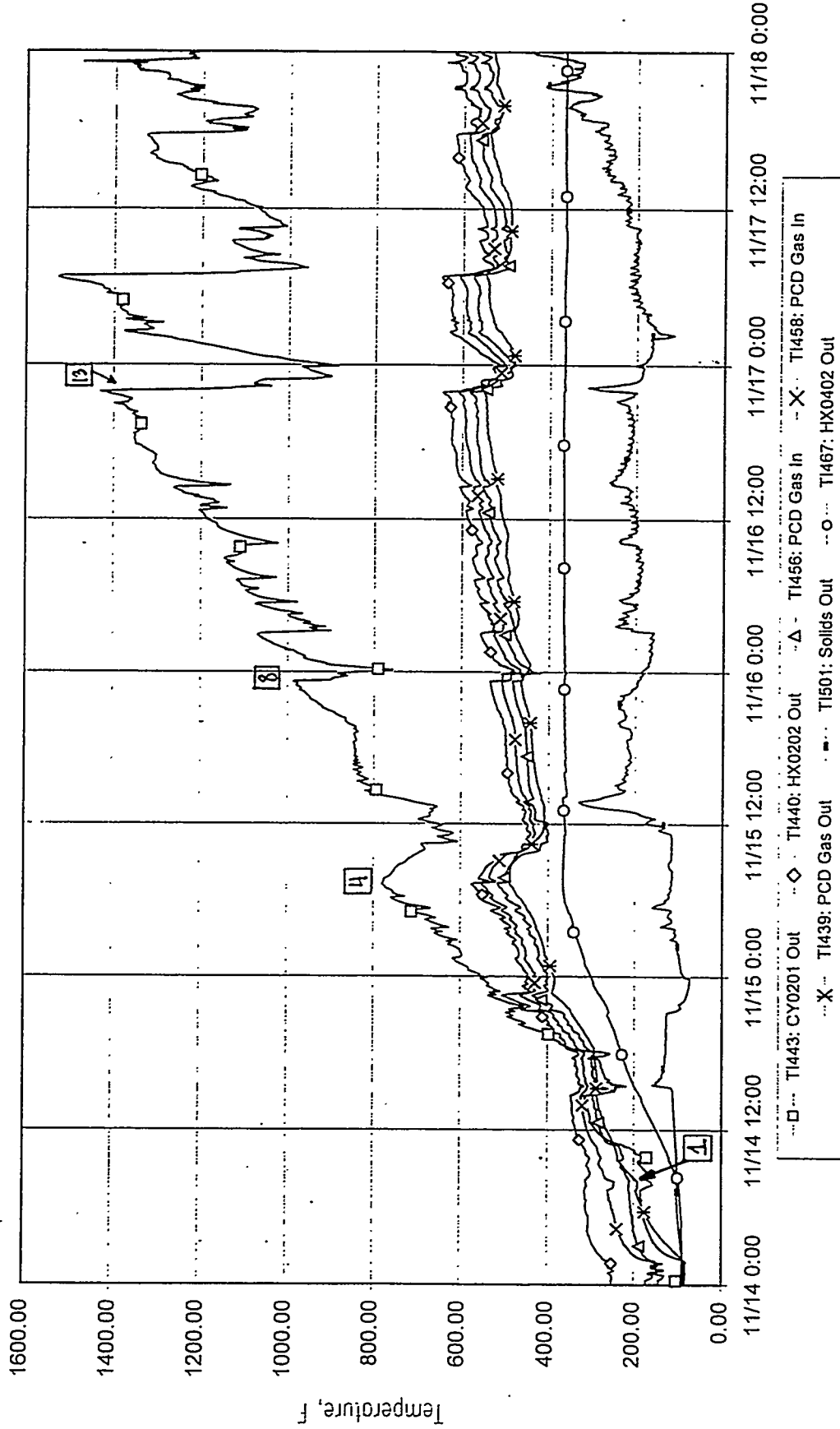


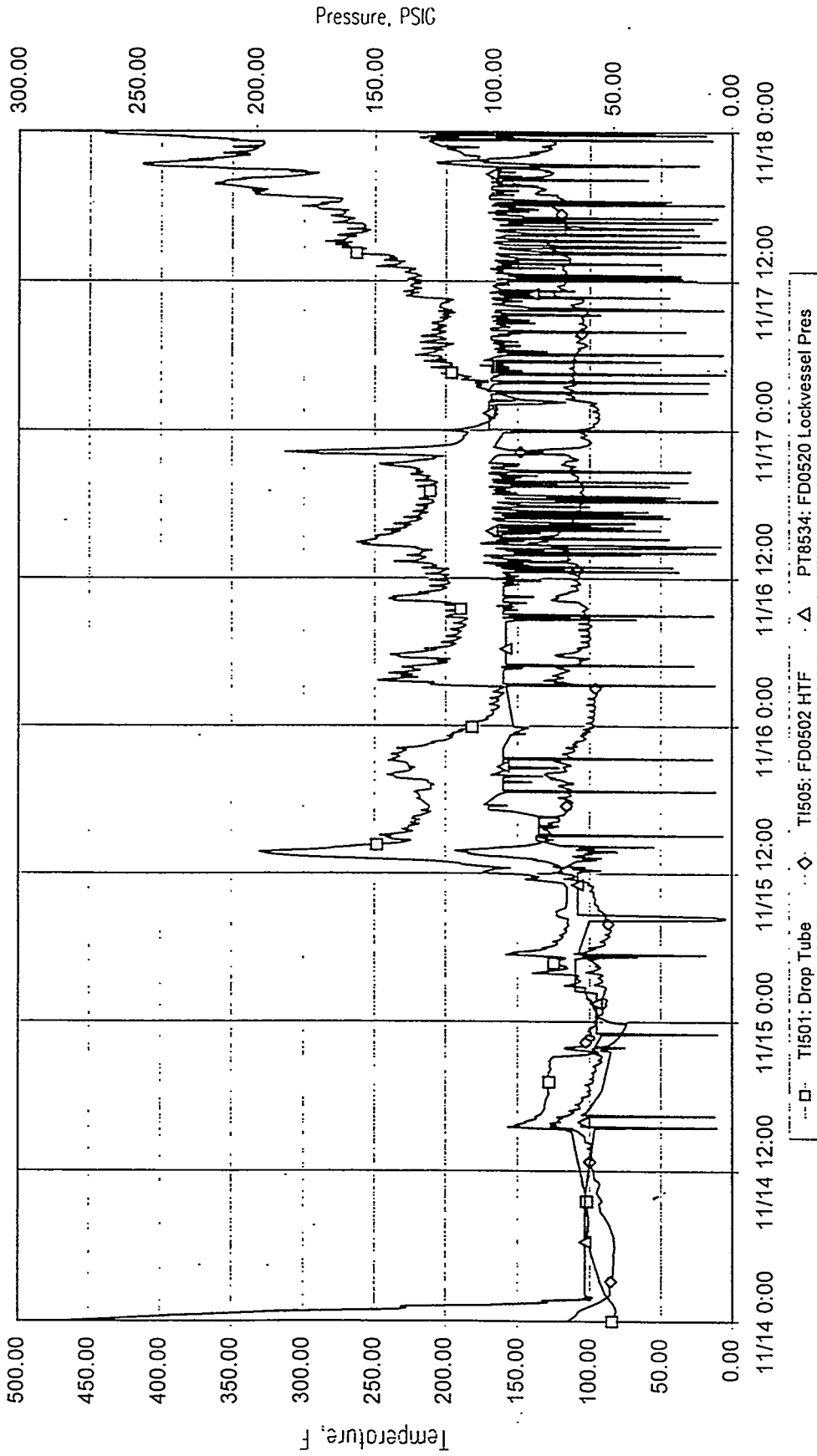
DOE Plot 16 of 45 - 5 minute data

5.1.10-10 Cyclone Dipleg Temperatures for November 14 Through November 17, 1996



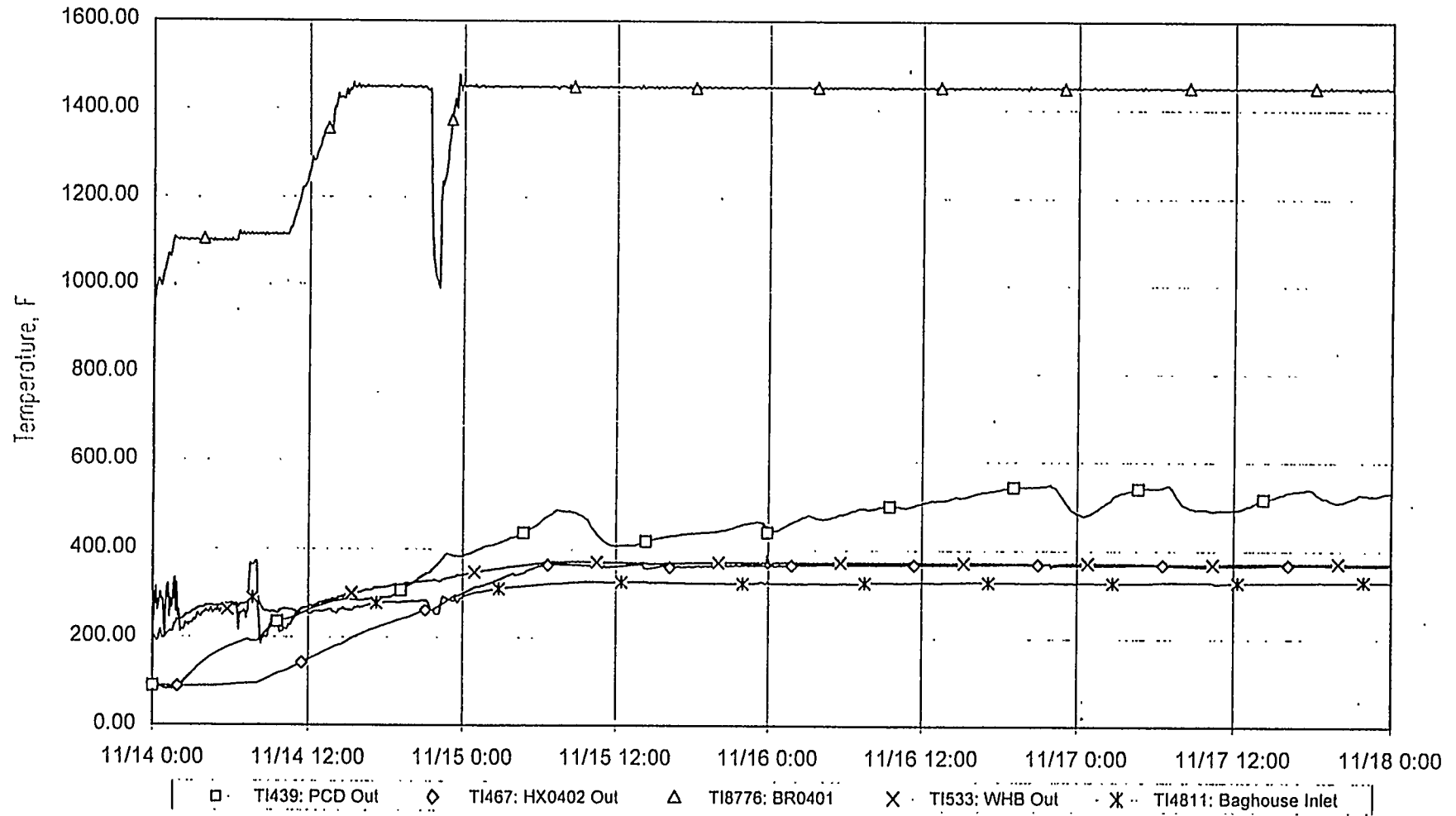
DOE Plot 17 of 45 - 5 minute data

5.1.10-11 Temperature Profiles Downstream of Reactor for November 14 Through November 17, 1996



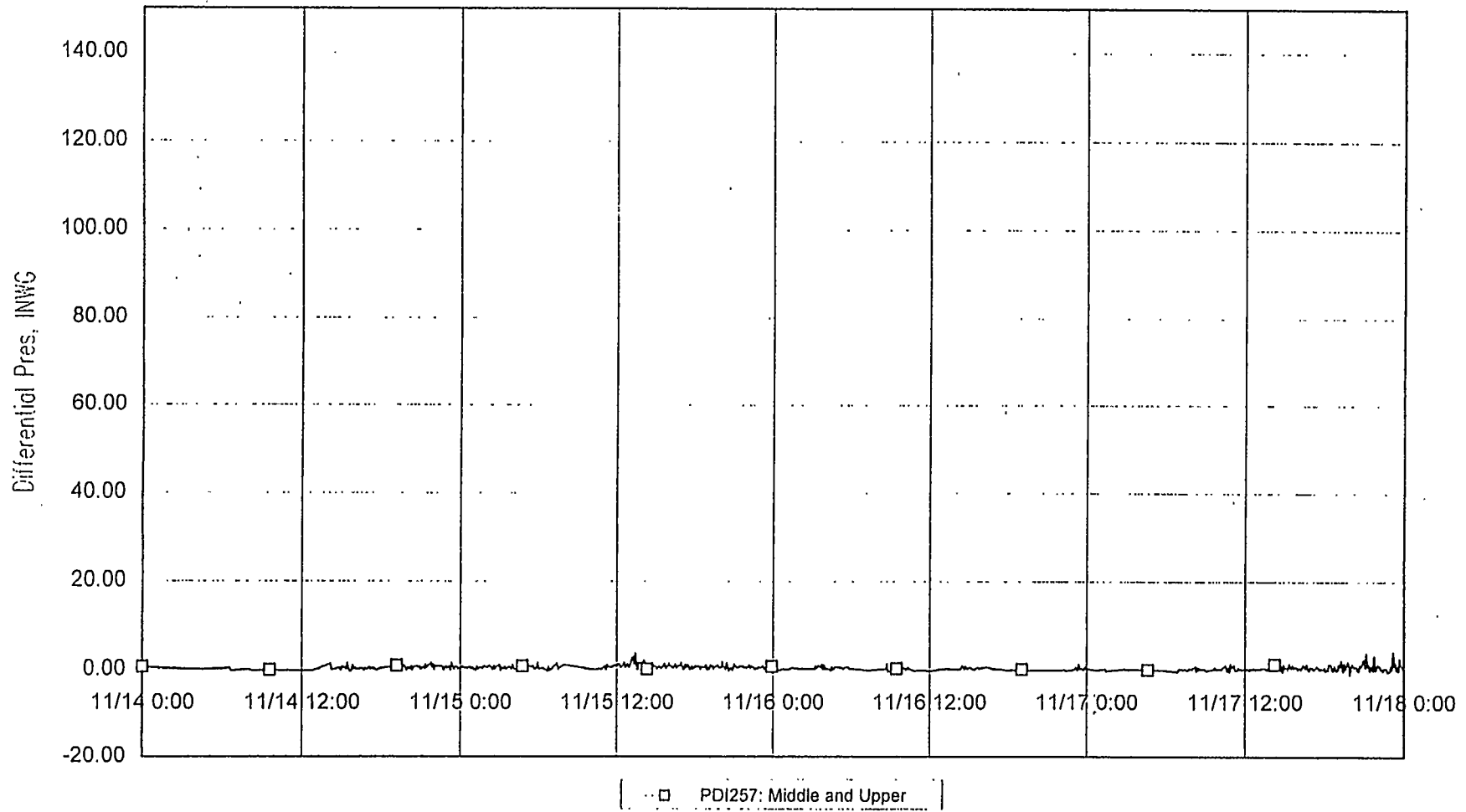
DOE Plot 18 of 45 - 5 minute data

5.1.10-12 PCD Ash Temperatures for November 14 Through November 17, 1996



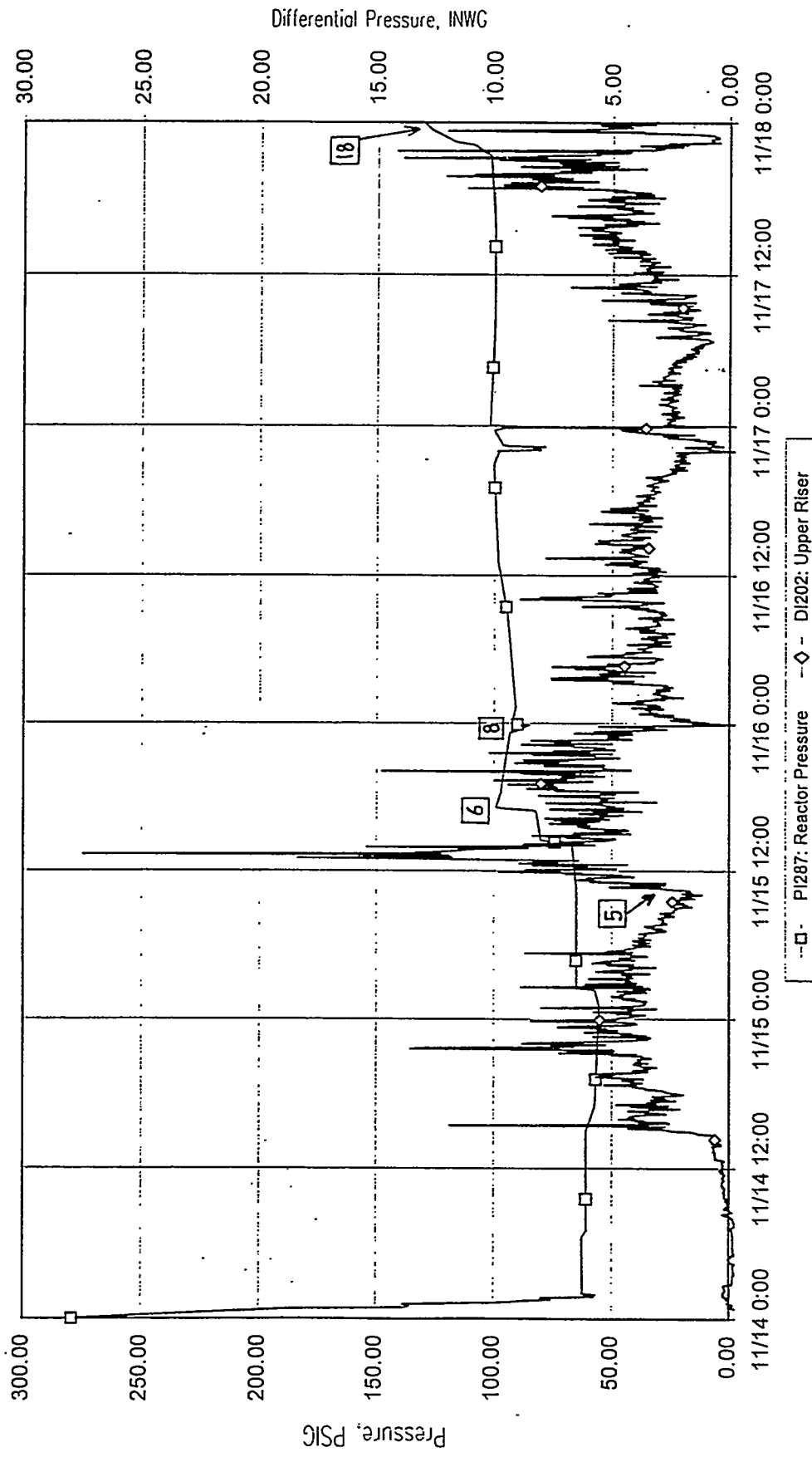
DOE Plot 19 of 45 - 5 minute data

5.1.10-13 System Temperatures Downstream of PCD for November 14 Through November 17, 1996



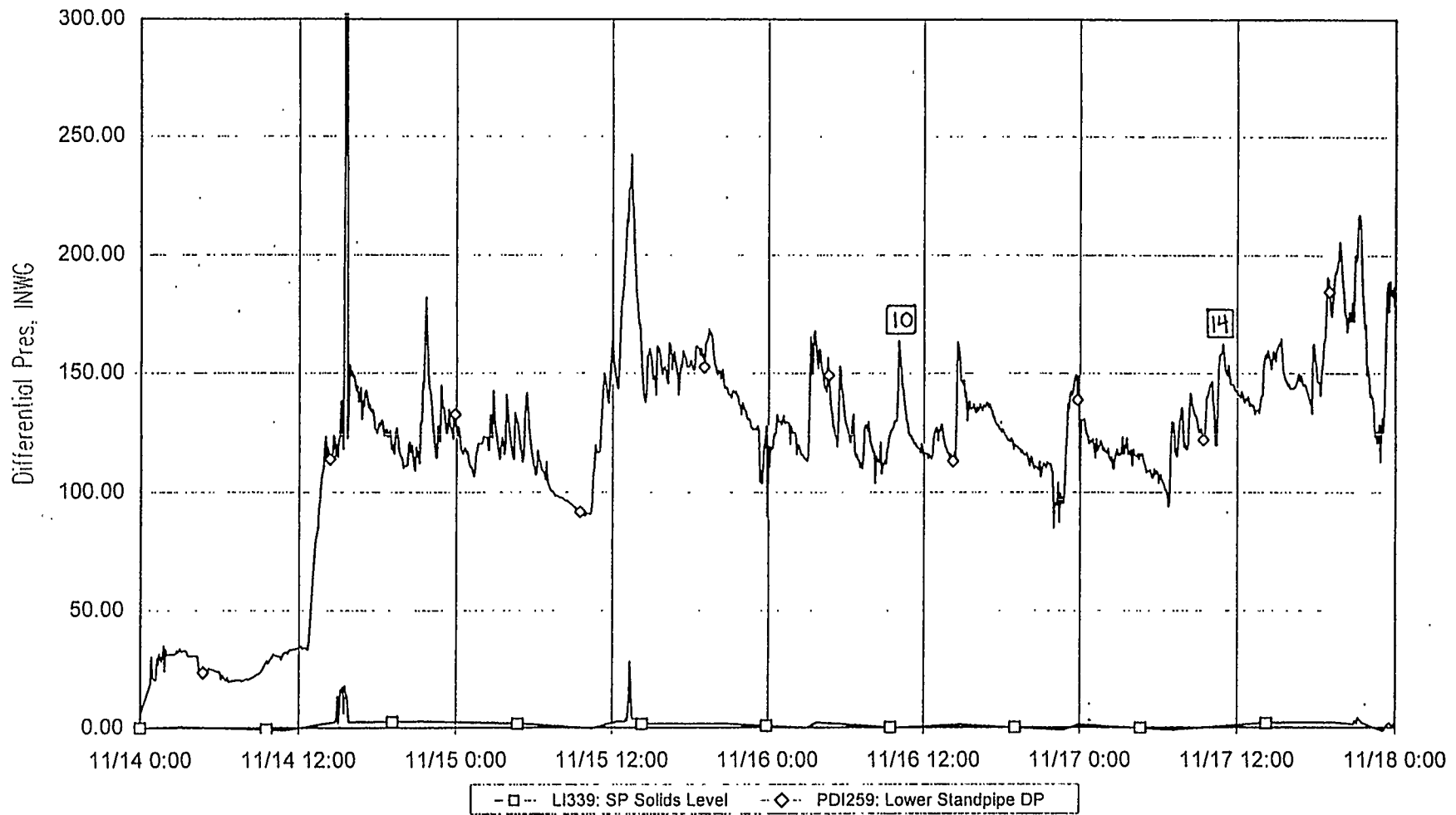
DOE Plot 20 of 45 - 5 minute data

5.1.10-14 Mixing Zone DP Profile for November 14 Through November 17, 1996



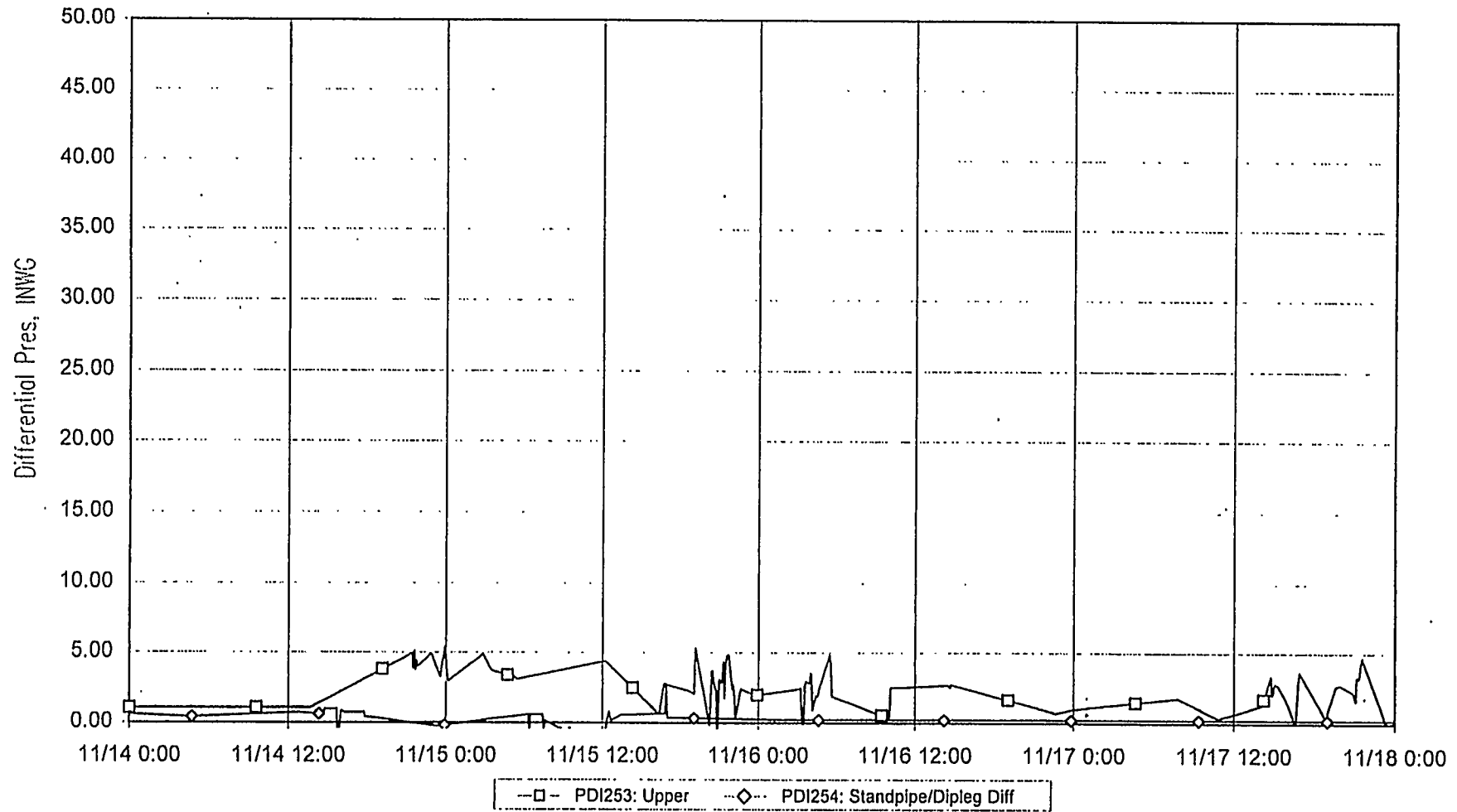
DOE Plot 21 of 45 - 5 minute data

5.1.10-15 Reactor Pressure/Riser DP Profiles for November 14 Through November 17, 1996



