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Background Report Reference

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Title: Filler Room Vent Emissions
Reduction, Project 3VT, Results and
Final Report

Coors Brewing Company

Coors Brewing Company

December 1993

AP-42 Section 9.12.1
Reference 7
Report Sect. 4
Reference 30

FILLER ROOM VENT EMISSIONS REDUCTION

PROJECT 3VT

RESULTS and FINAL REPORT

December 1993



Coors Brewing Company
Golden, Colorado 80401-1295

FILLER ROOM VENT EMISSIONS REDUCTION STUDY*

EXECUTIVE SUMMARY

A brewing facility evaluated the feasibility of using process changes to reduce emissions of volatile organic compounds (VOC) from the filling operation. The facility implemented and tested the effects of filler room air flow controls, and fill-level controls and drip troughs to control beer spillage on can filler ethanol emissions. Evaluation of bottle filler changes included filler room air flow controls, and drip troughs.

The objective of the air flow control test was to determine whether a reduction in air flow would result in a reduction in the ethanol emission rate, and, if so, would the reduction be directly proportional to the reduction in air flow. Testing performed indicated that the use of air flow controls reduce VOC emissions by reducing the air velocity in the filler room. The use of air flow controls resulted in a reduction of VOC emissions of 24%.

The fill-level controls were installed with the purpose of controlling the amount of beer that is spilled when filling. The troughs were designed to collect the spilled beer and pipe it directly to the floor drains without letting the beer spread out on the floor, therefore, decreasing the surface area of the beer and reducing VOC emissions. Neither the use of fill-level control, in the form of adjustable ball cages and fill valve monitors, or the use of drip troughs resulted in any significant change in ethanol emissions. Tests were also performed to evaluate the effect of flushing the floor drains with water. These tests also revealed little effect on ethanol emissions.

*Confidential business information has been removed from this report.
If you have any questions regarding this report please contact:

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I. INTRODUCTION.

Ethanol is a volatile organic compound (VOC) and is subject to control and regulation by the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH). The purpose of this project was to assess the possibility of using process changes to reduce the ethanol emissions from the fillers rather than adding end-of-pipe pollution control devices.

This project implemented and tested the effects of prototype process changes on ethanol emissions on can and bottle fillers at the Golden packaging facility. The test beds chosen were 9 can filler and 3 bottle filler.

The can filler modifications tested were fill level control, filler room air flow control, and drip troughs.

The bottle filler modifications examined were filler room air flow control and drip troughs.

II. CONCLUSIONS.

Air flow control reduced ethanol emissions by reducing air velocity in the filler room. The amount of reduction from air flow control was 24%.

The effects of fill level control (adjustable ball cages and fill valve monitor) and drip troughs did not reveal any significant changes in ethanol emissions.

Air flow control reduced ethanol emissions in the bottle filler room by 21%. Drip troughs could not be implemented in the bottle filler room. However, based on the results of drip troughs in the can filler, reductions were not anticipated. Further work needs to be done on bottle fillers in identifying the source of ethanol emissions. One

possible technique would be washing the bottles with chilled water when the bottles are still contained in the shroud.

III. BACKGROUND.

A. 9 FILLER MODIFICATIONS.

Nine filler consists of one 72-valve Cemco filler with an Angelus 120L closer. The filler room has stainless steel walls and floor with no gap between the wall and the floor.

1. Fill Level Control.

Adjustable ball cages were installed on all 72 fill valves. The adjustable ball cages were adjusted to provide an average of 5.5 gms overflow as opposed to 7.2 gms.

A Filler Valve Monitor System (FILTEC Model FT-100) was installed to provide information on fill levels for each fill valve. In addition the hard copy output port of the fill valve monitor system was connected to a printer in order to provide a printout of the shift summaries.

2. Air Flow Control.

Air flow automation was provided and installed by Landis & Gyr Powers, Inc. There were 2 systems installed under this project. One system for the 9 can filler room and another for the 3 bottle filler room. Each system is physically separate and functions independently of the other. Both systems are tied into the Powers Network for the

Brewery and are accessed through modems or direct connections.

Each system controls the air flow for its associated filler room. The objective was to minimize air flow while maintaining a positive pressure within the room and at the same time ensure that the CO₂ level did not exceed a preset threshold. These objectives were accomplished in the following manner:

- a. **Filler Shroud Air (Hepa/Sterile air).** - The air flow to the filler shroud was maintained at a constant velocity. Control dampers and sensors were installed to accomplish this goal. The shroud air supply was set to 1000 scfm per filler.
- b. **Room Supply Air (Filtered).** - The air supply to the room was controlled so that the CO₂ level in the room did not exceed a preset value. The air supply to the room was also increased when exhaust air temperature exceeded a preset value. The set point for room CO₂ level was 4500 ppm. The temperature threshold was 72° F.
- c. **CO₂ Exhaust Air Flow.** - The air flow out of the room through the CO₂ exhaust duct was controlled so that a positive pressure in the room was maintained. The set point for room static pressure was 0.01 inches water column that translated into a fugitive escape velocity of approximately 500 fpm.
- d. **Monitoring and Control.** - A CRT and printer were installed in the offices of Continuous Improvement to monitor and control both

Note: All charts and graphs
are located in Appendix A.

systems. This CRT also accessed all systems on the network. In addition, Facilities Maintenance maintained a host computer system that monitored and controlled all Powers Automation Systems on the brewery network.

A fortuitous ability of the automation system was its ability to trend data. This ability provided a data logging capability when VOC testing was being performed. Types of data logged were supply air flow, shroud air flow, CO₂ exhaust duct air flow, room static pressure, room CO₂ level, and exhaust duct air temperature. The ethanol data from the B&W Plant Rat instrument installed in 9 filler was also logged.

The minimum room air supply in 9 filler was set to 1000 scfm in order to supply adequate air flow to the operator. This resulted in a static pressure that was higher than the desired 0.01 inches water column.

3. Drip Troughs.

Drip troughs were installed on the 4 sides of the closer and under the no can/no fill station on the filler. These troughs were designed to catch spilled beer and pipe it directly to the floor drains without letting the beer spread out on the floor.

B. 3 BOTTLE FILLER MODIFICATIONS.

Three (3) Bottle consists of two 72-valve Cemco fillers in one room. The room consists of stainless steel walls with a concrete floor. There are no gaps between the walls and the floor.

Note: All charts and graphs
are located in Appendix A.

1. **Air Flow Control.**

An air flow control system described above was installed to control the air flow in the 3 bottle filler room. See § III.A.3 above for details.

2. **Drip Troughs.**

There was not a practical way of installing drip troughs on a bottle filler. The installation of drip troughs would needlessly interfere with operations, maintenance and sterilization.

C. **FLOW METERS.**

Rosemont magnetic flow meters were installed on the beer supply lines for 9 filler and 3 bottle (2 meters, 1 per filler). A resettable readout for each meter was installed that provides total beer in gallons entering each filler. Various studies performed by the Continuous Improvement Department reveal that the accuracy of the meters is approximately 5%. A Filler Flow Meter Accuracy Task Force addressed the accuracy problems. Until better meter accuracy is obtained, the technique of relating VOC emissions as a function of beer into a filler is not viable.

D. **VOC MONITORING.**

An alternate method of measuring ethanol concentration in air (other than FID) was investigated. A B&W Technologies Plant Rat Model IS-PRB-1 instrument was installed on 9 filler to test its capabilities of detecting ethanol. The Plant Rat uses fuel cell technology that originally was developed for carbon monoxide and modified to work with ethanol. In fact,

the sensor is calibrated using carbon monoxide gas and reads directly in ppm ethanol.

The sensor was installed in the CO₂ exhaust duct with the display located on the 1st floor near the filler room. The 4-20 ma output of the instrument was routed to the Powers automation system for data logging.

The ability of the B&W Plant Rat to detect and measure the presence of ethanol is excellent. Comparisons were made to Clean Air Engineering's (CAE) flame ionization detector (FID) which sampled the exhaust duct near the Plant Rat. As can be seen from the 2 sets of data from August 31, 1993 (FID and Plant Rat, presented in Appendix B, pages 1 & 2), there was excellent correlation between the two instruments. There is a scale difference due to the fact that the FID is calibrated using propane and the Plant Rat is calibrated using carbon monoxide. That scale factor difference is 2.18. The chart shown on page 3 of Appendix B shows the FID plotted against the Plant Rat. The FID measurements resolves 97% of the Plant Rat variations.

IV. ANALYSIS.

A. SAMPLE CALCULATIONS.

1. Emission Rate.

The emission rate is the amount of ethanol released to the atmosphere for every hour of filler operation.

The emission rate in lbs/hr ethanol was calculated as follows:

$$ER = \frac{\{\text{response_factor}\}[\text{voc_conc. (ppm)}][\text{supply_air (scfm)} + \text{shroud_air(scfm)}][60 \text{ min/hr}][28.317 \text{ liter/ft}^3][44.09 \text{ g/mole}][2.205 \text{ lb/kg}]}{\{\{24.055 \text{ liters/mole @ STP}\}[1000\text{g/kg}][1 * 10^6][1\% \text{H}_2\text{O}/100]\}}$$

or

$$ER = \frac{2.18 * (\text{voc})(\text{air_supply} + \text{shroud_air}) * 60 * 28.317 * 44.09 * 2.205}{24.055 * 1000 * 1000000 * (1 - 1/100)}$$

The emission rate was calculated for every minute of time during the sample interval.

2. Emission Factor.

The emission factor is the amount of ethanol released to the atmosphere for every barrel of beer packaged.

The emission factor in lbs/bbl was calculated as follows:

$$EF = \frac{\text{emission_rate (lbs/hr)}}{\text{packaging_rate (bbls/hr)}}$$

An emission factor for each test was calculated using the emission rate mean for a test and the associated production rate for that test interval.

3. VOC Measurements.

VOC concentrations were measured in the CO₂ exhaust ducts of the 9 Can filler and 3 Bottle filler rooms.

The test schedule and test conditions for each room are detailed in Charts I and II.

Continuous VOC monitoring was accomplished during each test interval. VOC's were detected using an FID instrument with a data logger rented from CAE. The equipment used was a TECO Model 51 FID, an

Odessa DSM 3260 data logger, a Yokogawa 3057-2 dual channel strip chart recorder, and a laptop computer for control and data disk creation. The FID was calibrated daily using a calibration gas of 86 ppm propane in nitrogen.

4. Air Flow.

Air flow data was collected using the data logging capability of the Powers Air Flow Automation System. Air flow data collected were from the shroud air supply, room air supply and CO₂ exhaust duct. The total air supplied to the room (shroud air plus supply air) were used in the emission calculations. The total air supplied to the filler room was used in the calculations in order to include air exhausted through the CO₂ exhaust duct plus fugitive emissions to the packaging building. This technique assumes that the VOC concentration at all room exits is the same as measured in the CO₂ exhaust duct.

The Air Flow Automation System sensors were calibrated by comparing against a manual transverse of the ducts involved. The 3 Bottle shroud air sensor measurements were reduced by 712 scfm as a result of these calibrations.

B. 9 FILLER.

A statistical box plot of the emission rates (lbs/hr) for all of the 9 Filler VOC tests are presented in Graph III. Graph IV presents the emission factors (lbs/bbl) for the same set of tests.

The raw data from all the tests are contained in Appendix C.

1. **Air Flow Control.**

The use of air flow control reduced ethanol emissions. The average reduction in emission rates was 32%.

The reductions were slightly less when emission factors were compared. Emission rates and factors were reduced the with and without air flow control were compared - 32% (0.0403 lbs/bbl to 0.0273 lbs/bbl

For proper biological control, it is essential that the differential pressure between the shroud and the room should remain positive to keep air from flowing into the shroud from the room and the room static pressure needs to be positive with respect to the building. This way the air flow within the shroud can be truly be minimized and still maintain biological control.

2. **Fill Level Control.**

The use of a fill valve monitor in conjunction with adjustable ball cages did not lower ethanol emissions. The December 1992 base line test compared to tests 1,2 & 3 did not reveal any significant reductions. A retest was performed on October 11, 1993, to validate this result. Graph VI presents the results of that test. The 7.4 gms test result was one in which the adjustable ball cages were screwed all the way in (no overflow reduction - similar to Dec. 1992); 5.3 gms was the ball cage optimum setting and 4.8 gms was with the ball cages screwed all the way out. The data from Figure VI reveals no significant variation between

tests, thus confirming the conclusion of the initial tests.

3. Drip Troughs.

The use of drip troughs did not reveal any reduction in ethanol emission rates. See tests 7,8 versus 14,15 and test 9 versus 16,17. The drip troughs as installed collected the beer after the bulk of the ethanol was already emitted. Therefore, the use of drip troughs has little effect.

C. 3 BOTTLE.

A statistical box plot of the emission rates (lbs/hr) for all of the 3 Bottle VOC tests are presented in Graph VII. Graph VIII presents the emission factors (lbs/bbl) for the same set of tests.

The raw data from all the tests are contained in Appendix D.

The tests resulted in emission decreases of 25% or less. Therefore, we believe that the major source of ethanol emissions in bottle filling has not yet been discovered.

1. Air Flow Control.

Decreasing only the filler shroud air flow resulted in an ethanol emissions reduction of 25% [tests 1,2,3 (7.45 lbs/hr) versus 4,5 (5.61 lbs/hr)].

Emission factors, for shroud air flow control only, showed a reduction of 36% (0.0542 lbs/bbl to 0.0349 lbs/bbl) .

When only shroud air flow control was on, the static pressure in the filler room went negative. Therefore, it is necessary to maintain room static control as well as shroud flow control.

With shroud air flow control, static pressure control and CO₂ level control active (full air flow control), the ethanol emissions were reduced by 21% over no air flow control [tests 1,2,3 (7.45 lbs/hr) versus 7,10 (5.85 lbs/hr)].

Full air flow control emission factors showed a 25% reduction (0.0542 lbs/bbl to 0.0407 lbs/bbl).

Air movement over the bottles within the shroud is a source of emissions. However, in order to obtain acceptable biological control and CO₂ level control, full air flow control is needed.

2. Drip Troughs.

A practical method of installing drip troughs in a bottle filler room was not discovered. However based on the drip trough experience on 9 Filler, drip troughs would not contribute to reducing ethanol emissions.

3. Drain Flushing.

Tests were performed to ascertain the effect of flushing the floor drains with water. These tests revealed little effect on ethanol emissions.

4. Future Work.

Air flow over the beer wetted bottles within the filler shroud is estimated to be the major source of ethanol emissions. The confined space of the shroud with air passing over the beer wetted bottles constitutes a very good evaporator. Air flow across the bottles should be minimized. The bottles should be rinsed (while still in the shroud) with chilled water to reduce the wetted surface. The chilled water temperature should be less than the surface temperature of the bottles. Chart IX presents a pictorial of bottle surface temperatures throughout the filling process.

For proper biological control, it is essential that the differential pressure between the shroud and the room should remain positive to keep air from flowing into the shroud from the room, and the room static pressure needs to be positive with respect to the building. This way the air flow within the shroud can be truly minimized and still maintain biological control.

Note: All charts and graphs
are located in Appendix A.

APPENDIX A

CHARTS and GRAPHS

9 FILLER VOC TESTING

TEST ID	DATE SHIFT (Sample Interval)	Fill Control	Air Flow Control	Drip Troughs	OVER FILL	Average Filler Speed (cpm)	Filler Efficiency %	Beer Packaged (bb)	Beer Type	Alcohol Content	COMMENTS
1	8/30/93 Day (0815 - 1420)	YES	OFF	NO	6.9 gms (measured)	843	84.33	991	LR		0815 - Air flow control off.
2	8/30/93 Swing (1431 - 2329)	YES	OFF	NO		898	89.81	1441	LR		
3	8/31/93 Graveyard (0031 - 0629)	YES	OFF	NO	Same overfill as Test #1 (fill valve monitor)	873	87.39	936	LR		
4	8/31/93 Day (0901 - 1429)	YES	OFF	NO	5.9 gms (measured)	1022	102.21	1024	LR		
5	8/31/93 Swing (1531 - 2329)	YES	OFF	NO		883	88.4	1238	LR		
6	9/1/93 Graveyard (0031 - 0640)	YES	OFF	NO	6+ gms (fill valve monitor)	903	90.38	1111	LR		Overfill constant for shift.
7	9/1/93 Day (0816 - 1323)	YES	ON	NO	0730 - 0945 5 gms rising to 8 gms. 0945 - 1330 8+ gms.	788** ** Filler down @ 1330.	78.8** ** Filler down @ 1330.	889	LR		0750 - Air Control on. 1330 - Filler down. Overfill drop from 6+ gms to 5 gms @ 0730. B&W ETOH sensor maxed out @ 200ppm. Filler down @ 1330.
8	9/2/93 Graveyard (0031 - 0629)	YES	ON	NO	1130 - 0100 3 - 6 gms. 0100 - 0700 6 - 7 gms 0700 dropped to 5.7 gms	837	83.74	1036	LR		Overfill changed at 0100 and 0700 hrs. Room supply high 0000 - 0545
9	9/2/93 Day (0734 - 1350)	YES	ON	NO	5.7 gms	833	83.31	1128	LR		Overfill dropped at 0700 Overfill during shift at ideal settings. Line shut down @ 1345. Supply & Exhaust air

Chart I-1

9 FILLER VOC TESTING

TEST ID	DATE SHIFT (Sample Interval)	Fill Control	Air Flow Control	Drip Troughs	OVER FILL	Average Filler Speed (rpm)	Filler Efficiency %	Beer Packaged (bb)	Beer Type	Alcohol Content	COMMENTS
10	9/8/93 Graveyard (0031 - 0629)	YES	ON	Partial	Increasing from 5.5 to 8.9 gms over shift. Source - Fill valve monitor.	824	82.42	928	CR		flows oscillating.
11	9/8/93 Day (0920 - 1430)	YES	ON	Partial	7.7 gms Source - Fill valve monitor.	865	86.57	799	CR LR @ 1130		Overflow experienced a positive step change of 1.5 gms @ 1045
12	9/8/93 Swing (1531 - 2329)	YES	ON	Partial		1009	100.97	1435	LR		
13	9/8/93 Graveyard (0031 - 0629)	YES	ON	Partial	7.1 gms Source - Fill valve monitor.	896	89.66	1042	QQ		Overflow constant. Filler down @ 0648.
14	9/8/93 Swing (1600 - 2329)	YES	ON	YES		517	51.74	791	QQ		Filler running: 1615 - 1700 1815 - 2055 2150 - 2300
15	9/10/93 Graveyard (0031 - 0629)	YES	ON	YES	8.0 gms Source - Fill valve monitor.	845	84.6	906	QQ		
16	9/10/93 Day (1100 - 1429)	YES	ON	YES	5.5 gms Before blackfill test - 8 gms Source - Fill valve monitor.	444	44.46	224	QQ		Black fill test 0900 - 1100.
17	9/10/93 Swing (1531 - 2244)	YES	ON	YES		722	72.28	1007	QQ		Filler down @ 2248.

Chart I-2

*Partial Drip Troughs - Short lip and beer released to floor.

3 BOTTLE VOC TESTING

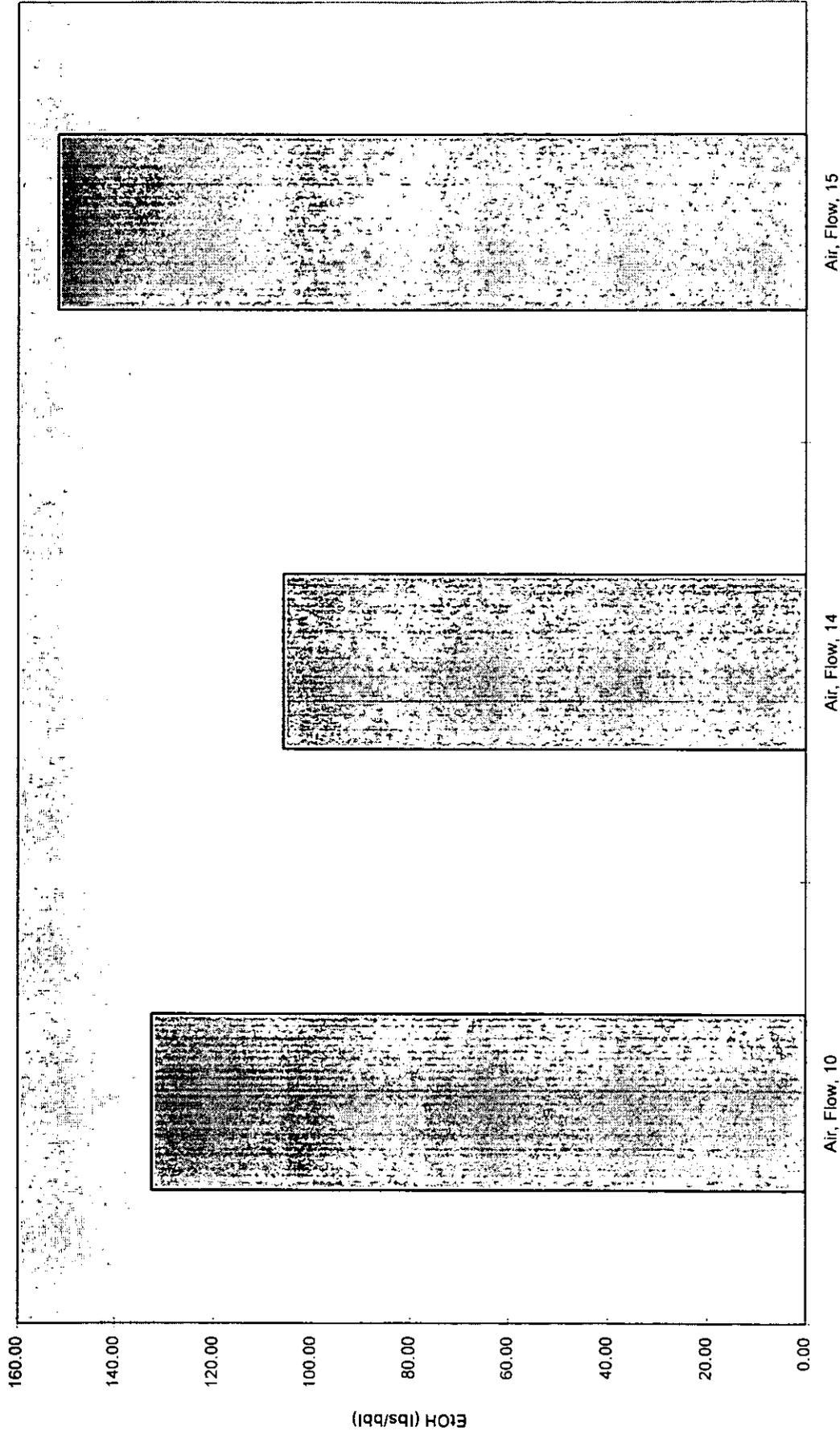
TEST ID	DATE SHIFT (Sample Interval)	SHROUD AIR FLOW CONTROL	ROOM STATIC PRESSURE CONTROL	ROOM CO ₂ LEVEL or TEMPERATURE CONTROL	BEER PACKAGED (bbl)	BEER TYPE	ALCOHOL CONTENT	COMMENTS
1	9/14/93 Day (0731 - 1429)	Off	Off	Off	1109	KR		Room static pressure negative @ 0825 and 0955.
2	9/14/93 Swing (1630 - 2329)	Off	Off	Off	994	KR		
3	9/15/93 Graveyard (0100 - 0629)	Off	Off	Off	861	KR 0200 - LR		
4	9/15/93 Day (0731 - 1429)	Constant @ 2000 scfm	Off	Off	1174	LR		Shroud air flow control turned on @ 0743. Room static pressure negative when negative at 0740 and stayed for rest of shift.
5	9/15/93 Swing (1531 - 2329)	Constant @ 2000 scfm	Off	Off	1219	LR		Room static pressure negative for duration of shift.
6	9/16/93 Graveyard (0031 - 0629)	Constant @ 2000 scfm	Off	Off	0			Filter down all Shift.
7	9/16/93 Day (0731 - 1429)	Constant @ 2000 scfm	On	On	1000	CR		Room static pressure and CO ₂ level control turned @ 0805.

Chart II-1

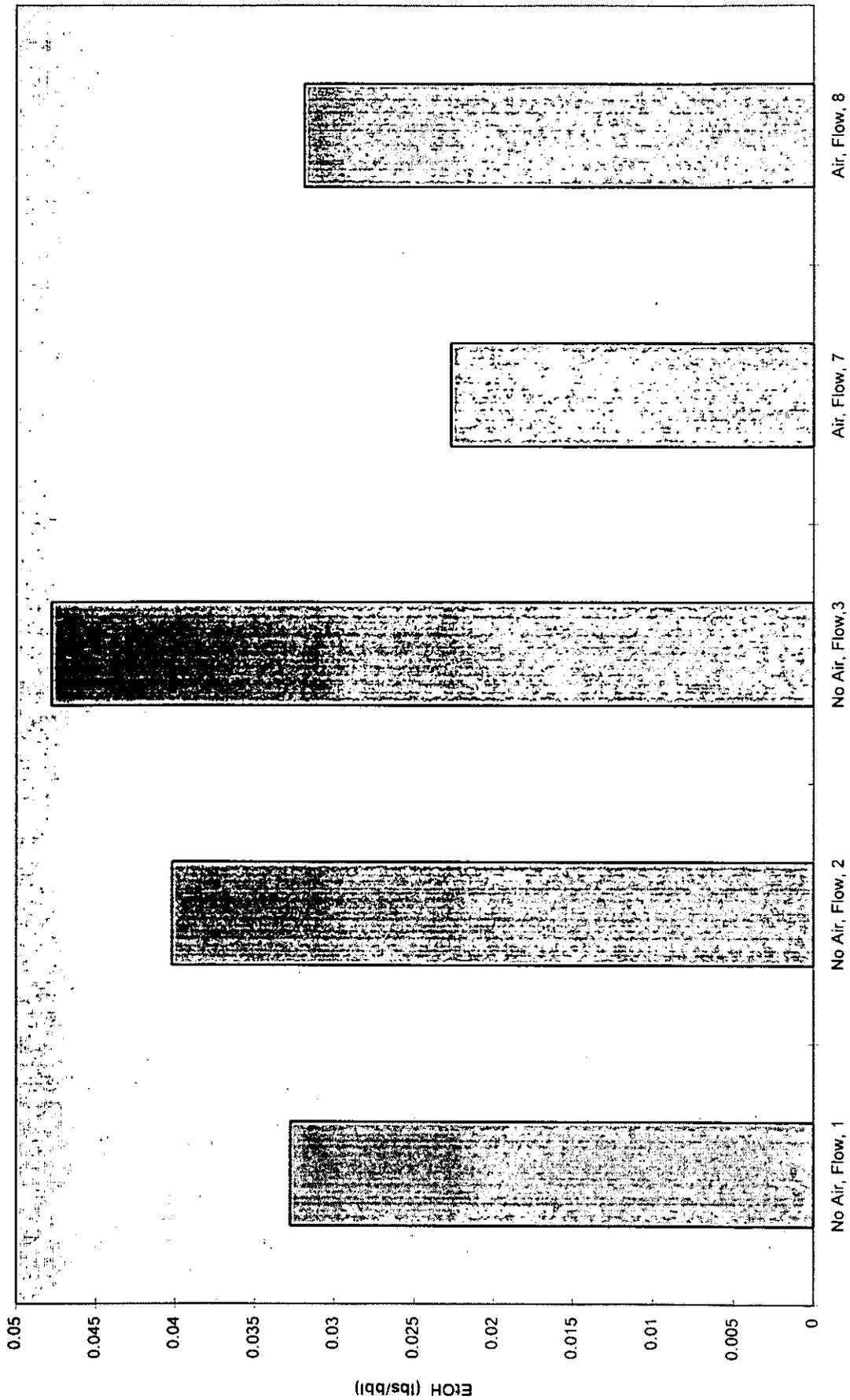
3 BOTTLE VOC TESTING

TEST ID	DATE SHIFT (Sample Interval)	SIROUD AIR FLOW CONTROL	ROOM STATIC PRESSURE CONTROL	ROOM CO ₂ LEVEL or TEMPERATURE CONTROL	BEER PACKAGED (bb)	BEER TYPE	ALCOHOL CONTENT	COMMENTS
8	9/16/93 Spring (1531 - 2329)	Constant @ 2000 scfm	On	Off	1208	CR		CO ₂ level control turned off @ 1515.
9	9/17/93 Graveyard (0031 - 0629)	Constant @ 2000 scfm	On	Off	1010	CR 0200 - LR		
10	9/17/93 Day (0731 - 1439)	Constant @ 2000 scfm	On	On	999	LR		CO ₂ level control turned on @ 0700.
11	9/17/93 Spring (1531 - 2329)	Constant @ 2000 scfm	On	Off	0			Filler down. CO ₂ level control turned off @ 1600.

