

AIR POLLUTION EMISSION TEST

PETROLEUM REFINERY
FUGITIVE EMISSIONS

Refinery "E"
Gulf-Coast U.S.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Emission Measurement Branch
Research Triangle Park, North Carolina

Emission Test Report

Miscellaneous Refinery Equipment VOC Sources

at

Refinery "E", Gulf Coast U.S.

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, ESED, OAQPS, EPA

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I. Introduction

The Environmental Protection Agency is preparing a series of documents to describe reasonable available control technology (RACT) for use by the States in developing implementation plans for control of volatile organic compound (VOC) emissions. Leaks from refinery equipment (pumps, valves, drains, etc.) are a potentially significant source of VOC emissions and therefore a study was begun to determine reasonable control techniques for this type source.

Testing was conducted by Emission Standards and Engineering Division, OAQPS, EPA personnel at a Gulf Coast U.S. refinery (designated as "Refinery E" in a study conducted by Radian Corporation for the Environmental Protection Agency⁽¹⁾) during November 28-30, 1977. The purpose of this test was to collect emission data for use in formulating the recommended level of control.

A portable hydrocarbon analyzer was used to determine the localized VOC concentration near individual sources and the ambient VOC levels in the unit processing areas. In addition to the survey work performed in close proximity to individual sources, the ambient VOC concentrations along the refinery perimeter were measured and recorded.

- (1) "Emission Factors and Frequency of Leak Occurrence for Fittings in Refinery Process Units", EPA Report No. EPA-600/2-79-044, February 1979.

II. Summary of Results

The refinery fenceline surveys were used to generally establish a background ambient hydrocarbon concentration. The records of these surveys are included in the Appendix. During the surveys, several elevated VOC concentrations were observed, however, no attempt was made to locate the specific location and cause for the indicated increases.

Walkthrough surveys were conducted in the aromatic extraction unit and the saturated gas plant. The results from the aromatics extraction unit survey cannot be easily evaluated since these are numerous elevated ambient concentrations, generally up to 60-70 ppm.

The saturated gas plant results generally show increased ambient concentrations in the area where a number of individual components were found to be leaking. Also, in those sections where no leaks were found, generally no ambient increases were observed.

The results of individual component surveys at 5 cm from the potential leak source are summarized for all units tested in Table II-1. Summaries for each individual unit are presented in Tables II-2 to II-3: In each of the summaries, the number of components that had localized VOC concentration readings in each of the ranges indicated is given for types of equipment and all equipment combined. The number of readings in each range is divided by the total number of measurements to determine an occurrence frequency distribution.

The field data sheets are included in the Appendix.

Table II-1 - Summary: Numbers on Components in All Units Tested vs. Volatile Organic Compound Emission-Concentration Ranges (Refinery E)

VOC Emission Concentration (ppm)	Number of Components Emitting VOC at Designated Concentrations						Open-Ended Valves	Pump Seals	
	Pump Seals	Compressor Seals	Drains	Block Valves	Control Valves	Block & Control Valves		Off ^a	On ^b
0 - 100	30	1	8	80	54	134	1	17	13
101 - 1000	6	0	10	30	5	35	0	3	3
1001 - 10,000	2	0	1	13	1	14	0	0	2
Over 10,000	5	0	5	19	1	20	2	2	3
<u>Total</u>	43	1	24	142	61	203	3	22	21
^w % of components Emitting VOC Greater than 100 ppm	30	0	67	44	11	34	67	23	38
% of Components Emitting VOC Greater than 1000 ppm	16	0	25	23	3	17	67	9	24

Total Components

0 - 100	174
101 - 1000	51
1001 - 10,000	17
Over 10,000	32

Total 274

% of Components
with VOC Greater
than 100 ppm 36

% of Components
with VOC Greater
than 1000 ppm 18

Footnotes:

- ^a Pumps not operating
- ^b Pumps operating

Table II-2 - Numbers of Components in Saturated Gas Plant vs. Volatile Organic Compound Emission-Concentration Ranges (Refinery E)

VOC Emission Concentration (ppm)	Number of Components Emitting VOC at Designated Concentrations							<u>Off^a</u> / <u>On^b</u>
	Seals	Valves	Control Valves	Drains	Bleed Valves	Compressor Seals		
0 - 100	8	30	27	4	0	1	4	4
101 - 1000	4	19	3	8	0	0	2	2
1001 - 10,000	1	9	1	1	0	0	0	1
Over 10,000	4	18	1	5	2	0	2	2
<u>Total</u>	17	76	32	18	2	1	8	9
% of components Emitting VOC Greater than 100 ppm	52	61	16	78	100	0	50	56
% of Components Emitting VOC Greater than 1000 ppm	29	36	6	33	100	0	25	33
<u>Total Components</u>								
0 - 100				70				
101 - 1000				34				
1001 - 10,000				12				
Over 10,000				30				
<u>Total</u>				146				
% of Components with VOC Greater than 100 ppm				52				
% of Components with VOC Greater than 1000 ppm				29				

Footnotes:

^a Pumps not operating

^b Pumps operating

Table II-3 - Numbers of Components in Aromatic Extraction (BTX) Unit vs.
Volatile Organic Compound Emission-Concentration Ranges
(Refinery E)

VOC Emission Concentration (ppm)	Number of Components Emitting VOC at Designated Concentrations					
	Seals	Valves	Control Valves	Drains	Seals	Off ^a / On ^b
0 - 100	22	50	22	4	13	9
101 - 1000	2	11	2	2	1	1
1001 - 10,000	1	4	0	0	0	1
Over 10,000	1	1	0	0	0	1
<u>Total</u>	26	66	24	6	14	12
% of components Emitting VOC Greater than 100 ppm	15	24	8	33	7	25
% of Components Emitting VOC Greater than 1000 ppm	8	8	0	0	0	17
<u>Total Components</u>						
0 - 100		98				
101 - 1000		17				
1001 - 10,000		5				
Over 10,000		2				
<u>Total</u>		122				
% of Components with VOC Greater than 100 ppm		20				
% of Components with VOC Greater than 1000 ppm		6				

Footnotes:

^a Pumps not operating

^b Pumps operating

III. Process Description

Refinery E is a fairly large integrated refinery located in the U.S. Gulf Coast area. It is a recently built grass-roots refinery and is owned by one of the major oil companies.

Two units were surveyed during the test period; an aromatics recovery unit and a saturated gas plant. Both units were operating normally during testing.

IV. Sampling and Analytical Procedures

The analysis instrument used at these facilities was a Century Systems Corporation OVA-108 organic vapor analyzer.⁽¹⁾ The analyzer was calibrated with methane by the local instrument distributor immediately prior to the beginning of the test program.

The refinery fence-line surveys were conducted by placing the instrument probe outside an automobile window and driving around the refinery perimeter at speeds of 10-15 mph. VOC concentrations and their location were recorded on a refinery plot plan and a portable strip chart recorder.

Walkthrough surveys were conducted by first selecting a survey path through the process unit so that all ground level pumps and control valves could be surveyed at an upwind and downwind distance of about 1 meter. Reference points to indicate location were noted on a unit plot plan. Then the path was walked slowly. The instrument meter was observed during the survey, and the VOC concentrations were recorded on a portable chart recorder. The prevailing wind direction was recorded on a unit plot plan for each walkthrough.

The cooling tower was evaluated by recording hydrocarbon concentration around the base of the tower, around the top railing, and in the fan exhaust vents.

Wastewater separators were evaluated by walking around the liquid pit area with the instrument probe positioned about 0.5 meter above ground level and recording the concentration.