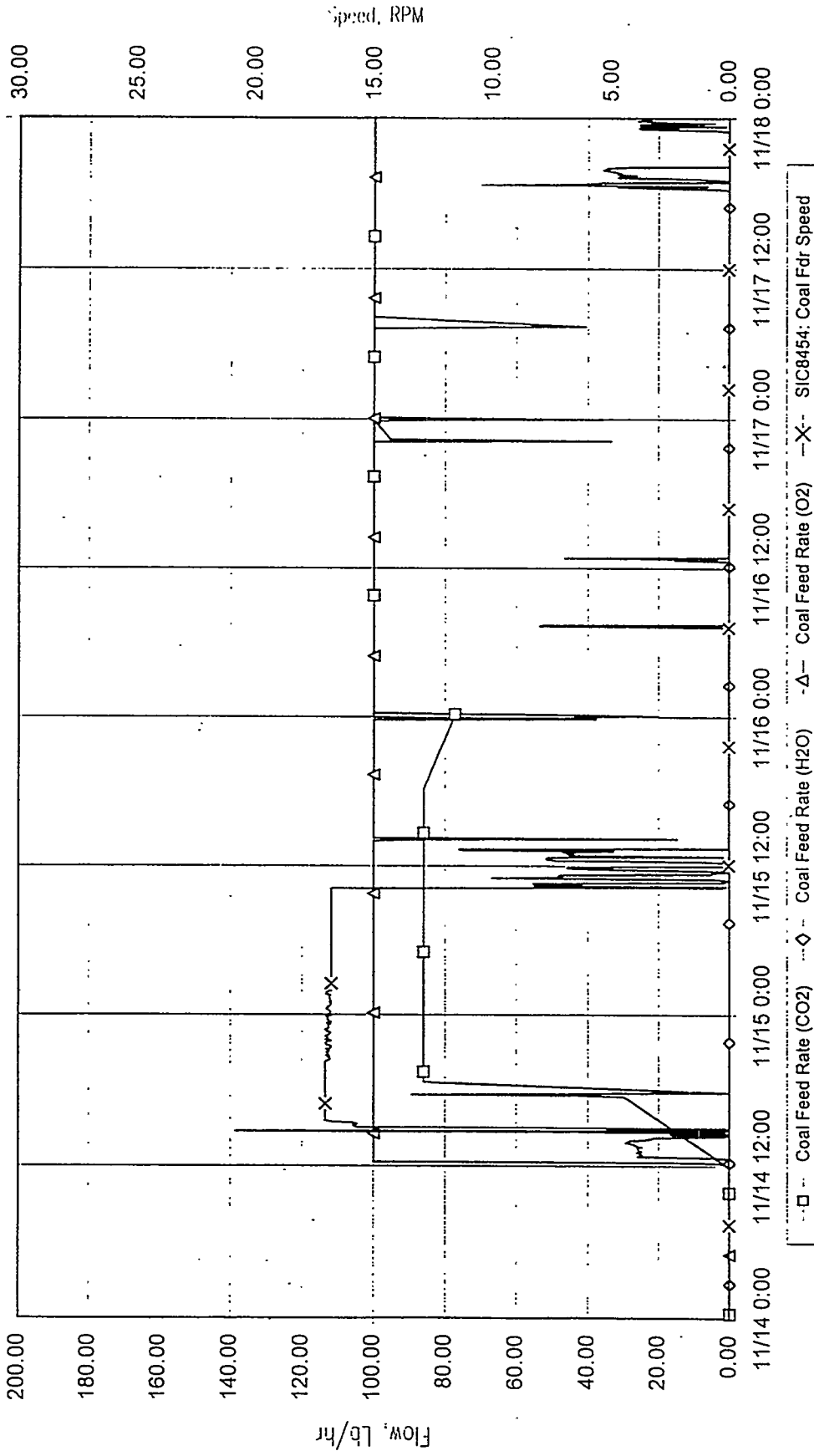
DOE Plot 22 of 45 - 5 minute data

5.1.10-16 Standpipe DP Profiles for November 14 Through November 17, 1996



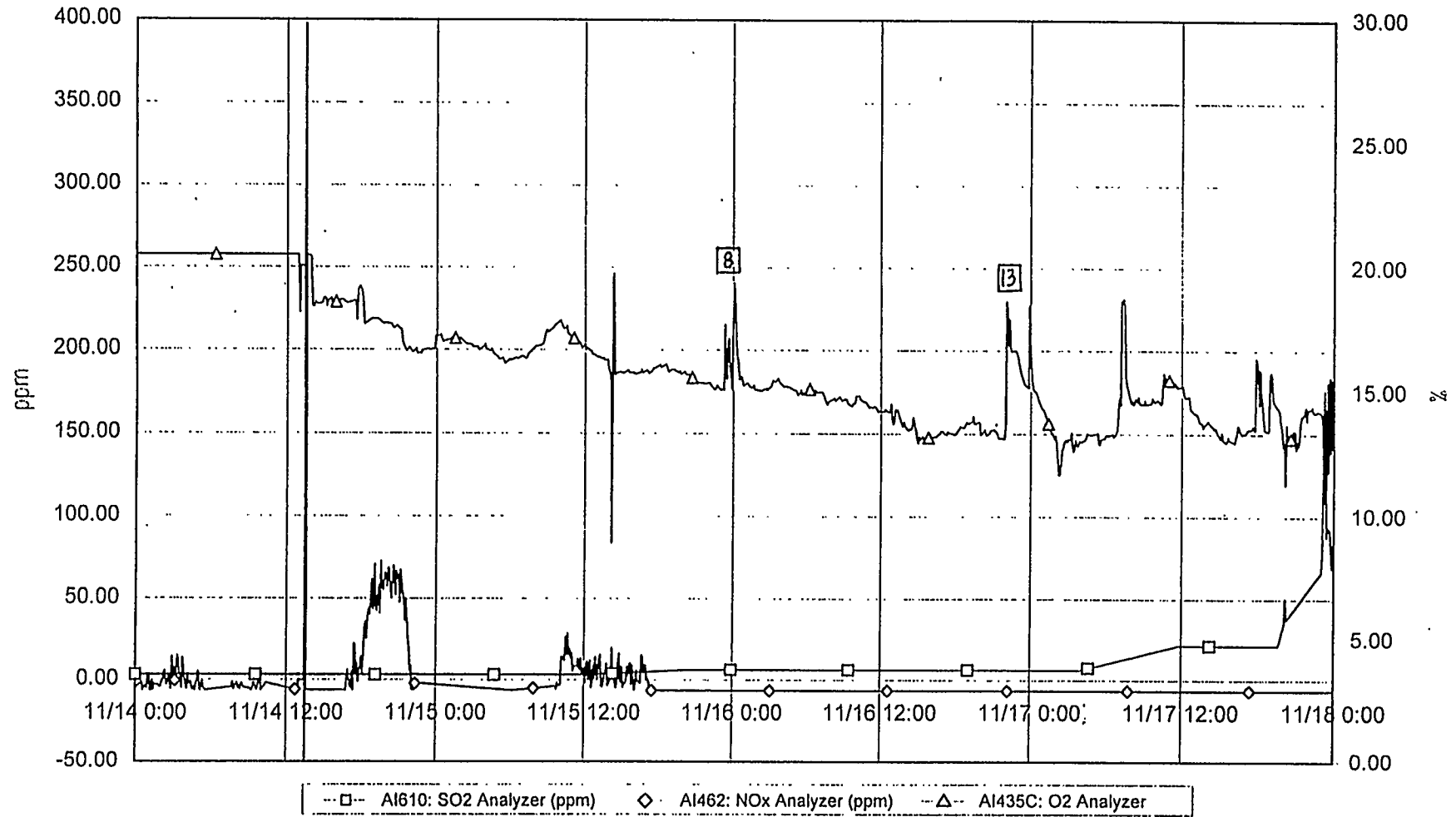
DOE Plot 23 of 45 - 5 minute data

5.1.10-17 CY0201 Dipleg DP Profiles for November 14 Through 17, 1996



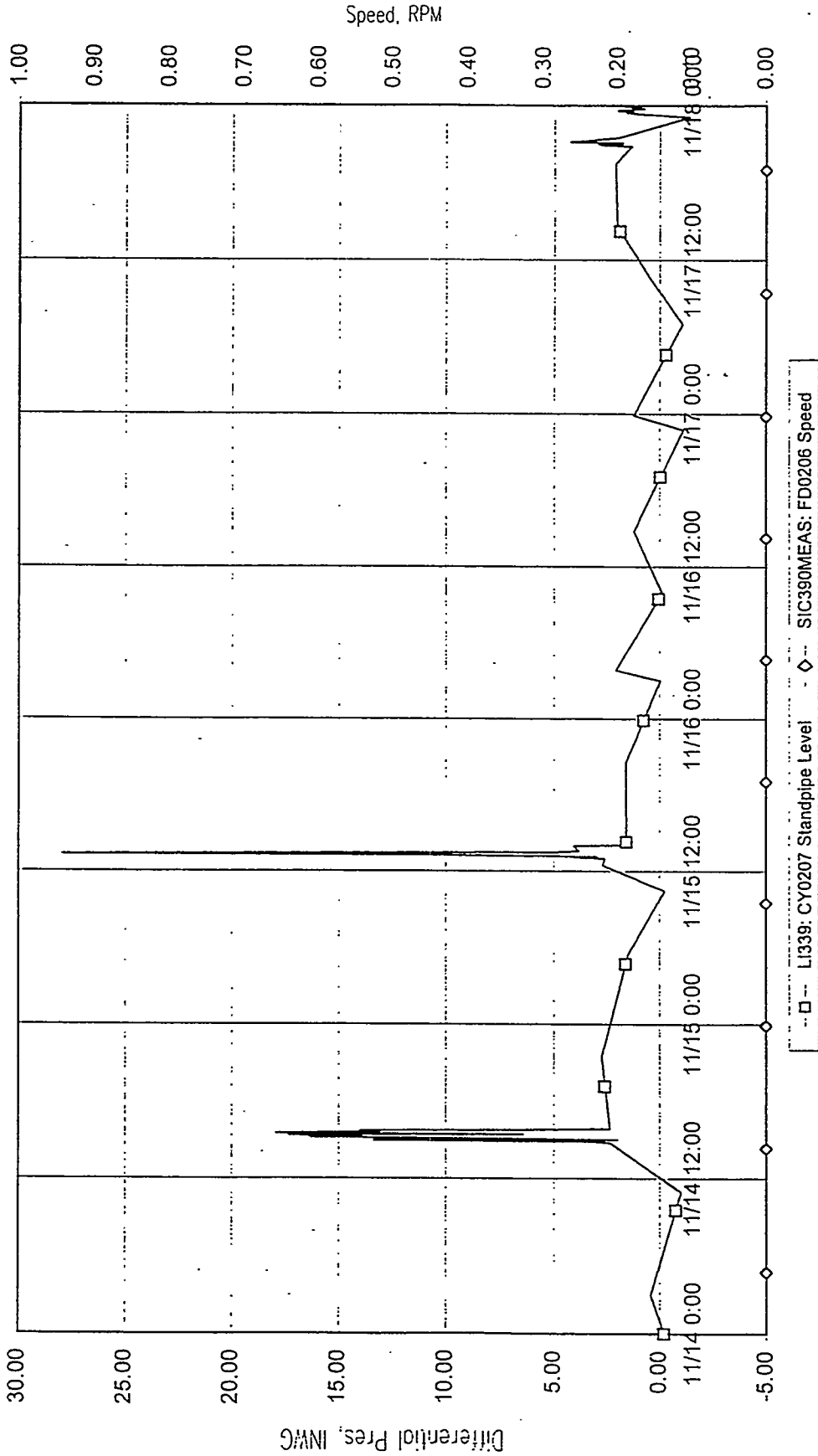
DOE Plot 24 of 45 - 5 minute data

5.1.10-18 Coal Feed Rate for November 14 Through November 17, 1996



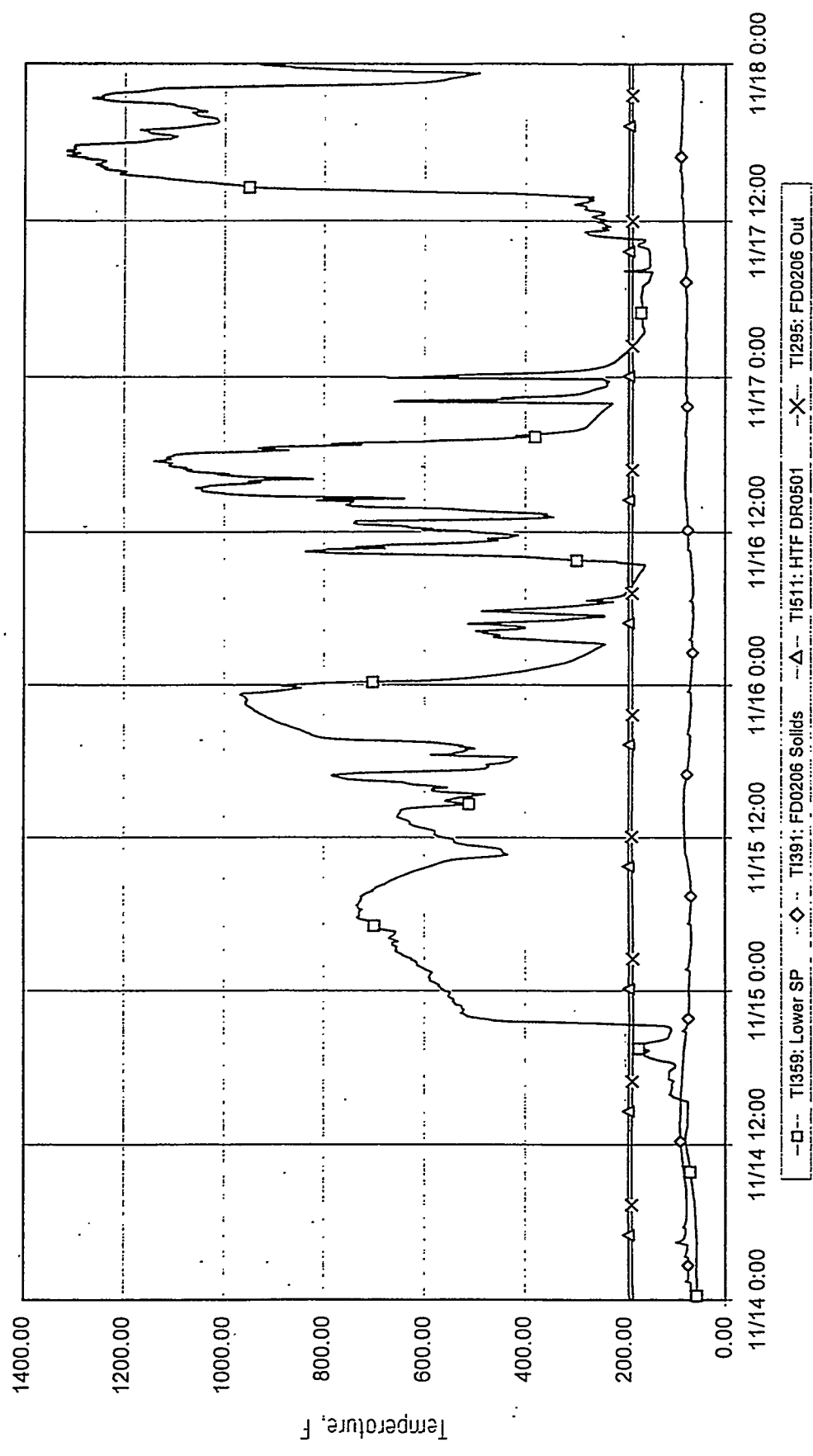
DOE Plot 25 of 45 - 5 minute data

5.1.10-19 O₂, SO₂, and NO_x Analyzers for November 14 Through November 17, 1996



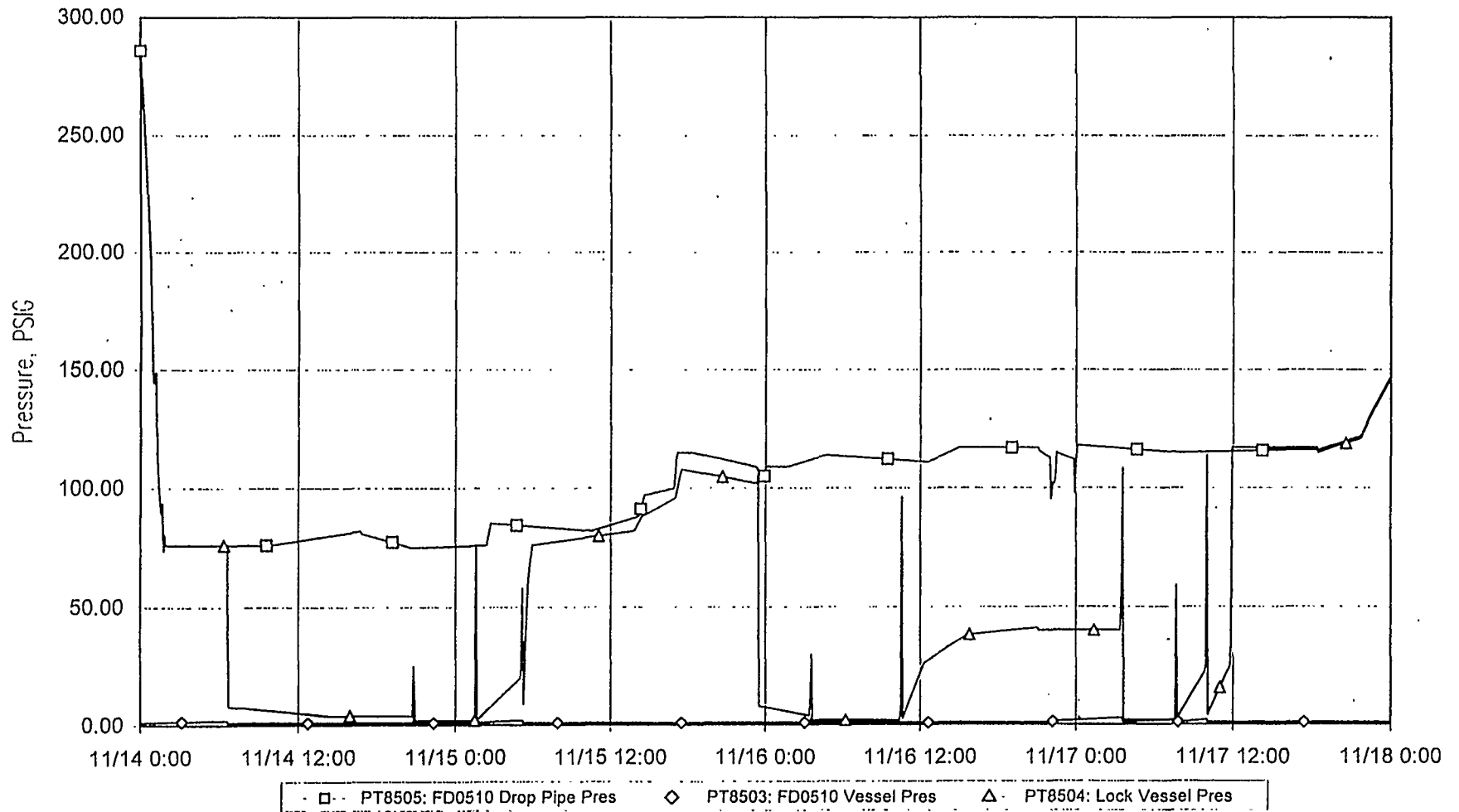
DOE Plot 29 of 45 - 5 minute data

5.1.10-20 Solids Withdrawal for November 14 Through November 17, 1996



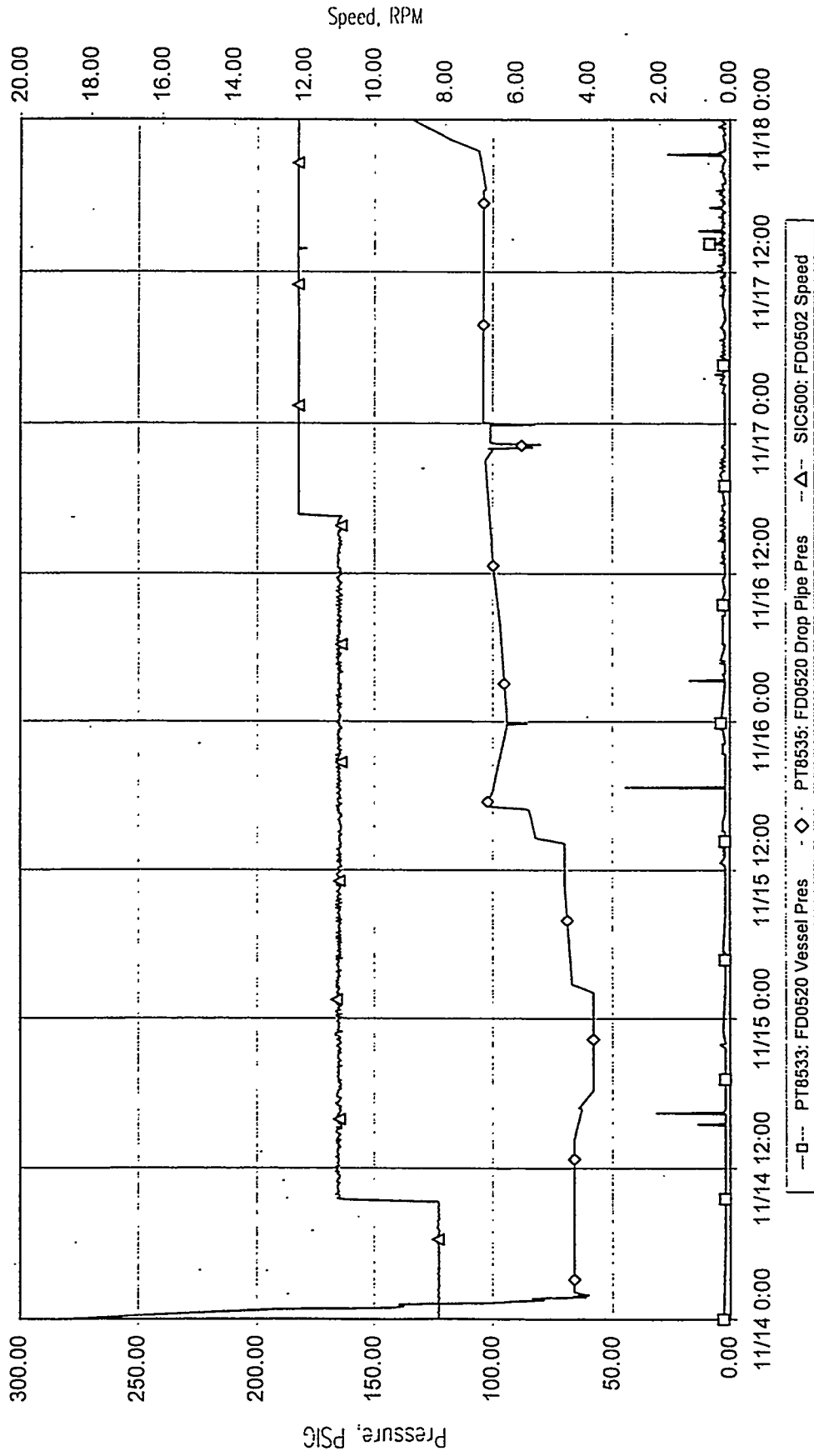
DOE Plot 30 of 45 - 5 minute data

5.1.10-21 FD0510 Temperature Profiles for November 14 Through November 17, 1996



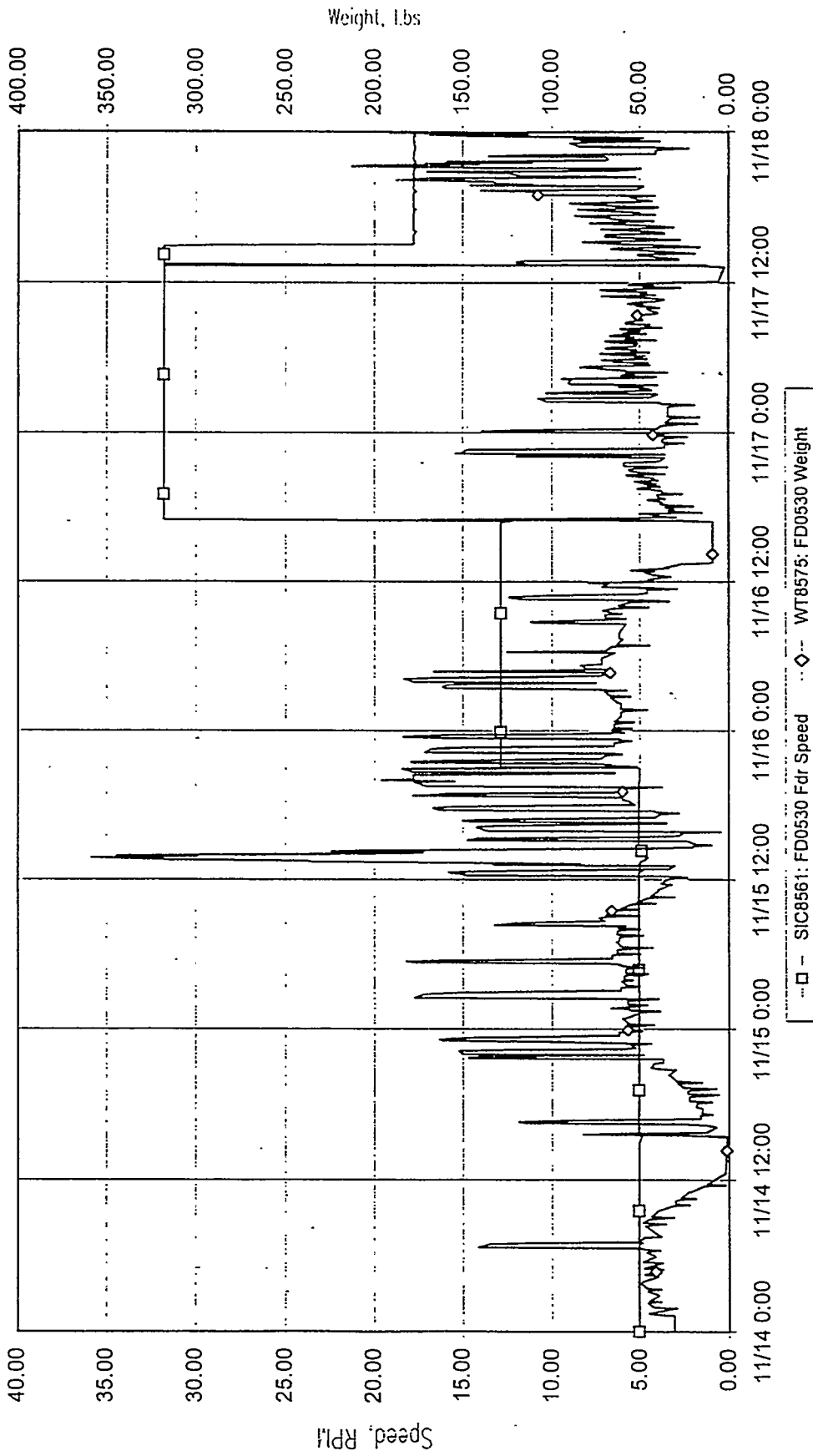
DOE Plot 31 of 45 - 5 minute data

5.1.10-22 FD0206 Pressure Profiles for November 14 Through November 17, 1996



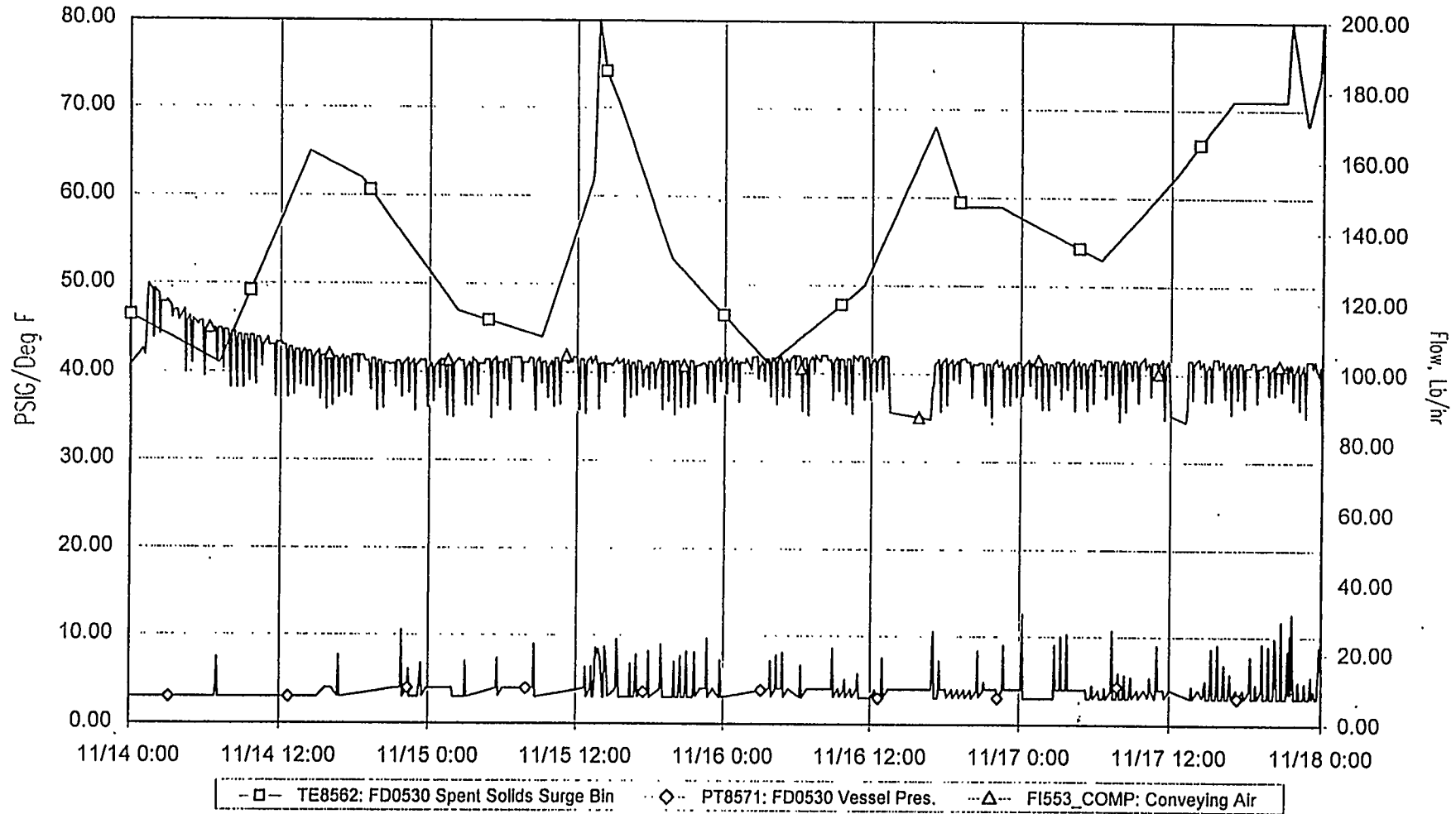
DOE Plot 32 of 45 - 5 minute data

5.1.10-23 FD0520 Pressures for November 14 Through November 17, 1996



