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Research Triangle Park NC 27711

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EPA

Synthetic Organic Chemical Manufacturing Industry

Emission Test Report Breathing Loss Emissions from Fixed-Roof Petrochemical Storage Tanks

SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY

EMISSION TEST REPORT BREATHING LOSS EMISSIONS FROM FIXED-ROOF PETROCHEMICAL STORAGE TANKS

CONTRACT NO. 68-02-2815
WORK ASSIGNMENT NO. 6

Submitted To

ENVIRONMENTAL PROTECTION AGENCY
EMISSION MEASUREMENT BRANCH, ESED
MAIL DROP 13, RESEARCH TRIANGLE PARK
NORTH CAROLINA 27711

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Submitted By

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SECTION I

INTRODUCTION

A study of breathing loss emissions from fixed-roof petrochemical storage tanks was requested by the Emission Measurement Branch of the Environmental Protection Agency, Research Triangle Park, North Carolina, under Work Assignment No. 6 of Contract No. 68-02-2815. The purpose of the project was to develop data for new source performance standards for fixed-roof storage tanks containing low vapor pressure petrochemicals.

The study consisted of continuous monitoring of organic vapor emission concentrations and rates from each of six fixed-roof storage tanks and correlation of this data with significant chemical and environmental parameters. The storage tanks chosen to be tested contained isopropanol, ethanol, acetic acid, formalin, cyclohexane, and ethyl benzene. The first three tanks were located at Union Carbide in Texas City, Texas and the others were located at Celanese in Bishop, Texas, Exxon at Bay Town, Texas, and Cosmar at Carville, Louisiana, respectively.

Sampling and analysis was performed at these locations between the dates of April 10, 1978 and May 18, 1978, by personnel of Engineering-Science.

SECTION II

SUMMARY OF RESULTS

Table II-1 details tank characteristics for each of the chemicals tested. Source parameters and breathing loss parameters for each chemical (on a daily basis) are shown in Table II-2.

The breathing loss parameters in Table II-2 include daily thru-put on a SCF (standard cubic foot) basis, concentration in lb/ft^3 (pounds per cubic foot), tank emissions in lb/day (pounds per day), maximum hourly emissions in lb/hr (pounds per hour) and the specific emissions calculated as $lb/day/ft^3$ (pounds per day per cubic foot).

Condensation formation in test instrumentation became a problem during the course of the tests. As a result, some data were lost. Whenever data are unavailable, it is so indicated in the tables and the field data sheets in Appendix B by a footnote.

The first tests (for anhydrous isopropanol emissions) were at Union Carbide's facility at Texas City, Texas. The tests on April 11 and 12, 1978 were disregarded due to organic vapor analyzer (OVA) failure (condensate formation). Testing continued on April 13 and 14 with successful results. Some OVA data were lost during the early morning hours of April 13 due to condensate formation. (Refer to Appendix B for a detailed tabulation of field data.) However, sufficient data were available to determine tank emissions.

Ethanol (190 proof) emissions were tested at Union Carbide's Texas City facility from April 18 through April 20, 1978. Testing proceeded smoothly with only a minimum of OVA data being lost due to condensate formation.

The next chemical sampled at the Union Carbide facility on April 20 and 21 was glacial acetic acid. Condensate formation briefly occurred on an intermittent basis in the Roots meter and the OVA. The condensate formation problems did not result in data being lost or voided. The emission of glacial acetic acid on April 21 varied from that on April 20 because both the daily ambient temperature change and total daily solar insolation were greater on April 21.

Emissions vary with tank parameters, ambient temperature and solar insolation. The solar insolation for April 20 (a partially cloudy day) was 470 cal/cm^2/day (calorie per square centimeter per day) while the solar insolation for April 21 (a clear, sunny day) was 650 cal/cm^2/day --- a difference of approximately 38 percent.

The Celanese plant at Bishop, Texas was the site of the formaldehyde tests. The period of testing was from April 26 through April 28, 1978. Formaldehyde caused considerable condensation in the Roots meter. Consequently, the Roots meter was vented free to the atmosphere. Some flow data were still lost due to condensation, and true vapor pressure for these days was not included in Table II-2.

The heated formaldehyde tank at Celanese had a constant emission rate which was totaled for a twenty-four hour period to determine daily standard cubic feet and pounds per day of organic emission. Water vapor was not included as part of these organic emissions.

Ethyl benzene was tested at the Cosmar facility in Baton Rouge, Louisiana on May 9 and 10, 1978. Ethyl benzene is shown to be oversaturated in Table II-2. (Theoretical saturation is approximately 0.004 lb/ft^3 based on the measured bulk liquid temperature.) The reason may be because the temperature of the liquid in the tank was more stratified than in the other tanks. The concentration calculations were re-checked and appear correct. Note that the average liquid temperature changes from 82°F to 80°F for the two days (Table II-2).

The Roots meter ran backwards during the ethyl benzene test. Refer to the worksheets in Appendix C. A Roots meter can measure flow in either direction. Error will not result from running the unit backwards.

The Exxon plant at Bay Town, Texas was the last facility tested during the sequence of tests. Cyclohexane emissions were sampled on May 16 through 18, 1978. An electrical outage on May 16 caused a lack of OVA and temperature readings until 1200. The Roots meter ran backwards during the cyclohexane sampling (refer to the worksheets in Appendix C). Testing was curtailed on May 16 and 18 in mid-afternoon at the request of plant personnel. The reason given was down-time required for tank maintenance.

Breathing loss calculations based on American Petroleum Institute procedures are in Appendix A. The field data sheets are detailed in Appendix B, and data reduction worksheets are included in Appendix C. Plots of ambient vapor temperature, concentration and outflow versus hours are also included in Appendix C. Appendix D consists of OVA calibration curve charts for each chemical tested, and Appendix E details information pertaining to formaldehyde gas chromatograph chart reduction. Appendix F details equipment used for testing. Appendix G is a comparison of breathing data for the tanks. Storage tanks typically breathe out during heating cycles (expansion) and breathe in during cooling cycles (contraction).

TABLE II-1

TANK CHARACTERISTICS

			Tank Parameters							
1978	Chemical	Company	Tank No.	Capacity (bbls)	Capacity (gal x 10^3)	Diam. (ft)	Height (ft)	Liquid Level (ft)	Color	Insulation
4/13	Isopropanol, 99%	Union Carbide	3710	19,000	800	54	41	15.5	white	No
4/14	Isopropanol, 99%	Union Carbide	3710	19,000	800	54	41	15.5	white	No
4/18	Ethanol, 190°	Union Carbide	17	24,500	1,030	70	40	30.7	white	No
4/19	Ethanol, 190°	Union Carbide	17	24,500	1,030	70	40	30.7	white	No
4/20	Ethanol, 190°	Union Carbide	17	24,500	1.030	70	40	30.7	white	No
4/20	Acetic Acid, Glacial	Union Carbide	4	80,000	3,360	120	41	18	gray	No
4/21	Acetic Acid, Glacial	Union Carbide	4	80,000	3,360	120	41	18	gray	No
4/26	Formaldehyde	Celanese	1745	12,300	520	47	40	15	gray	Yes
4/27	Formaldehyde	Celanese	1745	12,300	520	47	40	15	Gray	Yes
4/28	Formaldehyde	Celanese	1745	12,300	520	47	40	15	Gray	Yes
5/9	Ethyl Benzene	Cosmar	302B	30,000	840	95	24	15	white	No
5/10	Ethyl Benzene	Cosmar	302B	30,000	840	95	24	15	white	No
5/16	Cyclohexane	Exxon	65	30,000	1,260	73	40	24	white	No
5/17	Cyclohexane	Exxon	65	30,000	1,260	73	40	24	white	No
5/18	Cyclohexane	Exxon	65	30,000	1,260	73	40	24	white	No

TABLE II-2

EMISSION MEASUREMENTS OF BREATHING LOSSES FROM STORAGE TANKS

					Source Parameters							Breathing Loss Parameters				
1978	Chemical	Company	Tank No.	Vapor Volume (ft^3)	Mol. Wt. (g/m)	Avg. Liquid Temp. (°F)	True Vapor Pressure (psia)	Avg. Vapor Temp. (°F)	Avg. Ambient Temp. Change (°F)	Baro-metric Pressure (in Hg)	Total Solar Insolation ($cal/cm^2/day$)	Daily Thru-Put (SCF)	Concen. (lb/ft^3 x 10^{-3})	Daily Emissions (lbs/day)	Max. Hourly Emissions (SCF/hr)	Specific Flow Rate ($lb/day/ft^3$ x 10^{-3})
4/13	Isopropanol, 99°	Union Carbide	3710	62,200	60.10	70	0.683	71.2	15	30.3	6.7 x 10^2	3,824	3.9	15.0	915	3.92
4/14	Isopropanol, 99°	Union Carbide	3710	62,200	60.10	70	0.683	73.6	13	30.3	6.2 x 10^2	4,248	4.1	17.0	1,199	4.00
4/18	Ethanol, 190°	Union Carbide	17	43,500	46.02	71	0.895	87.4	16	30.1	4.6 x 10^2	1,313	4.6	6.0	603	4.57
4/19	Ethanol, 190°	Union Carbide	17	43,500	46.02	71	0.895	87.1	20	30.2	6.3 x 10^2	790	4.3	3.4	358	4.30
4/20	Ethanol, 190°	Union Carbide	17	43,500	46.02	71	0.895	77.7	15	30.3	4.7 x 10^2	1,435	4.0	5.7	282	3.97
4/20	Acetic Acid, Glacial	Union Carbide	4	297,800	60.05	70	0.230	76.8	11	30.3	4.7 x 10^2	9,508	2.5	24.0	3,410	2.52
4/21	Acetic Acid, Glacial	Union Carbide	4	297,800	60.05	70	0.230	85.7	17	30.2	6.5 x 10^2	18,934	2.4	45.0	4,558	2.38
4/26	Formaldehyde	Celanese	1745	48,300	30.03	150	a)	161.7	18	30.3	6.4 x 10^2	25,000	1.0	25.0	a)	1.00
4/27	Formaldehyde	Celanese	1745	48,300	30.03	150	a)	158.9	7	30.2	6.7 x 10^2	24,000	1.0	24.0	a)	1.00
4/28	Formaldehyde	Celanese	1745	48,300	30.03	147	a)	156.0	11	30.1	5.0 x 10^2	22,000	1.0	22.0	a)	1.00
5/9	Ethyl Benzene	Cosmar	302B	70,200	106.11	82 b)	0.200	84.4	17	30.2	5.8 x 10^2	2,526	4.4	11.0	734	4.35
5/10	Ethyl Benzene	Cosmar	302B	70,200	106.11	80 b)	0.200	81.1	22	30.3	6.9 x 10^2	3,740	4.0	15.0	845	4.01
5/16	Cyclohexane	Exxon	65	75,300	34.16	79	1.97	87.0	15	30.1	4.7 x 10^2	2,965	6.8	20.0	1,175	6.75
5/17	Cyclohexane	Exxon	65	75,300	84.16	79	1.97	81.4	10	30.1	6.8 x 10^2	3,094	5.6	17.0	686	5.49
5/18	Cyclohexane	Exxon	65	75,300	84.16	79	1.97	83.0	12	30.1	a)	2,980	4.8	14.0	839	4.70

a) Data unavailable.

b) Measured temperature may not reflect actual temperature conditions in bulk liquid (large temperature changes in bulk could have resulted from radiation).

SECTION III

SAMPLING AND MEASUREMENTS

The testing procedures used in this study were designed to measure both the amount and concentration of the emissions from fixed-roof storage tanks. Also taken into consideration was the fact that the equipment used had to be easily moved between and universally applicable to different types of fixed-roof storage tanks.

Two twelve-foot vans served both as a mobile testing laboratory and a means of transporting the metering system. Once located at the testing site, the metering system was placed on the tank roof. The temperature and sampling lines were connected from the metering system to the analyzers located inside the van. Sampling lines were kept as short as possible and heated to prevent condensation.

Tank and test equipment schematics for each test are shown in Appendix B. Refer to Appendix F for a listing of major components of the testing system and a schematic diagram.

FLOW MEASUREMENT

Vapors expelled from the tank were passed through positive displacement meters of either the bellows or rotary-type, depending on flow rate. The bellows meter, manufactured by Singer, was used to monitor flows below 300 CFH and the rotary meter, manufactured by Roots, was used during peak flow periods when the differential pressure drop across the bellows meter approached the tank relief valve settings.

Both meters were mounted so that they could be manually switched for positive and negative flow through a one-way pressure/vacuum relief valve which was weighted, when applicable, to simulate the action of a conservation vent set at 0.86 inch water. In all cases, a separate emergency pressure/vacuum relief valve set at the tank manufacturer's specifications was used in case of equipment failure. The emergency pressure/vacuum valve settings are listed in Table III-1.

The meters were held by fittings of 4-inch I.D. polyvinyl chloride and the system was connected using 4-inch I.D. flexible plastic hose.

TABLE III-1

EMERGENCY PRESSURE AND VACUUM VALUES

Date	Chemical	Company	Tank No.	Maximum Pressure	Maximum Vacuum
4/13/78	Isopropanol, 99%	Union Carbide	3710	0.5	0.5
4/14/78	Isopropanol, 99%	Union Carbide	3710	0.5	0.5
4/18/78	Ethanol, 190°	Union Carbide	17	1.0	0.5
4/19/78	Ethanol, 190°	Union Carbide	17	1.0	0.5
4/20/78	Ethanol, 190°	Union Carbide	17	1.0	0.5
4/20/78	Acetic Acid, Glacial	Union Carbide	4	1.5	0.5
4/21/78	Acetic Acid, Glacial	Union Carbide	4	1.5	0.5
4/26/78	Formaldehyde	Celanese	1745	1.5	0.5
4/27/78	Formaldehyde	Celanese	1745	1.5	0.5
4/28/78	Formaldehyde	Celanese	1745	1.5	0.5
5/9/78	Ethyl Benzene	Cosmar	302B	0.5	0.5
5/10/78	Ethyl Benzene	Cosmar	302B	0.5	0.5
5/16/78	Cyclohexane	Exxon	65	0.25	0.25
5/17/78	Cyclohexane	Exxon	65	0.25	0.25
5/18/78	Cyclohexane	Exxon	65	0.25	0.25

The entire system was mounted onto the tank roof using the sample hatch flange.

The entire metering system as well as other openings in the storage tank were sealed with the use of silicone gasket material. These seals were checked under positive pressure to ensure that all emission passed through the meters. Both meters were calibrated by the manufacturer.

ORGANIC VAPOR CONCENTRATION MEASUREMENT

A sample stream of the tank vapors was drawn continuously through a 1/4-inch I.D. heated teflon line to the van for analysis. The sample was mixed with a known volume of hydrocarbon-free air through a heated dilution system and was then fed to a Century Organic Vapor Analyzer (OVA) equipped with a flame ionization detector to obtain concentration measurements.

The OVA was calibrated and periodically checked between sample runs with both 5000 ppm propane and standard concentrations of the organic vapors being studied. Electronic calibrations were also run and the OVA voltage output was double checked using a volt meter.

Laboratory calibration curves can be found following this section.

Since formalin is a mixture of formaldehyde, water and methanol, it does not respond well to a flame ionization detector; therefore, a Carle gas chromatograph equipped with a thermal conductivity detector and a Porapack T column was used for organic vapor measurements at Celanese. The oven and injector were maintained at a temperature of 140°C, and the helium carrier flow was set at 25 cc/min. Undiluted emission vapor was drawn through the heated sample line directly into the injector port and was analyzed on an hourly basis. Standard gases of propane, formaldehyde, methanol, and water were used to span the gas chromatograph periodically. The OVA was used to detect trace levels in addition to the Carle gas chromatograph.

TEMPERATURE

An Omega ten channel temperature system was used to monitor ambient, liquid, vapor, meter, dilution box and sample line temperatures. Temperature probes were fitted in the tank and throughout the metering system to allow the various temperatures to be read. Specifications on the Omega unit are included in Appendix F.

SAFETY CONSIDERATIONS

Due to the explosive and hazardous nature of the hydrocarbon vapors which were metered and sampled during the investigation, the mobile laboratory was equipped with nitrogen purged fiberglass boxes in which all electrical connections were made.

SECTION IV

DATA REDUCTION AND CALCULATIONS

Calculations were performed according to the equations listed in Table IV-1.

Propane (C_3) was used as a primary standard, in addition to the chemical being tested, to double check the calibration of the organic vapor analyzer's electronics. Standard temperature and pressure was taken to be 68°F and 29.92 inches of mercury, respectively.

The data reduction tables summarize all the calculations for each individual reading. Total pounds of organic emissions per day were calculated by averaging all reasonable organic concentrations in pounds per cubic foot and multiplying by the total standard cubic feet of vapor lost during the day.

TABLE IV-1
EXAMPLE CALCULATIONS

$$\frac{(ft^3)(\text{Baro.}"\text{Hg})(528°R)}{(29.92"\text{Hg})(°F + 460)} = \text{standard cubic feet}$$

$$\frac{(ppm)(MW\ g/m)}{(1 \times 10^6)(385.6)} = \#/ft^3 \text{ at } 68°F \text{ and } 29.92"\text{Hg}$$

$$\text{Field Response Factor} = \frac{\%\ \text{Chart for X ppm } C_3}{\%\ \text{Chart for X ppm Sample}}$$

$$\text{Dilution Factor} = \frac{\%\ \text{Chart Undiluted 5000 ppm } C_3 \text{ to ppm } C_3}{\%\ \text{Chart Diluted 5000 ppm } C_3 \text{ to ppm } C_3}$$

$$\left[\text{ppm (mole Wt)} \times (2.81 \times 10^{-9}) = \#/ft^3\right]$$

APPENDIX A

AMERICAN PETROLEUM INSTITUTE BREATHING LOSS CALCULATIONS

AMERICAN PETROLEUM INSTITUTE BREATHING LOSS CALCULATIONS

Calculations were performed in accordance with API Bulletin 2523, Petrochemical Evaporation Loss From Storage Tanks, November 1969, for each test date. Where vapor pressure data were missing from this bulletin the vapor pressures were calculated using data from the Handbook of Chemistry and Physics, 57th Edition, 1977. Appendix Table A-1 lists all the factors for the API calculations and Appendix Table A-2 lists the measured breathing losses and the calculated breathing losses for comparison.

The API calculation procedures were developed primarily from tests conducted on tanks containing gasoline. A few tests were made on storage tanks containing crude oil. No test results were available for pure product storage.

APPENDIX TABLE A-1

API BREATHING LOSS FORMULAE FACTORS

Date	Chemical	Vapor Pressure (PSIA)	Tank Diameter (ft)	Average Outage (ft)	Daily Ambient Temp. Change (°F)	Paint Factor	Small Dia. Adj. Factor	M/W Factor
4/13/78	Isopropanol, 99%	0.683	54	28	15	1	1	11.934
4/14/78	Isopropanol, 99%	0.683	54	28	13	1	1	11.934
4/18/78	Ethanol, 190°	0.895	70	12	16	1.15	1	12.917
4/19/78	Ethanol, 190°	0.895	70	12	20	1.15	1	12.917
4/20/78	Ethanol, 190°	0.895	70	12	14	1.15	1	12.917
4/20/78	Acetic Acid, Glacial	0.230*	120	28	11	1.33	1	6.86*
4/21/78	Acetic Acid, Glacial	0.230*	120	28	17	1.33	1	6.86*
5/9/78	Ethyl Benzene	0.200*	60	25	17	1	1	14.68*
5/10/78	Ethyl Benzene	0.200*	60	25	22	1	1	14.68*
5/16/78	Cyclohexane	1.97	73	19	15	1	1	11.004
5/17/78	Cyclohexane	1.97	73	19	10	1	1	11.004
5/18/78	Cyclohexane	1.97	73	19	12	1	1	11.004

* Not listed in API 2523

APPENDIX TABLE A-2

MEASURED VERSUS API CALCULATED EMISSIONS

Date	Chemical	Measured Breathing Losses			Calculated Breathing Losses		
		lbs/day	bbls/year	tons/year	lbs/day	bbls/year	tons/year
4/13/78	Isopropanol, 99%	15.0	20.0	2.75	44.0	59.0	8.1
4/14/78	Isopropanol, 99%	17.0	22.0	3.02	46.0	59.0	8.1
4/18/78	Ethanol, 190°	6.0	7.9	1.1	74.0	98.0	16.5[a)]
4/19/78	Ethanol, 190°	3.4	4.5	0.6	82.4	109.0	18.4[a)]
4/20/78	Ethanol, 190°	5.7	7.5	1.1	70.0	92.0	15.6[a)]
4/20/78	Acetic Acid, Glacial	24.0	24.0	4.4	74.6	74.6	13.7
4/21/78	Acetic Acid, Glacial	45.0	45.0	8.3	92.7	92.7	17.1
5/9/78	Ethyl Benzene	11.0	15.0	2.3	28.4	38.7	5.9
5/10/78	Ethyl Benzene	15.0	19.0	2.9	34.7	43.9	6.7
5/16/78	Cyclohexane	20.0	27.0	3.7	127.0	172.0	23.5
5/17/78	Cyclohexane	17.0	23.0	3.1	104.0	141.0	19.3
5/18/78	Cyclohexane	14.0	19.0	2.6	123.0	167.0	22.8

APPENDIX B

FIELD DATA SHEETS

EPA FIXED-ROOF STORAGE TANK STUDY

PLANT NAME Union Carbide

LOCATION Texas City, Texas

CHEMICAL Anhydrous Isopropanol

TANK I.D. 3710

DIAMETER (ft) 54

HEIGHT (ft) 41

CAPACITY (bbls) 19,000

COLOR White

INSULATION: TOP No. SIDE NO

STORAGE TEMPERATURE (°F) Ambient

ROOF SLOPE 10°

TEST DATES 4/13-14/78

TEST OPERATORS A. L. Wilson, J. Mitchell, M. Escovitz

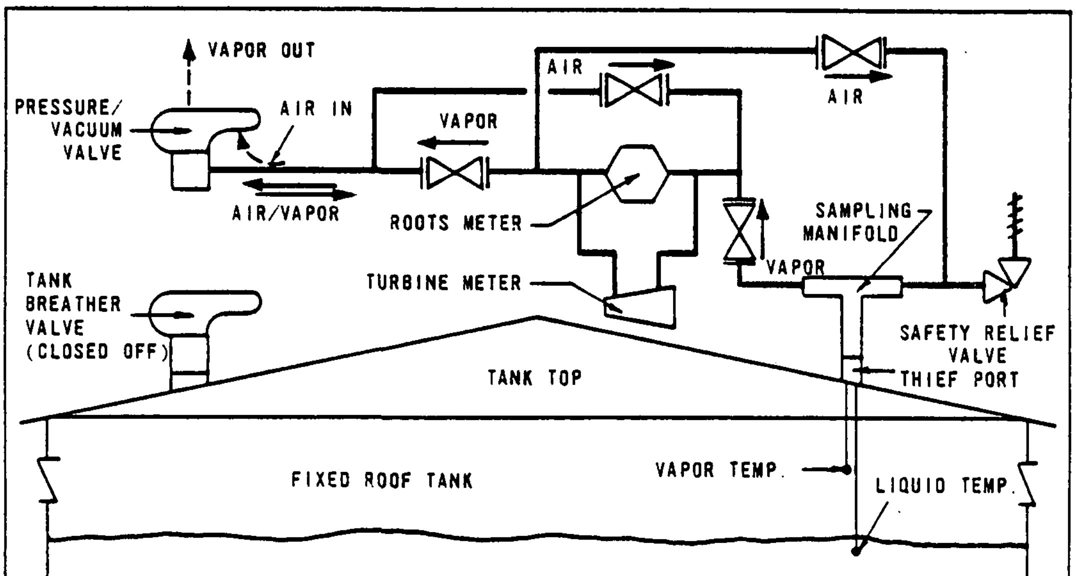
NORMAL RELIEF SETTINGS

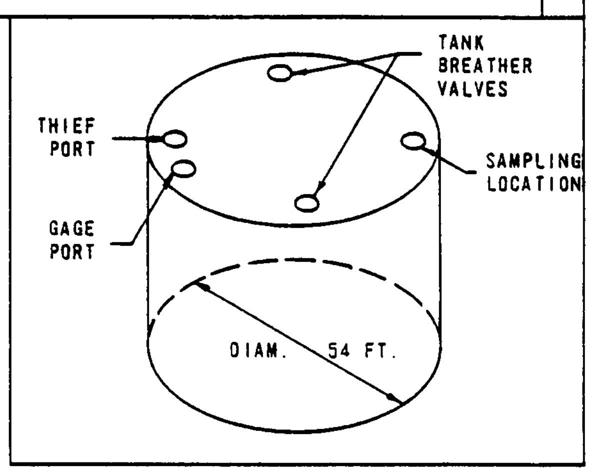
PRESSURE 0 OF VACUUM 0

MAXIMUM ALLOWED RELIEF SETTINGS

PRESSURE 0.5 OF VACUUM 0.5

TANK GAUGE HEIGHT (ft) 15.5





COMMENTS: Tests on 4/11-12/78 were disregarded because of organic vapor analyzer failure.

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Anhydrous Isopropanol

Location Texas City, Texas

O.V.A. 1400

Date 4/13/78

Weather Conditions: AM Clear-Sunny

PM Clear-Sunny

Relative Humidity: AM 83%

PM 47%

O.V.A. Calibration:

Propane C_3	______ %	Chart ______		Chemical	______ %	Chart ______	
5000 ppm	______	AM 90	PM 90	ppm	______	AM 84	PM 85
5000 ppm	Diluted	AM 63	PM 63	ppm	Diluted	AM 55	PM 56

	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
Time	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0600	541	6166		70°F				-				
0630	541	6220						-				
0645	541	6255						+				
0700	541	6357						+				
0715	541	6497	60			57	55	+				
0730	541	6697	61			58	56	0.0				
0800	541	7187	62			59	58	+0.1				
0830	541	7599	65			60	60	+0.1				
0845	541	7875	67			61	61	+0.1		91		
0900	541	8062	67			61	61	+0.1		91		
0930	541	8432	71			63	64	+0.2		92		
1000	541	8882	76			64	67	+0.0		95		
1030	541	9110	79			64	69	+0.4		84	75	28
1100	541	9373	81			65	70	0.0		84	75	28
1130	541	9574	82			66	129	+0.1	30.31			
1200	541	9938	86			68	207	+0.1				
1230	541	10050	87			68	171	+0.1		83	75	28
1300	541	10084	85			68	166	+0.0		82	75	28
1330	633	10084	88			68	155	+0.0		83	75	28
1400	633	10266	88			69	117	-0.0		84	75	28
1430	633	10441	88			70	98	+0.0		85	75	28
1500	675	10441	90			70	87	-0.0		87	75	28

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical: Anhydrous Isopropanol (Cont'd.)

Location: Texas City, Texas

O.V.A.: 1400

Date: 4/13/78

Weather Conditions: AM Clear-Sunny; PM Clear-Sunny

Relative Humidity: AM 83%; PM 47%

O.V.A. Calibration:

Propane C_3 ____ % Chart ____ Chemical ____ % Chart ____

5000 ppm ____ AM 90 PM 90 ppm ____ AM 84 PM 85

5000 ppm Diluted AM 63 PM 63 ppm Diluted AM 55 PM 56

	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
Time	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
1530	695	10441	84	70°F		71	82	+0.0	30.31	87	75	28
1600	695	10441	82			71	79	-0.0				
1630	697	10441	80			72	78	-0.1		88	75	28

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical: Anhydrous Isopropanol
Location: Texas City, Texas
O.V.A.: 1400
Date: 4/14/78

Weather Conditions: AM Clear-Sunny
PM Clear-Sunny
Relative Humidity: AM 67%
PM 38%

O.V.A. Calibration:

Propane C_3	____ %	Chart			Chemical	____ %	Chart		
5000 ppm		AM 90	PM 90		ppm		AM 84	PM 84	
5000 ppm	Diluted	AM 63	PM 63		ppm	Diluted	AM 55	PM 56	

	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		Rate	
Time	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	%	Chart	Air	Sample
0615	874	13078	57	70°F		60	56	-0.2					
0630	874	13078											
0645	933	13078	64			63	56	+0.6			83	75	28
0700	933	13310	63			64	71	+0.0			83	75	28
0730	933	13708	65			64	69	+0.0			84	75	28
0800	933	14202	71			66	72	+0.0			84	75	28
0830	933	14841	73			66	72	+0.0			84	75	28
0900	933	15340	76			67	75	+0.0			83	75	28
0930	933	15750	79			68	77	+0.0			85	75	28
1000	933	16153	82			70	79	+0.0			85	75	28
1030	933	16367	79			70	80	+0.0	30.33		85	75	28
1100	933	16558	83			71	81	+0.0			85	75	28
1130	933	16758	82			70	82	+0.0			84	75	23
1200	933	16930	87			72	83	+0.0			84	75	28
1230	933	17129	87			71	83	+0.0			85	75	28
1300	933	17220	87			73	84	+0.0			84	75	28
1330	933	17266	83			72	83	-0.1					
1400	933	17266	83			72	82	-0.1					
1430	933	17266	82			73	82	+0.3			84	75	28
1500	933	17275	82			72	81	+0.1			84	75	28

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Anhydrous Isopropanol (Cont'd.)

