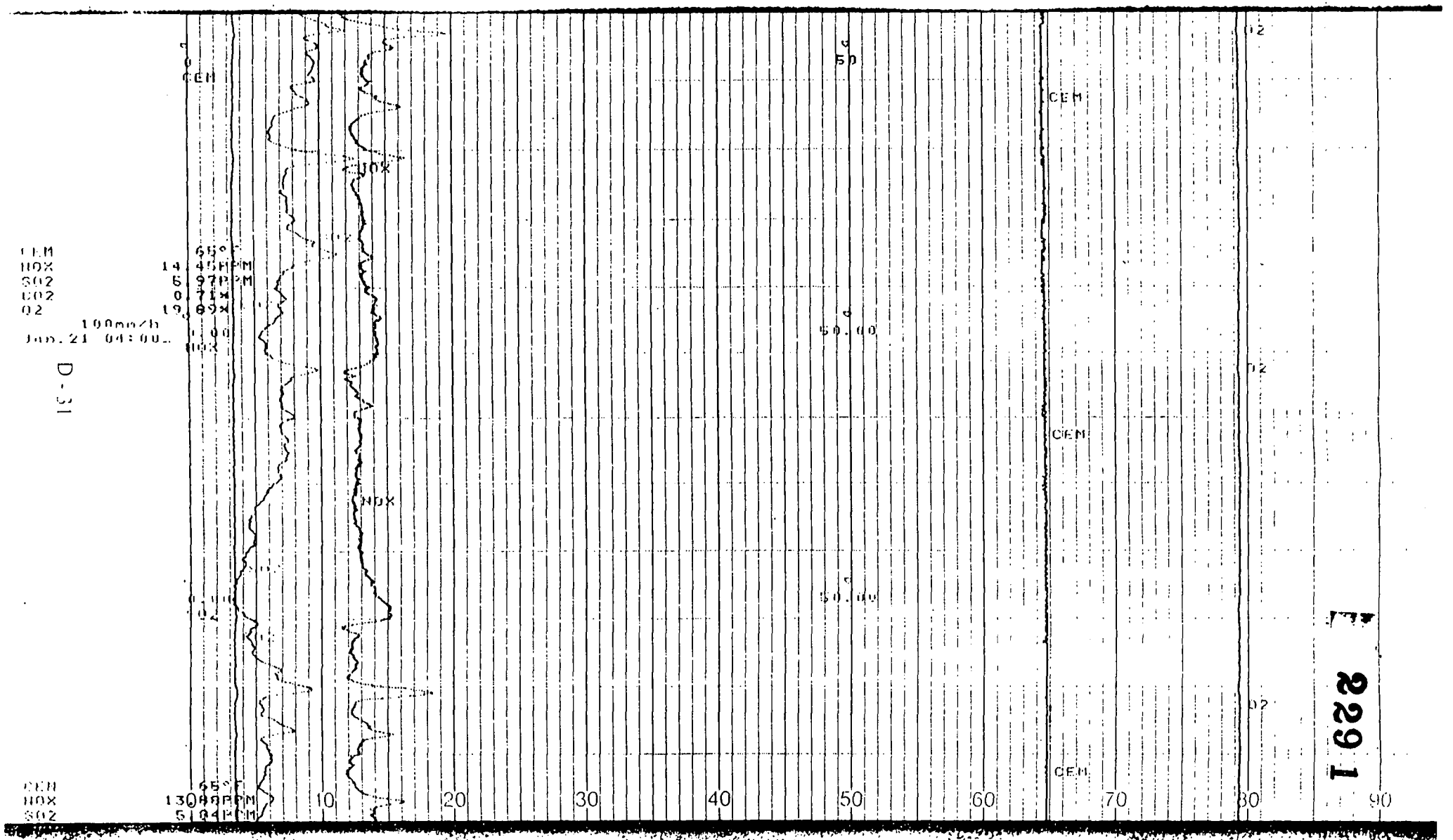
820

H 622


CO2 0.73%
O2 19.88%
100mm/h
Jan.21 03:00
NOX
O2
0.00
O2
NOX
CEM
NOX 14.11PPM
SO2 9.68PPM
CO2 0.73%
O2 19.97%
100mm/h
Jan.21 02:00
CEM
NOX
12.50
50
CEM
O2
0
10
20
30
40
50
60
70
80
90

D-30

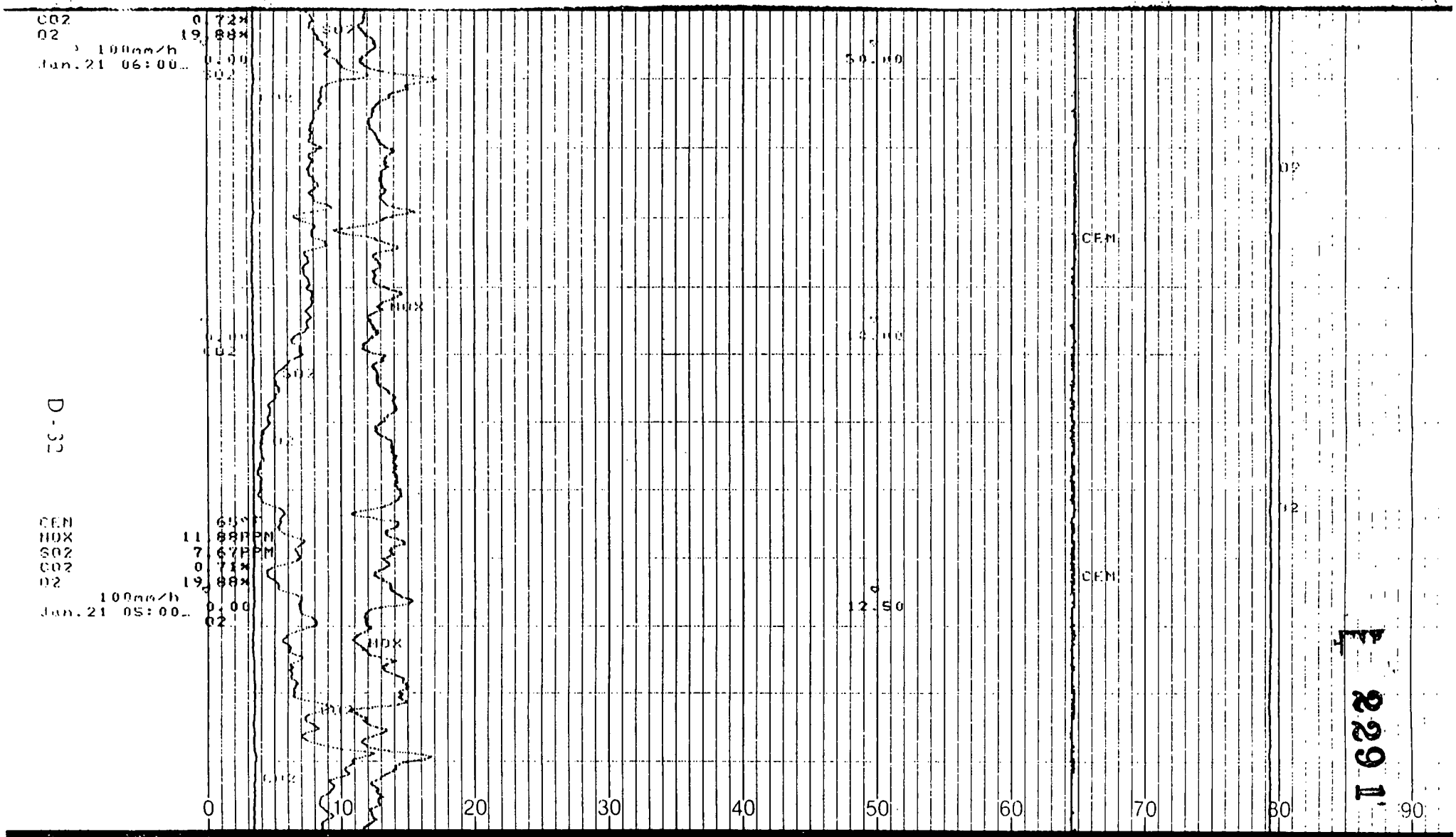
229


CEM
NOX
SO2
CO2
O2
100mm/h
Jan.21 04:00
CEM
NOX
SO2
55°C
13088RPM
5.04PPM
10
20
30
40
50
60
70
80
90
50
50.00
50.00
CEM
NOX
CEM
NOX
CEM
O2
O2
O2