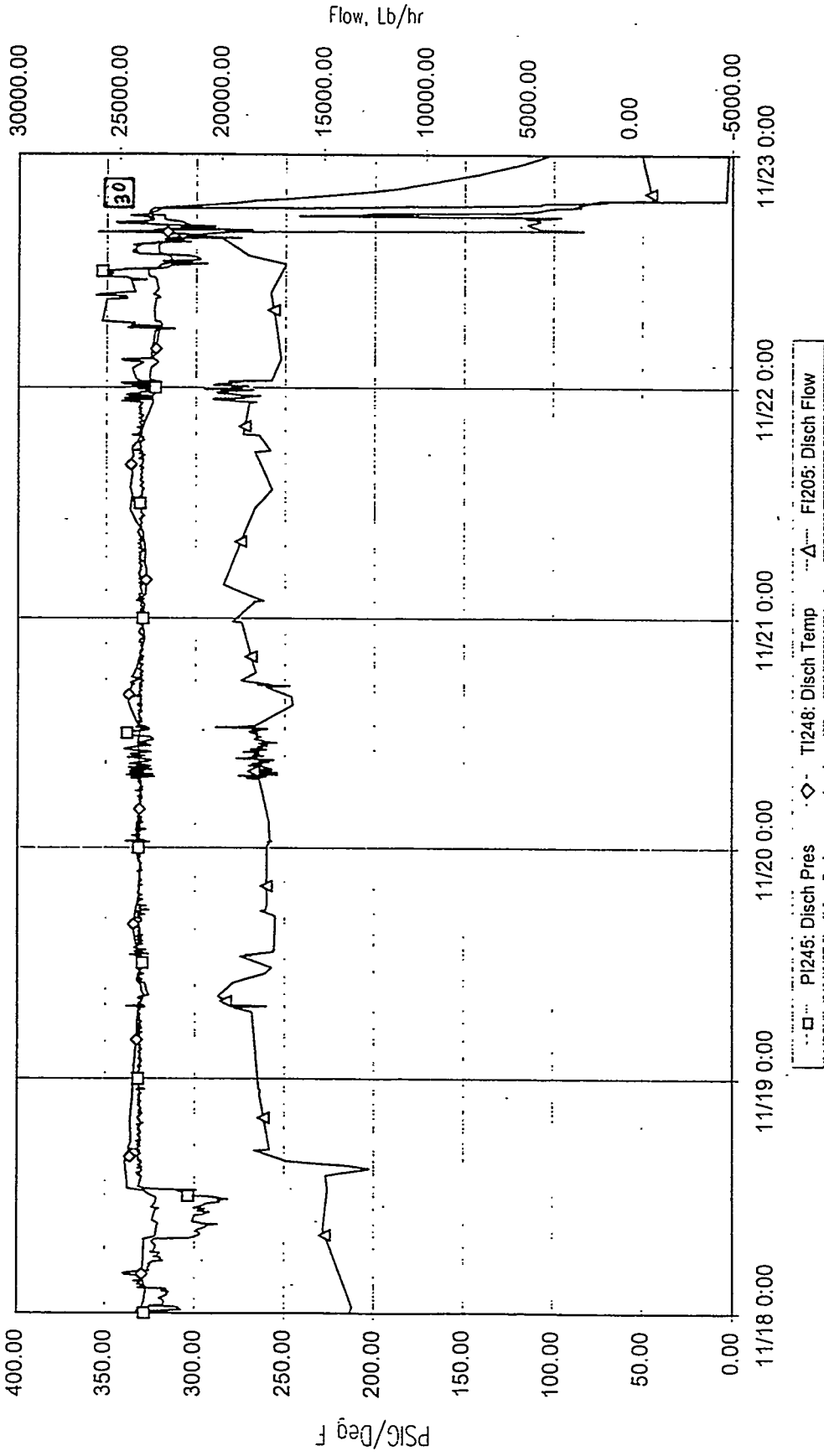
DOE Plot 33 of 45 - 5 minute data

5.1.10-24 FD0530 Feeder for November 14 Through November 17, 1996



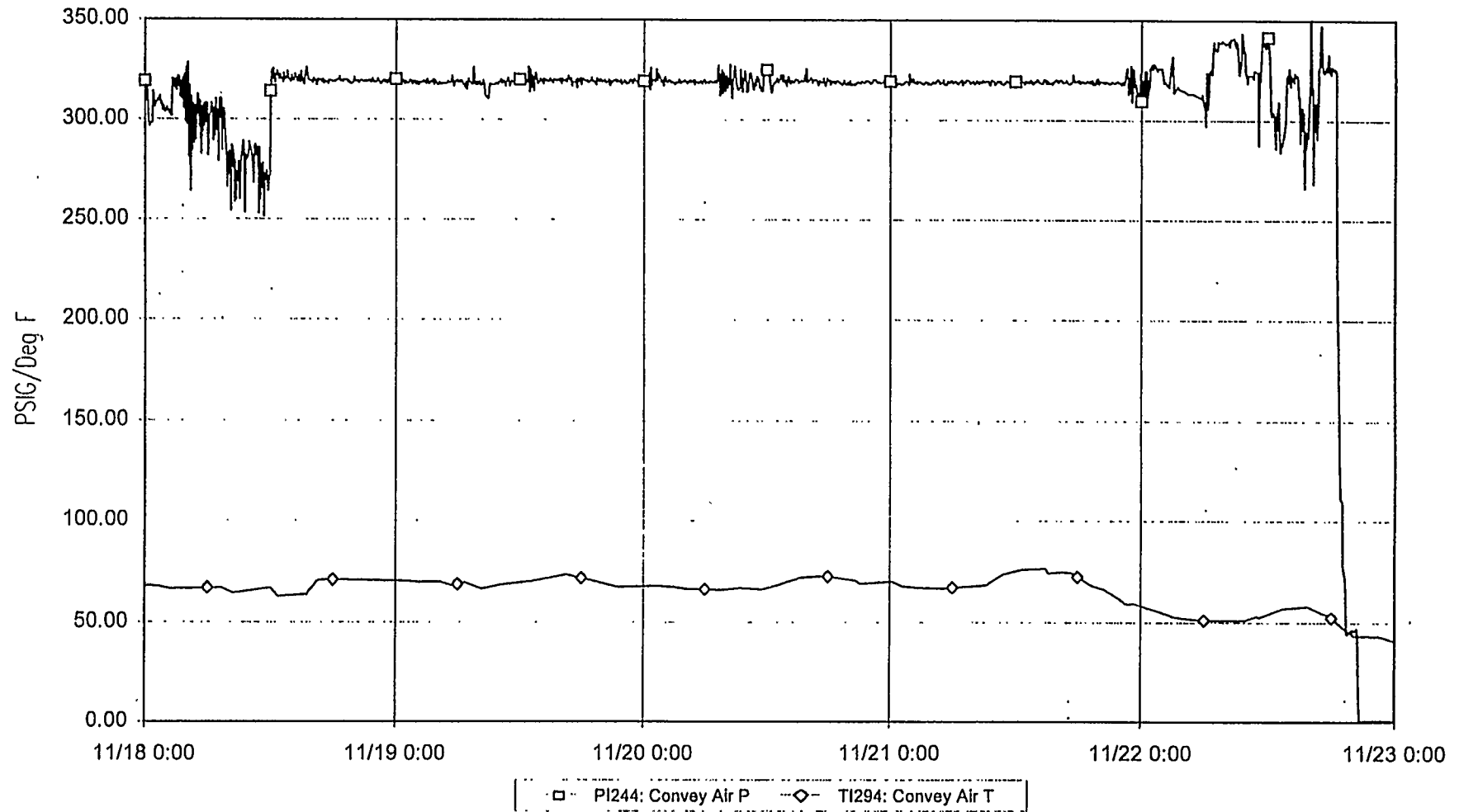
DOE Plot 34 of 45 - 5 minute data

5.1.10-25 FD0530 Feeder for November 14 Through November 17, 1996



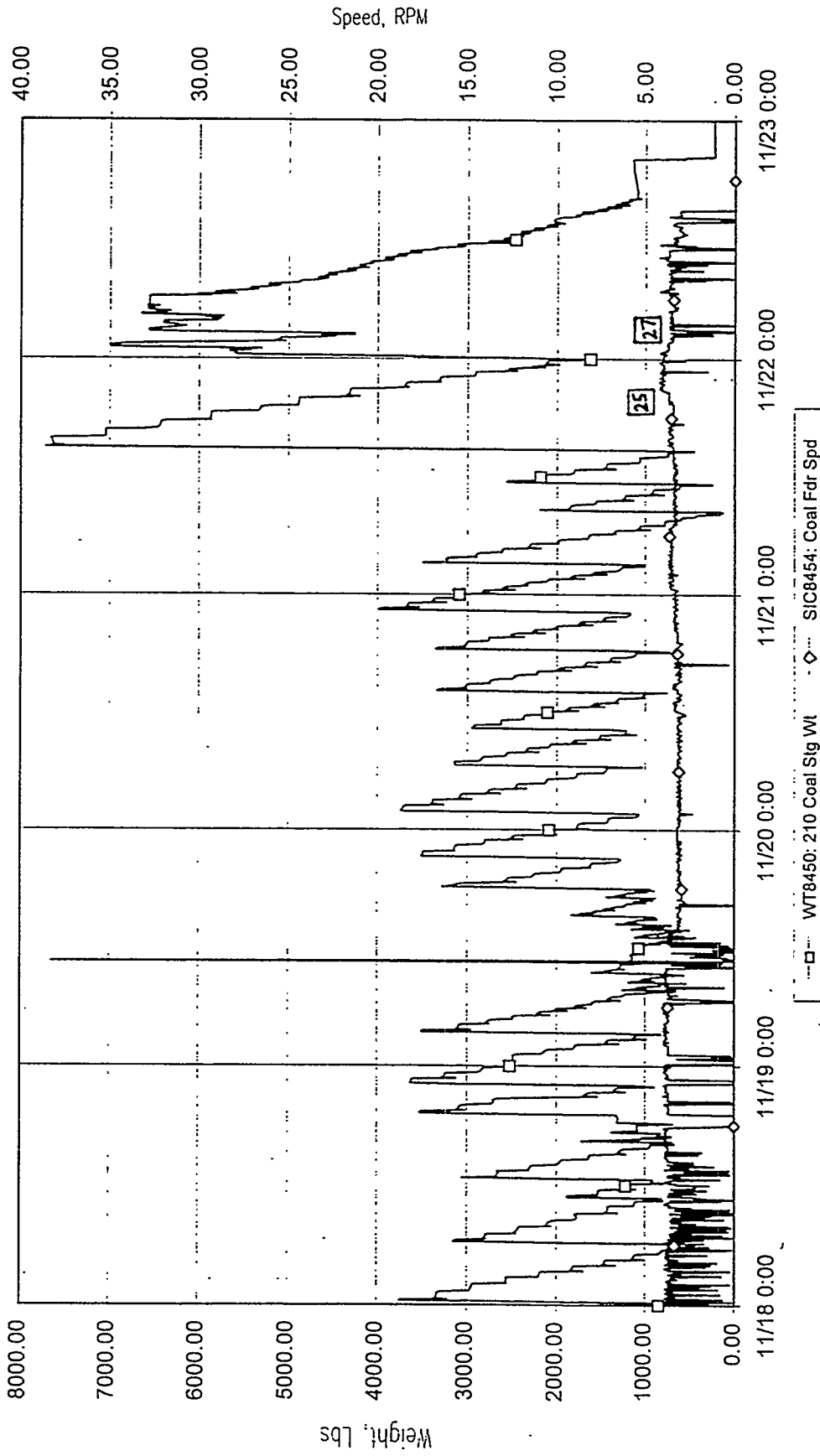
DOE Plot 1 of 47 - 5 minute data

5.1.10-26 C00201 System Profile for November 18 Through November 22, 1996



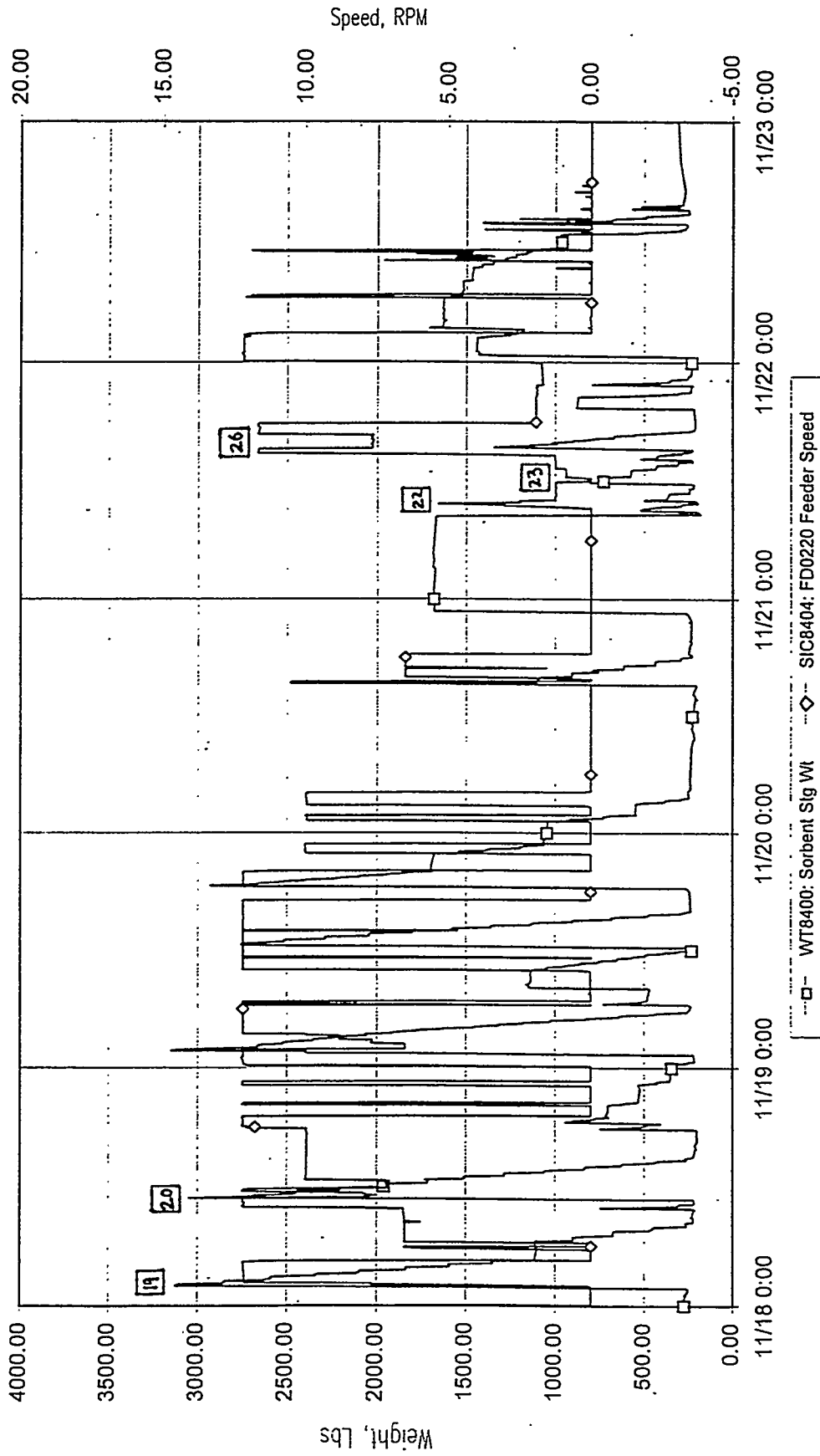
DOE Plot 5 of 47 - 5 minute data

5.1.10-27 Transport Air System for November 18 Through November 22, 1996



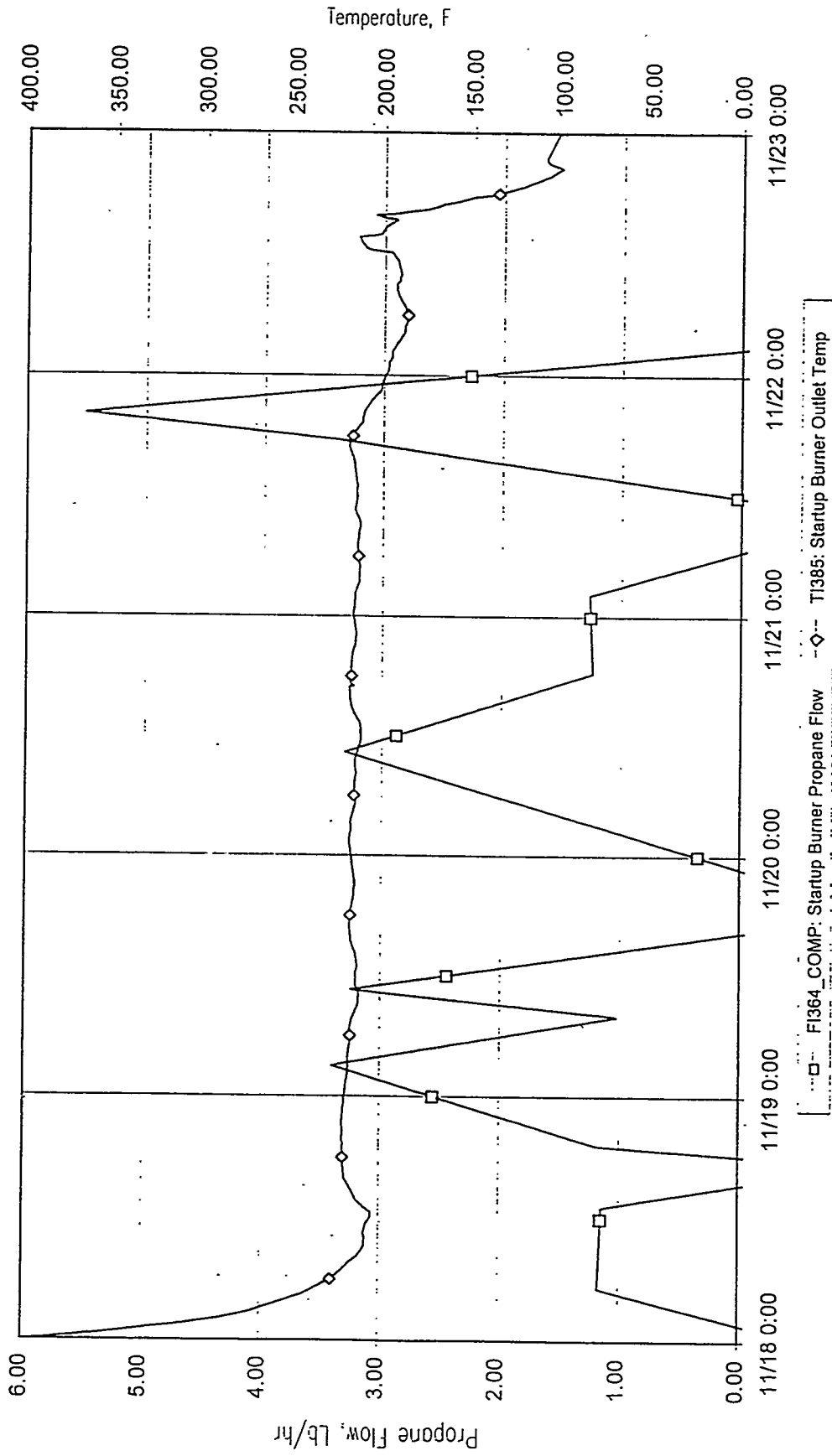
DOE Plot 7 of 47 - 5 minute data

5.1.10-28 Coal Feed for November 18 Through November 22, 1996



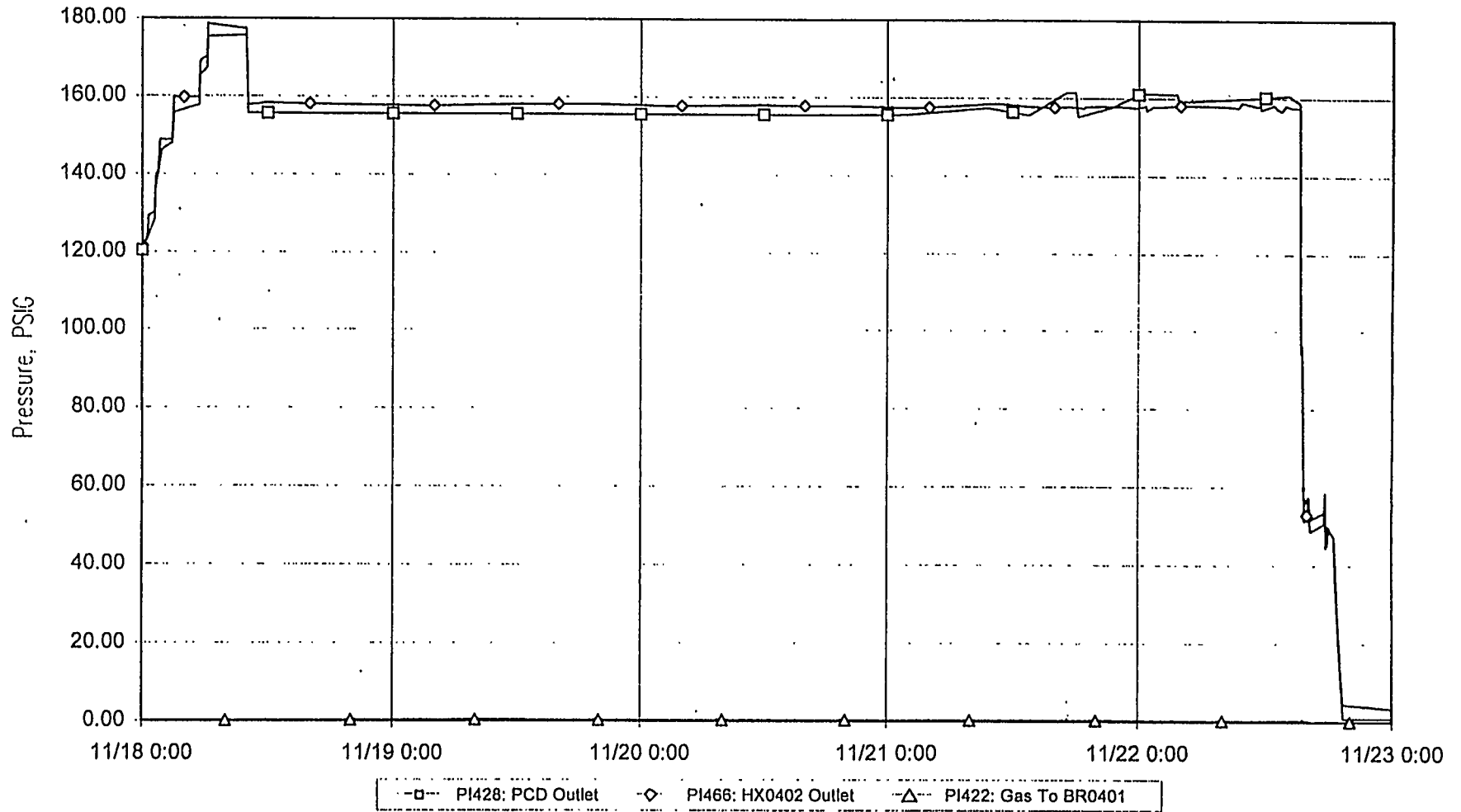
DOE Plot 8 of 47 - 5 minute data

5.1.10-29 Sorbent Feed for November 18 Through November 22, 1996



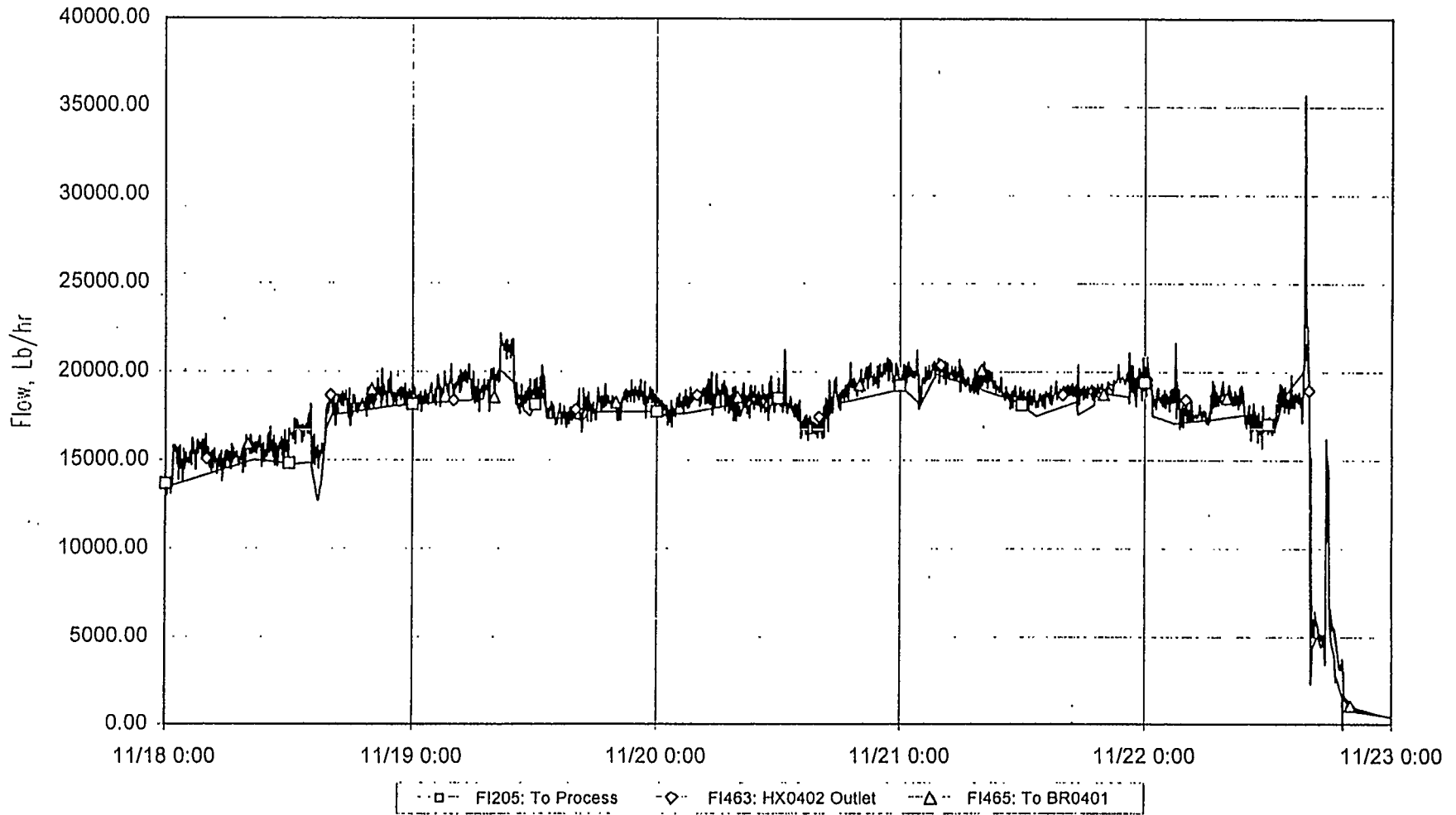
DOE Plot 9 of 47 - 5 minute data

5.1.10-30 Start-Up Burner Flow/Temperature for November 18 Through November 22, 1996



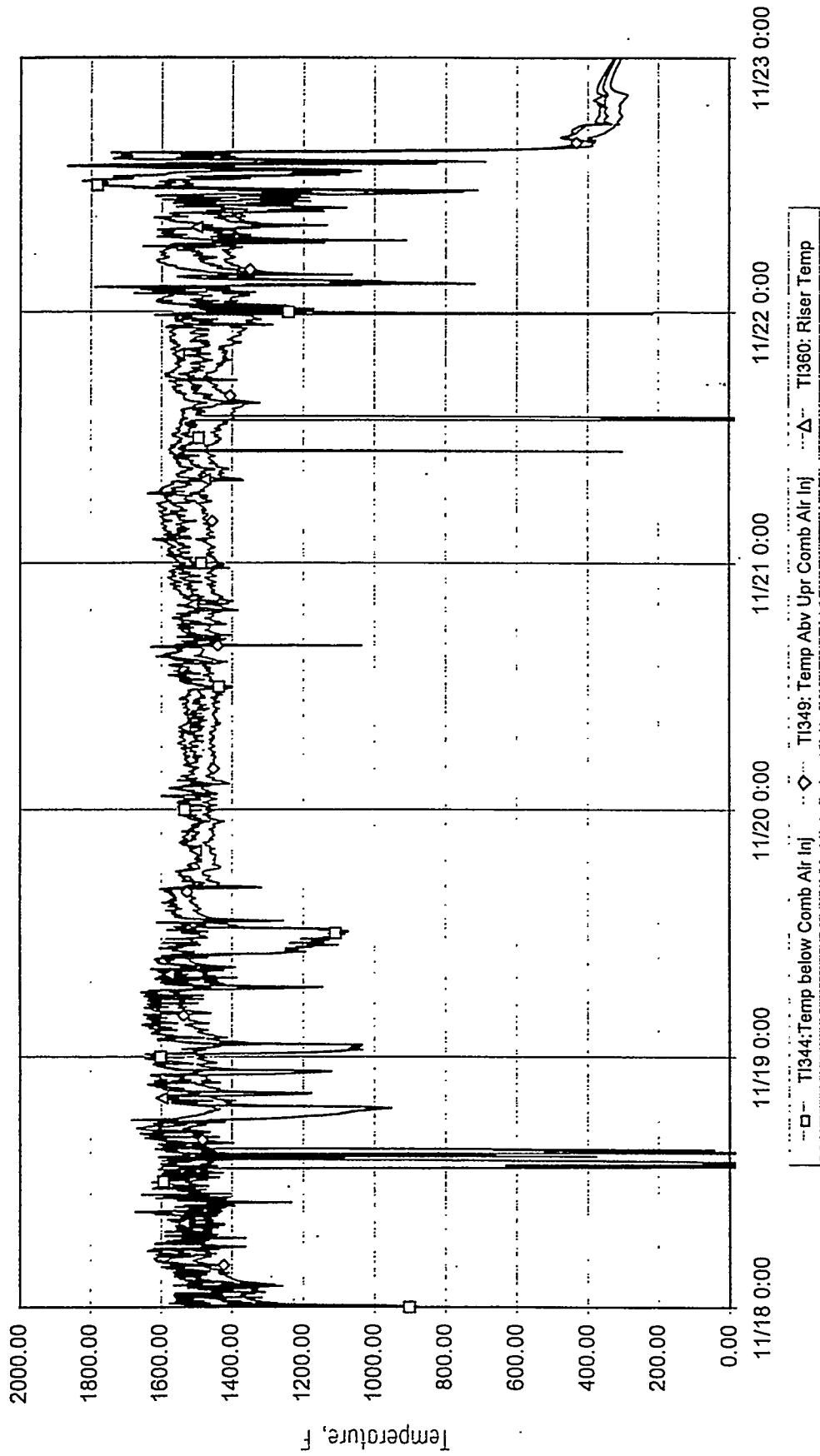
DOE Plot 10 of 47 - 5 minute data

5.1.10-31 System Pressures Downstream of PCD for November 18 Through November 22, 1996