Location Texas City, Texas

O.V.A. 1400

Date 4/14/78

Weather Conditions: AM Clear-Sunny

PM Clear-Sunny

Relative Humidity: AM 67%

PM 38%

O.V.A. Calibration:

Propane C_3 ____ % Chart ____ Chemical ____ % Chart ____

5000 ppm ____ AM 90 PM 90 ppm ____ AM 84 PM 84

5000 ppm Diluted AM 63 PM 63 ppm Diluted AM 55 PM 56

	Meter ACF		Temperature °F					Pressure		O.V.A. Reading			
								Tank H_2O	Baro. Hg			Rate	
Time	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Inches	Inches	%	Chart	Air	Sample
1530	933	17293	81	70°		73	81	+0.1			84	75	28
1600	933	17293	79			73	80	-0.2			84	75	28
1715	933	16750	71			71	76	-0.1	30.34			75	28

EPA FIXED-ROOF STORAGE TANK STUDY

PLANT NAME Union Carbide

LOCATION Texas City, Texas

CHEMICAL Ethanol , 190°

TANK I.D. 17

DIAMETER (ft) 70

HEIGHT (ft) 40

CAPACITY (bbls) 24500

COLOR White

INSULATION: TOP No SIDE No

STORAGE TEMPERATURE (°F) Ambient

ROOF SLOPE 10°

TEST DATES 4/18-21/78

TEST OPERATORS J. Mitchell

J. Wilson

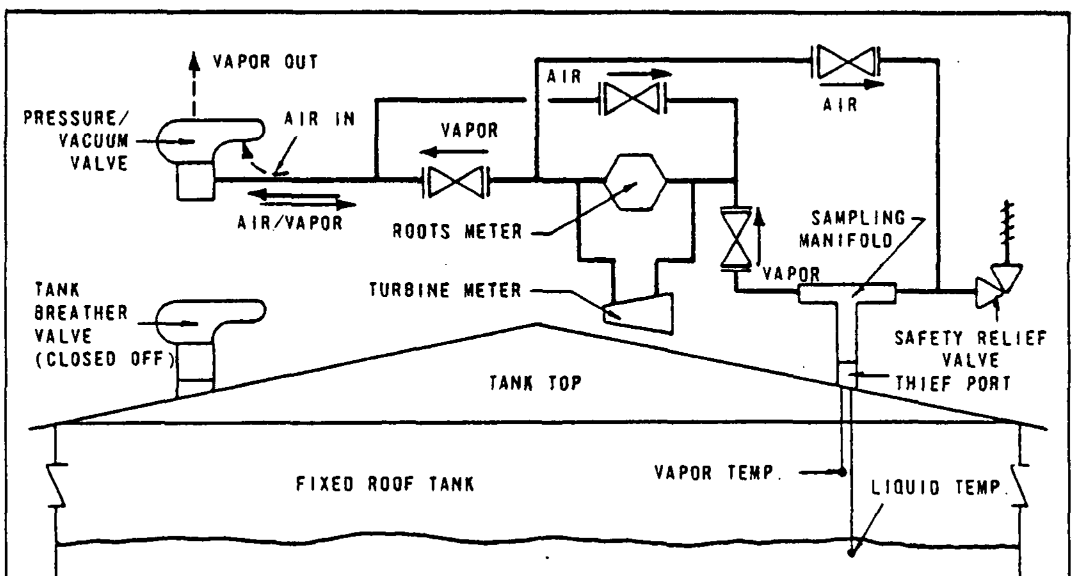
NORMAL RELIEF SETTINGS

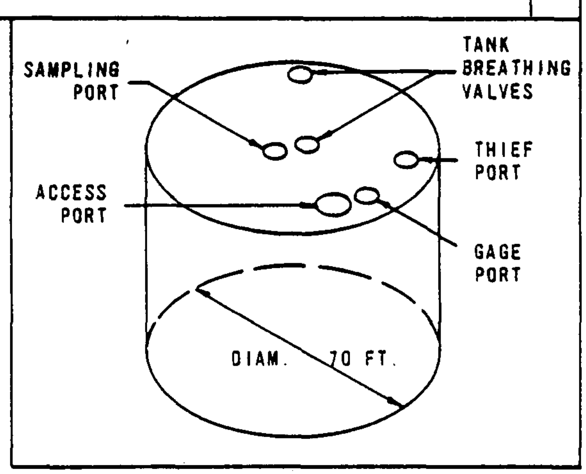
PRESSURE 0 OF VACUUM 0

MAXIMUM ALLOWED RELIEF SETTINGS

PRESSURE 1.0 OF VACUUM 0.5

TANK GAUGE HEIGHT (ft) 30.69





COMMENTS:

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical: Ethanol, 190°

Location: Texas City, Texas

O.V.A.: 1400

Weather Conditions: AM Cloudy-Rain; PM Partly Cloudy-Sun

Relative Humidity: AM 93%; PM 74%

DATE: 4/18/78

O.V.A. Calibration:

Propane C_3 ______ % Chart ______ Chemical ______ % Chart ______

5000 ppm ______ AM 90 PM 90 ppm ______ AM 71 PM 71

5000 ppm Diluted AM 63 PM 63 ppm Diluted AM 50 PM 50

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0600	933	12583	68	69	69	69	93	-0.1	30.10			
0630	933	12583	69	69	69	69	91	0.0	30.09			
0700	933	12583		70	71	70	118	0.0	30.10	85	75	28
0730	933	12583	70	70	70	71	127	+0.2	30.11	86	75	28
0800	933	12596	71	70	71	71	164	+0.7	30.11	87	75	28
0830	933	12824	72	70	73	72	172	+0.1	30.10	87	75	28
0900	933	12969	74	70	74	73	159	+0.3	30.10	82	75	28
0930	933	13277	78	70	78	77	164	+0.7	30.13	87	75	28
1000	933	13577	78	70	79	76	167	+0.4	30.13	89	75	28
1030	933	13701	81	71	80	78	168	+0.2	30.13	84	75	28
1100	933	13791	84	70	92	82	173	+0.4	30.12	86	75	28
1130	933	13908	87	70	97	83	172	+0.6	30.12	88	75	28
1200	933	13908	86	70	97	81	173	+0.2	30.12	83	75	28
1230	933	13908	85	70	99	83	172	+0.5	30.10	82	75	28
1300	933	13908	85	70	102	85	166	+0.3	30.06	83	75	28
1330	933	13908	85	71	104	85	171	+0.2	30.05			
1400	933	13908	85	71	104	83	173	-0.1	30.05	85	75	28
1430	933	13908	83	71	103	82	173	-0.3	30.05	85	75	28
1500	933	13908	81	71	100	81	170	-0.4	30.05	74	75	28
1530	933	13908	80	71	98	81	174	-0.4	30.00	68	75	28
1600	933	13908	78	71	96	80	172	-0.5	30.00	64	75	28
1630	933	13924	78	71	94	78	174	-0.9	30.00	56	75	28
1700	933	13968	78	72	90	78	173	-0.8	30.00	51	75	28

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical: Ethanol, 190°

Location: Texas City, Texas

O.V.A.: 1400

Weather Conditions: AM Partly Cloudy; PM Sun

Relative Humidity: AM 91%; PM 27%

DATE: 4/19/78

O.V.A. Calibration:

Propane C_3 ____ % Chart ____ Chemical ____ % Chart ____

5000 ppm ____ AM 90 PM 90 — ppm ____ AM 71 PM 71

5000 ppm Diluted AM 63 PM 63 — ppm Diluted AM 50 PM 50

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0630	933	15008	64	71	67	63	168	-0.5	30.16			
0700	933	15008	64	71	67	64	169	0.0	30.16			
0730	933	15008	65	71	69	68	172	0.5	30.16			
0800	933	15116	71	71	72	70	172	0.8	30.16	82	75	28
0830	933	15365	72	71	77	69	172	0.6	30.19	83	75	28
0900	933	15391	74	71	78	70	168	0.6	30.20	86	75	28
0930	933	15391	74	71	82	71	167	0.4	30.20	85	75	28
1000	933	15391	75	71	84	72	170	0.4	30.21	84	75	28
1030	935	15391	76	71	86	75	165	0.4	30.22	85	75	28
1100	938	15391	79	71	89	76	166	0.5	30.22	86	75	28
1130	1026	15391	88	71	92	76	166	0.2	30.22	86	75	28
1200	1091	15391	89	71	94	79	166	0.1	30.22	87	75	28
1230	1167	15391	91	71	96	78	167	0.1	30.20	87	75	28
1300	1220	15391	92	72	97	81	167	0.1	30.20	88	75	28
1330	1245	15427	98	72	98	82	170	0.1	30.20	86	75	28
1410	1275	15427	84	72	98	83	169	0.2	30.19	89	75	28
1440	1312	15427	83	72	98	82	168	-0.2	30.16	91	75	28
1510	1311	15427	82	72	96	81	172	-0.2	30.16	79	75	28
1530	1311	15427	83	72	97	81	167	-0.3	30.16	89	75	28
1600	1313	15427	81	72	95	80	165	-0.3	30.15	90	75	28
1630	1384	15427	84	72	93	79	167	-0.4	30.15	50	75	28
1645	1427	15427	81	72	91	79	164	-0.2	30.15	53	75	28

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Ethanol, 190°

Location Texas City, Texas

O.V.A. 1400

Weather Conditions: AM Sun-Wind
PM Sun-Wind

Relative Humidity: AM 50%
PM 44%

DATE 4/20/78

O.V.A. Calibration:

Propane C_3 ________ % Chart ________

5000 ppm ________ AM 90 PM 90

5000 ppm Diluted AM 63 PM 63

Chemical ________ % Chart ________

ppm ________ AM 71 PM 71

ppm Diluted AM 50 PM 50

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0630	2865		56	71	63	57	171	0.0	30.21			
0700	2871		58	71	64	59	164	0.4	30.21	78	75	28
0730	3005		63	71	66	62	166	0.6	30.21	78	75	28
0800	3116		63	71	68	61	165	0.1	30.21	80	75	28
0830	3253		66	70	69	64	167	0.4	30.22	81	75	28
0900	3395		71	70	73	68	168	0.9	30.24	81	75	28
0930	3512		70	70	74	69	166	0.6	30.25	83	75	28
1000	3612		69	70	76	68	166	0.1	30.25	83	75	28
1030	3718		72	70	77	71	170	0.4	30.29	83	75	28
1100	3745		70	70	78	71	166	0.3	30.30	81	75	28
1130	3928		76	70	82	67	166	0.5	30.29	85	75	28
1200	3957		66	70	83	64	168	-0.2	30.28	85	75	28
1230	3961		67	70	81	67	167	-0.3	30.26	82	75	28
1300	3992		68	70	79	65	166	-0.5	30.25	75	75	28
1330	4043		81	70	82	65	166	0.9	30.25	86	75	28
1400	4070		76	70	84	69	164	0.4	30.25	85	75	28
1430	4154		78	70	87	69	162	0.0	30.24	85	75	28
1500	4267		86	71	89	68	166	0.5	30.24	85	75	28
1530	4297		77	71	91	71	163	0.0	30.24	89	75	28
1600	4422		72	71	87	71	163	-1.0	30.24	83	75	28

EPA FIXED-ROOF STORAGE TANK STUDY

PLANT NAME Union Carbide

LOCATION Texas City, Texas

CHEMICAL Glacial Acetic Acid

TANK I.D. 4

DIAMETER (ft) 120

HEIGHT (ft) 40' 11-3/4'

CAPACITY (bbls) 80,000

COLOR Gray

INSULATION: TOP No SIDE NO

STORAGE TEMPERATURE (°F) Ambient

ROOF SLOPE 10°

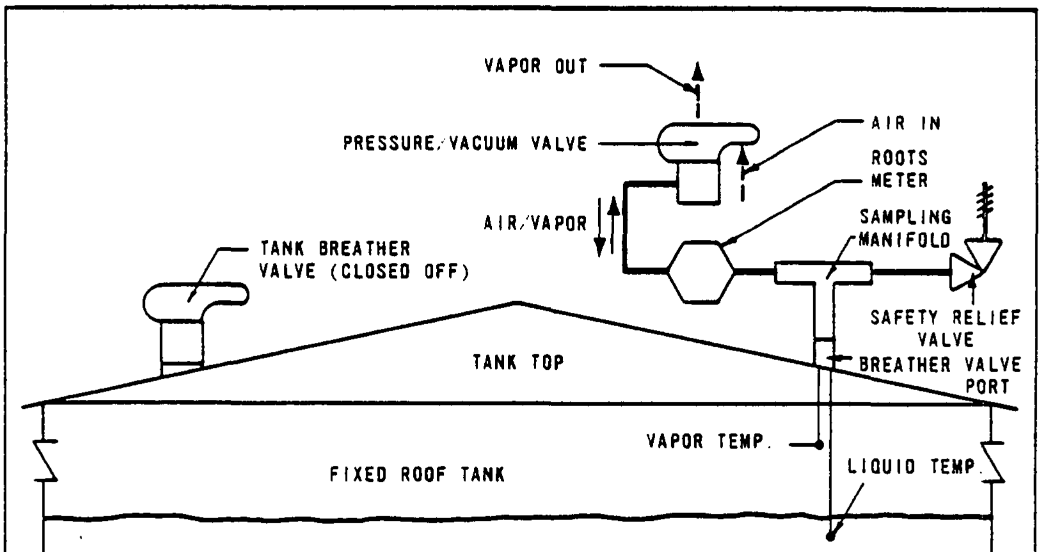
TEST DATES 4/20-21/78

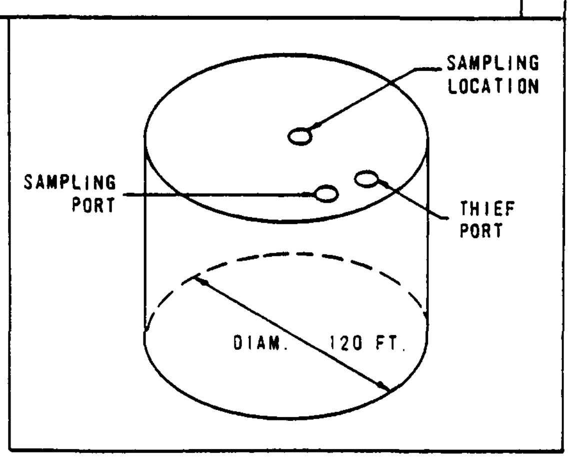
TEST OPERATORS M. Escovitz
S. Lambert

NORMAL RELIEF SETTINGS
PRESSURE 0 OF VACUUM 0

MAXIMUM ALLOWED RELIEF SETTINGS
PRESSURE 1.5 OF VACUUM 0.5

TANK GAUGE HEIGHT (ft) 17' 9-3/8"





COMMENTS: Condensation of Acetic Acid into the metering system caused a delay in testing.

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Glacial Acetic Acid

Location Texas City, Texas

O.V.A. 1410

Weather Conditions: AM Sun-Clouds-Windy PM

Relative Humidity: AM 53% PM

DATE 4/20/78

O.V.A. Calibration:

Propane C_3 ____ % Chart ____

5000 ppm ____ AM 90 PM 89

5000 ppm Diluted AM 73 PM 72

Chemical ____ % Chart ____

ppm ____ AM 54 PM 54

ppm Diluted AM 45 PM 45

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0615		1120	56	69	61	56	213	-0.2	30.21			
0630		1120	56	69	61	56	218	0.0	30.21			
0700		1120	57	70	63	57	215	+0.3	30.21			
0730		1140	60	70	68	58	215	+0.4	30.22	83	75	74
0800		2870	63	70	68	58	218	+0.4	30.24	82	75	74
0830		4489	65	70	69	58	220	+0.4	30.25	82	75	74
0900		5780	68	70	71	61	219	+0.3	30.25	83	75	74
0930		6640	68	70	73	62	220	+0.2	30.29	88	75	74
1000		6970	69	70	76	61	218	+0.3	30.30	88	75	74
1030			69	70	77	61	215	+0.3	30.29	88	75	74
1100			69	70	78	63	220	+0.4	30.28	88	75	74
1130			73	70	80	63	220	+0.4	30.26	88	75	74
1200		8700	75	70	82	64	220	+0.5	30.25	89	75	74
1230		10107	75	70	81	63	215	0.0	30.25	88	75	74
1300		10105	71	70	79	64	180	-0.6	30.24			
1315		9919	71	70	81	64	200	+0.1	30.24			
1330		9922	71	70	81	64	219	+0.4	30.24			
1400		9923	76	70	81	66	219	+0.5	30.24			
1430		9980	79	70	84	66	214	+0.6	30.24			
1500		10435	80	70	87	67	208	+0.7	30.24			
1530		11150	83	70	88	67	209	+0.7	30.24	88	75	74
1600		11596	76	70	91	64	207	+0.5	30.24	88	75	74
1640		11598		70	87			-0.6	30.24			

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Glacial Acetic Acid

Location Texas City, Texas

O.V.A. 1410

Weather Conditions: AM Clear-Sun; PM Clear-Sun

Relative Humidity: AM 56%; PM 49%

DATE 4/21/78

O.V.A. Calibration:

Propane C_3 ____ % Chart ____ | **Chemical** ____ % Chart ____

		AM	PM			AM	PM
5000 ppm		90	89	**ppm**		54	54
5000 ppm	Diluted	73	72	**ppm**	Diluted	45	44

Time	Meter ACF Singer	Meter ACF Roots	Temperature °F Meter	Temperature °F Liquid	Temperature °F Vapor	Temperature °F Ambient	Temperature °F Dilution	Pressure Tank H_2O Inches	Pressure Baro. Hg Inches	O.V.A. Reading % Chart	O.V.A. Reading Rate Air	O.V.A. Reading Rate Sample
0615		712	50	68	59	53	219	-0.1				
0630		712	53	69	61	55	208	+0.3				
0700		712	55	69	63	57	211	+0.4				
0730		2710	65	70	66	60	218	+0.4		86	75	74
0800		4454	72	69	71	62	214	+0.5		87	75	74
0830		6650	79	70	77	65	213	+0.5	30.15	88	77	74
0900		9043	84	70	84	66	218	+0.6	30.15	88	75	74
0930		11110	88	70	88	67	216	+0.6		88	70	74
1000		13580	91	70	93	68	212	+0.5		87	75	74
1030		15226	92	70	94	68	216	+0.4	30.15	87	74	73
1100		17050	94	70	96	69	215	+0.3	30.17	87	73	74
1130		18520	93	70	97	70	216	+0.1	30.16	88	72	74
1200		19280	92	70	97	70	212	0.0	30.16	87	75	74
1230		19708	89	70	98	70	211	-0.1	30.16	87	75	74
1300		19708	84	70	97	71	213	-0.4	30.16			
1311		19482										
1330		19482	81	70	96	70	210	-0.3	30.12			
1420		19482	80	70	95	70	216	-0.2				
1430		19276	79	70	96	70	218	-0.2	30.08			
1500		18912	77	70	94	69	212	-0.2				
1530		18058	73	70	91	68	209	-0.7				

EPA FIXED-ROOF STORAGE TANK STUDY

PLANT NAME Celanese

LOCATION Bishop, Texas

CHEMICAL Formaldehyde

TANK I.D. 1745

DIAMETER (ft) 47

HEIGHT (ft) 40

CAPACITY (bbls) 12300

COLOR Gray

INSULATION: TOP 2" SIDE 2"

STORAGE TEMPERATURE (°F) 147

ROOF SLOPE 20°

TEST DATES 4/26-28/78

TEST OPERATORS J. Mitchell, S. Lambert, H. Deriada

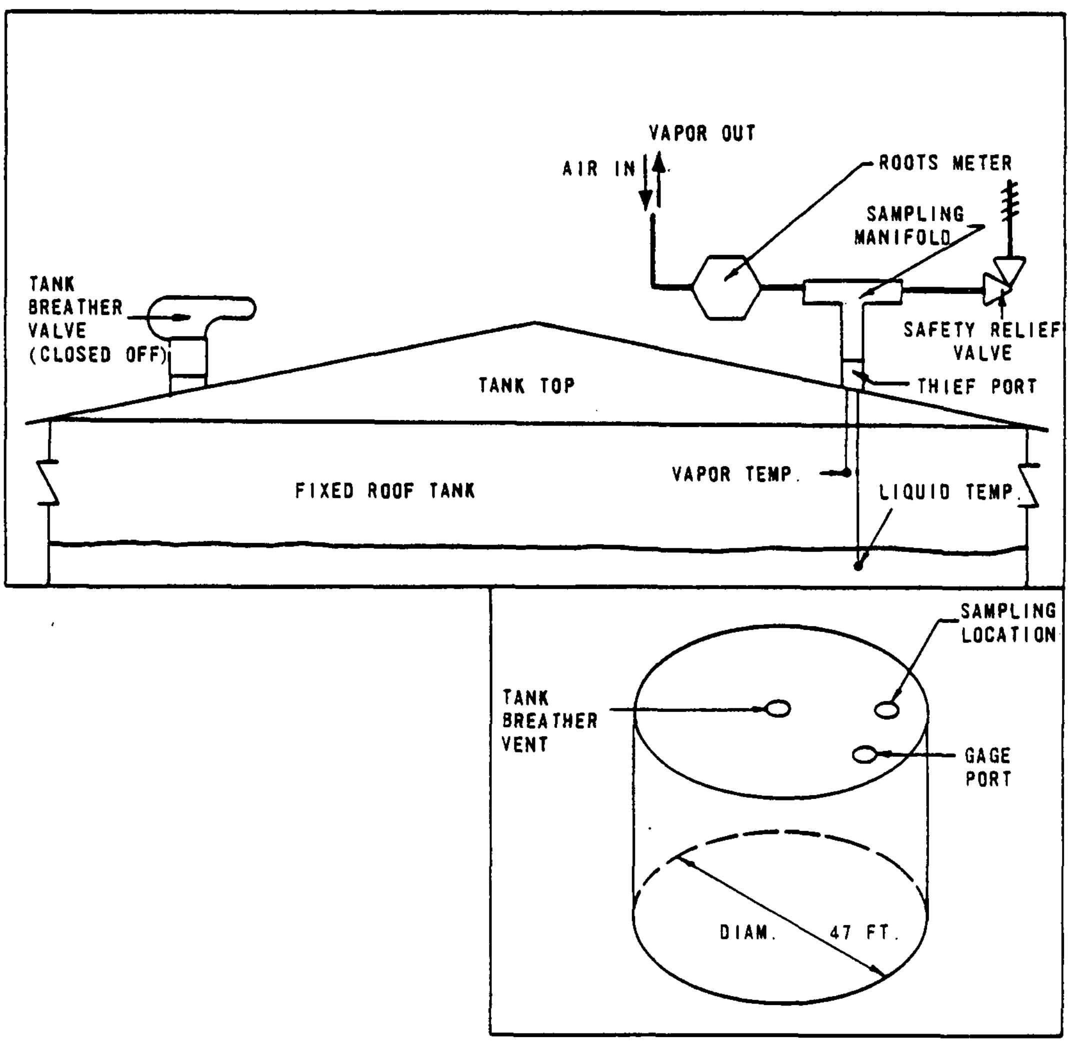
NORMAL RELIEF SETTINGS

PRESSURE 0 OF VACUUM 0

MAXIMUM ALLOWED RELIEF SETTINGS

PRESSURE 1.5 OF VACUUM 0.5

TANK GAUGE HEIGHT (ft) 15



COMMENTS: Because of large amounts of condensation the roots meter was mounted to vent free to the atmosphere.

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Formaldehyde | Weather Conditions: AM Clouds
Location Bishop, Texas | PM Sunny
O.V.A. 1410 | Relative Humidity: AM 38%
Date 4/26/78 | PM ____

O.V.A. Calibration:

Propane C_3 ____% Chart ____ | Chemical ____% Chart ____

5000 ppm ____ AM 90 PM 90 | ppm ____ AM ____ PM ____

5000 ppm Diluted AM ____ PM ____ | ppm Diluted AM ____ PM ____

	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
											Rate	
Time	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Air	Sample
0630		6100										
0700		5999	80	144	161	58	55	0.05	30.26			
0730		5406	122	145	161	60	56	0.05	30.27			
0800		4760	124	147	161	63	62	0.05				
0830		4284	126	148	161	64	144	0.05	30.28			
0900		3606	127	148	162	65	195	0.05	30.29			
0930		2870										
1000		2148	133	149	162	70	214	0.05	30.29			
1030		1492	135	150	162	71	211	0.02	30.29	58	0	100
1100		850	137	150	162	72	210	0.0	30.26	52	0	100
1130		95	139	151	162	74	198	0.0	30.25			
1200		9451	137	152	162	76	207	0.0	30.23	53	0	100
1230		8743	137	151	162	76	216	0.1	30.23			
1300		8192	133	153	162	76	207	0.1	30.22	54	0	100
1330		7729	121	153	162	74	212	0.1	30.21	58	0	100
1400		7389	127	150	162	75	207	0.1	30.21			
1430		7374	134	151	162	75	216	0.1	30.21	58	0	100
1500		6730	137	152	162	75	208	0.1				
1530		6080	137	150	162	74	213	0.1		62	0	100
1600		5364						0.1				
1630		4863	135	151	162	75	214	0.1	30.21	55	0	100

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Formaldehyde (Cont'd.)

Location Bishop, Texas

O.V.A. 1410

Date 4/26/78

Weather Conditions: AM Clouds

PM Sunny

Relative Humidity: AM 38%

PM

O.V.A. Calibration:

Propane C_3 ______ % Chart ______ Chemical ______ % Chart ______

5000 ppm ______ AM 90 PM 90 ppm ______ AM ______ PM ______

5000 ppm Diluted AM ______ PM ______ ppm Diluted AM ______ PM ______

	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
											Rate	
Time	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Air	Sample
1700		4353	133	152	162	74	211	0.1	30.20	51	0	100
1730		3924	133	151	162	72	208	0.1	30.18	58	0	100
1800		3495	130	151	162	71	205	0.1	30.18	58	0	100
2000		3401	117	148	161	66	207	0.05	30.22	56	0	100
2030		2946	126	149	161	65	200	0.1	30.21			
2100		2477	127	148	161	64	207	0.1	30.21	53	0	100
2130		2019	128	146	161	64	208		30.21	54	0	100

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Formaldehyde

Location Bishop, Texas

O.V.A. 1410

Weather Conditions: AM Cloudy
PM Sunny

Relative Humidity: AM 81%
PM 41%

DATE 4/27/78

O.V.A. Calibration:

Propane C_3 ______ % Chart ______ Chemical ______ % Chart ______

5000 ppm ______ AM 90 PM 90 ppm ______ AM ______ PM ______

5000 ppm Diluted AM ______ PM ______ ppm Diluted AM ______ PM ______

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0800		991894	114	144	158	67	67	0.0				
0830		991348	127	145	159	59	128	0.1	30.24	53	0	100
0900		990812	128	147	159	70	183	0.1	30.24	57	0	100
0930		990255	127	146	159	71	210	0.1	30.24	53	0	100
1000		989727	124	146	159	73	218	0.1	30.24			
1030		989078	128	146	159	73	215	0.1	30.24	54	0	100
1100		988562	132	148	159	75	215	0.1	30.24	55	0	100
1130		988009	131	148	159	77	207	0.1	30.24	52	0	100
1200		987434	131	149	159	77	205	0.1	30.24			
1230		986883	132	149	159	78	215	0.1	30.22	53	0	100
1300		986344	127	148	159	77	214	0.1	30.22			
1330		985801	128	148	159	79	205	0.12	30.19	54	0	100
1400		985310	126	148	159	78	211	0.1	30.17	51	0	100
1430		984754	129	147	159	78	209	0.1	30.17			
1500		984244	129	148	159	78	216	0.1	30.15	54	0	100

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Formaldehyde

Location Bishop, Texas

O.V.A. 1410

Weather Conditions: AM Cloudy

PM Sun

Relative Humidity: AM 64%

PM 53%

DATE 4/28/78

O.V.A. Calibration:

Propane C_3 ______ % Chart ______ Chemical ______ % Chart ______

5000 ppm ______ AM 90 PM 90 ppm ______ AM ______ PM ______

5000 ppm Diluted AM ______ PM ______ ppm Diluted AM ______ PM ______

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0815		984050	97	140	156	73	79	+0.1	30.11			
0830		983794	119	143	156	75	142	0.1				
0900		983320	122	143	156	75	200	0.1	30.12	53	0	100
0930		982745	126	145	156	77	213	0.1		55	0	100
1000		982175	127	144	156	78	207	0.1	30.08	54	0	100
1030		981639	127	145	156	79	206	0.1				
1100		981134	126	145	156	79	215	0.1	30.08	56	0	100
1130		980612	128	145	156	81	209	0.1		54	0	100
1200		980067	128	145	156	81	202	0.1	30.06			
1230		979570	125	143	156	81	211	0.1		56	0	100
1300		979120	124	144	156	81	202	0.1	30.04			
1330		978685	128	145	156	81	207	0.1	30.04	56	0	100
1400		978265	128	144	156	81	200	0.1	30.01			
1430			123	144	156	80	199		30.00	56	0	100
1500			124	144	156	80	208					

EPA FIXED-ROOF STORAGE TANK STUDY

PLANT NAME Cosmar

LOCATION Baton Rouge, Louisiana

CHEMICAL Ethyl Benzene

TANK I.D. 302B

DIAMETER (ft) 95

HEIGHT (ft) 24

CAPACITY (bbls) 30,000

COLOR White

INSULATION: TOP No SIDE No

STORAGE TEMPERATURE (°F) Ambient

ROOF SLOPE 10°

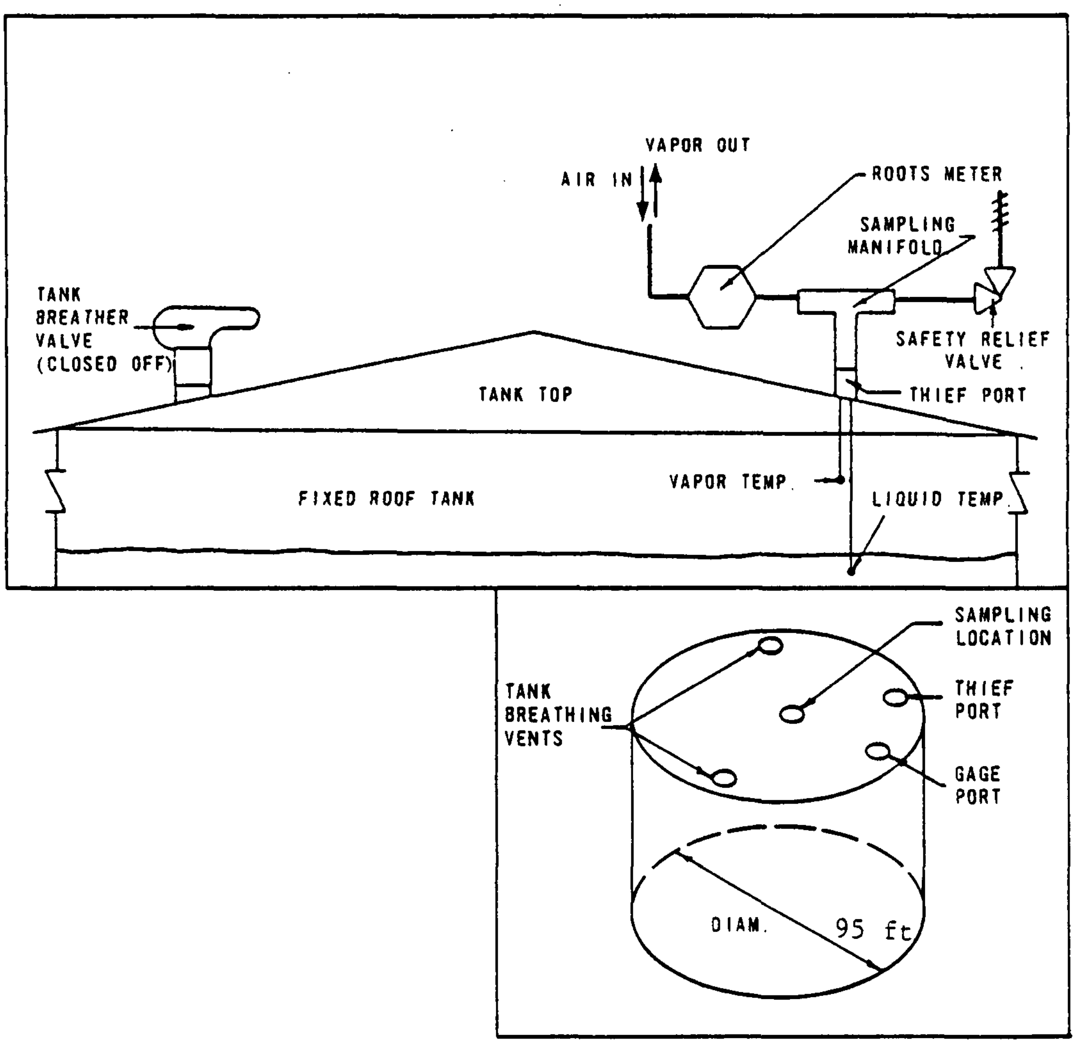
TEST DATES 5/9-10/78

TEST OPERATORS J. Mitchell
M. Escovitz

NORMAL RELIEF SETTINGS
PRESSURE 0.5 OF VACUUM 0.5

MAXIMUM ALLOWED RELIEF SETTINGS
PRESSURE 0.5 OF VACUUM 0.5

TANK GAUGE HEIGHT (ft) 14' 10-1/2"



COMMENTS: Cosmar officials were forced to work the tank on 5/11/78 thus cutting the test short one day.

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Ethyl Benzene

Location Baton Rouge, Louisiana

O.V.A. 1410

Weather Conditions: AM Cloudy-Rain
PM Cloudy

Relative Humidity: AM 80%
PM 62%

DATE 5/9/78

O.V.A. Calibration:

Propane C_3 ____ % Chart ____ Chemical ____ % Chart ____

5000 ppm ____ AM 90 PM 90 ppm ____ AM 74 PM ____

5000 ppm Diluted AM 65 PM ____ ppm Diluted AM ____ PM ____

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0700		a) 6379										
0730		6420	72	80	76	71	176	-0.1	30.19	78		
0800		6468	73	80	76	72	173	0.0		78		
0830		6494	73	81	77	72	178	-0.1		84		
0900		6472	74	81	77	73	166	0.0		83	75	28
0930		6256	78	82	78	75	165	0.0		83	75	28
1000		6082	80	82	80	79	199	0.0		87	75	28
1030		6065	82	82	81	79	195	+0.1	30.19	89	75	28
1100		5826	84	81	79	87	173	+0.1		87	75	28
1130		5369	87	82	84	88	193	+0.1		89	75	28
1200		5071	90	82	87	87	196	+0.1	30.19	90	75	28
1230		4839	92	82	88	82	195	+0.1		91	75	28
1300		4559	94	82	90	83	190	+0.1		92	75	28
1330		4326	95	83	91	84	193	+0.1		92	75	28
1400		4222	95	83	92	83	193	+0.1		93	75	28
1430		4092	96	82	93	85	191	+0.1		93	75	28
1500		4012	96	82	93	84	191	0.0		92	75	28
1530		4012	96	82	93	84	191	0.0				

a) Roots meter ran backwards during this sequence of tests.