9 Filler-Emission Factors (w/Adj. Ball Cages, Test #10 with partial drip troughs and tests #14,15 with full drip troughs)

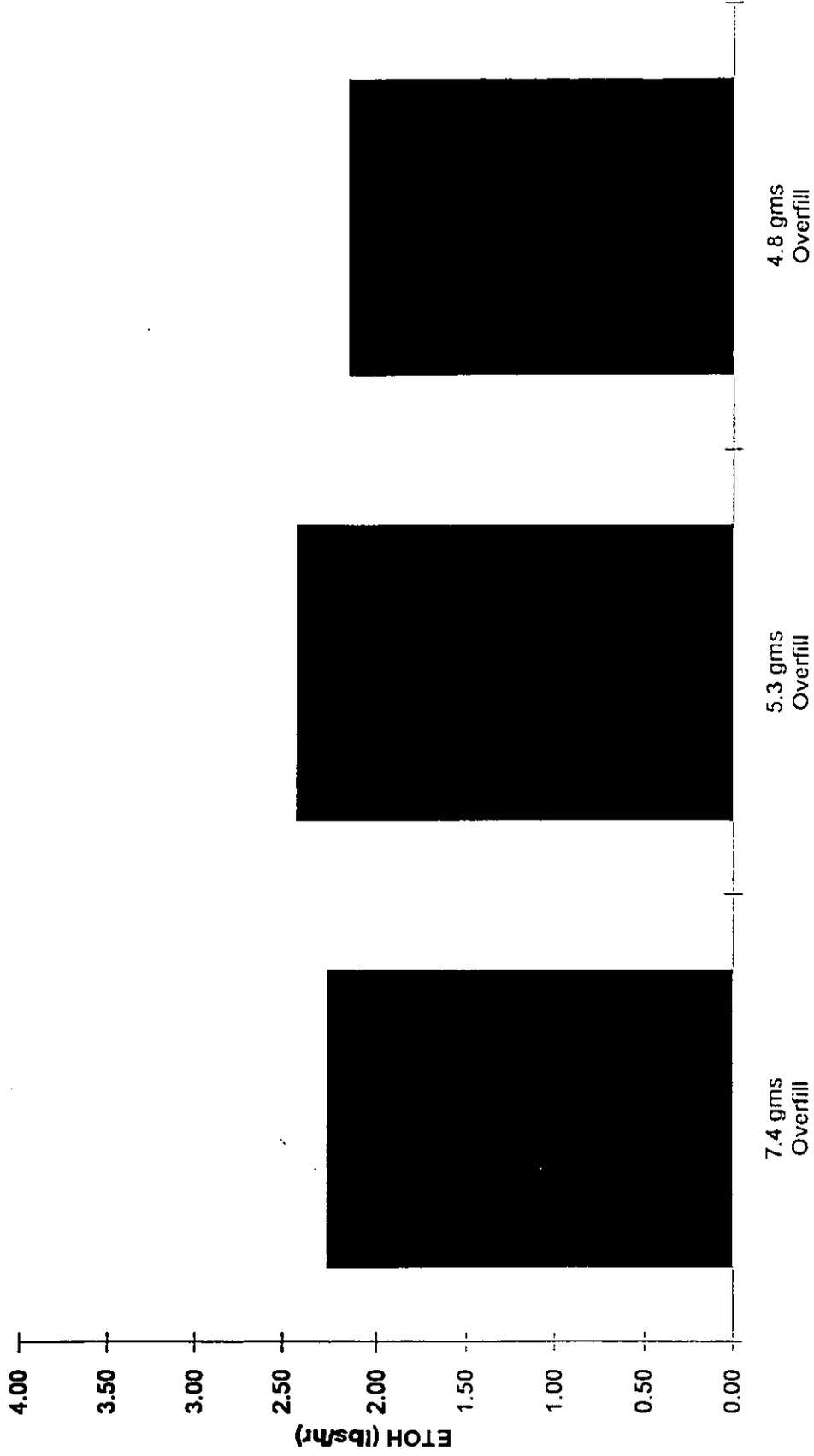


9 Filler Emission Factors (w/Adj. Ball Cages & No Drip Troughs)



9 FILLER EMISSION FACTORS (Aug. & Sept. 1993)					
Test	EtOH lb/bbl	EtOH lb/hr	Production Rate bbl/hr	Sample Interval hrs	Beer Packaged bbl
No Air, Flow, 1	0.032762059	5.34	162.99	6.08	991
No Air, Flow, 2	0.040212491	6.46	160.65	8.97	1441
No Air, Flow, 3	0.047788462	6.39	133.71	7	936
Air, Flow, 7	0.022688976	3.57	157.35	5.65	889
Air, Flow, 8	0.031891892	4.72	148.00	7	1036
Air, Flow, 10	0.04887931	6.48	132.57	7	928
Air, Flow, 14	0.040473325	4.28	105.75	7.48	791
Air, Flow, 15	0.033737748	5.12	151.76	5.97	906
			Page 1		

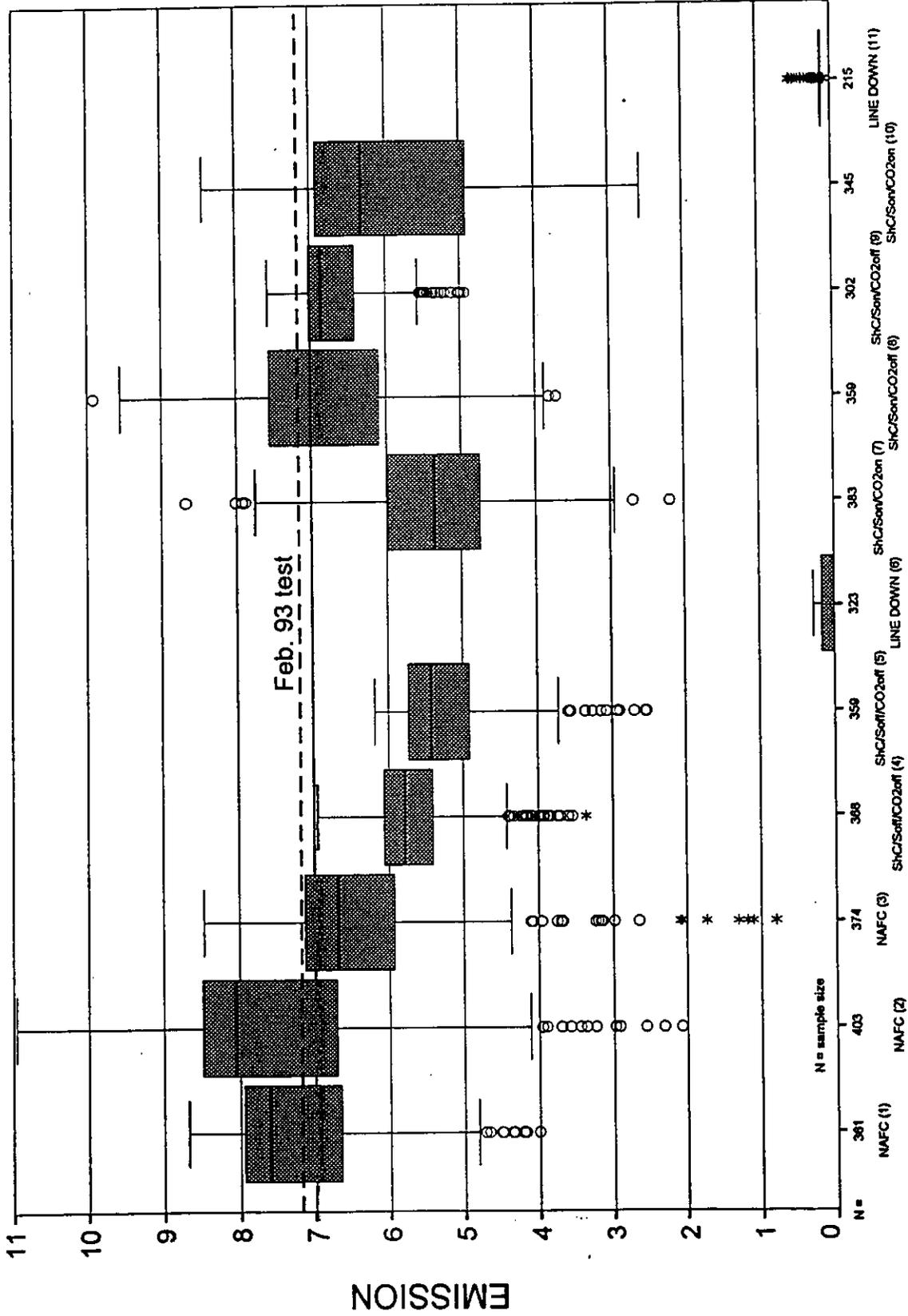
9 Filler Adj. Ball Cages Test
Manual Air Flow Control
(Oct. 11, 1993)



Graph VI

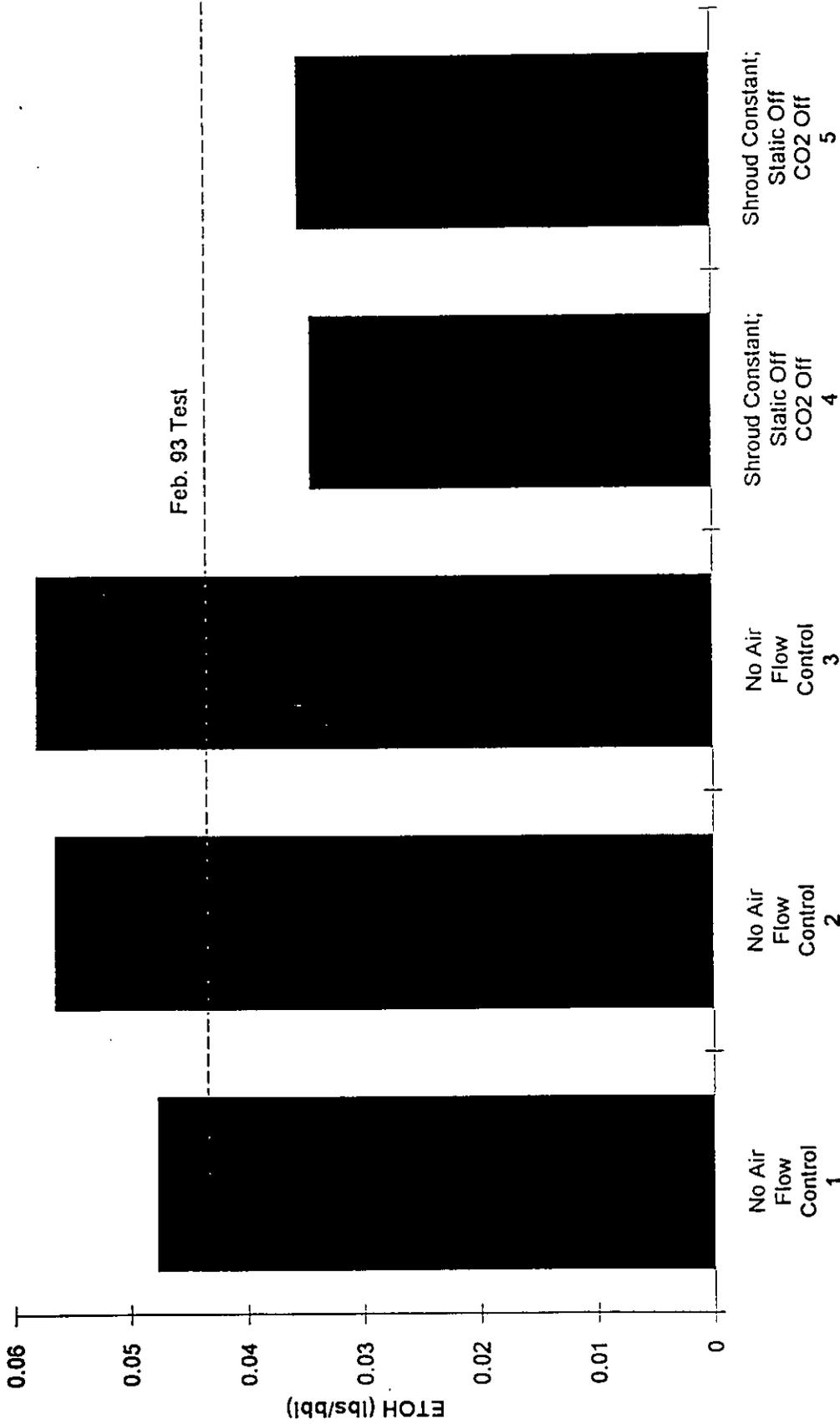
3-BOTTLE VOC TESTS (Sept 1993)

graph VII

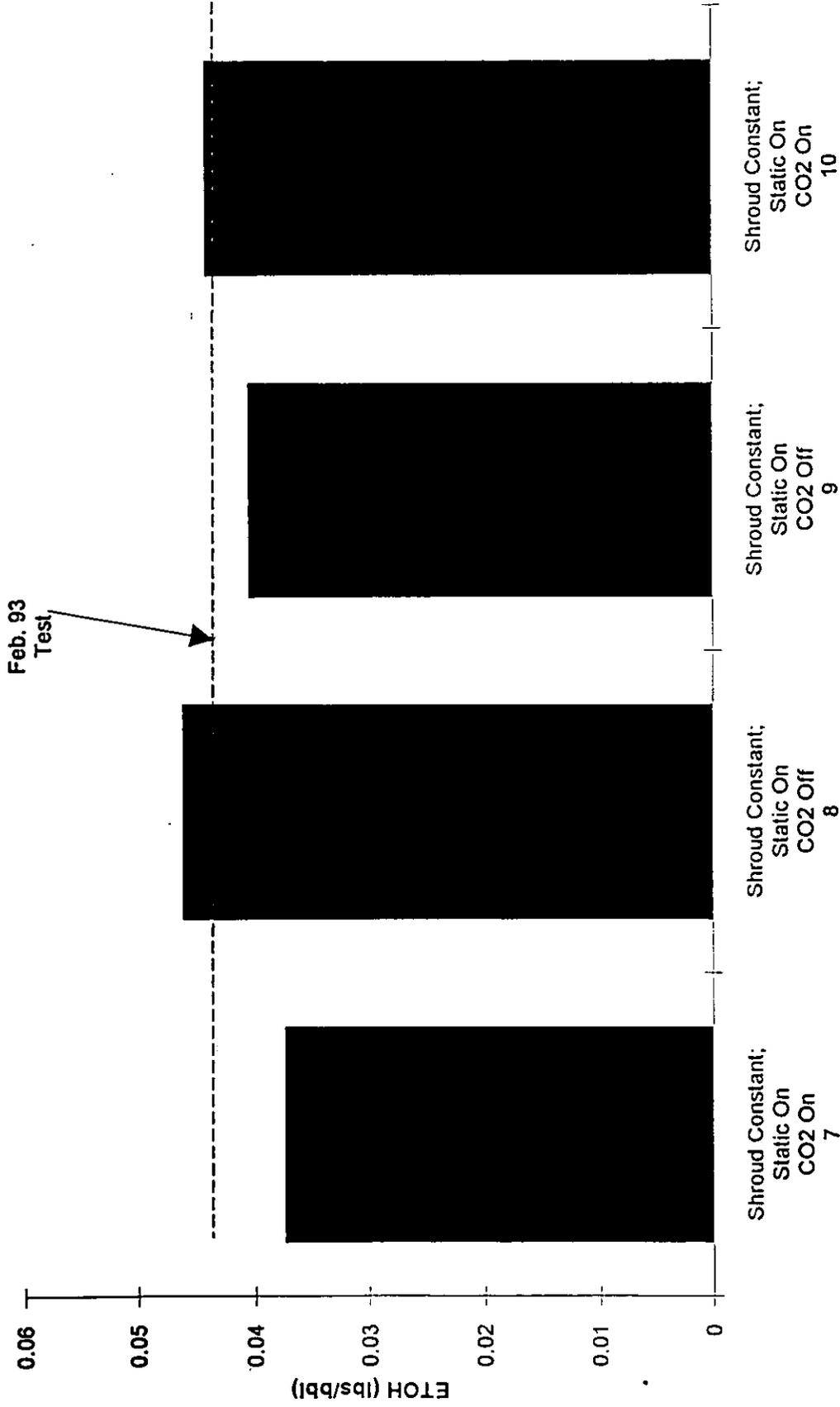


NOTE: NAFC=no air flow control; SHC=shroud constant; S=static

3 Bottle Emission Factors

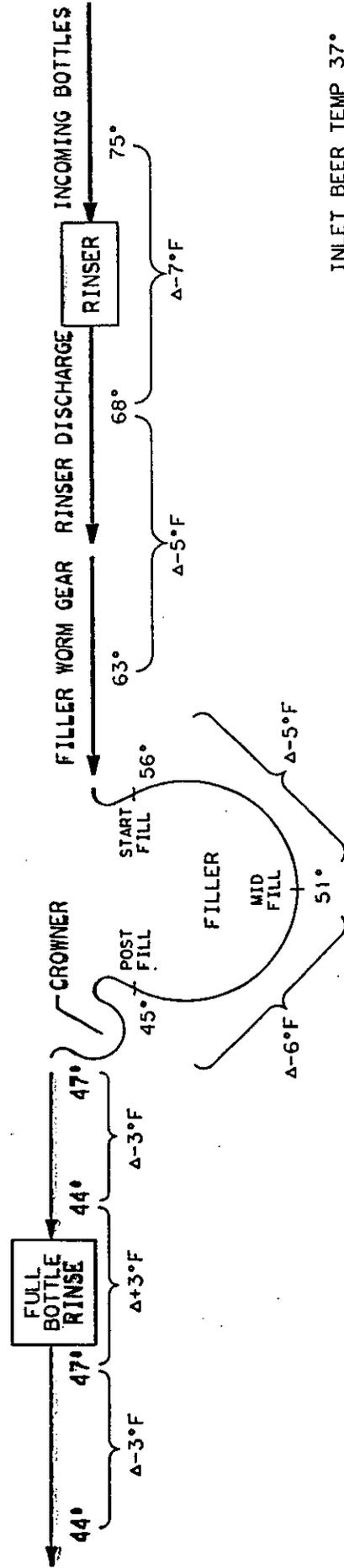


3 Bottle Emission Factors



3 BOTTLE EMISSION FACTORS (Sept. 1993)						
Test ID	Test ID	ETOH lb/bbl	ETOH lb/hr	Production Rate bbl/hrs	Sample Interval hrs	Beer Packaged bbl
1	No Air□Flow□Control□1	0.047805526	7.61	159.19	6.97	1109
2	No Air□Flow□Control□2	0.056554894	8.05	142.34	6.98	994
3	No Air□Flow□Control□3	0.058232416	6.70	115.06	7.48	861
4	Shroud Constant;□Static Off□CO2 Off□	0.034358274	5.79	168.52	6.97	1174
5	Shroud Constant;□Static Off□CO2 Off□	0.035421634	5.42	153.01	7.97	1219
6	Filler□Down□6	0	0.00	0.00	5.97	0
7	Shroud Constant;□Static On□CO2 On□	0.037340976	5.36	143.54	6.97	1000
8	Shroud Constant;□Static On□CO2 Off□	0.046164073	7.00	151.63	7.97	1208
9	Shroud Constant;□Static On□CO2 Off□	0.040584695	6.87	169.28	5.97	1010
10	Shroud Constant;□Static On□CO2 On□	0.044143139	6.33	143.40	6.97	999
11	Filler□Down□11	0	0.13	0.00	7.97	0

R. Peterson
 L. Barnard
 10/14/93 1540 hrs

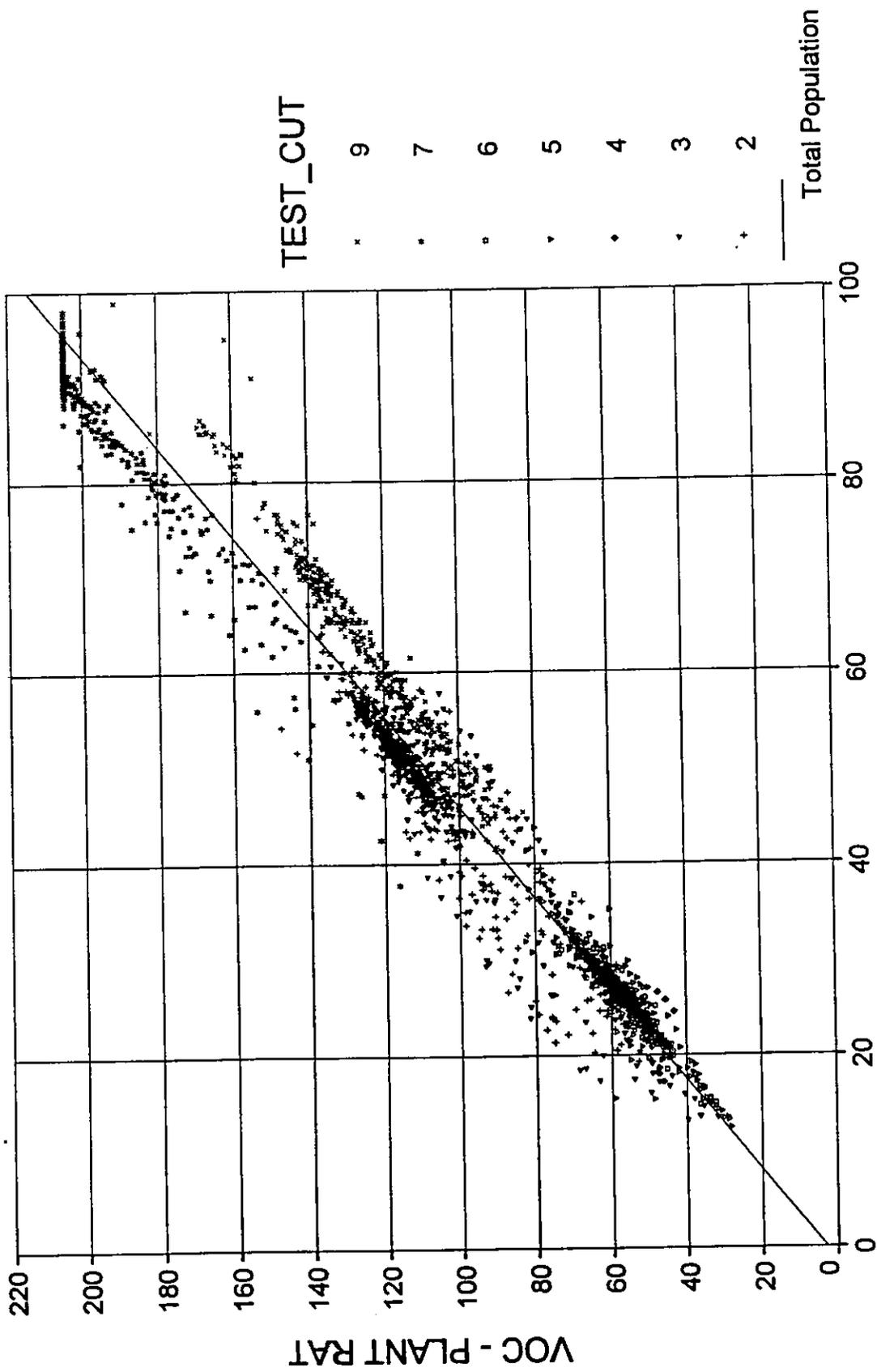


3-2 BOTTLE FILLER
 BOTTLE SURFACE TEMPERATURE

APPENDIX B

FID versus PLANT RAT

VOC 9-FILLER TEST



GAS - FID

APPENDIX C

9 FILLER

RAW DATA

9 FILLER

VOC TESTING

WEEK of AUGUST 30, 1993

SHIFT	Aug. 30 Mon	Aug. 31 Tues	Sept. 1 Wed	Sept. 2 Thur	Sept. 3 Fri	Sept 4. Sat	Sept. 5 Sun
GRAVEYARD		FILL LEVEL CONTROL NO AIR FLOW CONTROL TEST ID = 3	FILL LEVEL CONTROL NO AIR FLOW CONTROL TEST ID = 6	FILL LEVEL CONTROL AIR FLOW CONTROL TEST ID = 8			
DAY	FILL LEVEL CONTROL NO AIR FLOW CONTROL TEST ID = 1	FILL LEVEL CONTROL NO AIR FLOW CONTROL TEST ID =4	FILL LEVEL CONTROL AIR FLOW CONTROL TEST ID = 7	FILL LEVEL CONTROL AIR FLOW CONTROL TEST ID = 9			
SWING	FILL LEVEL CONTROL NO AIR FLOW CONTROL TEST ID = 2	FILL LEVEL CONTROL NO AIR FLOW CONTROL TEST ID = 5					