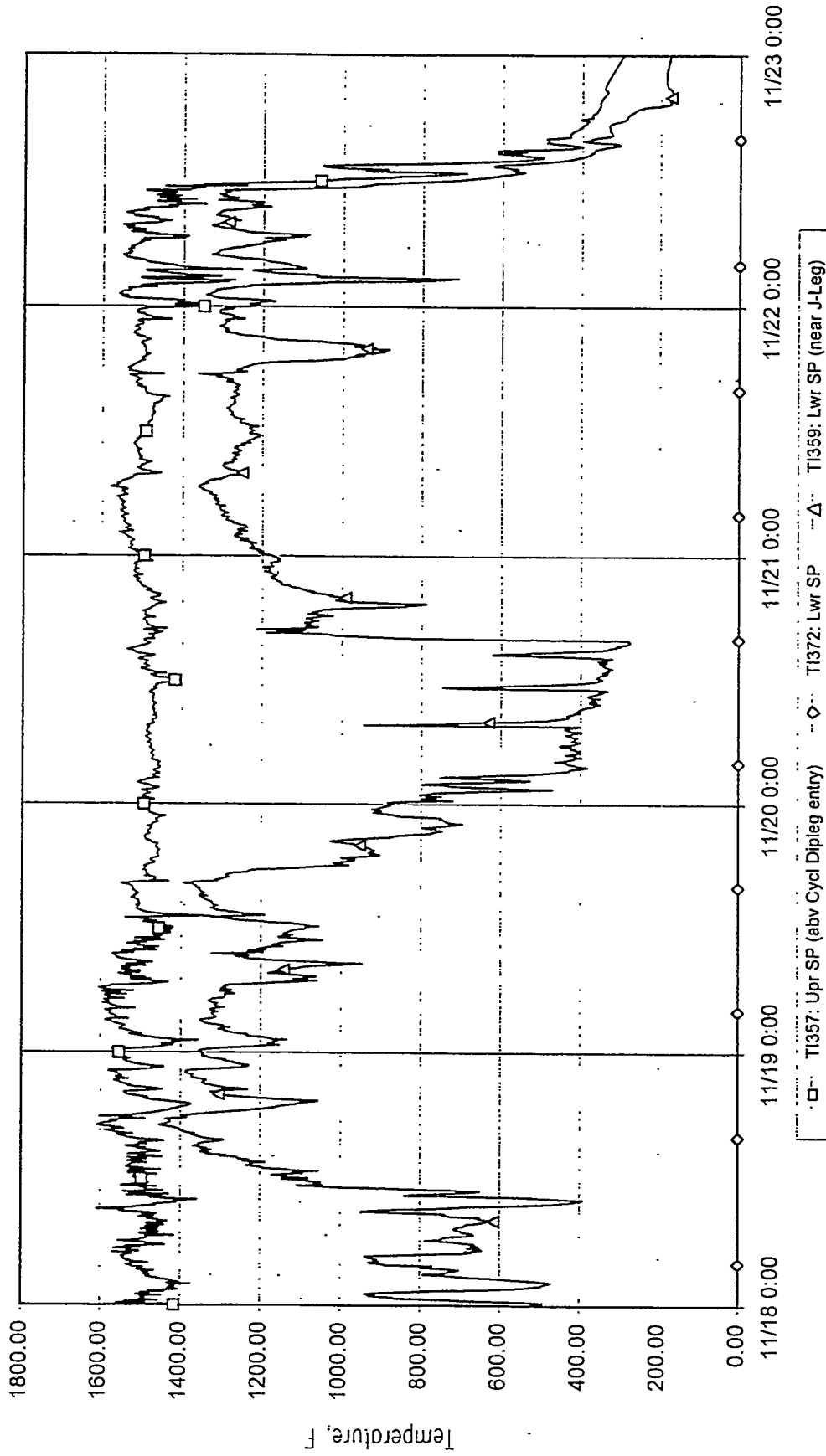
DOE Plot 11 of 47 - 5 minute data

5.1.10-32 Total Gas In/Out Flow Rates for November 18 Through November 22, 1996



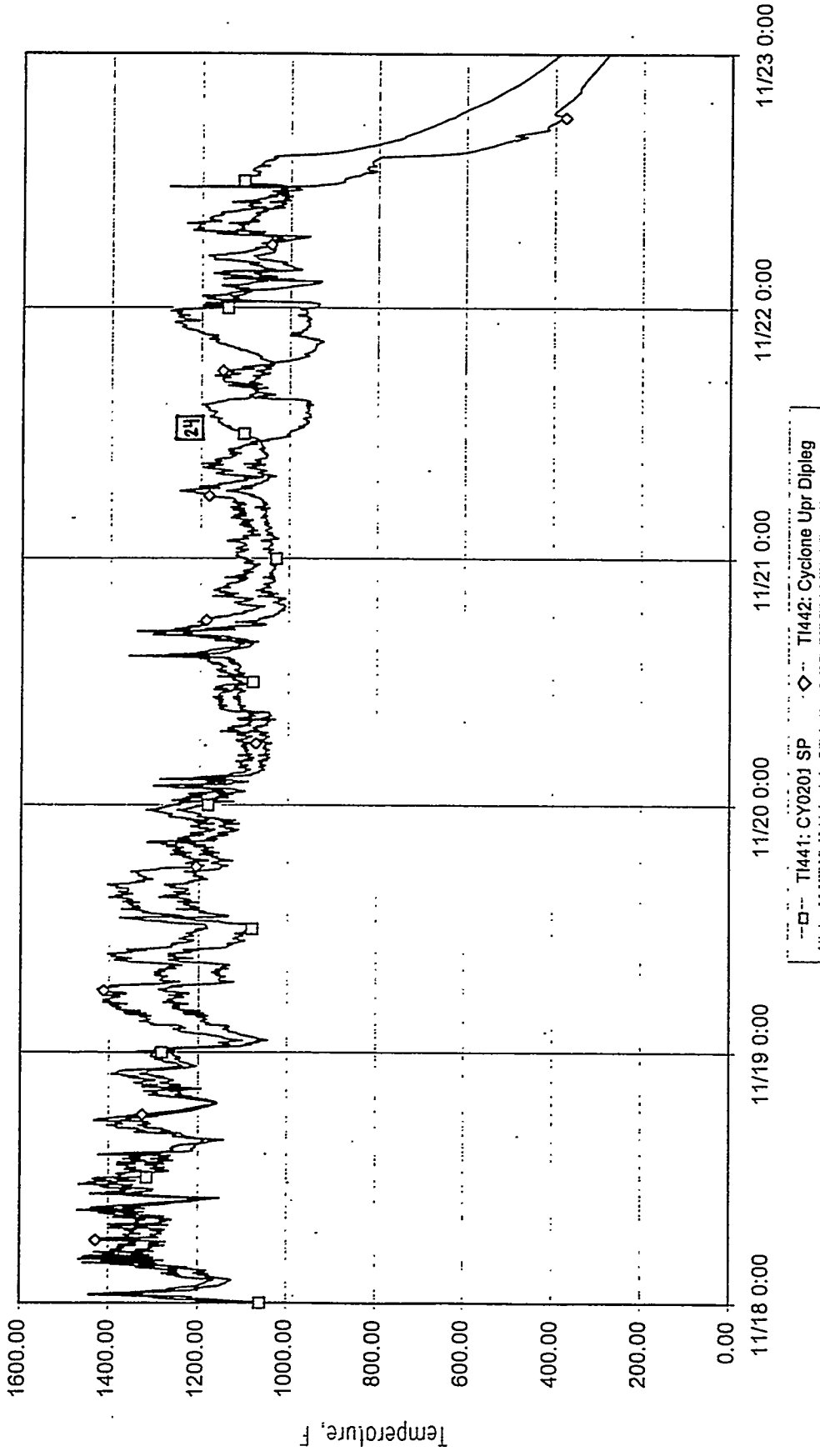
DOE Plot 12 of 47 - 5 minute data

5.1.10-33 Reactor Mixing Zone and Riser Temperatures for November 18 Through November 22, 1996



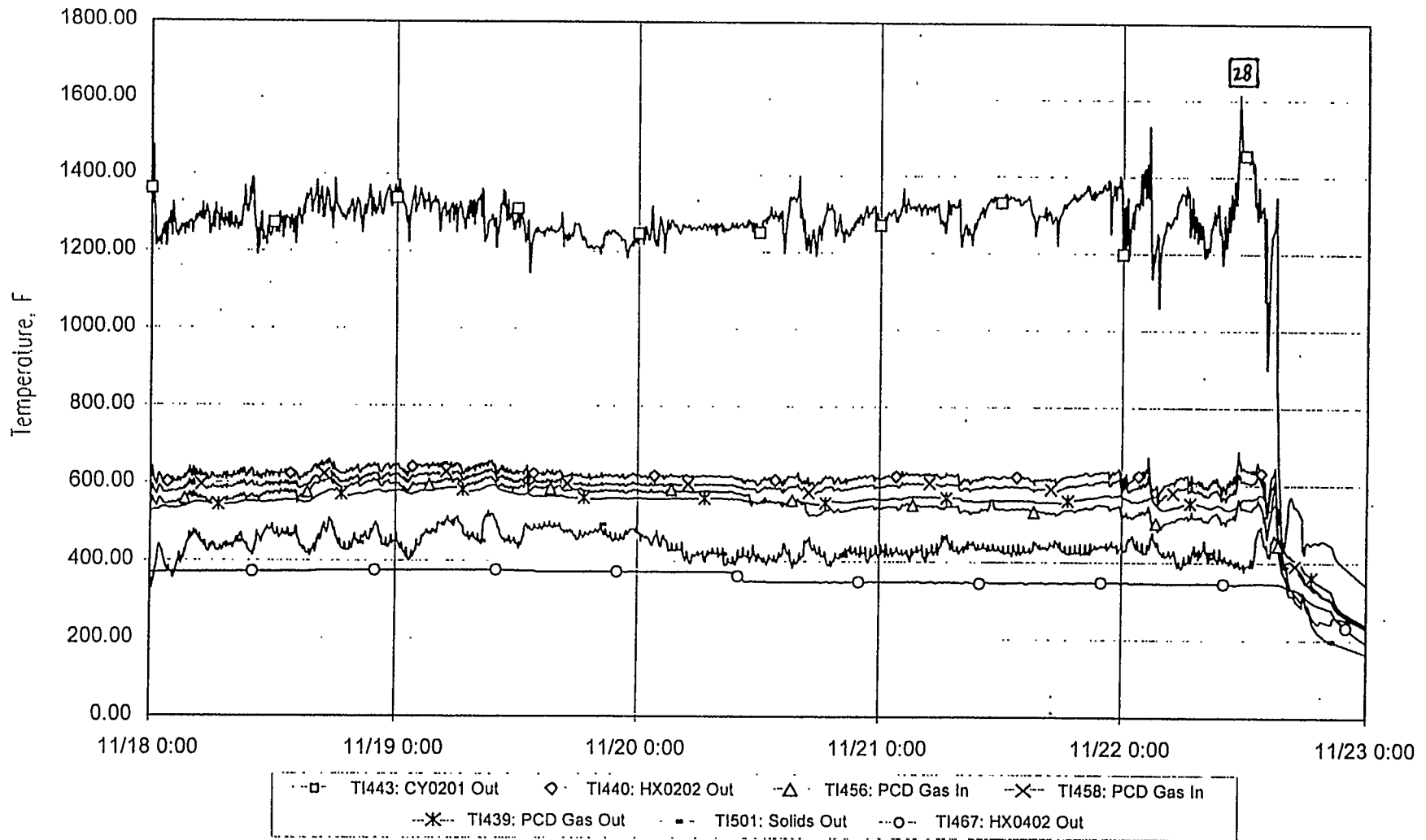
DOE Plot 13 of 47 - 5 minute data

5.1.10-34 Standpipe Temperatures for November 18 Through November 22, 1996



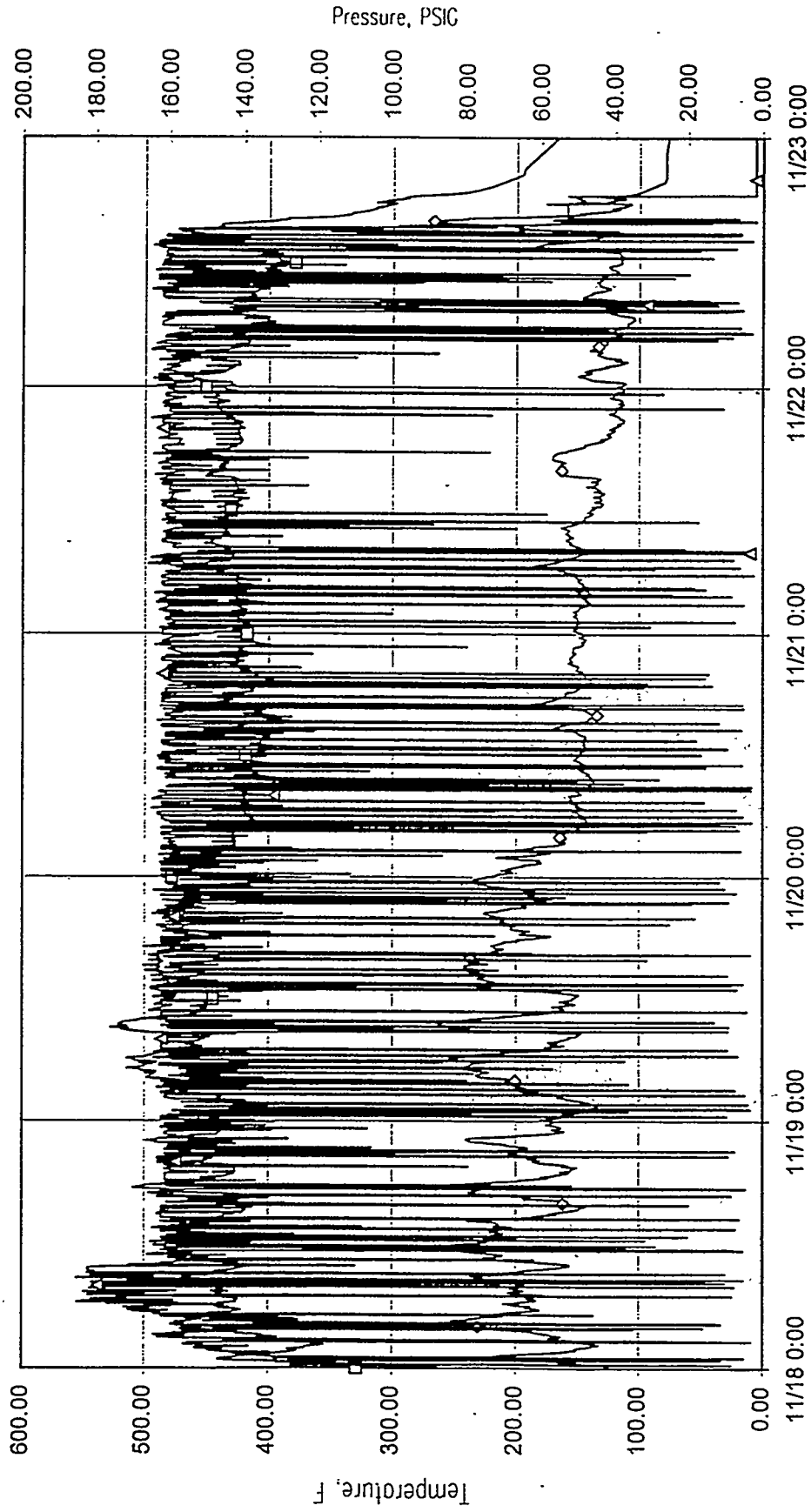
DOE Plot 14 of 47 - 5 minute data

5.1.10-35 Cyclone Dipleg Temperatures for November 18 Through November 22, 1996



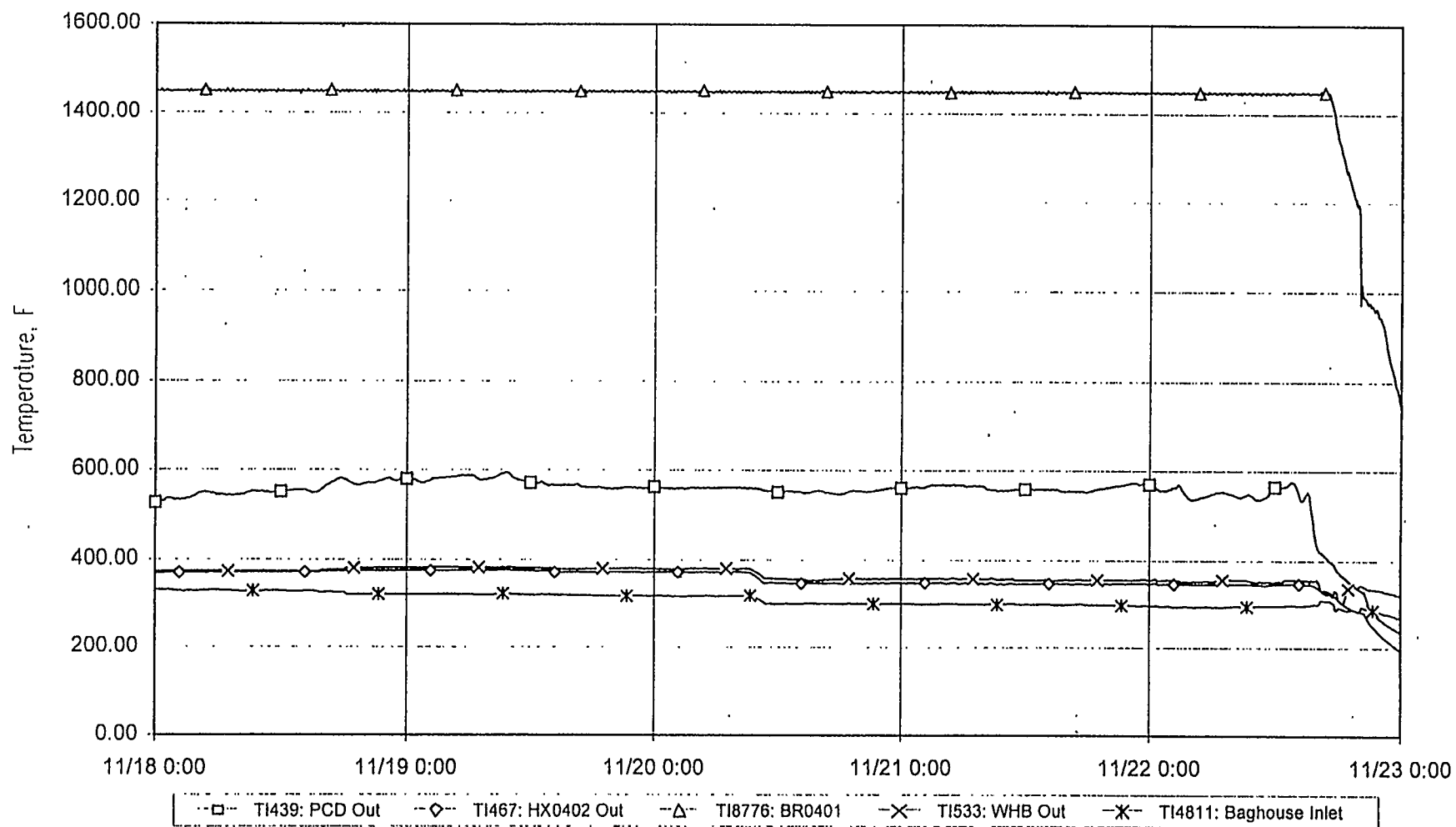
DOE Plot 15 of 47 - 5 minute data

5.1.10-36 Temperature Profiles Downstream of Reactor for November 18 Through November 22, 1996



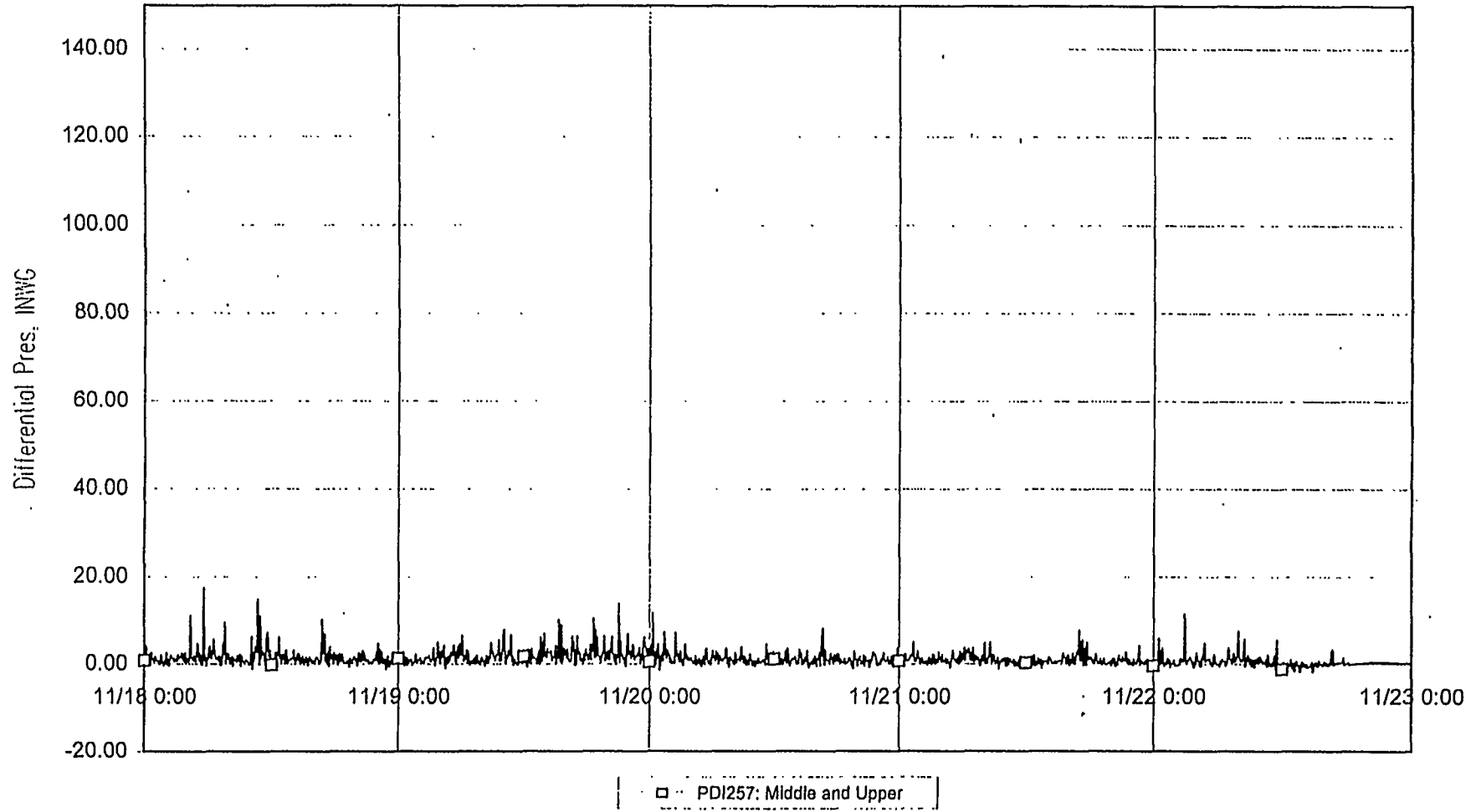
DOE Plot 16 of 47 - 5 minute data

5.1.10-37 PCD Ash Temperatures for November 18 Through November 22, 1996



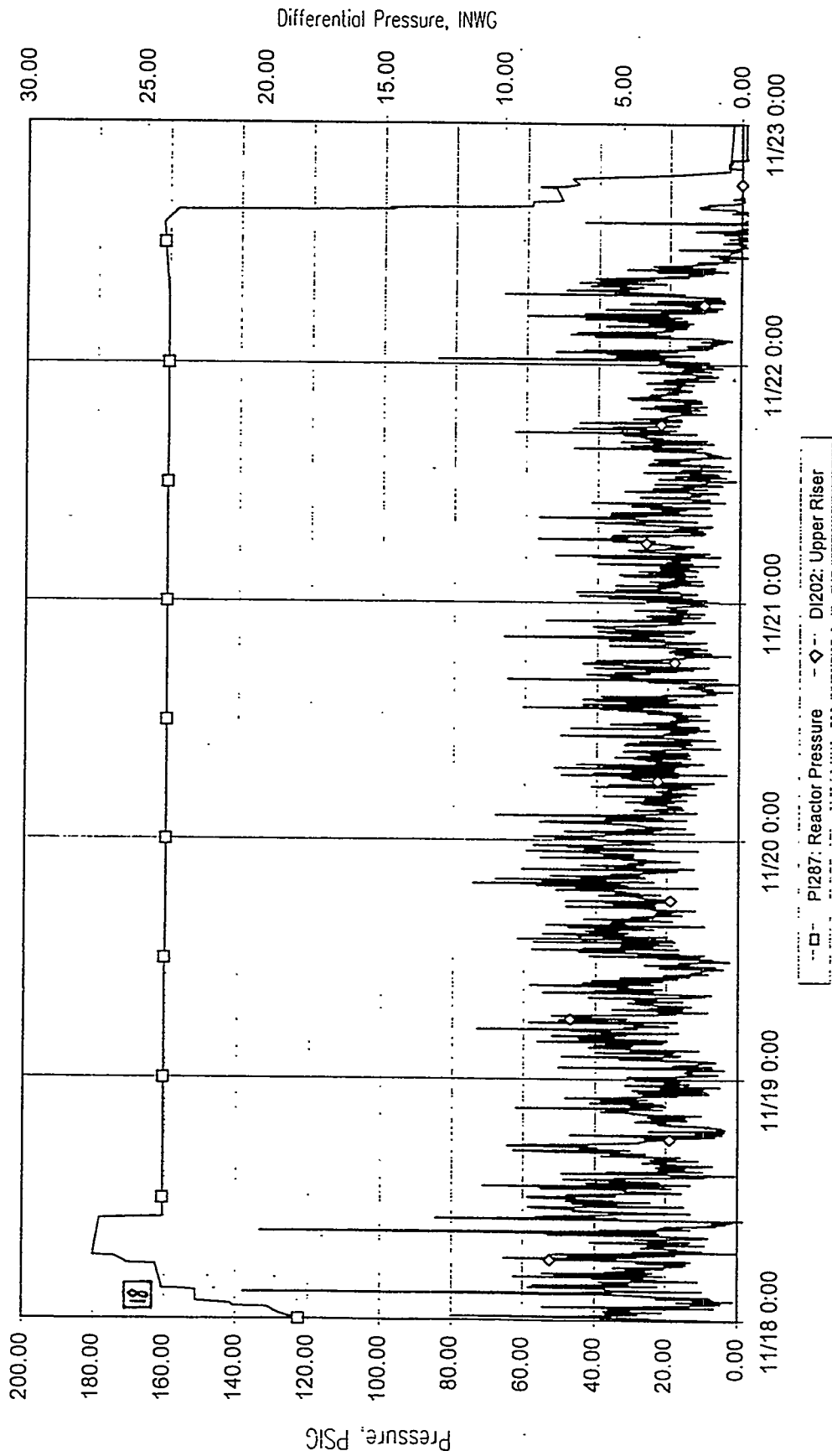
DOE Plot 17 of 47 - 5 minute data

5.1.10-38 System Temperatures Downstream of PCD for November 18 Through November 22, 1996