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical: Ethyl Benzene
Location: Baton Rouge, Louisiana
O.V.A.: 1410

Weather Conditions: AM Sun
PM Sun
Relative Humidity: AM 60%
PM

DATE: 5/10/78

O.V.A. Calibration:

Propane C_3 ____ % Chart ____ Chemical ____ % Chart ____

5000 ppm ____ AM 90 PM 89 ppm ____ AM 74 PM ____

5000 ppm Diluted AM 64 PM 62 ppm Diluted AM ____ PM ____

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0700		8813	65	78	67	61	128	+0.0				
0730		8642	65	78	67	61	130	+0.1	30.34	81	75	28
0800		8449	70	79		67	187	+0.1		81	75	28
0830		8156	73	80	72	73	195	+0.1		82	75	28
0900		7604	76	80	74	76	192	+0.1		83	75	28
0930		7543	79	80	76	78	196	+0.1		83	75	28
1000		7229	81	80	78	79	196	+0.1		84	75	28
1030		6901	83	80	80	81	192	+0.1		84	75	28
1100		6601	85	80	82	80	192	+0.1		85	75	28
1130		6422	87	80	84	80	192	+0.1		86	75	28
1200		6273	90	80	87	81	193	+0.1		88	75	28
1230		5867	91	81	88	81	193	+0.1		88	75	28
1300		5501	92	81	89	82	198	+0.1		89	75	28
1330		5374	94	81	90	83	197	+0.1		90	75	28
1400		5172	95	81	91	83	199	0.0	30.34	90	75	28
1430		5016	96	81	91	83	196	0.0		90	75	28
1500		5017										
1530		5093										

EPA FIXED-ROOF STORAGE TANK STUDY

PLANT NAME Exxon

LOCATION Bay Town, Texas

CHEMICAL Cyclohexane

TANK I.D. 65

DIAMETER (ft) 73

HEIGHT (ft) 40

CAPACITY (bbls) 30,000

COLOR White

INSULATION: TOP No SIDE No

STORAGE TEMPERATURE (°F) Ambient

ROOF SLOPE 10°

TEST DATES 5/16-17-18/78

TEST OPERATORS J. Mitchell

M. Escovitz

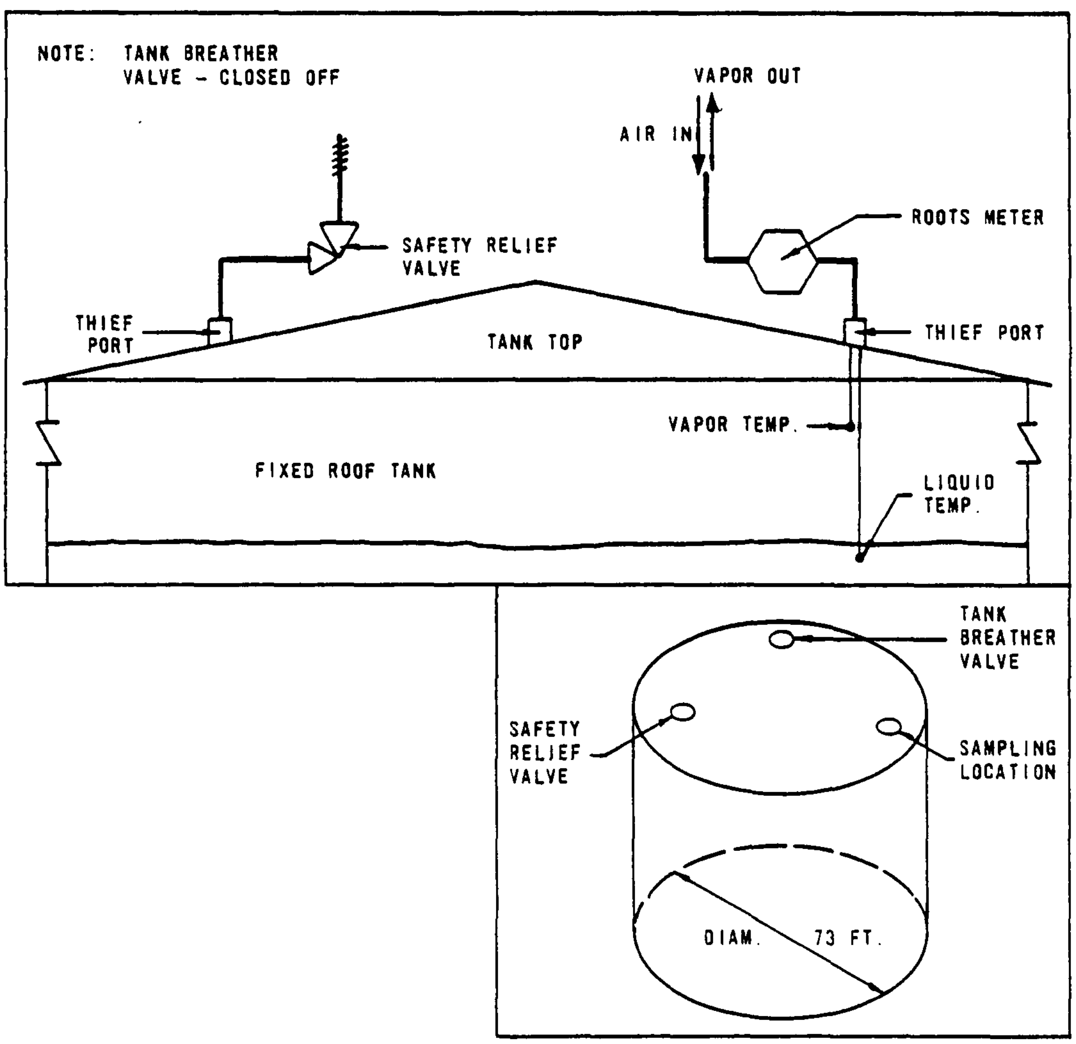
NORMAL RELIEF SETTINGS

PRESSURE 0.5 OF VACUUM 0.25

MAXIMUM ALLOWED RELIEF SETTINGS

PRESSURE 0.25 OF VACUUM 0.25

TANK GAUGE HEIGHT (ft) 24' 3-1/2"



COMMENTS: Electrical outage on 5/16/78 caused lack of OVA and temperature readings until 1200.

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical: Cyclohexane

Location: Bay Town, Texas

O.V.A.: 1410

Weather Conditions: AM Cloudy; PM Sun

Relative Humidity: AM 56%; PM 60%

DATE: 5/16/78

O.V.A. Calibration:

Propane C_3 ________ % Chart ________ Chemical ________ % Chart ________

5000 ppm ________ AM 90 PM 90 ppm ________ AM 82 PM ________

5000 ppm Diluted AM 37 PM 34 ppm Diluted AM ________ PM ________

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0700		8706										
0730		8682										
0800		8598										
0830		7873										
0900		7407										
0930		7322										
1000		7006										
1030		6713										
1100		6462							30.12			
1130		6120										
1200		5853										
1230		5752						+0.1	83	83	75	75
1300		5712	91	79	88	89	196	+0.1	82	82	75	75
1330		5699	92	79	87	89	198		83	83	75	75
1400		5696	91	79	86	82	198		82	82	75	75

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical Cyclohexane

Location Bay Town, Texas

O.V.A. 1410

Weather Conditions: AM Cloudy PM Sun

Relative Humidity: AM 91% PM

DATE 5/17/78

O.V.A. Calibration:

Propane C_3 ______ % Chart ______ Chemical ______ % Chart ______

5000 ppm ______ AM 90 PM 89 ppm ______ AM 82 PM ______

5000 ppm Diluted AM 35 PM 34 ppm Diluted AM ______ PM ______

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0700		4575						-0.1				
0730		4386	76	77	75	74	133	+0.1		79	75	75
0800		4129	79	78	76	76	152	+0.1		79	75	75
0830		3726	81	78	78	78	152	+0.1		80	75	75
0900		3429	83	79	79	78	148	+0.1	30.10	80	75	75
0930		3149	85	79	81	80	153	+0.1		80	75	75
1000		2869	85	79	81	81	155	+0.1		79	75	75
1030		2768	84	79	80	79	152	+0.1		70	75	75
1100		2667	85	79	80	79	152	0.0		70	75	75
1130		2557	84	79	80	79	153	+0.1		79	75	75
1200		2192	85	79	83	82	152	+0.1		79	75	75
1230		1877	86	79	84	82	153	+0.1		80	75	75
1300		1614	87	79	85	84	151	+0.1		80	75	75
1330		1557	89	79	86	84	154	+0.1		80	75	75
1400		1436	90	79	85	84	153	+0.1		81	75	75
1430		1412	90	79	88	83	154	+0.1		79	75	75
1500		1406										

EPA FIXED-ROOF STORAGE TANK STUDY

FIELD DATA SHEET

Chemical: Cyclohexane
Location: Bay Town, Texas
O.V.A.: 1410

Weather Conditions: AM Sun-Clouds
PM Sun-Clouds
Relative Humidity: AM 91%
PM 91%

DATE: 5/18/78

O.V.A. Calibration:

Propane C_3 ______ % Chart ______ Chemical ______ % Chart ______

5000 ppm ______ AM 90 PM 89 ppm ______ AM 82 PM 82

5000 ppm Diluted AM 36 PM ______ ppm Diluted AM ______ PM ______

Time	Meter ACF		Temperature °F					Pressure		O.V.A. Reading		
	Singer	Roots	Meter	Liquid	Vapor	Ambient	Dilution	Tank H_2O Inches	Baro. Hg Inches	% Chart	Rate Air	Rate Sample
0730		546	78	77	76	75	142	0.0		79	75	75
0800		189	80	78	77	76	145	+0.2		78	75	75
0830		9999913	82	78	78	77	148	+0.2	30.10	77	75	75
0900		9999604	84	79	78	78	153	+0.2		77	75	75
0930		9999412	86	79	80	79	149	+0.2		78	75	75
1000		9999117	88	79	83	82	149	+0.2		78	75	75
1030			91	79	85	84	150	+0.2		78	75	75
1100		9998246	92	79	86	84	152	+0.2		78	75	75
1130			94	79	87	85	155	+0.2		79	75	75
1200		9997483	95	79	87	87	154	+0.2		79	75	75
1230		9997327	96	79	87	87	154	+0.2		78	75	75
1300		9997299	95	79	88	86	153	+0.2		77	75	75
1330		9992292	94	79	87	86	154	+0.1		76	75	75

APPENDIX C

DATA REDUCTION
WORK SHEETS

WORKSHEET

CHEMICAL Isopropanol (Anhydrous)

LOCATION Union Carbide

O.V.A. # 1400

DATE 4/13/78

FIELD RESPONSE FACTOR 1.07

DILUTION FACTOR 7.81

M.W. = 60.10 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0600			30.28		←		a)		→
0630	-54	520	30.28	-55			a)		
0700	-35	520	30.28	-36			a)		
0730	102	521	30.28	105			a)		
0800	140	522	30.28	143			a)		
0830	200	525	30.28	204			a)		
0900	490	527	30.29	497			a)		
0930	412	527	30.29	418			a)		
1000	276	531	30.30	278	84	3100	3300	26000	4.0×10^{-3}
1030	187	536	30.30	186	84	3100	3300	26000	4.0×10^{-3}
1100	370	539	30.31	370					
1130	450	541	30.31	445					
1200	228	542	30.31	225					
1230	263	546	30.31	258	83	2900	3100	24000	3.7×10^{-3}
1300	201	547	30.31	196	82	2700	2900	23000	3.6×10^{-3}
1330	364	545	30.31	357	83	2900	3100	24000	3.7×10^{-3}
1400	112	548	30.31	109					
1430	34	548	30.31	33	84	3100	3300	26000	4.0×10^{-3}
1500	-92	548	30.31	-90	84	3100	3300	26000	4.0×10^{-3}
1530	0	550	30.31	0	85	3400	3600	28000	4.4×10^{-3}
1600	-2	544	30.31	-2					
1630	0	542	30.31	0					
TOTAL	3829			3824				25000	15 lbs/day

a) Data lost due to condensate formation.

WORKSHEET

CHEMICAL Isopropanol (Anhydrous)

LOCATION Union Carbide

O.V.A. # 1400

DATE 4/14/78

FIELD RESPONSE FACTOR 1.07

DILUTION FACTOR 7.81

M.W. = 60.10 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0630	0	524	30.33	0	83	2900	3100	24000	3.7×10^{-3}
0700	0	523	30.33	0	83	2900	3100	24000	3.7×10^{-3}
0730	688	525	30.33	701	84	3100	3300	26000	4.0×10^{-3}
0800	494	531	30.33	498	84	3100	3300	26000	4.0×10^{-3}
0830	639	533	30.33	642	84	3100	3300	26000	4.0×10^{-3}
0900	499	536	30.33	498	83	2900	3100	24000	3.7×10^{-3}
0930	410	539	30.33	407	85	3400	3600	28000	4.4×10^{-3}
1000	403	542	30.33	398	85	3400	3600	28000	4.4×10^{-3}
1030	214	539	30.33	212	85	3400	3600	28000	4.4×10^{-3}
1100	191	553	30.33	185	85	3400	3600	28000	4.4×10^{-3}
1130	200	552	30.33	194	84	3100	3300	26000	4.0×10^{-3}
1200	172	557	30.33	165	84	3100	3300	26000	4.0×10^{-3}
1230	199	557	30.33	191	85	3400	3600	28000	4.4×10^{-3}
1300	91	557	30.33	87	84	3100	3300	26000	4.0×10^{-3}
1330	46	553	30.33	44	←		a)		→
1400	0	553	30.33	0					
1430	0	552	30.33	0	84	3100	3300	26000	4.0×10^{-3}
1500	9	552	30.33	9	84	3100	3300	26000	4.0×10^{-3}
1530	18	551	30.33	17	84	3100	3300	26000	4.0×10^{-3}
1600	0	549	30.33	0	84	3100	3300	26000	4.0×10^{-3}
1630	-543	541	30.33	-537					
1700									
TOTAL	4273			4248				26000	17 lbs/day

a) Equipment inoperative because of condensate formation.

WORKSHEET

CHEMICAL Ethanol, 190°

LOCATION Union Carbide

O.V.A. # 1400

DATE 4/18/78

FIELD RESPONSE FACTOR 1.26

DILUTION FACTOR 8.06

M.W.= 46.02 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0630	0	528	30.09	0					
0700	0	529	30.10	0	85	3400	4300	35000	4.2×10^{-3}
0730	0	529	30.11	0	86	3600	4500	36000	4.3×10^{-3}
0800	13	530	30.11	13	87	4000	5000	40000	4.8×10^{-3}
0830	228	531	30.10	228	87	4000	5000	40000	4.8×10^{-3}
0900	145	532	30.10	145	82	2700	3400	27000	3.2×10^{-3}
0930	308	534	30.13	307	87	4000	5000	40000	4.8×10^{-3}
1000	300	538	30.13	296	89	4600	5800	47000	5.6×10^{-3}
1030	124	538	30.13	122	84	3200	4000	32000	3.8×10^{-3}
1100	90	541	30.12	88	86	3600	4500	36000	4.3×10^{-3}
1130	117	544	30.12	114	88	4300	5400	44000	5.2×10^{-3}
1200	0	547	30.10	0	←		a)	→	
1230	0	546	30.10	0			a)		
1300	0	545	30.06	0			a)		
1330	0	545	30.05	0			a)		
1400	0	545	30.05	0			a)		
1430	0	545	30.05	0			a)		
1500	0	543	30.05	0			a)		
1530	0	541	30.05	0			a)		
1600	0	540	30.00	0			a)		
1630	-16	538	30.00	-16			a)		
1700	-44	538	30.00	-43			a)		
TOTAL	1325			1313				38000	6.0 lbs/day

a) Data lost because of condensate formation

WORKSHEET

CHEMICAL Ethanol, 190°

LOCATION Union Carbide

O.V.A. # 1400

DATE 4/19/78

FIELD RESPONSE FACTOR 1.26

DILUTION FACTOR 8.06

M.W. 46.02 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0630	0	524	30.16	0					
0700	0	524	30.16	0					
0730	0	525	30.16	0					
0800	108	531	30.16	108	82	2700	3400	27000	3.2×10^{-3}
0830	250	532	30.19	250	83	2900	3600	29000	3.5×10^{-3}
0900	25	534	30.20	26	86	3600	4500	36000	4.3×10^{-3}
0930	0	534	30.20	0	85	3400	4300	35000	4.2×10^{-3}
1000	0	535	30.21	0	84	3200	4000	32000	3.8×10^{-3}
1030	3	536	30.22	3	85	3400	4300	35000	4.2×10^{-3}
1100	2	539	30.22	2	86	3600	4500	36000	4.3×10^{-3}
1130	88	548	30.22	86	86	3600	4500	36000	4.3×10^{-3}
1200	65	549	30.22	63	87	4000	5000	40000	4.8×10^{-3}
1230	77	551	30.20	74	87	4000	5000	40000	4.8×10^{-3}
1300	52	552	30.20	50	87	4000	5000	40000	4.8×10^{-3}
1330	61	550	30.20	59	86	3600	4500	36000	4.3×10^{-3}
1400	30	544	30.19	29	89	4600	5800	47000	5.6×10^{-3}
1430	37	543	30.16	36	←		a)		→
1500	2	542	30.16	2			a)		
1530	0	543	30.16	0			a)		
1600	2	541	30.16	2			a)		
1630	-71	544	30.15	-69			a)		
1700	-43	541	30.15	-42			a)		
TOTAL	802			790				36000	3.4 lbs/day

a) Data lost because of condensate formation

WORKSHEET

CHEMICAL Ethanol, 190°

LOCATION Union Carbide

O.V.A. # 1400

DATE 4/20/78

FIELD RESPONSE FACTOR 1.26

DILUTION FACTOR 8.06

M.W. 46.02 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0630	0	516	30.21	0					
0700	6	518	30.21	6	78	2000	2500	20000	2.4×10^{-3}
0730	134	523	30.21	136	79	2200	2800	22000	2.6×10^{-3}
0800	111	523	30.21	113	80	2400	3000	24000	2.9×10^{-3}
0830	137	526	30.22	139	81	2500	3200	26000	3.1×10^{-3}
0900	142	531	30.24	143	81	2500	3200	26000	3.1×10^{-3}
0930	117	530	30.25	118	83	2900	3600	29000	3.5×10^{-3}
1000	100	529	30.25	101	83	2900	3600	29000	3.5×10^{-3}
1030	106	532	30.29	106	83	2900	3600	29000	3.5×10^{-3}
1100	27	530	30.30	27	81	2500	3200	26000	3.1×10^{-3}
1130	183	536	30.29	182	85	3400	4300	35000	4.2×10^{-3}
1200	29	526	30.28	29	85	3400	4300	35000	4.2×10^{-3}
1230	4	527	30.26	4	82	2700	3400	27000	3.2×10^{-3}
1300	31	528	30.25	31	75	1600	2000	16000	1.9×10^{-3}
1330	51	541	30.25	50	86	3600	4500	36000	4.3×10^{-3}
1400	27	536	30.25	27	85	3400	4300	35000	4.2×10^{-3}
1430	84	538	30.24	83	85	3400	4300	35000	4.2×10^{-3}
1500	113	546	30.24	110	88	4300	5400	44000	5.2×10^{-3}
1530	30	537	30.24	30	89	4600	5800	47000	5.6×10^{-3}
1600	-125	532	30.24	-125	83	2900	3600	29000	3.5×10^{-3}
TOTAL	1432			1435				33000	5.7 lbs/day

WORKSHEET

CHEMICAL: Acetic Acid, Glacial

LOCATION: Union Carbide

O.V.A. #: 1410

DATE: 4/20/78

FIELD RESPONSE FACTOR: 1.111

DILUTION FACTOR: 3.33

M.W.: 60.05 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0630	0	516	30.21	0					
0700	0	517	30.21	0					
0730	+ 20	520	30.21	20	83	3100	3400	11000	1.7×10^{-3}
0800	+1730	523	30.22	1764	82	2900	3200	11000	1.7×10^{-3}
0830	+1619	525	30.24	1646	82	2900	3200	11000	1.7×10^{-3}
0900	1291	528	30.25	1305	83	3100	3400	11000	1.7×10^{-3}
0930	860	528	30.25	869	88	4300	4800	16000	2.5×10^{-3}
1000	330	529	30.29	333	88	4300	4800	16000	2.5×10^{-3}
1030		529	30.30		88	4300	4800	16000	2.5×10^{-3}
1100		529	30.29		88	4300	4800	16000	2.5×10^{-3}
1130		533	30.28		88	4300	4800	16000	2.5×10^{-3}
1200	1730	535	30.26	1727	88	4300	4800	16000	2.5×10^{-3}
1230	-1407	535	30.25	-1404			a)		
1300	- 2	531	30.25	- 2			a)		
1330	186	531	30.24	187			a)		
1400	4	531	30.24	4			a)		
1430	57	536	30.24	57			a)		
1500	455	539	30.24	450			a)		
1530	715	540	30.24	706	88	4300	4800	16000	2.5×10^{-3}
1600	446	543	30.24	438	88	4300	4806	16000	2.5×10^{-3}
1630	2	536	30.24	2					
TOTAL	9445			9508				16,000	24 lbs/day

a) Data lost because of condensate formation

WORKSHEET

CHEMICAL Acetic Acid (Glacial)

LOCATION Union Carbide

O.V.A. # 1410

DATE 4/21/78

FIELD RESPONSE FACTOR 1.111

DILUTION FACTOR 3.33

M.W. 60.05 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0630	0	510	30.15	0					
0700	0	513	30.15	0					
0730	1998	515	30.15	2064	86	3800	4200	14000	2.2×10^{-3}
0800	1744	525	30.15	17627	87	4100	4600	15000	2.3×10^{-3}
0830	2196	532	30.15	2196	88	4300	4800	16000	2.5×10^{-3}
0900	2393	539	30.15	2362	88	4300	4800	16000	2.5×10^{-3}
0930	2067	544	30.15	2022	88	4300	4800	16000	2.5×10^{-3}
1000	2470	548	30.15	2398	87	4100	4600	15000	2.3×10^{-3}
1030	1646	551	30.15	1589	87	4100	4600	15000	2.3×10^{-3}
1100	1824	552	30.17	1759	87	4100	4600	15000	2.3×10^{-3}
1130	1470	554	30.16	1412	88	4300	4800	16000	2.5×10^{-3}
1200	760	553	30.16	731	87	4100	4600	15000	2.3×10^{-3}
1230	428	552	30.16	413	88	4300	4800	16000	2.5×10^{-3}
1300	0	549	30.16	0	88	4300	4800	16000	2.5×10^{-3}
1330	226	544	30.15	221			a)		
1400	0		30.13	0			a)		
1430	-206	541	30.12	-202			a)		
1500	-364	540	30.12	-358			a)		
1530	-854	537	30.12	-845			a)		
1600									
TOTAL	19222			18934				15,000	45 lbs/day

a) Data lost because of condensate formation

WORKSHEET

CHEMICAL Formaldehyde

LOCATION Bishop, Texas

O.V.A. # 1410

DATE 4/26/78

FIELD RESPONSE FACTOR N.A.

DILUTION FACTOR N.A.

M.W. N.A.

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart a)	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0630									
0700	101	540	30.26	99					
0730	593	582	30.27	544					
0800	646	584	30.27	590					
0830	476	586	30.28	434					
0900	678	587	30.29	617					
0930	736	587	30.29	670					
1000	722	593	30.29	650					
1030	656	595	30.29	589	58				
1100	642	597	30.26	574	52				
1130	755	599	30.25	673					
1200	453	597	30.23	405	53				
1230	708	597	30.23	633					
1300	551	593	30.22	496	54				
1330	463	581	30.21	425	58				
1400	340	587	30.21	309					
1430	15	594	30.21	13	58				
1500	644	597	30.21	575					
1530	650	597	30.21	580	62				
1600	716	597	30.21	639					
1630	501	595	30.21	449	55				
1700	510	593	30.20	458	51				
1730	429	593	30.18	385	58				
1800	429	590	30.18	387	58				
2000			30.22		56				
2030	455	577	30.21	420					
								(cont'd.)	
TOTAL									

a) Gas chromatograph samples were used to calculate emissions.

WORKSHEET

CHEMICAL Formaldehyde

LOCATION Bishop, Texas

O.V.A. # 1410

DATE 4/26/78

FIELD RESPONSE FACTOR N.A.

DILUTION FACTOR N.A.

M.W. N.A.

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart[a)]	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
2100	469	587	30.21	426	53				
2130	458	588	30.21	415	54				
TOTAL									

a) Gas Chromatograph samples were used to calculate emissions.

WORKSHEET

CHEMICAL Formaldehyde

LOCATION Bishop, Texas

O.V.A. # 1410

DATE 4/27/78

FIELD RESPONSE FACTOR N.A.

DILUTION FACTOR N.A.

M.W. N.A.

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart[a)]	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0800		574							
0830	546	587	30.24	496	53				
0900	536	588	30.24	486	57				
0930	557	587	30.24	506	53				
1000	528	584	30.24	482					
1030	649	588	30.24	589	54				
1100	516	592	30.24	465	55				
1130	553	591	30.24	499	52				
1200	575	591	30.24	519					
1230	551	592	30.22	496	53				
1300	539	587	30.22	490					
1330	543	588	30.19	492	54				
1400	491	586	30.17	446	51				
1430	556	589	30.17	503					
1500	510	589	30.15	460	54				
TOTAL									

a) Gas Chromatograph samples were used to calculate emissions.

WORKSHEET

CHEMICAL Formaldehyde

LOCATION Bishop, Texas

O.V.A. # 1410

DATE 4/28/78

FIELD RESPONSE FACTOR N.A.

DILUTION FACTOR N.A.

M.W. N.A.

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart[a)]	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0830		579	30.11						
0900	474	582	30.11	433	53				
0930	575	586	30.12	522	55				
1000	570	587	30.12	516	54				
1030	536	587	30.08	485					
1100	505	586	30.08	457	56				
1130	522	588	30.08	471	54				
1200	545	588	30.08	492					
1230	497	585	30.06	451	56				
1300	450	584	30.06	409					
1330	435	588	30.04	392	56				
1400	420	588	30.04	379					
TOTAL									

a) Gas chromatograph samples were used to calculate emissions.

WORKSHEET

CHEMICAL Ethyl Benzene

LOCATION Cosmar

O.V.A. # 1410

DATE 5/9/78

FIELD RESPONSE FACTOR 0.625

DILUTION FACTOR 6.17

M.W. 106.11 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0700	0	532	30.19	0					
0730	41	532	30.19	41	78	2000	1250	7700	2.2×10^{-3}
0800	48	533	30.19	48	78	2000	1250	7700	2.2×10^{-3}
0830	26	533	30.19	26	84	3200	2000	12000	3.3×10^{-3}
0900	22	534	30.19	22	83	2900	1800	11000	3.0×10^{-3}
0930	216	538	30.19	214	83	2900	1800	11000	3.0×10^{-3}
1000	174	540	30.19	172	87	4000	2500	15000	4.1×10^{-3}
1030	17	542	30.19	17	89	4600	2900	18000	5.0×10^{-3}
1100	239	544	30.19	234	87	4000	2500	15000	4.1×10^{-3}
1130	457	547	30.19	445	89	4600	2900	18000	5.0×10^{-3}
1200	298	550	30.19	289	90	5000	3100	19000	5.2×10^{-3}
1230	232	552	30.19	224	91	5200	3200	20000	5.5×10^{-3}
1300	280	554	30.19	269	92	5400	3400	21000	5.8×10^{-3}
1330	233	555	30.19	224	92	5400	3400	21000	5.8×10^{-3}
1400	104	555	30.19	100	93	5600	3500	22000	6.0×10^{-3}
1430	130	456	30.19	124	93	5600	3500	22000	6.0×10^{-3}
1500	80	556	30.19	77	92	5400	3400	21000	5.3×10^{-3}
1530	0	556	30.19	0					
Total	2597			2526				16000	11 lbs/day

WORKSHEET

CHEMICAL Ethyl Benzene

FIELD RESPONSE FACTOR 0.625

LOCATION Cosmar

DILUTION FACTOR 6.17

O.V.A. # 1410

M.W. 106.16 g/m

DATE 5/10/78

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0700	0	525	30.34	0					
0730	171	525	30.34	174	81	2500	1600	9900	2.7×10^{-3}
0800	193	530	30.34	195	81	2500	1600	9900	2.7×10^{-3}
0830	293	533	30.34	294	82	2700	1700	10000	2.8×10^{-3}
0900	552	536	30.34	551	83	2900	1800	11000	3.0×10^{-3}
0930	61	539	30.34	60	83	2900	1800	11000	3.0×10^{-3}
1000	314	541	30.34	311	84	3200	2000	12000	3.3×10^{-3}
1030	328	543	30.34	323	84	3200	2000	12000	3.3×10^{-3}
1100	300	545	30.34	295	85	3400	2100	13000	3.6×10^{-3}
1130	179	547	30.34	175	86	3600	2200	14000	3.8×10^{-3}
1200	149	550	30.34	145	88	4200	2600	16000	4.4×10^{-3}
1230	406	551	30.34	394	88	4200	2600	16000	4.4×10^{-3}
1300	366	552	30.34	355	89	4800	3000	18000	5.0×10^{-3}
1330	127	554	30.34	123	90	5000	3100	19000	5.2×10^{-3}
1400	202	555	30.34	195	90	5000	3100	19000	5.2×10^{-3}
1430	156	556	30.34	150	90	5000	3100	19000	5.2×10^{-3}
1500	- 1	556	30.34	- 1					
1530	- 76	556	30.34	- 73					
Total	3797			3740				15000	15 lbs/day

WORKSHEET

CHEMICAL Cyclohexane

LOCATION Exxon

O.V.A. # 1410

DATE 5/16/78

FIELD RESPONSE FACTOR 0.835

DILUTION FACTOR 12.5

M.W. 84.16 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0700	0		30.12	0	←		a)	→	
0730	24	539 *	30.12	24			a)		
0800	84	539	30.12	83			a)		
0830	725	539	30.12	715			a)		
0900	466	539	30.12	460			a)		
0930	85	539	30.12	84			a)		
1000	316	539	30.12	312			a)		
1030	293	539	30.12	289			a)		
1100	251	539	30.12	248			a)		
1130	342	539	30.12	337			a)		
1200	267	539	30.12	263	83	3100	2600	32000	7.0×10^{-3}
1230	101	551	30.12	97	82	2900	2400	30000	6.5×10^{-3}
1300	40	552	30.12	38	83	3100	2600	32000	7.0×10^{-3}
1330	13	551	30.12	12	82	2900	2400	30000	6.5×10^{-3}
1400	3	551	30.12	3					
1430									
		* average temp. 5/17/78							
TOTAL	3010			2965				31000	20 lbs/day

a) Data lost because of condensate formation.

WORKSHEET

CHEMICAL Cyclohexane

LOCATION Exxon

O.V.A. # 1410

DATE 5/17/78

FIELD RESPONSE FACTOR 0.835

DILUTION FACTOR 12.5

M.W. 84.16 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0700	0	536	30.10	0	←		a)		→
0730	189	536	30.10	187	79	2300	1900	24000	5.2×10^{-3}
0800	257	539	30.10	253	79	2300	1900	24000	5.2×10^{-3}
0830	403	541	30.10	396	80	2500	2100	26000	5.7×10^{-3}
0900	297	543	30.10	290	80	2500	2100	26000	5.7×10^{-3}
0930	280	545	30.10	273	80	2500	2100	26000	5.7×10^{-3}
1000	280	545	30.10	273	79	2300	1900	24000	5.2×10^{-3}
1030	101	544	30.10	99			a)		
1100	101	545	30.10	98			a)		
1130	110	544	30.10	107	79	2300	1900	24000	5.2×10^{-3}
1200	365	545	30.10	356	79	2300	1900	24000	5.2×10^{-3}
1230	315	546	30.10	306	80	2500	2100	26000	5.7×10^{-3}
1300	263	547	30.10	255	80	2500	2100	26000	5.7×10^{-3}
1330	57	549	30.10	55	80	2500	2100	26000	5.7×10^{-3}
1400	121	550	30.10	117	81	2700	2200	28000	6.1×10^{-3}
1430	24	550	30.10	23	79	2300	1900	24000	5.2×10^{-3}
1500	6	550	30.10	6			a)		
TOTAL	3169			3094				25000	17 lbs/day

a) Data lost because of condensate formation.