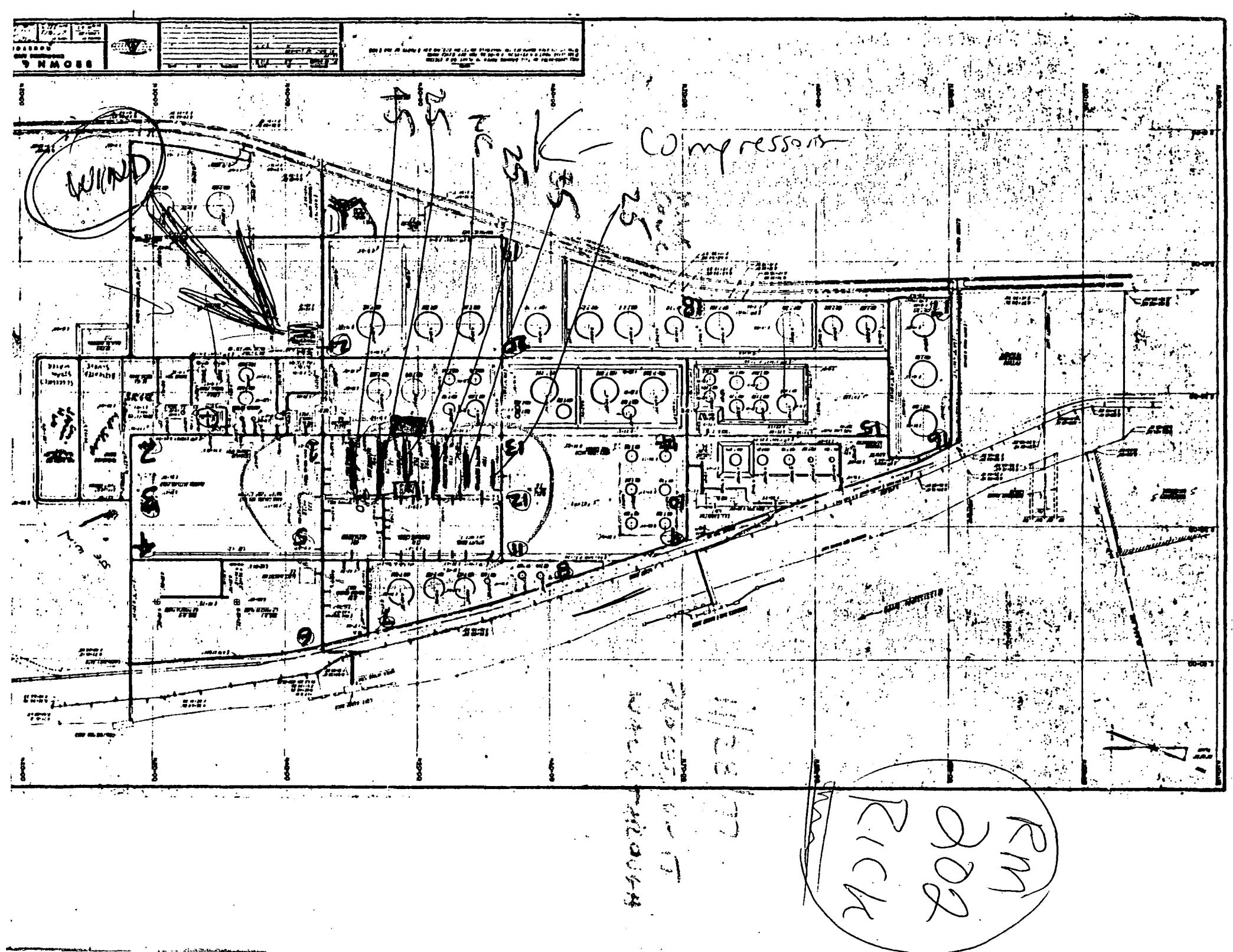
The height above water level at this probe location varied due to the liquid level and is noted on the respective data sheets. Any pumps and valves associated with waste water separators were evaluated by the procedures described below.

Individual component surveys were conducted by placing the probe inlet at a distance of 5 cm from each potential leak source and traversing the periphery. The largest reading observed was recorded.

(1) Mention of a specific product or trade name does not constitute endorsement by the Environmental Protection Agency.

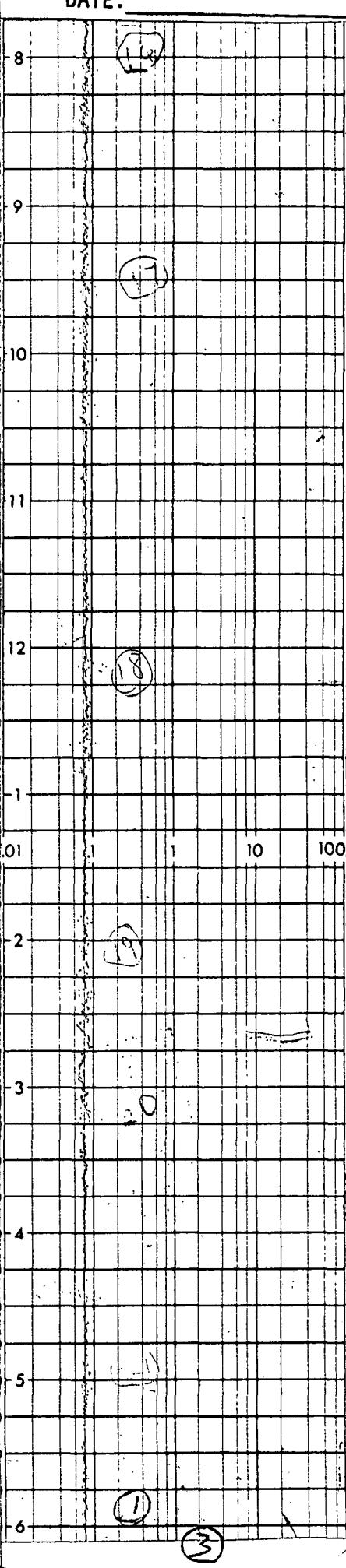
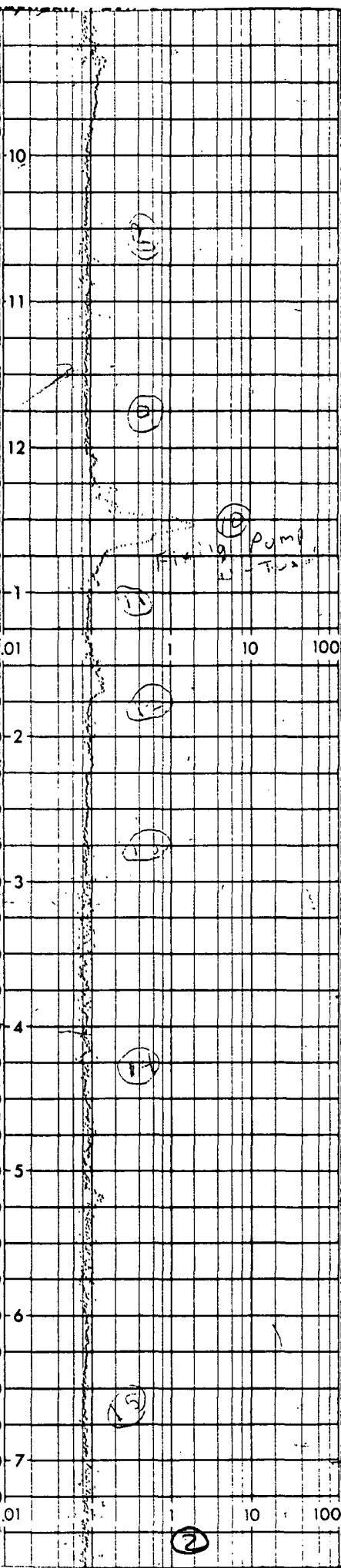
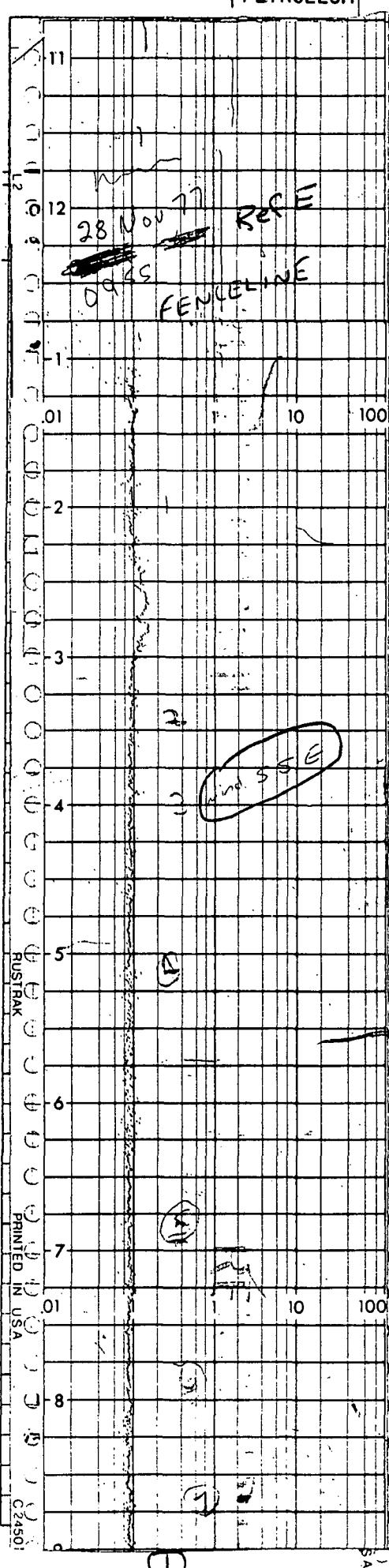
APPENDIX A