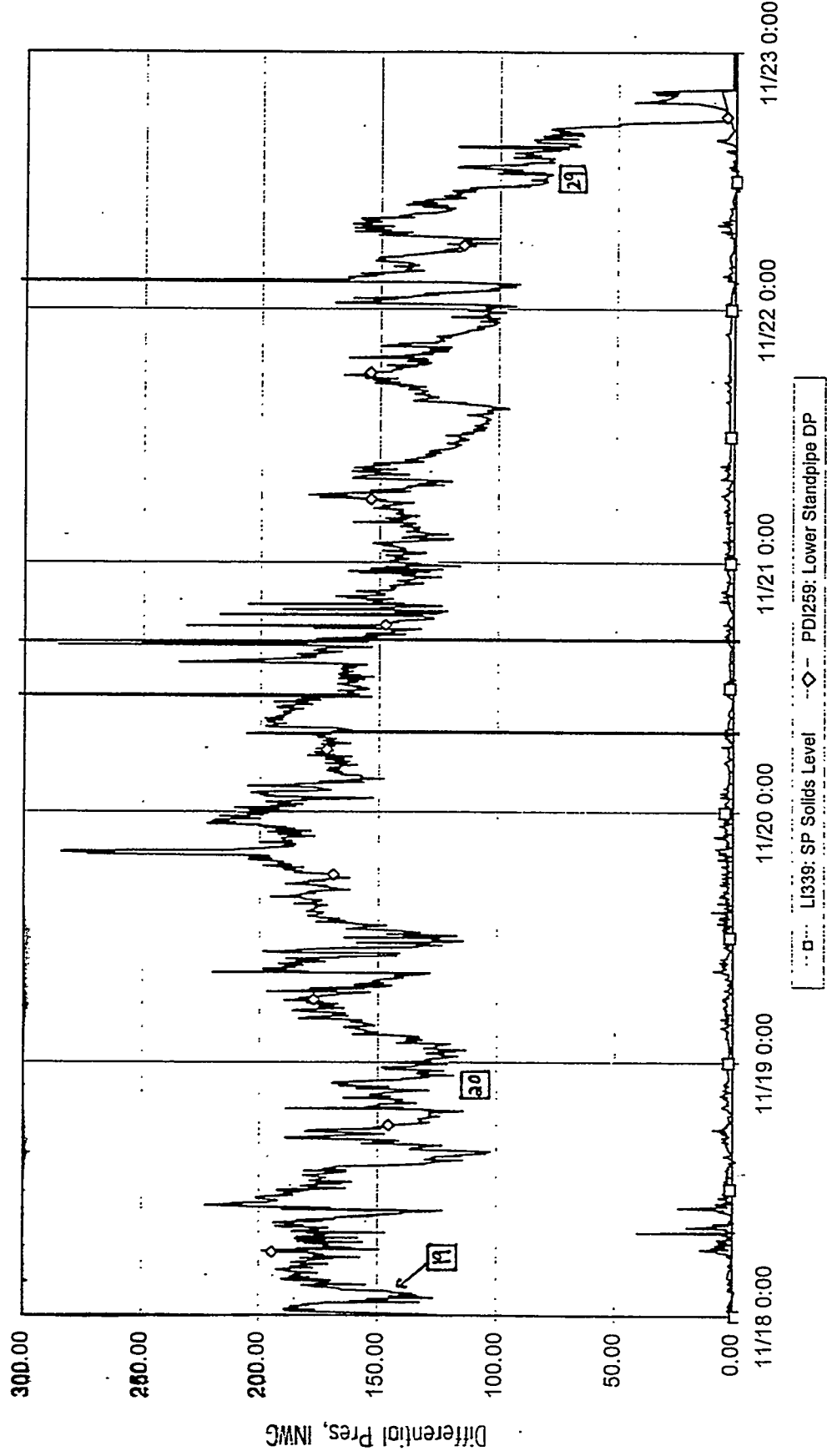
DOE Plot 18 of 47 - 5 minute data

5.1.10-39 Mixing Zone DP Profile for November 18 Through November 22, 1996



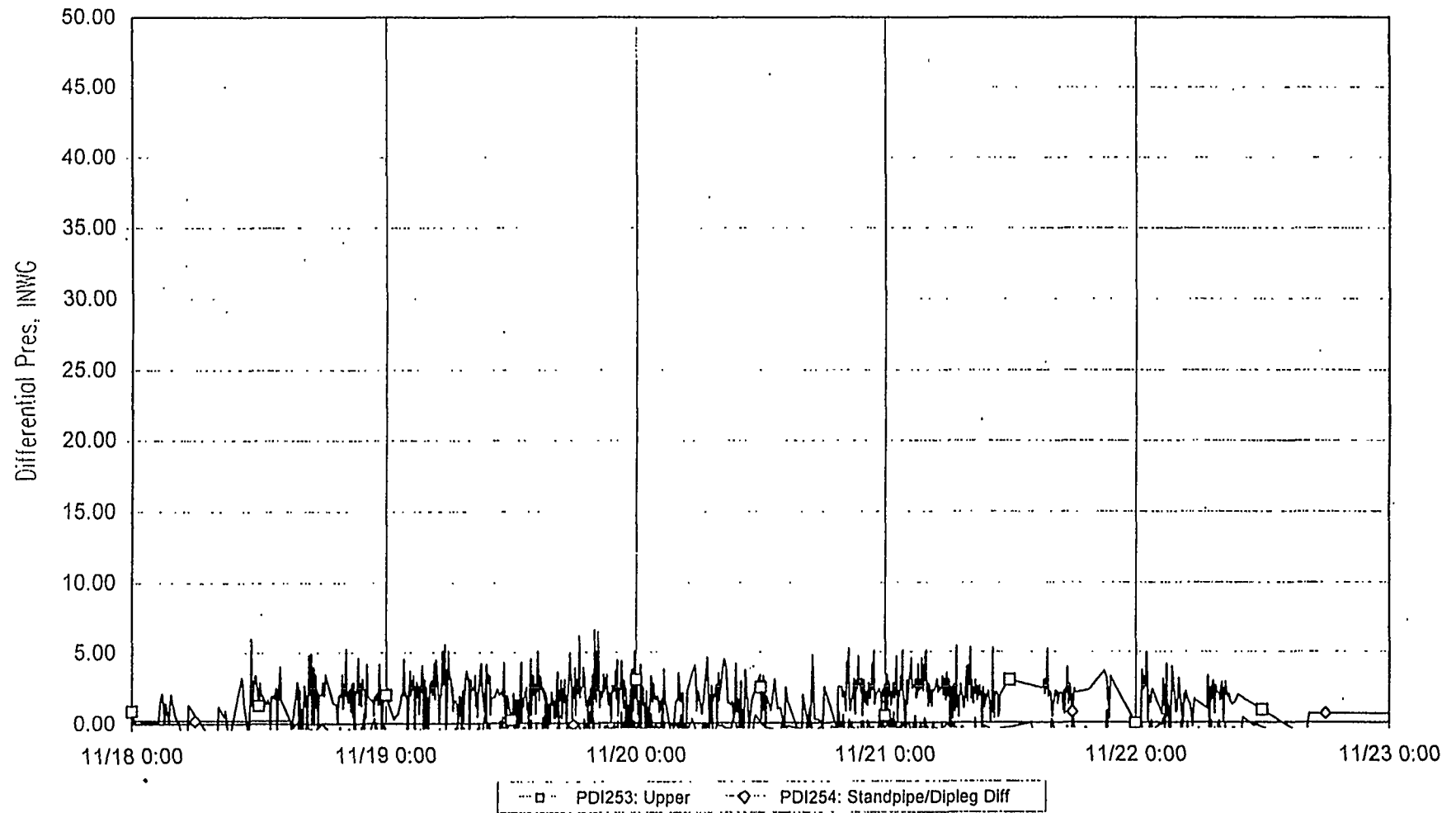
DOE Plot 19 of 47 - 5 minute data

5.1.10-40 Reactor Pressure/Riser DP Profiles for November 18 Through November 22, 1996