WORKSHEET

CHEMICAL Cyclohexane

LOCATION Exxon

O.V.A. # 1410

DATE 5/18/78

FIELD RESPONSE FACTOR 0.835

DILUTION FACTOR 12.5

M.W. 84.16 g/m

Time	Δ ACF	Meter Temp °R	Baro. Hg Inches	Δ SCF	% Chart	ppm as C_3	Diluted ppm	Undiluted ppm	Lbs/Ft^3
0730	0	538	30.10	0	79	2300	1900	24000	5.2×10^{-3}
0800	357	540	30.10	351	78	2200	1800	22000	4.8×10^{-3}
0830	103	542	30.10	101	77	2000	1700	21000	4.6×10^{-3}
0900	309	544	30.10	302	77	2000	1700	21000	4.6×10^{-3}
0930	192	546	30.10	187	78	2200	1800	22000	4.8×10^{-3}
1000	295	548	30.10	286	78	2200	1800	22000	4.8×10^{-3}
1030	435	551	30.10	419	78	2200	1800	22000	4.8×10^{-3}
1100	436	552	30.10	420	78	2200	1800	22000	4.8×10^{-3}
1130	281	554	30.10	365	79	2300	1900	24000	5.2×10^{-3}
1200	382	555	30.10	366	79	2300	1900	24000	5.2×10^{-3}
1230	156	556	30.10	149	78	2200	1800	22000	4.8×10^{-3}
1300	28	555	30.10	27	77	2000	1700	21000	4.6×10^{-3}
1330	7	554	30.10	7	76	1900	1600	20000	4.4×10^{-3}
1400									
TOTAL	3081			2980				21000	14 lbs/day

PLANT NAME Union Carbide

CHEMICAL Isopropanol

COLOR White

LIQUID HEIGHT 15.5'

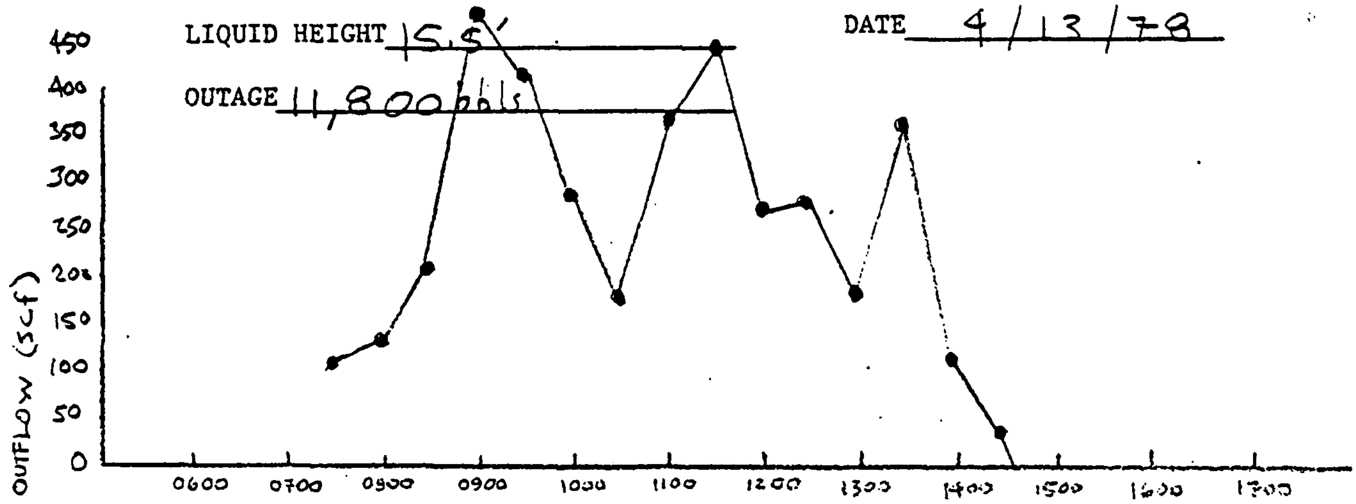
OUTAGE 11,800 bbls

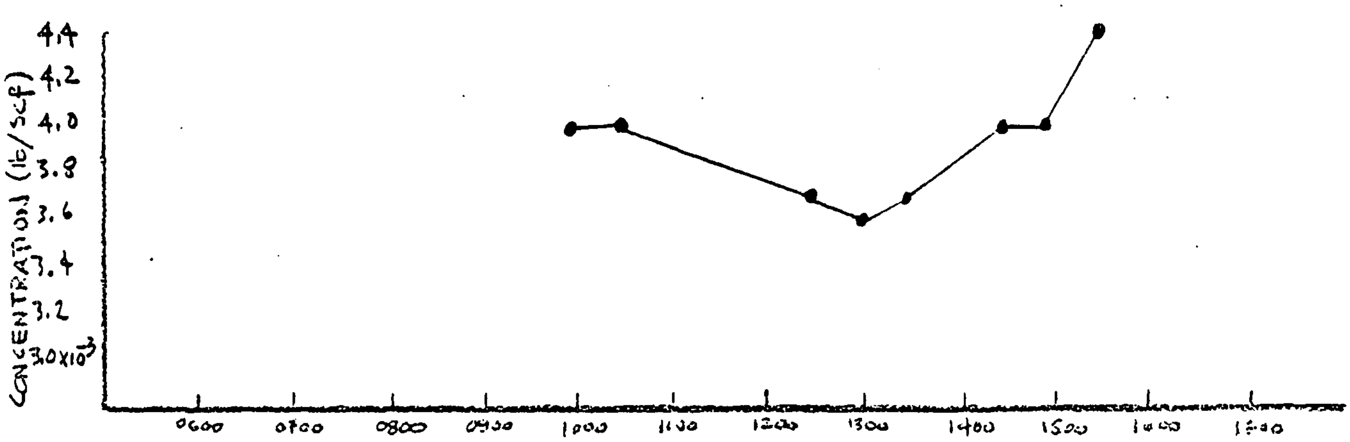
TVP 0.683 psia

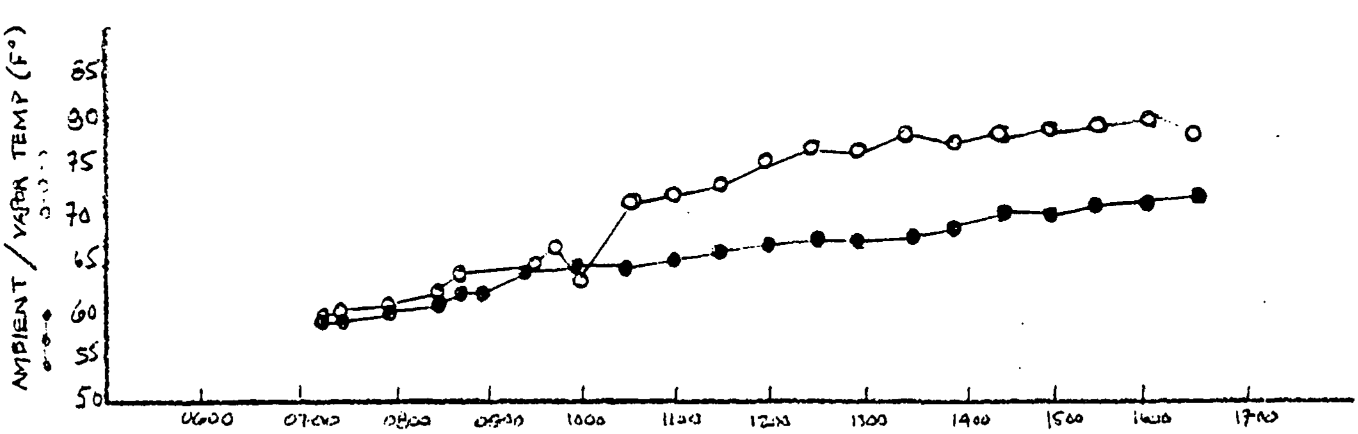
TANK HT. 41 ft.

CAPACITY 19,000 bbls.

DATE 4/13/78







PLANT NAME Union Carbide

CHEMICAL Isopropanol

COLOR White

LIQUID HEIGHT 15.5'

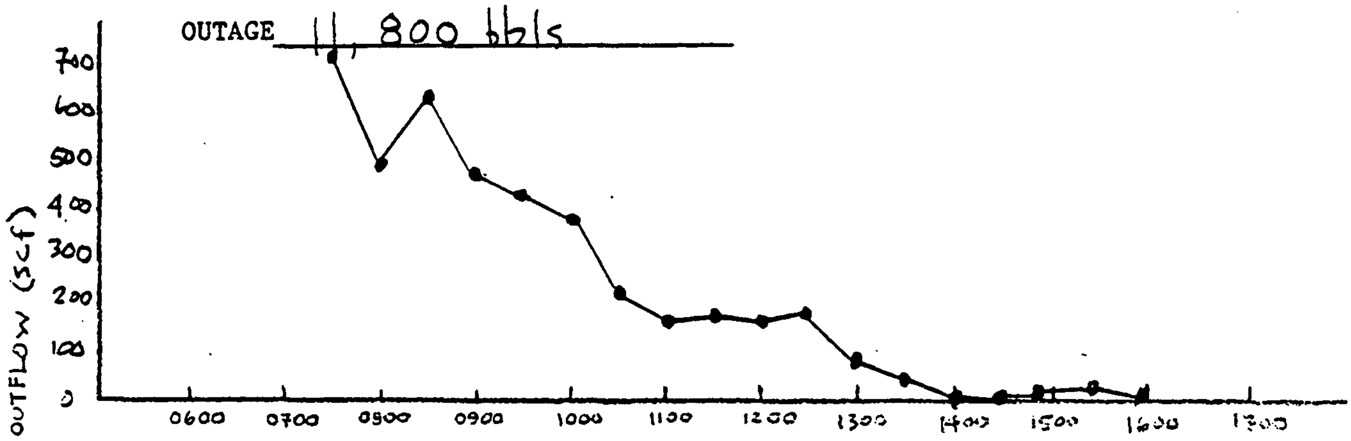
OUTAGE 11,800 bbls

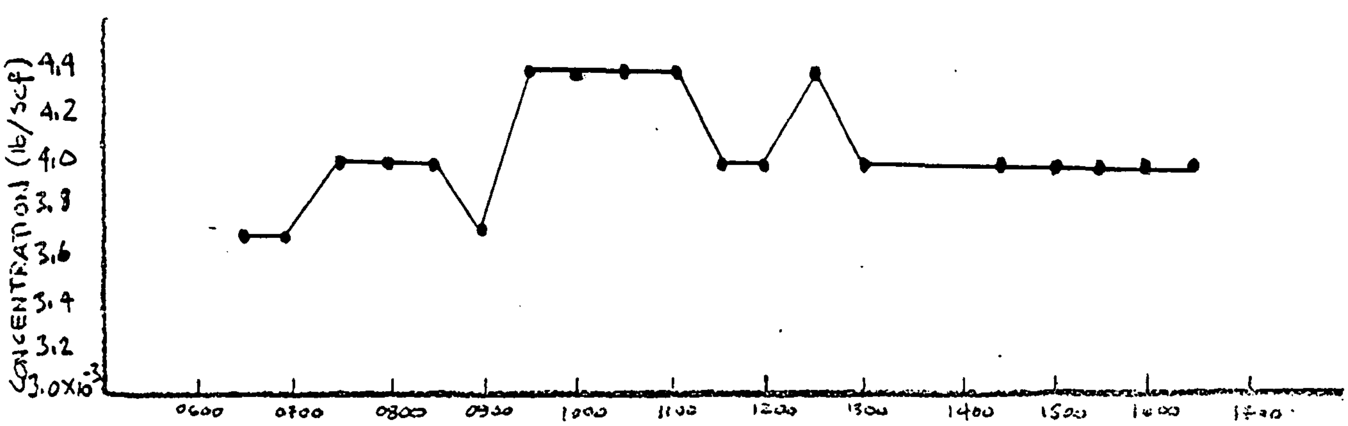
TVP 0.683 psia

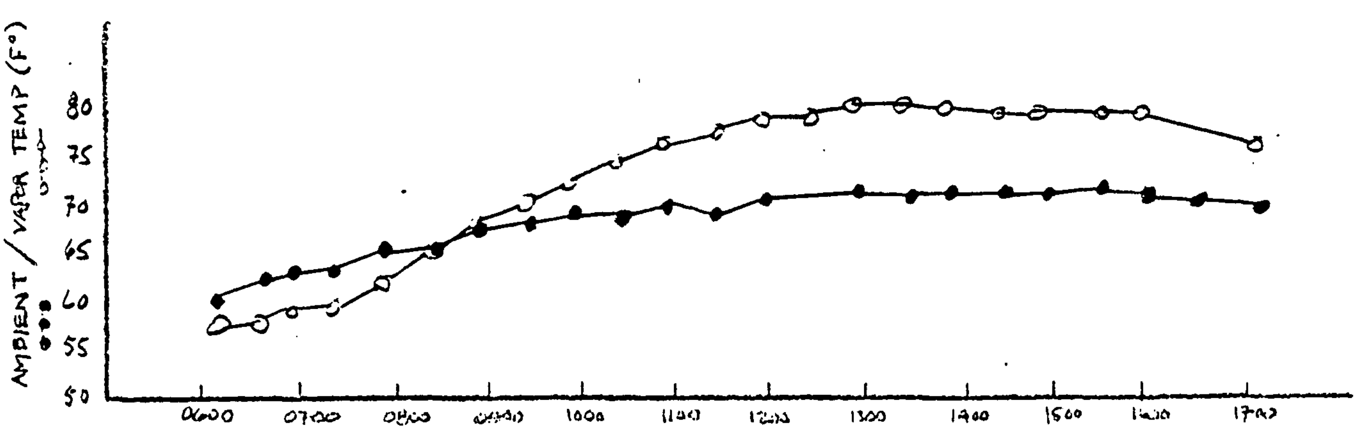
TANK HT. 41 ft.

CAPACITY 18,00 bbls.

DATE 4/14/78







PLANT NAME Union Carbide

CHEMICAL Ethanol

COLOR White

LIQUID HEIGHT 30.7'

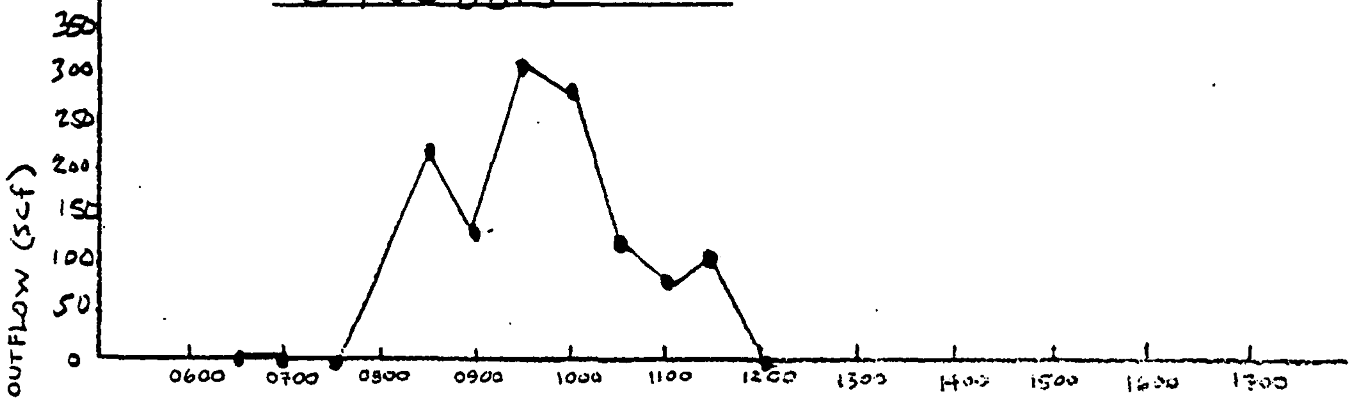
OUTAGE 5700 bbls

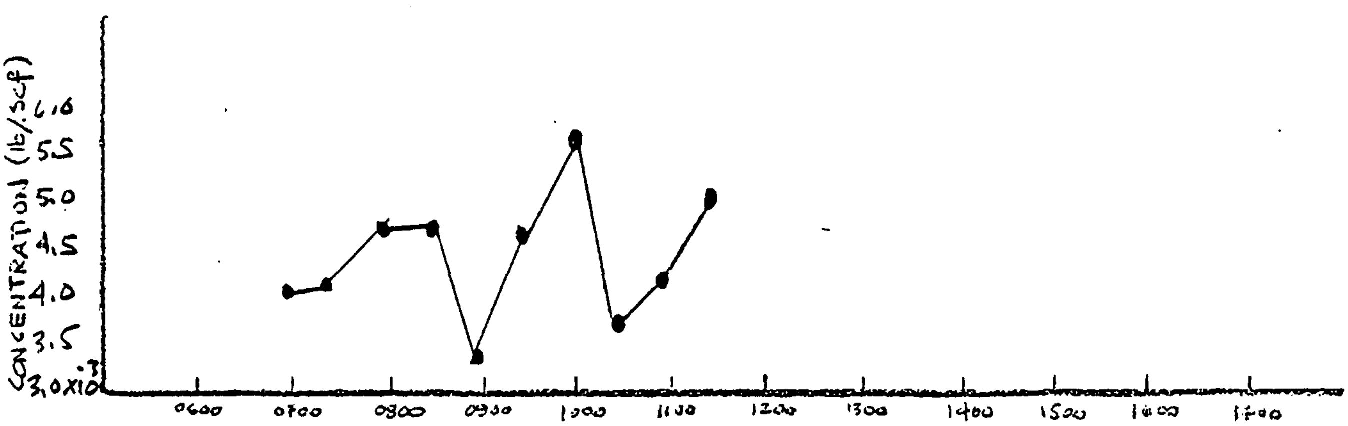
TVP 0.895 psia

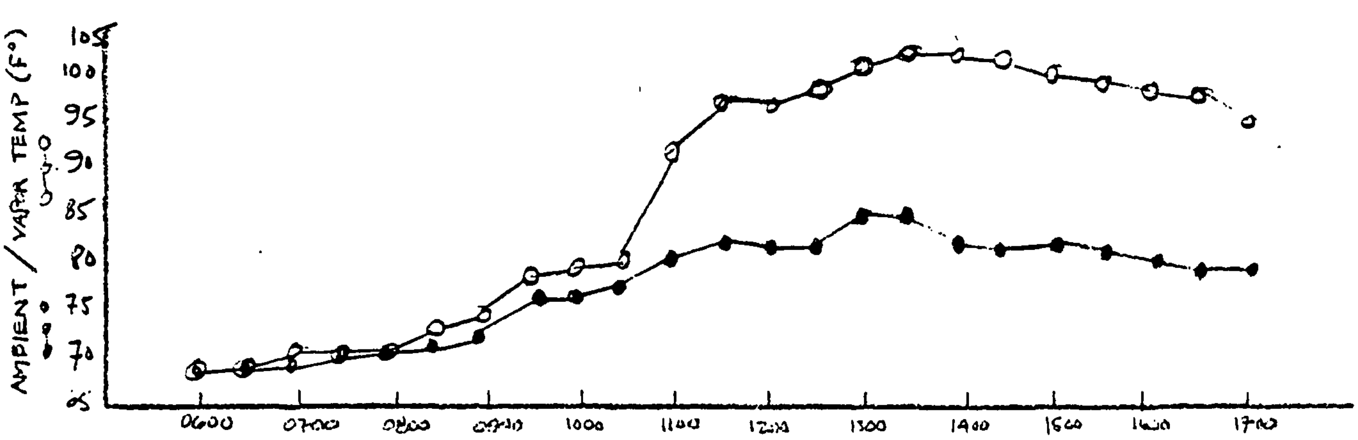
TANK HT. 40 ft.

CAPACITY 24,500 bbls.

DATE 4/18/78







PLANT NAME Union Carbide

CHEMICAL Ethanol

COLOR White

LIQUID HEIGHT 30.7'

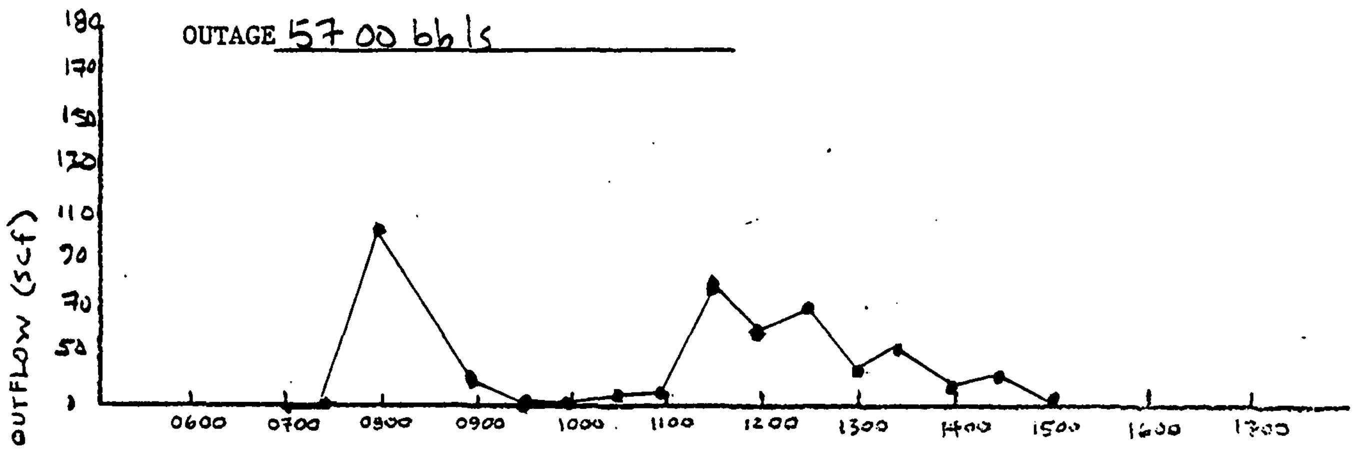
OUTAGE 5700 bbls

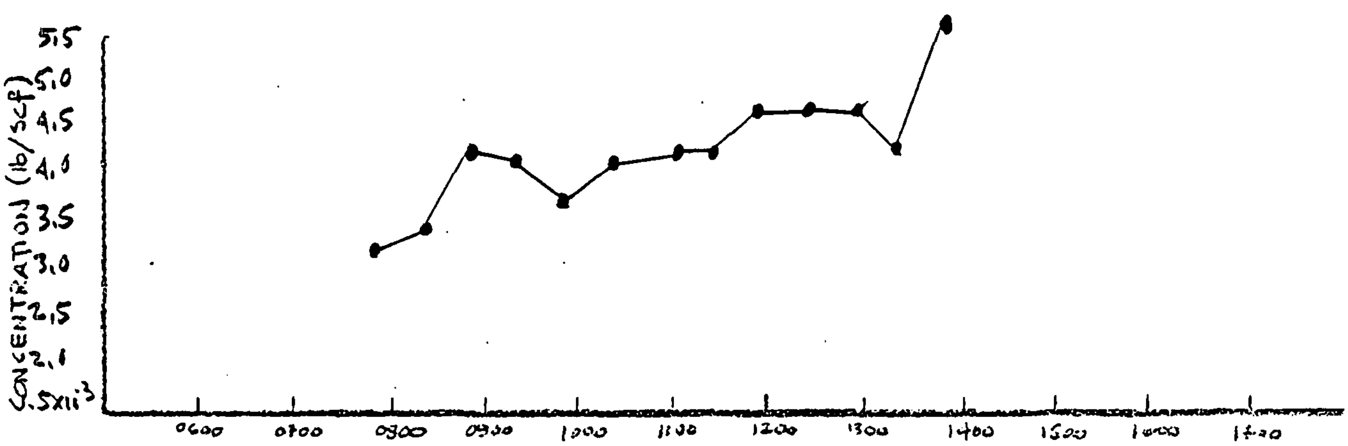
TVP 0.895 psia

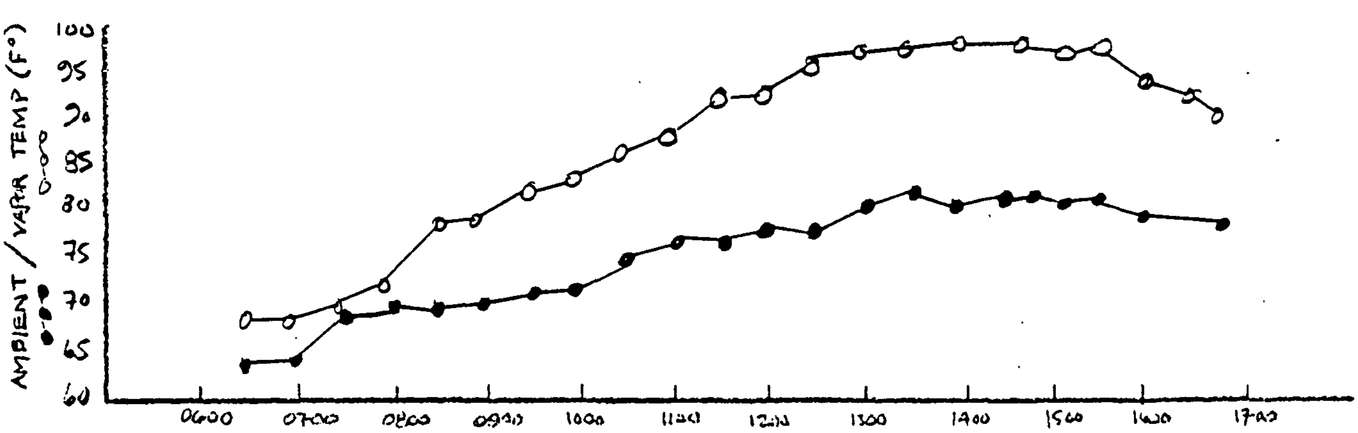
TANK HT. 40 ft.

CAPACITY 24,500 bbls.

DATE 4/19/78







PLANT NAME Union Carbide

CHEMICAL Ethanol

COLOR White

LIQUID HEIGHT 30.7'

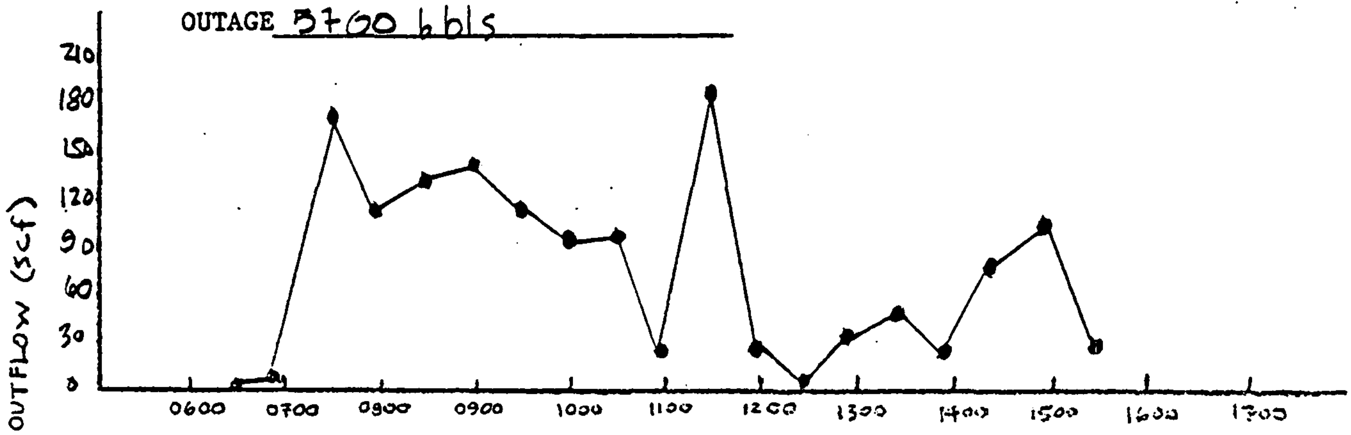
OUTAGE 3700 bbls

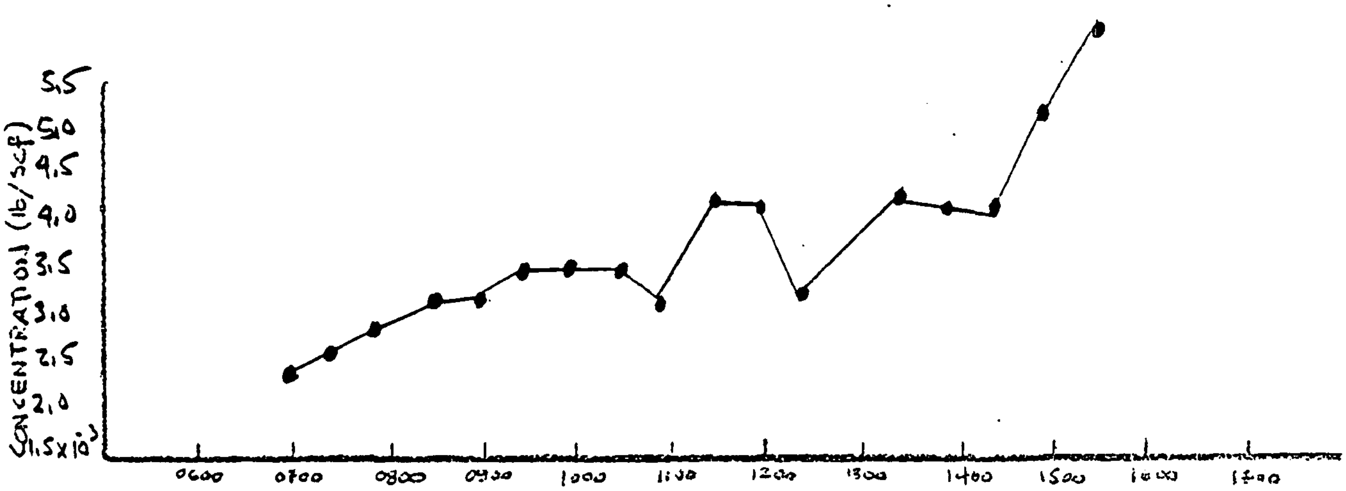
TVP 0.895 psia

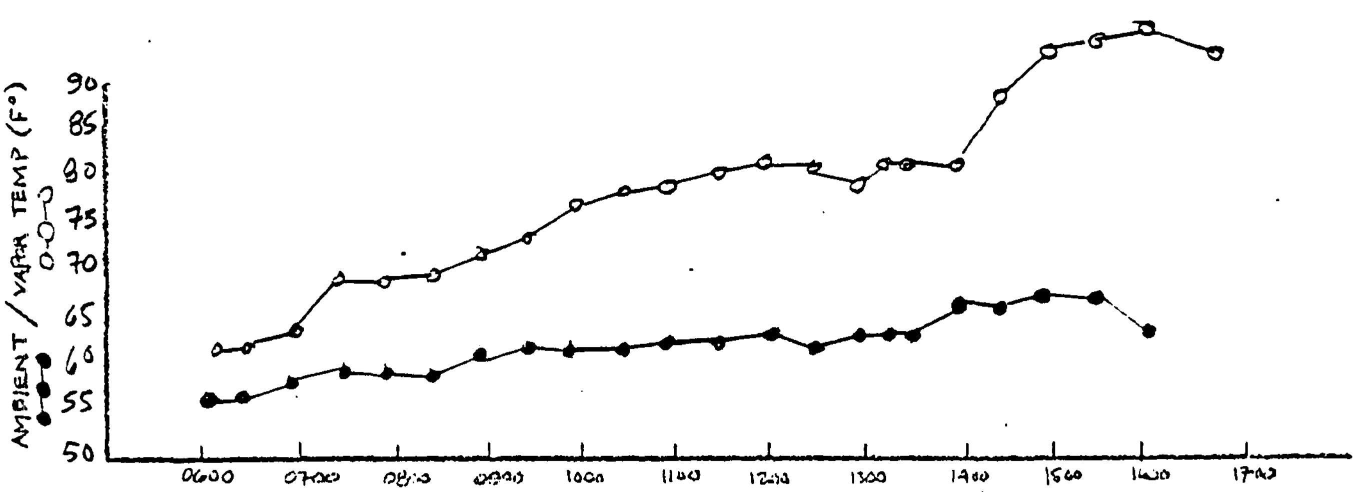
TANK HT. 40 ft.

CAPACITY 24,500 bbls.