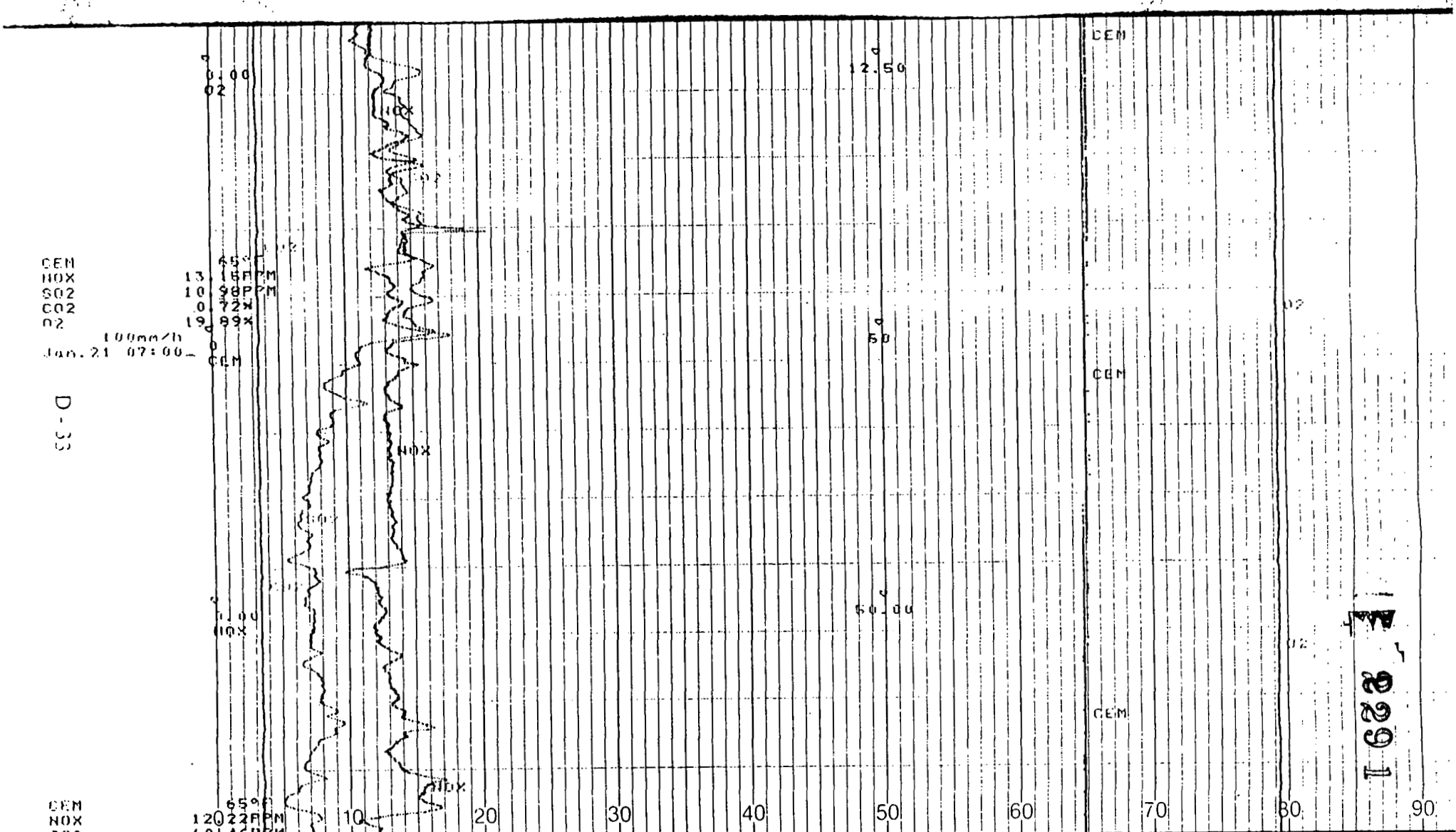
D-31

229 1

838


CO2 0.72%
O2 19.88%
100mm/h
Jan.21 06:00
CEM
NOX
SO2 7.67PPM
CO2 0.71%
O2 19.88%
100mm/h
Jan.21 05:00
CEM
NOX
50.00
12.50
CEM
CEM
0
10
20
30
40
50
60
70
80
90

D-32


CEM
NOX
SO2
CO2
O2
13.16PPM
10.98PPM
0.72%
19.89%
100mm/h
Jan.21 07:00
12.50
50
50.00
0.00
NOX
CEM
65°C
12022PPM
10146PPM
10
20
30
40
50
60
70
80
90