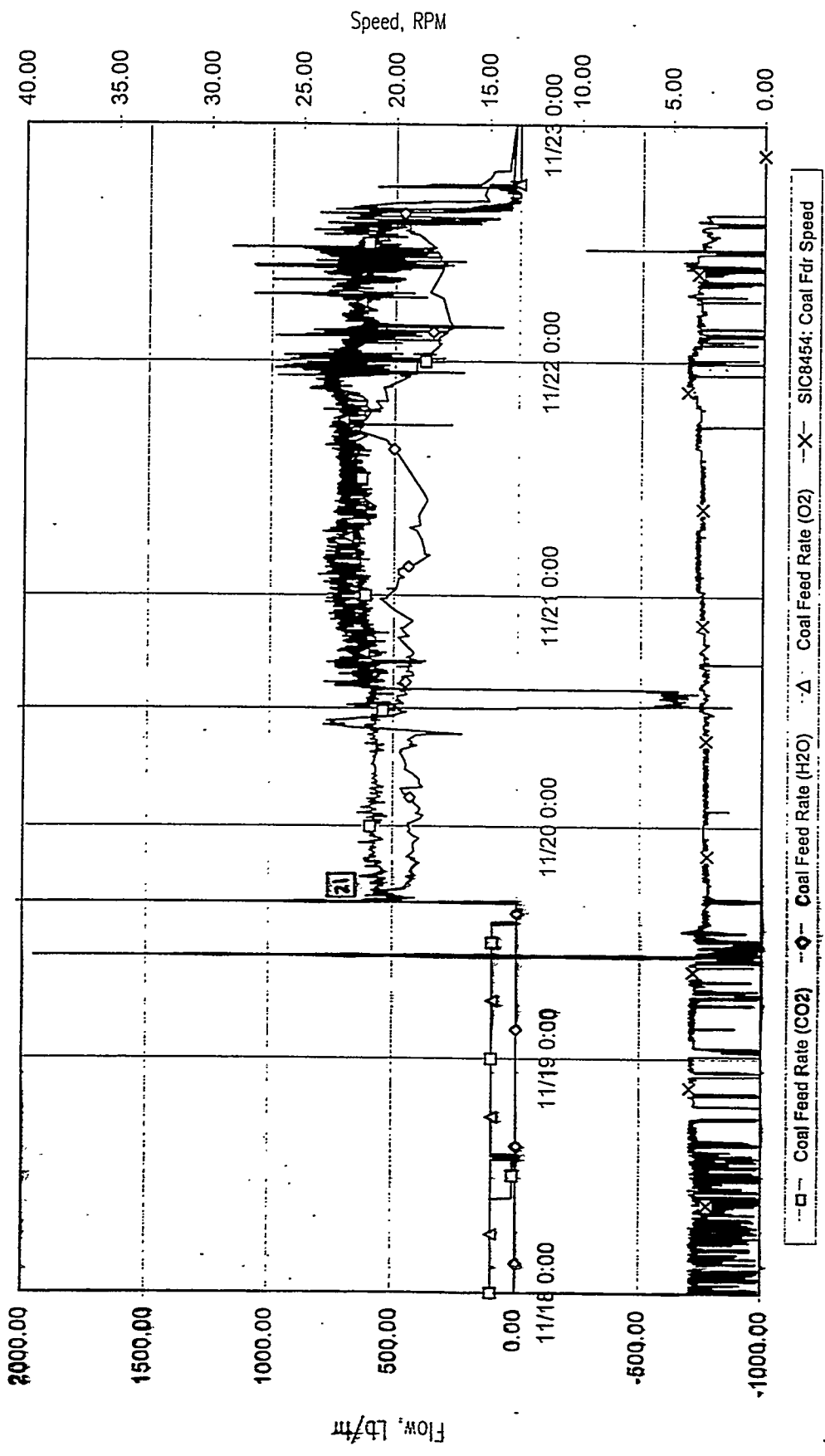
DOE Plot 20 of 47 - 5 minute data

5.1.10-41 Standpipe DP Profiles for November 18 Through November 22, 1996



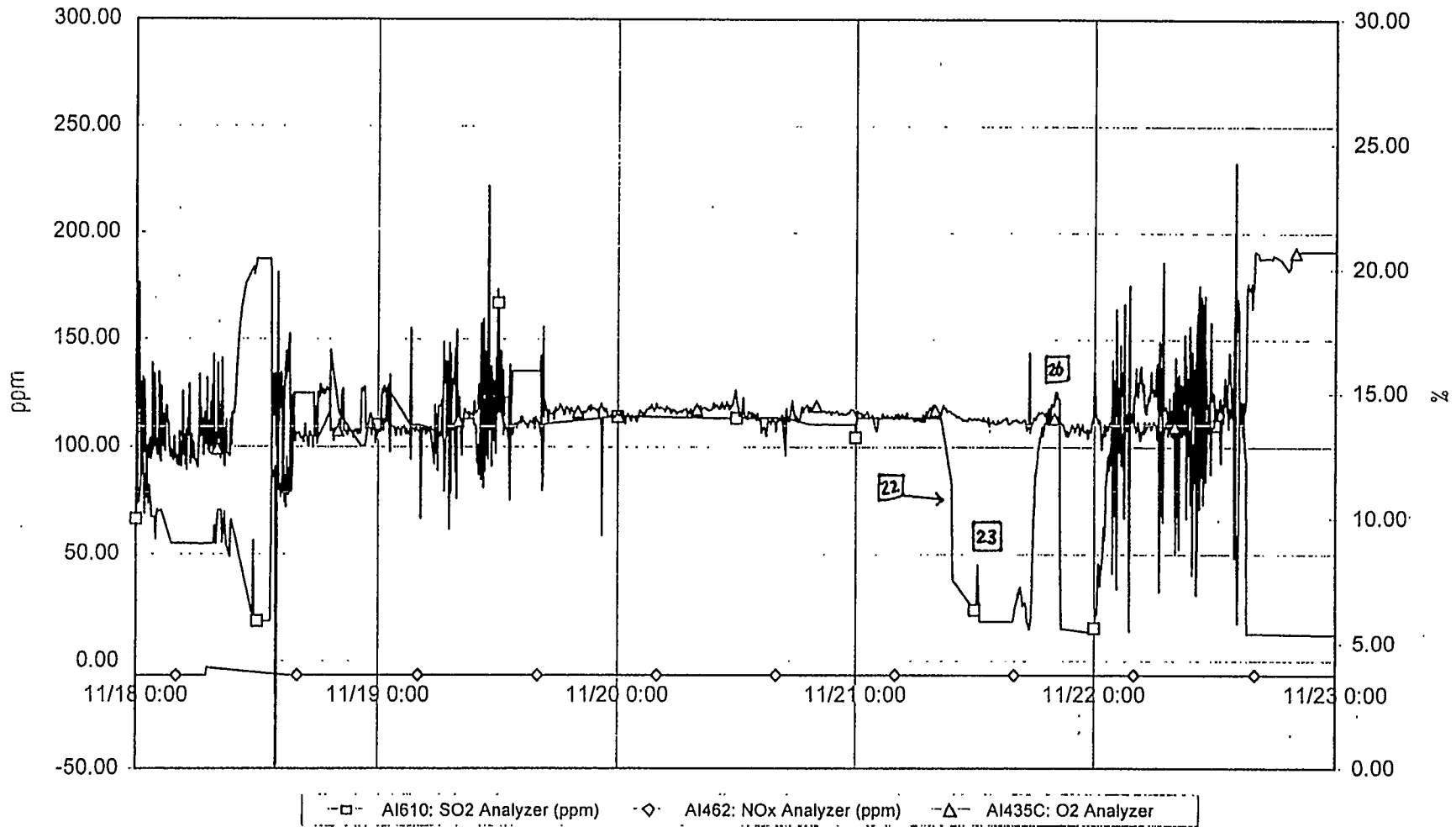
DOE Plot 21 of 47 - 5 minute data

5.1.10-42 CY0201 Dipleg DP Profiles for November 18 Through November 22, 1996



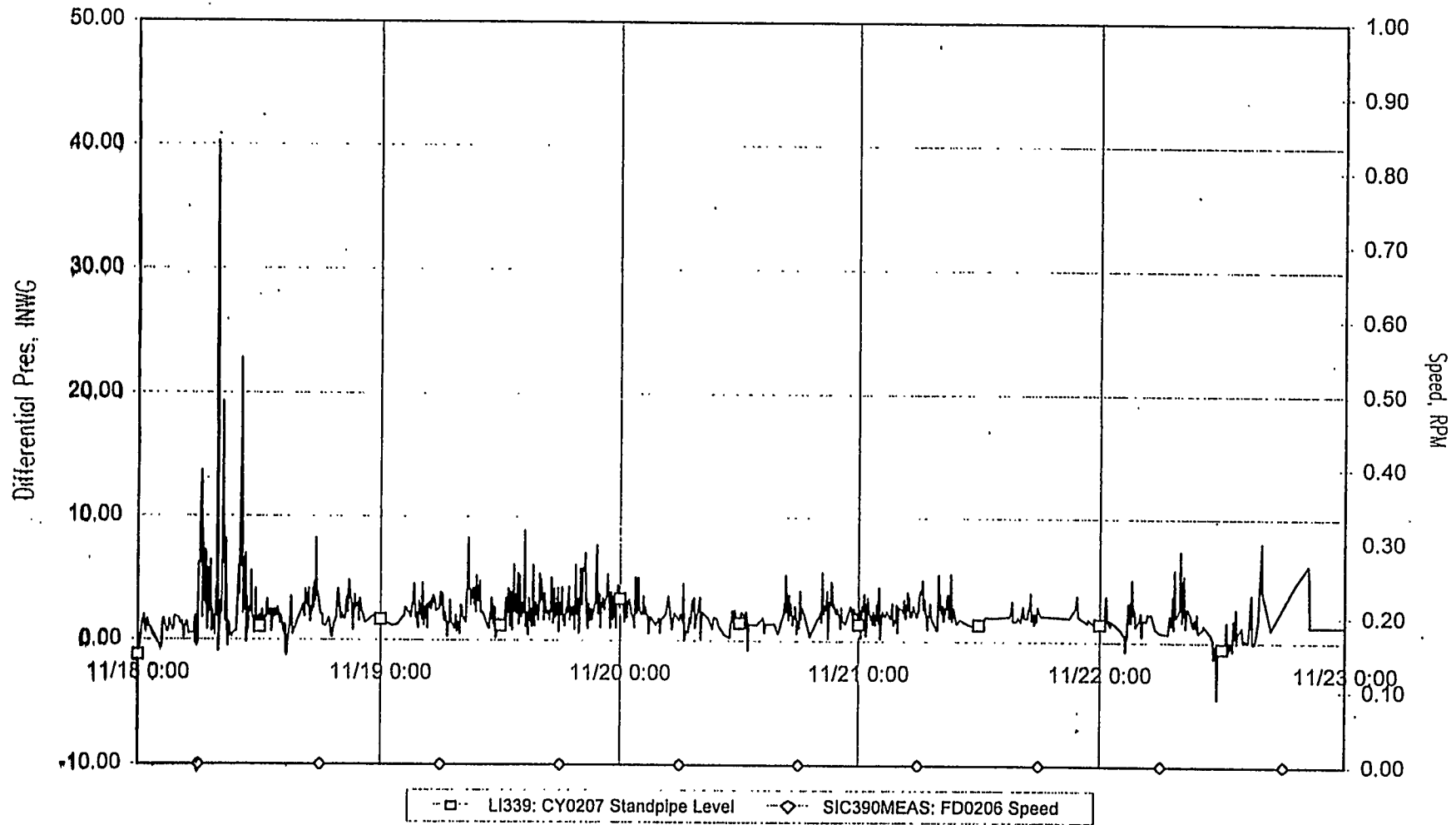
DOE Plot 22 of 47 - 2 minute data

5.1.10-43 Coal Feed Rate for November 18 Through November 22, 1996



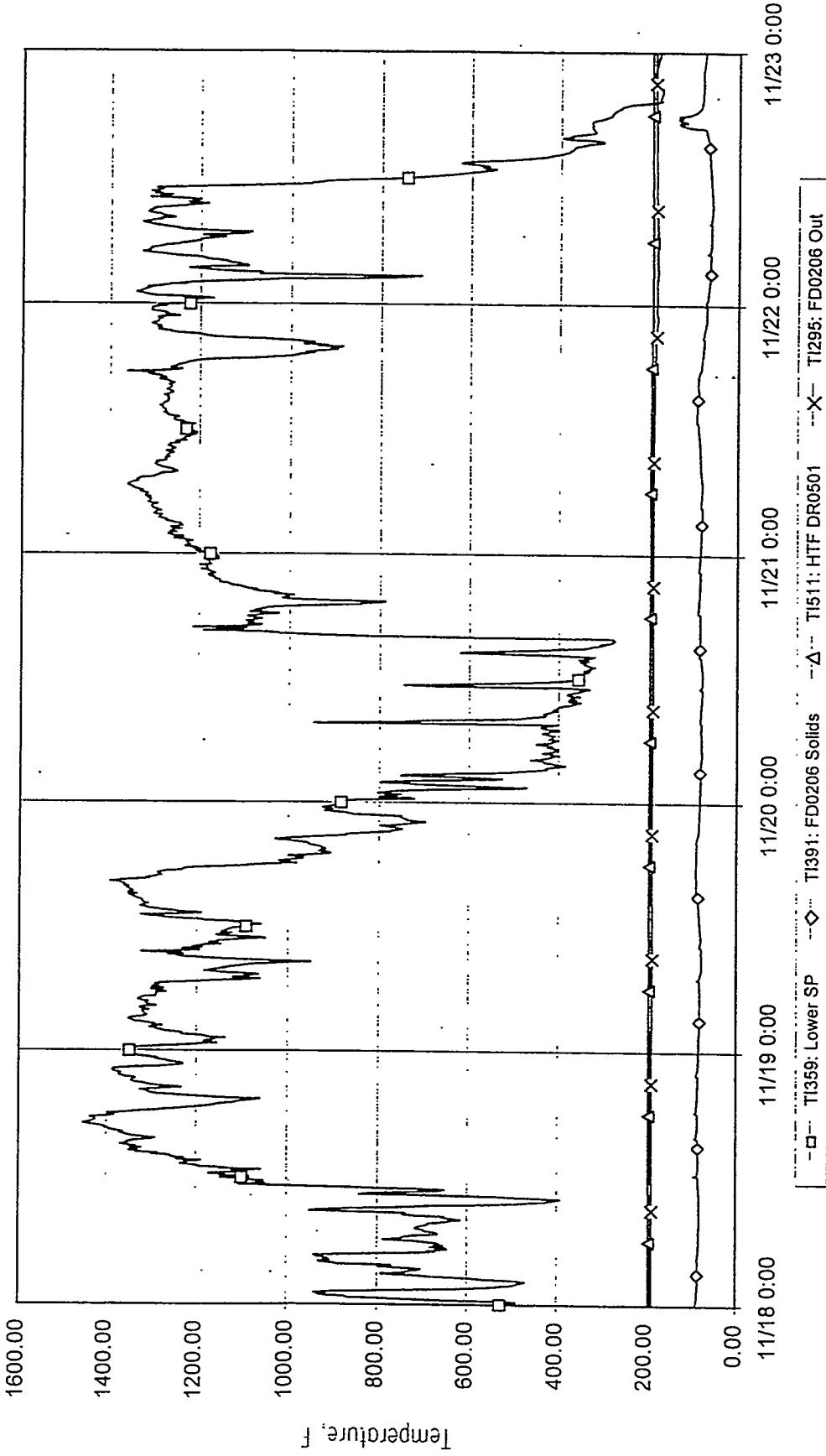
DOE Plot 23 of 47 - 5 minute data

5.1.10-44 O₂, SO₂, and NO_x Analyzers for November 18 Through November 22, 1996



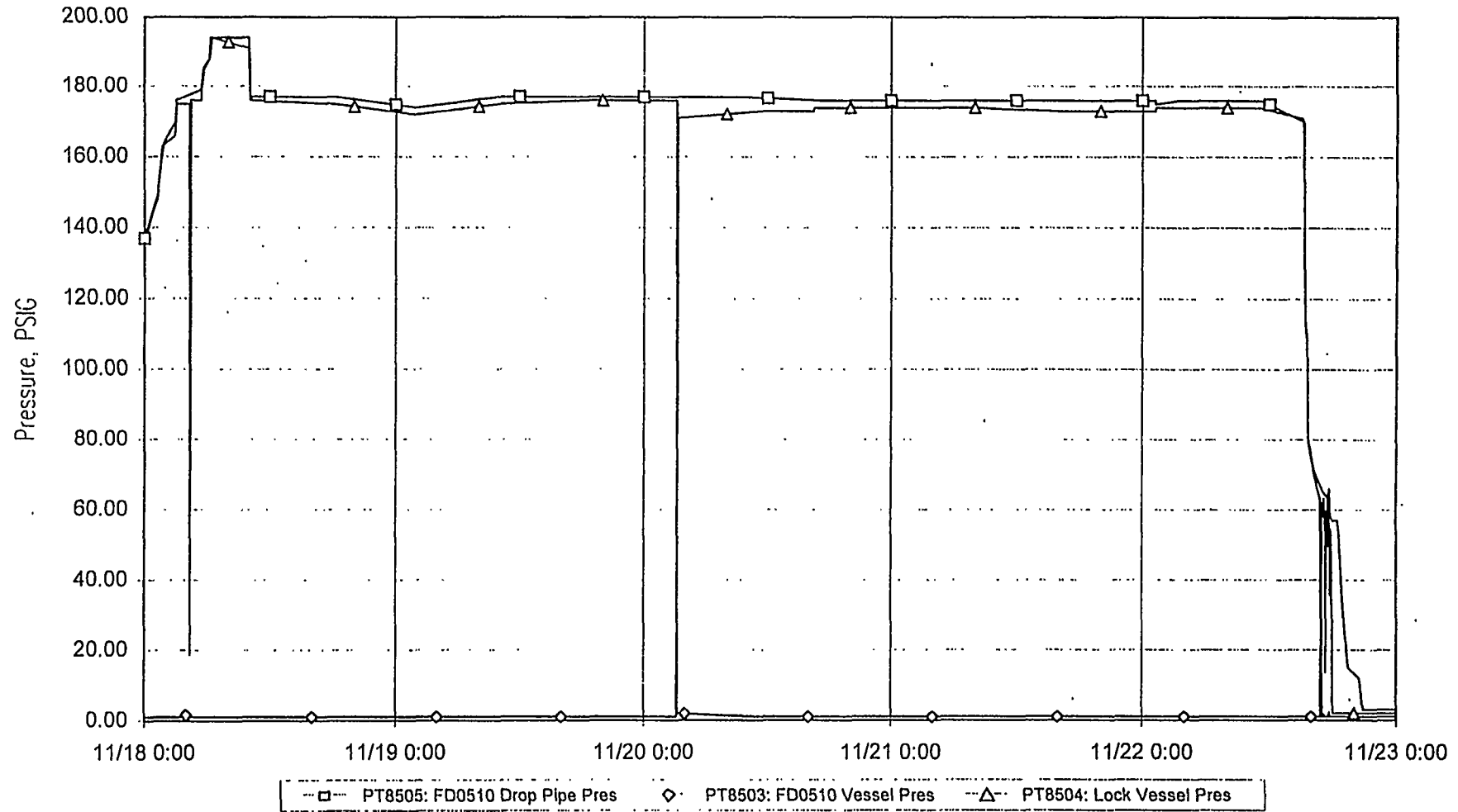
DOE Plot 27 of 47 - 5 minute data

5.1.10-45 Solids Withdrawal for November 18 Through November 22, 1996



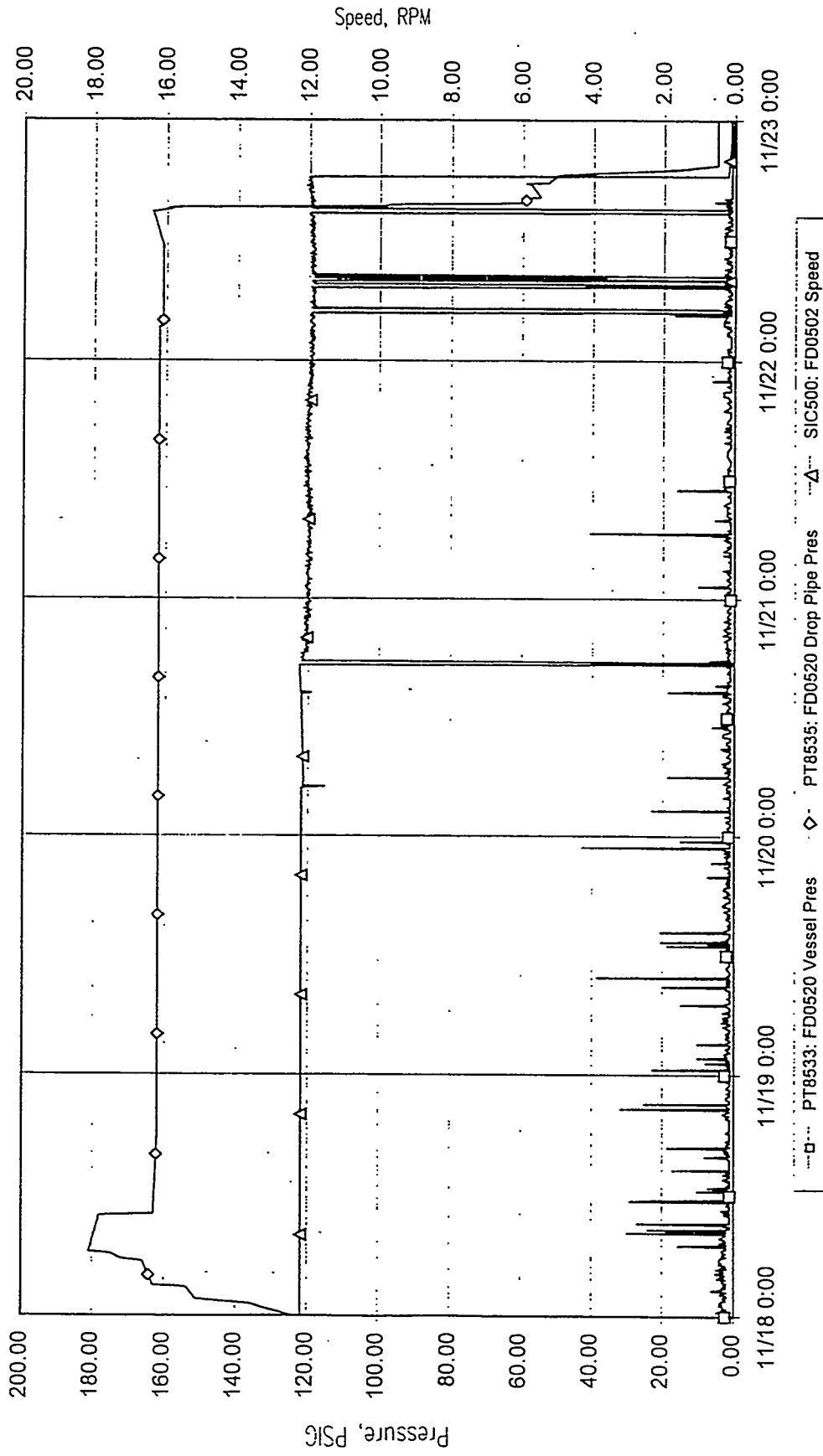
DOE Plot 28 of 47 - 5 minute data

5.1.10-46 FD0510 Temperature Profiles for November 18 Through November 22, 1996



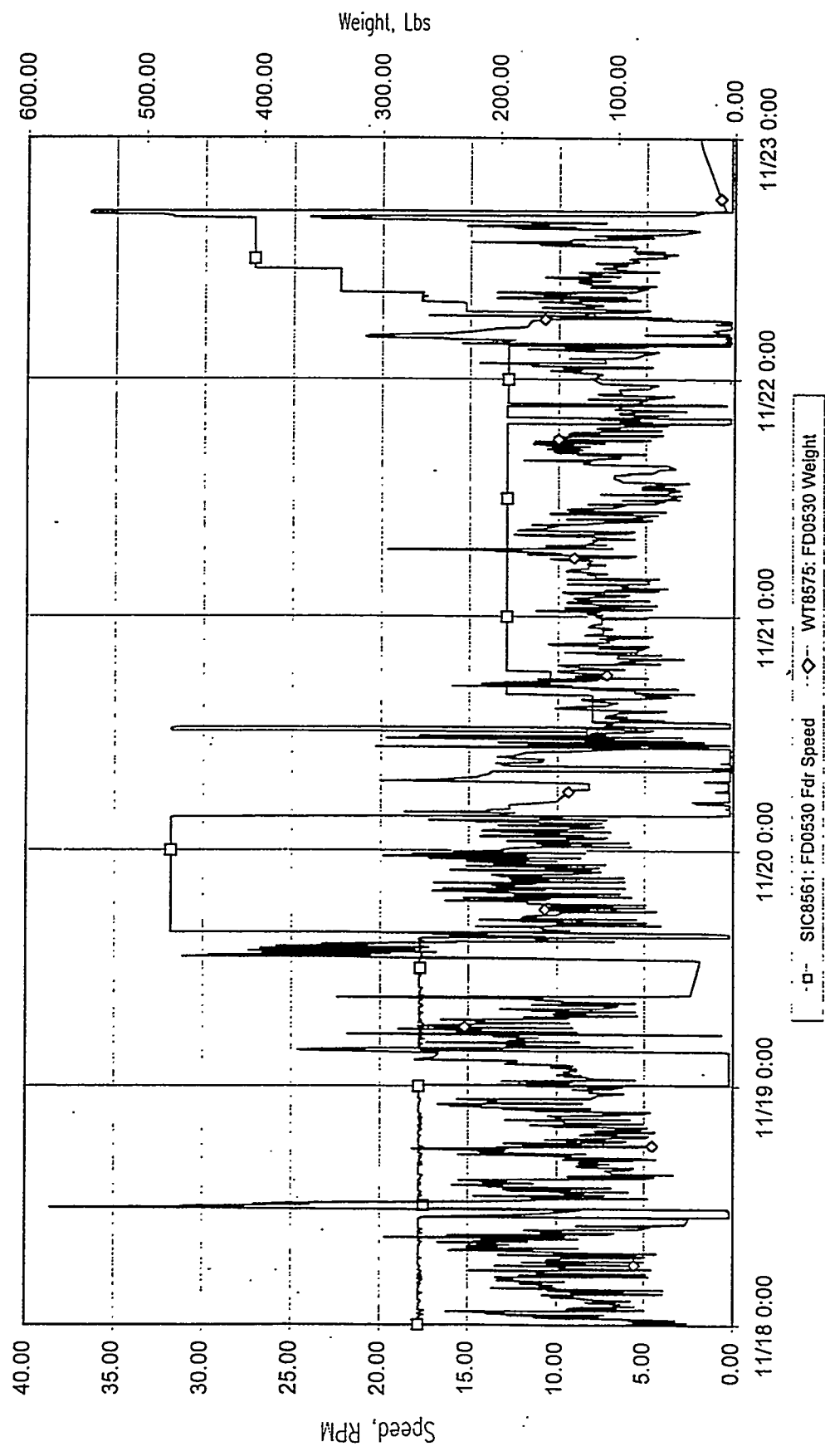
DOE Plot 29 of 47 - 5 minute data

5.1.10-47 FD0206 Pressure Profiles for November 18 Through November 22, 1996



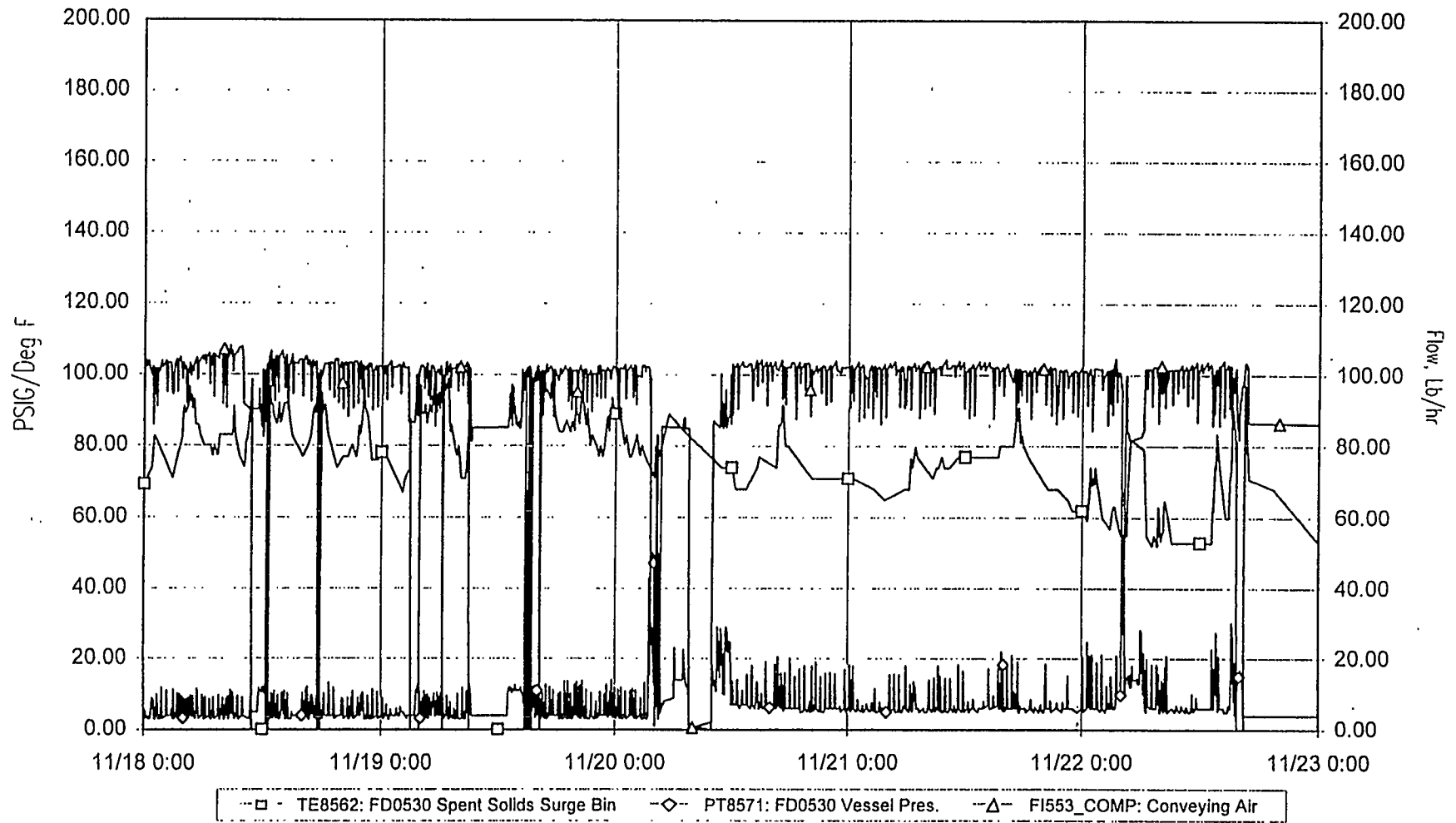
DOE Plot 30 of 47 - 5 minute data

5.1.10-48 FD0520 Pressures for November 18 Through November 22, 1996



DOE Plot 31 of 47 - 5 minute data

5.1.10-49 FD0530 Feeder for November 18 Through November 22, 1996



DOE Plot 32 of 47 - 5 minute data

5.1.10-50 FD0530 Feeder for November 18 Through November 22, 1996

TERMS

List of Abbreviations

AAS	Automated Analytical Solutions
ADEM	Alabama Department of Environmental Management
APFBC	Advance Pressurized Fluidized-Bed Combustion
ASME	American Society of Mechanical Engineers
AW	Application Workstation
BFI	Browning-Ferris Industries
BFW	Boiler Feed Water
BMS	Burner Management System
BOC	BOC Gases
BOP	Balance-of-Plant
BPIR	Ball Pass Inner Race, Frequencies
BPOR	Ball Pass Outer Race, Frequencies
BSF	Ball Spin Frequency
CAD	Computer-Aided Design
CEM	Continuous Emissions Monitor
CFB	Circulating Fluidized Bed
CFR	Code of Federal Regulations
CHE	Combustor Heat Exchanger
CPC	Combustion Power Company
CPR	Cardiopulmonary Resuscitation
DC	Direct Current
DCS	Distributed Control System
DOE	U.S. Department of Energy
E & I	Electrical and Instrumentation
EERC	Energy and Environmental Research Center
EPRI	Electric Power Research Institute
FCC	Fluidized Catalytic Cracker
FETC	Federal Energy Technology Center
FFG	Flame Front Generator
FI	Flow Indicator
FIC	Flow Indicator Controller
FOAK	First-of-a-Kind
FTF	Fundamental Train Frequency
FW	Foster Wheeler
GBF	Granular Bed Filter
GC	Gas Chromatograph
GEESI	General Electric Environmental Services, Inc.
HTF	Heat Transfer Fluid
HTHP	High-Temperature, High-Pressure
I/O	Inputs/Outputs
ID	Inside Diameter
IF&P	Industrial Filter & Pump
IGV	Inlet Guide Vanes
IR	Infrared

PSDF Terms

LAN	Local Area Network
LIMS	Laboratory Information Management System
LOC	Limiting Oxygen Concentration
LOI	Loss on Ignition
LPG	Liquefied Propane Gas
LSLL	Level Switch, Low Level
MAC	Main Air Compressor
MCC	Motor Control Center
MS	Microsoft Corporation
MWK	The M. W. Kellogg Company
NDIR	Nondestructive Infrared
NFPA	National Fire Protection Association
NO _x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NPS	Nominal Pipe Size
OD	Outside Diameter
OSHA	Occupational Safety Health Administration
OSI	OSI Software, Inc.
P&IDs	Piping and Instrumentation Diagrams
PC	Pulverized Coal
PCD	Particulate Control Device
PDI	Pressure Differential Indicator
PDT	Pressure Differential Transmitter
PFBC	Pressurized Fluidized-Bed Combustion
PI	Plant Information
PLC	Programmable Logic Controller
PPE	Personal Protection Equipment
PSD	Particle Size Distribution
PSDF	Power Systems Development Facility
PT	Pressure Transmitter
RFQ	Request for Quotation
RO	Restriction Orifice
RSSE	Reactor Solid Separation Efficiency
SCS	Southern Company Services, Inc
SRI	Southern Research Institute
TCLP	Toxicity Characteristic Leaching Procedure
TR	Transport Reactor
TRDU	Transport Reactor Demonstration Unit
TSS	Total Suspended Solids
UND	University of North Dakota
UPS	Uninterruptible Power Supply
UV	Ultraviolet
VOCs	Volatile Organic Compounds
WPC	William's Patent Crusher
XXS	Extra, Extra Strong

List of Units

acfm	Actual Cubic Feet Per Minute
Btu	British Thermal Units
°F	Degrees Fahrenheit
°C	Degrees Celsius or Centigrade
ft	Feet
gpm	Gallons Per Minute
hp	Horsepower
hr	Hour
inWG	Inches, Water Gauge
mA	milliamps
MB	Megabytes
MW	Megawatts
m/s	Meters per second
μ or μm	Microns or Micrometers
dp ₅₀	Particle Size Distribution at 50 Percentile
ppm (W or V)	Parts Per Million (by weight (w) or volume(v))
lb	Pounds
pph	Pounds per hour
psia	Pounds Per Square Inch Gauge
psig	Pounds Per Square Inch Gauge
ΔP	Pressure Drop
rpm	Revolutions Per Minute
s or sec	Seconds
scf	Standard Cubic Feet
scfm	Standard Cubic Feet Per Minute
V	Volts
W/PPPM	weight/parts per million

Power Systems Development Facility

Commissioning Report of M.W. Kellogg Transport Reactor Train, Westinghouse Particulate Control Device, and Associated Balance-of-Plant Equipment: September 1995 - December 1996

DOE Cooperative Agreement Number
DE-FC21-90MC25140

Volume II

POWER SYSTEMS DEVELOPMENT FACILITY

COMMISSIONING REPORT OF M.W. KELLOGG TRANSPORT REACTOR TRAIN, WESTINGHOUSE PARTICULATE CONTROL DEVICE, AND ASSOCIATED BALANCE-OF-PLANT EQUIPMENT:

SEPTEMBER 1995 - DECEMBER 1996

DOE Cooperative Agreement Number
DE-FC21-90MC25140 -- 25 b

ACQUISITION & ASSISTANCE
1998 OCT 14 P 12:44
USDOE-FE1C

VOLUME II

Prepared by:
Southern Company Services, Inc.
Power Systems Development Facility
P.O. Box 1069
Wilsonville, AL 35186

August 1998

POWER SYSTEMS DEVELOPMENT FACILITY

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor Southern Company Services, Inc., nor any of its employees, nor any of its subcontractors, nor any of its sponsors or cofunders, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. Phone orders accepted at (703) 487-4650.

CONTENTS

<u>Section</u>	<u>Page</u>
Title Page	Inside Cover
Disclaimer	
Acknowledgements	
VOLUME 1	
Listing of Tables and Figures	vii
1.0 EXECUTIVE SUMMARY.....	1.0-1
2.0 INTRODUCTION.....	2.1-1
2.1 The Power Systems Development Facility.....	2.1-1
2.2 Transport Reactor System Description.....	2.2-1
2.3 Westinghouse Particulate Control Device.....	2.3-1
2.4 Balance-of-Plant.....	2.4-1
3.0 SCHEDULE OF PSDF START-UP/COMMISSIONING ACTIVITIES.....	3.0-1
4.0 DESIGN, PROCUREMENT, AND INSTALLATION.....	4.1.1-1
4.1 Conceptual Design.....	4.1.1-1
4.1.1 Transport Reactor Train.....	4.1.1-1
4.1.2 Balance-of-Plant.....	4.1.2-1
4.2 Procurement.....	4.2.1-1
4.2.1 Transport Reactor Train.....	4.2.1-1
4.2.2 Balance-of-Plant.....	4.2.2-1
4.3 Installation.....	4.3-1
5.0 COMMISSIONING OF M. W. KELLOGG TRANSPORT REACTOR TRAIN.....	5.1.1-1
5.1 Transport Reactor Loop.....	5.1.1-1
5.1.1 Commissioning Test Run CR01.....	5.1.1-1
5.1.2 Commissioning Test Run CR02.....	5.1.2-1

5.1.3 Commissioning Test Run CR03 5.1.3-1
 5.1.4 Commissioning Test Run CR04 5.1.4-1
 5.1.5 Characterization Test Run CCT1A 5.1.5-1
 5.1.6 Characterization Test Run CCT1B 5.1.6-1
 5.1.7 Characterization Test Run CCT1C 5.1.7-1
 5.1.8 Characterization Test Run CCT2A 5.1.8-1
 5.1.9 Characterization Test Run CCT2B 5.1.9-1
 5.1.10 Characterization Test Run CCT2C 5.1.10-1

TERMS PSDF Terms-1

VOLUME 2

5.1.11 Disengager Performance Tests 5.1.11-1
 5.1.12 Solids Conveying System 5.1.12-1
 5.1.13 Pressure Letdown Valve 5.1.13-1

5.2 Operability Analysis of Commissioning Tests 5.2.1-1

5.2.1 Analysis of the Reactor Coal Feed Rate and Comparison
 With Other Processes 5.2.1-1
 5.2.2 The Relationship Between the Coal Feed Rate and Solid
 Circulation Rate 5.2.2-1
 5.2.3 The Relationship Between the Reactor Temperature and
 the Coal Feed Rate 5.2.3-1
 5.2.4 Solid Carryover and Cyclone Separation Efficiency 5.2.4-1
 5.2.5 Riser Pressure Drop and Solid Circulation Rate 5.2.5-1

6.0 COMMISSIONING OF WESTINGHOUSE PARTICLE
 FILTER SYSTEM 6.1.1-1

6.1 Westinghouse Filter System 6.1.1-1

6.1.1 1996 PCD Overview 6.1.1-1
 6.1.2 Westinghouse PCD FL0301 System Description 6.1.2-1
 6.1.3 Westinghouse PCD Installation 6.1.3-1
 6.1.4 Candle Layout #1 6.1.4-1
 6.1.5 Westinghouse PCD Gasket 6.1.5-1
 6.1.6 Test Run CCT1A 6.1.6-1
 6.1.7 Test Run CCT1B 6.1.7-1
 6.1.8 Test Run CCT1C 6.1.8-1
 6.1.9 Candle Layout #2 6.1.9-1
 6.1.10 Test Run CCT2A 6.1.10-1

6.1.11	Test Run CCT2B	6.1.11-1
6.1.12	Test Run CCT2C	6.1.12-1
6.1.13	Coal Combustion Characterization Test CCT3	6.1.13-1
6.1.14	Filter System Permeance	6.1.14-1
6.1.15	Monitoring Ash Level in the Westinghouse PCD FL0301.....	6.1.15-1
6.2	High-Pressure Air and High-Pressure Nitrogen System	6.2.1-1
6.2.1	High-Pressure Air System	6.2.1-1
6.2.2	High-Pressure Nitrogen System	6.2.2-1
6.3	PCD Fines Removal System Commissioning.....	6.3.1-1
6.3.1	PCD Fines Screw Cooler	6.3.1-1
6.3.2	PCD Fines Transporter.....	6.3.2-1
7.0	SOUTHERN RESEARCH INSTITUTE (SRI) PARTICULATE SAMPLING SYSTEM	7.1-1
7.1	Description of Particulate Sampling System	7.1-1
7.2	Cold Shakedown.....	7.2-1
7.3	Hot Shakedown	7.3-1
7.4	System Modifications.....	7.4-1
7.5	Initial Sampling Runs.....	7.5-1
7.6	Port Inspection.....	7.6-1
7.7	Summary	7.7-1
7.8	Major Events (Chronology).....	7.8-1
8.0	BALANCE-OF-PLANT.....	8.1.1-1
8.1	Feedstock Preparation.....	8.1.1-1
8.1.1	Coal and Sorbent (Feedstock) Reclaim System Description.....	8.1.1-1
8.1.2	MWK Coal Mill Process Description.....	8.1.2-1
8.1.3	MWK Sorbent Mill Process Description	8.1.3-1
8.2	Main Air Compressor	8.2.1-1
8.2.1	Description.....	8.2.1-1
8.2.2	Commissioning Tests/Runs	8.2.2-1
8.2.3	Highlights of Problems and Solutions.....	8.2.3-1
8.2.4	Performance During Normal Operation.....	8.2.4-1

8.3	Transport Air System	8.3.1-1
8.3.1	Description.....	8.3.1-1
8.3.2	Commissioning Tests/Runs.....	8.3.2-1
8.3.3	Highlights of Problems and Solutions	8.3.3-1
8.4	Recycle Gas Booster Compressor	8.4.1-1
8.4.1	Description.....	8.4.1-1
8.4.2	Commissioning Tests/Runs.....	8.4.2-1
8.4.3	Performance During Normal Operation	8.4.3-1
8.5	Process Gas Sampling System	8.5.1-1
8.5.1	System Description	8.5.1-1
8.5.2	Alternative Conceptual Designs Considered for Sample Extraction and Transport.....	8.5.2-1
8.5.3	Sample Conditions at Extraction	8.5.3-1
8.5.4	Checkout and Commissioning Experience	8.5.4-1
8.5.5	Operational Experience	8.5.5-1
8.6	Thermal Oxidizer	8.6.1-1
8.6.1	Description.....	8.6.1-1
8.6.2	Commissioning Tests/Runs.....	8.6.2-1
8.6.3	Highlights of Problems and Solutions	8.6.3-1
8.6.4	Performance During Normal Operation	8.6.4-1
8.7	Steam System	8.7.1-1
8.7.1	Description.....	8.7.1-1
8.7.2	Commissioning Tests/Runs.....	8.7.2-1
8.7.3	Highlights of Problems and Solutions	8.7.3-1
8.8	Sulfator System	8.8.1-1
8.8.1	System Description	8.8.1-1
8.8.2	Commissioning Status.....	8.8.2-1
8.8.3	Commissioning Experience	8.8.3-1
8.8.4	Sulfator Start-Up Heater Performance Test	8.8.4-1
8.8.5	Other General Problems.....	8.8.5-1

8.9	Baghouse, Baghouse Ash Removal, and MWK Ash Storage System.....	8.9.1-1
8.9.1	Baghouse Commissioning Report	8.9.1-1
8.9.2	Baghouse Ash Removal System.....	8.9.2-1
8.9.3	MWK Ash Storage.....	8.9.3-1
8.10	Heat Transfer Fluid System	8.10.1-1
8.10.1	Description.....	8.10.1-1
8.10.2	Commissioning/Operations.....	8.10.2-1
8.11	Medium- and Low-Pressure Nitrogen System.....	8.11.1-1
8.11.1	Description.....	8.11.1-1
8.11.2	Commissioning/Operating Experience.....	8.11.2-1
8.12	Propane System.....	8.12.1-1
8.12.1	Description.....	8.12.1-1
8.12.2	Commissioning/Operations.....	8.12.2-1
8.12.3	Performance During Normal Operations	8.12.3-1
8.13	Service and Instrument Air System.....	8.13.1-1
8.13.1	Description.....	8.13.1-1
8.13.2	Commissioning/Operations.....	8.13.2-1
8.14	Closed-Loop Cooling, Circulating, and Service Water Systems	8.14.1-1
8.14.1	MWK Closed-Loop Cooling Water System	8.14.1-1
8.14.2	SCS Closed-Loop Cooling Water System.....	8.14.2-1
8.14.3	Circulating Water System.....	8.14.3-1
8.14.4	Service Water System	8.14.4-1
8.15	Waste Water Treatment/Chemical Injection.....	8.15.1-1
8.15.1	Description.....	8.15.1-1
8.15.2	Commissioning/Operations.....	8.15.2-1
8.16	Station Service and Diesel Generator.....	8.16.1-1
8.16.1	Station Service	8.16.1-1
8.16.2	Diesel Generator.....	8.16.2-1

8.17 Flare System 8.17.1-1

 8.17.1 Description..... 8.17.1-1

 8.17.2 Commissioning Tests/Runs..... 8.17.2-1

9.0 SUPPORT SERVICES 9.1.1-1

 9.1 Data Management Systems 9.1.1-1

 9.1.1 LIMS 9.1.1-1

 9.1.2 PI..... 9.1.2-1

 9.2 Operations and Maintenance 9.2.1-1

 9.2.1 Ultrasonic Thickness Measurements..... 9.2.1-1

 9.2.2 Vibration Monitoring 9.2.2-1

 9.2.3 Thermal Scan 9.2.3-1

 9.3 DCS and PLC Configuration and Support..... 9.3-1

 9.4 Environmental and Safety 9.4.1-1

 9.4.1 Environmental 9.4.1-1

 9.4.2 Safety..... 9.4.2-1

TERMSPSDF Terms-1

Listing of Tables
(Page 1 of 2)

<u>Table</u>	<u>Page</u>
VOLUME 1	
2.2-1	Major Equipment in the Transport Reactor Train2.3-3
2.2-2	Major Equipment in the Balance-of-Plant 2.2-4
3-1	Operational Dates for Various Systems in the Transport Reactor Train Along With Systems Associated With the Westinghouse PCD and Balance-of-Plant.....3.0-2
3-2	Chronology of Major Events During Installation, Checkout, Shakedown, and Commissioning of Westinghouse PCD and Associated Systems.....3.0-4
3-3	Chronology of Initial Commissioning and Characterization Test Runs3.0-5
5.1.7-1	Results From Reactor Loop Skin Temperature Surveys..... 5.1.7-12
5.1.9-1	Results From Reactor Loop Skin Temperature Surveys.....5.1.9-8
VOLUME 2	
5.1.11A-1	Average Test Conditions 5.1.11-6
5.1.11A-2	Sand Makeup Into Reactor..... 5.1.11-6
5.1.11A-3	Summary of Results 5.1.11-6
5.1.11B-1	Disengager Test Results (GEESI) 5.1.11-7
5.2.1-1	Comparison of Heat Release Rates From Different Combustion Processes5.2.1-4
6.1.6-1	CCT1A Run Statistics6.1.6-6
6.1.6-2	CCT1A Major Events (Refer to Figures 6.1.6-1 and -2)6.1.6-6
6.1.7-1	CCT1B Run Statistics6.1.7-4
6.1.7-2	CCT1B Major events (Refer to Figures 6.1.8-1 and -2)6.1.7-4
6.1.8-1	CCT1C Run Statistics.....6.1.8-10
6.1.8-2	CCT1C Major Events (Refer to Figures 6.1.8-1 and -2)6.1.8-11

Listing of Tables
(Page 2 of 2)

<u>Table</u>	<u>Page</u>
6.1.9-1 Element Information for FL0301 Top Plenum	6.1.9-2
6.1.9-2 Element Information for FL0301 Bottom Plenum Tubesheet ID Numbers 1 through 30.....	6.1.9-3
6.1.9-3 Element Information for FL0301 Bottom Plenum Tubesheet ID Numbers 31 through 55.....	6.1.9-4
6.1.10-1 CCT2A, Phase 1 Run Statistics	6.1.10-6
6.1.10-2 CCT2A, Phase 1 Major Events (Refer to Figures 6.1.10-1 and -2)	6.1.10-7
6.1.10-3 CCT2A, Phase 2 Run Statistics	6.1.10-8
6.1.10-4 CCT2A, Phase 2 Major Events (Refer to Figures 6.1.10-3 and -4)	6.1.10-8
6.1.11-1 CCT2B Run Statistics.....	6.1.11-5
6.1.11-2 CCT2B Major Events (Refer to Figures 6.1.11-1 and -2)	6.1.11-5
6.1.12-1 CCT2C Run Statistics	6.1.12-8
6.1.12-2 CCT2C Major Events (Refer to Figures 6.1.12-1 and -2)	6.1.12-8
6.1.12-3 Sampling Parameters and Process Conditions	6.1.12-9
6.1.12-4 Measured Particulate Loadings	6.1.12-9
6.1.13-1 CCT3 Run Statistics	6.1.13-4
6.1.13-2 CCT3 Major Events (Refer to Figures 6.1.15-1 and -2).....	6.1.13-4
8.5.1-1 Process Gas Sampling System Instruments	8.5.1-2
8.5.1-2 Calibration Ranges for the GC.....	8.5.1-2

Listing of Figures

<u>Figure</u>		<u>Page</u>
VOLUME 1		
1-1	Schematic Process Flow Diagram of the Transport Reactor Train.....	1.0-9
1-2	Combustion Test Runs With Hours of Solids Circulation and Coal Feed.....	1.0-10
1-3	Cluster Being Lifted From the Specially Designed Levels of the Maintenance Bay.....	1.0-11
2.2-1	Flow Diagram of the Transport Reactor Train	2.2-7
5.1.2-1	Start-Up Burner Flow/Temperature for June 11 Through 15, 1996.....	5.1.2-3
5.1.2-2	Reactor Mixing Zone and Riser Temperatures for June 11 Through 15, 1996.....	5.1.2-4
5.1.2-3	Standpipe/Dipleg Temperatures for June 11 Through 15, 1996	5.1.2-5
5.1.2-4	PCD Temperatures for June 11 Through 15, 1996.....	5.1.2-6
5.1.2-5	Reactor Pressure/Standpipe DP for June 11 Through 15, 1996.....	5.1.2-7
5.1.2-6	Reactor Flows for June 11 Through 15, 1996	5.1.2-8
5.1.2-7	CO0201 System Profile for June 10 Through June 12, 1996	5.1.2-9
5.1.3-1	CO0201 System Profile for June 17 Through 20, 1996.....	5.1.3-4
5.1.3-2	CO0201 Fourth-Stage Vane Position for June 17 Through 20, 1996	5.1.3-5
5.1.3-3	Transport Air System for June 17 Through 20, 1996	5.1.3-6
5.1.3-4	Coal Feed for June 17 Through 20, 1996	5.1.3-7
5.1.3-5	FD0210 Conveying Line Pres/Flow for June 17 Through 20, 1996	5.1.3-8
5.1.3-6	Start-Up Burner Flow/Temperature for June 17 Through 20, 1996.....	5.1.3-9
5.1.3-7	System Pressures Downstream of PCD June 17 Through 20, 1996	5.1.3-10
5.1.3-8	Total Gas In/Out Flow Rates for June 17 Through 20, 1996	5.1.3-11
5.1.3-9	Reactor Mixing Zone and Riser Temperatures for 17 Through June 20, 1996.....	5.1.3-12
5.1.3-10	Standpipe Temperatures for June 17 Through 20, 1996.....	5.1.3-13
5.1.3-11	Cyclone Dipleg Temperatures for June 17 Through 20, 1996	5.1.3-14
5.1.3-12	Temperature Profiles Downstream of Reactor for June 17 Through 20, 1996	5.1.3-15
5.1.3-13	System Temperatures Downstream of PCD for June 17 Through 20, 1996.....	5.1.3-16
5.1.3-14	Mixing Zone DP Profile for June 17 Through 20, 1996	5.1.3-17
5.1.3-15	Reactor Pressure/Riser DP Profiles for June 17 Through 20, 1996	5.1.3-18
5.1.3-16	Standpipe DP Profiles for June 17 Through 20, 1996	5.1.3-19
5.1.3-17	FD0510 Temperature Profiles for June 17 Through 20, 1996.....	5.1.3-20

5.1.3-18	Steam Drum Pressure and BFW Temperature for 17 Through June 20, 1996.....	5.1.3-21
5.1.3-19	Baghouse Temperatures and Differential Pressure for June 17 Through June 20, 1996	5.1.3-22
5.1.4-1	CO0201 System Profile for June 27 Through July 1, 1996.....	5.1.4-6
5.1.4-2	Recycle Gas System Temperatures for June 27 Through July 1, 1996.....	5.1.4-7
5.1.4-3	Recycle Gas System Pressure for June 27 Through July 1, 1996	5.1.4-8
5.1.4-4	Transport Air System for June 27 Through July 1, 1996	5.1.4-9
5.1.4-5	Coal Feed for June 27 Through July 1, 1996	5.1.4-10
5.1.4-6	Sorbent Feed for June 27 Through July 1, 1996	5.1.4-11
5.1.4-7	Start-Up Burner Flow/Temperature for June 27 Through July 1, 1996	5.1.4-12
5.1.4-8	System Pressures Downstream of PCD for June 27 Through July 1, 1996	5.1.4-13
5.1.4-9	Total Gas In/Out Flow Rates for June 27 Through July 1, 1996	5.1.4-14
5.1.4-10	Reactor Mixing Zone and Riser Temperatures for June 27 Through July 1, 1996	5.1.4-15
5.1.4-11	Standpipe Temperatures for June 27 Through July 1, 1996.....	5.1.4-16
5.1.4-12	Cyclone Dipleg Temperatures for June 27 Through July 1, 1996	5.1.4-17
5.1.4-13	Temperature Profiles Downstream of Reactor for June 27 Through July 1, 1996.....	5.1.4-18
5.1.4-14	System Temperatures Downstream of PCD for June 27 Through July 1, 1996.....	5.1.4-19
5.1.4-15	Mixing Zone DP Profile for June 27 Through July 1, 1996	5.1.4-20
5.1.4-16	Reactor Pressure/Riser DP Profiles for June 27 Through July 1, 1996	5.1.4-21
5.1.4-17	Standpipe DP Profiles for June 27 Through July 1, 1996	5.1.4-22
5.1.4-18	CY0201 Dipleg DP Profiles for June 27 Through July 1, 1996	5.1.4-23
5.1.5-1	CO0201 System Profile for July 22 Through 24, 1996	5.1.5-7
5.1.5-2	Transport Air System for July 22 Through 24, 1996.....	5.1.5-8
5.1.5-3	Coal Feed for July 22 Through 24, 1996.....	5.1.5-9
5.1.5-4	Sorbent Feed for July 22 Through 24, 1996.....	5.1.5-10
5.1.5-5	Start-Up Burner Flow/Temperature for July 22 Through 24, 1996.....	5.1.5-11
5.1.5-6	System Pressures Downstream of PCD for July 22 Through 24, 1996.....	5.1.5-12
5.1.5-7	Total Gas In/Out Flow Rates for July 22 Through 24, 1996	5.1.5-13
5.1.5-8	Reactor Mixing Zone and Riser Temperatures for July 22 Through 24, 1996.....	5.1.5-14
5.1.5-9	Standpipe Temperatures for July 22 Through 24, 1996	5.1.5-15
5.1.5-10	Cyclone Dipleg Temperatures for July 22 Through 24, 1996.....	5.1.5-16