FIELD DATA SHEETS

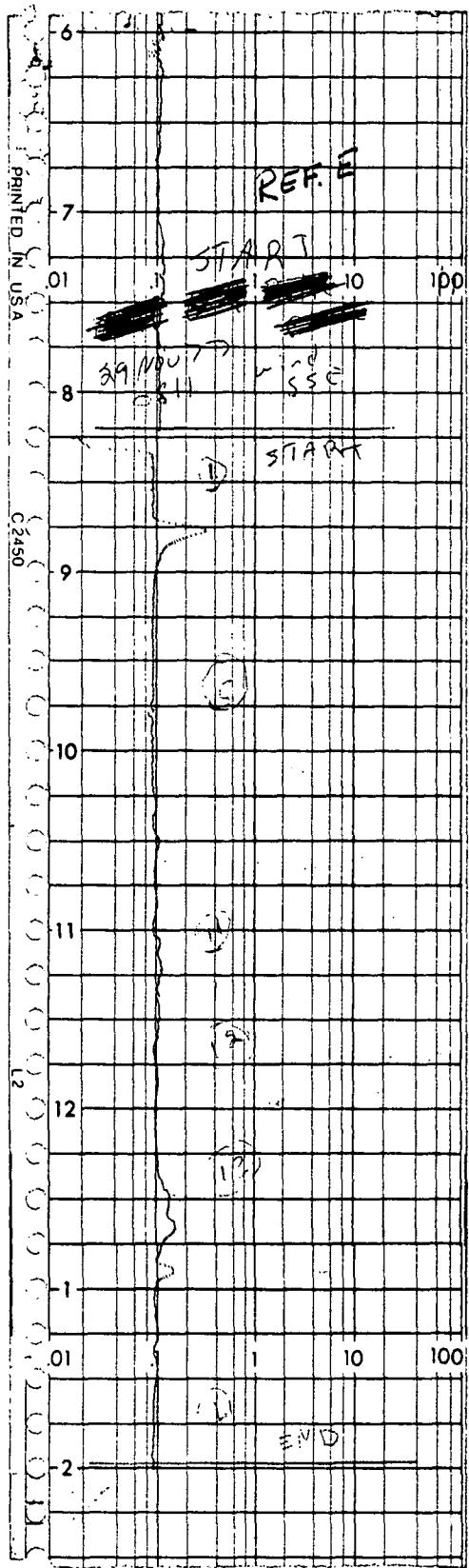


PETROLEUM

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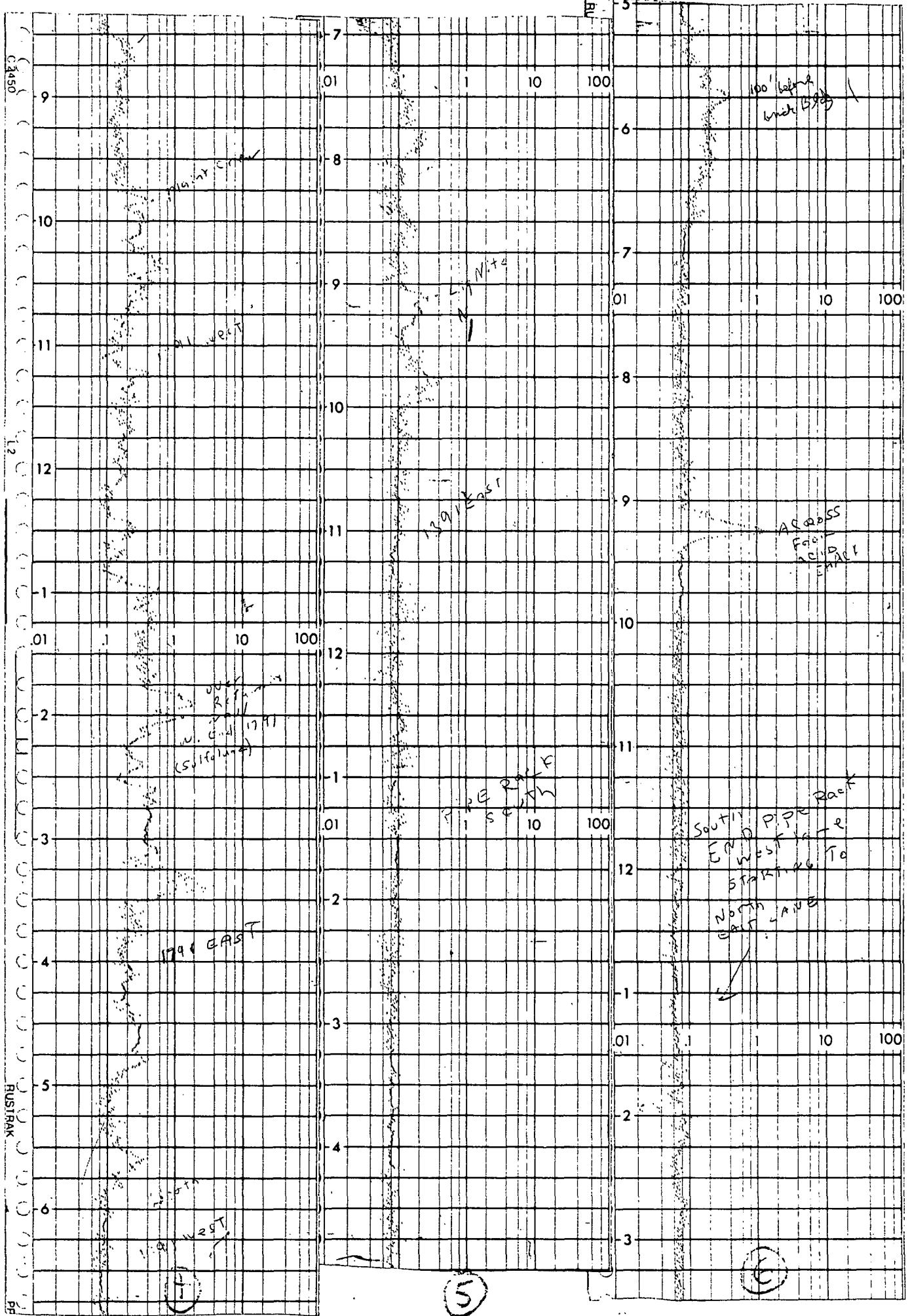
PROCESS UNIT
DRIVE GEARBOX