9 FILLER

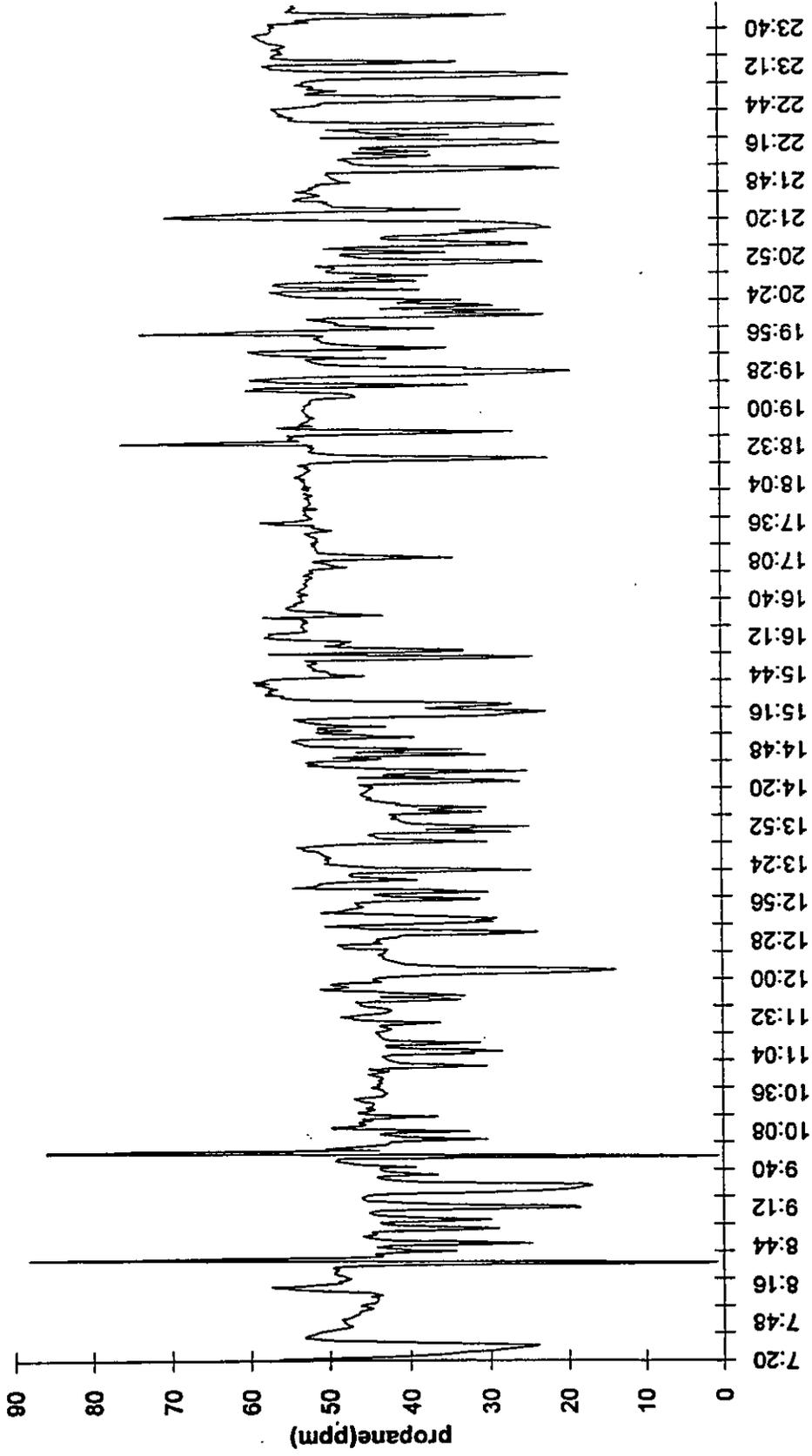
VOC TESTING

WEEK of SEPTEMBER 6, 1993

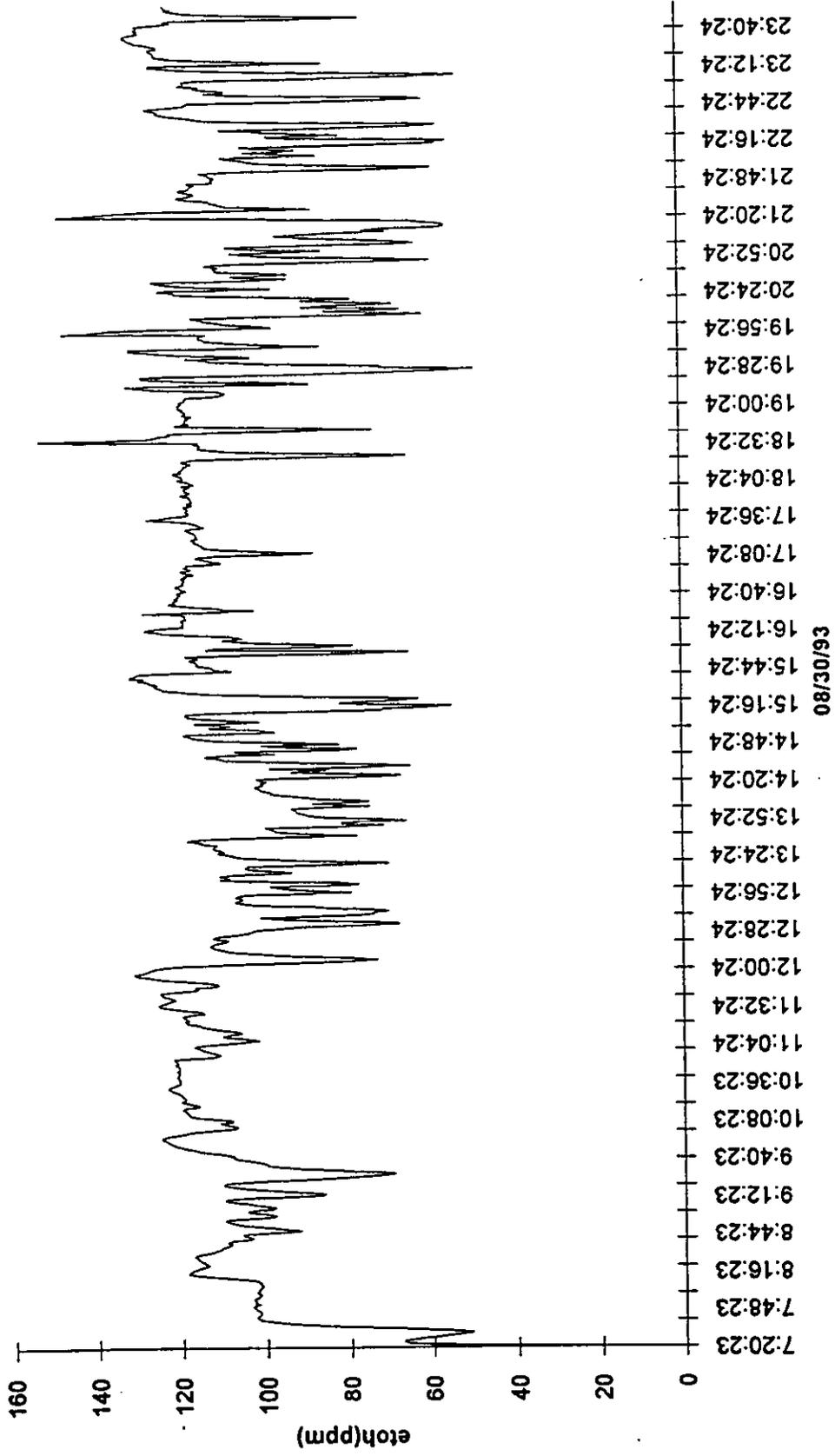
SHIFT	Sept. 6 Mon	Sept. 7 Tues	Sept. 8 Wed	Sept. 9 Thur	Sept. 10 Fri	Sept 11 Sat	Sept. 12 Sun
GRAVEYARD			FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] TEST ID = 10	FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] TEST ID = 13	FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] TEST ID = 15	FILLER NOT SCHEDULE D	FILLER NOT SCHEDULED
DAY			FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] TEST ID = 11	FILLER NOT SCHEDULED	FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] BLACK FILL TEST TEST ID = 16	FILLER NOT SCHEDULE D	FILLER NOT SCHEDULED
SWING			FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] TEST ID = 12	FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] TEST ID = 14	FILL LEVEL CONTROL AIR FLOW CONTROL DRIP TROUGH [*] TEST ID = 17	FILLER NOT SCHEDULE D	FILLER NOT SCHEDULED

* PARTIAL DRIP TROUGH^S
 - SHORT LIP
 - BEER RELEASED TO FLOOR

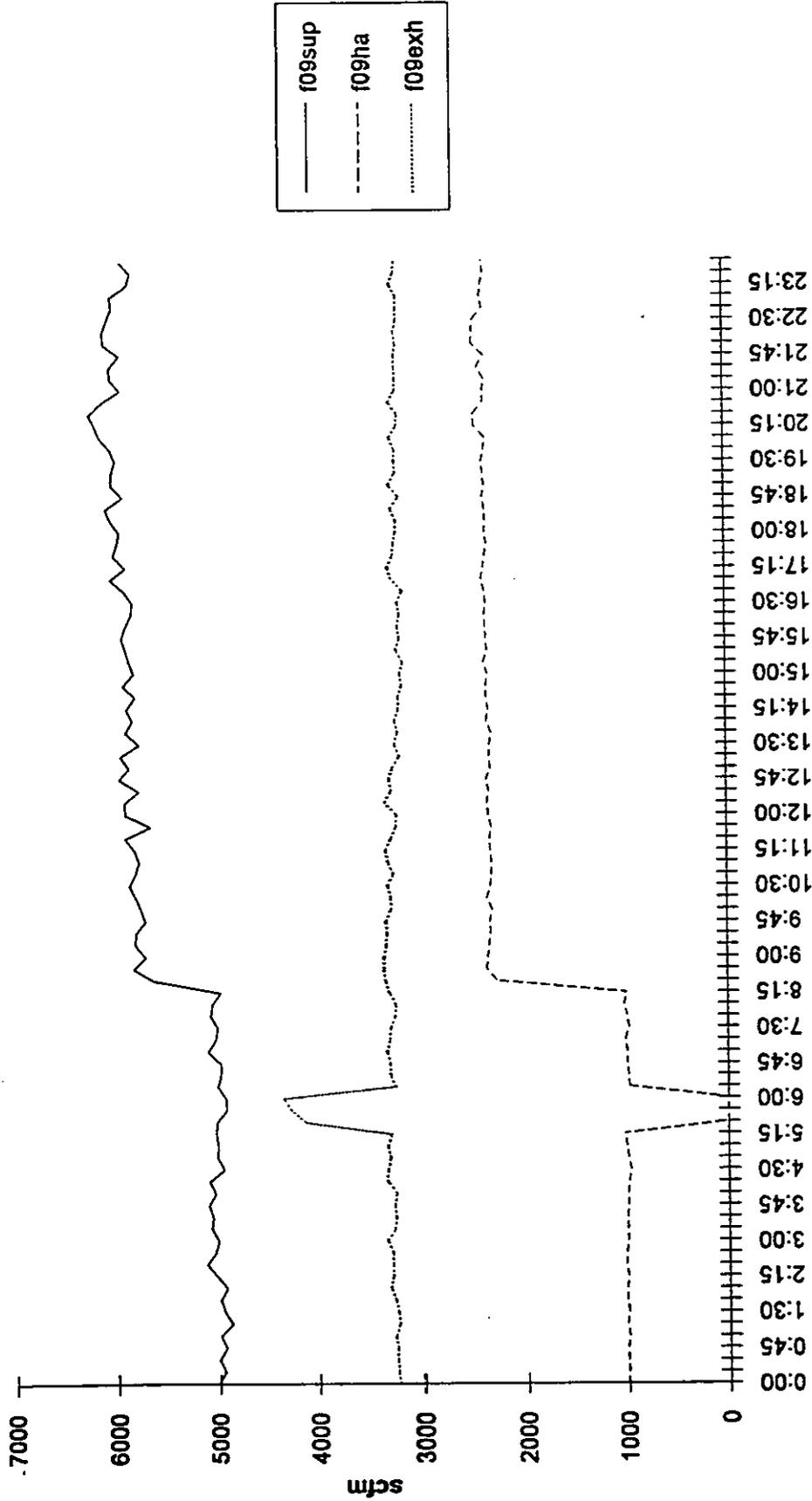
9 Filler
(FID)



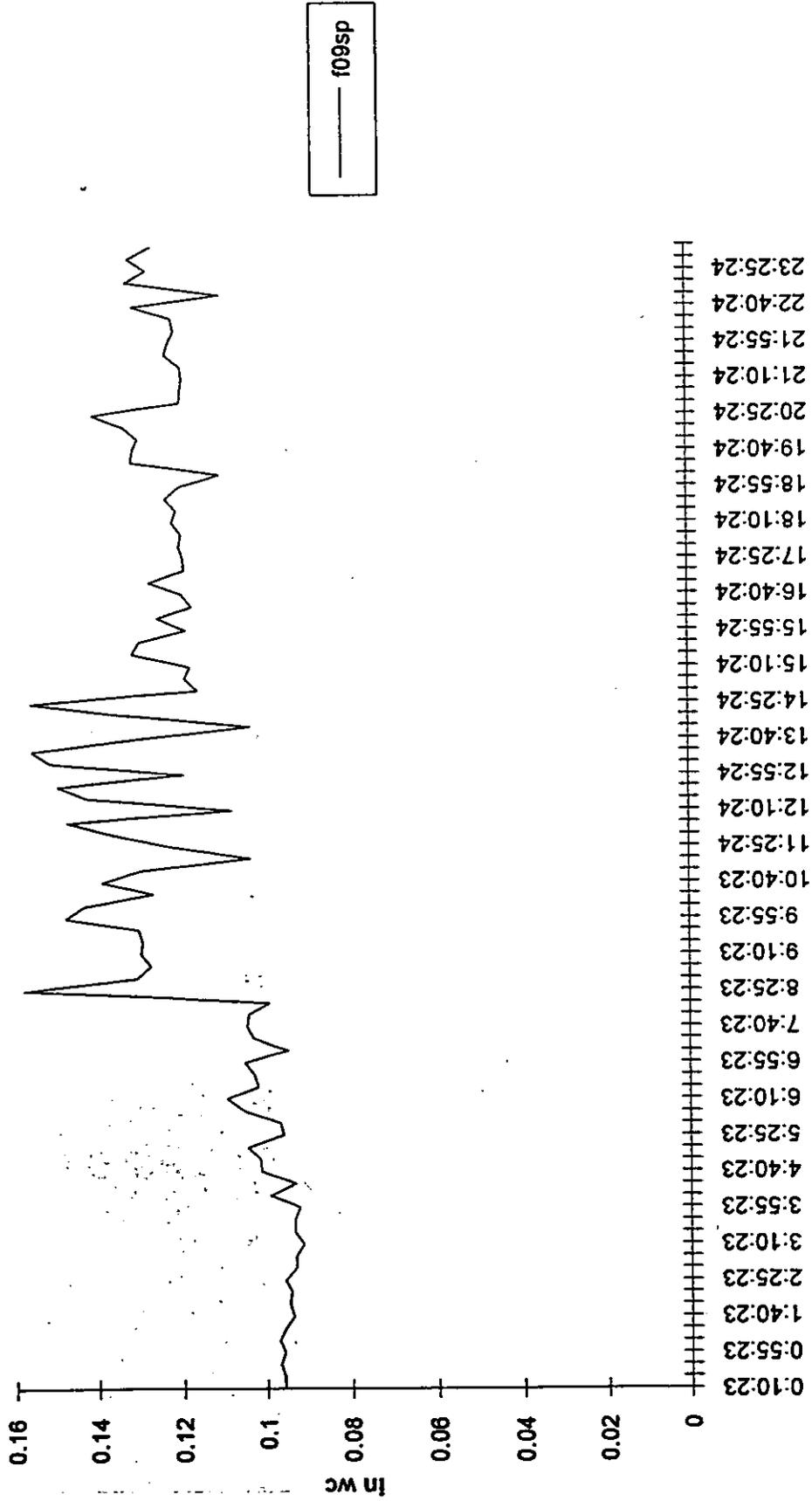
9 Filler
(Plant Rat)