5.1.5-11	Temperature Profiles Downstream of Reactor for July 22 Through 24, 1996.....	5.1.5-17
5.1.5-12	PCD Ash Temperatures for July 22 Through 24, 1996	5.1.5-18
5.1.5-13	System Temperatures Downstream of PCD for July 22 Through 24, 1996.....	5.1.5-19
5.1.5-14	Reactor Pressure/Riser DP Profiles for July 22 Through 24, 1996.....	5.1.5-20
5.1.5-15	Standpipe DP Profiles for July 22 Through 24, 1996.....	5.1.5-21
5.1.5-16	CY0201 Dipleg DP Profiles for July 22 Through 24, 1996.....	5.1.5-22
5.1.5-17	FD0520 Pressures for July 22 Through 24, 1996.....	5.1.5-23
5.1.5-18	FD0530 Feeder for July 22 Through 24, 1996.....	5.1.5-24
5.1.5-19	CO0201 System Profile for July 25 Through 27, 1996	5.1.5-25
5.1.5-20	Transport Air System for July 25 Through 27, 1996.....	5.1.5-26
5.1.5-21	Coal Feed for July 25 Through 27, 1996.....	5.1.5-27
5.1.5-22	Sorbent Feed for July 25 Through 27, 1996.....	5.1.5-28
5.1.5-23	Start-Up Burner Flow/Temperature for July 25 Through 27, 1996.....	5.1.5-29
5.1.5-24	System Pressures Downstream of PCD for July 25 Through 27, 1996.....	5.1.5-30
5.1.5-25	Total Gas In/Out Flow Rates for July 25 Through 27, 1996.....	5.1.5-31
5.1.5-26	Reactor Mixing Zone and Riser Temperatures for July 25 Through 27, 1996.....	5.1.5-32
5.1.5-27	Standpipe Temperatures for July 25 Through 27, 1996	5.1.5-33
5.1.5-28	Cyclone Dipleg Temperatures for July 25 Through 27, 1996.....	5.1.5-34
5.1.5-29	Temperature Profiles Downstream of Reactor for July 25 Through 27, 1996.....	5.1.5-35
5.1.5-30	PCD Ash Temperatures for July 25 Through 27, 1996	5.1.5-36
5.1.5-31	System Temperatures Downstream of PCD for July 25 Through 27, 1996.....	5.1.5-37
5.1.5-32	Reactor Pressure/Riser DP Profiles for July 25 Through 27, 1996.....	5.1.5-38
5.1.5-33	Standpipe DP Profiles for July 25 Through 27, 1996.....	5.1.5-39
5.1.5-34	CY0201 Dipleg DP Profiles for July 25 Through 27, 1996.....	5.1.5-40
5.1.5-35	FD0520 Pressures for July 25 Through 27, 1996.....	5.1.5-41
5.1.5-36	FD0530 Feeder for July 25 Through 27, 1996.....	5.1.5-42
5.1.6-1	Reactor Flows for July 31 Through August 2, 1996	5.1.6-7
5.1.6-2	Start-Up Burner Flow/Temperatures for July 31 Through August 2, 1996.....	5.1.6-8
5.1.6-3	Reactor Mixing Zone and Riser Temperatures for July 31 Through August 2, 1996	5.1.6-9
5.1.6-4	Standpipe/Dipleg Temperatures for July 31 Through August 2, 1996.....	5.1.6-10
5.1.6-5	PCD Temperatures for July 31 Through August 2, 1996	5.1.6-11

5.1.6-6	Reactor Pressure/Standpipe DP for July 31 Through August 2, 1996	5.1.6-12
5.1.6-7	Outlet Gas Compositions for July 31 Through August 2, 1996	5.1.6-13
5.1.6-8	PCD Pulse System Pressures for July 31 Through August 2, 1996.....	5.1.6-14
5.1.6-9	PCD Differential Pressures for July 31 Through August 2, 1996	5.1.6-15
5.1.6-10	Reactor Flows for August 3 Through August 5, 1996	5.1.6-16
5.1.6-11	Start-Up Burner Flow/Temperature for August 3 Through August 5, 1996	5.1.6-17
5.1.6-12	Reactor Mixing Zone and Riser Temperatures for August 3 Through August 5, 1996	5.1.6-18
5.1.6-13	Standpipe/Dipleg Temperatures for August 3 Through August 5, 1996	5.1.6-19
5.1.6-14	PCD Temperatures for August 3 Through August 5, 1996	5.1.6-20
5.1.6-15	Reactor Pressure/Standpipe DP for August 3 Through August 5, 1996	5.1.6-21
5.1.6-16	Outlet Gas Compositions for August 3 Through August 5, 1996	5.1.6-22
5.1.6-17	PCD Differential Pressures for August 3 Through August 5, 1996	5.1.6-23
5.1.6-18	PCD Pulse System Pressures for August 3 Through August 5, 1996.....	5.1.6-24
5.1.6-19	Sorbent Feed for August 3 Through August 5, 1996	5.1.6-25
5.1.6-20	PV287 Erosion (View 1 of 4)	5.1.6-26
5.1.6-21	PV287 Erosion (View 2 of 4)	5.1.6-26
5.1.6-22	PV287 Erosion (View 3 of 4)	5.1.6-26
5.1.6-23	PV287 Erosion (View 4 of 4)	5.1.6-26
5.1.6-24	FD0220 Vent Valve	5.1.6-26
5.1.6-25	FD0210 Vent Valve	5.1.6-26
5.1.7-1	CO0201 System Profile for August 14 Through 16, 1996	5.1.7-13
5.1.7-2	Transport Air System for August 14 Through 16, 1996	5.1.7-14
5.1.7-3	Coal and Sorbent Silo Levels for August 14 Through 16, 1996	5.1.7-15
5.1.7-4	Coal Feed for August 14 Through 16, 1996.....	5.1.7-16
5.1.7-5	Sorbent Feed for August 14 Through 16, 1996.....	5.1.7-17
5.1.7-6	Start-Up Burner Flow/Temperature for August 14 Through 16, 1996.....	5.1.7-18
5.1.7.7	System Pressures Downstream of PCD for August 14 Through 16, 1996.....	5.1.7-19
5.1.7.8	Total Gas In/Out Flow Rates for August 14 Through 16, 1996.....	5.1.7-20
5.1.7-9	Reactor Mixing Zone and Riser Temperatures for August 14 Through 16, 1996.....	5.1.7-21
5.1.7-10	Standpipe Temperatures for August 14 Through 16, 1996	5.1.7-22
5.1.7-11	Cyclone Dipleg Temperatures for August 14 Through 16, 1996.....	5.1.7-23
5.1.7-12	Temperature Profiles Downstream of Reactor for August 14 Through 16, 1996.....	5.1.7-24
5.1.7-13	PCD Ash Temperatures for August 14 Through 16, 1996	5.1.7-25

5.1.7-14	System Temperatures Downstream of PCD for August 14 Through 16, 1996.....	5.1.7-26
5.1.7-15	Reactor Pressure/Riser DP Profiles for August 14 Through 16, 1996.....	5.1.7-27
5.1.7-16	Standpipe DP Profiles for August 14 Through 16, 1996.....	5.1.7-28
5.1.7-17	CY0201 Dipleg DP Profiles for August 14 Through 16, 1996.....	5.1.7-29
5.1.7-18	O ₂ , SO ₂ , and NO _x Analyzers for August 14 Through 16, 1996.....	5.1.7-30
5.1.7-19	CO and H ₂ O Analyzer for August 14 Through 16, 1996.....	5.1.7-31
5.1.7-20	FD0510 Temperature Profiles for August 14 Through 16, 1996.....	5.1.7-32
5.1.7-21	FD0206 Pressure Profiles for August 14 Through 16, 1996.....	5.1.7-33
5.1.7-22	FD0520 Pressures for August 14 Through 16, 1996.....	5.1.7-34
5.1.7-23	FD0530 Feeder for August 14 Through 16, 1996.....	5.1.7-35
5.1.7-24	FD0530 Feeder for August 14 Through 16, 1996.....	5.1.7-36
5.1.7-25	PCD Temperatures for August 14 Through 16, 1996.....	5.1.7-37
5.1.7-26	PCD Differential Pressures for August 14 Through 16, 1996.....	5.1.7-38
5.1.7-27	PCD Pressure and Pulse Pressure for August 14 Through 16, 1996.....	5.1.7-39
5.1.7-28	CO0201 System Profile for August 17 Through 19, 1996.....	5.1.7-40
5.1.7-29	Transport Air System for August 17 Through 19, 1996.....	5.1.7-41
5.1.7-30	Coal and Sorbent Silo Levels for August 17 Through 19, 1996.....	5.1.7-42
5.1.7-31	Coal Feed for August 17 Through 19, 1996.....	5.1.7-43
5.1.7-32	Sorbent Feed for August 17 Through 19, 1996.....	5.1.7-44
5.1.7-33	Start-Up Burner Flow/Temperature for August 17 Through 19, 1996.....	5.1.7-45
5.1.7-34	System Pressures Downstream of PCD for August 17 Through 19, 1996.....	5.1.7-46
5.1.7-35	Total Gas In/Out Flow Rates for August 17 Through 19, 1996.....	5.1.7-47
5.1.7-36	Reactor Mixing Zone and Riser Temperatures for August 17 Through 19, 1996.....	5.1.7-48
5.1.7-37	Standpipe Temperatures for August 17 Through 19, 1996.....	5.1.7-49
5.1.7-38	Cyclone Dipleg Temperatures for August 17 Through 19, 1996.....	5.1.7-50
5.1.7-39	Temperature Profiles Downstream of Reactor for August 17 Through 19, 1996.....	5.1.7-51
5.1.7-40	PCD Ash Temperatures for August 17 Through 19, 1996.....	5.1.7-52
5.1.7-41	System Temperatures Downstream of PCD for August 17 Through 19, 1996.....	5.1.7-53
5.1.7-42	Reactor Pressure/Riser DP Profiles for August 17 Through 19, 1996.....	5.1.7-54
5.1.7-43	Standpipe DP Profiles for August 17 Through 19, 1996.....	5.1.7-55
5.1.7-44	CY0201 Dipleg DP Profiles for August 17 Through 19, 1996.....	5.1.7-56
5.1.7-45	O ₂ , SO ₂ , and NO _x Analyzers for August 17 Through 19, 1996.....	5.1.7-57
5.1.7-46	CO and H ₂ O Analyzer for August 17 Through 19, 1996.....	5.1.7-58
5.1.7-47	FD0510 Temperature Profiles for August 17 Through 19, 1996.....	5.1.7-59

5.1.7-48	FD0206 Pressure Profiles for August 17 Through 19, 1996.....	5.1.7-60
5.1.7-49	FD0520 Pressures for August 17 Through 19, 1996.....	5.1.7-61
5.1.7-50	FD0530 Feeder for August 17 Through 19, 1996.....	5.1.7-62
5.1.7-51	FD0530 Feeder for August 17 Through 19, 1996.....	5.1.7-63
5.1.7-52	PCD Temperatures for August 17 Through 19, 1996.....	5.1.7-64
5.1.7-53	PCD Differential Pressures for August 17 Through 19, 1996.....	5.1.7-65
5.1.7-54	PCD Pressure and Pulse Pressure for August 17 Through 19, 1996	5.1.7-66
5.1.7-55	CO0201 System Profile for August 20 Through 23, 1996	5.1.7-67
5.1.7-56	Transport Air System for August 20 Through 23, 1996.....	5.1.7-68
5.1.7-57	Coal and Sorbent Silo Levels for August 20 Through 23, 1996	5.1.7-69
5.1.7-58	Coal Feed for August 20 Through 23, 1996.....	5.1.7-70
5.1.7-59	Sorbent Feed for August 20 Through 23, 1996.....	5.1.7-71
5.1.7-60	Start-Up Burner Flow/Temperature August 20 Through 23, 1996	5.1.7-72
5.1.7-61	System Pressures Downstream of PCD for August 20 Through 23, 1996.....	5.1.7-73
5.1.7-62	Total Gas In/Out Flow Rates for August 20 Through 23, 1996.....	5.1.7-74
5.1.7-63	Reactor Mixing Zone and Riser Temperatures for August 20 Through 23, 1996.....	5.1.7-75
5.1.7-64	Standpipe Temperatures for August 20 Through 23, 1996	5.1.7-76
5.1.7-65	Cyclone Dipleg Temperatures for August 20 Through 23, 1996.....	5.1.7-77
5.1.7-66	Temperature Profiles Downstream of Reactor for August 20 Through 23, 1996.....	5.1.7-78
5.1.7-67	PCD Ash Temperatures for August 20 Through 23, 1996	5.1.7-79
5.1.7-68	System Temperatures Downstream of PCD for August 20 Through 23, 1996.....	5.1.7-80
5.1.7-69	Reactor Pressure/Riser DP Profiles for August 20 Through 23, 1996.....	5.1.7-81
5.1.7-70	Standpipe DP Profiles for August 20 Through 23, 1996.....	5.1.7-82
5.1.7-71	CY0201 Dipleg DP Profiles for August 20 Through 23, 1996.....	5.1.7-83
5.1.7-72	O ₂ , SO ₂ , and NO _x Analyzers for August 20 Through 23, 1996	5.1.7-84
5.1.7-73	CO and H ₂ O Analyzer for August 20 Through 23, 1996.....	5.1.7-85
5.1.7-74	FD0510 Temperature Profiles for August 20 Through 23, 1996	5.1.7-86
5.1.7-75	FD0206 Pressure Profiles for August 20 Through 23, 1996.....	5.1.7-87
5.1.7-76	FD0520 Pressures for August 20 Through 23, 1996.....	5.1.7-88
5.1.7-77	FD0530 Feeder for August 20 Through 23, 1996.....	5.1.7-89
5.1.7-78	FD0530 Feeder for August 20 Through 23, 1996.....	5.1.7-90
5.1.7-79	PCD Temperatures for August 20 Through 23, 1996.....	5.1.7-91
5.1.7-80	PCD Differential Pressures for August 20 Through 23, 1996.....	5.1.7-92
5.1.7-81	PCD Pressure and Pulse Pressure for August 20 Through 23, 1996	5.1.7-93
5.1.7-82	Coal and Dolomite Solids Size Distribution Run CCT1C.....	5.1.7-94
5.1.7-83	Solids Size Distribution Run CCT1C August 16 to 19, 1996	5.1.7-95
5.1.7-84	Solids Size Distribution Run CCT1C August 20 to 21, 1996	5.1.7-96

5.1.8-1	CO0201 System Profile for September 27 Through 30, 1996	5.1.8-6
5.1.8-2	Total Gas In/Out Flow Rates for September 27 Through 30, 1996	5.1.8-7
5.1.8-3	Reactor Mixing Zone and Riser Temperatures for September 27 Through 30, 1996	5.1.8-8
5.1.8-4	Standpipe Temperatures for September 27 Through 30, 1996	5.1.8-9
5.1.8-5	Cyclone Dipleg Temperatures for September 27 Through 30, 1996	5.1.8-10
5.1.8-6	Temperature Profiles Downstream of Reactor for September 27 Through 30, 1996	5.1.8-11
5.1.8-7	System Temperatures Downstream of PCD for September 27 Through 30, 1996	5.1.8-12
5.1.8-8	Reactor Pressure/Riser DP Profiles for September 27 Through September 30, 1996	5.1.8-13
5.1.8-9	CO0201 System Profile for October 2 Through October 6, 1996	5.1.8-14
5.1.8-10	Transport Air System for October 2 Through October 6, 1996	5.1.8-15
5.1.8-11	Start-Up Burner Flow Temperature for October 2 Through October 6, 1996	5.1.8-16
5.1.8-12	System Pressures Downstream of PCD for October 2 Through October 6, 1996	5.1.8-17
5.1.8-13	Total Gas In/Out Flow Rates for October 2 Through 6, 1996	5.1.8-18
5.1.8-14	Reactor Mixing Zone and Riser Temperatures for October 2 Through October 6, 1996	5.1.8-19
5.1.8-15	Standpipe Temperatures for October 2 Through October 6, 1996	5.1.8-20
5.1.8-16	Cyclone Dipleg Temperatures for October 2 Through October 6, 1996	5.1.8-21
5.1.8-17	Temperature Profiles Downstream of Reactor for October 2 Through October 6, 1996	5.1.8-22
5.1.8-18	PCD Ash Temperatures for October 2 Through October 6, 1996	5.1.8-23
5.1.8-19	System Temperatures Downstream of PCD for October 2 Through October 6, 1996	5.1.8-24
5.1.8-20	Mixing Zone DP Profile for October 2 Through October 6, 1996	5.1.8-25
5.1.8-21	Reactor Pressure/Riser DP Profiles for October 2 Through October 6, 1996	5.1.8-26
5.1.8-22	Standpipe DP Profiles for October 2 Through October 6, 1996	5.1.8-27
5.1.8-23	CY0201 Dipleg DP Profiles for October 2 Through October 6, 1996 ..	5.1.8-28
5.1.8-24	CO0201 System Profile for October 14 Through October 17, 1996	5.1.8-29
5.1.8-25	Transport Air System for October 14 Through October 17, 1996	5.1.8-30
5.1.8-26	Start-Up Burner Flow/Temperature for October 14 Through October 17, 1996	5.1.8-31
5.1.8-27	System Pressures Downstream of PCD for October 14 Through October 17, 1996	5.1.8-32
5.1.8-28	Total Gas In/Out Flow Rates for October 14 Through 17, 1996	5.1.8-33
5.1.8-29	Reactor Mixing Zone and Riser Temperatures for October 14 Through October 17, 1996	5.1.8-34

5.1.8-30	Standpipe Temperature for October 14 Through October 17, 1996	5.1.8-35
5.1.8-31	Cyclone Dipleg Temperatures for October 14 Through 17, 1996	5.1.8-36
5.1.8-32	Temperature Profiles Downstream of Reactor for October 14 Through October 17, 1996	5.1.8-37
5.1.8-33	PCD Ash Temperatures for October 14 Through October 17, 1996	5.1.8-38
5.1.8-34	System Temperatures Downstream of PCD for October 14 Through October 17, 1996	5.1.8-39
5.1.8-35	Mixing Zone DP Profile for October 14 Through October 17, 1996....	5.1.8-40
5.1.8-36	Reactor Pressure/Riser DP Profiles for October 14 Through October 17, 1996	5.1.8-41
5.1.8-37	Standpipe DP Profiles for October 14 Through 17, 1996.....	5.1.8-42
5.1.8-38	CY0201 Dipleg DP Profiles for October 14 Through 17, 1996.....	5.1.8-43
5.1.8-39	FD0510 Temperature Profiles for October 14 Through 17, 1996	5.1.8-44
5.1.8-40	FD0206 Pressure Profiles for October 14 Through 17, 1996.....	5.1.8-45
5.1.8-41	FD0520 Pressures for October 14 Through 17, 1996.....	5.1.8-46
5.1.8-42	FD0530 Feeder for October 14 Through 17, 1996.....	5.1.8-47
5.1.8-43	FD0530 Feeder for October 14 Through 17, 1996.....	5.1.8-48
5.1.8-44	Disengager Cone Covered With Deposits	5.1.8-49
5.1.8-45	Disengager Cone After Removal of Deposits.....	5.1.8-49
5.1.8-46	Primary Cyclone Showing Deposit Behind the Gas Outlet Tube.....	5.1.8-50
5.1.8-47	Primary Cyclone After Removal of Deposits	5.1.8-50
5.1.9-1	CO0201 System Profile for November 3 Through 7, 1996	5.1.9-9
5.1.9-2	Transport Air System for November 3 Through 7, 1996.....	5.1.9-10
5.1.9-3	Coal Feed for November 3 Through 7, 1996.....	5.1.9-11
5.1.9-4	Sorbent Feed for November 3 Through 7, 1996.....	5.1.9-12
5.1.9-5	Start-Up Burner Flow/Temperature for November 3 Through 7, 1996	5.1.9-13
5.1.9-6	System Pressures Downstream of PCD for November 3 Through 7, 1996	5.1.9-14
5.1.9-7	Total Gas In/Out Flow Rates for November 3 Through 7, 1996	5.1.9-15
5.1.9-8	Reactor Mixing Zone and Riser Temperatures for November 3 Through 7, 1996	5.1.9-16
5.1.9-9	Standpipe Temperatures for November 3 Through 7, 1996	5.1.9-17
5.1.9-10	Cyclone Dipleg Temperatures for November 3 Through 7, 1996.....	5.1.9-18
5.1.9-11	Temperature Profiles Downstream of Reactor for November 3 Through 7, 1996	5.1.9-19
5.1.9-12	PCD Ash Temperatures for November 3 Through 7, 1996	5.1.9-20
5.1.9-13	System Temperatures Downstream of PCD for November 3 Through 7, 1996	5.1.9-21
5.1.9-14	Mixing Zone DP Profile for November 3 Through 7, 1996.....	5.1.9-22
5.1.9-15	Reactor Pressure/Riser DP Profiles for November 3 Through 7, 1996.....	5.1.9-23

5.1.9-16	Standpipe DP Profiles for November 3 Through 7, 1996.....	5.1.9-24
5.1.9-17	CY0201 Dipleg DP Profiles for November 3 Through 7, 1996.....	5.1.9-25
5.1.9-18	O ₂ , SO ₂ , and NO _x Analyzers for November 3 Through 7, 1996	5.1.9-26
5.1.9-19	FD0520 Pressures for November 3 Through 7, 1996.....	5.1.9-27
5.1.9-20	FD0530 Feeder for November 3 Through 7, 1996.....	5.1.9-28
5.1.9-21	FD0530 Feeder for November 3 Through 7, 1996.....	5.1.9-29
5.1.9-22	Feed Sand and PCD Solids Particle Size Distribution on November 4, 1996.....	5.1.9-30
5.1.9-23	Feed Sand and PCD Solids Particle Size Distribution on November 4, 1996.....	5.1.9-31
5.1.9-24	Standpipe and PCD Solids Particle Size Distribution on November 5, 1996.....	5.1.9-32
5.1.9-25	PCD Solids Particle Size Distribution on November 6 and 7, 1996	5.1.9-33
5.1.10-1	CO0201 System Profile for November 14 Through 17, 1996.....	5.1.10-11
5.1.10-2	Transport Air System for November 14 Through 17, 1996	5.1.10-12
5.1.10-3	Coal Feed for November 14 Through 17, 1996	5.1.10-13
5.1.10-4	Sorbent Feed for November 14 Through 17, 1996	5.1.10-14
5.1.10-5	Start-Up Burner Flow/Temperature for November 14 Through 17, 1996.....	5.1.10-15
5.1.10-6	System Pressures Downstream of PCD for November 14 Through 17, 1996.....	5.1.10-16
5.1.10-7	Total Gas In/Out Flow Rates for November 14 Through 17, 1996	5.1.10-17
5.1.10-8	Reactor Mixing Zone and Riser Temperatures for November 14 Through 17, 1996.....	5.1.10-18
5.1.10-9	Standpipe Temperatures for November 14 Through 17, 1996.....	5.1.10-19
5.1.10-10	Cyclone Dipleg Temperatures for November 14 Through 17, 1996	5.1.10-20
5.1.10-11	Temperature Profiles Downstream of Reactor for November 14 Through 17, 1996.....	5.1.10-21
5.1.10-12	PCD Ash Temperatures for November 14 Through 17, 1996.....	5.1.10-22
5.1.10-13	System Temperatures Downstream of PCD for November 14 Through 17, 1996.....	5.1.10-23
5.1.10-14	Mixing Zone DP Profile for November 14 Through 17, 1996	5.1.10-24
5.1.10-15	Reactor Pressure/Riser DP Profiles for November 14 Through 17, 1996	5.1.10-25
5.1.10-16	Standpipe DP Profiles for November 14 Through 17, 1996	5.1.10-26
5.1.10-17	CY0201 Dipleg DP Profiles for November 14 Through 17, 1996	5.1.10-27
5.1.10-18	Coal Feed Rate for November 14 Through 17, 1996.....	5.1.10-28
5.1.10-19	O ₂ , SO ₂ , and NO _x Analyzers for November 14 Through 17, 1996	5.1.10-29

5.1.10-20	Solids Withdrawal for November 14 Through 17, 1996.....	5.1.10-30
5.1.10-21	FD0510 Temperature Profiles for November 14 Through 17, 1996.....	5.1.10-31
5.1.10-22	FD0206 Pressure Profiles for November 14 Through 17, 1996.....	5.1.10-32
5.1.10-23	FD0520 Pressures for November 14 Through 17, 1996.....	5.1.10-33
5.1.10-24	FD0530 Feeder for November 14 Through 17, 1996.....	5.1.10-34
5.1.10-25	FD0530 Feeder for November 14 Through 17, 1996.....	5.1.10-35
5.1.10-26	CO0201 System Profile for November 18 Through 22, 1996.....	5.1.10-36
5.1.10-27	Transport Air System for November 18 Through 22, 1996.....	5.1.10-37
5.1.10-28	Coal Feed for November 18 Through 22, 1996.....	5.1.10-38
5.1.10-29	Sorbent Feed for November 18 Through 22, 1996.....	5.1.10-39
5.1.10-30	Start-Up Burner Flow/Temperature for November 18 Through 22, 1996.....	5.1.10-40
5.1.10-31	System Pressures Downstream of PCD for November 18 Through 22, 1996.....	5.1.10-41
5.1.10-32	Total Gas In/Out Flow Rates for November 18 Through 22, 1996.....	5.1.10-42
5.1.10-33	Reactor Mixing Zone and Riser Temperatures for November 18 Through 22, 1996.....	5.1.10-43
5.1.10-34	Standpipe Temperatures for November 18 Through 22, 1996.....	5.1.10-44
5.1.10-35	Cyclone Dipleg Temperatures for November 18 Through 22, 1996.....	5.1.10-45
5.1.10-36	Temperature Profiles Downstream of Reactor for November 18 Through 22, 1996.....	5.1.10-46
5.1.10-37	PCD Ash Temperatures for November 18 Through 22, 1996.....	5.1.10-47
5.1.10-38	System Temperatures Downstream of PCD for November 18 Through 22, 1996.....	5.1.10-48
5.1.10-39	Mixing Zone DP Profile for November 18 Through 22, 1996.....	5.1.10-49
5.1.10-40	Reactor Pressure/Riser DP Profiles for November 18 Through 22, 1996.....	5.1.10-50
5.1.10-41	Standpipe DP Profiles for November 18 Through 22, 1996.....	5.1.10-51
5.1.10-42	CY0201 Dipleg DP Profiles for November 18 Through 22, 1996.....	5.1.10-52
5.1.10-43	Coal Feed Rate for November 18 Through 22, 1996.....	5.1.10-53
5.1.10-44	O ₂ , SO ₂ , and NO _x Analyzers for November 18 Through 22, 1996.....	5.1.10-54
5.1.10-45	Solids Withdrawal for November 18 Through 22, 1996.....	5.1.10-55
5.1.10-46	FD0510 Temperature Profiles for November 18 Through 22, 1996....	5.1.10-56
5.1.10-47	FD0206 Pressure Profiles for November 18 Through 22, 1996.....	5.1.10-57
5.1.10-48	FD0520 Pressures for November 18 Through 22, 1996.....	5.1.10-58
5.1.10-49	FD0530 Feeder for November 18 Through 22, 1996.....	5.1.10-59
5.1.10-50	FD0530 Feeder for November 18 Through 22, 1996.....	5.1.10-60