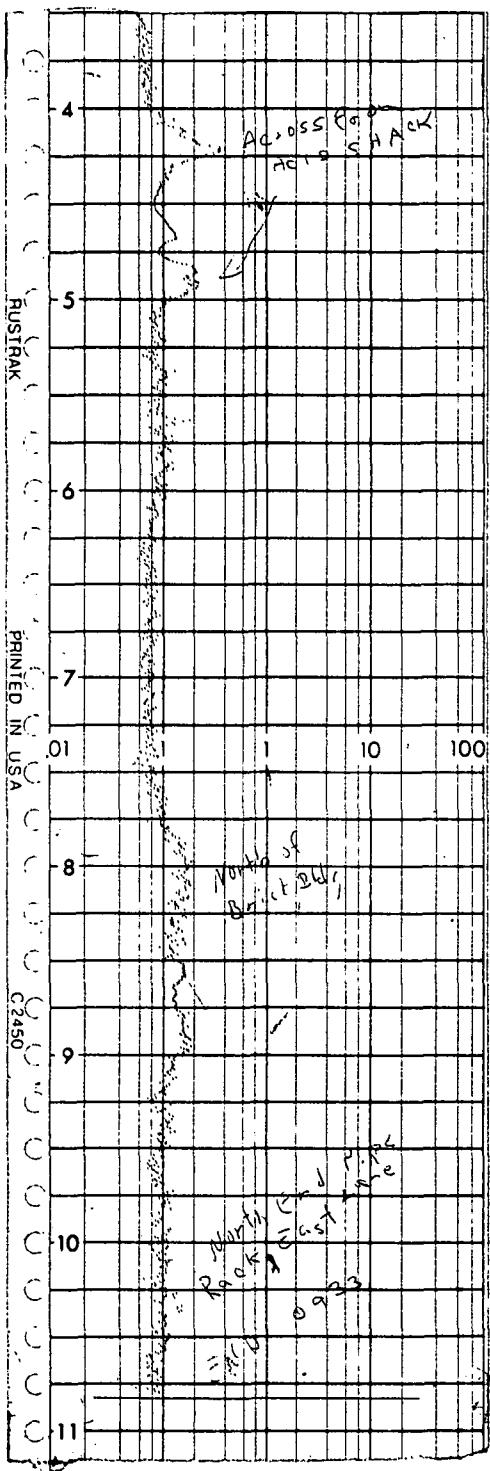


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(1)

(2)





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PETROLEUM REFINERY LEAK DETECTION

DATE: 11/11/77

Refinery:

Instrument:

Unit:

Operator:

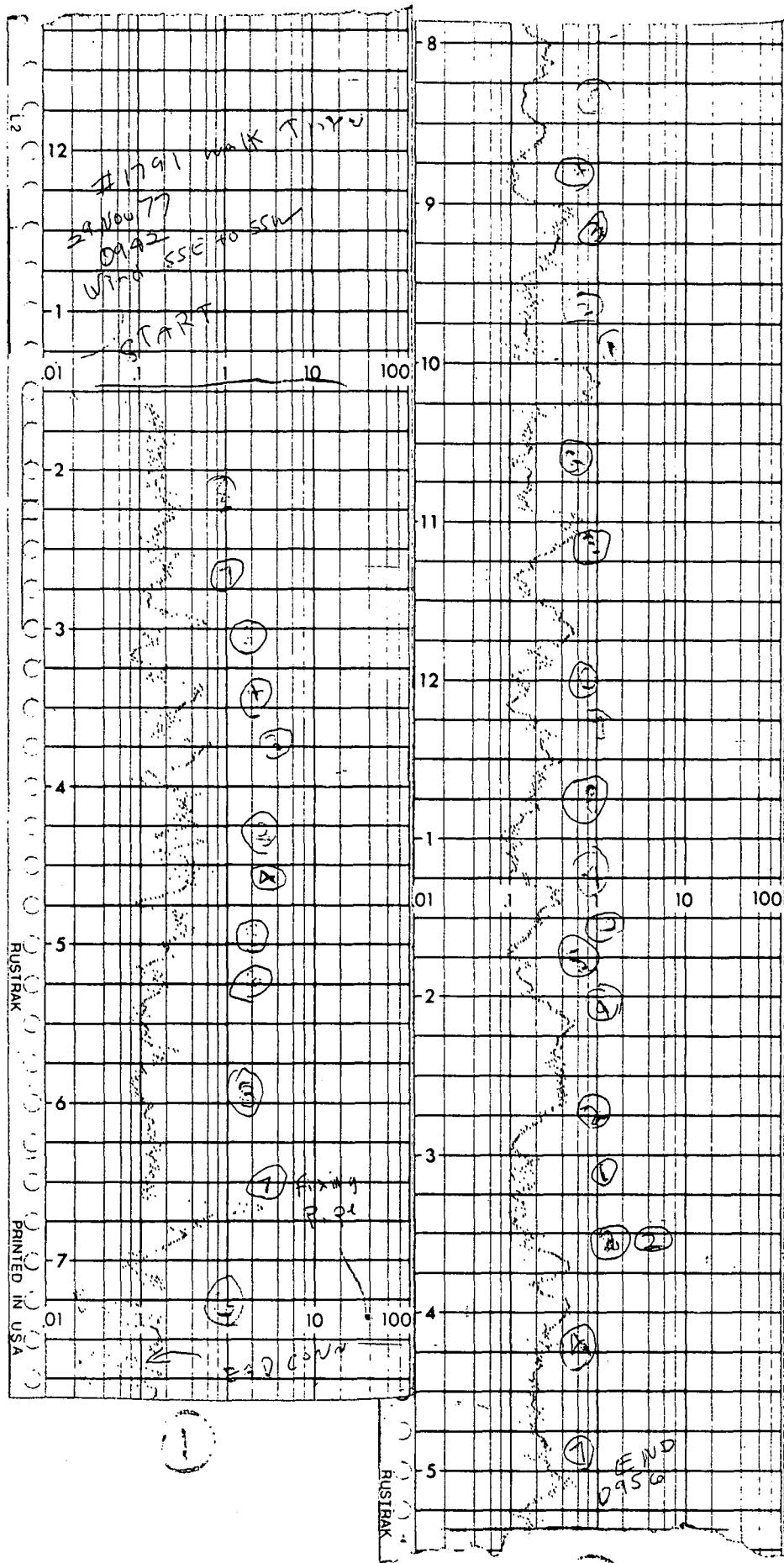
(UNIT FEEDLINE)

SQUARE 5 X 5 TO THE INCH AS-0002-60

GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York
Printed in U.S.A.