D-33

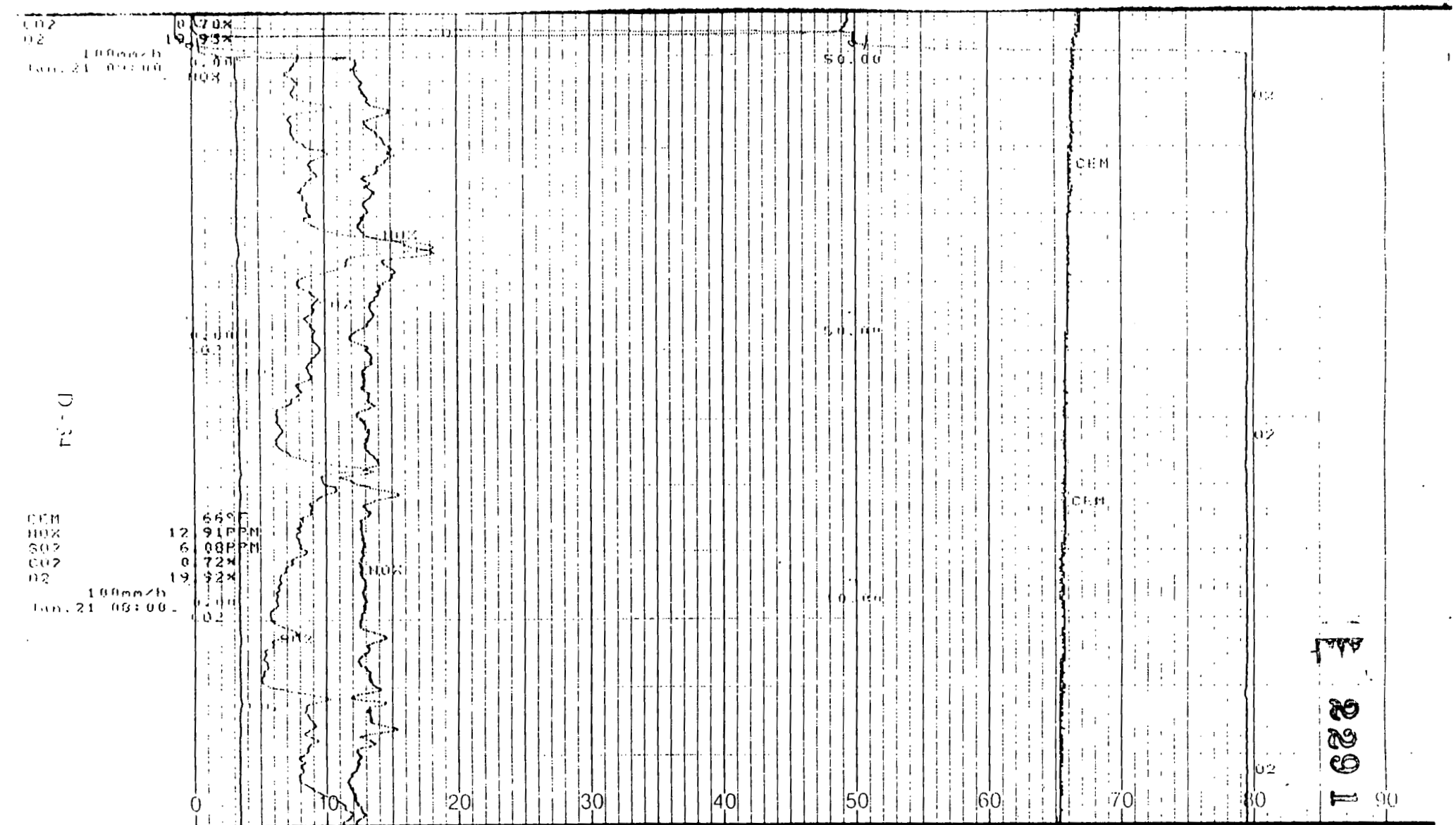
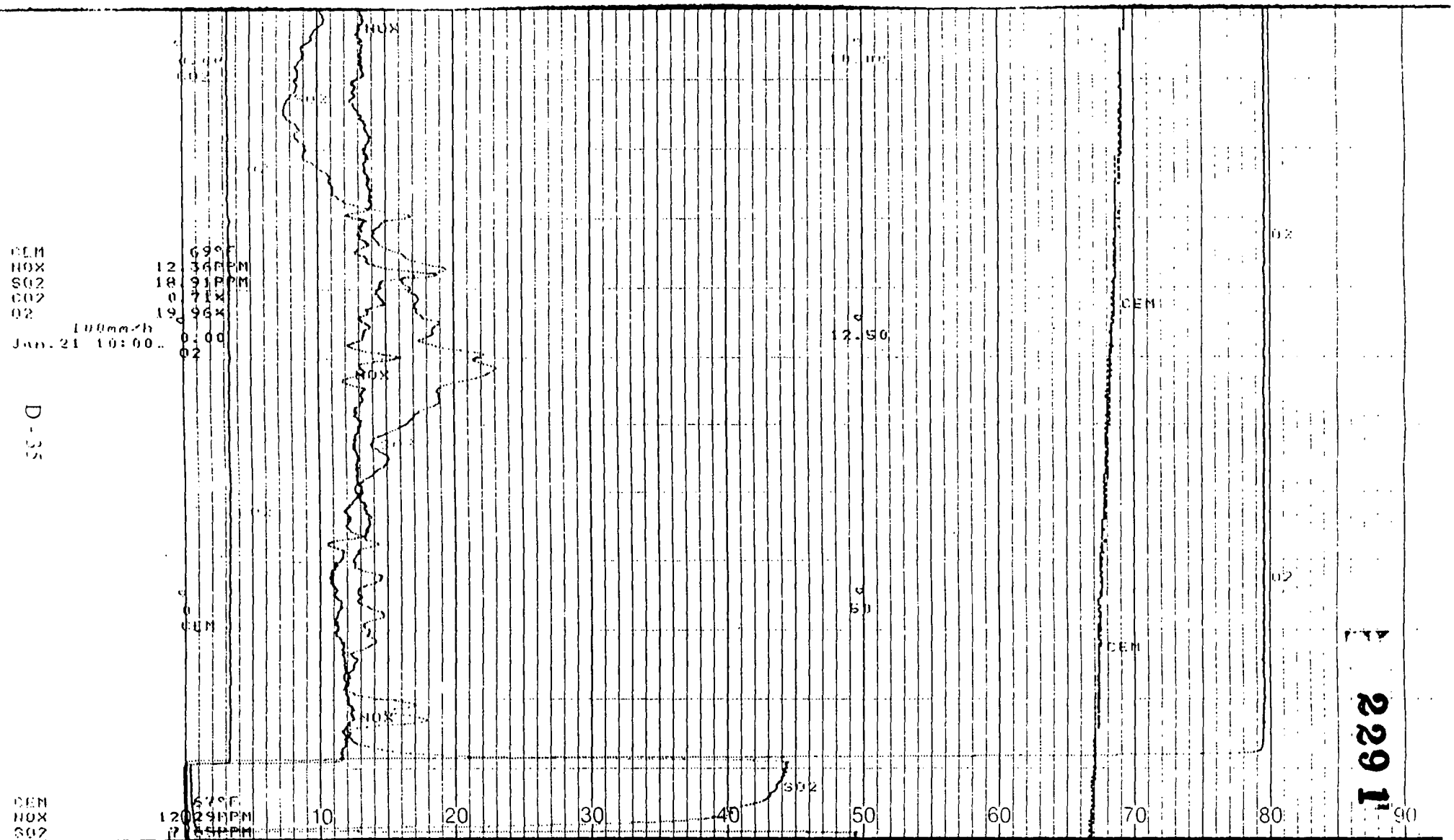

CO2
O2
100mm/h
Jan.21 00:00
CEM
NOX
SO2
CO2
O2
12.91PPM
6.08PPM
0.72%
19.92%
100mm/h
Jan.21 08:00
50.00
0.00
0
10
20
30
40
50
60
70
80
90

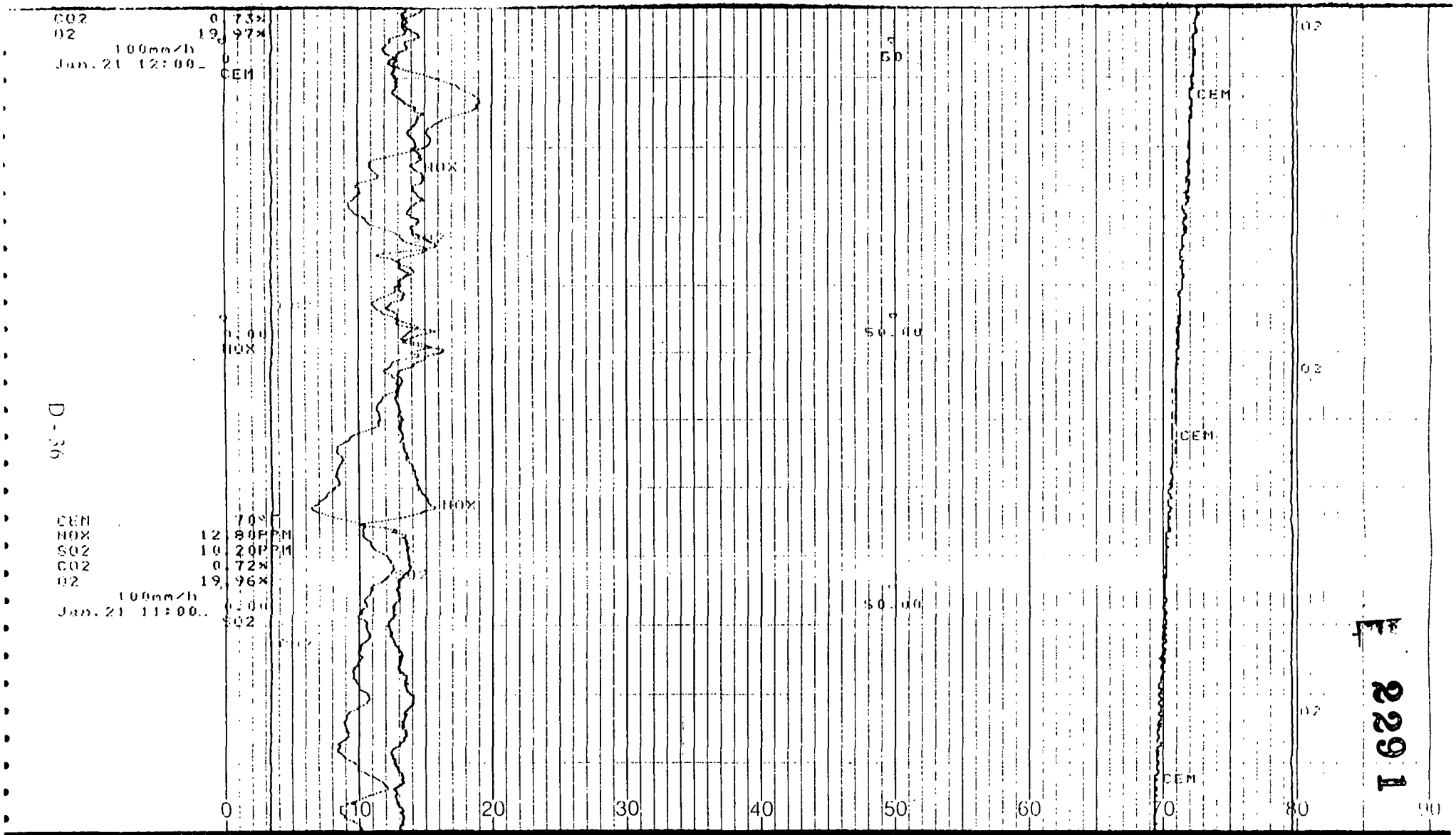
FIG 2


CEM
NOX 12.36PPM
SO2 18.91PPM
CO2 0.71%
O2 19.96%
100mm/h
Jan.21 10:00
CEM
NOX 12029PPM
SO2
NOX
SO2
CEM
O2
CEM
O2
12.50
50
10
20
30
40
50
60
70
80
90