DATE 4/20/78







PLANT NAME Union Carbide

CHEMICAL Acetic Acid

COLOR Gray

LIQUID HEIGHT 18'

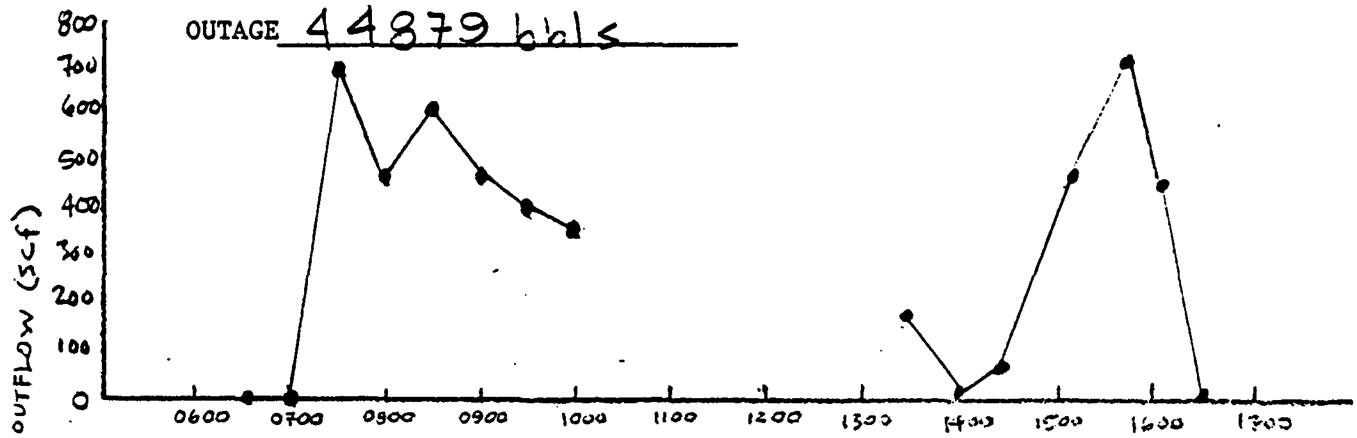
OUTAGE 44879 bbls

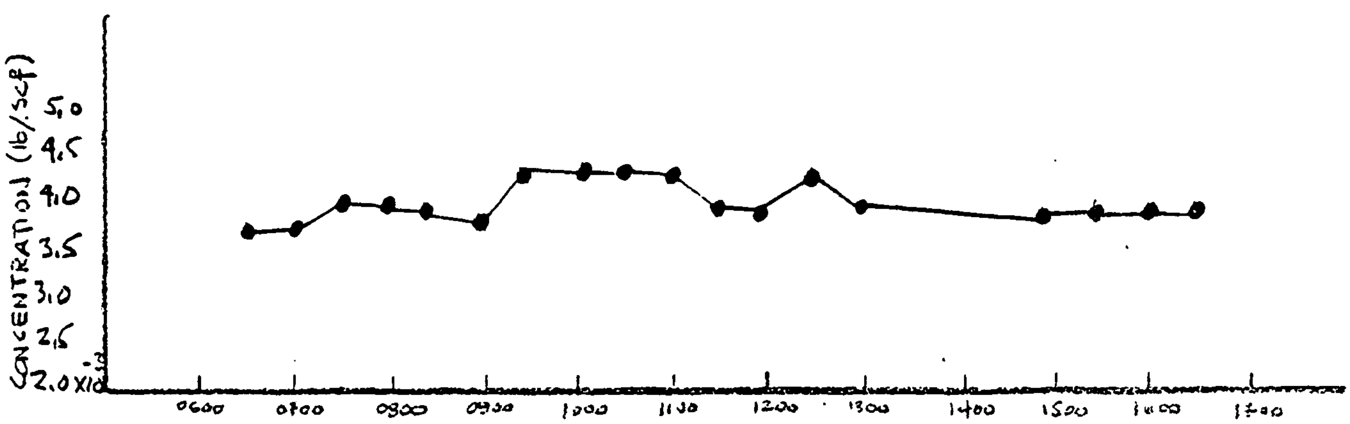
TVP 0.230 psia

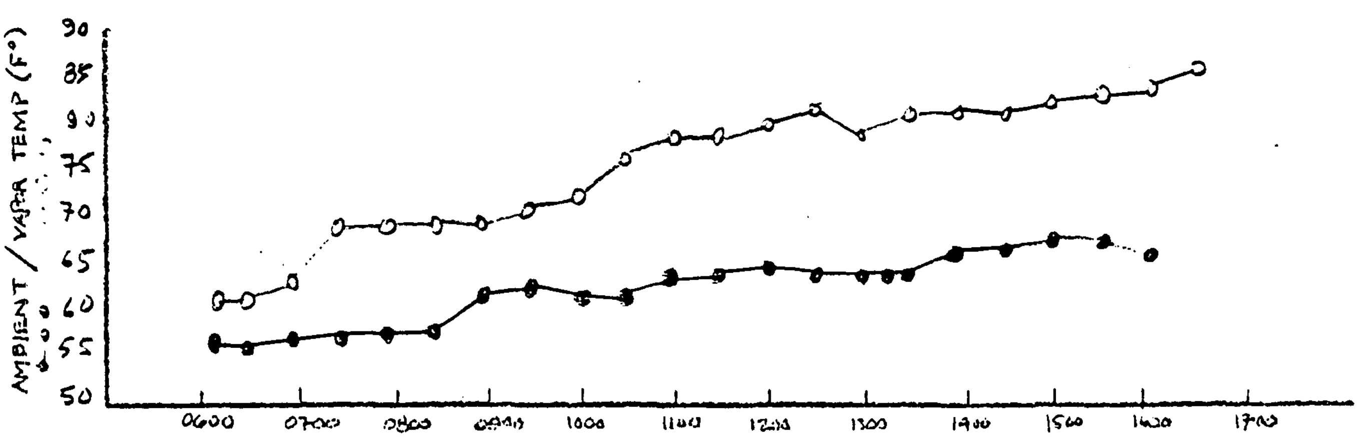
TANK HT. 41 ft.

CAPACITY 80,000 bbls.

DATE 4/20/78







PLANT NAME Union Carbide

CHEMICAL Acetic Acid

COLOR Gray

LIQUID HEIGHT 18'

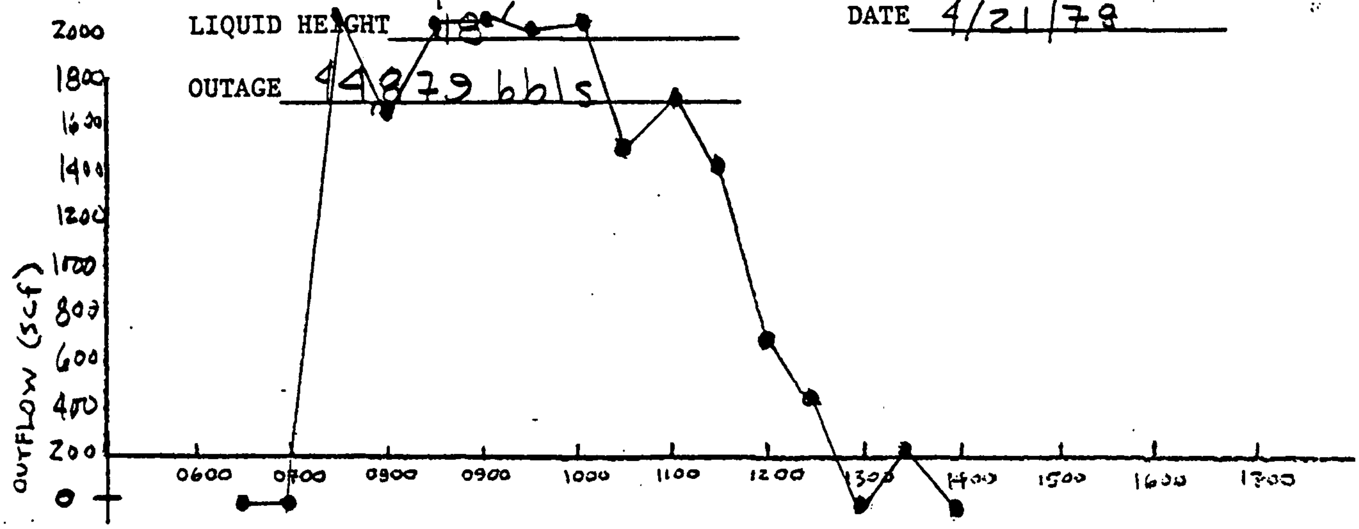
OUTAGE 44879 bbls

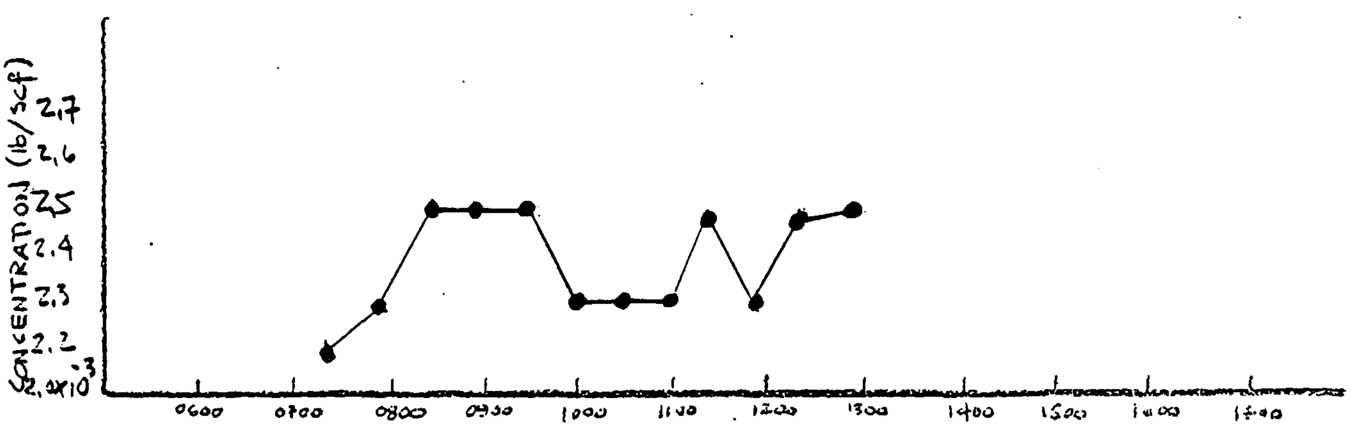
TVP 0.230 psia.

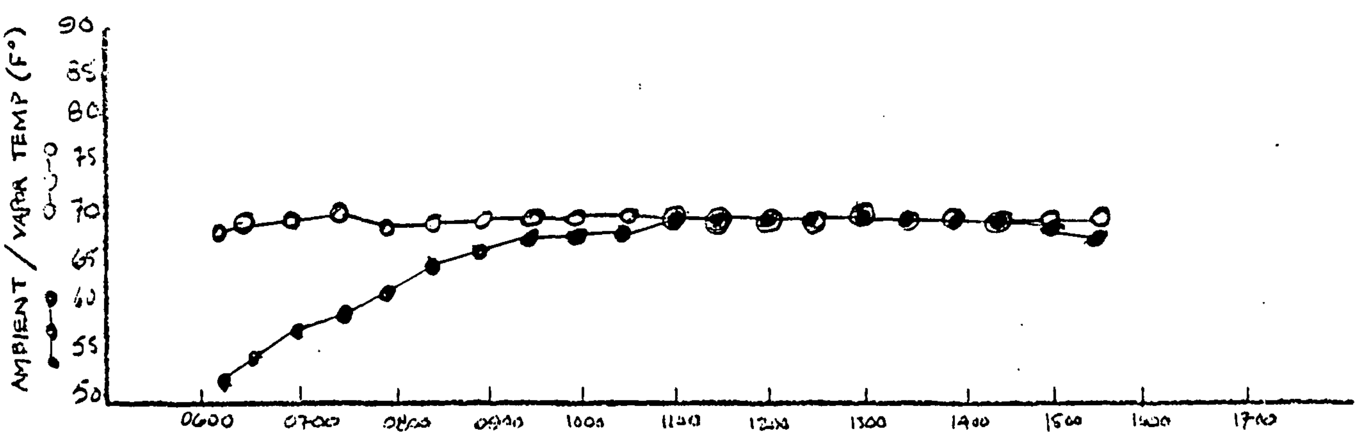
TANK HT. 41 ft.

CAPACITY 80,000 bbls.

DATE 4/21/79







PLANT NAME Celanese

CHEMICAL Formaldehyde

COLOR Gray

LIQUID HEIGHT 15'

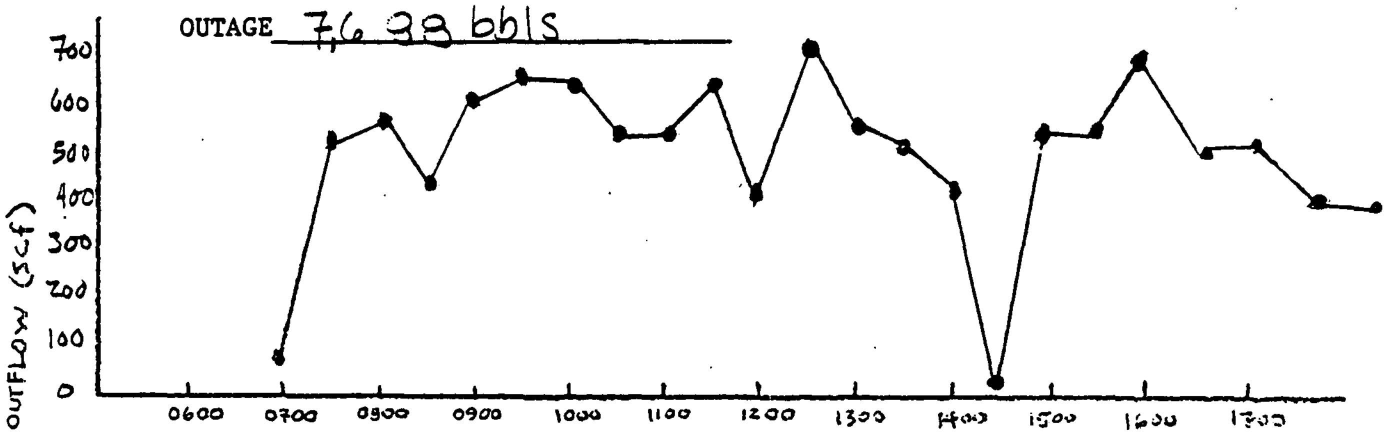
OUTAGE 7,638 bbls

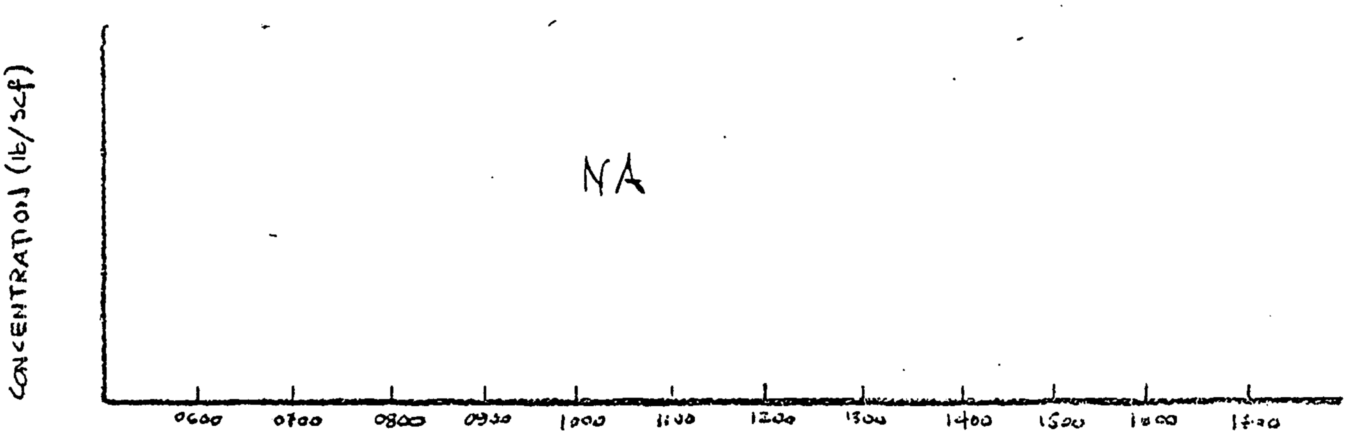
TVP NA psia

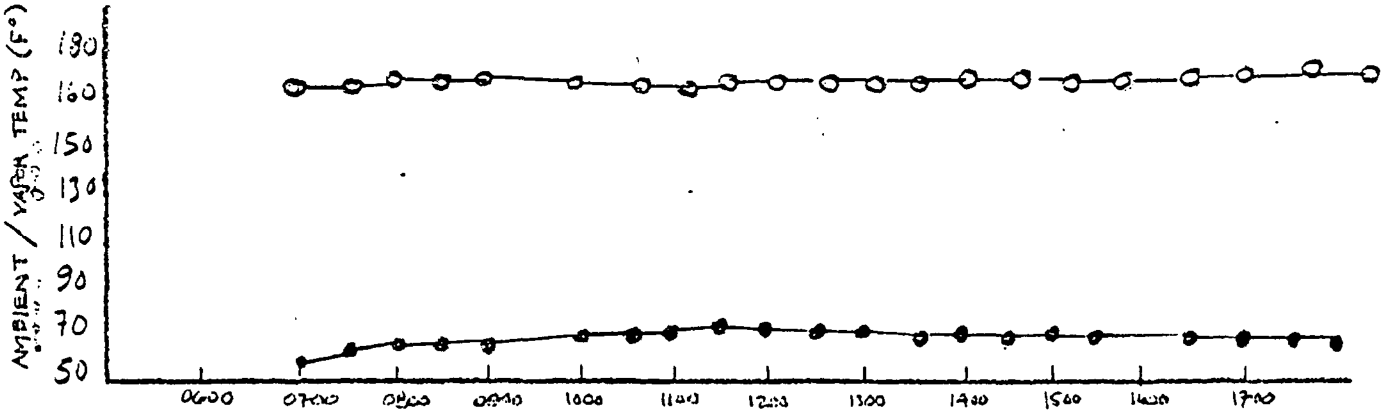
TANK HT. 40 ft.

CAPACITY 12,300 bbls.

DATE 4/26/78







PLANT NAME Celanese

CHEMICAL Formaldehyde

COLOR Gray

LIQUID HEIGHT 15'

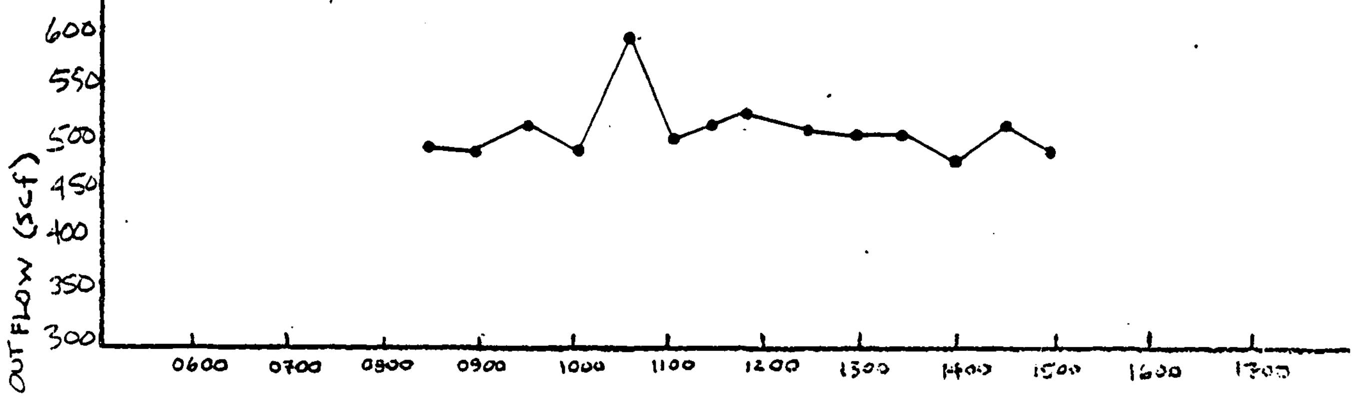
OUTAGE 7,688 bbls

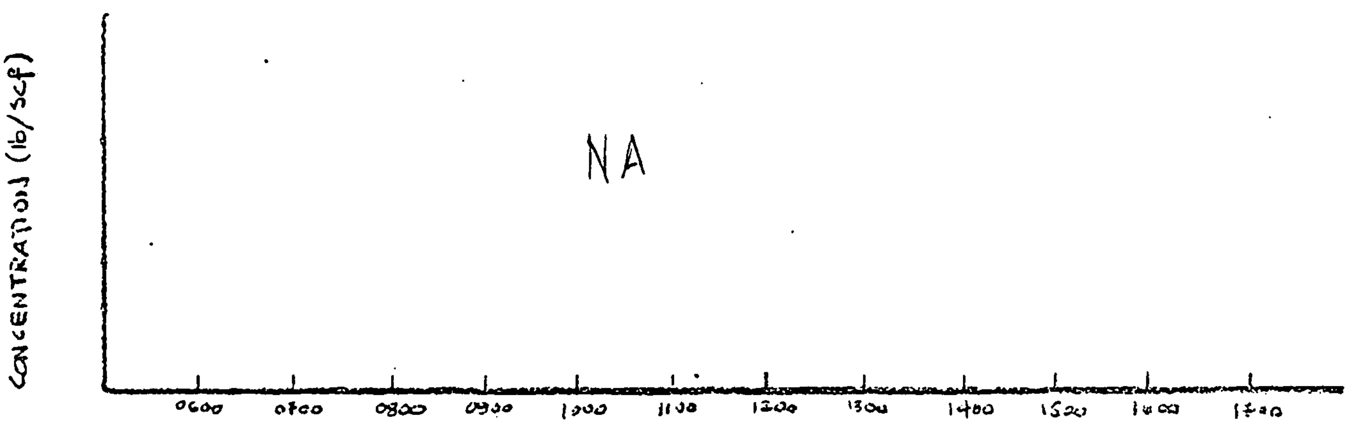
TVP N.A. psia

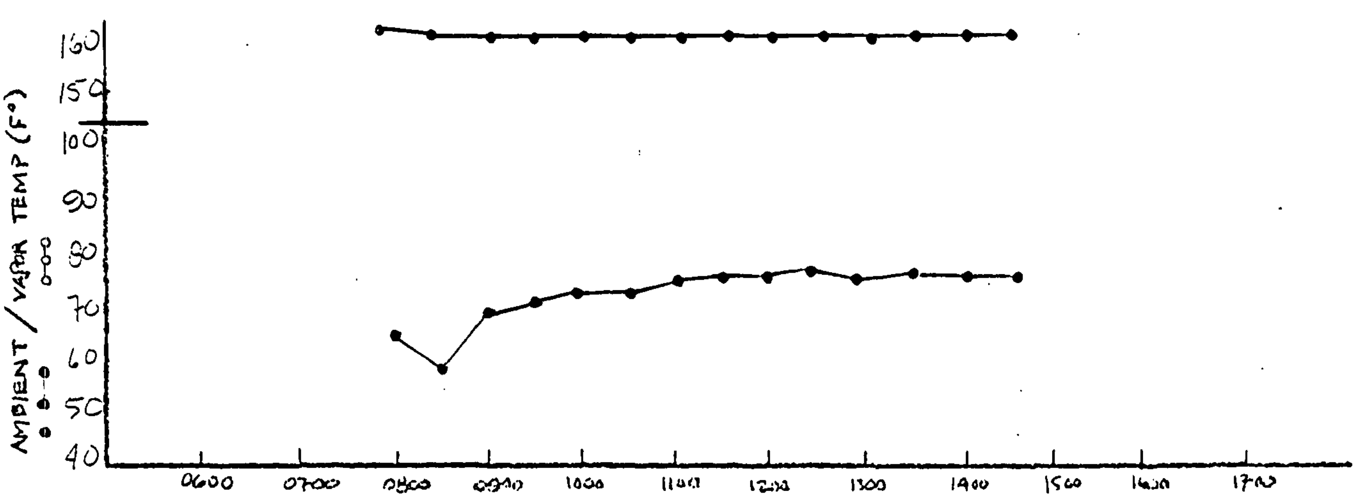
TANK HT. 40 ft.

CAPACITY 12300 bbls.

DATE 4/27/79







PLANT NAME Celanese

CHEMICAL Formaldehyde

COLOR Gray

LIQUID HEIGHT 15'

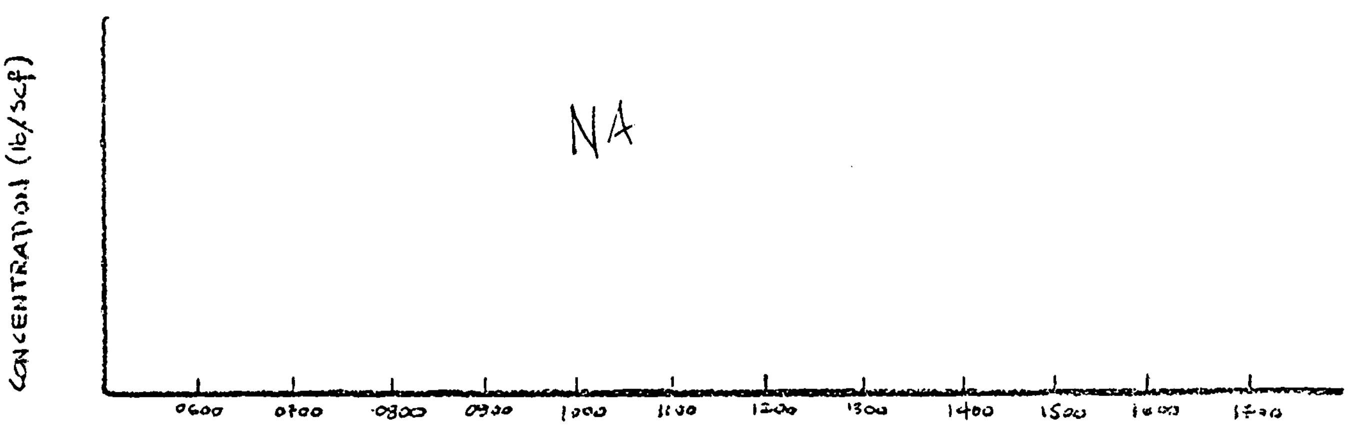
OUTAGE 7,688 bbls

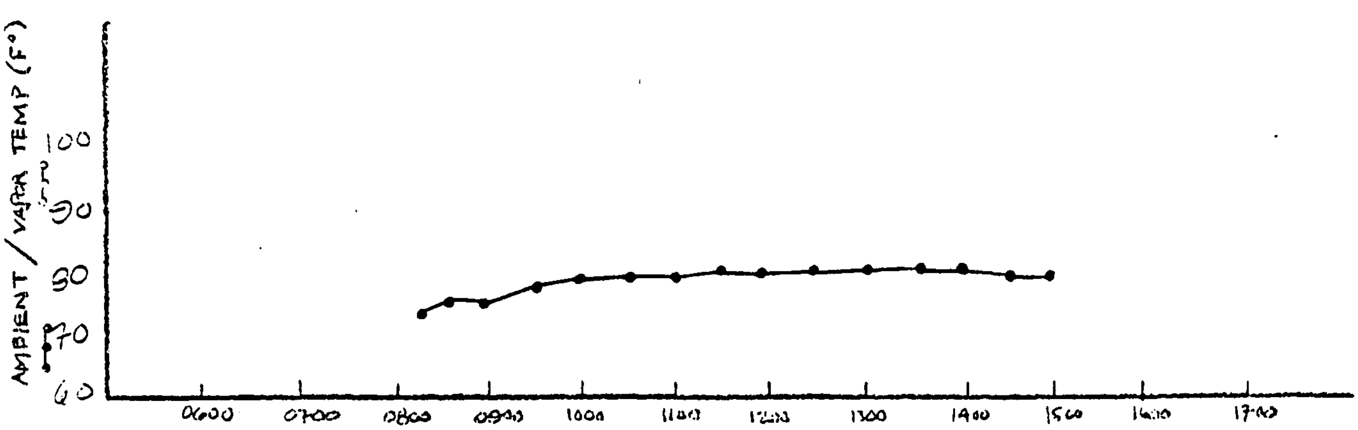
TVP NA psia

TANK HT. 40 ft.

CAPACITY 12,300 bbls.

DATE 4/28/78





PLANT NAME Cosmar

CHEMICAL Ethyl Benzene

COLOR White

LIQUID HEIGHT 15'

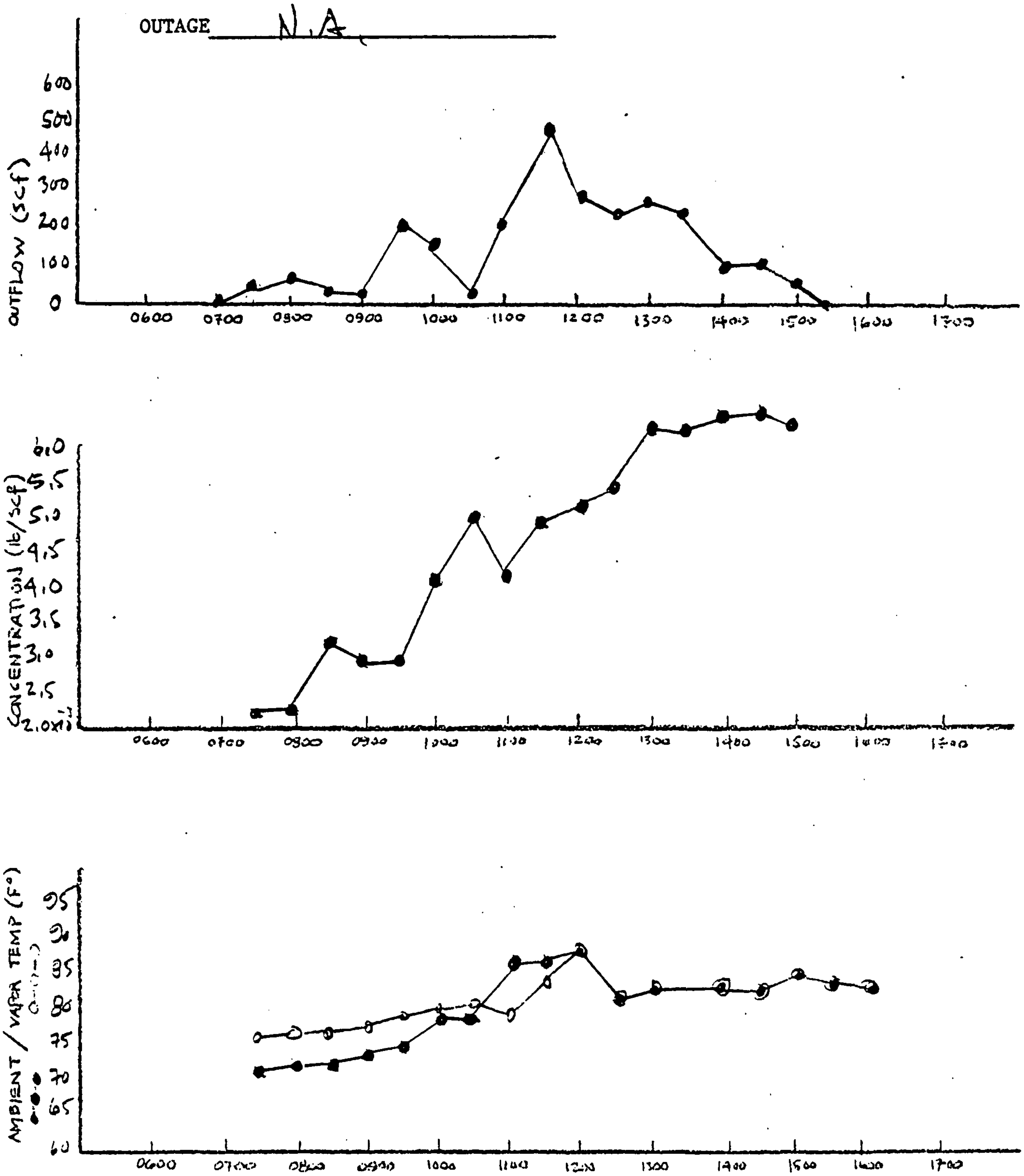
OUTAGE N.A.

TVP .200 psia

TANK HT. N.A. ft.

CAPACITY 20,000 bbls.