1791 WALKTHROUGH

11/29/79



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(2)

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PRINTED IN USA

RUSTRAK

PETROLEUM REFINERY LEAK DETECTION

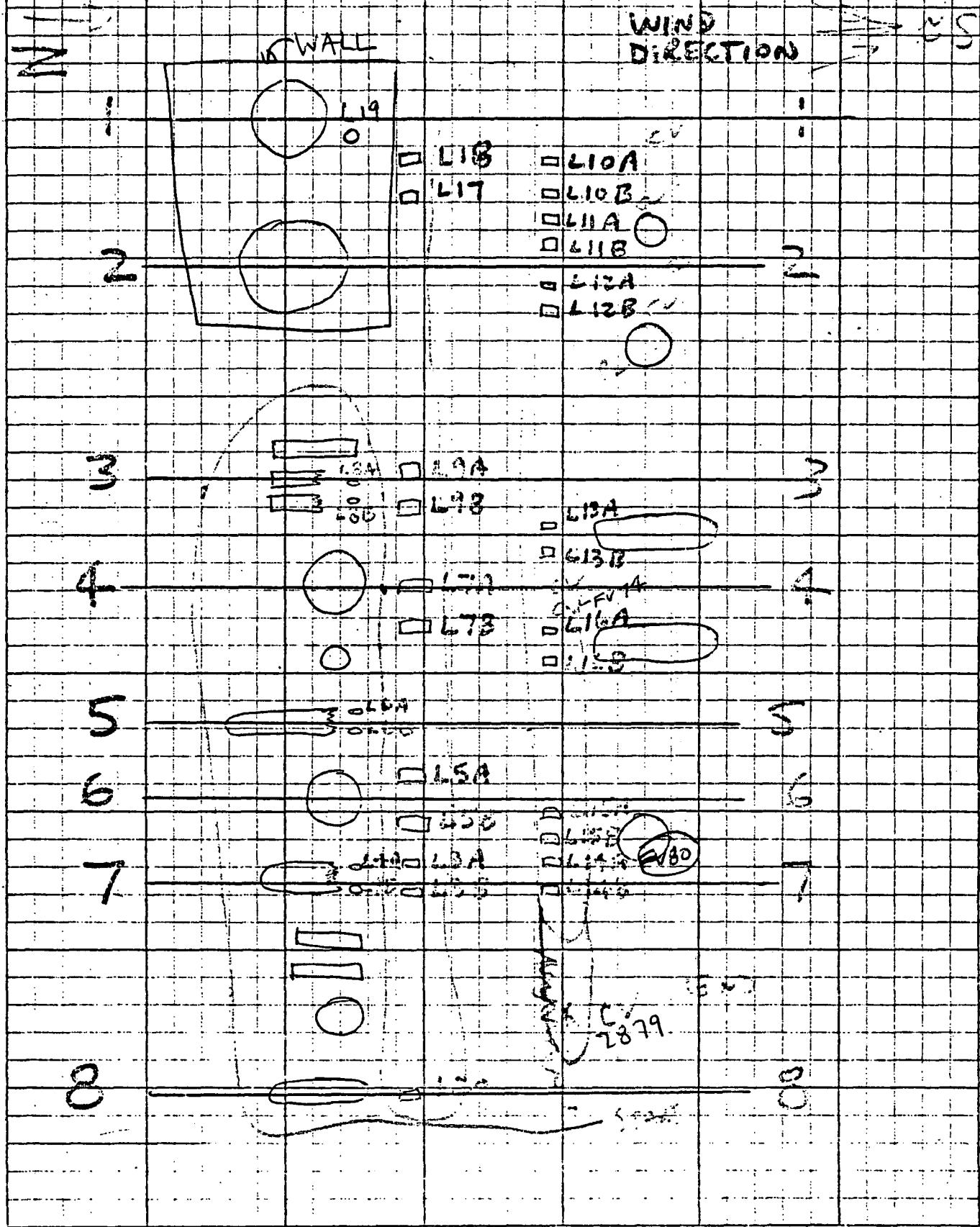
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Refinery: REEVE

Instrument:

Unit: 2 COMBUSTION EXTRACTION
UNIT NO. 1741

Operator:



PETROLEUM REFINERY LEAK DETECTION

DATE:

Refinery: CSEB 2.

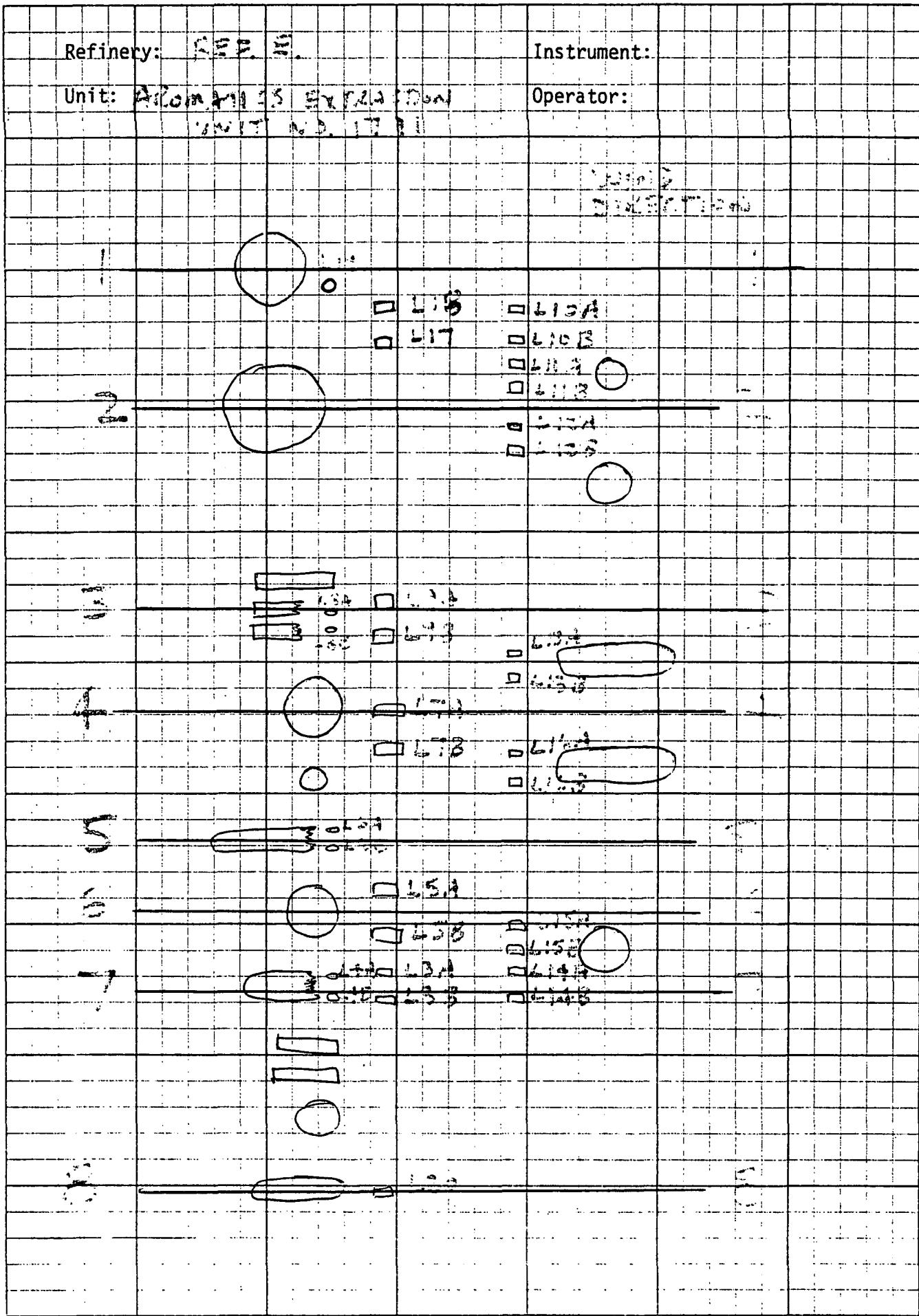
Instrument:

Unit: Aeronautics Extra Credit
SNT N.D. 178 P.I.

Operator:

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SHAPY PAPER GRAPHIC CONTROLS CORPORATION Built-in, New York
Printed in U.S.A.