D-35

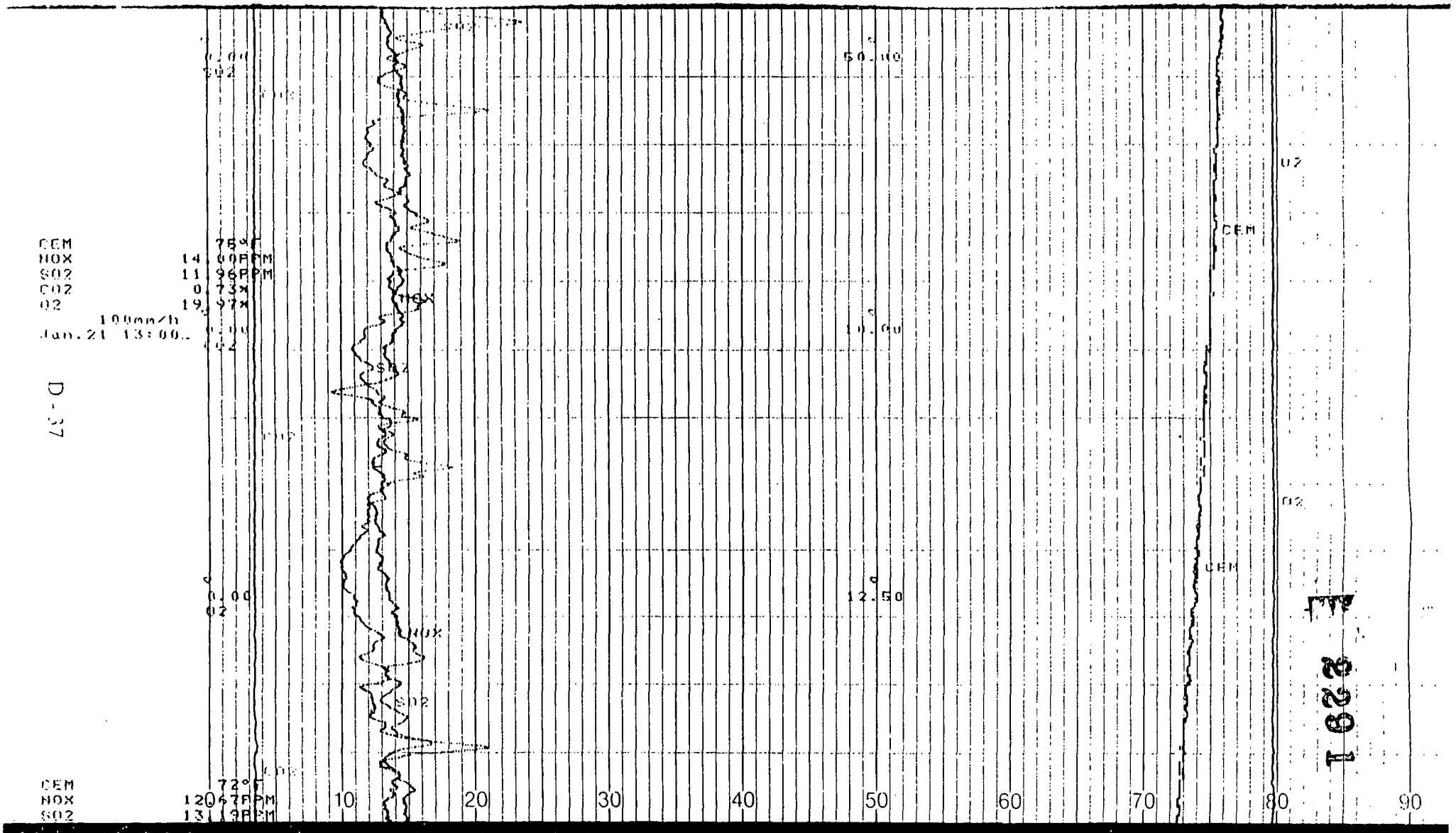
2291

48


CO2 0.73%
O2 19.97%
100mm/h
Jan.21 12:00
CEM
NOX
CEM 70%
NOX 12.80PPM
SO2 10.20PPM
CO2 0.72%
O2 19.96%
100mm/h
Jan.21 11:00
SO2
0
10
20
30
40
50
60
70
80
90

D-36

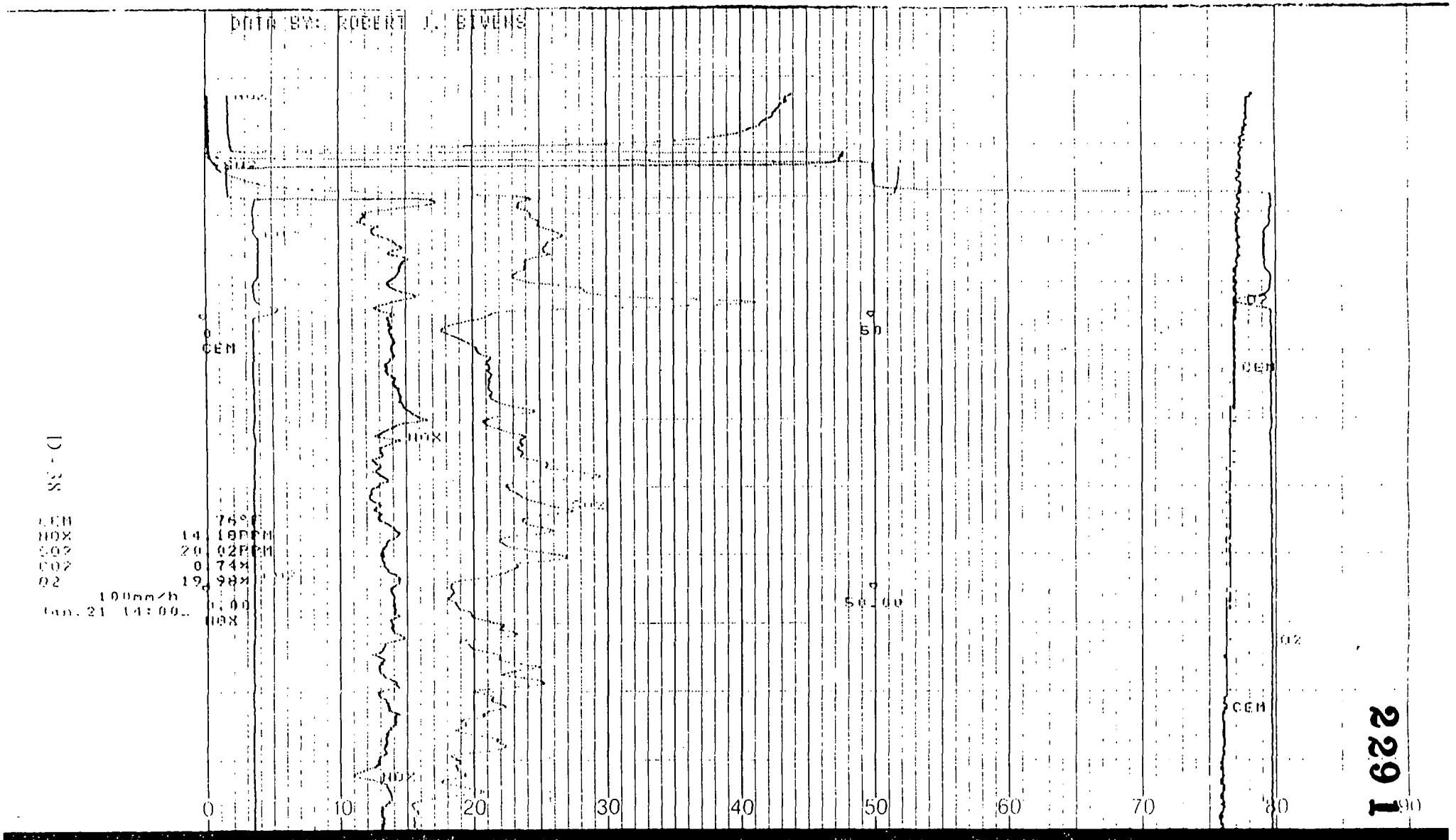
229 1


CEM
NOX 14.00PPM
SO2 11.96PPM
CO2 0.73%
O2 19.97%
100mm/h
Jan.21 13:00
CEM
NOX 120.67PPM
SO2 13.19PPM
50.00
10.00
12.50
10
20
30
40
50
60
70
80
90
O2
CEM
NOX
SO2
CO2