VOLUME 2

<u>Figure</u>	<u>Page</u>
5.1.11A-1 Disengager Grade Efficiency Curve	5.1.11-8
5.1.11A-2 Disengager Grade Efficiency Curve	5.1.11-9
5.1.11B-1 Schematic Diagram of Experimental Setup at GEESI	5.1.11-10
5.1.11B-2 GEESI Disengager Cold Flow Test Results	5.1.11-10
5.1.11B-3 Comparison of Disengager Performance (PSDF vs GEESI)	5.1.11-11
5.1.13-1 Comparison of Flow Characteristics of Original Cage vs Modified Cage During Startup (PV-287 Whisper III Trim)	5.1.13-3
5.1.13-2 Flow Capacity vs Percent Valve (PV-287) Open for Inlet Pressure at 500°F (View 1)	5.1.13-3
5.1.13-3 Flow Capacity vs Percent Valve (PV-287) Open for Inlet Pressure at 500°F (View 2)	5.1.13-3
5.1.13-4 Flow Capacity vs Percent Valve (PV-287) Open for Inlet Pressure at 500°F (View 3)	5.1.13-3
5.1.13-5 Flow Capacity vs Percent Valve (PV-287) Open for Inlet Pressure at 500°F (View 4)	5.1.13-4
5.1.13-6 Flow Capacity vs Percent Valve (PV-287) Open for Inlet Pressure at 500°F (View 5)	5.1.13-4
5.1.13-7 Flow Capacity vs Percent Valve (PV-287) Open for Inlet Pressure at 500°F (View 6)	5.1.13-4
5.2-1 Comparison of Coal Feed Rates Calculated From Oxygen Balance and From Weight Cell Measurements for November 19 to 20, 1996, Test Period.....	5.2 Exhibit - 1
5.2-2 Comparison of Coal Feed Rates Calculated From Oxygen Balance and From Weight Cell Measurements for November 20 to 21, 1996, Test Period.....	5.2 Exhibit - 1
5.2-3 Comparison of Coal Feed Rates Calculated From Oxygen Balance and From Weight Cell Measurements for August 19 to 20, 1996, Test Period	5.2 Exhibit - 2
5.2-4 Comparison of Coal Feed Rates Calculated From Oxygen Balance and From Weight Cell Measurements for August 20 to 21, 1996, Test Period	5.2 Exhibit - 2
5.2-5 Variation of the Required Solid Circulation Rate With the Coal Feed Rate at Different Mass Fraction of Solid Circulating Through the Reactor Standpipe	5.2 Exhibit - 3
5.2-6 Heat-Up Rate of a Single Particle vs the Dimensionless Radius...	5.2 Exhibit - 3
5.2-7 Variation of the Solid Circulation Rate With Time for the Test Period November 19 to 20, 1996.....	5.2 Exhibit - 4

5.2-8	Variation of the Measured Standpipe Pressure Difference With Time	5.2 Exhibit - 4
5.2-9	Variation of Solid Circulation Rate With the Standpipe Pressure Difference	5.2 Exhibit - 5
5.2-10	The Relationship Between the Coal Feed Rate and Solid Circulation Rate for the Test Period of November 19 to 20, 1996	5.2 Exhibit - 5
5.2-11	The Variation of Coal Feed Rate With Solid Circulation Rate for the First 12 Hours of Operation November 19 to 20, 1996.....	5.2 Exhibit - 6
5.2-12	The Variation of Coal Feed Rate With Solid Circulation Rate for the Test Period of August 20 to 21, 1996.....	5.2 Exhibit - 6
5.2-13	Variation of Solids Level in the Standpipe With Time for the Test Period of August 20 to 21, 1996.....	5.2 Exhibit - 7
5.2-14	Variation of Coal Feed Rate with Solid Circulation Rate for the Test Period of November 20 to 21, 1996	5.2 Exhibit - 7
5.2-15	Coal Feed Rate Vs Riser Temperature for Test Period November 19-20, 1996	5.2 Exhibit - 8
5.2-16	Coal Feed Rate Vs Riser Temperature for Test Period November 20-21, 1996	5.2 Exhibit - 8
5.2-17	Solid Circulation Rate Vs Riser Temperature for the Operation Period of November 19 to 20, 1996	5.2 Exhibit - 9
5.2-18	Estimated Solid Carryover Rate With Time for the Operation Period of November 19 to 20, 1996	5.2 Exhibit - 9
5.2-19	Estimated Solid Circulation Rate With Time for the Test Period of November 20 to 21, 1996	5.2 Exhibit - 10
5.2-20	Estimated Cyclone System Collection Efficiency Vs Solid/Gas Loading Ratio for the Test Period of November 19 and 20, 1996	5.2 Exhibit - 10
5.2-21	Estimated Cyclone System Collection Efficiency Vs Loading Ratio for the Test Period of November 20 and 21, 1996.....	5.2 Exhibit - 11
5.2-22	Solid/Gas Estimated Cyclone Efficiency Vs Solid/Gas Loading Ratio for Given Disengager Efficiency	5.2 Exhibit - 11
5.2-23	the Required Total Collection Efficiency of the Cyclone System Vs Solid/Gas Loading Ratio to Balance the Ash Production Rate and Solid Carryover Rate	5.2 Exhibit - 12
5.2-24	Estimated Collection Efficiencies for the Individual Cyclone to Balance Ash Production Rate and Solid Carryover Rate.....	5.2 Exhibit - 12
5.2-25	The Pressure Drop Across the Primary Cyclone for the Test Period November 20 to 21, 1996	5.2 Exhibit - 13

5.2-26	The Relationship Between the Cyclone Inlet Gas Velocity and the Cyclone Pressure Drop for the Test Period of November 20 to 21, 1996.....	5.2 Exhibit - 13
5.2-27	Estimated Solid Carryover Rate Vs the Solid Circulation Rate for the Test Period of November 20 to 21, 1996	5.2 Exhibit - 14
5.2-28	Estimated Solid Carryover Rate Vs the Solid Circulation Rate for the Test Period of November 19 to 20, 1996	5.2 Exhibit - 14
5.2-29	Comparison Between the Measured Pressure Drop Across the Riser and Calculated Pressure Drops Based on the Gas-Phase Flow, Only, Riser and Gas Phase With Only Solid Feed, to Show That the Measured Pressure Drop is Low	5.2 Exhibit - 15
5.2-30	Comparison of the Measured Pressure Drop at the Top of the Riser With Calculated Pressure Drop for Test Period of November 19to 20, 1996.....	5.2 Exhibit - 15
5.2-31	Comparison of Solid Circulation Rates Calculated From Energy Balance and Pressure Difference for the Test Period of November 19 to 20, 1996.....	5.2 Exhibit - 16
5.2-32	Comparison of Solid Circulation Rates Calculated From Energy Balance and Pressure Difference for the Test Period of November 20 to 21, 1996.....	5.2 Exhibit - 16
5.2-33	Comparison of Solid Circulation Rates Calculated From Energy Balance and Pressure Difference for the Test Period of August 20 to 21, 1996	5.2 Exhibit - 17
5.2-34	Comparison of Solid Circulation Rates Calculated From Energy Balance and Pressure Difference for the Test Period of August 19 to 20, 1996	5.2 Exhibit - 17
6.1.1-1	Operation Record for the PCD Over 994 Hours in 1996.....	6.1.1-3
6.1.2-1	PCD Flow Diagram.....	6.1.2-6
6.1.2-2	Westinghouse PCD FL0301 Filter Vessel	6.1.2-7
6.1.2-3	Westinghouse PCD Pulse Skid	6.1.2-8
6.1.3-1	PCD Maintenance Bay.....	6.1.3-3
6.1.4-1	FL0301 Tubesheet Map.....	6.1.4-2
6.1.5-1	Westinghouse PCD FL0301.....	6.1.5-5
6.1.5-2	Westinghouse PCD FL0301 Gasket Details.....	6.1.5-6
6.1.5-3	Westinghouse PCD FL0301 Orientation.....	6.1.5-6
6.1.6-1	CCT1A Summary Information	6.1.6-7
6.1.6-2	CCT1A Summary Information	6.1.6-8
6.1.6-3	CCT1A PCD Hopper Samples.....	6.1.6-9

6.1.6-4	CCT1A PCD Hopper Particle Size Distribution	6.1.6-9
6.1.6-5	CCT1A Baghouse Differential Pressure	6.1.6-10
6.1.6-6	CCT1A PCD Hopper vs Baghouse Hopper PSD	6.1.6-10
6.1.7-1	CCT1B Summary Information.....	6.1.7-5
6.1.7-2	CCT1B Summary Information.....	6.1.7-6
6.1.8-1	CCT1C Summary Information	6.1.8-12
6.1.8-2	CCT1C Summary Information	6.1.8-13
6.1.8-3	CCT1C Summary Information	6.1.8-14
6.1.8-4	CCT1C Summary Information	6.1.8-15
6.1.8-5	Approximate Ash Level on August 18 15 09:00	6.1.8-16
6.1.8-6	Approximate Ash Level on August 18 at 11:30	6.1.8-17
6.1.8-7	Approximate Ash Level on August 19 at 03:45	6.1.8-18
6.1.8-8	Approximate Ash Level on August 20 at ~04:00	6.1.8-19
6.1.8-9	Approximate Ash Level on August 20 at ~16:00	6.1.8-20
6.1.8-10	Approximate Ash Level on August 21 at ~12:00	6.1.8-21
6.1.8-11	CCT1C Hopper Samples.....	6.1.8-22
6.1.8-12	CCT1C PCD Hopper Particle Size Distributions.....	6.1.8-22
6.1.8-13	CCT1C PCD Hopper Ash Chemistry (Primary Constituents)	6.1.8-23
6.1.8-14	Broken Elements After CCT1C (Top of Page Is North).....	6.1.8-24
6.1.9-1	FL0301 Tubesheet Map.....	6.1.9-5
6.1.10-1	CCT2A, Phase 1 Summary Information	6.1.10-9
6.1.10-2	CCT2A, Phase 1 Summary Information	6.1.10-10
6.1.10-3	CCT2A, Phase 2 Summary Information	6.1.10-11
6.1.10-4	CCT2A, Phase 2 Summary Information	6.1.10-12
6.1.10-5	CCT2A, Phase 1 PCD Hopper Samples.....	6.1.10-13
6.1.10-6	CCT2A, Phase 2 PCD Hopper Samples.....	6.1.10-13
6.1.10-7	CCT2A PCD Hopper Particle Size Distribution	6.1.10-14
6.1.11-1	CCT2B Summary Information.....	6.1.11-6
6.1.11-2	CCT2B Summary Information.....	6.1.11-7
6.1.11-3	CCT2B PCD Hopper Samples	6.1.11-8
6.1.11-4	CCT2B Hopper Particle Size Distribution.....	6.1.11-8
6.1.12-1	Run CCT2C Summary Information	6.1.12-10
6.1.12-2	Run CCT2C Summary Information	6.1.12-11
6.1.12-3	PCD Inlet Particle Size Distribution From Combined Sieve and Microtrac X-100 Measurements on In Situ Sample MWKIMT-3.....	6.1.12-12
6.1.12-4	Comparison of Size Distributions Measured by Microtrac Alone and Combined Sieve and Microtrac Measurements	6.1.12-12

6.1.12-5	Comparison of Microtrac Measured Size Distributions for Complete Sample and Particles Smaller Than 120 Mesh	6.1.12-13
6.1.12-6	Comparison of Cumulative Percent Particle Size Distributions for All Isokinetically Collected Samples	6.1.12-13
6.1.12-7	Comparison of Cumulative Mass Size Distribution for All Isokinetically Collected Samples	6.1.12-14
6.1.12-8	Comparison of Size Distributions From PCD Inlet In Situ Sample and PCD Cone Samples.....	6.1.12-14
6.1.12-9	PCD Cone Ash Analysis (Major Constituents)	6.1.12-15
6.1.13-1	CCT3 Summary Information	6.1.13-5
6.1.13-2	CCT3 Summary Information	6.1.13-6
6.1.13-3	CCT3 Hopper Particle Size Distribution - December 1996 (Reactor Solid Separation Efficiency Tests 1, 2, and 3)	6.1.13-7
6.1.13-4	CCT3 Hopper Particle Size Distribution - December 1996 (Reactor Solid Separation Efficiency Tests 4 and 5)	6.1.13-7
6.1.13-5	CCT3 PCD Hopper Samples.....	6.1.13-8
6.1.14-1	Resistances to Gas Glow	6.1.14-4
6.1.14-2	Buildup of Residual Cake ΔP	6.1.14-4
6.1.14-3	FL0301 1996 Permeance.....	6.1.14-5
6.1.14-4	CCT2C Filter ΔP and Particulate Loading	6.1.14-5
6.1.15-1	PCD/Ash Removal Instrumentation.....	6.1.15-7
6.1.15-2	Normal PCD Operation.....	6.1.15-8
6.1.15-3	Excessive Carryover to PCD	6.1.15-8
6.1.15-4	“Rat-Holing” of PCD Cone.....	6.1.15-9
6.1.15-5	“Normal” Operation of PCD Prior to Filling.....	6.1.15-9
6.1.15-6	Bottom of PCD Cone Filled With Ash	6.1.15-10
6.1.15-7	Top of PCD Cone Filled With Ash.....	6.1.15-11
6.1.15-8	Lower Shroud Filled With Ash.....	6.1.15-12
6.1.15-9	Beginning to Cover Lower Level With Ash	6.1.15-13
6.1.15-10	Lower Level Elements Covered With Ash	6.1.15-14
6.1.15-11	Beginning to Cover Upper Level With Ash.....	6.1.15-15
6.2.1-1	High-Pressure Air Accumulator Tank Pressure.....	6.2.1-3
6.3.1-1	Fines Removal Screw Cooler Operation November 20, 1996	6.3.1-2
6.3.1-2	Fines Transporter System Cycles November 20, 1996.....	6.3.1-2
7.1-1	Particulate Sampling System	7.1-1
8.1.2-1	Coal Particle Size Distribution	8.1.2-3
8.1.3-1	Dolomite Particle Size Distribution.....	8.1.3-2

8.2.4-1	Main Air Compressor Operations August 20 to 21, 1996	8.2.4-2
8.2.4-2	Main Air Compressor Operations November 15 to 16, 1996.....	8.2.4-2
8.4.2-1	Recycle Gas Booster Compressor Commissioning June 29, 1996.....	8.4.2-2
8.5.1-1	Porous Metal Cross-Flow Filter.....	8.5.1-3
8.6.2-1	Thermal Oxidizer Refractory Cureout.....	8.6.2-2
8.6.4-1	Two Views of Top Areas of Thermal Oxidizer December 19, 1996	8.6.4-2
8.7.3-1	Steam System Operations August 5, 1996.....	8.7.3-2
8.7.3-2	Steam System Operations November 21, 1996	8.7.3-2
8.8.3-1	Sulfator Start-Up Heater Refractory Dry Out May 23 to 25, 1996	8.8.3-3
8.8.4-1	Sulfator Performance Test September 9 to October 7, 1996	8.8.4-4
8.8.4-2	Sulfator Performance Test October 14 to 18, 1996	8.8.4-4
8.8.4-3	Sulfator Performance Test November 3 to 6, 1996	8.8.4-5
8.8.4-4	Sulfator Performance Test November 8 to 14, 1996	8.8.4-5
8.9.1-1	Baghouse ΔP CCT1A	8.9.1-4
8.9.1-2	Baghouse ΔP CCT1B.....	8.9.1-4
8.9.1-3	Baghouse ΔP CCT1C	8.9.1-5
8.9.1-4	Baghouse ΔP CCT2A	8.9.1-6
8.9.1-5	Baghouse ΔP CCT2B.....	8.9.1-7
8.9.1-6	Baghouse ΔP CCT2C	8.9.1-7
8.14.3-1	Change in Behavior of Float Valve After Adding Larger Float and Installing Baffles.....	8.14.3-3
9.1.2-1	Typical PI Display	9.1.2-3
9.2.1-1	Typical Piping Schematic Showing How Each Component for a Particular System is Identified	9.2.1-3
9.2.1-2	Typical Trend Plot for Pipe Kinks in the FD0210 Line	9.2.1-3
9.2.2-1	Typical Spectrum Recorded at up to 30,000 rpm Where Vibration Was Measured in Velocity Units.....	9.2.2-3
9.2.2-2	Typical Summary Plot Showing Vibration Maximum Amplitude Reading for Each Measurement Location on Fluid Pump A	9.2.2-3
9.2.2-3	Typical Plot Including Current Spectrum, a Comparison of the Current Spectrum With the Past Spectrum, and a Magnitude Trend Plot	9.2.2-3

9.2.3-1	Various Shades of Gray (From Black to White) Showing a Typical Thermal Image (Test Run CR02).....	9.2.3-5
9.2.3-2	A Scanned Image of the Top of the Combustor Heat Exchanger Taken During Coal Combustion of Test Run CCT1C.....	9.2.3-6
9.2.3-3	A Second Example of Scanned Image of the Top of the Combustor Heat Exchanger Taken During Test Run CCT1A.....	9.2.3-7
9.2.3-4	An Image Taken at Elevation 132 at the Start of Test Run CCT1C.....	9.2.3-8
9.2.3-5	A Second View of Scanned Image Shown in Figure 9.2.3-4 Taken After Coal Combustion in Test Run CCT1C.....	9.2.3-9
9.2.3-6	An Example of Temperature Differences Identified During Test Run CCT1C Where Elbows in the Pipe Slightly Hotter than the Pipe Itself.....	9.2.3-10
9.2.3-7	A Second Example of Temperature Differences Identified During Test Run CR02 Where Elbows in the Piping Were Slightly Hotter Than the Pipe Itself (Showing Primary Cyclone Gas Outlet During Coal Combustion of Test Run CCT1C).....	9.2.3-11
9.2.3-8	Results of Test Run CCT1C Indicating Temperature Differences Where Nozzle Temperature Was typically Hotter than Piping Showing Riser Crossover to the Disengager).....	9.2.3-12
9.2.3-9	A Second Image of Test Run CCT1C Indicating Temperature Differences Where Nozzle Temperature Was Typically Hotter Than the Piping (Showing line PM04 From the Primary Gas Cooler to the PCD).....	9.2.3-13
9.2.3-10	Results of Test Run CR02 Showing Temperature Differences Where Weld Joints Were Consistently at a Higher Temperature Than the Piping (Showing the Thermal Gradient at the at the Weld Joint in the Riser, Standpipe, and Dipleg).....	9.2.3-14
9.2.3-11	Results of Test Run CCT1C Showing Temperature Differences Where Weld Joints Were Consistently at a Higher Temperature Than the Piping.....	9.2.3-15
9.2.3-12	Results of Test Run CCT1C Showing Various Temperature Gradients.....	9.2.3-16
9.2.3-13	A Typical Image of the Thermal Oxidizer Taken During the Start of Test Run CCT1C Showing Fairly Uniform Temperatures.....	9.2.3-17
9.2.3-14	An Image of the Standpipe Outlet Connection to the Screw Cooler Taken at Elevation 120 Feet at the Start of Test Run CCT1C.....	9.2.3-18
9.2.3-15	Second View of the Standpipe Outlet Connection to the Screw Cooler Taken from Ground Level During Test Run CCT1C.....	9.2.3-19

5.0 Commissioning of
M.W. Kellogg
Transport Reactor Train

**Sections 5.1.1 through 5.1.10
are contained in Volume I
of this report**

5.1.11 Disengager Performance Tests

5.1.11.1 Background

During the October 1996 test run CCT2A, a high level of solids carryover from the reactor loop was observed when the system began operating with silica sand as start-up bed material. The geometric mean size of the sand was approximately 290 μm , with the top and bottom sizes of 500 and 45 μm , respectively. The solids separation system installed on the M. W. Kellogg Company (MWK) transport train was designed to separate ash and char with geometric mean sizes of less than 60 and 100 microns, respectively, with overall collection efficiencies of 99.96 percent with ash and 99.95 percent with char. Analysis of the test data collected indicated that the overall collection efficiency achieved ranged from 87 to 99.4 percent. The low collection efficiency resulted in greater than desired dust loading to the particulate control device (PCD). The excessive loss of solids from the reactor loop required frequent makeup of bed material to maintain a reasonable level of solids circulation in the reactor to permit the reactor to be operated at a lower than desired coal throughput.

A technical meeting held at Wilsonville on November 15, 1996, which was attended by representatives from GEESI (the cyclone system designer), MWK, SCS, and DOE who reviewed the performance of the solids separation system. It also provided an opportunity for GEESI to witness first hand the solids carryover from the reactor loop. At the meeting, the performance of the disengager was suspected to be the cause of the excessive solids carryover. It was speculated that difficulties of separated solids draining out of the disengager cone (cone angle of 8° to vertical) resulted in solids reentrainment out of the disengager. The design of the disengager was also discussed.

From operations to date, it was clear that solids carryover from the reactor loop increased whenever the solids circulation rate increased beyond a certain threshold, and it did not seem to be influenced very much by gas velocity. Also solids carryover at high-solids loading to the disengager did not seem to be affected by the particle size distribution. The material escaping the cyclone had geometric mean size comparable with the feed. The high solids loss as the standpipe solids level builds up does not permit filling the standpipe to the desired operating level. The excessive solids carryover makes it difficult to maintain the bed level in standpipe and more importantly it overwhelms the solids discharge system under the PCD, causing solids to accumulate in the PCD cone.

It was agreed at the meeting that GEESI would perform solids flowability test on the start-up bed material and that a test would be conducted at Wilsonville to characterize the performance of the disengager at high solids circulation rates approaching the design solids circulation rate of 250,000 lb/hr (combustion mode), at approximately 25 to 35 ft/s riser

superficial gas velocity, ambient temperature (~200 to 300°F), and at 60 psig reactor pressure. To accomplish this, the dipleg of the primary cyclone was isolated from the solids traffic by inserting a plug inside the dipleg. This temporary modification essentially eliminated the primary cyclone from the circuit to test the performance of the disengager without interaction with the cyclone dipleg perturbations. The test was identified as CCT3A.

5.1.11.2 Disengager Performance Tests CCT3A

The disengager efficiency tests were performed on December, 12, 1996, using silica sand with a geometric mean diameter of approximately 400 μm . The riser velocity and solids loading to the disengager were varied to investigate their effect on disengager operation. The reactor was operated at approximately 60 psig and nominal 200°F. Sand was continuously fed into the reactor during the test except during the last period of testing when sand was not fed. Solid samples were taken from the reactor and the discharge of the PCD to represent the size distribution exiting the disengager. The PCD solids at the end of each test run period were transferred to the ash silo and a solid sample was taken for analysis. The amount of material lost to the PCD was estimated from the transfer bin weigh cell differentials. The particle size distribution at the inlet to the disengager was calculated from the standpipe and PCD solid flow rates and their size distributions. The average test operating conditions are presented in table 5.1.11A-1. The average solids circulation rate was calculated by assuming a gas-solid slip factor of 2. The particle size distribution was relatively finer at the beginning of the test.

Except for test period 3, the HX0203 vent valve (PDV384) was 100-percent open. During period 3, HX0203 vent valve was closed to prevent gas entrained from the disengager with the particles from bypassing through the HX0203 vent into the primary cyclone. The results from test period 3 will indicate whether this type of gas bypassing affects the disengager efficiency.

Experimental Findings

During the test, makeup sand was added intermittently into the reactor. The amount of sand fed and the average feed rate during the periods analyzed are presented in table 5.1.11A-2. Using the solids circulation rate and the solids collected by the PCD, the average disengager efficiency was estimated. The results are presented in table 5.1.11A-3.

From the particle size distribution of the circulating solids and the solids captured by the PCD (using ash silo solids size distribution), the grade efficiencies were calculated for each period.

The grade efficiencies for all test periods (except for period 4) were plotted as a function of particle size distribution as shown in figure 5.1.11A-1. The disengager cut diameters were read from figure 5.1.11A-1 and the results are presented in table 5.1.11A-3. The disengager grade efficiency curve was replotted using the normalized particle size as shown in figure 5.1.11A-2.

The following general conclusions can be drawn from the test results:

- A. The disengager efficiency is lower than expected for the coarser particle size distribution used for this test.
- B. Within the operational range of aeration/fluidization flow through HX0203, closing off PDV384 does not appear to affect the disengager performance.
- C. The disengager appears to be more efficient at low riser superficial velocity at lower circulation rates.
- D. Comparing results from test periods 1 and 5, it appears that the disengager efficiency is not very sensitive to solids loading. However, comparison of test period 2 and test period 5 data indicates some dependency of disengager efficiency on inlet solids loading.
- E. The performance of the disengager during this test does not appear to be significantly different from its performance during previous test runs.

5.1.11.3 Cold Flow Testing of Disengager at GEESI (CCT3B)

From February 6 to 7, 1997, a full-scale cold-flow model of the disengager constructed from sheet metal with a Plexiglas top was tested at the GEESI facilities located in Lebanon, Penn. Representatives from GEESI, SCS, and MWK conducted the testing. The objective of the test was to characterize the efficiency of the disengager with sand, and to understand and identify the cause of the low solids separation efficiencies at the PSDF. Prior to the test, performance of the disengager was suspected as the cause of the dust carryover.

A schematic drawing of the experimental setup is shown in figure 5.1.11B-1. The test solid was silica sand from the PSDF with size distribution as shown in figure 5.1.11B-2. A screw feeder with maximum feed rate of ~350 lb/min was used to feed the solids into the disengager. An induction fan was used to convey the solids through the disengager and the secondary cyclone. The solids separated in the disengager and cyclone were collected in 55-gallon drums. The capacity of the drum under the disengager limited the duration of

the test. If the disengager collected all the solids, it would hold approximately 700 to 800 lb of solids corresponding to a maximum test duration of 2.3 minutes.

Prior to February 2, 1997, GEESI completed a trial test (test 1). Samples from this test were sent to SCS for particle size distribution determination. The results are shown in figure 5.1.11B-2.

Discussions were held with GEESI regarding the possibility of increasing the feed rate into the disengager by either modifying the feeder motor-gear arrangement (which was later found to be impossible) or renting another feeder with a higher feed rate. The blower had enough capacity to allow the velocity through the disengager to be increased from 26 ft/s to 45 ft/s. In addition to sand, fly ash was also run through the disengager. Being of a lower density than sand, the maximum fly ash feed rate obtained was approximately a third of that of sand. Between February 6 and 7, 1997, nine test runs were completed. The results of the tests, including test 1, are summarized in table 5.1.11B-1. In test 2, two buckets of sand (each bucket containing ~50 lb of sand) were manually dumped directly into the disengager through the funnel while the screw was running at maximum speed. In test 4, the screw feeder was shut off and buckets of sand were manually dumped into the disengager in an attempt to increase the feed rate and also simulate slugs of solids entering the disengager. In test 5, the screw was not run. The solids were fed directly from the spout dumped from the bottom of the supersack. This run simulated a very high feed rate into the disengager. This test lasted for only 6.5 seconds. In tests 7 and 8, fly ash was used instead of sand.

The collection efficiencies are plotted in figure 5.1.11B-3 as a function of solid/gas weight ratio. Also included on the graph are data from the December 1996 test of the PSDF disengager with the cyclone dipleg blocked and test data from November 1996 operation of the PSDF transport reactor with the primary cyclone functional (dipleg not blocked off).

It appears from figure 5.1.11B-3 that the performance of the disengager during the cold flow tests at GEESI is similar to what had been observed during the PSDF disengager tests in December 1996. The data from the November 1996 test suggests strongly that the primary cyclone was not capturing solids since the disengager efficiency seemed to follow the same trend as the cold flow results. During all test campaigns at PSDF the cyclone dipleg was not sealed with solids in the standpipe. However, it is possible that gas was bypassing up through the dipleg into the cyclone causing the cyclone's efficiency to be penalized. It is also plausible that a hole (or gap) might have developed in the roof of the cyclone allowing gas and solids to bypass the gas outlet tube. Either of these scenarios would be consistent with the low-cyclone-pressure drop observed during the PSDF test runs.

The collection efficiency of the disengager with fly ash is significantly lower than with sand. Based on the fly ash and sand data, it could be speculated that the actual disengager efficiency with char and transport reactor ash may be significantly lower than the design values of 97.6 and 96.4 percent for combustion and gasification operations, respectively.

From the results of the disengager tests, the following recommendations and implementations were made:

- A. Review the cyclone trend data from previous tests and compare the cyclone differential pressures with those of the December 1996 tests when the cyclone dipleg was blocked off. Trending should include cyclone dipleg temperature profile displayed with differential pressure.

This was done and there was no evidence of significant gas bypass up the cyclone dipleg.

- B. Provide GEESI with an alternate test material with properties close to the ash and char to be generated from the PSDF transport reactor for testing.

Plans were drawn to test coke breeze at a later date.

- C. Inspect the roof of the cyclone for cracks or holes that could provide a bypass path, especially around the gas outlet tube. It is possible that a dye test would be required to detect cracks that could seal when the unit is cold and open when the cyclone is heated up.

Borescope inspection of the gas outlet pipe did not reveal any gross defects.

- D. Conduct test at PSDF, with the cyclone dipleg sealed with solids, to investigate possible cyclone inefficiency caused by standpipe disengager gas venting up the cyclone dipleg. This test may require manually filling the dipleg.

- E. Review data with GEESI and determine options available and action to take.

Modifications to cyclone gas inlet and outlet were suggested by GEESI. Cyclone inlet modifications (restriction of cross sectional area and change from a circular to a rectangular cross section) were carried out. Plans were made to move the disengager cold-flow model from GEESI to Wilsonville. This decision was made because more tests could be needed and since the disengager performance is expected to be very different in gasification than in combustion.

Table 5.1.11A-1
Average Test Conditions

Test No.	Average Riser Velo., ft/s	Average Solids Circ. Rate, lb/hr	Average Disengager DP, inH ₂ O	Average Cyclone DP, in H ₂ O	Average Riser Exit Temp. (TI355), °F	Average Reactor Pressure, psig
1	36	4,148	2.2	4.0	208	59
2	37	4,027	2.5	4.2	218	62
3	38	9,539	2.8	6.7	216	61
4	28	42,888	3.1	2.5	191	61
5	37	72,325	8.4	6.4	202	62

Table 5.1.11A-2
Sand Makeup Into Reactor

Test No.	Duration of External Feeding	Total Sand Fed, lb	Average Feed Rate, lb/hr
1	10:53 to 11:40	1,171	1,731
2	12:47 to 14:35	1,175	1,438
3	14:40 to 15:39	2,059	2,094
4	15:50 to 16:40	3,214	3,857
5	No External Feeding	0	0

Table 5.1.11A-3
Summary of Results

Test No.	Period Analyzed	Average Riser Velocity, ft/s	Average Solids Circ. Rate, lb/hr	Average Solids Loss Rate From Disengager lb/hr	Estimated Disengager Cut Diameter, μm	Disengager Efficiency Percent
1	10:37 to 11:40	36	4,148	213	72	94.5
2	12:39 to 14:35	37	4,027	556	82	86.2
3*	14:40 to 15:39	38	9,539	1,478	144	84.5
4	15:50 to 16:40	28	42,888	112	N/A	99.74*
5**	17:20 to 18:05	37	72,325	5,032	146	93

* Only one PCD dump cycle was observed in approximately 1 hour.

** With HX0203 solids circulation.

PDV384 was closed.

N/A Not estimated.