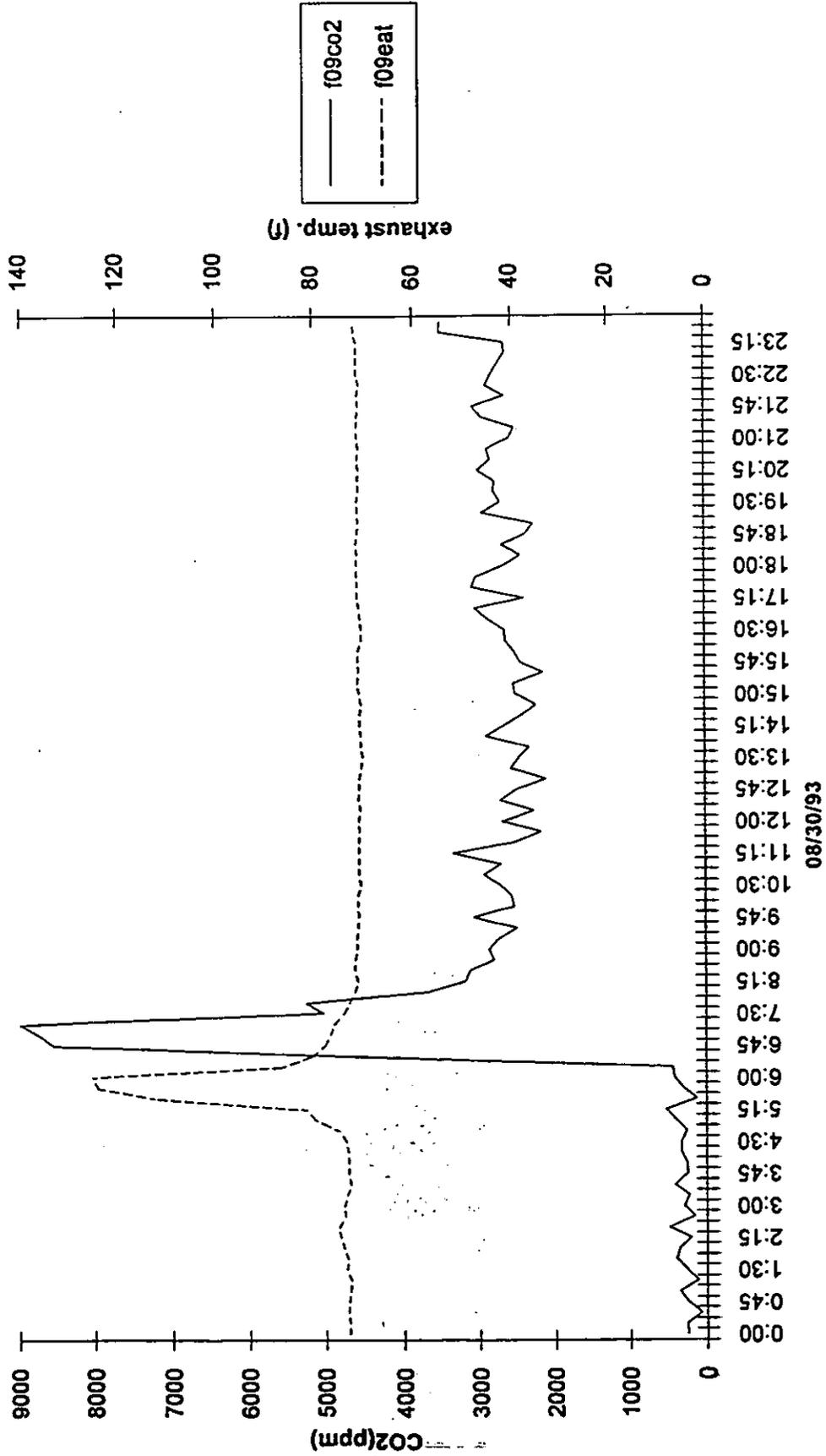
9 Filler
Air Flow



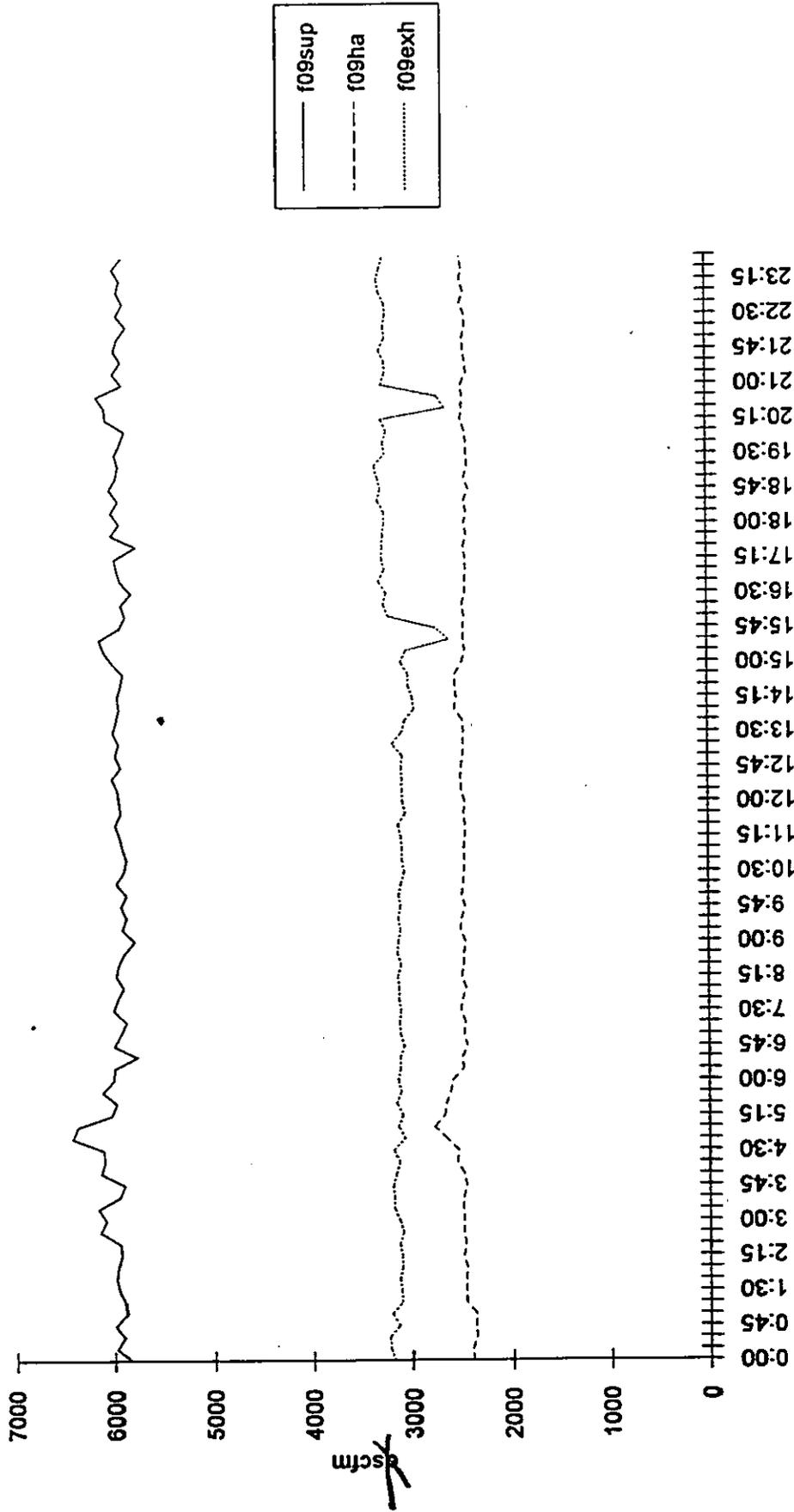
9 Filler
Static Pressure



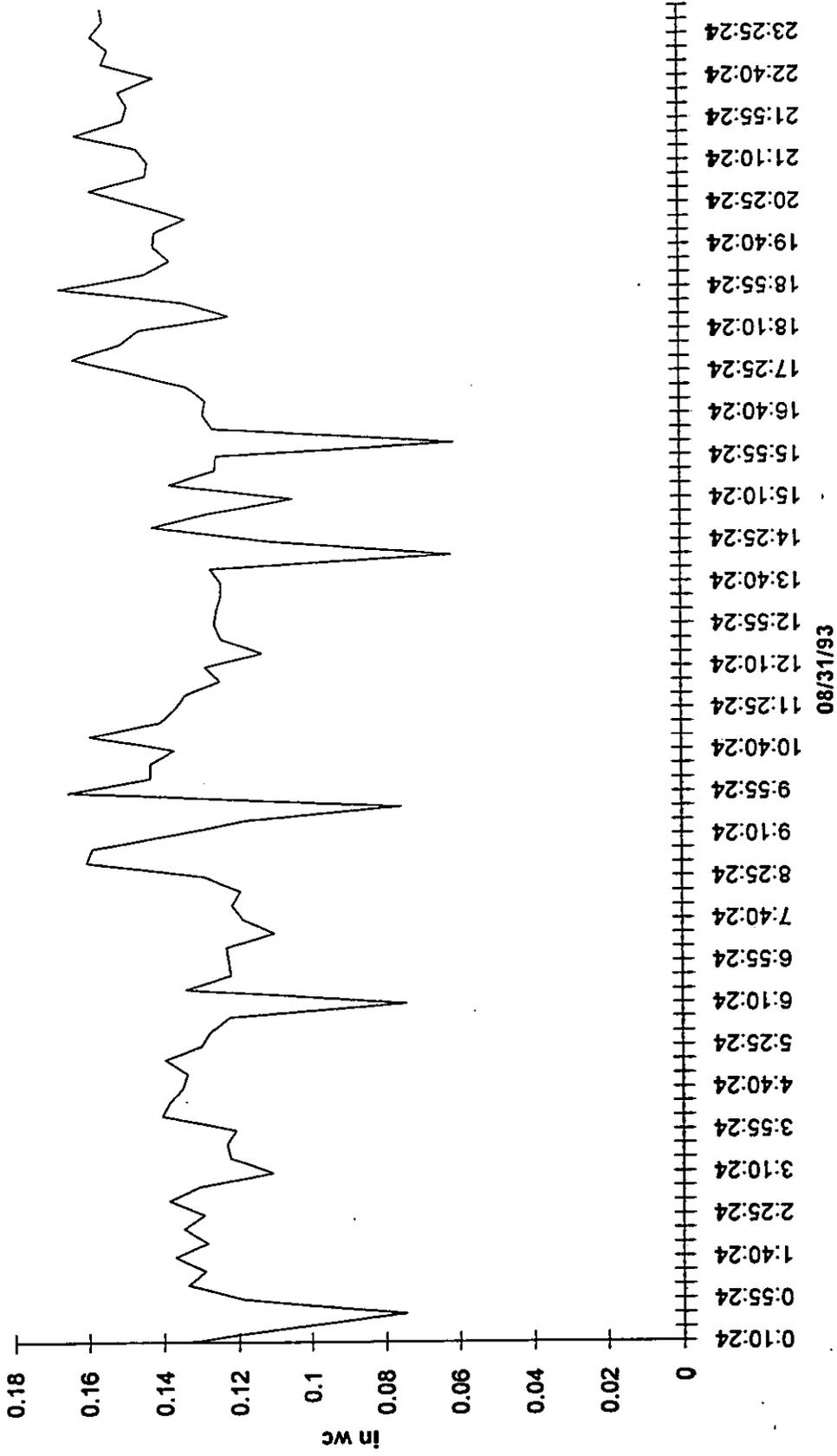
9 Filler
CO2 & Temperature



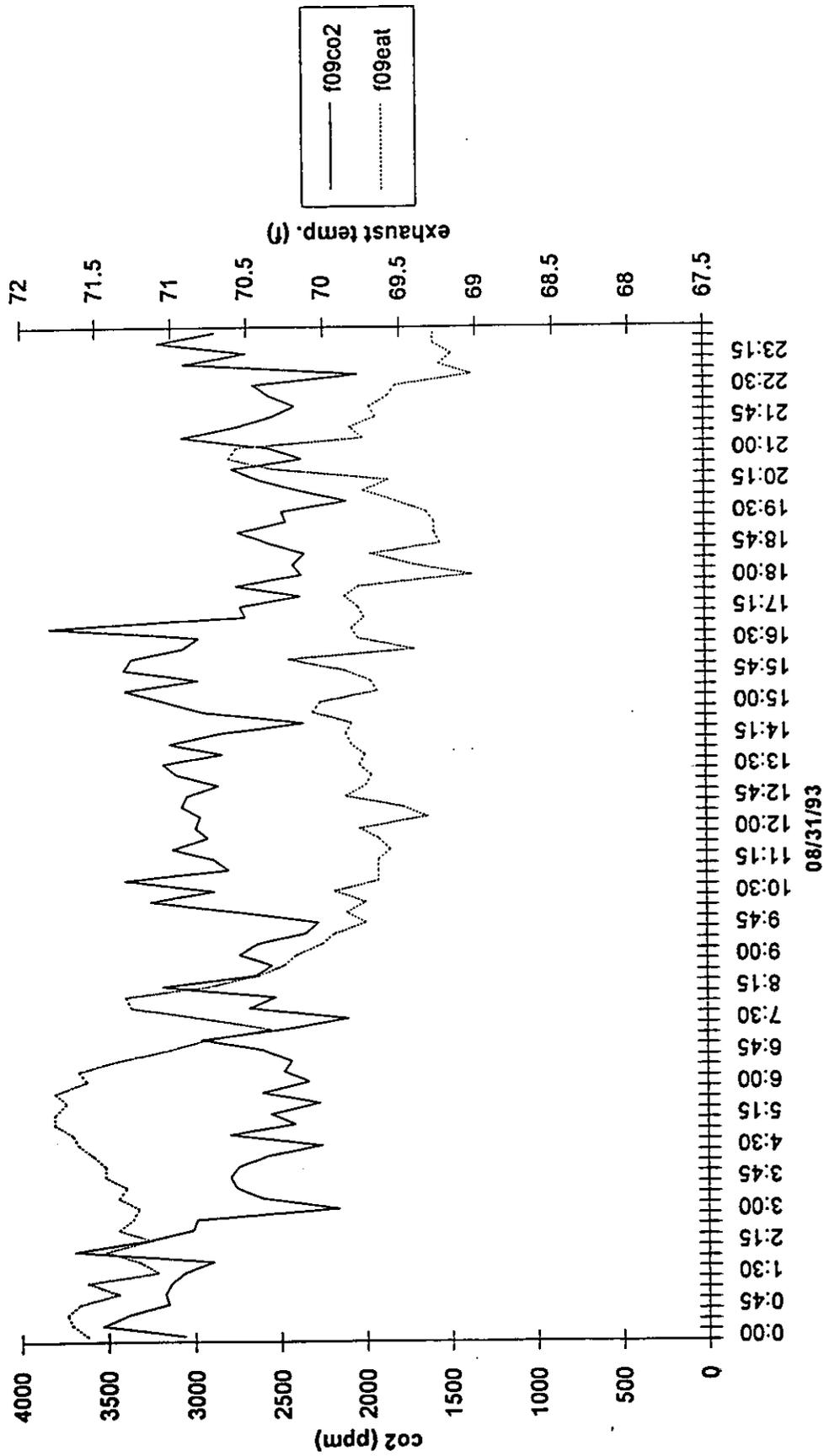
9 Filler
Air Flow



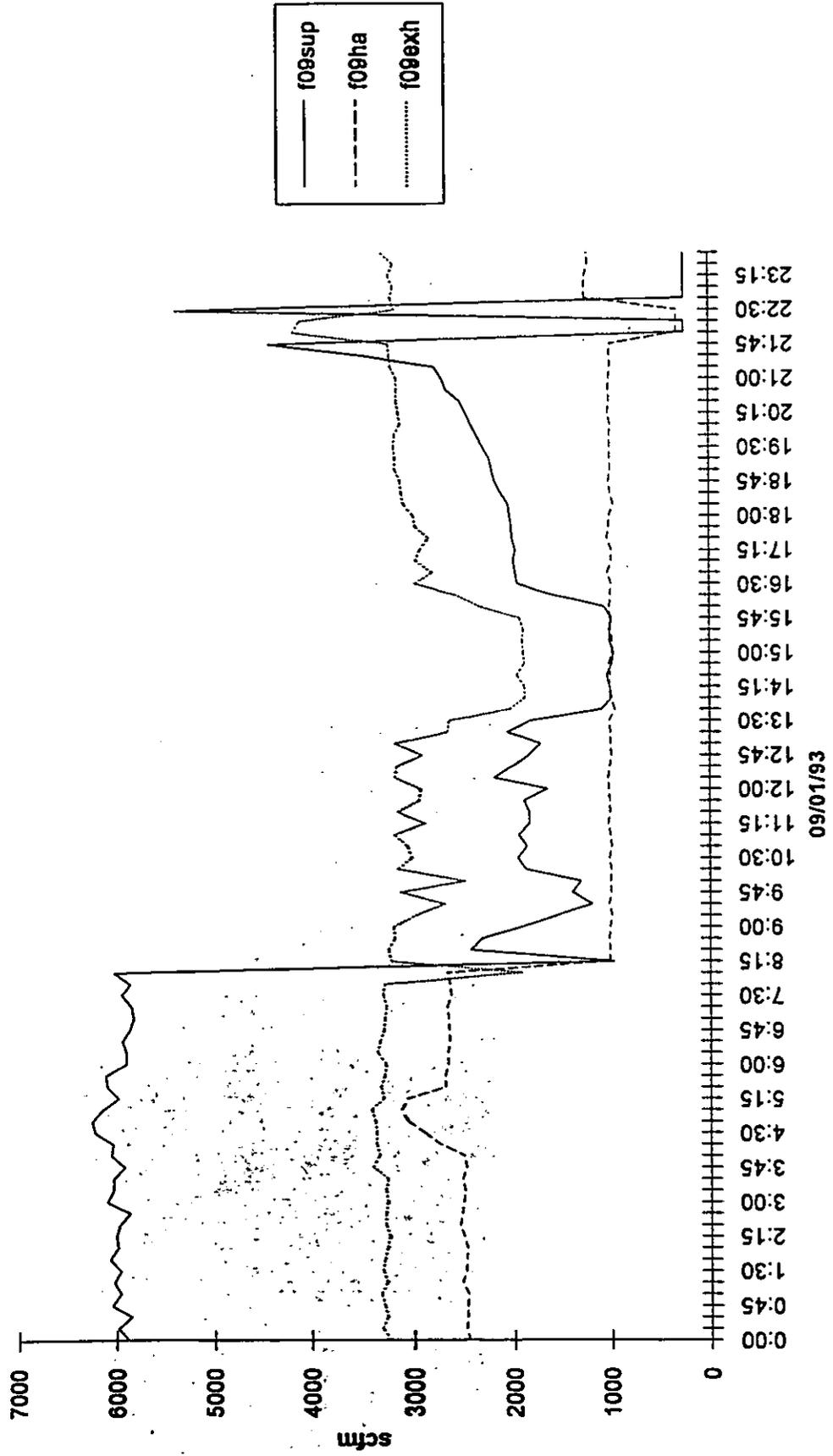
9 Filler
Static Pressure



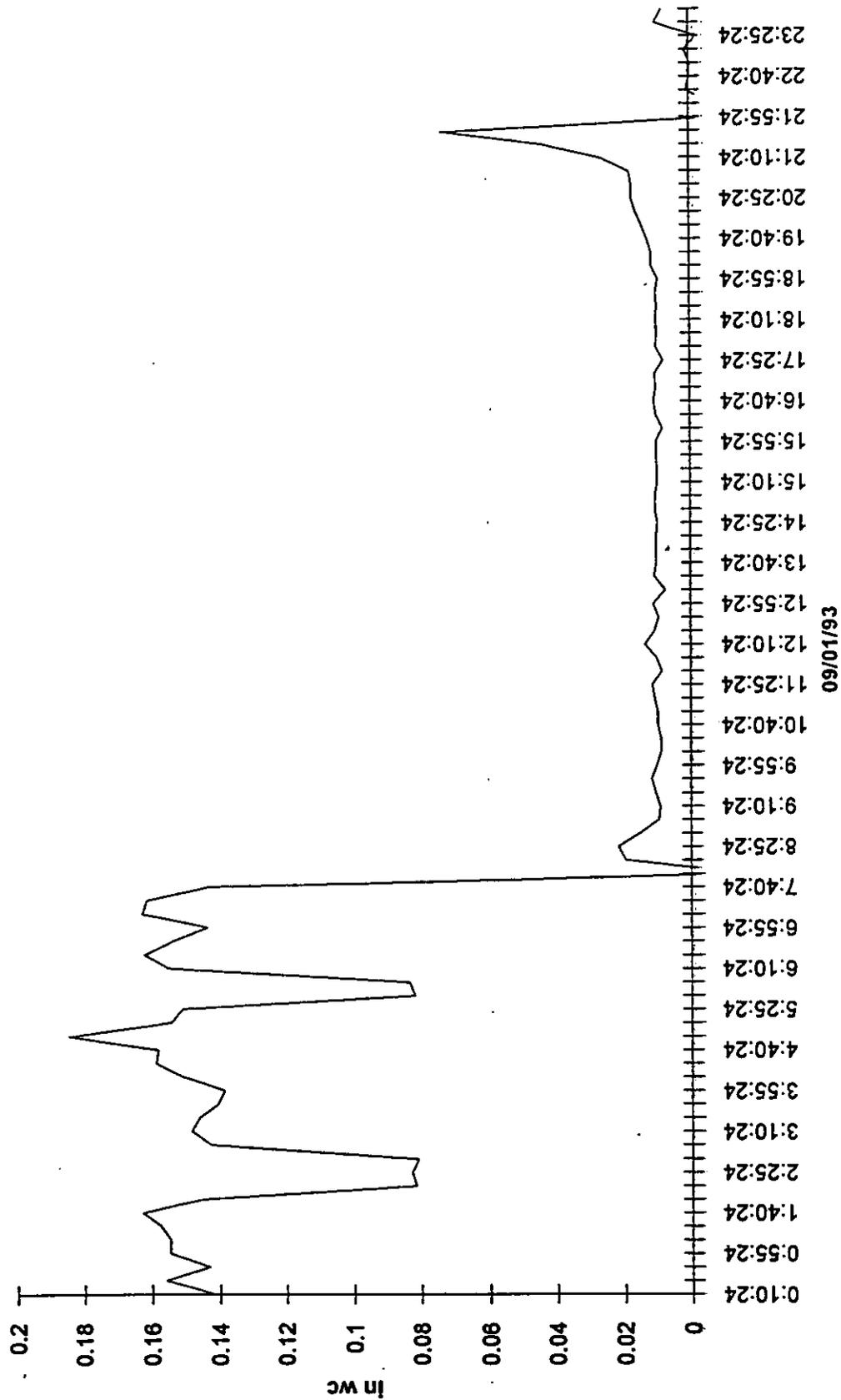
9 Filler
CO2 & Temperature



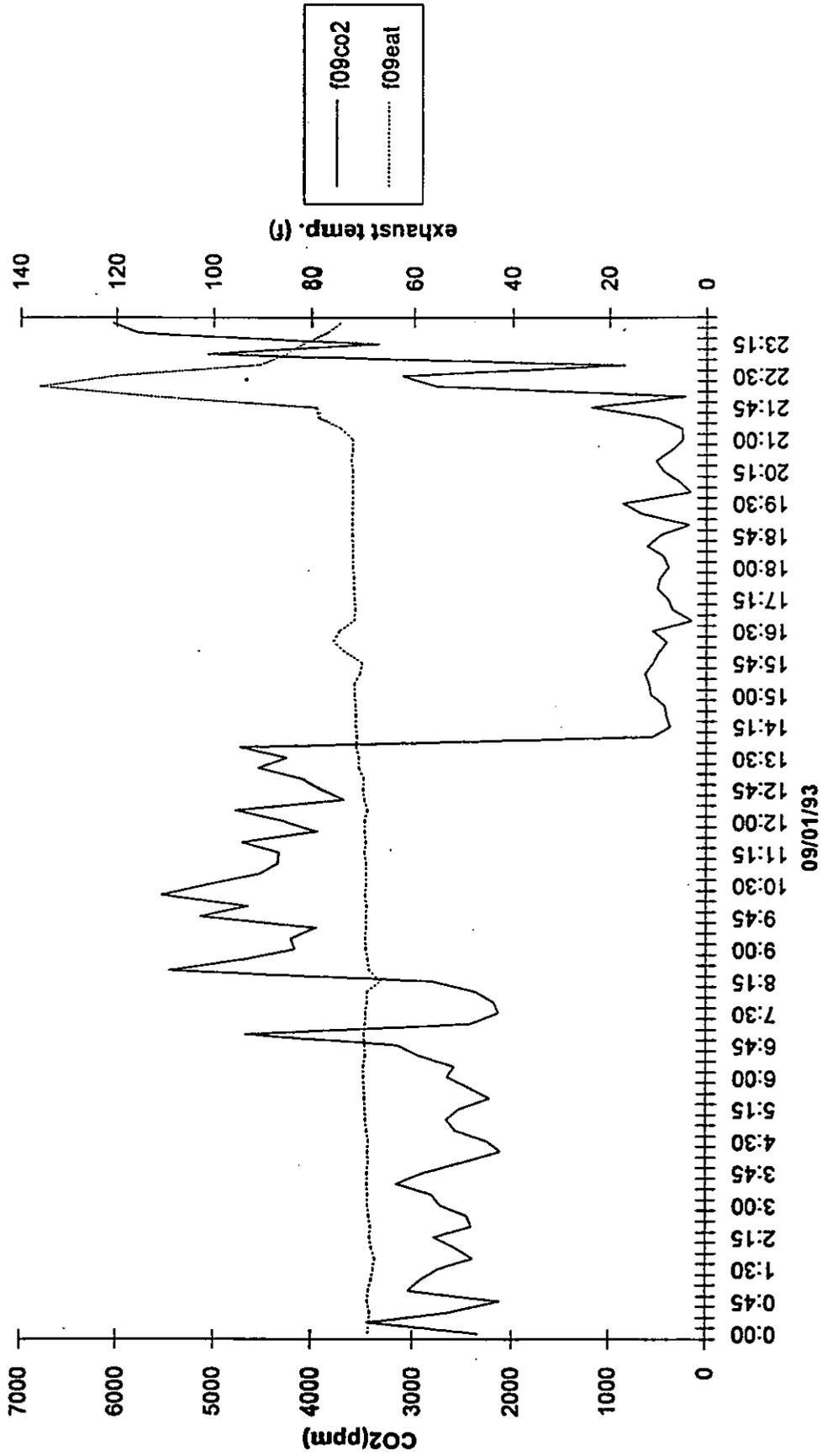
9 Filler
Air Flow



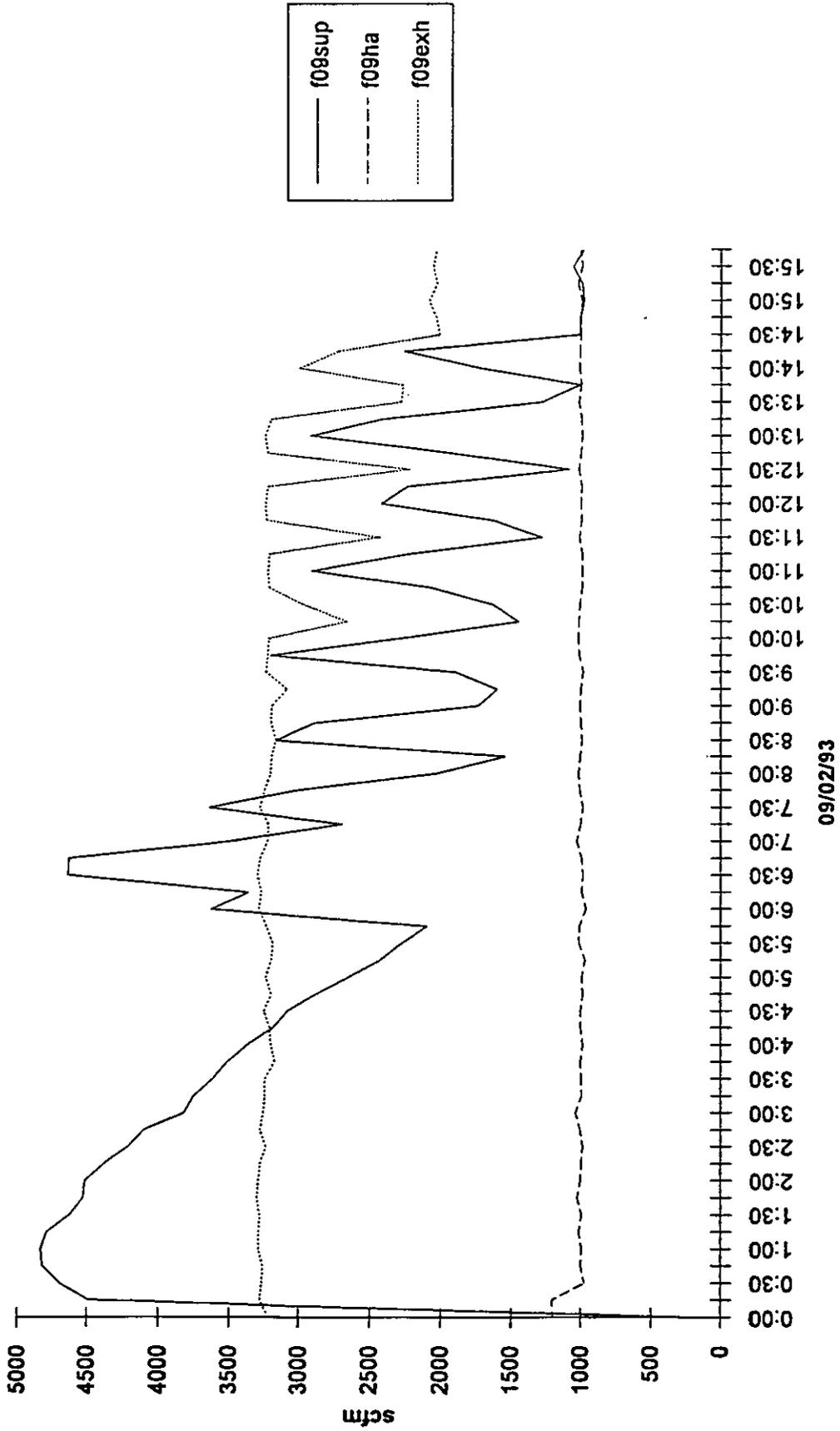
9 Filler - Static Pressure