PETROLEUM REFINERY LEAK DETECTION

DATE: 11/29/77

Refinery: E

Instrument: DVT

Unit: AROMATICS EXTRACTION - #1791 Operator: KCIT/FC

Component / Number	Seat / 12	Valve / 13	DRAIN (most CLOSING) VALVE	BYPASS VALVE	PRODUCT
L 19					
L 18					
L 17					
OFF L 10 A	NC	NC NC NC NC			
ON L 10 B	NC	MC MC NC NC			RAFF WASH RECYCLE
ON L 11 A	NC	MC NC NC NC			
OFF L 11 B	NC	NC NC NC NC			RAFF RECYCLE
ON L 12 A	2000	NC MC 400			
OFF L 12 B	NC	325 NC 700			RAFF SPL. COL BOTT
L 8 A					
L 8 B					
L 9 A					
L 9 B					
L 7 A					
L 7 B					
OFF L 13 A	NC	110 >10,000			
ON L 13 B	NC	500 750			RAFF SPLITTER COL OFF
OFF L 16 A	60	90 NC			
ON L 16 B	NC	70 NC			BT COL REFUX
L 6 A					
L 6 B					
L 5 A					
L 5 B					
L 3 A					
L 3 B					
L 4 A					
L 4 B					
ON L 15 A	190	150 325			
OFF L 15 B	70	1-110 1-130			BT COL BOTTOMS (CLOSING)
OFF L 14 A	NC	1-450 1-NC			
ON L 14 B	>10,000	1-1500 1-NC			BT COL SIDE CUT OPERATOR NC KU TRANSFER TOP OFF
OFF L 20	700	2- NC			

DRAINS TIED INTO CLOSED SYSTEM

(ALS. 1T92)

/1 P - Pump, C - Compressor, CV - Control Valve, PRV - Pressure Relief Valve

/2 M - Mechanical, P - Packed, R - Reciprocating

/3 B - Block, G - Gate, P - Plug

PETROLEUM REFINERY LEAK DETECTION

DATE: 11/29/77

11/30/77

Refinery: E

Instrument: DVA

Unit: AROMATICS EXTRACTION - #1791 Operator: KGH/FCC

Component / Number	Seal	Valve ^{1/3}	DRAIN (min) CLOSING	BYPASS VALVE	PRODUCT
OFF L 19	NC				SOLVENT SUMP PUMP
OFF L 18	MC	NC NC			WET SOLVENT
ON L 17	NC	NC NC			SOLVENT TRAVER
OFF L 10 A	NC	NC NC NC NC			RATE WASH RECIRC
ON L 10 B	NC	MC MC NC NC			
ON L 11 A	NC	NC NC NC			RAFF RECYCLE
OFF L 11 B	NC	NC NC NC			
ON L 12 A	2000	NC NC 400			
OFF L 12 B	NC	325 NC 700			RAFF SPL. CO. BOTT
L 8 A	NO SEAL - ENCLOSED				
L 8 B					REMOVED SULF. WATER WAS H
ON L 9 A	70	NC NC			
OFF L 9 B	60	NC NC			REC. COL. REFLUX
ON L 7 A	NC	90 NC			
OFF L 7 B	60	NC NC			LEAN SOLVENT
OFF L 13 A	NC	110 >10,000			
ON L 13 B	NC	500 750			RAFF SPLITTER 100 SH
OFF L 16 A	60	90 NC			
ON L 16 B	NC	70 NC			BT COL. REFLUX
L 6 A	ENCLOSED - NO SEAL				WATER STRIPPER IN. BOTT.
L 6 B					(HC & SULFOLANE)
ON L 5 A	NC	NC			
OFF L 5 B	NC	NC			STRIPPER R. TURNS
ON L 3 A	NC	NC NC NC NC			
OFF L 3 B	NC	NC NC NC NC			EXT. COL. REF
L 4 A	ENCLOSED - NO SEAL - WATER SERVICE - (REMOVED)				
L 4 B	70				& SULFOLANE
ON L 11 A	190	150 325			
OFF L 15 B	70	1-110 1-130			BT COL. B. TURNS
OFF L 14 A	NC	1-450 1-NC			(REMOVED)
ON L 14 B	>10,000	1-1500 1-NC			BT COL. SIDE C. T
OFF L 20	700	2- NC			OPR. - WASH, BY NC K0 TRANSFER (REMOVED)
					100 ft + off
DRAINS TIED INTO (CLOSED) SYSTEM					
(ALS 1792)					
1/1 P - Pump, C - Compressor, CV - Control Valve, PRV - Pressure Relief Valve					
1/2 M - Mechanical, P - Packed, R - Reciprocating					
1/3 B - Block, G - Gate, P - Plug					

PETROLEUM REFINERY LEAK DETECTION

DATE: 11/29/17

Refinery:

Instrument: OVA

Unit: 1791

Operator: KCCH IFC

CONTROL VALUES

Component / Number	VALVE Seat	GATE Valve	1/2	1/3	Drain	Bleed Valve	Other
FV-78	NC	1-1200	1-NC				SLUP
FV-79	NC	1-110	1-NC				SLUP
FV-11	NC			1 NC			EXT REFLUX
FV-1	NC						LT RCF.
LV-7	NC						OH TO RAFF W/W COLUMN
TIC-20	NC						LEAN SOLVENT TO EXT.
FV-81	NC						STEAM
FV-80	NC	1200	NC				BTX
FV-91	250			NC			REFLUX - BT COLUMN
FV-85	—	—					STEAM
FV-74	NC	3000	600				LT RAFF
FV-71	65	475	NC				HVY RAFF
FV-70	NC						RAFF SPL COND
FV-72	NC						REFLUX
TV-65	NC						
PV-64	175	mmhg					
LV-59	NC						
FV-51	NC						
FV-61	NC						
FV-62	NC						