D-37

838

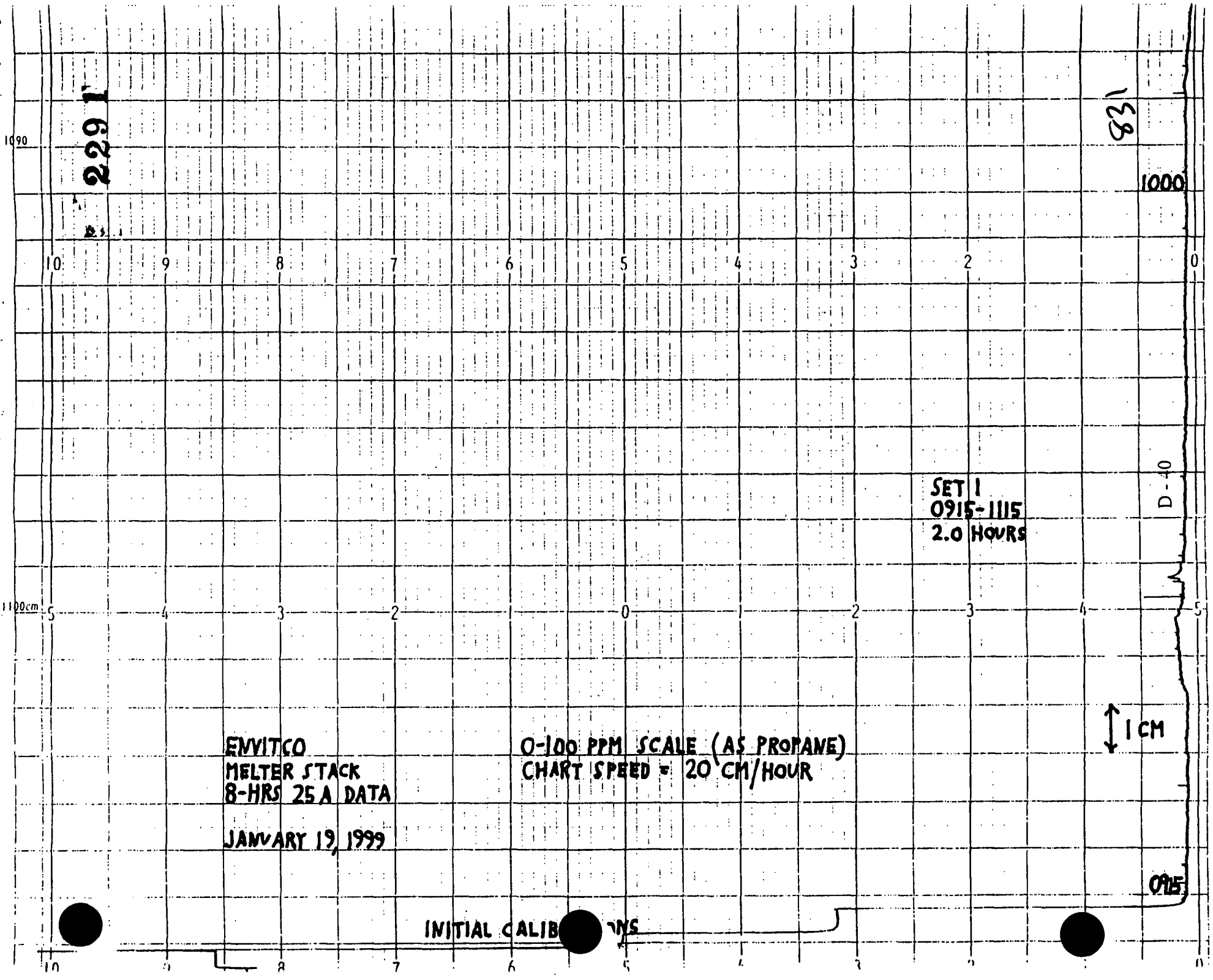
1823

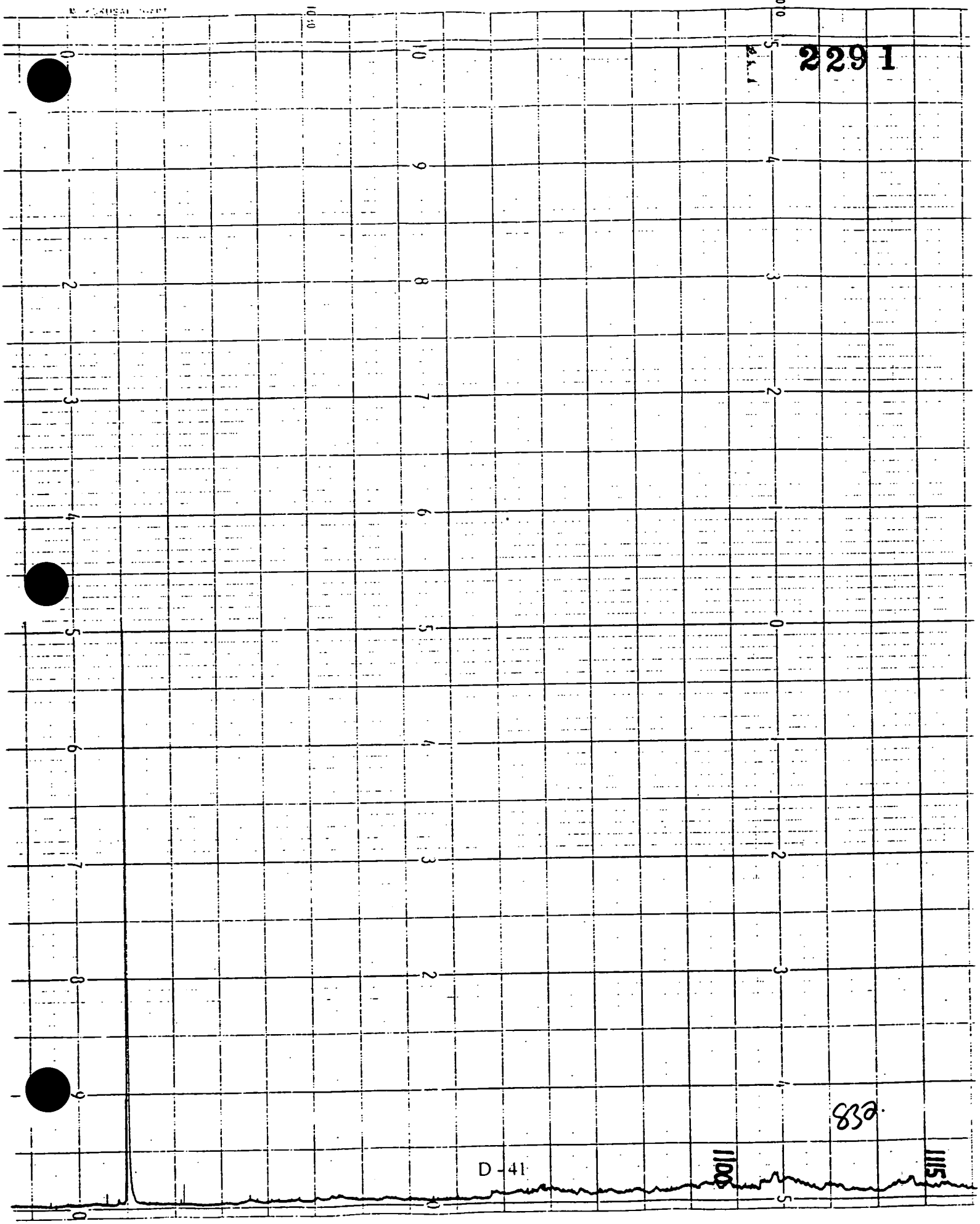

DATA BY: ROBERT J. BIVENS
CEM
76°F
NOX
14.18PPM
SO2
20.02PPM
CO2
0.74%
O2
19.98%
100mm/h
Jan.21 14:00
NOX
SO2
CEM
NOX
50
50.00
NOX
CO2
CEM
O2
CEM
0
10
20
30
40
50
60
70
80
90