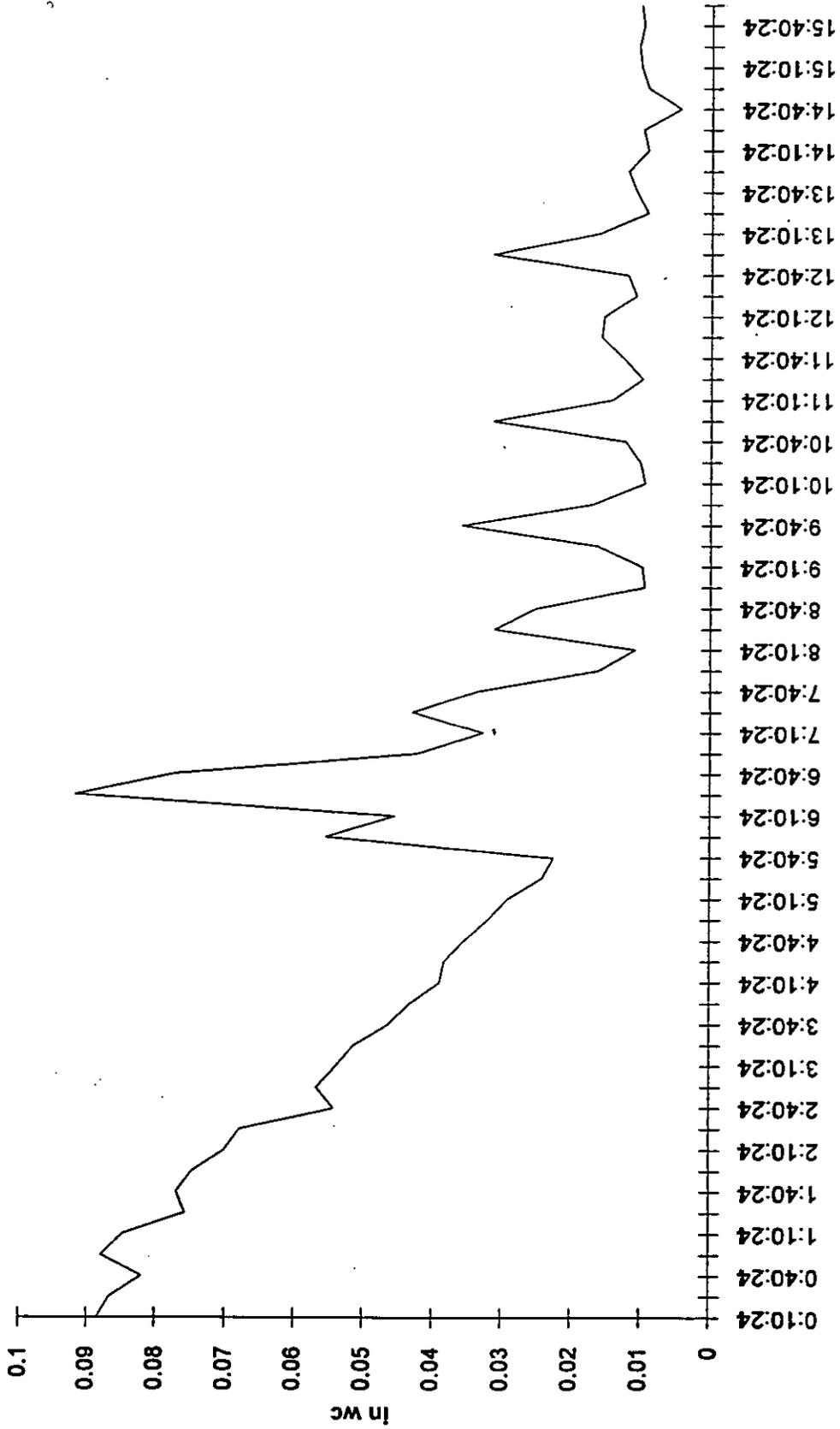
9 Filler CO2 & Temperature



9 Filler - Air Flow

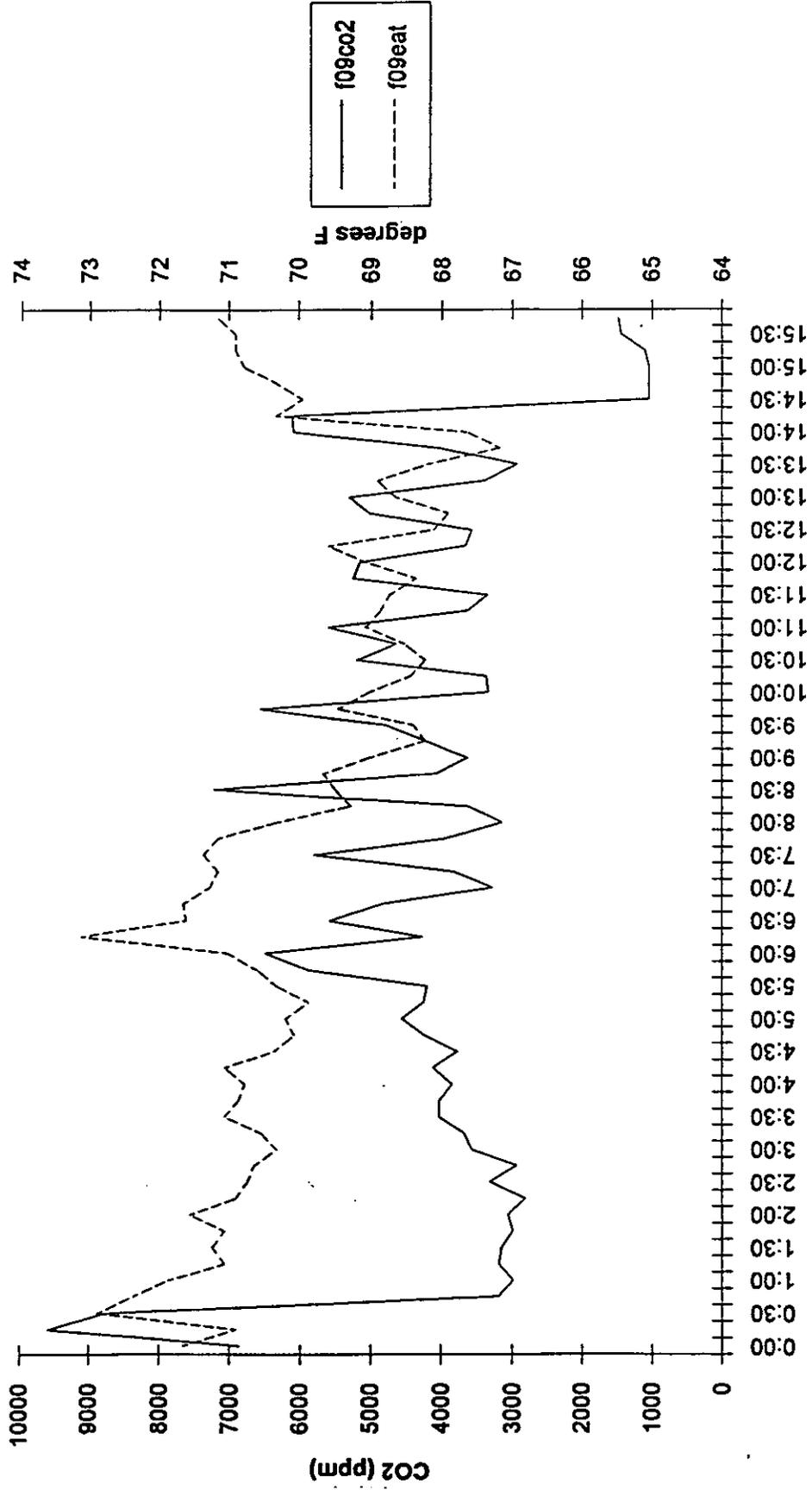


9 Filler - Room Static Pressure

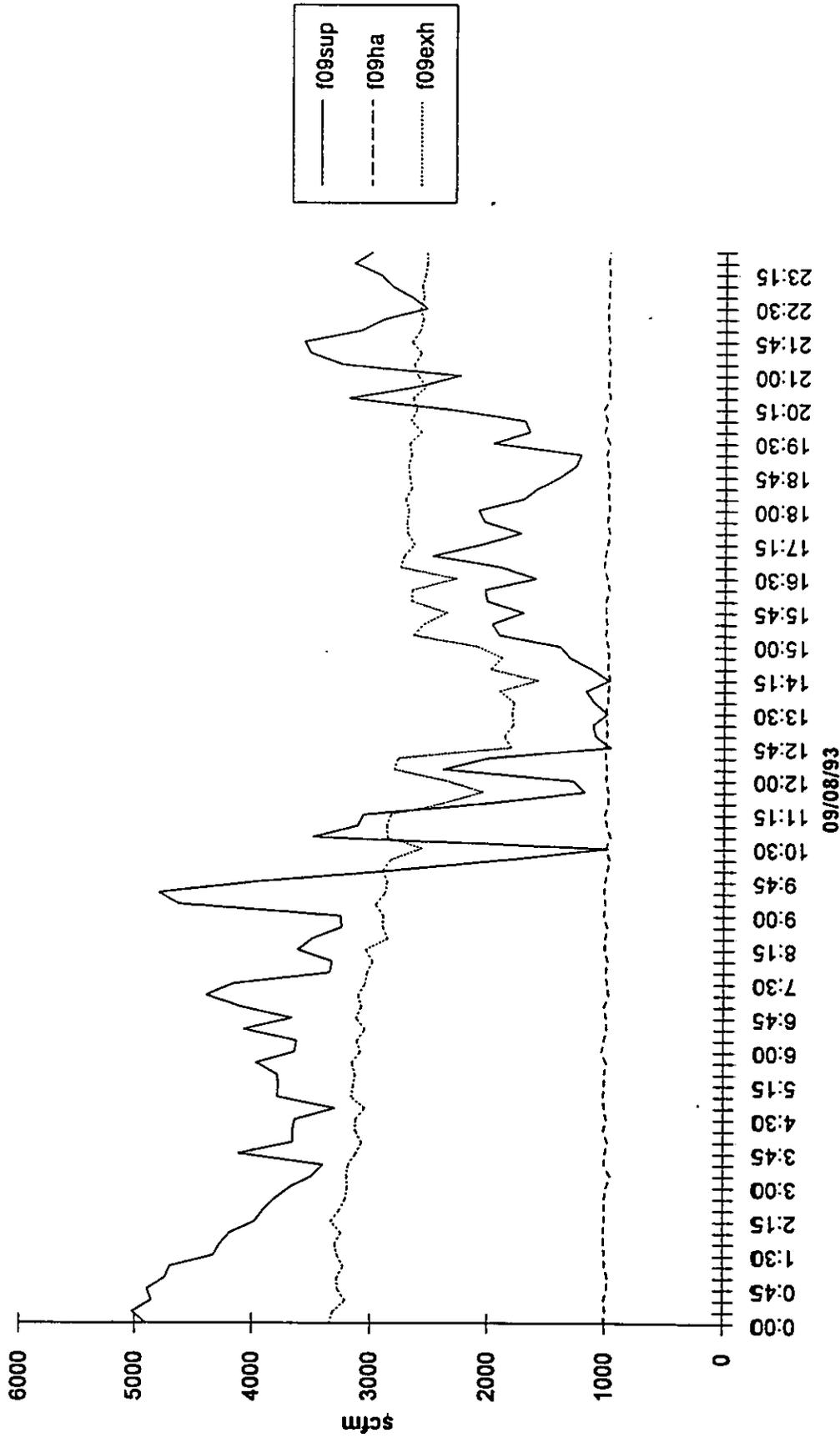


09/02/93

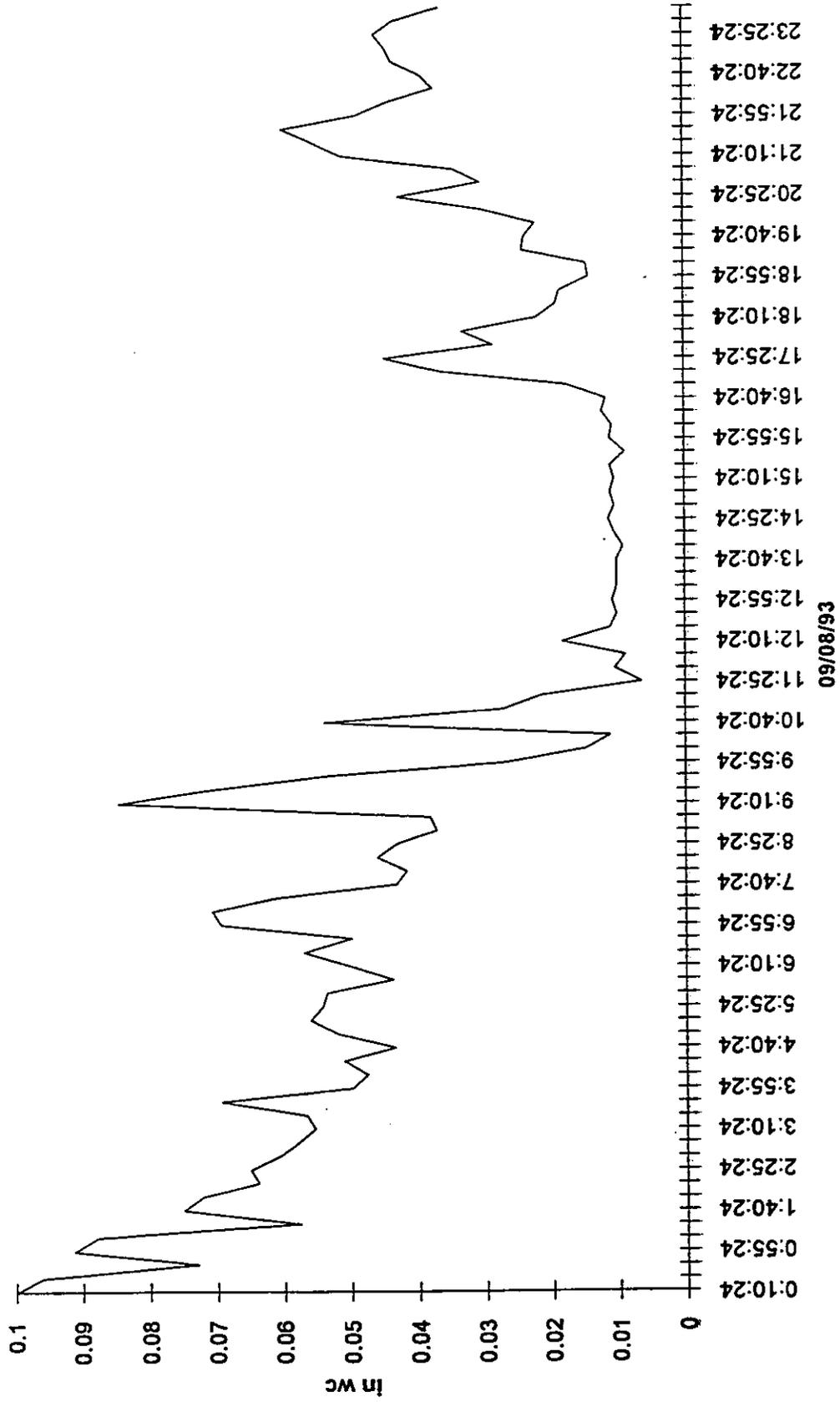
9 Filler
CO2 Level & Exhaust Temperature



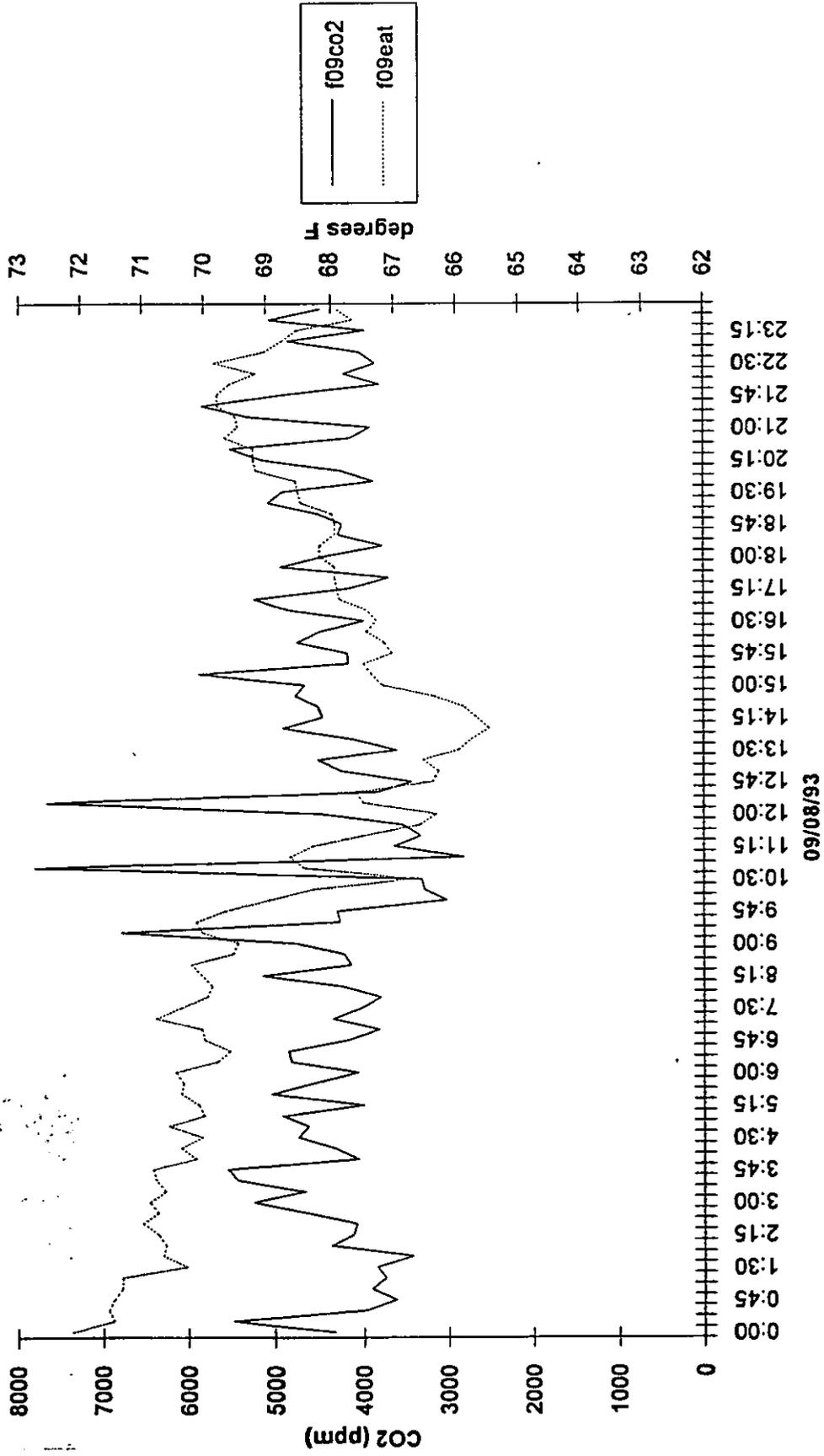
9 Filler - Air Flow



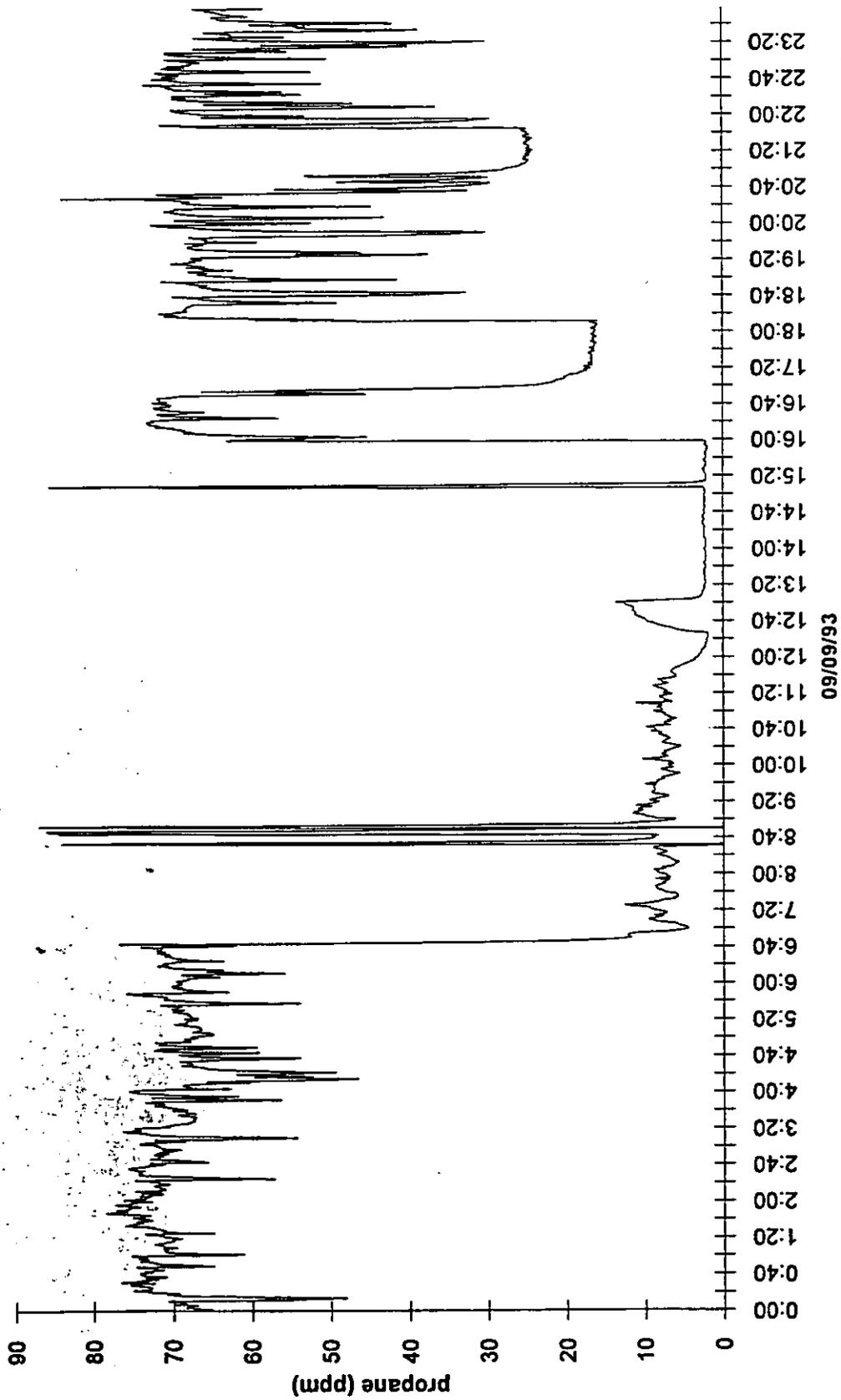
9 Filler - Room Static Pressure



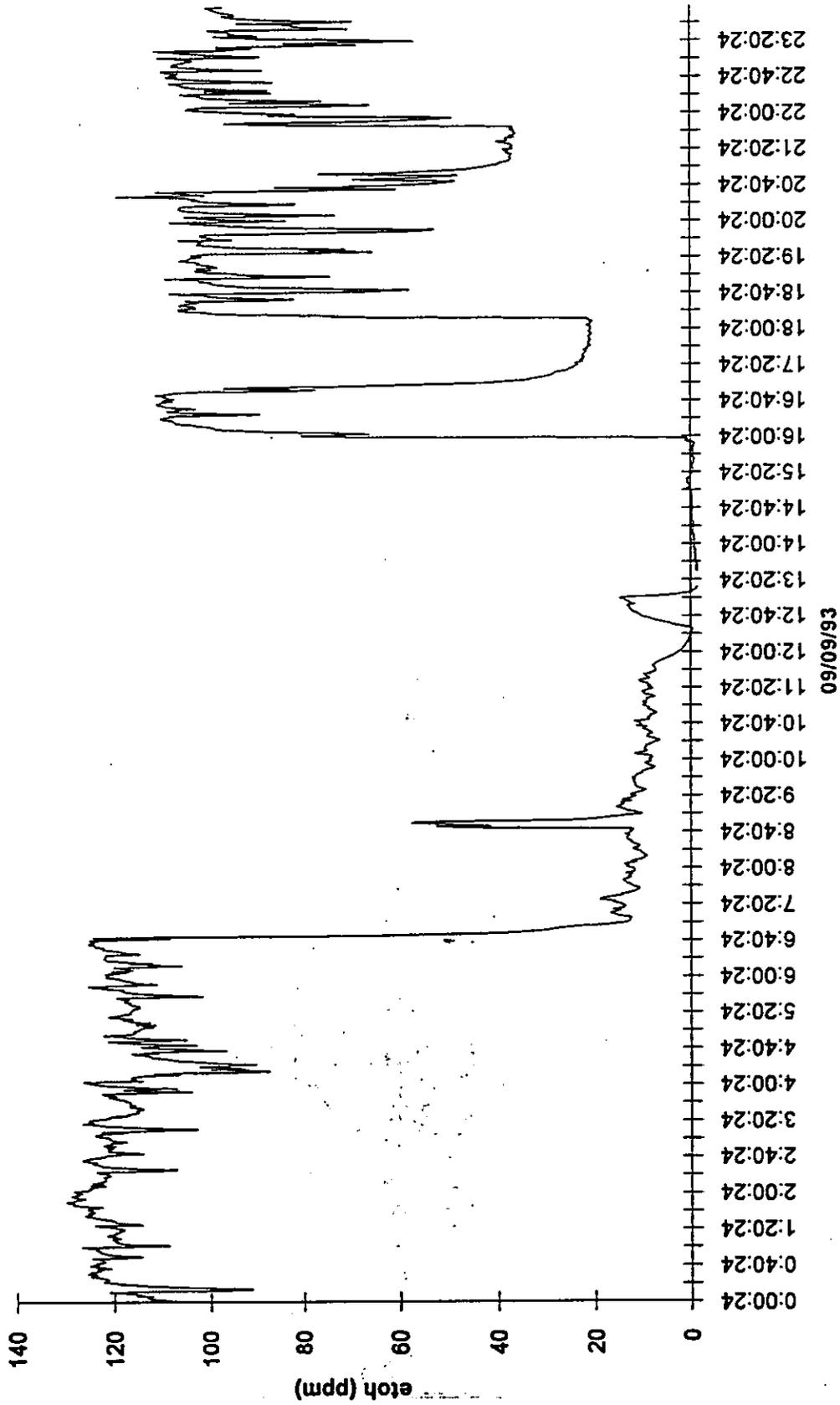
9 Filler
CO2 Level & Exhaust Air Temperature