/1 P - Pump, C - Compressor, CV - Control Valve, PRV - Pressure Relief Valve

/2 M - Mechanical, P - Packed, R - Reciprocating

73 B - Block, G - Gate, P - Plug

PETROLEUM REFINERY LEAK DETECTION

DATE: 11/29/17

Refinery: E

Instrument: CVA

Unit: 179

Operator: KCH/JFC

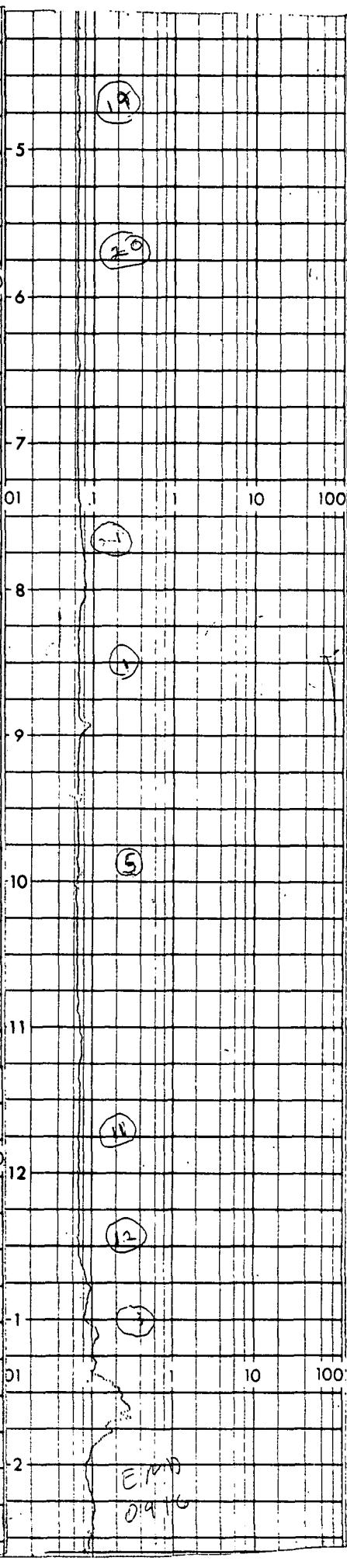
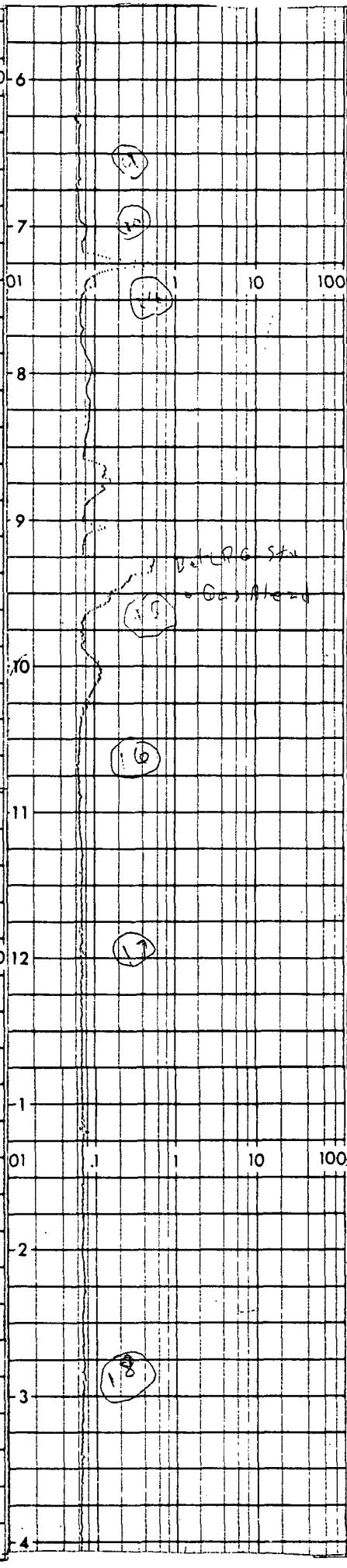
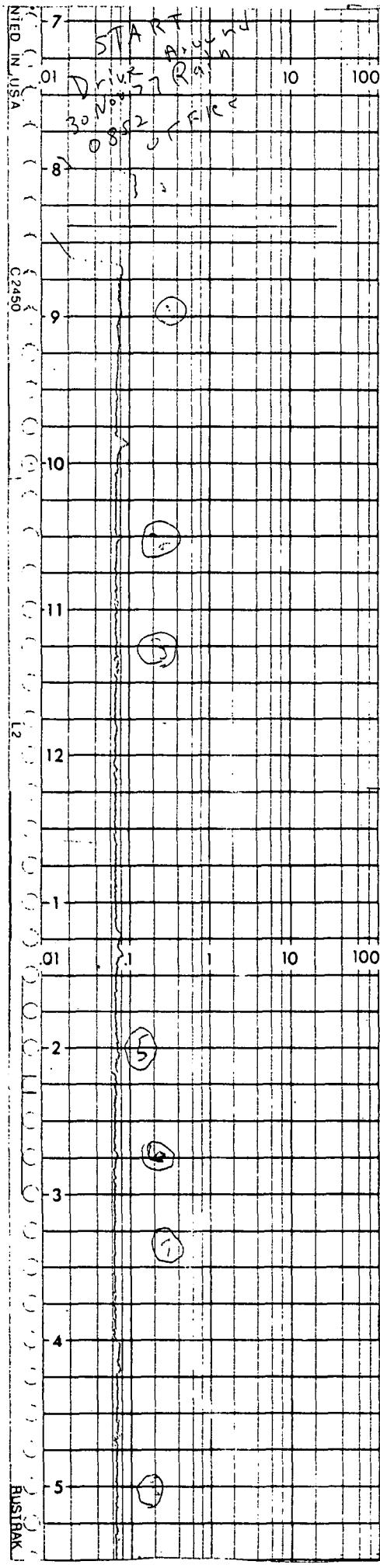
CONTROL VALVES

Component / Number	VALVE Seat 1/2	GATE Valve 1/3	Drain	Bleed Valve	Other
FV-78	NC	-1200	1-NC		SLOP
FV-79	NC	-110	1-NC		SLOP
FV-44	NC		1-NC		EXT REFLUX
FV-1	NC				LT REFLUX
LV-7	NC				CH TO RAFF W/ COLUMN
TIC-20	NC				LEAN SOLVENT TO EXT.
FV-81	NC				STEAM
FV-80	NC	1200	NC		BTX
FV-91	250		NC		REFLUX - BT COLUMN
FV-85	—	—			STEAM
FV-74	NC	3000	60		LT RAFF
FV-71	65	475	NC		HVY RAFF
FV-70	NC				RAFF SPL COND
FV-72	NC				REFLUX
TV-65	NC				
PV-64	175				
LV-59	NC				
FV-51	NC				
FV-61	NC				
FV-62	NC				
LV-16	NC				
FV-21	NC				
FV-92	NC				
FV-28	NC				
FV-22	NC				
FV-76	NC				
FV-52	NC				
FV-29	NC				
TV-98	NC				
TV-93	NC				
					1/30/77
					SOUR WATER??
					RICH SOLVENT
					FAMS(?) TO V-5
					STEAM
					LEAN SOLVENT
					?
					BTX
					STGAM
					STEAM CONDENSER
					STEAM

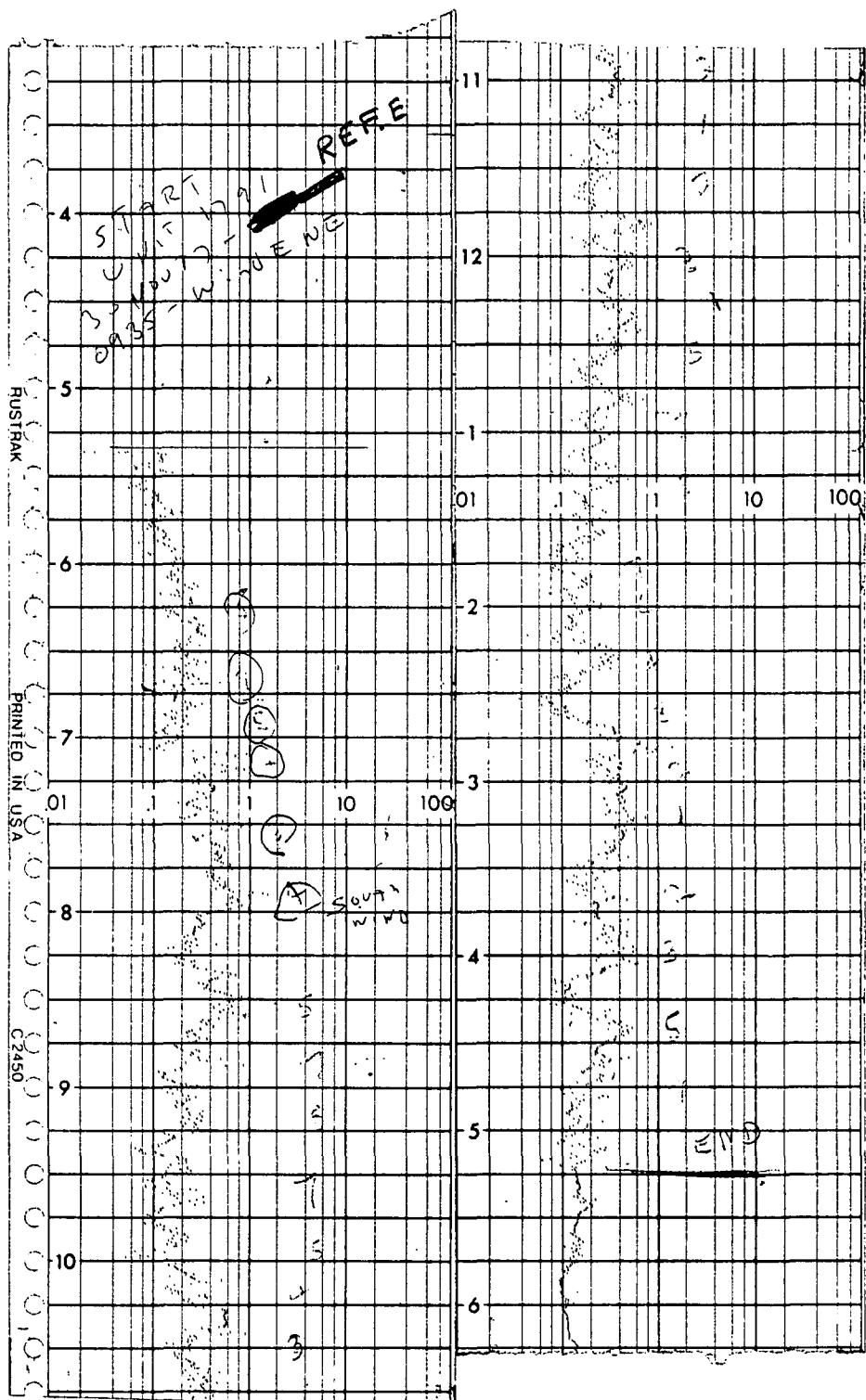
/1 P - Pump, C - Compressor, CV - Control Valve, PRV - Pressure Relief Valve