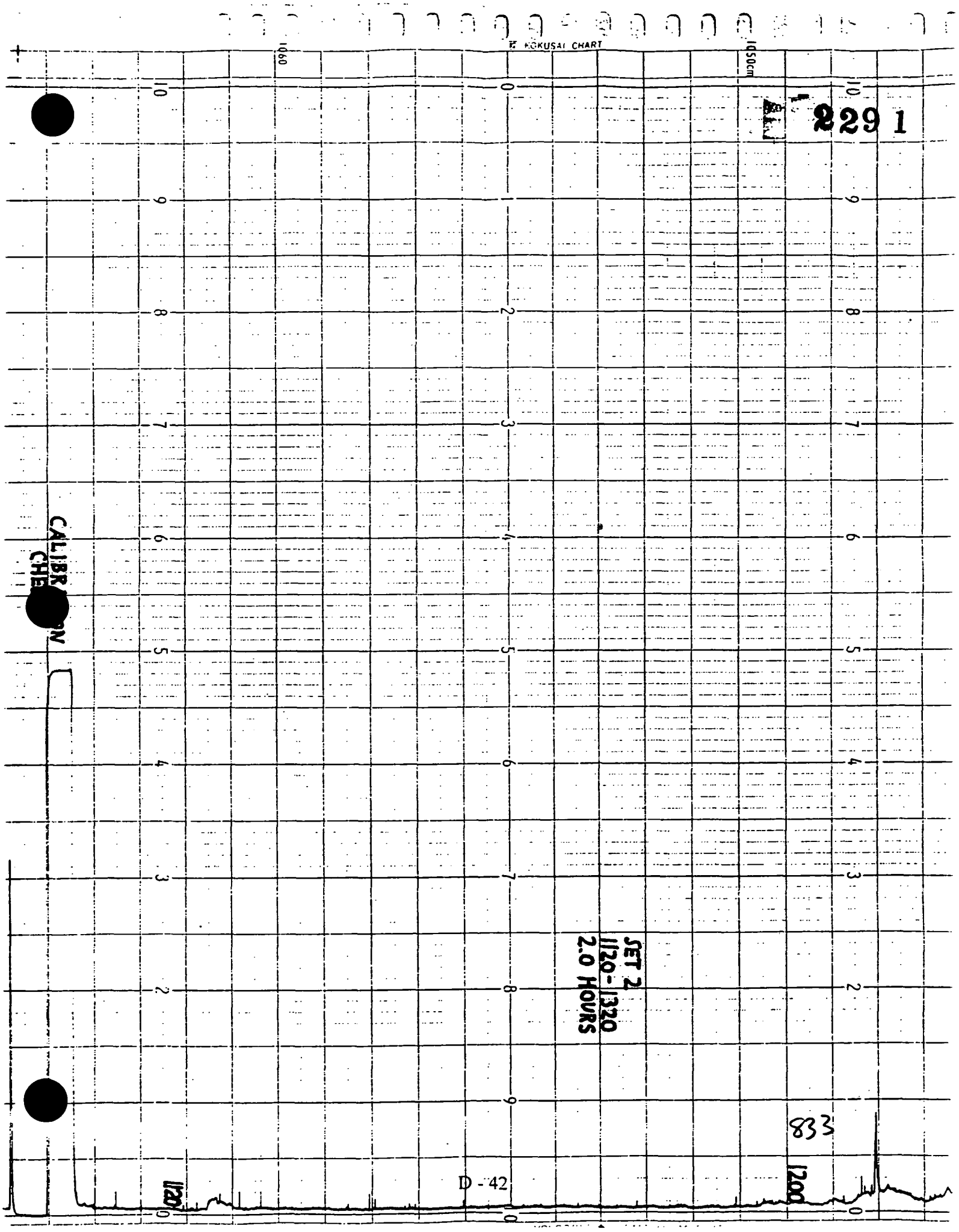
229 1

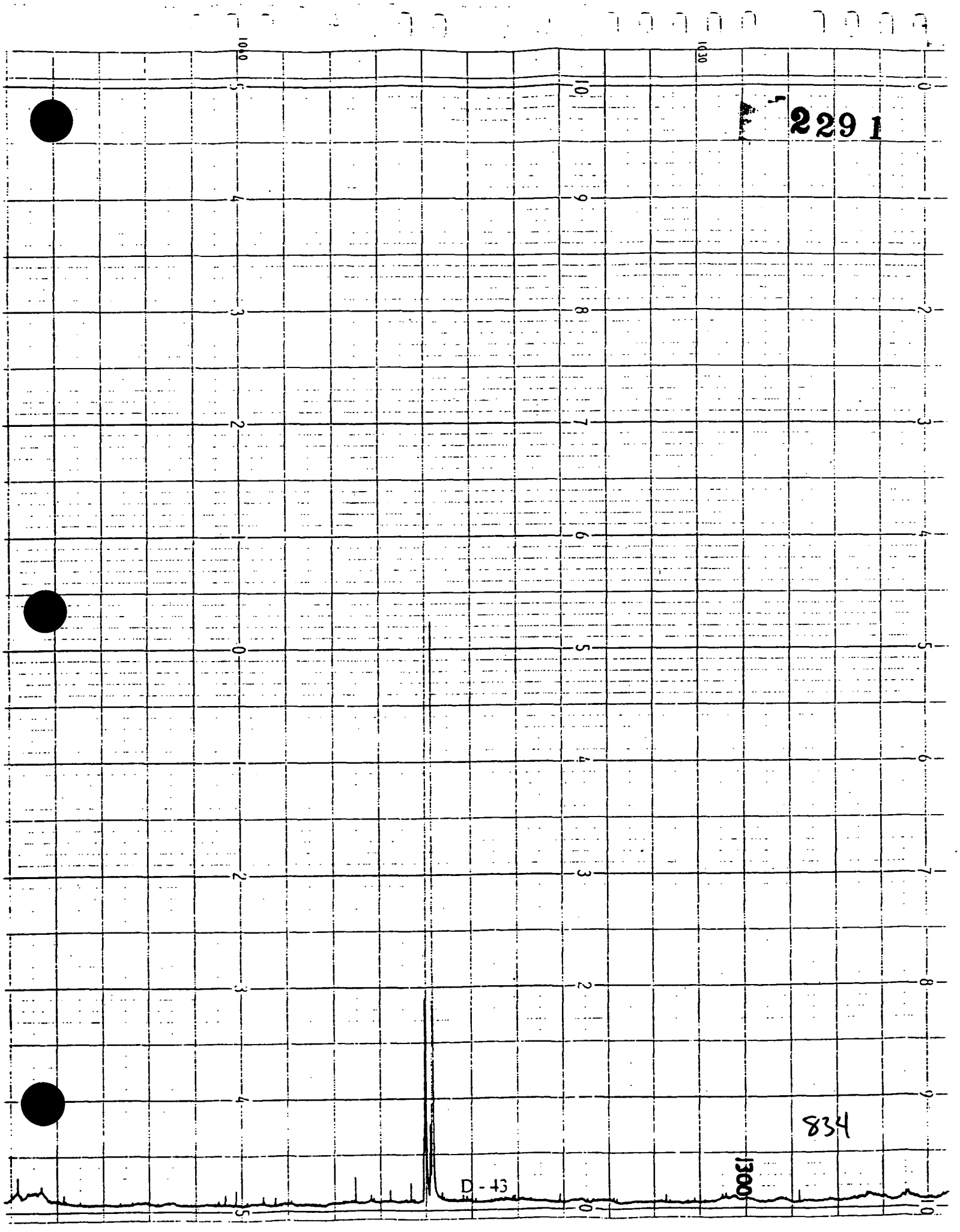
D-38

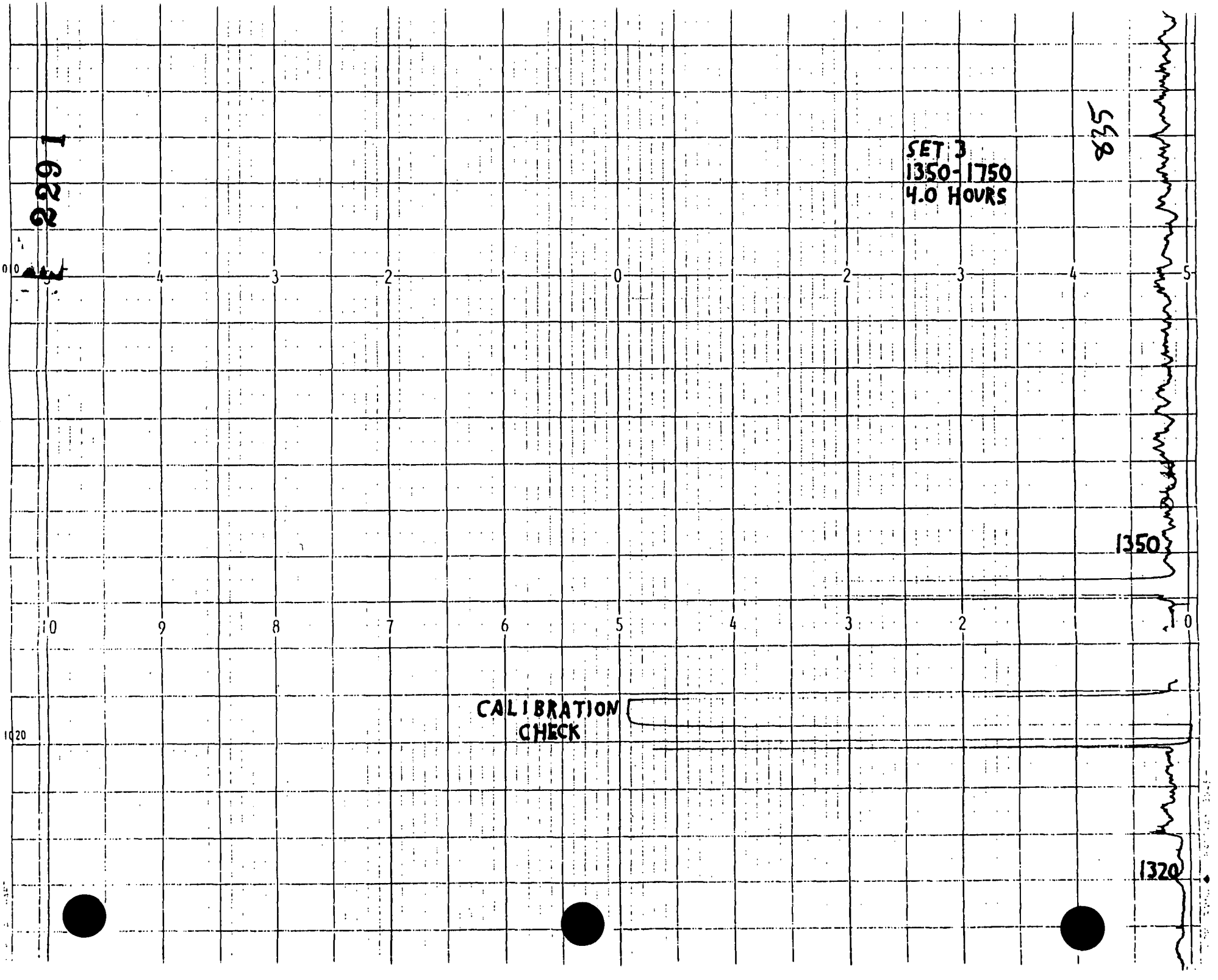
2291
0
10
20
30
40
50
60
70
80
90
ENVITOX
CLEMSON SOUTH CAROLINA
ESP STACK