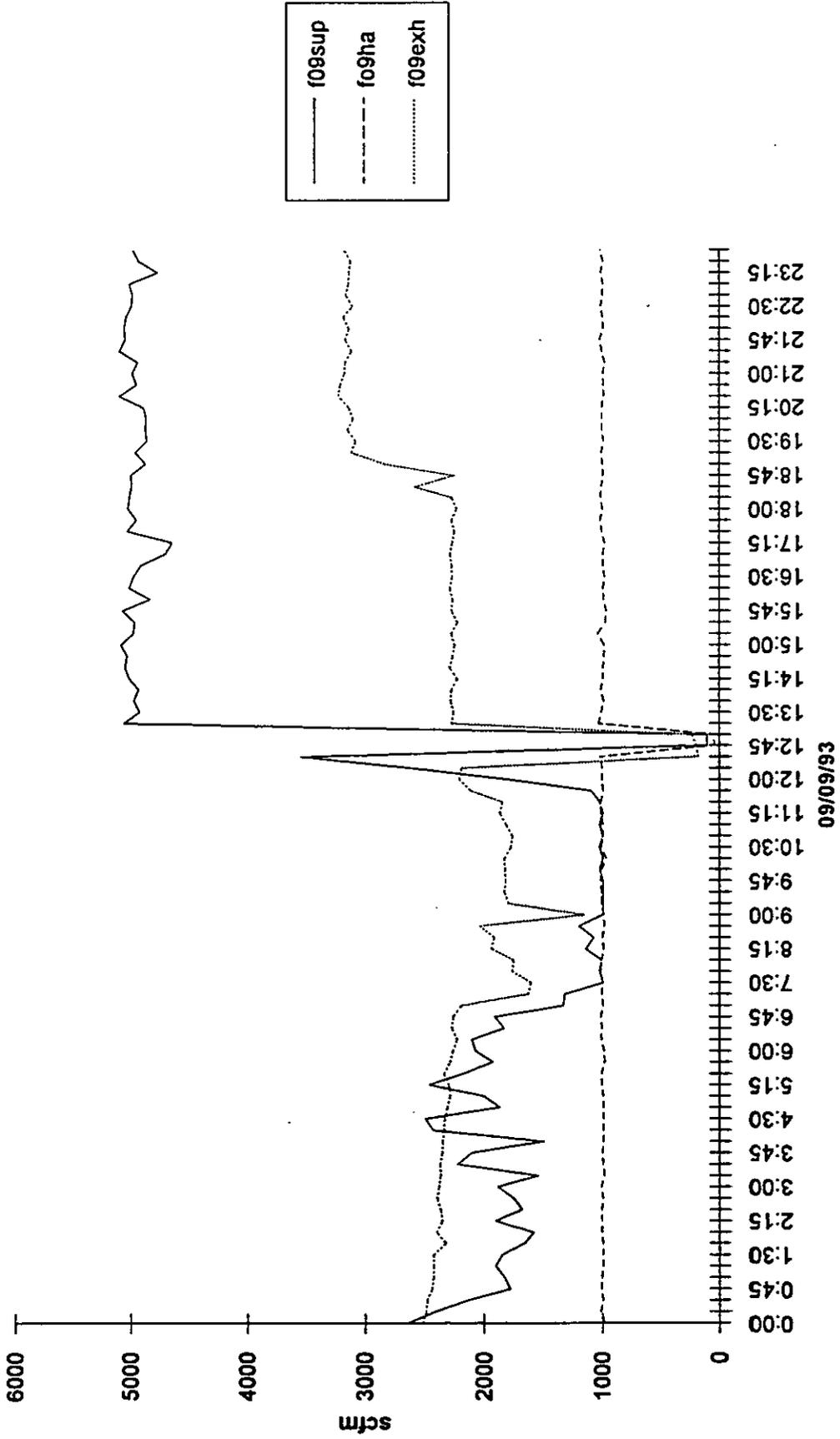
9 Filler - FID



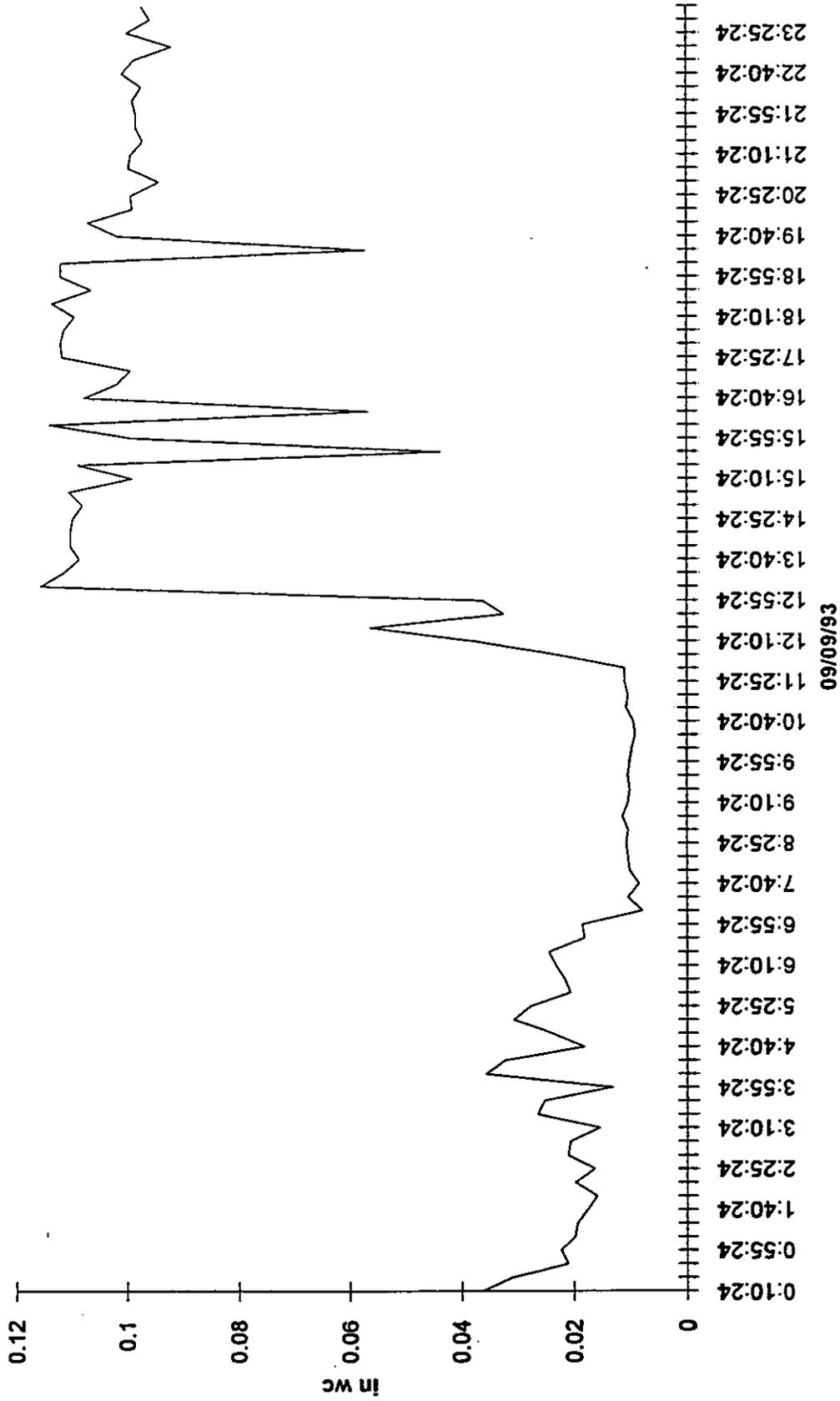
9 Filler - Plant Rat



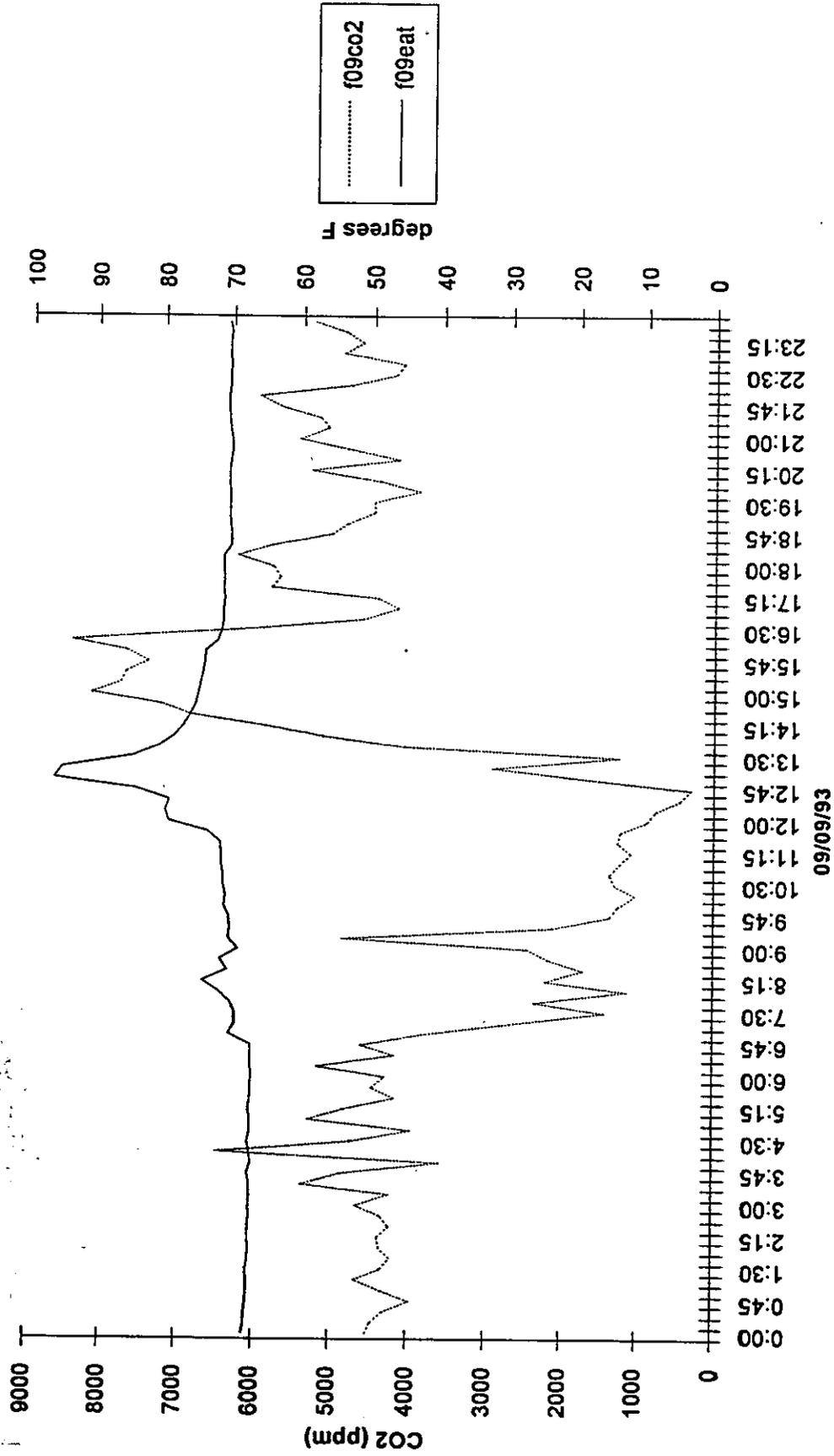
9 Filler - Air Flow



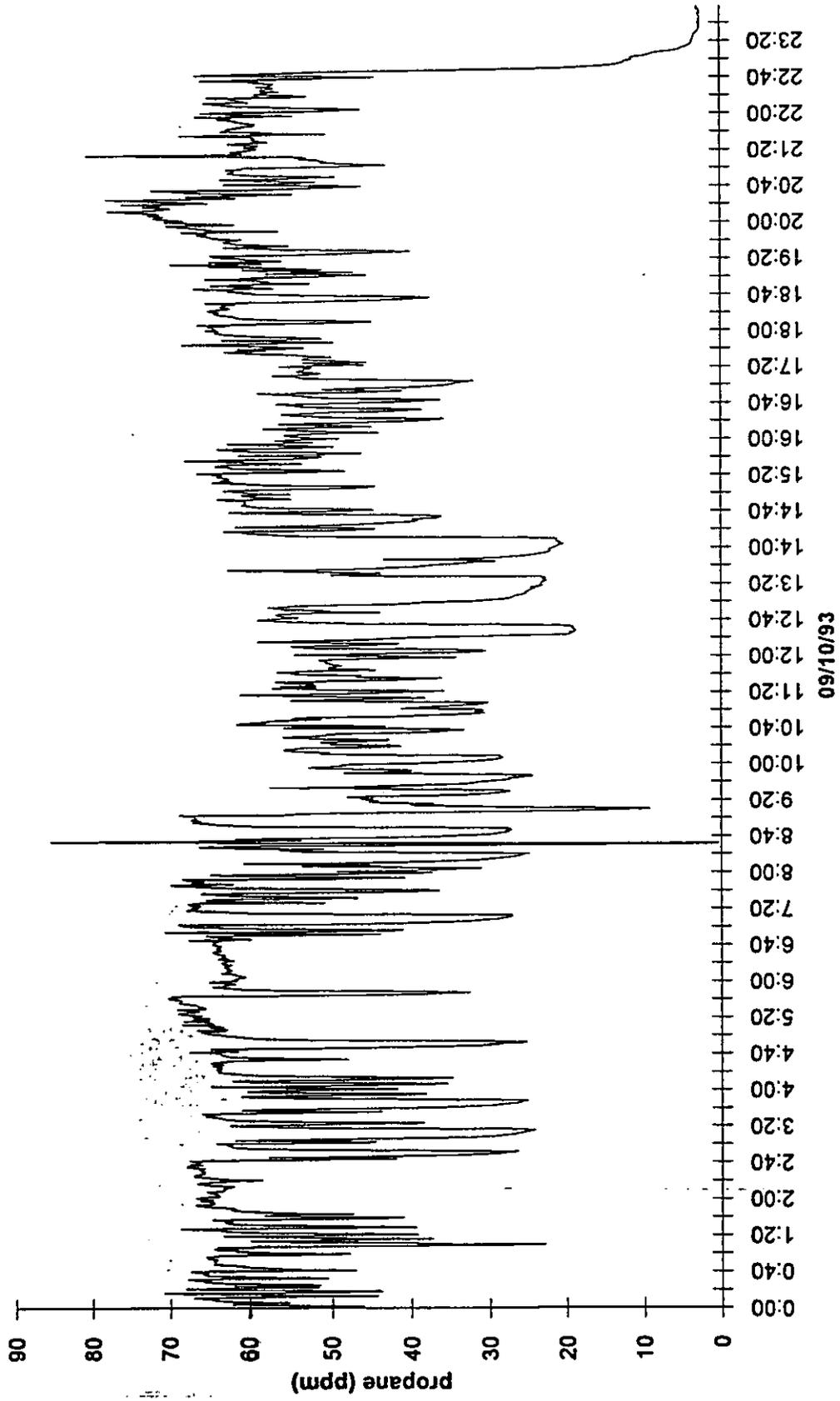
9 Filler - Room Static Pressure



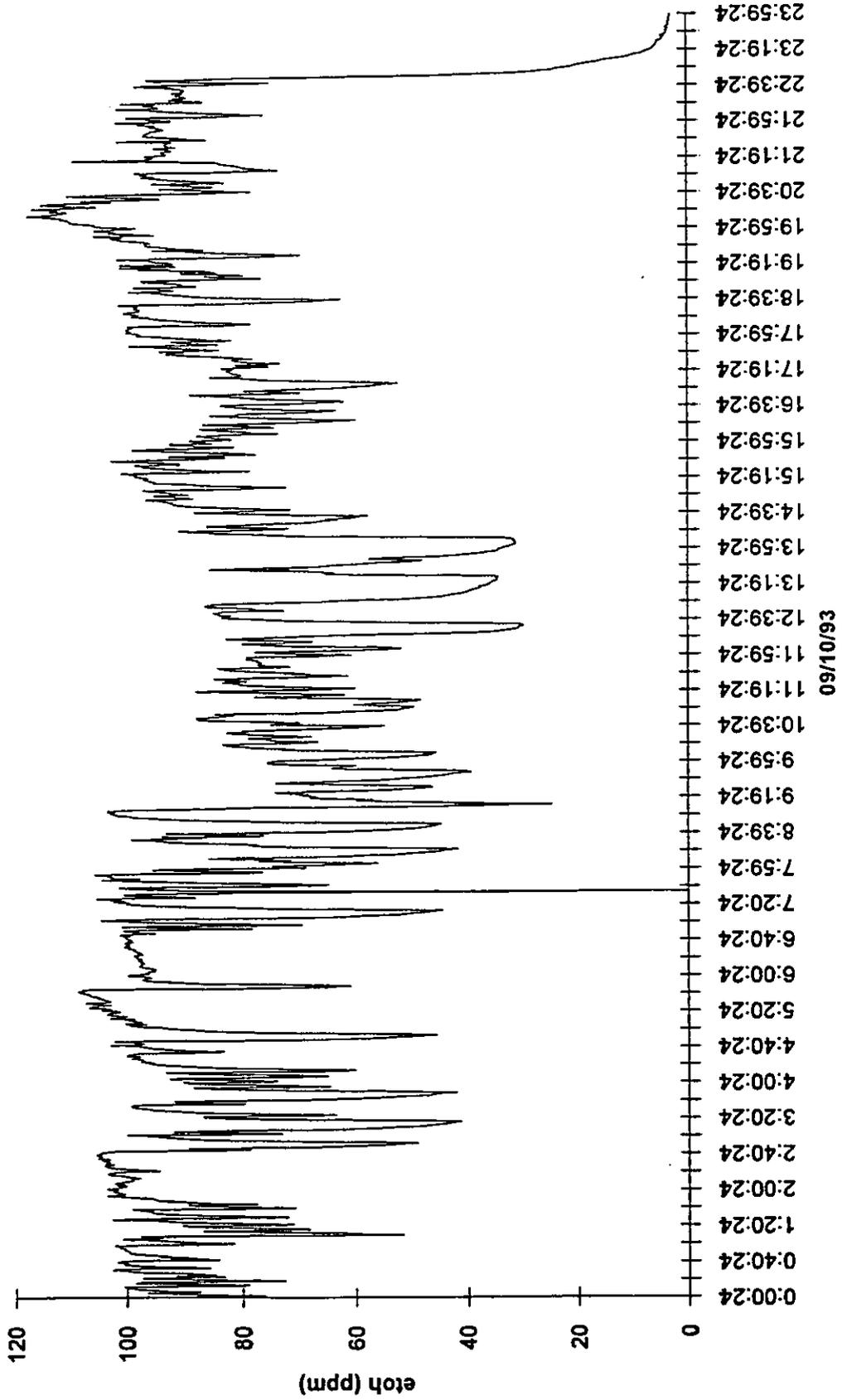
9 Filler CO2 Level & Exhaust Air Temperature



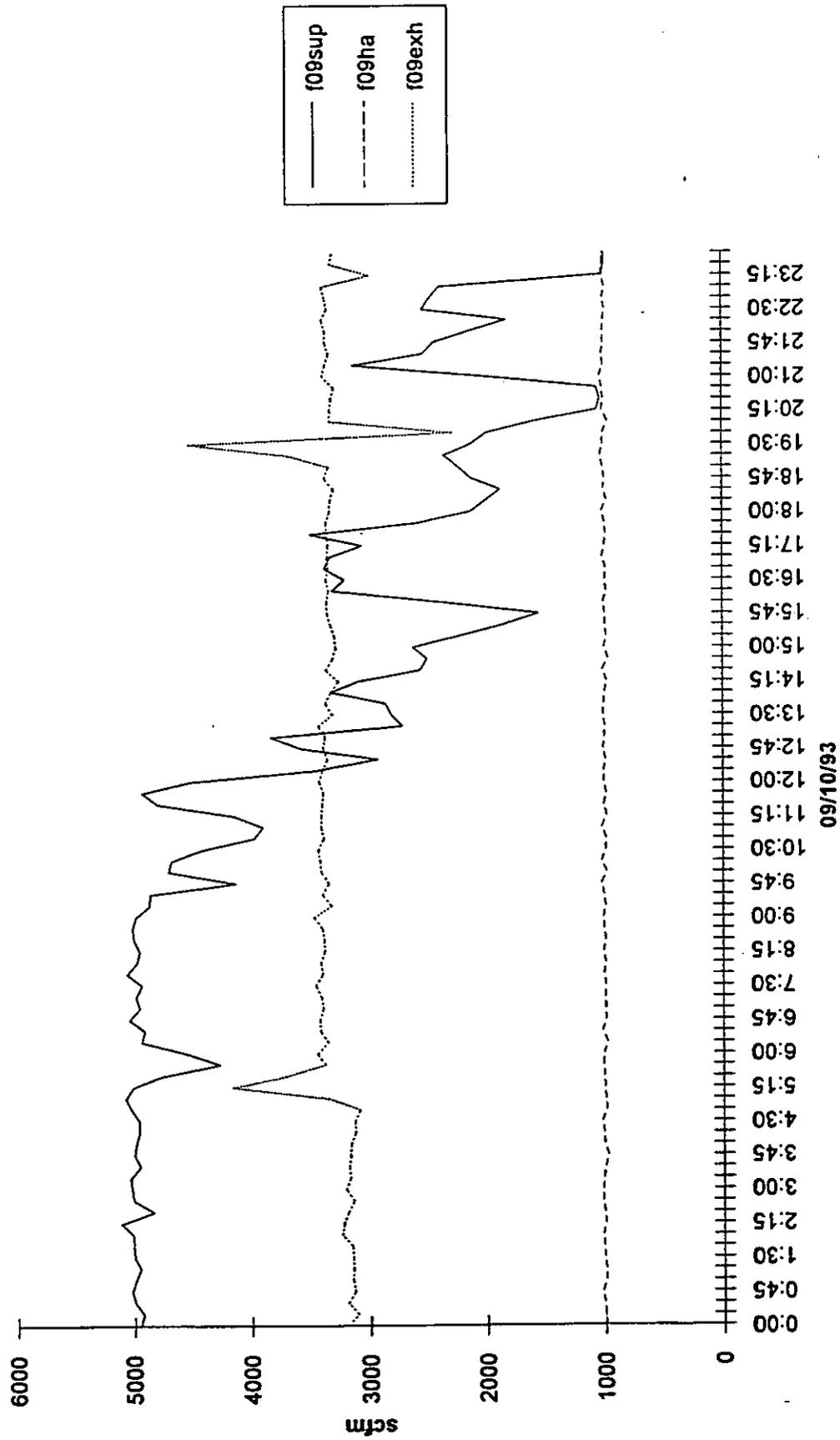
9 Filler -FID



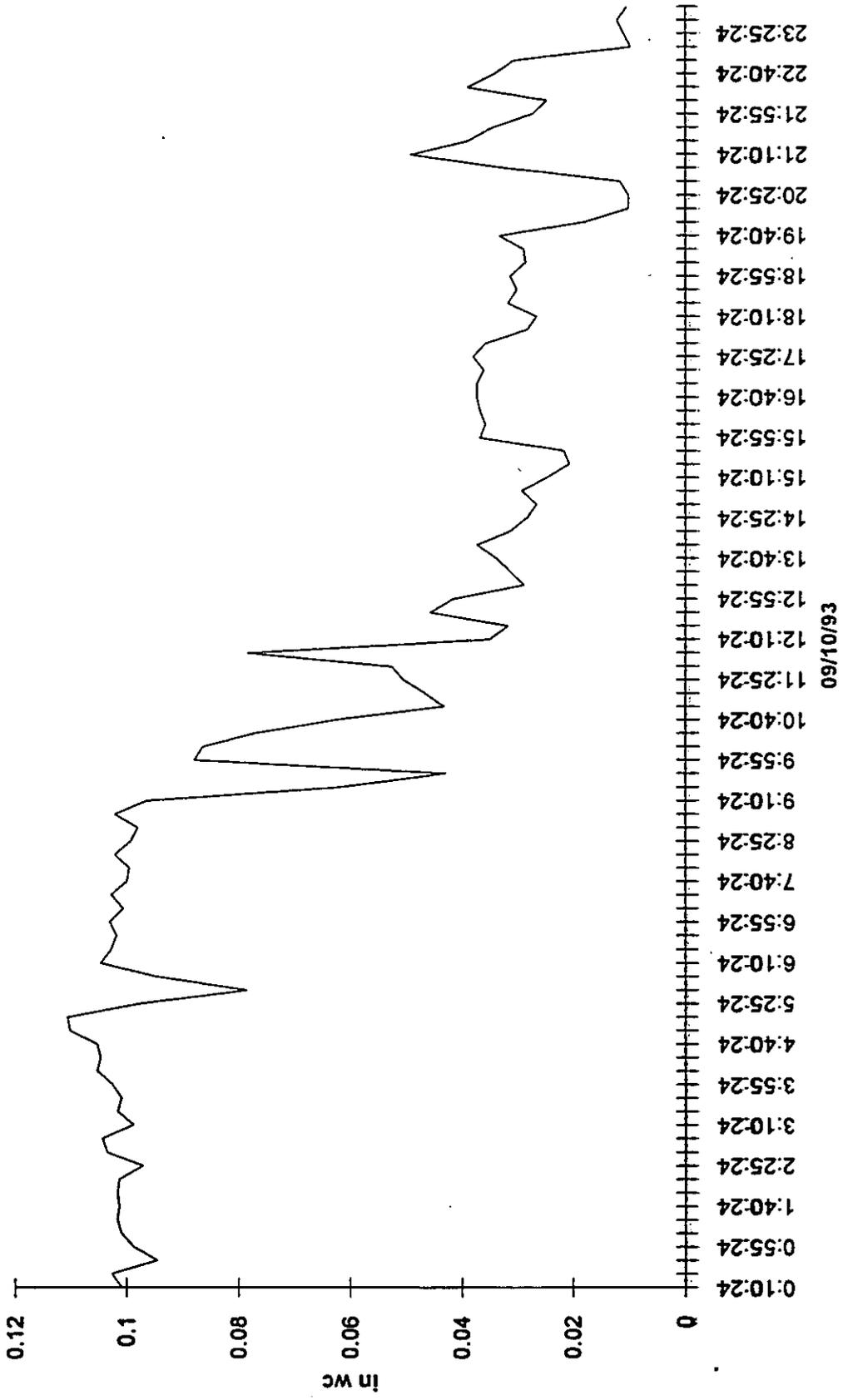
9 Filler - Plant Rat



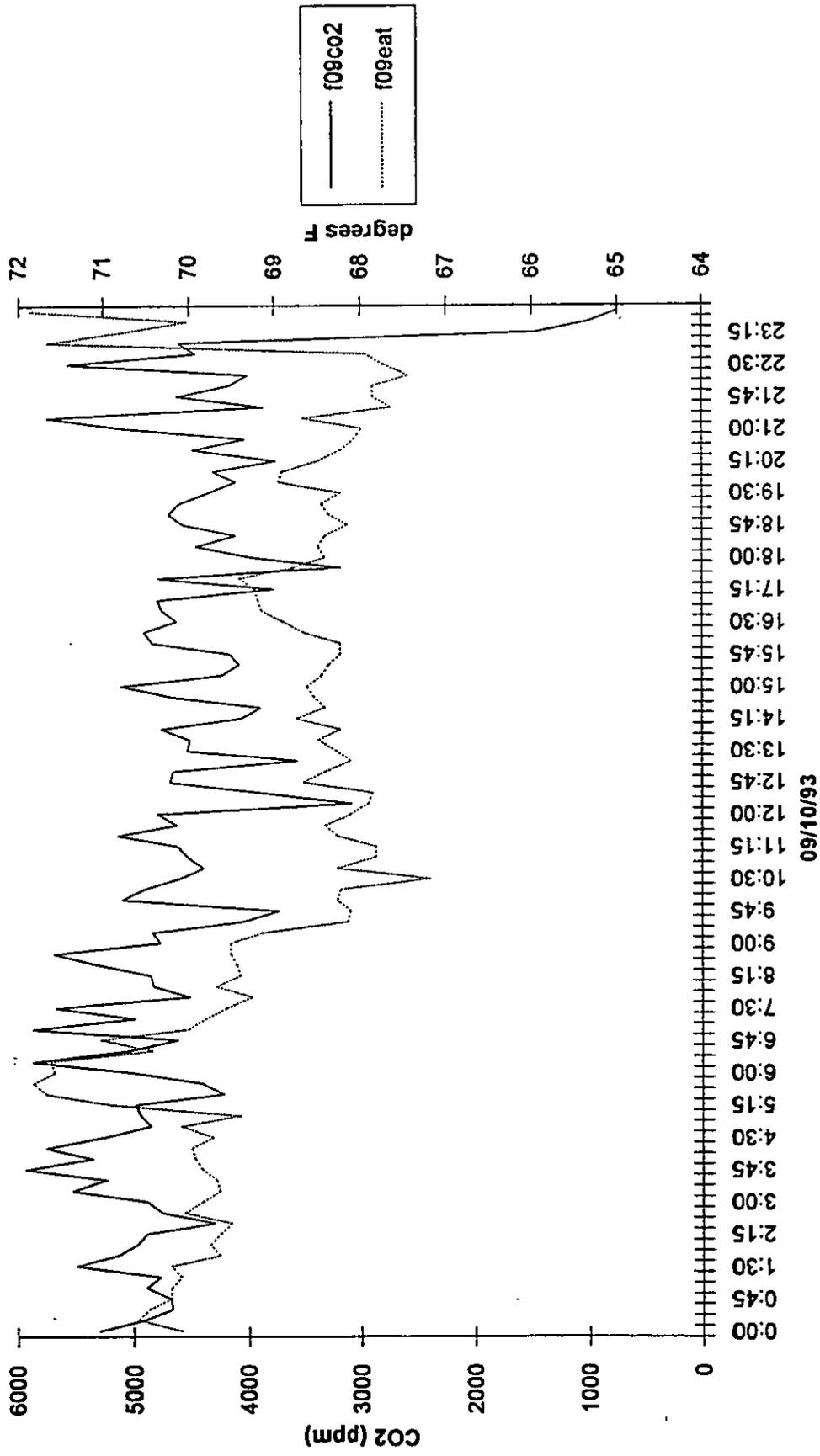
9 Filler - Air Flow



9 Filler - Room Static Pressure



9 Filler
CO2 Level & Exhaust Air Temperature



APPENDIX D

3 BOTTLE

RAW DATA

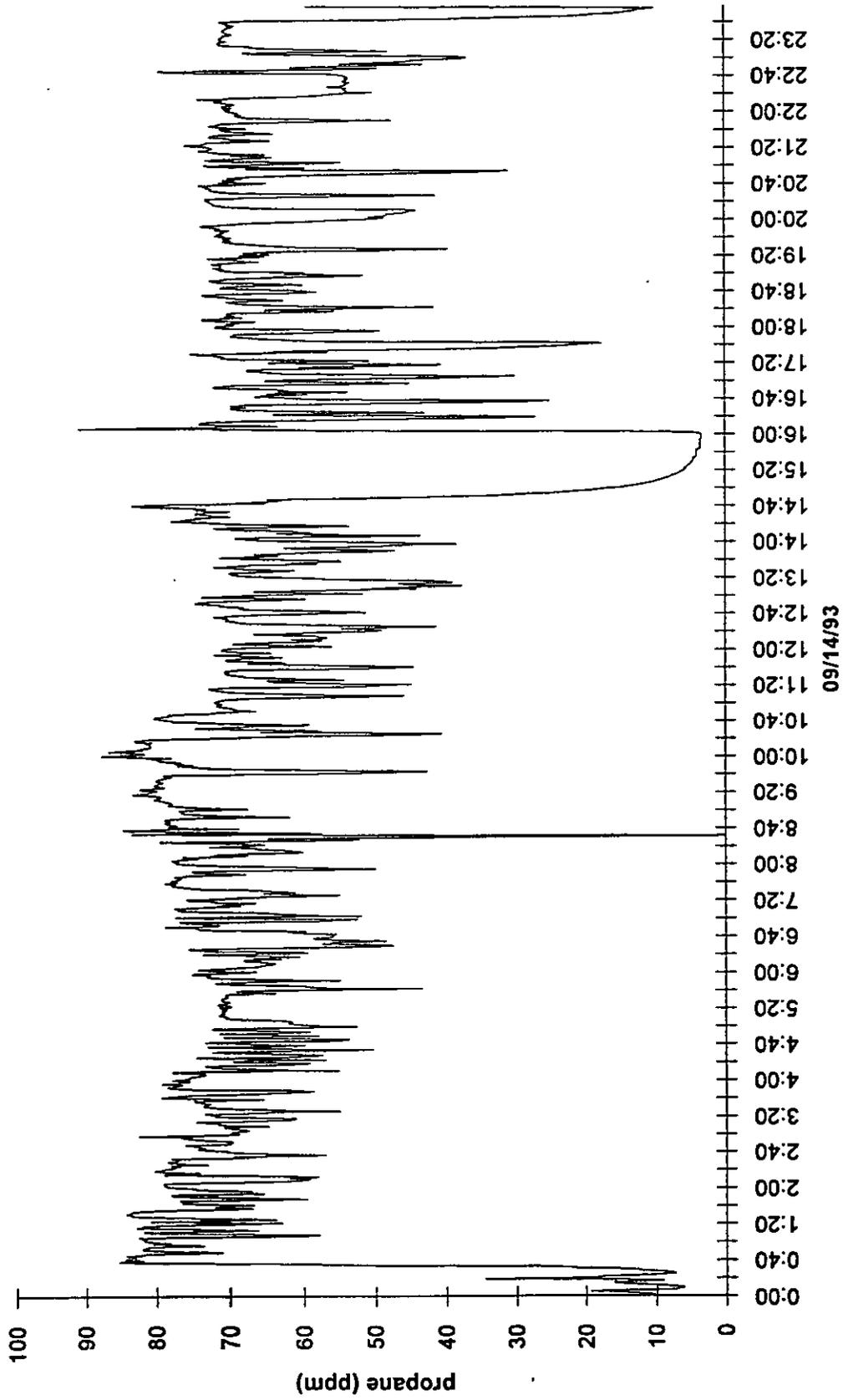
3 BOTTLE

VOC TESTING

WEEK of SEPTEMBER 13, 1993

SHIFT	Sept. 13 Mon	Sept. 14 Tues	Sept. 15 Wed	Sept. 16 Thur	Sept. 17 Fri	Sept. 18 Sat	Sept. 19 Sun
GRAVEYARD		NO AIR FLOW CONTROL	NO AIR FLOW CONTROL TEST ID = 3	FILLER DOWN (0000 - 0700) TEST ID = 6	SHROUD AIR FLOW CONSTANT ROOM STATIC CONTROL NO CO2 CONTROL TEST ID = 9		
DAY		NO AIR FLOW CONTROL TEST ID = 1	SHROUD AIR FLOW CONSTANT NO CONTROL FOR SUPPLY AIR OR EXHAUST AIR TEST ID = 4	FULL AIR FLOW CONTROL TEST ID = 7	FULL AIR FLOW CONTROL TEST ID = 10		
SWING		NO AIR FLOW CONTROL TEST ID = 2	SHROUD AIR FLOW CONSTANT NO CONTROL FOR SUPPLY AIR OR EXHAUST AIR TEST ID = 5	SHROUD AIR FLOW CONSTANT ROOM STATIC CONTROL NO CO2 CONTROL TEST ID = 8	FILLER DOWN (1630 - 1930) TEST ID = 11		