DATE 5/9/78



PLANT NAME Cosmar

CHEMICAL Ethyl Benzene

COLOR White

LIQUID HEIGHT 15'

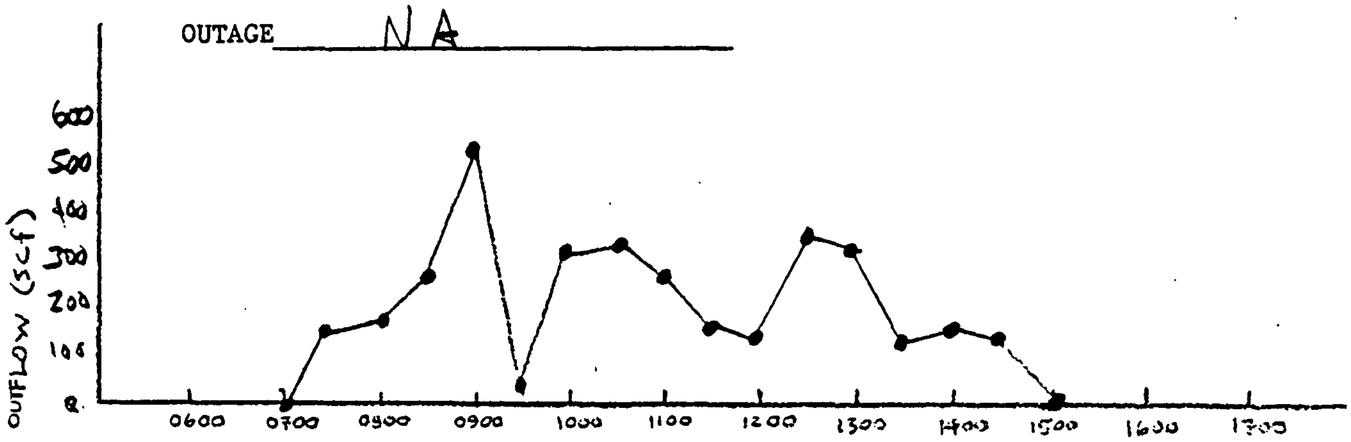
OUTAGE NA

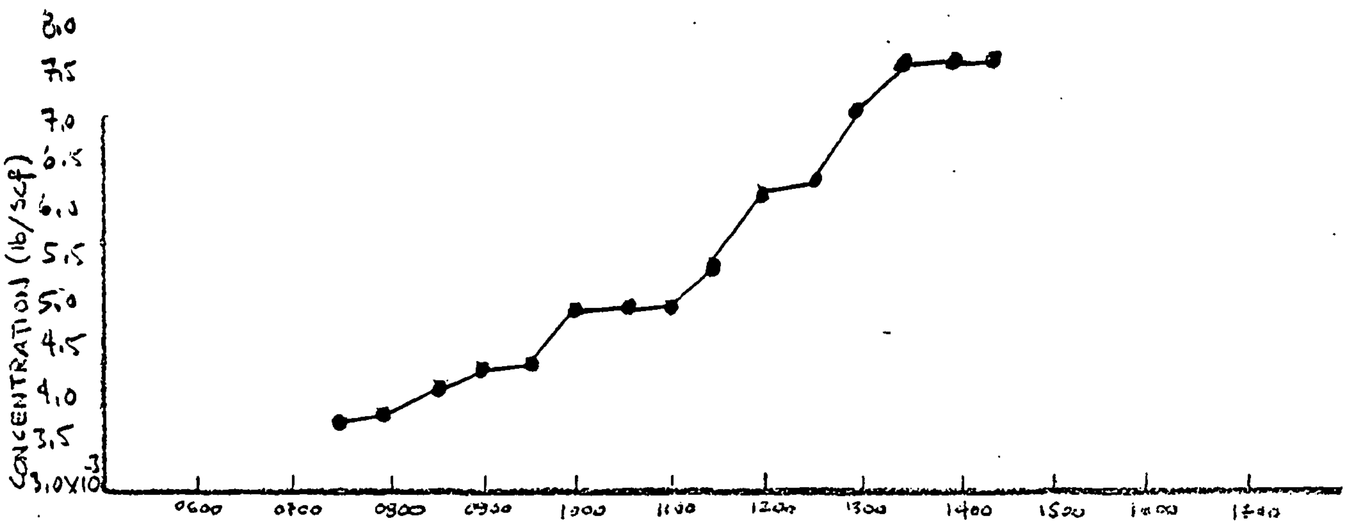
TVP NA psia

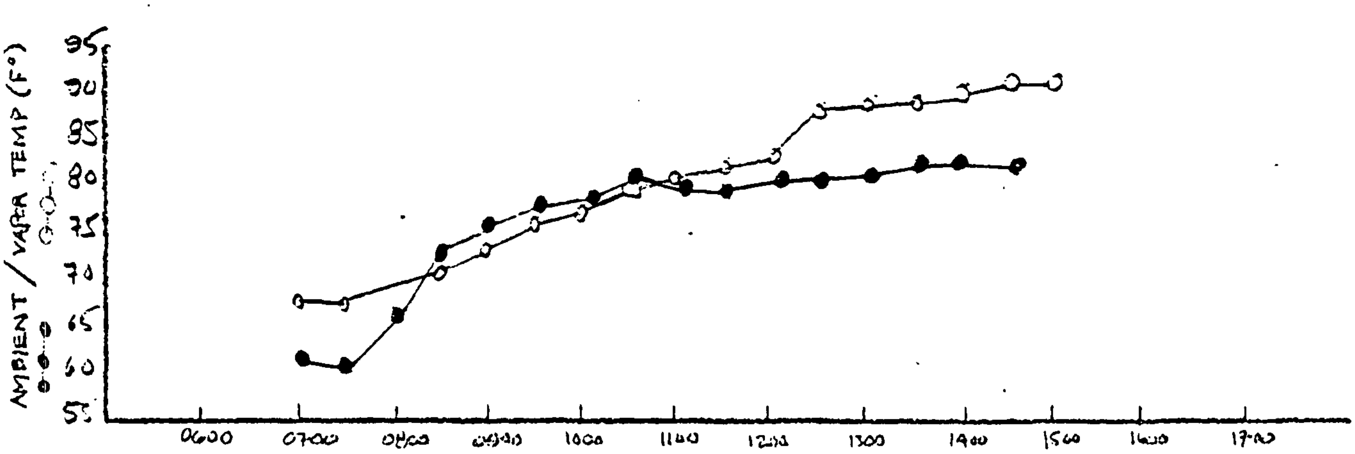
TANK HT. NA ft.

CAPACITY 20,000 bbls.

DATE 5/10/78







PLANT NAME Exxon

CHEMICAL Cyclohexane

COLOR White

LIQUID HEIGHT 24'

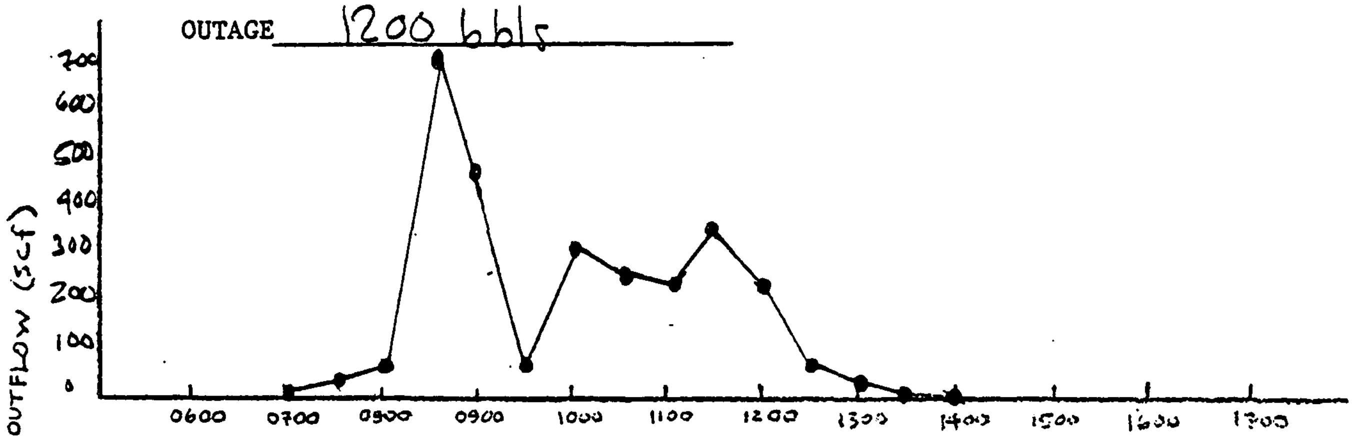
OUTAGE 1200 bbls

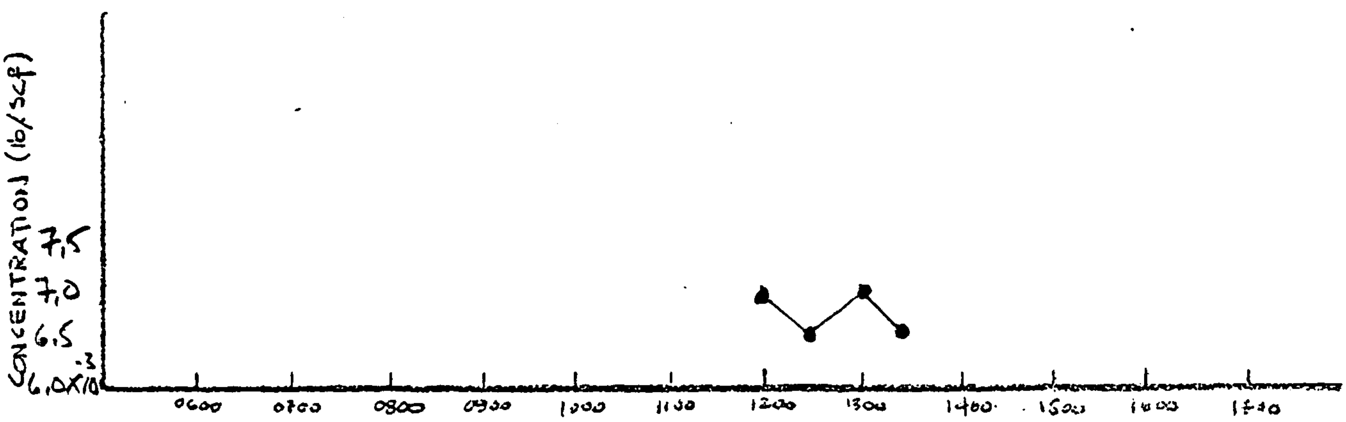
TVP 1.97 psia

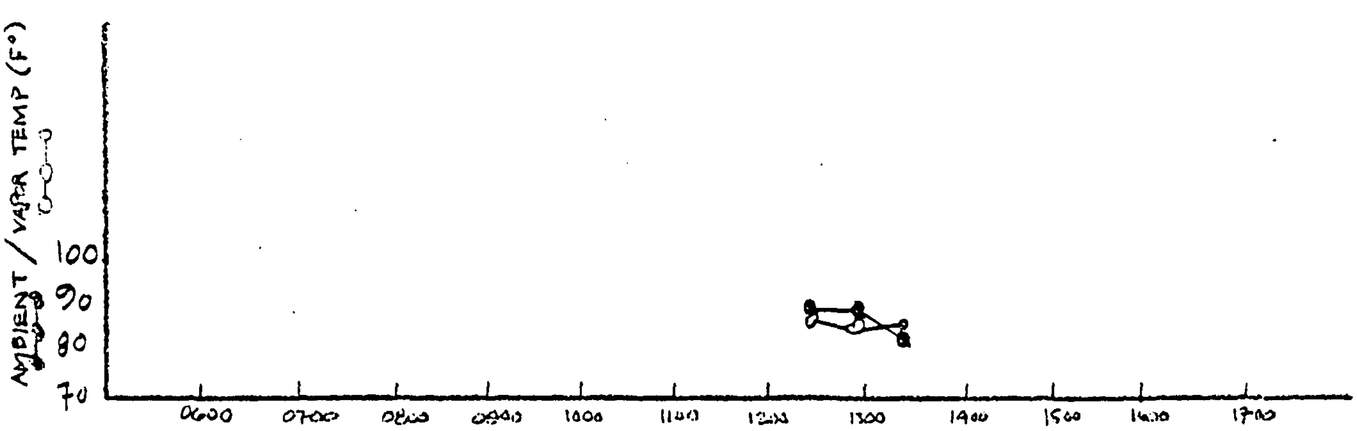
TANK HT. 40 ft.

CAPACITY 30,000 bbls.

DATE 5/16/78







PLANT NAME Exxon

CHEMICAL Cyclohexane

COLOR White

LIQUID HEIGHT 24'

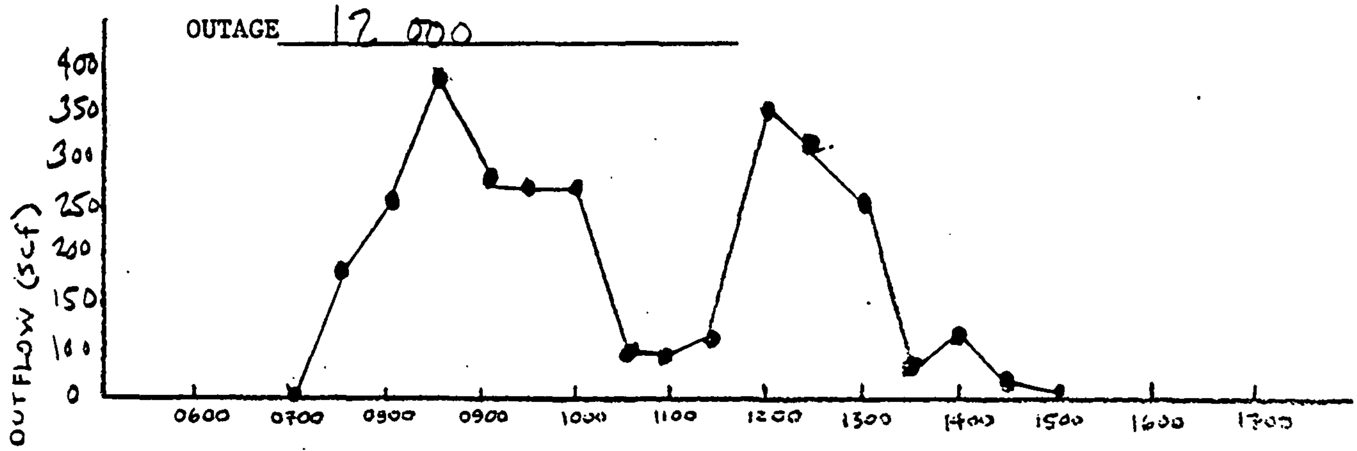
OUTAGE 12 000

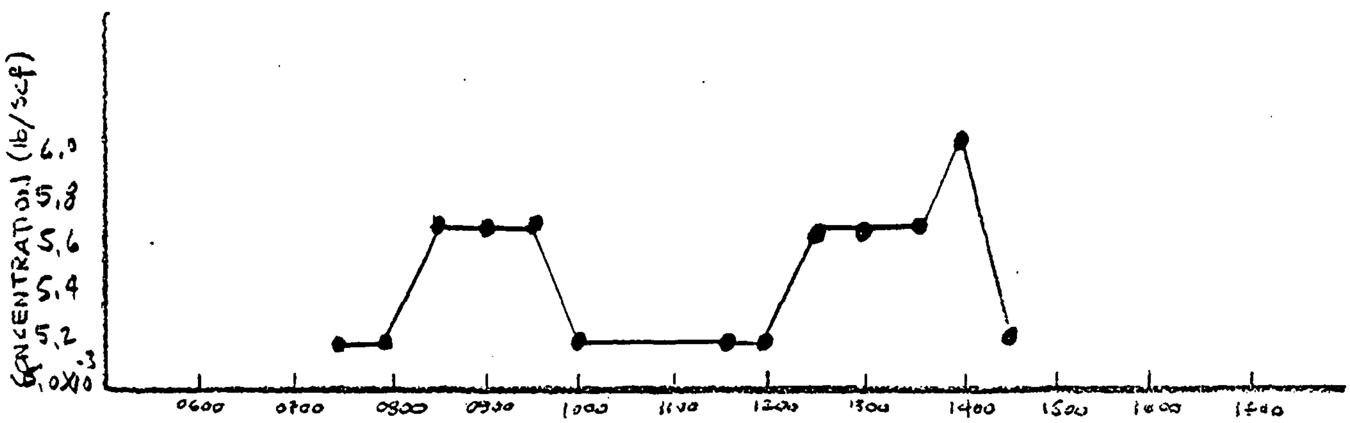
TVP 1.97 psia

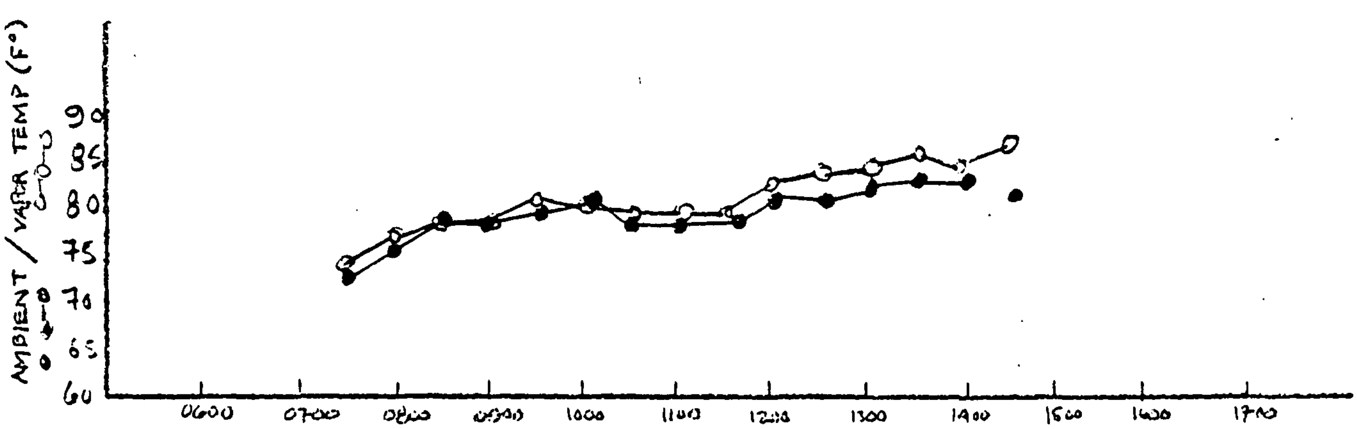
TANK HT. 40 ft.

CAPACITY 30,000 bbls.

DATE 5/17/79







PLANT NAME Exxon

CHEMICAL Cycohexane

COLOR White

LIQUID HEIGHT 24'

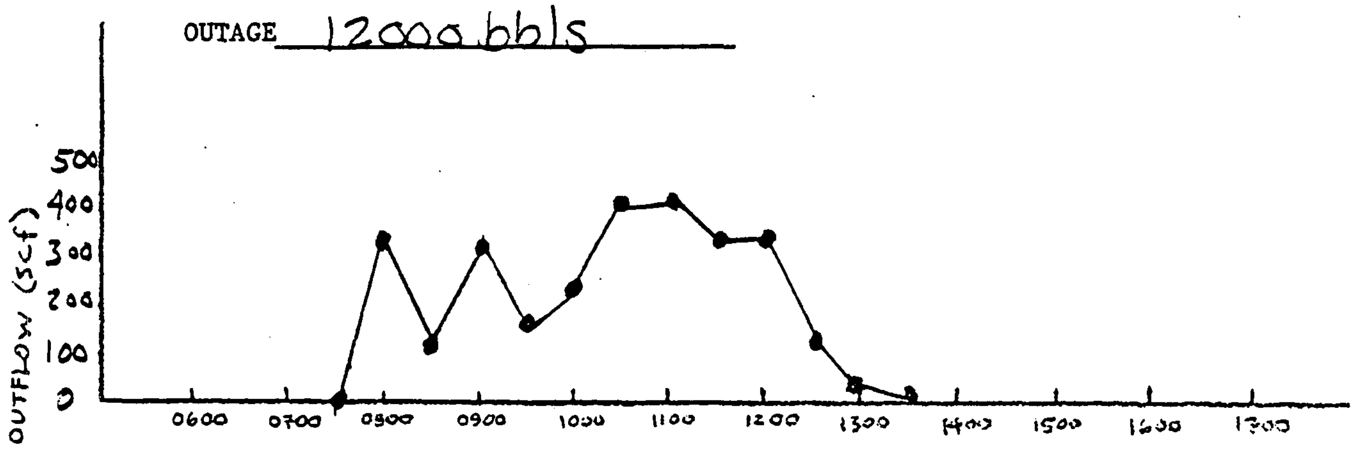
OUTAGE 12000 bbls

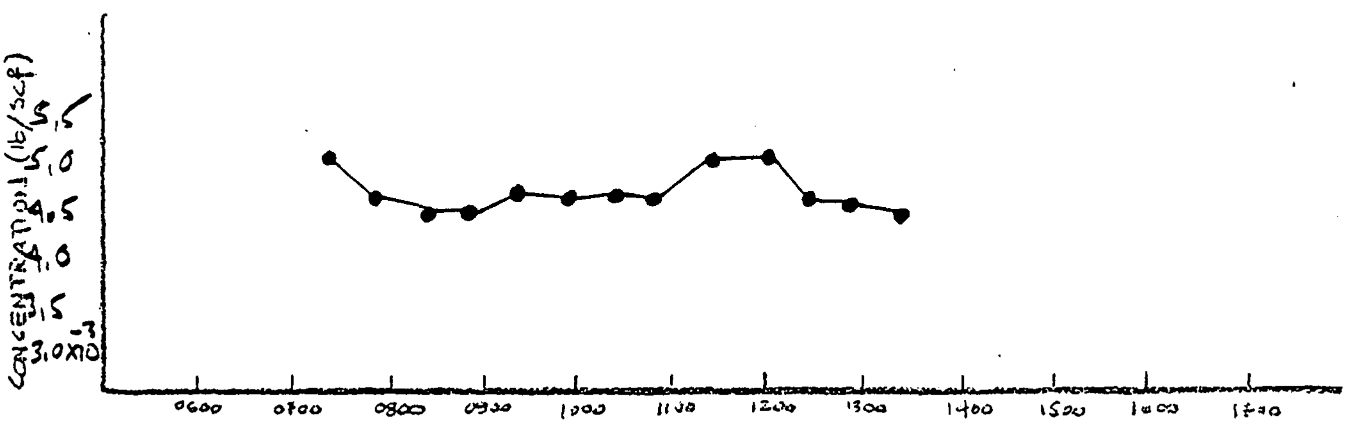
TVP 1.97 psia

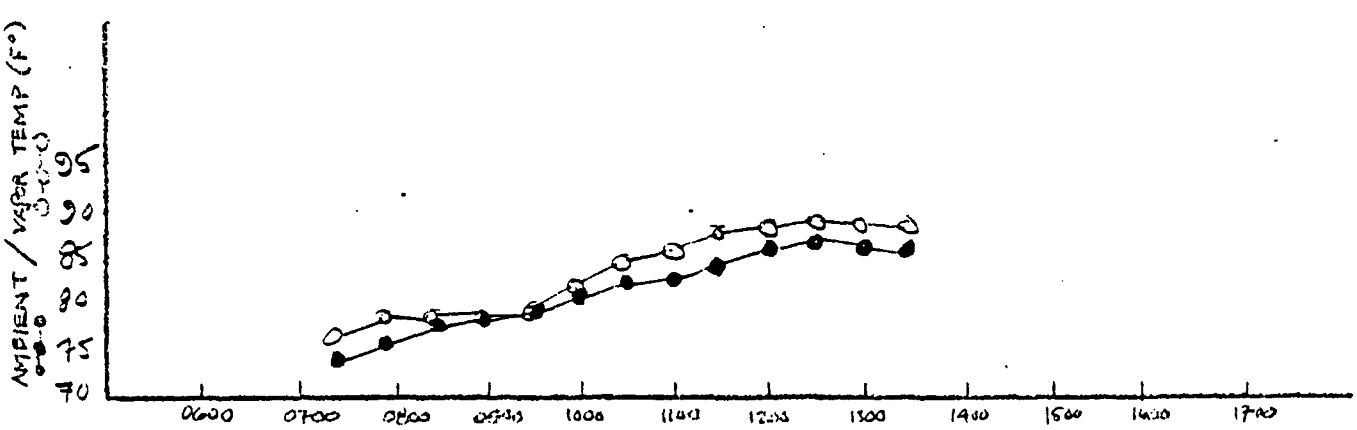
TANK HT. 40 ft.

CAPACITY 30,000 bbls.