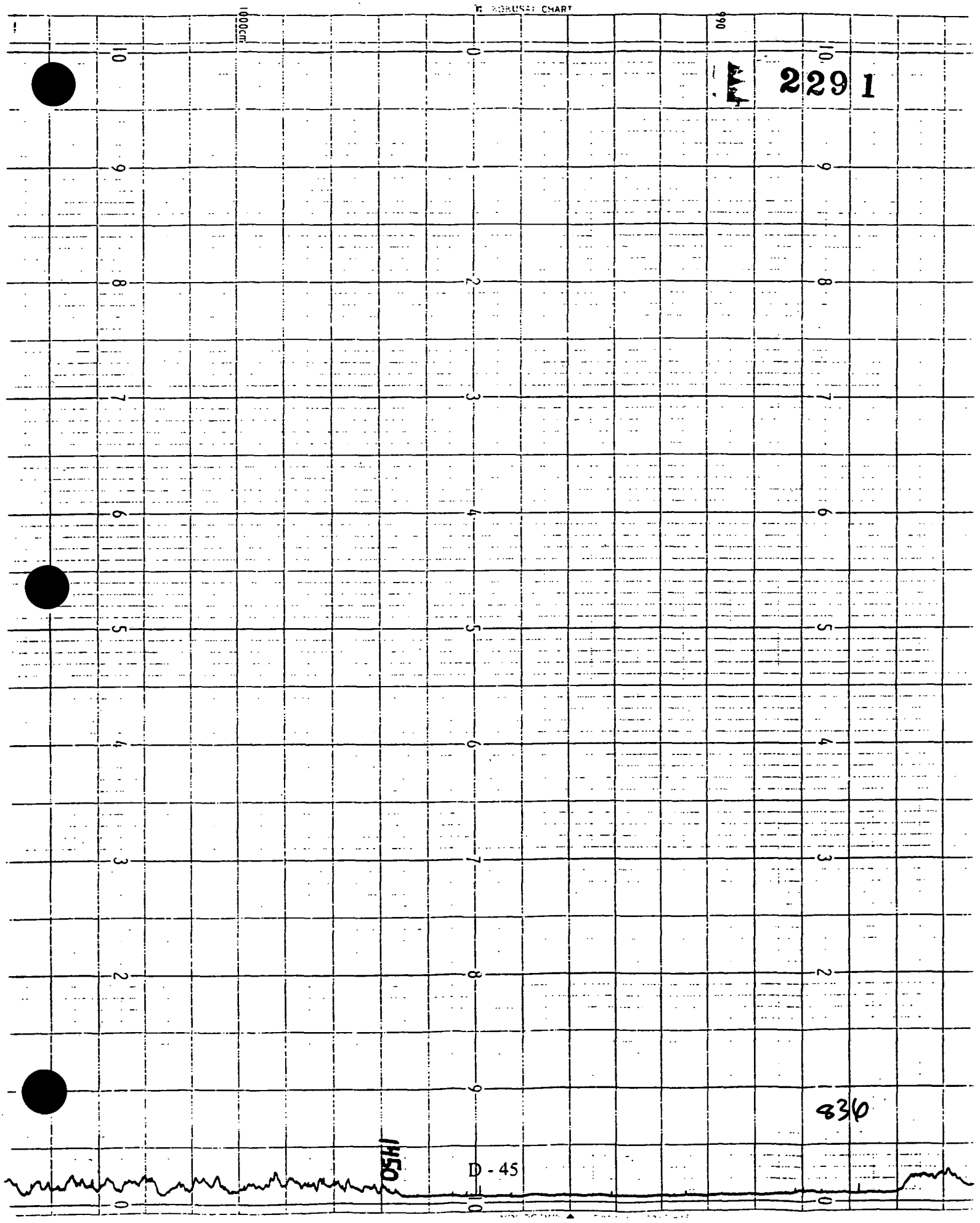

229 1
1090
1100cm
1000
0915
SET 1
0915-1115
2.0 HOURS
D-40
1 CM
ENVITCO
MELTER STACK
8-HRS 25A DATA
JANUARY 19, 1999
0-100 PPM SCALE (AS PROPANE)
CHART SPEED = 20 CM/HOUR
INITIAL CALIB