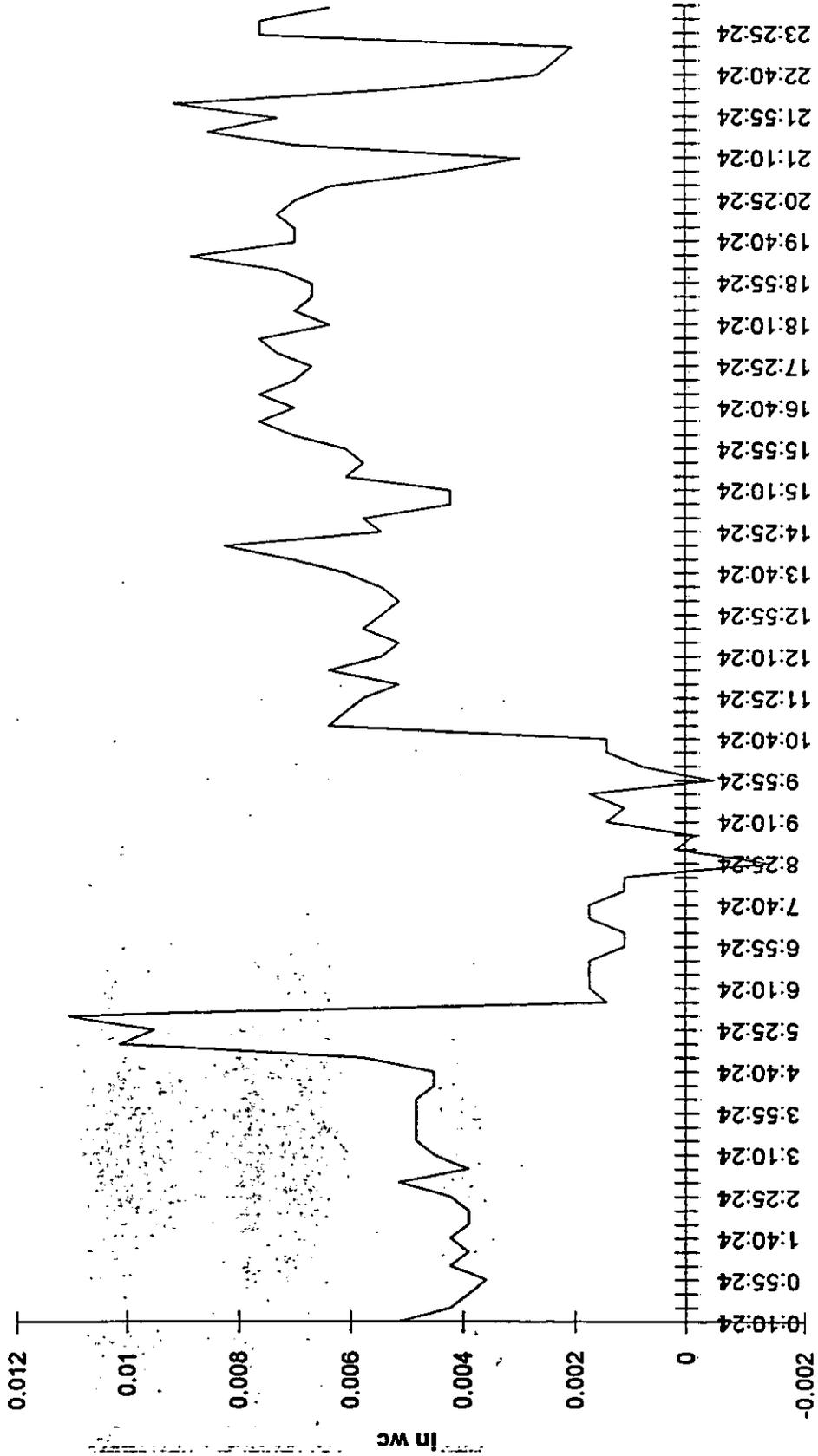
3 Bottle - FID



3 Bottle - Air Flow

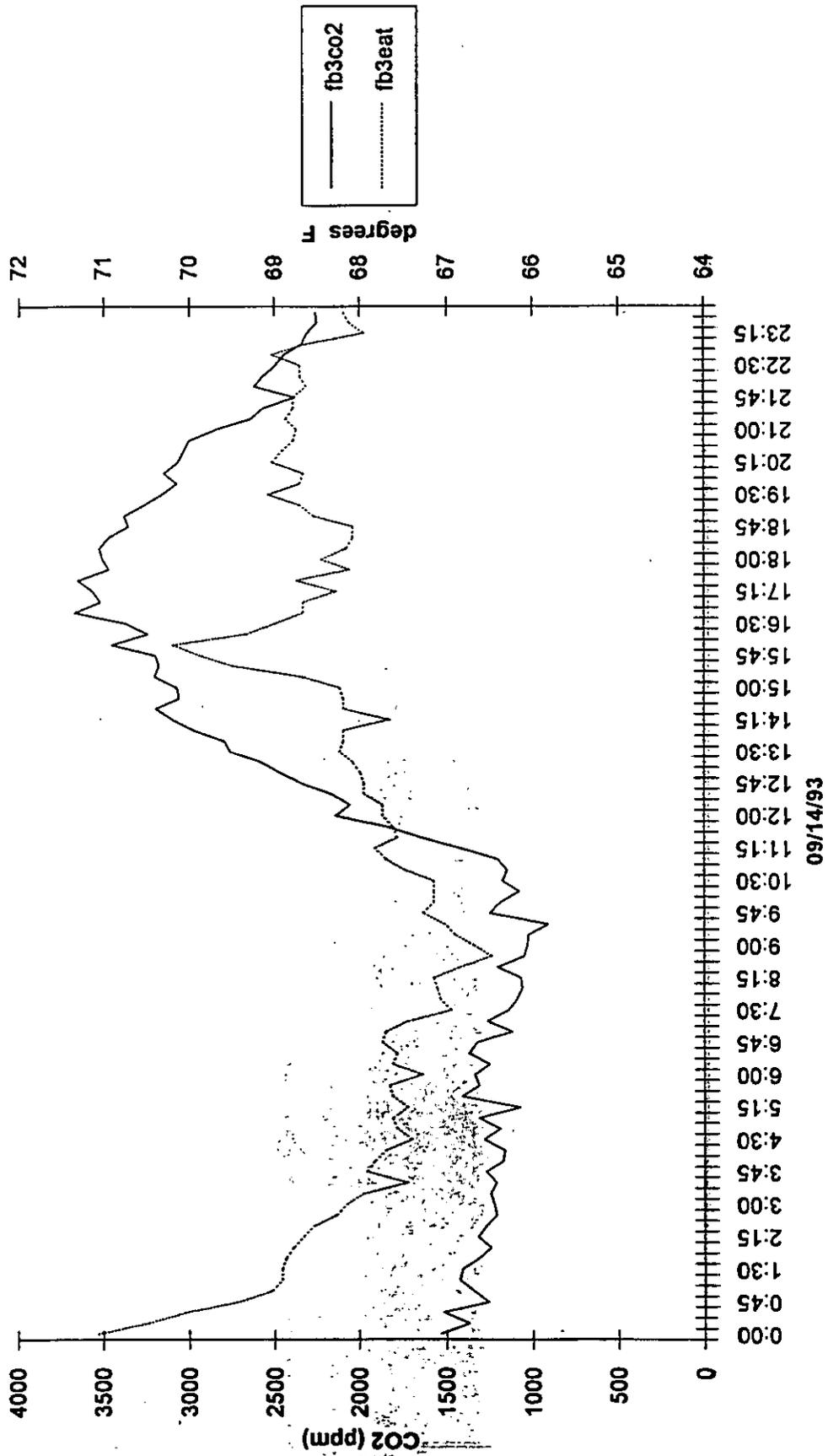


3 Bottle - Room Static Pressure



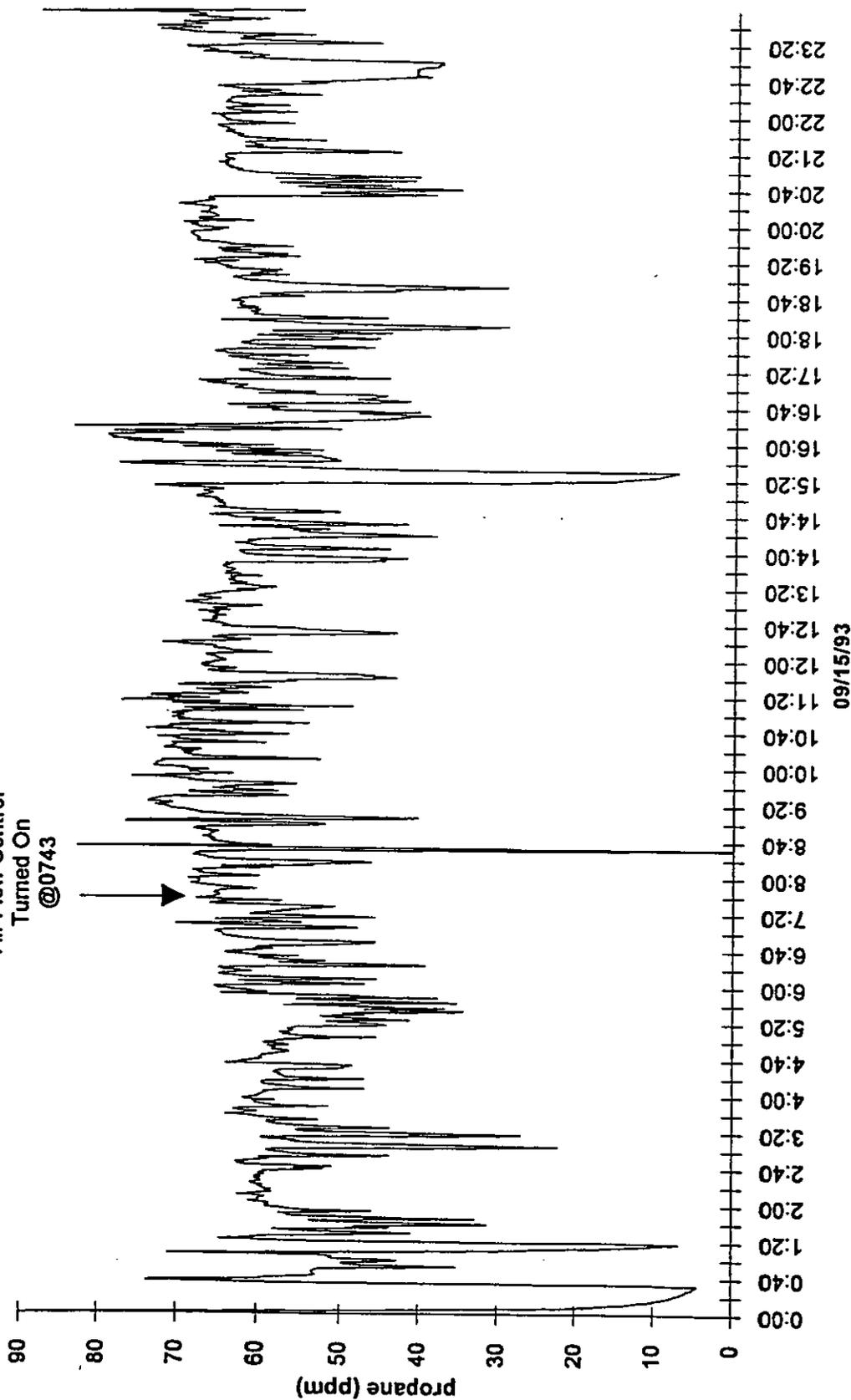
09/14/93

3 Bottle CO2 Level & Exhaust Air Temperature

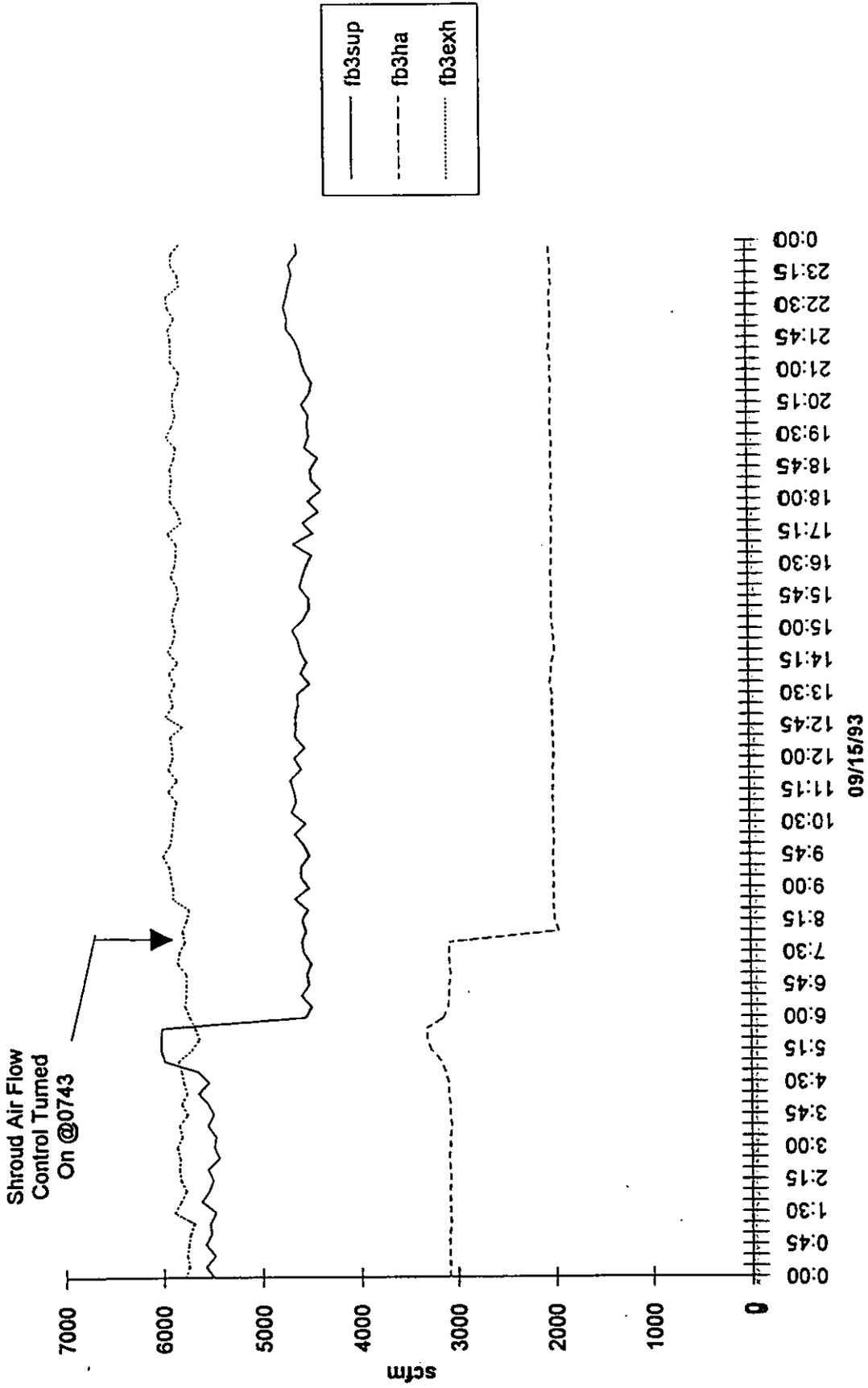


3 Bottle - FID

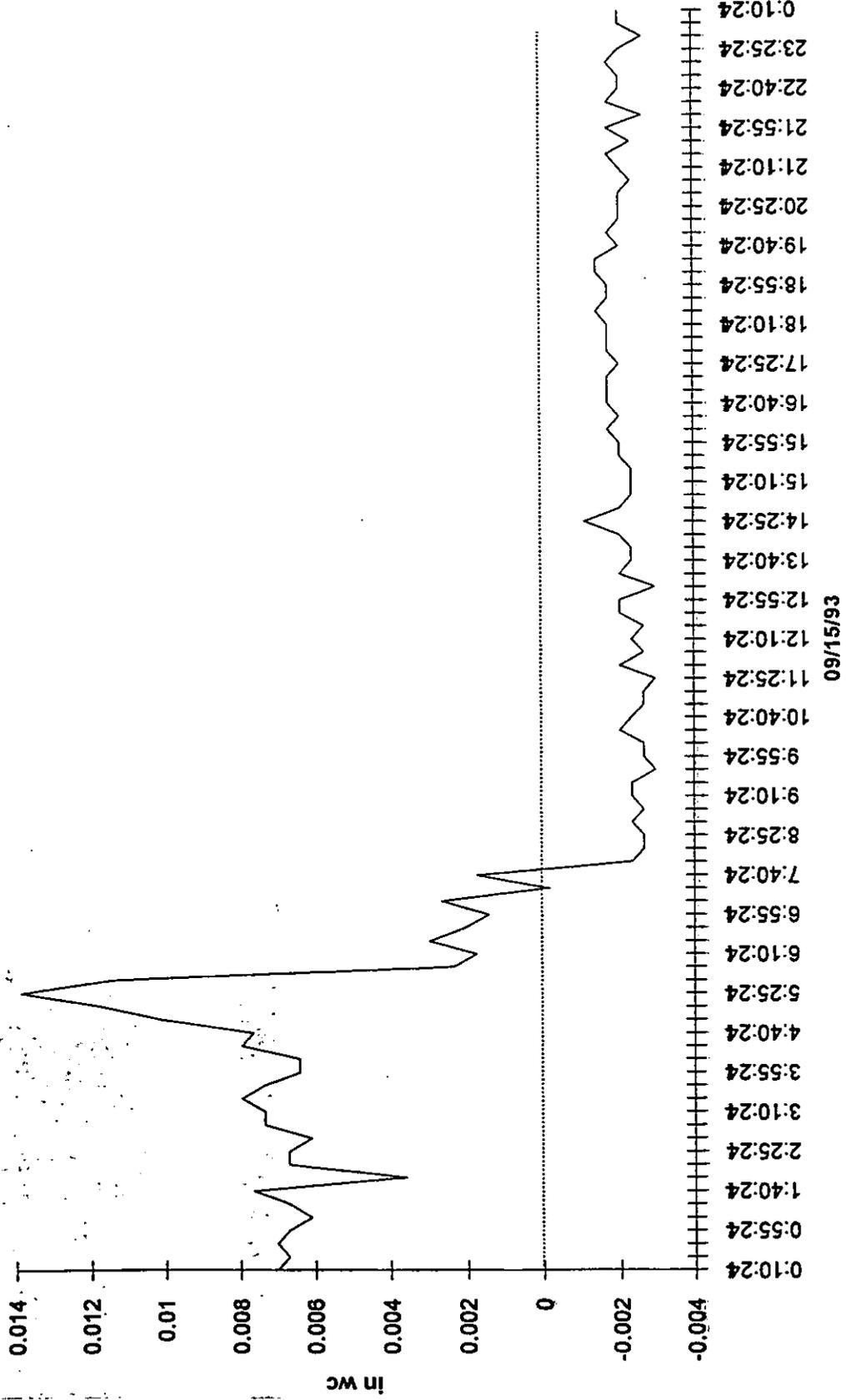
Shroud
Air Flow Control
Turned On
@0743



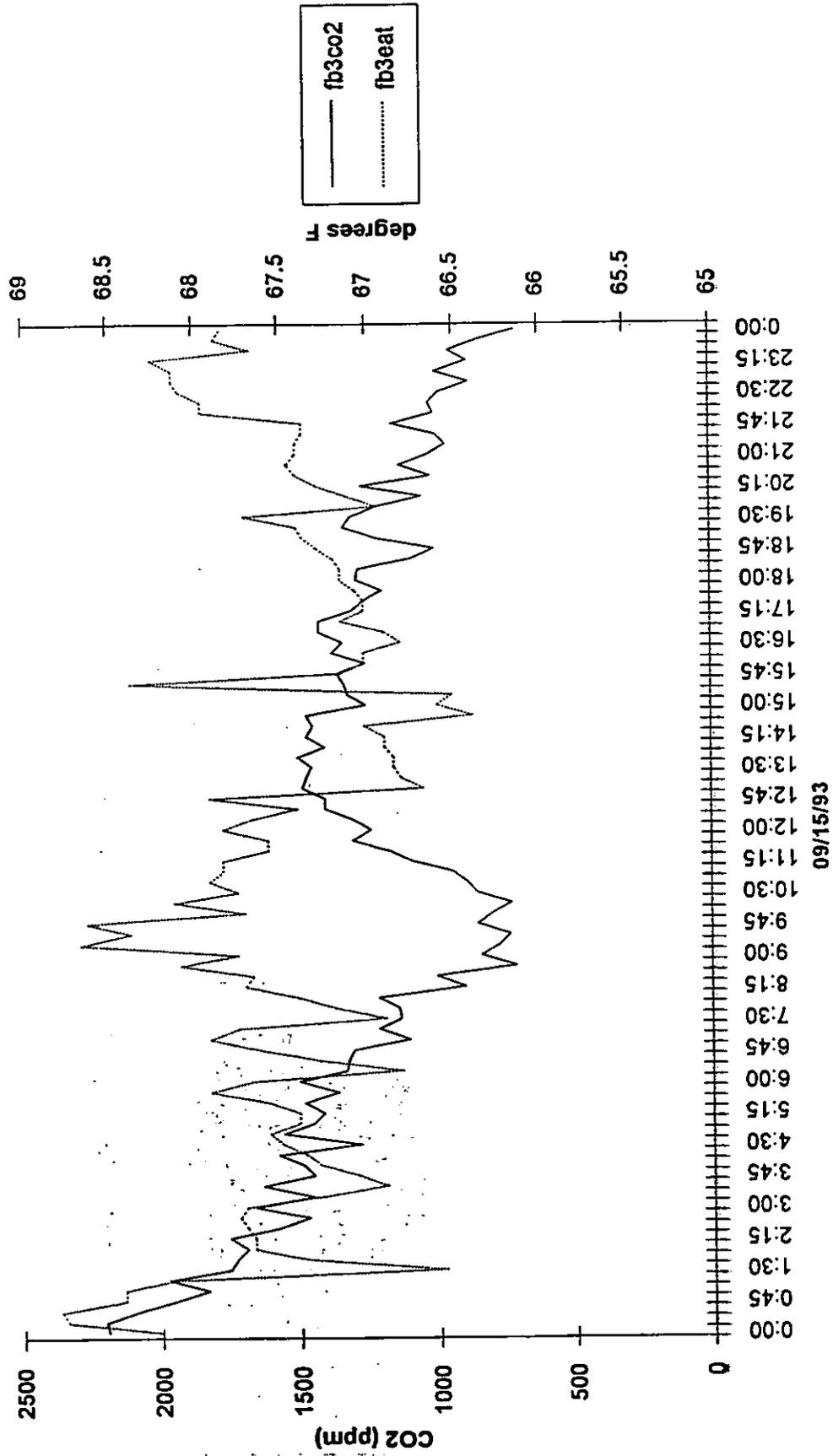
3 Bottle - Air Flow



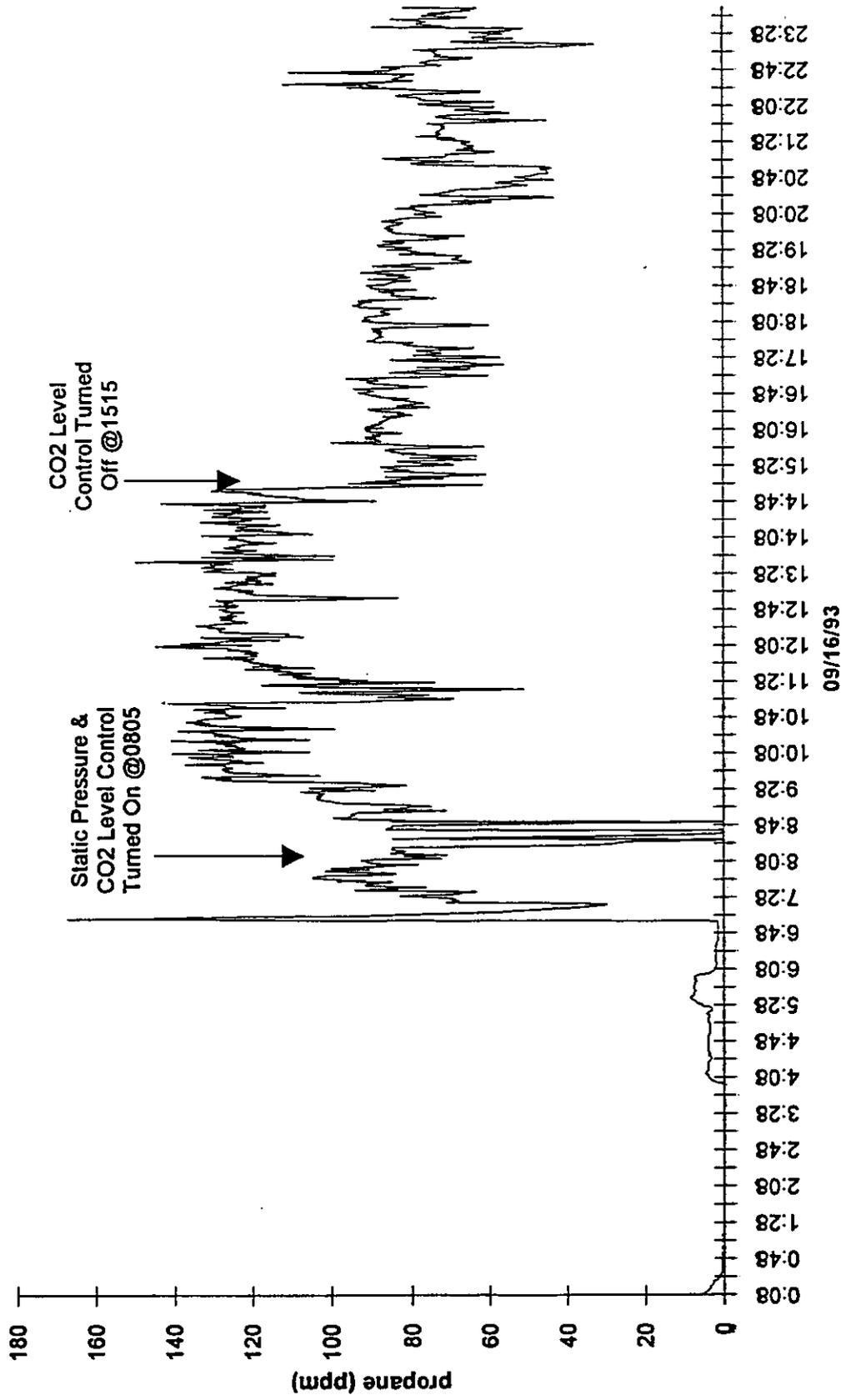
3 Bottle - Room Static Pressure