/2 M - Mechanical, P - Packed, R - Reciprocating

73 B - Block, G - Gate, P - Plug



11/30/77
A. LOMAR GS
SECTION 2



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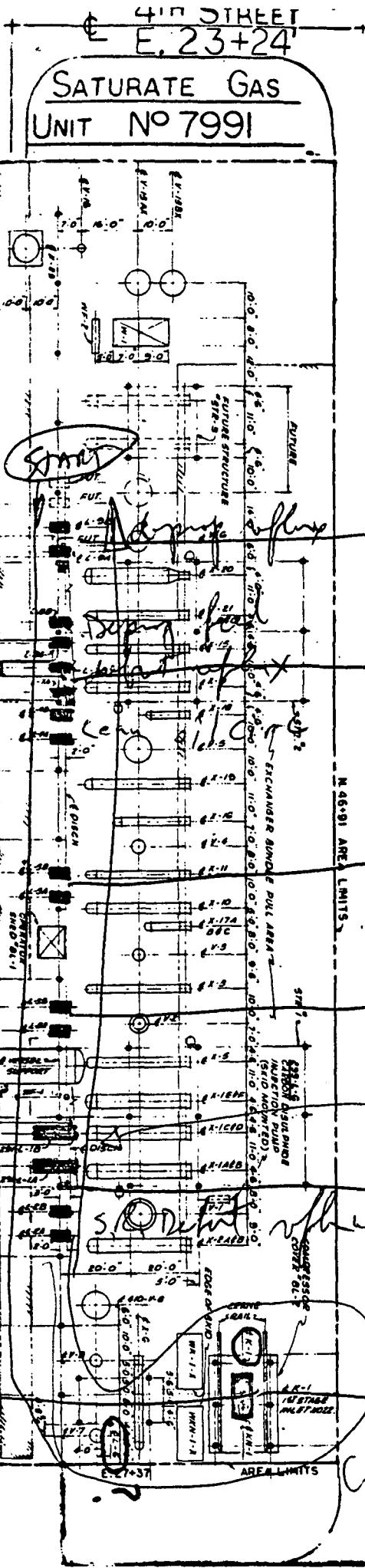
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62	10	10	100
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64	10	10	100
65	10	10	100
66	10	10	100
67	10	10	100
68	10	10	100
69	10	10	100
70	10	10	100
71	10	10	100
72	10	10	100
73	10	10	100
74	10	10	100
75	10	10	100
76	10	10	100
77	10	10	100
78	10	10	100
79	10	10	100
80	10	10	100
81	10	10	100
82	10	10	100
83	10	10	100
84	10	10	100
85	10	10	100
86	10	10	100
87	10	10	100
88	10	10	100
89	10	10	100
90	10	10	100
91	10	10	100
92	10	10	100
93	10	10	100
94	10	10	100
95	10	10	100
96	10	10	100
97	10	10	100
98	10	10	100
99	10	10	100
100	10	10	100

RUSIBAK



PETROLEUM REFINERY LEAK DETECTION

DATE: 11/30/77

Refinery: E

Instrument: OVI-108

Unit: 1991 SAT GAS PLANT

Operator: CC/KCH

	Component / Number	Seal / 1/2	Valve / 3	Drain	Bleed Valve	Other
ON	L-9B	>10,000	>10,000, >10,000	700	>10,000	DETRUP REFLUX
OFF	1-9A	>10,000	>10,000, >10,000	>10,000	>10,000	
CV	PV125	2000 @ packing	anti-sag too high by 5 cm check			PROPANE
	(CV) PV125	>10,000	@ seal - high internal P 5cm -			(DETRUP REFLUX)
CV	FV127	NC	>10,000			
CV	PV128	NC	300	NC		PROVATE TV FLUTTER w/ PROPAGATING
CV	FV133	NC	>10,000			
CV	LV130	NC	>10,000, 5000			BUTANE
CV	TV133	NC	700			HOT OIL DEP. REBOILER
CV	FV124	NC	90			DETRUP FED
ON	L8-B	>10,000	500 >10,000	3500		DETRUP FED
OFF	L8-A	>10,000	1100,7000	>10,000		
OFF	L7-B	600	>10,000, >10,000	250		DEBUT REFLUX
ON	L7-A	7000	>10,000, >10,000	>10,000		
ON	L4-B	300	700 >10,000	800		LEAN OIL CIRC
OFF	L4-A	NC	NC 400	400		
CV	PV83B	475	>10,000, 3,000	250		DEBUT REFLUX
CV	LV90	NC	2000 900			LT. S. R. NITRO
CV	FV82	NC	NC NC			OFFSPEC PROP REBOIL
	FV89	NC	>10,000 (2000)			DETRUP REFLUX
	TV94	NC	IN			HOT OIL (DEBUT REBOILER)
	TV90	NC	NC			HOT OIL
PV	76	NC	>10,000	X		V4 OH (RECYCLING GAS)
FV	74	NC		>10,000		V4 REFLUX
FV	73	700	NC			SO CIRC.
LV	67	NC				SU
PV	72	NC	NC, NC			FUEL GAS (V3 OH)
TV	65	NC	NC NC			RE3 STRIPPER REACTOR
OFF	L5-B	NC	NC NC	NC		SPONGE OIL CIRC
ON	L5-A	NC	NC NC	NC		
	LV61	750	4000, >10,000			
ON	L3B	90	250	600		SPONGER FED
OFF	L3A	150	250, 600	>10,000		
FV	60	NC	150			STR. FED DCRIT B, gas
FV	50	NC	110			STR. FED
GATE VALVE	225	NC	2000			WATER FED

/1 P - Pump, C - Compressor, CV - Control Valve, PRV - Pressure Relief Valve

/2 M - Mechanical, P - Packed, R - Reciprocating

/3 B - Block, G - Gate, P - Plug

MOST BLEED VALVES DIRECTLY INTO DRAIN

PETROLEUM REFINERY LEAK DETECTION

DATE: 11/20/77

Refinery: E

Instrument: UV A - 100

Unit: Gas Plant

Operator: VCCG / PC

Component / Number	Seal / 1/2	Valve / 3	Drain	Bleed Valve	Process Description
ON LIB	NC	NC	700		NAP. FEED
OFF L1-A	NC	MAC	125		REF. FEED
FV 19	NC	NC			DEBUT FEED
FV 37	NC	2500, 500			V10H.
UN L2-B	700	NC 300	150		DEBUT REFLUX
OFF L2-A	NC	NC NC	NC		RUG GAS
PR 80	NC	600, 900			V1 REFLUX
FV 42	150	2000			REBS. LFT
TV 23	NC	150 NC			EVAP OIL
PR 160	NC	NC			RAW GASLINE
L-6	NC				
FV 2	NC	700 NC	NC		
FV 4	PL	NC MC NC			

COMPRESSOR - NC and
LUBRILATE & SUMP OIL VENTED TO ATMOSPHERE (?)

/1 P - Pump, C - Compressor, CV - Control Valve, PRV - Pressure Relief Valve
 /2 M - Mechanical, P - Packed, R - Reciprocating
 /3 B - Block, G - Gate, P - Plug