DATE 5/10/78



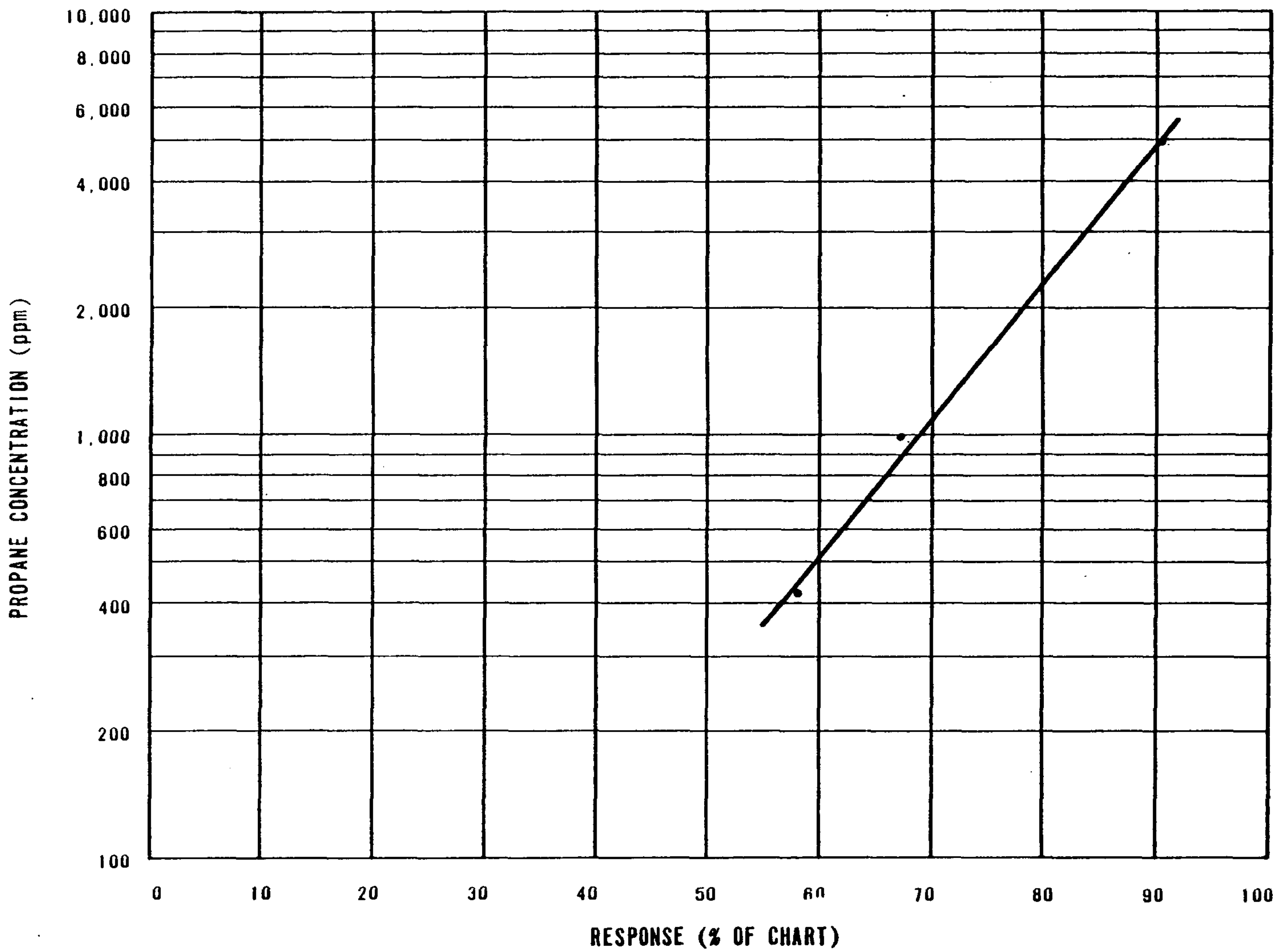




APPENDIX D

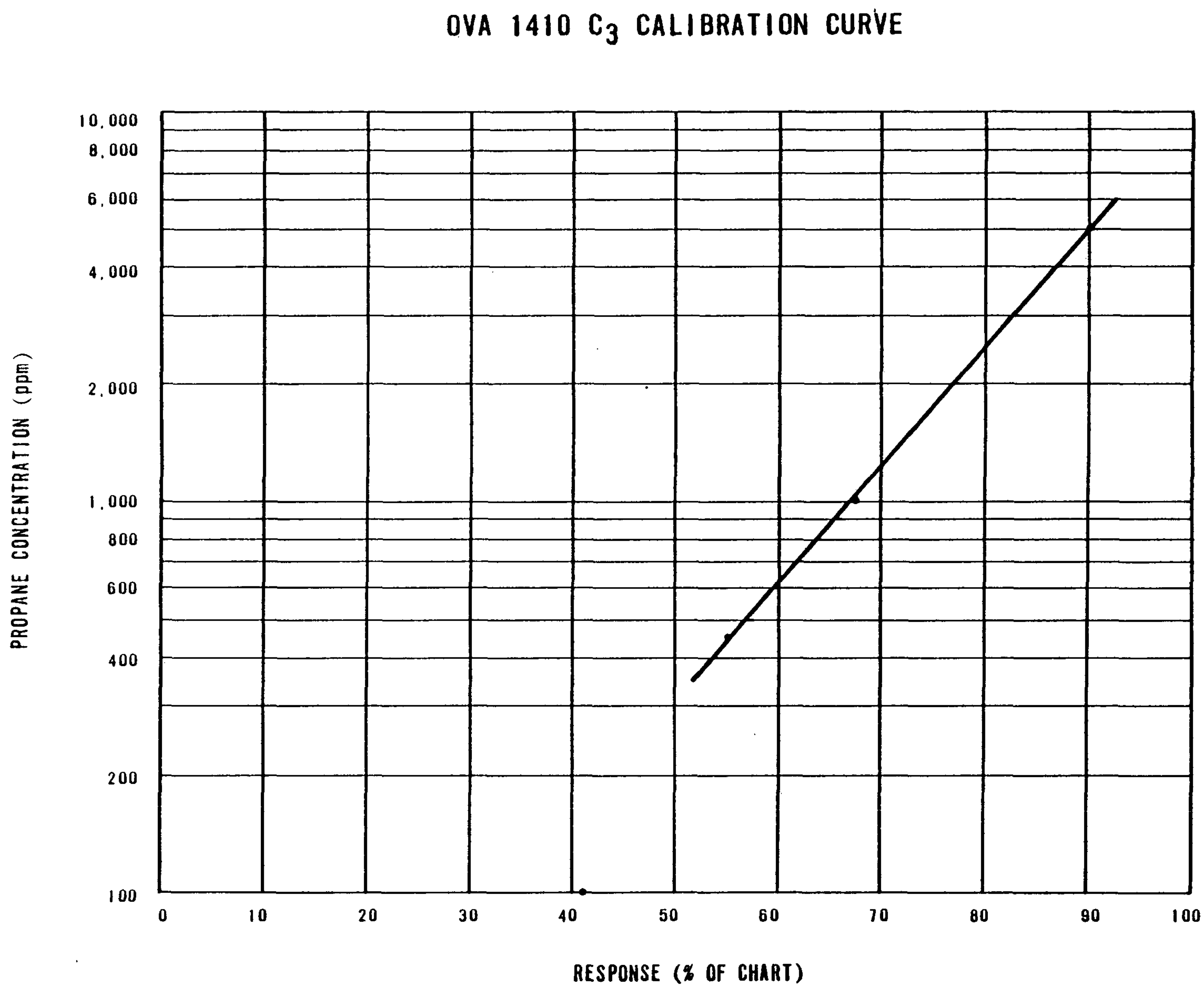
O.V.A. CALIBRATION CURVE CHARTS

OVA 1400 C_3 CALIBRATION CURVE



ENGINEERING-SCIENCE

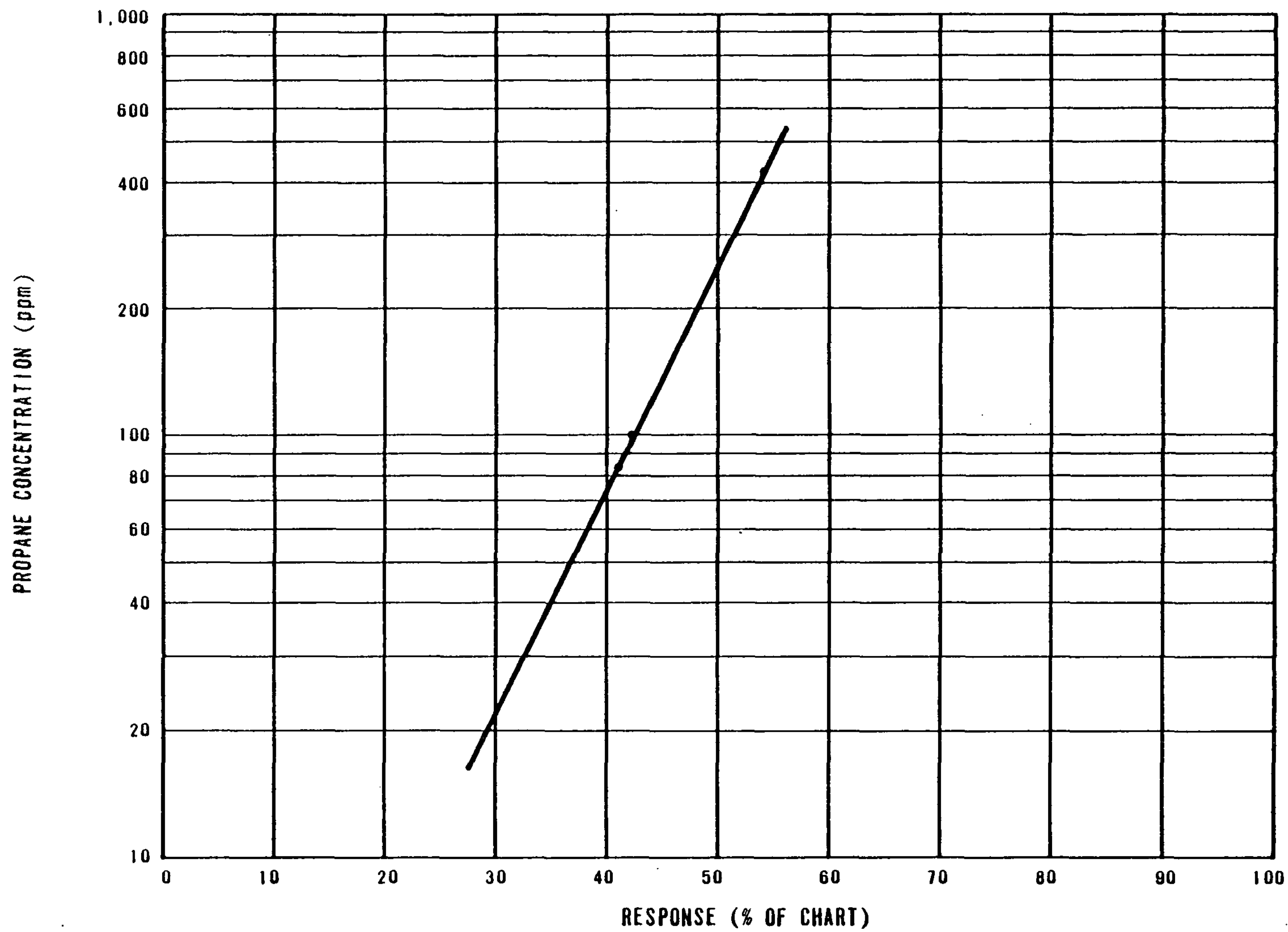
FIGURE III-1



ENGINEERING-SCIENCE

FIGURE III-2

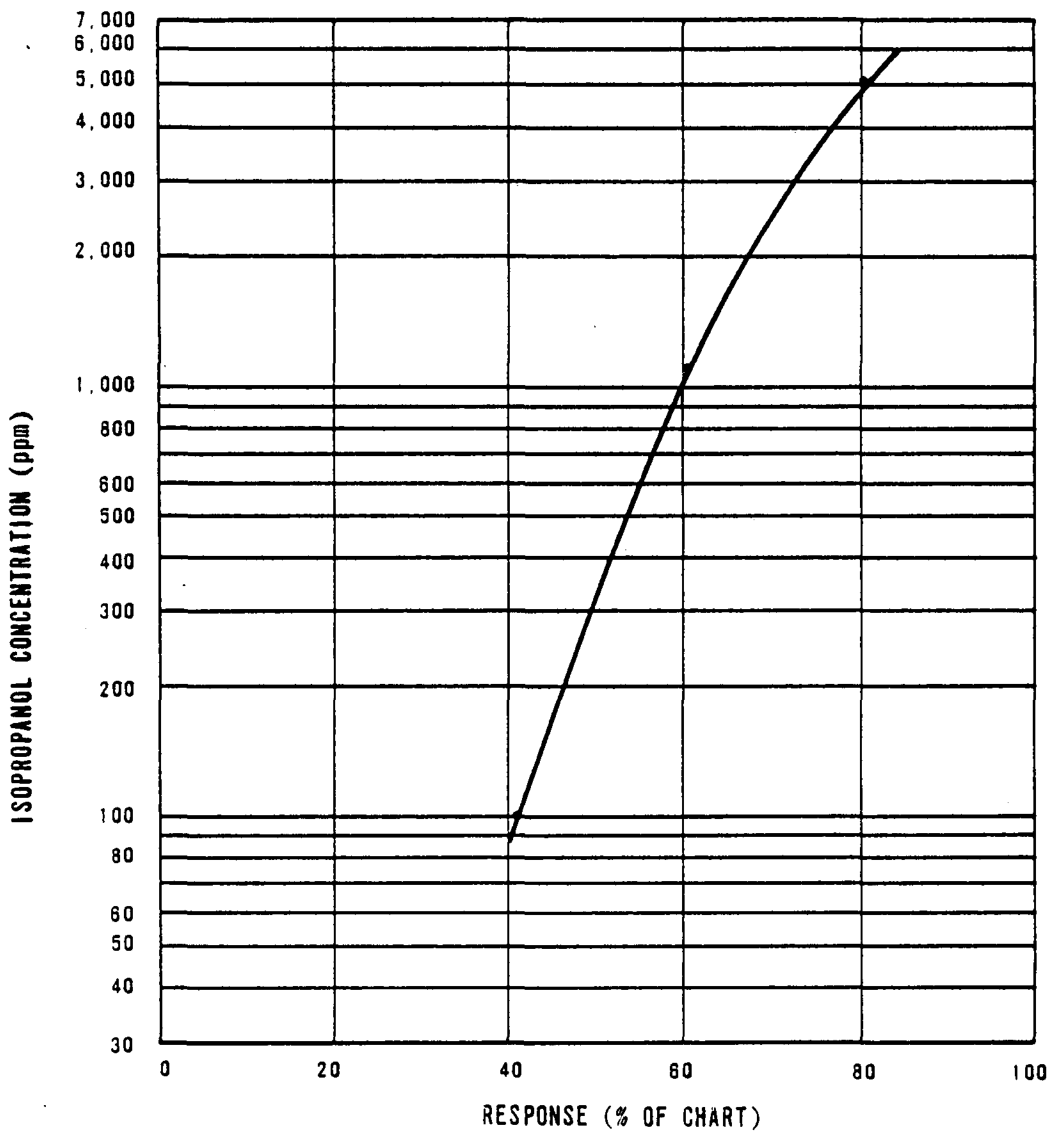
OVA 1410 C3 CALIBRATION CURVE



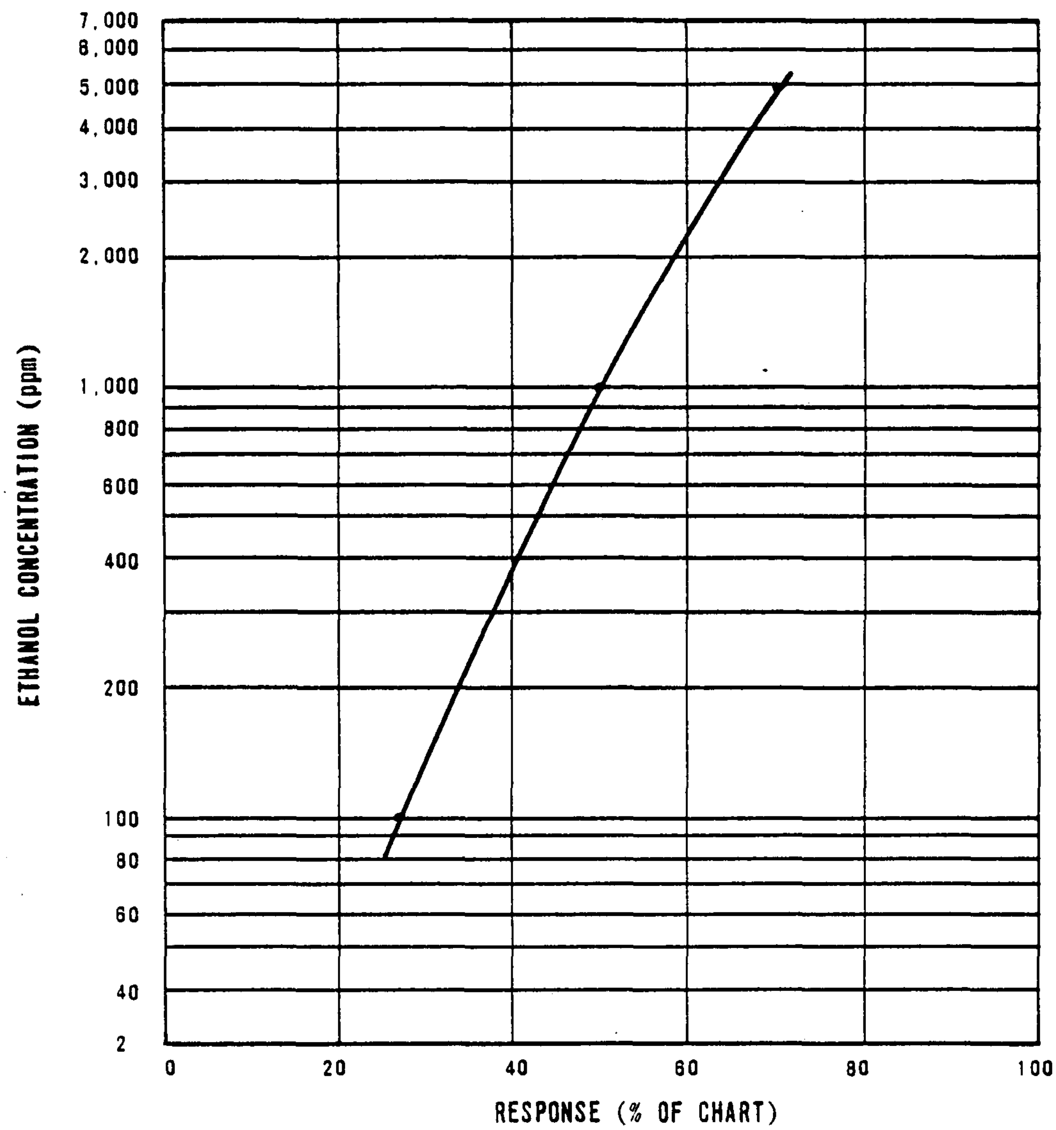
ENGINEERING-SCIENCE

FIGURE III-3

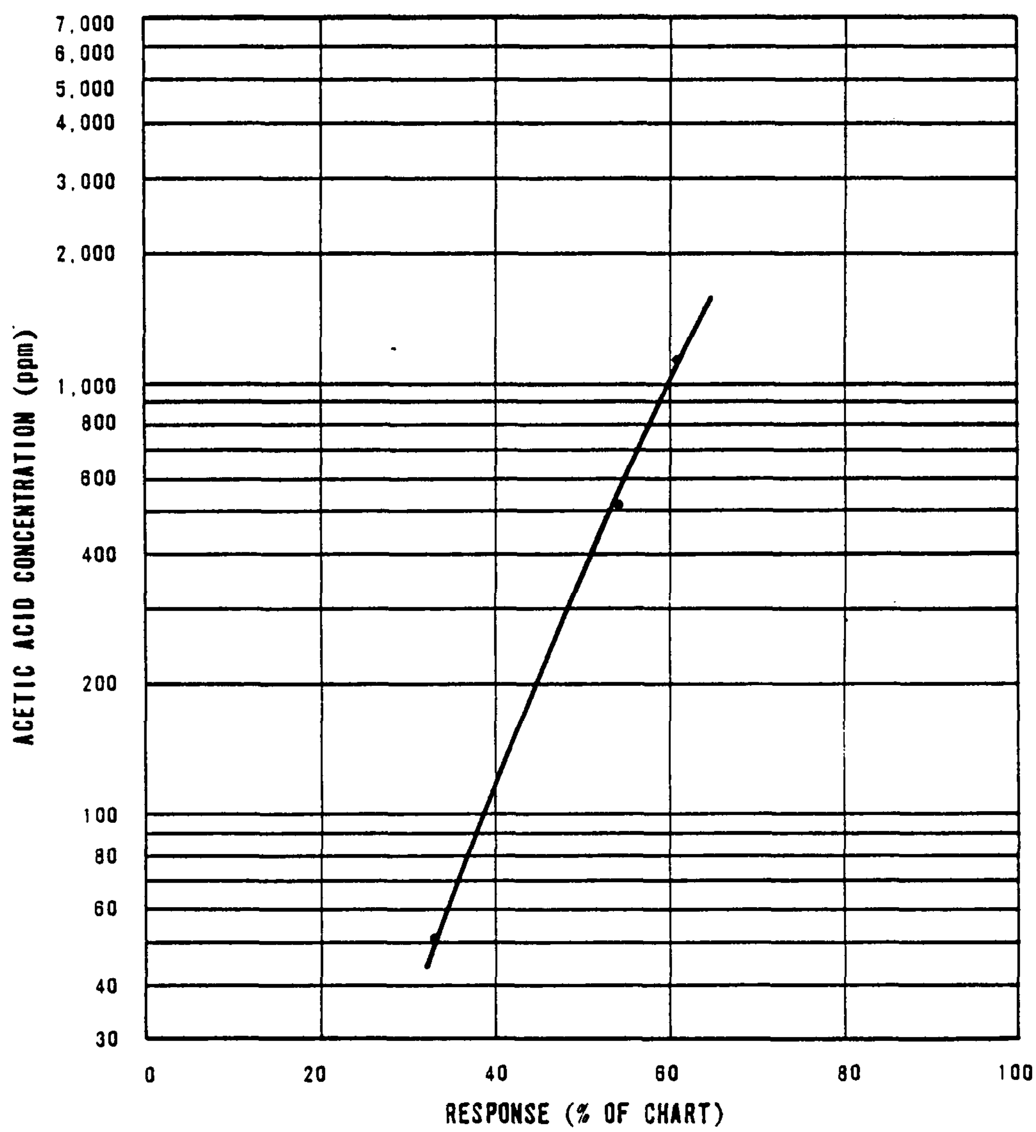
ISOPROPANOL O.V.A. 1400 CALIBRATION CURVE



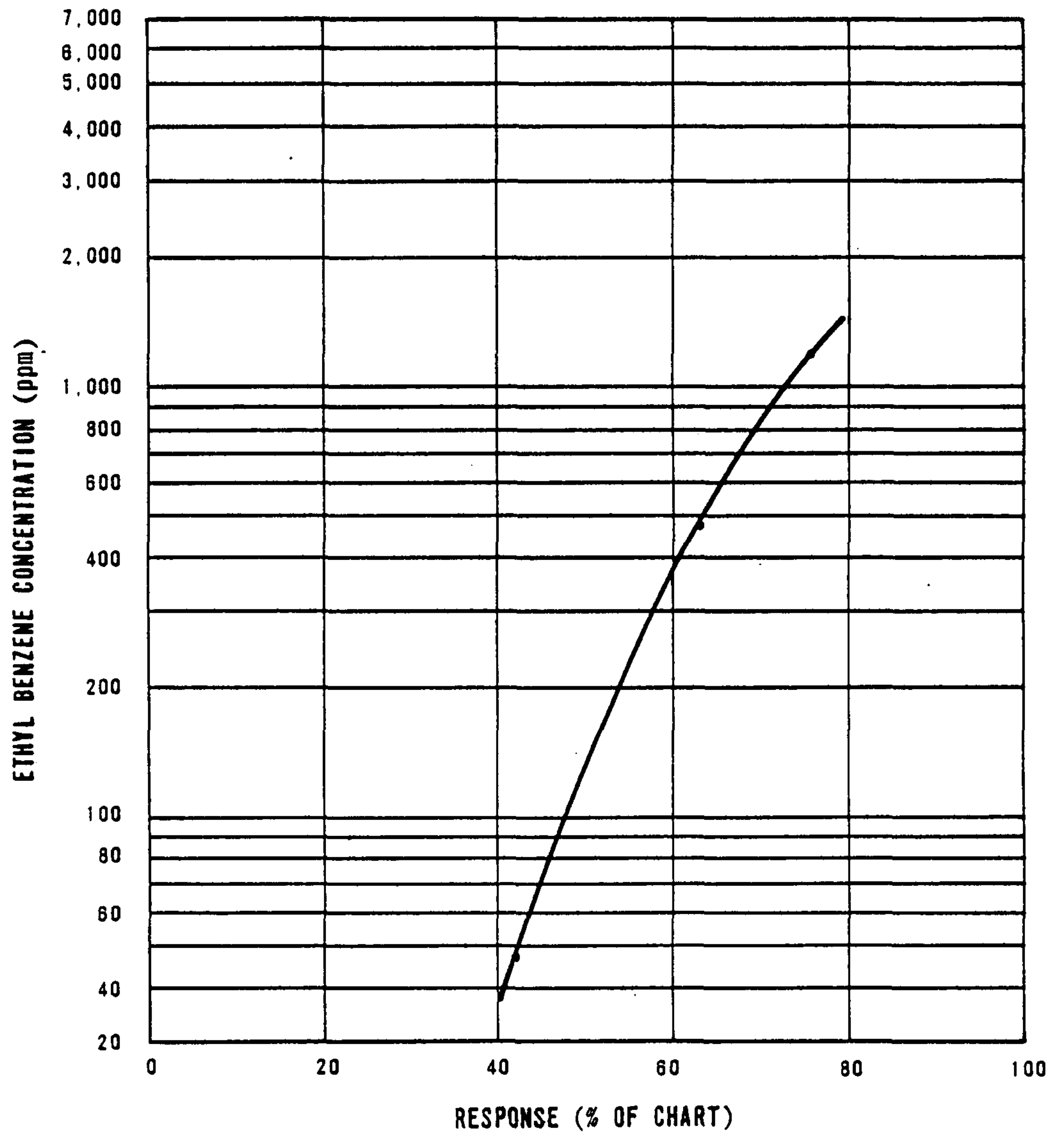
ETHANOL O.V.A. 1400 CALIBRATION CURVE



ACETIC ACID O.V.A. 1410 CALIBRATION CURVE



ETHYL BENZENE O.V.A. 1410 CALIBRATION CURVE



APPENDIX E

FORMALDEHYDE GAS CHROMATOGRAPH CHART REDUCTION

APPENDIX TABLE E-1

FORMALDEHYDE GAS CHROMATOGRAPH

CHART REDUCTION

THERMAL CONDUCTIVITY CALIBRATION

Formaldehyde			Water			Methanol		
Attn	Area	ppm	Attn	Area	ppm	Attn	Area	ppm
4	16	5000	4	7.0	5000	4	14	5000
4	16.5	5000	4	7.5	5000	4	14	5000
4	16	5000	4	7.5	5000	4	13.5	5000

APPENDIX TABLE E-2

FORMALDEHYDE GAS CHROMATOGRAPH

CHART REDUCTION

		Formaldehyde			Water			Methanol		
Date	Time	Attn	Area	ppm	Attn	Area	ppm	Attn	Area	ppm
4/26/78	1300	4	42.0	13000	4	103	70000	1	5.0	450
	1345	4	42.0	13000	4	103	70000	1	5.0	450
	1445	4	41.0	13000	4	100	68000	1	4.5	410
	1500	4	42.0	13000	4	96	66000	1	4.5	410
	1600	4	41.0	13000	4	105	72000	1	6.0	540
	1730	4	42.0	13000	4	92	63000	1	6.0	540
	1800	4	41.5	13000	4	90	62000	1	4.5	410
	2000	4	43.0	13000	4	77	53000	1	3.5	320
	2030	4	42.0	13000	4	95	65000	1	4.0	360
	2045	4	42.0	13000	4	95	65000	1	4.5	410
4/27/78	1230	4	45.0	14000	4	112	77000	1	6.0	540
	1300	4	48.0	14000	4	107	73000	1	5.0	450
	1330	4	49.0	14000	4	105	72000	1	4.5	410
	1400	4	44.0	14000	4	108	74000	1	5.0	450
	1430	4	43.0	13000	4	110	75000	1	6.0	540
	1500	4	48.0	14000	4	103	70000	1	4.0	360
	1530	4	45.0	14000	4	108	74000	1	5.0	450

APPENDIX F

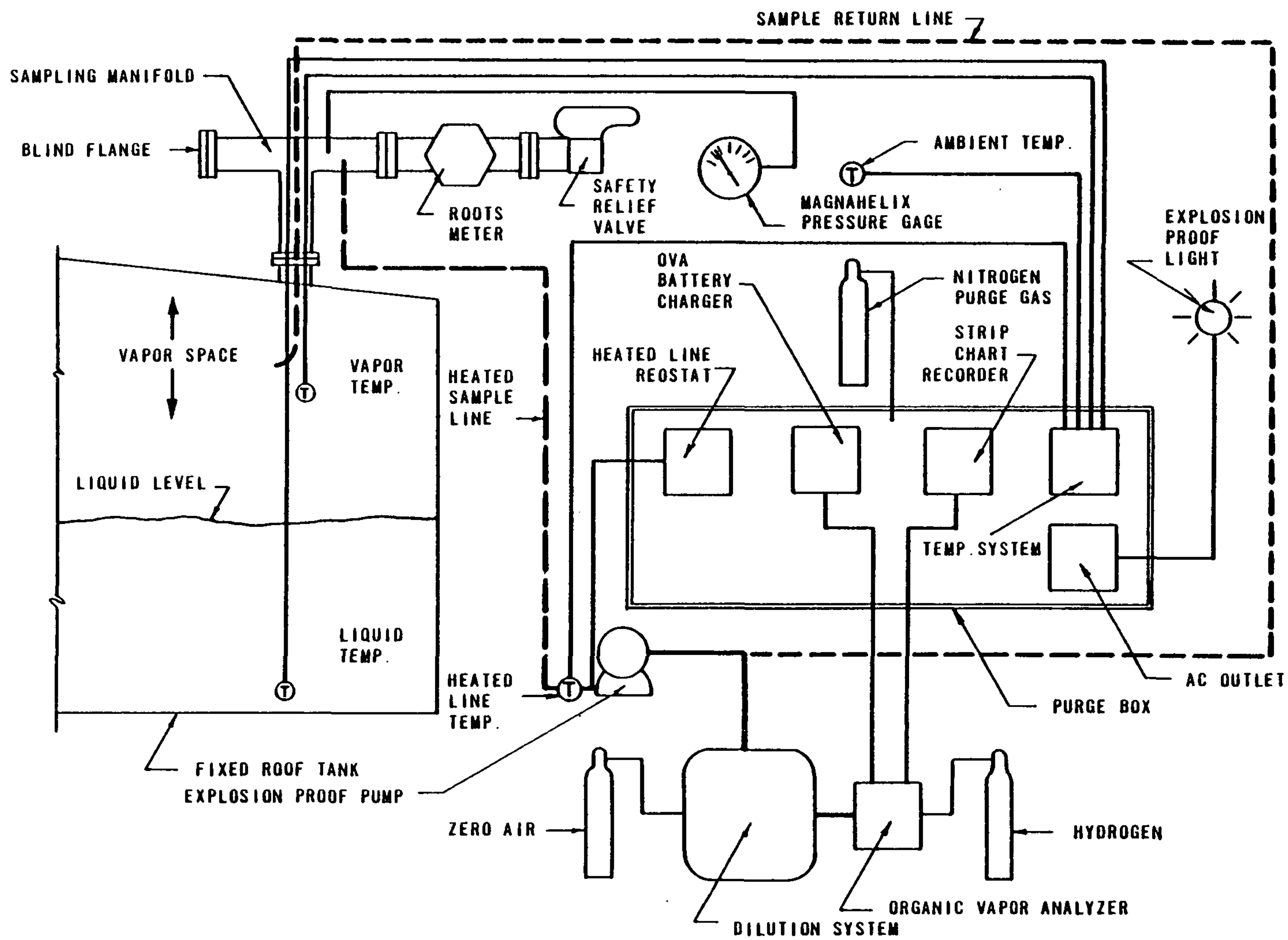
EQUIPMENT USED FOR TESTING

APPENDIX TABLE F-1

EQUIPMENT USED FOR TESTING

Description	Manufacturer	Model	Comments
Pump Pump	Gast Mfg. Corp. Thomas Industries, Inc.	DOA-104-AA 107C Series	Used to pull sample from source. One pump was also required to pull dilution system air.
Dilution System	(Built by ES)	---	----
Recorder	Linear Instruments Corp.	N/A	No integrator.
Magnahelic	Dwyer Instruments	Cat.# 2310	0-5" H_2O
Digital Temperature Indicator	Omega Engineering	175	Ten channel digital read-out.
Positive Displacement Gas Meter (Roots)	Dresser Industries, Inc.	11ml25	125 PSIG - 11,000 CFH Max 310 M^3/H - 860 KPA Four inch flanges, 10-1/2" between flanges.
Turbine Gas Meter (Singer)	American Meter Div.	AL-425	425 CFH @ 1/2" Diff. 900 CFH @ 2" Diff. M.A.O.P-10 PSI

BASIC TEST EQUIPMENT CONFIGURATION



ENGINEERING-SCIENCE

FIGURE F1

OMEGA ENGINEERING, INC.

OWNERS MANUAL

MODEL 175

OMEGA'S DIGITAL TEMPERATURE INDICATORS

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 1 year. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return Number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been opened or tampered with, shows evidence of being damaged as a result of excessive current, heat, moisture, vibration or misuse. OMEGA assumes no consequential warranties or obligations beyond repair or replacement of the above unit.

OMEGA ENGINEERING INC.

OMEGA ENGINEERING, INC.
P.O. BOX 4047, STAMFORD, CONNECTICUT 06907
PHONE (203) 359-1660
TELEX 996404

MODEL 175

DIGITAL PYROMETER

OWNERS MANUAL

TABLE OF CONTENTS

CERTIFICATION

OMEGA ENGINEERING, INC., certifies that this instrument was throughly inspected and tested at the factory prior to shipment and found to meet all requirements defined by the contract under which they are furnished.

Warranty and Assistance

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 1 year. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return Number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with, shows evidence of being damaged as a result of excessive current, heat moisture, vibration or misuse. OMEGA assumes no consequential warranties or obligations beyond repair or replacement of the above unit.

In all orders for service, please include a description of the failure and a diagram of the test conditions that will allow the factory to reproduce the failure symptoms.

INITIAL CHECKOUT PROCEDURE

See Section 2.1 for Unpacking and Inspection instructions.

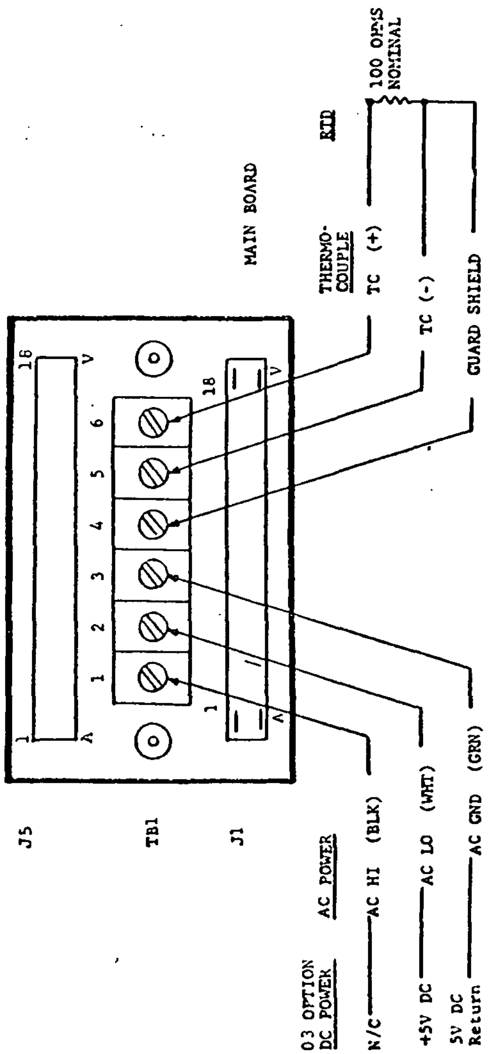
> **CAUTION**
>
> Meters are internally connected for either 115V or 230V AC power, or 5V DC power. Check label on meter for proper supply voltage.

REQUIRED EQUIPMENT

1. 115V or 230V 50-60 Hz power source (4.5 watts), or 5V DC at 750mA.
2. Three wire AC power cord, or a two wire DC power cord.
3. Flat blade screwdriver (1/4" blade).
4. Piece of copper buss wire.
5. 100 Ohm resistor.

TEST EQUIPMENT

1. Connect AC power as follows:
   a. AC power HI (Blk) to TB1-1.
   b. AC power LO (Wht) to TB1-2.
   c. AC power GND (Grn) to TB1-3.
2. Connect DC power as follows:
   a. +5V DC to TB1-2.
   b. 5V DC Return to TB1-3.
3. For Thermocouple Meters connect a piece of copper wire between TB1-5 and TB1-6.
4. Apply power and examine the display. The readout should show the approximate ambient temperature in °C or °F as applicable.
5. For RTD meters connect a 100 Ohm resistor between TB1-5 and TB1-6. Then connect a piece of copper wire between TB1-4.and Tb1-5.
6. Apply power and examine the display. The readout should show approximately zero.



REAR VIEW OF UNIT

Figure 1

SECTION 1

DESCRIPTION

1.1 General

Dual slope integration with automatic zero correction is universally accepted as the most accurate method of analog to digital conversion. In the Model 175 this technique is further enhanced by the utilization of low noise input components to maintain noise levels below the resolution of the thermometer. Accuracy near the reference temperature of each range is not degraded by normal mode noise because the 175 performs true bipolar signal integration around zero. Many competitive meters rectify the signal before intergration which erroneously adds the absolute value of the normal mode noise to the signal reading. The 175 average value circuit provides full normal mode and superior AC line transient noise rejection at all signal levels.

An inherent feature of dual slope integration is the automatic rejection of AC line noise on the signal if the signal integration period is equal to a multiple of the AC line period. In the limit with precisly equal periods the AC line noise rejection is infinite. The Model 175 uses an accurate and stable oscillator which limits the instability of the signal measuring interval to within ±1% and provides 30 dB of normal mode rejection. An input filter provides an additional 30 dB of normal mode rejection. Overall, normal mode rejection is the sum of these two numbers of 60 dB.

Noble metal and some base metal thermocouples are described by the expression emf = AT + BT^2 in which emf is the output voltage, T is the temperature stimulus, and A and B are constants. Over the full range a thermocouple output can be divided into two or three intervals that are each described by an emf expression with different values for the constants. It should be noted that the two terms of the emf expression are the first terms of the series expansion of Ln(1-X). By utilizing Ln(1-X) functions to fit the thermocouple characteristic in the two or three intervals, the resulting conformity error is less than the thermocouple limits of error. OMEGA'S POLYLOG linearizer (patent applied for) is equal in performance to 16 to 20 segment digital or diode function generator linearizer but without the drift and complexity problems of the diode function generator.

1.1 (Continued)

A platinum RTD is described by the expression $R_T = R_O(1 + CT - DT^2)$ in which R_T is the resistance at a given temperature, R_O is the resistance at 0 °C, T is the temperature stimulus, and C and D are constants. By subtracting the R_O term (offset) from the R_T expression one is left with two terms that are the first two terms of the series expansion of Ln(1 + X). By utilizing one of at the most two Ln(1 + X) functions to describe the Pt RTD over its entire range the resulting conformity error is less than 0.2%. OMEGA'S POLYLOG linearizer (patent applied for) in this case is equal in performance to a 64 segment digital linearizer.

1.2 Specifications

1.2.1 Input

Configuration	Single-Ended
Polarity	Bipolar with Polarity Indicator
Zero	Automatic with negligible long term drift. Thermal emf's from input terminals, signal conditioning and basic meter is less than 0.15uV/°C.
Full Scale Voltage	20mV to 200mV
Overvoltage Protection ..	130V RMS for TC or 6Vp for RTD without damage
Impedance	100 Megohm
Bias Current	1 Nanoamp
Sensor Break Detection ..	60 Nanoamps current source with positive overload indication
Lead Resistance	250 Ohms max for rated TC accuracy. Add 0.005% R per Ohm of RTD conductor resistance to overall RTD accuracy.
NMR @ 50/60 Hz	60dB
CMR with 250 Ohm Imbalance	120dB AC power to Signal low. 120dB (opt) Digital Gnd to Signal low.
CMV (DC to 60 Hz)	500 volts peak.

1.2.2 Signal Conditioning

Reference Junction	From 10-40 C ambient, 0.03 deg/deg for base metals and 0.05 deg/deg for noble metals with 1 deg resolution. Sensor offset adjusted to zero from front panel.
RTD	From 10-40 C ambient, 0.02 deg/deg for platinum with 1.0 deg resolution. Sensor offset adjusted to zero from front panel.