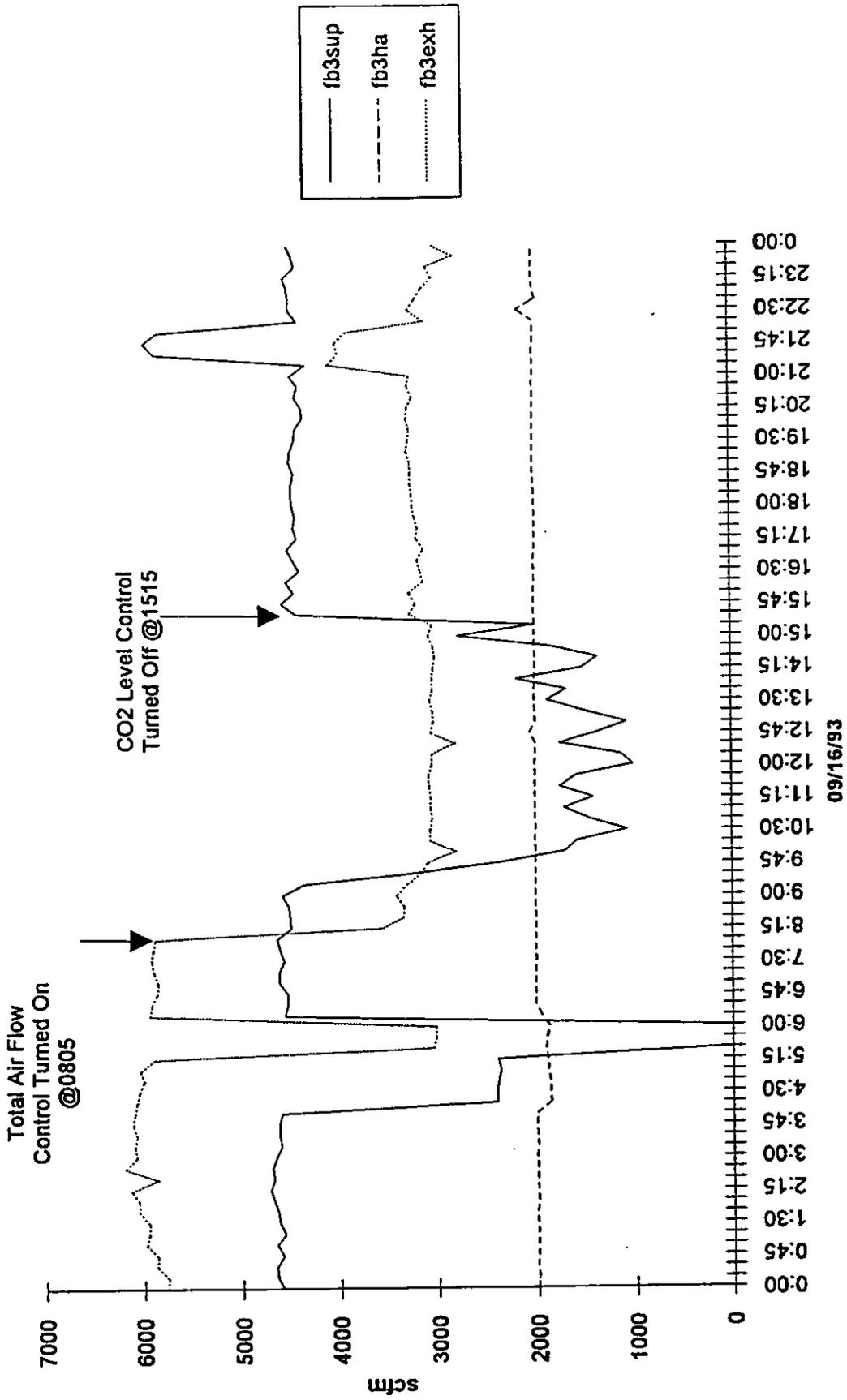
3 Bottle CO2 Level & Exhaust Air Temperature



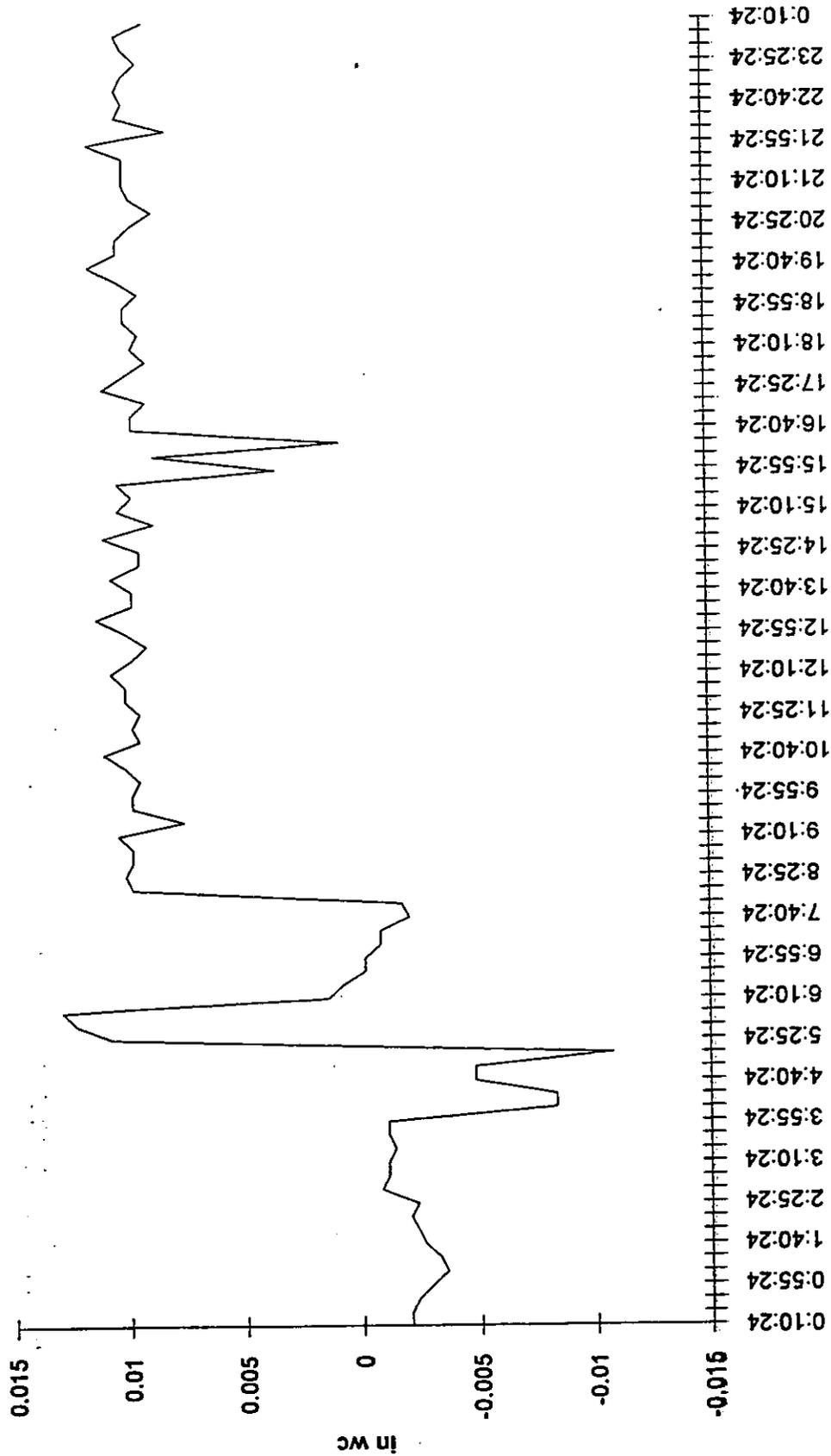
3 Bottle - FID



3 Bottle Air Flow

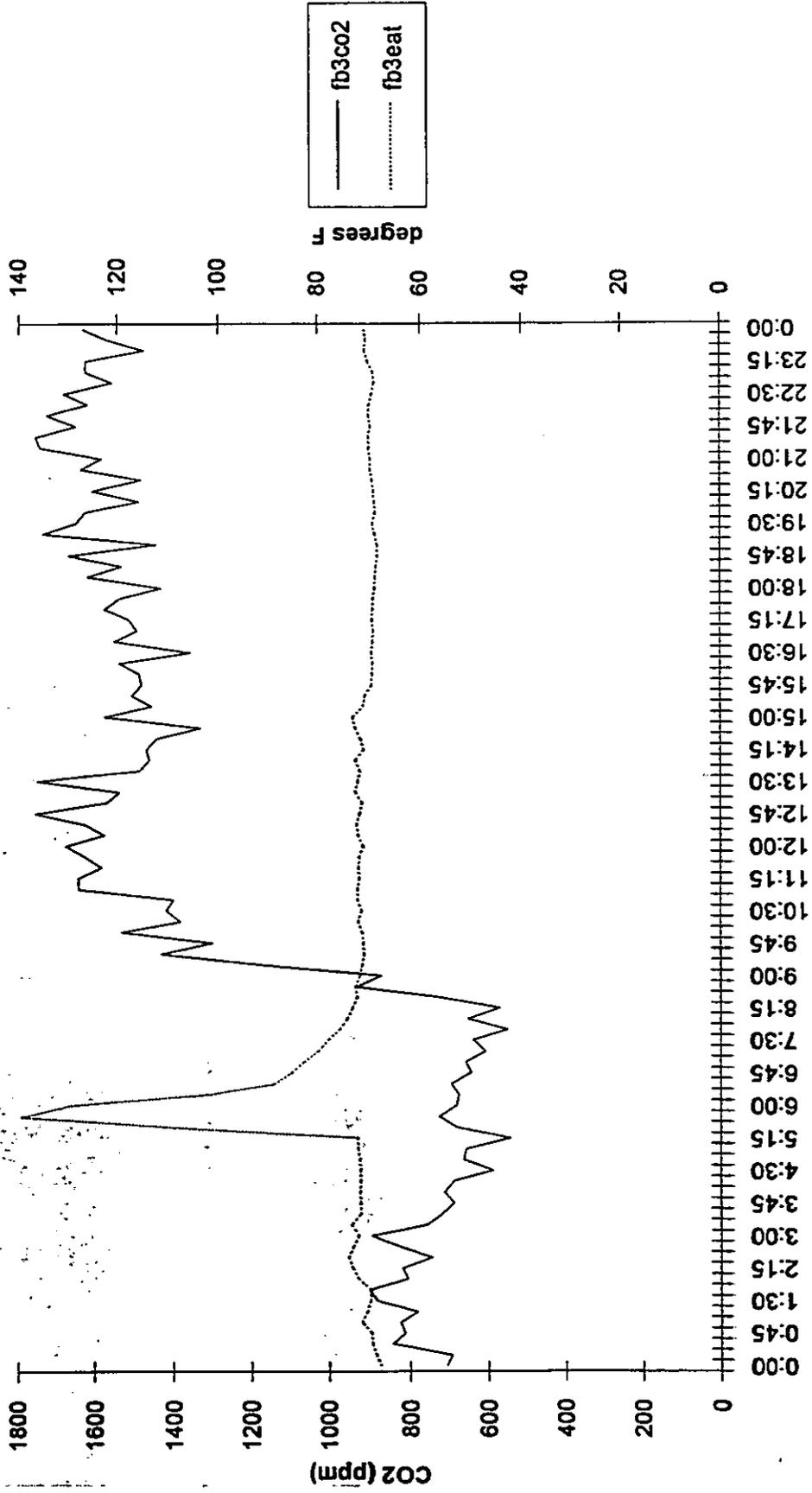


3 Bottle - Room Static Pressure

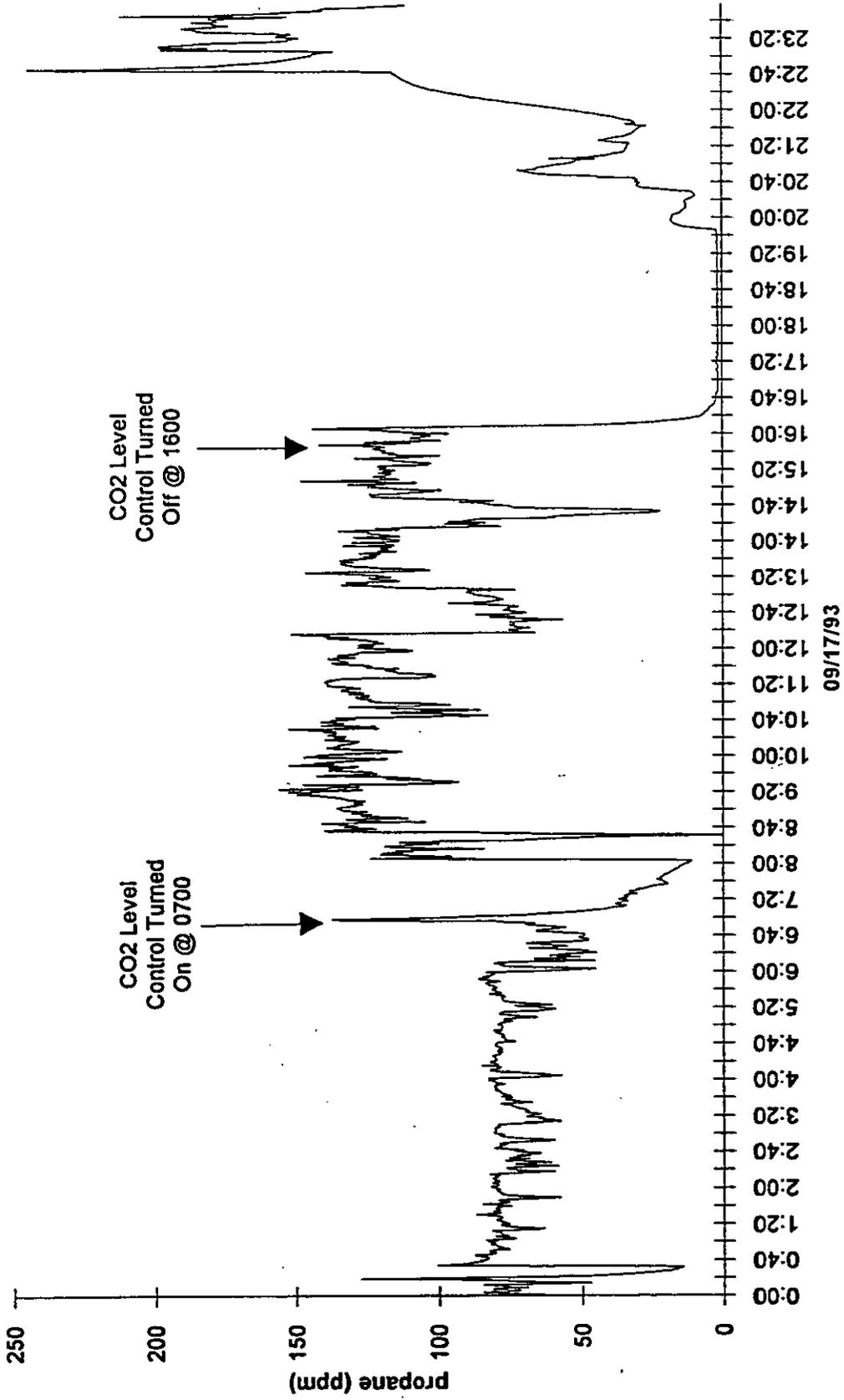


09/16/93

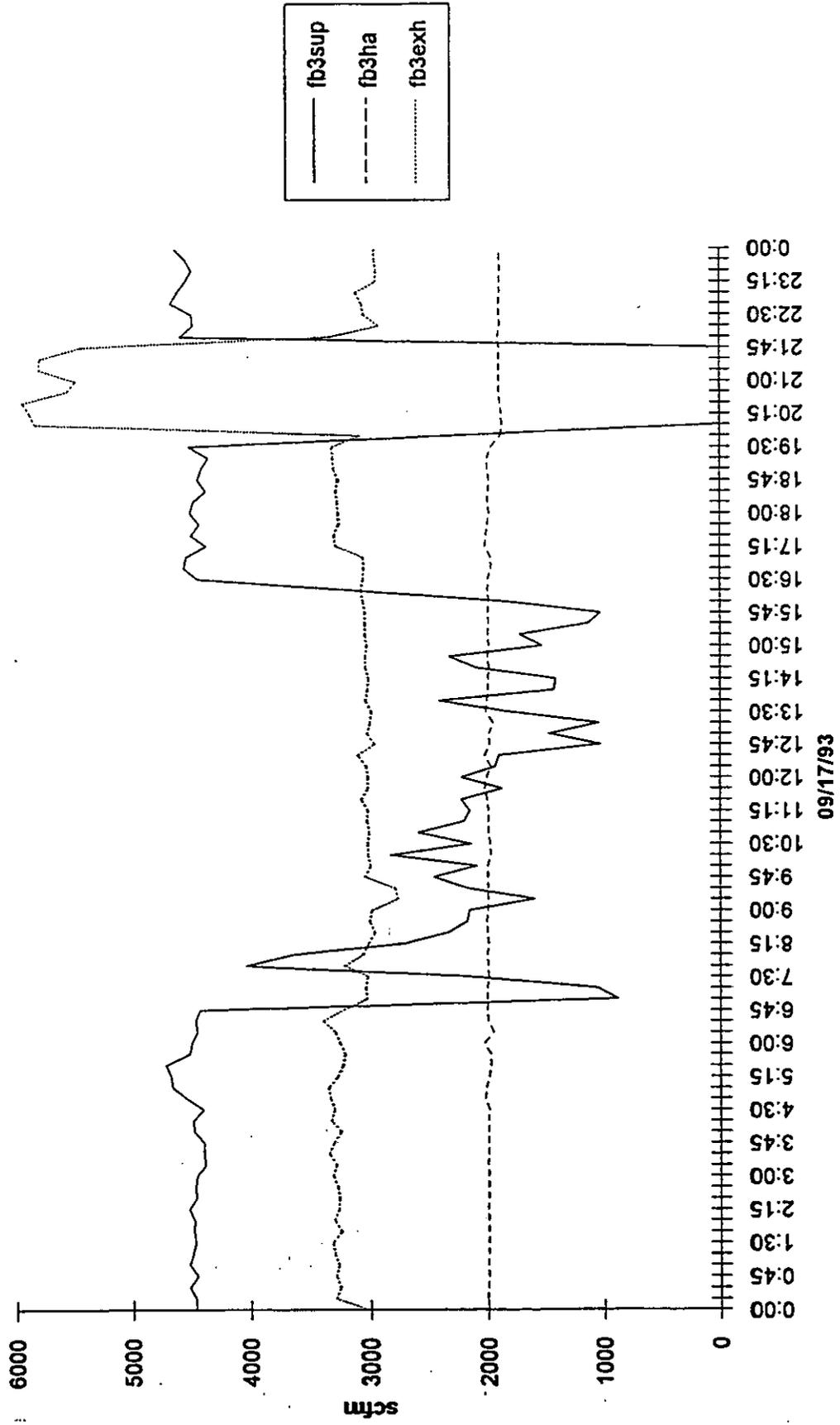
3 Bottle
CO2 Level & Exhaust Air Temperature



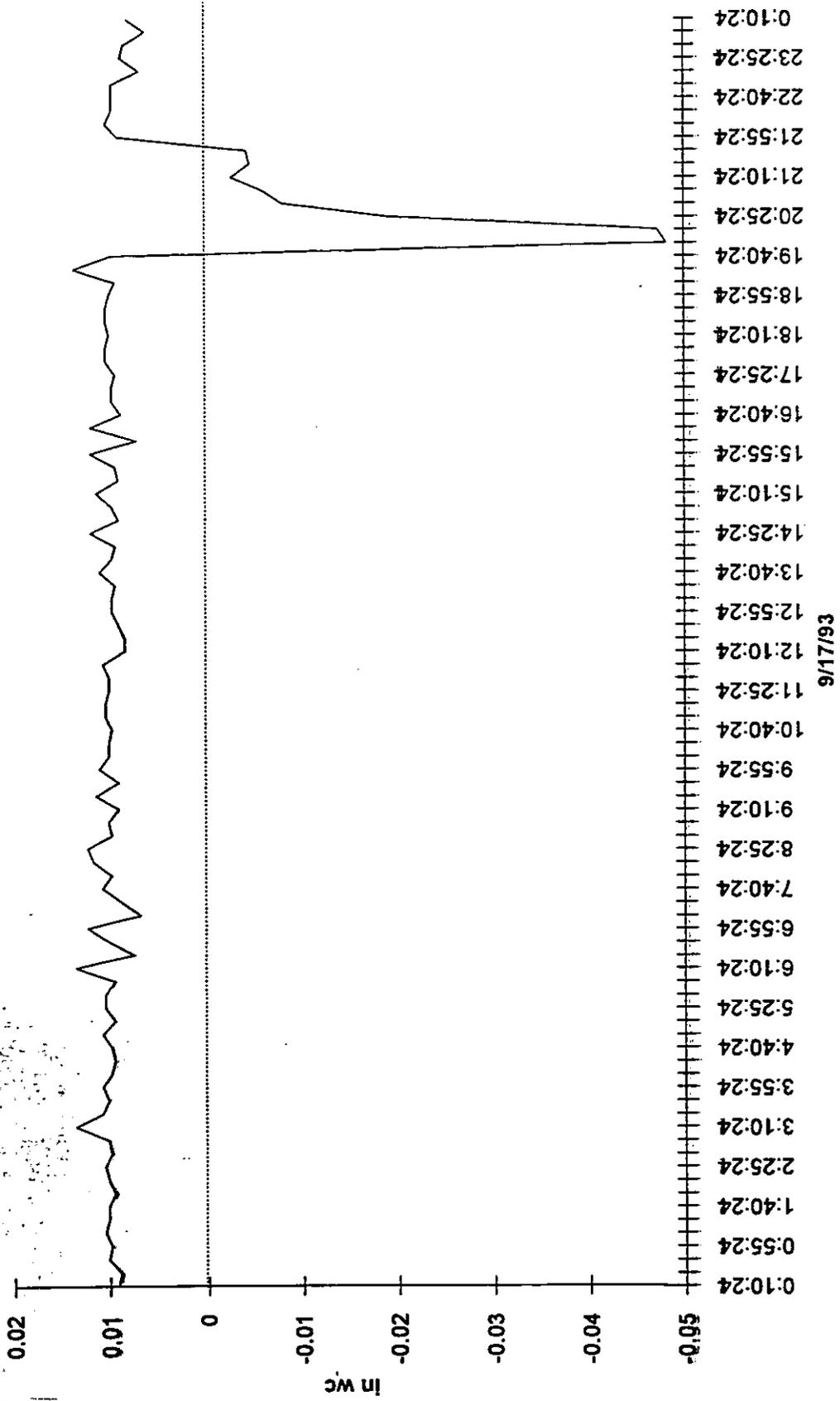
3 Bottle - FID



3 Bottle - Air Flow



3 Bottle - Room Static Pressure



3 Bottle CO2 Level & Exhaust Air Temperature