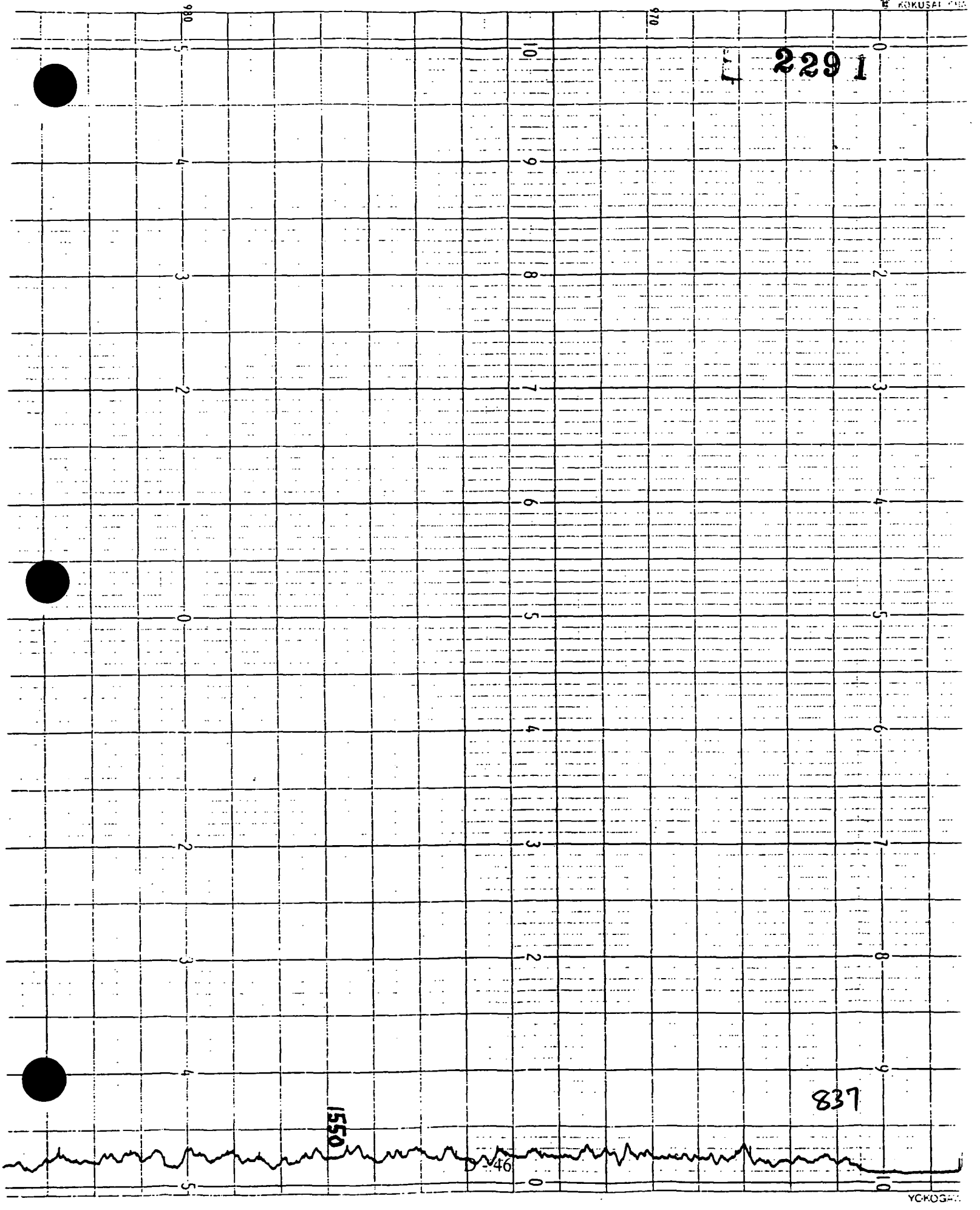

2291
832
1108
1115


KOKUSAI CHART
1060
1050cm
2291
CALIBR
CHE
SET 2
1120-1320
2.0 HOURS
833
1200
1200


2291
834
1300
D - 43


SET 3
1350-1750
4.0 HOURS
CALIBRATION
CHECK
1350
1320
1010
1020
10
9
8
7
6
5
4
3
2
0
4
3
2
0
2
3
4
5

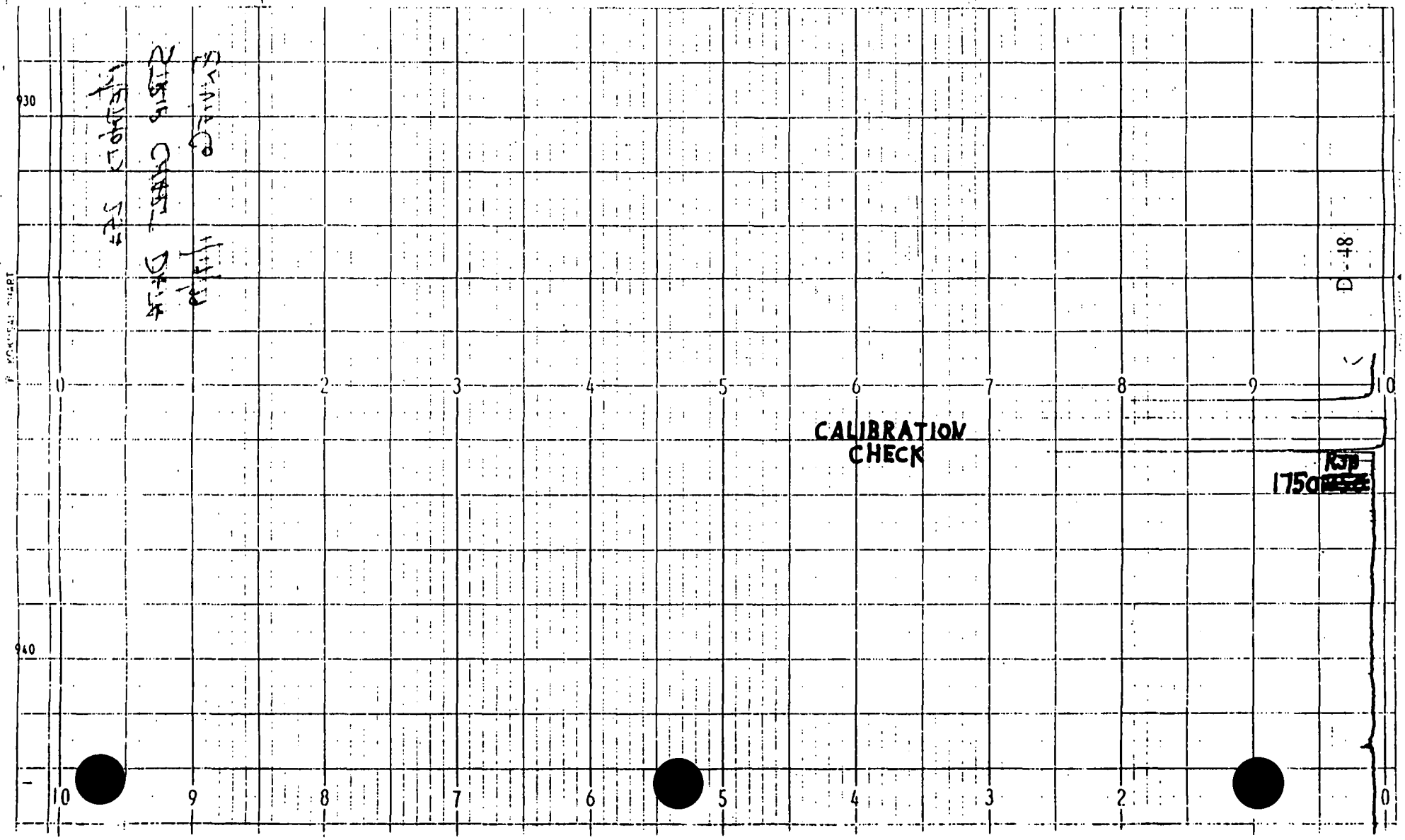

2291
836
1450


KOKUSAI
980
970
2291
837
1550
YOKOGA

229

838

1650



229 1

838