1.2.3 Conversion

Technique	
TC	Dual Slope, Average value
RTD	Dual Slope ratiometric, average value
Signal Integration	100 milliseconds
Reading Rate	Int. 3/4sec, Ext. 0 to 3-4/sec.
Linearization	POLYLOG (patent applied for)

1.2.4 Display

Type	13mm, 7 segment LED
Symbols	0.0.0 to -1.9.9.9
Decimal Points	Any of Three
Overload	3 Least Significant Digits Flash.

1.2.5 Digital Signals

Logical '0'	0 to .6V (Input) 0 to .4V (Output)
Logical '1'	2.0 to 5.5V (Input) 2.4 to 5.5V (Output)
1 Unit Load	Logical '0' 1.6mA Logical '1' .04mA
Hold	'0' = Hold data Input load = 1 Unit load
Data Ready	'0' = Valid data Output drive = 3 Unit loads
BCD Parallel Data	'1' = True Output drive = 3 Unit loads
+ Polarity	'1' = Positive Output drive = 1 Unit load
Overload	'1' = Overload = 3 Unit loads

1.2.6 Power

Input Voltage	115V +10% 50/60 Hz 230V ∓10% 50/60 Hz Option 01 100V ∓10% 50/60 Hz Option 02 5VDC ∓5% 750mA Option 03
Input Power	4.5 watts at nominal input
Output Voltage	+5V @ 100mA without options

1.2.7 General

Operating Temperature .... 0°C to 40°C

Storage Temperature ...... -40°C to 70°C

Humidity .... Up to 95% at 40°C

Weight .... 540g or 1.2 lb.

Case Material .... ABS KJB

Case Size

Bezel (W x H x T)....... (96 x 40 x 6)mm or (3.78 x 1.89 x 0.24) in.

Depth Behind Bezel With Connector .... 135.4mm or 5.33 in.

Panel Coutout (W x H)... (92 x 45)mm or (3.62 x 1.77) in.

Connectors .... Barrier Strip, Signal and Power. 36 Pin connector, BCD output 36 Pin connector, options (Viking VK 18D/12, SAE DAC 18D/1-2, Winchester HSD 18SO)

1.2.8 Ranges

TEMPERATURE SENSOR RANGES & ACCURACY @ 25°C

SENSOR TYPE	MATERIAL	RANGE	CONFORMITY ERROR	OVERALL ERROR ± ½ LSD	RESOLUTION	MODEL
J	Iron Constantan	-170°C to 0°C	±1.4°C	±1.9°C	1.0°C	JC1
		0°C to 277°C	±1.1°C	±1.6°C		
		277°C to 760°C	±.3% Reading	±.4% Reading		
		-300°F to 32°F	±3.0°F	±3.5°F	1.0°F	JF1
		32°F to 530°F	±2.0°F	±2.5°F		
		530°F to 1400°F	±.3% Reading	±.4% Reading		
K	Chromel Alumel	-180°C to 0°C	±2.0°C	±2.5°C	1.0°C	KC1
		0°C to 450°C	±1.7°C	±2.2°C		
		450°C to 1260°C	±.4% Reading	±.8% Reading		
		-255°F to 32°F	±2.75°F	±3.25°F	1.0°F	KF1
		32°F to 2000°F	±2.0°F	±2.5°F		
T	Copper Constantan	-130°C to 400°C	±0.1°C	±1.4°C	1.0°C	TC1
		-200°F to 750°F	±2.0°F	[illegible]	1.0°F	TF1
E	Chromel Constantan	-155°C to 0°C	±2.0°C	±2.5°C	1.0°C	EC1
		0°C to 316°C	±1.25°C	±1.7°C		
		316°C to 871°C	±.8% Reading	±.5% Reading		
		-330°F to 32°F	±3.0°F	±3.5°F	1.0°F	EF1
		32°F to 600°F	±2.5°F	±3.0°F		
		600°F to 1600°F	±.8% Reading	±.4% Reading		
RTD	Platinum 100 Ohms DIN 43760	-216°C to 0°C	±0.2°C	[illegible]	1.0°C	PC1
		0°C to 100°C	±0.2°C	±0.7°C		
		100°C to 800°C	±0.2% Reading	±0.25% Reading		
		-350°F to 32°F	±0.3°F	±0.5°F	1.0°F	PF1
		32°F to 212°F	±0.3°F	±0.8°F		
		212°F to 1500°F	±0.2% Reading	±0.25% Reading		

Conformity errors are with respect to thermocouple reference tables based on the IPTS-68 and DIN 43760, September 1968, for platinum RTD.

Overall error includes all error sources (basic meter, signal conditioner, linearizer conformity, etc.) @ 25°C.

Long Term Stability .... 0.15% error/yr

SECTION 2

RECEIVING AND INSTALLATION

2.1 Unpacking and Inspection

Your Model 175 was fully inspected and tested, then carefully packed before shipment. Unpack the meter carefully and inspect it for obvious shipping damage.

2.2 Mechanical Installation

The Outline and Mounting drawing on the last page illustrates the mounting method for your digital pyrometer. The unit is inseted from the front of the panel and held in place by two slide retainers. The panel thickness may be between .75mm (.030") and 6.35mm (.25").

SECTION 3

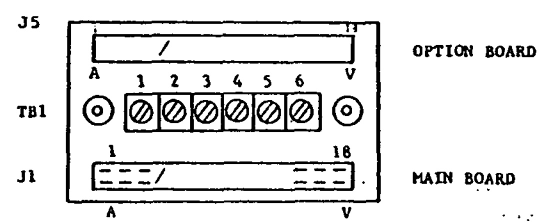
OPERATING INSTRUCTIONS

3.1 Pin Assignments

3.1.1 Connector TB1

	POWER	
TB1-PIN	AC OPERATION	5 DC OPERATION
1	AC Power HI	N/C
2	AC Power LO	+ 5 Volts
3	AC Power GND	5V Return

	FUNCTION	
TB1-PIN	TC OPERATION	RTD
4	AC Guard Shield	
5	TC (-) Input	
6	TC (+) Input	



REAR VIEW OF UNIT

Figure 2

3.1.2 Connector J1

J1-PIN	FUNCTION	J1-PIN	FUNCTION
1	No Connection	A	Spare
2	Spare	B	No Connection
3	No Connection	C	Spare
4	$\overline{\text{Blank}}$	D	1 Bit
5	COMP	E	2 Bit
6	SIG	F	4 Bit
7	Clock	H	8 Bit
8	80 Bit	J	100 Bit
9	40 Bit	K	200 Bit
10	20 Bit	L	400 Bit
11	10 Bit	M	800 Bit
12	1K Bit	N	$\overline{\text{+ Polarity}}$
13	Spare	P	$\overline{\text{Data Ready}}$
14	Spare	R	$\overline{\text{Hold}}$
15	+5V	S	$\overline{\text{Ext OL (In)}}$
16	Signal Gnd	T	Digital Gnd
17	Signal In	U	$\overline{\text{Conv}}$
18	OL	V	REF

Connector Type Viking		
	Viking	VK18D/12
	SAE	SAC18D/12
	Winchester	HSD18S0

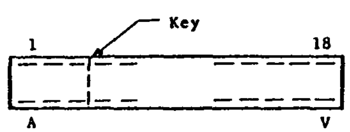


Figure 3

Connector Pin Orientation as Viewed From the Rear of the Meter.

3.2 Power

3.2.1 Input Voltage

The standard meter operates from 115V ±10%, 60 Hz. It consumes about 4.5 watts. A three wire connection should be used to connect power to the meter. Two conductors provide power and the third provides a ground for noise rejection.

Option 01 is 230V ±10%, 50 Hz operation. To change the meter in the field, from 115 to 230V operation, use the following procedure. See Figure 3

(1) Remove power lines from meter and remove the meter form the case.

(2) Remove the two jumpers on the transformer W1 and W2.

(3) Add jumper W3 on the printed circuit board. The meter is now wired for 230V.

To change the meter from 230V to 115V operation, reverse the above steps.

3.2.2 Input Fuse

The power input to the Model 175 is protected by a carbon composition resistor fuse. If the meter does not light and it is suspected that the fuse has been blown, check the continuity of the primary circuit. The resistance from power Hi to power Lo will be approximately 180 ohms for 115V meter and 700 ohms for the 230V meter. If the fuse is blown, it is imperative that it is replaced by an identical part, failure to do so will void the warranty. The fuse is an Allen-Bradley 1/8W 10 ohm, ±10% carbon composition resistor OMEGA part number 8111109.

3.2.3 Output Voltage

The +5V output is a regulated supply with the voltage range 4.5V to 5.1V. A maximum current of 100mA is available for external use.

3.3 Signal Input

3.3.1 Signal

For best results a shielded thermocouple should be used for the input signal, with the shield terminated to Signal Ground at the connector TB1-4.

Signal Ground and Digital Ground are internally connected and should not be connected externally.

3.3.2 Ground Precautions

All Digital Signals used should be returned to Digital Ground Pin T.

Analog Ground Pin 16 or TB1-4 may be used for a shielded thermocouple or RTD cable IF SHIELD IS NOT RETURNED TO DIGITAL GROUND AT ANY POINT.

3.4 Digital Signal Outputs

3.4.1 BCD Parallel

All BCD outputs are TTL and DTL compatible.

Logical '1'	2.4 to 5.1V, source 0.12mA
Logical '0'	0 to 0.4V, sink 4.8mA

The data outputs are parallel BCD. The outputs are stable and valid while Data Ready (pin P) is low.

3.4.2 + Polarity

Logical '1'	2.4 to 5.1V, source 0.08mA
Logical '0'	0 to 0.4V, sink 1.6mA

The + Polarity output is a logical '1' when the meter indicates a positive reading.

3.4.3 Data Ready

Logical '1'	2.4 to 5.1V, source 0.12mA
Logical '0'	0 to 0.4V, sink 4.8mA

Data Ready will go to a logical '0' at the end of a conversion cycle and to a logical '1' at the beginning of a conversion cycle.

3.4.4 Overload

Logical '1'	2.4 to 5.1V, source 0.12mA
Logical '0'	0 to 0.4V, sink 4.8mA

Overload will go to a logical '1' if the display is equal to or greater than the internal overload set point or when Pin S Ext. OL In is forced low by external command. It is stable while Data Ready is low. The Overload bit will reset during each conversion cycle.

3.4.5 $\overline{\text{Conv.}}$

Logical '1'	2.4 to 5.1V, source 0.32mA
Logical '0'	0 to 0.4V, sink 6.4mA

$\overline{\text{Conv.}}$ will go to a logical '0' at the beginning of a conversion cycle and to a logical '1' at the end of a conversion cycle.

3.4.6 Clock

Logical '1'	2.4 to 5.1V, source 0.12mA
Logical '0'	0 to 0.4V, sink 4.8mA

Clock is factory set at 20KHz ±1%. It is available during the conversion cycle and if gated off with (SIG) signal time it can be used as a serial BCD output.

3.4.7 SIG

Logical '1'	2.4 to 5.1V source 0.12mA
Logical '0'	0 to 0.4, sink 4.8mA

SIG will go to a logical '1' at the beginning of signal integrated and will go to logical '0' at the end of signal integrate.

3.4.8 REF

Logical '1'	2.4 to 5.1V, source 0.12mA
Logical '0'	0 to 0.4V, sink 4.8mA

REF will go to a logical '1' at the beginning of reference integrate and will go to logical '0' at the end of reference integrate.

3.5 Digital Signal Inputs

3.5.1 $\overline{\text{Hold}}$

Logical '1'	2.0V, source 0.16mA
Logical '0'	0.8V, sink 3.2mA

When a logical '0' is applied to the $\overline{\text{Hold}}$ input, the meter will finish the conversion cycle it is on and will hold that reading. If it is applied before the beginning of a conversion, the meter will not start that conversion. Upon a logical '1' at the $\overline{\text{Hold}}$ input, a new conversion will begin within 360msec.

3.5.2 $\overline{\text{EXT OL In}}$

Logical '1'	2.7V, source .040mA
Logical '0'	0.4V, sink 1.2mA

When a external control signal is wired to Pin S and goes to a logical '0', the three least significant digits will flash.

3.5.3 $\overline{\text{Blank}}$

Logical '1'	2.4V, source 0.12mA
Logical '0'	0.4V, sink 3.6mA

When a logical '0' is applied to the $\overline{\text{Blank}}$ input, the three least significant digits will go blank.

3.5.4 Comp.

Logical '1'	1.5V, source 0.0mA
Logical '0'	0.8V, sink 4.8mA

3.5.5 Decimal Points

Any of three decimal points can be lighted by connecting the appropriate jumper with a bridge of solder as shown in Figure 4.

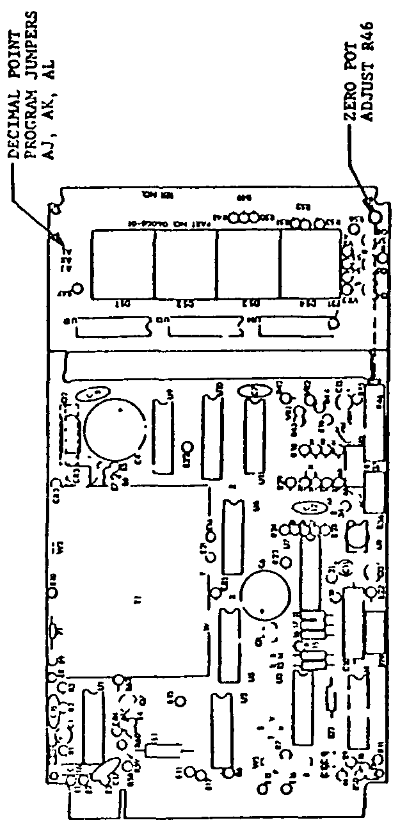


Figure 4

SECTION 4

ADJUSTMENT AND CALIBRATION

4.1 The Model 175 was calibrated at the factory with a precision source. Frequent calibration is not necessary due to the stability and internal accuracy of the meter. All adjustments are sealed except the zero adjustment which is accessible with the lens removed.

If calibration is required, return to the factory for calibration. Be sure to pack in a shipping container of sufficient size to allow ample packing material around unit to prevent damage in shipping.

4.2 Calibration Verification for Thermocouples.

The following procedure should be used to verify the calibration of thermocouple type meters.

1. Connect test cables as shown in Figure 5.
2. Apply power and allow meter to warm up for ten minutes.
3. Apply zero volts from calibrated voltage source and verify readout of 000°C or 032°F. Adjust zero pot if required (See Figure 4 for location).
4. Verify that the 175 is calibrated to the international practical Temperature Scale, IPTS-68, as published in NBS Monograph 125 issued March 1974 or ASTM E230-72 or ASA C96.2-1973.

4.3 Calibration Verification for RTD's

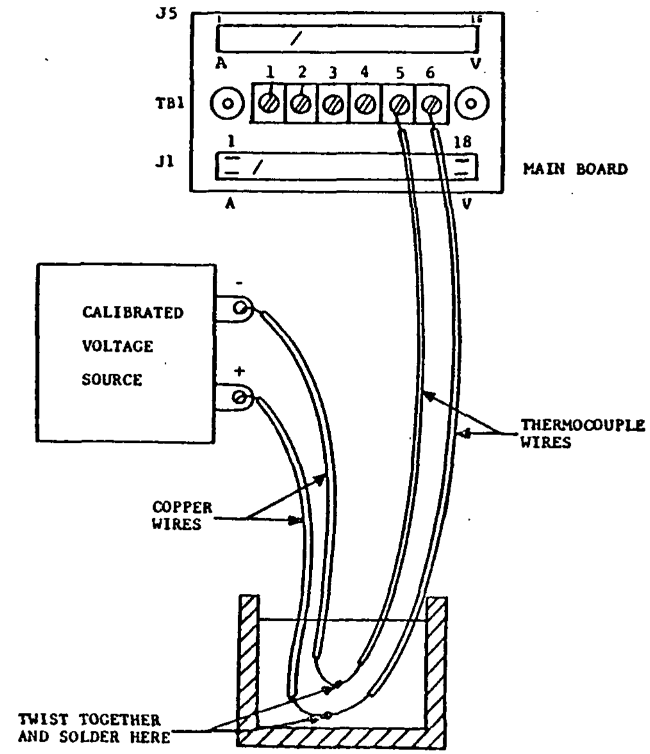
The following procedure should be used to verify the calibration of RTD type meters.

1. Connect test cables as shown in Figure 6.
2. Apply power and allow meter to warm up for ten minutes.

4.3 (Continued)

3. Apply appropriate resistance from the calibrated resistance source from DIN 43760, September 1968. This calibration, with an $\alpha = .00385$, is for specially processed platinum with improved stability in industrial environments.

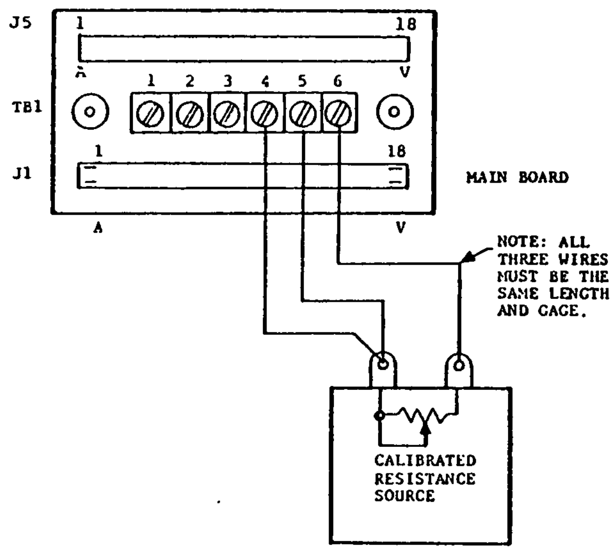
NOTE: Reference Paragraphs 4.2 and 4.3 see Temperature Range and Accuracy Chart 1.2.8.



ICE BATH

Figure 5

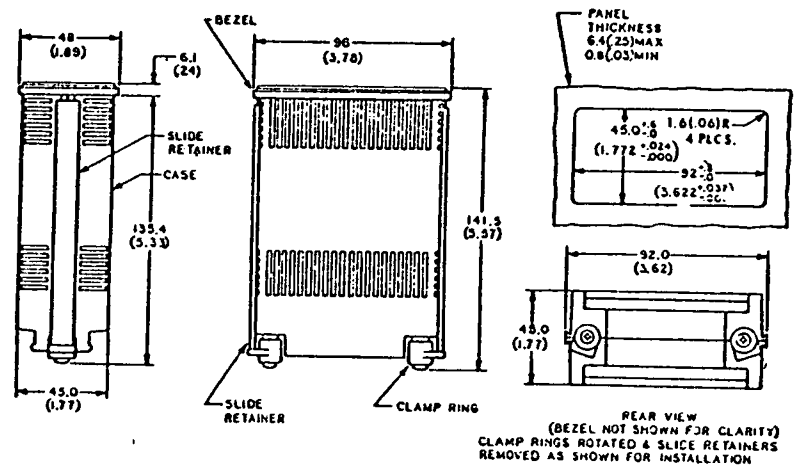
REAR VIEW OF UNIT



3 WIRE RTD CALIBRATION

Figure 6

OUTLINE AND MOUNTING



NOTES: DIMENSIONS IN MILLIMETERS ±.25MM
AND IN (INCHES)±.01 III

DIN CASE

5.1 Analog Output (Option 05)

5.1.1 This option is contained on a second printed circuit board parallel to the main board, (See Fig. 2, Pg. 13). A precalibrated linerized analog output of ±2 volts maximum capable of driving a 1 MA load is available for conventional analog recording and controlling instruments.

The following connections are required between connections J1 and J5:

a. J1-C to J5-14 AC
b. J1-2 to J5-17 AC
c. J1-T to J5-16 Digital Ground
d. J1-15 to J5-U +5 Volts
e. J1-U to J5-10 CONV.
f. J1-V to J5-P Ref.
g. J1-N to J5-S +Pol.

The analog output is available between J5-18 (Hi) and J5-V (Lo).

NOTE: If connection J1-N to J5-S is removed, and J5-S is jumpered to J5-U, an absolute value function is obtained from the 05 option.

5.1.2 Field Calibration Procedures:

<u>MODEL 175</u>

1. Perform needed cabling between J1 lower connector (meter) and J5 (Option Board).

   Install a jumper between TB1-4 and TB1-5 (Fig. 1). Connect a millivolt source to TB1-5 and TB1-6, and set for OMV.

2. Apply AC power listd on meter label. (115 VAC or 230 VAC). The analog output should be zero and a zero reading should be displayed with polarity sign toggling. Adjust R19 on option board for zero voltage between J5 pin 18 and J5 pin V if necessary. (Drawing No. 06526).

3. To calibrate positive polarity, open the thermocouple input and the meter will display its positive overload set point. (This set point is internally programmed and will vary with range and type of meter.). Adjust R5 until the analog output in millivolts corresponds to the flashing displayed reading. (Drawing No. 06526).

4. To calibrate the negative polarity of the analog output option, disconnect power and remove the wire attached to J5 pin S. Short pin S to pin 16 on J5. Apply power and adjust R6 until the analog output in millivolts corresponds to the flashing displayed reading. Ignore displayed polarity on meter. (Drawing No. 06526).

5. Disconnect power.

6. Remove ground jumper from J5 pin S to pin 16 and reconnect loose wire disconnected in Step 4.

7. Reassemble meter and connect thermocouple. With thermocouple at ice point, adjust °C meters for a toggling polarity sign. For °F meters adjust for a reading of +31.5°F (example 31 toggling 32). Zero Pot R 46 Shown on Pg. 20 figure 4.

5.2 DIGITAL CONTROLLER (Option 06)

SPECIFICATIONS

I.. Power Required: 5V @ 60MA from basic meter.
Accuracy of Switching Point: Same as basic meter.
Outputs: FORM C relay contact rated @ 2 AMPS 28 VDC
or 1 AMP @ 115 VAC
ALARM - 1 TTL load.
-POLARITY - 1 TTL load.
OL/Test - 5 TTL loads
Hi ALARM - 2 TTL loads
Lo ALARM - 2 TTL loads
RESET - 2 TTL loads

Inputs: +5 Volts @ 60 MA
12 BCD BITS - 1 TTL load
POLARITY - 2 TTL loads
EXTERNAL RELAY CONTROL - 1 TTL load
EXTERNAL RESET - 2 TTL loads
ALARM ZONE - 2 TTL loads
LATCH - 2 TTL loads
COMP - 1 TTL load

II. Description.

The 06 option is a two state digital controller or alarm which accepts up to 4 digits of BCD with polarity. Its outputs are a Form C relay, a TTL output, and a front panel L.E.D. which flashes when the meter is reading in the alarm zone. (The alarm zone can be above or below any selected point.) The controller outputs go true whenever the meter reading is in the alarm zone; and reset as soon as the meter reading returns to the operating zone. For alarm applications, the outputs may be set to latch true whenever the meter reading enters the alarm zone and remain true even though the meter reading has returned to the operating zone. It may be reset either externally or by pressing the front panel button.

The TTL alarm output is HI when the alarm is true. The Form C relay contacts can be true when the alarm is true or can be externally controlled. The front panel L.E.D flashes when the alarm is true. It can be made to go on continuously or inhibited altogether. Pressing the front panel button causes the switching point to be displayed on the meter, and resets the alarm if latching operation is being used. It also inhibits the alarm output for about 1 second after the button has been released.

III. Required Connections.

(J1 is the bottom connector on the Model 175 or 250; J5 is the upper connector on the meter, used to make all connections to the 05/06 option.) See Pg. 13, Fig. 2.

WARNING: Disconnect A.C. power from meter before doing any wiring!

A. The following connections must be permanently wired for proper operation of an 06 option:

1.	(+5V)*	J5-U	to	J1-15
2.	(GND)*	J5-16	to	J1-T
3.	(REF)*	J5-P	to	J1-V
4.	(CONV)*	J5-10	to	J1-U
5.	(SIG)	J5-12	to	J1-6
6.	(OL)	J5-R	to	J1-S
7.	(COMP)	J5-13	to	J1-5

* Required either 05 or 06 or Both.

B. The following connections vary according to your application:

1. Switching Point: Those BCD Bits which are Hi (Positive true logic) for the desired switching point must be wired to any of the following Pins on J5: 1, A, 2, B, 3, C, 4, D, 5, E, 6 or 7.

A. Wire length must be kept under 6 inches for proper meter operation. (See D below).

B. For example: A switching point of 873 requires connecting the 800, 40, 20, 10, 2 and 1 Bits. All other BCD Bits on J5 should be left open, or connected to J5 Pin U through a single 10K resistor.

C. For applications where the operator must change the switching poing, an external BCD thumbwheel switch can be connected between the BCD outputs and the controller inputs.

D. If wire lengths greater than 6 inches total are needed, a 100 Ohms, 1/8 Watt resistor may be used at J1 in series with each BCD Bit.

C. TABLE - PIN ASSIGNMENTS FOR 05 AND 06 OPTIONS - CONNECTOR J5

Function	Pin	Function	Pin
BCD Input	A	BCD Input	1
BCD Input	B	BCD Input	2
BCD Input	C	BCD Input	3
BCD Input	D	BCD Input	4
BCD Input	E	BCD Input	5
-Pol Output	F	BCD Input	6
Pol Bit In	H	BCD Input	7
Relay Common	J	Hi Pulse	8
Relay N.C.	K	Relay N.O.	9
Latch	L	$\overline{\text{Conv}}$**	10
Alarm Zone	M	Low Pulse	11
Alarm Output	N	Signal	12
Ref Input**	P	Comp.	13
$\overline{\text{OL}}$/Test	R	ACV for 05*	14
+Pol In	S	Reset	15
Ext Relay Control	T	Power GND**	16
+5 Bolts Power In**	U	ACV For 05*	17
Analog Output (LO)*	V	Analog Output (HI)*	18

*05 Only
**05 and 06

IV Polarity:

A. For a positive polarity switching point connect J5 pin S and J5 pin H to J1 pin N.

B. For a negative polarity switching point, jumper J5 pin H to J5 pin F. Also connect J5 pin S to J1 pin N.

C. For a switching point which ignores polarity (absolute value) connect J5 pin H to J5 pin U. (If your meter has an 05 option also; connecting J5 pin H to J1 pin N will allow the 05 to function with normal polarity, while the 06 functions with absolute value.)

V Alarm Zone:

A. For a HI alarm zone: (The alarm is true for all meter readings equal to or greater than the switching point.) Connect J5 pin M (ALARM ZONE) to J5 pin 8 (HI).

B. For a LO alarm zone: (The alarm is true for all meter readings less than the switching point.) Connect J5 pin M (alarm zone) to J5 pin 11 (LO).

VI Latch:

A. LATCHING OPERATION:

If it is desirable for an alarm condition to remain true after the meter reading has returned from the alarm zone to the operating zone; connect J5 pin L (Latch) to J5 pin 15 (Reset). This provides a reset from the front panel button. This reset lasts about 1 second after the button is released. The meter may be reset externally by connecting J5 pin L momentarily to ground (1 TTL load) (A 27K pull up to +5V is necessary and is provided internally at J5 pin 15).

B. CONTROLLER OPERATION:

If it is desirable that the alarm reset as soon as the meter reading returns from the alarm zone to the operating zone; make the connection specified below:

1. If the alarm zone is HI; connect J5 pin L (Latch) to J5 pin 11 (Lo).

2. If the alarm zone is LO; connect J5 pin L (Latch) to J5 pin 8 (Hi).

VII OUTPUTS:

A. L.E.D. on the front panel will flash when the alarm is true. No connections are required. If it is desirable that the front panel L.E.D. not flash when the alarm is true, cut the wire from J5 pin 12 to J1 pin 6. This will cause the L.E.D. simply to go on in an alarm true state. The L.E.D. may be inhibited entirely by connecting J5 pin 12 to J5 pin 16 (J1 pin 6 must be left open if this is done).

B. The alarm output (J5 pin N) can source 1.5 TTL loads or sink 9.9 TTL loads. It is HI when the alarm is true. (If additional source capability is desired, a 3.3K pull up can be added to J5 pin 15. This will allow the alarm output to source or sink 9 TTL loads.)

C. The relay (Form C contacts) is driven through J5 pin T (@ 1 TTL load): to use the relay as an alarm indicator or to controller; connect J5 pin T to J5 pin N.

1. J5 pin J is connected to J5 pin 9 when the alarm is true (J5 pin T HI).

2. J5 pin J is connected to J5 pin K when the alarm is false.

3. The relay contacts are rated at 2 amps, 28 volts D.C. or 1 amp, at 115 volts A.C.

4. Care must be taken when using the relay to avoid coupling noise into the meter or 06 option.

VIII Testing and Operation.

After the 06 Option has been wired per Section II; and the 05 Option, if any, has also been wired, apply power to the meter. An input in the normal operating range should be applied to the meter. The meter reading should be normal.

Press the front panel button. The switching point should be displayed. Release the button. After at least 1 second, apply an input in the alarm zone (avoid overloading the meter). The outputs should go true, causing a contact closure of the relay. Continuity will exist between J5-J and J5-9. When the meter is returned to the operating range the outputs should return to a false condition causing the relay to change state giving continuity between J5-J and J5-K. If the unit is wired for latching operation, press the front panel button momentarily to reset the relay.

The meter is now ready for use in your application. When the meter reading is in the operating range, the meter reads normally and the outputs are false. When meter readings enter the alarm zone; the front panel L.E.D. begins flashing (unless inhibited) and the alarm goes true. Pressing the front panel button recalls the switching point, which is displayed, and also resets the alarm if latching operation is being used. The alarmis inhibited for about 1 second after it is released.

NOTE: False alarms are possible if the meter goes into overload, since meter "readings" are not valid in overload, it is recommended that you avoid overloading your meter.

APPENDIX G

COMPARISON OF BREATHING IN AND BREATHING OUT DATA

APPENDIX TABLE G-1

COMPARISON OF BREATHING IN AND BREATHING OUT DATA

Chemical	Date		Time	Δ ACF In	Δ ACF Out
Isopropanol	From	4/13/78	0800		
	To	4/13/78	1430		3,436
	From	4/13/78	1430		
	To	4/14/78	0645	2,937	
	From	4/14/78	0645		
	To	4/14/78	1600		4,215
Ethanol	From	4/18/78	0600		
	To	4/18/78	1400		1,325
	From	4/18/78	1400		
	To	4/19/78	0630	1,100	
	From	4/19/78	0630		
	To	4/19/78	1440		1,217
	From	4/19/78	1440		
	To	4/20/78	0630	1,553	
	From	4/20/78	0630		
	To	4/20/78	1530		1,432
Acetic Acid	From	4/20/78	0700		
	To	4/20/78	1200		7,580
	From	4/20/78	1200		
	To	4/20/78	1315	1,219	

APPENDIX TABLE G-1 (Continued)

COMPARISON OF BREATHING IN AND BREATHING OUT DATA

Chemical		Date	Time	Δ ACF In	Δ ACF Out
Acetic Acid (Cont'd)	From	4/20/78	1315		
	To	4/20/78	1600		1,677
	From	4/20/78	1600		
	To	4/21/78	0615	10,884	
	From	4/21/78	0615		
	To	4/21/78	1200		18,568
	From	4/21/78	1200		
	To	4/21/78	1530	1,222	
Ethyl Benzene	From	5/9/78	0900		
	To	5/9/78	1500		2,460
	From	5/9/78	1500		
	To	5/10/78	0700	4,801	
	From	5/10/78	0700		
	To	5/10/78	1430		3,797
Cyclohexane 1)	From	5/17/78	0700		
	To	5/17/78	1500		3,169
	From	5/17/78	1500		
	To	5/18/78	0730	860	
	From	5/18/78	0730		
	To	5/18/78	1330		8,253

1) It should be noted that a greater Δ ACF out occurred in the formaldehyde and cyclohexane tanks because these are heated, compared to the other tanks which were at ambient temperature.

APPENDIX TABLE G-1 (Continued)

COMPARISON OF BREATHING IN AND BREATHING OUT DATA

Chemical		Date	Time	Δ ACF In	Δ ACF Out
Formaldehyde [1)]	From	4/26/78	0630		
	To	4/26/78	2130		4,081
	From	4/26/78	2130		
	To	4/27/78	0800	125	
	From	4/27/78	0800		
	To	4/27/78	1500		2,350
	From	4/27/78	1500		
	To	4/28/78	0815	194	
	From	4/28/78	0815		
	To	4/28/78	1400		4,215